Water Quality Annual Report (2002 - 2023)

An Analysis: Current Conditions & Trends

Presented by Saugeen Valley Conservation Authority

July 2024

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1. Introduction

The Saugeen watershed is one of the largest drainage basins in the region. Spanning 4,675 km^2 of southwestern Ontario, it comprises three primary river systems that stretch from the Osprey Wetlands to the Lake Huron shoreline: Pine River, Penetangore River, and the Saugeen River. These watercourses are influenced by underlying soil types, and land use such as agriculture and development. The Saugeen watershed can be divided into ten distinct subwatersheds, each with unique natural and human-made features (Figure 1). Most of the land within the Saugeen watershed is dedicated to agricultural use.

Figure 1. Map of the Saugeen watershed boundary, also known as the Saugeen Valley Conservation Authority. Featured are each of the 10 subwatersheds, major watercourses and neighbouring authorities.

Saugeen Valley Conservation Authority (SVCA) actively monitors surface water quality at 14 sites within the Saugeen watershed through the Provincial Water Quality Monitoring Network (PWQMN), a collaborative effort with the Ministry of the Environment, Conservation and Parks (MECP). The PWQMN program is a crucial source of water quality data for the Saugeen watershed; however, information gaps existed. In 2012, SVCA addressed this through an internal monitoring program that included 15 additional sites throughout the watershed. Together, there are 29 monitoring sites that are used to gather the data required to understand the health of our watershed.

SVCA conducts a biomonitoring program which involves the collection of benthic macroinvertebrates (bottom-dwelling aquatic organisms) at 20 locations across the watershed.

These sites are aligned with other surface water sampling locations to offer a better understanding of watershed health.

Monitoring and management of surface water conditions has become increasingly important with population growth, agricultural intensification, and shifting climate patterns. Water quality monitoring programs collect valuable information to quantify current and long-term water quality conditions.

2. Methods

2.1 Surface Water

Surface water samples are collected using in-stream grab techniques throughout the year. Sampling occurs in the first week of every month during ice free periods (April to November). These samples are collected in accordance with PWQMN sample protocols. Additionally, field measurements of water temperature, pH, conductivity, turbidity, and dissolved oxygen are taken at the time of sample collection. Sampling was conducted regardless of rainfall events, or temperature fluctuations.

In 2023, surface water samples were collected at 29 sites within SVCA's watershed. All samples collected under the PWQMN program were analyzed at the MECP laboratory, while SVCA samples were sent to SGS laboratories located in Lakefield, ON. Sample collection in 2020 was variable due to laboratory shutdowns associated with the pandemic.

All surface water samples were analyzed using a standard set of water quality parameters. A complete list of sample parameters for PWQMN and SVCA sampling programs can be found in Appendix A.

For this report, five parameters were selected for discussion: total phosphorus, nitrogen; nitrate-nitrite, chloride, total suspended solids, and *E. coli*. The results for each parameter were compared to the Provincial Water Quality Objectives (PWQO) or the Canadian Water Quality Guidelines (CWQG) (Table 1).

The PWQO and CWQG were established to protect public health (*E. coli*), as well as aquatic life and aquatic life cycles.

Parameter (Unit)	Water Quality Objectives/Guidelines (Unit)	PWQO or CWQG
Total Phosphorus (mg/L)	0.03 mg/L	PWQO
Nitrogen; nitrate-nitrite (mg/L)	2.93 mg/L	CWQG
Total Suspended Solids (TSS) (mg/L)	30 mg/L	CWQG
Escherichia coli (*E. coli*) cfu/100mL)	(100 cfu/100mL) for swimming	PWQO
Chloride (mg/L)	120 mg/L	CWQG

Table 1. PWQO & CWQG for the five parameters covered in this report.

2.2 Benthic Macroinvertebrates

Benthic macroinvertebrates were collected at 20 sites throughout the Saugeen watershed using the Ontario Benthic Biomonitoring Network (OBBN) stream sampling protocol. Samples were collected every other year in the springtime using the kick-and-sweep method with a D-net.

As per the OBBN protocol, three samples were collected per site to cover different sections of the watercourse. At each site, two riffles (fast/shallow area) and one pool (slow/deep area) were sampled. A minimum of a 100-individual count was obtained across the width of the river, at each sample area. Samples were then sieved and placed into plastic containers and preserved with 95% ethanol. Large debris and organic material were discarded. Finally, samples were transported and stored in a cool environment until sorting was completed.

Identification of benthic macroinvertebrates requires specific skills and certification under the OBBN. Generally, samples were mixed, and a subsample viewed under a microscope. Samples were then analyzed until a minimum of 100 individual organisms were obtained. At minimum, all organisms were identified to the 27-group taxonomic level. The 27-group level is the minimum requirement for identification under the OBBN protocol.

3. Parameters

3.1 Total Phosphorus

Phosphorus is an essential nutrient for the growth and productivity of aquatic plants and animals. Phosphorus is naturally found in weathering rocks, but is also a common element in fertilizers, livestock manure, industrial emissions, and wastewater discharges. Phosphorus can act as a pollutant in high concentrations.

Phosphorus can easily enter a watercourse following events such as storms or spring melt. High total phosphorus concentrations in a watercourse can lead to eutrophication, which is an increased supply of nutrients. This can cause excess algae growth, dead zones, and the suffocation of aquatic organisms due to lack of oxygen in the water.

PWQO recommends total phosphorus concentrations below 0.03 mg/L to limit excessive plant and algae growth.

3.2 Nitrogen; Nitrate-Nitrite

Like phosphorus, nitrogen is an essential nutrient for aquatic plants and animals. Although naturally occurring, additional nitrogen can be introduced through fertilizers, livestock manure, and septic systems.

Nitrogen occurs in various forms, including:

- Nitrite (NO_2-): dissolved inorganic nitrogen that can be toxic at low concentrations, especially when sewage is present
- Nitrate (NO_3-): is the most common dissolved inorganic nitrogen used by bacteria and algae. Nitrates are not absorbed by plants and can enter a watercourse through runoff. High concentrations can cause excess plant and algae growth, which can be toxic to aquatic life

To protect aquatic life, CWQG recommends nitrogen; nitrate-nitrite concentrations below 2.93 mg/L.

3.3 Chloride

Chloride can be naturally occurring and is generally present at low concentrations. According to Health Canada, drinking water concentrations are normally less than 10 mg/L.

Chlorides runoff into watercourses through human activities, such as applying road salt and industrial production. Chloride does not readily absorb onto surfaces, and therefore concentrations can be high in surface water and shallow aquifers.

High chloride concentrations can be toxic to aquatic life. The CWQG has two guidelines for chloride: acute, or short term (640 mg/L), and chronic, or long-term (120 mg/L). In this report, the guidelines for long-term chloride concentrations were considered.

3.4 Total Suspended Solids

Total suspended solids are a measure of the number of suspended particles in water. The particles that contribute to total suspended solids come from a wide variety of materials including sediment, silt, sand, clay, organic and inorganic matter, and microscopic organisms.

Total suspended solids can exist naturally through erosion and high watercourse flows but can also be increased by stormwater runoff, development, and agricultural processes. If total suspended solids concentrations are high, sunlight will not reach the lower depths of a watercourse, thereby impacting aquatic plants and animals. Organics and metals can attach to suspended solids and may be absorbed by aquatic organisms when the particles settle.

The CWQG suggests total suspended solids should be no more than 30 mg/L higher than background concentrations to protect aquatic life.

3.5 E. coli

Escherichia coli (*E. coli*) are a group of bacteria often found in the digestive systems of warm-blooded animals. *E. coli* are commonly used to indicate the presence of fecal contamination in water as they do not occur naturally in aquatic ecosystems.

E.coli can affect human health by causing serious gastrointestinal illnesses, which can lead to death. SVCA's *E. coli* data helps to determine overall water quality for aquatic organisms and should not be used to assess water conditions for human consumption.

The PWQO suggests that water is safe for swimming when *E. coli* concentrations are less than 100 colony-forming units (cfu) per 100mL. The maximum acceptable concentration of *E. coli* in drinking water is nondetectable.

3.6 Benthic Macroinvertebrates

Benthic macroinvertebrates (benthics) are the most common group of freshwater organisms used in assessing water quality. They are an important food source for numerous fish species and are partially responsible for recycling nutrients in a watercourse. Benthics are common and diverse, with a range of sensitivities to environmental stressors. Certain species are more sensitive to pollution than others, and therefore their presence can indicate the quality of water in which they are found.

4. Data Analysis

4.1 Surface Water

An annual and long-term data analysis was completed for each of the 10 subwatersheds. The data collected was compared to the water quality objectives listed in Table 1.

4.2 Benthic Macroinvertebrates

A review of benthic data was conducted for each of the 10 subwatersheds using local abundance, species richness and Hilsenhoff's Family-level Biotic Index (FBI).

- Local abundance refers to the number of individual organisms per species in each sample.
- Species richness is the number of different species collected in each sample. Generally, species richness increases with improved water quality, habitat diversity, and habitat suitability.
- The FBI summarizes overall pollution tolerances of benthic communities with a single value (0-10) (Table 2). Only species with an assigned pollution tolerance value were used in this calculation.

Through their biology, the benthic data was analyzed using each of these methods to understand watercourse health.

Family Biotic Index Values	Water Quality	Degree of Organic Pollution
0.0 - 3.75	Excellent	Organic pollution unlikely
3.76 - 4.25	Very good	Possible slight organic pollution
4.26 – 5.00	Good	Some organic pollution probable
5.01 – 5.75	Fair	Fairly substantial pollution likely
5.76 – 6.50	Fairly poor	Substantial pollution likely
6.51 – 7.25	Poor	Very substantial pollution likely
7.26 – 10.00	Very poor	Severe organic pollution likely

Table 2. Evaluation of the family-level Hilsenhoff Biotic Index as an indication of water quality (Hilsenhoff 1998).

5. Subwatershed Results

5.1 South Saugeen River

With a drainage area of 798 km^2, the South Saugeen subwatershed primarily consists of agricultural land, which constitutes 72% of its expanse. With a length of 97 km, the South Saugeen River features tributaries such as Carrick, Meux, Bell's, and Fairbanks Creeks, along with smaller, unnamed watercourses. The South Saugeen River outlets into the Main Saugeen River, south of Hanover.

Three long term water quality monitoring sites are established in the South Saugeen subwatershed (Figure 2). These sites are a combination of the PWQMN (Q10 and Q14) and SVCA's internal monitoring program (S13). Two benthic biomonitoring sites are located at two of the water quality sites (S13 and Q14).

All graphical data representation for the South Saugeen subwatershed can be found in Appendix B.

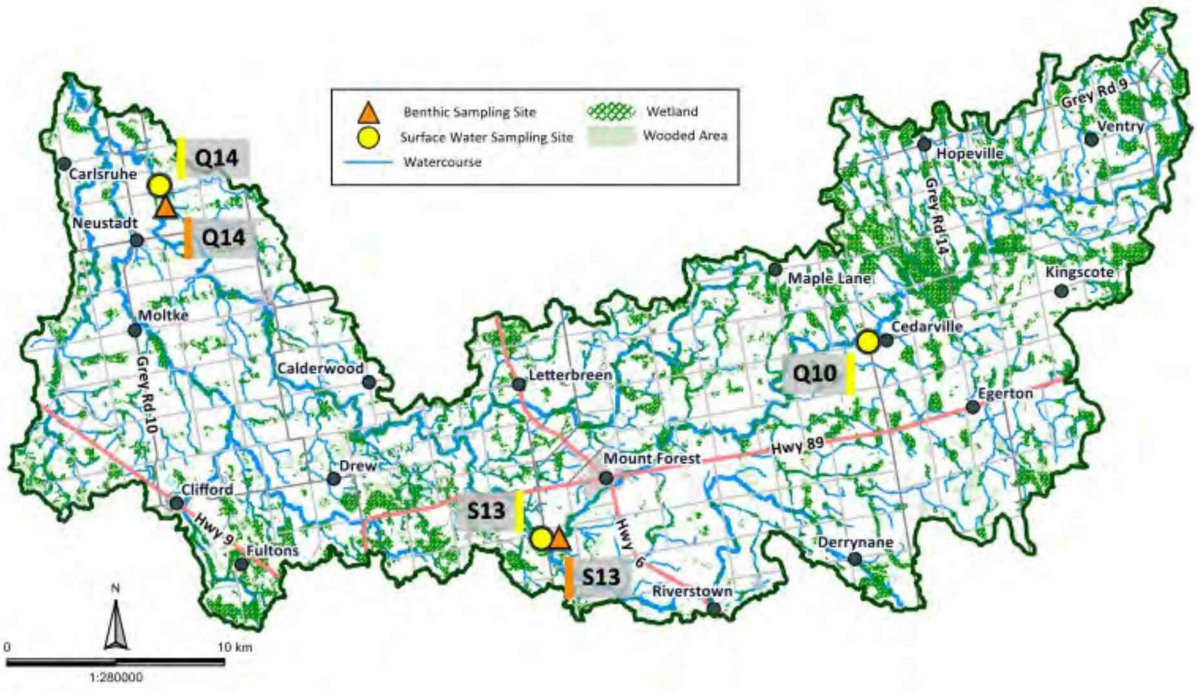

Figure 2. Map of the South Saugeen subwatershed showing locations of surface water and benthic sampling sites. Major roadways (Highways 9, 6 and 89, and Grey Road 10), towns (including Neustadt, Clifford and Mount Forest), wooded areas, wetlands and watercourses are also featured.

5.1.1 Surface Water Results – 2023

The 2023 review of the South Saugeen subwatershed indicated overall concentrations generally well below water quality objectives for total suspended solids and chloride.

Total phosphorous had three exceedances and *E. coli* had five exceedances in 2023. Nitrogen; nitrate-nitrite concentrations were highest in the Spring and Fall. There were ten nitrogen;

nitrate-nitrite exceedances in 2023, this value was in exceedance 42% of the time. There were two suspended solids exceedances across the subwatershed in 2023.

There were no recorded exceedances for chloride across all three sites.

5.1.2 Surface Water Results – Long-term

The long-term review of this subwatershed revealed annual average exceedances for total phosphorus, *E.coli*, and nitrogen.

Across all three sites, there were five average total phosphorus exceedances (from 2002 to 2023) and nine average annual *E. coli* exceedances (from 2012 to 2023).

There was one average annual nitrogen exceedance at Q14 in 2020 (3.35 mg/L). At Q10, nitrogen has generally shown an increasing trend since 2002. S13 has also shown a gradual increase in nitrogen while Q14 data suggests no significant changes are occurring. There were two annual total suspended solids exceedances at Q14 in 2010 and 2014 (29.87 mg/L and 37.05 mg/L respectively).

There were no average annual chloride exceedances.

5.1.3 Benthic Biomonitoring Results (2015-2020)

From 2015 to 2020, the local abundance of species observed varied widely, ranging from 153 to 509. Since 2015, the species richness, or the number of different species, remained relatively stable with an average of 13.8 species per sampling event.

There has been a significant decline in the FBI for this subwatershed since 2015, which suggests an improvement in water quality. In 2015, the FBI stood at 6.51, indicating that the water quality was poor. By 2020, the FBI has dropped to 2.67, which is considered excellent.

5.2 Beatty Saugeen River

The Beatty Saugeen subwatershed drains an area of approximately 274 km^2. The Beatty Saugeen River originates in wetlands within the Township of Southgate, and spans 46km in length. Drainage within this subwatershed occurs slowly, leading to the formation of swamps, and poorly drained depressions. The system outlets into the South Saugeen River, west of Hanover.

Two long-term water quality monitoring sites are established in the Beatty Saugeen subwatershed (Figure 3). These sites are a combination of the PWQMN (Q13) and SVCA's internal monitoring program (S14). One benthic biomonitoring site exists (Q13).

All graphical data representation for the Beatty Saugeen subwatershed can be found in Appendix C.

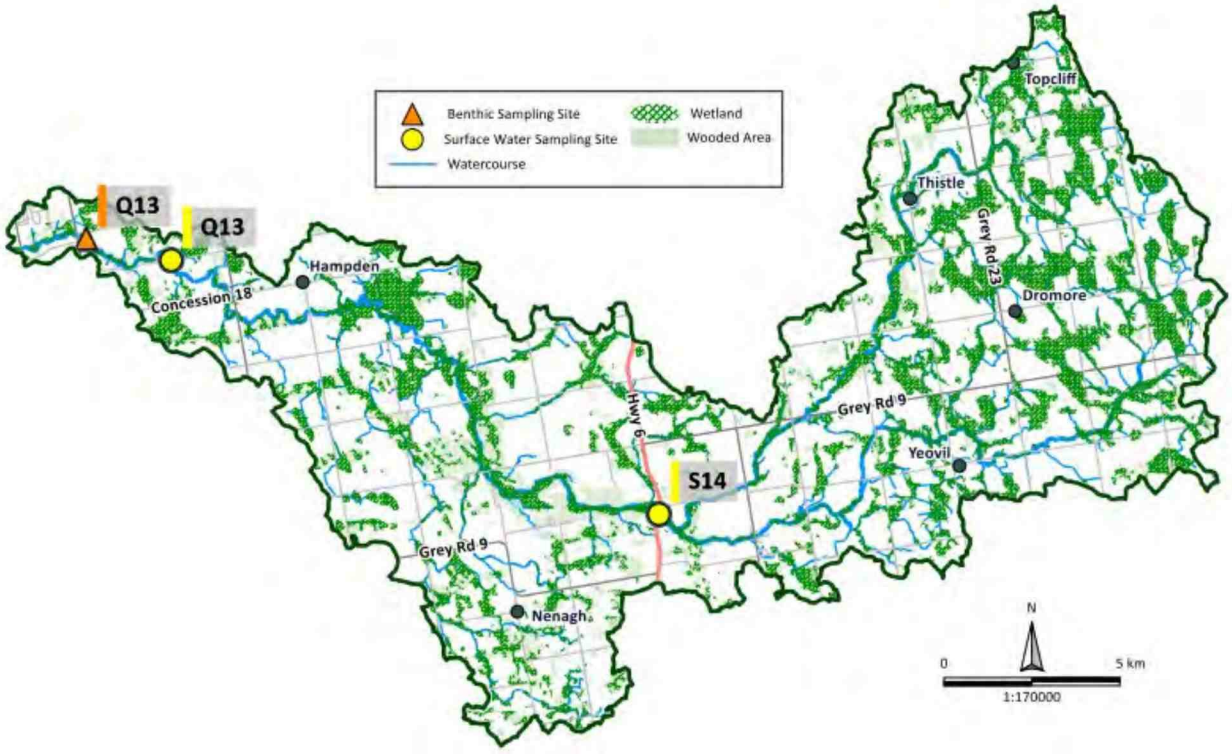

Figure 3. Map of the Beatty Saugeen subwatershed showing the locations of the surface water and benthic sampling sites. Major roadways (Grey Road 9 and 23 and Concession 18), towns (including Hampden and Yeovil), wooded areas, wetlands and watercourses are also featured.

5.2.1 Surface Water Results – 2023

The 2023 review of the Beatty Saugeen subwatershed indicated overall concentrations generally below the water quality objectives, with no exceedances reported for nitrogen, total suspended solids, or chloride.

Total phosphorus showed exceedances in one S14 sample (July). There were six *E. coli* exceedances: three Q13 samples (September, October, November), and three S14 samples (July, September, October). The highest recorded *E. coli* concentration was at S14 in July, at 1280 cfu/100mL.

At S14, nitrogen concentrations peaked in June before decreasing throughout the summer. Q13 nitrogen concentrations remained relatively stable until November.

5.2.2 Surface Water Results – Long-term

The long-term review of this subwatershed revealed no annual average exceedances for total suspended solids, nitrogen, and chloride. A slight trend suggests that nitrogen levels have increased throughout the years for both Q13 and S14.

At S14, there was one average annual total phosphorus exceedance, recorded in 2022 (0.0424 mg/L).

Since 2012, *E. coli* had eight exceedances above the PWQO, four at each sample site (Q13 and S14). Both sites had exceedances of the PWQO in 2014, 2018 and 2023.

5.2.3 Benthic Biomonitoring Results (2019-2021)

The local abundance of species present in this subwatershed has increased from 98 to 219 individuals from 2019 to 2021. Species richness increased from 13 species to 27 between 2019 and 2021.

The FBI has decreased from 5.33 to 4.21, suggesting an improvement in water quality. The three-year average of 4.07 suggests overall water quality in this subwatershed is in very good condition.

5.3 Upper Main Saugeen River

Approximately 782 km^2 of land is drained in the Upper Main Saugeen subwatershed. The river spans 116 km in length, with key tributaries including Habermehl and Camp Creek, as well as the Styx River. The subwatershed is primarily composed of agricultural land.

Five long-term monitoring sites are established in the Upper Main Saugeen subwatershed (Figure 4). These sites are a combination of the PWQMN (Q9 and Q11) and SVCA's internal monitoring program (S9, S10, and S15).

All graphical data representation for the Upper Main Saugeen subwatershed can be found in Appendix D.

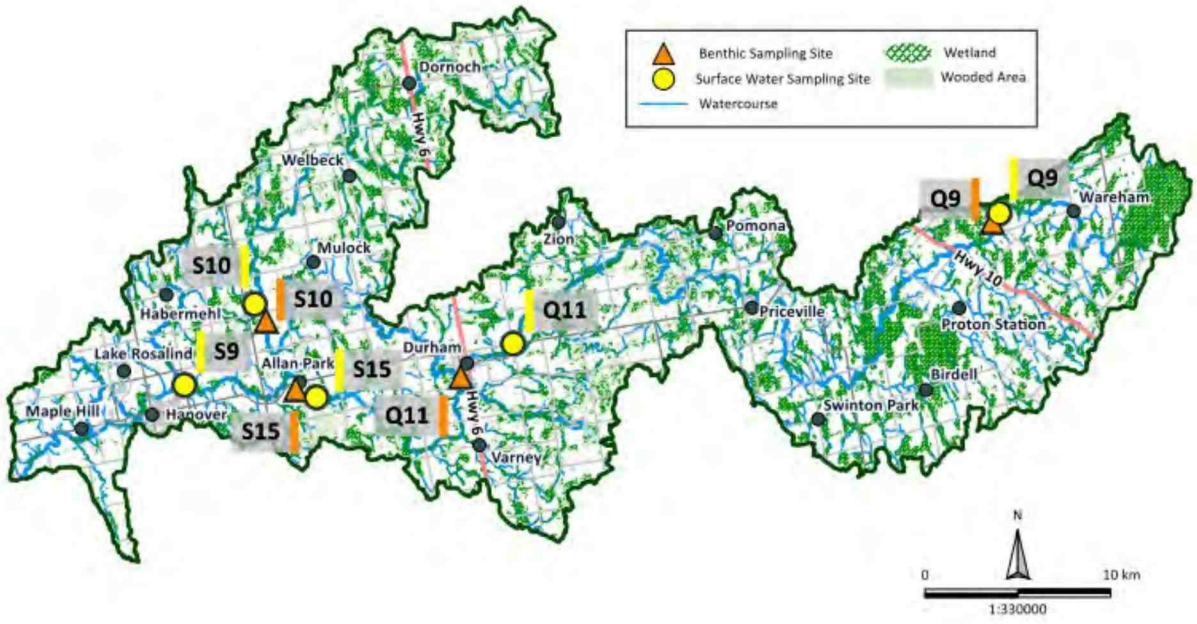

Figure 4. Map of the Upper Main Saugeen subwatershed surface water and benthic sampling sites. Major roadways (Highways 6 and 10), towns (including Dornoch, Durham, Priceville and Proton Station), wooded areas, wetlands and watercourses are also featured.

5.3.1 Surface Water Results – 2023

The 2023 review of the Upper Main Saugeen subwatershed indicated exceedances for total phosphorus, nitrogen; nitrate-nitrite, and *E. coli*.

Total phosphorus concentrations at S15 exceeded the PWQO five times in 2023, between June to November. There was one exceedance at Q9 in July. Nitrogen; nitrate-nitrite had one exceedance at Q11 in November (3.13 mg/L).

Total suspended solids and chloride concentrations remained below the water quality objectives with no exceedances detected.

E. coli concentrations exceeded PWQO objectives at multiple sites from June to November (seven exceedances).

5.3.2 Surface Water Results – Long-term

The long-term review of the Upper Main Saugeen subwatershed indicated exceedances for annual average total phosphorus, and *E. coli* concentrations.

At S15, annual average total phosphorus concentrations exceeded the PWQO in 2022 for the first time, since monitoring began in 2012. An exceedance was also noted in 2023 at S15.

Nitrogen, chloride, and total suspended solids concentrations remained well below the water quality objectives with no exceedances. Nitrogen concentrations displayed a gradual increase at Q11, Q9, and S9.

There was a total of eleven exceedances for annual average *E. coli* concentrations: one at Q11, five at Q9, three at S10, and two at S15.

5.3.3 Benthic Biomonitoring Results (2015-2021)

The local abundance of species in this subwatershed, ranged from 308 to 400 individuals per sample. The lowest species richness was recorded at 14 species in 2015 and 2016. The highest species richness was recorded at 20 species in 2018.

The FBI has decreased from 6.07 to 3.75 from 2015 to 2021. This suggests water quality has improved from fairly poor to excellent.

5.4 Rocky Saugeen River

The Rocky Saugeen River stretches for 51.4km and drains an area of 282 km^2. Its tributaries include McKechnie, Blacks, Traverston, and Barhead Creeks, as well as the West Arm Rocky Saugeen River. As one of the most forested watersheds, this system is known for its rolling landscape, rocky outcrops, and winding streams. The river's source can be traced to significant wetlands (Bells Lake and the Beaverdale Bog); primarily owned by Saugeen Conservation.

Two long term monitoring sites are established in the Rocky Saugeen subwatershed (Figure 5). These sites are a combination of the PWQMN (Q12) and SVCA's internal monitoring program (S12).

All graphical data representation for the Rocky Saugeen subwatershed can be found in Appendix E.

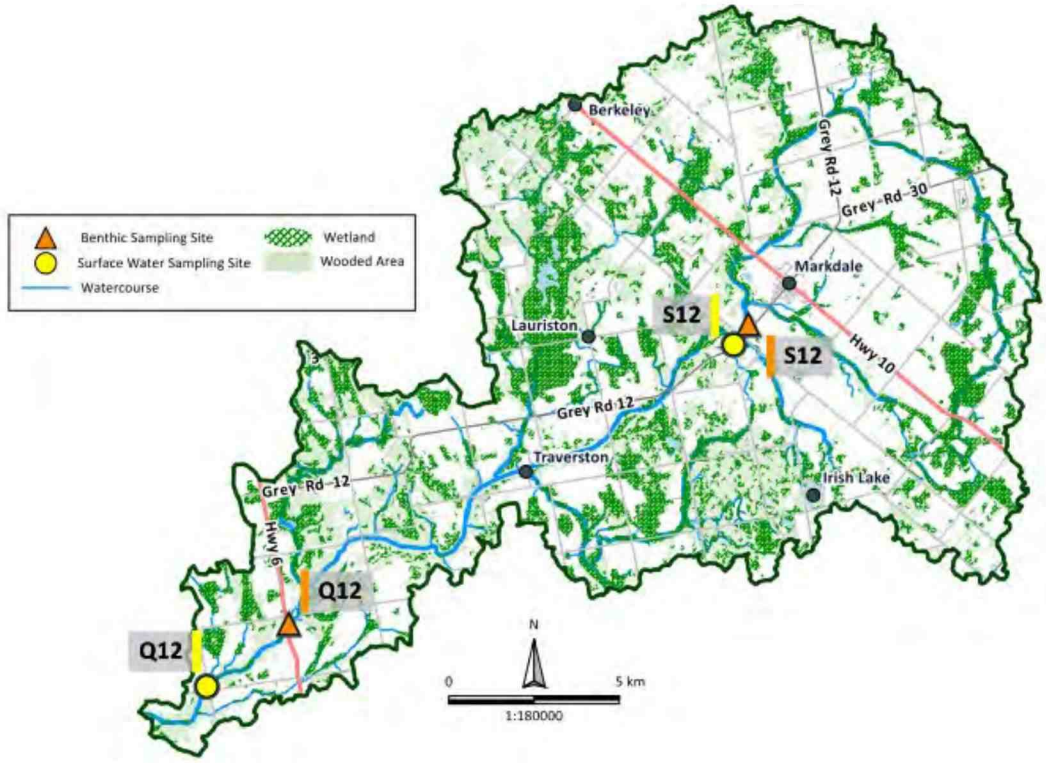

Figure 5. Map of the Rocky Saugeen River subwatershed and locations of the surface water and benthic sampling sites. Major roadways (Highways 6 & 10, Grey Roads 12 and 30), towns (including Markdale and Traverston), wooded areas, wetlands and watercourses are also featured.

5.4.1 Surface Water Results – 2023

The 2023 review of the Rocky Saugeen subwatershed indicated water quality objective exceedances for total phosphorus and *E. coli*.

Total phosphorus concentrations exceeded the PWQO at S12 in July, reaching 0.036 mg/L.

E. coli concentrations were typically below the PWQO, with exceedances noted in July (S12 and Q12).

No exceedances occurred for nitrogen; nitrate-nitrite, chloride, and total suspended solids in 2023.

5.4.2 Surface Water – Long-term

The long-term review of this subwatershed indicated parameter exceedances for total phosphorus and *E. coli*.

There were no annual average total phosphorus exceedances at Q12. In 2014 and 2022, S12 had exceeded PWQO at 0.032mg/L and 0.037mg/L, respectively.

From 2012 to 2023, average *E. coli* concentrations were frequently elevated at S12, with 66% of annual averages exceeding the PWQO. There were no *E. coli* exceedances at Q12.

There were no exceedances recorded for nitrogen, chloride, and total suspended solids for either site. Although below objectives, nitrogen at S12 has shown a slight increase since 2012.

5.4.3 Benthic Biomonitoring Results (2015-2021)

From 2019 to 2021, the local abundance of species per sample has decreased significantly. However, the 2021 abundance was still above the minimum 100 animal count. Species richness has been variable, ranging from 22 to 13 species per sample.

Since 2015, FBI has shown a general decrease from 5.83 to 3.35. This suggests significant improvement has occurred during the review period, with water quality now in very good condition.

5.5 North Saugeen River

The North Saugeen subwatershed drains an area of 269 km^2 and is primarily composed of agricultural and forested land. The North Saugeen River spans 52 km in length, with tributaries including Negro and Hamilton Creeks, as well as several smaller unnamed creeks. The watershed is home to natural ponds and lakes, including Robson Lake and McCullough Lake.

Three long term monitoring sites are established in the North Saugeen subwatershed (Figure 6). These sites are a combination of the PWQMN (Q5 and Q8) and the SVCA's internal monitoring program (S11).

All graphical data representation for the North Saugeen subwatershed can be found in Appendix F.

Figure 6. Map of the North Saugeen subwatershed and the location of the surface water and benthic sampling sites. Major roadways (Highways 10 and 6) towns (including Lockerby, Chesley and Holland Centre), wooded areas, wetlands and watercourses are also featured.

5.5.1 Surface Water Results – 2023

The 2023 review of the North Saugeen subwatershed indicated concentrations were generally below the water quality objectives, with exceedances noted for total suspended solids, total phosphorus and *E. coli.*

Q5 exceeded objectives for total suspended solids in July and November reaching 30.7 mg/L and 56.6 mg/L, respectively.

Total phosphorus has three exceedances in 2023 in February, October, and November. All exceedances occurred at Q5.

E. coli exceeded objectives at Q5 (September, October and November), Q8 (September), and S11 (July).

Nitrogen and chloride were both well below water quality objectives.

5.5.2 Surface Water Results – Long-term

A long-term annual average review of parameters reveals exceedances for total phosphorus, total suspended solids, and *E. coli.*

There were nine annual average total phosphorus exceedances, most occurring at Q5 (89% of the time). S11 had one average total phosphorus exceedance in 2022 at 0.034mg/L. There were no total phosphorus exceedances at Q8.

There were two annual average total suspended solids exceedances: Q5 in 2014 (68.22mg/L) and Q5 in 2003 (31.58 mg/L). All Q5 samples were elevated when compared to Q8 and S11.

Between 2012 and 2023, average *E. coli* concentrations at Q5 exceeded the PWQO 66% of the time (eight exceedances total). Q8 had two annual average *E.* coli exceedances, in 2019 and 2022.

Annual average chloride and nitrogen concentrations were below the CWQG for all sites. Although below the objectives, S11 has showed a slight, steady increase in nitrogen since 2012.

5.5.3 Benthic Biomonitoring Results (2015-2020)

Since 2015, local abundance of individuals present per sample has been consistent, with a slight increase in 2020.

Species richness ranged from 28 to 16 species from 2015 to 2020.

The average FBI score for this subwatershed is 4.73, suggesting the overall water quality is good. FBI ranged from 5.42 (2019) to 3.83 (2020).

5.6 Teeswater River

Spanning 75 km in length, the Teeswater River drains an area of 683 km^2. Its tributaries consist of Greenock, Formosa, Alps, Plum, Kinlough, Schmidt, and Allen Creeks. The Teeswater subwatershed contains the Greenock Swamp, the largest forested wetland in Southern Ontario.

Four long term monitoring sites are established in the Teeswater subwatershed (Figure 7). These sites are a combination of the PWQMN (Q6) and the SVCA's internal monitoring program (S1, S2, and S7).

All graphical data representation for the Teeswater subwatershed can be found in Appendix G.

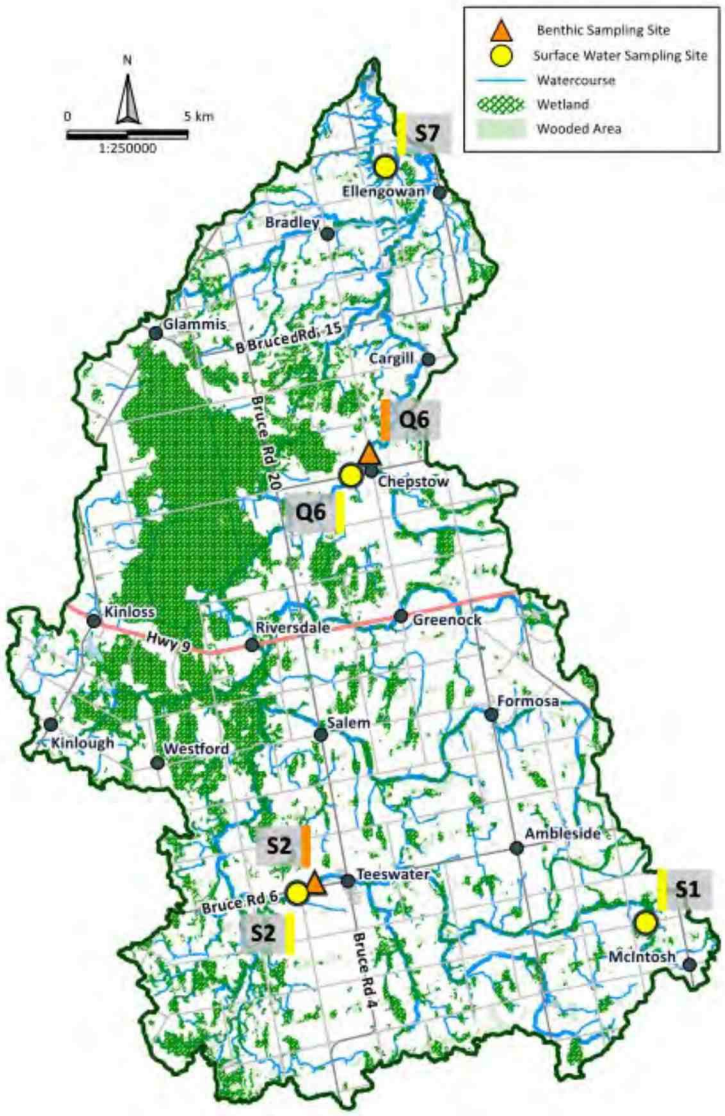

Figure 7. Map of the Teeswater subwatershed surface water and benthic sampling sites. Major roadways (Highway 9, Bruce Roads 6 and 15), towns (including Chepstow, Teeswater and Formosa), wooded areas, wetlands and watercourses are also featured.

5.6.1 Surface Water Results – 2023

The 2023 review of the Teeswater subwatershed indicated numerous total phosphorus, *E. coli*, and nitrogen exceedances. There were also two total suspended solids exceedances.

There were a total of four total phosphorous exceedances in 2023: October and November (S2 and S7).

All nitrogen samples at S2 exceeded the CWQG in 2023. S7 had exceedances in October and November, Q6 had one exceedance in January and S1 had one exceedance in April.

Chloride concentrations were well below the water quality objectives for all sites.

E. coli exceedances were observed at Q6, S2 and S7 from September to November. These results occurred following rain in the 3 days leading up to the sampling event, 10mm in September, 20mm in October, and 6.8 mm in November.

5.6.2 Surface Water Results – Long-term

The long-term review within the Teeswater subwatershed showed numerous exceedances for total phosphorus, nitrogen, and *E. coli*.

There were nine annual average exceedances for total phosphorus: three at Q6, two at S2, and four at S7. S1 consistently remained below objectives.

Average nitrogen; nitrate-nitrite concentrations were generally below the CWQG, except for S2 which had eleven annual exceedances. Concentrations at S2 and S7 suggest a gradual average increase from 2016 to 2022.

Average chloride and total suspended solids concentrations were below the water quality objectives with no exceedances. Chloride concentrations at S2 indicated an overall increase.

From 2012 to 2023, *E. coli* concentrations were frequently elevated, with multiple exceedances. S1 had the highest number of exceedances (six), followed by S2 (five). S7 had four annual exceedances and Q6 had three annual exceedances.

5.6.3 Benthic Biomonitoring Results (2015-2021)

The local abundance of species observed generally increased from 336 to 383 from 2015 to 2020. Species richness has been consistent, with an average of 16 species per sample.

The FBI has decreased from 6.67 to 4.48 from 2015 to 2021. This suggests water quality has improved in this subwatershed.

5.7 Lower Main Saugeen River

With a drainage area of 908 km^2, the Saugeen River within this watershed spans 76 kilometers in length. Its main tributaries consist of Mill, Burgoyne, Snake, Vesta, Pearl, Deer, Otter, Willow, and Silver Creeks, along with numerous smaller watercourses.

Four long term monitoring sites are established in the Lower Main Saugeen subwatershed. These sites are a combination of the PWQMN (Q3, Q4, and Q7) and the SVCA's internal monitoring program (S8). (Figure 8).

All graphical data representation for the Lower Main Saugeen subwatershed can be found in Appendix H.

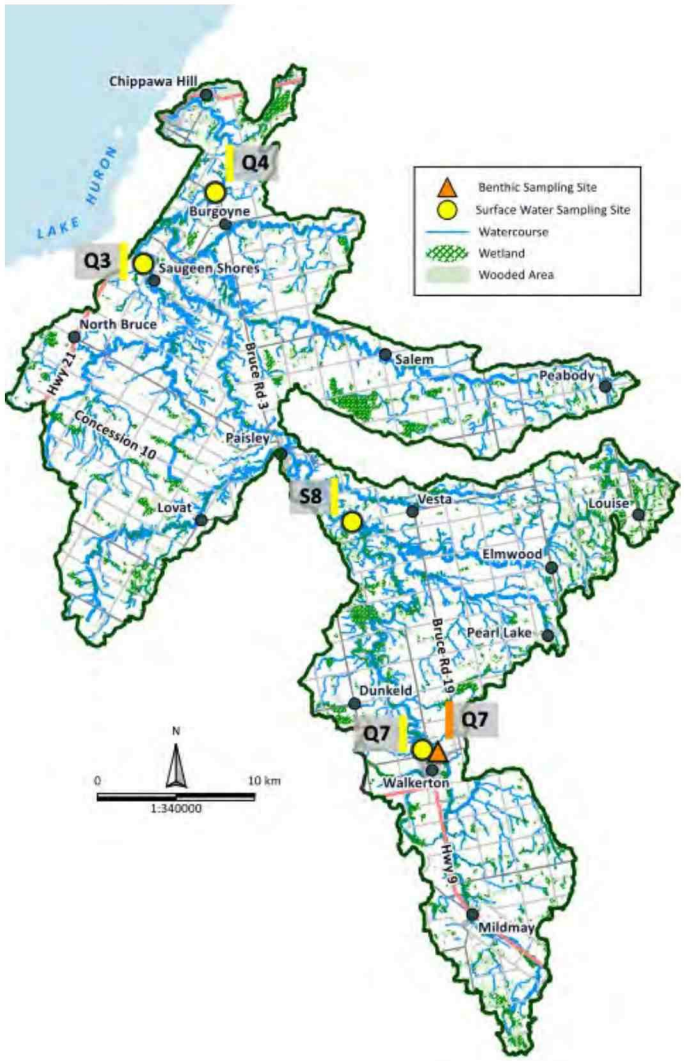

Figure 8. Map of the Lower Main Saugeen subwatershed and the locations of the surface water and benthic sampling sites. Major roadways (Highways 21 and 9, Bruce Roads 3 and 19), towns (including Saugeen Shores, Paisley, Elmwood and Walkerton), wooded areas, wetlands and watercourses are also featured.

5.7.1 Surface Water Results – 2023

The 2023 review indicated concentrations exceeded water quality objectives for all parameters except chloride.

There were seven total phosphorus exceedances at Q3 in 2023. Q4 had three exceedances and S8 had 2 exceedances.

All sites had nitrogen; nitrate- nitrite, *E. coli* and total suspended solids exceedances.

5.7.2 Surface Water Results – Long-term

Between 2002 and 2023, average total phosphorus concentrations at Q3 exceeded PWQO 81% of the time. During this time, Q4 had six exceedances and S8 had two exceedances.

Average nitrogen concentrations were below the CWQG for all sites except for Q3 in 2015, 2018, 2021, and 2023. Average total suspended solids had annual exceedances at all sites apart from Q7. Q3 and Q4 had three exceedances, and S8 had one.

From 2012 to 2023, Q3 exceeded average *E. coli* concentrations for PQWO 32% of the time. Exceedances occurred at Q4 (2015, 2020, and 2023), Q7 (2022), and S8 (2020 and 2023). In 2014, Q3 had the highest average *E. coli* concentration at 2366 cfu/100mL, 23 times higher than the PWQO.

There were no chloride exceedances.

5.7.3 Benthic Biomonitoring Results (2015-2021)

The local abundance of species decreased from 318 to 273 from 2015 to 2021. Species richness has increased from 11 to 17 species from 2015 to 2021.

In 2015 the FBI score was 6.07, suggesting water quality was in fairly poor condition. By 2021, the FBI dropped to 4.63, suggesting water quality has improved. Over the review period, the average FBI was 5.37.

5.8 Lake Fringe

Stretching from north of Kincardine to Southampton, the Lake Fringe subwatershed has a drainage area of 254 km^2. Small tributaries flow directly into Lake Huron, including Lorne, Andrews, Tiverton, and Underwood Creeks, as well as the Little Sauble River. This subwatershed is predominantly agricultural, with intense development along the lakeshore. Lake Fringe subwatershed contains the coastal wetland, Baie du Dore.

Three long term monitoring sites are established in the Lake Fringe subwatershed (S4, S5, S6) (Figure 9). These sites are part of the SVCA's internal monitoring program established in 2012.

All graphical data representation for the Lake Fringe subwatershed can be found in Appendix I.

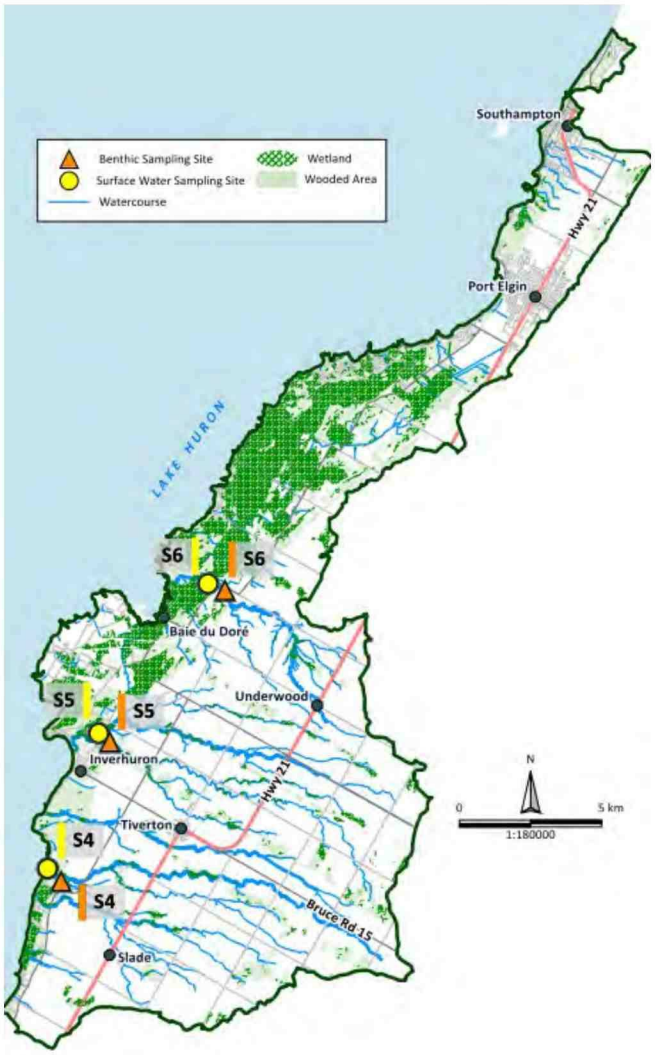

Figure 9. Map of the Lake Fringe subwatershed surface water and benthic sampling sites. Major roadways (Highway 21, Bruce Road 15), towns (including Southampton, Port Elgin and Tiverton), wooded areas, wetlands and watercourses are also featured.

5.8.1 Surface Water Results – 2023

The 2023 review indicated exceedances for all parameters apart from chloride which had none.

In 2023, nitrogen concentrations exceeded the CWQG at five times at S4, three times at S5 and once at S6. S4 had the highest recorded concentration at 10.1 mg/L in July.

Total phosphorus exceeded the PWQO ten times, twice at S4, and four times each at S5 and S6.

Total suspended solids were generally below the CWQG with only one exceedance at each site. There were no exceedances in chloride concentration.

E. coli concentrations exceeded the PWQO three times at S5, twice at S4 and twice at S6. S4 had the highest *E. coli* concentration in October at 3100 cfu/100mL. All three sites exceeded the PWQO in September and October.

5.8.2 Surface Water Results – Long-term

The long-term averages in the Lake Fringe subwatershed indicate concentrations were generally below the objectives for each parameter except for total phosphorus, nitrogen, and *E. coli.*

Since 2012, there were five total phosphorous exceedances at S6 (2014, 2015, 2020, 2022, 2023). S6 had the highest average concentration of total phosphorus at 0.06 mg/L in 2022, double the PWQO. S4 had two exceedances (2015, 2023), and S5 had two (2015, 2023).

Average nitrogen; nitrate-nitrite concentrations were typically below the CWQG, except for S4 in 2015 and 2023, S6 in 2015, and S5 in 2018. Nitrogen concentrations were variable and did not show any trends.

There were six *E. coli* exceedances at S6, five at S5, and five at S4.

All three sites exceeded objectives for *E. coli* in 2015, 2020, and 2023. S5 had the highest average for *E. coli* counts at 1385 cfu/100mL in 2014, 13 times higher than the PWQO.

Chloride and total suspended solids did not have any average exceedances.

5.8.3 Benthic Biomonitoring Results (2015-2020)

The local abundance of individuals collected has been generally consistent. However, the 2018 sample event had a significant increase in individuals (520, up from 364 in 2016). Species richness was fairly consistent, ranging between 12 to 17 species per sample.

From 2015 to 2020, the FBI decreased from 6.86 to 5.12. This suggests water quality has improved in this subwatershed. The average FBI score is 5.95, indicating overall water quality in this subwatershed is in fairly poor condition.

5.9 Pine River

The Pine River in southern Bruce County flows through agricultural and densely developed lakeshore areas, before outletting into Lake Huron. Its main tributaries are Royal Oak and Clark Creeks, and the South Pine River, with a drainage area of 195km^2. The region's fertile soil has supported agricultural development, leading to removal of wetlands and forests for land use purposes.

Two long term monitoring sites are established in the Pine River subwatershed. These sites are a combination of the PWQMN (Q1) and the SVCA's internal monitoring program (S3). (Figure 10).

All graphical data representation for the Pine River subwatershed can be found in Appendix J.

Figure 10. Map of the Pine River subwatershed showing locations of surface water and benthic sampling sites. A major roadway (Highway 21), towns (including Point Clark and Ripley), wooded areas, wetlands and watercourses are also featured.

5.9.1 Surface Water Results – 2023

The 2023 review of surface water indicated overall concentrations were frequently above the water quality objectives for each parameter except for chloride, which had no exceedances.

Total phosphorus exceeded the PWQO at Q1 three times, and five times at S3. S3 displayed the lowest results in the spring and increased through to October before decreasing in November. Q1 had the highest concentration at 0.18 mg/L in October.

Nitrogen concentrations exceeded the CWQG several times at each site; Q1 had 3 exceedances (April, October, November) and S3 had 6 exceedances (April, May, June, July, October, November). S3 had the highest concentration of nitrogen at 12 mg/L in May, four times higher than the CWQO.

E. coli counts indicated three exceedances at Q1 (September, October, November), and five at S3 (June, July, August, September, October). Q1 had the highest E. coli concentration recorded of 3260 CFU/100mL in October.

Chloride concentrations across both sites recorded no exceedances in water quality objectives in 2023.

5.9.2 Surface Water Results – Long-term

The long-term review revealed similar findings to the 2023 period with concentrations generally above the water quality objectives.

There were exceedances for total phosphorus at Q1 for 27% of the samples. S3 exceeded the PWQO for 91% of the yearly averages. Q1 had the highest average concentration of total phosphorus at 0.25 mg/L in 2005, eight times higher than the PWQO.

Average nitrogen; nitrate-nitrite concentrations at S3 consistently exceeded the CWQG, except for 2016. Average concentrations at Q1 exceeded objectives 77% of the time. S3 had the highest average concentration of nitrogen at 9.32 mg/L in 2021.

Average *E. coli* exceedances occurred at Q1 (66% of samples) and S3 (92% of samples). S3 consistently exceeded the PWQO since 2017. The highest sample at S3 was 1301.50 cfu/100mL in 2017, thirteen times higher than the PWQO.

There were no exceedances for chloride in the Pine River subwatershed. Chloride concentrations at S3 showed a slight increase from 2012 to 2023.

5.9.3 Benthic Biomonitoring Results (2015-2021)

The local abundance of individuals in this subwatershed has decreased since 2015. Abundance has ranged from 359 to 107 (2016 to 2020, respectively). Species richness has remained consistent, with an average of 13.7 species per sample event.

The FBI had an average score of 5.7 over the reporting period. This indicates water quality in fair condition. In 2020, the FBI decreased to 3.71, but increased again in 2021.

5.10 Penetangore River

The Penetangore River subwatershed, consists of two main tributaries, the North and Main Penetangore Rivers, and two intermediate ones, Millarton and Kincardine Creeks. The river drains a 192 km^2 area and spans 51.2 km in length. The subwatershed, mainly used for agriculture (83%), is smooth, gently sloping terrain.

One long term monitoring station is established in the Penetangore subwatershed, as part of the PWQMN, Q2. (Figure 11).

All graphical data representation for the Penetangore River subwatershed can be found in Appendix K.

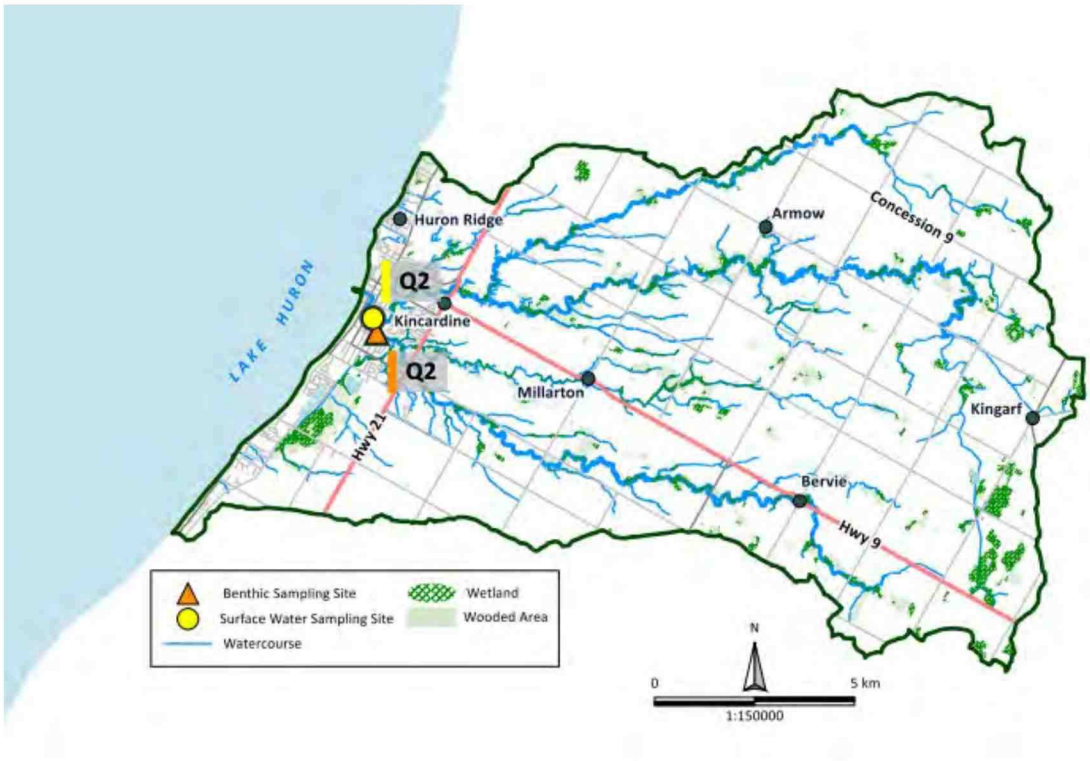

Figure 11. Map of the Penetangore subwatershed and the locations of the surface water and benthic sampling sites. Major roadways (Highways 21 and 9), towns (including Kincardine and Bervie), wooded areas, wetlands and watercourses are also featured.

5.10.1 Surface Water Results – 2023

The 2023 review indicated concentrations were generally below the water quality objectives, except for a few events where exceedances were recorded. There were no chloride exceedances in 2023.

There were four total phosphorus exceedances in 2023. There were also four nitrogen exceedances.

Chloride concentrations were slightly elevated from June to September, although all samples remained below the CWQG. Total suspended solids were below the CWQG for 2023.

E. coli concentrations exceeded the PWQO in September and October.

5.10.2 Surface Water Results – Long-term

The long-term review indicated that concentrations for all parameters, except chloride, were often above the water quality objectives.

Average total phosphorus concentrations frequently exceeded PWQO from 2002 to 2023, 52% of the time. The highest average concentration of total phosphorus was 0.133 mg/L in 2020, over four times higher than the PWQO.

Average nitrogen concentrations were generally below the CWQG, except for three exceedances in 2010, 2015, and 2023.

Average chloride concentrations had no exceedances. Total suspended solids were also typically below the CWQG, with three exceedances in 2004, 2010, and 2014.

E. coli concentrations were frequently elevated, with 75% of yearly averages exceeding the PWQO.

5.10.3 Benthic Biomonitoring Results (2015-2021)

The local abundance of individuals per sample increased from 2019 to 2021 (from 304 to 2108). Although the species richness has decreased since 2015, it has been consistent the past two sample years of 2019 and 2021.

FBI has gradually been decreasing since 2017. The average FBI for this subwatershed is 5.79, indicating water quality is fairly poor.

6. Summary of Results

6.1 2023 Results – All Subwatersheds

In 2023, surface water quality in the Saugeen watershed was fair to poor. Total phosphorus concentrations often exceeded the PWQO, a common occurrence in agricultural watersheds. Of the 29 sampled sites, 18 exceeded the PWQO at least once. The highest exceedance was in the Lower Saugeen subwatershed. Total phosphorous concentrations tended to be more variable from July through September.

Nitrogen levels exceeded the PWQO in seven out of ten subwatersheds during at least one sample event. Sample sites in Beatty Saugeen, North Saugeen, and Rocky Saugeen did not show any nitrogen exceedances. The highest nitrogen concentration was in the Pine River subwatershed. Studies have demonstrated commonality between fluctuations in nitrogen levels and seasonal agricultural practices, other contributing factors may exist.

E. coli concentrations at all sites exceeded the PWQO at least once during 2023. The highest number of exceedance events occurred in the Pine River subwatershed (five events). Rainfall events could be connected to increased *E. coli* counts in all subwatersheds.

Total suspended solids concentrations were generally below the CWQG in most subwatersheds. Total suspended solids exceedances were observed closer to river outlets, along with other parameter exceedances, potentially indicating a transport mechanism for other nutrients. There were no identifiable trends for total suspended solids.

Chloride concentrations stayed below the CWQG across all subwatersheds, with the highest concentration event in the Pine River subwatershed. High chloride concentrations are commonly related to road salt application. Based on the report findings, the Saugeen watershed appears to be largely unaffected by this application. This could be attributed to the presence of riparian buffers in the SVCA watershed. As climate change intensifies, winter storms and urban development expands, chloride levels might be impacted.

6.2 Long-Term Results – All Subwatersheds

A long-term assessment of the Saugeen watershed's surface water quality has now been completed, extending the reporting made through Watershed Report Cards. This 2002-2023 study has the following general findings:

Total Phosphorous

- Annual average total phosphorus concentrations exceeded the PWQO of 0.03 mg/L every year.
- Q1 in the Pine River subwatershed had the highest annual average in 2005 at 0.25 mg/L, eight times higher than the PWQO.
- In 2023 all subwatersheds exceeded the PWQO for total phosphorus.

Nitrogen: Nitrate-Nitrite

- Six out of the ten subwatersheds (Lake Fringe, Lower Saugeen, Penetangore River, Pine River, South Saugeen, Teeswater River) exceeded the CWQG of 2.93 mg/L for nitrogen from 2002 to 2023.
- S3 in the Pine River subwatershed had the highest average nitrogen concentration at 14.8 mg/L, five times higher than the CWQG.

Chloride

- All subwatersheds maintained chloride concentrations below the CWQG of 120 mg/L.
- S6 in the Lake Fringe subwatershed had the highest chloride concentration at 35.8 mg/L.
- Chloride concentrations remained relatively stable over time, with no noticeable trend.

E.Coli

- From 2012 to 2023, 90% of the sampling sites exceeded the PWQO of 100 cfu/100mL for annual average *E. coli* concentrations.
- The highest *E. coli* concentrations were at Q2 (Penetangore subwatershed) with 2400 cfu/100mL, twenty-four times the PWQO.

Total Suspended Solids

- Most sites remained below the CWQG of 30 mg/L for total suspended solids since 2012. Q2, Q3, Q4, Q5, S8, Q1, and Q14 exceeded the CWQG at least once.
- Q1 (Pine River) had the highest total suspended solids concentration in 2010 at 100.17 mg/L, three times the CWQG.

6.3 Benthic Macroinvertebrates

The Saugeen watershed demonstrates fluctuations in species abundance and richness. Species richness varies from 12.7 in Penetangore to 19.8 in North Saugeen. All but North Saugeen and Upper Main Saugeen had increased richness, although they maintain a higher richness than other subwatersheds. Despite a decline in species abundance at 70% of subwatersheds, all samples contained a minimum of 100 individuals. (OBBN standard).

The FBI decreased in all but Pine River and Beatty Saugeen subwatersheds. Beatty Saugeen has the lowest average FBI of 4.07, indicating excellent water quality. The Lake Fringe subwatershed has the highest FBI of 5.95, indicating possible pollution.

7. Discussion

7.1 Surface Water

The Saugeen watershed has both short and long term trends observed in total phosphorus and nitrogen concentrations. Agriculturally dominant areas can commonly experience high phosphorus and nitrogen concentrations through over-fertilization, excess manure, and soil erosion (Burdon, McIntosh & Harding, 2013). Research suggests cropping systems, particularly row crops like corn and soybeans, have more significant nutrient losses compared to perennial crops such as hay (Randall et al. 1997; Schilling & Spooner, 2006). Over-fertilization can lead to excess phosphorus and nitrogen in the soils, eventually entering our surface waters through erosion.

High *E. coli* concentrations can come from sources such as livestock manure, rural area wastewater treatment and leaking septic systems (Brendel & Soupir, 2017). Excessive manure application or post-application rainfall can also lead to *E. coli* transportation into streams via tile drains.

How might farming practices and waste management systems be altered to mitigate nutrient pollution and *E. coli* contamination in the Saugeen watershed?

7.2 Benthic Macroinvertebrates

Aquatic organisms are crucial for maintaining healthy aquatic ecosystems. Biodiversity, reflected by high species presence and variability, can be indicators of good water quality, especially when the species present have a low pollution tolerance.

Wooded riparian zones often have a positive influence on benthic diversity due to lower runoff potential and the ability to capture water in plants and soils (Stauffer et al. 1999). For example, the North Saugeen subwatershed, characterized by managed forests and buffered watercourses, has demonstrated an average species richness of 19.8 species from 2015 to 2020. In contrast, the more urbanized and agriculturally intensive Penetangore subwatershed, shows an average species richness of 12.7 species from 2015 to 2021.

Previous studies found that implementing conservation tillage practices yielded higher species richness and lower FBI scores than conventional tillage streams (Barton and Farmer); this further highlights the influence of land use on benthic diversity.

How could land management strategies be effectively implemented to improve water quality?

7.3 Agricultural Best Management Practices

Implementing best management practices (BMPs) in agriculture can improve water quality. Practices include riparian buffer strips, alterations in tillage practices, planting cover crops, proper nutrient management, and livestock exclusion fencing:

- Riparian buffers (i.e., vegetation surrounding a watercourse) are instrumental in filtering out nutrients and bacteria, moderating water temperature, providing habitats, and reducing erosion.
- Livestock exclusion fencing prevents livestock from entering watercourses, which can degrade water quality and damage riparian vegetation (Agriculture and Agri-Food

Canada, 2019). Heavy livestock presence around a watercourse can lead to increased soil erosion and high *E. coli* concentrations. Despite the initial costs, the long-term environmental and livestock health benefits make it a worthy investment.

- Over tilling can leave soil bare and susceptible to soil erosion and moisture loss; this can cause water pollution and degraded soil health through reduced infiltration and high runoff potential. Soil erosion can further cause significant nutrient inputs into our watercourses as well as high total suspended solids concentrations. Implementation of conservation tillage practices can leave crop residue on the soil surface, thereby reducing erosion and nutrient runoff (Agriculture and Agri-Food Canada, 2019; Busari et al. 2015). Conservation tillage can range from no tillage to minimum tillage or mulch tillage.
- Cover crops provide benefits similar to those of riparian buffers, including increased water infiltration and retention, decreased surface runoff, and reduced nutrient loss through soil erosion. They also can reduce wind erosion, recycle soil nitrogen and control weeds without the use of herbicides (Dabney, Delgado & Reeves, 2001).

Historically, a large percentage of southern Ontario's small streams were in poor condition, and the subsequent 32 years have witnessed significant scientific advancements and improvement in water quality through implementation of BMPs (Barton and Farmer).

Given these findings, what can be done to improve awareness and implementation of these best management practices?

7.4 Economic Benefits to the Community

Key economic drivers in the Saugeen watershed are energy, agriculture, and tourism. These economic drivers all benefit from water quality monitoring:

- Regular water monitoring helps safeguard our watershed’s environmental resources for energy operations and ensure no negative impact to our local aquatic ecosystems. Energy production is a substantial economic driver in the Saugeen watershed.
- Agriculture thrives on clean water for optimal crop and livestock health.
- Lake Huron's shoreline and recreational river systems are very appealing to tourists. This industry also benefits from a healthy watershed.

How can our watershed further optimize the use of water quality monitoring to boost these economic sectors?

8. Conclusion

SVCA’s water quality monitoring programs are an integral part of understanding the health of the watershed. The purpose of this report is to identify trends in present water quality data and prepare for the future.

As development increases across the Saugeen watershed, the ongoing monitoring of water quality becomes increasingly important. Urban expansion drastically transforms the natural environment. SVCA staff provide insight on ecosystem health that will guide decision-making processes, foster sustainable development, and help adapt to evolving climate change.

This data analysis can be used to support municipal land use planning and development. Since SVCA subwatershed boundaries do not correspond to municipal boundaries, we must continue to collaborate at the watershed level.

The 2023 Water Quality Annual Report equips decision-makers with the knowledge needed to promote sustainable growth while protecting the natural resources within the Saugeen watershed.

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Appendix A – Sample Suite of Parameters

Parameters analyzed for PWQMN and SVCA sampling sites.

Parameter	Units	PWQMN ('Q') Sites (Y/N)	SVCA ('S') Sites (Y/N)
Alkalinity, Total as CaCO3	mg/L	Y	Y
Carbon, dissolved inorganic carbon	mg/L	Y	N
Carbon, dissolved organic	mg/L	Y	N
Chloride	mg/L	Y	Y
Conductivity	Varies	Y (µS/cm)	Y (mS/cm)
E. coli	[cfu/100mL]	Y	Y
Nitrogen, Ammonia + Ammonium	mg/L	Y	N
Nitrogen, Nitrite	mg/L	Y	Y
Nitrogen, Nitrate	mg/L	Y	Y
Nitrogen, Nitrate + Nitrite	mg/L	Y	Y
Nitrogen, Total Kjeldahl	mg/L	Y	Y
pH		Y	Y
Phosphorus, phosphate	mg/L	Y	N
Temperature	°C	N	Y
Total Phosphorus	Varies	Y (µg/L)	Y (mg/L)
Total Suspended Solids	mg/L	Y	Y
Silicon, reactive silicate	mg/L	Y	N
Sulphate	mg/L	N	Y

*Metals are analyzed at select sites: Q1, Q4, Q12, and Q14

Appendix B – South Saugeen Subwatershed

2023 Results

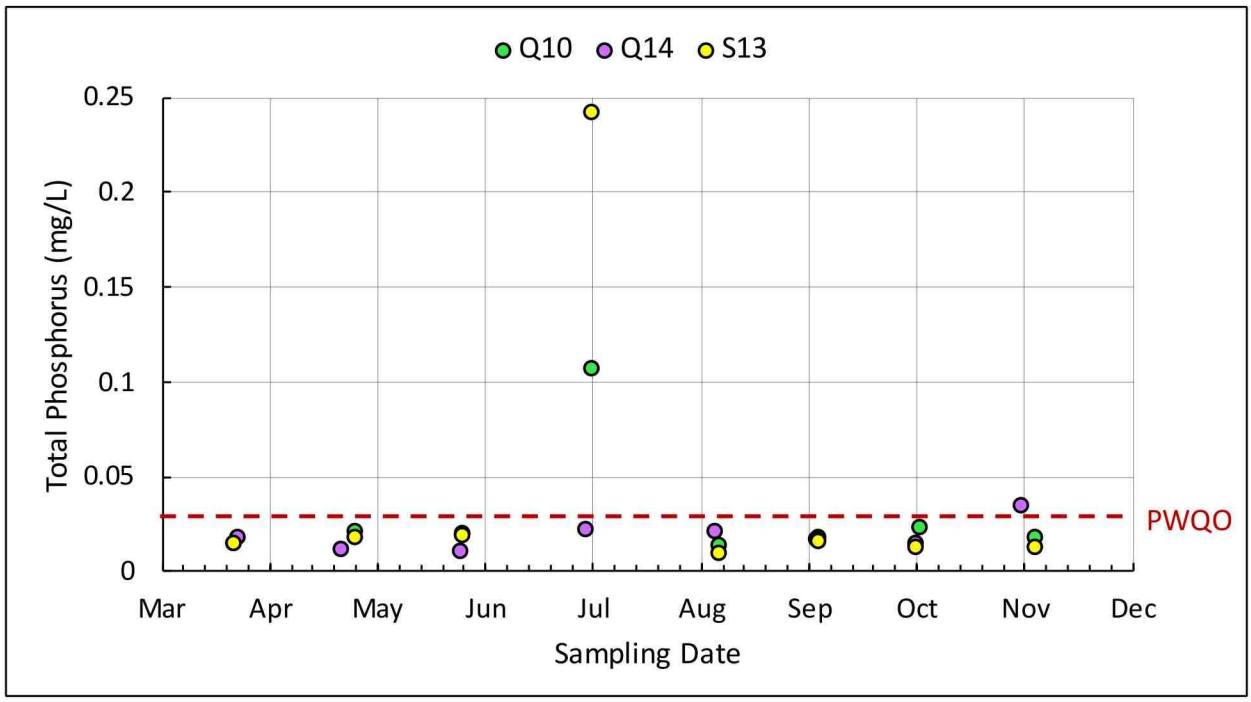

Figure B.1 2023 South Saugeen subwatershed total phosphorus concentrations (mg/L) in a graph format. Graph shows Q10, Q14 and S13 sampling sites, the horizontal line indicates the PWQO of 0.03 mg/L. There are 3 exceedances of the PWQO.

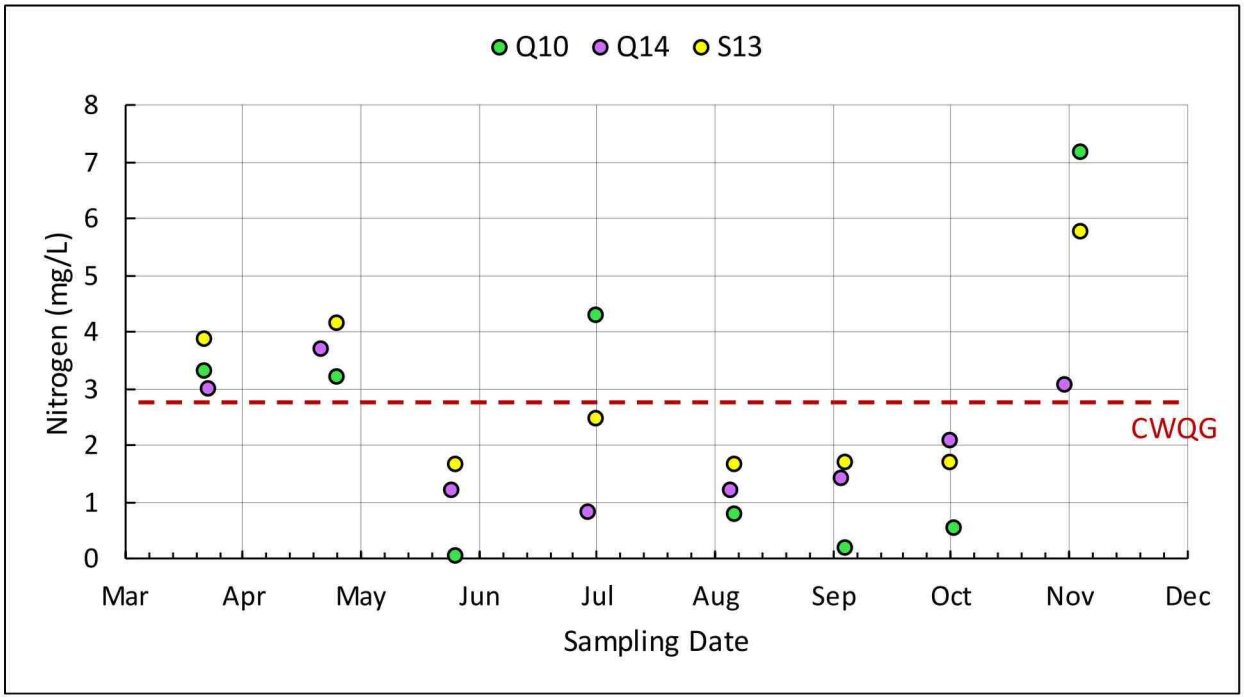

Figure B.2 2023 South Saugeen subwatershed nitrogen concentrations (mg/L) in a graph format. Graph shows Q10, Q14 and S13 sampling sites, the horizontal line indicates the CWQG of 2.93 mg/L. There are 10 exceedances of the CWQG.

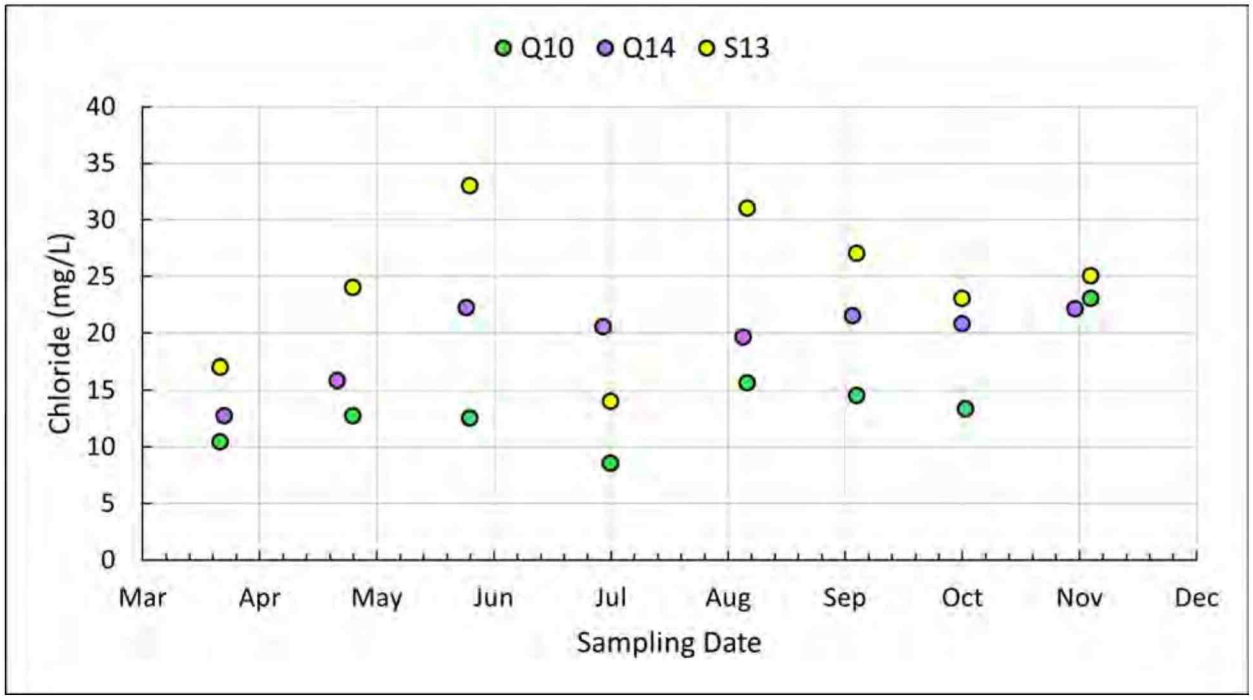

Figure B.3 2023 South Saugeen subwatershed chloride concentrations (mg/L) in a graph format. Graph shows Q10, Q14 and S13 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

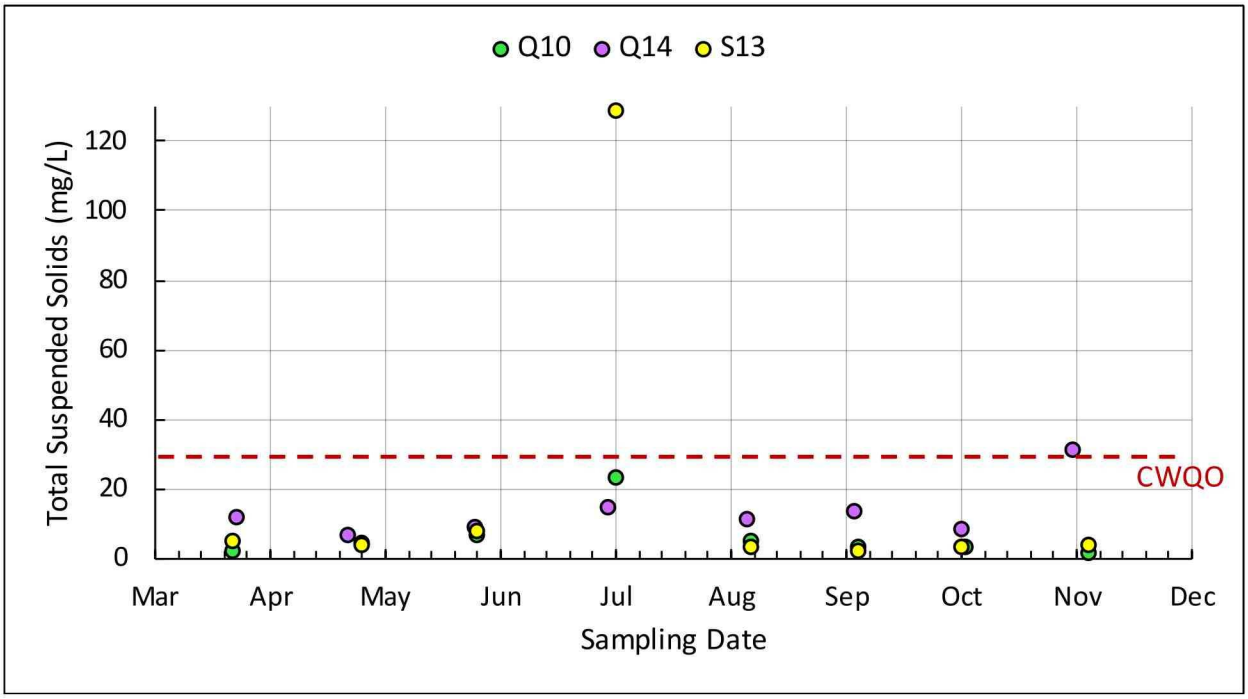

Figure B.4 2023 South Saugeen subwatershed total suspended solids concentrations (mg/L) in a graph format. Graph shows Q10, Q14 and S13 sampling sites, the horizontal line indicates the CWQG of 30 mg/L. There are 2 exceedances of the CWQG.

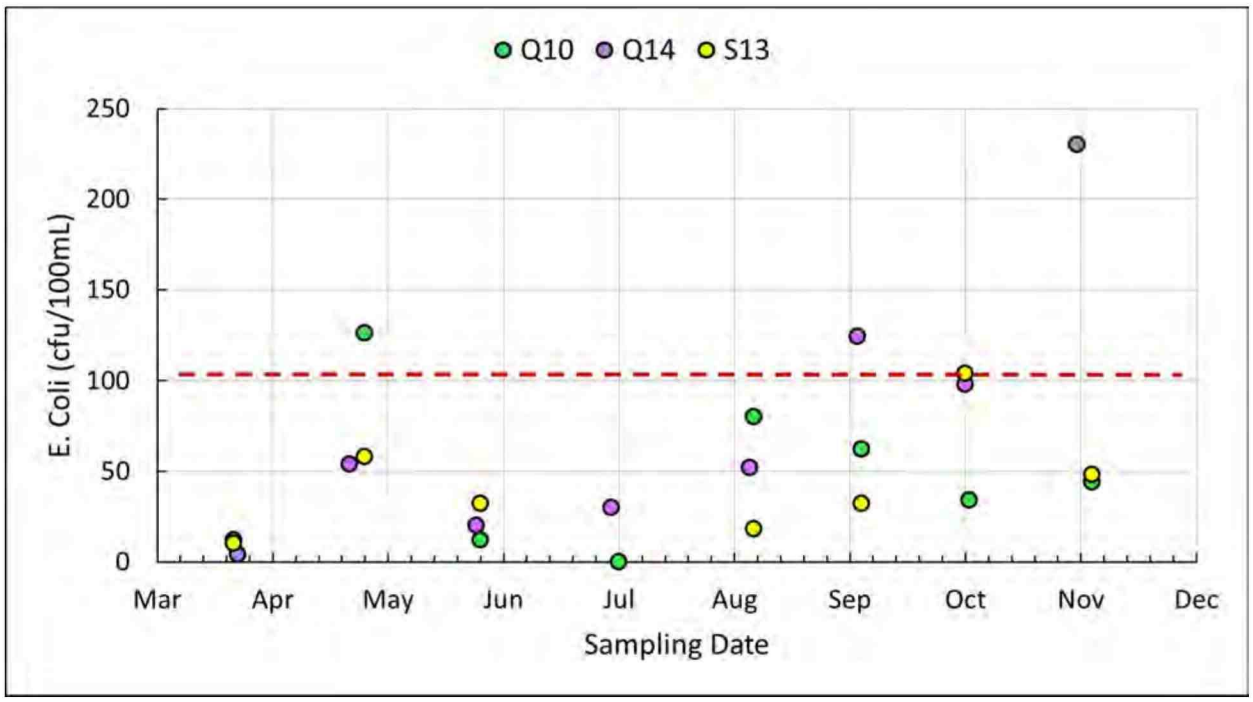

Figure B.5 2023 South Saugeen subwatershed *E. coli* concentrations (cfu/100mL) in a graph format. Graph shows Q10, Q14 and S13 sampling sites, the horizontal line indicates the PWQO of 100 cfu/100mL for swimming. There are 5 exceedances of the PWQO, one exceedance in July at S13 is not shown on this graph (3900 cfu/100mL).

Long-term Results

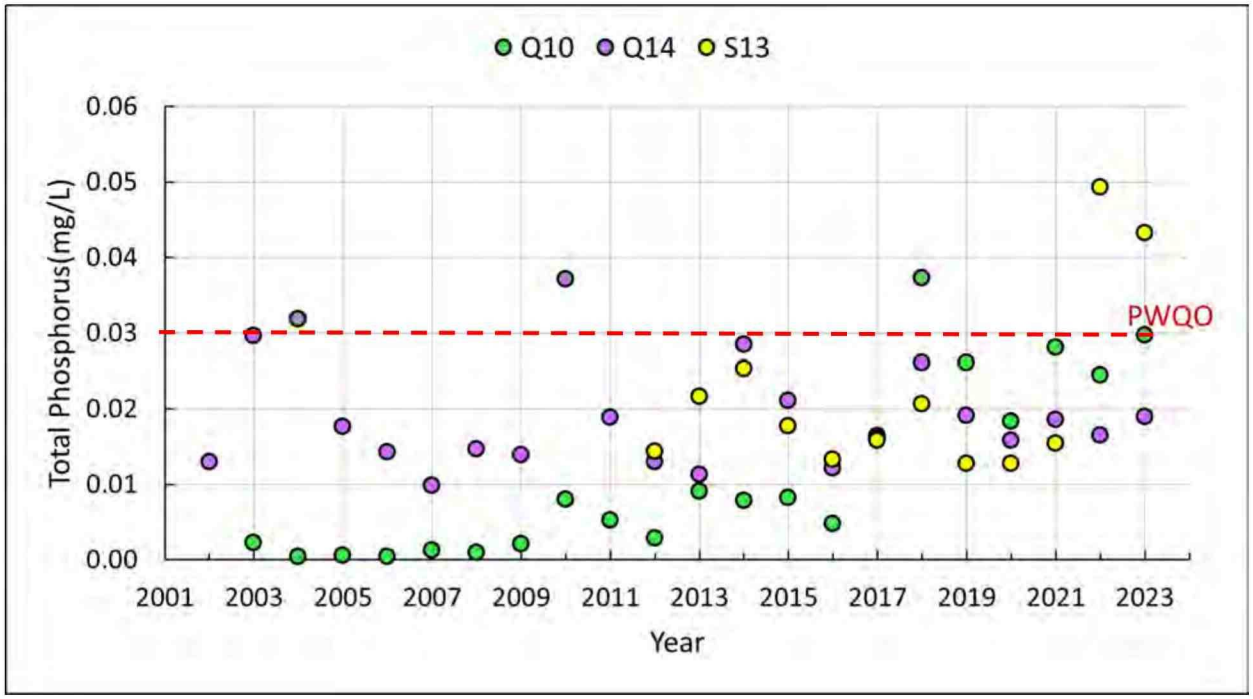

Figure B.6 2002 to 2023 South Saugeen subwatershed annual average total phosphorus concentrations (mg/L) in a graph format. Graph shows Q10, Q14 and S13 sampling sites, and a horizontal line indicating a PWQO of 0.03 mg/L. There are 5 exceedances of the PWQO.

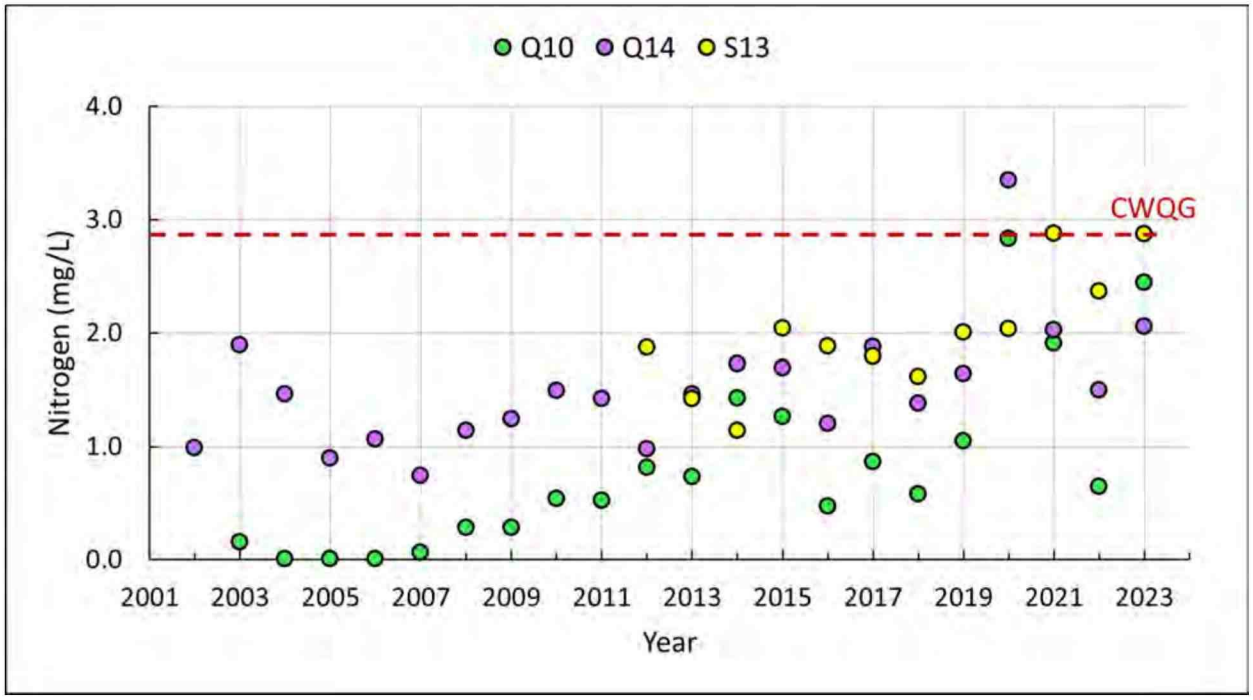

Figure B.7 2002 to 2023 South Saugeen subwatershed annual average nitrogen concentrations (mg/L) in a graph format. Graph shows Q10, Q14 and S13 sampling sites, and a horizontal line indicating a CWQG of 2.93 mg/L. There is 1 exceedance of the CWQG.

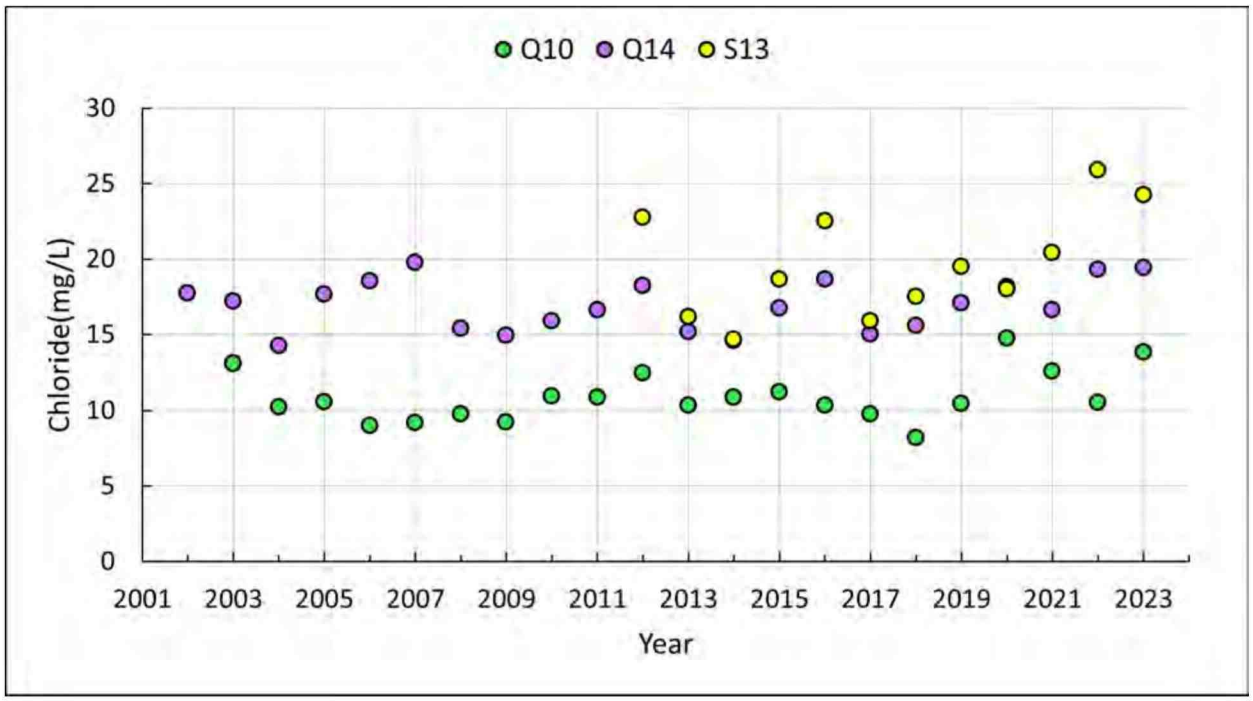

Figure B.8 2002 to 2023 South Saugeen subwatershed annual average chloride concentrations (mg/L) in a graph format. Graph shows Q10, Q14 and S13 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

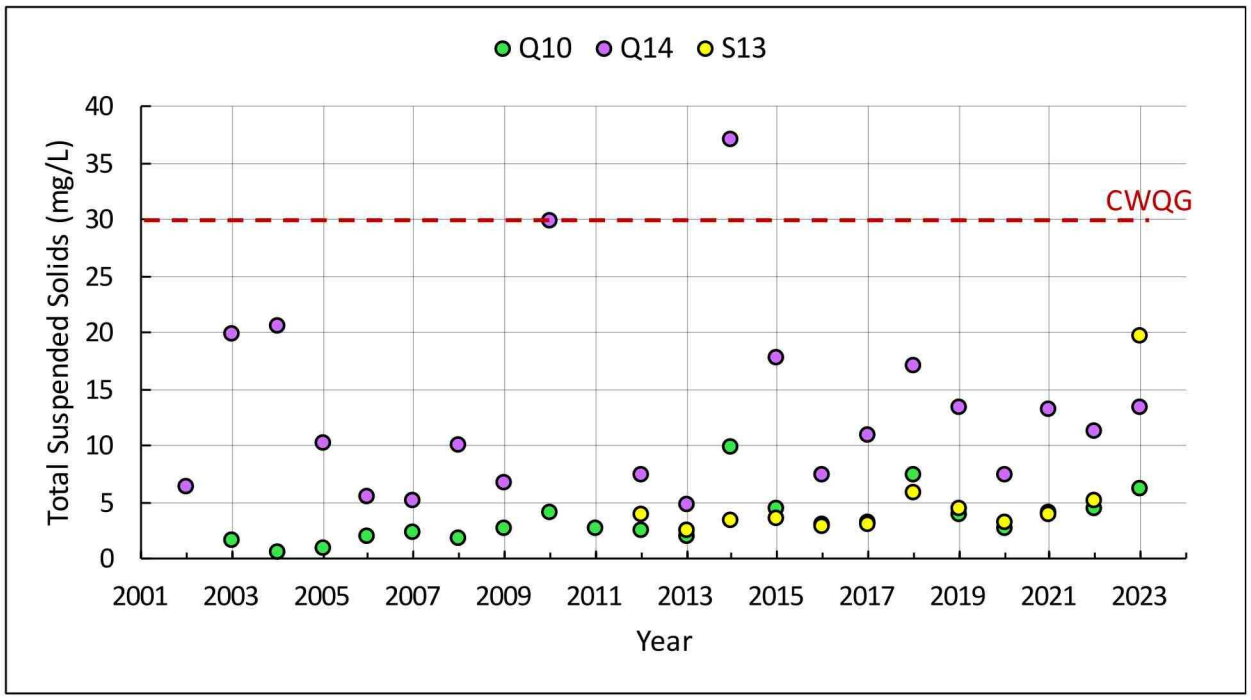

Figure B.9 2012 to 2023 South Saugeen subwatershed annual average total suspended solids concentrations (mg/L) in a graph format. Graph shows Q10, Q14 and S13 sampling sites and a horizontal line indicating a CWQG of 30 mg/L. There are 2 exceedances.

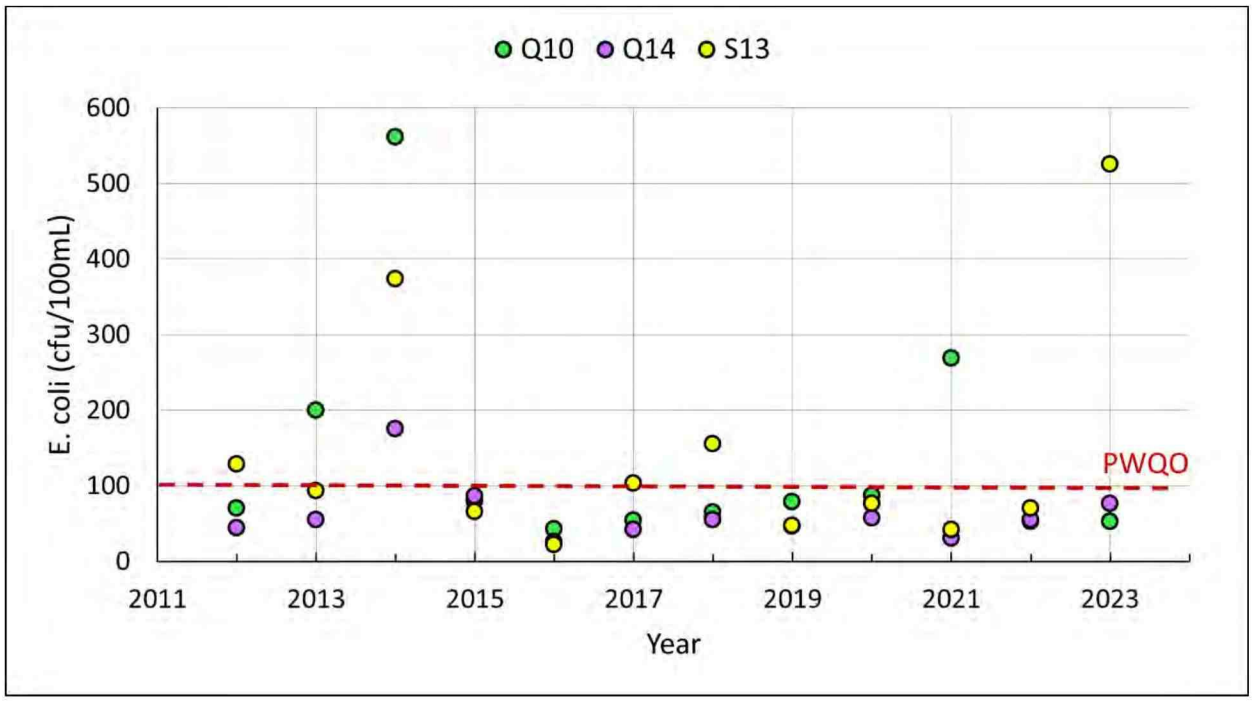

Figure B.10 2012 to 2023 South Saugeen subwatershed annual average *E. coli* concentrations (cfu/100mL) in a graph format. Graph shows Q10, Q14 and S13 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 9 exceedances of the PWQO.

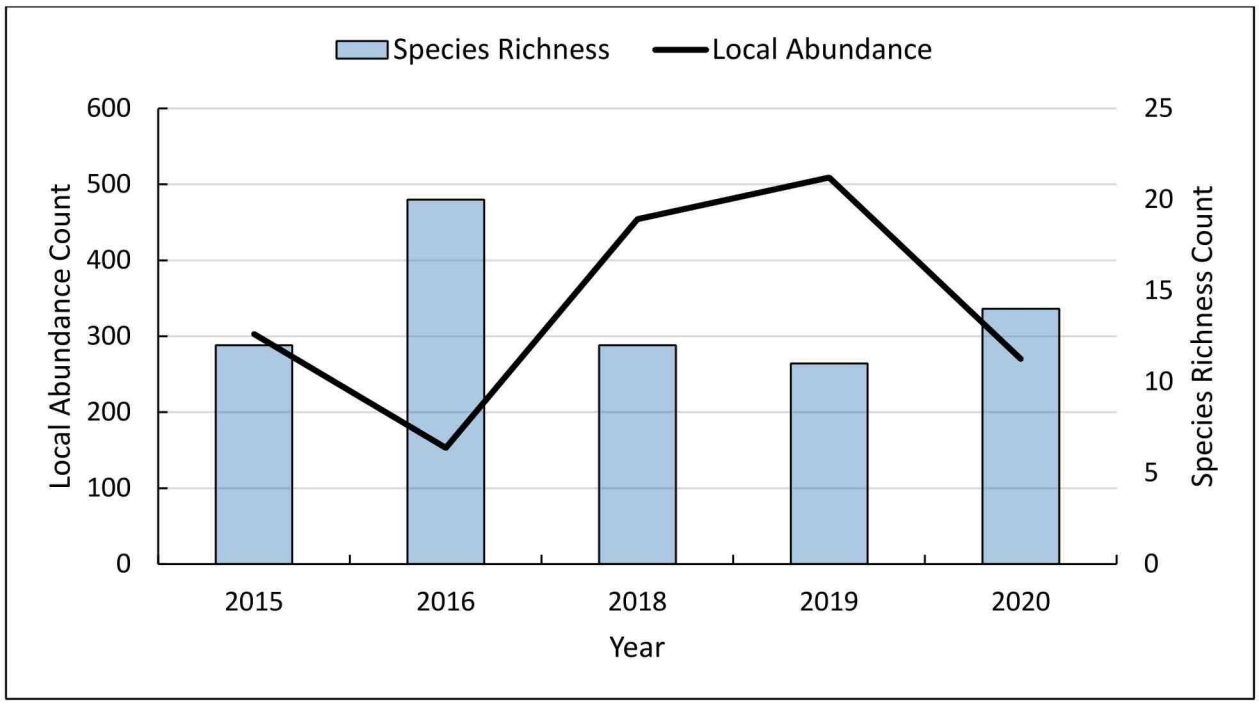

Figure B.11 Local abundance and species richness found within the South Saugeen subwatershed from 2015 to 2020.

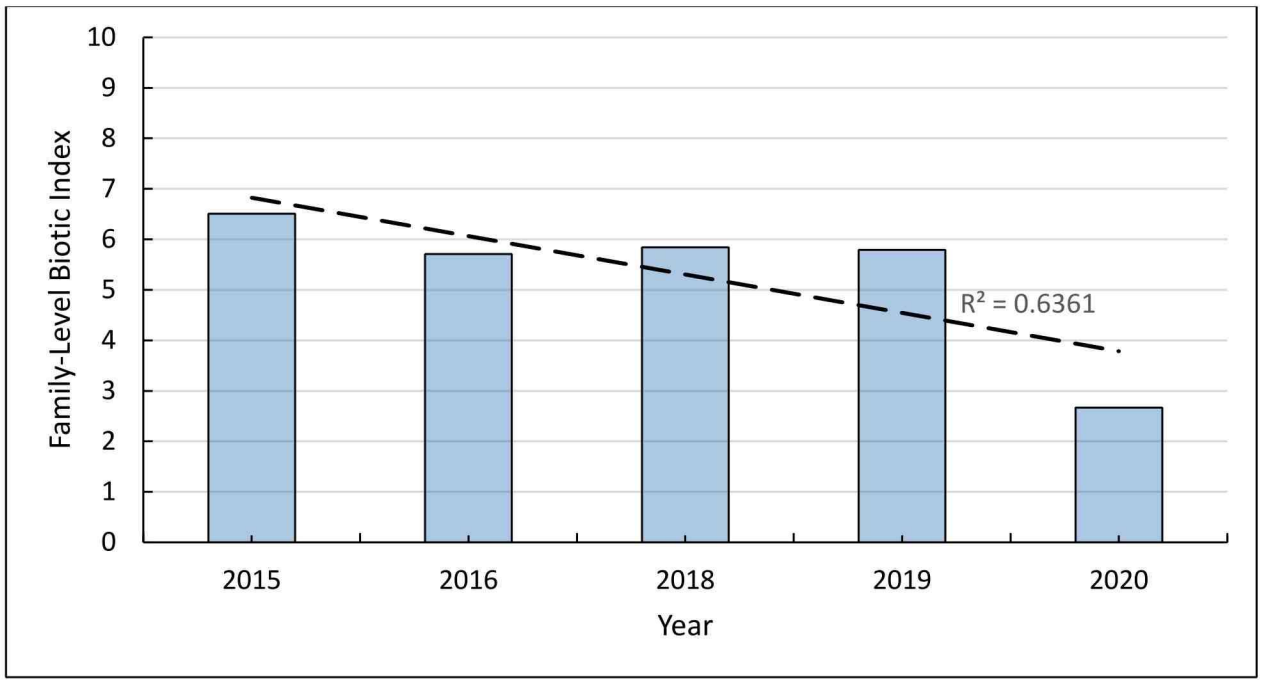

Figure B.12 Family-level biotic index scores for the South Saugeen subwatershed from 2015 to 2020.

Appendix C – Beatty Saugeen Subwatershed

2023 Results

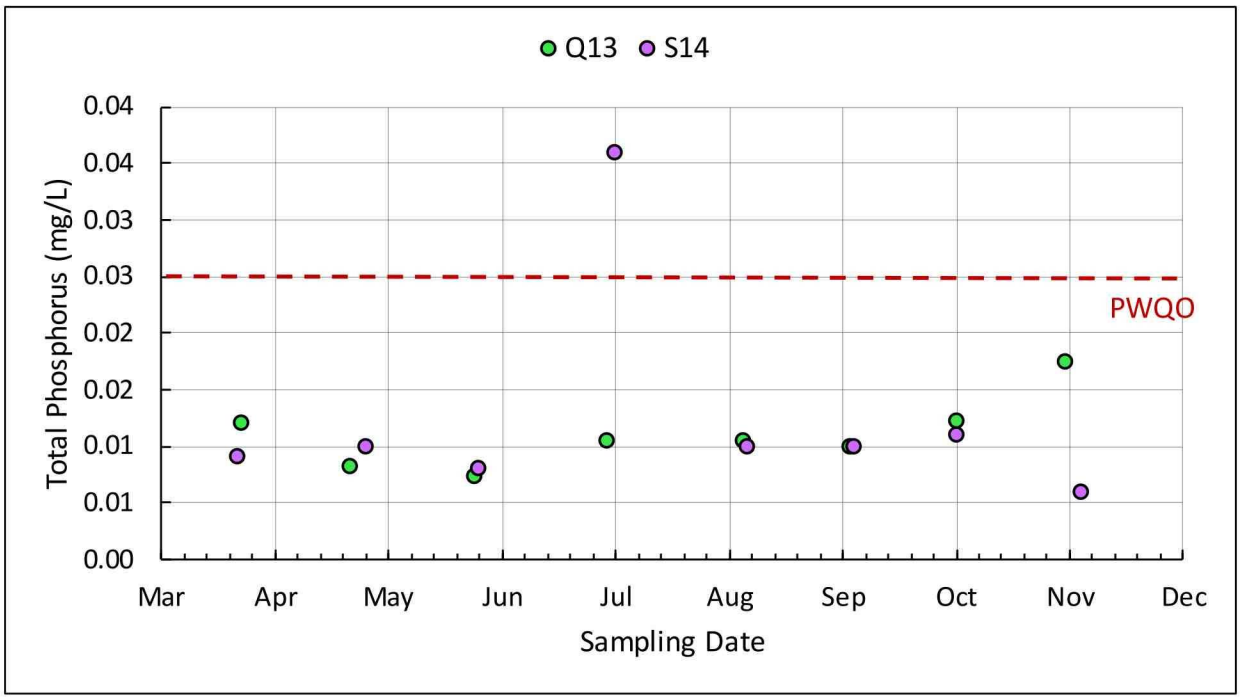

Figure C.1 2023 Beatty Saugeen subwatershed total phosphorus concentrations (mg/L) in a graph format. Graph shows Q13 and S14 sampling sites, the horizontal line indicates the PWQO of 0.03 mg/L. There is 1 exceedance of the PWQO.

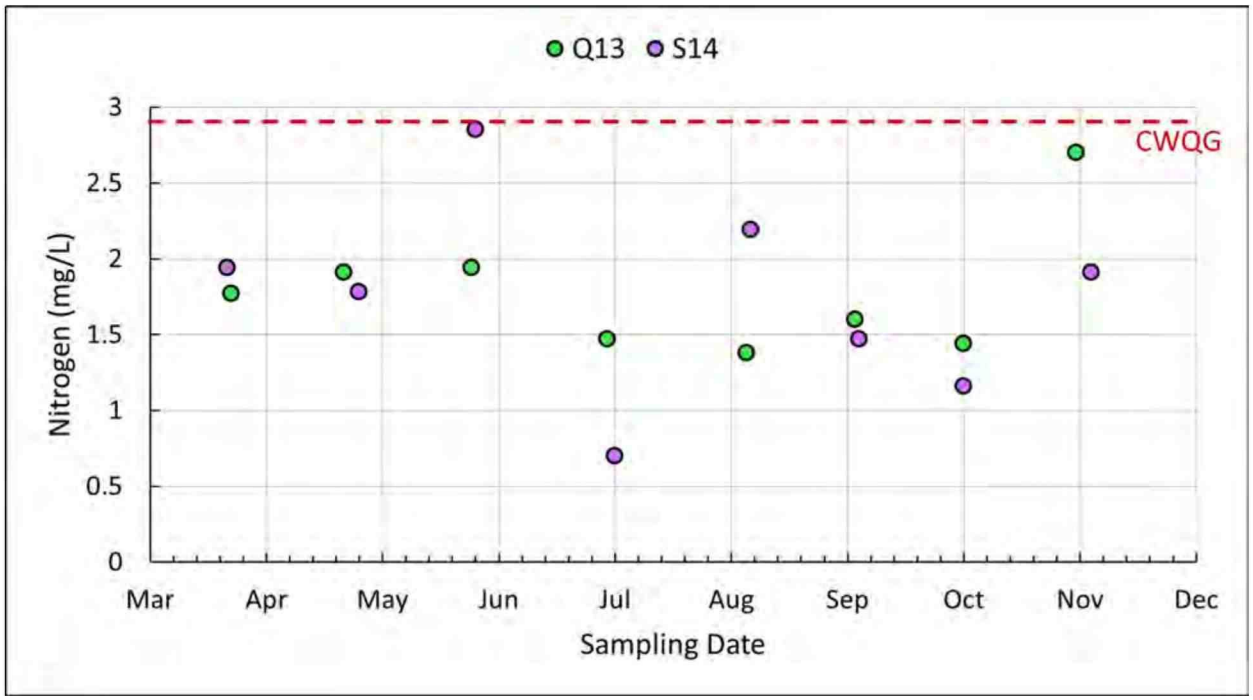

Figure C.2 2023 Beatty Saugeen subwatershed nitrogen concentrations (mg/L) in a graph format. Graph shows Q13 and Q14 sampling sites, the horizontal line indicates the CWQG of 2.93 mg/L. There are no exceedances.

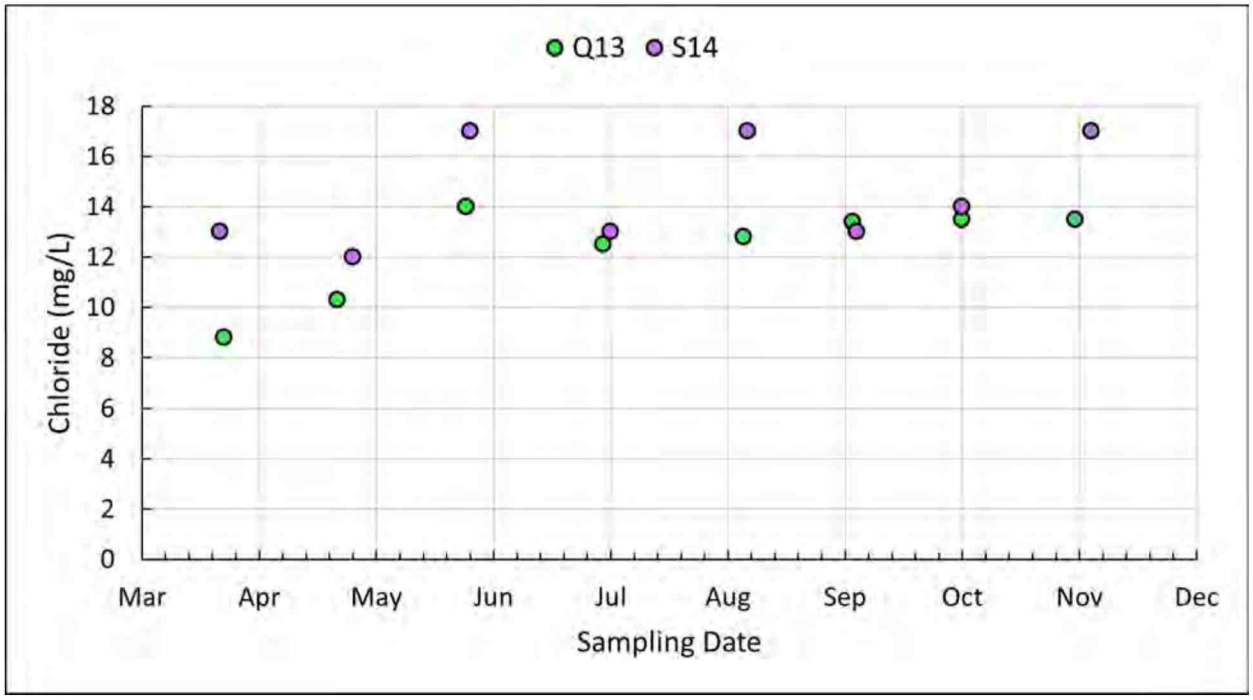

Figure C.3 2023 Beatty Saugeen subwatershed chloride concentrations (mg/L) in a graph format. Graph shows Q13 and Q14 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

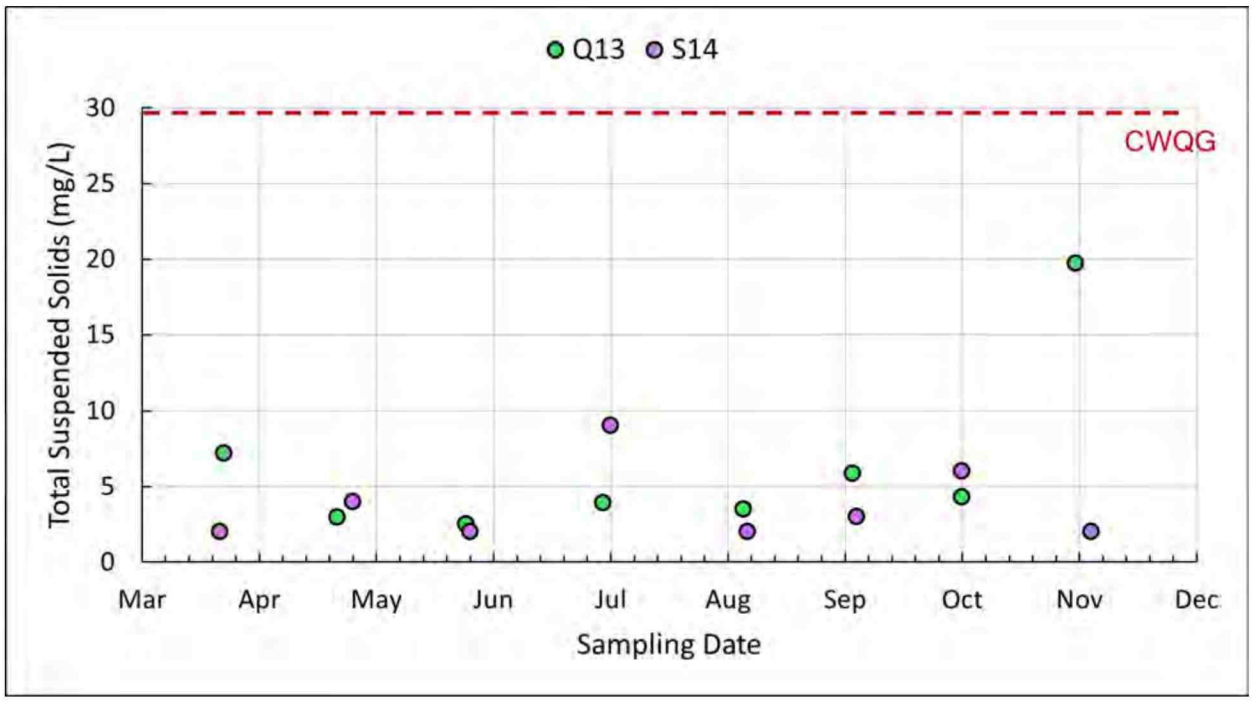

Figure C.4 2023 Beatty Saugeen subwatershed total suspended solids concentrations (mg/L) in a graph format. Graph shows Q13 and S14 sampling sites, the horizontal line indicates the CWQG of 30 mg/L. There are no exceedances.

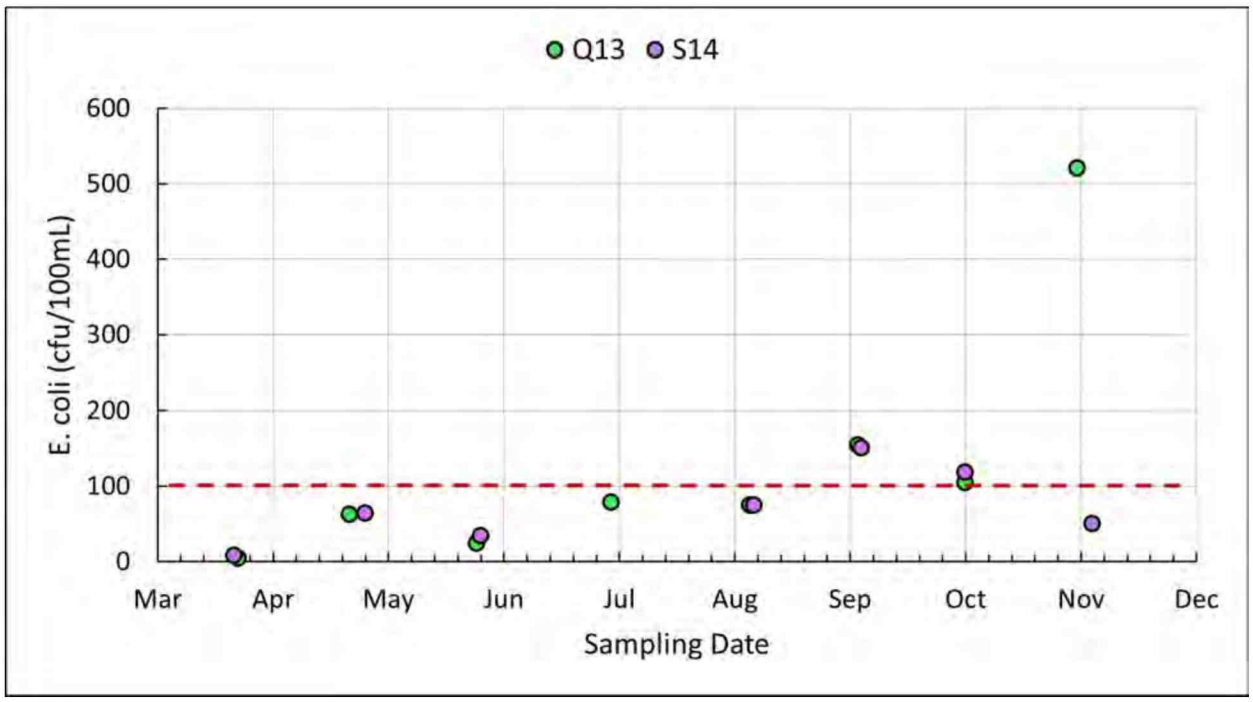

Figure C.5 2023 Beatty Saugeen subwatershed *E. coli* concentrations (cfu/100mL) in a graph format. Graph shows Q13 and Q14 sampling sites, the horizontal line indicates the PWQO of 100 cfu/100mL for swimming. There are six exceedances of the PWQO, the exceedance for July is not shown on this graph (1280 cfu/100mL).

Long-term Results

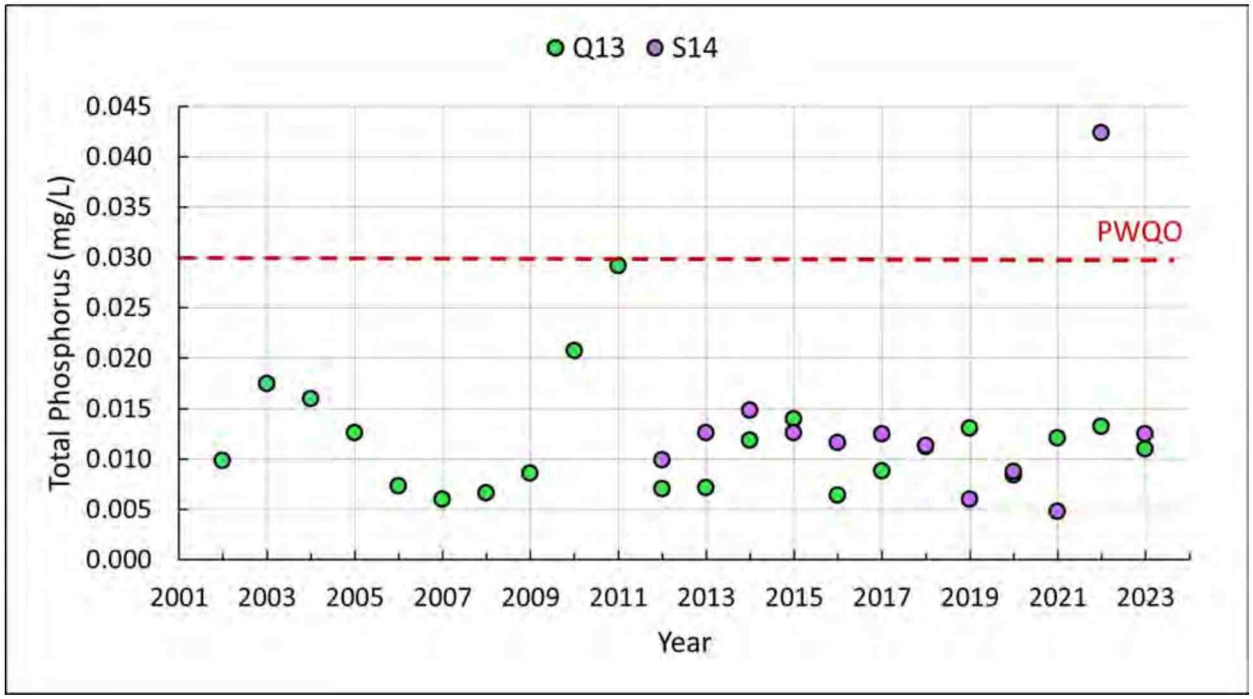

Figure C.6 2002 to 2023 Beatty Saugeen subwatershed annual average total phosphorus concentrations (mg/L) in a graph format. Graph shows Q13 and S14 sampling sites, and a horizontal line indicating a PWQO of 0.03 mg/L. There was 1 exceedance of the PWQO.

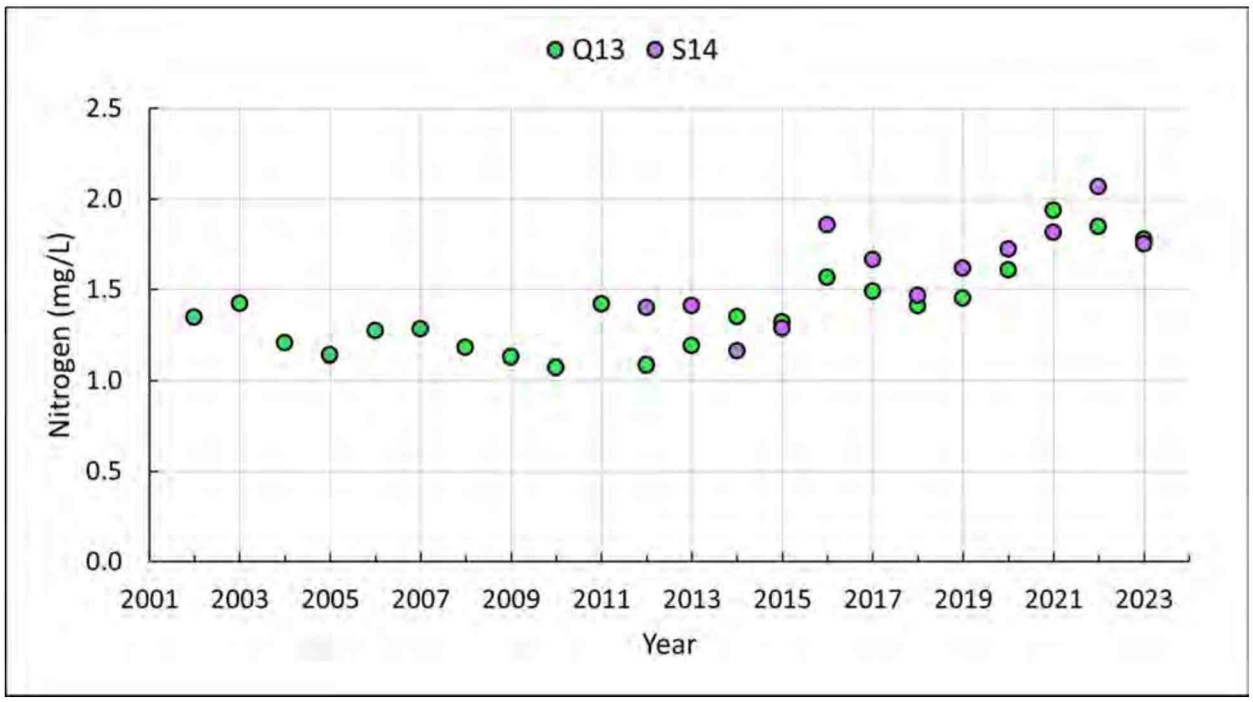

Figure C.7 2002 to 2023 Beatty Saugeen subwatershed annual average nitrogen concentrations (mg/L) in a graph format. Graph shows Q13 and S14 sampling sites. The CWQG is 2.93 mg/L. There are no exceedances.

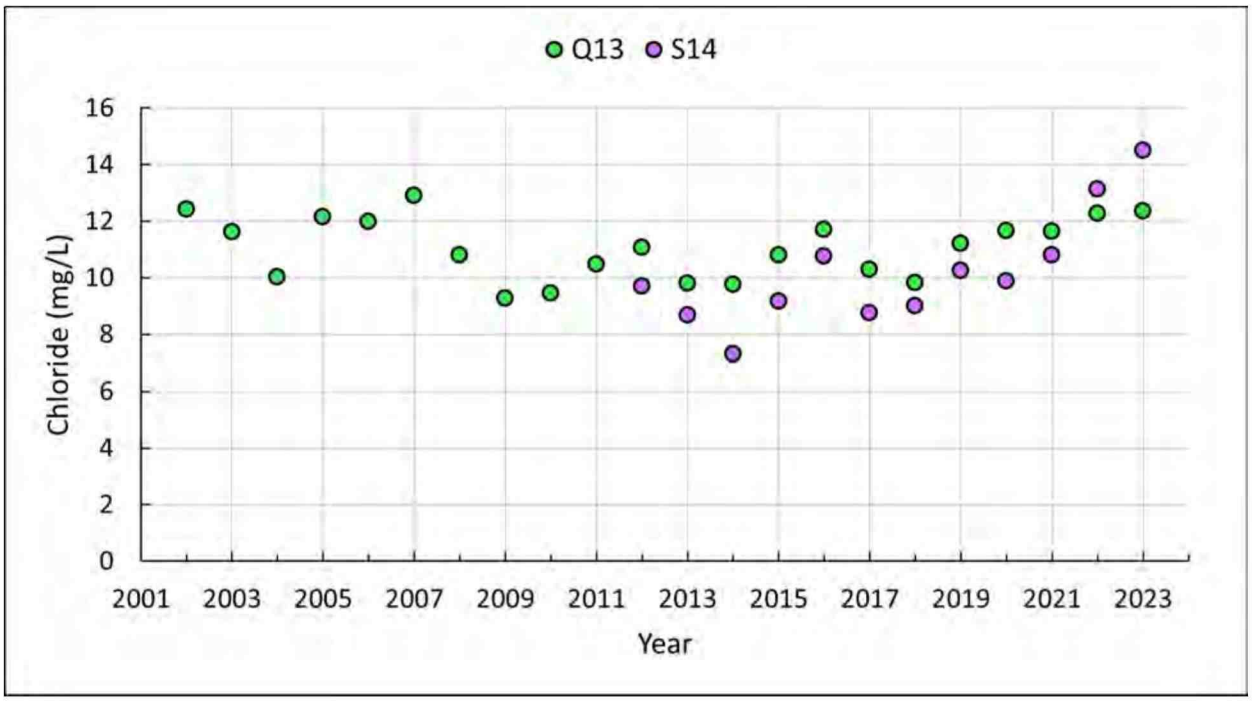

Figure C.8 2002 to 2023 Beatty Saugeen subwatershed annual average chloride concentrations (mg/L) in a graph format. Graph shows Q13 and S14 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

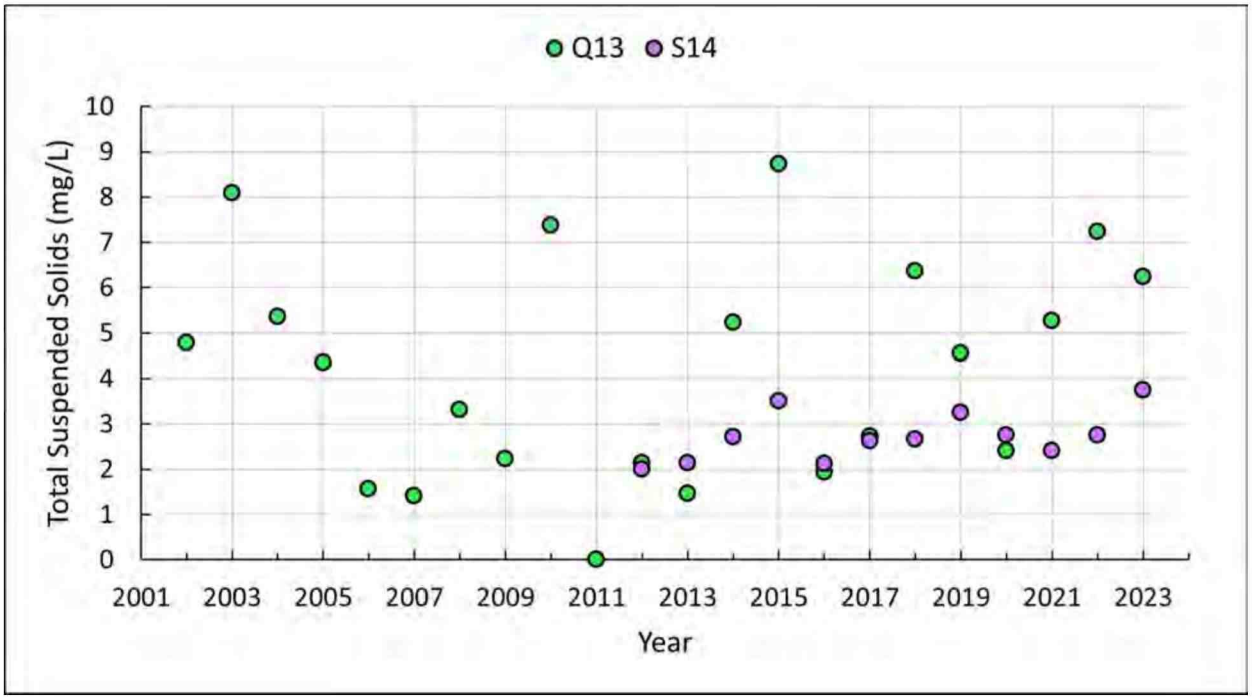

Figure C.9 2012 to 2023 Beatty Saugeen subwatershed annual average total suspended solids concentrations (mg/L) in a graph format. Graph shows Q13 and Q14 sampling. The CWQG is 30 mg/L. There are no exceedances.

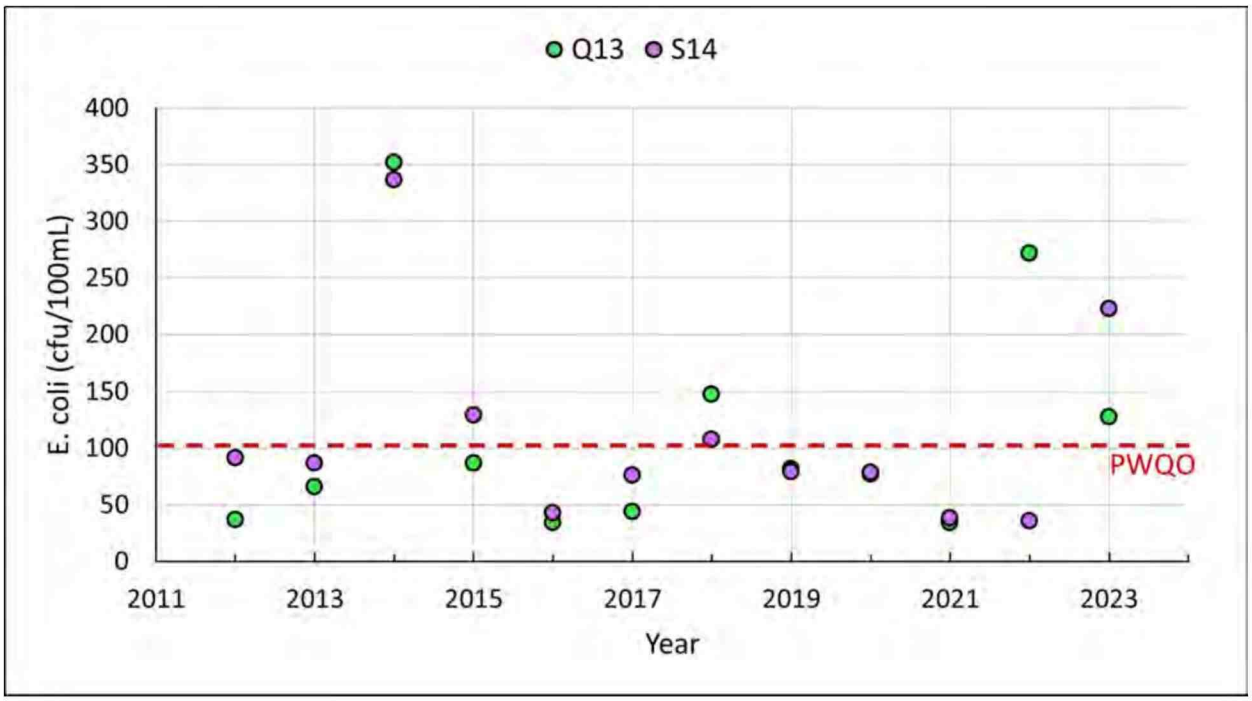

Figure C.10 2012 to 2023 Beatty Saugeen subwatershed annual average *E. coli* concentrations (cfu/100mL) in a graph format. Graph shows Q13 and S14 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 8 exceedances of the PWQO.

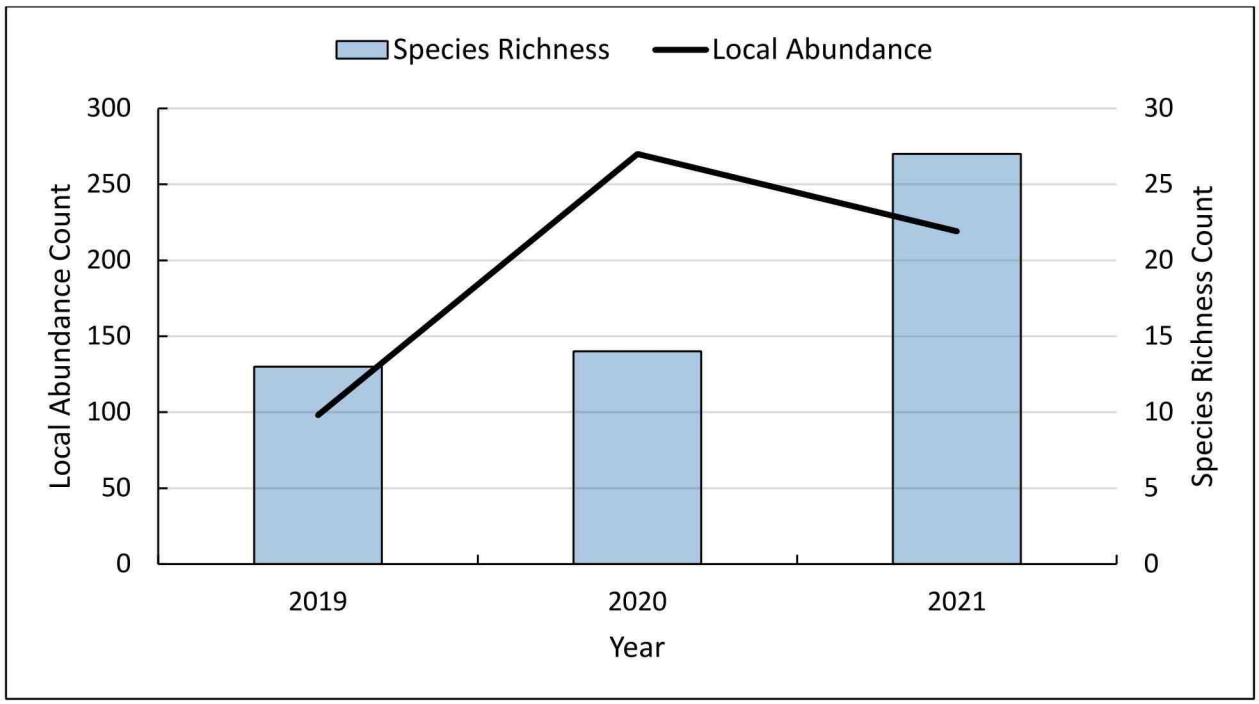

Figure C.11 Local abundance and species richness found within the Beatty Saugeen subwatershed from 2019 to 2021.

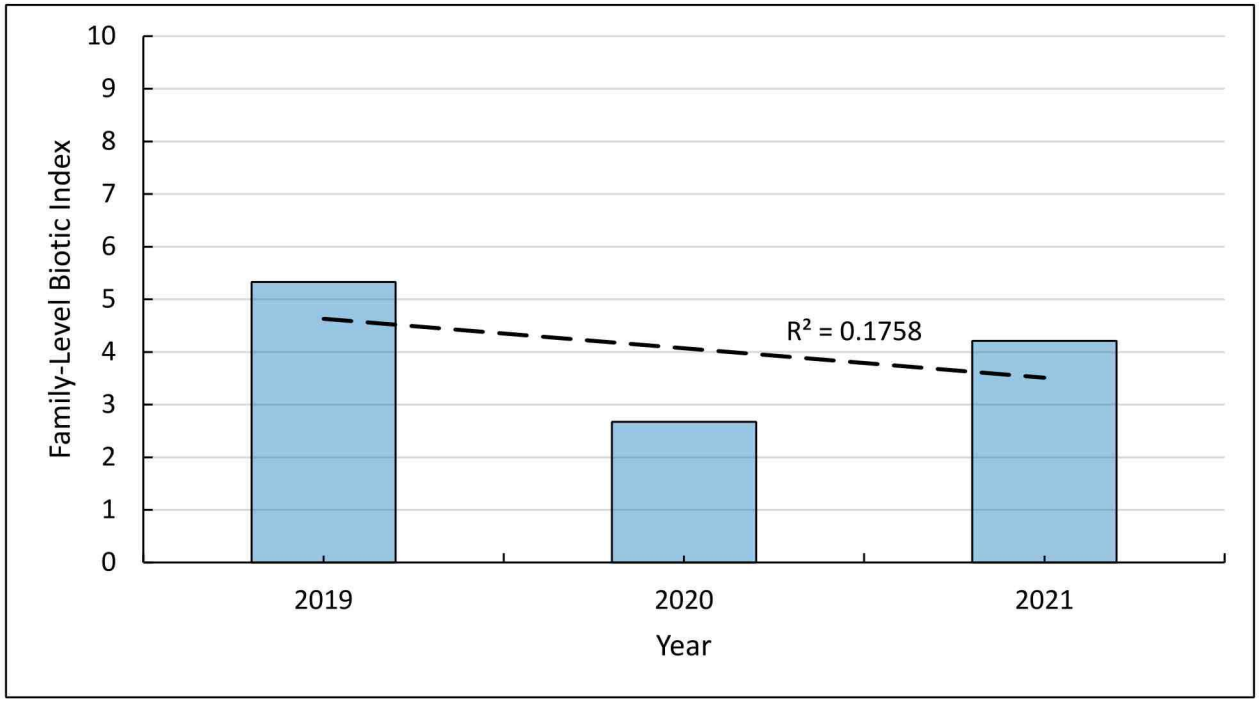

Figure C.12 Family-level biotic index for the Beatty Saugeen from 2019 to 2021.

Appendix D – Upper Main Saugeen Subwatershed

2023 Results

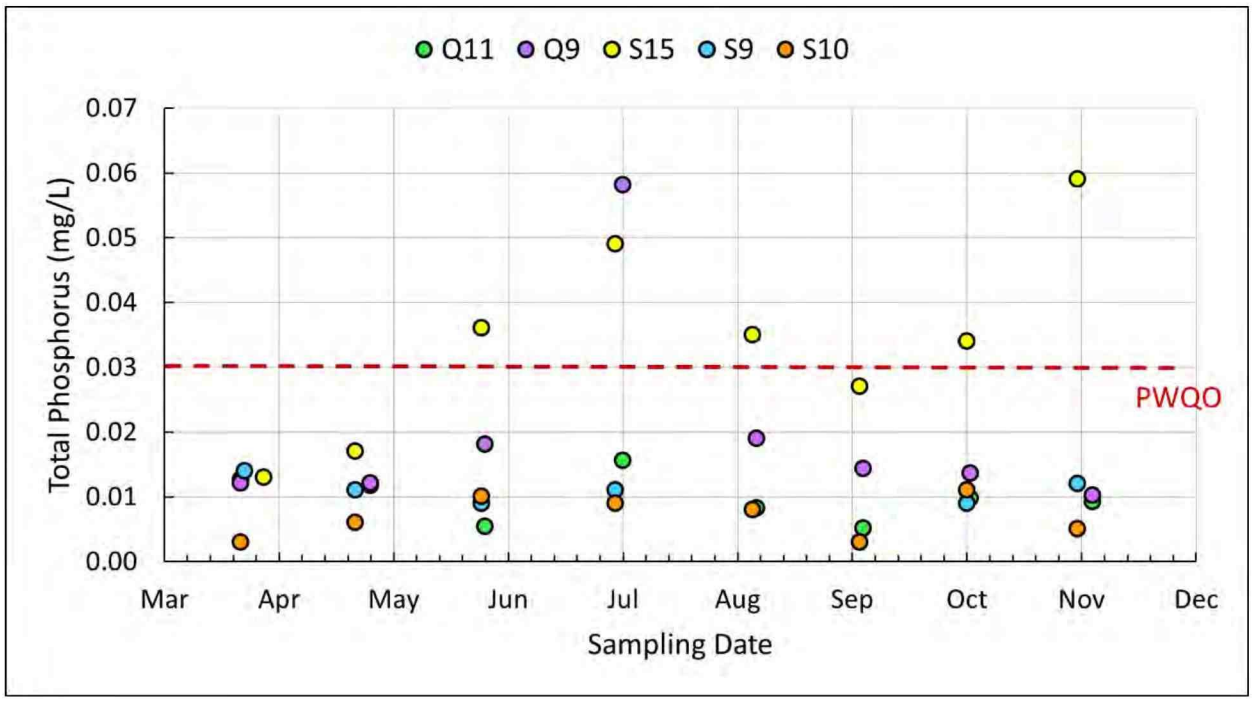

Figure D.1 2023 Upper Main Saugeen subwatershed total phosphorus concentrations (mg/L) in a graph format. Graph shows Q11, Q9, S15, S9 and S10 sampling sites and a horizontal line indicating a PWQO of 0.03 mg/L. There are 6 exceedances of the PWQO.

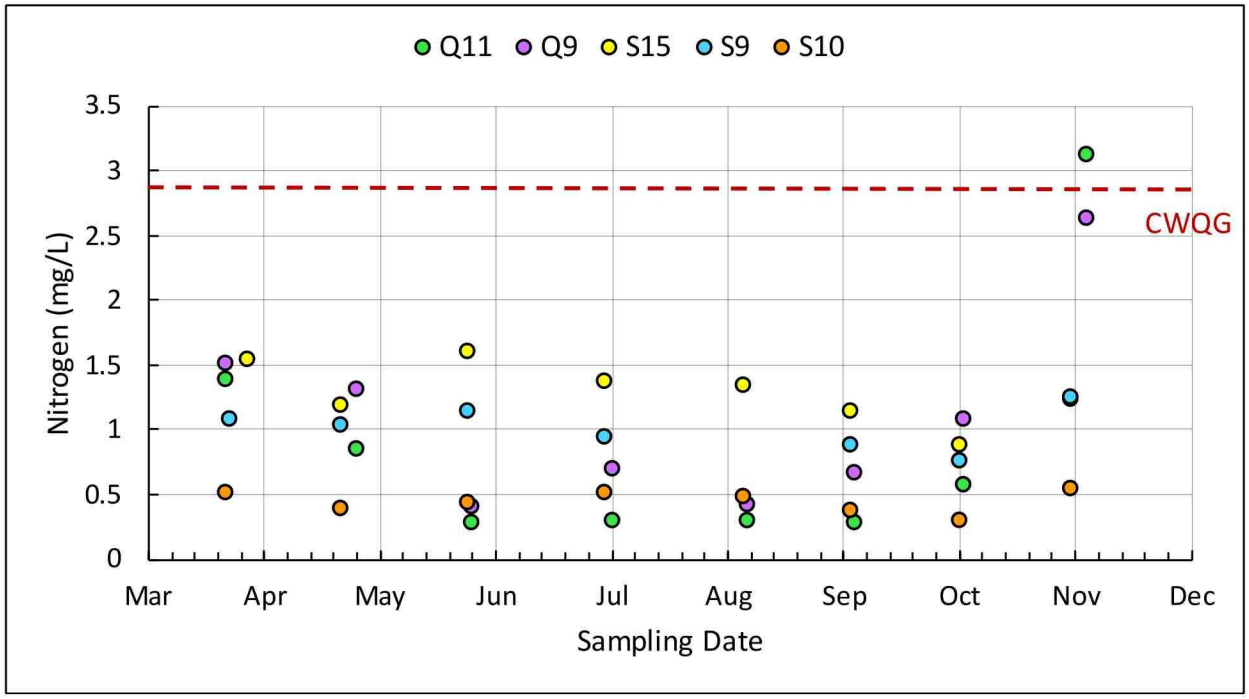

Figure D.2 2023 Upper Main Saugeen subwatershed nitrogen concentrations (mg/L) in a graph format. Graph shows Q11, Q9, S15, S9 and S10 sampling sites and a horizontal line indicating a CWQG of 2.93 mg/L. There was 1 exceedance of the CWQG.

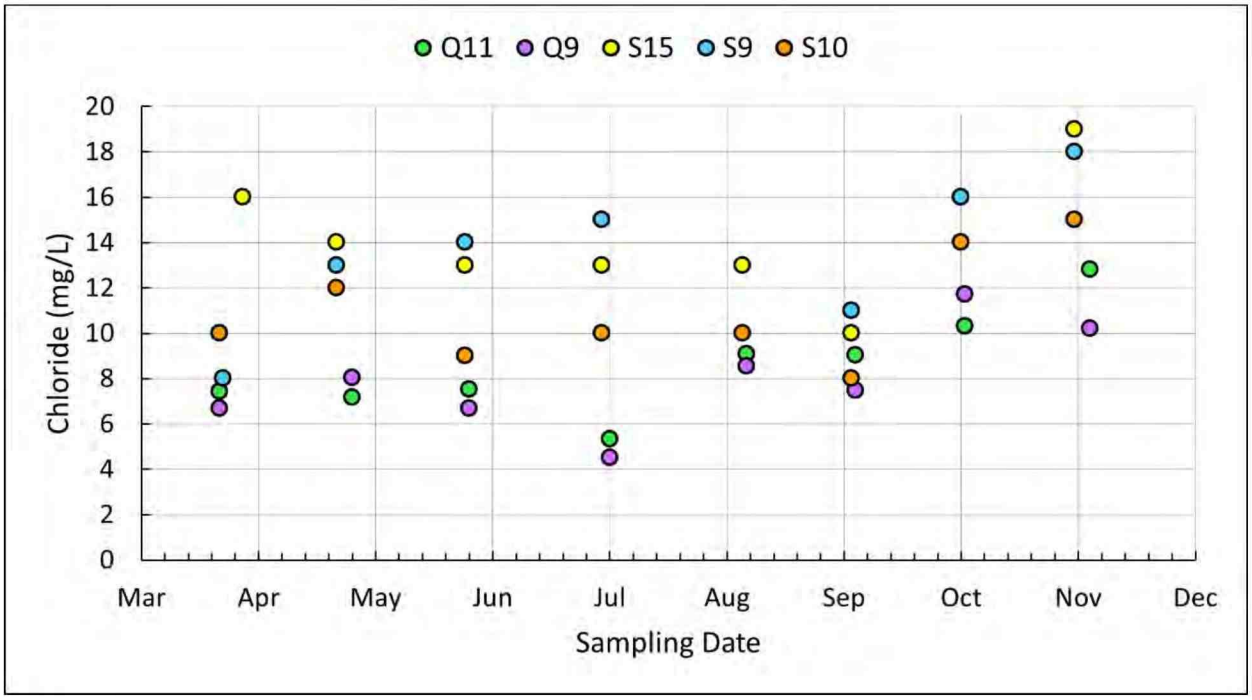

Figure D.3 2023 Upper Main Saugeen subwatershed chloride concentrations (mg/L) in a graph format. Graph shows Q11, Q9, S15, S9 and S10 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

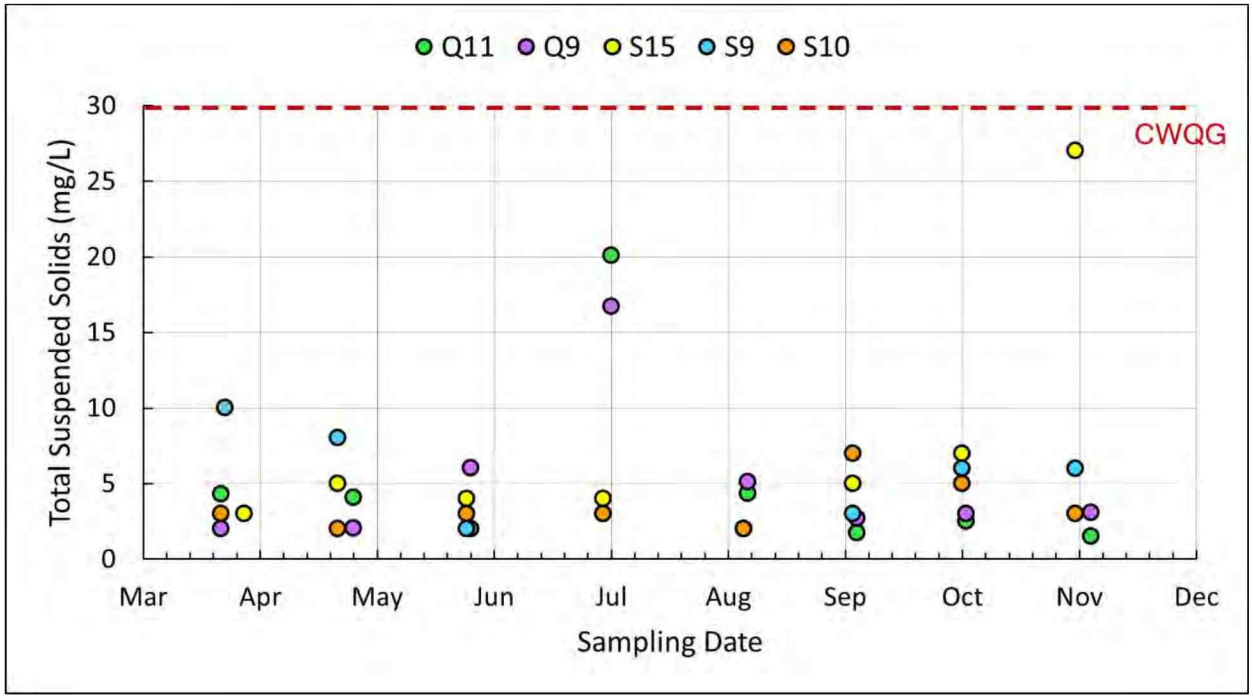

Figure D.4 2023 Upper Main Saugeen subwatershed total suspended solids concentrations (mg/L) in a graph format. Graph shows Q11, Q9, S15, S9 and S10 sampling sites, and a horizontal line indicating a CWQG of 30 mg/L. There are no exceedances of the CWQG.

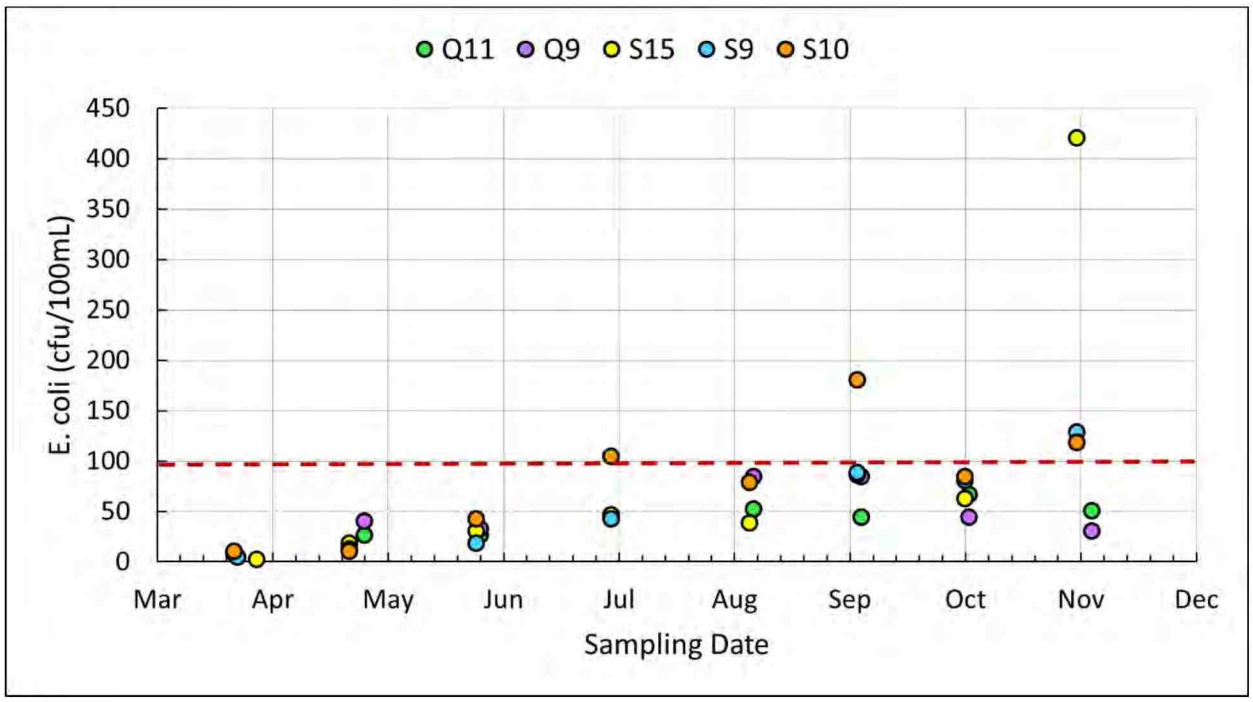

Figure D.5 2023 Upper Main Saugeen subwatershed *E. coli* concentrations (cfu/100mL) in a graph format. Graph shows Q11, Q9, S15, S9 and S10 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 7 exceedances of the PWQO. Two exceedances from July are not shown on this graph (Q11 at 1760 cfu/100mL, Q9 at 8000 cfu/100mL).

Long-term Results

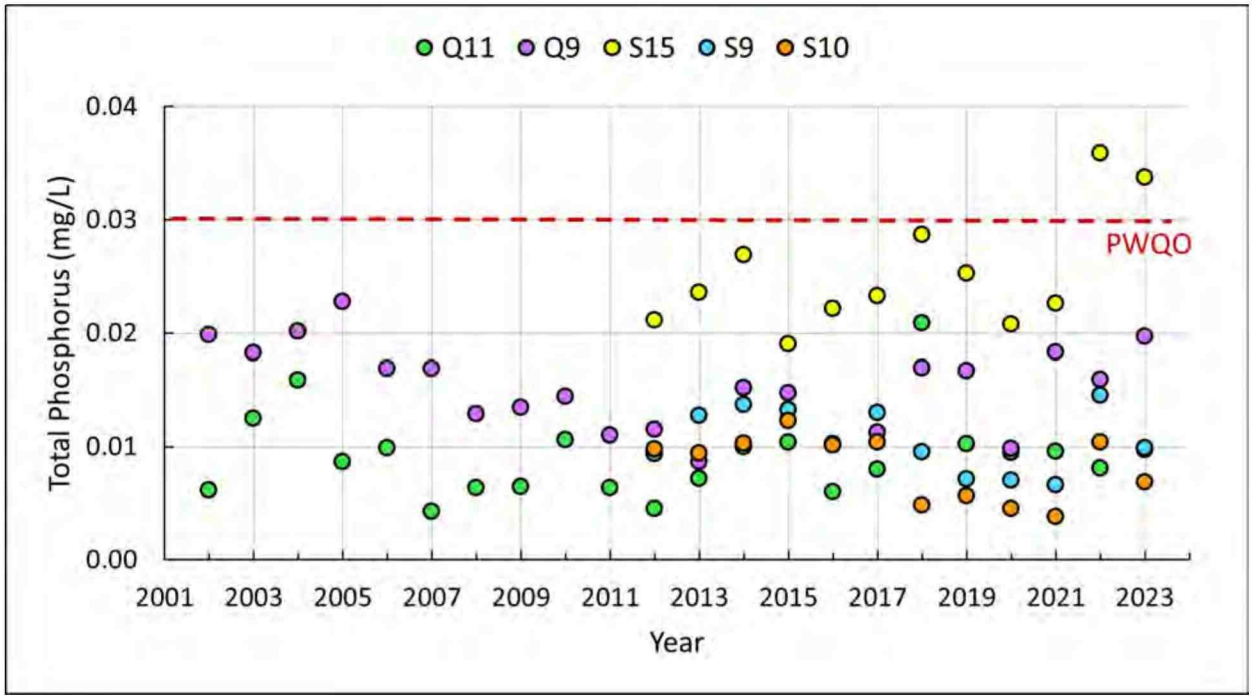

Figure D.6 2002 to 2023 Upper Main Saugeen annual average total phosphorus concentrations (mg/L) in a graph format. Graph shows Q11, Q9, S15, S9 and S10 sampling sites, and a horizontal line indicating a PWQO of 0.03 mg/L. There are 2 exceedances of the PWQO.

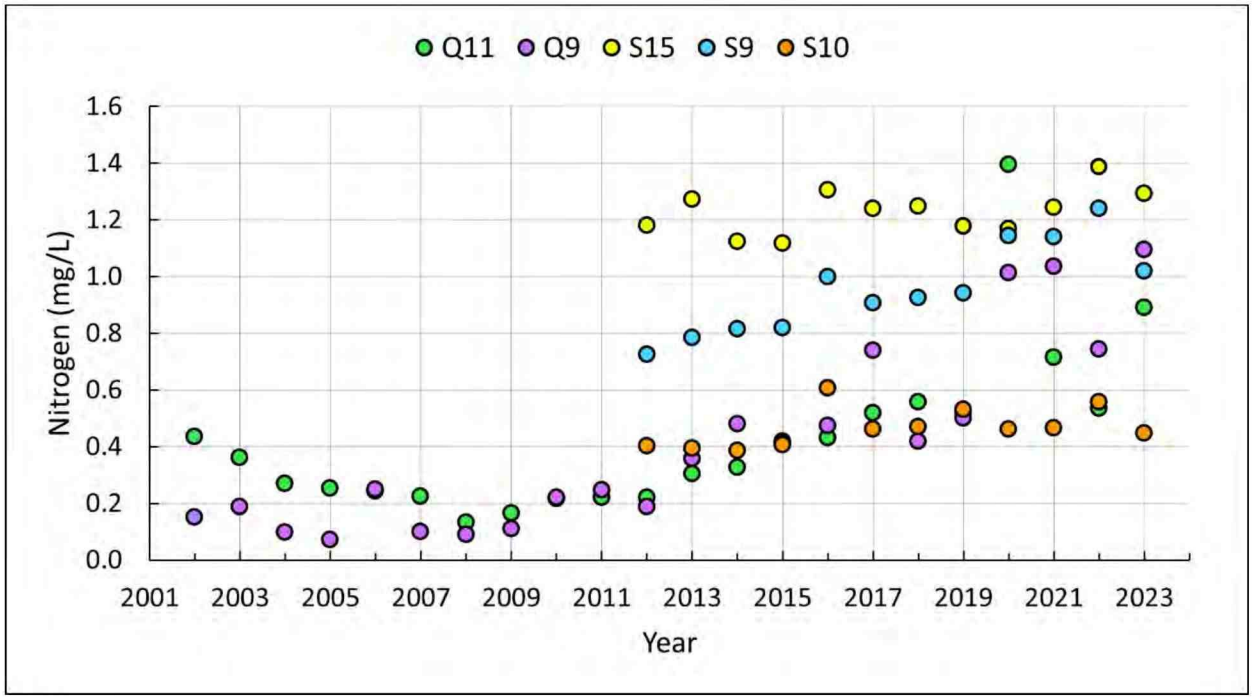

Figure D.7 2002 to 2023 Upper Main Saugeen subwatershed annual average nitrogen concentrations (mg/L) in a graph format. Graph shows Q11, Q9, S15, S9 and S10 sampling sites. The CWQG is 2.93 mg/L. There are no exceedances.

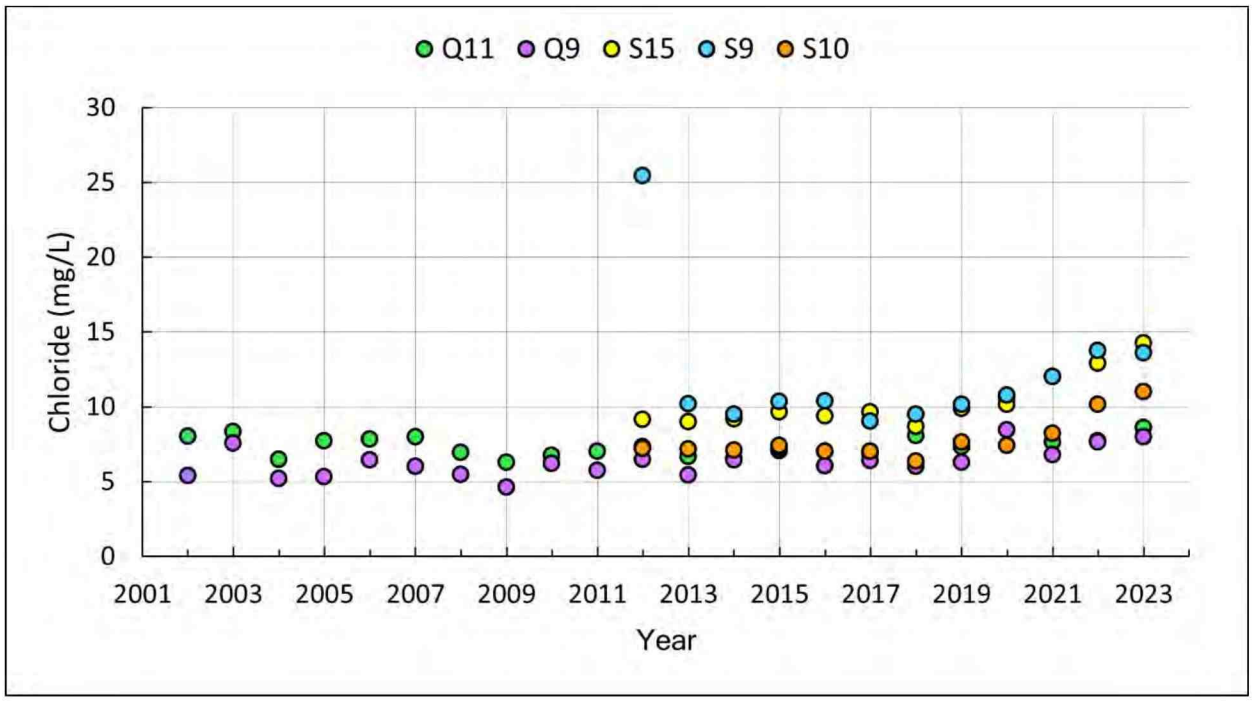

Figure D.8 2002 to 2023 Upper Main Saugeen subwatershed annual average chloride concentrations (mg/L) in graph format. Graph shows Q11, Q9, S15, S9 and S10 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

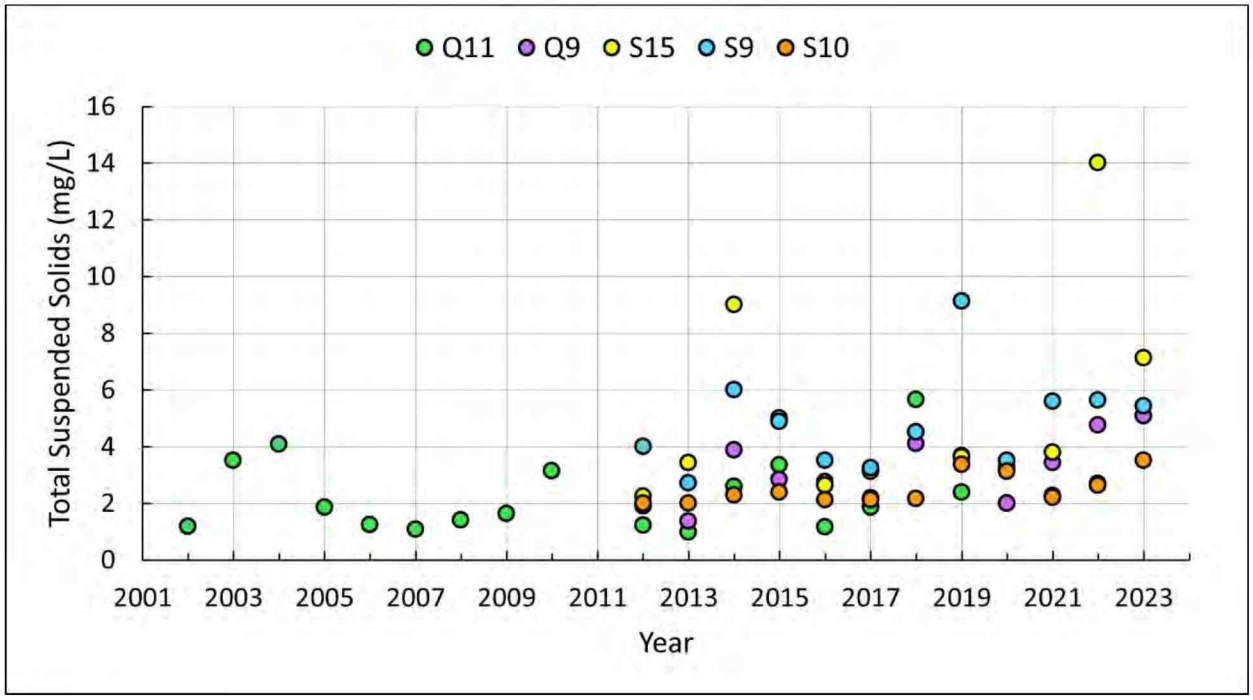

Figure D.9 2002 to 2023 Upper Main Saugeen subwatershed annual average total suspended solids concentrations (mg/L) in graph format. Graph shows Q11, Q9, S15, S9 and S10 sampling sites. The CWQG is 30 mg/L. There are no exceedances. Results for Q11 in 2011 are not available.

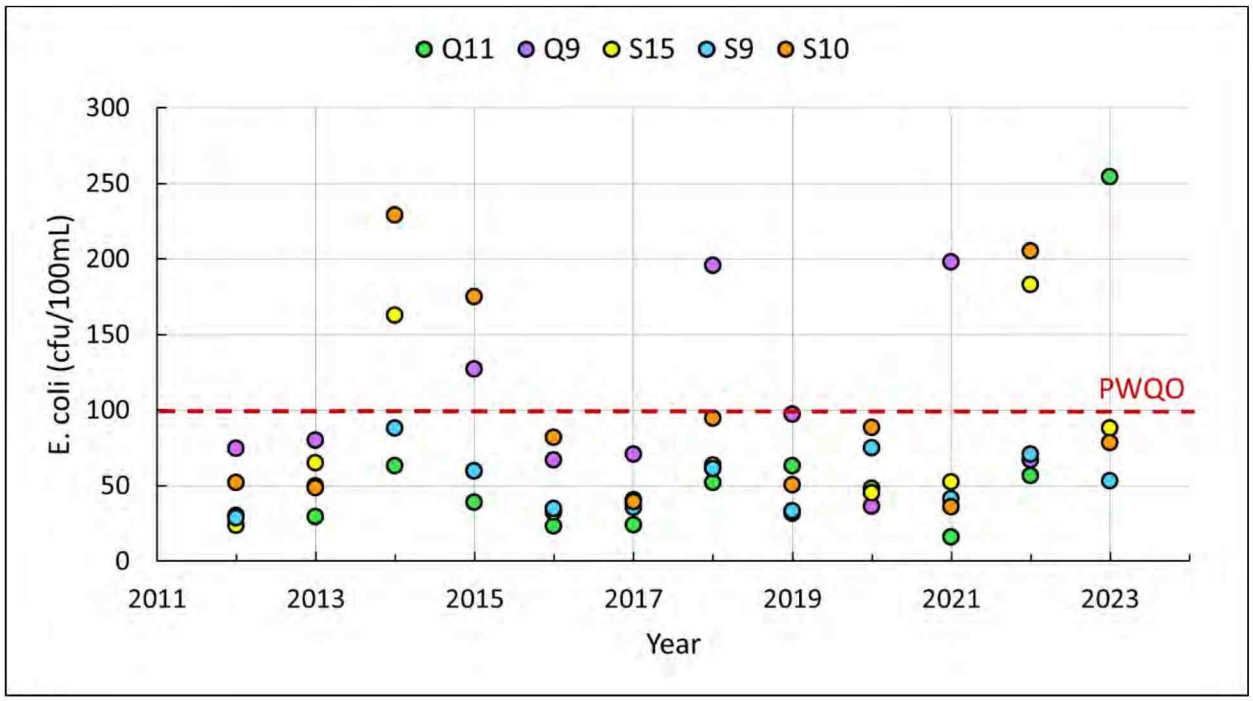

Figure D.10 2012 to 2023 Upper Main Saugeen subwatershed annual average *E. coli* concentrations (cfu/100mL) in a graph format. Graph shows Q11, Q9, S15, S9 and S10 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 11 exceedances of the PWQO; there are two exceedances at Q9 in 2014 and 2023 that are not shown on this graph (805 and 1040 cfu/100mL, respectively).

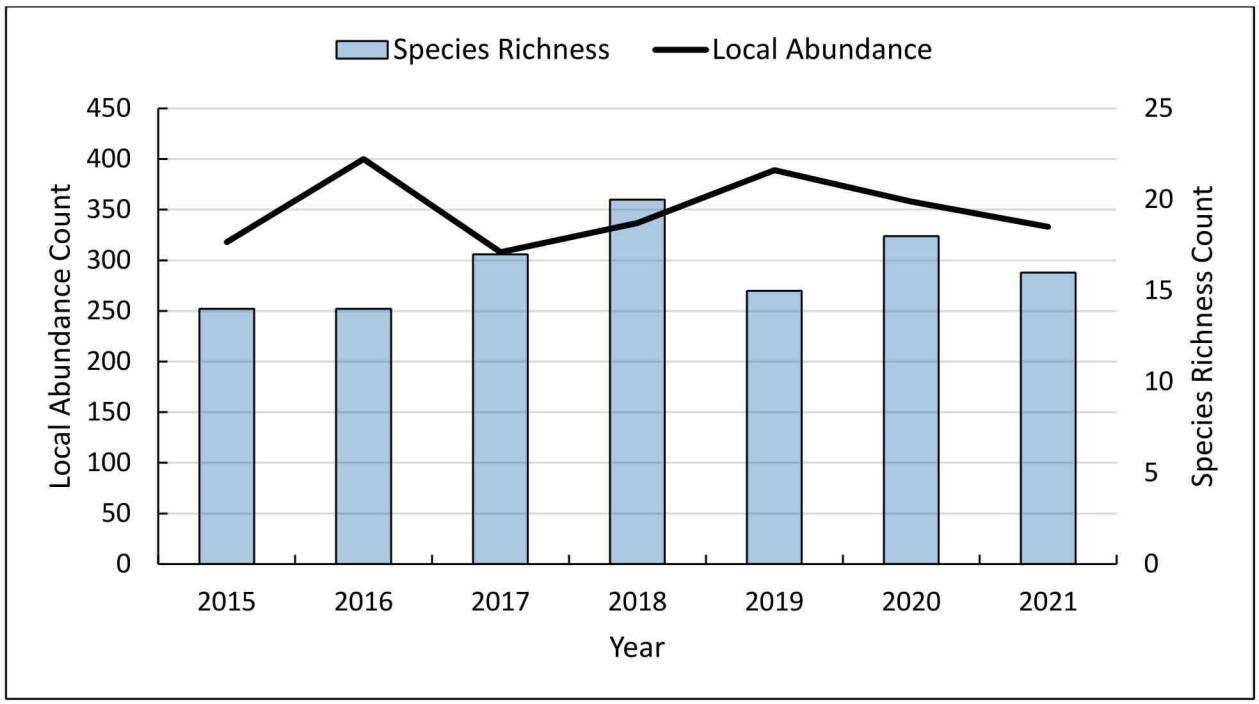

Figure D.11 Local abundance and species richness found within the Upper Main Saugeen subwatershed from 2015 to 2021.

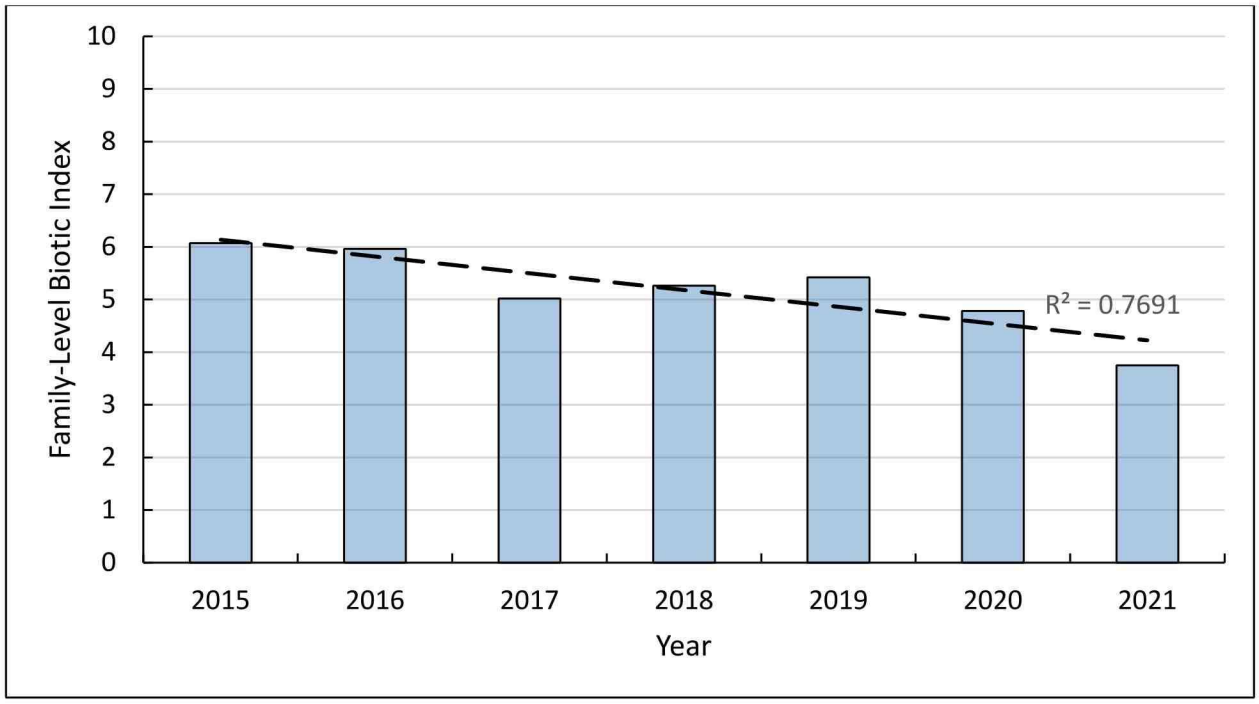

Figure D.12 Family-level biotic index for the Upper Main Saugeen from 2015 to 2021.

Appendix E – Rocky Saugeen Subwatershed

2023 Results

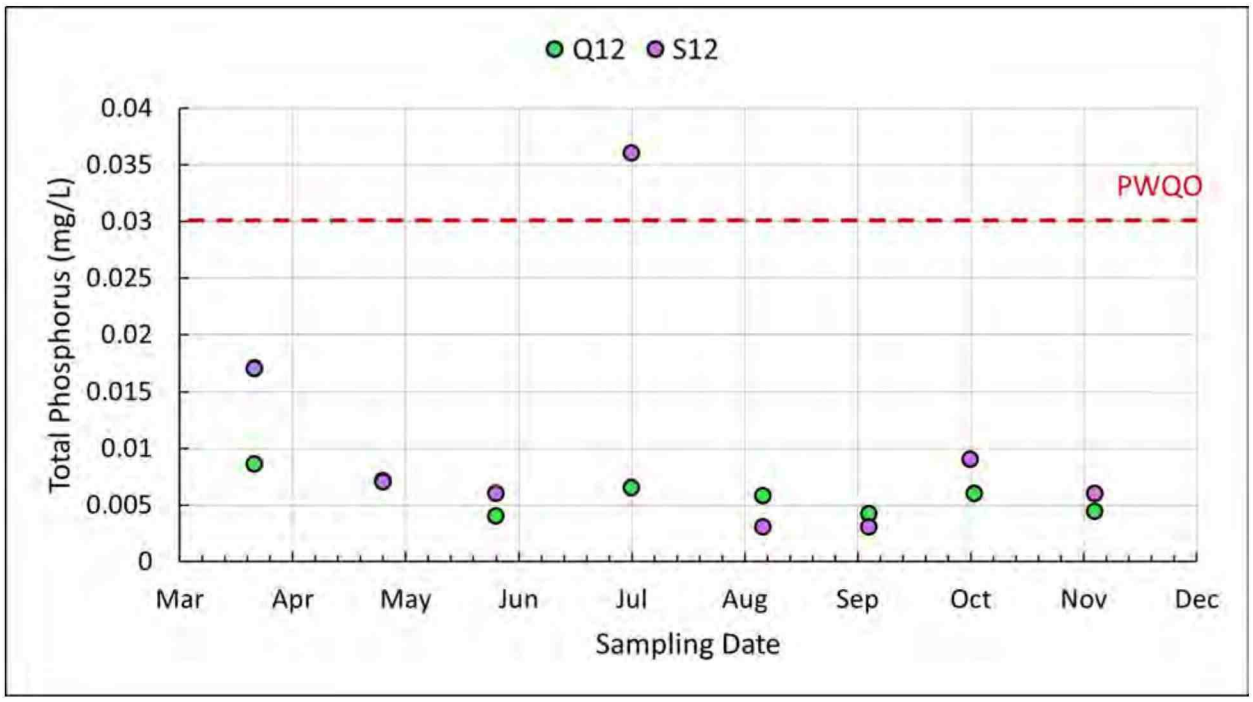

Figure E.1 2023 Rocky Saugeen subwatershed total phosphorus concentrations (mg/L) in a graph format. Graph shows Q12 and S12 sampling sites, and a horizontal line indicating a PWQO of 0.03mg/L. There is 1 exceedance of the PWQO.

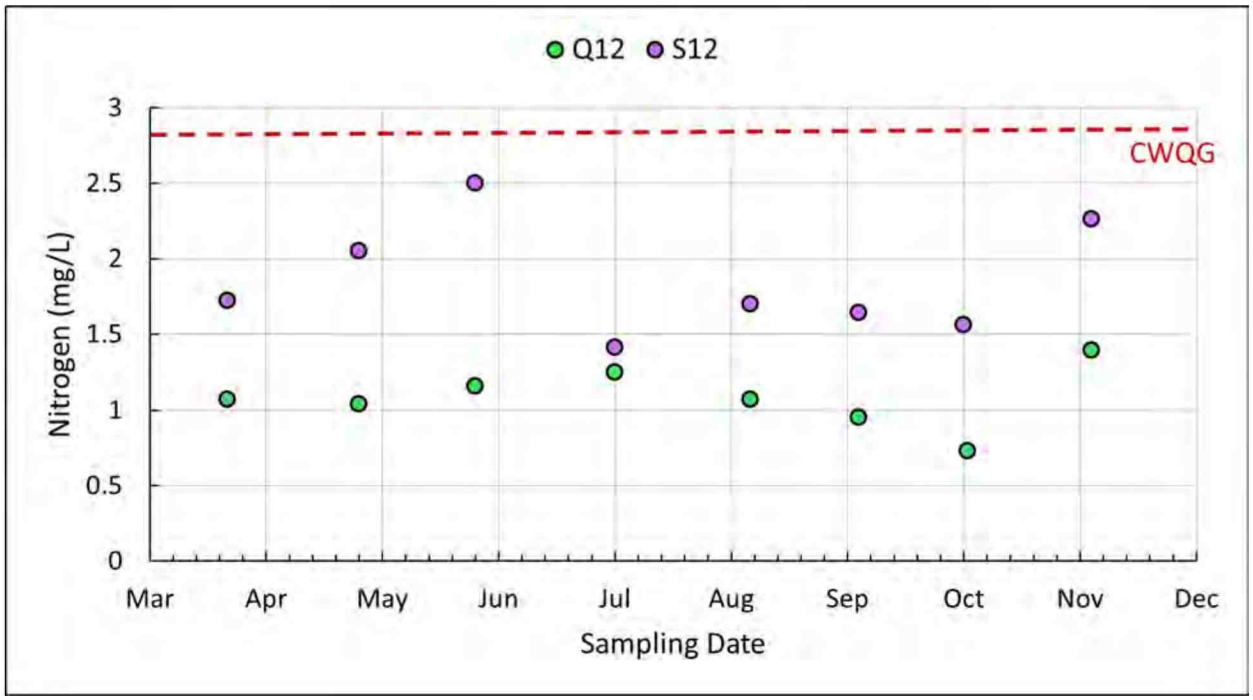

Figure E.2 2023 Rocky Saugeen subwatershed nitrogen concentrations (mg/L) in a graph format. Graph shows Q12 and S12 sampling sites, and a horizontal line indicating a CWQG of 2.93 mg/L. There are no exceedances.

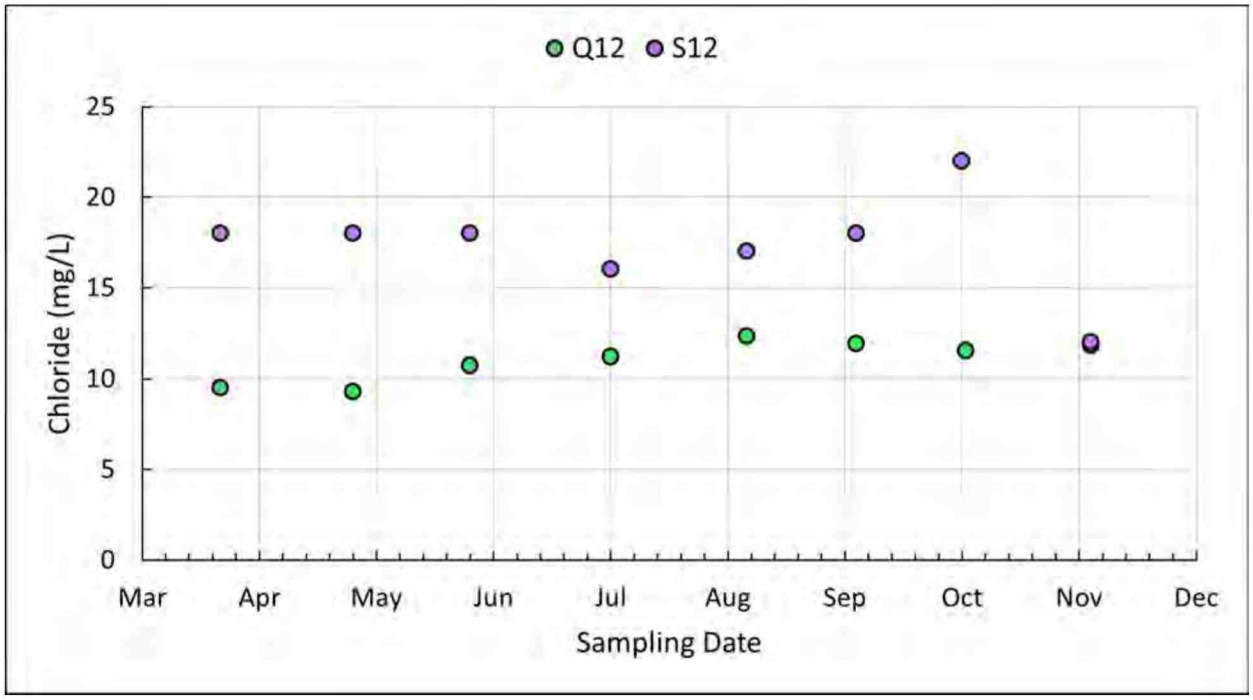

Figure E.3 2023 Rocky Saugeen subwatershed chloride concentrations (mg/L) in a graph format. Graph shows Q12 and S12 sampling sites. The CWQG is 120mg/L. There are no exceedances.

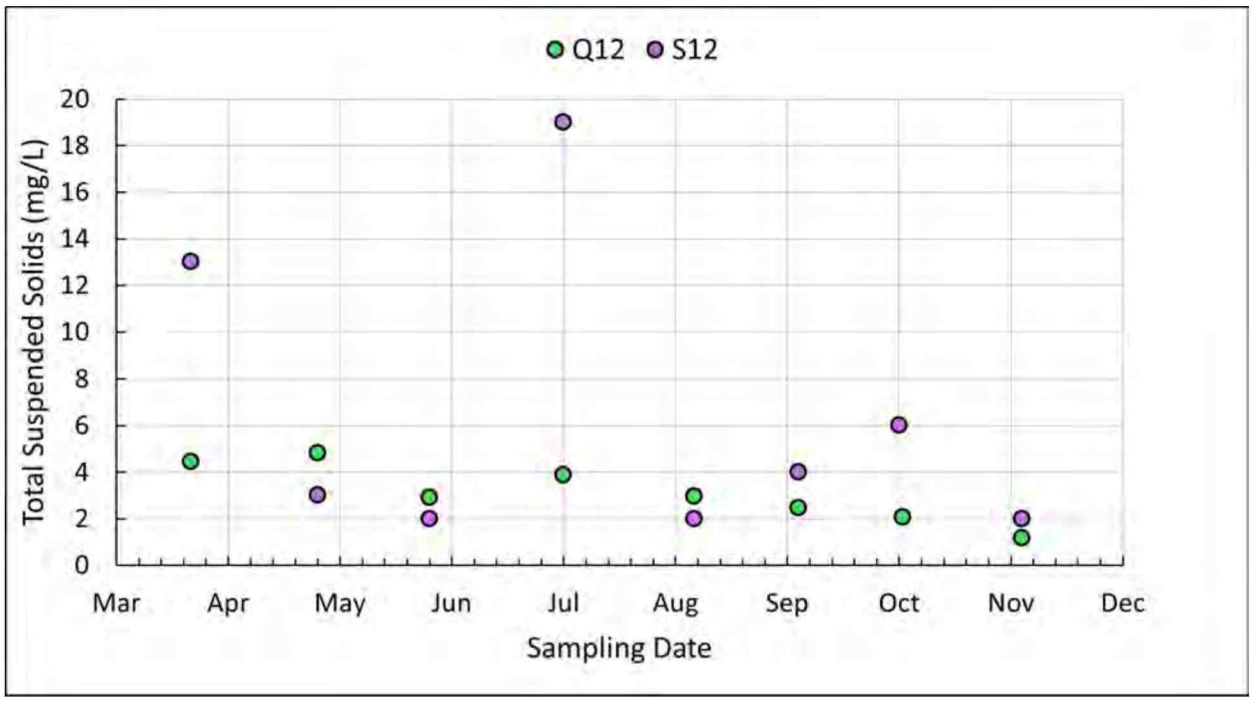

Figure E.4 2023 Rocky Saugeen subwatershed total suspended solids concentrations (mg/L) in a graph format. Graph shows Q12 and S12 sampling sites. The CWQG is 30mg/L. There are no exceedances.

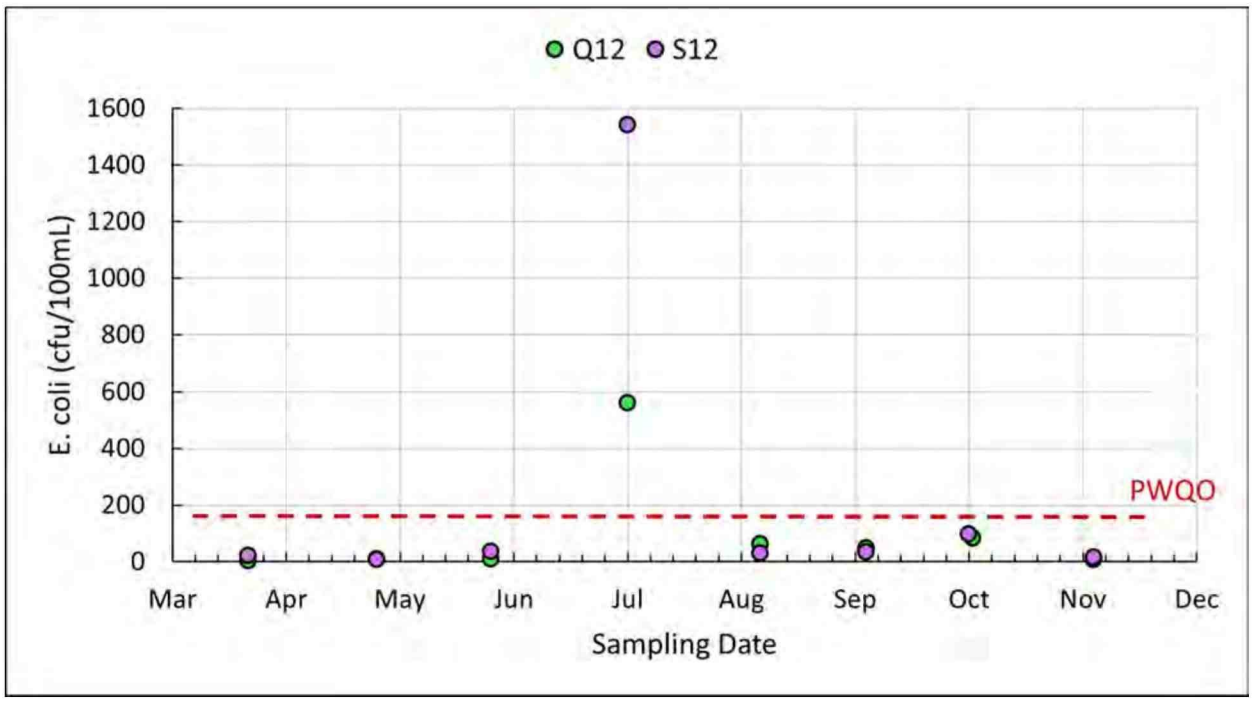

Figure E.5 2023 Rocky Saugeen subwatershed *E. coli* concentrations (cfu/100mL) in a graph format. Graph shows Q12 and S12 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 2 exceedances of the PWQO.

Long-term Results

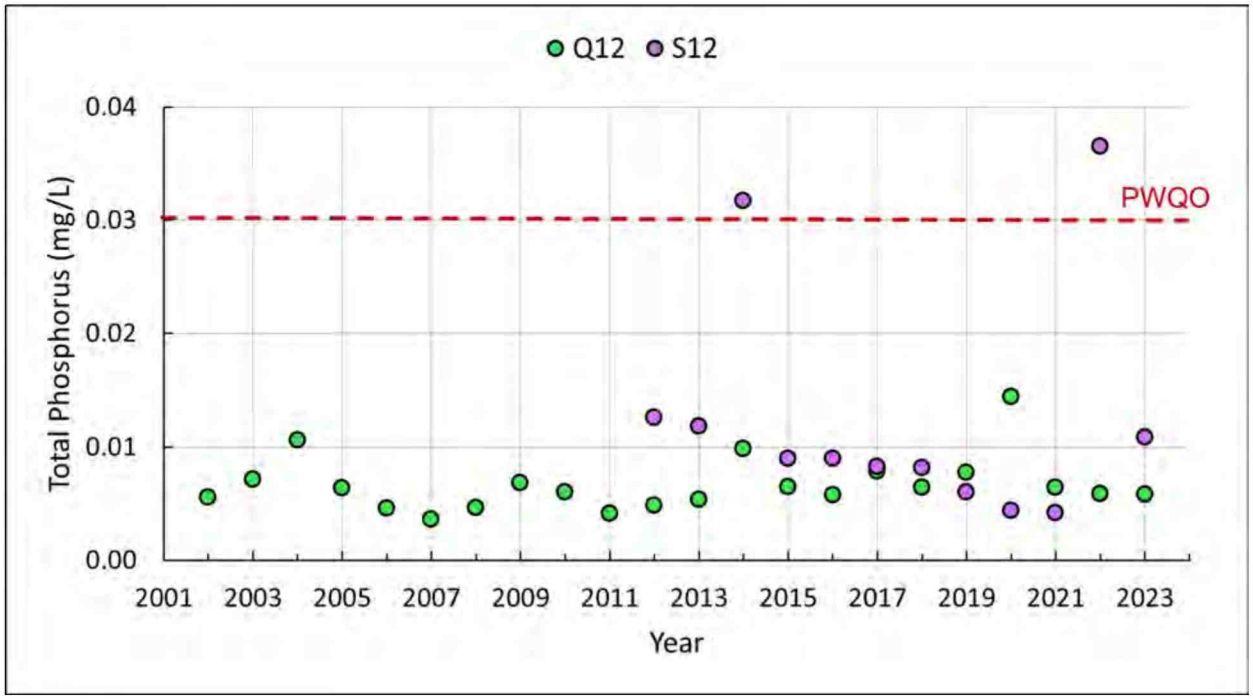

Figure E.6 2002 to 2023 Rocky Saugeen subwatershed annual average total phosphorus concentrations (mg/L) in graph format. Graph shows Q12 and S12 sampling sites, and a horizontal line indicating a PWQO of 0.03 mg/L. There are 2 exceedances of the PWQO.

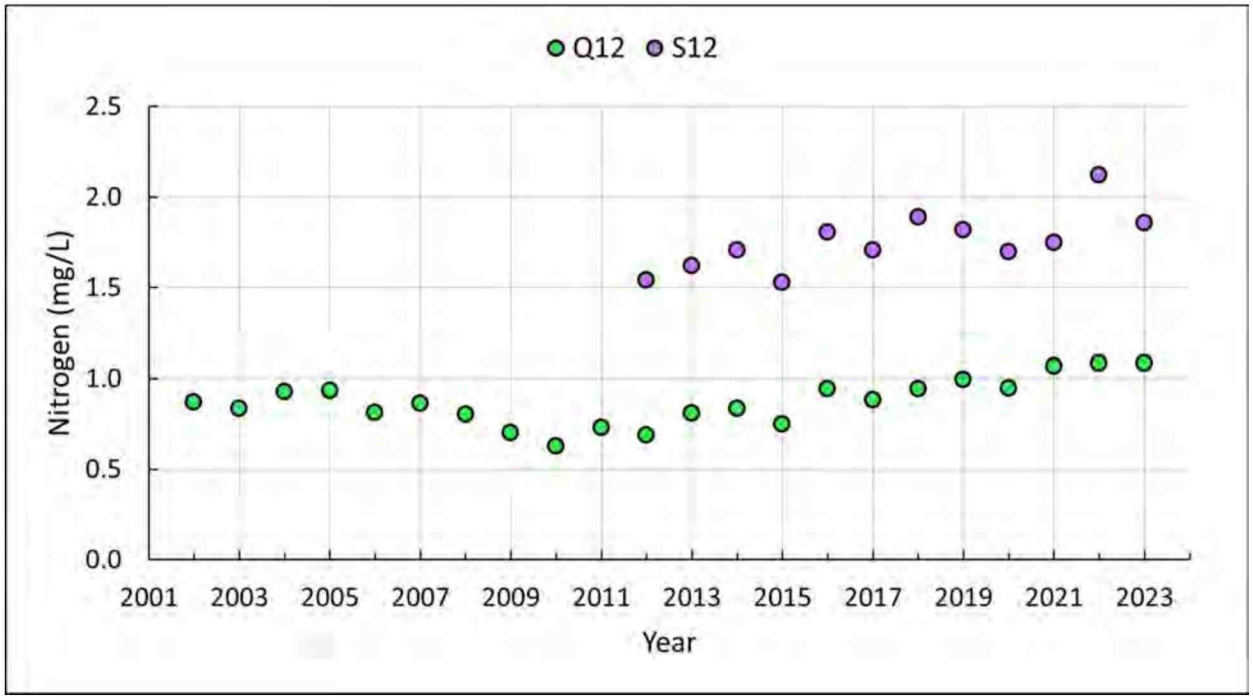

Figure E.7 2002 to 2023 Rocky Saugeen subwatershed annual average nitrogen concentrations (mg/L) in graph format. Graph shows Q12 and S12 sampling sites. The CWQG is 2.93 mg/L. There are no exceedances.

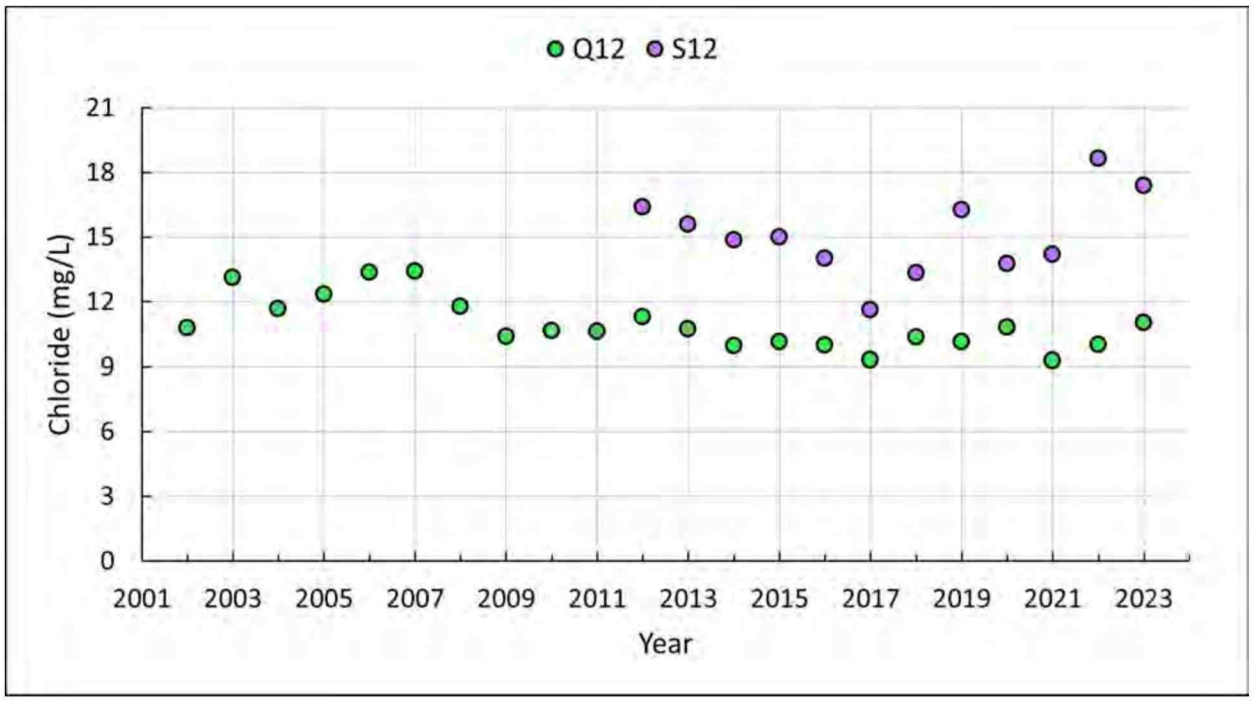

Figure E.8 2002 to 2023 Rocky Saugeen subwatershed annual average chloride concentrations (mg/L) in graph format. Graph shows Q12 and S12 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

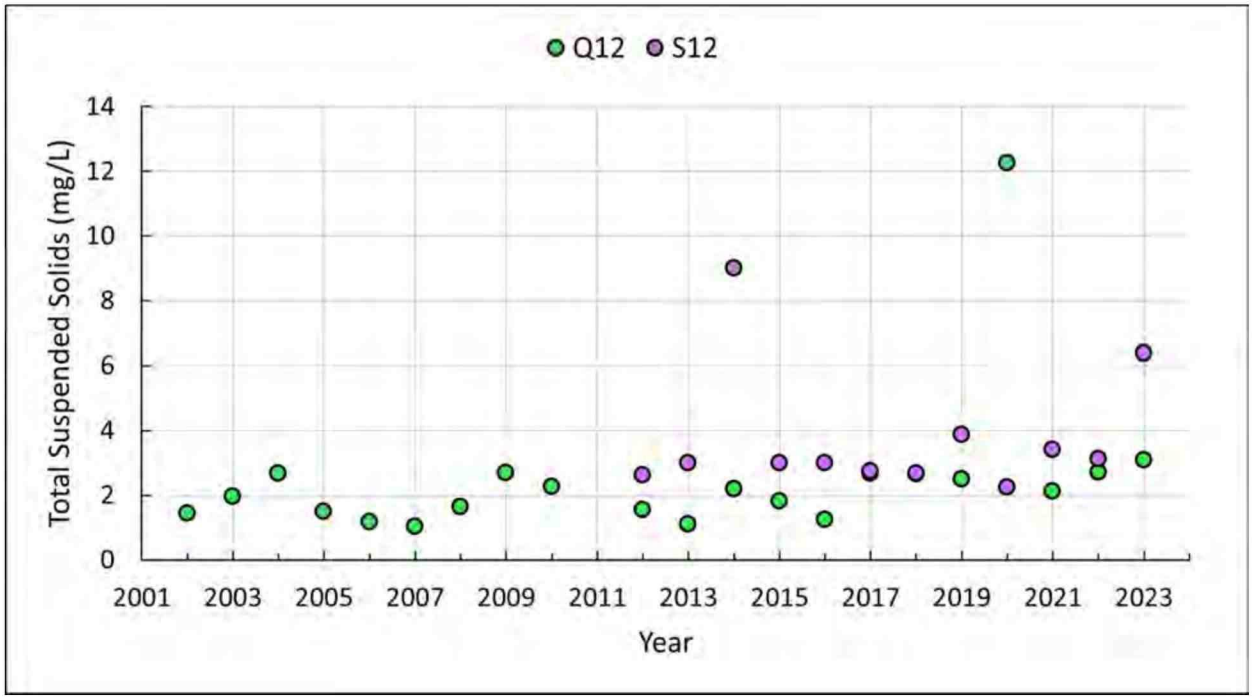

Figure E.9 2012 to 2023 Rocky Saugeen subwatershed annual average total suspended solids concentrations (mg/L) in graph format. Graph shows Q12 and S12 sampling sites. The CWQG is 30 mg/L. There are no exceedances.

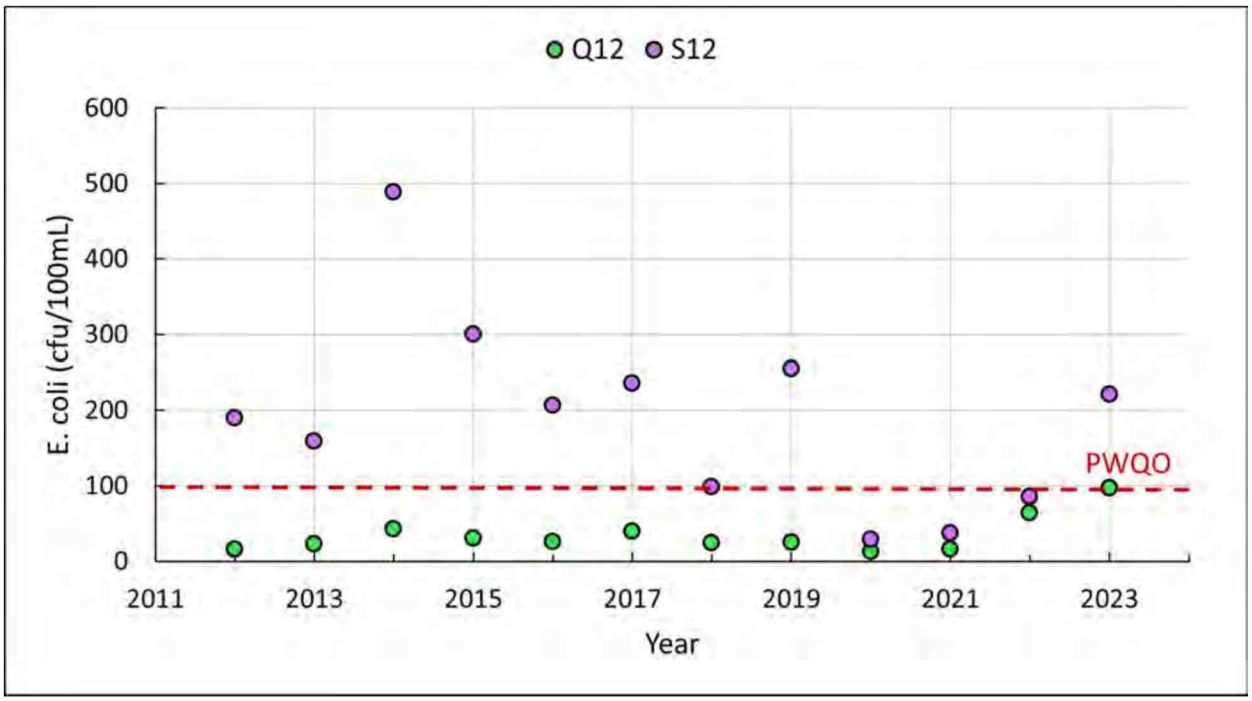

Figure E.10 2012 to 2023 Rocky Saugeen subwatershed annual average *E. coli* concentrations (cfu/100mL) in graph format. Graph shows Q12 and S12 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 8 exceedances of the PWQO.

Benthic Biomonitoring Results (2015-2022)

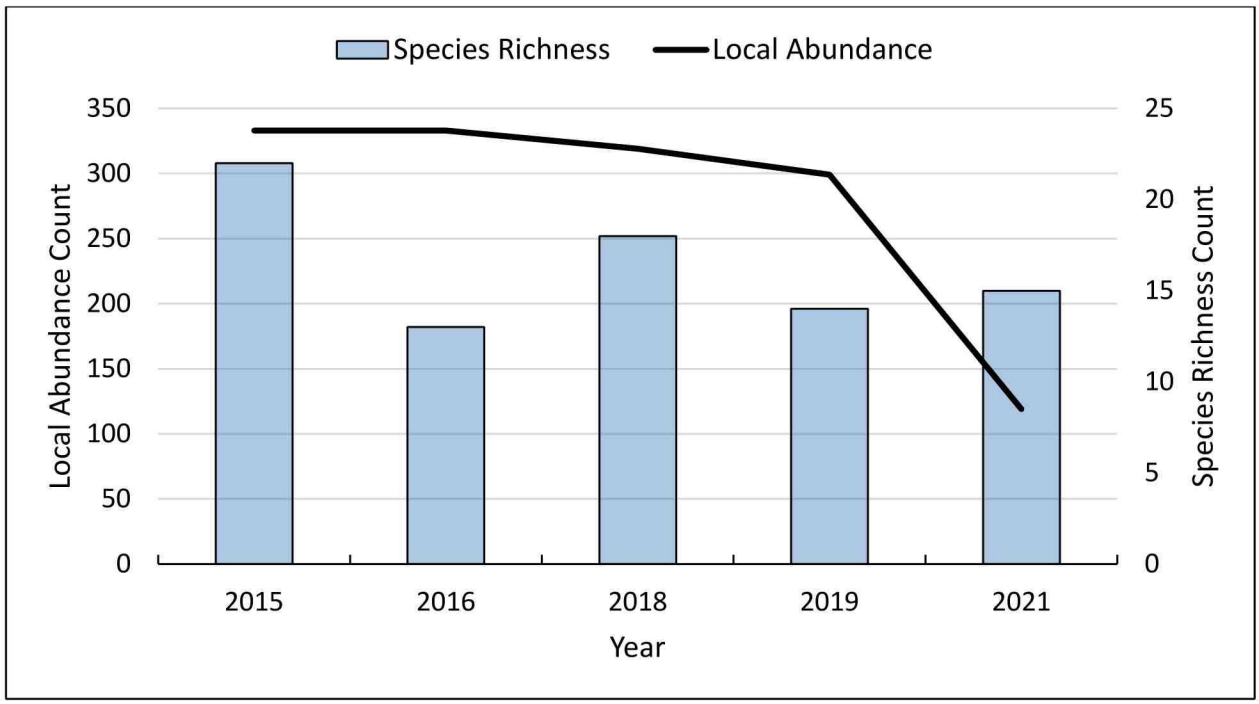

Figure E.11 Local abundance and species richness found within the Rocky Saugeen subwatershed from 2015 to 2021.

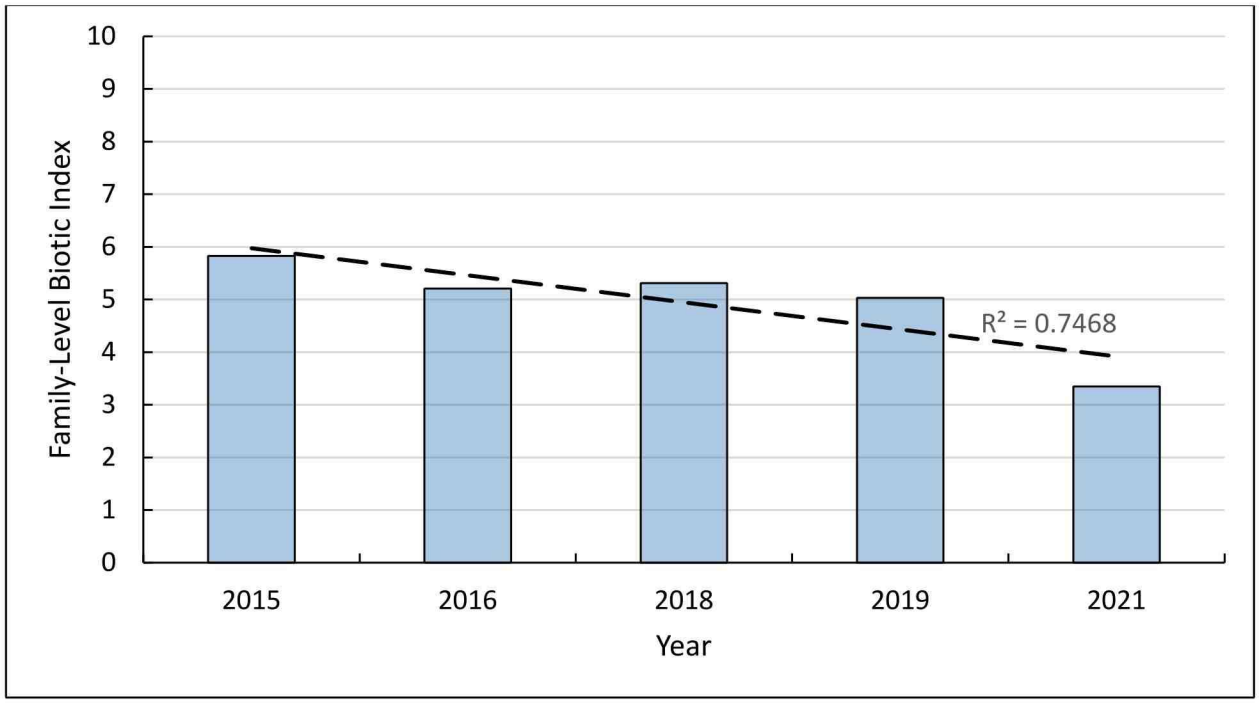

Figure E.12 Family-level biotic index for the Rocky Saugeen subwatershed from 2015 to 2021.

Appendix F – North Saugeen Subwatershed

2023 Results

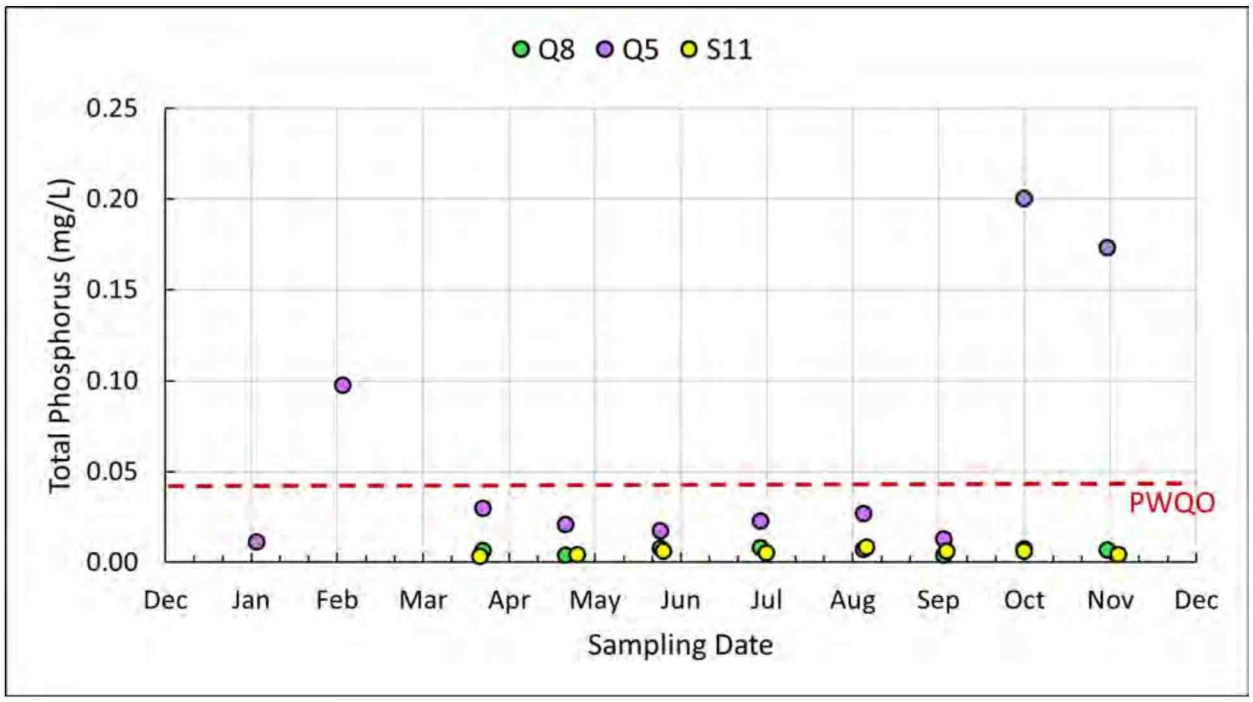

Figure F.1 2023 North Saugeen subwatershed total phosphorus concentrations (mg/L) in graph format. Graph shows Q8, Q5, and S11 sampling sites, and a horizontal line indicating a PWQO of 0.03 mg/L. There are 3 exceedances of the PWQO.

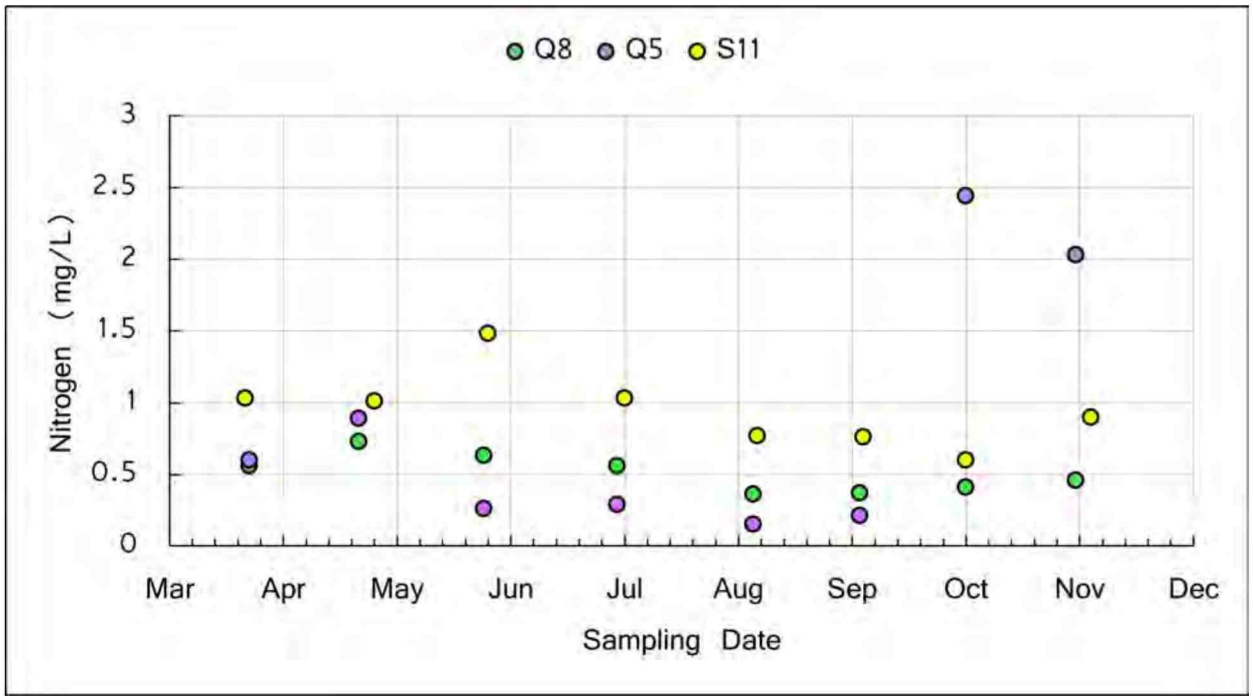

Figure F.2 2023 North Saugeen subwatershed nitrogen concentrations (mg/L) in graph format. Graph shows Q8, Q5, and S11 sampling sites. The CWQG is 2.93 mg/L. There are no exceedances.

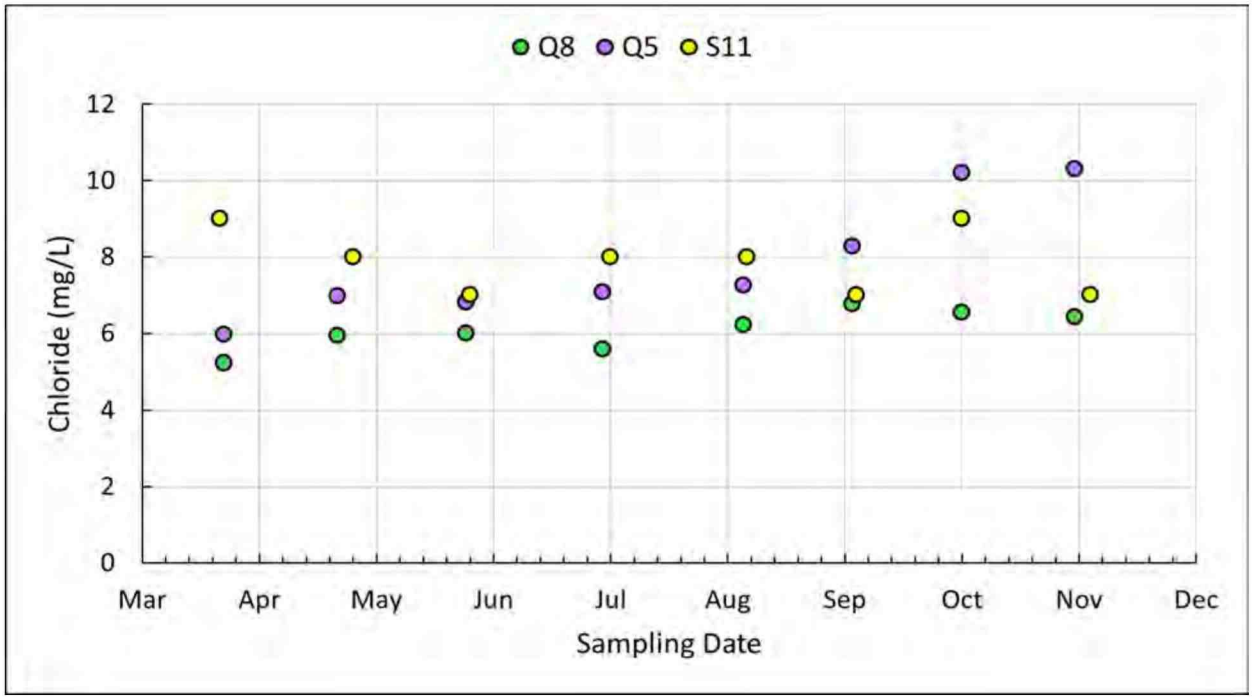

Figure F.3 2023 North Saugeen subwatershed chloride concentrations (mg/L) in graph format. Graph shows Q8, Q5, and S11 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

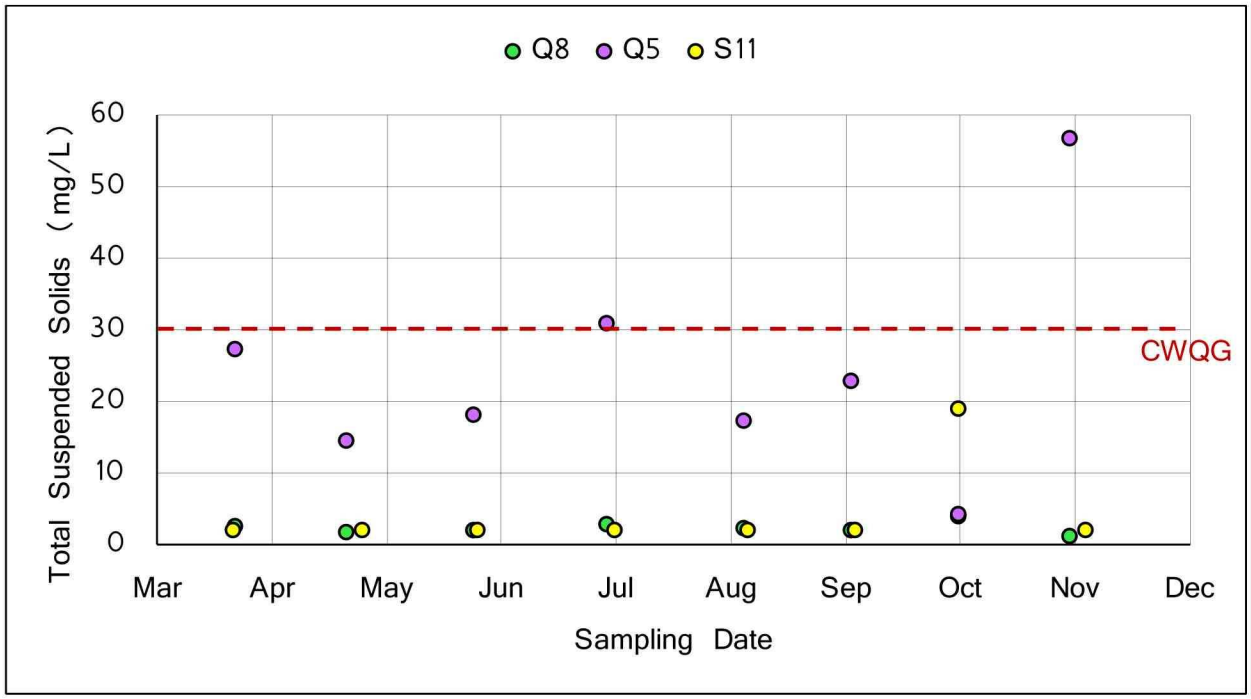

Figure F.4 2023 North Saugeen subwatershed total suspended solids concentrations (mg/L) in graph format. Graph shows Q8, Q5, and S11 sampling sites and a horizontal line indicating a CWQG of 30 mg/L. There are 2 exceedances of the CWQG.

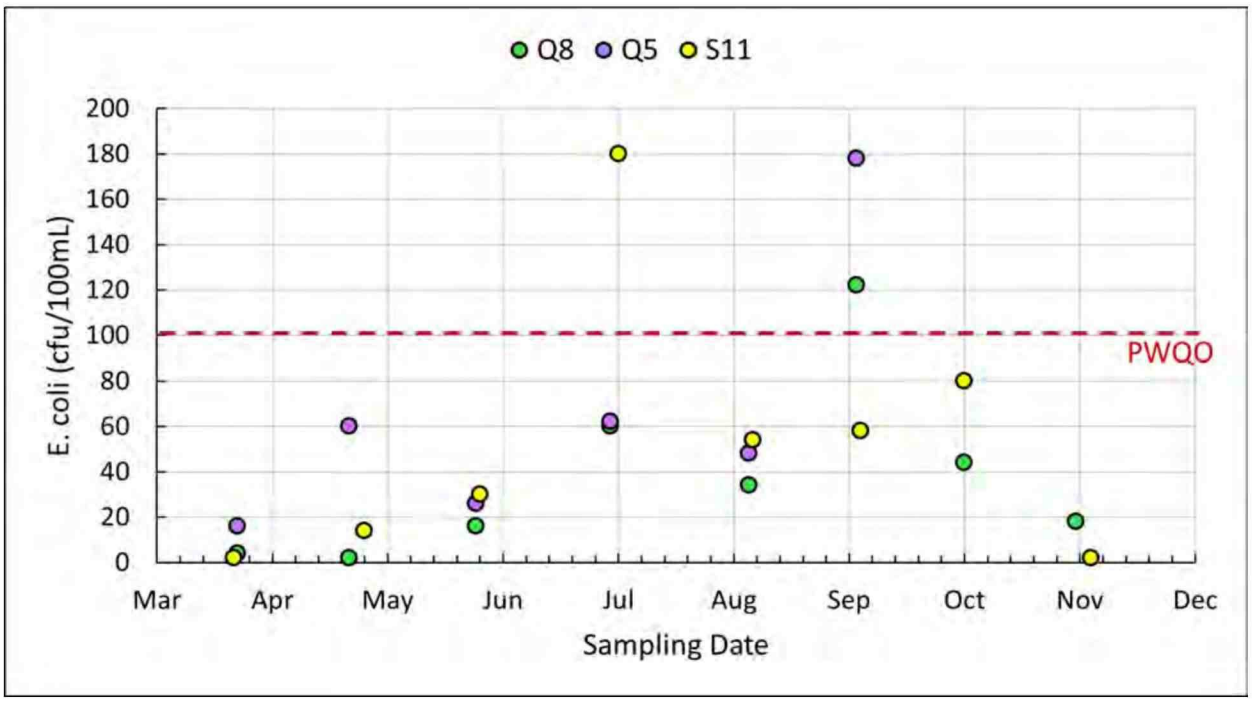

Figure F.5 2023 North Saugeen subwatershed *E. coli* concentrations (cfu/100mL) in graph format. Graph shows Q8, Q5, and S11 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 5 exceedances of the PWQO, two Q5 exceedances are not shown on this graph (October at 2600 cfu/100mL, November at 4500 cfu/100mL).

Long-term Results

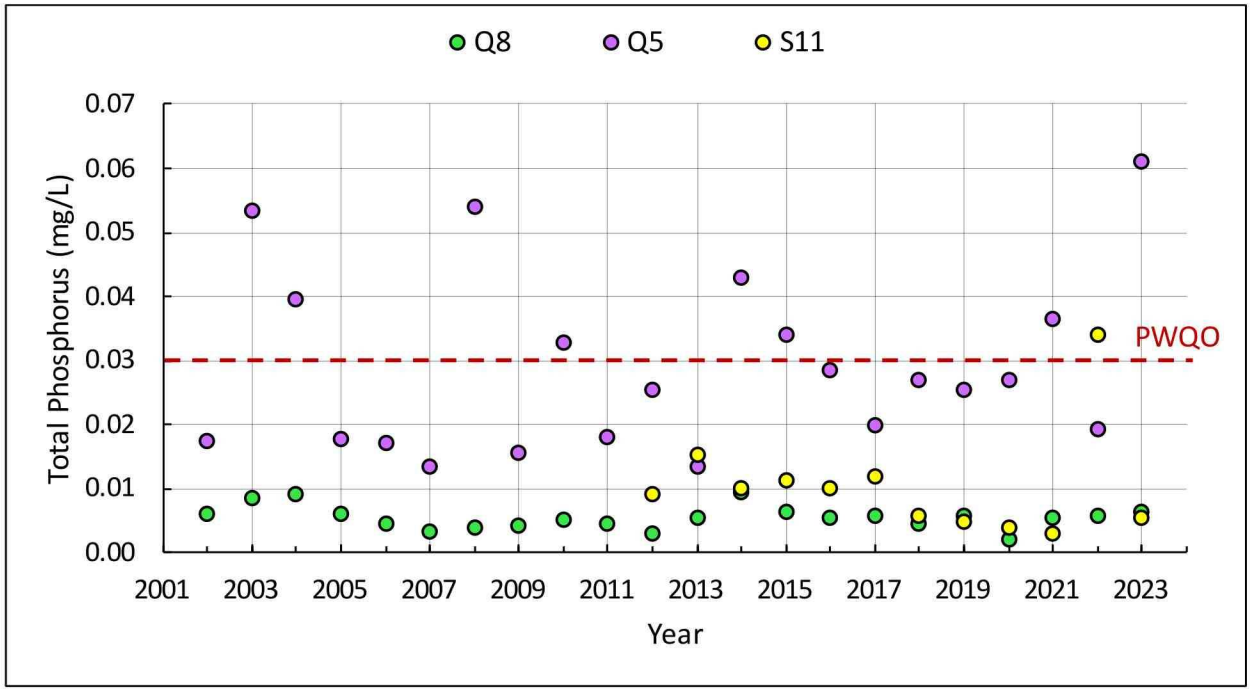

Figure F.6 2002 to 2023 North Saugeen subwatershed annual average total phosphorus concentrations (mg/L) in graph format. Graph shows Q8, Q5, and S11 sampling sites, and a horizontal line indicating a PWQO of 0.03 mg/L. There are 9 exceedances of the PWQO.

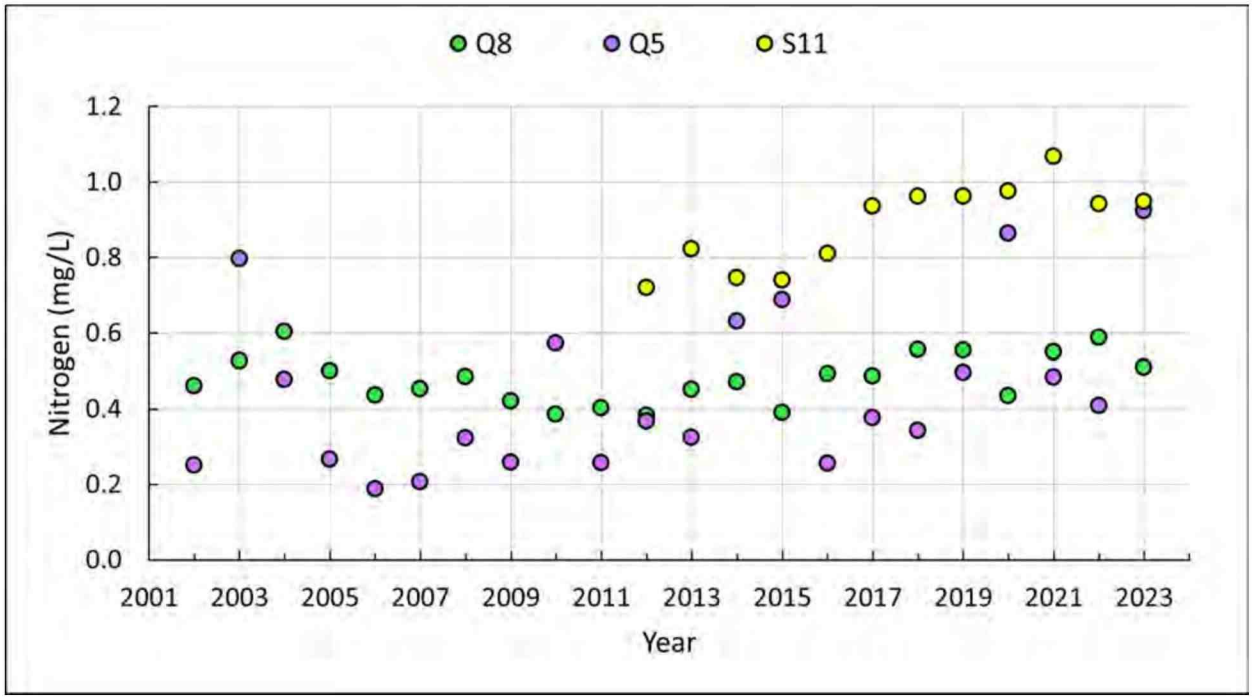

Figure F.7 2002 to 2023 North Saugeen subwatershed annual average nitrogen concentrations (mg/L) in graph format. Graph shows Q8, Q5, and S11 sampling sites. The CWQG is 2.93 mg/L. There are no exceedances.

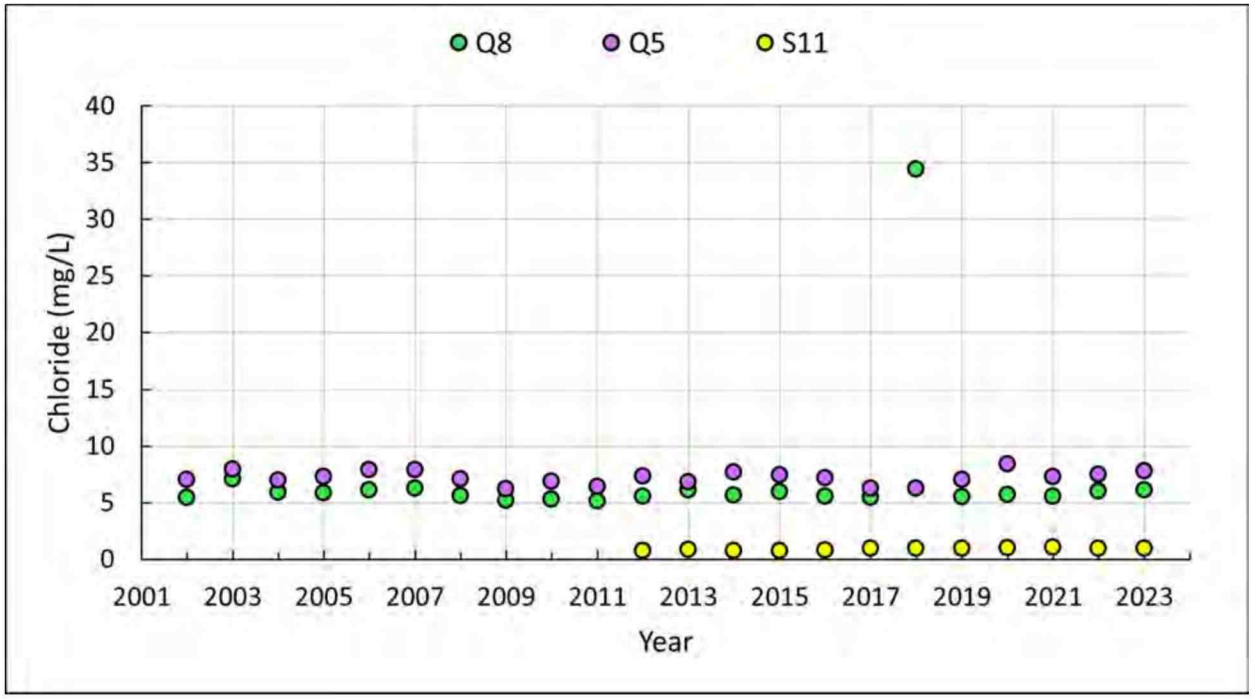

Figure F.8 2002 to 2023 North Saugeen subwatershed annual average chloride concentrations (mg/L) in graph format. Graph shows Q8, Q5, and S11 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

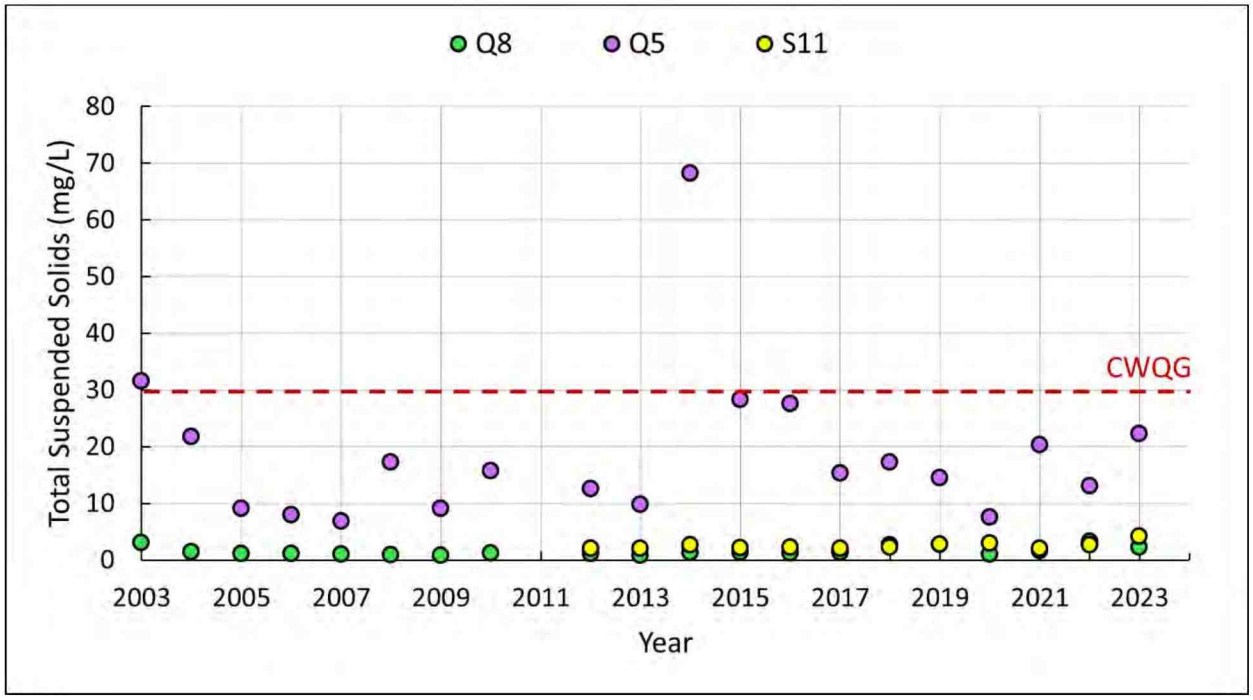

Figure F.9 2012 to 2023 North Saugeen subwatershed annual average total suspended solids concentrations (mg/L) in graph format. Graph shows Q8, Q5, and S11 sampling sites, and a horizontal line indicating a CWQG of 30 mg/L. There are 2 exceedances of the CWQG.

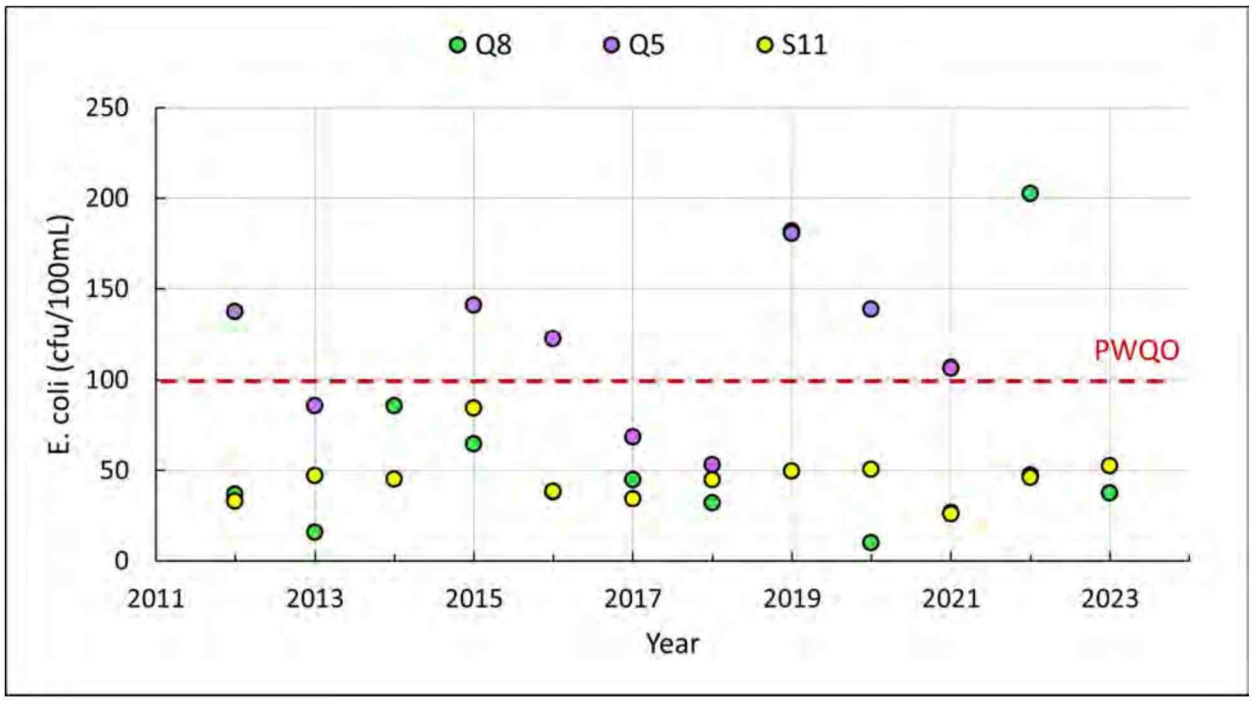

Figure F.10 2012 to 2023 North Saugeen subwatershed annual average *E. coli* concentrations (cfu/100mL) in graph format. Graph shows Q8, Q5, and S11 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 10 exceedances of the PWQO; there are two exceedances at Q5 in 2014 and 2023 that are not shown on this graph (1595 and 936 cfu/100mL, respectively).

Benthic Biomonitoring Results (2015-2020)

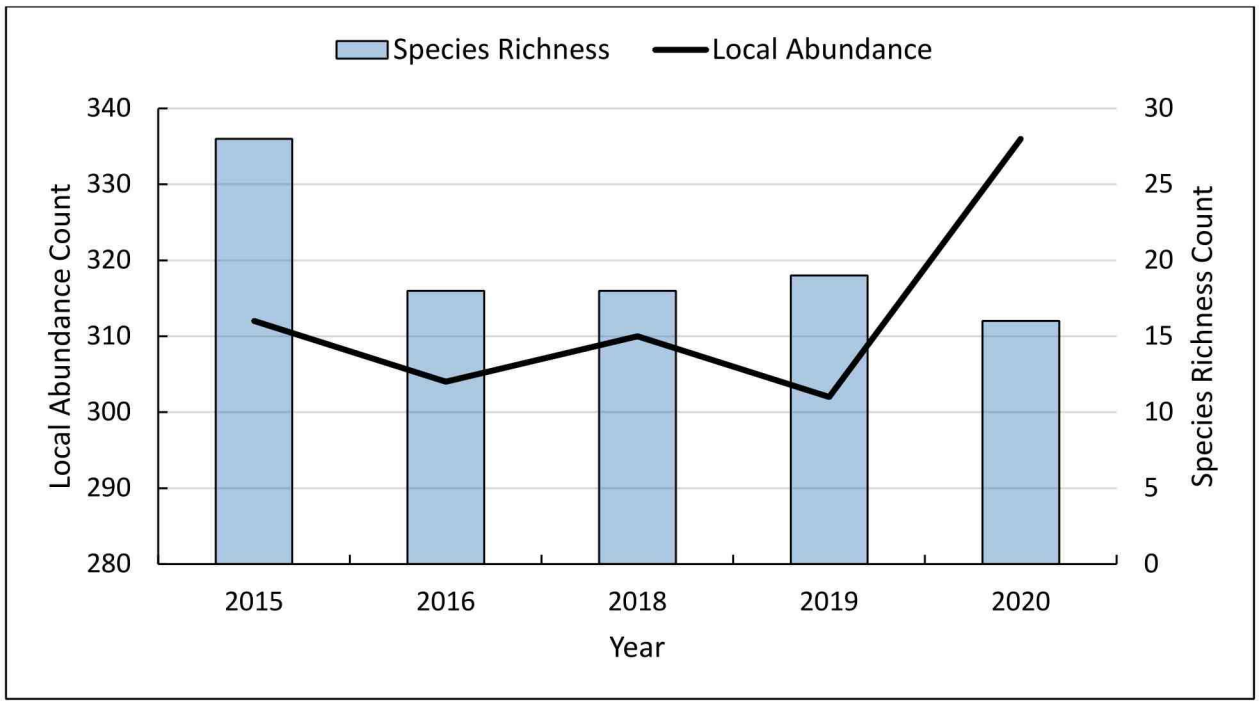

Figure F.11 Local abundance and species richness found within the North Saugeen subwatershed from 2015 to 2020.

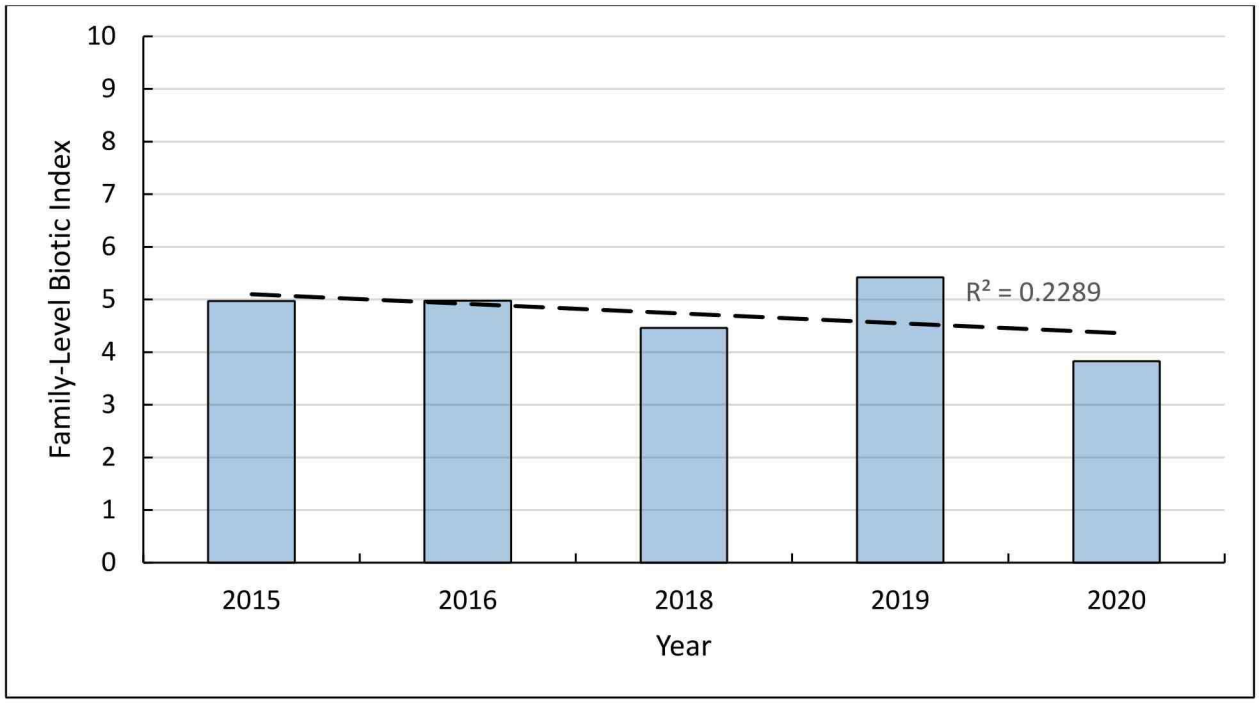

Figure F.12 Family-level biotic index scores for the North Saugeen subwatershed from 2015 to 2020.

Appendix G – Teeswater Subwatershed

2023 Results

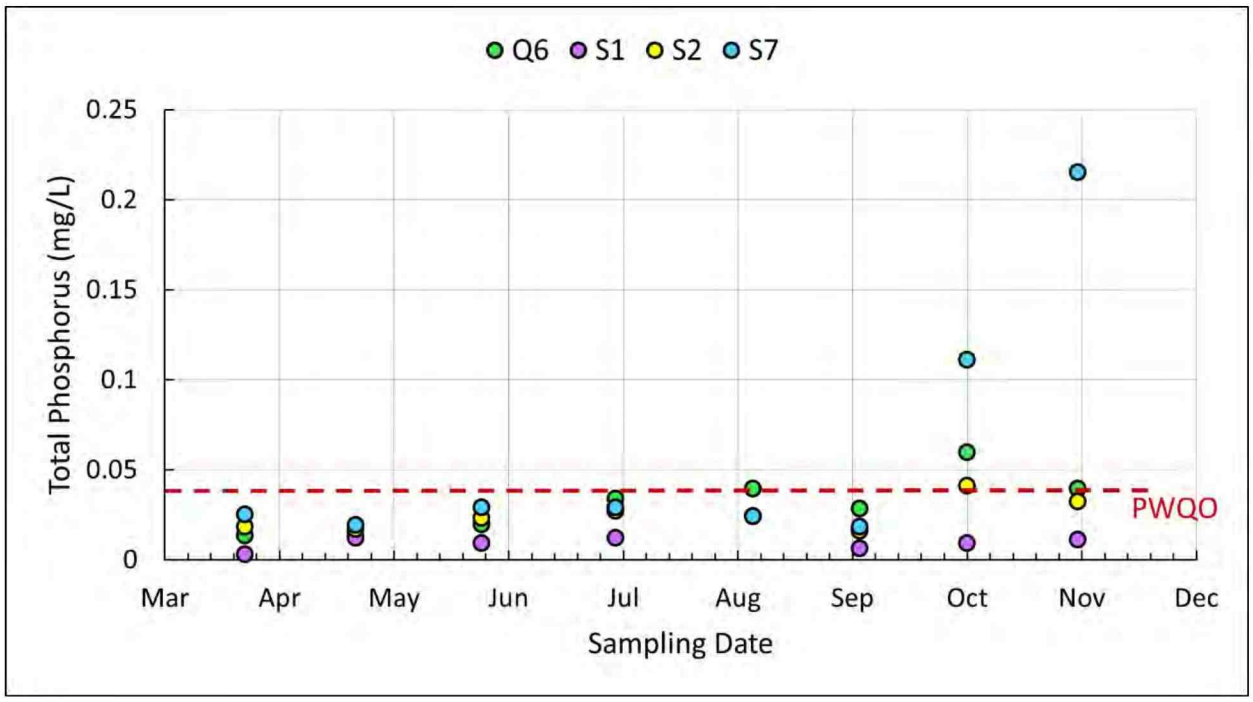

Figure G.1 2023 Teeswater subwatershed total phosphorus concentrations (mg/L) in graph format. Graph shows Q6, S1, S2, and S7 sampling sites, and a horizontal line indicating a PWQO of 0.03 mg/L. There are 4 exceedances of the PWQO.

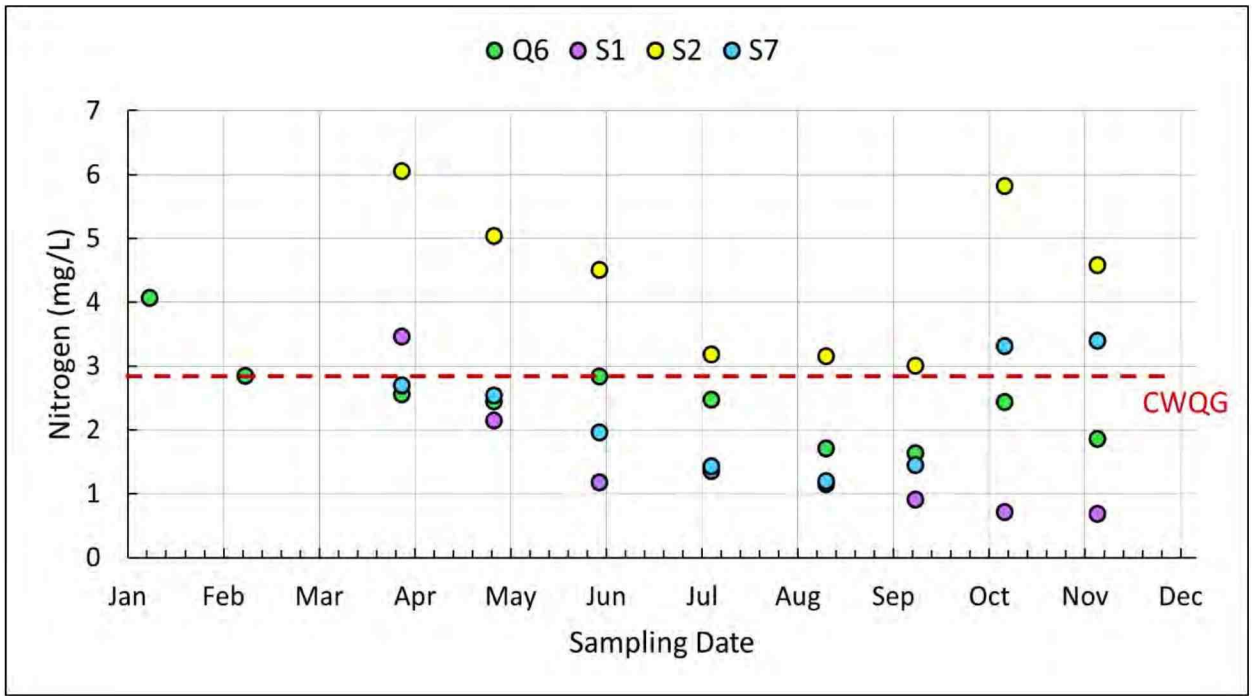

Figure G.2 2023 Teeswater subwatershed nitrogen concentrations (mg/L) in graph format. Graph shows Q6, S1, S2, and S7 sampling sites, and a horizontal line indicating a CWQG of 2.93 mg/L. There are 12 exceedances of the CWQG.

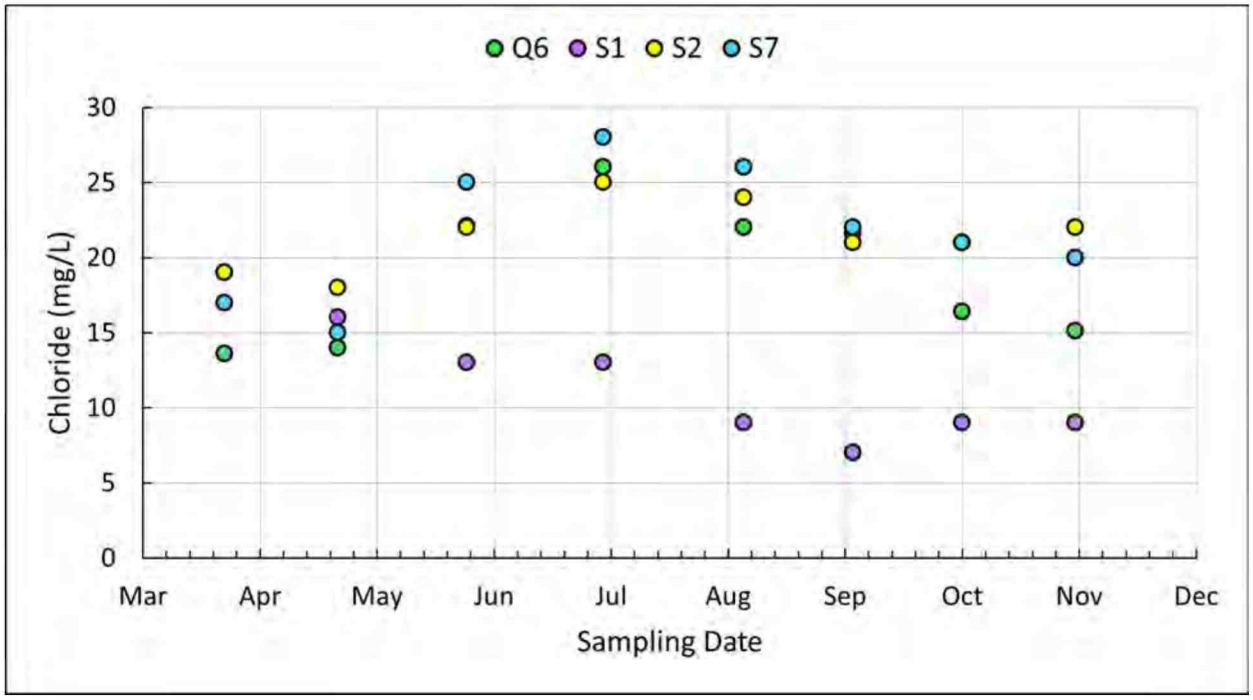

Figure G.3 2023 Teeswater subwatershed chloride concentrations (mg/L) in graph format. Graph shows Q6, S1, S2, and S7 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

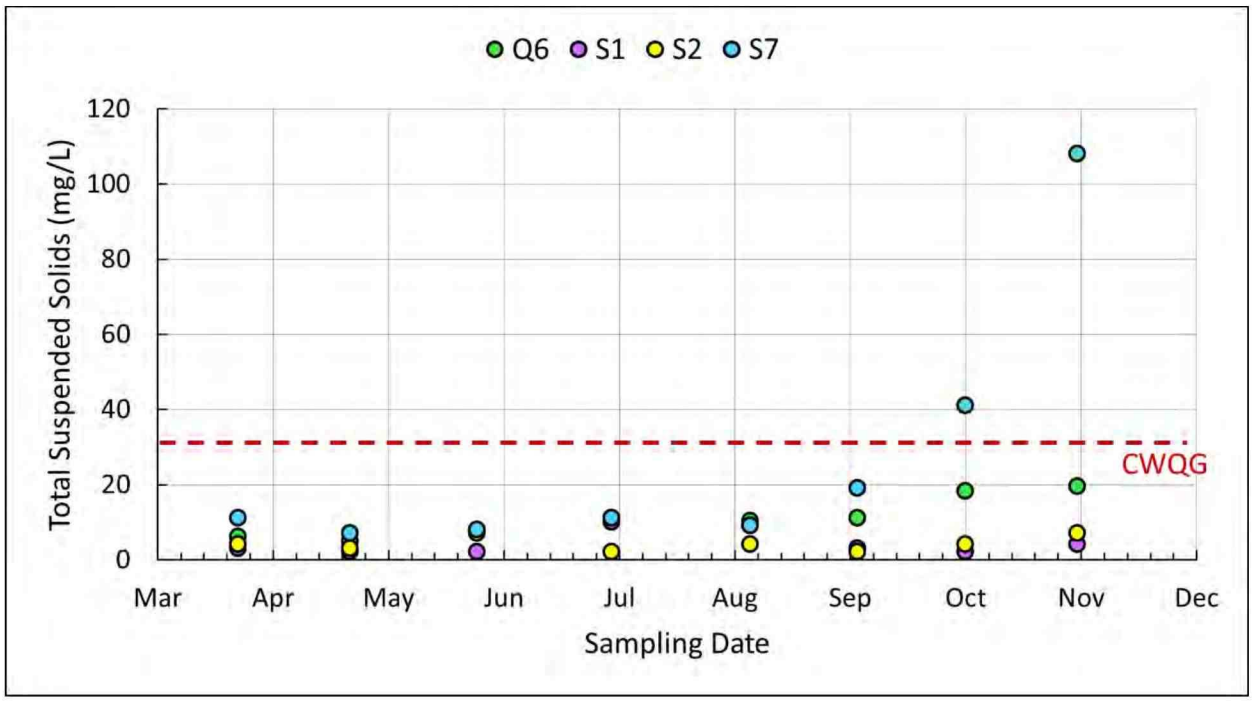

Figure G.4 2023 Teeswater subwatershed total suspended solids concentrations (mg/L) in graph format. Graph shows Q6, S1, S2, and S7 sampling sites, and a horizontal line indicating a CWQG of 30 mg/L. There are 2 exceedances of the CWQG.

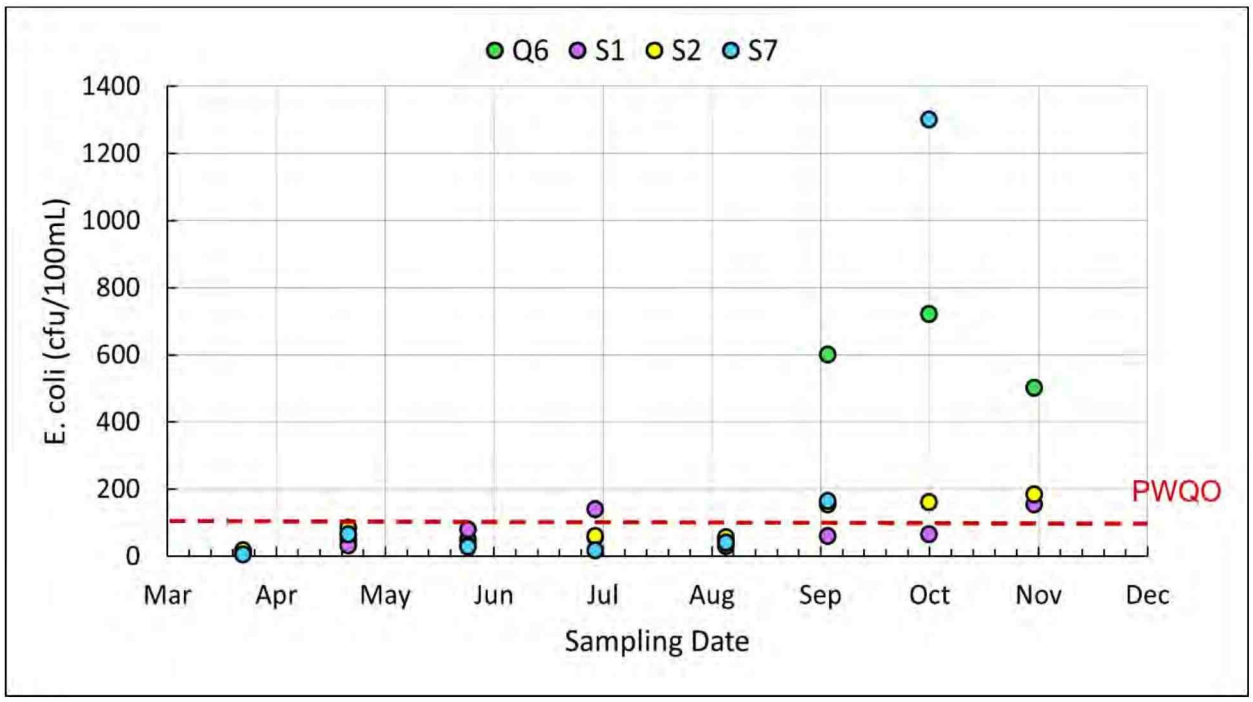

Figure G.5 2023 Teeswater subwatershed *E. coli* concentrations (cfu/100mL) in graph format. Graph shows Q6, S1, S2, and S7 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 11 exceedances of the PWQO, one exceedance in November is not shown on this graph (S7 at 3300 cfu/100mL).

Long-term Results

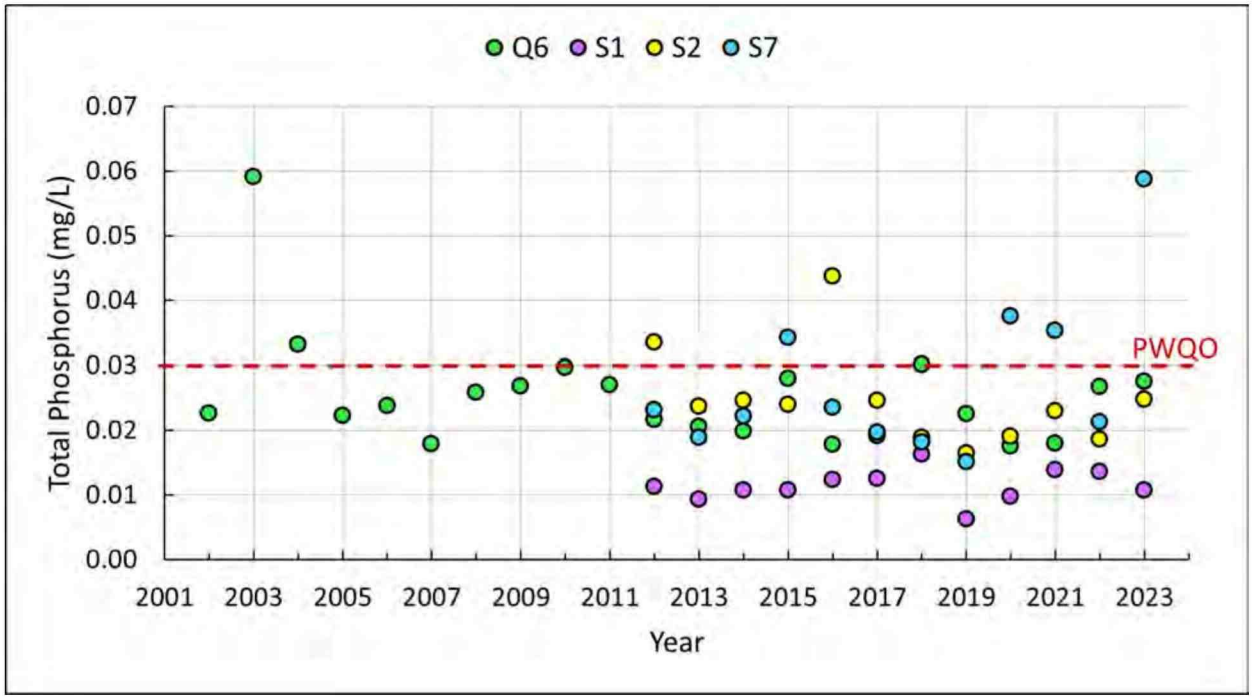

Figure G.6 2002 to 2023 Teeswater subwatershed annual average total phosphorus concentrations (mg/L) in graph format. Graph shows Q6, S1, S2, and S7 sampling sites and a horizontal line indicating a PWQO of 0.03 mg/L. There are 9 exceedances of the PWQO.

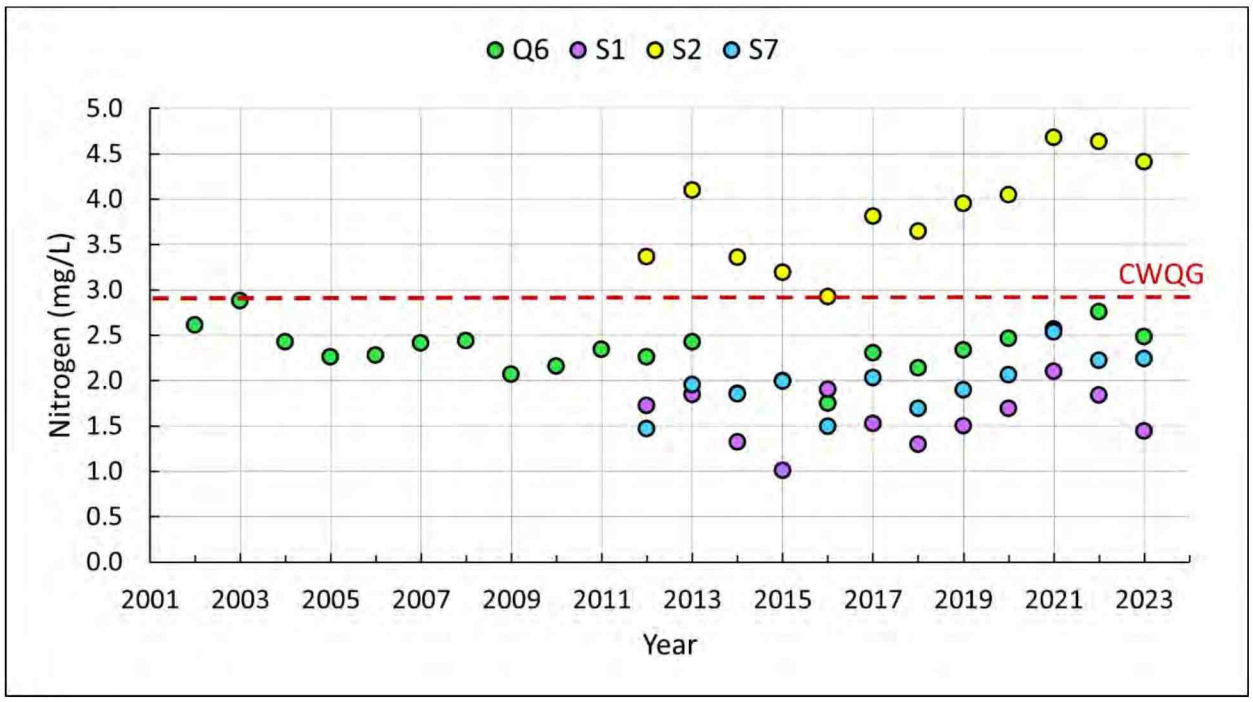

Figure G.7 2002 to 2023 Teeswater subwatershed annual average nitrogen concentrations (mg/L) in graph format. Graph shows Q6, S1, S2, and S7 sampling sites and a horizontal line indicating a CWQG of 2.93 mg/L. There are 11 exceedances of the CWQG.

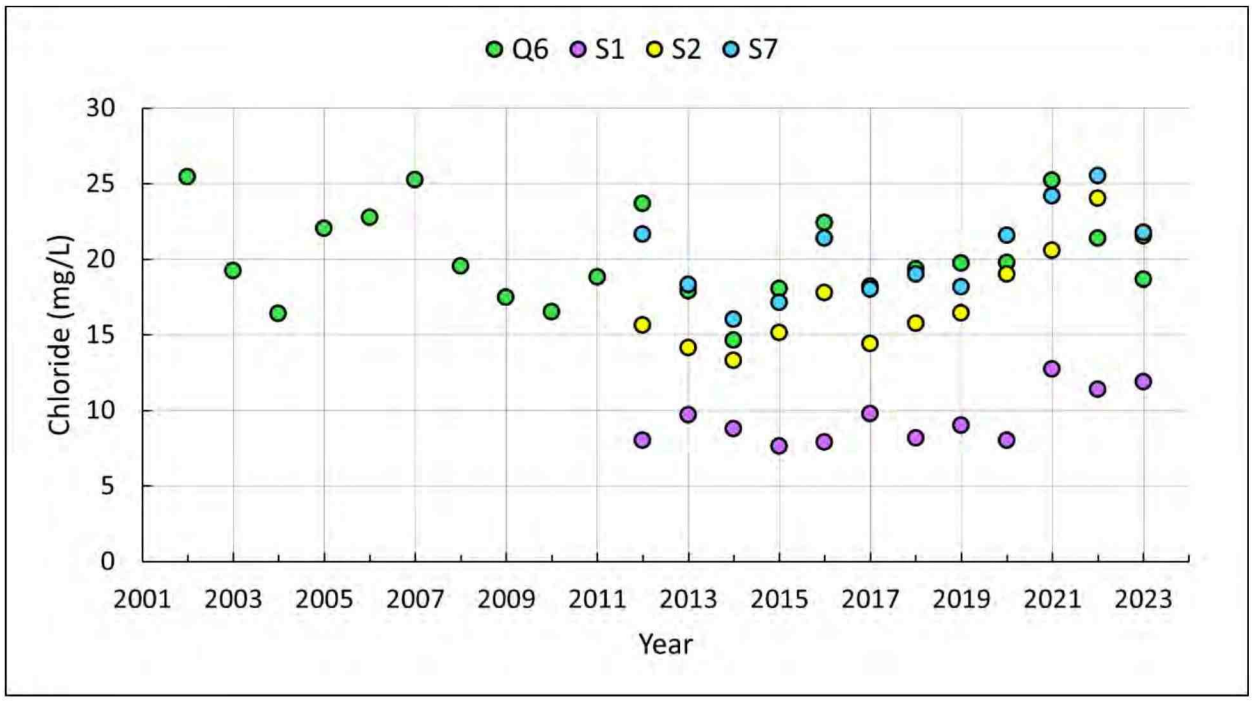

Figure G.8 2002 to 2023 Teeswater subwatershed annual average chloride concentrations (mg/L) in graph format. Graph shows Q6, S1, S2, and S7 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

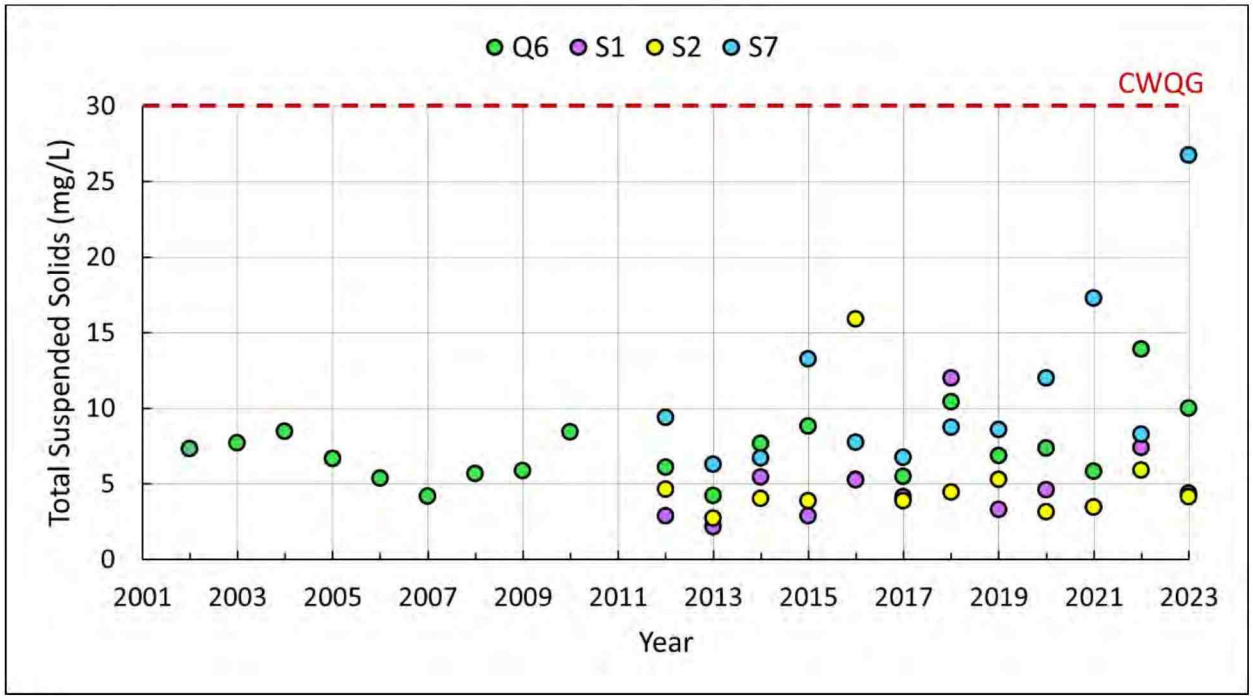

Figure G.9 2012 to 2023 Teeswater subwatershed annual average total suspended solids concentrations (mg/L) in graph format. Graph shows Q6, S1, S2, and S7 sampling sites and a horizontal line indicating a CWQG of 30 mg/L. There are no exceedances. Results for Q6 in 2011 are not available.

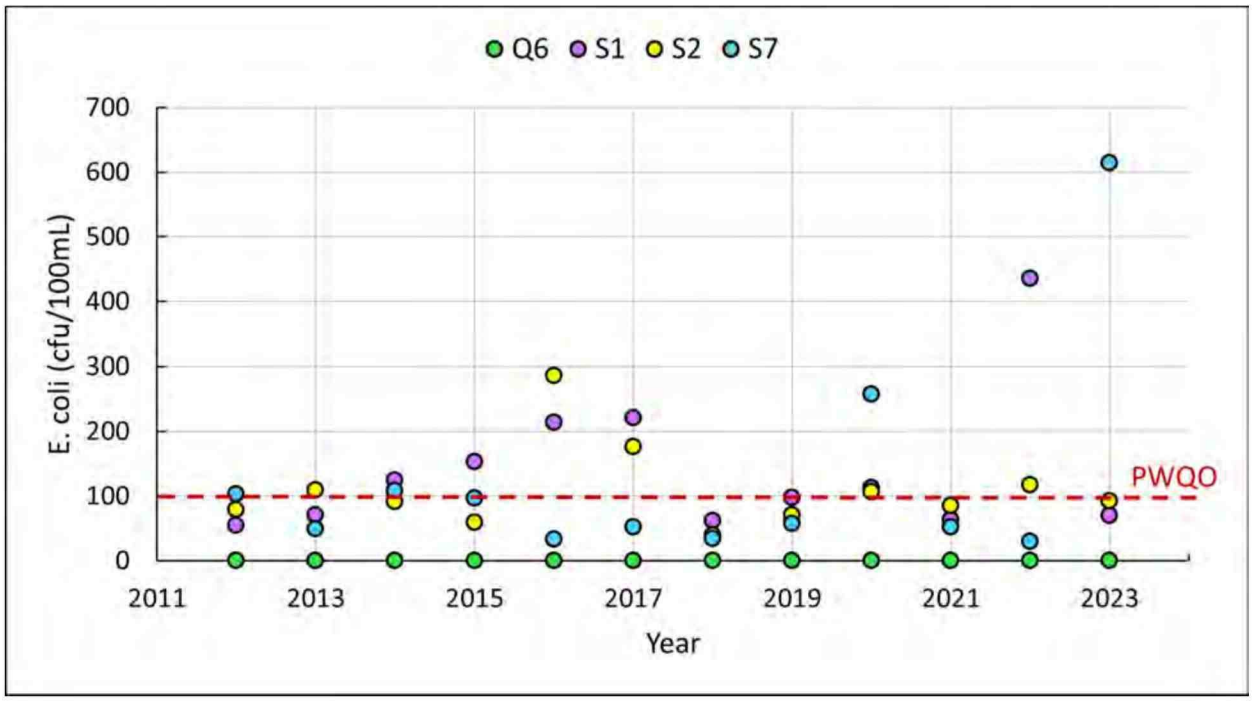

Figure G.10 2012 to 2023 Teeswater subwatershed annual average *E. coli* concentrations (cfu/100mL) in graph format. Graph shows Q6, S1, S2, and S7 sampling sites, and a horizontal line indicating a PWQO of 100cfu/100mL for swimming. There are 18 exceedances of the PWQO.

Benthic Biomonitoring Results (2015-2021)

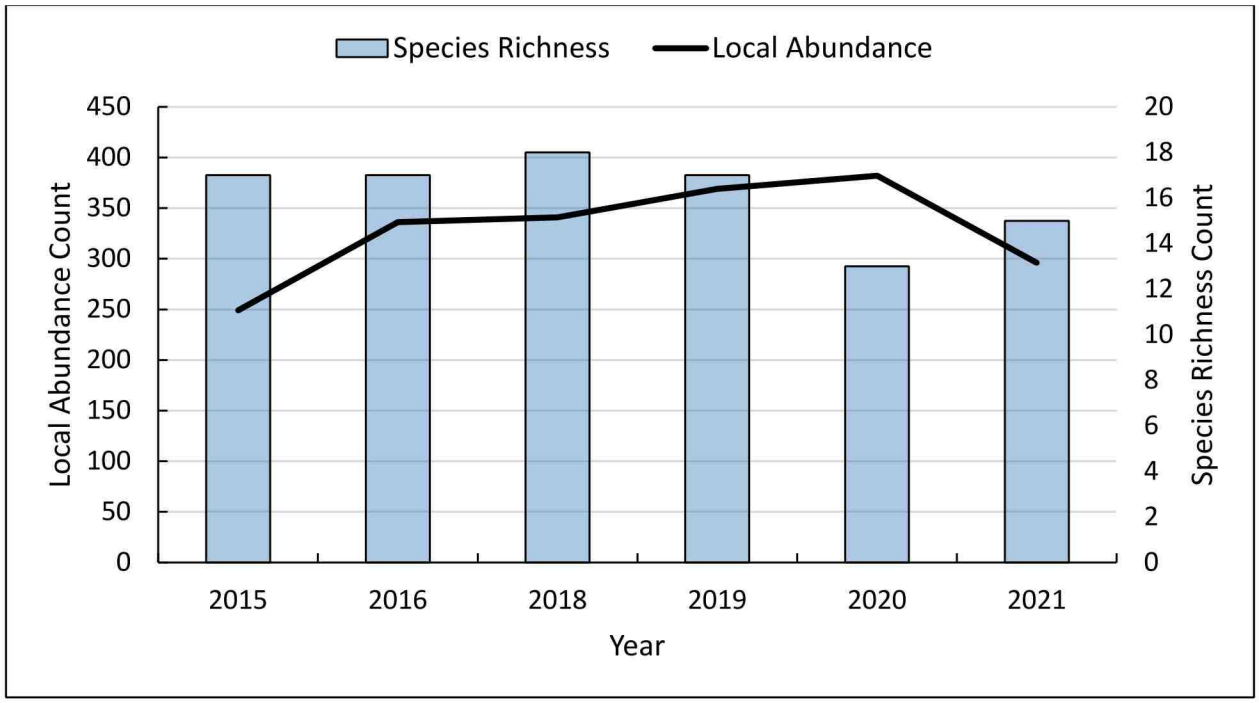

Figure G.11 Local abundance and species richness found within the Teeswater subwatershed from 2015 to 2021.

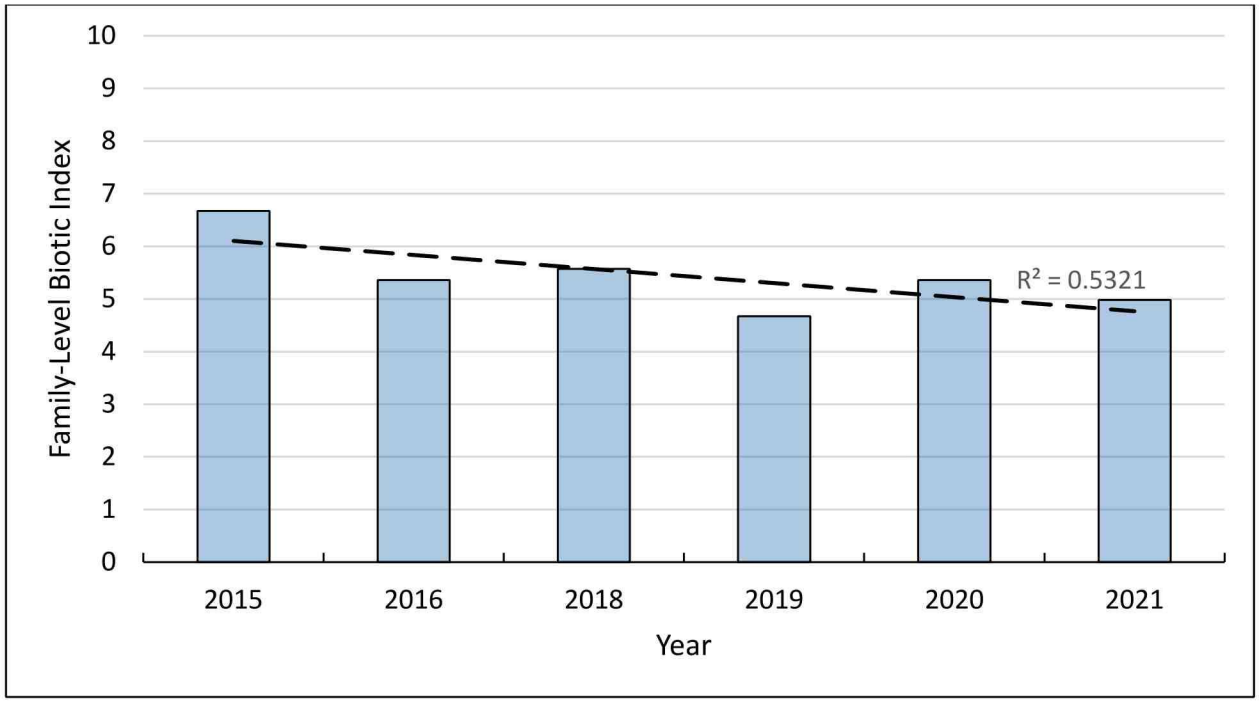

Figure G.12 Family-level biotic index for the Teeswater subwatershed from 2015 to 2021.

Appendix H – Lower Main Saugeen Subwatershed

2023 Results

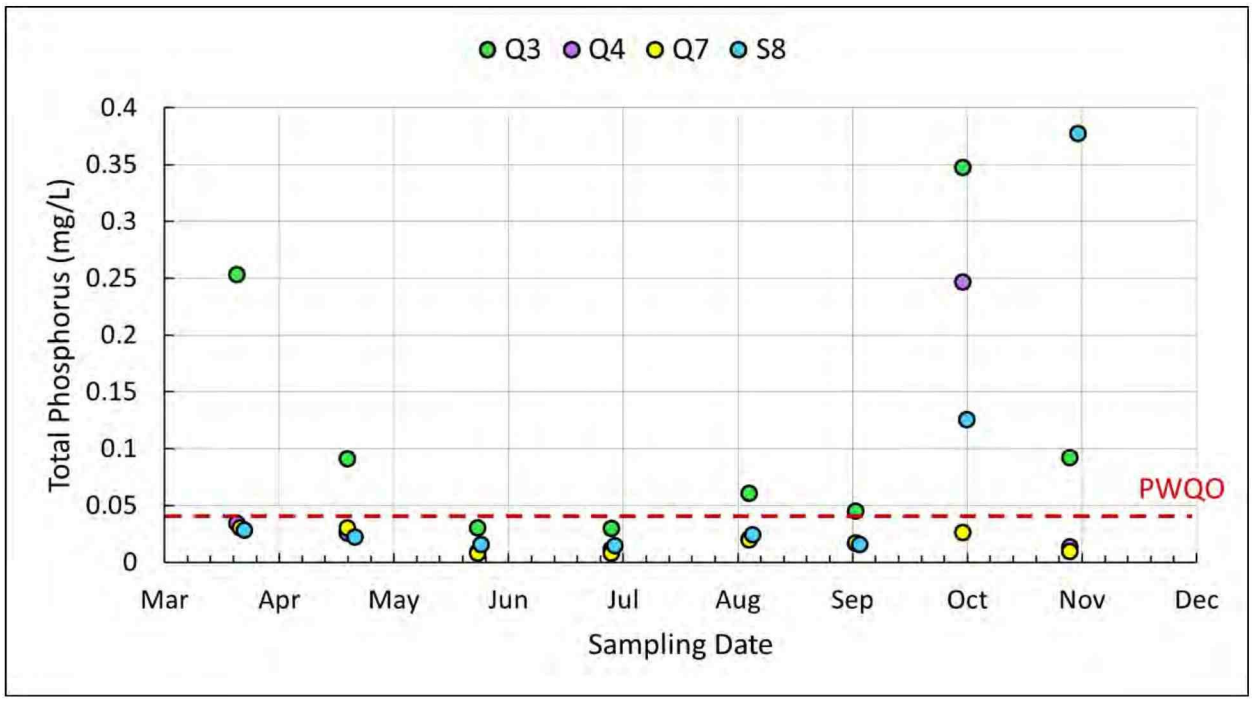

Figure H.1 2023 Lower Main Saugeen subwatershed total phosphorus concentrations (mg/L) in graph format. Graph shows Q3, Q4, Q7 and S8 sampling sites, and a horizontal line indicating a PWQO of 0.03 mg/L. There are 12 exceedances of the PWQO.

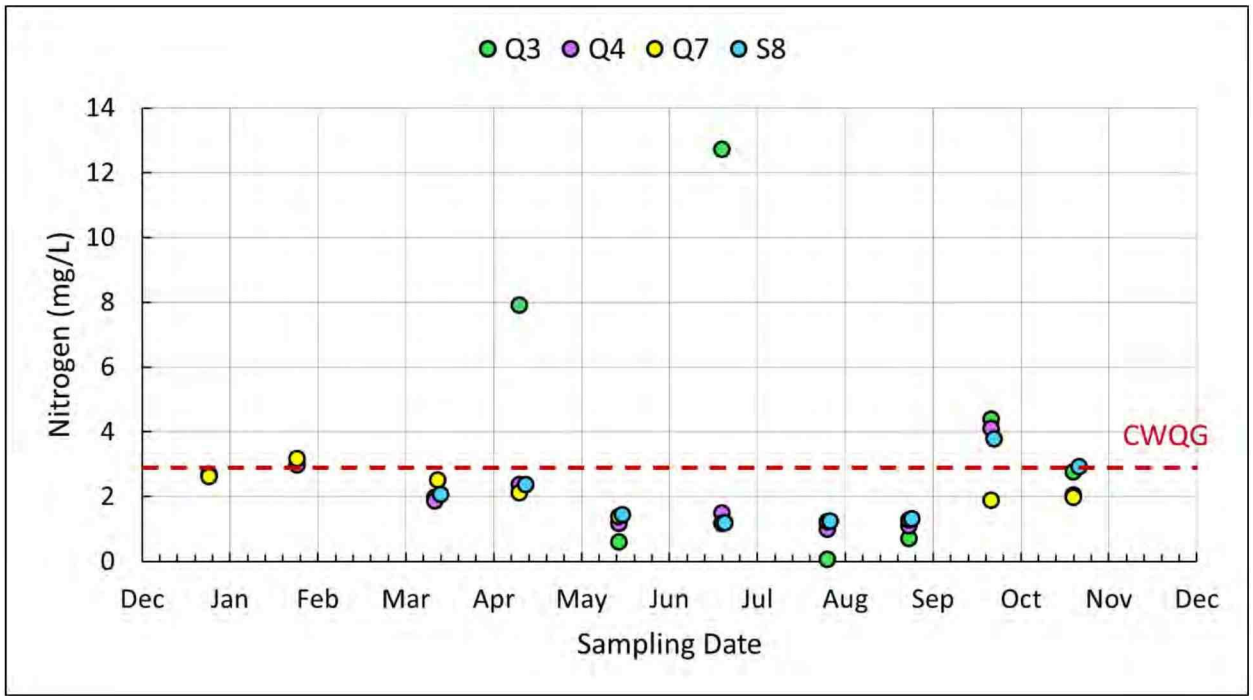

Figure H.2 2023 Lower Main Saugeen subwatershed nitrogen concentrations (mg/L) in graph format. Graph shows Q3, Q4, Q7 and S8 sampling sites, and a horizontal line indicating a CWQG of 2.93 mg/L. There are 7 exceedances of the CWQG.

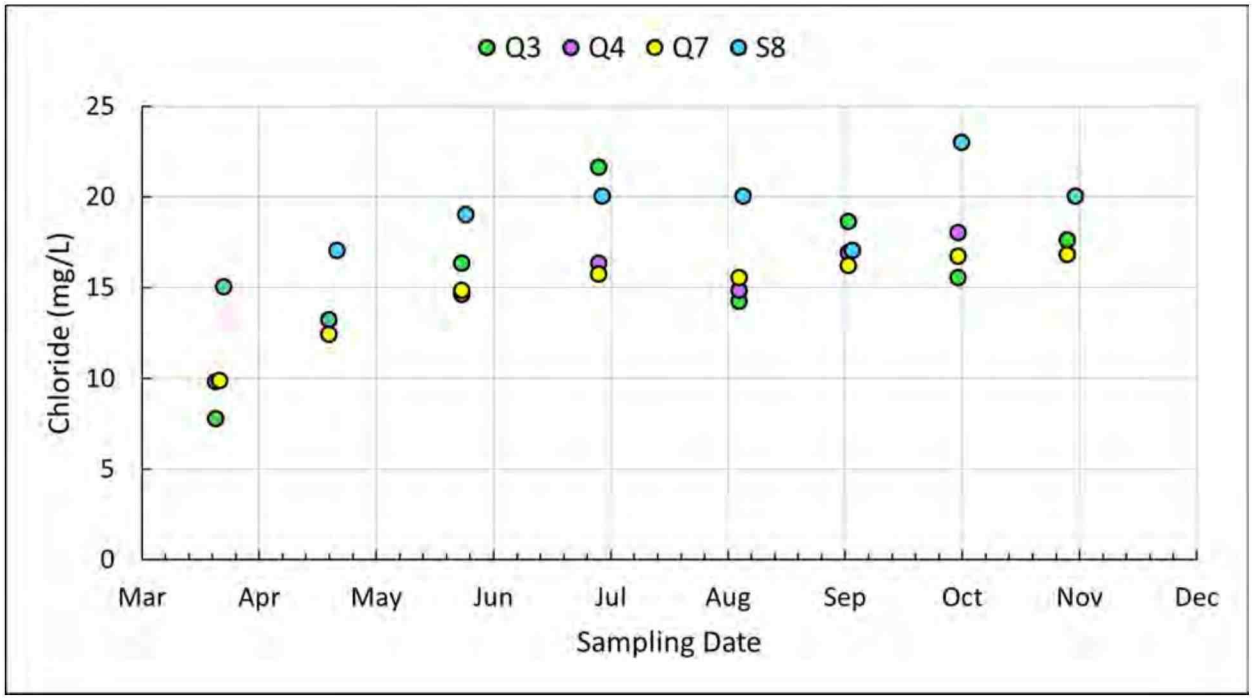

Figure H.3 2023 Lower Main Saugeen subwatershed chloride concentrations (mg/L) in graph format. Graph shows Q3, Q4, Q7 and S8 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

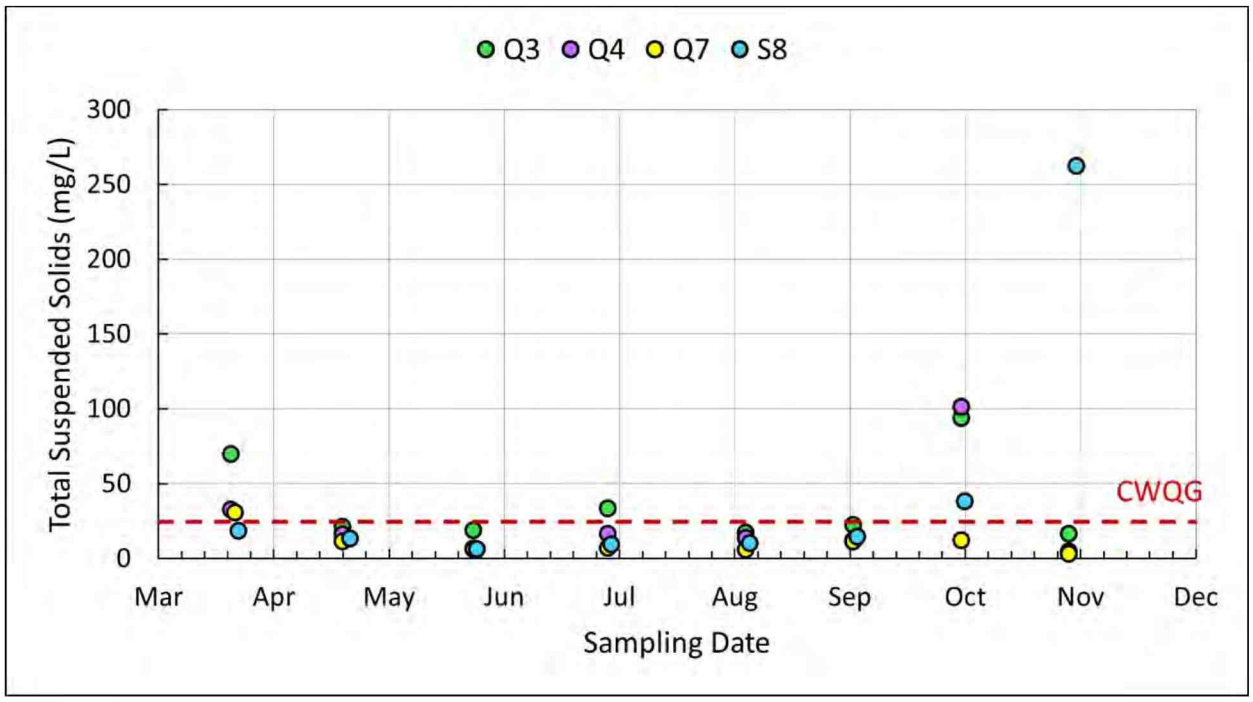

Figure H.4 2023 Lower Main Saugeen subwatershed total suspended solids concentrations (mg/L) in graph format. Graph shows Q3, Q4, Q7 and S8 sampling sites, and a horizontal line indicating a CWQG of 30 mg/L. There are 8 exceedances of the CWQG.

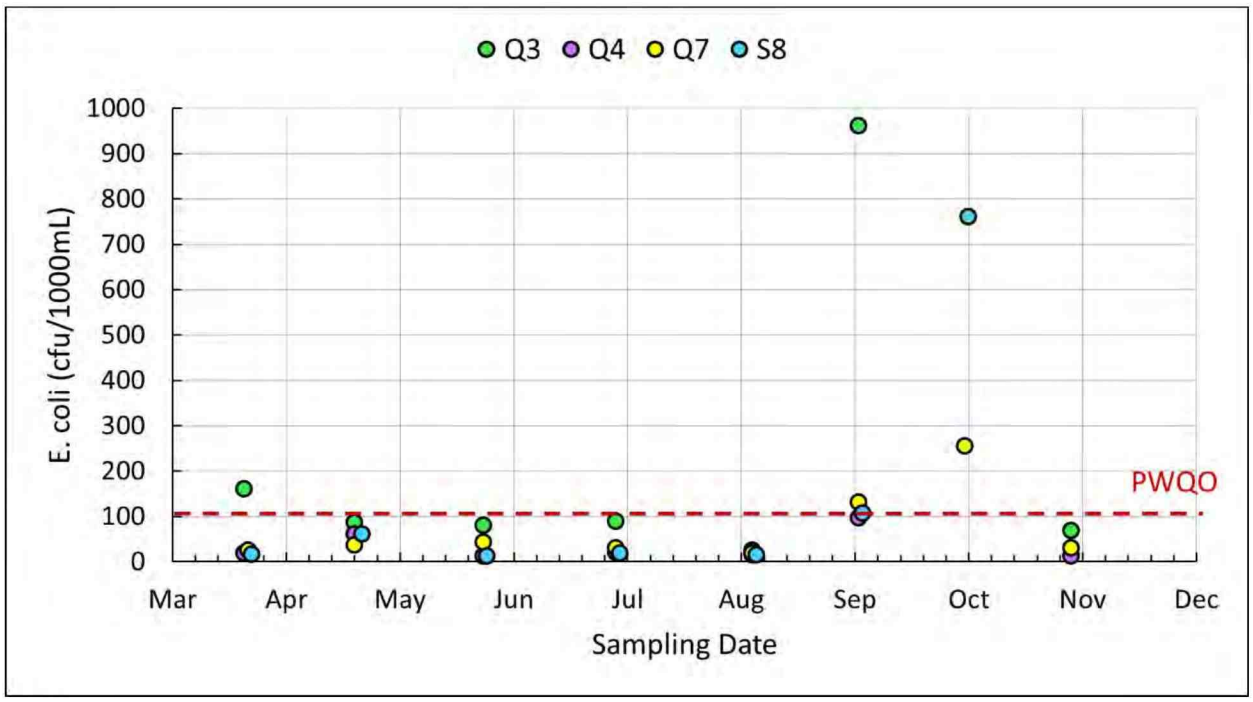

Figure H.5 2023 Lower Main Saugeen subwatershed *E. coli* concentrations (cfu/100mL) in graph format. Graph shows Q3, Q4, Q7 and S8 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 9 exceedances of the PWQO. Three exceedances are not shown in this graph (Q3 at October 2860 cfu/100mL; S8 at November 2700 cfu/100mL; and Q4 at October 2040 cfu/100mL).

Long-term Results

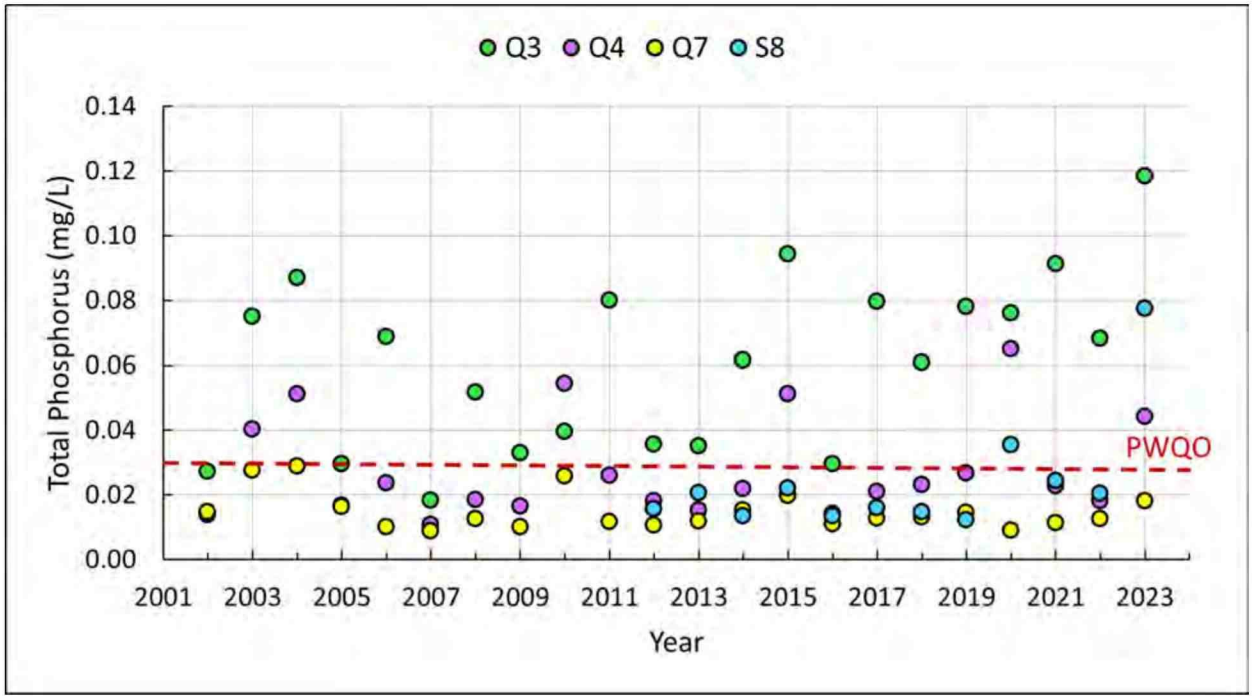

Figure H.6 2002 to 2023 Lower Main Saugeen subwatershed annual average total phosphorus concentrations (mg/L) in graph format. Graph shows Q3, Q4, Q7 and S8 sampling sites, and a horizontal line indicating PWQO of 0.03 mg/L. There are 26 exceedances of the PWQO.

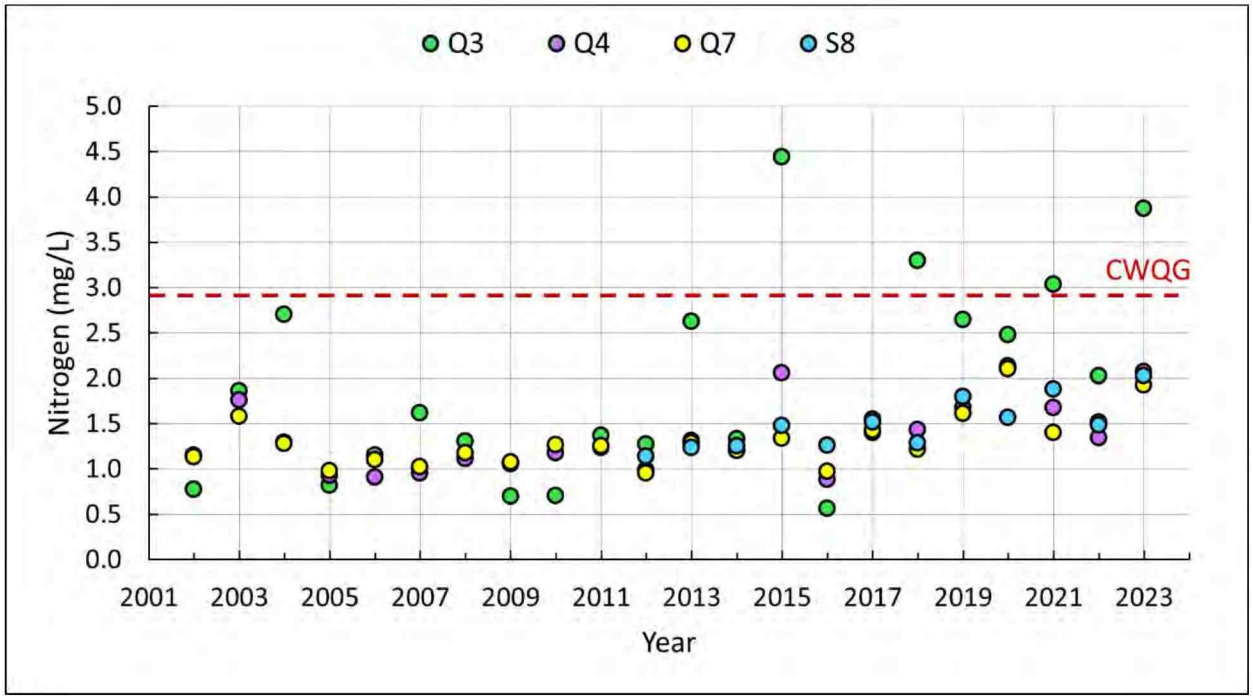

Figure H.7 2002 to 2023 Lower Main Saugeen subwatershed annual average nitrogen concentrations (mg/L) in graph format. Graph shows Q3, Q4, Q7 and S8 sampling sites, and a horizontal line indicating a CWQG of 2.93 mg/L. There are 4 exceedances of the CWQG.

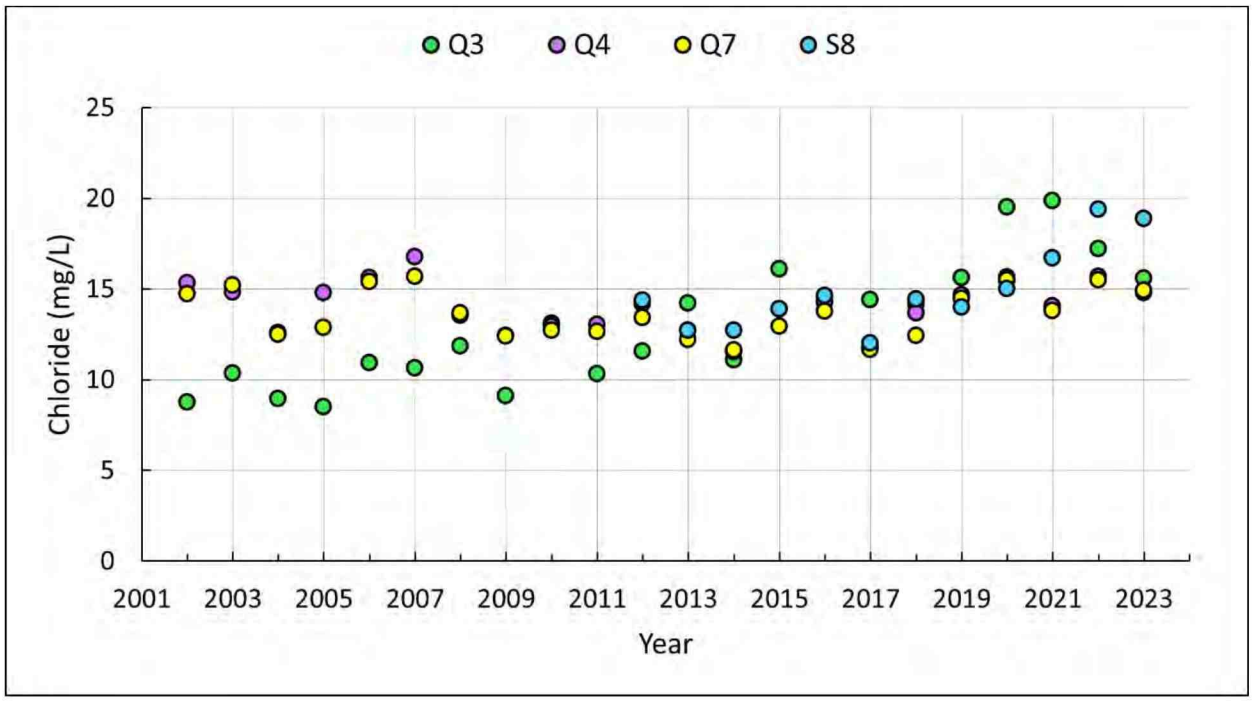

Figure H.8 2002 to 2023 Lower Main Saugeen subwatershed annual average chloride concentrations (mg/L) in graph format. Graph shows Q3, Q4, Q7 and S8 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

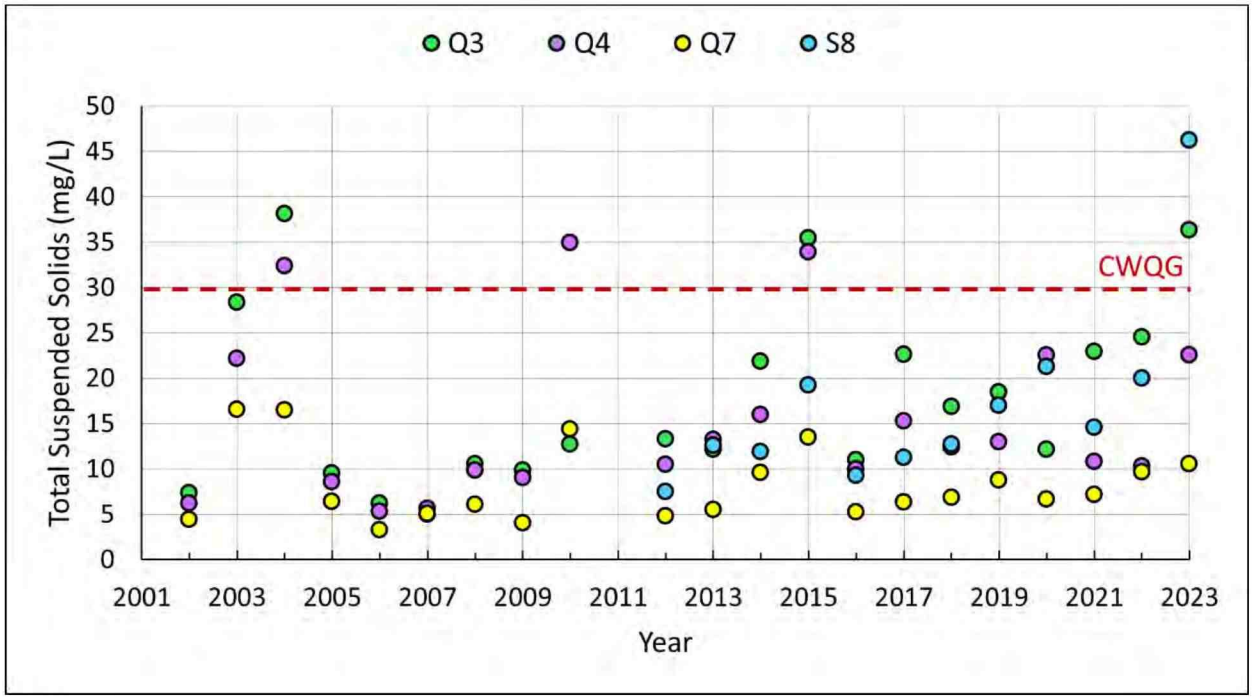

Figure H.9 2012 to 2023 Lower Main Saugeen subwatershed annual average total suspended solids concentrations (mg/L) in graph format. Graph shows Q3, Q4, Q7 and S8 sampling sites, and a horizontal line indicating a CWQG of 30 mg/L. There are 7 exceedances of the CWQG.

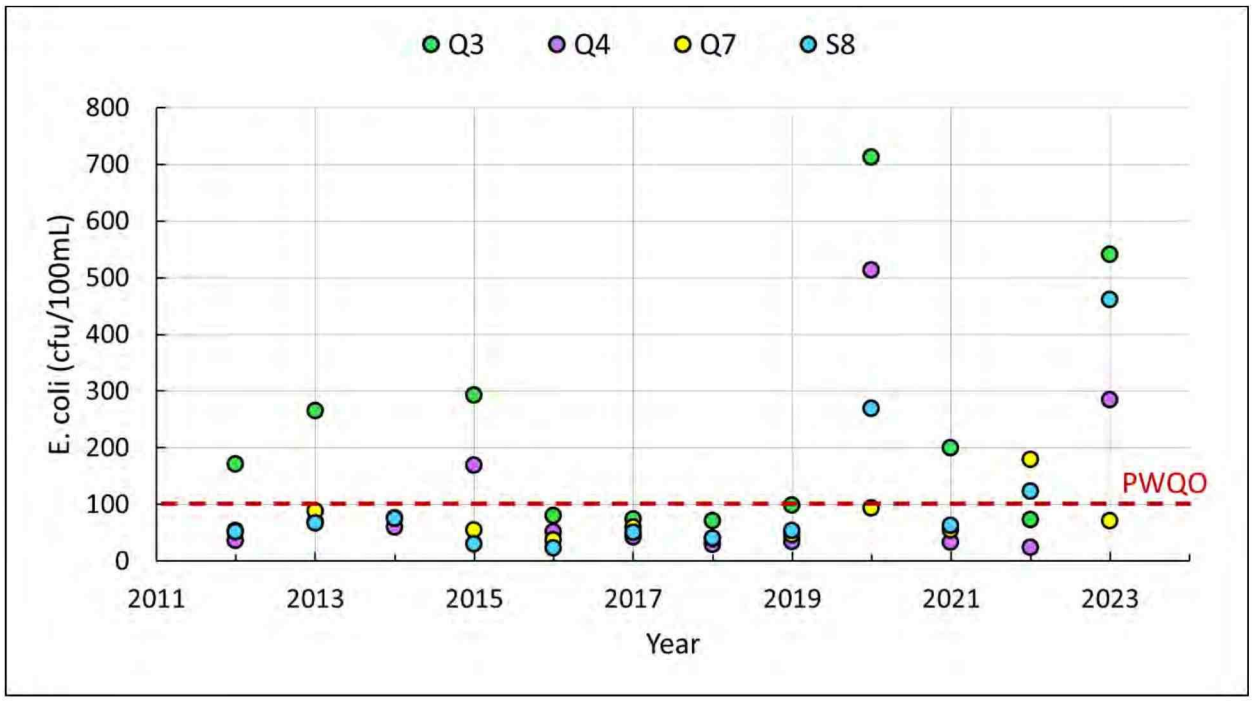

Figure H.10 2012 to 2023 Lower Main Saugeen subwatershed annual average *E. coli* concentrations (cfu/100mL) in graph format. Graph shows Q3, Q4, Q7 and S8 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 14 exceedances of the PWQO; there is one exceedance at Q3 in 2014 that is not shown on this graph (2367 cfu/100mL).

Benthic Biomonitoring Results (2015-2021)

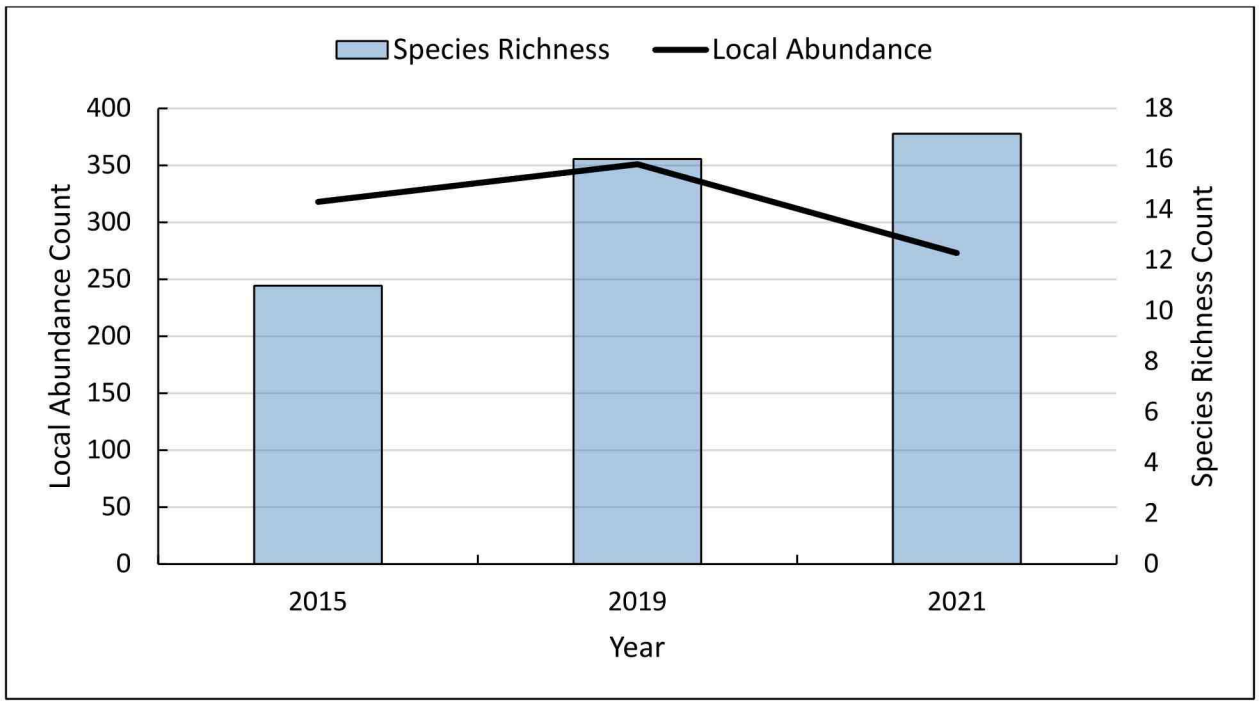

Figure H.11 Local abundance and species richness found within the Lower Main Saugeen subwatershed from 2015 to 2021.

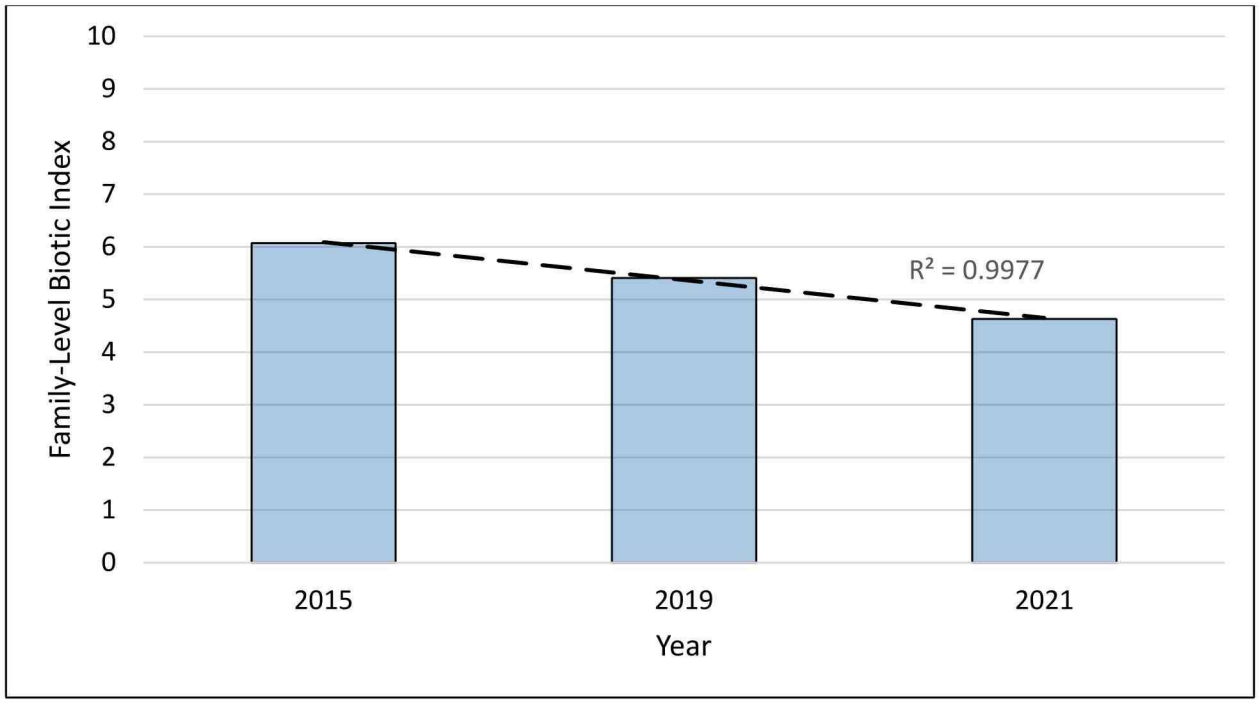

Figure H.12 Family-level biotic index for the Lower Main Saugeen subwatershed from 2015 to 2021.

Appendix I – Lake Fringe Subwatershed

2023 Results

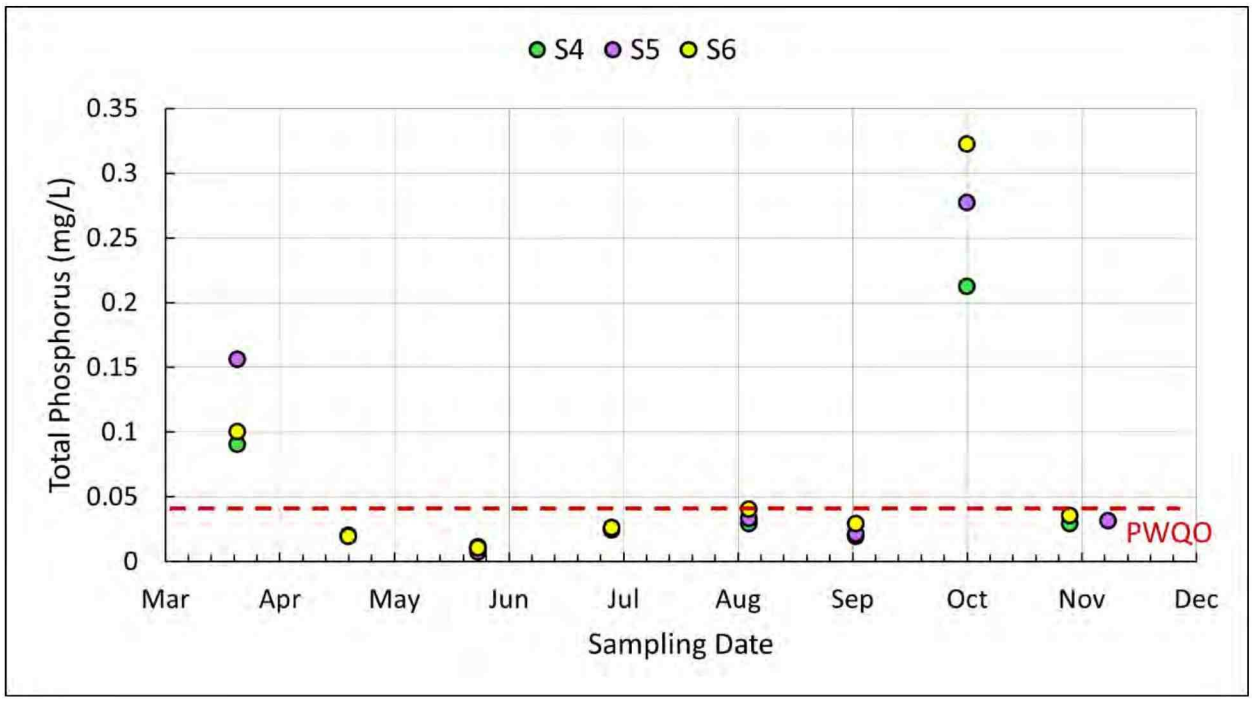

Figure I.1 2023 Lake Fringe subwatershed total phosphorus concentrations (mg/L) in graph format. Graph shows S4, S5, and S6 sampling sites and a horizontal line indicating a PWQO of 0.03 mg/L. There are 10 exceedances of the PWQO.

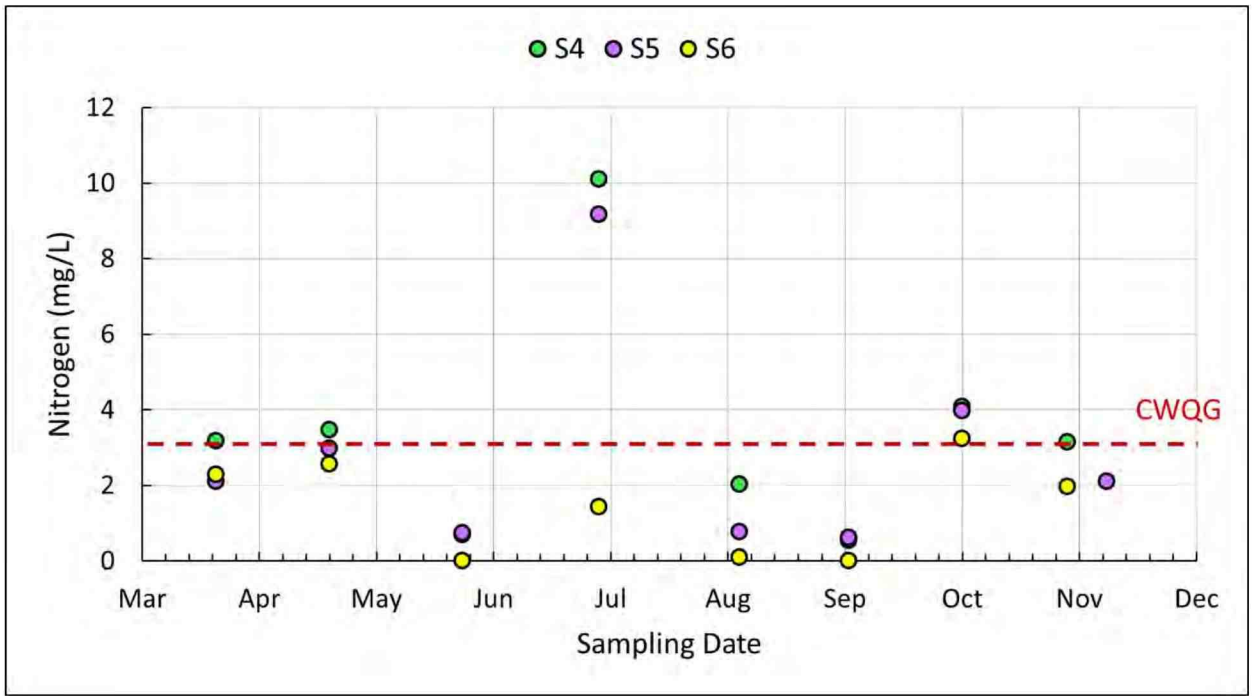

Figure I.2 2023 Lake Fringe subwatershed nitrogen concentrations (mg/L) in graph format. Graph shows S4, S5, and S6 sampling sites and a horizontal line indicating a CWQG of 2.93 mg/L. There are 9 exceedances of the CWQG.

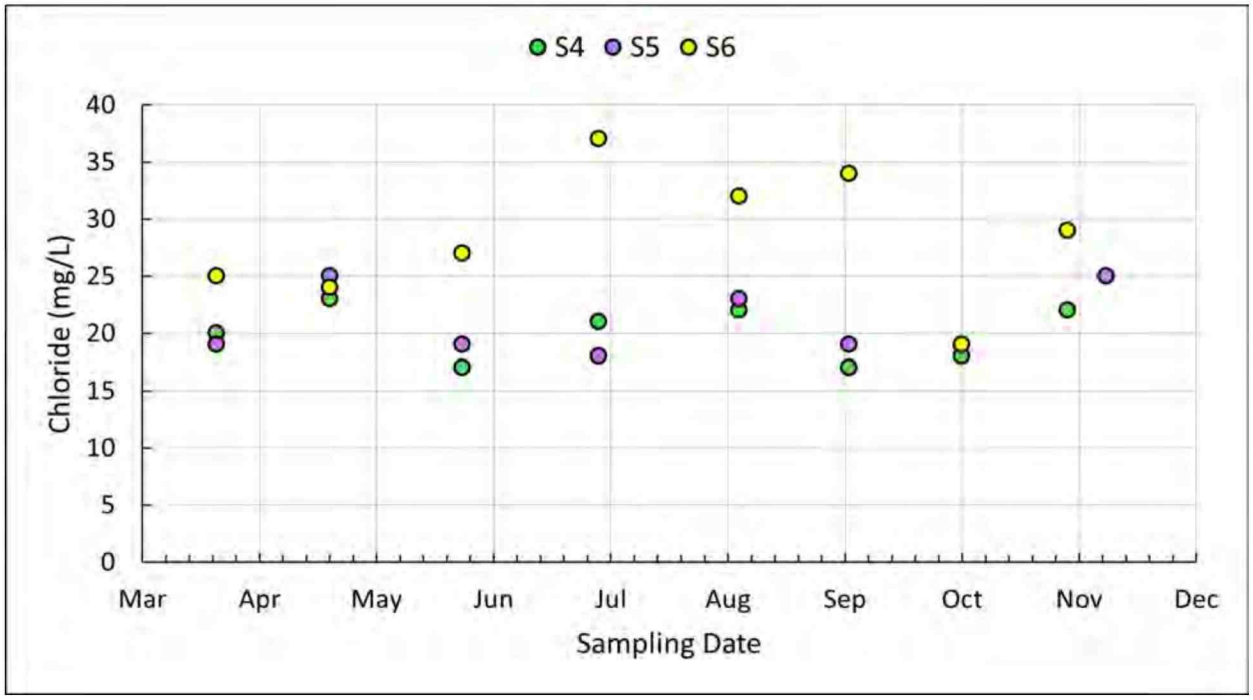

Figure I.3 2023 Lake Fringe subwatershed chloride concentrations (mg/L) in graph format. Graph shows S4, S5, and S6 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

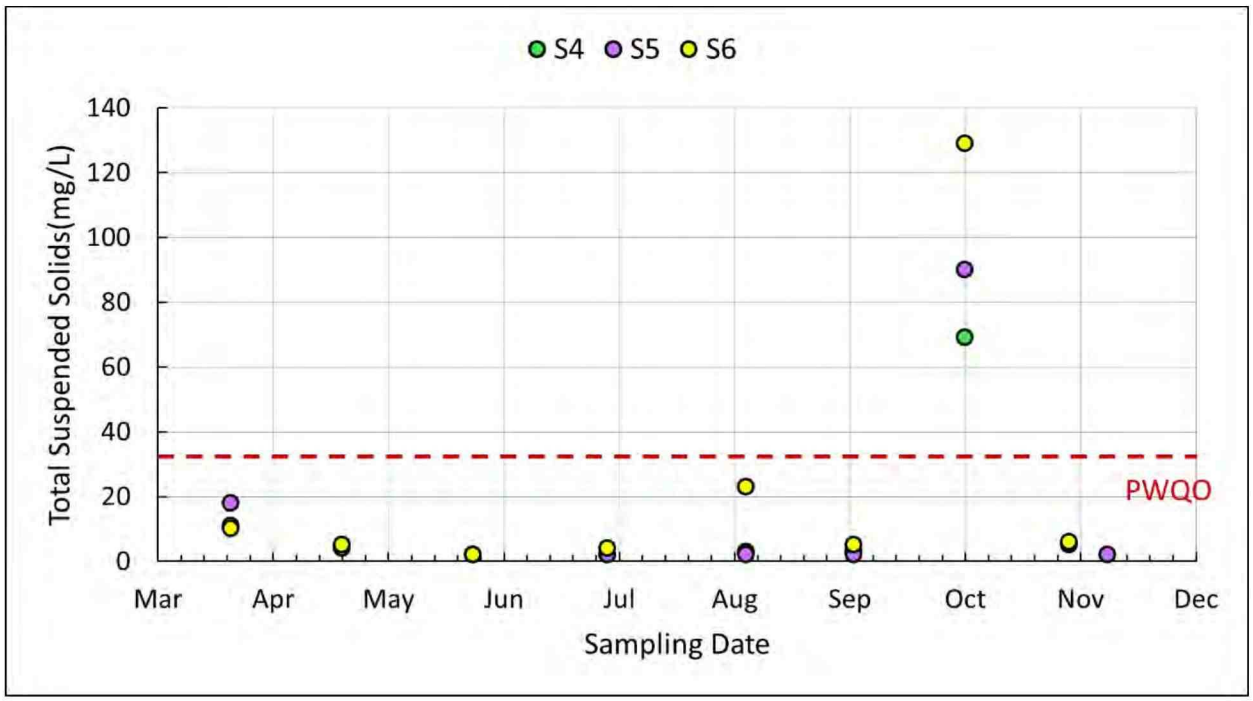

Figure I.4 2023 Lake Fringe subwatershed total suspended solids concentrations (mg/L) in graph format. Graph shows S4, S5, and S6 sampling sites and a horizontal line indicating a CWQG of 30 mg/L. There are 3 exceedances of the CWQG.

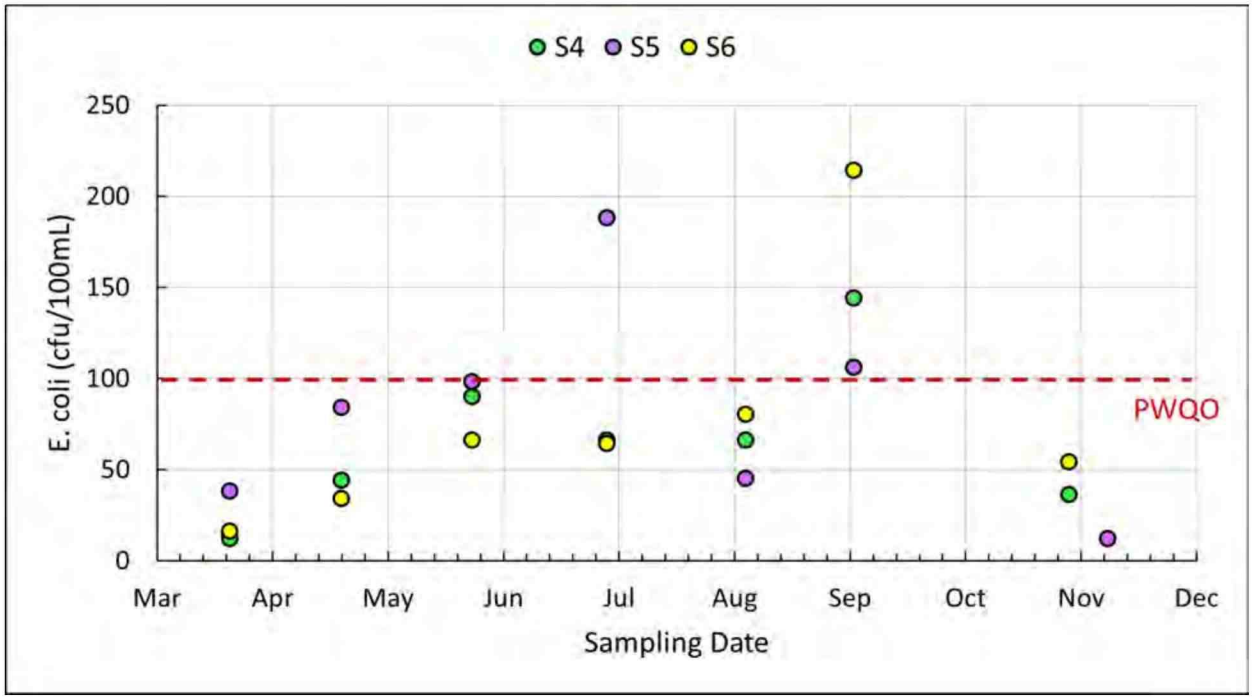

Figure I.5 2023 Lake Fringe subwatershed *E. coli* concentrations (cfu/100mL) in graph format. Graph shows S4, S5, and S6 sampling sites and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 7 exceedances of the PWQO, three exceedances from October are not shown on this graph (S4 at 3100 cfu/100mL; S6 at 2300 cfu/100mL; and S5 at 1700 cfu/100mL).

Long-term Results

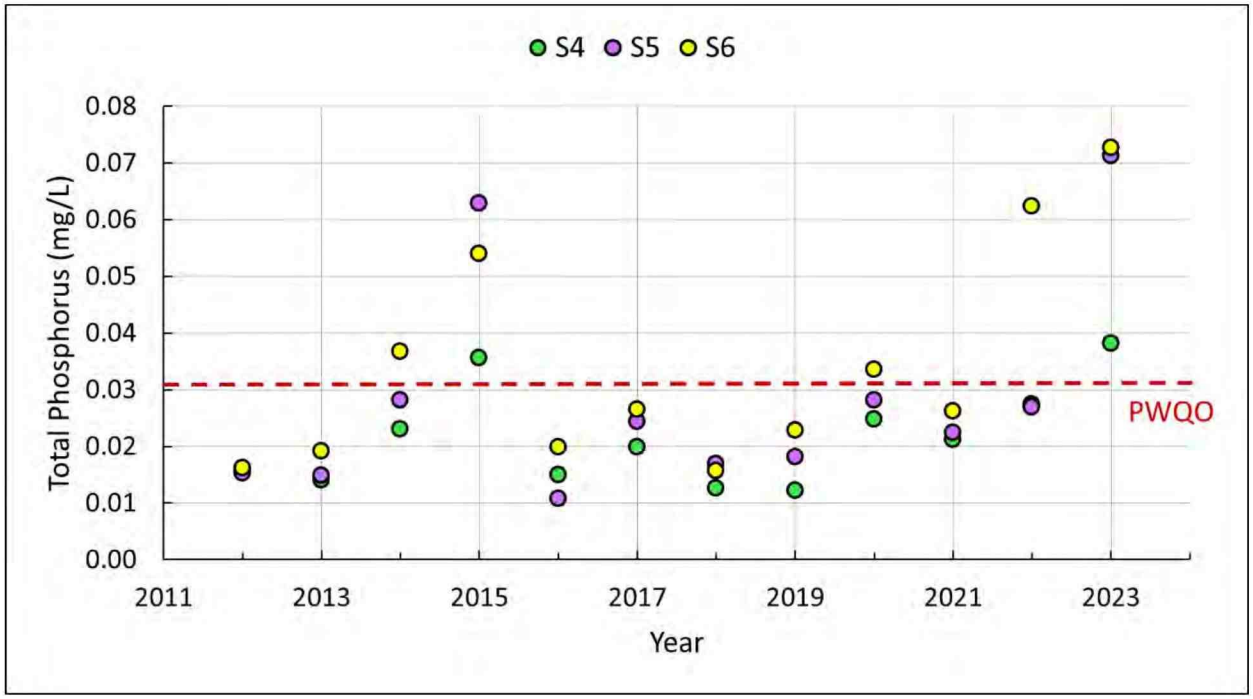

Figure I.6 2012 to 2023 Lake Fringe subwatershed annual average total phosphorus concentrations (mg/L) in graph format. Graph shows S4, S5, and S6 sampling sites and a horizontal line indicating a PWQO of 0.03 mg/L. There are 9 exceedances of the PWQO.

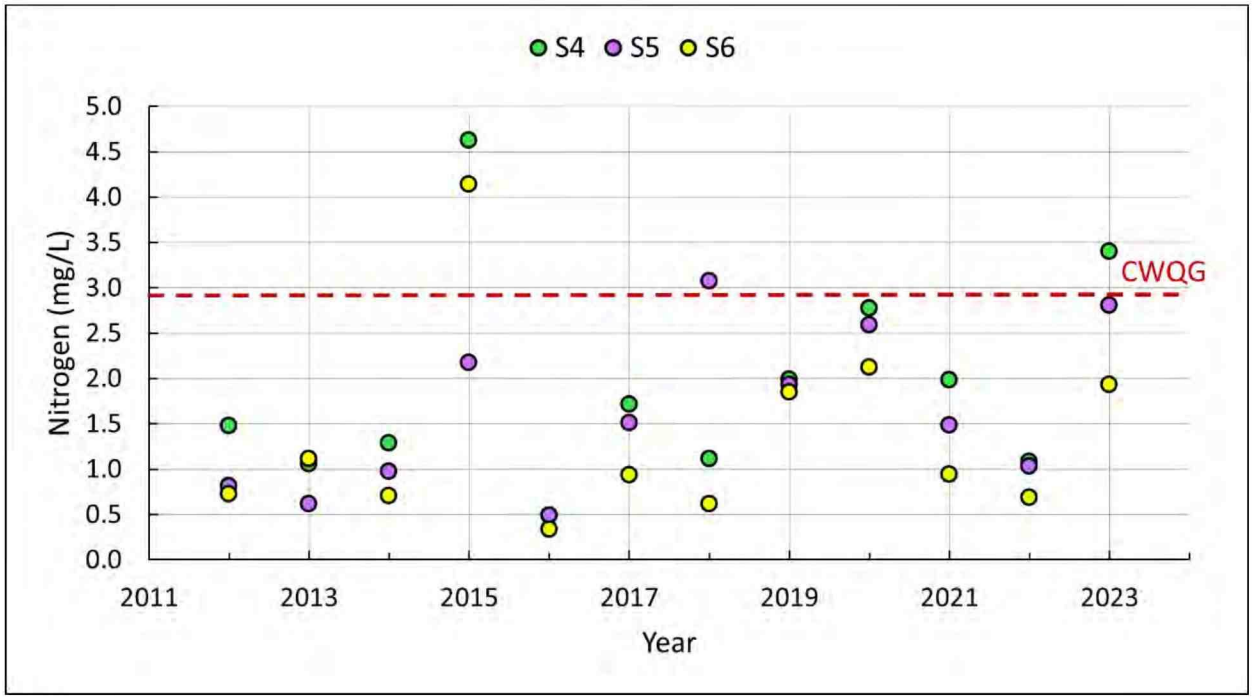

Figure I.7 2012 to 2023 Lake Fringe subwatershed annual average nitrogen concentrations (mg/L) in graph format. Graph shows S4, S5, and S6 sampling sites and a horizontal line indicating a CWQG of 2.93 mg/L. There are 4 exceedances of the CWQG.

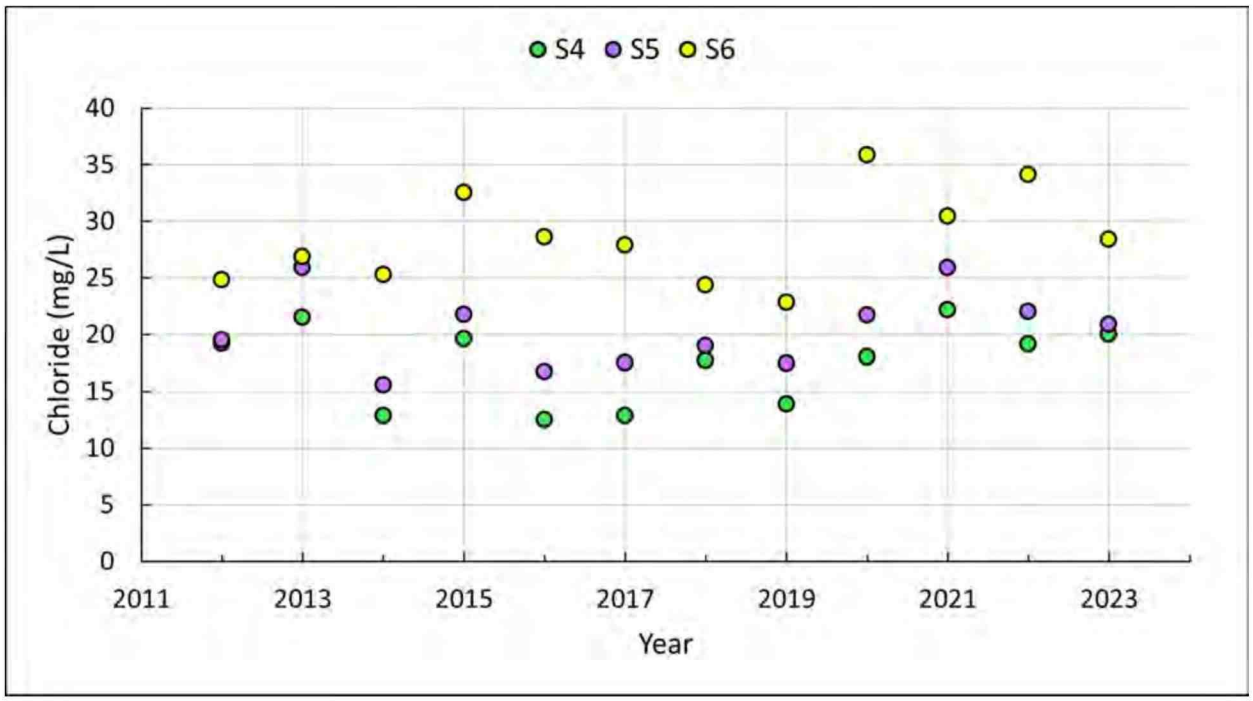

Figure I.8 2012 to 2023 Lake Fringe subwatershed annual average chloride concentrations (mg/L) in graph format. Graph shows S4, S5, and S6 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

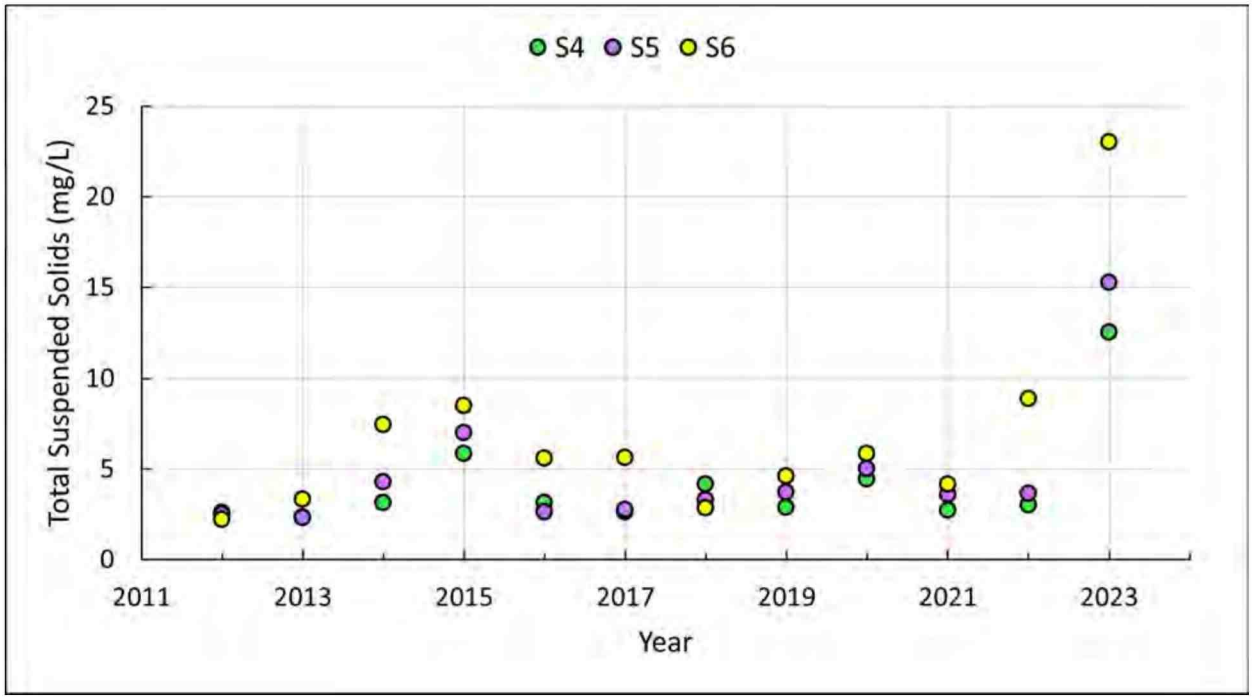

Figure I.9 2012 to 2023 Lake Fringe subwatershed annual average total suspended solids concentrations (mg/L) in graph format. Graph shows S4, S5, and S6 sampling sites. The CWQG is 30 mg/L. There are no exceedances.

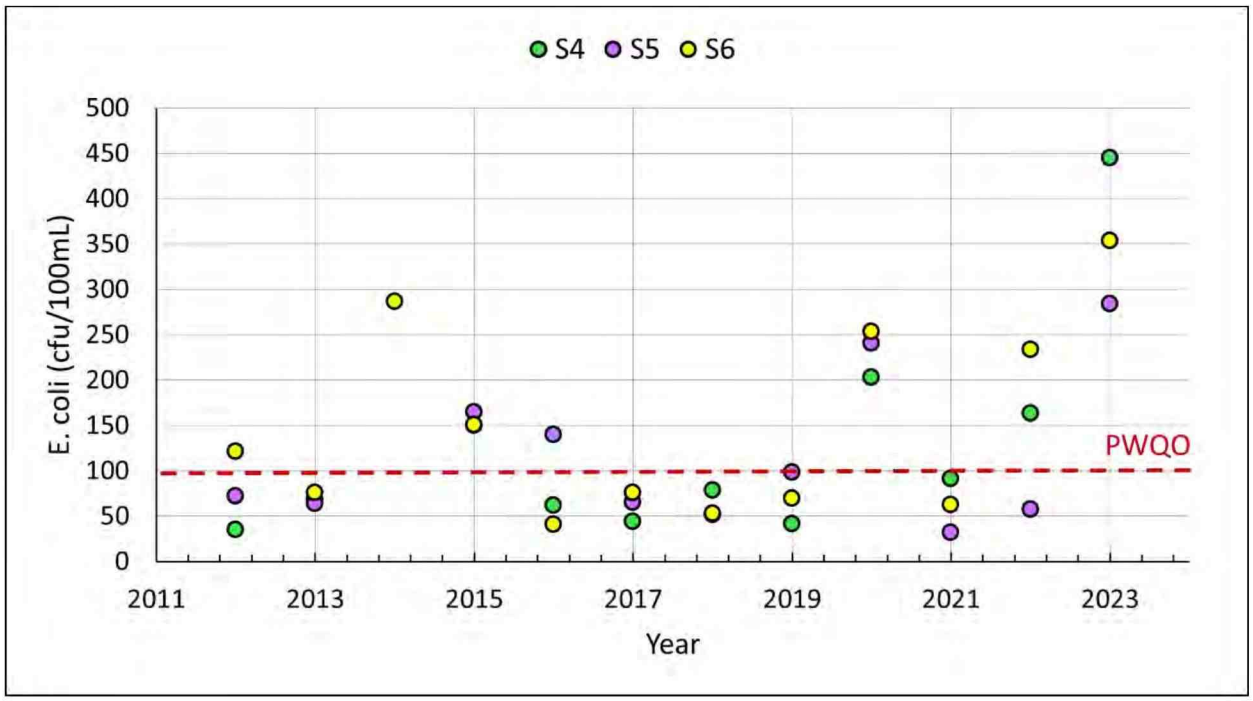

Figure I.10 2012 to 2023 Lake Fringe subwatershed annual average *E. coli* concentrations (cfu/100mL) in graph format. Graph shows S4, S5, and S6 sampling sites and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 16 exceedances of the PWQO; there are two exceedances in 2014 at S4 and S5 that are not shown on this graph (668 cfu/100mL and 1386 cfu/100mL, respectively).

Benthic Biomonitoring Results (2015-2020)

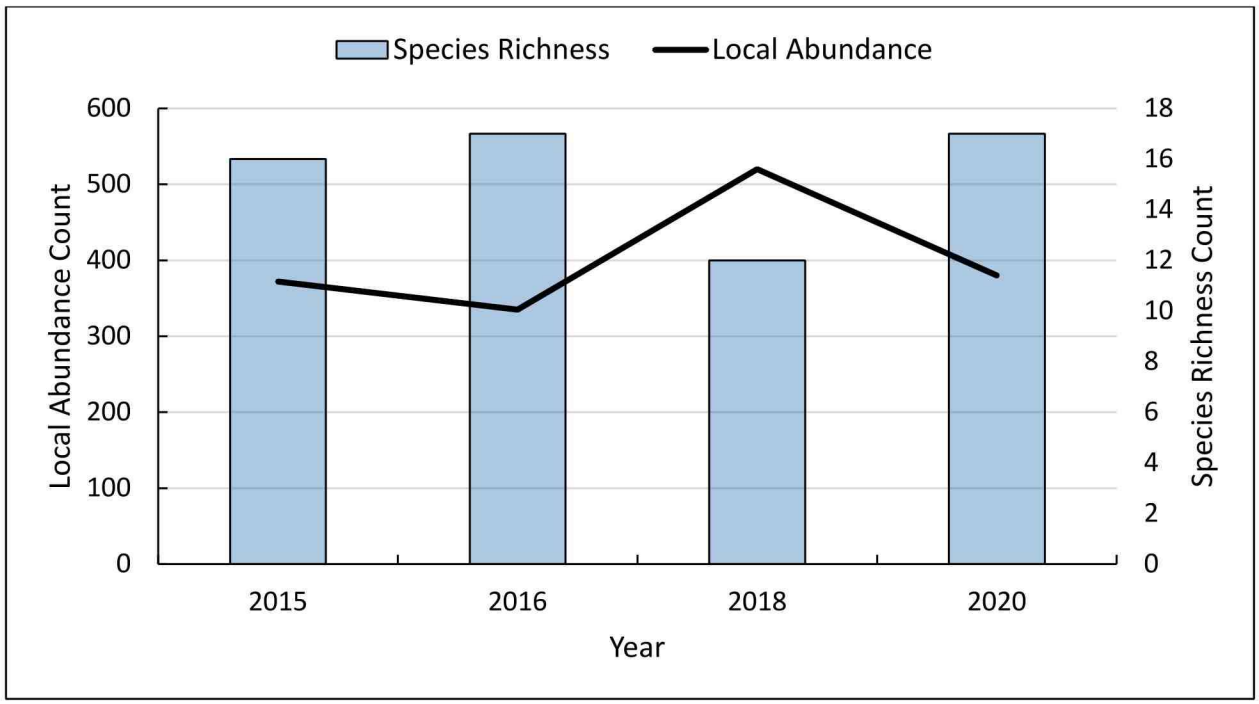

Figure I.11 Local abundance and species richness found within the Lake Fringe subwatershed from 2015 to 2020.

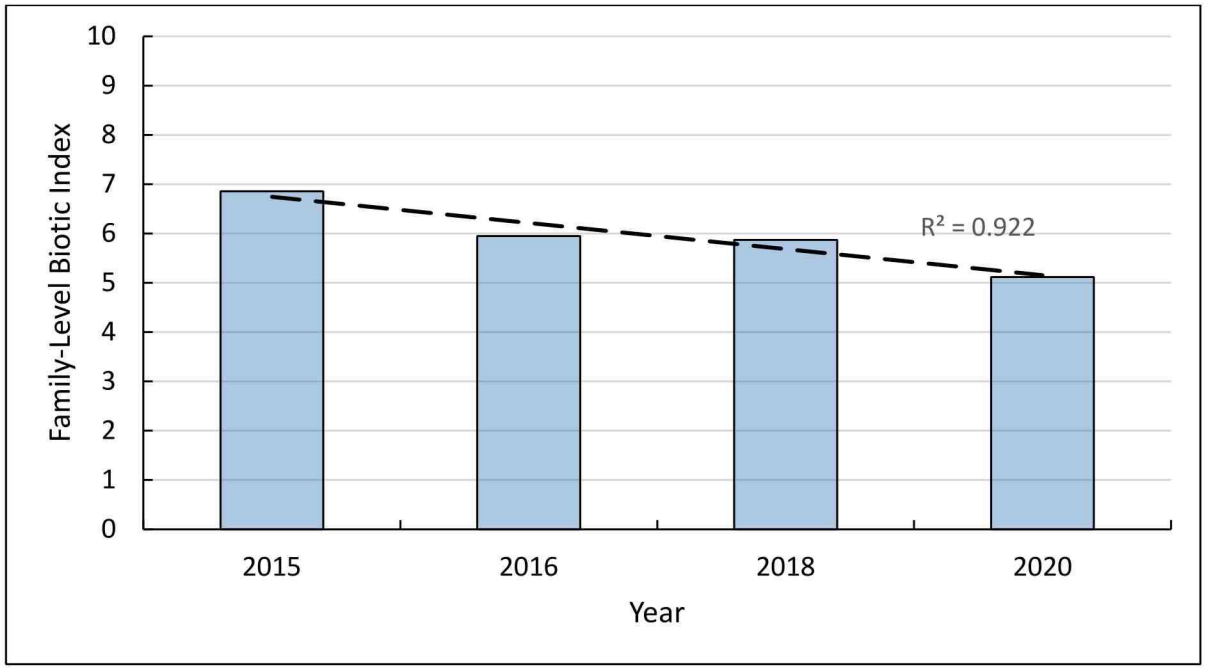

Figure I.12 Family-level biotic index for the Lake Fringe subwatershed from 2015 to 2020.

Appendix J – Pine Subwatershed

2023 Results

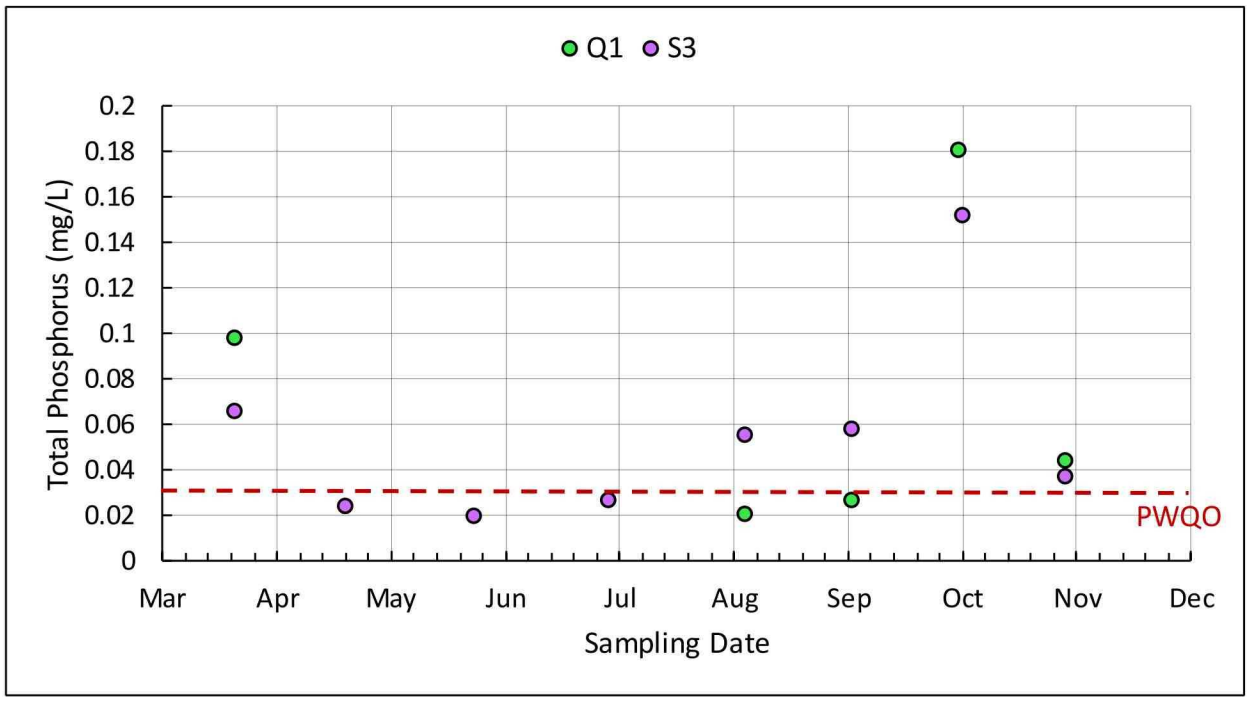

Figure J.1 2023 Pine subwatershed total phosphorus concentrations (mg/L) in graph format. Graph shows Q1 and S3 sampling sites, and a horizontal line indicating a PWQO of 0.03 mg/L. There are 8 exceedances of the PWQO.

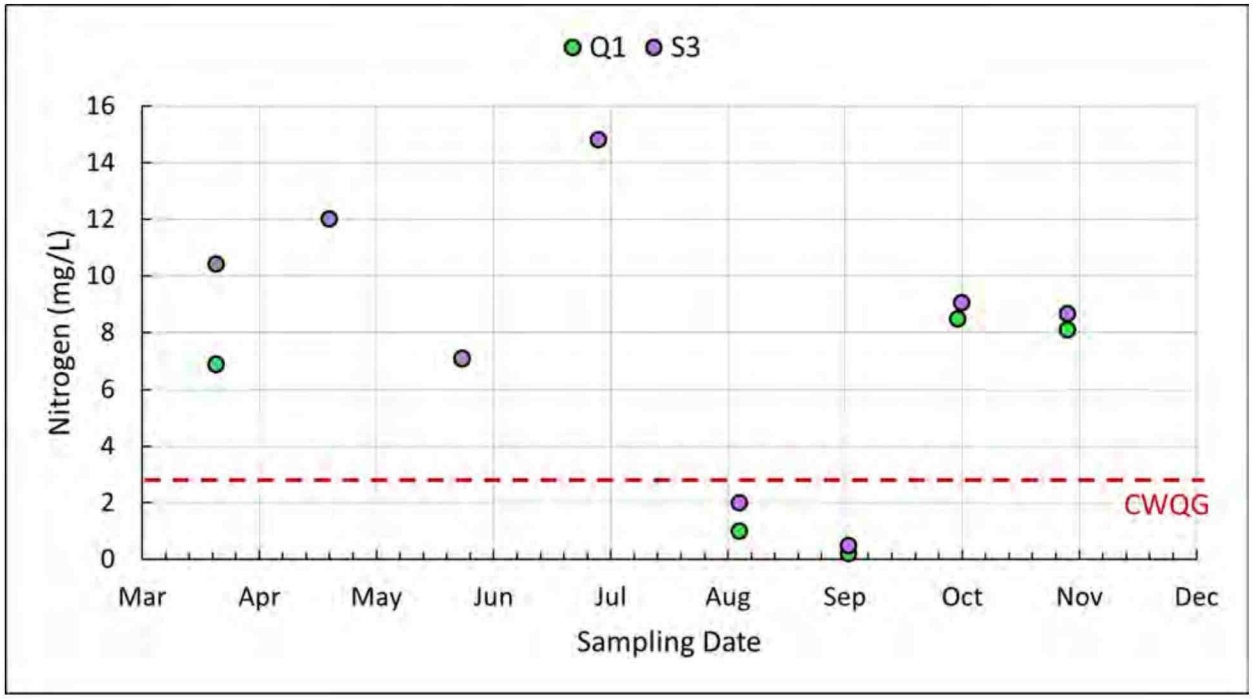

Figure J.2 2023 Pine subwatershed nitrogen concentrations (mg/L) in graph format. Graph shows Q1 and S3 sampling sites, and a horizontal line indicating a CWQG of 2.93 mg/L. There are 9 exceedances of the CWQG.

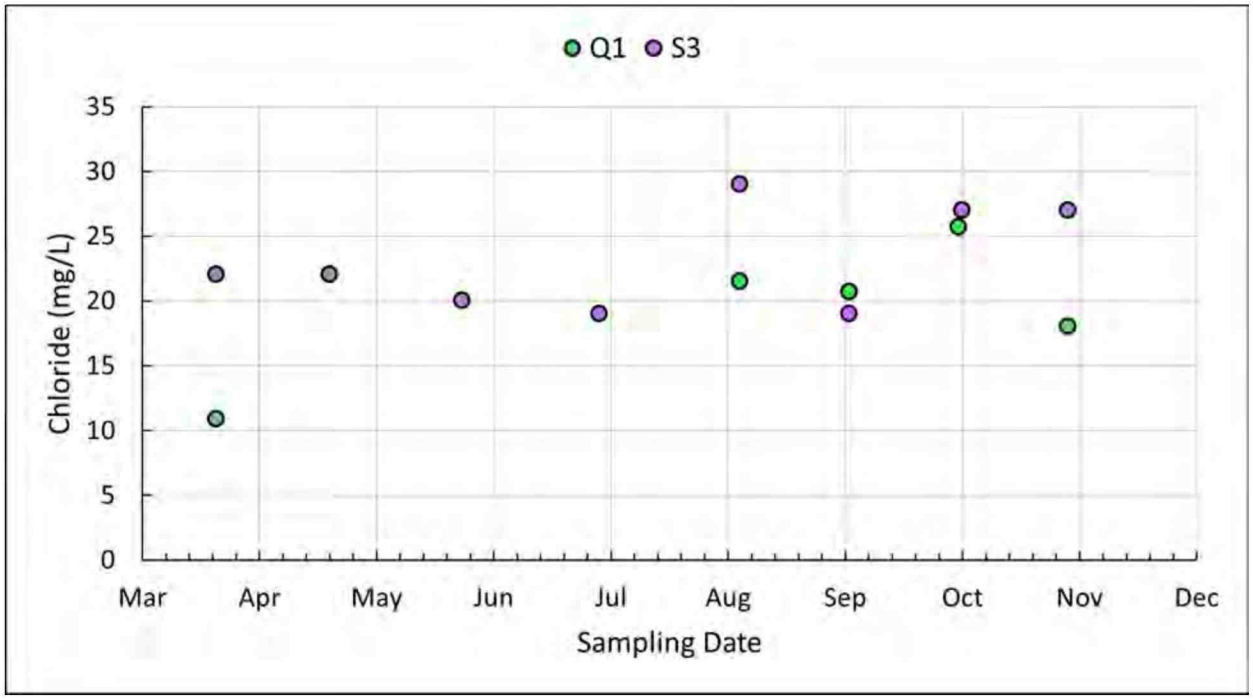

Figure J.3 2023 Pine subwatershed chloride concentrations(mg/L) in graph format. Graph shows Q1 and S3 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

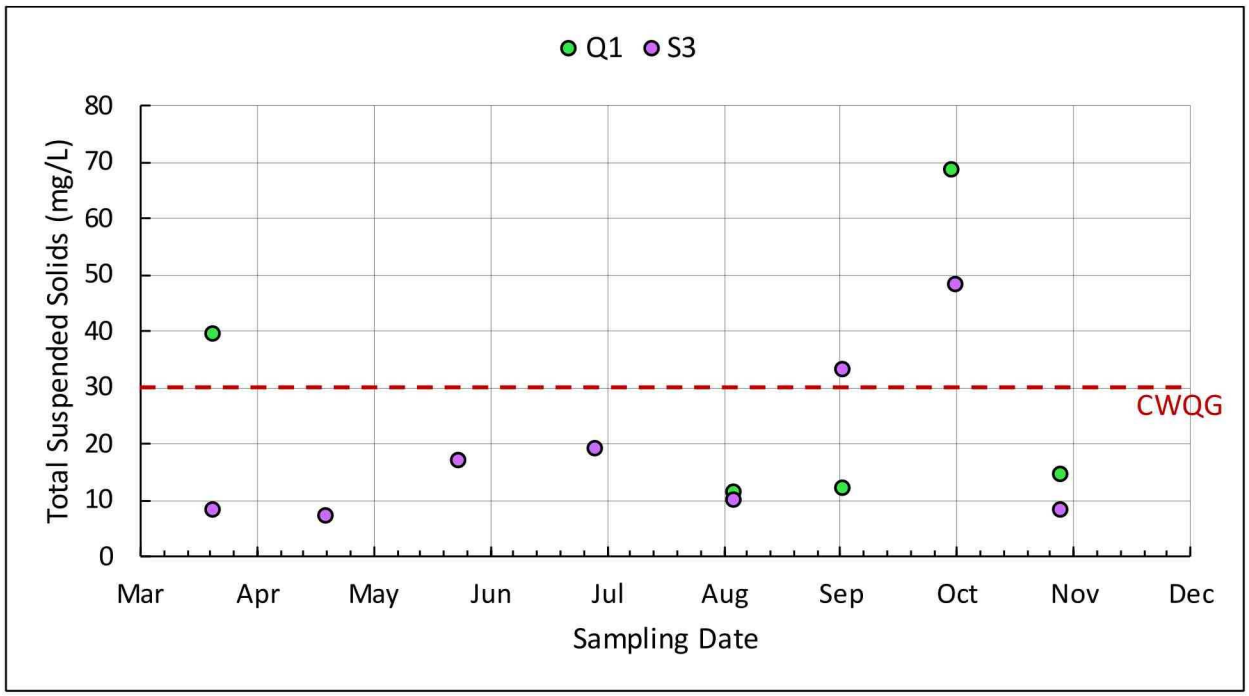

Figure J.4 2023 Pine subwatershed total suspended solids concentrations (mg/L) in graph format. Graph shows Q1 and S3 sampling sites, and a horizontal line indicating a CWQG of 30 mg/L. There are 4 exceedances.

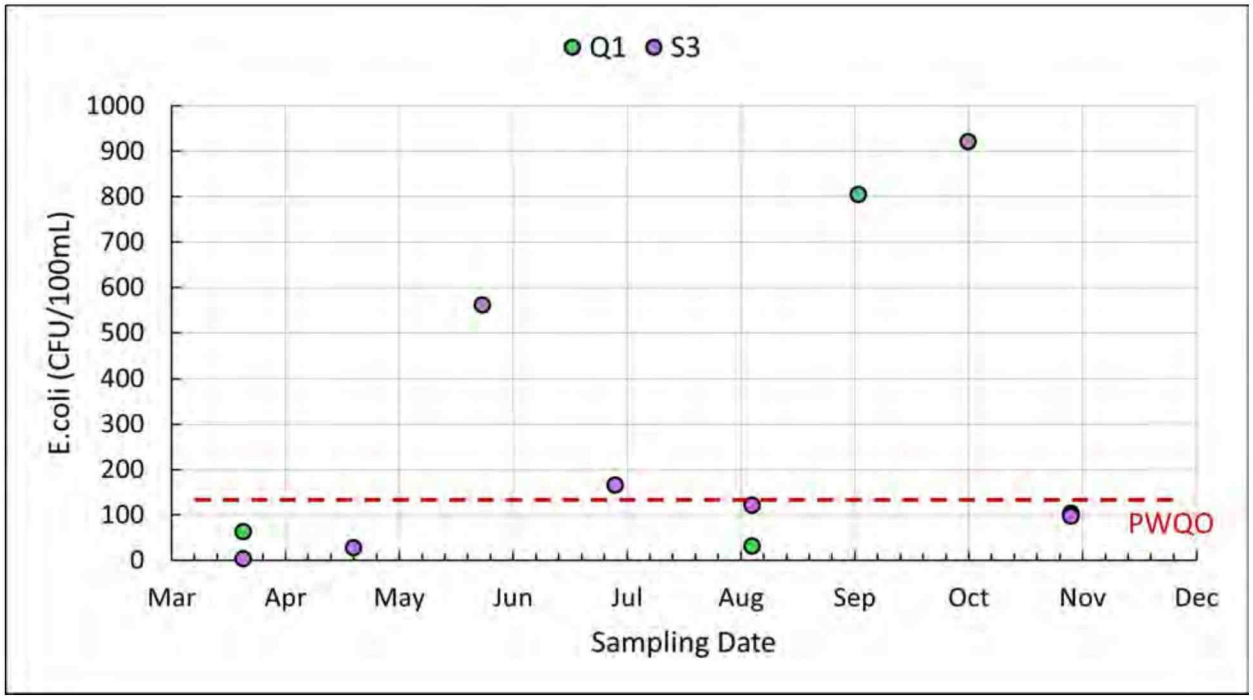

Figure J.5 2023 Pine subwatershed *E. coli* concentrations (cfu/100mL) in graph format. Graph shows Q1 and S3 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 19 exceedances of the PWQO. Two exceedances are not shown on this graph (Q1, October at 3260 cfu/100mL; and S3, September at 2200 cfu/100mL).

Long-term Results

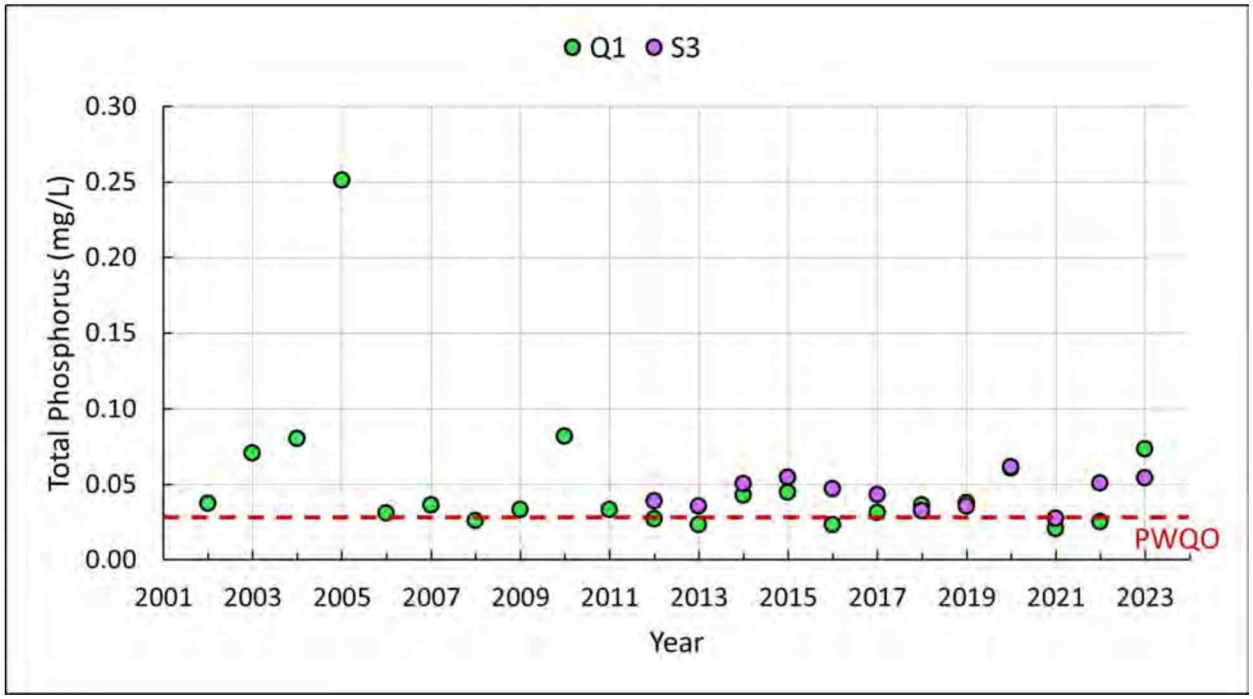

Figure J.6 2002 to 2023 Pine subwatershed annual average total phosphorus concentrations (mg/L) in graph format. Graph shows Q1 and S3 sampling sites, and a horizontal line indicating a PWQO of 0.03 mg/L. There are 17 exceedances of the PWQO.

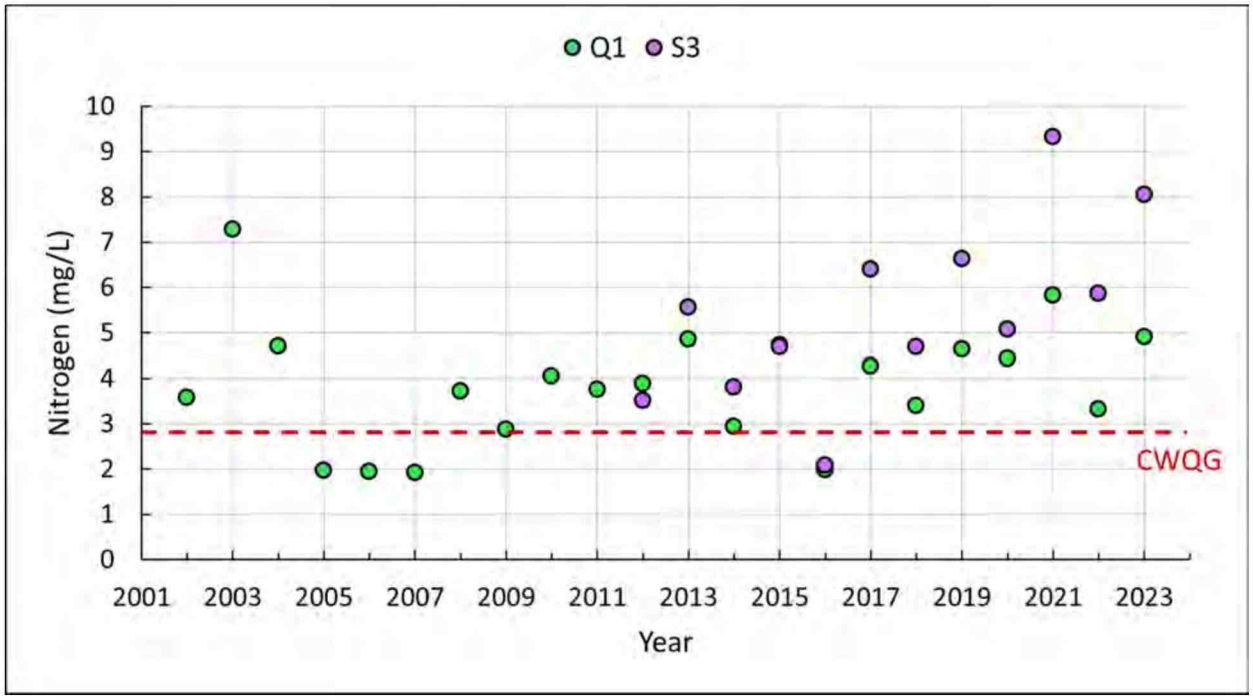

Figure J.7 2002 to 2023 Pine subwatershed annual average nitrogen concentrations (mg/L) in graph format. Graph shows Q1 and S3 sampling sites, and a horizontal line indicating CWQG of 2.93 mg/L. There are 28 exceedances of the CWQG.

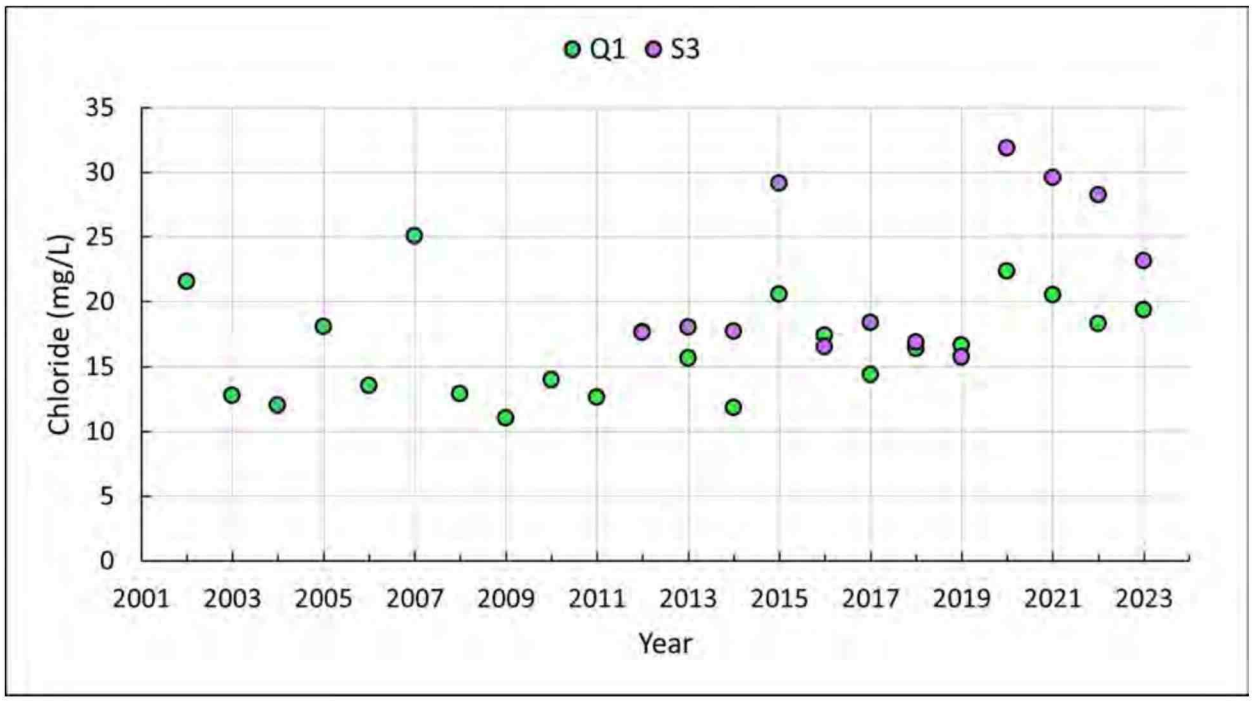

Figure J.8 2002 to 2023 Pine subwatershed annual average chloride concentrations (mg/L) in graph format. Graph shows Q1 and S3 sampling sites. The CWQG is 120 mg/L. There are no exceedances.

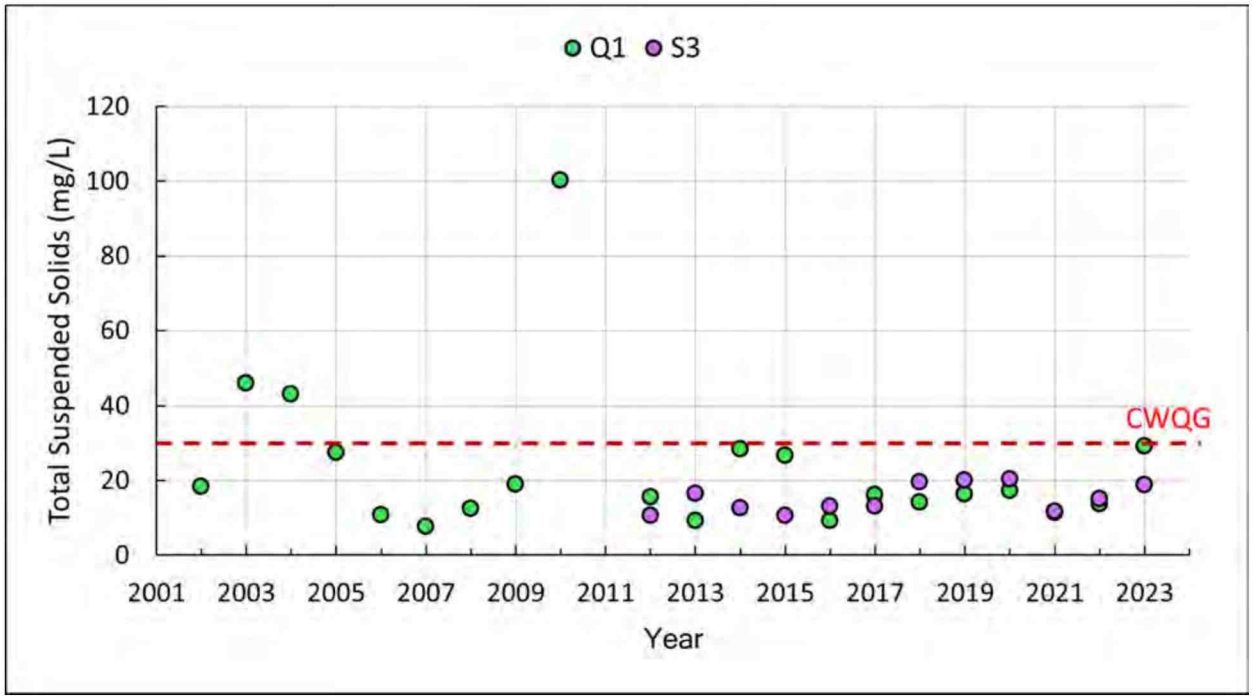

Figure J.9 2012 to 2023 Pine subwatershed annual average total suspended solids concentrations (mg/L) in graph format. Graph shows Q1 and S3 sampling sites, and a horizontal line indicating CWQG of 30 mg/L. There are 3 exceedances of the CWQG.

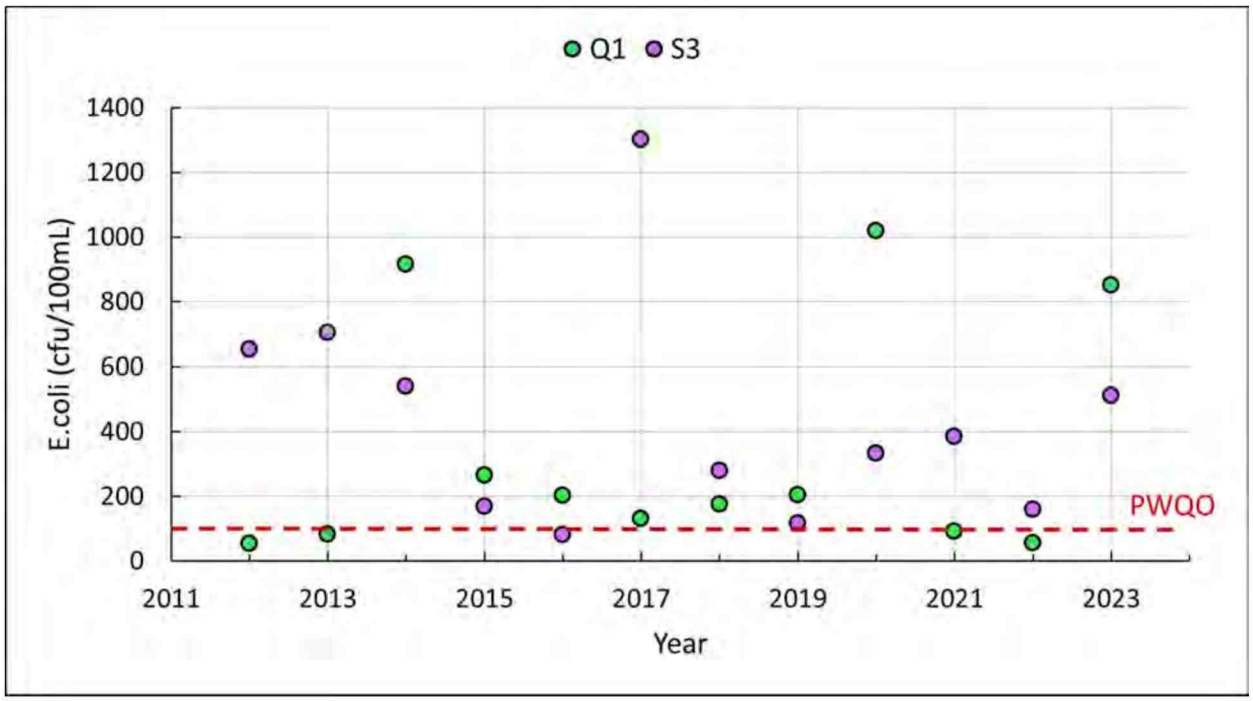

Figure J.10 2012 to 2023 Pine subwatershed annual average *E. coli* concentrations (cfu/100mL) in graph format. Graph shows Q1 and S3 sampling sites, and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 19 exceedances of the PWQO.

Benthic Biomonitoring Results (2015-2021)

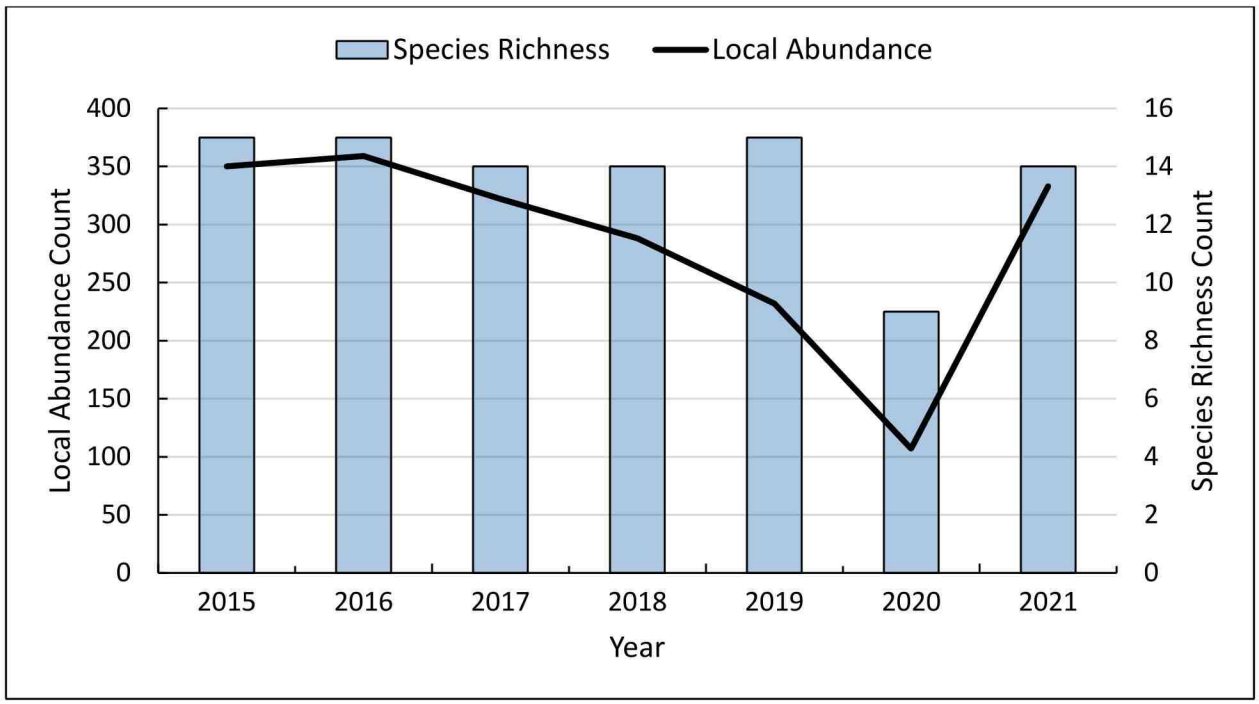

Figure J.11 Local abundance and species richness found within the Pine subwatershed from 2015 to 2021.

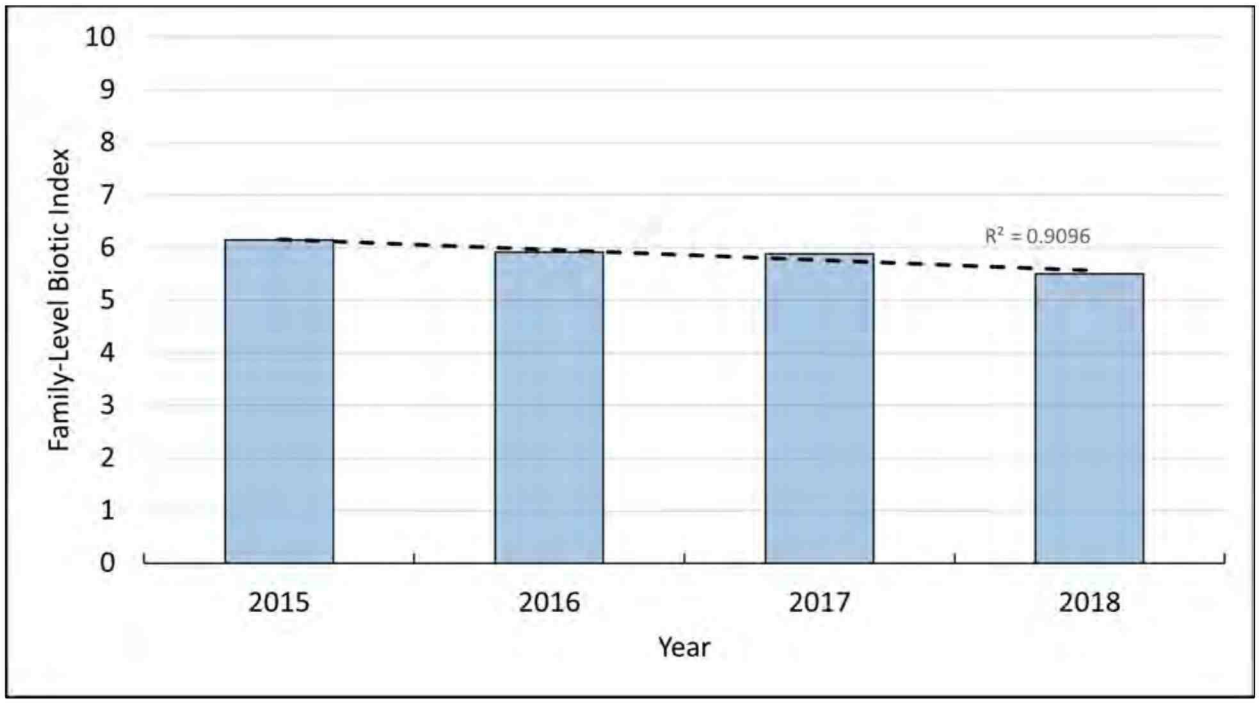

Figure J.12 Family-level biotic index for the Pine subwatershed from 2015 to 2021.

Appendix K – Penetangore Subwatershed

2023 Results

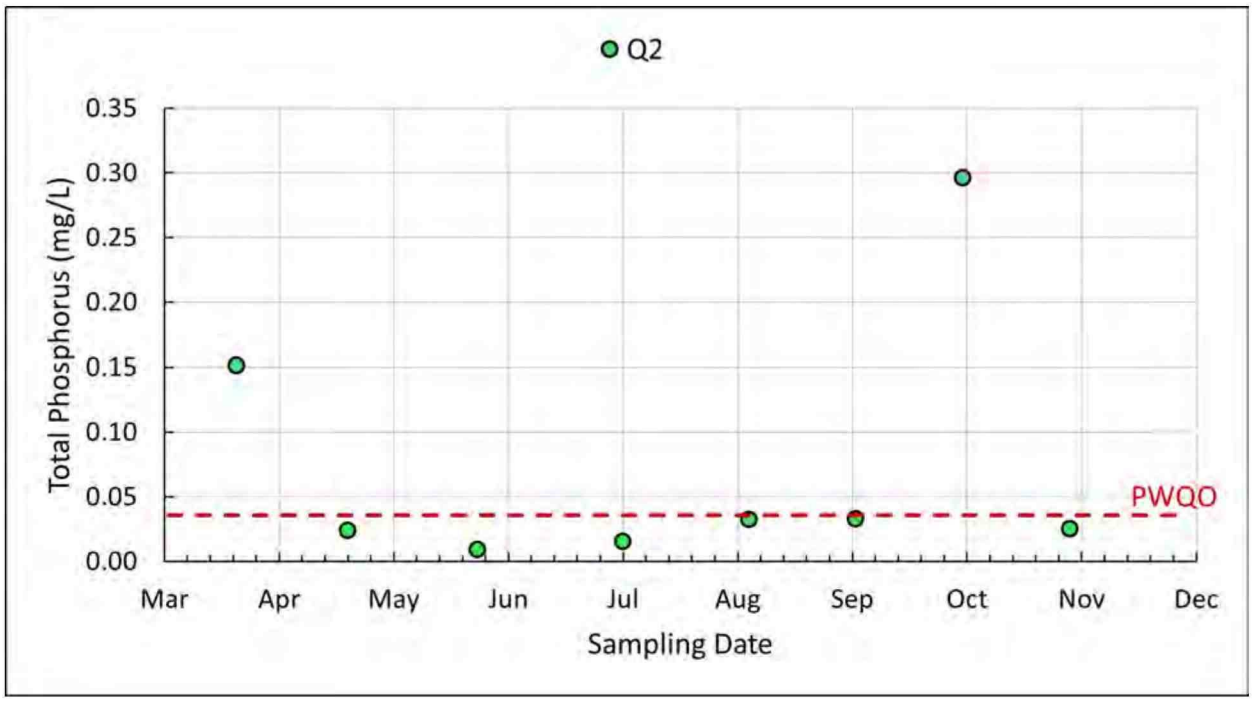

Figure K.1 2023 Penetangore subwatershed total phosphorus concentrations (mg/L) in graph format. Graph shows Q2 sampling site and a horizontal line indicating a PWQO of 0.03 mg/L. There are 4 exceedances of the PWQO.

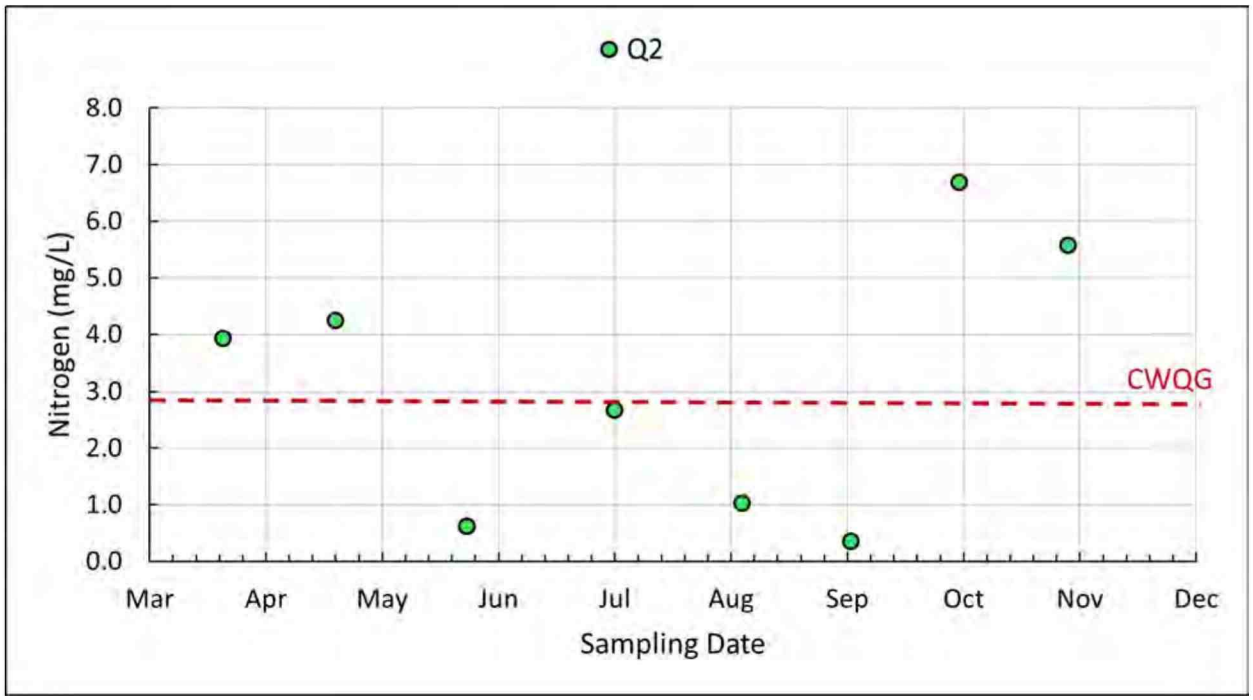

Figure K.2 2023 Penetangore subwatershed nitrogen concentrations (mg/L) in graph format. Graph shows Q2 sampling site and a horizontal line indicating a CWQG of 2.93 mg/L. There is 4 exceedances of the CWQG.

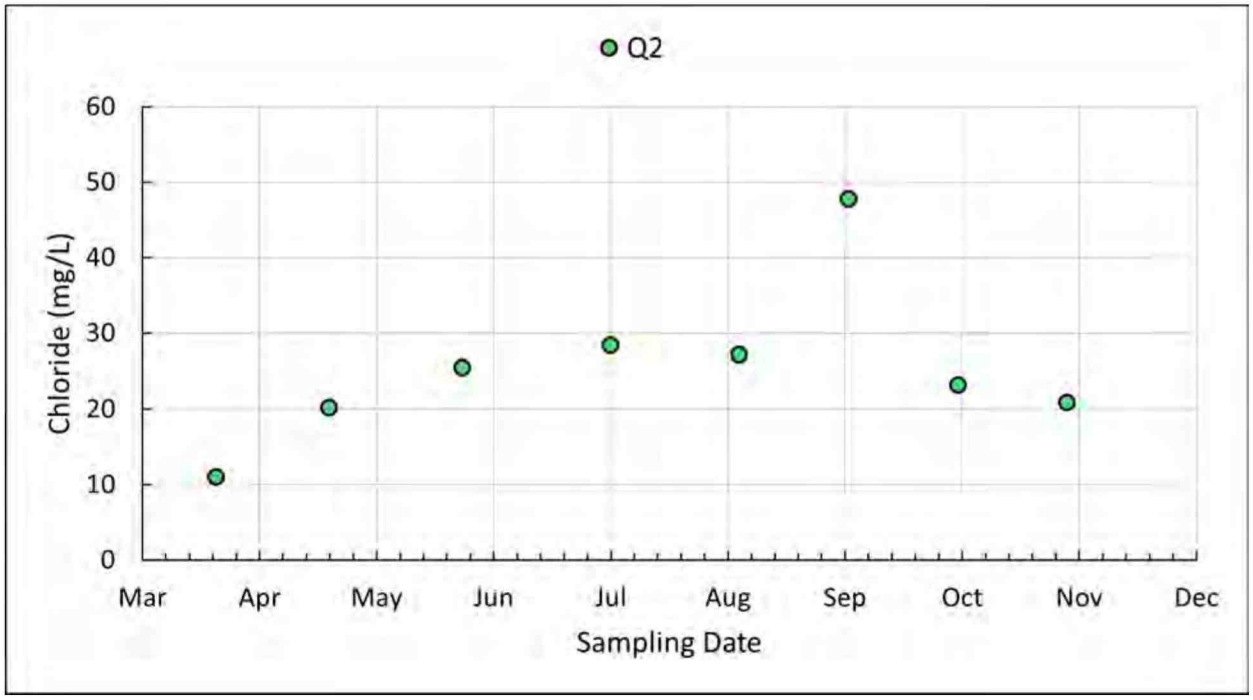

Figure K.3 2023 Penetangore subwatershed chloride concentrations (mg/L) in graph format. Graph shows Q2 sampling site. The CWQG is 120mg/L. There are no exceedances.

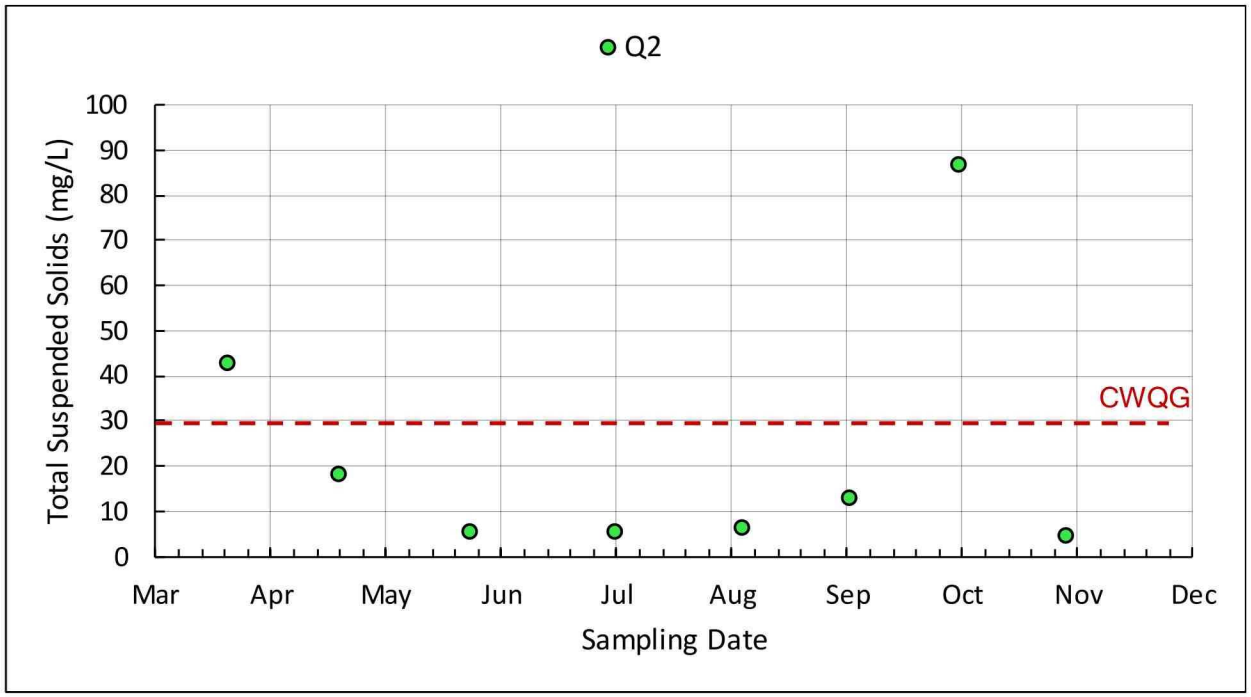

Figure K.4 2023 Penetangore subwatershed total suspended solids concentrations (mg/L) in graph format. Graph shows Q2 sampling site and a horizontal line indicating a CWQG of 30mg/L. There are 2 exceedances.

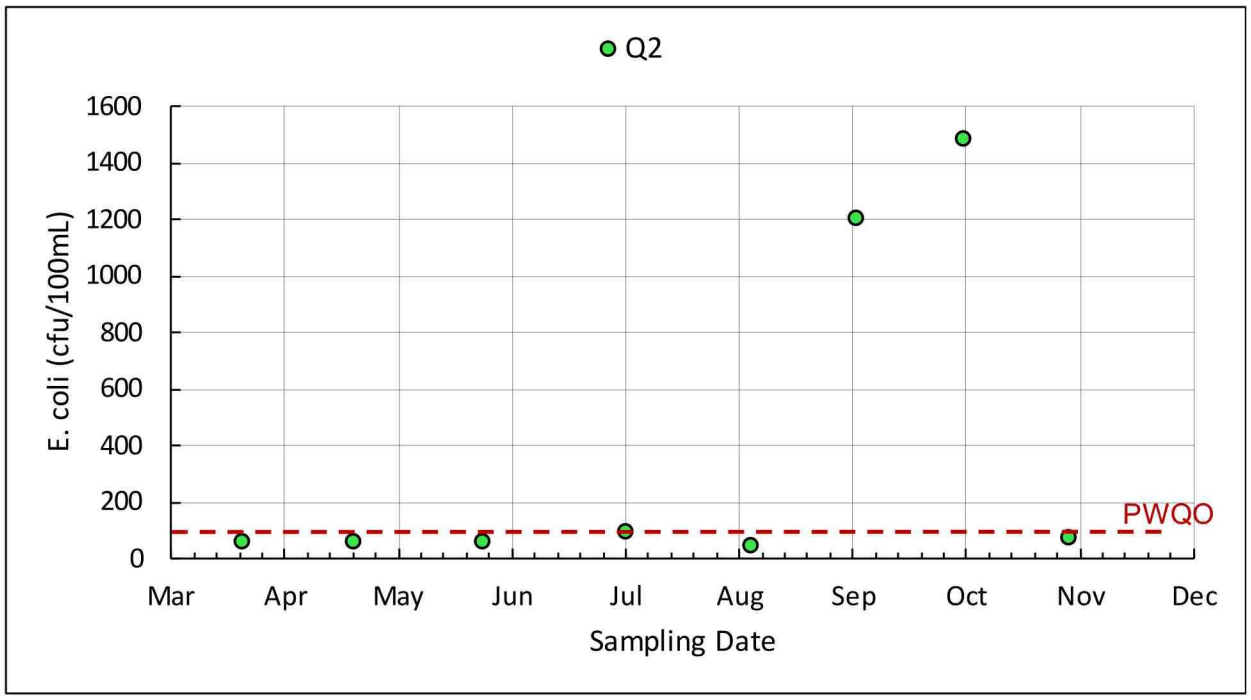

Figure K.5 2023 Penetangore subwatershed *E. coli* concentrations (cfu/100mL) in graph format. Graph shows Q2 sampling site and a horizontal line indicating a PWQO of 100 cfu/100mL for swimming. There are 2 exceedances of the PWQO.

Long-term Results

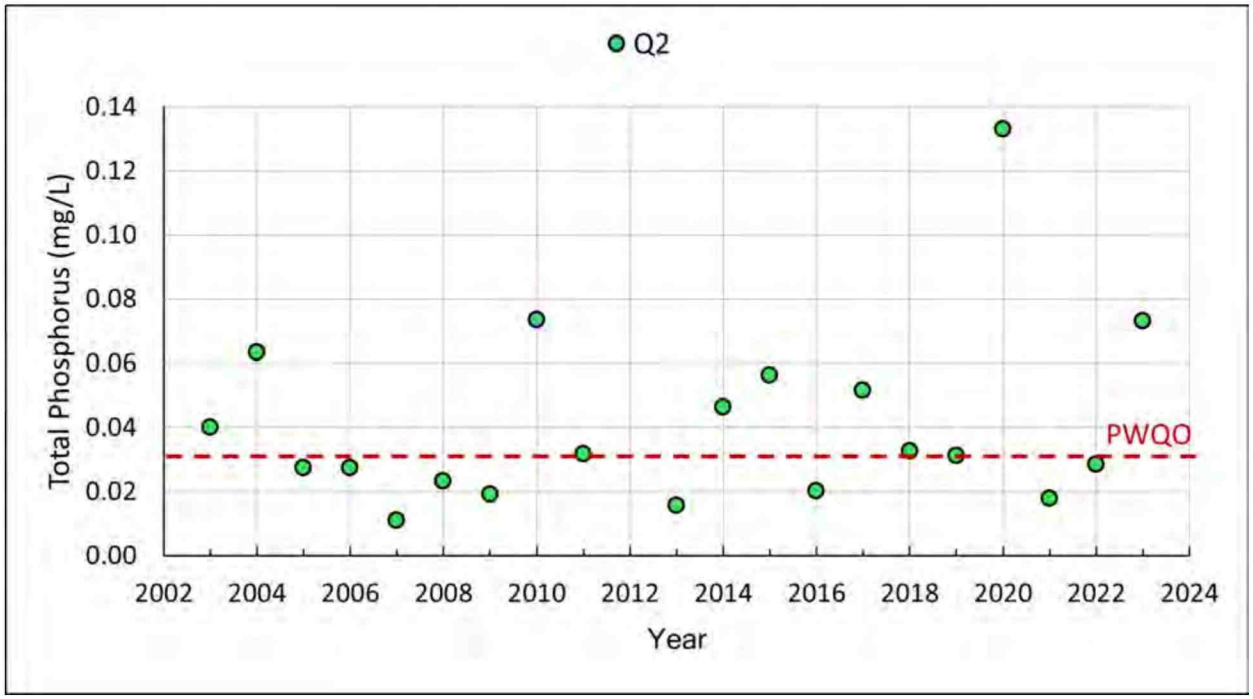

Figure K.6 2002 to 2023 Penetangore subwatershed annual average total phosphorus concentrations (mg/L) in graph format. Graph shows Q2 sampling site and a horizontal line indicating a PWQO of 0.03 mg/L. There are 11 exceedances of the PWQO.

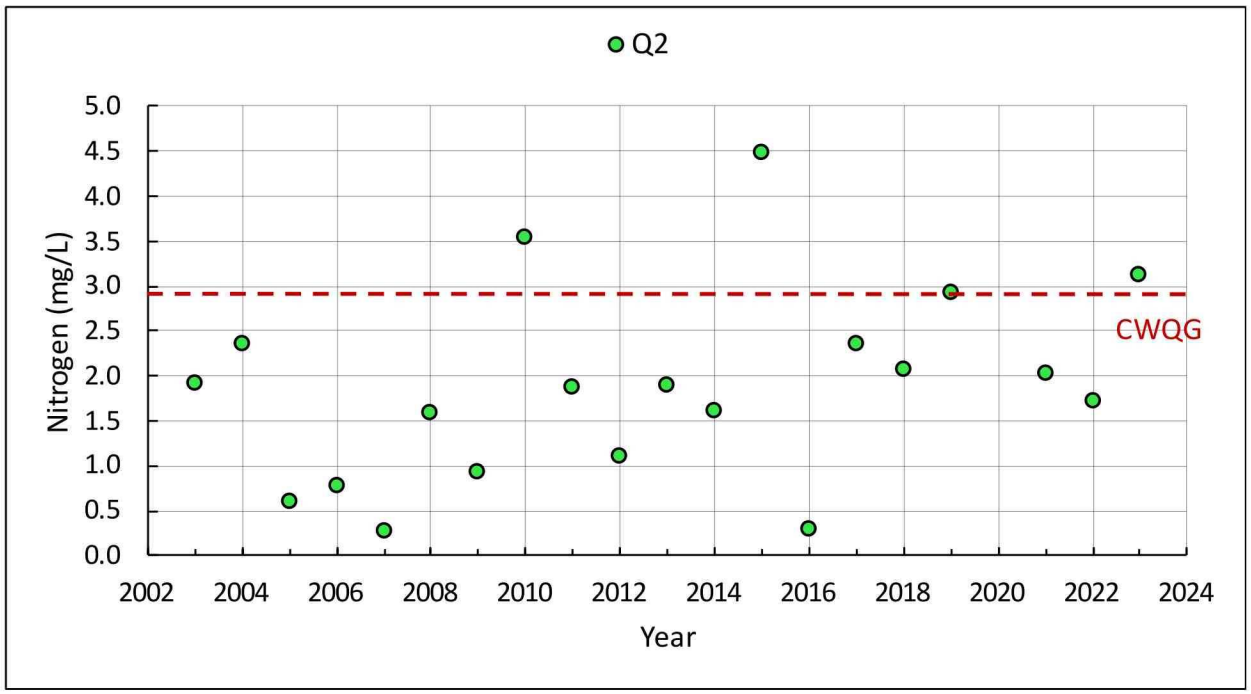

Figure K.7 2002 to 2023 Penetangore subwatershed annual average nitrogen concentrations (mg/L) in graph format. Graph shows Q2 sampling site and a horizontal line indicating a CWQG of 2.93 mg/L. There are 3 exceedances of the CWQG.

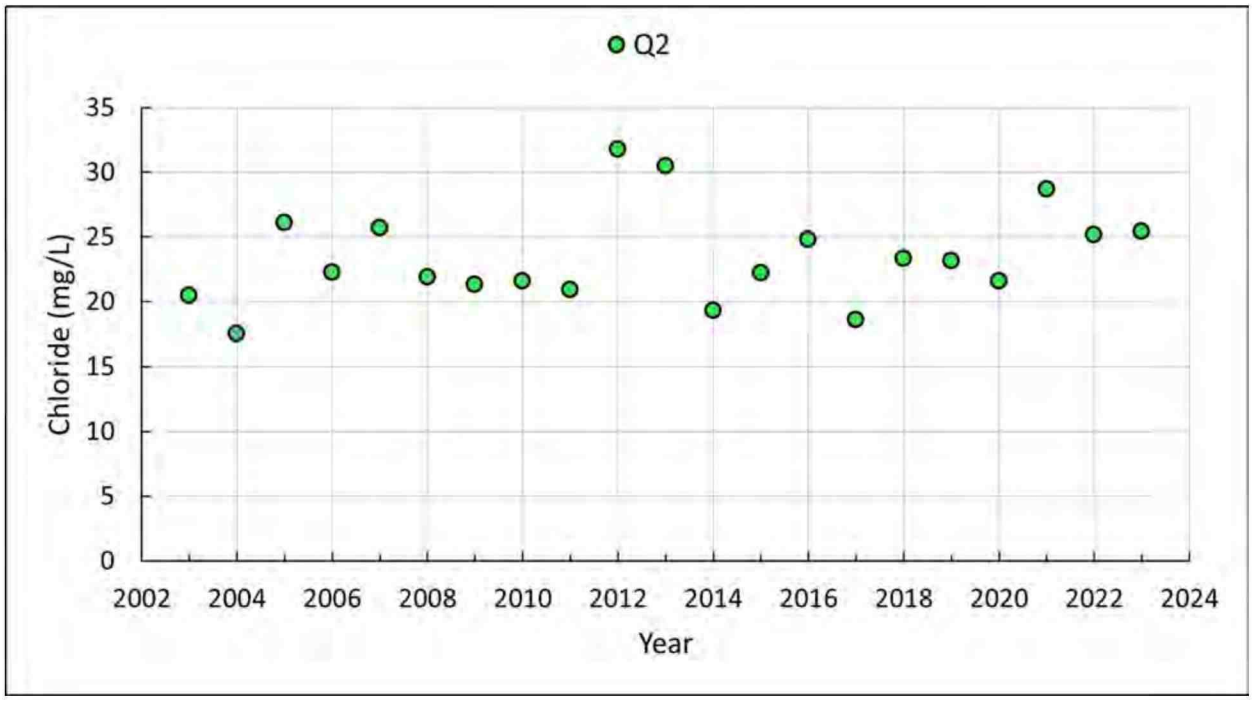

Figure K.8 2002 to 2023 Penetangore subwatershed annual average chloride concentrations (mg/L) in graph format. Graph shows Q2 sampling site. The CWQG is 120 mg/L. There are no exceedances.

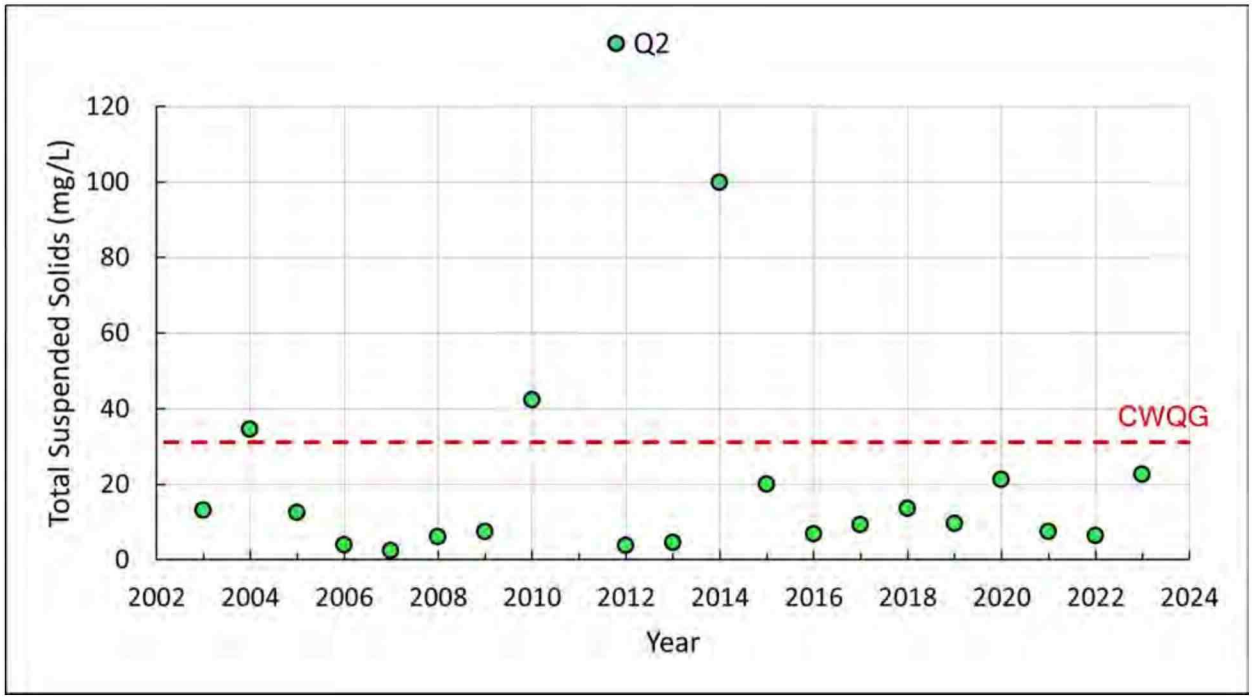

Figure K.9 2012 to 2023 Penetangore subwatershed annual average total suspended solids concentrations (mg/L) in graph format. Graph shows Q2 sampling site and a horizontal line indicating a CWQG of 30 mg/L. There are 3 exceedances of the CWQG.

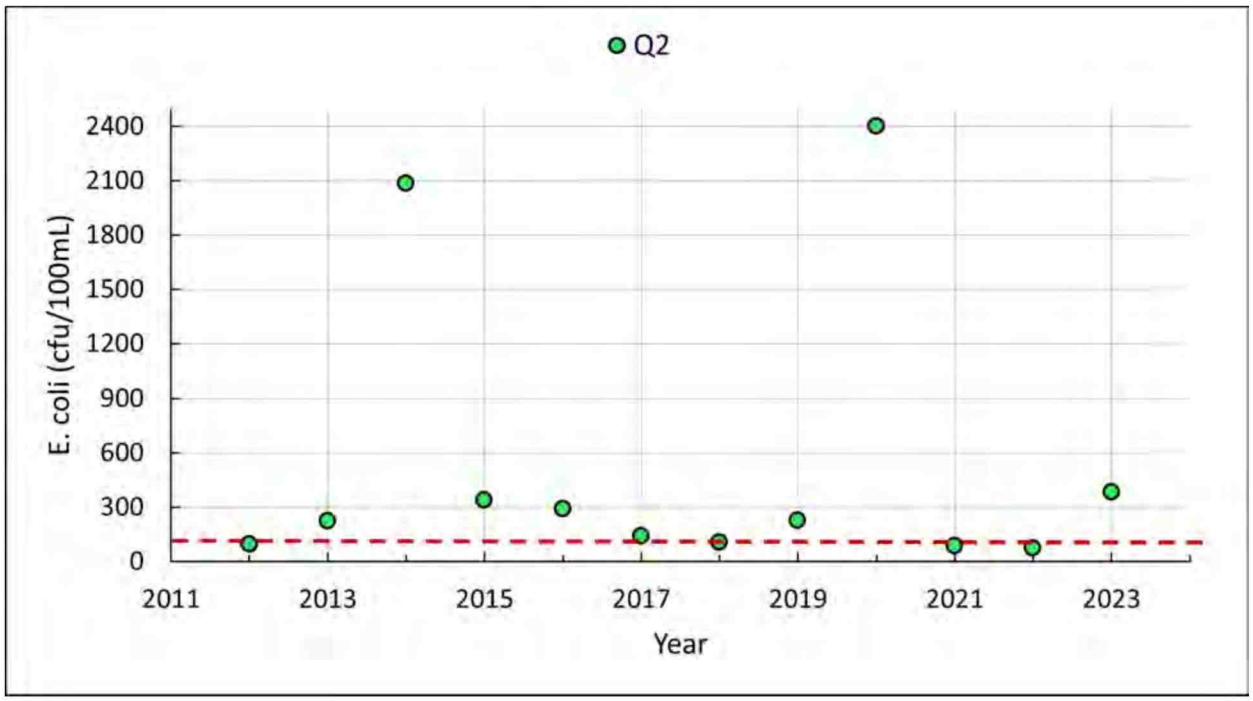

Figure K.10 2012 to 2023 Penetangore subwatershed annual average *E. coli* concentrations (cfu/100mL) in graph format. Graph shows Q2 sampling site and a horizontal line indicating a PWQO of 100cfu/100mL for swimming. There are 9 exceedances of the PWQO.

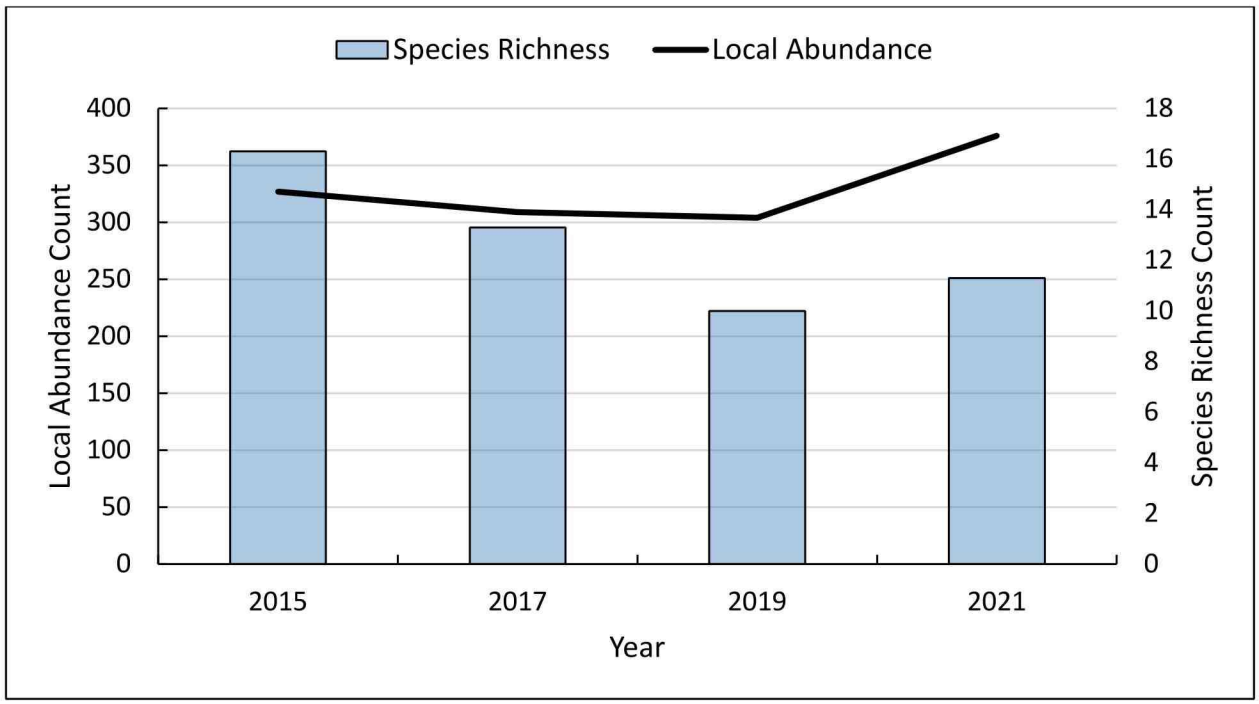

Figure K.11 Local abundance and species richness found within the Penetangore subwatershed from 2015 to 2021.

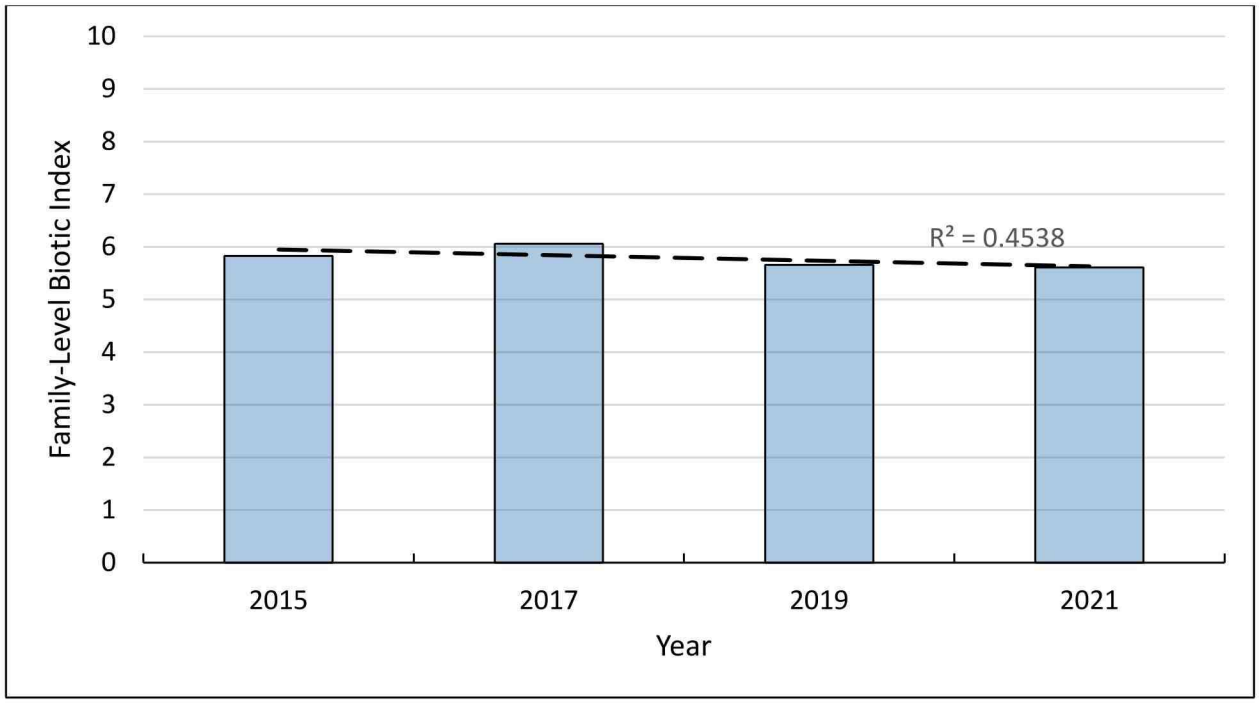

Figure K.12 Family-level biotic index scores for the Penetangore subwatershed from 2015 to 2021.