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# Surface Water Monitoring Strategy for the Cowichan Valley Regional District

## Monitoring Strategy in support of the Drinking Water and Watershed Protection Function

***Palmer Project#***
1904902

***Prepared By***
Palmer

July 2, 2020

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July 2, 2020

Kate Miller, Keith Lawrence
Cowichan Valley Regional District
175 Ingram Street, Duncan,
BC V9L 1N8

Dear Kate and Keith:

**Re: Surface Water Monitoring Strategy for the Cowichan Valley Regional District**
**Project #: 1904902**

Palmer is pleased to submit this report that describes the proposed surface water monitoring strategy for the Cowichan Valley Regional District.

We look forward to addressing any questions or comments you have on the proposed draft strategy.

Thank you for the opportunity to work with you on this project.

Yours truly,

Rick Palmer
President & CEO

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# 1. Introduction

The Cowichan Valley Regional District (CVRD) is approximately 3.5 x $10^5$ ha in surface area, with at least 20 watersheds wholly or partially contained within its boundaries (Figure 1.1; Table 1.1). The watersheds are of varying size, ranging from 1,100 ha for the Stocking Creek watershed to 93,000 ha for the Cowichan River watershed. The two largest watersheds wholly contained within the CVRD are the Cowichan River watershed and the Chemainus River watershed (Table 1.1). The three largest watersheds only partially contained within the CVRD include the Nanaimo River watershed, the Nitinat River watershed and the San Juan River watershed (Figure 1.1; Table 1.1). The relatively numerous smaller watersheds are located along the eastern shoreline of the CVRD, while the relatively fewer, larger watersheds are further inland and to the west (Figure 1.1).

Watershed pressures in the CVRD include activities associated with forestry, agriculture, and urban development due to a growing population. These pressures can result in stormwater runoff which mobilizes pollutants such as oil, fertilizers, septic waste, and animal waste. Although it is recognized that every watershed is unique and important, watershed pressures are relatively intense within the smaller watersheds in the eastern portions of the CVRD and less intense in the larger watersheds in the western portions of the CVRD (SNC Lavalin 2019).

In 2018, the CVRD established the Drinking Water and Watershed Protection (DWWP) Function designed to facilitate watershed management planning, to protect, maintain and/or enhance water quality long-term, and to increase public awareness of water-related issues.

To achieve the goals of the DWWP, it was recognized that a regional, watershed-based, surface-water sampling and monitoring strategy was required. A properly designed and executed monitoring program must provide a thorough characterization of surface waters and an understanding of the effects of watershed pressures, such as population growth and associated urbanization, forestry, climate change, and industrial and agricultural development, on surface water quality.

## 1.1 Historical Surface Water Monitoring

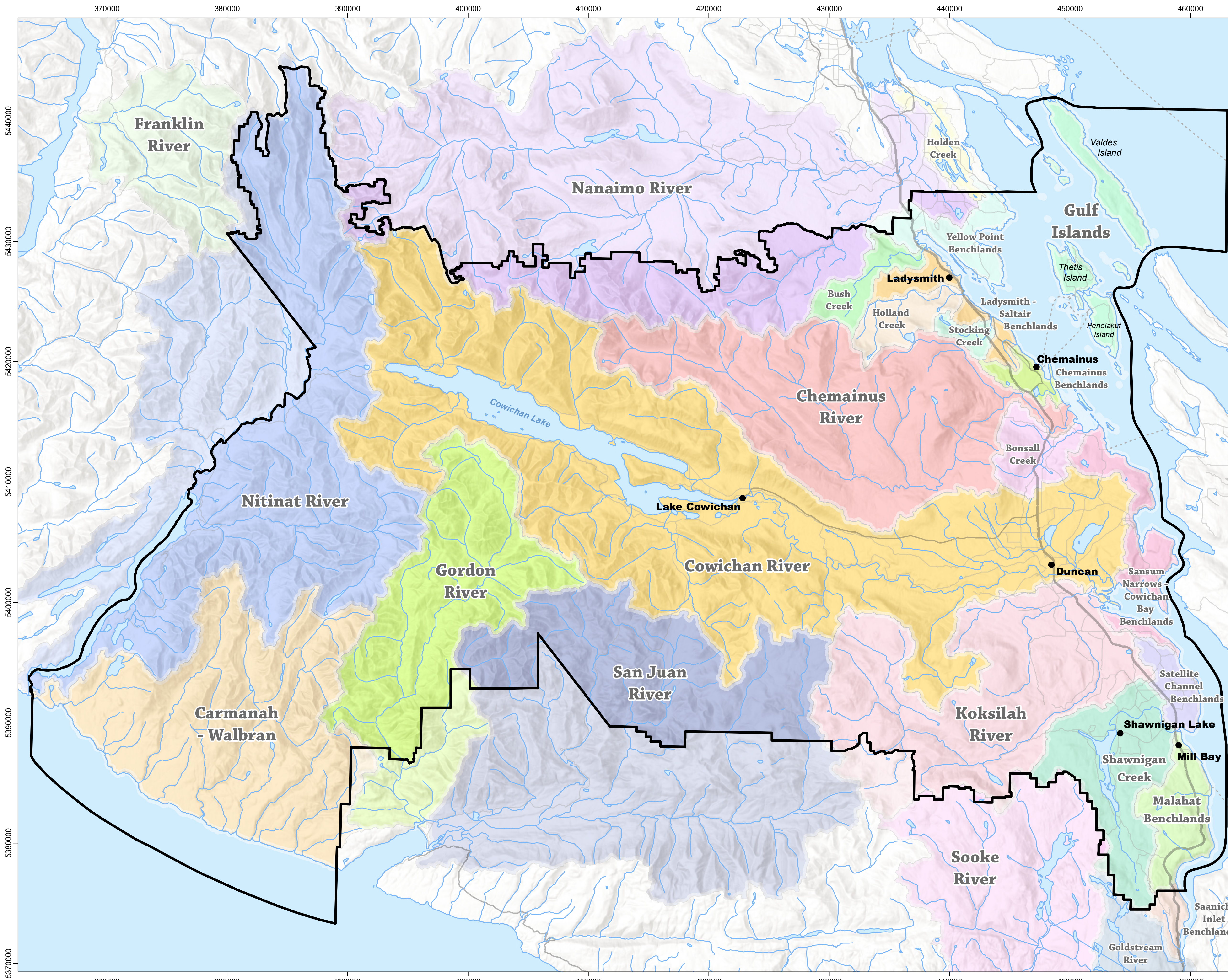
Numerous surface water monitoring sites have been established within the CVRD over the past several decades, and the data collected from these sites have primarily been stored in the provincial Environmental Monitoring System (EMS) database. In late 2019, a search of the EMS database indicated that the surface water dataset for the 20 watersheds in the CVRD included at least 248 EMS monitoring sites (Table 1.1) and approximately 16,000 surface water samples with potentially over 100 surface water analytes reported for each sample. The period of record included over 50 years of data, starting in 1968 and continuing to the present day (Appendix B, Table B.1). A request to the CVRD and partnering agencies was made for all available surface water data for the region. The data that were made available were those from the EMS database and from a local stewardship organization.

Seasonal trends analysis and characterization of surface water using conductivity and hardness resulted in the delineation of two main hydrological seasons, including a summer dry season (May – September) and winter rainy season (November – April). For many analytes, concentrations increased during the dry season and then decreased during the rainy season.

Temporal trends analysis was undertaken for the watersheds and sites with a consistent long-term data record. The result was determination of 17 statistically significant trends from five watersheds. The Cowichan River watershed had the highest number of analytes with significant temporal trends, including increasing trends for alkalinity, ammonia, nitrate, total nitrogen, and total phosphorus.

Due to inconsistent sampling and laboratory analysis, and a consequent lack of an adequate data record, it was not possible to complete a spatial analysis comparing surface water quality to land use impacts in CVRD watersheds.

The assessment of water chemistry resulted in many guideline and objective exceedances over the period of record, including for conductivity, dissolved oxygen, pH, temperature and turbidity. Overall, the monitoring sites with the largest datasets had the greatest number of exceedances. Temperature and conductivity were the two analytes that had the largest number of exceedances.




LEGEND:

- City/Town
- CVRD Boundary
- Highway/Road
- Ferry Route
- Watercourse
- Waterbody

Notes:
1. Watershed boundaries provided by Cowichan Valley Regional District.
2. Base map data provided by Natural Resources Canada (CanVec 250k) and Esri basemap service (World Hillshade, World Street Map).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CLIENT: Cowichan Valley Regional District

PROJECT: Watershed Planning

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Figure 1.1

**CVRD Boundary and Watersheds**

Project No. 1904902
Date: Apr 08, 2020
Revision: 1

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***Table 1.1 Cowichan Valley Regional District Watersheds and total number of EMS sites within each watershed***

| Watershed Name | Approximate Watershed Area (ha) | EMS Sites (n) |
|---|---|---|
| Bonsall Creek | 3,600 | 0 |
| Bush Creek | 2,800 | 0 |
| Carmanah-Walbran | 36,000 | 9 |
| Chemainus River | 36,000 | 10 |
| Chemainus Benchlands | 1,500 | 2 |
| Cowichan River | 93,000 | 77 |
| Gordon River | 31,000 | 5 |
| Gulf Islands | 5,000 | 0 |
| Holland Creek | 3,100 | 4 |
| Koksilah River | 31,000 | 24 |
| Ladysmith - Saltair Benchlands | 2,700 | 0 |
| Malahat Benchlands | 2,800 | 7 |
| Nanaimo River | 83,000 | 4 |
| Nitinat River | 81,000 | 20 |
| San Juan River | 67,000 | 4 |
| Sansum Narrows – Cowichan Bay Benchlands | 4,700 | 11 |
| Satellite Channel Benchlands | 4,300 | 4 |
| Shawnigan Creek | 9,900 | 64 |
| Stocking Creek | 1,100 | 3 |
| Yellowpoint Benchlands | 4,000 | 0 |
| **Totals** | **503,500*** | **248** |

*The total watershed area is greater than the size of the CVRD (approximately 350,000 ha) because it includes the total watershed area for all those watersheds that are only partially within the CVRD boundaries (see
Figure 1.1).

## 1.2 Objectives

The purpose of this Regional Surface Water Monitoring Strategy is to support the CVRD DWWP goal to protect water quality at the source. The objectives of this Strategy are to:

- Identify surface water bodies where water quality problems are occurring and may be threatening aquatic ecosystem health, ecosystem services, and drinking water
- Enable the identification of water quality management actions

The Strategy contains five separate tasks (Figure 1.2) and was designed to provide the consistent, comprehensive and foundational surface water data required for spatial, seasonal and temporal trends analysis, for surface water characterization and determination of normal range, and for development of water quality objectives and subsequent assessment of water quality.

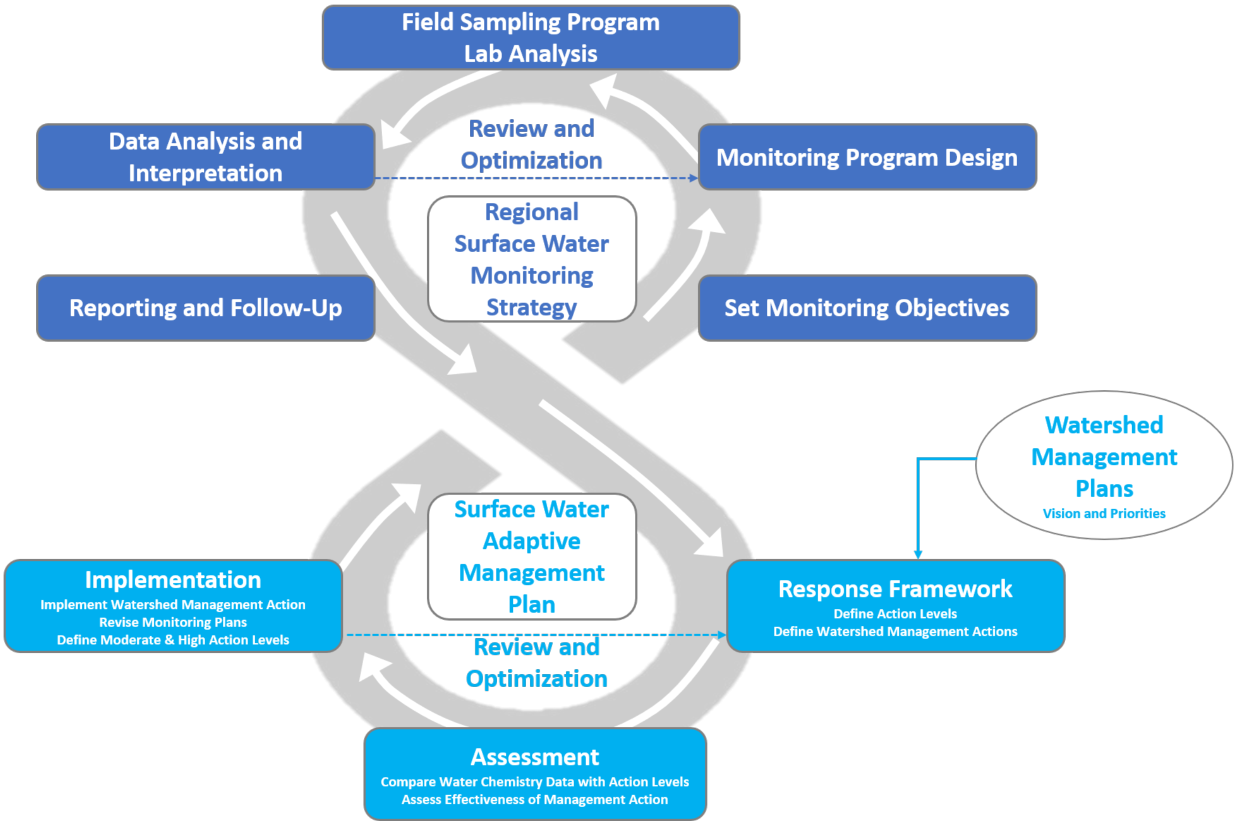



***Figure 1.2 Surface water monitoring strategy, and adaptive management plan flow diagram (adapted from CCME, 2015, and MVLWB & GLWB, 2019)***

The collection and analysis of surface water data within the Regional Surface Water Monitoring Strategy were considered essential to support the science-based development of watershed-level Adaptive Management Plans (AMP), as required to support the DWWP (Figure 1.2). The overall goal of a watershed-based AMP is to provide a systematic watershed management response to the results of water quality assessment (e.g. MVLWB & GLWB 2019).

A watershed-level AMP (Figure 1.2) is initially supported by development of a Watershed Management Plan (e.g. SSG 2016, WRGI 2007) that through consultation sets out a vision and conservation priorities and management actions for a watershed. Based on the identified priorities in the Watershed Management Plan, a response framework is then developed. The primary activity in developing a response framework is the definition of Action Levels and management actions. For surface water the Action Levels are predetermined triggers which, if exceeded, require a watershed management response. Action Levels must include both a degree of severity (i.e. BC Water Quality Guidelines) and spatial extent and should be as specific as possible. Through reporting and follow-up the response framework is then implemented through comparison of the water chemistry data with the Action Levels. If an Action Level is exceeded, then predetermined watershed management actions are implemented (Figure 1.2). Among the management actions is a re-evaluation of the Surface Water Monitoring Strategy.

# 2. Monitoring Approach and Rationale

A two-component watershed monitoring program was developed for the CVRD based on an analysis of the available data for all CVRD watersheds and the long term objectives of the DWWP to assess the impacts of land use on water quality.

The first component included the development of a relatively limited group of permanent long-term monitoring sites in the CVRD. The first component was designed to provide a consistent, long-term data record suitable for spatial, seasonal, and/or temporal trends analysis. It was expected that the location and number of these sites would evolve through discussion with stakeholders.

The second component included the development of a short-term monitoring program designed to increase monitoring intensity at sites or watersheds identified as at risk (i.e. exceeding Action Level triggers), or as requiring development of watershed-specific water quality objectives. This component included the short-term intensive sampling of a relatively large number of sites concentrated in a relatively small area. This second component was also consistent with the monitoring strategy that has been developed and implemented by the BC Ministry of Environment and by the Nanaimo Regional District (Plewes, 2018): the Nanaimo Regional District ten year water quality and land use trend analysis was reviewed to assess if parallels could be inferred given the similar landscape and growth patterns and to where possible build synergies within the two programs.

## 2.1 Long-Term Monitoring

An essential tool for aquatic ecosystem management is trends analysis, which includes spatial trends analysis, seasonal trends analysis, and long-term temporal trends analysis.

### 2.1.1 Rationale

Spatial trends analysis requires sample collection at multiple locations within a watershed. In creeks and rivers spatial trends analysis provides understanding of alterations in water chemistry moving from high-elevation headwaters to final lowland deltas at the mouth of creeks and rivers. In lakes spatial trends, such as depth profiles, can provide understanding of physical lake structure and ecosystem function (i.e. trophic status).

Seasonal trends analysis requires sample collection during each season of the year and provides an understanding of the interaction between yearly climate fluctuations and watershed processes that results in cyclical alterations in water chemistry.

Finally, long-term temporal trends analysis requires consistent yearly sampling over at least a ten-year period and is critical for two reasons. First, it is essential for robust calculation of normal range, which defines the limits of ‘expected’ values and provides benchmarks for definition of ‘outliers’ in the data. And second, temporal trends analysis provides understanding of the long-term implications of both anthropogenic development and climate change.

All the analyses described above provide the foundation on which to rest a competent, robust and confident assessment of water quality. The trends analyses are therefore of critical importance in development of a robust watershed management strategy, in identifying emerging watershed risks, in determination of meaningful water quality objectives, and in structuring a useful and effective adaptive management plan.

A fundamental guiding principle of robust trends analysis is consistency. This includes consistent sampling both seasonally and yearly for each site, and consistency in the number of samples, date of sampling, list of analytes, and analytical laboratory. Trends analysis also requires a consistent seasonal coverage and spatial coverage over time. These requirements include the establishment of permanent sample stations that are sampled on a consistent, regular, defined schedule over a long time period. And the longer the period of record and the more consistent the data collection, the more valuable the data set will become for trends analysis, definition of normal range, and watershed management.

It is also of critical importance to have a comprehensive and consistent training of volunteers and staff involved with water sampling and to develop a guidance and training manual for surface water sampling. As discussed for the recent monitoring effort undertaken in the Regional District of Nanaimo (Plews et al. 2018), the engagement and training of volunteers is an absolutely critically important component of a monitoring strategy. It takes time to develop and maintain relationships and so it is recommended that effort be expended in forming and maintaining relationships with community volunteers and that one part of that should be the open access and timely reporting of monitoring results.

### 2.1.2 Site Selection

The permanent long-term surface water monitoring sites that were identified for the Regional Surface Water Monitoring Strategy included 37 established EMS sites and 2 new sites located in a total of 13 of the 20 identified CVRD watersheds (Figure 2.1, Appendix A, Table A.1).

This list, however, was considered an initial identification of monitoring sites in recognition of the absolute necessity for a collaborative approach in development of a final monitoring strategy given limited resourcing. It was considered that only through collaboration with multiple stakeholders and First Nations could a defensible and supportable long-term monitoring strategy be developed.

The first step in the site selection process included identifying a list of all possible sites to evaluate for sampling. The list of all possible sites comprised all those noted in the EMS database within the CVRD boundary as well as additional sites in watersheds or waterbodies that had no previous surface water sampling. The second step in the process was a semi-quantitative assessment based on the following six variables: ‘period of record’, ‘number of sites in a watershed’, ‘size of watershed’, ‘location of site within the watershed’, ‘environmental sensitivity’ based on presence of salmon and/or potable water intakes, and ‘assessed risk’ (SNC Lavalin 2019). The six variables were organized into the following three categories;

- Value of Data Record - included the variables ‘period of record’ and ‘number of sites in a watershed’
- Scope of Integration - included the variables ‘size of watershed’ and ‘location of site within the watershed’
- Magnitude of Risk - included the variables ‘environmental sensitivity’ and ‘assessed risk’

Each of the six variables contained three levels of classification based on a quantitative delineation. The levels were defined by examination of the data for each variable: the objective was to encompass the entire range of data for each variable so that each level would be represented by actual conditions for at least one site within the pool of potential sites.

Each site was given a rank for each of the three categories: the rank was based on the classification of the two variables within each category. For each of the three categories, a site was ranked as 'low, 'medium', 'high', or 'high+'. These three category ranks were then integrated using a scoring matrix that provided a final numerical assessment of monitoring priority for each site.

The assessment process is discussed further in the following subsections.

#### *2.1.2.1 Value of Data Record*

In consideration of the guiding principle of consistency, and to maximize the period of record and size of the existing database, the long-term monitoring sites recommended for the Regional Surface Water Monitoring Strategy gave preference to the current set of identified sample locations in the EMS with the longest and most recent period of record and the most extensive set of water chemistry data (Table 2.1, Appendix B).

It was considered that the value of a site for the long-term monitoring program depended on its location, the length of the period of record and the number of sites within the watershed available for selection. Established sites with a recent (last record within 5 years of present day), long-term (>10yr) continuous data record were considered the most valuable for trends analysis and definition of normal range (Table 2.1).

### *Table 2.1 Value of Data Record*

| Period of Record ↑ \ Number of Sites* → | ≥Third | Second | First |
|---|---|---|---|
| | **Value of Data Record** | | |
| **Continuous, Recent, >10 yr** | High | High+ | High+ |
| **Sporadic, Historical, <10 yr** | Low | Medium | High |
| **Intermittent, Historical, <5yr** | Low | Low | Medium |

**Lakes and streams were assessed separately in each watershed. If there were multiple sites in a watershed, the site with the best data record was ranked the highest.*

### *2.1.2.2 Scope of Watershed Integration*

Preference was given to downstream locations in creeks, rivers and lakes in larger watersheds because they integrated all upstream watershed inputs. The scope was therefore considered as an indication of the area that was integrated within a sample site. The greater the watershed area and the further downstream a monitoring site was located, the larger the area integrated into the monitoring data from that site and the more comprehensive the understanding of watershed processes it provided (Table 2.2)

Within the CVRD, there are four large watersheds greater than 40,000 ha and five intermediate watersheds greater than 5,000 ha. Monitoring data from these watersheds integrate data from the largest areas within the CVRD. The majority of the watersheds are relatively smaller: monitoring of these watersheds provides surface water data integrated over only a fraction of the area within the CVRD.

Another important consideration was that the further downstream a site was located, the greater the reliability of flow, which was considered important for maintaining a consistent data record in a District prone to drought.

**Table 2.2 Scope of Watershed Integration**

| Size of Watershed | Scope of Watershed Integration | | |
|---|---|---|---|
| >40,000 ha | Medium | High | High+ |
| <40,000 ha | Low | Medium | High+ |
| <5000 ha | Low | Medium | High |
| Percent of Watershed | <25% | 25% to 75% | >75% |

### *2.1.2.3 Magnitude of Risk*

It was considered that the magnitude of risk to a watershed increased as the environmental sensitivity (i.e. presence of sensitive species or water uses) and percentage assessed risk (SNC Lavalin, 2019) increased (Table 2.3).

The highest risk areas were those of critical importance to the sustainable supply of potable drinking water and sites within these waterbodies were ranked the highest. Sites with anadromous salmon species were also ranked relatively high.

### *Table 2.3 Magnitude of Risk*

| Environmental Sensitivity | Magnitude of Risk: <25% | Magnitude of Risk: 25% to 75% | Magnitude of Risk: >75% |
|---|---|---|---|
| Potable Water | Medium | High | High+ |
| Salmon | Low | Medium | Medium |
| None | Low | Low | Low |
| **Assessed Risk** | <25% | 25% to 75% | >75% |

*Source of Assessed Risk: SNC Lavalin (2019) – see Table 2.4*

Preference was also given to the eastern watersheds/locations because of the relatively greater watershed pressures identified in these areas (SNC Lavalin 2019: Appendix II). To quantify watershed pressures the recently completed risk assessment (SNC Lavalin 2019) was summarized for water quality to rank watersheds with respect to the percentage of land area considered at high or extreme risk of major or catastrophic consequences (Table 2.4). The summary of risk was based on consequence and hazard attributes. Consequence attributes included whether a stream was a drinking water source and the stream order. Hazard attributes included the land use type adjacent to a stream and the riparian forest cover. (SNC Lavalin 2019). This analysis indicated that greater than 80% of the area of several small eastern watersheds were at high or extreme risk, including Sansum Narrows - Cowichan Bay Benchlands, Satellite Channel Benchlands, and Yellowpoint Benchlands (Table 2.4).

### *Table 2.4 Water Quality Risk Assessment for the Cowichan Valley Regional District based on Land Area (%)*

| Watershed | Risk Rating Categories | | | | | SUM (%) High & Extreme |
|---|---|---|---|---|---|---|
| | 1000 | 2000 | 4000 | 7000 | 10000 | |
| | Very Low | Low | Moderate | High | Extreme | |
| Sansum Narrows - Cowichan Bay Benchlands | 1.5 | 0.0 | 3.7 | 57.8 | 36.9 | 95 |
| Satellite Channel Benchlands | 1.7 | 0.0 | 4.6 | 31.2 | 62.5 | 94 |
| Yellowpoint Benchlands | 1.2 | 0.0 | 14.3 | 58.8 | 25.7 | 84 |
| Malahat Benchlands | 10.2 | 0.5 | 31.6 | 57.3 | 0.4 | 58 |
| Bonsall Creek | 6.6 | 0.9 | 38.8 | 44.3 | 9.3 | 54 |
| Chemainus Benchlands | 16.7 | 18.4 | 12.8 | 29.9 | 22.3 | 52 |
| Stocking Creek | 4.1 | 0.0 | 51.4 | 41.0 | 3.5 | 44 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Koksilah River | 40.4 | 0.8 | 16.6 | 35.2 | 7.1 | 42 |
| Shawnigan Creek | 42.1 | 2.9 | 14.8 | 31.5 | 8.7 | 40 |
| Chemainus River | 36.3 | 0.4 | 24.7 | 36.7 | 1.9 | 39 |
| Cowichan River | 44.6 | 1.7 | 15.1 | 34.6 | 3.9 | 39 |
| Bush Creek | 0.7 | 0.0 | 61.2 | 38.1 | 0.0 | 38 |
| Holland Creek | 37.5 | 2.0 | 22.6 | 37.7 | 0.2 | 38 |
| Ladysmith-Saltair Benchlands | 67.0 | 15.3 | 13.4 | 4.3 | 0.0 | 4.3 |
| Carmanah-Walbran | ---- | ---- | ---- | ---- | ---- | ---- |
| Gordon River | ---- | ---- | ---- | ---- | ---- | ---- |
| Gulf Islands | ---- | ---- | ---- | ---- | ---- | ---- |
| Nanaimo River | ---- | ---- | ---- | ---- | ---- | ---- |
| Nitinat River | ---- | ---- | ---- | ---- | ---- | ---- |
| San Juan River | ---- | ---- | ---- | ---- | ---- | ---- |

Source: SNC Lavalin (2019) Appendix II

#### *2.1.2.4 Numerical Assessment*

Each of the 39 sites was assigned a rank of low, medium, high, or high+ for each of the three categories as defined by Table 2.1 (Value of Data Record), Table 2.2 (Scope of Watershed Integration), and Table 2.3 (Magnitude of Risk). These three category ranks were then integrated using a scoring matrix that provided a final numerical assessment of monitoring priority for each site (Table 2.5). Site scores within the scoring matrix ranged from 1 to 64, with the highest score based on a rank of 'high+' for each of the three categories.

The importance and priority of sites for inclusion in the monitoring program were based on the integrated score. Sites were assessed as low priority for monitoring with integrated scores of 1 to 6, medium priority with scores of 8 to 12, high priority with scores of 16 to 27, and high+ priority with scores >27 (Table 2.5).

## *Table 2.5 Scoring Matrix*

| | | Value of Data Record (Table 2.1) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | | | | Medium | | | | High | | | | High+ | | | |
| | | **Scope of Watershed Integration (Table 2.2)** | | | | | | | | | | | | | | | |
| | | Low | Medium | High | High+ | Low | Medium | High | High+ | Low | Medium | High | High+ | Low | Medium | High | High+ |
| Magnitude of Risk (Table 2.3) | High+ | 4 | 8 | 12 | 16 | 8 | 16 | 24 | 32 | 12 | 24 | 36 | 48 | 16 | 32 | 48 | 64 |
| | High | 3 | 6 | 9 | 12 | 6 | 12 | 18 | 24 | 9 | 18 | 27 | 36 | 12 | 24 | 36 | 48 |
| | Medium | 2 | 4 | 6 | 8 | 4 | 8 | 12 | 16 | 6 | 12 | 18 | 24 | 8 | 16 | 24 | 32 |
| | Low | 1 | 2 | 3 | 4 | 2 | 4 | 6 | 8 | 3 | 6 | 9 | 12 | 4 | 8 | 12 | 16 |

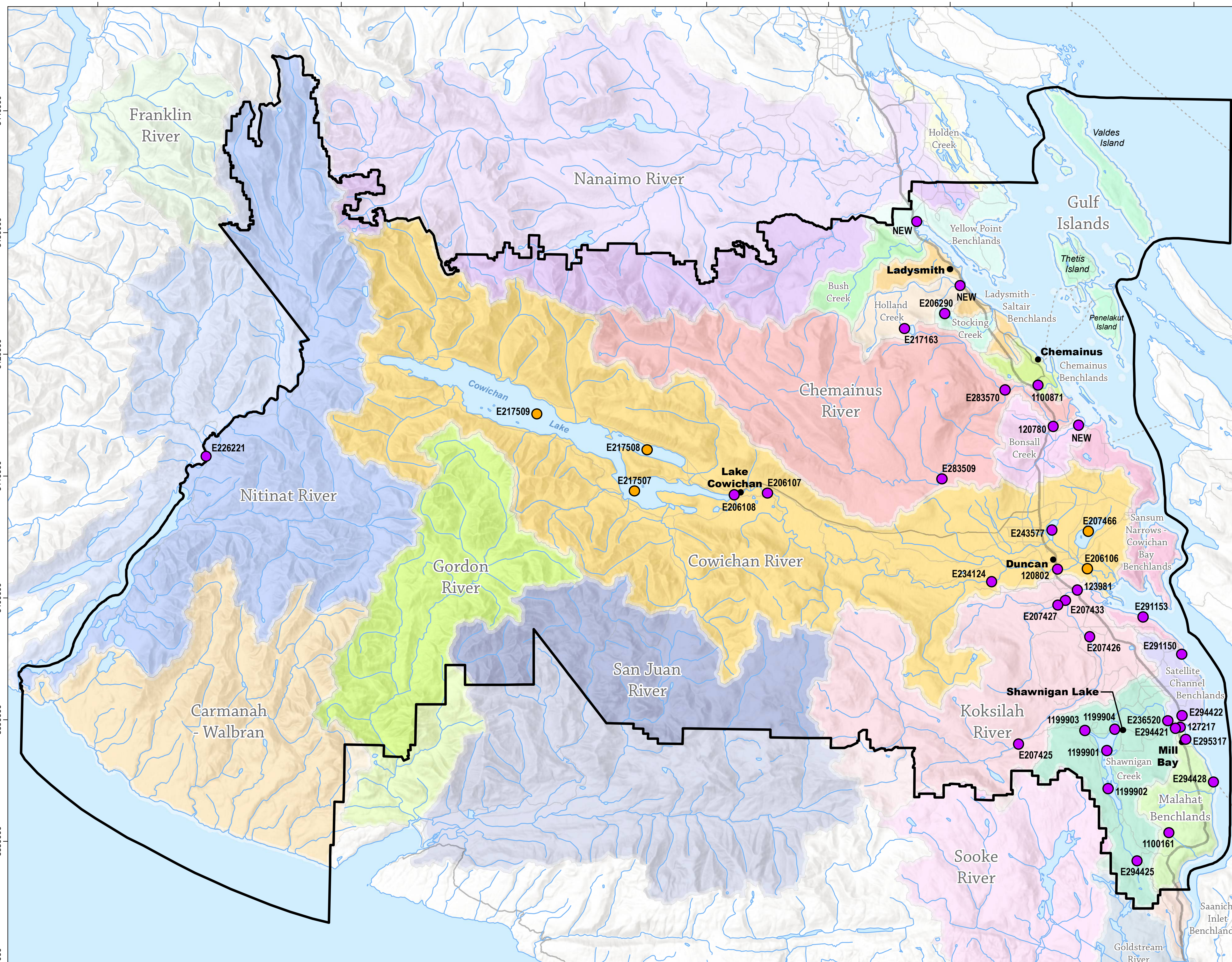
**Monitoring Priority:**

| Score | Priority |
|---|---|
| 1 to 6 | Low |
| 8 to 12 | Medium |
| 16 to 27 | High |
| >30 | High+ |

#### 2.1.2.5 Assessment Results

Of the 39 sites in 13 watersheds that were included in the monitoring strategy, a total of 21 sites were assessed as of high or high+ priority for monitoring and a further 14 were assessed as of medium priority (Appendix A,Table A.1 and Table A.2). The remaining four sites were assessed as of low priority: they were included as components of a spatial monitoring network designed to assess alterations in water chemistry upstream to downstream in four of the important rivers within the CVRD. Because assessment of spatial trends in rivers was considered a special case for monitoring, this variable was not included in the scoring matrix for site selection, but rather was included as a key addition to the monitoring program. Spatial trends in lakes will also be examined, but for lakes the spatial trend is related to depth profiles rather than distance from headwaters.

Seven watersheds were not included in the long-term monitoring program (i.e. no long-term water monitoring sites in these watersheds): Ladysmith-Saltair Benchlands, Carmanah-Walbran, Gordon River, Gulf Islands, Nanaimo River, San Juan River, and Bush Creek. These watersheds were excluded because they were assessed as low risk relative to the included watersheds even though not explicitly considered in the recently completed risk analysis (SNC Lavalin 2019), and were assessed as of low monitoring priority during the assessment process. In addition, some of the watersheds are only partially inside CVRD boundaries (e.g. San Juan River, Gordon River, Nanaimo River). However, if subsequent information and assessment indicates that any of these watersheds require monitoring, sites can be selected in collaboration with the relevant stakeholders.




LEGEND:

- CVRD Planned Long-Term Monitoring Site
- Federal/Provincial Monitoring Site
- City/Town
- CVRD boundary
- Highway/Road
- Ferry Route
- Watercourse
- Waterbody

Notes:
1. Watershed boundaries provided by Cowichan Valley Regional District.
2. Base map data provided by Natural Resources Canada (CanVec 250k) and Esri basemap service (World Hillshade, World Street Map).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Cowichan Valley Regional District

PROJECT:
Watershed Planning

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Figure 2.1

**CVRD Planned Long-Term Water Quality Monitoring Sites**

Project No. 1904902
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Revision: 1

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### 2.1.3 Sampling Effort

For the long-term permanent monitoring locations, three samples per year on an ongoing yearly basis are recommended: one sample during the spring wet period (March/April), one sample during summer low-flow (July/August), and one sample during the fall rainy season (November/December). For the lake sites, depth profiles located at the deepest part of the lake are recommended.

Streams and rivers are responsive to transient events such as intense spring rainfall. To capture the alteration of surface water chemistry in response to these events, it is recommended that continuous monitoring systems be installed and maintained at a number of river sites. It is recommended that sites with active hydrometric stations be used for continuous monitoring.

### 2.1.4 Surface Water Analytes

The long-term analysis of surface water consists of two sets of analyses. The first set includes determination of *in situ* analytes measured using a multi-probe and Secchi disc, including the following:

- Temperature, dissolved oxygen (DO), pH, turbidity, conductivity
- Secchi depth in lakes

These five analytes describe fundamental characteristics of a water body and are particularly useful because with a minimal amount of training, they can be competently measured by volunteers and community groups. These analytes do, however, require purchase and ongoing maintenance and calibration of multi-parameter probes.

The second set of analyses requires collection of surface water samples and laboratory analysis for the following;

- E. coli, fecal coliforms, and total coliforms, which are a measure of fecal contamination from animal and human waste
- Biological Oxygen Demand (BOD), which is a measure of the organic loading from wastewater
- Total Nitrogen (TN) and Total Phosphorus (TP), which is a measure of trophic status
- Complete scan of dissolved and total metals (cations), which are useful for surface water characterization and which provide an understanding of the effects of particulate loading and mine drainage on water quality
- Major anions, including alkalinity, chloride, and sulphate, which are useful for surface water characterization

It is expected that a given long-term sampling program may not require all these analytes, depending on the specific watershed concerns.

## 2.2 Intensive Short-Term Monitoring

The short-term program was designed to increase monitoring intensity at sites or watersheds identified as at risk and requiring further development and/or implementation of an adaptive watershed management plan, under development pressure and requiring a multivariate understanding of the relationship between development and water quality, and/or as requiring development of watershed-specific water quality objectives.

### 2.2.1 Rationale

Identification and assessment of emerging water quality issues, particularly related to development, requires multiple upstream/downstream sample sites consistent with requirements for effects assessment, multivariate analyses, watershed management, and/or for an understanding of the magnitude and extent of observed effects. These data are of critical importance in the adaptive management of affected watersheds.

Developing site-specific water quality objectives requires intensive and comprehensive monthly sampling and provincially mandated five in thirty sampling, that is, collection of five samples in thirty days during periods of maximum hydrological fluctuation (e.g. BCMOE 2016, Cavanagh *et al.* 1998). This is not necessary in all watersheds or subbasins where a relevant set of objectives have already been established or can be used as defensible proxies.

### 2.2.2 Site Selection for Short-Term Monitoring

The short-term strategy requires initial identification of a watershed or sub-watershed requiring intensive sampling due to a particular threat. Once the watershed or subbasin is selected, then sites are located based on the specific configuration of watershed pressures and any other watershed-specific concerns. It is expected that in most cases, approximately 10 to 12 sites would be adequate for intensive short-term monitoring.

It is recommended, however, that many more than 10 to 12 sites be sampled to conduct a multivariate analysis. As a comparison, the Regional District of Nanaimo (Plewes et al. 2018) developed a multivariate analysis using a much larger number of sites. It is recommended that 70 to 80 sites be sampled to develop a robust and spatial understanding of the effect of watershed pressures on surface water chemistry within the CVRD.

### 2.2.3 Sampling Effort

The total number of samples will depend on the final selection of sample sites for the short-term monitoring program (see Section 2.2.2 above). For each of the selected sample sites for short-term sampling, monthly sampling with additional sampling effort to include 5 samples in 30 days for comparison with BC Water Quality Guidelines could be required. It is expected that this intensity of sampling would be required for a three-year period per short-term monitoring program.

For collection of surface water data for multivariate analysis it is recommended that sampling effort be consistent with the level of efforts used in the Regional District of Nanaimo (Plewes et a. 2018).

### 2.2.4 Surface Water Analytes

The analysis of surface water for short-term monitoring consists of three sets of analyses. The first set includes determination of *in situ* analytes measured using a multi-probe and Secchi disc, including the following:

- Temperature, dissolved oxygen (DO), pH, turbidity, conductivity
- Secchi depth in lakes

These five analytes describe fundamental characteristics of a water body and are particularly useful because with a minimal amount of training, they can be competently measured by volunteers and community groups. These analytes do, however, require purchase and ongoing maintenance and calibration of multi-parameter probes.

The set also includes determination of several fundamental analytes through collection of surface water samples and laboratory analysis, including:

- E. coli, fecal coliforms, and total coliforms, which are a measure of fecal contamination from animal and human waste
- Biological Oxygen Demand (BOD), which is a measure of the organic loading from wastewater
- Total Nitrogen (TN) and Total Phosphorus (TP), which is a measure of trophic status
- A complete scan of dissolved and total metals (cations), which are useful for surface water characterization and which provide an understanding of the effects of particulate loading on water quality
- Major anions, including alkalinity, chloride, and sulphate, which are useful for surface water characterization

It is expected that a given intensive, short-term sampling program may not require all these analytes, depending on the specific watershed concerns.

The third set includes all those analytes identified as of potential concern within the specific watershed under study (e.g. Sites with recent mining activity would require assessment of sulfate, metals and pH).

## 2.3 Summary

Long-term monitoring of watersheds is important for the development of robust seasonal, spatial and temporal trends analysis relating to ecosystem change and for delineation of normal range. Short-term intensive monitoring is important for assessment of aquatic impacts related to watershed pressures and for development of robust water-quality objectives. By establishing both a long-term monitoring strategy and a relatively intensive short-term strategy, the CVRD can both proactively identify watershed trends, develop water quality objectives, and react quickly and effectively in response to emerging issues within the CVRD.

### 2.3.1 Next Steps

This document provides monitoring objectives and an outline of the monitoring program design (Figure 1.2) for the surface water monitoring strategy within the CVRD. Recommendations for next steps include the following;

- Consultation with stakeholders to confirm site selection for long-term monitoring, including determination of site access. Stakeholders should also have the opportunity to evaluate additional candidate sites using the assessment protocol. However, once the monitoring strategy has been implemented, it is important that additions and deletions of sites be minimized to the extent possible.
- Identification of community volunteer organizations.
- Training of volunteers (where used) in water sampling protocols.

- Implementation of the monitoring program for surface water sample collection.
- Collaboration with the Province to continue development of EMS for data management. It is recognized that community groups may wish to access data from their area of interest.
- Development of CVRD database structures and management strategies to collect and warehouse data: not all data that are collected will be added to provincial EMS system.

# 3. Certification

This report was prepared, reviewed and approved by the undersigned:

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# Appendix A

# Appendix A

***Table A.1 Surface Water Monitoring Sites Rationale***

| Watershed | EMS ID | Location | Latitude | Longitude | Site Rationale |
|---|---|---|---|---|---|
| Bonsall Creek | NEW | Bonsall Creek East of Crofton Rd. | 48.8786 | 123.6744 | Projected population growth and the significant presence of agriculture will place increasing stress on surface water quality. The watershed has a large number of lower order streams leading to greater susceptibility due to lower dilution capacity. A total of 54% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019). There are no established monitoring sites in this watershed so the identified site will be new. The site is downstream in the watershed to integrate all upstream watershed processes. |
| Chemainus Benchlands | 1100871 | Fuller's Lake | 48.9078 | 123.7203 | This is a lake monitoring site with a moderate dataset. There is a considerable amount of urban and industrial development in this watershed. Fuller's Lake is a drinking water source therefore it is important to have a long-term data record at this particular site. Projected population growth will place increasing stress on surface water quality. The watershed has a large number of lower order streams leading to greater susceptibility due to lower dilution capacity. A total of 52% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019). |
| Chemainus River | 120780 | Chemainus River at Highway #1 | 48.8775 | 123.7028 | A total of 39% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019). This site is downstream of agricultural areas and Highway #1 and has the greatest surface water quality risk in the watershed. The watershed has a large number of lower order streams leading to greater susceptibility due to lower dilution capacity. This site is the most downstream site in the watershed. Approximately 80 samples have been analyzed over the period of record. |
| Chemainus River | E283570 | Chemainus River at Grace Road | 48.903942 | 123.757161 | A mid-reach site on the Chemainus River suitable for spatial analysis of water quality. This site is south of the town of Chemainus with industrial pressures in the region. |
| Chemainus River | E283509 | Chemainus River at Park | 48.837692 | 123.826661 | An upstream site on the Chemainus River suitable for spatial analysis of water quality. This site has 32 samples analysed since 2000 (most in 2011). |
| Cowichan River | E243577 | Somenos Lake; Centre | 48.8008 | 123.7031 | This is a lake monitoring site with a moderate dataset. Watershed pressures include urban proximity, agriculture, and drainage issues. Cowichan River supports numerous domestic drinking water licenses along the reach of the river. Surface water quality risk is highest in the developed areas of this watershed, including around Lake Cowichan and the city of Duncan. The Cowichan River watershed is the largest in the CVRD and so has multiple sites for coverage. A total of 39% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019). |

| Watershed | EMS ID | Location | Latitude | Longitude | Site Rationale |
|---|---|---|---|---|---|
| Cowichan_River | E207466 | Quamichan Lake; Centre | 48.8003 | 123.6625 | Prov. Lake monitoring site - extensive dataset. Quamichan Lake has been subject to blue-green algae blooms due to high content of phosphorus due to runoff from agricultural activity around the lake. Due to the effect these blooms can have on water quality, continued long-term monitoring of this lake is important. Most samples analyzed at this monitoring site where data is available in the EMS is after 2010. A long-term monitoring program will ensure changes over time are monitored and recorded accurately. |
| Cowichan_River | E217507 | Cowichan Lake Station #1 | 48.8258 | 124.1706 | This is an established provincial lake monitoring site with an extensive dataset. The Cowichan River watershed pressures include forestry operations, land development, increased urbanization and agriculture. There are numerous drinking water licenses on Cowichan Lake and the lake is a significant area for recreational activities. Water quality objectives have been set specifically for this lake and preliminary data analyses indicate guideline and objective exceedances at several long-term lake monitoring sites. |
| Cowichan_River | E217508 | Cowichan Lake Station #2 | 48.8564 | 124.1572 | This is an established provincial lake monitoring site with an extensive dataset. The Cowichan River watershed pressures include forestry operations, land development, increased urbanization and agriculture. There are numerous drinking water licenses on Cowichan Lake and the lake is a significant area for recreational activities. Water quality objectives have been set specifically for this lake and preliminary data analyses indicate guideline and objective exceedances at several long-term lake monitoring sites. |
| Cowichan_River | E217509 | Cowichan Lake Station #3 | 48.8817 | 124.2811 | This is an established provincial lake monitoring site with an extensive dataset. The Cowichan River watershed pressures include forestry operations, land development, increased urbanization and agriculture. There are numerous drinking water licenses on Cowichan Lake and the lake is a significant area for recreational activities. Water quality objectives have been set specifically for this lake and preliminary data analyses indicate guideline and objective exceedances at several long-term lake monitoring sites. |
| Cowichan_River | E206106 | Cowichan River Below Somenos Creek | 48.7726 | 123.6633 | This is an established federal/provincial monitoring site with an extensive dataset that is one of the longest on record in the CVRD. This site is one of the most downstream sites in the watershed and integrates the effect of watershed pressures for the entire watershed. |
| Cowichan River | 120802 | Cowichan River at Highway #1 | 48.7719 | 123.6964 | Second of two downstream monitoring sites important for understanding spatial trends. |
| Cowichan River | E234124 | Cowichan River at Vimy Beach | 48.7622 | 123.77 | A mid-reach site on the Cowichan River important for spatial analysis of water quality. |
| Cowichan River | E206107 | Cowichan River 400m Below PE-247 | 48.8258 | 124.0219 | A second 'mid-reach' monitoring site downstream from PE-247 which is a sewage treatment plant. The site is important for long-term monitoring to ensure surface water quality doesn't exceed provincial guidelines or regional water quality objectives. |

| Watershed | EMS ID | Location | Latitude | Longitude | Site Rationale |
|---|---|---|---|---|---|
| Cowichan River | E206108 | Cowichan River at Cowichan Lake Weir | 48.8243 | 124.0589 | An upper-reach site for spatial analysis of water quality. |
| Holland Creek | E217163 | Holland Lake; Outflow | 48.9486 | 123.8708 | A lake monitoring site with a moderate dataset. Watershed pressures include urban development and water-based recreation. The lake is an identified drinking water source for Town of Ladysmith. A total of 38% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019). |
| Holland Creek | NEW | Holland Creek; Mainstem at Dogwood Drive crossing | 48.9808 | 123.809 | Holland Creek watershed pressures include urban development and logging. Watershed risk is highest around Highway #1 (SNC Lavalin 2019). Holland Creek at Highway #1 is potentially subject to saltwater influence and therefore the proposed site location is approximately 250 m upstream from the highway, at the Dogwood Drive crossing. The exact location of the site will be determined on the ground when the site is established. |
| Koksilah River | 123981 | Koksilah River at Highway #1 | 48.7567 | 123.6742 | This site has extensive dataset. Surface water quality risk is highest in the developed area near the highway and the ocean due to pressures from population increases, and urban and commercial development. Koksilah River has a number of key water uses such as commercial and sport fishing, industrial, domestic and irrigation uses as well as additional recreational activities. There are no authorized discharges on the Koksilah River but due to summer low flows, the extent of development could have an impact on surface water quality. The watershed has pressures from non-point sources such as agriculture (dairy farms) and onsite sewage disposal system and upstream forestry operations. A total of 42% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019). |
| Koksilah River | E207433 | Koksilah River D/S of Kelvin Creek | 48.7489 | 123.6875 | This monitoring site has a moderate dataset over the period of record. Because of the extensive non-point sources of potential contaminants, a spatial water quality analysis within the Koksilah River is useful. |
| Koksilah River | E207427 | Kelvin Creek at Koksilah Road | 48.7453 | 123.6956 | This monitoring site has a moderate dataset over the period of record. |
| Koksilah River | E207426 | Patrolas Creek at Hillbank Road | 48.7222 | 123.66 | Koksilah River 'mid-reach' for spatial analysis of water quality. Historic dataset is minimal. |
| Koksilah River | E207425 | Koksilah River at Port Renfrew Road | 48.6425 | 123.7383 | Koksilah River 'upper-reach' for spatial analysis of water quality. A moderately robust dataset exists at this monitoring site (1988-2012). |
| Malahat Benchlands | 1100161 | Spectacle Lake; South End | 48.578 | 123.5698 | Relatively rapid population growth is expected in this watershed leading to increased additional pressures on surface water quality. Most of the watershed has low order streams which are susceptible to water quality issues due to limited dilution capacities. An extensive dataset exists for this monitoring site but the data are not current (1970s and 1980s). Spectacle Lake is a local source for recreational fishing and other forms of water-based recreation. |

| Watershed | EMS ID | Location | Latitude | Longitude | Site Rationale |
|---|---|---|---|---|---|
| Malahat Benchlands | E294428 | Malahat Creek at Mill Bay Rd. | 48.615599 | 123.52068 | Malahat Creek downstream has only recent data (2013-2018). Urban runoff, land development, sewage systems, agriculture and logging activities are main sources of potential contaminants. A total of 58% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019). |
| Malahat Benchlands | E295317 | Unnamed Creek near Keir Road (CVRD SW018) | 48.647033 | 123.551819 | A new CVRD monitoring site located in a residential area in the Mill Bay area. Very few samples have been collected to date but it is an important for long-term monitoring to determine downstream effects of increased urbanization in the watershed. |
| Nitinat River | E226221 | Nitinat River D/S of Hatchery | 48.8457 | 124.6501 | Potential long-term CVRD pristine monitoring site. Downstream site to maximize information from watershed before the Nitinat River flows into Nitinat Lake. Monitoring site is downstream of the Nitinat River Hatchery. This long-term monitoring site could be used a benchmark for potential long-term impacts due to climate change in a relatively undisturbed watershed. This watershed was not evaluated in the risk assessment (SNC Lavalin 2019). |
| Sansum Narrows | E291153 | Waldy Creek at Foreshore | 48.737367 | 123.600706 | Sansum Narrows is a watershed experiencing population growth. Combined with many low order streams, watershed pressures result in increased risk of potential surface water quality issues in the watershed. The monitoring site is downstream close to the ocean. A total of 95% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019). |
| Satellite Channel Benchlands | E294422 | Unnamed Creek @Kilmalu Road; CVRD sampling site | 48.664503 | 123.556137 | Numerous low order streams combined with increased impervious surfaces throughout the majority of the watershed have the potential to create additional pressures on water quality. Watershed pressures include urban development and agricultural activity. This downstream site is a recently established CVRD monitoring site (2013-2018). A total of 94% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019). |
| Satellite Channel Benchlands | E291150 | Garnett Creek at Cherry Point Beach | 48.709919 | 123.557003 | A second monitoring site designed to extend coverage in the watershed. |
| Shawnigan Creek | 127217 | Shawnigan Creek at Highway #1 | 48.6558 | 123.5583 | The furthest downstream long-term monitoring site on Shawnigan Creek near the sewage treatment discharge location (PE 451) and before the creek flows into the ocean. The Shawnigan Creek watershed in the Mill Bay area has seen increased pressures for rapidly expanding population densities, increased agriculture runoff and increased overall development.  A total of 40% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019), although this assessment does not include the risk associated with the contaminated waste disposal site. |
| Shawnigan Creek | 1199901 | Shawnigan Lake; #1 | 48.63835 | 123.639889 | This is a provincial lake monitoring site with an extensive dataset. Surface water quality pressures are greatest surrounding Shawnigan Lake and in streams in the watershed with little forest cover. Projected population increases in the watershed will add increased pressures on water quality from urban, commercial and industrial development. Shawnigan Lake is a destination for water-based recreational activities |

| Watershed | EMS ID | Location | Latitude | Longitude | Site Rationale |
|---|---|---|---|---|---|
| | | | | | and is also a municipal and private drinking water source for the surrounding communities. |
| Shawnigan Creek | 1199902 | Shawnigan Lake; #2 | 48.6103 | 123.6381 | This is a provincial lake monitoring site with an extensive dataset located in the lower reach of Shawnigan Lake. |
| Shawnigan Creek | 1199903 | Shawnigan Lake; West Arm | 48.653126 | 123.664378 | This is a provincial lake monitoring site with an extensive dataset located in the west arm of Shawnigan Lake. |
| Shawnigan Creek | 1199904 | Shawnigan Lake; East Arm | 48.654052 | 123.631048 | This is a provincial lake monitoring site with an extensive dataset located in the east arm of Shawnigan Lake. |
| Shawnigan Creek | E294421 | Shawnigan Creek at Shawnigan-Mill Bay Rd. (CVRD Site2) | 48.655136 | 123.563591 | A relatively new CVRD monitoring site (2013 and 2018) located downstream of an unnamed green space in the middle of residential neighbourhoods. Similar to Shawnigan Lake, increased development in this area has increased pressures on water quality in this area. Establishing this long-term monitoring site in conjunction with the other urban monitoring sites will provide a spatial analysis of water quality along Shawnigan Creek downstream of Shawnigan Lake. This site is also downstream of permitted sewage discharge location PE12302. |
| Shawnigan Creek | E236520 | Shawnigan Creek U/S of PE12302 | 48.660712 | 123.572234 | This long-term monitoring site is downstream of Shawnigan Lake and upstream of PE12302. In conjunction with the other urban monitoring sites on Shawnigan Creek, this site will provide a spatial analysis of water quality along Shawnigan Creek downstream of Shawnigan Lake. The site has been monitored occasionally since 2000. |
| Shawnigan Creek | E294425 | Shawnigan Creek D/S of South Island Aggregates | 48.55698 | 123.60517 | Shawnigan Creek tributary site in close proximity to previously identified water quality pressures related to the presence of a contaminated soils waste disposal facility. This particular site does not have a robust dataset. |
| Stocking Creek | E206290 | Stocking Lake; Centre | 48.96 | 123.8258 | A lake monitoring site with a moderate dataset. The Town of Ladysmith holds a water license for drinking water withdrawals from Stocking Lake. Water-based recreation is a major activity on the lake. Urban development has occurred in the watershed. A total of 44% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019). |
| Yellowpoint Benchlands | NEW | Unnamed Creek U/S of Brenton Page Rd. | 49.027535 | 123.858491 | This new site is the most downstream location at the confluence of several low order streams just prior to ocean discharge. Risk to surface water quality is highest near residential, commercial and agricultural areas in the watershed near highway #1. Pressures are expected to continue due to increased population projections with an increased risk near the north end of Ladysmith Harbour. A total of 84% of the watershed has been assessed as within a high or extreme risk rating category (SNC Lavalin 2019). |

*Table A.2 Cowichan Valley Regional District Long-Term Monitoring Site Selection: Scoring Assessment*

| Watershed | Type** | EMS ID | Table 1: Value of Data Record | | | Table 2: Scope of Watershed Integration | | | Table 3: Magnitude of Potential Risk | | | Table 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Period of Record | # Sites | Value | Size Watershed | % Watershed | Scope | Sensitivity | Risk | Magnitude | Score |
| Bonsall Creek | Mainstem | ---- | Intermittent, Historical, <5yr | First | Medium | <5000 ha | >75% | High | Potable Water | 25% to 75% | High | 24 |
| Chemainus Benchlands | Lake | 1100871 | Sporadic, Historical, <10 yr | First | High | <5000 ha | >75% | High | None | 25% to 75% | Low | 9 |
| Chemainus River | Mainstem | 120780 | Sporadic, Historical, <10 yr | First | High | <40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 36 |
| Chemainus River | Mainstem | E283570 | Sporadic, Historical, <10 yr | Second | Medium | <40,000 ha | >75% | High+ | None | 25% to 75% | Low | 8 |
| Chemainus River | Mainstem | E283509 | Sporadic, Historical, <10 yr | ≥Third | Low | <40,000 ha | 25% to 75% | Medium | None | 25% to 75% | Low | 2 |
| Cowichan River | Lake | E243577 | Continuous, Recent, >10 yr | First | High+ | >40,000 ha | <25% | Medium | Salmon | 25% to 75% | Medium | 16 |
| Cowichan River | Lake | E207466 | Continuous, Recent, >10 yr | First | High+ | >40,000 ha | <25% | Medium | Salmon | 25% to 75% | Medium | 16 |
| Cowichan River | Lake | E217507 | Continuous, Recent, >10 yr | ≥Third | High | >40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 36 |
| Cowichan River | Lake | E217508 | Continuous, Recent, >10 yr | Second | High+ | >40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 48 |
| Cowichan River | Lake | E217509 | Continuous, Recent, >10 yr | First | High+ | >40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 48 |
| Cowichan River | Mainstem | E206106 | Continuous, Recent, >10 yr | First | High+ | >40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 48 |
| Cowichan River | Mainstem | 120802 | Continuous, Recent, >10 yr | Second | High+ | >40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 48 |
| Cowichan River | Mainstem | E234124 | Sporadic, Historical, <10 yr | ≥Third | Low | >40,000 ha | 25% to 75% | High | Potable Water | 25% to 75% | High | 9 |
| Cowichan River | Mainstem | E206107 | Sporadic, Historical, <10 yr | ≥Third | Low | >40,000 ha | 25% to 75% | High | Potable Water | 25% to 75% | High | 9 |
| Cowichan River | Mainstem | E206108 | Sporadic, Historical, <10 yr | ≥Third | Low | >40,000 ha | 25% to 75% | High | Potable Water | 25% to 75% | High | 9 |
| Holland Creek | Lake | E217163 | Intermittent, Historical, <5yr | First | Medium | <5000 ha | >75% | High | Potable Water | 25% to 75% | High | 18 |
| Holland Creek | Mainstem | NEW | Intermittent, Historical, <5yr | First | Medium | <5000 ha | >75% | High | Potable Water | 25% to 75% | High | 18 |
| Koksilah River | Mainstem | 123981 | Continuous, Recent, >10 yr | First | High+ | <40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 48 |
| Koksilah River | Mainstem | E207433 | Sporadic, Historical, <10 yr | Second | Medium | <40,000 ha | >75% | High+ | Salmon | 25% to 75% | Medium | 16 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Koksilah River | Mainstem | E207427 | Sporadic, Historical, <10 yr | ≥Third | Low | <40,000 ha | >75% | High+ | Salmon | 25% to 75% | Medium | 8 |
| Koksilah River | Tributary | E207426 | Intermittent, Historical, <5yr | ≥Third | Low | <40,000 ha | 25% to 75% | Medium | Salmon | 25% to 75% | Medium | 4 |
| Koksilah River | Mainstem | E207425 | Sporadic, Historical, <10 yr | Second | Medium | <40,000 ha | 25% to 75% | Medium | Salmon | 25% to 75% | Medium | 8 |
| Malahat Benchlands | Lake | 1100161 | Sporadic, Historical, <10 yr | First | High | <5000 ha | >75% | High | None | 25% to 75% | Low | 9 |
| Malahat Benchlands | Mainstem | E294428 | Sporadic, Historical, <10 yr | First | High | <5000 ha | >75% | High | Potable Water | 25% to 75% | High | 27 |
| Malahat Benchlands | Tributary | E295317 | Sporadic, Historical, <10 yr | Second | Medium | <5000 ha | 25% to 75% | Medium | Potable Water | <25% | Medium | 8 |
| Nitinat River | Mainstem | E226221 | Intermittent, Historical, <5yr | First | Medium | >40,000 ha | 25% to 75% | High | Salmon | >75% | Medium | 12 |
| Sansum Narrows | Mainstem | E291153 | Sporadic, Historical, <10 yr | First | High | <5000 ha | <25% | Low | Potable Water | >75% | High+ | 12 |
| Satellite Channel Benchlands | Mainstem | E294422 | Sporadic, Historical, <10 yr | ≥Third | Low | <5000 ha | >75% | High | Potable Water | 25% to 75% | High | 9 |
| Satellite Channel Benchlands | Mainstem | E291150 | Sporadic, Historical, <10 yr | Second | Medium | <5000 ha | <25% | Low | Potable Water | 25% to 75% | High | 6 |
| Satellite Channel Benchlands | Mainstem | 127217 | Intermittent, Historical, <5yr | First | Medium | <5000 ha | >75% | High | Potable Water | 25% to 75% | High | 18 |
| Shawnigan Creek | Lake | 1199901 | Continuous, Recent, >10 yr | First | High+ | <40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 48 |
| Shawnigan Creek | Lake | 1199902 | Continuous, Recent, >10 yr | Second | High+ | <40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 48 |
| Shawnigan Creek | Lake | 1199903 | Continuous, Recent, >10 yr | ≥Third | High | <40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 36 |
| Shawnigan Creek | Lake | 1199904 | Continuous, Recent, >10 yr | ≥Third | High | <40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 36 |
| Shawnigan Creek | Mainstem | E294421 | Continuous, Recent, >10 yr | First | High+ | <40,000 ha | >75% | High+ | Potable Water | 25% to 75% | High | 48 |
| Shawnigan Creek | Mainstem | E236520 | Sporadic, Historical, <10 yr | Second | Medium | <40,000 ha | 25% to 75% | Medium | Potable Water | <25% | Medium | 8 |
| Shawnigan Creek | Tributary | E294425 | Sporadic, Historical, <10 yr | ≥Third | Low | <40,000 ha | <25% | Low | Potable Water | 25% to 75% | High | 4 |
| Stocking Creek | Lake | E206290 | Sporadic, Historical, <10 yr | First | High | <5000 ha | >75% | High | Potable Water | >75% | High+ | 36 |
| Yellowpoint Benchlands | Mainstem | ---- | Intermittent, Historical, <5yr | First | Medium | <5000 ha | 25% to 75% | Medium | Potable Water | <25% | Medium | 8 |

*** Lake or Mainstem or Tributary: A mainstem flows to the ocean, a tributary joins another creek prior to marine discharge*

# Appendix B

# Appendix B

***Table B.1 Surface Water Monitoring Sites Periods of Record and Sample Numbers by Year***

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| Bonsall Creek | NEW | NA | NA | NA | NA | NA | NA | NA |
| Chemainus Benchlands | 1100871 | 1979 | 159 | 30 | 125 | 30 | 117 | 30 |
| | | 1980 | 55 | 9 | 42 | 9 | 42 | 9 |
| | | 1981 | 14 | | 13 | | 13 | 13 |
| | | 1984 | 3 | 3 | | | | 3 |
| | | 1988 | 3 | 3 | | | | 3 |
| | | 1992 | 2 | 2 | | | | |
| | | 1994 | 13 | 2 | 11 | | 11 | 2 |
| | | 2004 | 19 | 19 | 16 | 3 | 19 | 19 |
| | | 2005 | 16 | 16 | 16 | | 16 | 16 |
| | | 2009 | 2 | 2 | | 2 | | 2 |
| | | 2012 | 2 | | | 2 | | 2 |
| | | 2015 | 18 | 16 | 16 | 2 | 16 | 2 |
| | | 2016 | 21 | 17 | 17 | 3 | 17 | 17 |
| Chemainus River | 120780 | 1986 | 1 | 1 | | | | 1 |
| | | 1987 | 2 | 1 | | | | 1 |
| | | 1988 | 16 | 14 | | | | 14 |
| | | 1989 | 11 | 9 | | 1 | | 10 |
| | | 1990 | 1 | 1 | | | | 1 |
| | | 1995 | 8 | | | | | 4 |
| | | 1999 | 4 | 2 | | 1 | | 2 |
| | | 2000 | 2 | 1 | | | | 1 |
| | | 2001 | 2 | 1 | | 1 | | 1 |
| | | 2010 | 1 | 1 | | 1 | | 1 |
| | | 2011 | 26 | 1 | 1 | 15 | 1 | 10 |
| | | 2012 | 6 | | | 3 | | 3 |
| | E283509 | 2010 | 1 | 1 | | 1 | | 1 |
| | | 2011 | 25 | 1 | 1 | 14 | 1 | 9 |
| | | 2012 | 6 | | | 3 | | 3 |
| | E283570 | 2010 | 1 | 1 | | 1 | | 1 |
| | | 2011 | 25 | 1 | 1 | 14 | 1 | 9 |
| | | 2012 | 6 | | | 3 | | 3 |
| Cowichan River | 120802 | 1968 | 4 | 3 | | 3 | 3 | 3 |

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| | | 1969 | 6 | 6 | | 6 | 6 | 6 |
| | | 1970 | 6 | 6 | | 6 | 5 | 6 |
| | | 1971 | 8 | 8 | | 8 | | 8 |
| | | 1972 | 5 | 5 | | 5 | | 5 |
| | | 1973 | 20 | 5 | 1 | 5 | 1 | 12 |
| | | 1974 | 6 | 4 | 2 | 4 | | 4 |
| | | 1975 | 7 | 5 | | 2 | 1 | 5 |
| | | 1976 | 5 | 3 | | 3 | | 3 |
| | | 1977 | 4 | 2 | | 2 | | 2 |
| | | 1978 | 13 | 6 | | 2 | | 6 |
| | | 1979 | 4 | 2 | | 2 | | 2 |
| | | 1980 | 2 | 1 | | 1 | | 1 |
| | | 1981 | 5 | 2 | 1 | 2 | 1 | 3 |
| | | 1982 | 11 | 4 | 1 | 2 | 2 | 6 |
| | | 1983 | 8 | 2 | 2 | 2 | 2 | 4 |
| | | 1984 | 6 | 2 | 1 | | 2 | 4 |
| | | 1985 | 11 | 11 | | 1 | | 10 |
| | | 1986 | 15 | 12 | | | | 12 |
| | | 1987 | 13 | 12 | | | | 12 |
| | | 1988 | 21 | 12 | | | 1 | 12 |
| | | 1989 | 21 | 3 | 3 | 5 | 6 | 11 |
| | | 1990 | 23 | 1 | 4 | 6 | 8 | 13 |
| | | 1991 | 10 | | 2 | 5 | 5 | 3 |
| | | 1992 | 9 | | 4 | 5 | 4 | |
| | | 1993 | 20 | 2 | 7 | 5 | 8 | 8 |
| | | 1994 | 36 | 5 | 9 | | 9 | |
| | | 1997 | 6 | | | | | 5 |
| | | 1998 | 25 | | | 1 | | 10 |
| | | 1999 | 9 | 1 | | 2 | | 5 |
| | | 2000 | 13 | | | | | 2 |
| | | 2001 | 14 | 1 | | 7 | | 1 |
| | | 2002 | 18 | 8 | | 8 | | 8 |
| | | 2003 | 19 | 10 | | 10 | | 10 |
| | | 2008 | 18 | | | 9 | 5 | 9 |
| | | 2010 | 1 | 1 | | 1 | | 1 |
| | | 2011 | 1 | | | 1 | | 1 |
| | | 2012 | 13 | | | 10 | | |
| | | 2014 | 19 | 2 | | 13 | | 2 |

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| | | 2017 | 3 | | | 3 | | |
| | E206106 | 1985 | 10 | 10 | | 1 | | 10 |
| | | 1986 | 15 | 12 | | | | 12 |
| | | 1987 | 13 | 12 | | | | 12 |
| | | 1988 | 20 | 12 | | | | 12 |
| | | 1989 | 23 | 4 | 4 | 5 | 7 | 12 |
| | | 1990 | 23 | 1 | 4 | 6 | 8 | 13 |
| | | 1991 | 9 | | 1 | 5 | 4 | 4 |
| | | 1992 | 9 | | 4 | 5 | 4 | |
| | | 1993 | 20 | 2 | 7 | 5 | 8 | 8 |
| | | 1994 | 30 | 5 | 9 | | 9 | |
| | | 1997 | 7 | | | | | 6 |
| | | 1998 | 25 | | | 1 | | 9 |
| | | 1999 | 9 | 1 | | 1 | | 4 |
| | | 2000 | 106 | | | 31 | 31 | 2 |
| | | 2001 | 104 | 3 | 10 | 35 | 32 | 3 |
| | | 2002 | 74 | 7 | 6 | 28 | 21 | 7 |
| | | 2003 | 55 | 17 | 3 | 29 | 19 | 10 |
| | | 2004 | 39 | 28 | 9 | 28 | 28 | |
| | | 2005 | 50 | 30 | 14 | 30 | 30 | 19 |
| | | 2006 | 61 | 30 | 30 | 30 | 30 | 30 |
| | | 2007 | 62 | 31 | 29 | 31 | 31 | 31 |
| | | 2008 | 65 | 32 | 32 | 32 | 32 | 32 |
| | | 2009 | 60 | 30 | 30 | 29 | 30 | 30 |
| | | 2010 | 51 | 25 | 25 | 25 | 25 | 25 |
| | | 2011 | 51 | 24 | 22 | 25 | 23 | 25 |
| | | 2012 | 46 | 22 | 22 | 34 | 22 | 22 |
| | | 2013 | 47 | 29 | 29 | 29 | 29 | 29 |
| | | 2014 | 53 | 24 | 24 | 24 | 24 | 24 |
| | | 2015 | 58 | 29 | 27 | 29 | 29 | 29 |
| | | 2016 | 33 | 29 | 29 | 29 | 28 | 29 |
| | | 2017 | 49 | 26 | 26 | 27 | 26 | 26 |
| | | 2018 | 54 | 27 | 27 | 27 | 27 | 27 |
| | | 2019 | 31 | 25 | 24 | 25 | 25 | 25 |
| | E206107 | 1985 | 9 | 9 | | | | 9 |
| | | 1986 | 8 | 5 | | | | 5 |
| | | 1987 | 2 | 1 | | | | 1 |
| | | 1988 | 10 | 4 | | | | 4 |

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| | | 1989 | 14 | | 2 | 5 | 3 | 4 |
| | | 1990 | 20 | 1 | 4 | 6 | 7 | 10 |
| | | 1991 | 1 | | 1 | | 1 | |
| | | 1992 | 10 | 6 | 4 | 6 | 4 | 6 |
| | | 1993 | 20 | 1 | 7 | 5 | 8 | 7 |
| | | 1994 | 31 | 5 | 9 | | 9 | |
| | | 1995 | 10 | | | | | 1 |
| | | 1996 | 2 | | | | | 1 |
| | | 1997 | 18 | | | | | 6 |
| | | 1998 | 47 | | | 1 | | 8 |
| | | 1999 | 12 | 1 | | 1 | | 2 |
| | | 2000 | 19 | | | | | 2 |
| | | 2001 | 8 | 1 | | 1 | | 1 |
| | | 2002 | 25 | 9 | | 9 | | 9 |
| | | 2003 | 22 | 9 | | 9 | | 9 |
| | | 2008 | 19 | | | 9 | 5 | 9 |
| | | 2010 | 1 | 1 | | 1 | | 1 |
| | | 2011 | 1 | | | 1 | | 1 |
| | | 2012 | 14 | | | 11 | | |
| | | 2013 | 11 | | | 11 | | |
| | E206108 | 1985 | 10 | 10 | | 2 | | 10 |
| | | 1986 | 14 | 12 | | | | 12 |
| | | 1987 | 12 | 12 | | | | 12 |
| | | 1988 | 21 | 12 | | | | 12 |
| | | 1989 | 19 | 4 | 1 | 5 | 1 | 9 |
| | | 1990 | 22 | 1 | 4 | 7 | 7 | 11 |
| | | 1992 | 9 | | 4 | 5 | 4 | |
| | | 1993 | 20 | 1 | 7 | 5 | 8 | 7 |
| | | 1994 | 21 | 5 | 9 | | 9 | |
| | | 1995 | 15 | | 4 | | 4 | 1 |
| | | 1996 | 3 | | | | | 2 |
| | | 1997 | 7 | | | | | 6 |
| | | 1998 | 24 | | | | | 8 |
| | | 1999 | 8 | 1 | | 1 | | 4 |
| | | 2000 | 14 | | | | | 2 |
| | | 2001 | 12 | | | 6 | | |
| | | 2002 | 18 | 8 | | 8 | | 8 |
| | | 2003 | 19 | 10 | | 10 | | 10 |

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| | | 2008 | 19 | | | 9 | 5 | 9 |
| | | 2012 | 14 | | | 11 | | |
| | | 2013 | 11 | | | 11 | | |
| | | 2014 | 10 | 1 | | 5 | | 1 |
| | | 2015 | 9 | 5 | 2 | 5 | 2 | 5 |
| | E207466 | 1988 | 9 | 4 | | | | 4 |
| | | 2010 | 9 | 9 | 9 | | 9 | 9 |
| | | 2014 | 10 | 10 | 10 | | | |
| | | 2015 | 15 | 9 | 9 | | 9 | 9 |
| | | 2016 | 20 | 15 | 15 | 2 | 15 | 15 |
| | | 2017 | 22 | 17 | 18 | 3 | 18 | 17 |
| | | 2018 | 23 | 9 | 18 | 1 | 18 | 10 |
| | | 2019 | 4 | 2 | 2 | 4 | 2 | 2 |
| | E217507 | 1994 | 2 | 2 | | | | |
| | | 2008 | 152 | 152 | 138 | 14 | 138 | 152 |
| | | 2009 | 3 | 3 | | 3 | | 3 |
| | | 2010 | 36 | 36 | 33 | 3 | 33 | 36 |
| | | 2013 | 71 | 62 | 62 | 9 | 62 | 71 |
| | | 2014 | 24 | 21 | 21 | 3 | | 3 |
| | | 2015 | 32 | 28 | 28 | | 28 | 28 |
| | | 2016 | 82 | 75 | 75 | 3 | 75 | 75 |
| | | 2017 | 58 | 54 | 55 | 2 | 55 | 54 |
| | | 2018 | 82 | 27 | 79 | 1 | 79 | 27 |
| | | 2019 | 30 | 1 | 28 | 4 | 28 | 2 |
| | E217508 | 1994 | 2 | 2 | | | | |
| | | 2008 | 164 | 164 | 150 | 14 | 150 | 164 |
| | | 2009 | 3 | 3 | | 3 | | 3 |
| | | 2010 | 37 | 37 | 34 | 3 | 34 | 37 |
| | | 2013 | 76 | 67 | 67 | 9 | 67 | 63 |
| | | 2014 | 24 | 21 | 21 | 3 | | 3 |
| | | 2015 | 33 | 29 | 29 | | 29 | 29 |
| | | 2016 | 89 | 82 | 82 | 3 | 82 | 82 |
| | | 2017 | 56 | 54 | 55 | | 55 | 54 |
| | | 2018 | 82 | 27 | 79 | | 79 | 27 |
| | | 2019 | 30 | 1 | 28 | 4 | 28 | 2 |
| | E217509 | 1994 | 2 | 2 | | | | |
| | | 2008 | 168 | 168 | 156 | 12 | 156 | 168 |
| | | 2009 | 3 | 3 | | 3 | | 3 |

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| | | 2010 | 62 | 62 | 59 | 3 | 59 | 62 |
| | | 2013 | 88 | 78 | 78 | 10 | 78 | 88 |
| | | 2014 | 24 | 21 | 21 | 3 | | 3 |
| | | 2015 | 34 | 30 | 30 | | 30 | 30 |
| | | 2016 | 113 | 106 | 106 | 3 | 106 | 106 |
| | | 2017 | 58 | 54 | 55 | 2 | 55 | 54 |
| | | 2018 | 58 | 27 | 55 | 1 | 55 | 27 |
| | | 2019 | 4 | 1 | 2 | 4 | 2 | 2 |
| | E234124 | 1998 | 11 | | | | | 2 |
| | | 1999 | 5 | | | | | 2 |
| | | 2000 | 12 | | | | | 1 |
| | | 2010 | 1 | 1 | | 1 | | 1 |
| | | 2011 | 1 | | | 1 | | 1 |
| | | 2012 | 15 | | | 12 | | |
| | | 2013 | 10 | | | 5 | | |
| | | 2014 | 1 | 1 | | 1 | | 1 |
| | E243577 | 2001 | 2 | 1 | | 1 | | 1 |
| | | 2002 | 3 | 2 | | 2 | | 2 |
| | | 2011 | 10 | 10 | 8 | 2 | 8 | 10 |
| | | 2012 | 2 | | | 2 | | 2 |
| | | 2014 | 11 | 11 | 9 | 2 | | 2 |
| Holland Creek | E217163 | 1992 | 16 | | | 16 | | 16 |
| | | 1993 | 7 | | | 7 | | 7 |
| Koksilah River | 123981 | 1971 | 2 | | | 2 | | |
| | | 1972 | 7 | 2 | 4 | 5 | 4 | 4 |
| | | 1973 | 5 | 1 | | 2 | 1 | 1 |
| | | 1974 | 8 | 3 | | 3 | | 3 |
| | | 1975 | 5 | 3 | | 2 | | 4 |
| | | 1976 | 4 | 2 | | 2 | | 2 |
| | | 1977 | 4 | 2 | | 1 | | 2 |
| | | 1978 | 7 | 2 | | 2 | | 2 |
| | | 1979 | 4 | 2 | | 2 | | 2 |
| | | 1980 | 2 | 1 | | 1 | | 1 |
| | | 1981 | 5 | 2 | | 2 | 1 | 2 |
| | | 1982 | 8 | 2 | 2 | 2 | 2 | 4 |
| | | 1983 | 7 | 2 | 2 | 1 | 2 | 4 |
| | | 1984 | 5 | 2 | 1 | | 2 | 4 |
| | | 1985 | 7 | 6 | | | 1 | 7 |

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| | | 1986 | 13 | 12 | | | | 12 |
| | | 1987 | 13 | 12 | | | | 11 |
| | | 1988 | 22 | 11 | | | 1 | 12 |
| | | 1989 | 25 | 5 | 3 | 5 | 5 | 14 |
| | | 1990 | 13 | | 4 | 5 | 6 | 6 |
| | | 1992 | 9 | | 4 | | 4 | |
| | | 1993 | 21 | 1 | 7 | 5 | 9 | 3 |
| | | 1994 | 25 | 5 | 9 | | 9 | |
| | | 1998 | 17 | | | | | 7 |
| | | 1999 | 5 | | | | | 5 |
| | | 2000 | 102 | | | 30 | 30 | 2 |
| | | 2001 | 108 | | 10 | 38 | 32 | |
| | | 2002 | 69 | 6 | 7 | 26 | 20 | 6 |
| | | 2003 | 52 | 10 | 1 | 30 | 20 | 10 |
| | | 2004 | 31 | 21 | | 28 | 28 | |
| | | 2005 | 51 | 31 | 5 | 31 | 31 | 20 |
| | | 2006 | 62 | 31 | 29 | 31 | 31 | 31 |
| | | 2007 | 62 | 31 | 28 | 31 | 30 | 31 |
| | | 2008 | 64 | 31 | 30 | 31 | 31 | 31 |
| | | 2009 | 60 | 30 | 29 | 29 | 29 | 30 |
| | | 2010 | 14 | 9 | 9 | 9 | 9 | 9 |
| | | 2012 | 14 | | | 11 | | |
| | | 2017 | 3 | | | 3 | | |
| | E207425 | 1988 | 19 | 8 | 1 | | 3 | 9 |
| | | 1989 | 25 | 5 | 3 | 4 | 5 | 14 |
| | | 1990 | 15 | | 4 | 5 | 6 | 6 |
| | | 1992 | 9 | | 4 | | 4 | |
| | | 1993 | 20 | 2 | 7 | 5 | 8 | 3 |
| | | 1994 | 25 | 5 | 9 | | 9 | |
| | | 1998 | 9 | | | | | 2 |
| | | 1999 | 34 | | | 3 | | 12 |
| | | 2000 | 13 | | | | | 2 |
| | | 2001 | 12 | | | 6 | | |
| | | 2002 | 21 | 11 | | 11 | | 11 |
| | | 2003 | 19 | 10 | | 10 | | 10 |
| | | 2008 | 19 | | | 9 | 5 | 9 |
| | | 2010 | 1 | 1 | | 1 | | 1 |
| | | 2012 | 16 | | | 11 | | |

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| | E207426 | 1988 | 6 | 4 | | | 1 | 4 |
| | | 1989 | 15 | 5 | 1 | | 2 | 9 |
| | | 1990 | 2 | | | | 1 | 1 |
| | E207427 | 1988 | 1 | 1 | | | | 1 |
| | | 1989 | 22 | 7 | 1 | 2 | 2 | 15 |
| | | 1990 | 9 | | 2 | 1 | 4 | 5 |
| | | 1998 | 24 | | | | | 11 |
| | | 2002 | 16 | 6 | | 6 | | 6 |
| | | 2003 | 19 | 10 | | 10 | | 10 |
| | | 2008 | 19 | | | 9 | 5 | 9 |
| | | 2012 | 14 | | | 11 | | |
| | | 2017 | 3 | | | 3 | | |
| | E207433 | 1988 | 15 | 7 | 1 | | 3 | 7 |
| | | 1989 | 24 | 6 | 3 | 4 | 4 | 14 |
| | | 1990 | 14 | | 4 | 5 | 6 | 7 |
| | | 1998 | 23 | | | | | 10 |
| | | 1999 | 2 | | | | | 2 |
| | | 2002 | 16 | 6 | | 6 | | 6 |
| | | 2003 | 19 | 10 | | 10 | | 10 |
| | | 2008 | 19 | | | 9 | 5 | 9 |
| | | 2012 | 56 | | | 32 | | |
| | | 2017 | 3 | | | 3 | | |
| Malahat Benchlands | 1100161 | 1973 | 1 | | | 1 | 1 | 1 |
| | | 1984 | 8 | 4 | | 4 | | 4 |
| | | 1985 | 62 | 13 | 32 | 10 | 35 | 14 |
| | | 1986 | 79 | 13 | 43 | | 53 | 13 |
| | | 1987 | 58 | 12 | 33 | | 34 | 11 |
| | | 1988 | 44 | 12 | 20 | | 24 | 12 |
| | | 1989 | 57 | 12 | 19 | | 32 | 12 |
| | | 1990 | 29 | 12 | 14 | | 14 | 12 |
| | | 1991 | 54 | 16 | 22 | | 38 | 16 |
| | | 1992 | 12 | 11 | | 1 | | |
| | | 1993 | 3 | 3 | | | | |
| | E294428 | 2013 | 11 | | | 11 | | |
| | | 2018 | 11 | 10 | | 10 | | |
| | E295317 | 2013 | 5 | | | 5 | | |
| | | 2018 | 1 | | | | 1 | |
| | | 2019 | 1 | | | | 1 | 1 |

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| Nitinat River | E226221 | 1997 | 13 | 4 | 1 | 4 | 1 | 4 |
| Sansum Narrows | E291153 | 2012 | 5 | | | 5 | | |
| Satellite Channel | 127217 | 1986 | 1 | 1 | | | | 1 |
| | | 1992 | 1 | | | | | 1 |
| | | 1995 | 27 | 3 | 1 | | 1 | 10 |
| | E291150 | 2012 | 7 | | | 7 | | |
| | | 2017 | 4 | | | 4 | | |
| | E294422 | 2013 | 5 | | | 5 | | |
| | | 2018 | 6 | 5 | | 5 | | |
| Shawnigan Creek | 1199901 | 1976 | 72 | 52 | 53 | | 53 | 18 |
| | | 1977 | 152 | 28 | 99 | 4 | 115 | 28 |
| | | 1978 | 278 | 26 | 234 | 7 | 242 | 26 |
| | | 1979 | 76 | 9 | 52 | 3 | 66 | 9 |
| | | 1980 | 74 | 9 | 59 | 9 | 57 | 9 |
| | | 1981 | 15 | | 15 | | 15 | 15 |
| | | 1982 | 1 | 1 | | 1 | | 1 |
| | | 1984 | 42 | 2 | 32 | 2 | 32 | 2 |
| | | 1986 | 6 | | | | 4 | |
| | | 1987 | 13 | | 9 | | 9 | |
| | | 1988 | 3 | 3 | | | | 3 |
| | | 1989 | 10 | | | | 7 | |
| | | 1992 | 3 | 3 | | | | |
| | | 1993 | 2 | 2 | | | | 2 |
| | | 1994 | 10 | 2 | 8 | | 8 | 2 |
| | | 1995 | 7 | 2 | | 2 | | 2 |
| | | 1997 | 4 | 2 | | 2 | | 2 |
| | | 1998 | 2 | 1 | | 1 | | 1 |
| | | 1999 | 3 | 2 | | 2 | | 2 |
| | | 2000 | 78 | 2 | | 2 | | 2 |
| | | 2001 | 78 | 3 | | 3 | | 2 |
| | | 2002 | 5 | 2 | | 2 | | 1 |
| | | 2003 | 177 | 125 | 143 | 27 | 143 | 143 |
| | | 2004 | 17 | 17 | 13 | 3 | 14 | 13 |
| | | 2005 | 34 | 34 | 31 | 3 | 31 | 34 |
| | | 2006 | 28 | 28 | 25 | 3 | 25 | 28 |
| | | 2007 | 19 | 19 | 17 | 2 | 17 | 19 |
| | | 2008 | 118 | 118 | 102 | 16 | 102 | 118 |
| | | 2010 | 21 | 21 | 18 | 3 | 18 | 21 |

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| | | 2013 | 88 | 78 | 78 | 10 | 78 | 88 |
| | | 2014 | 24 | 21 | 21 | 3 | | 3 |
| | | 2018 | 100 | 89 | 90 | 6 | 90 | 84 |
| | | 2019 | 31 | 27 | 27 | 4 | 27 | 31 |
| | 1199902 | 1976 | 76 | 40 | 63 | | 62 | 13 |
| | | 1977 | 101 | 22 | 70 | 2 | 70 | 22 |
| | | 1978 | 216 | 25 | 179 | 6 | 186 | 25 |
| | | 1979 | 53 | 7 | 45 | 3 | 44 | 7 |
| | | 1980 | 26 | 3 | 21 | 3 | 21 | 3 |
| | | 2003 | 175 | 118 | 139 | 27 | 139 | 136 |
| | | 2004 | 22 | 22 | 19 | 3 | 19 | 19 |
| | | 2005 | 23 | 23 | 20 | 3 | 20 | 23 |
| | | 2006 | 22 | 22 | 19 | 3 | 19 | 22 |
| | | 2007 | 26 | 26 | 22 | 4 | 22 | 26 |
| | | 2008 | 117 | 117 | 100 | 17 | 100 | 117 |
| | | 2010 | 24 | 24 | 21 | 3 | 21 | 24 |
| | | 2013 | 72 | 63 | 63 | 9 | 63 | 72 |
| | | 2014 | 24 | 21 | 21 | 3 | | 3 |
| | | 2018 | 73 | 62 | 62 | 8 | 62 | 69 |
| | | 2019 | 22 | 20 | 20 | 2 | 20 | 22 |
| | 1199903 | 1976 | 6 | 4 | | | | 4 |
| | | 1977 | 14 | 8 | | 2 | | 8 |
| | | 1978 | 19 | 11 | | 3 | | 11 |
| | | 1979 | 2 | 1 | | | | 1 |
| | | 1984 | 1 | 1 | | 1 | | 1 |
| | | 2001 | 2 | 1 | | 1 | | |
| | | 2003 | 121 | 79 | 94 | 20 | 94 | 93 |
| | | 2004 | 13 | 13 | 11 | 2 | 11 | 11 |
| | | 2005 | 13 | 13 | 11 | 2 | 11 | 13 |
| | | 2006 | 12 | 12 | 10 | 2 | 10 | 12 |
| | | 2007 | 11 | 11 | 9 | 2 | 9 | 11 |
| | | 2008 | 60 | 60 | 50 | 10 | 50 | 60 |
| | | 2010 | 12 | 12 | 10 | 2 | 10 | 12 |
| | | 2013 | 39 | 33 | 33 | 6 | 33 | 39 |
| | | 2014 | 13 | 11 | 11 | 2 | | 2 |
| | | 2018 | 42 | 32 | 32 | 5 | 32 | 37 |
| | | 2019 | 13 | 10 | 10 | 3 | 10 | 13 |
| | 1199904 | 1977 | 3 | 3 | | 2 | | 3 |

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| | | 1978 | 15 | 10 | | 3 | | 10 |
| | | 1979 | 2 | 1 | | | | 1 |
| | | 1984 | 1 | 1 | | 1 | | 1 |
| | | 2002 | 4 | 2 | | 2 | | |
| | | 2003 | 114 | 65 | 75 | 22 | 85 | 80 |
| | | 2004 | 14 | 14 | 12 | 2 | 12 | 12 |
| | | 2005 | 16 | 16 | 14 | 2 | 14 | 16 |
| | | 2006 | 17 | 17 | 15 | 2 | 15 | 17 |
| | | 2007 | 16 | 16 | 14 | 2 | 14 | 16 |
| | | 2008 | 86 | 86 | 77 | 9 | 77 | 86 |
| | | 2010 | 16 | 16 | 14 | 2 | 14 | 16 |
| | | 2013 | 52 | 46 | 46 | 6 | 46 | 52 |
| | | 2014 | 22 | 20 | 20 | 2 | | 2 |
| | | 2018 | 56 | 49 | 47 | 5 | 47 | 51 |
| | | 2019 | 16 | 14 | 14 | 2 | 14 | 16 |
| | E236520 | 2013 | 21 | | | 11 | | |
| | | 2018 | 11 | 10 | | 10 | | |
| | E294421 | 2013 | 11 | | | 9 | | |
| | | 2018 | 11 | 10 | | 10 | | |
| | E294425 | 2013 | 11 | | | 11 | | |
| | | 2016 | 14 | 13 | | 14 | | 13 |
| | | 2017 | 5 | 5 | | 5 | | 5 |
| Stocking Creek | E206290 | 1985 | 22 | 10 | 12 | 6 | 12 | 10 |
| | | 1986 | 82 | 11 | 48 | | 60 | 11 |
| | | 1987 | 77 | 12 | 52 | | 53 | 11 |
| | | 1988 | 72 | 12 | 44 | | 52 | 11 |
| | | 1989 | 75 | 12 | 32 | 1 | 50 | 12 |
| | | 1990 | 42 | 11 | 30 | | 30 | 11 |
| | | 1991 | 95 | 12 | 63 | | 83 | 12 |
| | | 1992 | 22 | 21 | | 1 | | |
| | | 1993 | 50 | 13 | 37 | 13 | 37 | |
| | | 1994 | 119 | 14 | 97 | 14 | 101 | |
| | | 1995 | 38 | 4 | 33 | 4 | 33 | |
| | | 1997 | 4 | 2 | | 2 | | 2 |
| | | 1998 | 4 | 2 | | 2 | | 2 |
| | | 2001 | 3 | 2 | | | | 2 |
| | | 2002 | 11 | | | 5 | | 5 |
| | | 2003 | 37 | 18 | 16 | 10 | 16 | 26 |

| Watershed | EMS_ID | Year | Total Samples | Conductivity (µS/cm) | Dissolved Oxygen (mg/L) | Turbidity (NTU) | Temperature (°C) | pH |
|---|---|---|---|---|---|---|---|---|
| | | 2004 | 6 | | | 3 | | 3 |
| | | 2005 | 25 | 25 | 23 | 2 | 23 | 25 |
| | | 2007 | 14 | | | 7 | | 7 |
| | | 2008 | 30 | 17 | 14 | 9 | 14 | 23 |
| | | 2011 | 25 | 25 | 22 | 3 | 22 | 25 |
| Yellowpoint Benchlands | NEW | NA | | NA | NA | NA | NA | NA |