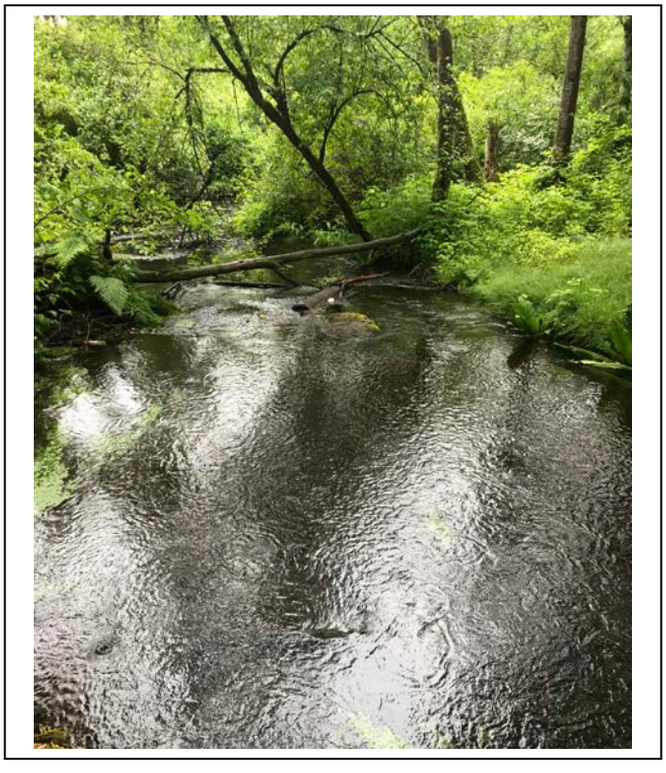
ENVIRONMENTAL QUALITY SERIES

# Nooksack River Transboundary Report: October 2019 to September 2020 Data Summary

Lyndsey Johnson



February 2021

BRITISH COLUMBIA

This is the third data summery report for the Nooksack Watershed Transboundary Partnership**.** The Ministry of Environment and Climate Change Strategy conducts water quality monitoring of freshwater and marine water through numerous programs to evaluate the condition of waterbodies in B.C. For additional information visit: https://www2.gov.B.C..ca/gov/content/environment/air-land-water/water/water-quality/water-quality-monitoring/water-quality-monitoring-documents

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**Cover Photographs:**
Pepin Brook in Aldergrove Regional Park, credit: Melany Sanchez

## Acknowledgements

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## EXECUTIVE SUMMARY

The Nooksack River is located south of the United States–Canada Border in the State of Washington and discharges primarily into Bellingham Bay through a wetland system. Bertrand Creek and Fishtrap Creek are two large sub-basins of the upper Nooksack River Watershed that straddle the international boundary. High concentrations of fecal coliform bacteria have impacted shellfish production in Portage Bay, near the Lummi Reservation (and located within Bellingham Bay) in Washington State (WA). As part of the Nooksack Watershed Transboundary Project, the B.C. Ministry of Environment & Climate Change Strategy (ENV) and Washington State (WA) Department of Ecology have initiated programs to monitor water quality and find opportunities to reduce preventable sources of fecal coliform bacteria.

Since 2017, monthly water samples have been collected by the Monitoring, Assessment & Stewardship (MAS) team of ENV. This report focuses on monitoring data collected from sample sites between October 2019 and September 2020 and indicates elevated fecal coliform and *E. coli* concentrations, including exceedances of applicable water quality guidelines, in each of the four tributaries (Cave Creek, Bertrand Creek, Fishtrap Creek and Pepin Brook) sampled in the Nooksack River Watershed.

The highest fecal and *E. coli* concentrations were observed in Spring and to a lesser degree in the Fall. In addition, concentrations in the upstream monitoring sites tended to be higher than sites located closer to the border. Between October 2019 and September 2020, the water quality bacteriological benchmark was met at all border sites during the wet season, but the benchmark was not met at Cave and Bertrand Creek border sites during the dry season in Spring 2020.

While the primary focus of this project is bacteriological concentrations, water samples were also analyzed for nutrients to provide additional information about the watershed. Monitoring results continue to indicate elevated levels of phosphorus. Results from every monitoring site show high phosphorus concentrations, sometimes thousands of times over the suggested limit. Elevated phosphorus concentrations may be an indicator of over application of fertilizers or improperly stored compost or livestock waste and excessive amounts can result in harm to aquatic life in waterways.

The water quality monitoring program in B.C. continues to identify sites of concern and sources of fecal bacteria in order to determine whether additional compliance and/or education efforts are required to reduce concentrations in the watershed.

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## FIGURES



## TABLES

## ACRONYMS

| | |
|---|---|
| B.C. | British Columbia |
| CFU/mL | Colony Forming Units per millilitre |
| DO | Dissolved Oxygen |
| *E. coli* | *Escherichia coli* |
| ENV | Ministry of Environment and Climate Change Strategy |
| EMA | *Environmental Management Act* |
| $km^2$ | Square kilometres |
| LEPS | Langley Environmental Partnership Society |
| MAS | Monitoring, Assessment & Stewardship |
| mg/L | Milligrams per litre |
| mm | Millimetre |
| TCG | Transboundary Technical Collaboration Group |
| URL | uniform resource locator (website address) |
| WA | State of Washington |
| WQG | Water Quality Group |
| WQTG | Water Quality Task Group |
| µg/L | Micrograms per litre |

# 1. PROJECT BACKGROUND

## 1.1 Introduction

The Nooksack River is located south of the United States–Canada border in the State of Washington (WA) and discharges primarily into Bellingham Bay through a wetland system. The watershed for this river spans both United States and Canada (Figure 1). In recent years, this watershed has experienced a significant increase in urban and agricultural development, which has led to an overall decline in water quality and ecosystem health. At the mouth of the Nooksack River is the Lummi Indian Reservation. Since 1998, Lummi Nation shellfish beds in Portage Bay have been closed for harvesting up to six months of the year due to seasonally elevated fecal coliform bacteria levels in the marine water (British Columbia Ministry of Environment and Climate Change Strategy [B.C. ENV], 2018b). The closures typically last from April to June and from October to December, and May and November historically have the highest fecal coliform counts.

The Nooksack River Water Quality Task Group (WQTG) began meeting in late 2016 to better understand water quality conditions and identify opportunities to reduce preventable sources of fecal coliform pollution in the transboundary area of the watershed. Water quality improvement efforts support mutual public and environmental health goals within the lower Nooksack River system and benefit shellfish harvest recovery efforts in the Nooksack River's receiving waters of Portage Bay (Portage Bay Shellfish Protection District Committee, 2014).

In August 2018, the WQTG recommended establishing a multi-agency Transboundary Technical Collaboration Group (TCG) for three years (August 2018 to August 2021). The TCG aims to deliver bacteria pollution reduction activities, as outlined in the Three-Year Work Plan and Terms of Reference. One of the WQTG's recommendations for the TCG was to continue long- and short-term ambient sampling in freshwater areas and to continue source identification sampling, including water quality monitoring, to identify fecal coliform sources.

This report provides an overview of water quality data collected between fall of 2019 and summer of 2020. This report is the third annual summary in the three-year Nooksack River Transboundary project. The first two reports covered the following data: June 2017 to July 2018 and August 2018 to September 2019. It should be noted that some water quality sampling was taking place in the watershed prior to the implementation of the Three-Year Work Plan.

Bertrand Creek and Fishtrap Creek are two large sub-basins of the upper Nooksack River Watershed that straddle the international boundary. Pepin Brook flows into Fishtrap Creek south of the international border. About half the land areas of both Bertrand Creek and Fishtrap Creek Watersheds are in B.C., Canada, and half are in WA, United States. Both B.C. and WA are working together to understand the sources of fecal coliform pollution and to share best practices to reduce these sources and improve water quality.

Fecal coliforms are a subset of total coliform bacteria. Typically found in the gut and feces of warm-blooded animals, they are a better indicator of animal or human waste than total coliforms (U.S. Environmental Protection Agency, 2012). *Escherichia coli* (*E. coli)* is a species of fecal coliform that is specific to fecal material from humans and other warm-blooded animals and is typically used by the U.S. Environmental Protection Agency as an indicator of the health risk from water contact during recreation. In B.C., *E. coli* is also the preferred bacteriological indicator in freshwater environments (Warrington, 2001).

ENV has two sampling programs developed to monitor and address the fecal coliform exceedances influencing the closure of shellfish production in the Nooksack Watershed. They

include regular monthly sampling, and five weekly consecutive samples collected in 30 days (5-in-30 sampling). These programs are described in more detail in the Methods section below. In addition, ENV is also involved in compliance activities, including inspections, promotion of best management practices as well as enforcement of unauthorized discharges.

# British Columbia - Washington Nooksack River Transboundary Water Quality Project

## Site Type

- EMS
- LEPS
- EC

## Freshwater Atlas - Watershed

- Bertrand Creek
- Fishtrap Creek
- Watersheds

- Streams / Ditches / Drainage Channels
- Lake - Definite
- Lake - Indefinite
- Lake - Intermittent
- Reservoir - Definite
- Canal
- Tailing Pond

- Parcels with Livestock

## Agriculture Structures

- Poly greenhouse
- Glass greenhouse
- Crop barn
- Farm

## Cultivated Field Crops

- Cereals & Oilseeds
- Tree fruits
- Vines & berries
- Forage, pasture
- Vegetables
- Floriculture
- Specialty, Turf, Nut trees
- Nursery & Tree plantations
- Other

Coordinate System: NAD 1983 BC Environment Albers
Projection: Albers
Datum: North American 1983

Created by Innovation and Adapatation Services Branch
Created on 2019/05/09

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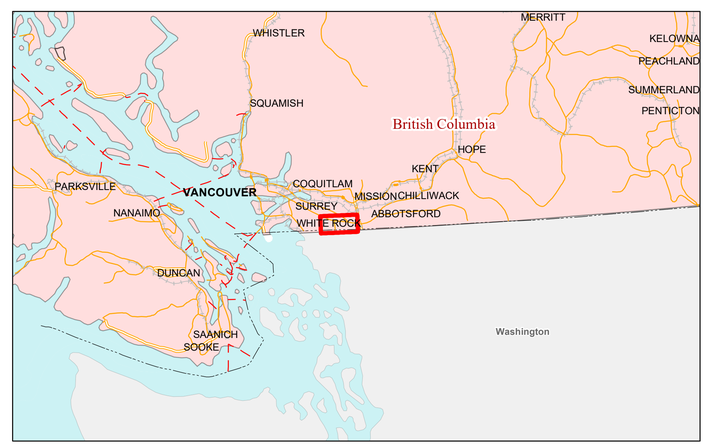
BRITISH COLUMBIA Ministry of Agriculture

N

0 1 2 3 4 Kilometers

0 0.5 1 1.5 2 Miles



## 1.2 Land Use

In B.C., the northern portion of the Nooksack River Watershed is in the South Coast Fraser Valley Region, which receives upwards of 600 mm of rain annually from October 1 to April 1. Rain events in the seasons between Fall 2019 and Summer 2020 had slightly less than normal rainfall with the exception of November 2019 (102.5 mm) and April 2020 (49.6 mm) which were much drier than normal rainfall events (240.5 mm, 115.4 mm, respectively) (Environment and Climate Change Canada, 2020).

The B.C. portion of the Nooksack Watershed has mixed land use including; industrial (compost, greenhouse, mushroom compost and on-land finfish), residential, parkland and agriculture including raising livestock (horses, beef cattle, dairy cattle, sheep, goats, llamas, donkeys, game, mink and chickens), providing forage and pasture, operating nurseries and greenhouses, and growing trees, berries, vine crops, mushrooms and other field vegetables or flowers (B.C ENV, 2018b). The WA portion of the Nooksack Watershed is predominately comprised of dairy farms and berry fields.

Bertrand Creek, located in the Township of Langley, flows near berry farms, and industrial operations including mushroom facilities. Pepin Brook flows through farmland, but mostly through Aldergrove Regional Park before crossing into WA at Double Ditch Road. Fishtrap Creek flows through mostly agriculture, specifically berry growing, and the cattle industry.

Water uses in this region include irrigation, well water for drinking, and water for livestock consumption. Pepin Brook flows through a well used recreational park, where there may be primary contact by domestic animals and humans.

## 1.3 Water Quality Sampling

The Monitoring, Assessment & Stewardship (MAS) section of the B.C. ENV has been collecting water samples from Bertrand Creek, Fishtrap Creek and Pepin Brook since June 2017. Prior to this, the Langley Environmental Partnership Society (LEPS) collected samples as per their contract with WA. When their contract ended December 2018, ENV took over some sample sites, based on high fecal coliform results and geographic location. Table 1 provides a summary of the sample locations with their associated referenced name in this report. Where there are bracketed numbers in the site description, this indicates the coinciding LEPS monitoring site number.

*Table 1: Summary of ENV sampling locations*

| Watershed | EMS ID | Latitude | Longitude | Name | Description |
|---|---|---|---|---|---|
| **Bertrand** | E207092 | 49.0506 | -122.4628 | Bertrand downstream of Aldergrove Lagoon, at 26B Ave. | About 50 m downstream of Aldergrove Lagoon, just off the end of 26B Ave. |
| | E314990 | 49.0599 | -122.4723 | Bertrand at 271 St and 32 Ave. | 271 St and south of 32 Avenue (B-08). |
| | E293977 | 49.03711 | -122.4925 | Bertrand at 264 Ave, north of 16 Ave. | Collected on south bank, upstream (east) of 264 St. bridge |
| | E314991 | 49.0260 | -122.5148 | Bertrand at 256 St and 12 Ave. | 256 Street and north of 12 Ave (B-10) |
| | E206847 | 49.0235 | -122.4707 | Howes at 272 St. | Collected upstream of 272 St. on Howes Creek (tributary to Bertrand Creek) |
| | E273723 | 49.0305 | -122.5325 | Bertrand at 16 Ave, near 248 St. | Collected from east bank 15 metres south (downstream) of bridge on 16th Ave. between 248 St. and 250 St. |
| | E315155 | 49.0064 | -122.5368 | Cave at 248 St. | 248 St. south of 4 Avenue (C-01). |
| | E312388 | 49.00238 | -122.5271 | Cave border site at 0 Ave. | Cave Creek at 0 Ave. |
| | E293980 | 49.00222 | -122.5233 | Bertrand border site at 0 Ave. | Collected underneath 0 Ave. bridge |
| **Pepin** | E253211 | 49.0122 | -122.4658 | Pepin within Aldergrove Park | Bridge crossing in Aldergrove Regional Park, accessed from 8th Ave. |
| | E279890 | 49.00333 | -122.4705 | Pepin border site at 0 Ave. | Collected at 0 Ave. and 272 St. (NE corner). |
| | E315157 | 49.0145 | -122.4488 | Pepin at Lefeuvre Rd. | Lefeuvre Road and South of Huntington Road (P-02) |
| | E309447 | 49.015810 | -122.455950 | Pepin tributary in Aldergrove Park | Pepin Brook tributary at Pepin Brook Trail bridge in Aldergrove Regional Park |
| **Fishtrap** | 0300069 | 49.0242 | -122.3953 | Fishtrap at Echo Rd. | Collected from south bank on east side of Echo St. bridge crossing |
| | E315795 | 49.0149 | -122.4046 | Fishtrap at Ross Rd. | Ross Road south of Huntington Road. |
| | E279889 | 49.00278 | -122.4061 | Fishtrap border site at 0 Ave. | Collected upstream of 0 Ave. bridge crossing on west bank. |
| | E310908 | 49.04573 | -122.3951 | Waetcher near Simpson Rd. | Collected on Waechter Creek near Simpson Rd. |

## 1.4 Compliance Activities

ENV staff continue to inspect operations in this watershed. The sites chosen for inspection are based on planned inspections for specific sector activities permitted under the *Environmental Management Act* (EMA), as well as recommendations from the ENV MAS section based on their findings through this project. Most of the inspections were located near Cave, Bertrand and Fishtrap Creeks and included hobby farms, chicken facilities and horse boarding businesses. About 40 percent of these properties were found to be in compliance at the time of the inspection. However, there was one property that had been receiving manure and stock piling it on the land adjacent to a tributary that enters Bertrand

Creek upstream from site E273723 (near 16th Avenue). This property was inspected and found to be out of compliance, resulting in a Pollution Abatement Order being issued under EMA. A PAO requires the landowner to rectify the non compliance issue such as improper manure storage. ENV Compliance staff continue to follow up with this landowner and other sources when identified. High fecal coliforms from this property may be affecting the exceedances at site E273723.

## 1.5 Report Objectives

The objective of this report is to provide a summary of the water quality sampling results for the third year of this transboundary project. It will note any improvements, identify any trends and make recommendations to the existing monitoring programs through the adaptive management process. This report will also form the basis for discussions with our WA partners as well as help focus future compliance activities.

## 2. METHODS

### 2.1 Water Quality Sampling

Discrete (or grab) water samples were collected by ENV in accordance with the *B.C. Field Sampling Manual* (B.C. ENV, 2013) and the B.C. Ministry of Environment, Lands and Parks *Freshwater Biological Sampling Manual* (Cavanagh, Nordin, & Warrington, 1996). Water samples were collected in laboratory-supplied sample bottles specific to the parameter being tested. Samples were either collected monthly or five consecutive weekly samples collected within 30 days (i.e., 5-in-30 sampling).

Parameters collected *in situ* using a hand-held metre (YSI pro plus meter) included:

- pH,
- temperature,
- specific conductivity, and
- dissolved oxygen (DO) (mg/L and %).

Monthly water samples were analyzed for:

- General chemistry: total organic carbon*, and total suspended solids,
- Nutrients: ammonia*, chloride, nitrate and nitrite*, total Kjeldahl nitrogen*, total nitrogen (N)*, total organic nitrogen*, dissolved ortho-phosphate*, phosphorus*,
- Microbiological parameters: *E. coli* and fecal coliform bacteria.

  * Parameters were not collected after June 2020 as there was not additional funding previously provided by the Ministry of Agriculture.

5-in-30 samples were only analyzed for microbiological parameters. Samples were delivered to ALS Laboratory in Burnaby for analysis on the same day they were collected. Quality assurance and quality control methods included replicate sampling (10% of samples, or 1 replicate sample, and travel blank per sampling event). Replicate samples that were collected for bacteriological indicators were incorporated into the seasonal geomean calculations, thus some of these geomeans may be based on four to six samples rather than the regular three (one per month). Replicate samples were also compared to determine sample reproducibility. Table 2 provides a summary of the number of samples collected by sampling event and by watershed.

*Table 2: Summary of ENV water quality sampling events and number of samples collected*

| Sampling date | Bertrand Creek | Pepin Brook | Fishtrap Creek | Total number of samples collected |
|---|---|---|---|---|
| October 22, 2019 | 9 | 5 | 4 | 18 |
| November 6, 2019 | 5 | 2 | 1 | 8 |
| November 13, 2020 | 5 | 2 | 1 | 8 |
| November 18, 2019 | 10 | 5 | 4 | 19 |
| November 27, 2019 | 5 | 2 | 1 | 8 |
| December 4, 2019 | 5 | 2 | 1 | 8 |
| December 10, 2019 | 9 | 4 | 4 | 17 |
| January 7, 2020 | 9 | 5 | 4 | 18 |
| February 4, 2020 | 6 | 5 | 4 | 15 |
| March 17, 2020 | 9 | 6 | 4 | 19 |
| May 11, 2020 | 9 | 5 | 4 | 18 |
| May 20, 2020 | 5 | 2 | 1 | 8 |
| May 26, 2020 | 5 | 2 | 1 | 8 |
| June 4, 2019 | 5 | 2 | 1 | 8 |
| June 9, 2020 | 9 | 5 | 4 | 18 |
| July 14, 2020 | 9 | 4 | 4 | 17 |
| August 4, 2020 | 9 | 4 | 4 | 17 |
| September 22, 2020 | 7 | 4 | 4 | 15 |
| **Total** | **130** | **66** | **51** | **247** |

## 3. WATER QUALITY GUIDELINES

B.C. ENV developed ambient water quality guidelines (WQG) to assess and manage the health, safety and sustainability of B.C.'s aquatic resources. These WQGs were established to protect designated uses such as aquatic life, wildlife, agriculture, drinking water sources and recreation. They include guidelines for microbiological indicators, which are types of bacteria used to detect and estimate the level of fecal contamination in water. Bacteria often enter surface waters via point and non-point sources, including wild and domestic animal feces as well as seepage from leaking or failing septic systems. In this summary report the WQG's are only used for comparison to the 5 in 30 sampling data as they allow for the proper geometric mean calculations as per the guidelines.

### 3.1 Bacteriology

Fecal coliforms have been used extensively for many years as indicators to determine the sanitary quality of surface, recreational and shellfish-growing waters. However, more recent studies have shown that *E. coli* is the main thermo-tolerant coliform species present in fecal samples (94 percent) from humans and other endotherms, such as birds and mammals (Tallon, Magajna, Lofranco, & Leung, 2005). In addition, where fecal coliform concentrations are higher than those of *E. coli*, it's highly likely that non-fecal sources are the dominant contributors to elevated bacteriology. Current B.C. WQGs are based on *E. coli* as the freshwater indicator and Enterococci as the marine indicator for microbial contamination. However, the Environment and Climate Change Canada shellfish program and Washington State still use fecal coliforms as indicators of risk in marine water. Therefore, this study monitored both fecal coliforms and *E. coli* in order to provide appropriate resource management recommendations to both B.C. and WA decision makers.

Table 3 provides the relevant guidelines for *E. coli* and fecal coliforms used in this report. Note that the updated 2017 B.C. Recreational WQGs document archived the fecal coliform guideline for recreation (≤ 200 colony-forming units (CFU)/100 mL geometric mean, based on the 2001 B.C. ENV report by Warrington, 2001) and identified *E. coli* as the preferred indicator (B.C. ENV, 2017). Also, note that the primary contact recreation fecal coliform criteria for Washington State is 100 CFU/100 mL, based on the geometric mean, with no more than 10% of the samples exceeding 200 CFU/100 mL (Washington State Department of Ecology, 2019).

*Table 3: Summary of applicable water quality guidelines*

| **ENV-approved water quality guidelines** | ***E. coli*** | **Fecal coliform** |
|---|---|---|
| Primary recreation | ≤ 200 CFU/100 mL (based on a geometric mean of a minimum of 5 samples collected weekly within 30 days);<br><br>or<br><br>< 400 CFU/100 mL (single-sample maximum concentration) | No B.C. guideline<br><br>*For comparison purposes:*<br>*Archived B.C. WQG = ≤ 200 CFU/100 mL geometric mean (based on a geometric mean of a minimum of 5 samples collected weekly within 30 days)*<br><br>*Washington State Primary Contact Recreation Criteria: 100 CFU/100 mL (based on the geometric mean), and not more than 10% of the samples exceeding 200 CFU/100 mL.* |
| Irrigation crops eaten raw | 77 CFU/100 mL (based on a geometric mean of a minimum of 5 samples collected weekly within 30 days) | ≤ 200 CFU/100 mL (based on a geometric mean of a minimum of 5 samples collected weekly within 30 days) |
| General irrigation | ≤ 1,000 CFU/100 mL (based on a geometric mean of a minimum of 5 samples collected weekly within 30 days) | ≤ 1,000 CFU/100 mL (based on a geometric mean of a minimum of 5 samples collected weekly within 30 days) |

## 3.2 Nutrients

There are no WQG's for phosphorus in streams, however, a draft report based on Vancouver Island Streams (with similar climate to the Nooksack Watershed) suggests that May to September total phosphorous average, with samples collected monthly, should not exceed 5 µg/L, and maximum total phosphorous should not exceed 10 µg/L in any one sample (Nordin, 2019). The phosphorus maximum of 10 µg/L was used for comparison because of the lack of data for a monthly average. Phosphorous is a cause for concern because its an indicator of nutrient loading, possibly from fertilizer application, manure and/or organic waste in sewage and industrial effluent. Phosphorus can be quite damaging to aquatic life by contributing to eutrophication, creating unsightly algal blooms which decrease water column oxygen levels upon decomposition.

The following additional relevant water quality guidelines are used in this report:

- pH: 6.5 -9.0 (aquatic life, freshwater)
- Chloride: <= 600 mg/L (short-term acute, aquatic life, freshwater)
- Nitrate: <= 33 mg/L (short-term acute, aquatic life, freshwater)
- Ammonia: pH and temperature dependent

- Nitrite: Chloride dependent
- Dissolved Oxygen guideline range for aquatic life: >5 mg/L (short-term acute, aquatic life, freshwater, all life stages other than buried embryo/alevin).

## 3.3 Border Benchmark

In an effort to minimize Canada's contribution of fecal coliforms entering the USA, the technical working group established a benchmark goal for the four border sites.

Border benchmarks were set as follows:

- *E. coli* of 200 CFU/100 mL – Short-term border benchmark to be achieved at border stations over two-years:
    - Benchmark is based on the geometric mean calculation of five weekly samples collected over 30 days (known as 5-in-30) and should apply to both wet and dry seasons.
- *E. coli* of 100 CFU/100 mL – Long-term border benchmark to be achieved at border stations within five years:
    - Benchmark is based on the geometric mean calculation of 5-in-30 samples and should apply to both wet and dry seasons.

## 4. RESULTS

The water quality data in this report was collected from a total of 19 sample sites from October 2019 to September 2020. Typically, geometric means are calculated based on 5 consecutive weekly samples collected within a 30-day period; however, due to the lack of weekly data sets, in this report, we calculated the geometric means seasonally and used the monthly sampling results (n=3), with some months having an n of up to 4 when 5 in 30 sampling data was included. It should also be noted that no sampling was conducted during the scheduled April 2020 monthly sampling due to field sampling restrictions associated with COVID-19 and therefore some seasons only had two monthly sampling events (n=2). The WQG's were used as a basis of comparison for these seasonal geomeans only.

The data were grouped by season using the Equinox calendar:

- Winter: December 21 to March 20
- Spring: March 21 to June 21
- Summer: June 22 to September 22
- Fall: September 23 to December 20

The data results in this report are presented by watershed, moving west to east (Bertrand Creek, Pepin Brook and Fishtrap Creek). Within each watershed, the data are summarized by parameter (i.e., fecal coliforms, *E. coli*). Results above the WQGs are called exceedances. The data are followed by a discussion section that provides insight into the potential sources of contamination for each watershed. Recommendations for follow up future monitoring programs, are proposed at the end of the report.

### 4.1 Bertrand Creek Results

The Bertrand Watershed drains an area of approximately 42.8 $km^2$ and is the largest creek system in the Canadian part of the Nooksack Watershed. Cave Creek is a 4 km long tributary to Bertrand Creek which joins Bertrand Creek approximately 250 m south of the border (Pearson, 1989) and therefore, water quality results are combined for both creeks. Bertrand Creek provides habitat for several species such as Nooksack dace and Salish sucker, and Coho salmon (LEPS, 2019). Bertrand Creek's headwaters originate close to the Fraser Highway, west of Aldergrove, and continues to flow through residential and urban areas. As the creek loops south, it flows through agricultural areas where Howes Creek (a tributary) joins to the main arm. During the summer months, water levels and dissolved oxygen tend to decrease and temperature tends to increase, with some sites on Howes Creek and Bertrand becoming ephemeral. The water in Bertrand Creek and its tributaries is highly influenced by farming practices and urban runoff. ENV also received reported incidents of homeless camps discarding their refuse into the headwater portion of Bertrand Creek in Aldergrove.

#### *4.1.1 Fecal Coliform*

Consistent with previous years' results, the main sites of concern continue to be Bertrand at 271 St. and 32 Ave. (E314990) and Howes at 272 St. (E206847) with fecal coliform concentrations regularly above 1000 CFU/100 mL for the protection of irrigation water and significantly above the irrigation for crops eaten raw guideline. These sites are both located downstream of organic matter composting facilities. The remaining sites all show high variability from season to season and between sites (Figure 2). Bertrand at 256 St. and 12 Ave. (E314991) had elevated concentrations in general throughout all seasons and significantly elevated concentrations in the Spring of 2020. The source of the elevated concentrations is unknown and will continue to be examined.

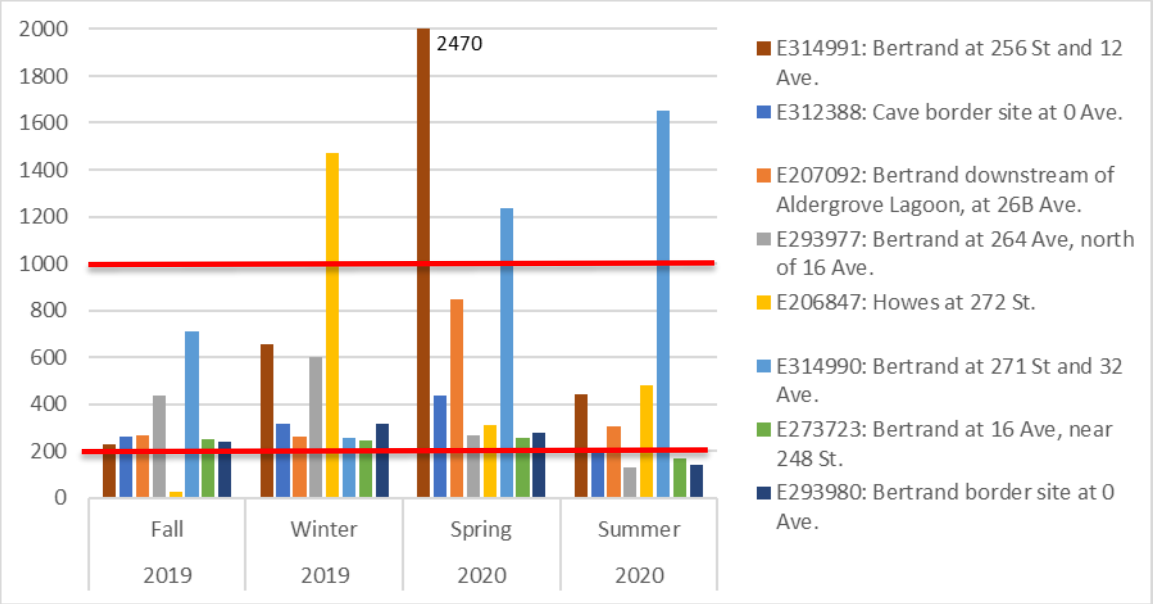



*Figure 2: Bertrand Creek fecal coliform geometric mean results by season and sample site.*

*Red lines represent the WQG for the protection of irrigation water for crops eaten raw (200 CFU/100 mL) and general irrigation (1000 CFU/100mL) shown for comparison purposes.*

### *4.1.2 E. coli*

The *E. coli* results follow the same patterns as the fecal coliform results, although with lower concentrations, as expected (Figure 3). These results confirm that sites Bertrand at 271 St. and 32 Ave. (E314990) and Howes at 272 St. (E206847) are areas of fecal pollution and may need additional compliance verification. The Bertrand border site at 0 Ave. (E93980) continues to have concentrations lower than the primary recreation guideline (200 CFU/100 mL) with the exception of Spring 2020.

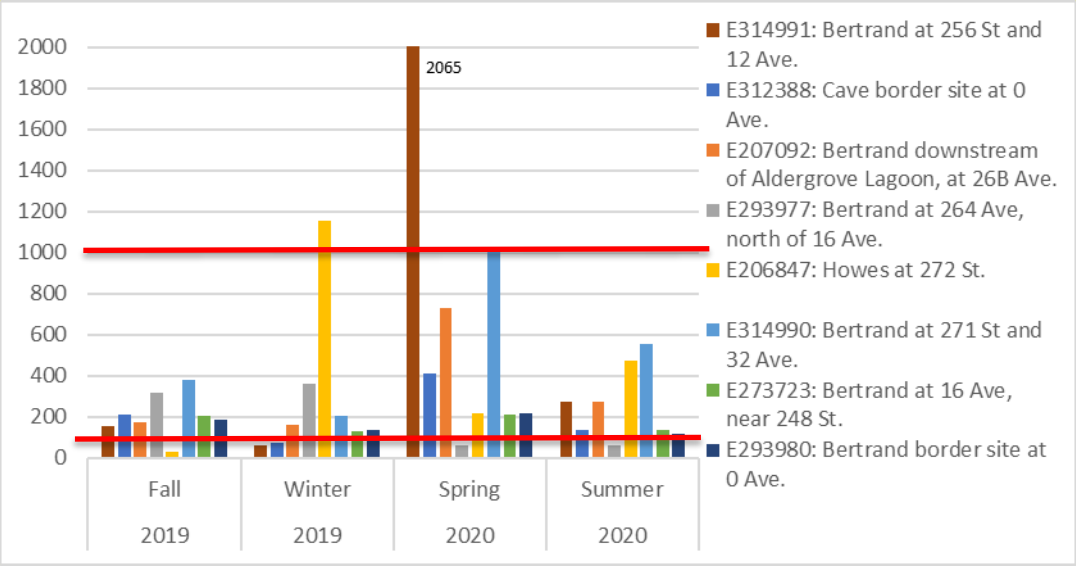



*Figure 3: Bertrand Creek E. coli geometric mean results by season and sample site.*

*Red lines represent the WQG for the protection of irrigation water for crops eaten raw (77 CFU/100 mL) and general irrigation (1000 CFU/100mL) shown for comparison purposes.*

### *4.1.3 Nutrients and Physical Water Quality Results*

Nutrient and physical parameter exceedances are shown in Appendix B. Consistent with previous years, elevated phosphorus results were recorded at almost every sampling event on Bertrand and Cave Creek sampling sites.

During the warm summer months, dissolved oxygen often drops below the instantaneous minimum of 5 mg/L, which is below the B.C. WQG for all life stages of fish, other than buried embryo/alevin. Lower dissolved oxygen concentrations occur because of the low flow and higher temperatures during the summer season, however elevated nutrient concentrations such as phosphorus are known to increase water column algae growth which in turn contributes to decreased DO when it decomposes.

## 4.2 Pepin Brook Results

Pepin Brook drains approximately 7.2 $km^2$ and is the smallest system in the Nooksack Watershed, mostly flowing through Aldergrove Regional Park. It provides habitat for species like lamprey, Longnose Dace, Coho Salmon, Cutthroat Trout, Rainbow Trout and American Shad as well as endangered species Nooksack Dace and Salish Sucker (LEPS, 2019). There is a large composting facility that discharges its effluent into a tributary to Pepin Brook and sampling data results suggest it is impacting the water quality in this system.

### *4.2.1 Fecal Coliform*

As Figure 4 shows, there are very high concentrations from Pepin at Lefeuvre Rd. (E215157) in the fall and winter of 2019; this site is Pepin Brook before it enters Aldergrove Regional Park and is downstream of several facilities, including a mushroom compost facility. The Pepin tributary in Aldergrove Park (E309447) has historically had extremely high concentrations, however the concentrations appear to be slightly decreasing, though they still are exceeding guidelines. The Pepin border site at 0 Ave. (E279890) continues to have concentrations lower than the primary recreation guideline (200 CFU/100 mL) and meets the guideline for the protection of irrigation water for crops eaten raw (200 CFU/100 mL), with the exception of Fall 2019 which was slightly higher (geometric mean of 207 CFU/100 mL).

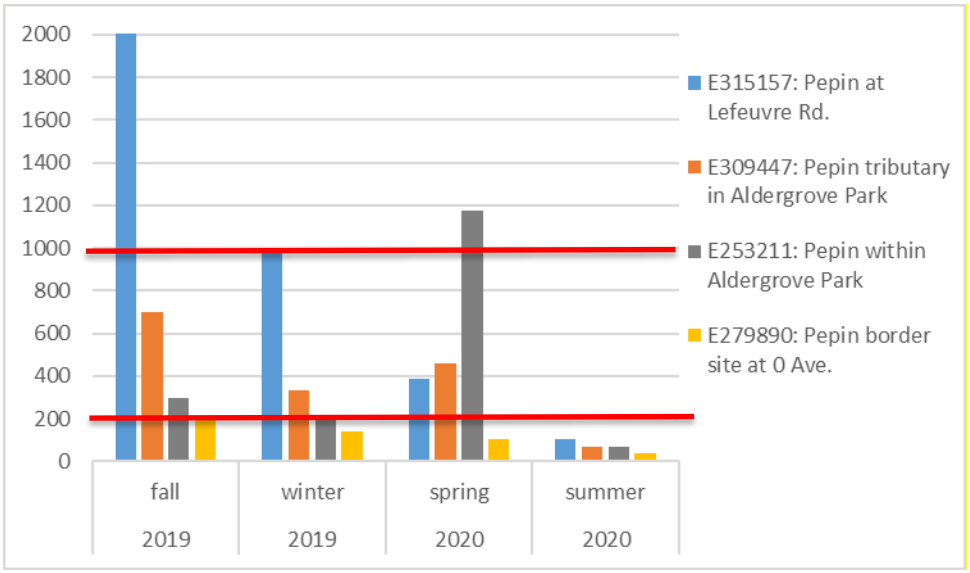



*Figure 4: Fecal coliform geometric mean results per season and sample site on Pepin Brook.*

*Red lines represent the WQG for the protection of irrigation water for crops eaten raw (200 CFU/100 mL) and general irrigation (1000CFU/100mL) shown for comparison purposes.*

### *4.2.2 E. coli*

Figure 5 also shows a very high concentration for *E. coli* at sites Pepin at Lefeuvre Rd. (E315157) and the Pepin tributary in Aldergrove Park (E309447) in fall 2019 which both exceed the recreational guideline based on 5-in-30 sampling. The Pepin border site at 0 Ave. (E279890) continues to have concentrations lower than the primary recreation guideline (200 CFU/100 mL), however it exceeds the WQG for the protection of irrigation water for crops eaten raw (77 CFU/100 mL) in all seasons except Summer 2020.

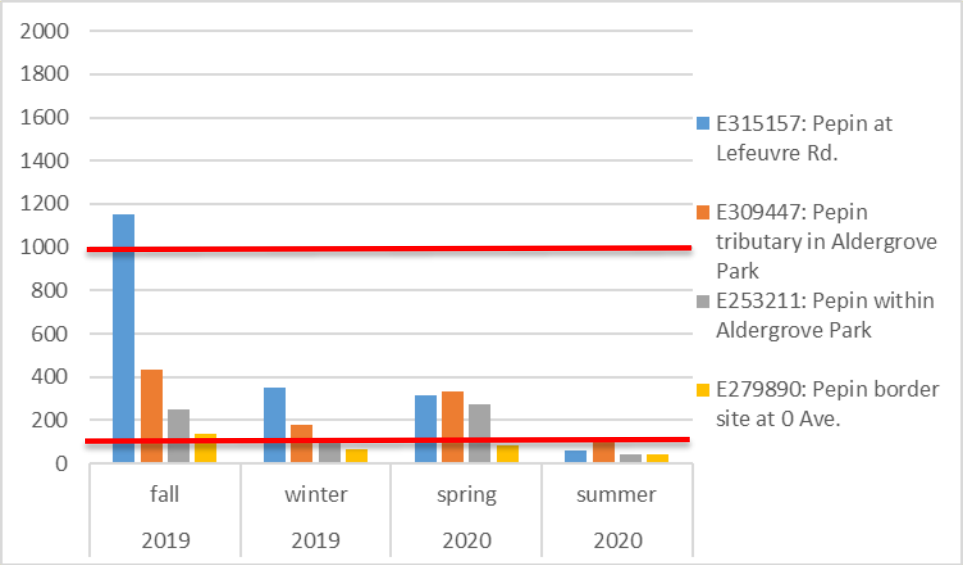



*Figure 5. E. coli geometric mean results per season and sample site on Pepin Brook.*

*Red lines represent the WQG for the protection of irrigation water for crops eaten raw (77 CFU/100 mL) and general irrigation (1000 CFU/100mL) shown for comparison purposes.*

### *4.2.3 Nutrients and Physical Water Quality*

Consistent with previous years, phosphorus concentrations were high and exceeded 10 µg/L at all sites sampled; phosphorus concentrations on Pepin Creek were lower than Bertrand Creek. DO was found to be low during summer months at Pepin at Lefeuvre Rd. (E315157) most likely because of low flow, warm temperature and possible nutrient loading. This site continues to have very low DO levels.

## 4.3 Fishtrap Creek Results

The Fishtrap Watershed drains approximately 30 $km^2$ before crossing the border into WA (City of Abbotsford, 2019). Fishtrap Creek also supports Nooksack Dace and Salish Sucker along with Coho salmon. Most of the length of this creek is on or bordering agricultural lands including dairy and berry growing. It is also important to note that Fishtrap Creek surface water feeds into the ground water aquifer that many Abbotsford citizens use for their drinking water.

### *4.3.1 Fecal Coliform*

The fecal coliform results were relatively low (under 200 CFU/100 mL guideline for irrigation of crops eaten raw), with the exception of Waetcher near Simpson Road (E310908) in Winter 2019 (Figure 6). A mushroom compost facility located at the headwater of Waetcher Creek had a pollution event resulting in extreme exceedances of WQG's in October 2018. Water quality data suggests that another incident happened in the Winter of 2019.

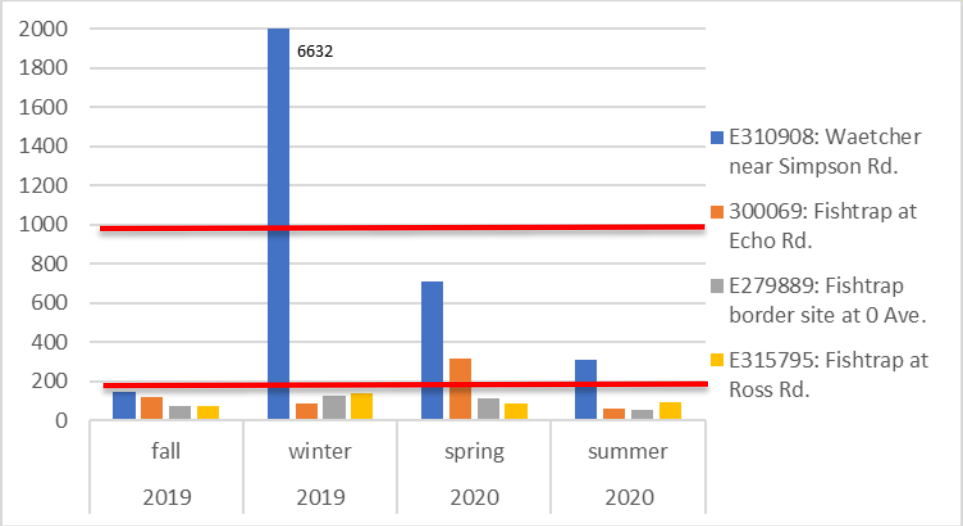



*Figure 6: Fecal coliform geometric mean results by season and sample site on Fishtrap Creek.*

*Red lines represent the WQG for the protection of irrigation water for crops eaten raw (200 CFU/100 mL) and general irrigation (1000 CFU/100mL) shown for comparison purposes.*

### *4.3.2 E. coli*

The *E. coli* results are very high at Waetcher at Simpson Rd. (E210908) and would exceed WQGs for primary recreation (200 CFU/100 mL), irrigation for crops eaten raw (77 CFU/100 mL) and general irrigation (10000 CFU/100 mL), based on 5-in-30 sampling, indicating that more of the coliforms are fecal in nature (Figure 7). In general *E. coli* concentrations on Fishtrap are relatively lower, compared to the other two systems' sample results.

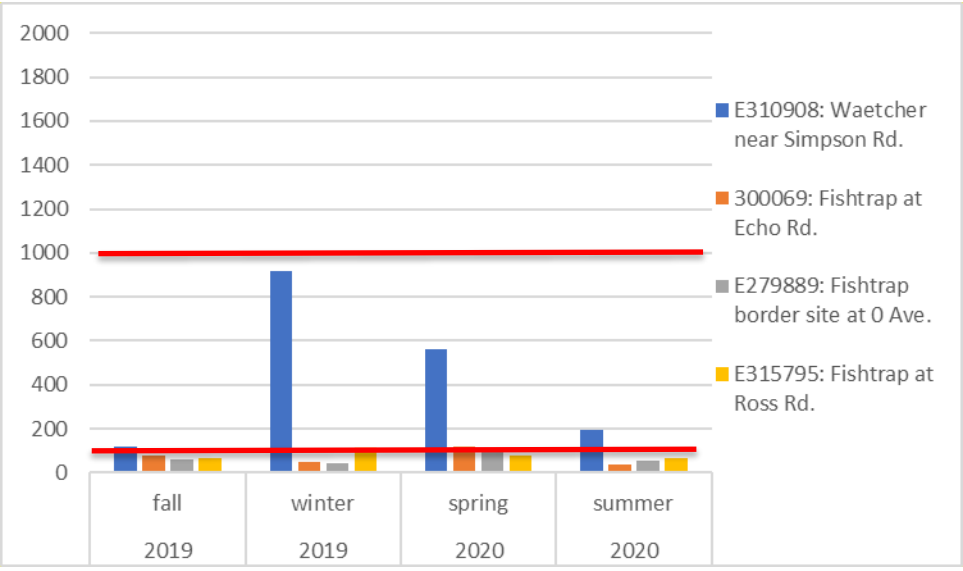



*Figure 7: E. coli geometric mean results per season and sample site on Fishtrap Creek.*

*Red lines represent the WQG for the protection of irrigation water for crops eaten raw (77 CFU/100 mL) and general irrigation (1000 CFU/100mL) shown for comparison purposes.*

### *4.3.3 Nutrients and Physical Water Quality*

Like the other creeks in the Nooksack watershed, Fishtrap Creek also had some exceedances of the maximum grab guideline of 10 µg/L of phosphorus at every site. DO was found to be low during May 2020 at Fishtrap at Echo Rd. (0300069) most likely because of low flow, warm temperature and possible nutrient loading.

## 4.4 CAN/USA Border Benchmarks

Figures 8 and 9 illustrate the status relative to the short-term border benchmarks based on data collected during two 5-in-30 sampling events completed at each of four border sites. B.C. completed one 5-in-30 sampling event during November-December 2019 (wet season) and one 5-in-30 event during May-June 2020 (dry season).

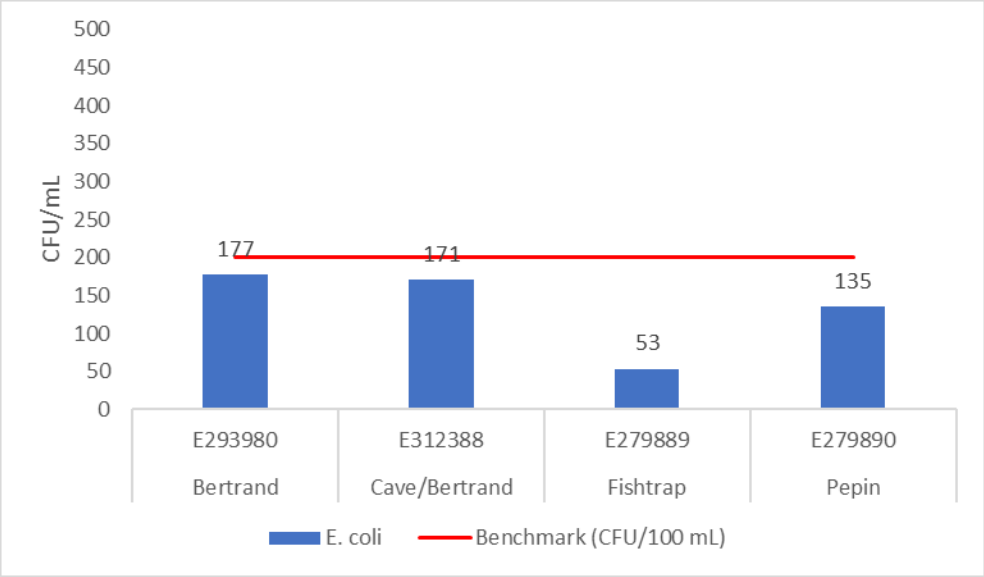



*Figure 8: Border Benchmark geometric means for E. coli in November/December 2019.*

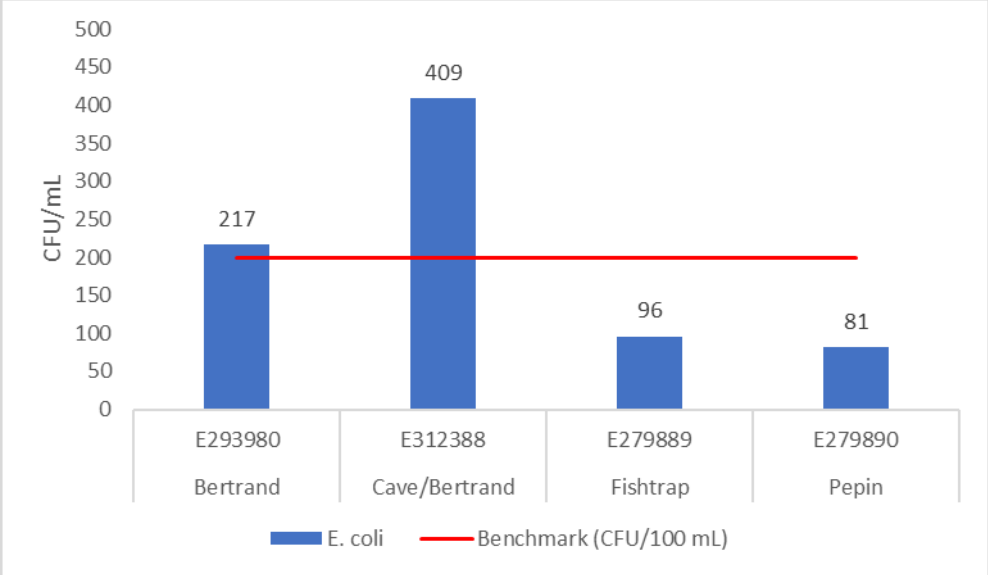



*Figure 9: Border Benchmark geometric means for E. coli in May/June 2020.*

Data analysis for 5-in-30 wet season 2019 and dry season 2020 sampling shows that:

- Bertrand Creek sub-basin: Sub-basin benchmark evaluation sites include both the Cave (E312388) and the Bertrand (E293980) sites.
    - Wet season 2019
        - Both Bertrand and Cave Creek achieved the short-term benchmark.

- Dry season 2020
    - Cave Creek had an extremely high *E. coli* concentration during one of the 5-in-30 dry season sampling dates, which contributed to an elevated geometric mean and as a result did not achieve the short-term benchmark.
    - Bertrand Creek had two sampling events that had elevated *E. coli* concentrations and as a result was slightly above the short-term benchmark.
    - ENV is working to identify the source(s) and to follow up with compliance verification.
- Pepin Brook sub-basin:
    - Wet season 2019 and dry season 2020 –
        - Pepin achieved the short-term benchmark during both 5-in-30 sampling events.
- Fishtrap sub-basin:
    - Wet season 2019 and dry season 2020 –
        - Fishtrap achieved the short-term border benchmark during both 5-in-30 sampling events.

## 4.5 Sampling at Sites of Concern

Hotspot sites, where the highest bacteriological levels were identified in the first two years of monitoring, continue to be sampled in conjunction with the border sites during 5-in-30 sampling (summarized in Section 4.4) to determine whether concentrations remain high and if additional compliance and/or education efforts are required. The four additional sites sampled include three sites on Bertrand (E207092, E206847, E273723) and one site at the Pepin Brook tributary (E309447) which often have high exceedances of bacteriology results that are not explained by weather or documented pollution incidents. Data analysis for 5-in-30 wet season 2019 and dry season 2020 sampling shows that all sites exceed both guidelines in both seasons, thus confirming their status still as hotspot sites and require additional source identification and follow up actions (Figures 10 and 11).

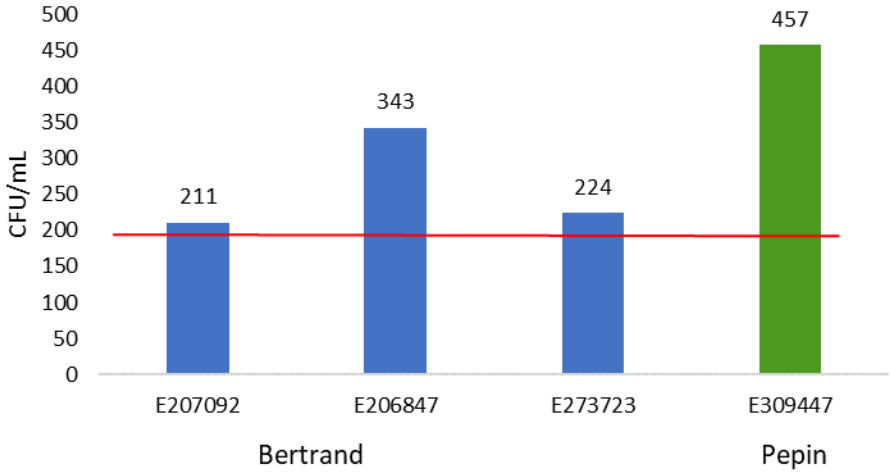



*Figure 10:: Hotspot geometric means for E. coli in November/December 2019.*

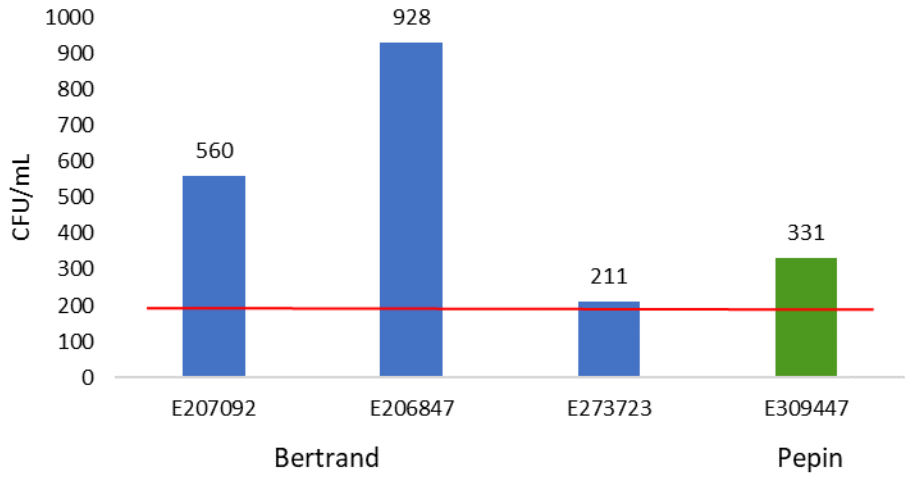



*Figure 11: Hotspot geometric means for E. coli in May/June 2020.*

## 5. DISCUSSION

The water quality results in the Canadian portion of the Nooksack Watershed indicate that there are high concentrations of *E. coli*, fecal coliform and phosphorus in each of the four creeks sampled. Based on previous years' results, the water quality data indicates contamination likely comes from run off from agricultural waste, composting facilities and possibly human sewage. Due to compliance efforts and continued monthly monitoring, the sites of concern can be targeted for focussed education and compliance follow up. A more detailed discussion of each of these watersheds is provided below, starting with the uppermost sites working downstream to the border sites.

**Bertrand Creek**

Bertrand Creek, being the largest system, had the most sites in exceedance of applicable guidelines. Of particular interest are sites E206847, E314990, and E314991, as they all have frequent and high bacterial exceedances and two of these sites are located downstream of composting facilities. Site E206847 located at Howes Creek also has the highest phosphorus results in the watershed.

Unlike in past years of sampling when both border stations have met the benchmark in both sets of 5-in-30 sampling, Cave and Bertrand Creek border sites did not meet the benchmark during the dry season in 2020. This is due to one of the 5-in-30 sampling dates having elevated concentrations due to rainfall. ENV is working to identify the source(s) and to follow up.

### Pepin Brook

Pepin Brook, which mainly runs through Aldergrove Regional Park is mostly low on fecal exceedances of guidelines. The tributary to Pepin Brook (E3019447) continues to have high concentrations and is directly downstream of a large composting facility suspected as a source of contaminants. This facility is working with ENV to improve their effluent management. This year, an additional sampling site was added on Pepin Brook before it flows through Aldergrove Park (site E315157) and it has shown very high concentrations in the Fall and winter of 2019. Despite these results, the Pepin Border site bacteriology results met the long-term border benchmark which is consistent with previous years.

### Fishtrap Creek

Fishtrap Creek is mainly surrounded by berry fields and other agricultural activities and its tributaries include Waetcher Creek. Throughout the last year, the bacteriological results have been low and were all less than the primary recreation guideline, with the exception of Waetcher Creek in Winter 2019 and Spring 2020. The border site at Fishtrap Creek is below the benchmark guidelines which is consistent with previous years.

## 6. RECOMMENDATIONS

The B.C. Nooksack Tributary sampling programs continue to produce meaningful results that inform where to target actions which should lead to improved water quality and the re-opening of the spring shellfish harvest in Portage Bay. Areas of concern and potential sources continue to be identified and followed up. Collaborative efforts between B.C. ENV teams and Washington state has seen some success in identifying, responding to and educating landowners and agricultural operators when it comes to the reduction of fecal contamination.

As the project enters its third and final year based on the Terms of Reference, the following recommendations are:

- To continue 5-in-30 sampling for border sites: E279980 Bertrand, E279890 Pepin, E3012388 Cave and E279889 Fishtrap in fall and spring, to determine whether they are meeting the border benchmark;
- To develop a transition plan that includes continuing essential activities, as identified in the Project Terms of Reference, specifically focussing on: outreach, targeted compliance and monitoring.
- To develop and implement this plan, it is recommended to work with the agricultural/composting industry and local stakeholder groups including LEPS.

## REFERENCES


B.C. Ministry of Environment, 2013. B.C. field sampling manual. Available at https://www2.gov.B.C..ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/B.C.-field-sampling-manual

B.C. Ministry of Environment and Climate Change Strategy, 2017. B.C. recreational water quality guidelines: Guideline summary. Water Quality Guideline Series, WQG-02. Available at https://www2.gov.B.C..ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/recreational_water_quality_guidelines_B.C.env.pdf

B.C. Ministry of Environment and Climate Change Strategy, 2018a. British Columbia approved water quality guidelines: Aquatic life, wildlife & agriculture, summary report. Available at https://www2.gov.B.C..ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf

B.C. Ministry of Environment and Climate Change Strategy, 2018b. Compliance Nooksack River watershed audit report, Environmental Management Act 2018. Available at https://www2.gov.B.C..ca/assets/gov/environment/research-monitoring-and-reporting/reporting/environmental-compliance/audit-reports/6270_nooksackwatershed_auditreport.pdf

B.C Ministry of Environment and Climate Change Strategy, 2019. Nooksack River Transboundary Water Quality Sampling Program June 2017- July 2018 Data Summary Report. Available at https://www2.gov.B.C..ca/assets/gov/environment/air-land-water/water/waterquality/monitoring-water-quality/south-coast-wq-docs/2019-04-29_nooksack_wq_report.pdf

Cavanagh, N., Nordin, R.N., and Warrington, P.D.,1996. Freshwater biological sampling manual. Water Management Branch, B.C. Ministry of Environment, Lands and Parks, Victoria, B.C. Available at https://www2.gov.B.C..ca/assets/gov/environment/natural-resource-stewardship/nr-laws-policy/risc/freshwaterbio.pdf

Environment and Climate Change Canada. 2019. Abbotsford Weather Stats. Available at https://abbotsford.weatherstats.ca/charts/rain-monthly.html

Langley Environmental Partners Society. 2019. Website by Motiontide. Available at http://www.leps.B.C..ca/stewardship/watersheds-of-langley/

Nordin, Rick. 2009. A Phosphorus Guideline for Vancouver Island Streams Draft. Prepared for British Columbia Ministry of Environment.

Pearson, Mike. 1989. British Columbia Conservation Foundation. Fisheries Project Report No.76. Province of British Columbia Ministry of Fisheries. https://www.for.gov.B.C..ca/hfd/library/documents/bib95170.pdf

Portage Bay Shellfish Protection District Advisory Committee, 2014. Portage Bay Shellfish Protection District Shellfish Recovery Plan. Available at https://www.whatcomcounty.us/DocumentCenter/View/3429/2014-Portage-Bay-Shellfish-Recovery-PlanPDF?bidId

Tallon, P., Magajna, B., Lofranco, C., & Leung, K.T., 2005. Microbial indicators of faecal contamination in water: A current perspective. *Water, Air, and Soil Pollution, 166*, 139–166. Available at https://doi.org/10.1007/s11270-005-7905-4

Warrington, P.D., 2001. Water quality criteria for microbiological indicators: Overview report. B.C. Ministry of Water, Land and Air Protection, Victoria, B.C. Available at https://www2.gov.B.C..ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/microindicators-or.pdf

Washington State Department of Ecology, 2019. Updates to water quality standards. Available at https://ecology.wa.gov/Water-Shorelines/Water-quality/Freshwater/Surface-water-quality-standards/Updates-to-the-standards

## Appendix A: Nutrient and Physical Water Quality Exceedance Results

### B.1 Physical Parameter Exceedance Table

| | | Date | DO | Total Suspended solids |
|---|---|---|---|---|
| WQG | | | For all Salmonid life stages: below 5 and above 11 | Table 44. Changes from background noted below |
| Bertrand Creek | E293977 | 2020-01-07<br>2020-05-11 | <br>4.74 | 21.8 |
| | E207092 | 2020-05-11<br>2020-07-14 | 4.5<br>4.78 | |
| | E206847 | 2020-01-07<br>2020-03-17<br>2020-05-17 | <br><br>4.05 | 99.4<br>24.9 |
| | E293980 | 2020-01-07 | | 62 |
| | E314991 | 2020-05-11<br>2020-08-04 | 2.4 | <br>41.1 |
| | E314990 | 2020-05-11<br>2020-07-14 | 3.02<br>3.27 | |
| Cave Creek | E312388 | 2020-01-07<br>2020-08-04 | <br>4.69 | 24.6<br>33.5 |
| | E315155 | 2020-01-07<br>2020-07-14 | <br>4.17 | 24.2 |
| Pepin Brook | E309447 | 2019-10-22<br>2020-01-07<br>2020-03-17<br>2020-06-09 | | 66.5<br>410<br>32.5<br>29.3 |
| | E279890 | 2020-01-07 | | 23 |
| | E253211 | 2020-01-07 | | 35 |
| | E315157 | 2020-07-14 | 4.93 | |
| Fishtrap Creek | 0300069 | 2020-01-07<br>2020-05-11 | <br>4.87 | 46 |
| | E279889 | 2020-01-07 | | 28.8 |
| | E310908 | 2020-01-07<br>2020-07-14 | | 74<br>38.5 |

## B.2 Nutrient Exceedance Table

| | | Date | Chloride mg/L | Ammonia | Nitrate as N mg/L | Nitrite as N mg/L |
|---|---|---|---|---|---|---|
| WQG | | | Aquatic life short term (acute), Wildlife, Livestock: 600 mg/L<br><br>Irrigation: 100 mg/L | Table 26C in WQGs | Short term (acute) wildlife and livestock: 100 mg/L | short term (acute)with chloride > 10: 0.60 mg/L as N |
| Bertrand Creek | E293977 | 2020-03-17<br>2020-05-11 | | | 4.17<br>3.85 | |
| | E206847 | 2020-02-04<br>2020-03-17<br>2020-05-11<br>2020-06-09 | | | 3.17<br>10.1<br>48.2<br>15.6 | |
| | E293980 | 2020-01-07 | | | 3.71 | |
| Cave Creek | E312388 | 18-09-2018<br>16-10-2018 | 176<br>187 | | | |
| Pepin Brook | E309447 | 18-09-2018 | | | 3.89 | |
| Fishtrap Creek | E279889 | 17-07-2018 | | | 3.02 | |