A Summary of the Water Quality Attainment Grab Sampling Activities Conducted in the Cowichan River Watershed: Summer/Fall 2024

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Cover Photograph: Sandy Cumming, Robertson River. November 19, 2024
Photo Credit: B. Greenway

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A special thank you is extended to the many volunteers and staff representing the public-at-large, project partners including the Cowichan Lake and River Stewardship Society (CLRSS), B.C. Fisheries, Cowichan Valley Regional District (CVRD), Somenos Marsh Wildlife Society, Cowichan Watershed Board (CWB), and ENV who collected water quality samples.

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Field coordination of the project, and the writing of this report were completed by David DePape under contract to CWB. Assistance with fall field coordination was also provided by Cam McCauley.

PREFACE

My involvement in this project began on May 29, 2023 when I met with several CWB staff to discuss how I might support the ongoing interests of the CWB in monitoring water quality in the Cowichan River watershed. The CWB had established targets for water quality (amongst other parameters), and was interested in acquiring more data in support of several ongoing projects; part of a larger watershed planning process on the Cowichan and Koksilah Rivers, and as a contributor to the provincial water quality attainment monitoring program.

The CWB, with the assistance of other not-for-profit organizations, is committed to supporting ongoing water quality monitoring work lead by the Province of British Columbia. The British Columbia Ministry of Environment and Parks has developed water quality objectives for numerous lakes, rivers, and marine water bodies in BC. Select prioritized water bodies with water quality objectives are sampled on a rotational basis to check if objectives are being met (attainment monitoring). This project was initially planned as part of water quality objective attainment monitoring for the Cowichan River watershed.

Over the course of the following year, I worked collaboratively with the Executive Director of the CWB to develop a scope of work for the water quality attainment water sampling project, a timeline and budget, and resourcing e.g. finding volunteer water samplers for the project. The scope of work changed dramatically however, with the occurrence of a major fish mortality event on the Cowichan River.

In July, 2023 a massive fish kill was observed in the Cowichan River. An initial estimate suggested that approximately 80,000 young of the year steelhead, salmon and trout had died in a “dead-zone” approximately eight river kilometers long; however, more extensive snorkel surveys later confirmed that in excess of 100,000 trout and salmon had perished over a period of about two days. In response, the CWB organized a series of workshops in the spring of 2024 with the express purpose of determining the cause of the fish kill, and to develop a monitoring and response plan in an effort to avoid another mortality event.

The defined monitoring program for the planned 2024 water quality attainment project was reviewed with this new objective in mind and additional water quality parameters and sample sites were included in a more comprehensive water quality monitoring program for this project. The final scope of work for the project addressed the objectives of both the provincial water quality attainment monitoring program and the need for additional water quality data to inform decision making with respect to the fish kill. The multi agency cooperation reflected in this approach avoided any duplication of effort, resulting in overall efficiencies and significant cost savings as well.

EXECUTIVE SUMMARY

This project was planned as a water quality attainment study to monitor and assess the status of water quality objectives (WQOs) in the Cowichan River watershed. It was also designed to build upon work done previously by others under the leadership of the Cowichan Watershed Board and Cowichan Tribes. Following a massive fish kill in July, 2023 in the Cowichan River, the objective of the study was expanded in order to support efforts to better understand the cause of the fish kill and to prevent another such event from occurring again. The scope of work specifically included contracting a Project Coordinator to assist with the planning, design, delivery and reporting of the grab sampling portion of the project.

Continuously recording data sondes were also installed at five sites in the Cowichan River. The scope of work for this project however, specifically excludes any discussion of that work or the analysis of data and any reporting on the attainment of WQOs from the 2024 grab sampling. That information is provided in reports which are published as part of the B.C. Ministry of Environment and Park's Environmental Quality Series while this report is provided as a tool to assist with the planning and delivery of water quality attainment (WQA) monitoring projects undertaken by the CWB.

The Cowichan River watershed lies within the Eastern Vancouver Island Ecoregion on the south-eastern portion of Vancouver Island. The watershed includes Cowichan Lake, Bear Lake, Mesachie Lake, the Cowichan River and numerous tributary streams. The Cowichan River is a Canadian Heritage River, so designated due to its outstanding natural, cultural and recreational values. The Cowichan River and its tributaries supports one of Vancouver Island's most valuable recreational, commercial and First Nations fisheries. The watershed is used extensively for aquatic recreation and is also a source of water for drinking, irrigation and industrial purposes. Water quality is influenced by a number of point and non-point sources. Water withdrawals from Cowichan Lake and the Cowichan River, and discharges into the lake and river, occur under various domestic and industrial licenses, authorizations, and permits throughout the watershed.

Water quality attainment monitoring was conducted by collecting water samples at 22 sites in the Cowichan River watershed following a 5-in-30 protocol i.e. five weekly samples in 30 days. Samples were collected in the summer of 2024 on July 30th , August 6th , 13th , 20th and 27th during low flow conditions; fall samples were collected immediately following the first 'flush' of heavy precipitation on October 22nd, 29th, November 5th, 12th, and 19thof 2024. Samples sites and monitoring parameters were selected based on historic WQA monitoring sites in the BC Environmental Management System (EMS) and current WQOs for the watershed. Several additional sample sites and analytical parameters were added in response to the massive fish kill on the Cowichan River in 2023.

Sample kits and related supplies were provided by ALS Environmental Laboratories in Burnaby, BC. Samples were collected by trained volunteers and project partner

representatives following procedures in the BC Field Sampling Manual. The collection and shipment of samples via overnight courier from Duncan to ALS in Burnaby for analyses was coordinated by a contracted Project Coordinator. Sample data was uploaded into EMS by ALS. Quality assurance and quality control (QA/QC) was conducted in the field by the Project Coordinator and by the ENV Project Sponsor prior to data being entered into EMS.

A number of aquatic invasive species which are of significant concern to resource management agencies are present in the Cowichan River watershed. The approach to biosecurity for this project was based on general “Clean, Drain Dry” principles; protocols specifically for whirling disease were adopted from work previously done in Alberta.

Recommendations with respect to the design, planning and delivery of future WQA monitoring work in the watershed by the CWB (or others), focussing on the use of volunteers, safety and liability, communication, biosecurity, sample collection methodology and logistics, sample site locations, and sample materials procurement are provided in detail.

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1.0 INTRODUCTION

1.1 Historical Context

The Cowichan River watershed, which includes the Cowichan River, Cowichan Lake, Mesachie Lake, Bear Lake, Beaver Lake and a large number of tributaries drains an estimated area of 939 km² in area from its headwaters in the Eastern Vancouver Island Ecoregion (Leeward Island Mountains Ecosection), downriver (Nanaimo Lowland Ecosection) to its outlet in the Cowichan Bay estuary near Duncan (Demarchi 2011). The Cowichan River is approximately 47 km. in length and is a fifth-order stream. Cowichan Lake has a surface area of 6,204 ha., a perimeter of 110 km., a maximum depth of 152 m. and a mean depth of 50 m. The elevation of Cowichan Lake is 164 m., with elevations within the watershed ranging from slightly over 1,500 m. on the northern side of the lake at Mount Landale, to sea level where it enters the Strait of Georgia at Cowichan Bay.[1].

The river is often described as having three distinct sections based on gradient – the middle section which is the steepest (1:200), the upper portion which is less steep (1:500) and the flatter lower section which starts about 15 km. from the mouth i.e. below the confluence with Holt Creek. There are numerous creeks within the Cowichan River watershed – major tributaries which discharge into Cowichan Lake on the south shore include Robertson River, Sutton Creek, and Nixon Creek while Shaw Creek, Cottonwood Creek and Meade Creek are the largest on the north side. A number of creeks drain into the lower section of the river including Menzies, Bings and Averill Creeks, which along with Richards and Quamichan Creeks, discharge into the Cowichan River via Somenos Creek.[2]

The Cowichan River and its tributaries supports one of Vancouver Island's most valuable recreational, commercial and First Nations fisheries. It is one of only three rivers in BC designated as a Canadian Heritage River, based on its outstanding natural, cultural and recreational values.[3]

Water flow in the Cowichan River is heavily influenced by high winter precipitation resulting in elevated winter flows and soft water (McKean 1989), and low flows -- the effects of seasonal drought caused by climate change during the summer months. River flow is monitored in the Cowichan River by the Water Survey of Canada (WSC). WSC also operated a hydrometric station on Cowichan Lake between 1913 and 1921. This station (08HA009) at the Cowichan Lake weir, began recording again in 1952. Water Survey of Canada currently operates three stations to record water flow within the Cowichan River watershed: 08HA009 at the weir on Cowichan Lake (Cowichan Lake

[1] Epps, D. June 2011. Water quality assessment and Objectives for Cowichan Lake: Overview Report. pg. 8. BC Ministry of Environment, Environmental Protection Division. Victoria, British Columbia.
[2] McKean, C.J.P. February 1989. Cowichan-Koksilah Rivers Water Quality Assessment and Objectives Technical Appendix. pg. 1. Water Management Branch, BC Ministry of Environment. Victoria, British Columbia.
[3] Obee, N. August 2011. Water Quality Assessment and Objectives for the Cowichan and Koksilah Rivers. First Update. pg. 1. British Columbia Ministry of Environment. Victoria, British Columbia.

near Lake Cowichan); 08HA002 (Cowichan River at Lake Cowichan) which has been continuously recording since 1940; and 08HA011 (Cowichan River at Allenby Road) in Duncan which has been continuously recording since 1965, although seasonal and periodic measurements extend to 1912. All three stations record water level and discharge (m^3/s) on regular intervals. (WSC 2025).

Flow in the Cowichan River is influenced by a weir operated by Paper Excellence (previously Catalyst Paper). The weir is operated under license/permit from the Province of British Columbia and a federal Fisheries and Oceans Canada (DFO) *Fisheries Act* Authorization. The weir controls seasonal water fluctuations, holding water in Cowichan Lake in early spring and releasing it during dry summer months which provides for summer flows in the Cowichan River which are higher than would otherwise occur in an uncontrolled system (Appendix I, Photo 1).

The British Columbia Ministry of Environment, now Ministry of Environment and Parks (ENV), and Environment Canada have been cooperatively monitoring surface water quality, in addition to water flow, at a number of locations across British Columbia since 1985. The primary purpose of this joint program is to determine the status and trends in surface water quality at various sites across the province. One of these monitoring stations is located on the Cowichan River downstream of Somenos Creek (BC08HA0018). Although water quality data has been collected since 1985 at this site, it has only been monitored as a federal-provincial station since 1999.[4]

As part of ENV's mandate to manage provincial water bodies i.e. to protect and facilitate the industrial, domestic and recreational use of water, WQOs are established. They provide approved policy direction to guide decisions that may impact a specific water body. They are developed to protect water quality and are tailored to the specific water body for which they have been created. WQO's are established on a priority basis for freshwater, estuarine and marine water bodies of regional, provincial, inter-provincial and international significance. They take into account natural water quality within the watershed, water uses, water movement and waste discharges. WQOs are numbers or statements representing low-risk conditions to provide protection for a specific water body and its associated water values and uses. They are developed collaboratively i.e. in partnership with other agencies and levels of government, and are informed by a number of factors including water quality guidelines (WQGs) and local and indigenous knowledge.[5] Once in place, these objectives provide direction for resource managers and agencies, and are used as a standard against which to measure the water quality of a particular lake or river. Monitoring is undertaken every three to

[4] Pommen, L.W. 2004. Water Quality Assessment of Cowichan River near the Mouth (1985-2003). CANADA-BRITISH COLUMBIA Water Quality Monitoring Agreement. pg. 1. Prepared for Environment Canada and BC Ministry of Environment. Victoria, B.C.

[5] BC Environmental Protection and Sustainability. Water Quality Objectives.

five years, or when operationally feasible by the Province (or its designate) to determine whether or not WQOs are being 'attained' [6]

WQO attainment monitoring is reported by ENV in technical reports, published by ENV as part of the Environmental Quality Series, which are available at https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-objectives/west-coast-region-water-quality-objectives

1.2 Situation Analysis

The Cowichan River and its watershed provides for a number of diverse recreational, domestic, First Nations and industrial water uses. These uses (and their users) apportion available water through formal regulatory and licensing permits and agreements from various levels of government e.g. municipal, provincial and federal. Increasingly more frequently, these uses are potentially competing with one another for this limited aquatic resource, particularly during the periods of lowest river flow e.g. May, June, July and August.

This watershed is used extensively for aquatic recreation; activities such as swimming, kayaking, and tubing down the river during the summer months attract thousands of visitors to the town of Lake Cowichan every year. (Appendix I, Photo 2). It is also a source of water for drinking, irrigation and industrial purposes (McKean 1989).

The Cowichan River, Cowichan Lake, and its tributaries support a significant commercial, recreational and First Nations fishery for a variety of anadromous fish species including chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), chum salmon (*Oncorhynchus keta*), and populations of sea-run steelhead (*Oncorhynchus mykiss*). Recreational freshwater (resident) species include cutthroat trout (*Oncorhynchus clarki*) brown trout (*Salmo trutta*), Dolly Varden char (*Salvelinus malma*), rainbow trout (*Oncorhynchus mykiss*) and kokanee salmon (*Oncorhynchus nerka*). Cowichan Lake is also home to the Threatened Cowichan Lake lamprey (*Entosphenus macrostomus*) which is only found in Bear Lake, Mesachie Lake, Cowichan Lake and some of its tributaries.

The Town of Lake Cowichan and the Cowichan Valley Regional District (CVRD) both have water licenses to remove water from Cowichan Lake for waterworks i.e. drinking water purposes (Epps, 2011). Point source impacts on water quality within the watershed include the municipal licenses for the Town of Lake Cowichan's sewage treatment plant and the City of Duncan/District of North Cowichan, (commonly referred to as the Joint Utilities Board (JUB). The Town of Lake Cowichan's sewage treatment plant discharges effluent into the Cowichan River approximately 3.5 km. downstream of the Cowichan Lake weir in the upper watershed. The JUB discharges

[6] Obee, N. August 2011. Water Quality Assessment and Objectives for the Cowichan and Koksilah Rivers. First Update. pg. 1. British Columbia Ministry of Environment. Victoria, British Columbia.

effluent into the river approximately 1.5 km. downstream of the Island Highway bridge in Duncan in the lower watershed.

Additionally, the fish hatchery operated by the Freshwater Fisheries Society of British Columbia upstream of the JUB discharges effluent from the trout it produces at that facility into the Cowichan River. There are also numerous water licenses on the mainstem of the river which allow individuals to withdraw water for domestic (drinking) and irrigation purposes.

Industrial users include Paper Excellence (now Domtar) who has licenses for industrial and storage use to provide process water to the pulp mill in Crofton via a pipeline from the Cowichan River. Water flow out of Cowichan Lake into the Cowichan River, when the weir is 'on-control', is regulated and mean daily flows are controlled in accordance with a 'rule-curve' which was negotiated by then licensee Norski Canada and ENV. Today, the rule-curve is administered by Paper Excellence as a condition of their license. In recent years the rule-curve has been manipulated, in collaboration with government regulators, agencies and resource users with a vested interest in the health of the Cowichan River watershed and its aquatic resources, to ensure there is sufficient flow in the river to support a healthy fishery. Desired flows, as determined from the rule-curve, are calibrated against real-time flow data from WSC stations on Cowichan Lake and the Cowichan River.

Other influences on water quality include numerous ageing residential sewage disposal systems for residences located along the lakeshore in the communities of Youbou, Honeymoon Bay, and Lake Cowichan as well as private residences along the Cowichan River. Non-point source impacts on water quality in the watershed include forestry activities e.g. logging, construction of haul roads, etc., recreation e.g. boating and camping, agriculture and urbanization. Trends in water quality in the Cowichan River and an analysis of these non-point influences on water quality is provided in the report "*Assessing the impacts of Nonpoint Source Pollution in the Cowichan River*" (Janke 2024).

2.0 SCOPE OF WORK

2.1 Background

In 2017, the CWB contracted work to design, implement and report on water quality sampling in the Cowichan River and Koksilah River watersheds (sample sites were located on streams tributary to Cowichan Bay, the Koksilah watershed, the Somenos and Quamichan watersheds and lower Cowichan River, and marine waters in, and adjacent to, Cowichan Bay)[7]. In 2018, the CWB again contracted water quality sampling in the Cowichan and Koksilah watersheds. This sampling was carried out in three areas:

[7] Preikshot, D. 2018. Cowichan/Koksilah Water Quality Sampling: Summer and Fall 2017. pg. 2 Cowichan Watershed Board, Duncan.

streams tributary to Cowichan Lake; stations in Cowichan Lake; and stations in the Cowichan River and Bings Creek[8]. This monitoring work continued the 2017 program and was supported through volunteer assistance from several stewardship groups including the CLRSS. More recently, WQA monitoring was completed in 2022 on the lower Cowichan and Koksilah Rivers. That work is summarized in the draft report "*Draft Lower Cowichan and Koksilah River Basin Water Quality Attainment Study 2022, Final Draft Report (V10).*"(Shawnigan Basin Society 2023).

Other monitoring work has also been done on the Cowichan River in recent years including federal/provincial trend monitoring on the Cowichan River downstream of Somenos Creek (BC08HA0018), benthic invertebrate monitoring in 2020 at Sandy Pool, fish population monitoring by B.C. Fisheries and DFO (2023, 2024), and monitoring conducted by CVRD in 2023 and 2024 as part of their drinking water and watershed protection programs. (Barlak, R. 2024).

2.2 Current Project

This project was designed initially as a WQA study to monitor and assess the status of WQOs previously established by the Province for Cowichan Lake and the Cowichan River i.e. to determine whether provincially established WQOs had been met. The work was also envisioned as a continuation of the WQA study conducted on the Lower Cowichan and Koksilah Rivers in 2022 by the CWB under the leadership of Cowichan Tribes. Additionally, the CWB was hopeful that "this monitoring work would provide local and provincial researchers, managers and the public with objective water quality data with which to enable transparent and objective discussions on the progress of management efforts. The CWB was also hopeful that the data collected would help identify areas of concern and new areas of research to inform the public and aid management decisions".[9]

Following the fish kill in July, 2023 the objective of the study was expanded to augment the WQA sampling in order to support efforts to better understand the cause of the fish kill on the Cowichan River and to prevent another such event from occurring again. The scope of work specifically included contracting a project coordinator whose role and responsibilities included:

- assisting with the planning and design of the sampling program;
- providing support to a newly struck "Fish Kill Monitoring Team" as a subject matter expert;
- assisting with volunteer recruitment, training, orientation and site familiarization;
- arranging logistics for the collection and delivery of water samples to the lab via courier;

[8] Preikshot, D. 2019. Cowichan/Bings Watersheds Water Quality Sampling: Summer and Fall 2018. pg. 2. Cowichan Watershed Board, Duncan.

[9] Paydli, D. 2024. Upper Cowichan Provincial WQA Study Project Outline. Cowichan Watershed Board. Duncan.

- coordinating the collection of samples and
- preparing a final report documenting the work completed.

It is important to note that although this report has been prepared as part of the project scope of work, it specifically excludes the presentation of any raw data, trend analysis, changes in watershed use, or reporting on the attainment of WQOs. That information is provided by others who are referenced and cited in this report. This report is written specifically as a framework and tactical tool to assist with the planning and delivery of the next WQA monitoring project undertaken by the CWB.

3.0 DESCRIPTION OF WORK

3.1 Monitoring Timeline and Sample Frequency

Monitoring of WQOs typically takes place at a critical time in the watershed i.e. when WQOs may not be met. These critical times are often associated with low flows and high water temperatures during late summer months, both of which adversely affect many of the major water uses in the Cowichan River watershed, and when lotic systems are typically most sensitive to anthropogenic disturbance e.g. point source impacts. Additionally, critical times can also occur during periods of peak flows i.e. when the majority of suspended and dissolved particulates and other contaminants, such as bacteria are introduced into a water body. These typically occur in the Cowichan River watershed in late fall following the onset of significant and continuous precipitation. Correspondingly, the fall sampling horizon typically begins following the first 'flush' caused by the onset of significant and continuous rainfall i.e. for more than three days. The identification of critical times within a watershed and the subsequent timeline for monitoring is determined by an ENV water quality specialist.

The monitoring of WQOs i.e. the collection of water samples for WQA monitoring purposes, usually takes place during a five-week period, twice during the same calendar year. Samples are collected preferably at the same time of the day, and on the same day of the week. This means that each sample site will be sampled for the same parameters five times within a 30 day period, a process which is then repeated again i.e. identically a second time, later in the year. This approach is often referred to as the 5-in-30 protocol. This provides for sampling during the worst i.e. critical times in the watershed. It also allows for comparison with the average conditions in the watershed and subsequent statistical analysis of the data e.g. calculating a mean value, maximum value, 95th percentile, etc.[10].

Following the aforementioned rationale, and on the advice of ENV's Senior Environmental Impact Assessment Biologist (Rosie Barlak), summer monitoring for this

[10] Epps, D. June 2011. Water Quality Assessment and Objectives for Cowichan Lake: Overview Report. pg. 6 Environmental Protection Division, BC Ministry of Environment. Victoria, British Columbia.

study began on July 30, 2024 and fall monitoring began on October 22nd. Sampling was conducted weekly during the summer low flow and fall high flow periods following the 5-in-30 sampling protocol. Actual sample dates are included in Table 1.

3.2 Sample Site Locations and Site Descriptions

Water quality monitoring has been conducted in the Cowichan River watershed by various levels of government for decades. More recently, this has included WQO attainment monitoring as well. As identified previously, this sampling has occurred at numerous locations on tributaries to Cowichan Lake, in Cowichan Lake, and on both the upper, middle and lower sections of the Cowichan River.

Table 1: Sampling Dates for 2024 WQA Grab Sampling

Summer Sampling 2024				
Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**
July 30	August 6	August 13	August 20	August 27
***Fall Sampling 2024**				
Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**
October 22	October 29	November 5	November 12	November 19

**Fall sampling was initially planned to start on November 5th, however, fall rains started earlier than anticipated necessitating the implementation of a previously arranged contingency plan to coordinate sampling for October 22nd and October 29th in the absence of the Project Coordinator.*

Much of this historic data, when the sampling has been done by or on behalf of the Province (or under a permit from the Province), is available in the provincial Environmental Management System (EMS). EMS provides much information about a monitoring site including a site description with corresponding geographic coordinates (latitude and longitude),a Site Identification Number (Site ID) and a unique Environmental Monitoring System (EMS) ID amongst other information. EMS archives water quality data while providing a standard for naming and locating sample sites; it also facilitates easy reference to data collected at the same location for comparative, trend and statistical analyses.

Grab sample sites for this project were predominantly sites pre-existing in EMS; however, not all pre-existing EMS sites within the Cowichan River watershed were sampled for this project. The sites actually selected for sampling were selected based on achieving overall project objectives and satisfying a number of specific criteria unique to the project. The process of selecting sites for the project was achieved through several processes which included:

- soliciting input, advice and direction from the Province's project sponsor (R. Barlak) to ensure that recommendations to improve, maintain and monitor water quality in Cowichan Lake, identified in previous WQA reports were considered;

- conducting a CWB staff-led review of EMS sites previously sampled for the last WQA monitoring in 2018;
- establishing a working group of subject matter experts who ensured that representative sections of the Cowichan River, and river reaches of specific concern with respect to the fish kill, were included in the sampling program. This outcome was achieved through a series of dedicated workshops sponsored by CWB in collaboration with Cowichan Tribes;
- identifying the special interests of supporting agencies in the project so they were included in the project so far as possible. This included CLRSS interests in better understanding how water quality might be affecting fish health and sustainability in major south-shore tributaries and the environmental protection of Shaw Creek;
- ensuring sites were selected which would allow the comparison and evaluation of major point source effluent inputs to the Cowichan River e.g. Town of Lake Cowichan and JUB sewage treatment plants;
- collaborating with other levels of government e.g. Cowichan Valley Regional District (CVRD) with similar interests and mandates to avoid duplication of effort and maximize efficiencies for this project; and
- working within established funding and manpower constraints.

Continuously logging data sondes (YSI Exo 3) which collected temperature, pH, conductivity and dissolved oxygen (DO) were also were installed in 2024 by DFO and B.C. Fisheries at five sites in the Cowichan River (300 m. u/s PE-247, 70.2 mile bridge, Horseshoe Bend, Rotary Park, and 500 m. d/s PE-1497). These were installed specifically to support decision making with respect to the fish kill. Benthic Invertebrate monitoring occurred following Environment Canada CABIN methodology at six sites in the Cowichan River by ENV and CVRD staff (Barlak 2025). An in-depth discussion of these processes is outside the scope of this report. Readers are referred to the CWB and forthcoming ENV WQA monitoring technical reports for further details.

A total of 22 sites were grab sampled in the Cowichan River watershed for the 2024 WQA monitoring project. Of these, five sample sites were located on Cowichan Lake, four sample sites were located on tributaries to Cowichan Lake (three on the south arm and one on the north side of the main body), one sample site in Bear Lake, four sample sites on the upper Cowichan River (including one – CR01, in the foreshore of Lake Cowichan below the weir), four sample sites in the middle section of the Cowichan River, and four sample sites in the lower Cowichan River. These sites reflect a broad range of micro-habitats, flow regimes and physical characteristics (Appendix I, Photo 3, Photo 4, Photo 5). Of the 22 sites sampled, 19 sites were part of previous WQA monitoring programs; four additional sites, E332091 (Cowichan River at 70.2 mile bridge), E334444 (Cowichan River at Horseshoe Bend), E286892 (Cowichan River @ Sandy Pool) and E284651 (Cowichan River 500 m d/s PE-1497) were included in this project to help inform decisions specifically regarding the 2023 fish kill.

A map showing the location of sample sites on Cowichan Lake (both historic and 2024 grab sample sites) is provided as Figure 1. An interactive map showing the locations of historic water quality monitoring locations in the Cowichan and Koksilah watersheds can be found on the CWB's website at: https://cowichanwatershedboard.ca/document/water-quality-monitoring-location-in-the-cowichan-and-koksilah-watersheds/. The map, which includes the 2024 grab sample sites as well as samples collected previously by other agencies, provides the EMS ID, site description and latitude/longitude for the sample sites. A map showing the location of sample sites on the Cowichan River is provided as Figure 2.

Most sites were sampled 10 times i.e. five times in the summer and five times in the fall as planned; however, there were several exceptions. Two of the south shore tributaries to Cowichan Lake, specifically Robertson River and Sutton Creek, were not sampled on several occasions during the summer sample horizon as they were dry.

Samples were **not** collected at the following sites on the dates specified:

Robertson River (E217516): July 30, 2024; August 6, 2024; August 13, 2024; August 20, 2024; and August 27, 2024

Sutton Creek E217515): August 6, 2024; and August 13, 2024

Very low to no flow conditions are not unusual for these small creeks during the heat of the summer (Appendix I, photo 10). As such, earlier discussions with ENV had confirmed that no samples would be collected (as opposed to collecting a sample at another location on the creek) under these conditions (R. Barlak, pers. comm. July 25, 2024). The site highlighted in red in Table 2 i.e. CR15, located under the Island Highway bridge crossing the Cowichan River in Duncan, was not sampled after initial ground truthing revealed site-specific safety concerns. That site was replaced with the sample site at Rotary Park. The list of sample sites for 2024 WQA grab samples including site code, EMS site description, EMS identifier, and location (latitude, longitude) is presented in Table 2.

The site descriptions and latitude/longitude coordinates initially provided by ENV from EMS for the project were used to 'ground-truth' i.e. locate every site prior to the start of the project. Ground truthing was accomplished with the assistance of ENV and project partners who were familiar with the location of the sites from previous sample programs. The "Google Maps" application on a cell-phone was also utilized to locate the latitude and longitude from EMS; specifically for the Cowichan Lake and tributary sites and the lower Cowichan River sites. This process was invaluable as it identified a number of inaccuracies with both the geographic locations and descriptions in EMS. These discrepancies were reviewed with both CWB senior staff (H. Pritchard), and the ENV Project Sponsor for resolution. It was decided that location information i.e. latitude and longitude coordinates should be updated to reflect the actual location agreed upon for sampling for this project while the 'site descriptions' were left as received from ENV for consistency and later analysis and reporting of the data. More

descriptive site access information, provided by the volunteers who conducted the sampling, is provided in Table 3 to assist with locating sample sites in the future.

The selection of the exact i.e. in-stream location for collection of the grab samples (and placement of the meter probe for parameters sampled by field meter) followed the BC B.C. Field Sampling Manual and applicable ENV “Grab Sampling (Analytical and QA/QC) (Appendix A), and “Field Meter Stream Monitoring” (Appendix B) protocols and procedures (Appendix I, Photo 6, Photo 7).

Table 2: List of Sample Sites for 2024 WQA Grab Samples Including Area, Site Code, EMS Site Description, EMS Identifier, and Location (Latitude, Longitude)

Area (N. – north; S. – south)	Site Code	EMS Site Description	EMS Identifier	Latitude	Longitude
Upper Cowichan River	CR01	Cowichan River south side at Cowichan Lake weir	E206108	48.8243	-124.0589
Upper Cowichan River	CR06	Cowichan River 300 m u/s PE247	0120808	48.82748	-124.03897
Upper Cowichan River	CR10	Cowichan River 400 m d/s PE247	E206107	48.8252	-124.02495
Upper Cowichan River		Cowichan River at 70.2 mile bridge	E332091	48.8037	-124.0035
Middle Cowichan River		Cowichan River at Horseshoe Bend	E334444	48.778714	-123.947570
Middle Cowichan River	CR12	Cowichan River at Stoltz Pool	E227752	48.770861	-123.891167
Middle Cowichan River		Cowichan River @ Sandy Pool	E286892	48.75766	-123.83637
Middle Cowichan River	CR13	Cowichan River at Vimy Beach	E234124	48.76066	-123.77461
Lower Cowichan River	CR14	Cowichan River at Allenby Bridge	E234125	48.7717	-123.7117
Lower Cowichan River		Cowichan River at Rotary Park	E333071	48.7721	-123.6921
Lower Cowichan River		Cowichan River 500 m d/s PE-1497	E284651	48.7770	-123.6742
Lower Cowichan River	CR15	Cowichan River at HWY#1	0120802	48.77149	-123.69806
Lower Cowichan River	CR17	Cowichan River 1 km. d/s PE1497 (d/s Somenos Creek)	E206106	48.7726	-123.6633
Cowichan Lake N. perimeter	CLP08	Youbou #1 Cottonwood Estates	E271688	48.879	-124.22332
Cowichan Lake N. perimeter	CLP09	Youbou #2 West	E271689	48.875	-124.21986
Cowichan Lake N. perimeter	CLP10	Youbou #3 East	E271690	48.870	-124.20389
Cowichan Lake N. perimeter	CLP04	Cowichan Lake at head of south arm	E273063	48.82308	-124.06494
Cowichan Lake S. perimeter	CLP12	Bear Lake – Lake Cowichan	E271685	48.815278	-124.128333
Cowichan Lake S. perimeter	CLP05	Honeymoon Bay – Lake Cowichan	E271687	48.821944	-124.181111
Cowichan Lake tributary	CLT10	Nixon Creek	E217514	48.8889	-124.3822
Cowichan Lake tributary	CLT12	Robertson River	E217516	48.8058	-124.1392
Cowichan Lake tributary	CLT14	Sutton Creek	E217515	48.8253	-124.2067
Cowichan Lake tributary	CLT13	Shaw Creek	E217513	48.9242	-124.3933

Legend:

Site Code: CR – Cowichan River; CLP – Cowichan Lake perimeter; CLT – Cowichan Lake tributary

Lower Cowichan River (CR15) was not sampled due to safety concerns. It was replaced with the Rotary Park site (EMS ID E333071)

Table 3: Enhanced Descriptions for 2024 WQA Grab Sample Sites

EMS Identifier	EMS Site Description	Enhanced Site Description
E206108	Cowichan River south side at Cowichan Lake weir	Cowichan 'River' below the weir at NW corner of Jake's on the Lake dock and upstream of the Duck Pond pedestrian bridge
0120808	Cowichan River 300 m u/s PE247	*Joe Saysell's property 300m upstream of TLC's sewage outfall (PE247)
E206107	Cowichan River 400 m d/s PE247	*private property 400 m downstream of TLC's sewage outfall (Permit No. PE247)
E332091	Cowichan River at 70.2 mile bridge	**immediately upstream of the trestle
E334444	Cowichan River at Horseshoe Bend	access via the footbath which starts about 100 m downstream of the Skutz Falls parking lot; approximately 10m downstream of the deep pool at the large bend (sampled in the shallow riffle)
E227752	Cowichan River at Stoltz Pool	accessed from parking lot and drift boat launch
E286892	Cowichan River @ Sandy Pool	access from the Sandy Pool Regional Park parking lot then follow the main foot path to the river. Just right of the interpretive signage/outhouse, there's an eroded bank, with gravel below, which is where samples were collected
E234124	Cowichan River at Vimy Beach	park at the Heritage River Rd River Access lot. Walk approx. 200m upstream from the drift boat launch/take-out (sampling upstream helps to avoid swimmers in the busy summer period.)
E234125	Cowichan River at Allenby Bridge	*park on the north side of the bridge, near the gate. Follow the footpath that leads directly to the river bank. Sampled on river left, just upstream of the bridge
E333071	Cowichan River at Rotary Park	park in the Rotary Park parking lot. Walk past the tennis courts towards the river, and turn left (downstream) on the dike walking path. Walk for approx. 150m to a small beach to collect samples.

Notes:

*These sites are accessed through private property, or are on Cowichan Tribes Land. Permission for access was previously obtained from the landowners and Cowichan Tribes.

**A locked gate at the Stolz Falls parking area limits vehicular access to the trailhead (which provides access to the trestle by vehicle). A key for the padlock was previously obtained from BC Parks to facilitate vehicular access for the 1.5 km to the sample site.

Table 3: Enhanced descriptions for 2024 WQA grab sample sites (continued).

EMS Identifier	EMS Site Description	Enhanced Site Description
E284651	Cowichan River 500 m d/s PE-1497	*Cowichan River 500 m downstream of the JUB (Permit No. PE-1497) outfall. accessed through John Charlie's (JC's) property on river right (Cowichan Tribes land). Advised to communicate immediately prior to sampling. Drive through JC's lot to get to the river, then drive along the bank downstream approximately 400 metres. At low flows, cross the stream to get to river left, then walk another 100m downstream to get to the sampling site. At high flows (i.e. during the fall), a stream crossing is impossible, so samples were collected just below where Quamichan Creek inputs into the Cowichan (accessed via Quamichan Rd).
0120802	Cowichan River at HWY#1	not sampled due to safety concerns
E206106	Cowichan River 1 km. d/s PE1497 (d/s Somenos Creek)	*Cowichan River 1 km. downstream of the JUB (Permit No. PE-1497) outfall; accessed on river **right**, via Hatchery Rd.; drive down Boys Rd, turn left on Wil'seem Rd, which becomes Hatchery Rd; turn **left** onto a dirt road that leads to the river bank; follow this road to the river; sample at the bottom of the rip rap.
E271688	Youbou #1 Cottonwood Estates	boat required; Cowichan Lake east of the old Youbou mill site approximately site50 m offshore
E271689	Youbou #2 West	boat required; Cowichan Lake in front of Arbutus Park approximately 50 m offshore
E271690	Youbou #3 East	boat required; Cowichan Lake west of Saseenos Point approximately 50 m offshore
E273063	Cowichan Lake at head of south arm	boat required; Cowichan Lake on the south arm; west of public boat launch and just west of the navigational buoys
E271685	Bear Lake – Lake Cowichan	boat required; approximately centre of lake looking from the public boat launch/dock

Table 3: Enhanced descriptions for 2024 WQA grab sample sites (continued).

EMS Identifier	EMS Site Description	Enhanced Site Description
E271687	Honeymoon Bay – Lake Cowichan	boat required; Cowichan Lake on the south arm approximately 100 m off shore from Honeymoon Bay
E217514	Nixon Creek	approximately 100m upstream where Southshore Road crosses Nixon Creek (walk upstream just **before** the bridge when coming from Lake Cowichan); sampled on the south bank
E217516	Robertson River	approximately 100m upstream where Southshore Road crosses Robertson River (walk upstream just **before** the bridge when coming from Lake Cowichan); sampled on the east bank.
E217515	Sutton Creek	approximately 100m upstream where Southshore Road crosses Sutton Creek (walk upstream just **before** the bridge when coming from Lake Cowichan); sampled on the south bank
E217513	Shaw Creek	approximately 100m upstream where Northshore Road crosses Shaw Creek (park and walk upstream just **after** the bridge when coming from Youbou; sampled on the west bank.

Figure 1: Map of Cowichan Lake Showing the Location of Historic and 2024 Grab Sample Sites[11]

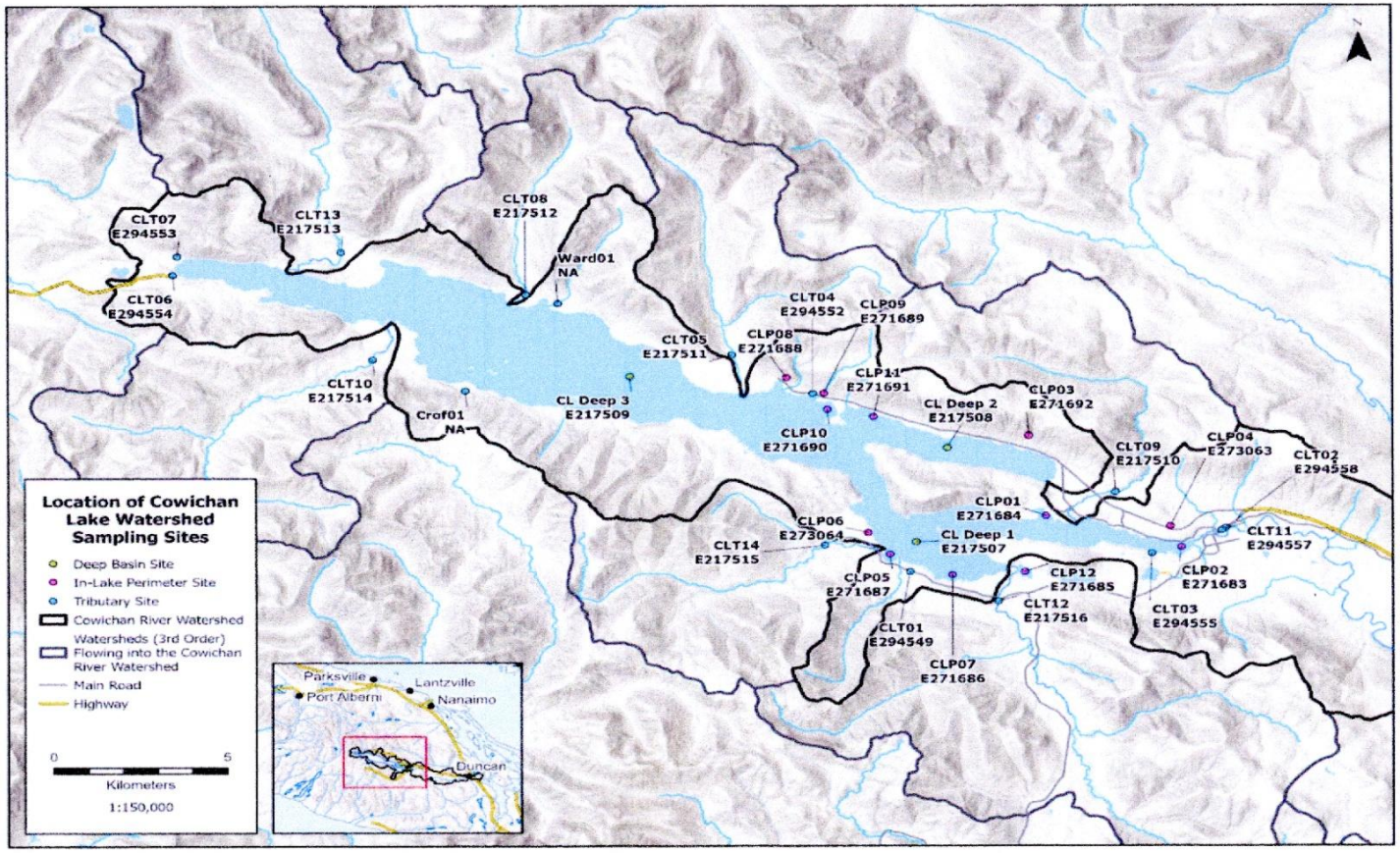
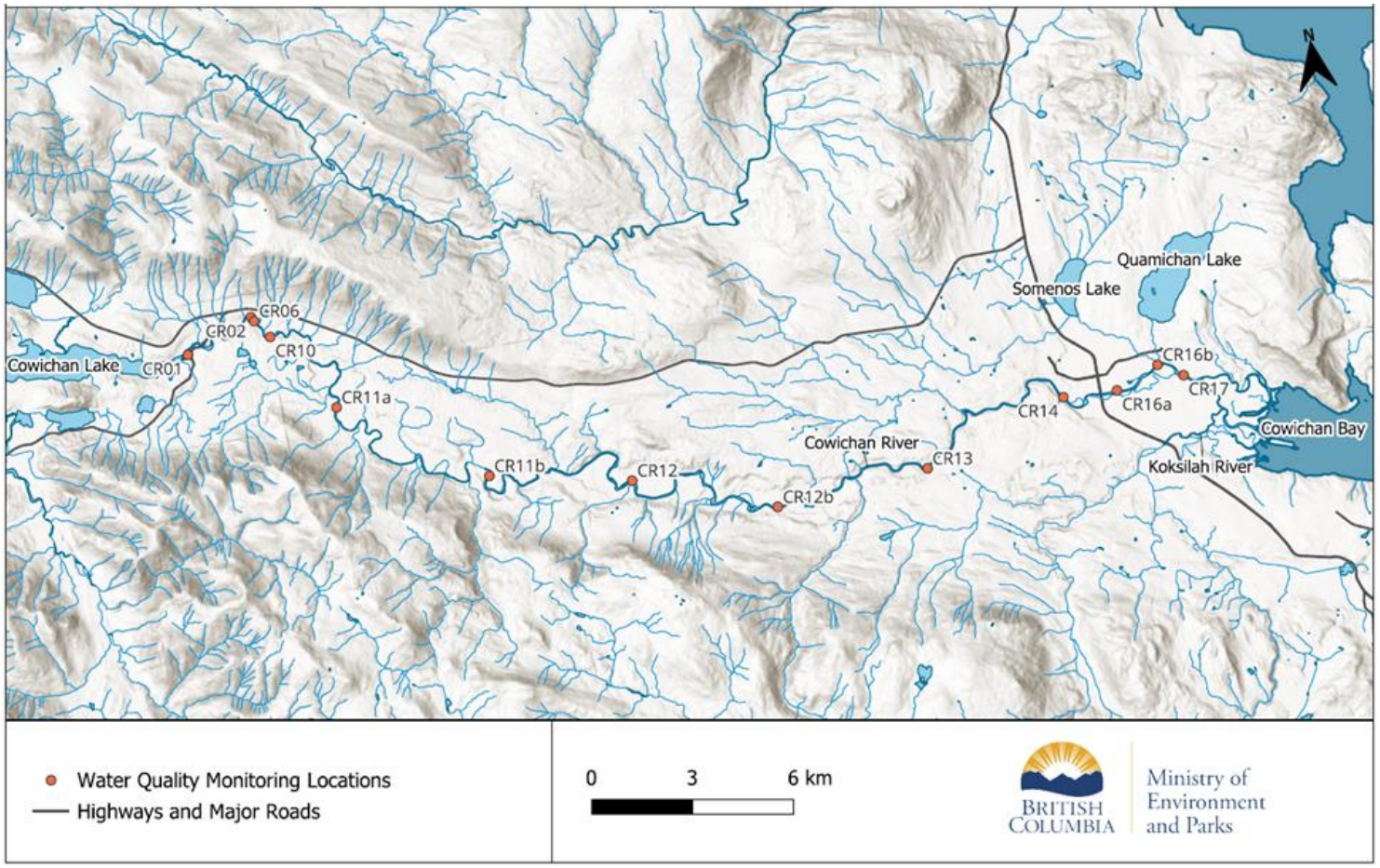


Figure 1: Map of Cowichan Lake showing the location of sample sites.

[11] Smorong, D and P. Saso. 2015. Cowichan Lake: Water Quality Objectives Attainment Report (2012- 2014). "Figure 1" pg.2. Environmental Quality Series 2015. Victoria, British Columbia.

Figure 2: Map of the Cowichan River Showing the Location of 2024 Grab Sample Sites[12]



[12] Barlak, R. 2024. Cowichan River and Koksilah River: Water Quality Objectives Attainment (2022- 2024). "Figure 2" pg. 4. Environmental Quality Series. Prov. B.C., Victoria, B.C.

3.3 Sample Parameters, Analyses, and Reporting

3.3.1 Sample Parameters

Initial WQOs were developed for the Cowichan River in 1989 (McKean 1989). Parameters for which objectives were proposed included fecal coliform, Escherichia coli, enterococci, dissolved oxygen, non-filterable residue (NFR), turbidity, ammonia, chlorophyll a, total residual chlorine, dissolved copper, dissolved lead, dissolved zinc, and copper-8-quinolinolate. WQA monitoring on the Cowichan River (and the Koksilah River) was conducted in 2002, 2003, and 2008 (Obee and Epps, 2011).

Objectives were subsequently updated in 2011; specifically, parameters for bacteriological, NFR, turbidity and metals were updated based on changes to the provincial guidelines. New temperature and total phosphorus objectives were also proposed. The objectives for total residual chlorine and copper-8-quinolinolate were removed as they were no longer relevant. Revised objectives for microbiological indicators were also more restrictive upstream from the City of Duncan (Obee and Epps 2011) due to licensed use for drinking water.

More detailed information about the original (1989) and updated (2011) objectives , and the WQO attainment monitoring data for 2002, 2003 and 2008 for the Cowichan River (and Koksilah River) is summarized in "*Water quality assessment and objectives for the Cowichan and Koksilah Rivers, First Update. August 2011*" (Obee and Epps, 2011).

WQO's were developed for Cowichan Lake in 2011 based on data collected in 2008 and 2009. WQA monitoring occurred on Cowichan Lake in 2013, 2014, (Obee and Epps, 2011) and 2018. WQA monitoring data for Cowichan Lake between 2012 and 2014 is summarized in the "*Cowichan Lake Water Quality Objectives Attainment Report (2012-2014)*" (Smorong and Saso 2021). Both reports are part of the B.C. ENV Environmental Quality Series and can be found on that website.

Water quality parameters to be monitored for this project were provided by ENV and CWB and were selected based on several criteria:

- current WQOs for Cowichan Lake and the Cowichan River;
- specific management concerns in the local area/river section;
- previous water quality assessment and WQA monitoring in the watershed and recommendations in those monitoring reports; and
- addressing data gaps in response to the 2023 fish kill on the Cowichan River.

As such, the parameters measured at each sample site were not identical e.g. only *Escherichia Coli* (*E. coli*) samples were collected at Cowichan Lake sites as previous sampling had indicated levels of concern; however, there had been no evidence of levels of concern from past sampling of phosphorus and turbidity consequently these parameters were not sampled at these sites in 2024. Similarly, concerns had been raised with respect to Turbidity and Total Suspended Solids (TSS) in the tributary

creeks, potentially as a result of changes in land use e.g. logging, from previous WQA monitoring. In response, Turbidity and Non-filterable Residue (NFR - measured as TSS) were included (along with *E. coli*) at these sites. Plates to collect periphyton for Chlorophyll a analysis were only placed at sample sites where they could be accessed in shallow water on the Cowichan River.

The proposed WQA sample parameters were also informed by discussion with subject matter experts during the workshops held by the CWB prior to the commencement of sampling for this project. The objectives of the initial workshop on March 12, 2024 included:

- designing a high-level water quality monitoring and sampling program in response to the July, 2013 fish kill on the Cowichan River; and
- assessing current water quality monitoring efforts and available data towards identifying gaps and developing strategies to address them.

This review was critically important to ensure that sufficient quantitative data from the Cowichan River was collected as part of this project's sample design in order to determine the cause of the 2023 fish kill on the Cowichan River and to prevent another fish mortality event. Including analyses for several specific water quality parameters e.g. dissolved ortho-phosphorus, ammonia, nitrite, and nitrite (which are important to the overall health of aquatic ecosystems and to fish in particular) was intended to increase the understanding of complex interactions between these parameters and help inform response strategies. These objectives and the desired outcomes are detailed in Appendix D "Cowichan Watershed Water Monitoring and Fish Response Workshop, Draft Agenda. March 12, 2024".

The samples were analyzed for a variety of general water chemistry parameters, total and dissolved metals, and bacteriology (see Table 4). Additional sample parameters included TSS, *E. Coli.,* and Chlorophyll a.

Table 4. Water Quality Parameters Analyzed by Grab Sample

General Water Chemistry	General Nutrients	Metals
Nitrogen: Nitrate and Nitrite	Nitrogen: Ammonia	Metals: Total
Nitrogen: Nitrate	Nitrogen: Total	Metals: Dissolved
Nitrogen: Nitrite	Nitrogen: Total Kjeldahl	Hardness
pH	Nitrogen: Total Organic	
Phosphorus: Diss. ortho-phosphate	Phosphorus: Total	
Specific Conductance	Carbon: DOC	
Turbidity	Phosphorus: Total Dissolved	
Sulphate		

Legend: DOC – Dissolved Organic Carbon; Metals: A complete listing of parameters analyzed as Total and Dissolved Metals is available from CWB or ENV.

Artificial substrates i.e. periphyton collector plates, were constructed from concrete blocks with closed cell foam attached to them to obtain samples for analysis of Chlorophyll a. These blocks were placed in-stream on the Cowichan River at 10 of the sites where grab samples were collected (E206108 was excluded due to water depth). Chlorophyll a samples were taken using the vials provided by ENV for this purpose. The vial cap was used to collect three core samples from the foam which were then put into the vials and light proof bags provided for this purpose. Unfortunately, many of the blocks were vandalized or otherwise removed from the river limiting the number of Chlorophyll a samples collected (see Section 5 Conclusions and Recommendations).

Hand held *e*lectronic meters were used in the field to measure water temperature, dissolved oxygen, pH and specific conductance. Several YSI models were employed for sampling (YSI Pro 2030 and YSI ProSolo). The same meter was always used to monitor the same sites in order to minimize sample error but also because the available meters had different functions i.e. YSI Pro 2030 measures temperature, pH dissolved oxygen and specific conductance whereas the YSI ProSolo only measures temperature, dissolved oxygen and specific conductance i.e. not pH. Meters were calibrated and disinfected within 24 hours of each sample date following YSI prescribed protocols, and biosecurity procedures (see Section 4 – Biosecurity). The water quality parameters monitored by grab sample for this project are listed by EMS site description and EMS ID in Table 5.

3.3.2 Analyses and Reporting

All samples were analyzed by ALS Environmental Laboratories in Burnaby per prior arrangement with ENV. Lab requisitions for all samples were completed at the start of the project by the ENV project sponsor and were submitted to the lab on a standard ENV lab requisition form (Appendix C). Requisitions were supplied at the start of the project in duplicate by ENV. Lab requisitions were completed (in duplicate) on site at the time of sampling. One copy was sent to the lab with the water samples in the cooler while the other copy was submitted to ENV at the end of the project. Lab requisitions were included in the cooler with the related water samples to avoid confusion on receipt by the lab. All lab requisitions were put into a clear plastic 8.5X11 inch zip lock baggy to protect them from moisture in transit.

Raw data was sent directly to the Project Sponsor and CWB and was uploaded by ALS into EMS. The data was only available to key project staff e.g. Project Sponsor and CWB. Data was reviewed by the Project Sponsor as it was submitted and any concerns arising e.g. out of range values, transcription errors, holding time exceedances, or incorrect data formats were communicated directly to the responsible party i.e. ALS lab staff or the Project Coordinator as appropriate. An analysis of water quality data and related attainment/exceedances is outside the scope of this report; however, preparation of a technical report detailing WQA monitoring results including the 2024 grab samples is in progress. (R. Barlak, pers. comm. March 3, 2025).

A replicate sample was collected for one site on each sample date. A separate sample pack (recorded on the same lab requisition) was included for each replicate sample; replicates were analyzed for all parameters at that site. A total of ten replicate samples were planned; however, only nine were collected as the replicate sample from Nixon Creek on August 6, 2024 was overlooked by the sample team.

Field notes were recorded by the volunteer samplers (see Section 3.4) at the time of sampling on a form which was adapted from a template and sample provided by ENV (Appendix E). The field notes were entered into an Excel spreadsheet by the Project Coordinator and emailed to the project sponsor, and key CWB staff typically within a day or two of sample collection. An analysis of the field notes is outside the scope of this project; however, they are included herewith (Appendix F) for future reference. All lab requisitions and field notes were reviewed for quality assurance and quality control (QA/QC), by the Project Coordinator prior to sample shipment i.e. on the day of sample collection, and any transcription errors, incomplete or missing information e.g. date, EMS ID, etc. was identified, noted/highlighted on the field notes form, and corrected.

3.4 Sample Kit Preparation

Sample supplies, based on lab requisitions and bottle requests previously submitted by ENV for this project, were ordered by the Project Sponsor from ALS Environmental Laboratories. Sample supplies provided by ALS included an initial shipment of 41 large (25 liter) coolers (plus an additional 15 subsequently sent), 1,220 labelled sample bottles, 130 filter/syringe kits, preservatives (vials of nitric and sulfuric acid), and 82 icepacks. Sample bottles were also packaged and labelled into 'kits' by the lab i.e. all sample bottles for a sample site were combined into a large clear waterproof ziplock bag (labelled with the site description), based on the parameters to be sampled at that site. Generic labels were also attached to all sample bottles by the lab (for completion in the field on the day of sampling). Sample supplies were shipped by ground freight directly to the Project Coordinator's home approximately two months prior to the first sample date (Appendix I, Photo 8).

Sample sites were grouped by the Project Coordinator according to location i.e. similar local area and access i.e. from shore or by boat, to both minimize the time required by volunteers to collect their samples on sample day and to expedite the subsequent collection of samples by the Project Coordinator (Table 6). These groupings were color coded by group and sample week i.e. week 1, week 2, etc., both for convenience i.e. easy visual reference, and to streamline the preparation and delivery of sample coolers to the volunteers prior to sample day(s). The coolers were then 'loaded' with the site specific bottle packs (Appendix I, Photo 9).

Table 5: Water Quality Parameters Analyzed by Grab Sample

Area	Site Description	EMS ID	Parameters
Upper Cowichan River	Cowichan River south side at Cowichan Lake weir	E206108	See sample lab requisition (Appendix C). All parameters included except for the four yellow highlighted sites, which **exclude** total and dissolved metals.
Upper Cowichan River	Cowichan River 300 m u/s PE247	0120808	
Upper Cowichan River	Cowichan River 400 m d/s PE247	E206107	
Upper Cowichan River	Cowichan River at 70.2 mile bridge	E332091	
Middle Cowichan River	Cowichan River at Horseshoe Bend	E334444	
Middle Cowichan River	Cowichan River at Stoltz Pool	E227752	
Middle Cowichan River	Cowichan River @ Sandy Pool	E286892	
Middle Cowichan River	Cowichan River at Vimy Beach	E234124	
Lower Cowichan River	Cowichan River at Allenby Bridge	E234125	
Lower Cowichan River	Cowichan River at Rotary Park	E333071	
Lower Cowichan River	Cowichan River 500 m d/s PE-1497	E284651	
Lower Cowichan River	Cowichan River at HWY#1	0120802	
Lower Cowichan River	Cowichan River 1 km. d/s PE1497 (d/s Somenos Creek)	E206106	
Cowichan Lake N. perimeter	Youbou #1 Cottonwood Estates	E271688	*E. Coli* only
Cowichan Lake N. perimeter	Youbou #2 West	E271689	
Cowichan Lake N. perimeter	Youbou #3 East	E271690	
Cowichan Lake N. perimeter	Cowichan Lake at head of south arm	E273063	
Cowichan Lake S. perimeter	Bear Lake – Lake Cowichan	E271685	
Cowichan Lake S. perimeter	Honeymoon Bay – Lake Cowichan	E271687	
Cowichan Lake tributary	Nixon Creek	E217514	*E. Coli*, turbidity and whole bottle NFR/TSS only
Cowichan Lake tributary	Robertson River	E217516	
Cowichan Lake tributary	Sutton Creek	E217515	
Cowichan Lake tributary	Shaw Creek	E217513	

Legend:
Yellow highlighted sites exclude total and dissolved metals

Table 6: Sample Sites by Group, Group Lead, and Access

Area	EMS Site Description	Group #	*Group Lead	Access
Upper Cowichan River	Cowichan River south side at Cowichan Lake weir	**Group 5 (green)**	BC Fisheries/At large	shore
Upper Cowichan River	Cowichan River 300 m u/s PE247			shore
Upper Cowichan River	Cowichan River 400 m d/s PE247			shore
Upper Cowichan River	Cowichan River at 70.2 mile bridge			shore
Middle Cowichan River	Cowichan River at Horseshoe Bend			shore
Middle Cowichan River	Cowichan River at Stoltz Pool			shore
Middle Cowichan River	Cowichan River @ Sandy Pool	**Group 6 (blue)**	CVRD/Somenos Marsh Wildlife Society/At large	shore
Middle Cowichan River	Cowichan River at Vimy Beach			shore
Lower Cowichan River	Cowichan River at Allenby Bridge			shore
Lower Cowichan River	Cowichan River at Rotary Park			shore
Lower Cowichan River	Cowichan River 500 m d/s PE-1497			shore
Lower Cowichan River	Cowichan River at HWY#1			shore
Lower Cowichan River	Cowichan River 1 km. d/s PE1497 (d/s Somenos Creek)			shore
Cowichan Lake N. perimeter	Youbou #1 Cottonwood Estates	**Group 3 (orange)**	CLRSS (Summer)/At large (Fall)	boat
Cowichan Lake N. perimeter	Youbou #2 West			boat
Cowichan Lake N. perimeter	Youbou #3 East			boat
Cowichan Lake N. perimeter	Cowichan Lake at head of south arm	**Group 4 (brown)**	CLRSS (Summer)/At large (Fall)	boat
Cowichan Lake S. perimeter	Bear Lake – Lake Cowichan			boat
Cowichan Lake S. perimeter	Honeymoon Bay – Lake Cowichan			boat
Cowichan Lake tributary	Nixon Creek	**Group 1 (yellow)**	At large/CLRSS	shore
Cowichan Lake tributary	Robertson River			shore
Cowichan Lake tributary	Sutton Creek			shore
Cowichan Lake tributary	Shaw Creek	**Group 2 (red)**	At large	shore

*Any affiliation by the lead sampler with an organization is reflected as the “Group lead”; however, it is important to note that there were numerous volunteers who collected samples every week in the same group who had no affiliation with the “Group Lead”. No affiliation is reflected as “At large”.

3.5 Sample Collection and Shipment

All samples for this project were collected either by volunteers, or by staff employed by supporting project partners. This approach i.e. the use of volunteers to collect samples (as opposed to contracting this service), was a deliberate decision on the part of the CWB for numerous reasons (T. Rutherford pers. Comm. July 25, 2024) including:

- increasing awareness about the role and activities of the CWB with regard to water quality monitoring in the Cowichan River watershed;
- increasing awareness amongst residents of the Cowichan Valley specifically about this project, the fish kill on the Cowichan River, and other CWB initiatives e.g. "Weir Ready";
- promoting the use of 'Citizen Science' to achieve CWB targets and outcomes;
- increasing capacity i.e. contributing to the Community of Practice, with respect to water quality monitoring expertise;
- supporting the priorities and existing programs of project partners e.g. CLRSS, CVRD, etc.; and
- efficient use of limited grant funding.

The use of this approach may have achieved the aforementioned outcomes (changes in social metrics e.g. knowledge and behavior were not measured as part of this project); however, acquiring a sufficient volunteer base to deliver the project was a challenge (see Section 5: Conclusions and Recommendations).

An initial target of 21 volunteers was established by the Project Coordinator for the project. The number of volunteers required was based on several criteria including:

- grouping sites to be sampled into local areas (originally envisioned as seven groups)specifically: south side tributaries to Cowichan Lake; north side tributaries to Cowichan Lake; south arm of Cowichan Lake; north arm of Cowichan Lake; upper Cowichan River; middle Cowichan River; and lower Cowichan River.
- utilizing a team of at least two samplers for each group for safety purposes i.e. a core of fourteen volunteers; and
- having an additional volunteer i.e. a back-up for each group who was familiar with the local area in the event assigned volunteers were unavailable.

Volunteers were actively recruited by the CWB, with the assistance of the Project Coordinator , through formal communication with partner organizations and supporting agencies e.g. newsletters, announcements/presentations at Board meetings, etc. and informally i.e. via word-of-mouth, to neighbours, friends, and acquaintances. Some volunteers committed to the entire project i.e. all five weeks in both the summer and fall sample horizons; however, some volunteers did indicate they were not available for some sample dates or were not available for more than one sample horizon e.g. summer sampling only.

In response to a shortage of volunteers, the sample site groupings were changed to reduce the number of groups to six by including the middle Cowichan River sites in the upper and lower Cowichan River groups. Additionally, ENV and CWB staff also 'volunteered' with the collection of samples on several occasions when volunteer assistance was otherwise limited (see Section 5).

A training workshop for all project volunteers and involved CWB/project partner staff was held in Duncan on July 25, 2024. The workshop was held to provide a brief overview of the project, familiarize volunteers with sample collection protocols and procedures and to provide a hands-on opportunity to collect samples on the Cowichan River and practice classroom training (Appendix G: Water Quality Workshop 2024 Lunch and Learn Agenda).

Grab samples were taken on Tuesday mornings from all sample locations at approximately the same time. This provided time for the Project Coordinator to deliver sample kits to key contacts, calibrate and disinfect field meters, etc. prior to sample day. Sampling usually began between 9:00 a.m.-10:00 a.m. and progressed from west to east i.e. from the headwaters of the watershed sequentially downstream. The time required to collect samples ranged between two and four hours depending on the Group being sampled e.g. Group 2 – two hours or Group 6 – four hours) and the experience of the team. Sample kits i.e. coolers, bottle packs, ice packs and YSI meters, were delivered to the key contact for each Group by the Project Coordinator at prearranged times and locations, typically the day before sample day. Water samples were picked up in the same sequence by the Project Coordinator, beginning at the headwaters of the watershed i.e. Group 2, Group 3, Group 4, Group 1, Group 5 and lastly Group 6. This sequence ensured that samples were delivered to the ACE courier depot in Duncan in time to have the samples ground shipped to ALS Environmental Laboratories in Burnaby within 24 of sample collection. Receipt of samples by ALS within 24 hours was critical to meet the analytical protocols for sample parameters e.g. *E. Coli* and avoid holding time exceedances.

Bottle labels were completed in the field when samples were collected. The date and time of collection and the EMS Site ID were recorded on each sample bottle. Preservatives provided by the lab were added to specified samples and specified samples were filtered with the filters and syringes provided by the lab in accordance with standard protocols. The date, start time and depth of sample collection, and meter readings i.e. pH, water temperature, dissolved oxygen, and specific conductivity, were recorded on duplicate lab requisitions (see Appendix C); meter readings were also recorded on the field notes forms.

In summary, a total of 23 individuals representing the ENV, CWB, four partner agencies (CVRD, CLRSS, B.C. Fisheries, Somenos Marsh Wildlife Society) and the public-at-large contributed 522.25 hours directly towards the collection of grab samples for this project. Individually, non-affiliated volunteers i.e. the public-at-large, contributed an

estimated 198.75 hours of the total effort to collect grab samples. Partner agencies contributed an estimated 214 hours of the total effort to collect grab samples (B.C. Fisheries – 27 hours); CVRD – 85.5 hours); Somenos Marsh Wildlife Society – 18 hours); and CLRSS – 83.5 hours). Project sponsors (ENV and CWB staff) also contributed an estimated 109.5 hours of the total effort, directly assisting in the field with grab sample collection.

4.0 BIOSECURITY

Biosecurity is defined as "a strategic and integrated approach to analysing and managing relevant risks to human, animal and plant life and health and associated risks for the environment." (WHO, 2010). Increasingly more often, these risks are from aquatic invasive species (AIS) threatening the health of our aquatic ecosystems. These threats come from a diversity of fish, invertebrates, plants and micro-organisms that are not endemic to the local aquatic environment.

There are a number of aquatic invasive species in the Cowichan River watershed. Governments, stewardship groups and other resource management agencies involved in aquatic ecosystem health are actively working to increase awareness and prevent the introduction (or further spread) of AIS. In the Cowichan River watershed, the CLRSS has targeted four 'alien invaders' for action in their strategic plan based on the biological and socio-economic risks they present. In order of priority these are: whirling disease (*Myxobolus cerebralis*); invasive mussels (zebra mussels – *Dreissena polymorpha* and quagga mussels – *Dreissena rostriformis bugensis*); eurasian watermilfoil (*Myriophyllum spicatum*); and yellow flag iris (*Iris pseudocorus*).

All of these organisms can be introduced or spread through the dissemination of contaminated water, sediment, or equipment. In some cases, e.g. whirling disease, microscopic amounts of infected material are sufficient to contaminate and infect water bodies. This can occur through any activity which moves equipment or water e.g. water sampling projects within or between watersheds, particularly if the equipment is not disinfected or decontaminated according to rigid, AIS specific protocols and procedures.

In July 2023, British Columbia became the second province in Canada (following Alberta in 2016) to become whirling disease positive. The Province is still quantifying the current extent of infection and whirling disease specific biosecurity protocols and procedures e.g. best management practices and standard operating procedures for the plethora of water based activities in the Province, are still being developed. The approach to biosecurity for this project was based on general "Clean, Drain Dry" principles (Appendix H). Specific protocols for whirling disease were adopted from work done in Alberta (DePape 2016) as protocols and procedures were not otherwise provided or available for this project (see Section 5).

The biosecurity principles generally applied in the planning and delivery of this project included:

- collecting samples from the headwaters of the watershed and moving sequentially downstream to avoid the potential transmission of disease from lower reaches upstream;
- disinfecting sample equipment provided by the Project Coordinator between sample dates according to approved whirling disease decontamination protocols; and
- disposing of potentially contaminated sample equipment after use e.g. filters, syringes and collection bottles, according to approved whirling disease decontamination protocols.

Disinfection procedures specifically for whirling disease included:

- disinfecting all coolers and related sample gear with a 1500 ppm solution of QUAT Plus between every use; and
- providing a minimum of 48 hours drying time for electronic meters (in direct sunlight when possible) between every use.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Project Planning and Design

1. A high-level review of the water quality sampling work i.e. WQA monitoring completed previously and the recommendations arising from that work would have helped inform the planning and design of this project. Sharing that information with all staff involved in this project prior to its commencement, and any additional work that was planned related to the project at hand would have been invaluable to the Project Coordinator and the volunteers. A process e.g. forum, meeting, etc. to share this information should be considered as part of the next project.

2. The availability of key staff e.g. the Project Sponsor, primary contacts for partner agencies, Group volunteer contacts, and core CWB staff contributed significantly to the ability to address problems as they arose and the implementation of solutions in a timely manner. A contact list should be developed and available to key staff prior to the commencement of the project. A standing weekly meeting/phone call between the Project Coordinator and both the Project Sponsor and Project Manager should be scheduled at the beginning of the project.

3. The risks and benefits associated with using volunteers to collect water samples should be re-evaluated for future projects. The accuracy and precision of the data collected by this project has significant value (biological and socio-economic) at multiple levels of government and is critical to the successful outcome of many projects. As evidenced, the limited response to volunteer recruitment efforts necessitated the significant involvement of project partners, sponsors and staff as documented in the summary of hours included in this report.

4. The safety of those involved in the collection of water samples is of paramount importance. Potential safety concerns were discussed during the training workshop and the need for personal protective equipment (PPE) was identified e.g. a suitable personal floatation device (PFD) and possibly the use of protective eyewear (given the use of acids as sample preservatives in the field). Although there were no first-aid or medical-aid injuries or accidents reported it is strongly recommended that a formal hazard assessment and risk analysis (HARA) be conducted for all of the tasks involved in this or similar projects, following prescribed Occupational Health and Safety processes, before the next project.

5. The involvement of staff and volunteers in potentially hazardous water sampling activities under often extreme environmental conditions raises potential legal liability concerns in the event of an accident. It was assumed that those 'volunteers' affiliated with a partner agency e.g. CVRD, were insured i.e. protected by WorkSafe BC as paid employees during their activities; however, the status of public-at-large, CLRSS members and other volunteers with respect to insurance coverage in this project was unclear. The Project Coordinator was covered by WorkSafe BC under the terms of the contract with CWB, as was the subcontractor; however, the issue of insurance and indemnification should be investigated further and addressed as required for future projects.

6. Volunteers worked in pairs for safety purposes so far as possible; however, there were a number of sample days when a volunteer worked alone. This poses a potential safety concern particularly given the poor/no cell reception in some of the more remote areas of the Cowichan valley e.g. Southshore road west of Lake Cowichan. An informal check-in process was established by the Project Coordinator with the Group team leads for both safety reasons, and to coordinate the pick up of water samples on sample days. A more formal 'journey management' approach has been adopted by industry and government as a Best Management Practice (BMP) where staff are frequently working alone in remote areas. The development of a Standard Operating Procedure (SOP) for working alone in remote areas is recommended for future projects.

7. The development of a biosecurity protocol (which can utilize existing BMP's for water sampling activities and decontamination procedures), with specific attention to whirling disease, should be a high priority for the CWB (and any agencies involved in any in-stream activities in British Columbia). Decontamination procedures should be specific to priority AIS e.g. whirling disease, and should clearly define not only the methods and materials required but also the role and responsibilities of contractors, employees and volunteers involved in a project. The following guide is a useful template: https://open.alberta.ca/dataset/c6a491b1-632f-405a-8f1a-1bad4b16127d/resource/94afd608-483e-4637-b822-5b0f57ca3c0c/download/decontaminationprotocol-watercraft-equipment-aug30-2017.pdf

8. The preparation of bottle labels and the assembly of sample kits by the lab saved a tremendous amount of time (as opposed to receiving individual sample bottles and labels as had occurred on past projects); however, assembling sample kits by site and week including appropriate lab requisitions and field notes forms, Chlorophyl a sample bottles, etc. still required several days prior to the start of both the summer and fall 5-in-30 sample horizons. It is recommended that this approach be adopted as the 'new normal' for future water sampling projects. It is important to ensure that sufficient lead time i.e. approximately six weeks, for the procurement and delivery of sample materials be included in any project plan.

9. Ground truthing the precise location of each sample site is critical. Although data entered in EMS is QA/QC'd, it is apparent that errors have occurred on previous projects with respect to both site descriptions and locations i.e. latitude and longitude coordinates. All proposed sample sites should be located, with the assistance of individuals previously involved in sample collection whenever possible, prior to the commencement of any project. A review of the site descriptions and latitude/longitude coordinates for all sites in EMS which were sampled for this project is strongly recommended as a number of them were incorrect as initially provided! Correct coordinates and detailed site descriptions have been provided in Table 2 and Table 3 respectively to assist with that process.

5.2 Project Execution and Delivery

1. A number of errors occurred in the entry of data on lab requisitions in the field by volunteer samplers. These problems related primarily to the "collection start", "collection end" and "depth" fields on the requisition form. Although these were discussed in the training workshop, (and communicated by the Project Sponsor to the Project Coordinator) a mid-project review to discuss problems to date and solutions would have been useful. This could be accomplished very effectively via a half-day workshop between the summer and fall sample horizons.

2. Sample sites were grouped to facilitate ease of sample collection and minimize the total time required by any group to collect samples. It was also imperative that samples be delivered to the courier on time i.e. no later than 3:00 PM for overnight delivery to ALS Environmental Laboratories in Burnaby. Sample groups were also assigned to volunteers who lived/worked closest to those sites. This process worked well and all samples were collected and shipped as planned with no hold time exceedances. In future, the time it takes to collect samples (by volunteers vs. trained staff) and compliance with biosecurity protocols i.e. sampling from the headwaters downstream, should be considered when developing the project design.

3. Samples and related documentation i.e. bottle labels, lab requisitions and field notes, were QA/QC'd and completed/corrected as necessary by the Project Coordinator in the field as samples were collected from Group leads. This process typically required 0.5 – 1.0 hour per group, depending on the number of sites within

the group, and the experience of the sampler(s). This approach ensured that the lab received samples with relatively few transcription errors (R. Barlak, pers. comm. August 20, 2024). In future, consideration should be given to arranging for the short-term use of a suitable space in Duncan for this purpose.

4. Samples were consolidated (while retaining the integrity of bottle packs from each sample site) into as few coolers as possible at the courier depot to reduce the number of coolers required and related shipping costs. An initial shipment of 41 coolers (Appendix I, Photo 8), including approximately 100 gel-type ice-packs, was received at the home of the Project Coordinator. Gel packs were used to keep samples cold in accordance with ENV protocols (1-4^{o}C). Additional coolers (15) and ice packs (30) were required to complete the project because of very warm summer temperatures and because of the inclusion of a replicate sample on each shipping date. Careful consideration to the number of coolers/ice packs and the storage space and location for these supplies should be included in initial project planning to minimize labour, mileage and shipping costs.

5. A shipping account with ACE courier in Duncan for the CWB was established for efficiency and tracking purposes at the onset of the project. All Bills of Lading were retained in order to track shipments and were provided to the CWB Project Manager (D. Paydli) for cost tracking at the end of the project.

6. The collection of Chlorophyll a samples was sporadic and incomplete because the artificial substrates at most sites disappeared during the summer sample horizon or were vandalized. Some were found on the stream bank and were put back in-stream by volunteers when samples were collected, complicating or invalidating data. In future, it may be helpful to identify these 'plates' as being property of the Government of B.C., and sign the sample site to indicate that research is being conducted. This may prevent the physical removal of the plates in the event they were viewed and removed as garbage by the public.

7. A number of suggestions were made by volunteers directly involved in sampling which would improve efficiency and reduce errors These are:
    - complete bottle labels so far as possible e.g. EMS Site ID and date when sample packs are received from the Project Coordinator i.e. before going into the field on sample day. This keeps labels dry and they are easier to complete at the kitchen table than on the stream bank in the rain!
    - print lab requisitions and field notes forms on waterproof paper e.g. "Write in the Rain"; and
    - provide an indelible fine point 'Sharpie', a clipboard, and a water thermometer to all volunteer groups.

5.3 Project Follow up

1. The recognition luncheon held at the end of the project was well attended and well received by volunteers. It should be included as part of the next project; however, many volunteers expressed a desire to know more about the actual data obtained from the samples they collected. This could be accomplished by proactively sending volunteers a copy of the final WQA monitoring report, or an email with a link to same (recognizing that the data was not available at the time of the recognition luncheon). Whenever possible, provision of a high-level summary of the data to volunteers during or at the end of the project would be highly desirable.
2. Consider holding a workshop at the end of the project for all of those involved which is designed to answer the following questions: What went well? and What can we improve next time? This could be combined with the volunteer recognition/thank-you event.

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Appendix A: Grab Sampling (Analytical and QA/QC)

Ministry of Environment and Climate Change Strategy

SURFACE WATER QUALITY STEWARDSHIP TOOLBOX

Grab Sampling (Analytical and QA/QC)

This is an information checklist template for a water quality monitoring project where grab samples (filling bottles with water to send to a laboratory) are collected at the same time as field data (collected with handheld instruments). Grab samples are used for additional water quality parameters that are not measurable using a field instrument, or for quality assurance/quality control (QA/QC) sampling.

QA/QC sampling allows lab and field meter readings for specific conductance and turbidity data to be directly compared to one another; ideally QA/QC will occur on 10% of samples (i.e., one in every ten). Replicate (taken at the same time, one directly after the other) grab samples can also be taken to QA/QC grab sample procedures. The grab sample QA/QC and field data results should be within 25% of one another. If not, it could indicate sampling protocol drift or an instrument malfunction. When/if this happens, seek guidance from a water quality specialist.

Collecting water samples properly for lab analysis is necessary to ensure that lab analysis is accurate. Errors in sampling technique can lead to sample contamination. Standard procedures for sample collection can be found in The BC Field Sampling Manual (found here: https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual). Below is a summary guide for water quality stewardship group grab sampling.

This template is based on taking five weekly samples within a 30-day period, also called "5 in 30s", which are used to compare these results to the chronic BC Water Quality Guidelines. It is very important that none of the five sample dates are missed, or the data cannot be directly compared to chronic guidelines/objectives. **Note, your project may vary depending on project goals, additional sampling parameters, and partnership agreements.**

The following items can either be directly requested from the laboratory or, if a partnership with ENV is supported and the project plan includes ensuring data are entered into the provincial database, ENV may provide these items:

- 5 coolers labelled by week
    - 1 cooler per week
        - To send to local lab (drop off at courier prior to closing time on the sample day) once sampling is completed. Avoid sampling on Thursdays or

Fridays as courier and lab opening times my be restricted on weekends and hold times for samples may be exceeded

- Sample bottles in the coolers labelled by site and parameter to be sampled
  - Write sampling date and time on each bottle (best done just prior to sample collection)
- Ice packs or bottles in the coolers (send as much as possible)
  - Fill with water (if bottles) and freeze at least one day before the sample day
- Requisition forms (ENV partnership)/chain of custody forms (direct from lab) in coolers
  - In each cooler there will be a general chemistry form (in duplicate) for the sites you will be sampling
  - At each site, fill in required information on both copies, then separate the copies. Keep one copy for your records (to submit to ENV at end of sample period), and send the other, sealed in the plastic bag, inside the cooler with the samples to the lab
  - When filling in the form, fill in date in the format YYYY-MM-DD HH:MM (24 hr). For stream samples just below the surface, record depth as 0m

Ensure you have the following miscellaneous small items (ENV partnership provides):

- Roll of packing tape for taping cooler closed during shipping
- Permanent ink pen
- Waybill for shipping, labels with lab address on them

If this is part of ENV partnership sampling, your ENV water quality contact in the partnership will give field sampling instructions on:

- Preparing for field day
  - Preparing sample bottles and requisition forms for all sites (as above). Note some labs have special bottle/sample procedures such as triplicate bottle rinsing prior to taking a sample, filtering a sample or addition of preservatives – always confirm with the lab if there are any special requirements
- Taking samples
  - When taking any samples, avoid crossing the stream whenever possible. Disturbing sediments will alter lab results and field test results. If you must cross a stream, cross **downstream** of the sampling site to avoid influencing results.
  - Sample bottles should be held into the upstream water flow (i.e., with the hand on the downstream side of the bottle, with flow going into the bottle) to avoid pollutants on the hands being collected in the bottle. Skin oil, hand sanitizer, and other such chemicals can influence lab results. Wear laboratory grade gloves (powder-free latex or nitrile gloves)

    - Submerge the mouth of the bottle entirely, keeping the mouth higher than the base of the bottle, in case there are preservatives in the bottle
    - Most bottles have a level to be filled to. Avoid overfilling, especially if your samples require a preservative
    - Do not place the bottle lid on the ground or touch the inside the bottle. This will contaminate the sample and the readings will be unreliable. If possible, use powder-free latex or nitrile gloves
    - Some samples require preservatives. Always attempt to put the preservative into the sample as close to collection as possible
        - Preservatives may be corrosive (e.g., acids), follow recommended safety precautions as applicable (e.g., wear gloves, safety goggles)
    - If you are collecting field parameters at the same time, make sure this is done as per the Field Meter Stream Sampling procedures (separate Toolbox information sheet)
- Notetaking (recording relevant information about sample site and surrounding area)
    - See Field Observation procedure document (separate Toolbox information sheet) for the most common factors to record
    - Notes should only be completed at the sampling site. Record any changes in conditions like weather as you arrive at each site
    - Always record any potential collection errors that occur while sampling (e.g., dropping bottles, animals crossing upstream of sample site, deviations from protocols) so that any discrepancies in lab results caused by such errors can be explained
- Store samples for transport/shipping
    - Cooler should be filled as much as possible to prevent bottles from moving excessively inside the cooler. Bottles are always stored upright. Some samples are collected in glass bottles and immobilizing them or surrounding them with soft packing material such as bubble wrap is important to keep the samples from breaking. Use ice bottles (loose ice is messy) to maintain temperature (4°C) and limit bottle movement. In summer heat, approximately half the cooler should be filled with ice bottles
- Before taping up a cooler, ensure the filled in requisition forms (remember to retain duplicate for ENV records) are in a resealable plastic bag, and in the cooler with the samples. Tape an address label onto the cooler and tape the cooler closed
- Ship cooler the same day sampling occurred, if possible. Most samples can be shipped overnight and not exceed laboratory hold times. For parameters with very short hold times or in more remote areas where shipping time may take longer, consider if expedited courier service needs be requested
- Upon dropping off cooler at courier, retain a copy of the waybill to submit to ENV for invoicing records (ENV partnership)

Appendix B: Field Meter Stream Monitoring

Ministry of Environment and Climate Change Strategy

SURFACE WATER QUALITY STEWARDSHIP TOOLBOX

Field Meter Stream Monitoring

This is a template information checklist for a water quality monitoring project collecting only temperature, dissolved oxygen (DO), conductivity, and turbidity data using field instruments in a river or stream. It outlines taking five weekly samples within a 30-day period (5 in 30s) in order to compare results to chronic (long-term) BC Water Quality Guidelines (https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines). **Your project may vary depending on project goals, additional sampling parameters, and partnership agreements.**

Most volunteer 5 in 30 sampling occurs during summer low flow and fall flush periods. It is very important that none of the five sample dates are missed, or the data cannot be directly compared to the chronic guidelines/objectives. Valuable sampling periods to add, if applicable, are spring freshet in high snowfall areas, spring fertilizer application periods in agricultural areas, or summer/fall fertilizer application periods in forests.

Spring melt/freshet	**Spring fertilization**	**Summer low flow**	**Fall flush**
Start date should be as close to snowmelt event as possible	Start as close to fertilizer spreading as possible, usually in March/April	Start in August as close to low flow as possible	Start date should be flexible to capture fall first flush event (first large rainfall) after summer

What you should have to complete sampling (may vary depending on project):

- Trained field samplers
- Temperature/DO/conductivity meter, turbidity meter
- If performing quality assurance/quality control (QA/QC) with grab samples, you may have sample bottles in a cooler with requisition forms (see separate grab and QA/QC sampling instructions)
- Calibration items
    - Conductivity standard solution (bottle), turbidity standard solutions (included in turbidity kit)
    - Meter maintenance supplies (extra batteries, screwdriver to access battery compartment, Kim Wipes, residue-free dry air canister, extra DO membranes/solution, brush for cleaning conductivity sensor, bottle with clean water for rinsing equipment after turbid sites)

- Folder of paperwork
    - List of sites and site descriptions, map (if available); sampling, calibration, and safety protocols, access agreements (if applicable)
- Miscellaneous items
    - Field notebook with waterproof paper/data entry tablet
    - Pencils
    - Drinking water and snacks
    - Camera
    - Sample gloves
- Safety gear
    - Safety check-in arranged (tell someone where you are going, your expected return time, and keep them informed)
    - Regular sites: good boots, first aid kit, appropriate clothing/protection for the weather or site hazards, gear for water condition (e.g., PFD)
    - Logging road sites: above items plus reflective vests, hardhat, VHF radio (if applicable) (know logging road callout procedures)

Upon completion of any seasonal sample period, do quality control on your data and submit the applicable data sheets to ENV Project contact.

Upon completion of all project sample periods (i.e., mid-November, if not earlier), return all loaned items, as well as field notes back to your group head, if applicable.

Contact information (fill in contact information organized during project planning phase):

ENV contact (responsibilities may vary but usually help with meters, sample protocols, technical advice)	**Other partner contacts (responsibilities will vary with partner but may include logistics, help with meters)**

Stream Monitoring Protocols

PREPARATION FOR FIELD:

1. Ensure field meters have adequate battery power (charge or replace batteries).

2. On the day before or the morning of the sample day (within 24 hours of site visit), calibrate meters as per instructions on calibration protocols. **Record calibration results in a calibration log.**
    a. NOTE – For our purposes conductivity is measured and recorded as specific conductance (SpC). SpC is electrical conductivity corrected/compensated to 25°C. Ensure the field meter is set to compensation at 25°C (not another temperature value) and that the SpC (not the conductivity) value is recorded.
3. For sample day, check that your sample party of minimum two people (for safety) have all items needed for sampling listed above.

IN THE FIELD:

1. If you have to walk in the stream, always walk downstream of where you will be taking your sample, being careful not to disturb sediment.
2. Prep field sheet: date and time (24 hr clock), EMS ID site number, site name, and sampler name.
3. Make notes on site conditions (weather, changes from last visit, anything that may obviously be affecting water quality).
4. Temperature/DO/conductivity meter (your meter may vary but for this outline we will talk about using a YSI meter) readings:
    a. Prep YSI probe by removing clear calibration/storage cup and replacing it with black perforated cover (protects probes), turn YSI meter on.
    b. Place YSI probe **gently** as far out in stream as possible in flowing water (if possible) downstream of where turbidity sample is to be taken, to ensure no sediment is disturbed. YSI probes should be fully submersed in the flowing part of the stream, as close to perpendicular as possible, and not laying in fine sediment that can be easily disturbed.
        i. Wait for readings to stabilize (30 - 60 seconds for YSI galvanic DO sensor; this may vary depending on meter used, always refer to manual that came with your meter) and record results into field notebook, including name of parameter measured and units in which it was measured (Temp: ^{o}C, DO: mg/L, Specific Conductance (SpC): µS/cm, pH: pH units).
    c. Turn off YSI meter.
    d. Remove black perforated cover and replace with clear calibration/storage cup, ensuring cap has 0.5 cm water (clear creek water is fine) in bottom. Note: too much water can cause the probes to need more frequent replacement.
5. Turbidity meter
    a. Due to the wide variety of turbidity meters available, detailed instructions are not included here. Please refer to the manual that came with your meter.

b. Turbidity readings are very susceptible to contamination and thus poor-quality results if there is any protocol drift. Maintain clean instruments, do not disturb sediments, and follow instructions exactly as recommended in turbidity meter manual.
c. Write results into field notebook, including name of parameter measured and units in which it was measured (Turbidity: NTU).
d. Turn off turbidity meter.
e. Clean and dry meter and any additional components for proper storage.

6. Collecting replicates or a water sample (if performing QA/QC)
    a. Please see detailed instructions in separate Stream Grab Sampling (QA/QC) Procedures if filling bottles for QA/QC.
    b. If taking replicate field meter readings for QA/QC, simply record a second reading following the above procedures for 10% of samples.

UPON RETURN FROM FIELD:

1. Ensure that any specific post-sampling equipment care is completed. Recharge and replace batteries if applicable.
2. Store equipment in a cool dry location. Know proper storage procedures for all equipment (e.g., storage between sample dates and winterization) to extend life of equipment.
3. Do QA/QC on field notes (check for transcription errors, missing information or out of range data – more details on QA/QC are outlined in **Stewardship Data QA/QC Guidelines** information sheet), then store field notes in a safe place or submit to appropriate project partner. Transcribe data results from field notes to an electronic file or upload instrument data to a secure archive (if applicable).
4. Set calibration date for next site visit.
5. Return any borrowed equipment if applicable.

Appendix C: Sample Lab Requisition

WATER, GENERAL CHEMISTRY AND BACTERIOLOGICAL REQUISITION ALS Global

Province Of British Columbia
Ministry of Environment

Req # 50264559

Urgent?	**Csr No.**	**Office** 10	**Client** DW
Study		**Project** N/A	
Lab	ALS Global		
Ministry Contact	RRBARLAK Rosie Barlak		
Sampler	BC Fisheries and CVRD		
Signature			
EMS Id	E206108	**Well Plate #**	
Location	COWICHAN RIVER SOUTH SIDE AT COWICHAN L. WIER		

Sampling Agency

Code 10	**Name** Vancouver Island, Nanaimo
Address	2080-A Labieux Road
City	Nanaimo
Postal Code	V9T6J9 **Phone** (250)751-3100

Number of Containers

Instructions To Lab email results to Ministry Contact and to: admin@cowichanwatershedboard.ca

State FW Descriptor GE Collection Method GRB

No.	Class	Collection Start YYYY-MM-DD HH:MI	Collection End YYYY-MM-DD HH:MI	Depth Upper	Depth Lower	Tide	Comment
1	REG	2024-07-25 13:30		0m			
2							
3							
4							
5							
6							

GENERAL (250 mL PLASTIC)

	Acidity pH 8.3
	Alkalinity Titration Curve
	Alkalinity: Total: pH 4.5
	Alkalinity: Phenolphthalein
	(500 mL Plastic) Biochemical Oxygen Demand (BOD)
	Bromide
	(500 mL Plastic) Carb. Biochem. Oxygen Demand (CBOD)
	Carbon: TIC
	Chloride
	Colour: True
	Fluoride
X	Nitrogen: Nitrate and Nitrite
X	Nitrogen: Nitrate
X	Nitrogen: Nitrite
X	pH
X	Phosphorus: Diss. ortho-phosphate
	(500 mL Plastic) Residue: Filterable (TDS)
	(500 mL Plastic) Residue: Nonfilterable (TSS) Subsample 3 mg/L LOR
	(500 mL Plastic) Residue: Nonfilterable, Fixed
	(500 mL Plastic) Residue: Total (TS)
X	Specific Conductance
X	Turbidity
X	Sulphate

GENERAL NUTRIENTS (125 mL AMBER GLASS) - H2SO4

	Carbon: TOC
	Chemical Oxygen Demand (COD)
X	Nitrogen: Ammonia
X	Nitrogen: Total
X	Nitrogen: Total Kjeldahl
X	Nitrogen: Total Organic
X	Phosphorus: Total

GENERAL (125 mL AMBER GLASS) - FIELD FILTER, H2SO4

	Carbon: DIC (Field Filter)
X	Carbon: DOC (FF, H2SO4)
	Nitrogen: Dissolved Kjeldahl (FF, H2SO4)
	Nitrogen: Total Dissolved (FF, H2SO4)
X	Phosphorus : Total Dissolved (FF, H2SO4)

METALS: TOTAL

High	Low	
X		Metal Pkg. (ICPMS) - HIGH (60 mL Plastic) - HNO3
		Metal Pkg. (ICPMS) - LOW (60 mL Plastic) - HNO3
		Mercury - 40mL Glass, HCl
X		Hardness (60 mL Plastic) - HNO3

METALS: DISSOLVED

High	Low	
X		Metal Pkg (ICPMS) - HIGH (60 mL Plastic)-Field Filter, HNO3
		Metal Pkg. (ICPMS) - LOW (60 mL Plastic)-Field Filter, HNO3
		Mercury - 40mL Glass, Field Filter, HCl
X		Hardness (60 mL Plastic) - Field Filter, HNO3

SPECIFIC Tests

	Obs Well Package
	Cyanide: SAD (60 mL Plastic + NaOH)
	Cyanide: WAD (60 mL Plastic + NaOH)
	Sulphide: Total (125 mL Plastic, ZnAc & NaOH)
X	Residue: Nonfilterable (TSS) -Whole Bottle - 1 mg/L LOR (150 mL Plastic)
	Chlorophyll a (250 mL Brown Plastic Bottle or Filter) Vol:
	Phaeophytin (250 mL Brown Plastic Bottle or Filter) Vol:

ORGANICS

	BTEX (2 X 40 mL glass vials, NaHSO4 or Na2S2O3, No headspace)
	VOC Full List (2 X 40 mL glass vials, NaHSO4 or Na2S2O3, No headspace)
	Volatile Hydrocarbons (VH) (2X40 mL glass vials, NaHSO4 or Na2S2O3, No headspace)
	Trihalomethanes (THM) (2 X 40 mL glass vials, NaHSO4 or Na2S2O3, No headspace)
	VPH (2 X 40 mL glass vials, NaHSO4 or Na2S2O3, No headspace)
	EPH (2 X 100 mL Amber Glass, NaHSO4)
	PAH (2 X100 mL Amber Glass, NaHSO4)
	LEPH/HEPH (Calc) (2 X 100 mL Amber Glass, NaHSO4)
	Oil & Grease (2 X 250 mL Amber Glass, 2 mL 1:1 HCl or 1:1 H2SO4)
	Mineral Oil & Grease (2 x 250 mL Amber Glass, 2 mL 1:1 HCl or 1:1 H2SO4)
	Organochlorine Pesticides (OCP) (2 X 500 mL Amber Glass)
	Organophosphorus Pesticides (OPP) (2 X 500 mL Amber Glass)
	Polychlorinated Biphenyls (PCBs) (2 X 500 mL Amber Glass)
	Chlorophenols (Tri, Tetra & Penta) (2 X 500 mL Amber Glass, C6H8O6 & NaHSO4)
	Phenolics, Chlorinated (2 X 500 mL Amber Glass, C6H8O6 & NaHSO4)
	Phenolics, Non-Chlorinated (2 X 500 mL Amber Glass, C6H8O6 & NaHSO4)
	Phenols, Colorimetric (125 mL Amber Glass, H2SO4)
	Acid Extractable Herbicides (2 X 1 L Amber Glass, NaHSO4)
	Resin Acids (2 X 500 mL Amber Glass, C6H8O6 & NaHSO4)
	Fatty Acids (2 X 500 mL Amber Glass, C6H8O6 & NaHSO4)

BACTERIOLOGY

X	E. coli - MF
	Enterococci - MF
	Fecal coliform - MF
	Fecal coliform - MPN
	Fecal streptoc - MF
	Total coliform - MF
	Total coliform - MPN

OTHER Tests

chl a on 3 foam cores(SA/core:4.91 cm2))

Smpl No.		FIELD TEST Details	Method	Results	Units
1	PH-F	pH-Field	FLD	7.2	pH units
1	TEMF	Temperature-Field	FLD	19.3	C
1	DO-F	Dissolved Oxygen-Field	FLD	3.3	mg/L
1	SC-F	Specific Conductivity-Field	FLD	405	uS/cm

Report ID: EMSR0900 Date: 2024-06-05 14:04

Appendix D: Cowichan Watershed Water Monitoring and Fish Response Workshop, Draft Agenda. March 12, 2024

Cowichan Watershed Water Monitoring and Fish Response Workshop

Towards a clear plan for detecting and responding to risks to juvenile fish

DRAFT Agenda

March 12, 2024
8:30 am – 4:30 pm
Si'em Lelum Gymnasium
5574 River Rd, Duncan BC

Workshop Purpose and Objectives:

The purpose of the workshop is to bring together community leaders, technical experts (reflecting both Indigenous and scientific knowledge) and stewards in the Cowichan Watershed to develop a clear and coordinated plan for detecting and responding to key risks to juvenile fish rearing. Following upon the devastating fish kill that occurred in the Cowichan River during July 2023, this workshop is grounded on a profound and deep commitment among all interested parties to come together in advance of what is expected to be another summer of drastically low flows and hot temperatures, and develop an effective and implementable water quality monitoring and fish response plan.

This is the first of likely several working sessions that are anticipated (but funding is not yet confirmed for) prior to the summer. Specific objectives of the first session are to:

a. Develop a common understanding of current water quality sampling and other relevant monitoring regimes in the Cowichan River;
b. Explore together the design of an ideal water quality sampling regime that tracks what we know about key impacts;
c. Apply collective knowledge to assess current water quality monitoring gaps and develop strategies to fill them;
d. Design, clarify and invite participation in a technical process for detecting and responding to lethal water quality conditions; and
e. Time permitting, brainstorm an initial list of possible response strategies for further deliberation at a future session.

Anticipated Outcomes include:

1. Renewed understanding of the wicked problem confronting the Cowichan River ecosystem, and renewed relationships among the people and organizations working to address it
2. High-level gap analysis of the current water monitoring and sampling regime
3. High-level water monitoring plan, and defined actions for implementing the plan this summer
4. Initial list of potential response strategies (time permitting)

Questions for participants to consider before the workshop include:

- Given your knowledge of water quality monitoring and the issues at play, what do you think are the key gaps in our current regime?
- Does the organization you represent have time or resources to dedicate to an enhanced monitoring program on the Cowichan River this year?
- If so, what do you need in order to bring these forward into a collaborative effort?
- If water conditions become poor, do you have ideas or concepts on potential responses that would help prevent a fish mortality event in the Cowichan River?

Time	Item
8:30 am	Informal Networking, Coffee and Snacks Settle into room space
9 am	Meeting Opening, Purpose and Objectives Territorial Welcome Opening Remarks and Workshop Objectives - *Cowichan Tribes representative TBC* - *Support from Jessica Bratty (facilitator)* Group Introductions
9:30 am	Key Background and Potential Pathway Ahead Why this workshop, now - *Tom Rutherford* Followed by questions and brief discussion
10 am	Current Approach to Water Quality Monitoring Overview of current programs and initiatives, across sectors *Heather Pritchard* Followed by questions and discussion
10:30	SHORT BREAK
10:50	What Could an Ideal Monitoring Regime Look Like? Outline of a potential water monitoring regime for the Cowichan, that tracks what we need to know and where to detect lethal summer conditions - *Mike McCullogh, WLRS* Followed by questions and group discussion
11:45	From Where We Are to Where We Want to Be..."Straw Dog" Monitoring Plan Gap Identification Plenary brainstorm and reflections
12:15	LUNCH
1 pm	Key Lessons and Priorities Initial reflections on what is emerging as a water quality monitoring plan, key lessons from elsewhere, answering the question what do we HAVE to do? - *Ken Ashley* Followed by group discussion and prioritization
2 pm	Strategies to Advance Monitoring Priorities Small group breakouts to identify: - strategies for advancing priorities in the emerging plan; - key barriers that need to be overcome
2:45 pm	SHORT BREAK
3 pm	Detailed Planning for Implementation Report back Followed by detailed action planning on how to advance the strategies or address the barriers Summary of key next steps
4 pm	Process Next Steps
4:15	Close
4:30 pm	Adjourn

Appendix E Field Notes Form and Example Field Notes

<u>Date (YYYY-MM-DD)</u> <u>General weather conditions</u> <u>Air Temp (°C)</u> Recorder

<u>Time (HH:MI)</u> <u>Site Name</u> <u>EMS ID</u>

Temp: **°C** **SpC:** **uS/cm** **pH:**

DO: **mg/L** **Turb:** **NTU**

<u>Site notes:</u>

<u>Date (YYYY-MM-DD)</u> <u>General weather conditions</u> <u>Air Temp (°C)</u> <u>Recorder</u>

<u>Time (HH:MI)</u> <u>Site Name</u> <u>EMS ID</u>

Temp: **°C** **SpC:** **uS/cm** **pH:**

DO: **mg/L** **Turb:** **NTU**

<u>Site notes:</u>

<u>Date (YYYY-MM-DD)</u> <u>General weather conditions</u> <u>Air Temp (°C)</u> <u>Recorder</u>

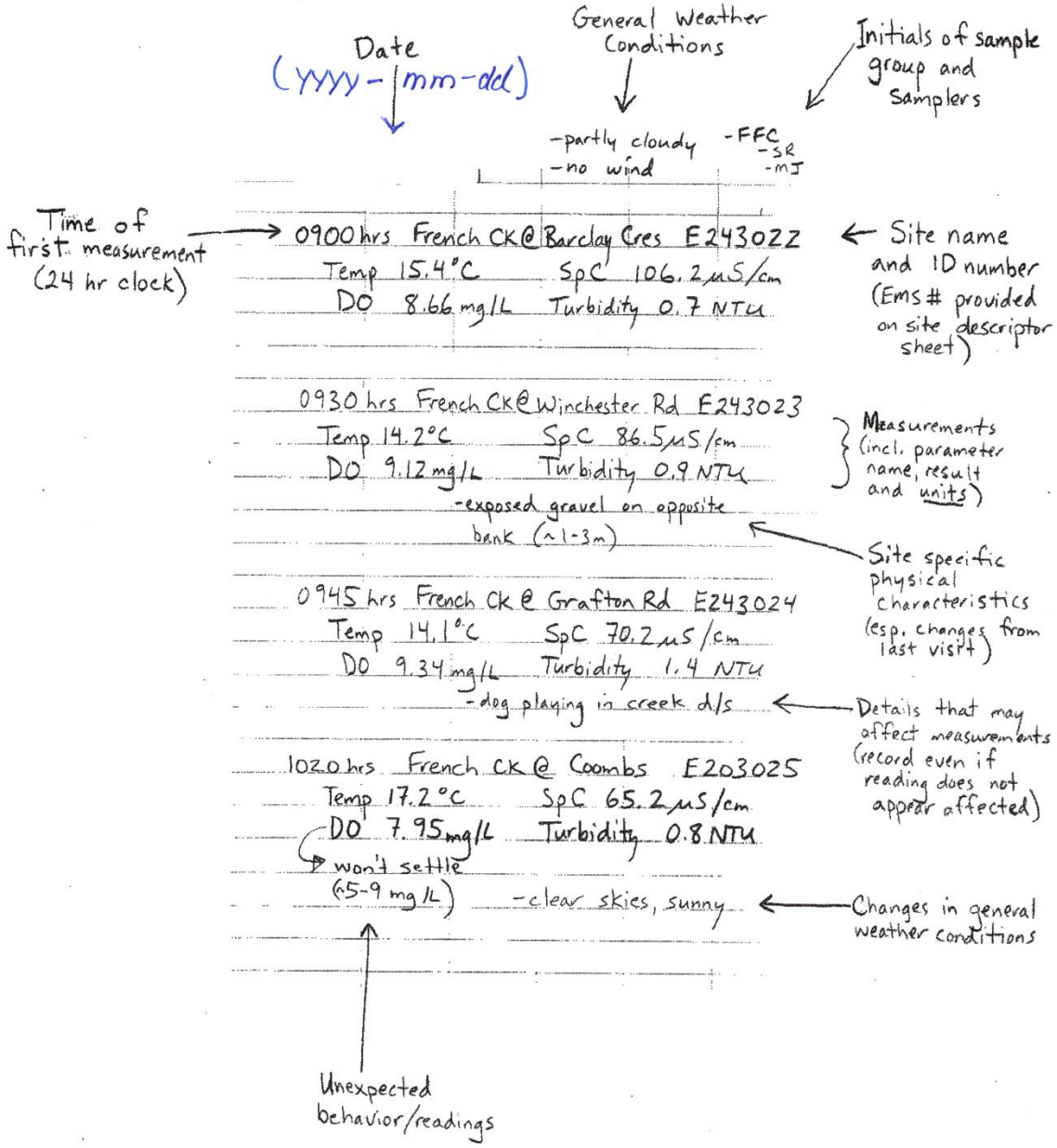
<u>Time (HH:MI)</u> <u>Site Name</u> <u>EMS ID</u>

Temp: **°C** **SpC:** **uS/cm** **pH:**

DO: **mg/L** **Turb:** **NTU**

<u>Site notes:</u>

SAMPLE FIELD SHEET
(required information)



Appendix F: Field notes for 2024 Grab Samples

2024 WQA Sampling Field Notes -- Cowichan Watershed

EMS ID	Sampler	Date	Time *	DO (mg/l)	SpC (us/cm	Temp	pH	Site Notes	Weather conditions
E206108	JD, IM	2024-07-30	10:25	8.13	53.50	21.90	7.43	Off dock at Jakes	overcast
0120808	JD, IM	2024-07-30	10:55	8.49	53.70	21.90	7.49	sample in riffle	bright, overcast
E206107	JD, IM	2024-07-30	11:35	8.62	84.60	21.90	7.49		overcast
E332091	JD, IM	2024-07-30	12:20	8.45	55.00	21.80	8.44	In riffle u/s trestle	overcast
E334444	JD, IM	2024-07-30	13:00	7.96	57.80	21.10	8.05	In pool off bedrock	overcast
E227752	JD, IM	2024-07-30	13:30	8.14	63.20	19.40	6.94		overcast
E286892	AS, BH, KB	2024-07-30	8:50	9.46	62.10	19.00	6.85	5 common mergansers fishing; two logs new over towards river right upstream 5m from sampling point; saw an American Dipper; good flow; Chlor A block had less than usual styrofoam; both centre pieces of syringes were dropped!!	overcast
E234124	AS, BH, KB	2024-07-30	10:05	9.20	62.30	19.10	7.75	rock walls still there, thick white foam along far bank in 3 spots; 8 mm precipitation in last 24 hrs.	dissipating clousds, air temp. 15 C, rain
E234125	AS, BH, KB	2024-07-30	10:52	9.45	62.20	19.20	7.50	N/A	cloudy, light rain, air temp 20 C
E333071	AS, BH, KB	2024-07-30	11:35	10.46	62.70	19.40	7.50	flow is a bit stronger from rrain in last 24 hours; a dog ran towards the probe just as numbers were coming; a dog ran in about 20m as we took samples; rock walls diverting flow; railroad track river right 50m away; woody debris	light rain and wind; air temp: 20 C
E284651	AS, BH, KB	2024-07-30	13:25	10.57	63.00	19.80	7.72	strong flows so samples were taken 200m upstream of the usual site	cloudy, light wind
E206106	AS, BH, KB	2024-07-30	12:20	9.30	70.80	19.40	7.04	3 river otters; 3 killdeer, yellow leg?; Canada Goose; algae bloom seems less now; 1 fry; blackberries ripening	cloudy, light rain, air temp 20 C
E271688	LV	2024-07-30	10:35	8.55	53.60	21.20		quiet, calm, no other boats; YSI meter was not calibrated for SpC; water depth was 30 ft.	overcast, calm, air temp: 17C
E271689	LV	2024-07-30	10:47	8.66	55.30	21.20		quiet, calm, no other boats; YSI meter was not calibrated for SpC; water depth was 150 ft.	overcast, calm, air temp: 17C
E271690	LV	2024-07-30	10:55	8.44	55.30	21.10		quiet, calm, no other boats; YSI meter was not calibrated for SpC; water depth was 50 ft.	overcast, calm, air temp: 17C
E273063	CM	2024-07-30	11:25	8.35	49.10	22.10		YSI meter was not calibrated for SpC i.e. DO only	overcast, cloudy, cool
E271685	CM	2024-07-30	11:54	7.84	54.40	20.80		YSI meter was not calibrated for SpC i.e. DO only	overcast, cloudy, cool
E271687	CM	2024-07-30	12:15	8.71	57.80	21.40		YSI meter was not calibrated for SpC i.e. DO only	overcast, cloudy, cool
E217514	SC	2024-07-30	10:55	10.06	110.10	14.80		approx. 100m upstream of bridge over Southshore Rd.; good flow in stream; YSI meter not calibrated for SpC	overcast, light rain, calm, air temp: 16C
E217516	SC	2024-07-30						***NO SAMPLE COLLECTED -- NO WATER IN STREAM***	
E217515	SC	2024-07-30	10:55	9.12	108.10	16.10		approx. 100m upstream of bridge over Southshore Rd.; some evidence of human activity on riverbank above sample site; YSI meter not calibrated for SpC	overcast, light rain, calm, air temp: 16C
E217513	MC	2024-07-30	10:25			13.00		no one else there, no animals, no pets, clear water, running	cloudy, slight drizzle, no wind

2024 WQA Sampling Field Notes -- Cowichan Watershed

EMS ID	Sampler	Date	Time *	DO (mg/l)	SpC (us/cm	Temp	pH	Site Notes	Weather conditions
E206108	IM, KB	2024-08-06	8:00	8.52	N/A	22.5		notes indicated probe set to measure mercury not Spec. Cond; however, after a call Dave clarified that the meter doesn't measure SpC and the 750.5 "mercury" reading on the display was barometric pressure!	overcast and cool; air temp: 16C thick, low cloud
0120808	IM, KB	2024-08-06	9:00	8.61	N/A	21.4			cloudy and cool; air temp: 18C
E206107	IM, KB	2024-08-06	9:36	8.53	N/A	22.3		#1 styrofoam fell in container; site access is quite overgrown - safety?	cloud cover starting to clear;
E332091	IM, KB	2024-08-06	11:44	8.94	N/A	22.3		no chlorophyll panel; YSI meter doesn't measure SpC	sunny/clear/warm
E334444	IM, KB	2024-08-06	11:12	9.34	N/A	21.2		dog and kids downstream in river; YSI meter doesn't measure SpC	sunny/clear
E227752	IM, KB	2024-08-06	10:38	9.18	N/A	20.4		Provided a YSI meter which doesn't measure SpC	full sun
E286892	EJ, AS	2024-08-06	8:40	9.10	58.4	19.3	6.96	chlor A block done now- no more styrofoam	clear skies, air temp: 17C
E234124	EJ, AS	2024-08-06	9:26	9.02	59.2	19.4	7.76	dissolved metals bottle replicate had red floatyy thing in it; large green botttle replicate outside neck was touched; large rock walls still upstream 10m - now a log there too, changing flow a little	clear skies; air temp: 19C
E234125	EJ, AS	2024-08-06	10:18	9.03	59	19.8	7.85	more garbage on shore than nrmal; chair in water d/s; shells in water d/s (oyster??)	clear skies; air temp: 20C
E333071	EJ, AS	2024-08-06	11:00	10.44	59.5	20.7	7.08	dog in water for blue bottle filling approx. 10 m upstream and for metal bottles. Log upstream for gren big bottle, lots of dogs in water throughout sampling; human made rock diversion still there, dogs in stream for probe - 4 dogs, tip of yellow filter lightly touched by hand.	clear, sunny. Air temp: 20C
E284651	EJ, AS	2024-08-06	12:55	10.37	67.4	21.3	7.44	blue bottle cap dropped in river; trash upstream 1 m (2 cans); we had to walk upstream of site; black algae in water ; green stringy algae; some algae is starting to die, brown/blackish	
E206106	EJ, AS	2024-08-06	11:34	9.52	67.5	20.5	7.08	still green/brown algae on other side of river across from site; metal old bar in upstream of site just on bank but some in water still	clear skies, windy, air temp 21C
E271688	RV	2024-08-06	10:20	8.55	53.6	21.0		no other boats or human activity	calm
E271689	RV	2024-08-06	10:25	8.81	53.2	20.9		no other boats or human activity	calm
E271690	RV	2024-08-06	10:30	8.88	100	21.0		no other boats or human activity	calm
E273063	CM	2024-08-06	10:45	7.8	55.2	22.7			ripple, low wind, air temp: 18.0C
E271685	CM	2024-08-06	10:20	7.56	60.7	21.3			calm, NW wind, air temp: 18.4C
E271687	CM	2024-08-06	10:05	8.36	54.4	22.0			slight chop, NW wind, 6/10 cloud cover
E217514	SC	2024-08-06	9:35	10.21	112.3	15.3		Did not collect replicate sample by mistake; water still flowing; no evidence of fry; DO reading stabilized at 10.21 but then dropped after 5 minutes to 10.04 (recorded initial reading); samples were collected in Sutton Cr. bottles by mistake so were poured into Nixon Cr. bottles (preservative was emptied out first).	clearing
E217516	SC	2024-08-06						No water so no sample collected	
E217515	SC	2024-08-06						No water so no sample collected	
E217513	MC	2024-08-06	9:09			14.0		clear water, no people around	air temp: 17C; slightly overcast

2024 WQA Sampling Field Notes -- Cowichan Watershed

EMS ID	Sampler	Date	Time *	DO (mg/l)	SpC (us/cm	Temp	pH	Site Notes	Weather conditions
E206108	JD, IM	2024-08-13	10:10	9.33	53	22.0	7.33	off dock at Jake's	overcast, windy
0120808	JD, IM	2024-08-13	10:25	8.75	53	21.7	7.48	surface in Saysell's riffle	overcast
E206107	JD, IM	2024-08-13	10:55	8.55	53.1	21.8	7.52	surface in riffle; 3 cores collected for ChlorA	overcast
E332091	JD, IM	2024-08-13	11:32	8.45	54.1	21.2	7.82	overfilled E.Coli sample bottle - excess poured out; in glide u/s of trestle	overcast
E334444	JD, IM	2024-08-13	12:05	9.17	56.8	20.2	7.62	in pool off rock bluff	overcast
E227752	JD, IM	2024-08-13	12:35	8.87	58.6	20.1	7.49		overcast
E286892	AS, EJ, KB	2024-08-13	8:45	9.10	61.2	18.5	6.60	water clarity is fair to good; flow is good; some large woody debris in river slightly upstream close to far bank	air temp: 19C, cloudy, wind - W
E234124	AS, EJ, KB	2024-08-13	9:21	8.85	61.7	18.4	7.43	flat foam present at sample sites on river right; some health cedar river right upstream; sediment on rocks close to shore clears in stronger flow areas; some green algae on shore noticed for first time; good flow; good clarity; turkey vulture above waterfall	cloudy
E234125	AS, EJ, KB	2024-08-13	10:03	8.45	62.1	18.5	7.69	replicate sample collected; good flow; lots of brown sediment? Algae?; red osier dogwood; pacific/douglas aster; black hawthorne	air temp: 19C; cloudy; no wind
E333071	AS, EJ, KB	2024-08-13	10:50	9.29	62.1	18.6	7.86	blackberries ripening; full snowberries; dog in water upriver for last general bottle and for probe	air temp: 20C, cloudy; light breeze
E284651	AS, EJ, KB	2024-08-13	12:10	9.35	68.8	18.8	7.97	black algae on rocks in water; we had to walk upstream of site on way in; lots of green/brown long flowy alge in water and green and brown in pools; oil looking substance in pool near site; no Chlor A sample collected	air temp: 20C, light breeze; overcast
E206106	AS, EJ, KB	2024-08-13	11:25	8.06	58.8	18.5	7.62	less algae than last time on river left; lots of woody debris upriver on river left	air temp: 20C; cloudy, very light breeze
E271688	LV	2024-08-13	10:30	8.31	53.6	21.2 *		calm water (in a bay). No other human activitiy nearby	cloudy, light wind, air temp: 15C
E271689	LV	2024-08-13	10:35	8.60	53.6	21.2 *		No other human activity nearby	slight chop
E271690	LV	2024-08-13	10:41	8.70	53.5	21.1 *		collected replicate sample; no nearby activity	choppy waters, windy
E273063	KC	2024-08-13	9:13	7.87	55	22.2 *		quiet, no one around	overcast, light wind
E271685	KC	2024-08-13	9:50	7.80	61.5	20.1 *		quiet, weeds in shallow water	overcast, light wind
E271687	KC	2024-08-13	10:24	8.11	54.8	22.2 *		quiet	overcast, light wind
E217514	SC, BG	2024-08-13	9:39	10.17	113	15.5 *		water flowing well; stream further downstream below bridge goes mostly underground; fry visible at site	air temp: 16C, overcast, calm
E217516	SC, BG	2024-08-13						DRY; NO SAMPLE COLLECTED	
E217515	SC, BG	2024-08-13						DRY; NO SAMPLE COLLECTED	
E217513	MC	2024-08-13	9:16			14.0 *		TSS-WB bottle empty as cap was not tighened properly. I went back and collected a new sample in a new bottle. Sample may not have been collected at exactly the same place as previous samples. New sample collected at 11:10. clear water	air temp: 15C; no people or animal activity

2024 WQA Sampling Field Notes -- Cowichan Watershed

EMS ID	Sampler	Date	Time *	DO (mg/l)	SpC (us/cm	Temp	pH	Site Notes	Weather conditions
E206108	KB, IM	2024-08-20	8:40	8.60 *		21.2 *			light rain
0120808	KB, IM	2024-08-20	9:06	8.53 *		20.8 *		noticed slightly stronger flow; moved core block a bit closer to shore	light rain
E206107	KB, IM	2024-08-20	9:30	8.56 *		20.9 *		half of foam core ha fallen off and therest is loose	light rain
E332091	KB, IM	2024-08-20	10:20	9.27 *		20.4 *		dissolved nutrients glass botlte - some acid did not make it into the bottle	clouds, no rain
E334444	KB, IM	2024-08-20	10:55	9.49 *		19.6 *			clouds, no rain
E227752	KB, IM	2024-08-20	11:25	9.52 *		19.5 *			clouds
E286892	AS, EJ	2024-08-20	8:52	9.82	60.5	17.7	6.62	maybe higher flow (than last week); DO fluctuating a bit	air temp: 15C, light rain
E234124	AS, EJ	2024-08-20	9:35	9.70	61.3	17.6	7.04	rock walls still upstream; foam on river right still	air temp: 15C, overcast
E234125	AS, EJ	2024-08-20	10:22	9.73	61.1	17.7	7.32	dissolved nutrients bottle got a drop of unfiltered water in it so we poured it out, rinsed it with filtered water and restarted	air temp: 16C, overcast, some sun
E333071	AS, EJ	2024-08-20	11:15	10.16	61.3	18.2	7.45	replicate sample collected; lots of dogs in and out upstream; one dog pooped in water upstream and iver right of site ; tip of filter lightly touched by finger before dissolved metals sample collected	overcast, sunny breaks
E284651	AS, EJ	2024-08-20	13:07	9.86	68.0	18.8	7.56	hard to walk upstream of site to get here; still lots of long brown and spony and long green algae; black algae on rocks still in water ; lessalgae overall than last time; DO fluctuated a lot	overcast, sunny breaks
E206106	AS, EJ	2024-08-20	12:18	9.43	59.8	17.9	7.14	less algae in water river left; some algae maybe floating through; lots of little fish, one jumped; what we can see of stream bed looks very brown	overcast and some blue sky
E271688	LV	2024-08-20	10:00	7.97	52.9	21.2 *		no other activity; calm water	air temp: 14C, overcast, light rain
E271689	LV	2024-08-20	10:05	8.10	52.7	21.3 *		no other activity; calm water	air temp: 14C, overcast, light rain
E271690	LV	2024-08-20	10:10	8.01	52.8	21.3 *		no other activity; calm water	air temp: 14C, overcast, light rain
E273063	CM	2024-08-20	10:00	7.91	60.5	21.3 *			air temp: 17.6C; light rain, calm
E271685	CM	2024-08-20	10:30	7.46	65.4	19.4 *			air temp: 17.8C
E271687	CM	2024-08-20	10:45	7.95	59.6	21.3 *			air temp: 19.1C
E217514	SC, BG	2024-08-20	10:30	9.30	126.0	14.6 *		creek running well; up from last week; fry visible	air temp: 13.2, overcast, calm
E217516	SC, BG	2024-08-20						no water running so no sample collected	
E217515	SC, BG	2024-08-20	11:40	8.10	123.0	16.4 *		water now running in creek as a result of recent rains (no water last week); pool max. 3' deep; small inflow, no outflow; surface of pool at sample site looks still, numerous fry present	air temkp: 16.0c; overcast, calm
E217513	MC	2024-08-20	*	*		13.0 *		Air Temp: 13C. Water clear, no animals or people activity; flowing water; no time recorded on field notes or lab req. - likely around 11:00 am	overcast and had rained previous day and overnight

2024 WQA Sampling Field Notes -- Cowichan Watershed

EMS ID	Sampler	Date	Time *	DO (mg/l)	SpC (us/cm	Temp	pH	Site Notes	Weather conditions
E206108	JD, IM	2024-08-27	10:10	7.68	58.3	20.0	7.26	No field notes; from lab req.; sampled off dock	sunny, mixed cloud
0120808	JD, IM	2024-08-27	10:30	7.73	53.5	19.5	7.30	No field notes; from lab req.; Chlor A 3 foam cores	
E206107	JD, IM	2024-08-27	10:50	8.20	40.2	19.7	7.41	No field notes	
E332091	JD, IM	2024-08-27	11:35	8.52	54.4	19.0	7.96	in riffle at surface	mixed cloud
E334444	JD, IM	2024-08-27	12:05	7.81	57.7	18.6	7.59		mainly sunny
E227752	JD, IM	2024-08-27	12:30	8.97	59.8	18.7	7.48		sunny, blue skies, minimal clouds
E286892	AS, EJ, KD	2024-08-27	9:50	10.27	63.1	16.3	6.79	eagle overhead; rianed yesterday so bank less stable	clear skys; light wind
E234124	AS, EJ, KD	2024-08-27	10:36	10.08	58.1	16.2	7.25	foam on river right and slightly downstream; rock walls still diverting water upstream	clear skys
E234125	AS, EJ, KD	2024-08-27	11:23	9.85	64.5	16.4	7.47	person on river right 10m d/s site sitting under bridge was smoking; less garbage on site than last week because of river clean-up	cloudy with sunny breaks; slight wind
E333071	AS, EJ, KD	2024-08-27	12:12	10.26	64.5	17.1	7.53	dog upstream disturbed water upstream; tapped filter with finger	sun and clouds
E284651	AS, EJ, KD	2024-08-27	13:45	10.11	72.8	17.2	7.37	replicate; had to walk upstream to get here; filter plunger was touched; fallen tree in water 200m upstream; pH was drifting upwards	cloudy with sunny breaks; slight rain
E206106	AS, EJ, KD	2024-08-27	13:00	9.60	75.3	16.8	7.11	2 X jumping fish; small school of fry; otter catching fish.	sun and clouds
E271688	LV	2024-08-27	10:00	19.80	59.0	19.8 *		no activity nearby	air temp: 13C, rained yesterday; sunny, calm
E271689	LV	2024-08-27	10:05	8.59	58.9	19.8 *		no activity nearby	air temp: 13C, rained yesterday; sunny, light
E271690	LV	2024-08-27	10:10	8.70	59.0	19.8 *		no activity nearby	air temp: 13C, rained yesterday; sunny,
E273063	CM	2024-08-27	10:00	8.25	61.7	20.1 *			air temp: 15.0, choppy, mostly sunny, 7/10
E271685	CM	2024-08-27	10:30	7.76	70.6	17.6 *			air temp: 16.4C, 5/10 cloud cover
E271687	CM	2024-08-27	10:50	8.42	61.1	20.1 *			air temp: 17.3C, cloud cover 4/10, choppy
E217514	SC, BG	2024-08-27	10:40	9.88	128.6	12.6 *		more water visible than last week; samplesite is 5" deep; fry present	air temp: 5.8C; recently rained, calm, partly cloudy
E217516	SC, BG	2024-08-27				*		NO WATER SO NO SAMPLE COLLECTED	
E217515	SC, BG	2024-08-27	11:03	8.19	131.6	14.3 *		someone has dug a small trench from sample site, going downsteream for some distance. Wate is flowing out of the pool where samples were taken this week; fry present; sample site is 18" deep	air temp: 12C; partly sunny, slight breeze
E217513	KC	2024-08-27	10:35 *	*		12.0 *			sunny, blue skies, minimal clouds

2024 WQA Sampling Field Notes -- Cowichan Watershed

EMS ID	Sampler	Date	Time *	DO (mg/l)	SpC (us/cm	Temp	pH	Site Notes	Weather Conditions
E206108	IM, HP	2024-10-22	10:10	9.60		14.9	*	replicate sample collected; notable current	cloudy with sunny breaks; air temp: 8C
0120808	IM, HP	2024-10-22	10:50	9.40		14.6	*		sunny breaks; air temp: 10C
E206107	IM, HP	2024-10-22	11:30	9.60		14.8	*	big salmon and lots of fry	sunny with clouds; air temp: 10C
E332091	IM, HP	2024-10-22						access blocked so no samples collected	
E334444	IM, HP	2024-10-22	12:30	10.50		14.5	*	lots of jumping fish	cloudy with sun; air temp: 10C
E227752	IM, HP	2024-10-22	13:20	10.00		14.2	*		sun with cloud; air temp: 11C
E286892	CP, RB, EJ	2024-10-22	9:31	**9.5/11.02	54.7/59.8	14/13.1	6.53/7.01	fly fisherman downstream	partly cloudy
E234124	CP, RB, EJ	2024-10-22	10:41	9.35/10.67	55.3/59.2	13.9/12.9	6.58/7.11	sampled north? parking lot (high flow) - downstream of usual; boat anchored upstream	partly cloudy
E234125	CP, RB, EJ	2024-10-22	11:20	8.78/10.41	56.4/60.2	13.8/12.8	6.88/7.08	two fishermen on RB across road and slightly d/s of sample area (one fishing rod, one spear); very high flows (approx. 60 cms.)	partly cloudy
E333071	CP, RB, EJ	2024-10-22	12:01	10.35/8.63	59.0/55.6	13.9/13.0	6.76/7.19	dog by the water; tent across river	sunny; light breeze
E284651	CP, RB, EJ	2024-10-22	12:50	8.59/103.2	60.2/63.7	13.8/12.9	6.77/7.05	(DO value appears incorrect); blue heron	sunny
E206106	CP, RB, EJ	2024-10-22	13:28	8.84/10.82	58.3/62.9	13.9/13.0	7.04/7.31	seagulls, crows	partly cloudy
E271688	KM	2024-10-22	9:18	9.38	51.6	15.1	*		
E271689	KM	2024-10-22	9:38	9.58	51.5	15.1	*	replicate sample collected;	
E271690	KM	2024-10-22	9:58	9.21	51.4	15.1	*		
E273063	CM	2024-10-22	9:07	9.75	52.2	15.0	*		
E271685	CM	2024-10-22	9:36	10.52	48.6	10.6	*		
E271687	CM	2024-10-22	10:00	9.63	52.1	14.9	*		
E217514	SC, TR	2024-10-22	9:50	10.91	70.91	9.1	*		
E217516	SC, TR	2024-10-22	11:10	10.02	54.7	10.0	*		
E217515	SC, TR	2024-10-22	10:22	10.72	88.6	9.3	*		
E217513	MC	2024-10-22	8:53	*	*	9.0	*		

2024 WQA Sampling Field Notes -- Cowichan Watershed

EMS ID	Sampler	Date	Time *	DO (mg/l)	SpC (us/cm	Temp	pH	Site Notes	Weather conditions
E206108	IM, JD	2024-10-29	10:05	10.05	50.0	13.7	*		overcast, air temp: 12C
0120808	IM, JD	2024-10-29	10:25	10.2	51.9	13.2	*		overcast, cool, air temp: 12C
E206107	IM, JD	2024-10-29	11:00	10.3	50.2	13.6	*		overcast, air temp: 13C
E332091	IM, JD	2024-10-29	11:30	10.14	50.6	13.6	*	surface sample upstream of trestle	overcast, air temp: 13.0C
E334444	IM, JD	2024-10-29	12:05	10.9	52.2	13.2	*	sample off bluffs in pool	overcast, air temp: 12.2C
E227752	IM, JD	2024-10-29	12:35	10.6	52.7	13.1	*	downstream of boat launch	overcast, air temp: 12.7C
E286892	CP, DP, JT	2024-10-29	9:54	10.35	52.8	12.7	7.17	dog visited	mostly cloudy, foggy
E234124	CP, DP, JT	2024-10-29	10:38	10.37	52.9	12.6	6.67	high flow over willows	cloudy, foggy
E234125	CP, DP, JT	2024-10-29	11:21	9.6	53.6	12.5	6.62	garbage-plastic bottles; fish splashing at surface	cloudy, foggy
E333071	CP, DP, JT	2024-10-29	12:45	9.2	53.6	12.6	6.72	fish splashing at surface (salmon)	cloudy, a bit rainy
E284651	CP, DP, JT	2024-10-29	13:28	9.41	57.2	12.6	6.67	many seagulls; large logs floating; salmon splashing	cloudy, light rain
E206106	CP, DP, JT	2024-10-29	14:11	9.61	55.4	12.7	6.43	seagulls, bald eagle and waterfowl; lost lid for total nutrients - no sample taken	sunny, light drizzle
E271688	KM	2024-10-29	9:09	9.19	52.3	13.7	*	calm	overcast, air temp: 8.4C
E271689	KM	2024-10-29	9:28	9.56	51.5	13.8	*	calm	air temp: 8.8C
E271690	KM	2024-10-29	9:38	9.71	51.3	13.8	*	calm	air temp: 9.0C
E273063	CM	2024-10-29	9:19	9.66	52.9	13.7	*	8/10 cloud cover with precip; ripple	air temp: 7.2C
E271685	CM	2024-10-29	9:40	10.45	49.2	9.4	*	7/10 cloud cover; calm	air temp: 8.6C
E271687	CM	2024-10-29	9:57	9.75	52.9	13.7	*	6/10 cloud cover; ripple	air temp: 9.3C
E217514	SC, PB	2024-10-29	10:17	12.6	71.0	7.9	*	no evidence of fish	partially cloudy; air temp: 7.0C
E217516	SC, PB	2024-10-29	11:35	11.7	47.5	8.9	*	evidence of fish (coho?)	air temp: 8.3C
E217515	SC, PB	2024-10-29	11:04	12.17	87.0	8.3	*	Replicate sample done; no evidence of fish; excellent condition	partially cloudy; air temp: 7C
E217513	MC	2024-10-29	9:15	*	*	7.5	*	grading underway on road; water clear and fast running; no other people or animals	air temp: 3C

2024 WQA Sampling Field Notes -- Cowichan Watershed

EMS ID	Sampler	Date	Time *	DO (mg/l)	SpC (us/cm	Temp	pH	Site Notes	Weather conditions
								incorrectly recorded barometric pressure as SpC (754.3 mg Hg) geese	
E206108	HP/IM	2024-11-05	9:05	10.10	754.3	12.2	*	nearby; water calm,	cloudy with sun, no wind; air temp: 8C
0120808	HP/IM	2024-11-05	9:25	9.30	754.7	11.8	*	incorrectly recorded barometric pressure as SpC (754.7 mg Hg)	cloudy with sun; air temp: 8C
								incorrectly recorded barometric pressure as SpC (754.9 mg Hg); spawning	
E206107	HP/IM	2024-11-05	9:50	10.00	754.9	12.1	*	fish, noticeable sediment in filters	cloudy with sun; air temp: 8C
E332091	HP/IM	2024-11-05	10:45	10.00	756.7	11.8	*	incorrectly recorded barometric pressure as SpC (756.7 mg Hg)	cloudy; air temp: 8C
E334444	HP/IM	2024-11-05	11:30	11.10	759.8	11.8	*	incorrectly recorded barometric pressure as SpC (759.9 mg Hg)	cloudy; air temp: 8C
E227752	HP/IM	2024-11-05	12:00	10.80	763.1	11.7	*	incorrectly recorded barometric pressure as SpC (763.1 mg Hg)	cloudy with sun; air temp: 10C
E286892	RB/CP	2024-11-05						No access so no samples collected	
E234124	RB/CP	2024-11-05	9:21	10.48	54.1	11.1	6.75	spawning salmon, small, decomposed	cloudy (partly); air temp: 10.3C
E234125	RB/CP	2024-11-05	10:01	10.42	53.4	11	6.60	dead salmon; fishermen (spear fishermen)	partly cloudy
E333071	RB/CP	2024-11-05	10:41	9.85	57.2	11.1	6.56	seagulls, fish splashing, dogs at the water	partly cloudy; air temp: 10.3C
E284651	RB/CP	2024-11-05	11:36	9.87	59.1	11.1	6.81	many dead fish at site; bald eagles	partly cloudy; air temp: 10.8C
E206106	RB/CP	2024-11-05	12:18	9.87	57.5	11.2	6.69	seagulls, bald eagles, lots of dead fish	sunny
E271688	KM	2024-11-05	9:27	12.31	53.7	12.4	*	quiet	overcast, light wind
E271689	KM	2024-11-05	9:39	12.52	53.6	12.4	*	quiet	overcast, light wind
E271690	KM	2024-11-05	9:55	12.51	53.5	12.4	*	quiet	overcast, light wind
E273063	CM	2024-11-05	10:15	12.78	53.1	12.2	*	*(nothing recorded)*	8/10 cloud cover
E271685	CM	2024-11-05	9:35	12.62	57.4	8.3	*	*(nothing recorded)*	8/10 cloud cover, ripple; air temp: 7.4C
E271687	CM	2024-11-05	9:15	12.75	53.3	12.4	*	*(nothing recorded)*	6/10 cloud cover, ripple; air temp: 8.9C
E217514	SC, BG	2024-11-05	9:56	16.20	68.9	7.5	*	no evidence of fish, creek flowing well, in good shape	calm, high overcast, air temp: 6.0C
E217516	SC, BG	2024-11-05	11:15	15.60	49.2	8.1	*	clear, running well, chum salmon sighted	calm, high overcast; air temp: 7.0C
E217515	SC, BG	2024-11-05	10:54	15.75	84.0	7.8	*	good flow, no evidence of fish, downed tree 100m upstream	calm, thin overcast; air temp: 7.0C
E217513	MC	2024-11-05	9:25 *	*		7.5	*	no activity, creek high and flowing quickly	cloudy, no rain; air temp: 5C

2024 WQA Sampling Field Notes -- Cowichan Watershed

EMS ID	Sampler	Date	Time *	DO (mg/l)	SpC (us/cm	Temp	pH	Site Notes	Weather conditions
E206108	JD/IM	2024-11-12	10:10	10.20	50.1	11.6 *			rain; air temp: 8.0C
0120808	JD/IM	2024-11-12	10:35	10.10	53.5	11.4 *		salmon spawning in area	rain; air temp: 8.0C
E206107	JD/IM	2024-11-12	10:55	10.20	50.6	11.5 *			rain; air temp: 8.0C
E332091	JD/IM	2024-11-12	11:25	10.40	51.2	11.4 *		replicate sample at 11:30; salmon carcasses along shore	rain; air temp: 8.0C
E334444	JD/IM	2024-11-12	12:05	11.20	52.7	11.3 *			rain; air temp: 9.0C
E227752	JD/IM	2024-11-12	12:25	11.06	53.1	11.2 *		lots of salmon spawning upstream	rain; air temp: 10.0C
E286892	EJ/CP	2024-11-12	9:32	11.36	54.2	10.9	6.61	very high water level; dropped filter	rain, cloudy; air temp: 9.4C
E234124	EJ/CP	2024-11-12	10:10	11.05	54.1	10.7	6.71	high water level	light rain; air temp: 10.5C
E234125	EJ/CP	2024-11-12	10:42	11.00	54.4	10.6	6.75	dead salmon just upstream of site; fisherman across river	partly cloudy; air temp: 10.4C
E333071	EJ/CP	2024-11-12	11:13			10.7		seagulls (many); dogs around swimming; salmon (large) at sampling spot; fish splashing; missed collecting some parameters	partly cloudy; air temp: 10.5C
E284651	EJ/CP	2024-11-12	12:05	10.17	62.2	10.7	6.26	seagulls, dead salmon at sampling spot; fish jumping	partly cloudy
E206106	EJ/CP	2024-11-12	12:35	10.64	57.6	10.8	6.63	many seagulls; seal on the river shore (jumped into the water); fish jumping	partly cloudy
E271688	KM	2024-11-12	8:25	13.28	49.7	12.0 *			overcast, rain; air temp: 8.7C
E271689	KM	2024-11-12	8:36	13.49	51.1	12.0 *			Overcast; air temp: 8.6C
E271690	KM	2024-11-12	8:47	13.47	51.2	12.0 *			Overcast; air temp: 8.5C
E273063	KM	2024-11-12	9:08	13.35	50.9	11.7 *			Overcast, drizzle; air temp: 7.9C
E271685	KM	2024-11-12	9:27	14.53	47.3	8.3 *			overcast; air temp: 8.2
E271687	KM	2024-11-12	9:42	13.31	51.3	11.2 *			overcast, rain; air temp: 9.0C
E217514	SC, BG	2024-11-12	10:00	15.18	65.9	7.9 *		river flowing freely but not above banks; no evidence of fish	calm, overcast, sprinkling; air temp: 7.0C
E217516	SC, BG	2024-11-12	11:13	14.27	47.8	8.5 *		river flowing well; not over banks; fish spotted - coho; some dying Chinook	calm, overcast, light rain; air temp: 8.0C
E217515	SC, BG	2024-11-12	10:50	14.90	80.1	8.3 *		river flowing strongly; not over banks; fallen tree 3m above site; other fallen trees in water 100m above site.	calm, overcast, light rain; air temp: 7.0C
E217513	MC	2024-11-12	10:20 *	*		8.0 *			cloudy with light rain; air temp: 9C

2024 WQA Sampling Field Notes -- Cowichan Watershed

EMS ID	Sampler	Date	Time *	DO (mg/l)	SpC (us/cm	Temp	pH	Site Notes	Weather conditions
E206108	PB/IM	2024-11-19	10:06	10.20 *		10.4 *			cloudy, rain, cold; air temp: 6C
0120808	PB/IM	2024-11-19	10:36	10.10 *		10.2 *			cloudy; air temp: 4C
E206107	PB/IM	2024-11-19	11:02	10.30 *		10.3 *			cloudy; air temp: 4C
E332091	PB/IM	2024-11-19	11:49	10.40 *		10.1 *			cloudy; air temp: 2C
E334444	PB/IM	2024-11-19	12:30	11.30 *		10.0 *		replicate sample	cloudy; air temp: 2C
E227752	PB/IM	2024-11-19	13:17	11.30 *		10.0 *			cloudy; air temp: 2C
E286892	EJ/CP	2024-11-19	9:37	11.16	52.4	9.8	6.73	very high flow	cloudy, foggy
E234124	EJ/CP	2024-11-19	10:11	10.86	52.6	9.7	6.63	high flow; 5+ dead salmon at this site	
E234125	EJ/CP	2024-11-19	10:55	10.91	52.6	9.6	6.50	3+ dead salmon at site; great blue heron	cloudy
E333071	EJ/CP	2024-11-19	11:31	10.46	53.2	9.6	6.64	ducks, seagulls, dead fish; splashing fish; tent across river	cloudy
E284651	EJ/CP	2024-11-19	12:15	10.19	60.4	9.4	6.69	seagulls, bald eagle diving for salmon	cloudy
E206106	EJ/CP	2024-11-19	12:50	10.58	56.3	9.6	6.51	seagulls, ducks	cloudy
E271688	KM	2024-11-19	8:52	13.82	53.2	10.7 *			windy, choppy, overcast; air temp: 5.3C
E271689	KM	2024-11-19	9:04	13.69	52.2	10.8 *			windy, choppy, overcast; air temp: 5.1C
E271690	KM	2024-11-19	9:11	13.49	51.9	10.7 *			windy, choppy, overcast; air temp: 5.1C
E273063	CM	2024-11-19	10:30	13.29	50.5	10.4 *			light rain, wavy; air temp: 4.5C
E271685	CM	2024-11-19	10:05	12.93	53.3	7.1 *			light rain, wavy; air temp: 4.5C
E271687	CM	2024-11-19	9:45	13.19	53.3	10.8 *		replicate sample:	cloud 10/10, drizzle, rough; air temp: 5.6C
E217514	SC, BG	2024-11-19	10:15	17.13	69.3	5.9 *		river running well; down about 6" from last week; no obstacles; no evidence of fish	overcast, misty; air temp: 3C
E217516	SC, BG	2024-11-19	11:25	15.95	50.0	6.7 *		river running well; down slightly from last week; no obstacles; several coho - a school; 1 chinook jack, spawned out	heavy overcast, calm; air temp: 3C
E217515	SC, BG	2024-11-19	11:05	16.56	85.0	6.4 *		river running well; down noticeably from last week; fallen tree 20' upstream; no evidence of fish	overcast, heavy mist; air temp: 3C
E217513	MC	2024-11-19	9:10 *	*		6.0 *		snow patches along road; no animals or people activity; water clear and fast running	cloudy, no rain; air temp: 3.0C

Appendix G: Water Quality Sampling Workshop 2024 Lunch and Learn

Water Quality Sampling Workshop 2024
Lunch and Learn

Date/time: July 25, 2024, 0930
Place: Koksilah Room, Cowichan Community Centre, Duncan
Facilitators: Dave DePape, Heather Pritchard (CWB), Rosie Barlak (BC MOECCS)

Workshop Goals:

1. To inform volunteers about the reason for the sampling, provide a brief overview about the water sampling program e.g. what's being analyzed, so that volunteers understand how the data will be used to inform decision making;
2. To explain the logistics of the sample program and match up volunteers with available sample dates and locations so that the sampling schedule is complete for the summer and fall programs;
3. Provide training on how to conduct the required sampling so that resultant data is accurate and reflective of actual conditions in the watershed;
4. Practice what's been learned so that volunteers are comfortable with conducting the required sampling according to MOE protocols; and
5. Have fun and enjoy the workshop!

Agenda

0930-10:00	Greetings, welcome and introductions		Dave
	i. Welcome on behalf of CWB	Heather	
	ii. Overview of the day	Dave	
	iii. Introductions	All	
10:00-10:15	Overview of the sampling project and logistics		Dave
	iv. Context for the sampling e.g. fish kill, 5/30		
	v. Current program logistics (dates, locations, timing of sampling, etc.)		
10:15-10:30	Review schedule and fill current gaps		Dave/all
	vi. Gap analysis (where do we still need volunteers?		
	vii. Sample locations (review map of sites)		
10:30-11:45	Sample Collection training		Rosie/Dave
	viii. Overview of what's being sampled where		
	ix. Demonstration of sampling procedures		
	x. Sampling do's and don'ts		
11:45-12:15	Lunch (provided)		
12:15-??	Practice sampling at the Cowichan River		All

Appendix H: Clean, Drain, Dry Fact Sheet

Practice **CLEAN DRAIN DRY** to protect our lakes and rivers from the spread of aquatic invasive species.

CLEAN

plants, animals and mud from your boat and gear

- Ensure that anything you remove is disposed of onto land
- Do a visual inspection of the watercraft and gear to make sure everything is removed

DRAIN

all water from your boat and gear onto land

- This includes all internal compartments, ballast tanks, live wells, bilges, bait buckets, motors etc.
- Pull all plugs—it is illegal to transport plugged watercraft in some provinces and US states

DRY

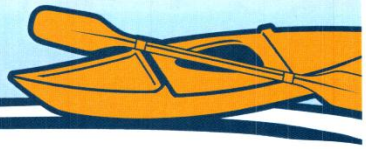
all parts of your boat and gear completely

- Make sure no water is left standing
- Use a sponge or towel for hard to dry areas

CleanDrainDry.ca

CLEAN DRAIN DRY

Prevent the Spread of Aquatic Invasive Species



What are aquatic invasive species?

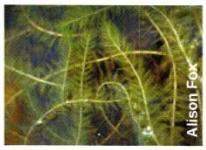
Aquatic invasive species threaten Canada's water bodies and the wildlife that rely on them. They spread alarmingly fast and can impact the environment and economy, and damage the recreational areas that we enjoy.

Water-based recreational activities can spread aquatic invasive species to new locations. Aquatic invasive species can cling to watercraft and gear, or be transported in standing water to new bodies of water. You can protect our lakes and rivers from aquatic invasive species by ensuring you **CLEAN**, **DRAIN** and **DRY** your watercraft and gear.

Watch for these and other aquatic invasive species!

Smallmouth Bass

American Bullfrog



Eurasian Watermilfoil

Flowering Rush

Brazilian Elodea

Zebra & Quagga Mussels

In BC:

For watercraft that have been operated outside of BC, AB, WA, ID, OR, or WY please contact the BC Conservation Officer Service **R.A.P.P. Hotline 1-877-952-7277** prior to entering BC waters. Additionally, all watercraft must stop at open designated watercraft inspection stations in BC. It's the LAW. Sightings of zebra or quagga mussels must be reported to the R.A.P.P. hotline.

ISC Invasive Species Council of BC

Fisheries and Oceans Canada / Pêches et Océans Canada

Canadian Council on Invasive Species / Conseil Canadien sur les Espèces Envahissantes

Report all suspected invasive species. Download the Report Invasives app.

IAS

CleanDrainDry.ca

Appendix I: Photograph Log

Photo 1: Cowichan Lake Weir , Sept. 2017

Photo Credit: Cowichan Watershed Board

Photo 2: Tubing on the Cowichan River

Photo Credit: Lake Cowichan River Tubing

Photo 3: A south-shore tributary (Nixon Creek)

Photo Credit: B. Greenway, CLRSS

Photo 4: Middle Section of Cowichan River (Vimy Beach)

Photo Credit: E. Jackson-Renz, CVRD

Photo 5: Lower section of Cowichan River (d/s of Somenos Creek)

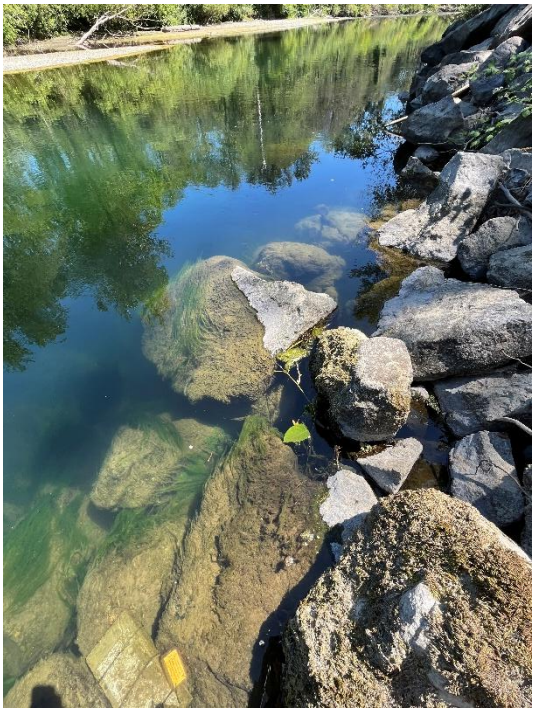


Photo Credit: E. Jackson-Renz, CVRD

Photo 6: A volunteer collecting samples at Nixon Creek (EMS ID 217514) on Aug. 21, 2024

Photo credit: B. Greenway, CLRSS

Photo 7: A volunteer taking a dissolved oxygen reading with a YSI meter at Nixon Creek

Photo credit: B. Greenway, CLRSS

Photo 8: Preparing sample kits for a sample day

Photo Credit: D. DePape

Photo 9: Sample kits being sorted by site.

Photo Credit: D. DePape

Photo 10: Robertson River, August 20, 2024

Photo Credit: S. Cumming