

Skagit County Monitoring Program



Annual Report

2019 Water Year
(October 2018 – September 2019)



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Definitions

Ag-CAO	-	Critical Areas Ordinance: Ongoing Agriculture
Ag-NRL	-	Agricultural Natural Resource Lands
BMP	-	Best Management Practice
County	-	Skagit County
CSI	-	Clean Samish Initiative
CV	-	Coefficient of Variation
DO	-	Dissolved Oxygen
Ecology	-	Washington State Department of Ecology
EPA	-	Environmental Protection Agency
FC	-	Fecal Coliform
GMHB	-	Growth Management Hearings Board
MPN	-	Most Probable Number
NH3	-	Ammonia
NO3+NO2	-	Nitrate + Nitrite
NTU	-	Nephelometric Turbidity Units
OP	-	Ortho-Phosphorous
pH	-	Power of Hydrogen
PIC	-	Pollution Identification and Correction
QAPP	-	Quality Assurance Project Plan
RR-NRL	-	Rural Resource Natural Resource Lands
RSD	-	Relative Standard Deviation
SCC	-	Skagit County Code
SCMP	-	Skagit County Monitoring Program
7-DADMax	-	7-Day Average of Daily Maximum Temperatures
SRC	-	Site Report Card
TKN	-	Total Kjeldahl Nitrogen
TMDL	-	Total Maximum Daily Load
TP	-	Total Phosphorous
TSS	-	Total Suspended Solids
VSP	-	Voluntary stewardship Program
WQI	-	Water Quality Index
WRC	-	State of Washington Water Research Center
WY	-	Water Year



Skagit County Water Quality Monitoring Program – 2019 Water Year Annual Report

Executive Summary

Skagit County Public Works has completed the sixteenth year of water quality monitoring under the Skagit County Water Quality Monitoring Program, and this is the 16th annual report, for the 2019 water year. This program was established to help determine if the Skagit County Critical Areas Ordinance for Ongoing Agriculture (SCC 14.24.120) was sufficient to protect water quality in areas of ongoing agriculture. Forty monitoring stations were established in agricultural areas as well as reference locations outside of the agricultural zones. Monitoring began in October 2003 and is continuing. Reports are published after each water year (October 1- September 30).

Data collected during this project indicates that many Skagit County streams, within and outside of the agricultural areas, do not meet state water quality standards for fecal coliform, temperature, and/or dissolved oxygen. None of the 40 sites has met all water quality standards for the entire project, although some sites meet the standards most of the time. The standards are developed to protect salmonid populations, recreation, and downstream shellfish resources, so streams not meeting the standards represent less-than-ideal conditions for those uses. Conditions in Skagit County streams range from watercourses with occasional failures to a pattern of continual inability to meet the standards. The Samish and Skagit Rivers have shown drastic improvement and a strong ratio of positive trends over the course of this program. Most of the substandard water quality occurs in slow-moving agricultural sloughs and in creeks that have low flow in the warmer months. Further investigation is ongoing to determine the causes of poor water quality in each case. Some cases may represent natural conditions rather than human-caused problems.

Based on court decisions that the Growth Management Act requires protection, but not restoration, of critical areas, the county uses trends monitoring as a method to determine whether water quality conditions are deteriorating in the county. Trends analysis for the 16 years of the program, alongside trends analysis of the last ten years and the last five years, reveals a mixed pattern of beneficial and deleterious trends both inside and outside of the agricultural areas.

Although county-wide trends in dissolved oxygen, water temperature, and fecal coliform count over 16 years reveals 23 positive trends and 21 negative, trend totals from the most recent five and ten years are starkly different. Looking at these same three metrics across their five and ten year timelines, positive trends massively outnumber negative, 75 to 13. Of all sites, the Samish River has shown the most remarkable improvement in the program. Of 16 significant trends at the upstream site of the Samish River, all 16 were positive. Of 19 significant trends at the downstream site of the Samish River, 17 were positive.



In looking at comparison of upstream and downstream measurements, a site that stood out from the rest for deterioration of water quality was the downstream sampling site of Hansen Creek. The downstream site had the worst percentage of positive trends in this report, with 8 percent positive, and 92 percent negative. In contrast, and being only roughly two miles away, 83 percent of significant trends at the upstream site of Hansen Creek were considered positive. The stretch of land between these two sites has been the target of ongoing restoration efforts and data from this program can aid in effectiveness monitoring.

Skagit County data has also proved useful to Ecology in their water cleanup (Total Maximum Daily load or TMDL) efforts, especially the Samish Bay Watershed Fecal Coliform TMDL. Skagit County, in cooperation with many local and state partners through the Clean Samish Initiative, is comprehensively addressing pollution in the Samish Bay Watershed. The County has received Environmental Protection Agency funding to address Samish Bay Watershed pollution issues and is working in partnership with the Washington State Department of Ecology (Ecology), the Skagit Conservation District, local tribes, and other partners in locating properties with possible pollution sources and seeking cooperative solutions to those problems.

Ecology used Skagit County data from the South Fork Skagit River to determine that additional monitoring for the County's National Pollutant Discharge Elimination System (NPDES) Phase II Stormwater Permit was not necessary. In most cases, water bodies with TMDLs require additional monitoring in association with the stormwater permits, but County data showed that the South Fork Skagit had improved substantially since the TMDL went into effect, and that additional stormwater monitoring was not necessary at the time of permit issuance.

Trends in fecal coliform reduction county-wide are overwhelmingly positive over all three analyzed time periods, and can only be a result of the hard work and dedication of the residents, farmers, tribes, government, environmental groups, establishing and enforcing strong regulations, and continued vision for a clean and sustainable environment that the citizens of Skagit County and the state of Washington continually portray. These improvements in water quality will continue to shine as an example for other communities and states across the country.

County staff participate in local and regional technical groups and in training of volunteer monitoring groups. Skagit County staff sponsor many community outreach events and participate in other events organized by partner organizations. Staff also give numerous presentations throughout the year to interested organizations.

It is the intention of the author that this new format of report be used as the means to sit down and form action plans to address trends in watercourses and sampling sites. The site report cards (SRCs), trends maps, and tabled trends summaries can paint a picture of the overall water quality at each site, in an effort to inform future action and to most efficiently direct public resources and efforts.



The Skagit County Water Quality Monitoring Program has now collected 16 years of high-quality data. Questions on the program can be addressed to Kevin Jackman at kevinj@co.skagit.wa.us or 360-416-1443.

Skagit County Monitoring Program Annual Report

2019 Water Year
(October 2018-September 2019)

Introduction

The Skagit County Monitoring Program (SCMP) began in October 2003 as part of Skagit County's (County) program to assess the effectiveness of Skagit County Code (SCC) Chapter 14.24.120: Critical Areas Ordinance for Areas of Ongoing Agriculture (Ag-CAO). The revised ordinance (Skagit County Ordinance O20030020) was passed by the Skagit County Board of Commissioners in June 2003 in response to a compliance order from the Western Washington Growth Management Hearings Board (GMHB).

The ordinance requires farmers to “do no harm” to adjacent watercourses and relies on specific watercourse protection measures and more generalized best management practices (BMPs) to protect the watercourses instead of requiring buffers. The associated Skagit County Resolution R20030210 committed the County to conduct water quality monitoring in the agricultural areas as one method of assessing if the ordinance was sufficient to protect the aquatic resources in agricultural areas. The resolution was subsequently amended in June 2004 as Resolution R20040211 in response to additional compliance orders from the Western Washington GMHB. This second resolution provided details about the water quality monitoring program in addition to other topics not associated with water quality. Included in R20040211 is the requirement for annual reporting on the water quality monitoring program. This document is intended to satisfy that requirement for the 2019 Water Year (WY).

R20040211 also required the County to conduct a triennial review of the Ag-CAO, including the water quality monitoring program, to seek public comment and to make changes if necessary. However, the State of Washington passed SSB 5248 in 2007, which placed a “time out” on changes to critical areas regulations impacting agriculture until 2010, while the statewide issues regarding agricultural regulation were studied. The legislature subsequently passed additional legislation to extend the “time out” to 2011. In 2011, the Washington State Legislature adopted the recommendations from one research group studying the critical areas regulations and created the Voluntary Stewardship Program (VSP). Skagit County enrolled in the program in 2012. Any county that enrolled agreed to maintain existing critical areas protections and ensure streams are protected using voluntary measures.

Sampling Locations

Figure 1 is a map with the sampling sites monitored by the SCMP, while **Table 1** and **Table 2** list the sampling site's names and their designations. Forty sites are currently included in the program. These sites are located primarily in agricultural zones, designated by the County as Agriculture-Natural Resource Lands (Ag-NRL) and Rural Resource-Natural Resource Lands (RR-NRL). Other sites were selected to provide context to, and comparisons with, the sites in the agricultural zones. These include sites located just upstream or downstream of agricultural areas or in streams draining suburban watersheds. The SCMP was designed to determine current conditions and long-term trends in water quality at these sampling locations. The data is also suitable for determining compliance with state water quality standards.

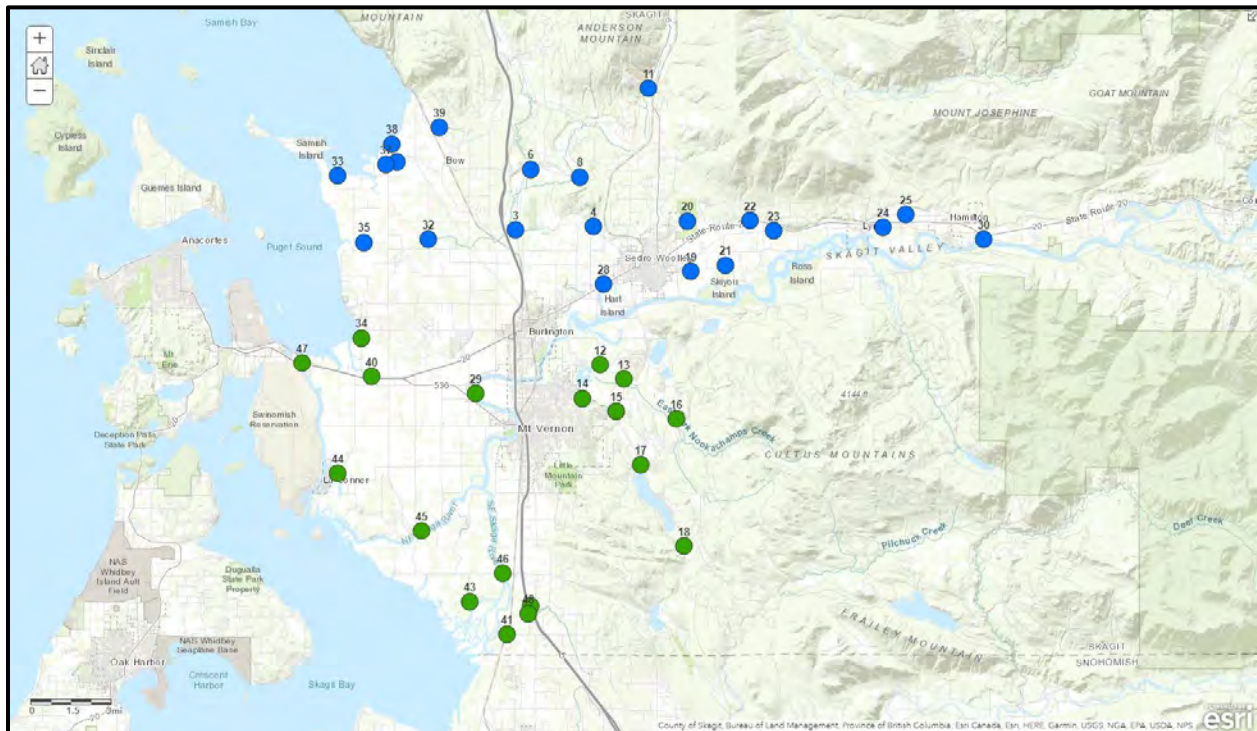


Figure 1 – Ambient sampling sites in the SCMP

A secondary purpose for some of the sites included in the SCMP is to provide data to the Washington State Department of Ecology (Ecology) in support of their Total Maximum Daily Load (TMDL) or water cleanup programs in Skagit County. The sites that provide TMDL data are also in the agricultural zones and are integral to the determination of trends and conditions in those areas. Active water cleanup plans in Skagit County include the Lower Skagit Tributaries Temperature TMDL, the Samish Bay Watershed Fecal Coliform TMDL, and the Lower Skagit River Fecal Coliform TMDL. Improvements made as a result of the



latter program indicate that the Lower Skagit River is a candidate for removal from Ecology's Impaired Waters list.

Table 1 - Sample site locations and types in the SCMP

Site Number	Watercourse	Location	Latitude	Longitude	Site Type ¹
3	Thomas Creek	Old Hwy 99 N	48.526	-122.339	3
4	Thomas Creek	F&S Grade Rd	48.528	-122.276	2
6	Friday Creek	Prairie Rd	48.559	-122.327	4
8	Swede Creek	Grip Rd	48.555	-122.287	3
11	Samish River	State Route 9	48.602	-122.231	1
12	Nookachamps Creek	Swan Rd	48.454	-122.270	3,6
13	E.F. Nookachamps Creek	State Route 9	48.446	-122.251	3,6
14	College Way Creek	College Way	48.436	-122.286	4
15	Nookachamps Creek	Knapp Rd	48.429	-122.258	2,6
16	E.F. Nookachamps Creek	Beaver Lake Rd	48.424	-122.208	2,6
17	Nookachamps Creek	Big Lake Outlet	48.400	-122.237	1,6
18	Lake Creek	State Route 9	48.356	-122.202	1,6
19	Hansen Creek	Hoehn Rd	48.504	-122.197	3,6
20	Hansen Creek	Northern State	48.531	-122.199	1,6
21	Coal Creek	Hoehn Rd	48.507	-122.169	3
22	Coal Creek	Hwy 20	48.531	-122.149	1
23	Wiseman Creek	Minkler Rd	48.526	-122.130	1
24	Mannser Creek	Lyman Hamilton Hwy	48.528	-122.041	2
25	Red Cabin Creek	Hamilton Cem. Rd	48.534	-122.023	1
28	Brickyard Creek	Hwy 20	48.497	-122.268	4
29	Skagit River	River Bend Rd	48.439	-122.372	5,6
30	Skagit River	Cape Horn Rd	48.521	-121.960	5
31	Drainage Dist 20 floodgate	Francis Rd	48.445	-122.317	3
32	Samish River	Thomas Rd	48.521	-122.410	3
33	Alice Bay Pump Station	Samish Island Rd	48.555	-122.483	3
34	No Name Slough	Bayview-Edison Rd	48.468	-122.464	3
35	Joe Leary Slough	D'Arcy Rd	48.520	-122.462	3
36	Edison Slough at school	W. Bow Hill Rd	48.562	-122.436	3
37	Edison Pump Station	Farm to Market Rd	48.561	-122.444	3
38	North Edison Pump Station	North Edison Rd	48.572	-122.441	3
39	Colony Creek	Colony Rd	48.581	-122.401	2
40	Big Indian Slough	Bayview-Edison Rd	48.447	-122.457	3
41	Maddox Slough/Big Ditch	Milltown Rd	48.309	-122.346	3
42	Hill Ditch	Cedardale Rd	48.324	-122.327	3
43	Wiley Slough	Wylie Rd	48.326	-122.372	3
44	Sullivan Slough ²	La Conner-Whitney	48.395	-122.485	3
45	Skagit River – North Fork	Moore Rd	48.364	-122.416	5,6
46	Skagit River – South Fork	Fir Island Rd	48.342	-122.349	5,6
47	Swinomish Channel	County Boat Launch	48.455	-122.512	7
48	Fisher Creek	Franklin Rd	48.320	-122.328	3,6



¹See Table 2 for site type descriptions

²Site 44 was moved to its current location in June, 2005. See text for details

Table 2 - Sample site type descriptions for the SCMP

Site Type Number	Description	Number of Sites¹
1	Ag-upstream: Located to determine status/trends at upstream end of agricultural areas.	6
2	Ag-midstream: Located to determine status/trends in the middle of agricultural areas.	6
3	Ag-downstream: Located to determine status/trends at downstream end of a watercourse in agricultural areas.	20
4	Reference: Located to determine status/trends in a non-agricultural area, such as urban/suburban or rural reserve, for comparison with agricultural area results.	3
5	Skagit River: Located to determine status/trends in the mainstem Skagit River or the forks. The Skagit may show effects from a wide variety of sources.	4
6	TMDL: Located to provide information for the Department of Ecology's TMDL efforts.	12
7	Swinomish Channel: Located to provide a water quality baseline for Swinomish Channel	1

¹Some sites have more than one type designation

Sample Site Revisions

Nineteen of the 40 sites (sites 3-25) are continued from the Skagit County Baseline Monitoring Project (Skagit County 2004a). The Baseline project used nearly identical methods to monitor water quality at 27 sites. Five additional sites were part of the Samish Bay Watershed Water Quality Monitoring Program (Skagit County 2003). The data from the Baseline and Samish Projects is used to help interpret trends in water quality for sites continued in the SCMP. Not all of the Baseline sites could be continued into the current program due to limited resources and the need to expand the current program into the Skagit Delta, where there were no Baseline sites. Several intermediate sites on the Samish River were discontinued, leaving one upstream and one downstream site on the Samish.

Three sample sites were moved from their original locations as delineated in the Quality assurance Project Plan (QAPP). Site 35 on Joe Leary Slough was moved approximately 3,500 feet upstream from Bayview-Edison Road to D'Arcy Road to solve right-of-entry problems. Site 40 on Big Indian Slough was moved approximately 2,800 feet upstream to solve right-of-entry problems and to move away from the tide gate and associated saltwater intrusion. These



two changes were made prior to any sampling. Site 42 on Hill Ditch/Carpenter Creek was moved approximately 4,300 feet upstream because the original site at Pioneer Highway was subject to backwater from the Skagit River, and in early samples it was determined that primarily Skagit River water was being sampled instead of Hill Ditch/Carpenter Creek water. These changes were approved by Ecology as revisions to the QAPP in 2003 and 2004.

In June 2005, the sample site at Rexville Pump Station (Site 44), at the east end of the Sullivan Slough watershed, was moved to the west end of Sullivan Slough, at La Conner-Whitney Road. This move was made in consultation with Ecology and the Western Washington Agricultural Association. The majority of flow from that system discharges through the west end into Swinomish Channel. The Rexville Pump Station site was initially chosen because it was cited as a possible fecal coliform source in the Lower Skagit Fecal Coliform TMDL (Pickett 1997). However, fecal coliform (FC) readings at the site during this study were generally low, and coupled with the infrequent discharges from the pump station, it was determined that sampling efforts would be better spent nearer the outlet of the slough.

For the 2017 season, Skagit County re-designated two sites to better reflect current land use patterns: Site 16 (East Fork Nookachamps Creek) was moved from Ag-Upstream to Ag-Midstream due to some agricultural activity directly upstream of the sample location. Site 23 (Wiseman Creek) was moved from Ag-Midstream to Ag-Upstream due to the cessation of agricultural activities upstream of the sample location.

Results from the first fifteen years of this program have been reported previously (Skagit County 2004-2017). This current report contains data and analysis from water years 2004 – 2019.

Sampling Frequency

Ambient Sampling

Weekly or bi-weekly sampling on a regular schedule is often referred to as ambient sampling to distinguish it from storm sampling, which takes place in response to heavy rain events. All ambient sampling trips were conducted on schedule during the 2019 water year, beginning in October 2018. Sampling normally took place on Tuesdays, but took place on other days to accommodate holiday and workplace schedules. Occasionally, samples are taken on different days due to flooding or other acts of nature.

Storm Sampling

As part of its Pollution Identification and Correction (PIC) Program, Skagit County conducts additional water quality sampling in the Samish Basin during significant rain events. Data collected during these rain events is not included in the tabulation of ambient sampling events to preclude undue influence of storm events on ambient trends analysis.



Clean Samish Initiative

The Clean Samish Initiative (CSI) was established by Ecology in the fall of 2008 to foster cooperation between local, state, tribal, and federal agencies, non-governmental groups, and citizens to address FC pollution in the Samish Bay Watershed. Excess FC pollution in the Samish River and other bay tributaries has resulted in numerous closures of the commercial shellfish beds in Samish Bay. The CSI participants (over 20 organizations) developed a work plan that included education and outreach, detailed water quality sampling to locate pollution sources, referrals of landowners to resource agencies for pollution abatement, and enforcement of water quality and land use regulations if necessary. Skagit County applied for and received EPA funding in 2010 to conduct a PIC project in the Samish Basin, incorporating CSI work plan elements into a program designed to locate and eliminate FC pollution in the Samish Basin.

The CSI grew out of Ecology's TMDL activities in the Samish Basin. Ecology sampling demonstrated that the Samish River was the largest source of FC bacteria to Samish Bay. While some of the independent Samish Bay tributaries (e.g. Edison Slough and Colony Creek) and agricultural drainages also contribute bacterial pollution to Samish Bay, the comparatively high discharge rate of the river combined with occasional high coliform counts determined that the river was, and continues to be, the most important pollution source for Samish Bay.

Numerous PIC water quality sampling, education, and outreach activities continued during the 2019 water year, and will be summarized in a separate CSI report. In addition, County staff, in cooperation with Ecology, have conducted site visits in areas where water quality sampling results indicate that pollution sources are present. These visits form the core of the PIC program and are summarized in the separate quarterly CSI reports, as well as the PIC Annual Report which can be found at the following link:

<https://www.skagitcounty.net/PublicWorksCleanWater/Documents/2019%20PIC%20Annual%20Report.pdf>

Water quality sampling in the Samish watershed consists of storm event sampling and investigatory sampling, in addition to the ambient sampling reported here. Storm event sampling consists of watershed-wide sampling during storm events in order to characterize the event and locate stream reaches with elevated FC counts. Investigatory sampling involves samples that may be taken in conjunction with investigations of specific areas or properties.

Recent sampling results for all sites, including those in the Samish Basin, are available at this site:

<http://nras.maps.arcgis.com/apps/MapJournal/index.html?appid=d191d07f2cbf47e9a54e78c78c06c1a8>



2008 Review by the State of Washington Water Research Center

Skagit County contracted with the State of Washington Water Research Center (WRC) for a review of its water quality program. The WRC Review Report draft was received in March, 2008, and the final report was received in June 2008. The report is available at: www.skagitcounty.net/SCMP.

Skagit County is implementing the report recommendations as the budget allows. Recommendations that have already been incorporated into the program include expansion of the sampling program to better identify pollution source locations (through the PIC program), increased use of stream discharge information, and some of the statistical analysis recommendations.

Funding

A proposal was submitted in February 2003 to Ecology for consideration in its FY 2004 Centennial Clean Water Grants program. The proposal was accepted and a grant of nearly \$500,000 was awarded to support five years of the monitoring program, fiscal year 2004 through fiscal year 2008.

The Centennial Clean Water Grant, that funded the program at 75%, ended in December 2008, with the remaining 25% having come from County funds. Work since that date has been funded by Skagit County's Clean Water Program (CWP). Skagit County has received some EPA funding to address Samish Bay watershed FC issues, but the core activities of the SCMP will continue to be funded out of the CWP.



Methods

Standard water quality monitoring methods are used in the SCMP. The methods are derived from several sources, including guidance from Ecology and the EPA. A brief description of monitoring procedures follows, and detailed monitoring procedures can be found in the QAPP developed for the program (Skagit County 2004b).

Each site in the monitoring program is visited every two weeks. At each visit, dissolved oxygen (DO), temperature, pH, turbidity, conductivity, and salinity are measured and samples are obtained for FC determinations. Additional water samples are obtained for laboratory quantification of plant nutrients (total nitrogen (TKN), ammonia (NH₃), nitrate (NO₃), nitrite (NO₂), total phosphorus (TP), orthophosphate (OP), and total suspended solids (TSS)) on a quarterly basis. Stream discharge was measured at selected sites as time and staffing permitted through 2008.

The sample routes are designed so that each station is visited at approximately the same time of day on each visit, to minimize the effects of diurnal variation in water quality parameters on overall data variability through the length of the program.

Data is collected on paper field sheets and later entered into an electronic database which is then checked for accuracy against the original data sheets. Microsoft Excel spreadsheets are used for data summary and analysis. These spreadsheets are also published on the County's web site: <http://www.skagitcounty.net/SCMP>

Data Analysis

Summary statistics for all measured parameters at each sampling site can be found in **Appendix B**. These statistics can be used as a general indication of water quality conditions at each station. However, water quality conditions vary greatly at each station over time and the summary statistics should not be used as a sole indicator of water quality.

A primary goal of the SCMP is to detect trends in water quality over time. The purpose of the trends analysis is to provide indications of whether water quality in agricultural areas is improving, staying the same, or deteriorating. Once trends are detected, efforts should be undertaken to determine if the they are caused by local activities or by regional conditions such as changes in climate. By comparing trends at stations inside and outside of the agricultural areas and by monitoring climate conditions, it should be possible to determine conditions that are likely caused by local circumstances.

One important statistical tool in trends monitoring is the Seasonal Kendall's Test. This test is designed to determine overall trends in water quality for parameters that vary seasonally, such as temperature and DO. The Seasonal Kendall's Test has been widely employed for similar purposes in Washington, Oregon, and throughout the country (e.g. Cude 2002, Ehinger 1993,



Holdeman et al 2003). Most parameters measured in the SCMP have seasonal variation, caused by our local climate, which produces comparatively high water flows and low temperatures in the winter and spring, and lower flows with higher temperatures in the summer and early fall.

The Seasonal Kendall's Test for this report was computed using WQStat Plus software (Intelligent Design Technologies, 1998). For most analyses, twelve seasons were designated, starting with the beginning of each month. This approach was recommended in the review of the SCMP by the WRC. Observations below detection limits were replaced with one-half of the detection limit per the software user manual. The software was able to ignore missing data, so no accommodation for missing data was necessary.

The SCMP completed trends analysis via the Seasonal Kendall's Test for 18 key parameters or calculated factors at each sampling location. The parameters tested include pH, DO, DO% saturation, temperature, turbidity, FC, NH₃, NO₃+NO₂, TP, OP, TKN, and TSS. Temperature data from biweekly sampling visits were used for this analysis instead of continuous data collected during the summer months because the test is not designed for summer-only data. Skagit County continues to examine methods for determining trends in the continuous temperature data. Since the temperature data from bi-weekly visits was collected at the same time of day for any individual station, the trends analysis should not be biased by differences caused by sampling time of day.

Three periods were analyzed for trends in this report: The 16 full years of SCMP data, the most recent ten years of data, and the most recent five years of data. Analyzing trends over three different timeframes allows for a more detailed picture of what changes have been occurring across the county. For example, a creek may exhibit a small trend in increasing DO from 16 years ago as compared to now, but it may also show a strong trend in decreasing DO from five years ago as compared to now. Analyzing a combination of time periods reveals a clearer picture of what is happening than can be ascertained from a single trend over the course of 16 years.

Several sites have extended dry periods during most summers and/or are flooded during high water events and not sampled. The WQStat trends analysis program was unable to compute trends based on 12 seasons for those sites due to the consistent lack of data for the dry or flooded periods. For those sites, trends were calculated based on four seasons, beginning in January, April, July, and October. All trends analyses on plant nutrient data mentioned above are also performed using four seasons, as these are only sampled quarterly.

Data used for the Seasonal Kendall's Test can be subject to autocorrelation, where each successive data point is correlated with the previous point. This situation usually occurs when samples are collected more frequently than monthly. For the SCMP, DO, temperature, and FC data are collected biweekly. Tests are available to detect autocorrelation, but in some cases may be confounded by the very seasonality we are trying to accommodate. Our approach for these parameters has been to conduct the analysis using all data, and repeat the analysis using monthly averages to avoid autocorrelation. In the cases where there are differences, it would



probably be prudent to use the monthly averages. All trends shown on the Site Report Card (SRC) section of this report are the monthly averages.

A summary of Seasonal Kendall's Test results for all parameters, significant or not, can be found in Appendix C.

Data Quality

Quality Assurance Project Plan (QAPP)

The SCMP operates under a QAPP that was approved by Ecology in 2003. This plan details sampling strategies, equipment to be used, and all other aspects of the sampling program. Ecology approval of the QAPP was required in order for Skagit County to be eligible for grant funds. The plan forms the basis for all sampling activities and may be viewed at:

<https://www.skagitcounty.net/PublicWorksSurfaceWaterManagement/Documents/QAppFinal103003.pdf>

Equipment Calibration and Maintenance

The turbidity meter (Lamotte Model 2020we) is calibrated the afternoon before or the morning of each sampling trip, and the reading before calibration is recorded.

The pH meter (Hanna Instruments Model 8314) is calibrated on the morning of each sampling trip. The pH meter is recalibrated during the trip if questionable results are obtained.

The DO/temperature/conductivity meter (YSI Model 2030 Pro) is calibrated for DO using the built-in calibration chamber (water-saturated air). The meter is recalibrated to local elevation at each sample site prior to sampling.

The DO meter probe is deployed in areas with sufficient current (> 0.5 fps) to produce reliable results, or the probe is stirred to produce adequate velocity across the membrane. Samples for pH and turbidity are obtained from the thalweg of the stream whenever possible with sample containers rinsed at least three times with sample water, and are analyzed immediately.

Lab Samples

Laboratory samples for nutrients are collected using clean equipment and proper procedures, collected with a sampling wand from the thalweg of the watercourse, and care is taken to prevent oversampling of the surface film or disturbing the bottom. The sampling container is rinsed at least three times with the water to be sampled. The sample is then poured into the bottles provided by the contract lab, Edge Analytical of Burlington, WA, an Ecology-certified



laboratory. Samples are capped and placed in a cooler with ice until they are picked up by the lab on the same day.

Samples for FC are collected directly into sterile bottles and transported under ice to the laboratory within eight hours of collection.

Personnel

The project manager performs the majority of samplings that generate data for this report. Any other staff that perform samplings and collections are adequately trained by the project manager according to EPA-approved sampling methods prior to sampling. Due to regular staff turnover and availability of assisting staff members, some staff may collect sample data only once, though repeated participation and experience with the project manager is preferred when possible.

Duplicate Analysis

Duplicate samples are collected for FC at a 20% rate and for selected nutrients at a 10% rate. Selected nutrient duplicates (TP, OP, NO₃, and/or NH₃) are intended to provide a precision estimate for all the nutrient analyses.

Table 3 summarizes the results of the duplicate analyses for the 2019 water year, using the coefficient of variation (CV) statistic. Variability in FC was above target level, but similar or slightly better than what was seen in previous years. The reason for the higher nitrate variability is from one large discrepancy of 3.33 to 0.22 of one duplicate, out of a collection of only three duplicates total. In this report, coefficient of variation is considered synonymous with relative standard deviation (RSD).

The high variability of the FC results is at least partially due to the use of the Most Probable Number (MPN) analysis technique. This method was chosen for the SCMP because the Skagit County Health Department laboratory was certified for the method, and because it is reportedly more reliable for samples with high turbidity, which are often encountered in the SCMP (Michaud 1991). The program continued using MPN when it switched to Edge Analytical in 2009 to maintain data comparability. Fecal coliform variability in the SCMP, although higher than the initial target level, is similar to that seen in other studies in Washington.



Table 3 - Data quality duplicate analysis for 2019 Water Year

Parameter	n	Coefficient of Variation (CV %)	
		2018 Results	Target
Fecal Coliform	207	39.9	33 ¹
Total Phosphorus	8	10.3	10 ²
Orthophosphate	6	0.0	10 ²
Nitrate	3	44.3	10 ²
Ammonia	10	8.2	10 ²

¹ Target precision as listed in QAPP

² 10% CV target was listed for all nutrients



Data Summaries and Trends Analysis

Trends were calculated for 30 measured or calculated parameters (such as monthly averages) at each of 39 sites, for a total of 1,170 tests. Of those, 509 tests showed a statistically significant trend at the 95% confidence level. Trends judged as improving or positive (e.g. increased dissolved oxygen, reduced temperature) made up 313 of the significant trends, or 61.5 percent. Negative or deleterious trends (e.g. reduced dissolved oxygen, increased nutrients) accounted for 196, or 38.5 percent of the significant trends. The implications of changes in pH for watercourses are not clear at this point, but in relation to the global trend in acidification of surface waters, declining pHs were considered as negative trends for this report. There were also statistically significant nutrient trends where the slope was zero. The statistical analysis used was very sensitive, and a slope of zero simply means that the slope was less than 0.0001 units, though the directionality as positive or negative was still given.

All trends can be found in the tables in **Appendix C**. Positive significant trends are shaded green and negative are shaded red. Trends that achieved 95% confidence in statistical significance are shaded the darkest blue. Some trends were very close to achieving 95% confidence, but fell short. Trends that achieved 90% confidence are shaded in a slightly lighter blue, and trends that achieved 80% confidence in even lighter blue. This helps to inform the reader of all changes that may be occurring at the sampling site, even if they are not statistically significant at a 95% confidence level. Any parameters that showed a significant trend with a slope of 0 are highlighted in yellow.

Trend statistics are tools to help us understand changing conditions in our watercourses, but do not completely describe the condition of a watercourse. Many of the sites with no significant trends or improving trends in water quality parameters still do not meet state water quality standards, and therefore still qualify as areas of concern. Many Skagit County sites remain on Ecology's Impaired Waters list. As previously discussed, high FC levels in the Samish Bay watershed have led to closures of shellfish beds and loss of revenue for shellfish growers. Dissolved oxygen and temperature conditions are still substandard in many watercourses, resulting in less than ideal rearing conditions for salmonids and other aquatic life.

Gaps in the data represent streams that were either flooded or dry at sampling time, or may represent equipment malfunctions.



Temperature

Water temperature governs the metabolic rate of aquatic organisms. Excessive temperature can serve as a stress on fish and other cold-water organisms, and extreme temperatures can be lethal.

Background

For the water years 2004-2007 and 2009-2019, temperatures were measured with Stowaway Tidbit® data loggers from Onset Computer Company. These devices were set to measure water temperature every half hour. They are normally deployed in late June and retrieved in early September. During those years, several of the data loggers went missing by the end of each monitoring period. Some may have been lost due to channel changes associated with heavy rains in late summer, while others may have been vandalized. For the 2008 water year, a computer programming error resulted in the data loggers measuring temperature for only two weeks in late June and early July. Since annual peak temperatures occur later in the summer, the 2008 data logger data was not very useful. Readers interested in the continuous temperature data collected in 2004-2007 can access those graphs in the 2007 Water Year Annual Report at this web address: www.skagitcounty.net/scmp.

In the fall of 2006, Ecology revised its water quality standards (WAC 173-201a) to comply with a request from the EPA. Included in this revision were several changes to temperature and DO standards for Skagit County watercourses. In particular, the lower Skagit River, Hansen, Nookachamps, Fisher, and Carpenter Creeks, and the upper Samish River and its tributaries were placed in the “Core salmonid spawning and rearing” use category. This change had the effect of imposing more stringent temperature and DO standards on these streams. Formerly, each of these streams was held to a 7-day average of the daily maximum temperatures (7-DADMax) standard of 17.5°C, but with the revised standards, these streams must now meet a 7-DADMax standard of 16°C. There were no changes to other streams in the county. Currently, Sites 3-4, 28, 31-44, and 48 are held to the 17.5 °C standard, while all other sites are held to the 16°C standard, including marine Site 47.

In addition to changes in the general standard, the revisions to the state temperature standards in 2006 also added spawning period temperature standards to some streams in the county. Portions of the Samish River, Friday Creek, Hansen Creek, Lake Creek, and East Fork Nookachamps Creek have a 13°C limit from February 15 to June 15 to protect steelhead spawning and egg incubation. The Skagit River upstream from Sedro-Woolley has a 13°C limit from September 1 through May 15 to protect spawning and egg incubation for several salmonids.

After a very dry 2015 water year and higher than normal precipitation in 2016, 2017 was characterized by a series of wetter and dryer than normal months. Overall precipitation was near normal for the entire year. The 2018 water year saw a return to below-normal precipitation. The 2019 water year was the driest overall year in the last ten, and would have



been worse, had it not been for the rainiest September in the sixteen-year history of this program occurring in the final month of the water year.

Results

Table 4 shows the daily maximum temperatures for the last five years of the study, based on data collected at bi-weekly samplings. Because the state water quality standards are based on 7-DADMax, the maximums reported on **Table 4** are not directly comparable to the state temperature standard, but are displayed here as an indication of the relative condition of each stream and for comparison of the temperature conditions from year to year.

Table 5 contains the 7-DADMax values for those sample sites where continuous temperature data is available. These data are directly comparable to the state water quality standards as described on the table and in the next paragraph.

Twenty-three dataloggers were deployed for the summer of 2019. Of these, four went missing or were not recoverable, two were out of the water for all of August due to abnormally low watercourse levels, and one was found damaged and had stopped recording at the end of June. The remaining 16 dataloggers were retrieved and their data analyzed. Of these, four of the sites recorded 7DADMax values passing state standards (**Table 5**). Temperature dataloggers are generally not deployed in agricultural drainage ditches.

Trends analyses reveal that in comparison to 16 years ago, at the start of this program, ten sites have shown an increase in temperature and one site has shown a decrease (**Figure 2**). Of these ten sites showing an increase, there is a notable concentration in the Nookachamps watershed. Looking at the map of trends from the most recent ten years (**Figure 3**), seven sites show an increase, while no sites show a decrease. These seven sites are located in the northern half of the county.

Trends from the most recent five years of data (**Figure 4**) show 24 sites significantly decreasing in temperature, with no sites showing a significant increase. A concentration of sites not showing this decreasing trend seem to be sites up the canyon and scattered throughout the Samish and Padilla watersheds. This observation seems to correlate well with the average annual air temperature dropping each year for the last five years, according to data from the Mount Vernon weather station provided by Washington State University's AgWeatherNet.

Ecology has developed temperature remediation cleanup plans (TMDLs) for Fisher, Carpenter, Nookachamps, and Hansen Creeks, but many other Skagit County streams also exceed temperature standards.



Table 4 – Maximum watercourse temperatures recorded from bi-weekly sampling

Site Number	Watercourse	Location	Highest daily temperature (°C)				
			2015	2016	2017	2018	2019
3	Thomas Creek	Old Hwy 99 North	20.1	19.6	19.2	18.4	17.8
4	Thomas Creek	F&S Grade Rd	16.6	15.9	15.3	14.9	14.8
6	Friday Creek	Prairie Rd	19.8	20.1	18.6	19.2	18.0
8	Swede Creek	Grip Rd	18.2	17.8	17.8	16.9	16.5
11	Samish River	State Route 9	14.6	14.1	13.5	13.2	13.6
12	Nookachamps Creek	Swan Rd	21.4	21.4	21.1	22.5	21.0
13	E.F. Nookachamps Creek	State Route 9	20.4	19.1	19.6	21.9	19.4
14	College Way Creek	College Way	18.0	17.7	17.3	19.0	16.7
15	Nookachamps Creek	Knapp Rd	21.8	21.8	22.0	22.7	20.1
16	E.F. Nookachamps Creek	Beaver Lake Rd	19.0	18.7	18.1	19.8	17.5
17	Nookachamps Creek	Big Lake Outlet	23.0	21.9	22.8	23.6	21.3
18	Lake Creek	State Route 9	17.2	16.3	16.3	18.1	16.4
19	Hansen Creek	Hoehn Rd	19.0	18.1	17.3	17.6	18.1
20	Hansen Creek	Northern State	15.6	15.3	15.3	15.4	14.9
21	Coal Creek	Hoehn Rd	16.9	16.1	15.7	15.2	15.6
22	Coal Creek	Hwy 20	15.5	14.6	15.3	15.2	15.3
23	Wiseman Creek	Minkler Rd	14.1	15.2	15.0	14.1	14.2
24	Mannser Creek	Lyman Ham. Hwy	12.5	12.1	12.5	11.9	12.5
25	Red Cabin Creek	Hamilton Cem. Rd	13.9	11.8	11.7	11.2	11.9
28	Brickyard Creek	Hwy 20	14.9	16.7	14.5	14.3	14.7
29	Skagit River	River Bend Rd	17.6	16.6	15.9	16.2	16.0
30	Skagit River	Cape Horn Rd	16.3	14.8	15.3	15.4	15.6
31	DD20 near floodgate	Francis Rd	13.7	15.2	10.8	ND	ND
32	Samish River	Thomas Rd	21.6	20.7	20.1	19.3	18.8
33	Alice Bay Pump Station	Samish Island Rd	25.9	23.4	22.7	25.0	22.1
34	No Name Slough	Bayview-Edison Rd	21.1	25.9	21.5	27.0	25.3
35	Joe Leary Slough	D'Arcy Rd	21.8	20.5	20.3	21.3	21.4
36	Edison Slough at school	W. Bow Hill Rd	30.1	27.6	27.0	30.2	28.3
37	Edison Pump Station	Farm to Market Rd	26.8	26.3	23.6	25.5	23.3
38	North Edison Pump Sta.	North Edison Rd	26.1	22.4	22.2	24.4	22.3
39	Colony Creek	Colony Rd	18.1	17.1	16.6	17.4	15.3
40	Big Indian Slough	Bayview-Edison Rd	18.7	17.3	19.4	19.5	18.3
41	Maddox/Big Ditch	Milltown Rd	22.0	21.4	22.4	21.7	21.4
42	Hill Ditch	Cedardale Rd	21.7	21.3	22.0	20.8	20.9
43	Wiley Slough	Wylie Rd	21.2	20.1	19.6	27.2	20.2
44	Sullivan Slough	La Conner-Whitney	19.6	18.1	20.0	18.3	16.7
45	Skagit River – N. Fork	Moore Rd	18.1	17.3	16.4	16.4	17.0
46	Skagit River – S. Fork	Fir Island Rd	18.3	17.7	16.7	16.7	17.0
47	Swinomish Channel	County Boat Launch	16.8	17.0	18.5	16.1	16.2
48	Fisher Creek	Franklin Rd	14.3	13.4	13.5	15.3	14.0

Data from biweekly site visits



Table 5 – Seven-day average of the daily maximum temperatures (7-DADMax)

Site Number	Watercourse	Location	7-DADMax (°C)				
			2015	2016	2017	2018	2019
3	Thomas Creek	Old Hwy 99 North	21.5	21.2	20.2	20.2	n/a
4	Thomas Creek	F&S Grade Rd	17.8	16.7	16.1	17.0	16.5
6	Friday Creek	Prairie Rd	22.9	21.6	n/a	22.6	21.3
8	Swede Creek	Grip Rd	20.4	18.4	17.6	19.0	17.8
11	Samish River	State Route 9	15.4	14.8	14.8	14.8	n/a
12	Nookachamps Creek	Swan Rd	n/a	23.5	22.9	23.5	23.5
13	E.F. Nookachamps Creek	State Route 9	23.3	20.8	20.5	21.7	n/a
14	College Way Creek	College Way	n/a	n/a	n/a	n/a	n/a
15	Nookachamps Creek	Knapp Rd	24.7	23.3	22.3	23.8	n/a
16	E.F. Nookachamps Creek	Beaver Lake Rd	23.4	21.2	20.8	22.2	20.1
17	Nookachamps Creek	Big Lake Outlet	27.1	25.2	25.5	26.5	n/a
18	Lake Creek	State Route 9	n/a	18.2	18.0	19.5	19.2
19	Hansen Creek	Hoehn Rd	21.2	21.1	19.0	20.1	19.7
20	Hansen Creek	Northern State	n/a	16.3	17.1	17.8	n/a
21	Coal Creek	Hoehn Rd	n/a	20.0	15.9	18.6	20.3
22	Coal Creek	Hwy 20	18.9	17.4	n/a	17.5	16.8
23	Wiseman Creek	Minkler Rd	n/a	n/a	n/a	n/a	n/a
24	Mannser Creek	Lyman Hamilton Hwy	14.2	17.2	13.9	13.7	13.4
25	Red Cabin Creek	Hamilton Cemetery Rd	n/a	n/a	n/a	n/a	n/a
28	Brickyard Creek	Hwy 20	n/a	n/a	n/a	n/a	n/a
29	Skagit River	River Bend Rd	n/a	n/a	n/a	n/a	n/a
30	Skagit River	Cape Horn Rd	17.1	15.2	11.9	n/a	17.1
31	DD 20 near floodgate	Francis Rd	n/a	n/a	n/a	n/a	n/a
32	Samish River	Thomas Rd	22.7	n/a	20.2	21.2	20.6
33	Alice Bay Pump Station	Samish Island Rd	n/a	n/a	n/a	n/a	n/a
34	No Name Slough	Bayview-Edison Rd	n/a	n/a	n/a	n/a	n/a
35	Joe Leary Slough	D'Arcy Rd	n/a	n/a	n/a	n/a	n/a
36	Edison Slough at school	W. Bow Hill Rd	n/a	n/a	n/a	n/a	n/a
37	Edison Pump Station	Farm to Market Rd	n/a	n/a	n/a	n/a	n/a
38	North Edison Pump Station	North Edison Rd	n/a	n/a	n/a	n/a	n/a
39	Colony Creek	Colony Rd	19.4	18.3	17.3	18.4	17.5
40	Big Indian Slough	Bayview-Edison Rd	n/a	n/a	n/a	n/a	n/a
41	Maddox Creek/Big Ditch	Milltown Rd	25.4	21.1	24.9	25.9	25.0
42	Hill Ditch	Cedardale Rd	27.3	25.9	25.7	25.9	24.9
43	Wiley Slough	Wylie Rd	n/a	n/a	n/a	n/a	n/a
44	Sullivan Slough	La Conner-Whitney Rd	n/a	n/a	n/a	n/a	n/a
45	Skagit River – North Fork	Moore Rd	n/a	18.7	17.7	19.4	n/a
46	Skagit River – South Fork	Fir Island Rd	n/a	n/a	n/a	n/a	n/a
47	Swinomish Channel	County Boat Launch	n/a	n/a	n/a	n/a	n/a
48	Fisher Creek	Franklin Rd	16.1	15.1	14.8	16.8	16.5

*Data from continuous temperature data loggers. Cells shaded green pass state standard.

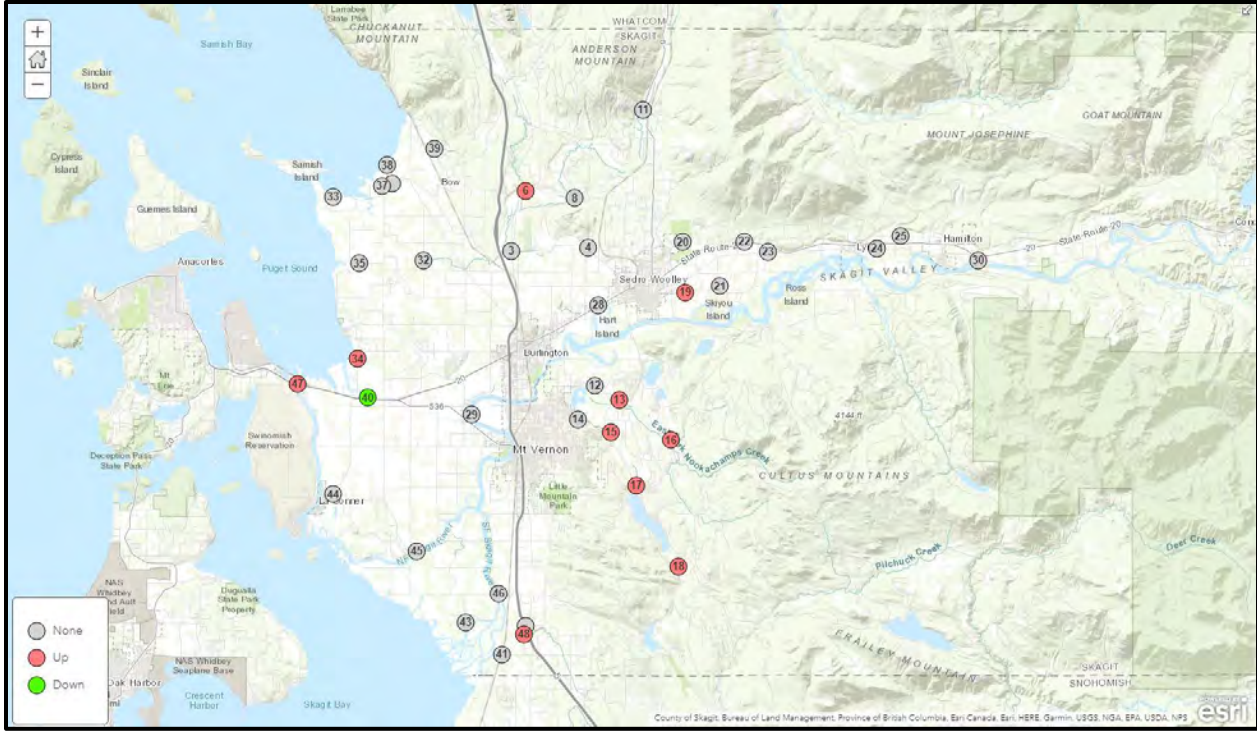


Figure 2 – Sixteen-year trends in watercourse temperatures

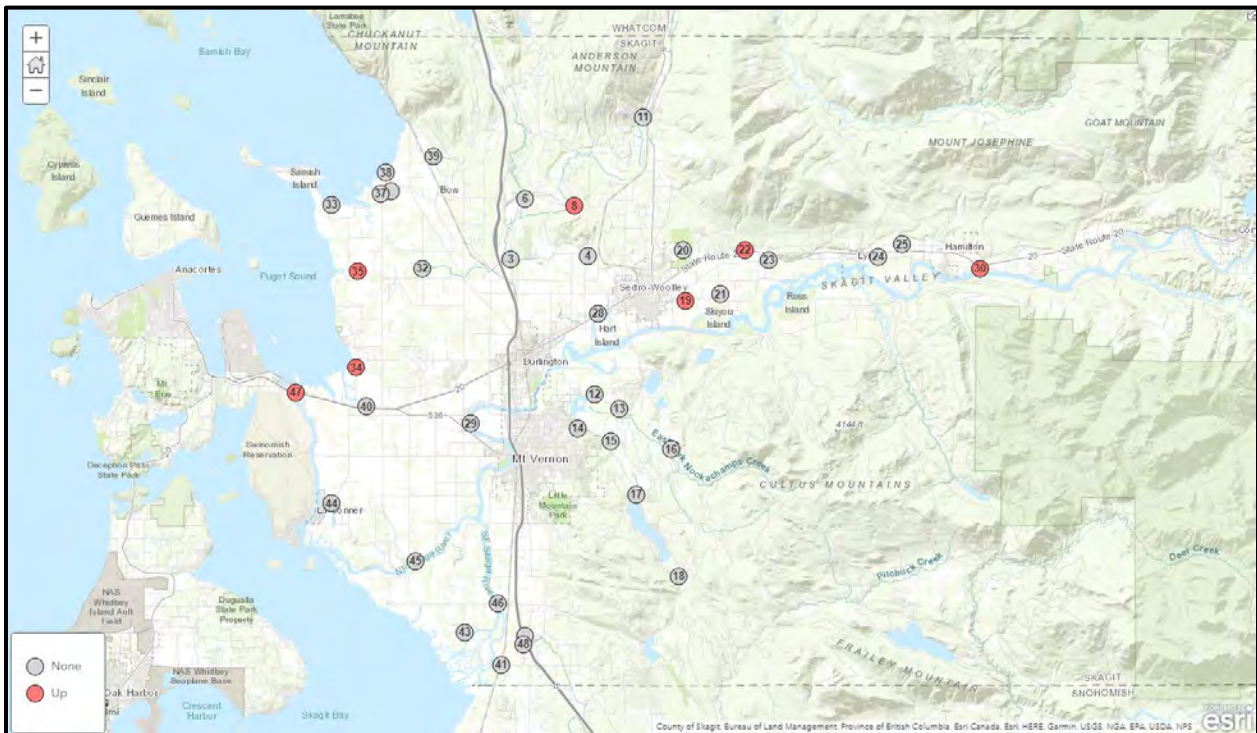


Figure 3 – Ten-year trends in watercourse temperatures

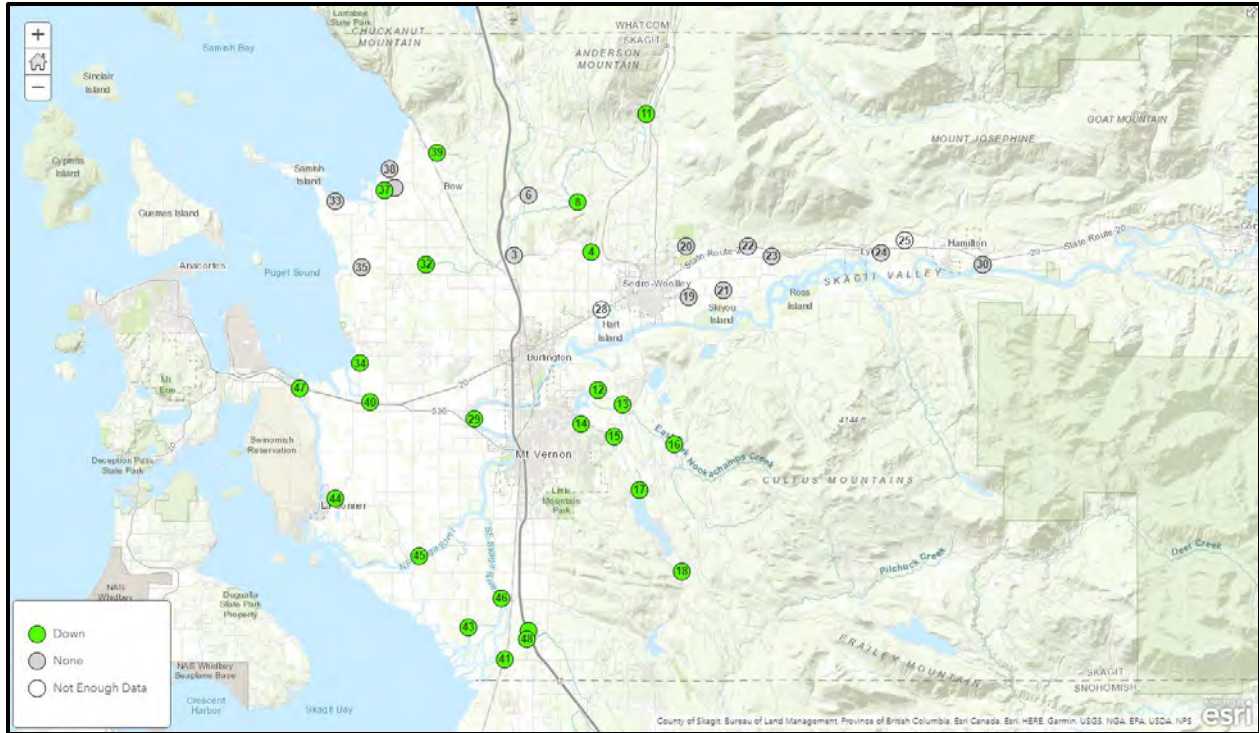


Figure 4 – Five-year trends in watercourse temperatures



Dissolved Oxygen (DO)

Dissolved oxygen measurements determine how much oxygen is available in the water for fish and other organisms.

Background

The state water quality standards for DO are based on single-day minimum measurements. For some lowland watercourses in the SCMP (Sites 3-4, 28, 31-44, and 48), the minimum standard is 8.0 mg/L. For the marine site (Site 47), the standard is 6.0 mg/L. For all other sites, the standard is 9.5 mg/L. The solubility of oxygen in water is inversely related to temperature, so that higher temperatures frequently result in lower dissolved oxygen values.

Results

A summary of DO readings (in mg/L) obtained during the 2019 water year is provided in **Table 6**. A summary of data from the most recent five years of this program can be found in **Table 7**.

Eight sites met the oxygen standards for the entire 2019 water year, compared to eight in 2018. Others met the oxygen standard for most of the year. In a few streams, oxygen levels show steep declines in summer, as can be seen by the graphs on their SRCs. These declines are usually associated with very low flows, less velocity, and higher temperatures.

In the drainage infrastructure and lower sloughs, DO levels can be greatly influenced by algal activity. During large algae blooms, the oxygen produced during photosynthesis can lead to very high oxygen levels during the day. However, night-time oxygen levels can be very low, as the large populations of algae turn from producing oxygen to consuming it. Because our oxygen readings are taken during the day, the monitoring program does not account for these night-time oxygen reductions. During times when algae blooms are dying off, the decomposition of the dying algae can lead to very low oxygen levels, both day and night. The results, as can be seen in the graphs of the drainage sites in their SRCs, are widely fluctuating DO levels, depending on the state of the algal blooms at sampling time. These fluctuations are very extreme, and data has been recorded from as low as 0% to as high as 300% typical oxygen saturation.

Trends analysis shows that in the 16 years since the program began, 11 sites have shown an increase in DO levels, while four have shown a decrease (**Figure 5**). There is a clustering of improved sites in the Samish and South Skagit watersheds. In the most recent ten years (**Figure 6**), trends show 18 sites increasing DO levels, while only three are decreasing. These sites appear to be spread county-wide. In the most recent five years (**Figure 7**), trends show 22 sites increasing DO levels, while only one site (Site 3 – Thomas Creek) is decreasing. These sites appear to also be spread county-wide. This increase of sites with rising DO levels is great news for water quality across the county, and possible contributions could be from lower water temperatures and lower biological oxygen demand (BOD), which can be a result of a decrease in pollution.



Table 6 - Dissolved oxygen (DO) measurements for 2019 water year

Site Number	Watercourse	Location	Mean DO (mg/L)	Minimum DO (mg/L)	St. Std ¹
3	Thomas Creek	Old Hwy 99 N	5.82	0.16	8.0
4	Thomas Creek	F&S Grade Rd	11.46	8.49	8.0
6	Friday Creek	Prairie Rd	11.63	9.82	9.5
8	Swede Creek	Grip Rd	10.72	7.80	9.5
11	Samish River	State Route 9	9.03	7.38	9.5
12	Nookachamps Creek	Swan Rd	9.42	5.43	9.5
13	E.F. Nookachamps Creek	State Route 9	9.62	7.46	9.5
14	College Way Creek	College Way	9.78	6.17	9.5
15	Nookachamps Creek	Knapp Rd	8.34	1.08	9.5
16	E.F. Nookachamps Creek	Beaver Lake Rd	11.98	9.90	9.5
17	Nookachamps Creek	Big Lake Outlet	10.18	4.94	9.5
18	Lake Creek	State Route 9	11.31	8.62	9.5
19	Hansen Creek	Hoehn Rd	10.30	6.60	9.5
20	Hansen Creek	Northern State	11.52	9.25	9.5
21	Coal Creek	Hoehn Rd	11.55	7.87	9.5
22	Coal Creek	Hwy 20	11.77	9.96	9.5
23	Wiseman Creek	Minkler Rd	12.19	10.54	9.5
24	Mannser Creek	Lyman Hamilton Hwy	7.86	5.25	9.5
25	Red Cabin Creek	Hamilton Cem. Rd	12.16	10.84	9.5
28	Brickyard Creek	Hwy 20	9.54	6.46	8.0
29	Skagit River	River Bend Rd	11.05	8.72	9.5
30	Skagit River	Cape Horn Rd	11.34	9.22	9.5
31	Drain District 20 floodgate	Francis Rd	ND	ND	8.0
32	Samish River	Thomas Rd	11.19	9.31	8.0
33	Alice Bay Pump Station	Samish Island Rd	9.18	2.08	8.0
34	No Name Slough	Bayview-Edison Rd	7.03	0.14	8.0
35	Joe Leary Slough	D'Arcy Rd	5.56	3.35	8.0
36	Edison Slough at school	West Bow Hill Rd	8.86	2.95	8.0
37	Edison Pump Station	Farm to Market Rd	8.20	3.41	8.0
38	North Edison Pump Station	North Edison Rd	7.35	0.51	8.0
39	Colony Creek	Colony Rd	11.06	7.75	9.5
40	Big Indian Slough	Bayview-Edison Rd	5.07	1.65	8.0
41	Maddox Slough/Big Ditch	Milltown Rd	7.37	1.53	8.0
42	Hill Ditch	Cedardale Rd	8.54	3.36	9.5
43	Wiley Slough	Wylie Rd	4.77	0.48	8.0
44	Sullivan Slough	La Conner-Whitney	6.34	2.90	8.0
45	Skagit River – North Fork	Moore Rd	11.33	9.31	9.5
46	Skagit River – South Fork	Fir Island Rd	11.41	9.44	9.5
47	Swinomish Channel	County Boat Launch	8.80	7.13	6.0
48	Fisher Creek	Franklin Rd	11.55	9.69	9.5

¹Washington State Water Quality Standard per WAC 173-201A



Table 7 - Mean dissolved oxygen (DO) levels for the most recent five years

Site Number	Watercourse	Location	Mean Dissolved Oxygen (mg/L)				
			2015	2016	2017	2018	2019
3	Thomas Creek	Old Hwy 99 North	5.4	6.2	6.6	6.1	5.8
4	Thomas Creek	F&S Grade Rd	10.9	11.2	11.5	11.6	11.5
6	Friday Creek	Prairie Rd	10.8	11.4	11.8	11.6	11.6
8	Swede Creek	Grip Rd	10.3	10.4	10.6	10.8	10.7
11	Samish River	State Route 9	8.3	8.7	9.4	9.4	9.0
12	Nookachamps Creek	Swan Rd	8.0	9.1	8.4	9.0	9.4
13	E.F. Nookachamps Creek	State Route 9	9.0	9.9	10.0	10.0	9.6
14	College Way Creek	College Way	8.5	9.0	9.7	9.9	9.8
15	Nookachamps Creek	Knapp Rd	7.3	7.7	8.4	8.6	8.3
16	E.F. Nookachamps Creek	Beaver Lake Rd	10.7	11.3	11.7	11.7	12.0
17	Nookachamps Creek	Big Lake Outlet	9.1	9.6	10.2	10.4	10.2
18	Lake Creek	State Route 9	10.5	10.8	11.2	11.1	11.3
19	Hansen Creek	Hoehn Rd	9.8	10.2	10.4	10.3	10.3
20	Hansen Creek	Northern State	10.7	11.3	11.6	11.6	11.5
21	Coal Creek	Hoehn Rd	10.8	11.2	11.7	11.8	11.6
22	Coal Creek	Hwy 20	11.2	11.6	11.9	12.1	11.8
23	Wiseman Creek	Minkler Rd	11.8	11.6	12.3	12.2	12.2
24	Mannser Creek	Lyman Ham. Hwy	7.2	7.0	7.5	7.9	7.9
25	Red Cabin Creek	Hamilton Cem. Rd	11.4	12.1	12.3	12.2	12.2
28	Brickyard Creek	Hwy 20	8.8	9.2	10.2	10.4	9.5
29	Skagit River	River Bend Rd	10.6	11.0	11.4	11.4	11.1
30	Skagit River	Cape Horn Rd	10.9	11.2	11.7	11.5	11.3
31	DD20 near floodgate	Francis Rd	5.7	7.4	5.9	ND	ND
32	Samish River	Thomas Rd	10.4	10.9	11.4	10.9	11.2
33	Alice Bay Pump Station	Samish Island Rd	9.3	10.3	8.2	11.1	9.2
34	No Name Slough	Bayview-Edison Rd	6.6	7.6	7.8	8.0	7.0
35	Joe Leary Slough	D'Arcy Rd	5.3	5.4	5.0	5.6	5.6
36	Edison Slough at school	W. Bow Hill Rd	8.7	9.9	10.4	11.2	8.9
37	Edison Pump Station	Farm to Market Rd	6.0	8.6	8.3	7.9	8.2
38	N. Edison Pump Station	North Edison Rd	6.5	10.4	8.4	7.5	7.4
39	Colony Creek	Colony Rd	10.2	10.7	11.0	11.0	11.1
40	Big Indian Slough	Bayview-Edison Rd	4.3	4.1	4.7	5.4	5.1
41	Maddox/Big Ditch	Milltown Rd	5.7	7.8	6.6	7.1	7.4
42	Hill Ditch	Cedardale Rd	8.9	9.0	8.3	8.9	8.5
43	Wiley Slough	Wylie Rd	5.3	5.3	4.5	5.0	4.8
44	Sullivan Slough	La Conner-Whitney	6.7	6.2	7.5	6.3	6.3
45	Skagit River – North Fork	Moore Rd	10.7	11.0	11.5	11.6	11.3
46	Skagit River – South Fork	Fir Island Rd	10.8	11.3	11.4	11.6	11.4
47	Swinomish Channel	County Boat Launch	8.4	8.5	9.0	8.8	8.8
48	Fisher Creek	Franklin Rd	10.7	11.0	11.6	11.4	11.6

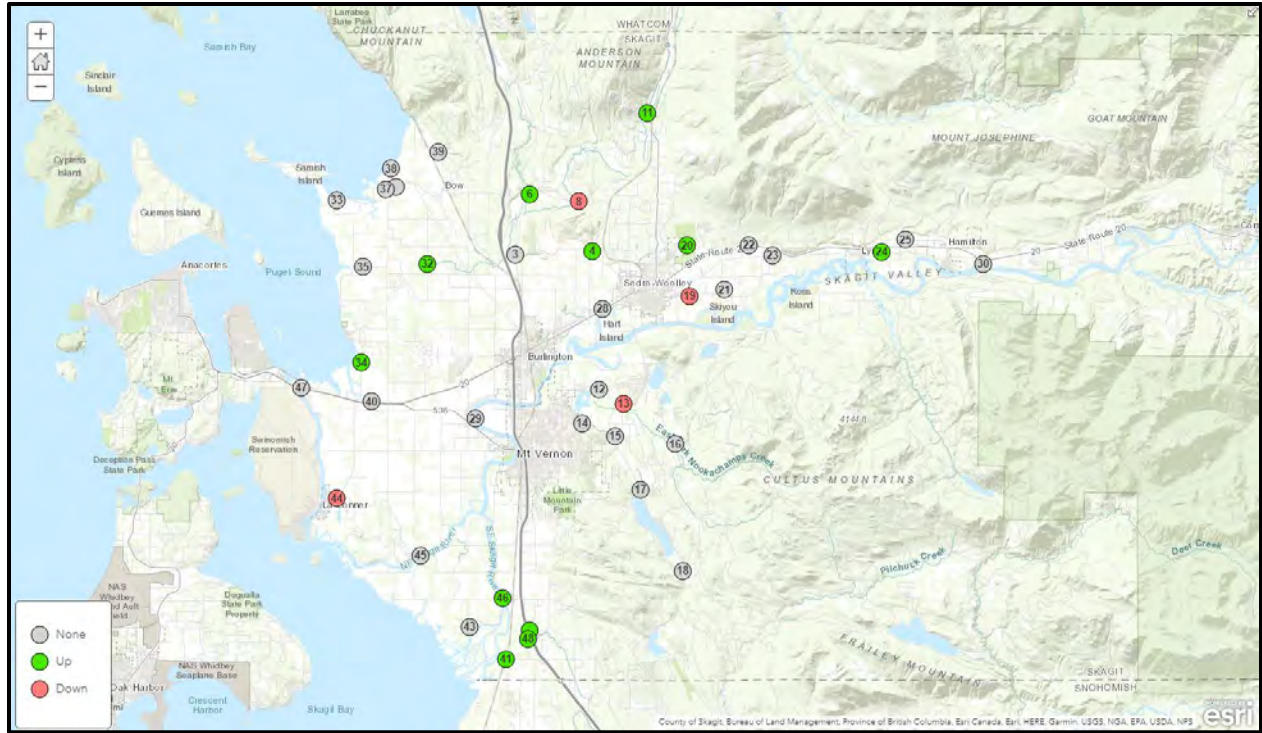


Figure 5 – Sixteen-year trends in dissolved oxygen (DO)

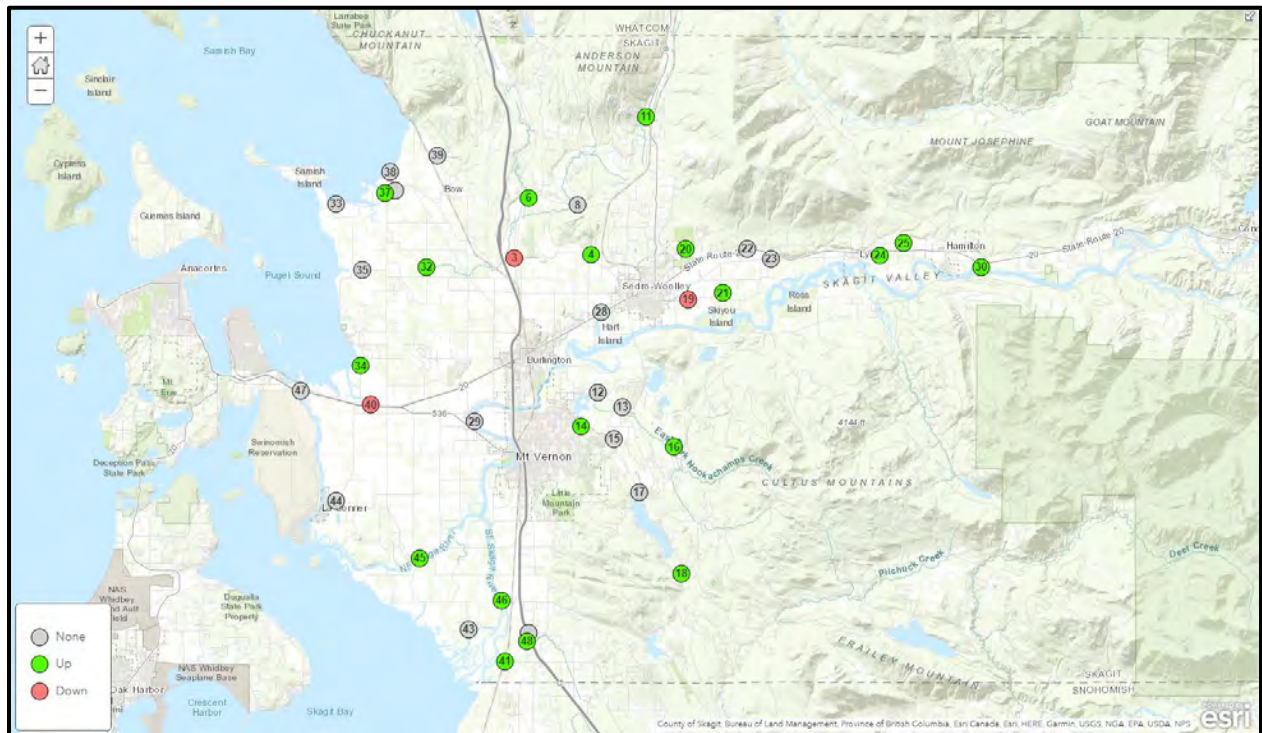


Figure 6 – Ten-year trends in dissolved oxygen (DO)

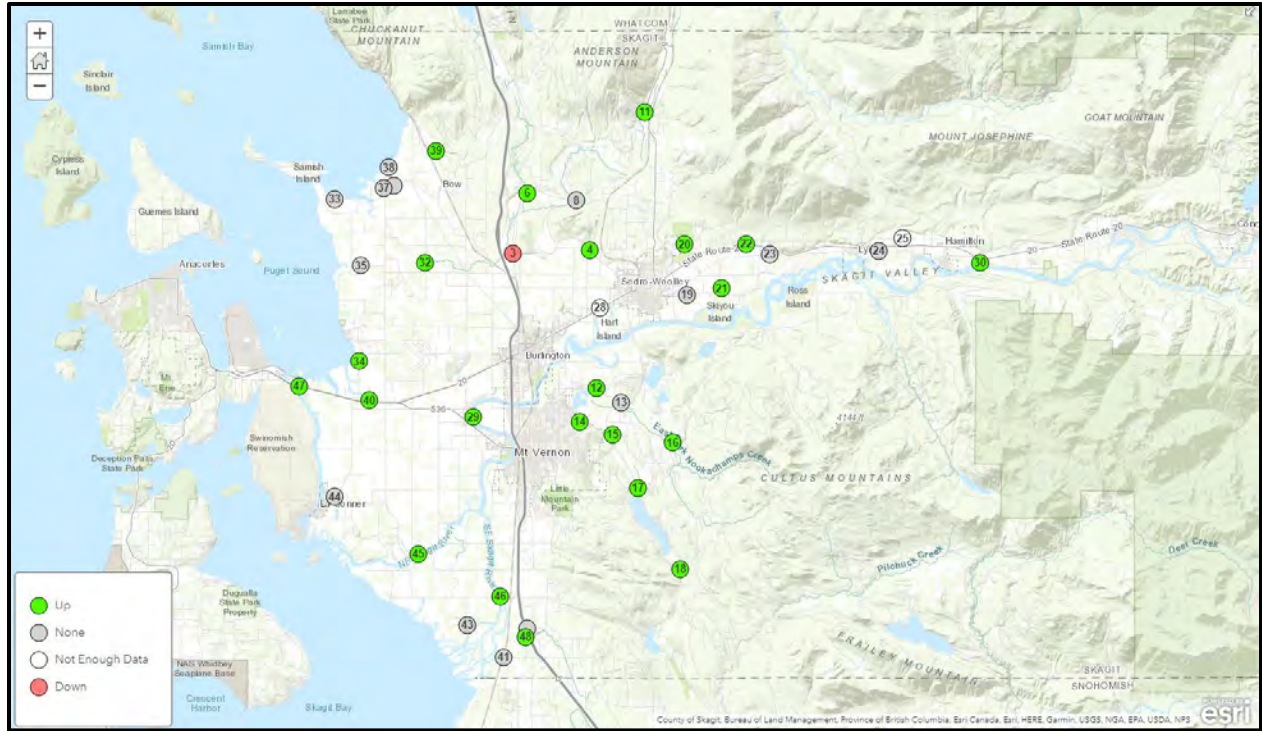


Figure 7 – Five-year trends in dissolved oxygen (DO)



Fecal Coliform (FC)

Fecal coliform is a measurement of the amount of enteric bacteria from warm-blooded animals present in a watercourse. Although FC measurements do not directly quantify disease-causing organisms, they serve as an indicator of the possible presence of such bacteria, viruses, and protozoa. The sources of FC organisms reaching the watercourses of Skagit County may include runoff from failing septic tanks, livestock operations, wildlife, recreationists, and pets.

Background

Samples for FC measurements were taken at each site during each visit and were submitted to the Skagit County Health Department Water Lab (2003-2008) or Edge Analytical (2009-2019) for analysis by the MPN method. State standards for FC are based on the geometric mean of the samples as well as the percent of the samples that exceed given criteria. For most of the watercourses in the SCMP (sites 3-20, 28-29, 31-46, 48), FC is not to exceed a geometric mean of 100 MPN, with no more than 10% of the measurements exceeding 200 MPN. For the upriver sites (sites 21-25, 30), the standard is a geometric mean of 50 MPN, with no more than 10% of the measurements exceeding 100 MPN. For the marine site (site 47), a more stringent standard of 14 MPN with no more than 10% exceeding 41 MPN is enforced to protect shellfish beds.

The 2008 water year was marked by several incidents of high FC counts at County monitoring stations in the Samish Bay Watershed. Each incident was triggered by moderate to heavy rainfall. These high counts resulted in at least four closures of the Samish Bay shellfish beds to commercial harvest. The most serious incident resulted in a mandatory closure of Samish Bay in response to a sample count of 17,000 MPN/100 mL from the Samish River at Thomas Road on April 29, 2008.

The 2009, 2010, and 2011 water years saw continued high FC counts in the Samish River and elsewhere in the Samish Bay Watershed, and many additional closures of shellfish beds. County and Storm Team volunteer monitoring continued to document the relationship between high rainfall events and excess FC. This ongoing situation prompted Ecology to initiate the Clean Samish Initiative in 2009, a partnership of over 20 Federal, State, and County governmental organizations, as well as shellfish industry and non-profit groups. This effort is aimed at making immediate improvements in the Samish Bay Watershed.

Results

Fecal coliform measurements for the 2019 water year, in MPN of bacterial colonies per 100 ml, are summarized in **Table 8**. The geometric mean FC at each site for the last five years of this program can be found in **Table 9**.



For the 2019 water year, 16 sites met the standard based on ambient sampling for the entire water year, compared to the same total of 16 sites in 2018. Most sites that did not meet the standard did so due to having more than 10% of samples with FC counts in excess of 200 MPN. Storm sampling in the Samish Basin also continues to show excessive FC during rain events.

Trends analysis shows that in the 16 years since the program began, 11 sites have showed improvement through a decline in FC counts, while seven sites have showed deterioration through an increase in FC counts (**Figure 8**). There is a clear clustering of improved sites in the Samish Bay watershed, relative to the rest of the county. In the most recent ten years, eight sites have shown improvement, while zero sites have shown deterioration (**Figure 9**). Improved sites have small clusters in the Nookachamps and South Skagit watersheds. In the most recent five years, four sites have shown improvement, while two sites (37 in Edison and 15 in Nookachamps) have shown significantly increased FC counts (**Figure 10**).



Table 8 - Fecal coliform (FC) results for 2019 water year (MPN/100ml)

Site Number	Watercourse	Location	n	Geometric mean (MPN) ¹	% > 100 or 200 ¹
3	Thomas Creek	Old Hwy 99 N	24	50	13
4	Thomas Creek	F&S Grade Rd	24	131	42
6	Friday Creek	Prairie Rd	25	28	8
8	Swede Creek	Grip Rd	26	29	12
11	Samish River	State Route 9	26	11	0
12	Nookachamps Creek	Swan Rd	26	45	4
13	E.F. Nookachamps Creek	State Route 9	26	38	4
14	College Way Creek	College Way	26	113	42
15	Nookachamps Creek	Knapp Rd	26	64	47
16	E.F. Nookachamps Creek	Beaver Lake Rd	26	22	4
17	Nookachamps Creek	Big Lake Outlet	26	17	8
18	Lake Creek	State Route 9	26	41	12
19	Hansen Creek	Hoehn Rd	21	62	14
20	Hansen Creek	Northern State	26	37	15
21	Coal Creek	Hoehn Rd	19	63	16
22	Coal Creek	Hwy 20	26	11	23
23	Wiseman Creek	Minkler Rd	23	10	0
24	Mannser Creek	Lyman Hamilton Hwy	26	14	8
25	Red Cabin Creek	Hamilton Cemetery Rd	19	6	0
28	Brickyard Creek	Hwy 20	15	53	20
29	Skagit River	River Bend Rd	26	7	0
30	Skagit River	Cape Horn Rd	26	4	0
31	Drain. Dist. 20 floodgate	Francis Rd	ND	ND	ND
32	Samish River	Thomas Rd	26	58	12
33	Alice Bay Pump Station	Samish Island Rd	25	33	12
34	No Name Slough	Bayview-Edison Rd	20	48	15
35	Joe Leary Slough	D'Arcy Rd	26	93	23
36	Edison Slough at school	W. Bow Hill Rd	26	49	19
37	Edison Pump Station	Farm to Market Rd	24	188	50
38	N. Edison Pump Station	North Edison Rd	26	113	31
39	Colony Creek	Colony Rd	25	58	28
40	Big Indian Slough	Bayview-Edison Rd	20	47	15
41	Maddox/Big Ditch	Milltown Rd	26	46	15
42	Hill Ditch	Cedardale Rd	25	48	4
43	Wiley Slough	Wylie Rd	25	74	24
44	Sullivan Slough	La Conner-Whitney Rd	25	45	4
45	Skagit River – North Fork	Moore Rd	26	4	0
46	Skagit River – South Fork	Fir Island Rd	26	9	4
47	Swinomish Channel	County Boat Launch	25	4	0
48	Fisher Creek	Franklin Rd	26	56	19

¹ State water quality standards for fecal coliform requires water bodies to have a geometric mean of less than 50 (sites 21-25,30) or 100 (sites 3-20,28-29, 31-46, 48) colony forming units (CFU) or Most Probable Number (MPN) per 100 ml and less than 10% of the samples >100 (sites 21-25,30) or >200 cfu (sites 3-20,28-29, 31-46, 48). Marine locations (site 47) are required to be <14 cfu with no more than 10% >41 cfu. Cells shaded green represent sites that pass state standards.



Table 9 - Geometric mean FC results for most recent five years (MPN/100ml)

Site Number	Watercourse	Location	2015	2016	2017	2018	2019
3	Thomas Creek	Old Hwy 99 N	46	49	63	47	50
4	Thomas Creek	F&S Grade Rd	133	138	107	138	131
6	Friday Creek	Prairie Rd	36	34	29	39	28
8	Swede Creek	Grip Rd	63	59	40	53	29
11	Samish River	State Route 9	13	26	14	12	11
12	Nookachamps Creek	Swan Rd	107	65	79	56	45
13	E.F. Nookachamps Creek	State Route 9	64	59	41	22	38
14	College Way Creek	College Way	148	106	172	83	113
15	Nookachamps Creek	Knapp Rd	93	54	62	63	64
16	E.F. Nookachamps Creek	Beaver Lake Rd	25	44	28	22	22
17	Nookachamps Creek	Big Lake Outlet	23	16	12	14	17
18	Lake Creek	State Route 9	41	50	24	26	41
19	Hansen Creek	Hoehn Rd	71	114	53	57	62
20	Hansen Creek	Northern State	45	35	50	48	37
21	Coal Creek	Hoehn Rd	91	84	53	65	63
22	Coal Creek	Hwy 20	19	22	18	13	11
23	Wiseman Creek	Minkler Rd	7	12	10	18	10
24	Mannser Creek	Lyman Hamilton Hwy	17	12	15	13	14
25	Red Cabin Creek	Hamilton Cemetery Rd	12	6	12	5	6
28	Brickyard Creek	Hwy 20	34	33	42	45	53
29	Skagit River	River Bend Rd	10	14	9	9	7
30	Skagit River	Cape Horn Rd	5	6	3	5	4
31	Drainage District 20 floodgate	Francis Rd	83	15	21	ND	ND
32	Samish River	Thomas Rd	50	54	48	41	58
33	Alice Bay Pump Station	Samish Island Rd	27	54	30	24	33
34	No Name Slough	Bayview-Edison Rd	171	71	65	59	48
35	Joe Leary Slough	D'Arcy Rd	63	98	91	108	93
36	Edison Slough at school	W. Bow Hill Rd	105	120	97	56	49
37	Edison Pump Station	Farm to Market Rd	166	386	317	214	188
38	North Edison Pump Station	North Edison Rd	222	264	148	148	113
39	Colony Creek	Colony Rd	91	76	57	61	58
40	Big Indian Slough	Bayview-Edison Rd	119	29	43	81	47
41	Maddox Slough/Big Ditch	Milltown Rd	123	61	87	52	46
42	Hill Ditch	Cedardale Rd	104	43	42	51	48
43	Wiley Slough	Wylie Rd	109	106	68	82	74
44	Sullivan Slough	La Conner-Whitney Rd	179	157	127	67	45
45	Skagit River – North Fork	Moore Rd	7	6	7	8	4
46	Skagit River – South Fork	Fir Island Rd	12	9	13	13	9
47	Swinomish Channel	County Boat Launch	5	6	6	6	4
48	Fisher Creek	Franklin Rd	96	92	69	78	56

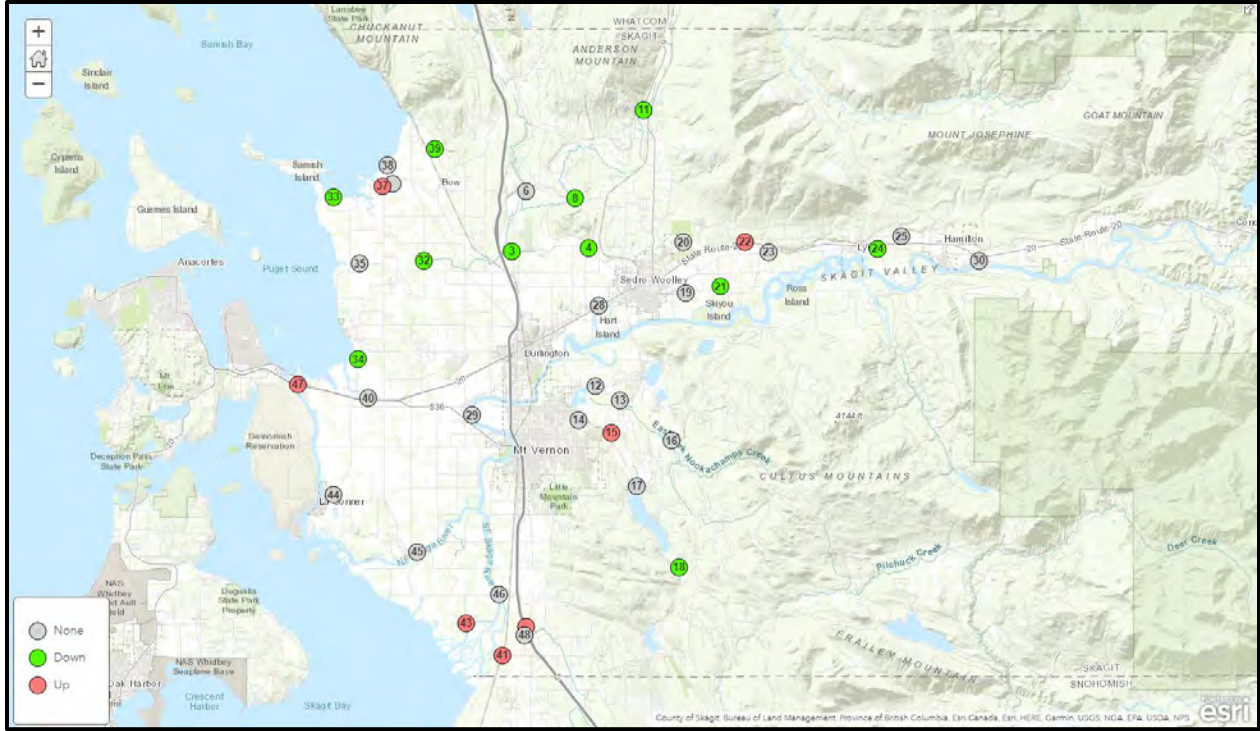


Figure 8 – Sixteen-year trends in fecal coliform (FC)

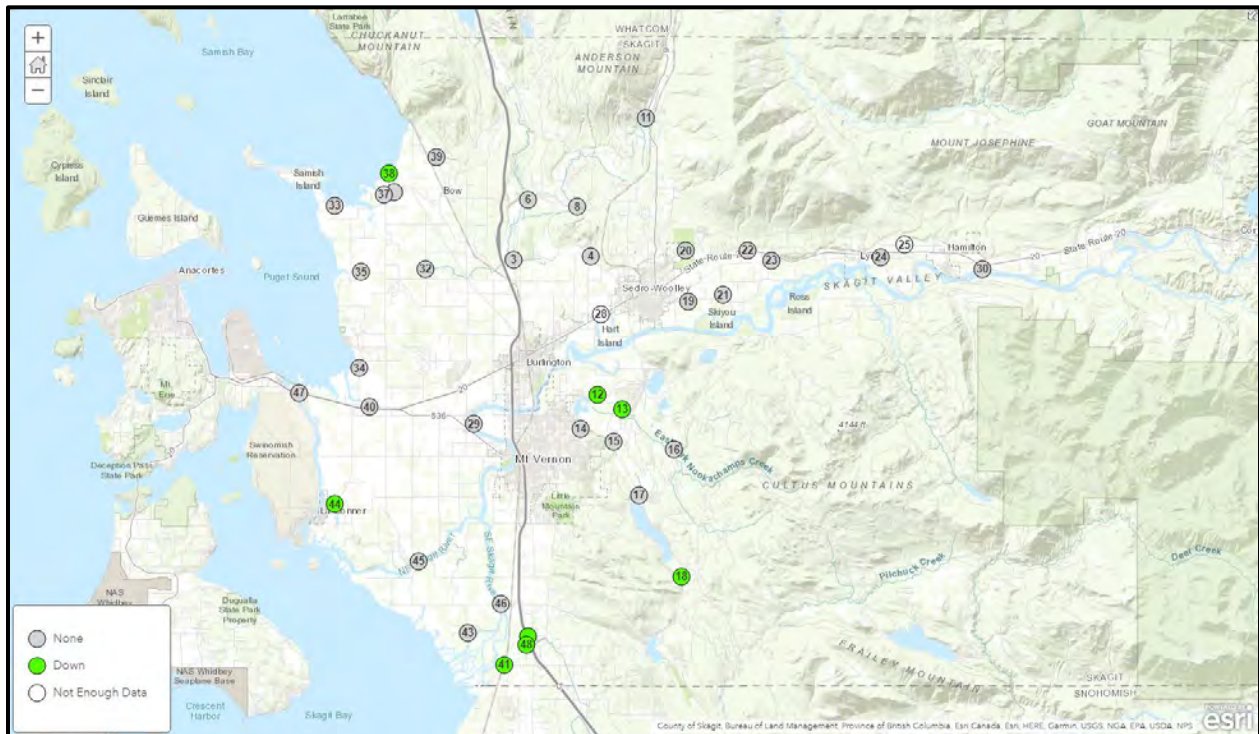


Figure 9 – Ten-year trends in fecal coliform (FC)

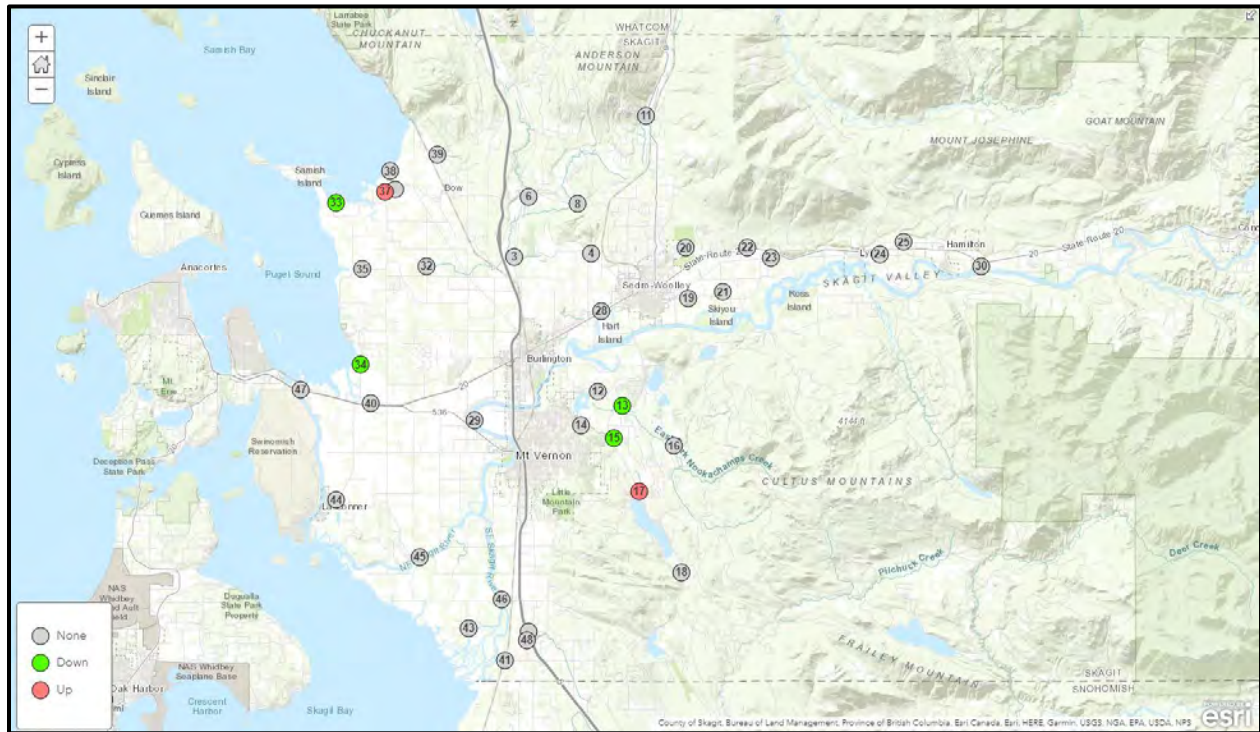


Figure 10 – Five-year trends in fecal coliform (FC)



Nutrients

Nutrient levels in watercourses help determine the potential for algal activity. Excessive nutrient levels can lead to large blooms of algae, which can increase DO levels during the day but lead to large decreases in DO at night, when the algae are respiring, and also when the algae die and decompose. Nutrients from freshwater sources discharged into Puget Sound bays can contribute to marine algal blooms as well.

Background

From the beginning of the program in water year 2004 up until the close of water year 2008 nutrients were sampled on a monthly basis. After the close of the grant from Ecology, maintaining monthly sampling of all nutrients was deemed too cost-prohibitive for the ongoing project budget and was switched to quarterly samplings to allow for four-season trend determinations rather than 12-season.

The subsequent section of this report covering Water Quality Index (WQI) is generated with contribution of this quarterly nutrient data. Therefore, since water year 2008, WQI data has been a four-season metric for this report.

Results

Water samples for measurement of plant nutrients were taken at each station quarterly. Samples were analyzed by Edge Analytical of Burlington, WA. Quarterly sampling brings with it a large caveat: these trends results are determined by a single sampling snapshot in time on one day of an entire three-month period. Needless to say, while this method is imperfect, it is still valuable for collecting and analyzing possible trends. If the conditions of the watercourses sampled were truly randomly assorted based on sampling, with too great of an intermittence (3 months) to have value, then running a trends analysis should theoretically show no discernible trend in the data, and any direction of the data would be determined as non-existent or non-significant. The trends analyses returning a large number of significant trends across the county, even with incredibly small slopes (e.g. parts per billion) is evidence that the data is still accurately representing the condition of these watercourses over time, even if it is taken less frequently than what may be considered optimal.

A second caveat must be taken: As mentioned in the first, some of these trends are statistically significant, even though the actual change in nutrient levels observed in the watercourse may be incredibly small. Take into consideration the actual change over time of that nutrient in the watercourse, as is provided in the tables in **Appendix C**. For example, over the sixteen year course of this program, a nutrient at a site may have increased by half of a milligram per liter (part per million), or at a different site it may have increased by one microgram per liter (part per billion), or less. Despite this, both analyses would show statistically significant increases in this nutrient on a map.



Table 10 gives mean nutrient values for selected parameters for the 2019 water year. All nutrient values are included in **Appendix A**, with summary statistics found in **Appendix B**, and trends analyses in **Appendix C**.

Most of the natural streams in the program showed moderate levels of total nitrogen, ammonia, and total phosphorus. The drainage infrastructure sampling sites generally had higher levels of nutrients compared to the stream stations.

There are no numeric state standards for nutrients as factors in algal blooms. However, the state has both acute and chronic water quality standards for ammonia toxicity that are calculated from the ammonia level combined with the water temperature, pH, and other factors for each individual ammonia measurement.

The following trends analyses were performed only on the 16-year dataset, representing the entire length of this program's monitoring:

Total Kjeldahl Nitrogen shows a decrease at three sites, and an increase at one site, with no obvious clustering pattern (**Figure 11**).

Total Phosphorous shows an increase at ten sites, and a decrease in zero sites, and is occurring almost entirely in sloughs (**Figure 12**).

Ortho-phosphorous shows an increase at 12 sites, and a decrease in zero sites, spread a little more uniformly around the county than total phosphorous (**Figure 13**).

Ammonia levels have gone down at 15 sites around the county, have increased at zero sites, and the trends appear to be occurring all across the valley (**Figure 14**).

Nitrate + Nitrite levels have decreased at ten sites across the county, concentrated in the north and east, and have increased at two sites, on the west edge of the valley (**Figure 15**).

Overall, phosphorous (total and ortho) is the only nutrient showing an increase across the valley. Combination of all significant nutrient trends shows a total of 28 positive trends, or decreases, and 25 negative trends, or increases, with 22 of those being phosphorous. Phosphorous is the most common "limiting nutrient" for algal blooms in the natural environment, which means that when an excess of phosphorous shows up in the watercourse, it is the only thing required to trigger an algal bloom.



Table 10 - Mean nutrient values (mg/l) for 2019 water year

Site Number	Watercourse	Location	Total Nitrogen ¹	Total Phosphorus	Ammonia	Nitrate + Nitrite
3	Thomas Creek	Old Hwy 99 N	0.62	0.08	0.03	0.43
4	Thomas Creek	F&S Grade Rd	0.42	0.06	0.02	0.84
6	Friday Creek	Prairie Rd	0.36	0.02	0.01	0.34
8	Swede Creek	Grip Rd	0.49	0.05	0.01	0.28
11	Samish River	State Route 9	0.27	0.02	0.02	0.24
12	Nookachamps Creek	Swan Rd	0.32	0.03	0.02	0.15
13	E.F. Nookachamps Creek	State Route 9	0.33	0.02	0.02	0.20
14	College Way Creek	College Way	0.44	0.05	0.02	0.43
15	Nookachamps Creek	Knapp Rd	0.43	0.13	0.13	0.19
16	E.F. Nookachamps Creek	Beaver Lake Rd	0.25	0.01	0.01	0.23
17	Nookachamps Creek	Big Lake Outlet	0.30	0.03	0.03	0.18
18	Lake Creek	State Route 9	0.24	0.02	0.01	0.34
19	Hansen Creek	Hoehn Rd	0.30	0.03	0.02	0.30
20	Hansen Creek	Northern State	0.30	0.02	0.01	0.42
21	Coal Creek	Hoehn Rd	0.43	0.03	0.04	1.29
22	Coal Creek	Hwy 20	0.32	0.03	0.01	1.05
23	Wiseman Creek	Minkler Rd	0.33	0.03	0.01	0.83
24	Mannser Creek	Lyman Hamilton Hwy	0.36	0.06	0.02	0.18
25	Red Cabin Creek	Hamilton Cem. Rd	0.25	0.02	0.06	0.35
28	Brickyard Creek	Hwy 20	0.49	0.04	0.02	0.37
29	Skagit River	River Bend Rd	0.25	0.06	0.01	0.05
30	Skagit River	Cape Horn Rd	0.29	0.03	0.01	0.06
31	Drain. Dist. 20 floodgate	Francis Rd	ND	ND	ND	ND
32	Samish River	Thomas Rd	0.29	0.03	0.02	0.46
33	Alice Bay Pump Station	Samish Island Rd	2.38	0.47	1.27	1.38
34	No Name Slough	Bayview-Edison Rd	1.07	0.90	0.11	0.33
35	Joe Leary Slough	D'Arcy Rd	0.90	0.15	0.41	0.72
36	Edison Slough at school	W. Bow Hill Rd	0.96	0.56	0.09	0.19
37	Edison Pump Station	Farm to Market Rd	2.15	0.95	1.08	0.74
38	N. Edison Pump Station	North Edison Rd	2.30	1.44	2.18	0.37
39	Colony Creek	Colony Rd	0.43	0.13	0.09	0.67
40	Big Indian Slough	Bayview-Edison Rd	0.83	0.19	0.28	0.84
41	Maddox/Big Ditch	Milltown Rd	0.98	0.20	0.24	0.86
42	Hill Ditch	Cedardale Rd	0.30	0.06	0.02	0.34
43	Wiley Slough	Wylie Rd	1.11	0.13	0.28	1.31
44	Sullivan Slough	La Conner-Whitney	1.10	0.18	0.62	0.72
45	Skagit River – North Fork	Moore Rd	0.25	0.04	0.01	0.05
46	Skagit River – South Fork	Fir Island Rd	0.25	0.05	0.02	0.06
47	Swinomish Channel	County Boat Launch	0.27	0.07	0.05	0.20
48	Fisher Creek	Franklin Rd	0.49	0.28	0.02	0.44

¹Total Kjeldahl Nitrogen

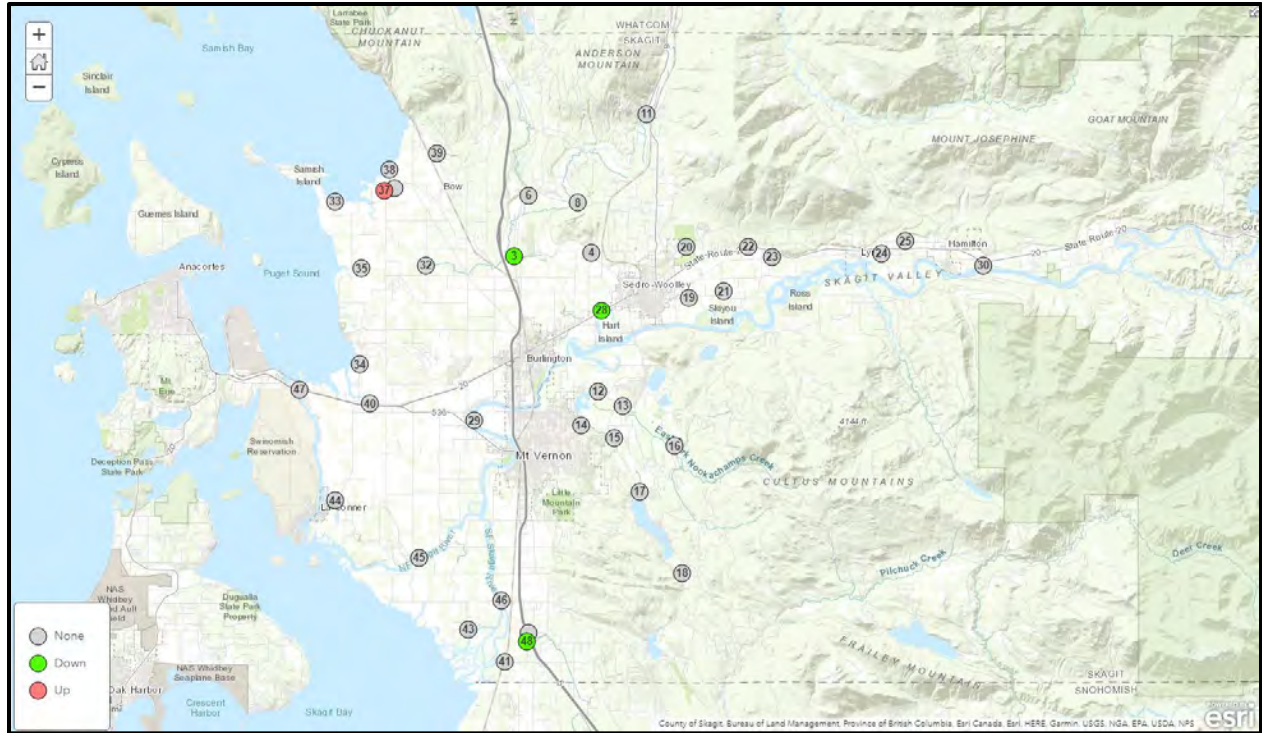


Figure 11 – Sixteen-year trends in Total Kjeldahl Nitrogen (TKN)

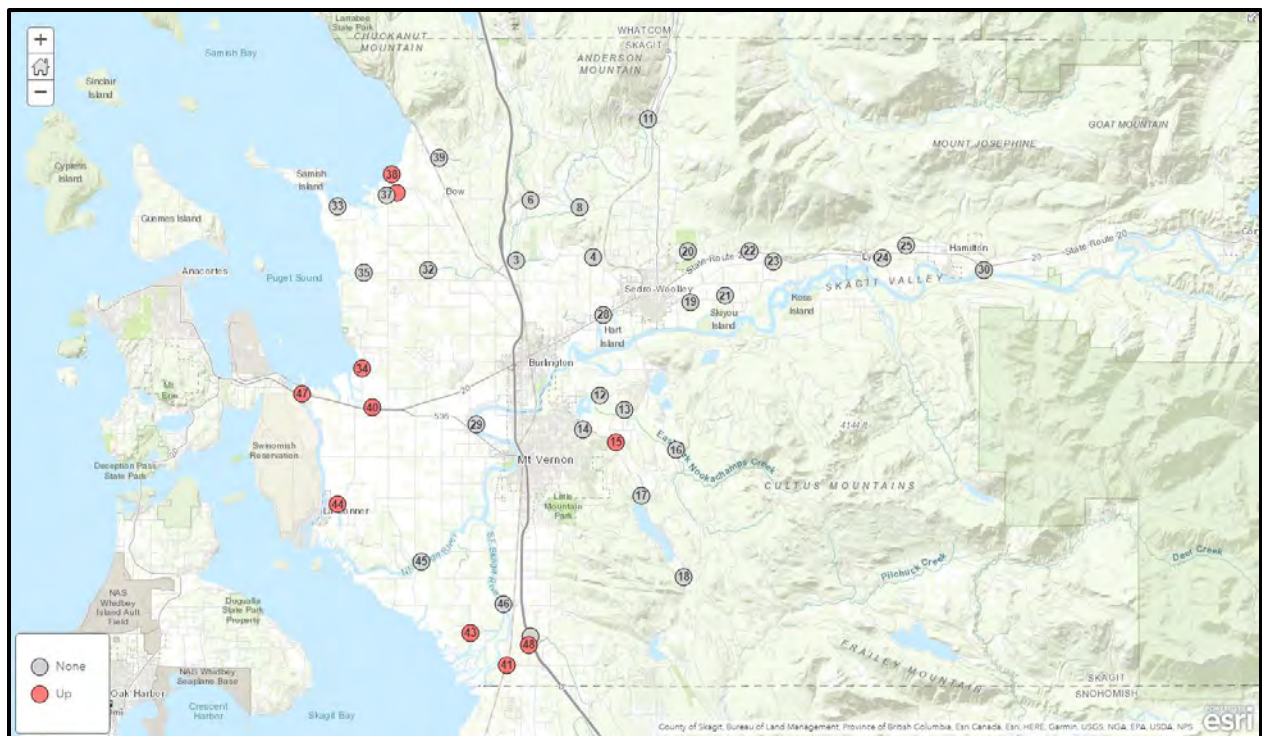


Figure 12 – Sixteen-year trends in Total Phosphorous (TP)

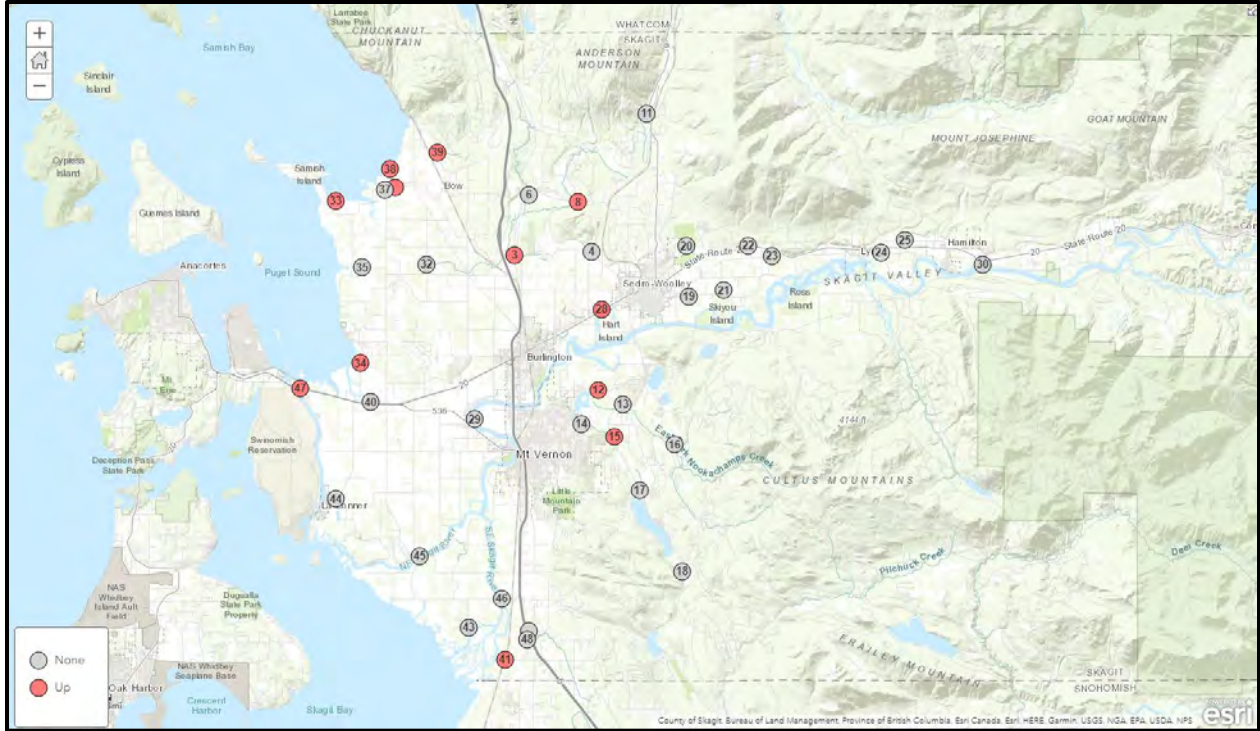


Figure 13 – Sixteen-year trends in Ortho-phosphorous (OP)

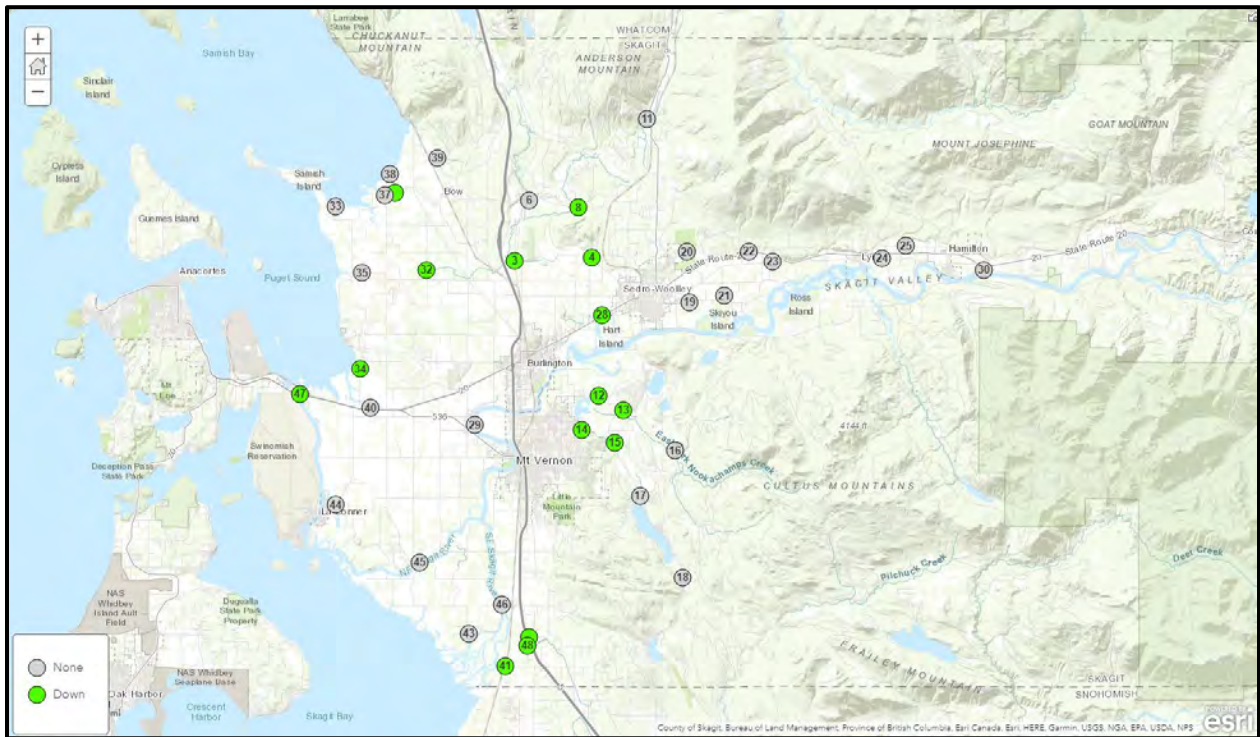


Figure 14 – Sixteen-year trends in Ammonia (NH3)

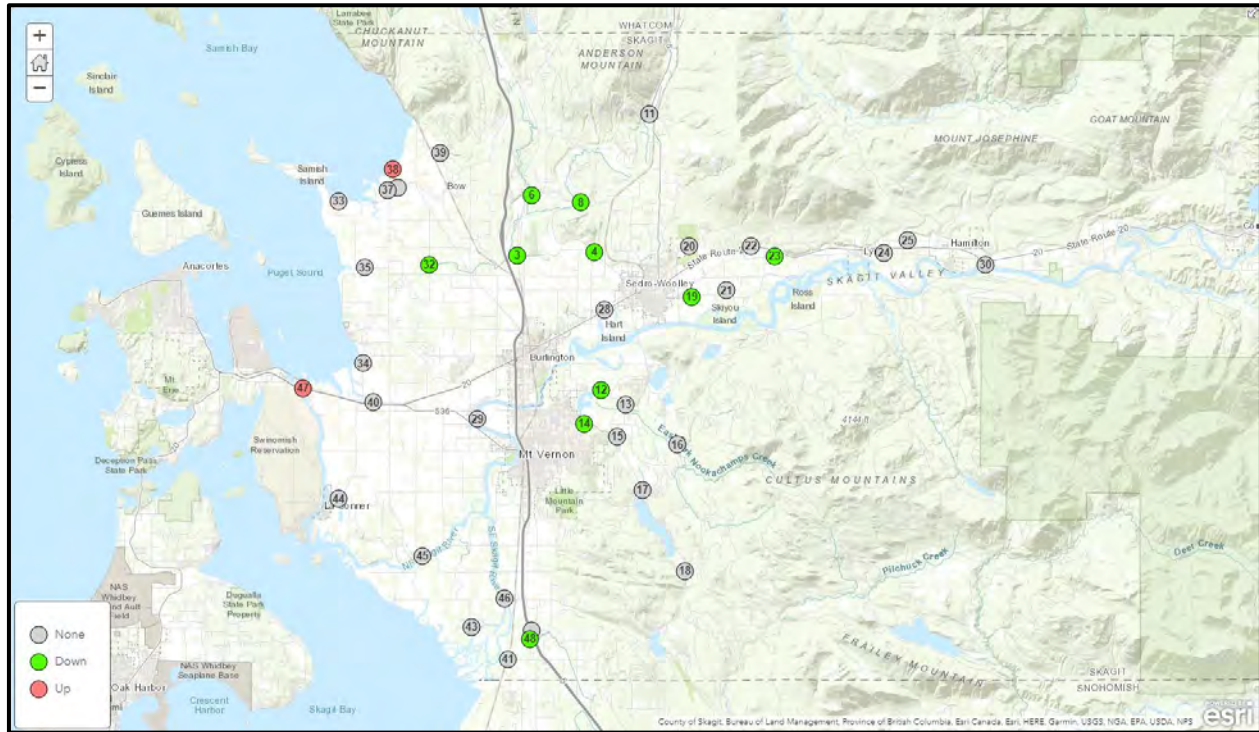


Figure 15 – Sixteen-year trends in Nitrate and Nitrite (NO₃ + NO₂)

Other Parameters

The SCMP also measures pH, conductivity, and salinity during each visit to each site. Conductivity and salinity are measured to help interpret other water quality parameters. Measurement of pH shows whether a watercourse is within the range that supports aquatic life. In general, pH in the SCMP has been within state standards.

Discharge measurements were made up until 2008 in selected locations and were intended to provide a general indication of the flow regime for that watercourse and as an aid in interpreting other water quality parameters. As Ecology has added several stream gauges in our area, Skagit County has de-emphasized performing manual discharge measurement.

Sixteen-year trends analysis on pH across Skagit County revealed 21 sites with significantly decreasing pH and seven sites with an increase (**Figure 16**).

All measurements for these parameters are available in **Appendix A** and are summarized in **Appendix B**.

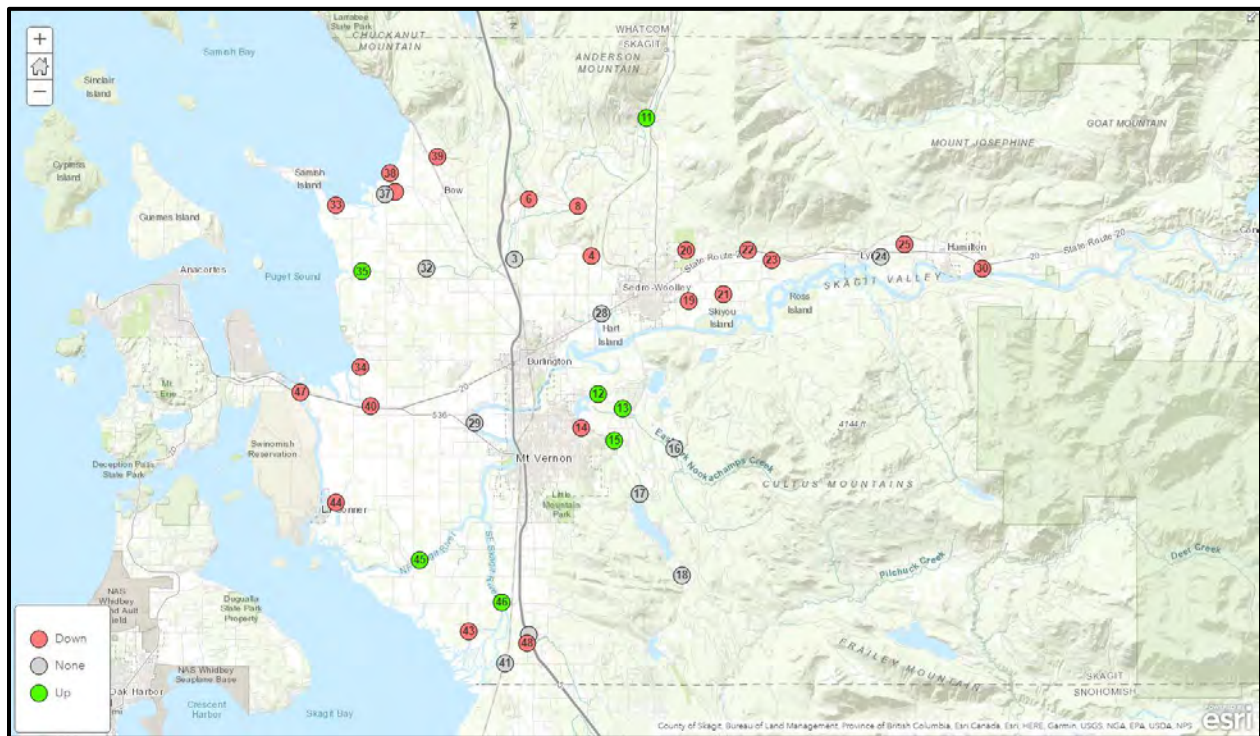


Figure 16 – Sixteen-year trends in pH



Summary Statistics of Significant Trends across Skagit County

In an effort to construct a bird's-eye view of what trends are occurring across Skagit County, two summary tables were created. These summary tables were populated from the site-specific tables provided in **Appendix C**. These tables take into account all trends analyses from the 16-year data (18 trends), the ten-year data (six trends), and the five-year data (six trends), combined, for a total of 30 possible significant trends. The results on these tables are biased toward the temperature and FC parameters, as they account for six of the 30 total trends in the group, and biased even further toward DO, as it accounts for eight total categories. Other parameters populate one or two categories each. For this report, positive trends were listed as: Increase in pH, increase in DO, increase in DO% saturation, decrease in temperature, decrease in turbidity, decrease in FC, decrease in nutrients, and decrease in TSS. Negative, or deleterious trends, were considered as the opposite of these statements.

The first table arranges all ambient monitoring sites by their percentage of positive significant trends as a ratio of total significant trends. Some sites recorded fewer than ten significant trends, while others recorded over twenty. The first table does not arrange by the number of trends total, but simply by how positively or negatively a particular site is trending overall. The sites in the county that have the highest ratio of positive trends are listed at the top, and the sites exhibiting the highest ratio of negative trends are at the bottom. This table is a quick reference for overall improving or deteriorating water quality for a site.

The second table arranges all ambient sampling monitoring sites by their total number of significant trends recorded. Some sites recorded fewer than ten significant trends, while others recorded over twenty. The second table does not arrange by the ratio of positive or negative trends recorded, but simply by the amount of significant change that is occurring at that site. This table is a quick reference for identifying which sites around the county are experiencing the most significant statistical change in water quality, and which sites are not. Sites located at the top of the table are those that have had their water quality parameters change the most.



Table 11 - Summary Statistics of Significant Trends, by Positive/Negative

Site		Significant Trends				Category
		Total	Positive	Negative	% Positive	
Samish River	11	16	16	0	100	Ag - Up
Samish River	32	19	17	2	89	Ag - Down
Thomas Creek	4	18	16	2	89	Ag - Up
Skagit River	46	14	12	2	86	Skagit - Low
Hansen Creek	20	12	10	2	83	Ag - Up
Skagit River	45	12	10	2	83	Skagit - Low
EF Nookachamps	16	12	9	3	75	Ag - Mid
Fisher Creek	48	20	15	5	75	Ag - Down
Nookachamps Creek	15	15	11	4	73	Ag - Mid
Alice Bay Pump	33	11	8	3	73	Ag - Down
College Way Creek	14	14	10	4	71	Ref - Urban
Mannser Creek	24	14	10	4	71	Ag - Mid
Coal Creek	21	10	7	3	70	Ag - Down
Lake Creek	18	13	9	4	69	Ag - Up
Nookachamps Creek	12	15	10	5	67	Ag - Down
No Name Slough	34	24	16	8	67	Ag - Down
Friday Creek	6	17	11	6	65	Ref - RR
EF Nookachamps	13	17	11	6	65	Ag - Down
Skagit River	30	14	9	5	64	Skagit - Up
Wiseman Creek	23	8	5	3	63	Ag - Up
Maddox/Big Ditch	41	18	11	7	61	Ag - Down
Hill Ditch/Carpenter	42	15	9	6	60	Ag - Down
Thomas Creek	3	14	8	6	57	Ag - Down
Joe Leary Slough	35	7	4	3	57	Ag - Down
Colony Creek	39	9	5	4	56	Ag - Down
Swede Creek	8	16	8	8	50	Ag - Down
Red Cabin Creek	25	10	5	5	50	Ref - RR
Brickyard Creek	28	4	2	2	50	Ref - Urban
Skagit River	29	8	4	4	50	Skagit - Mid
Big Indian Slough	40	12	6	6	50	Ag - Mid
Nookachamps Creek	17	11	5	6	45	Ag - Up
N. Edison Pump	38	11	5	6	45	Ag - Down
Edison Slough	36	8	3	5	38	Ag - Down
Sullivan Slough	44	11	4	7	36	Ag - Down
S. Edison Pump	37	10	3	7	30	Ag - Down
Coal Creek	22	11	3	8	27	Ag - Up
Wiley Slough	43	9	2	7	22	Ag - Down
Swinomish Channel	47	17	3	14	18	Ref - Marine
Hansen Creek	19	13	1	12	8	Ag - Down



Table 12 - Summary Statistics of Significant Trends, by Total Count

Site		Significant Trends				Category
		Total	Positive	Negative	% Positive	
No Name Slough	34	24	16	8	67	Ag - Down
Fisher Creek	48	20	15	5	75	Ag - Down
Samish River	32	19	17	2	89	Ag - Down
Thomas Creek	4	18	16	2	89	Ag - Up
Maddox/Big Ditch	41	18	11	7	61	Ag - Down
Friday Creek	6	17	11	6	65	Ref - RR
EF Nookachamps	13	17	11	6	65	Ag - Down
Swinomish Channel	47	17	3	14	18	Ref - Marine
Swede Creek	8	16	8	8	50	Ag - Down
Samish River	11	16	16	0	100	Ag - Up
Nookachamps Creek	12	15	10	5	67	Ag - Down
Nookachamps Creek	15	15	11	4	73	Ag - Mid
Hill Ditch/Carpenter	42	15	9	6	60	Ag - Down
Thomas Creek	3	14	8	6	57	Ag - Down
College Way Creek	14	14	10	4	71	Ref - Urban
Mannser Creek	24	14	10	4	71	Ag - Mid
Skagit River	30	14	9	5	64	Skagit - Up
Skagit River	46	14	12	2	86	Skagit - Low
Lake Creek	18	13	9	4	69	Ag - Up
Hansen Creek	19	13	1	12	8	Ag - Down
EF Nookachamps	16	12	9	3	75	Ag - Mid
Hansen Creek	20	12	10	2	83	Ag - Up
Big Indian Slough	40	12	6	6	50	Ag - Mid
Skagit River	45	12	10	2	83	Skagit - Low
Nookachamps Creek	17	11	5	6	45	Ag - Up
Coal Creek	22	11	3	8	27	Ag - Up
Alice Bay Pump	33	11	8	3	73	Ag - Down
N. Edison Pump	38	11	5	6	45	Ag - Down
Sullivan Slough	44	11	4	7	36	Ag - Down
Coal Creek	21	10	7	3	70	Ag - Down
Red Cabin Creek	25	10	5	5	50	Ref - RR
S. Edison Pump	37	10	3	7	30	Ag - Down
Colony Creek	39	9	5	4	56	Ag - Down
Wiley Slough	43	9	2	7	22	Ag - Down
Wiseman Creek	23	8	5	3	63	Ag - Up
Skagit River	29	8	4	4	50	Skagit - Mid
Edison Slough	36	8	3	5	38	Ag - Down
Joe Leary Slough	35	7	4	3	57	Ag - Down
Brickyard Creek	28	4	2	2	50	Ref - Urban



Water Quality Index (WQI)

The Water Quality Index is an indicator developed by Ecology as an overall indicator of water quality at a given site. The index compares typical water quality parameters with established standards and yields a single, unit-less number between 1 and 100 to describe the overall water quality of a site at the time of sampling. The index can then be summarized in a number of ways to give a site an overall score for a water year. The parameters included in the WQI are DO, temperature, pH, turbidity, suspended solids, FC, and nutrients.

The WQI is best used to answer general questions about the condition of watercourses, such as “What is the general condition of this stream?” or “How does this stream compare to others in the area?” (Hallock 2002). Because the index is a distillation of many parameters, it is unsuitable for answering detailed questions concerning the water quality of an individual stream. As is demonstrated by the Samish River, a stream can have an adequate WQI score based on ambient sampling, but significant pollution problems revealed by storm sampling.

Ecology rates streams with WQI Overall Score of 80 or greater “of lowest concern.” Streams with ratings of 40-79 are considered “of moderate concern,” while scores less than 40 are considered “of highest concern.”

Water Quality Index calculations for the sample sites in the SCMP during the 2019 water year are summarized in **Table 13**, and are mapped geographically in **Figure 17**. WQI scores over the length of this program are categorized for the years 2009-2019 in **Table 14**. Note that although the WQI was designed for freshwater bodies, we have applied the index to the Swinomish Channel monitoring site (Site 47), which is primarily marine. This allows trend detection over time at this station, but the WQI for Site 47 should not be compared to the freshwater sites.

The WQI results show that several watercourses in the study area fall into the “highest concern” category. Most, but not all, are agricultural drainages with little summer flow that are not considered salmonid habitat.

Over the course of the SCMP, the number of sites in the Lavender (Lowest Concern) category has generally increased since 2012, while the number of sites in the Red (Highest Concern) category has held steady. Streams and ditches in the Red category can have either one water quality parameter that is well below standards or several categories that are below standards.

Water quality during storm events remains problematic as the results from storm event monitoring in the Samish Basin associated with the CSI continue to show excessive fecal coliform concentrations.



Table 13 - Water Quality Index (WQI) results for the 2019 Water Year

*Note: Overall score is the mean of the three lowest monthly scores (Hallock 2002)

Site Number	Watercourse	Location	Mean WQI	Overall Score*	Max	Min
3	Thomas Creek	Old Hwy 99 N	49	37	88	1
4	Thomas Creek	F&S Grade Rd	73	65	96	38
6	Friday Creek	Prairie Rd	89	87	98	81
8	Swede Creek	Grip Rd	69	59	97	30
11	Samish River	State Route 9	85	81	96	62
12	Nookachamps Creek	Swan Rd	77	72	94	41
13	E.F. Nookachamps Creek	State Route 9	80	74	98	52
14	College Way Creek	College Way	63	54	92	15
15	Nookachamps Creek	Knapp Rd	42	27	86	1
16	E.F. Nookachamps Creek	Beaver Lake Rd	90	87	98	84
17	Nookachamps Creek	Big Lake Outlet	72	65	96	44
18	Lake Creek	State Route 9	85	82	94	74
19	Hansen Creek	Hoehn Rd	76	73	60	79
20	Hansen Creek	Northern State	88	85	98	75
21	Coal Creek	Hoehn Rd	79	74	95	47
22	Coal Creek	Hwy 20	84	79	98	66
23	Wiseman Creek	Minkler Rd	96	89	98	76
24	Mannser Creek	Lyman Hamilton Hwy	55	47	77	32
25	Red Cabin Creek	Hamilton Cem. Rd.	91	91	99	79
28	Brickyard Creek	Hwy 20	89	85	93	85
29	Skagit River	River Bend Rd	85	81	96	76
30	Skagit River	Cape Horn Rd	95	93	99	87
31	Drain Dist 20 Floodgate	Francis Rd	ND	ND	ND	ND
32	Samish River	Thomas Rd	92	91	97	84
33	Alice Bay Pump Station	Samish Island Rd	39	16	67	1
34	No Name Slough	Bayview-Edison Rd	36	27	66	1
35	Joe Leary Slough	D'Arcy Rd	19	15	26	13
36	Edison Slough	W. Bow Hill Rd	52	45	72	34
37	Edison Pump Station	Farm to Market Rd	13	11	19	1
38	N. Edison Pump Station	North Edison Rd	10	5	16	1
39	Colony Creek	Colony Rd	68	58	97	24
40	Big Indian Slough	Bayview-Edison Rd	23	16	54	16
41	Maddox Slough/Big Ditch	Milltown Rd	39	33	57	12
42	Hill Ditch	Cedardale Rd	77	73	88	64
43	Wiley Slough	Wylie Rd	34	26	56	1
44	Sullivan Slough	La Conner-Whitney	42	32	72	2
45	Skagit River – North Fork	Moore Rd	91	88	98	86
46	Skagit River – South Fork	Fir Island Rd	89	86	97	81
47	Swinomish Channel	County Boat Launch	84	80	95	74
48	Fisher Creek	Franklin Rd	88	87	93	84

Color code: **Lowest Concern** (>80 Overall Score), **Moderate Concern** (40-80), **Highest Concern** (<40)

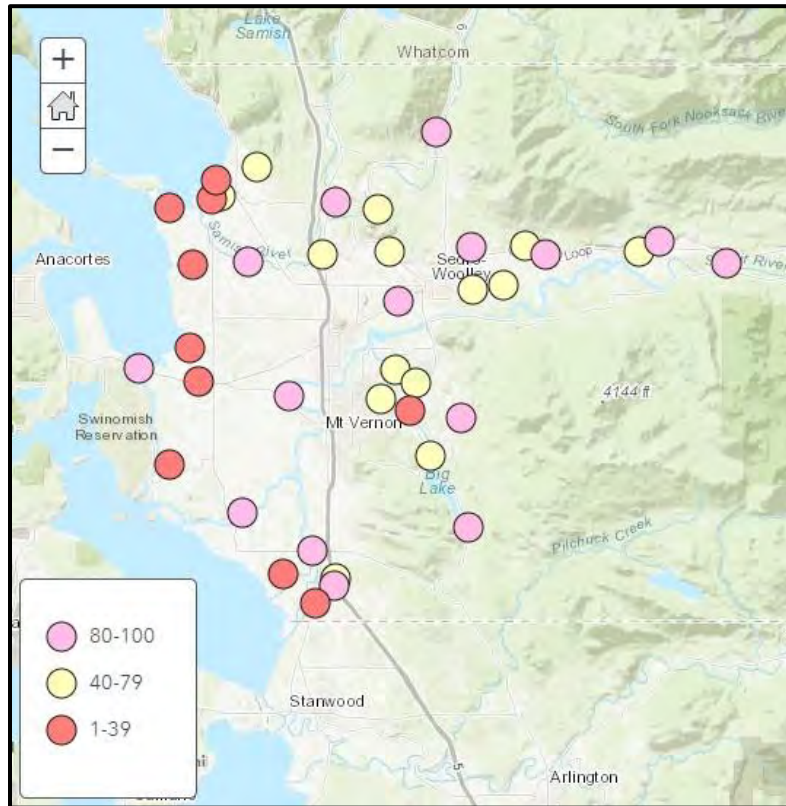


Figure 17 - Color coded map of 2019 WQI results

Table 14 - Number of sites in each WQI category for 2019 Water Year

Year	Lavender (80-100)	Light yellow (40-79)	Red (1-40)
2009	17	11	12
2010	13	19	8
2011	20	9	11
2012	13	16	11
2013	15	14	11
2014	16	13	11
2015	16	13	11
2016	15	15	10
2017	20	8	12
2018*	23	6	10
2019*	15	12	12

*39 sites sampled in 2018 and 2019



Site Report Cards (SRCs)

Tables and maps on the following pages report results from the SCMP for DO, temperature, and FC. Please note that each graph within a series may have a different Y-axis scale due to differences in magnitude between sample sites. Full data listings for each sampling event at each sample site are included in Appendix A. A summary of water quality results for each sample site is included in Appendix B.

The graphs are meant to give an overall picture of the water quality at a given site over time. They are not intended to fully describe the conditions at that site, only to give an “at a glance” indication of the conditions over the course of the project. Detailed descriptive statistics are included in the summary tables and in Appendix B. Results of the Trends Analysis are described in the Data Analysis section that follows the Data Summary.

Note that the y-axes on the graphs in this section are not all equivalent. The y-axes for temperature and DO align with the particular state standard that is in accordance with that sampling site. The y-axes for FC counts are vastly different to accommodate the data for each site. Normalizing these y-axes to each other would render data un-viewable and un-interpretable at several sites. Some data points are outliers to a data set and would stretch the size of the y-axis to a point that this same effect is seen, and have therefore been cropped at the top of the plot, and the quantification of the data point has been added next to the crop to inform the reader of its value.

All photographs in the following section were taken by the author and are therefore public property.



3

Thomas Creek
@ Highway 99

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	20	14	31	49	58	41	60	41	45	53	41	30	37

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	↓	↓	—	—	—	↓	—	—

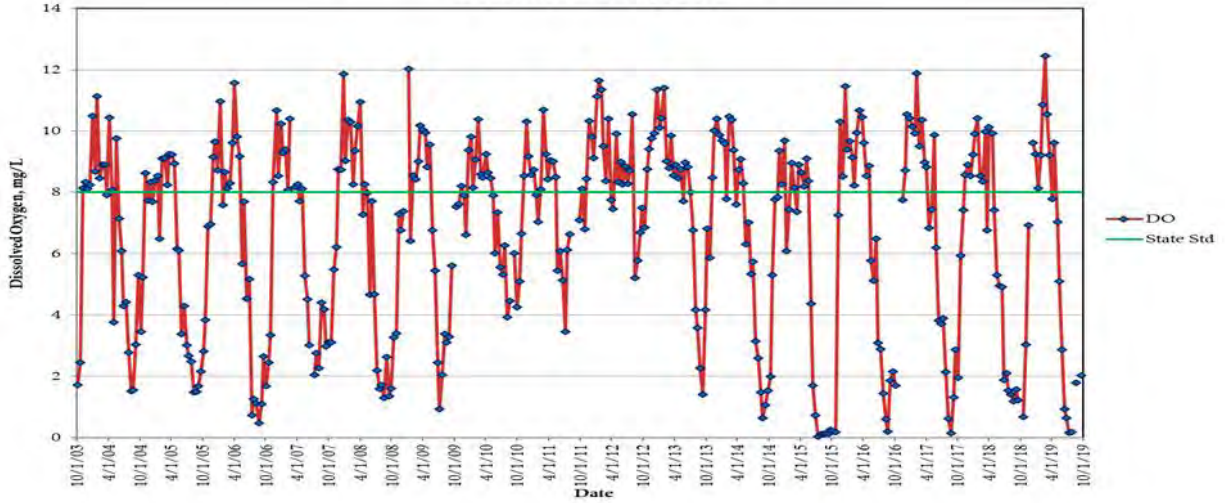
Site 3 is Thomas Creek, downstream from site 4, and sits just prior to the creek joining the Samish River. This section of the creek is more of a slough, with slow-moving, channelized water. This site has substantially lower flow volumes in the summer months. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Dissolved oxygen has declined over the last ten years and over the last five years. Fecal coliform counts are lower than they were sixteen years ago. WQI scores have improved since monitoring began, but have never reached the category of lowest concern.

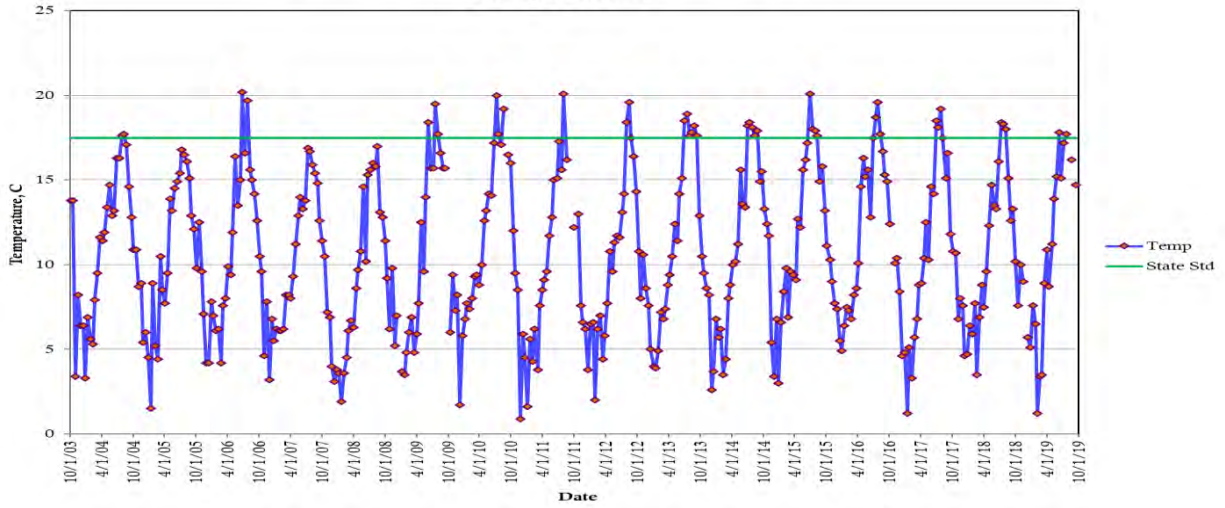
Site 3 regularly fails to meet state standards for DO and temperature in the warmer months. Annual FC levels meet or nearly meet state standards.

Site 3 is tied for 14th out of 39 sites for number of significant trends, with 14, and 23rd out of 39 sites for positive trends, at 57%.

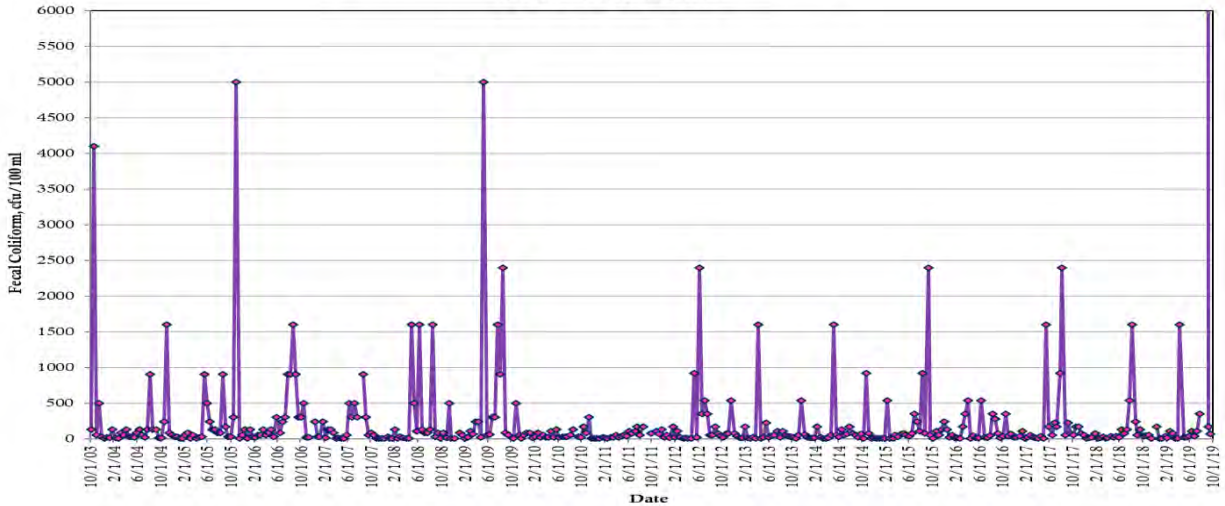
Thomas Creek at Highway 99 - Site 3 Dissolved Oxygen



Thomas Creek at Highway 99 - Site 3 Temperature



Thomas Creek at Highway 99 - Site 3 Fecal Coliform





4

Thomas Creek
@ F&S Grade Road

Upstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
15	54	39	66	76	77	62	81	89	71	52	89	81	65

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↑	↑	↑	—	—	↓	↓	—	—

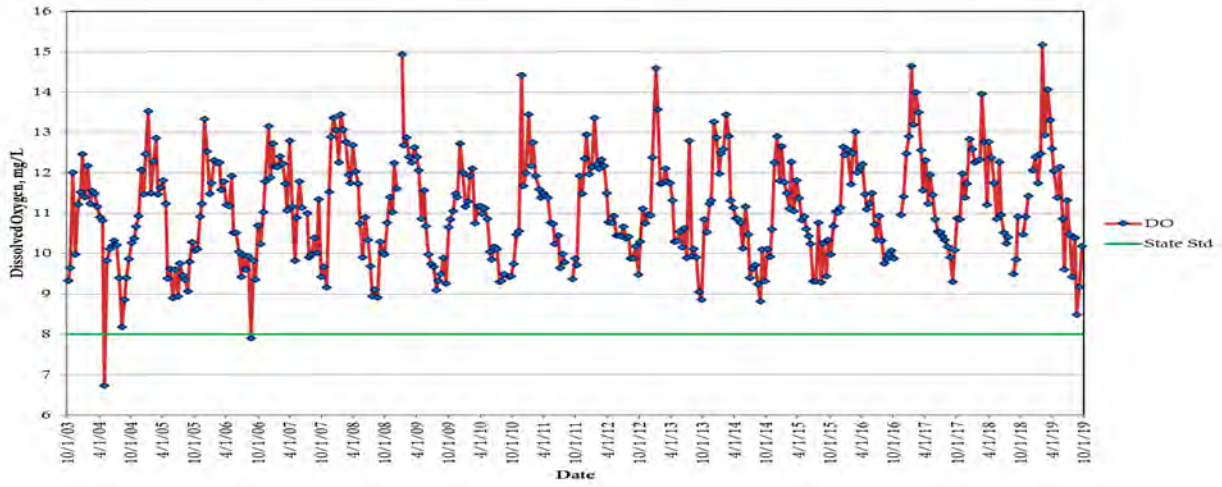
Site 4 is Thomas Creek, upstream of site 3. Upstream of this sampling site, the creek is fairly oxygenated and fast-moving. This site has substantially lower flow volumes in the summer months. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Dissolved oxygen has increased significantly across all time periods. Temperature has declined over the most recent five years. Fecal coliform counts are lower than they were 16 years ago. WQI scores have substantially improved since monitoring began.

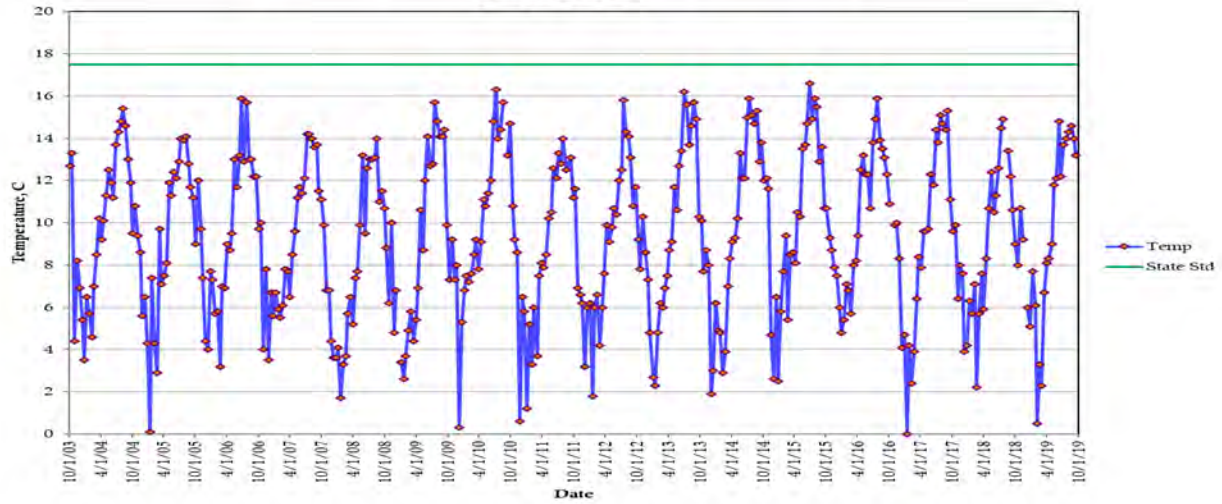
Site 4 regularly meets state standards for temperature and DO year-round. Fecal coliform levels regularly exceed annual state standards.

Site 4 is tied for 4th out of 39 sites for number of significant trends, with 18, and tied for 2nd out of 39 sites for positive trends, at 89%.

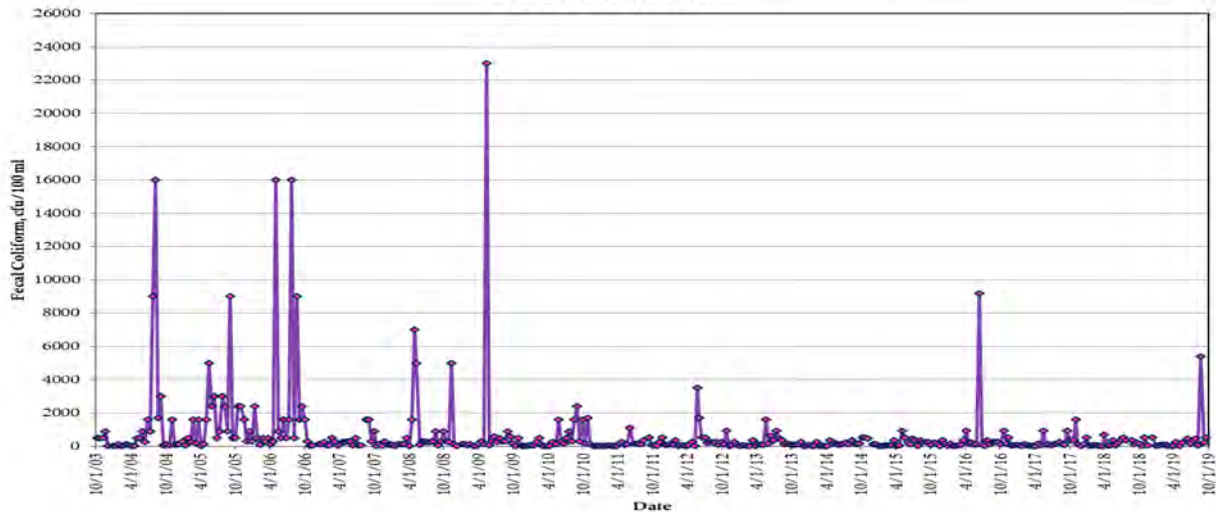
Thomas Creek at F&S Grade Road - Site 4 Dissolved Oxygen



Thomas Creek at F&S Grade Road - Site 4 Temperature



Thomas Creek at F&S Grade Road - Site 4 Fecal Coliform





6

Friday Creek
@ Prairie Road

Reference – Rural Reserve

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
45	81	65	86	90	94	81	88	88	90	85	86	91	87

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↑	↑	↑	↑	—	—	—	—	—

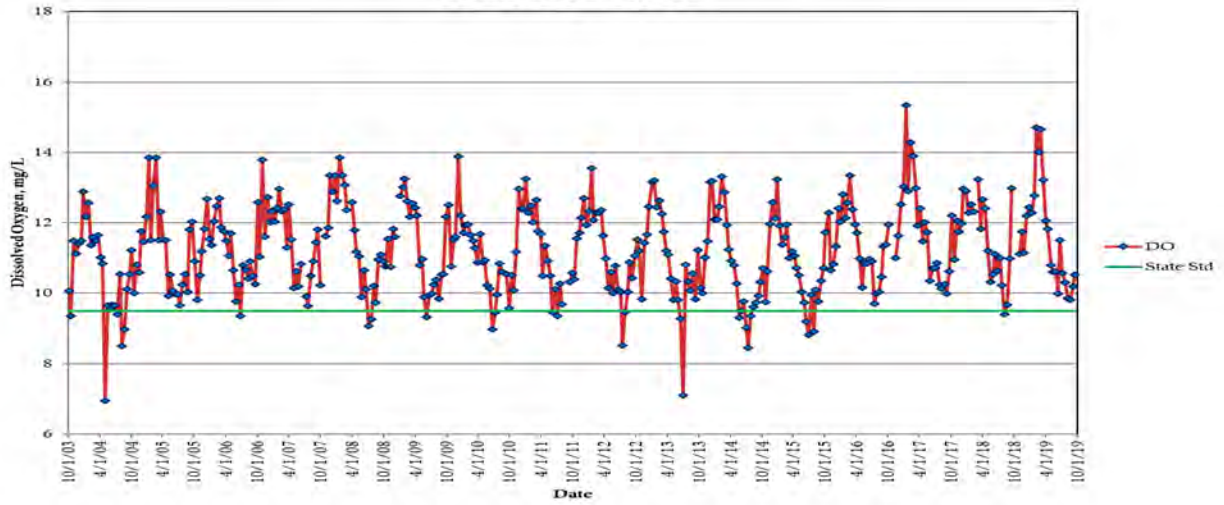
Site 6 is Friday Creek, and sits just prior to the creek joining the Samish River. This creek has a high flow volume and rate, and can seasonally contribute around 40% or more of the total volume of the Samish River. This site is designated as core salmonid habitat.

Dissolved oxygen has significantly increased across all time periods analyzed. Temperature is higher now than it was 16 years ago. No significant changes were observed in fecal coliform levels. WQI is consistently in the category of least concern.

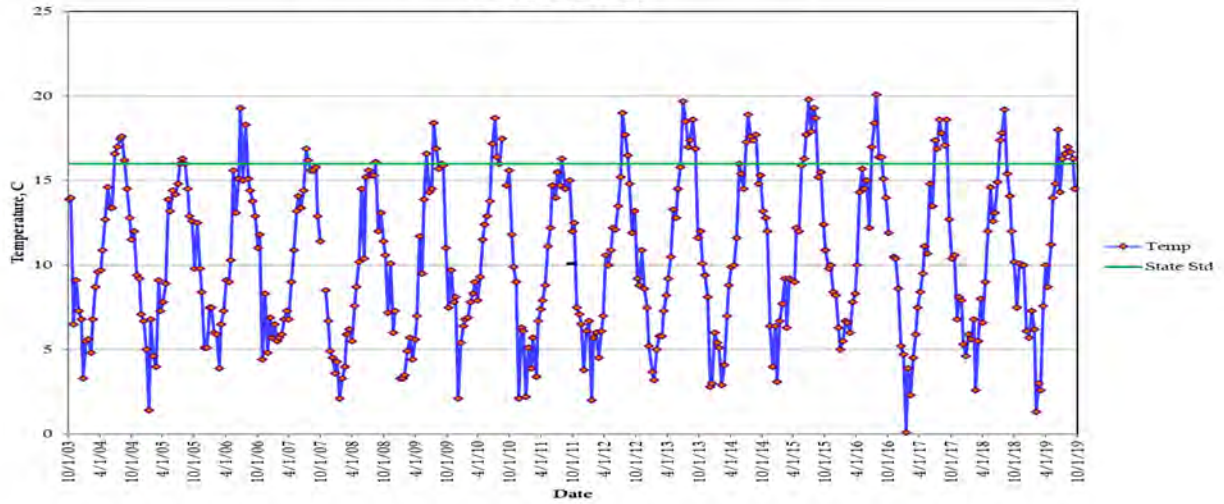
Site 6 regularly meets state standards for DO year-round. Temperature exceeds state standards during the hottest time of the year. Annual FC levels meet state standards.

Site 6 is tied for 6th out of 39 sites for number of significant trends, with 17, and is tied for 17th out of 39 sites for positive trends, at 65%.

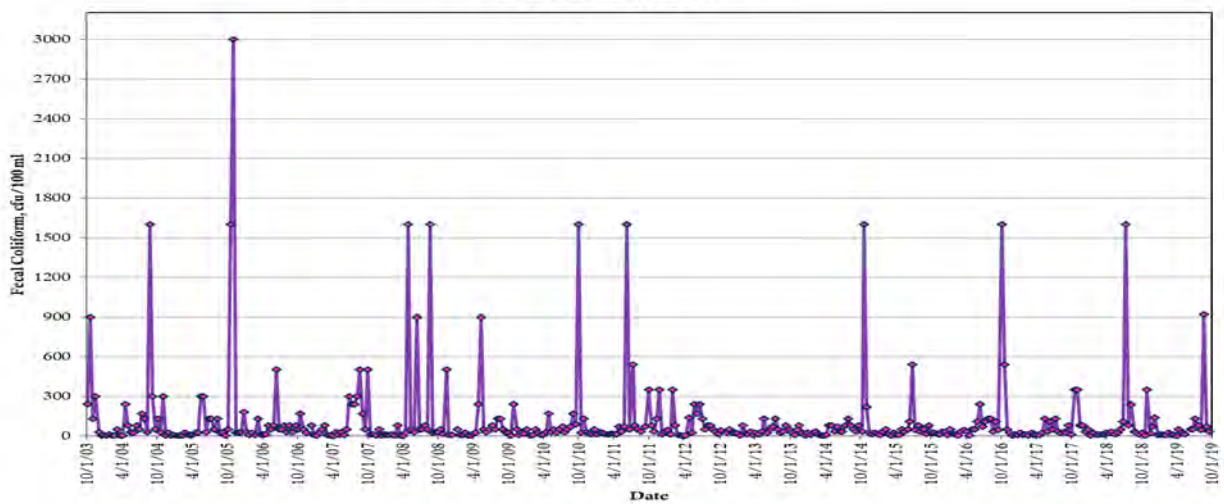
Friday Creek at Prairie Road - Site 6 Dissolved Oxygen



Friday Creek at Prairie Road - Site 6 Temperature



Friday Creek at Prairie Road - Site 6 Fecal Coliform





8

Swede Creek
@ Grip Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
34	58	48	72	76	90	71	83	77	75	61	75	81	59

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↓	—	—	—	↑	↓	↓	—	—

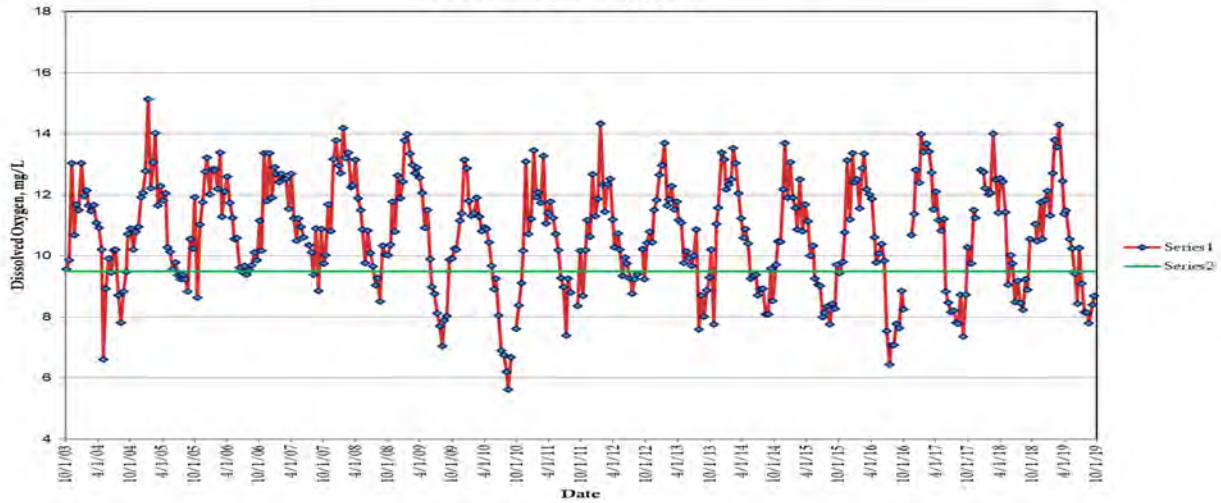
Site 8 is Swede Creek, and sits just prior to the creek joining the Samish River. Swede Creek has been a focus of pollution monitoring efforts in the Samish basin, with rural residential and agricultural sources in the watershed. The site is designated as core salmonid habitat.

Dissolved oxygen has declined as compared to 16 years ago. Temperatures are higher than they were ten years ago, but lower than they were five years ago. Fecal coliform counts are lower than they were 16 years ago. WQI scores are generally in the higher-scoring end of the moderate concern category, and sometimes score as least concern.

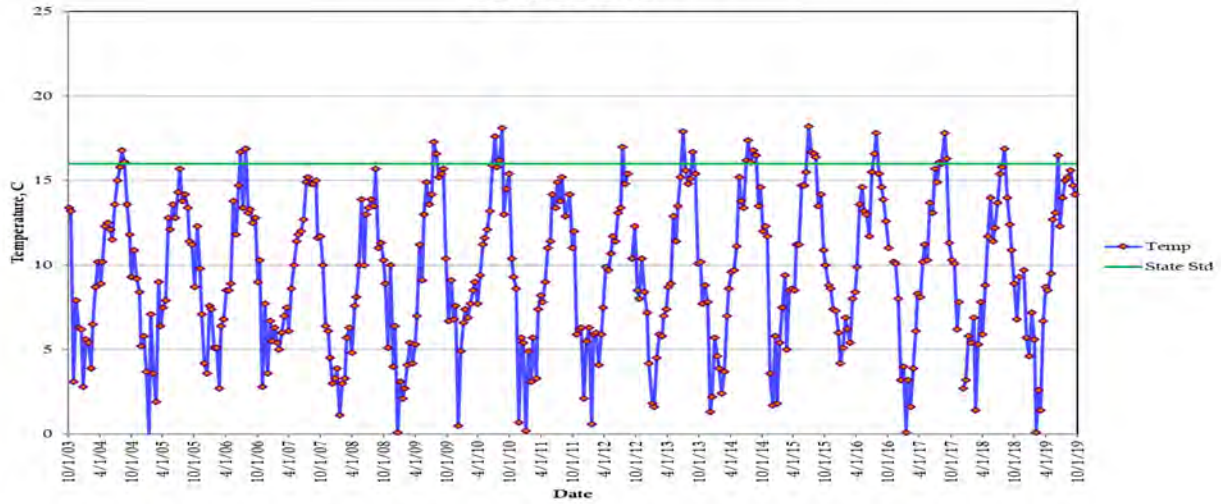
Site 8 regularly fails to meet state DO standards in the warmer months, and fails to meet state temperature standards only at the warmest time of year. Annual FC levels meet state standards.

Site 8 is tied for 9th out of 39 sites for number of significant trends, with 16, and 26th out of 39 sites for positive trends, at 50%.

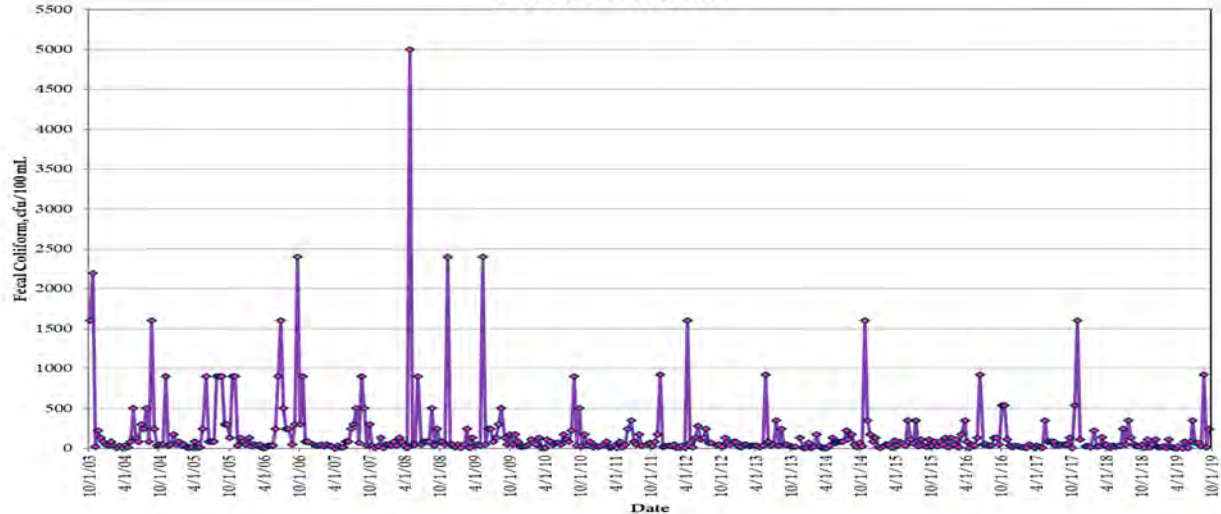
Swede Creek at Grip Road - Site 8 Dissolved Oxygen



Swede Creek at Grip Road - Site 8 Temperature



Swede Creek at Grip Road - Site 8 Fecal Coliform





11

Samish River
@ Highway 9

Upstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
57	85	68	81	78	86	65	72	68	66	80	82	87	81

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↑	↑	↑	—	—	↓	↓	—	—

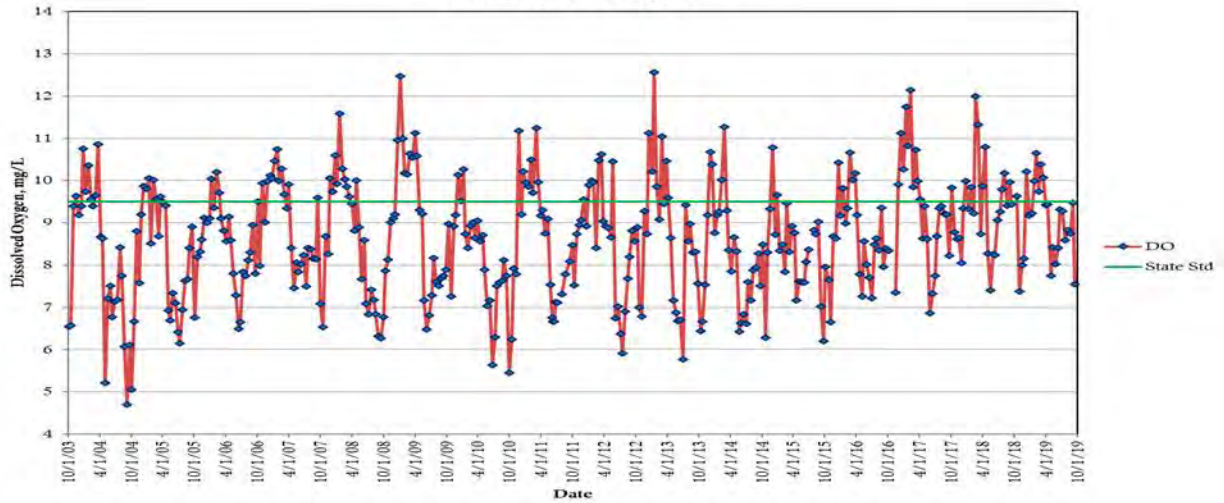
Site 11 is the Samish River, upstream of all other Samish River sampling sites. This site shows the condition of the Samish River prior to all monitored tributaries. This site is designated as core salmonid habitat.

Dissolved oxygen has significantly increased over all time periods. Temperature has decreased in the last five years. Fecal coliform counts are lower than they were 16 years ago. WQI scores are generally in the higher-scoring end of the moderate concern category, and often score as least concern.

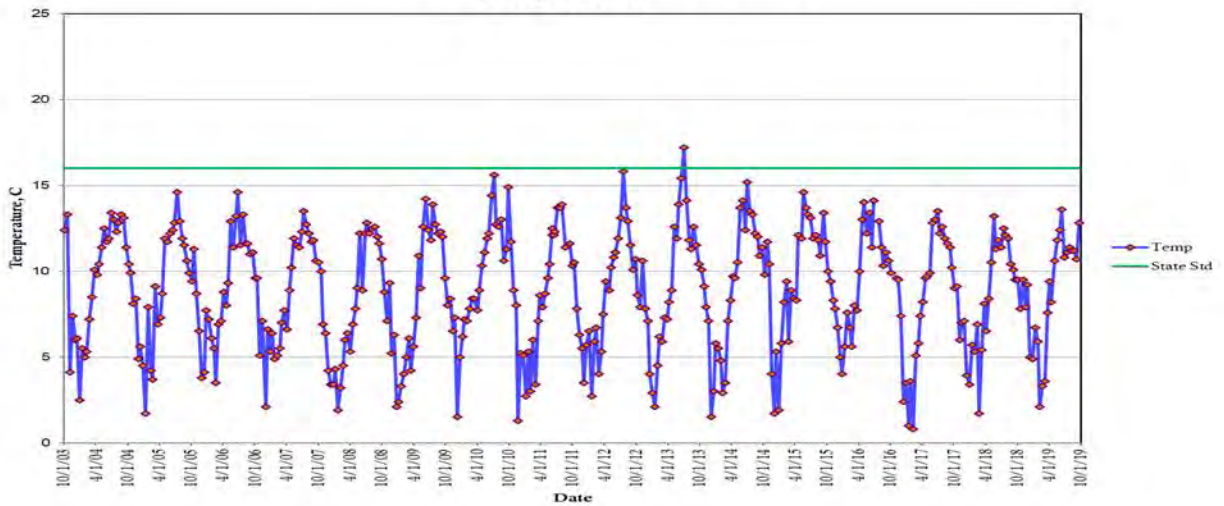
Site 11 regularly fails to meet state standards for DO, but rarely fails state standards for temperature, year-round. Annual FC levels easily meet state standards.

Site 3 is tied for 14th out of 39 sites for number of significant trends, with 14, and 1st out of 39 sites for positive trends, with 100%.

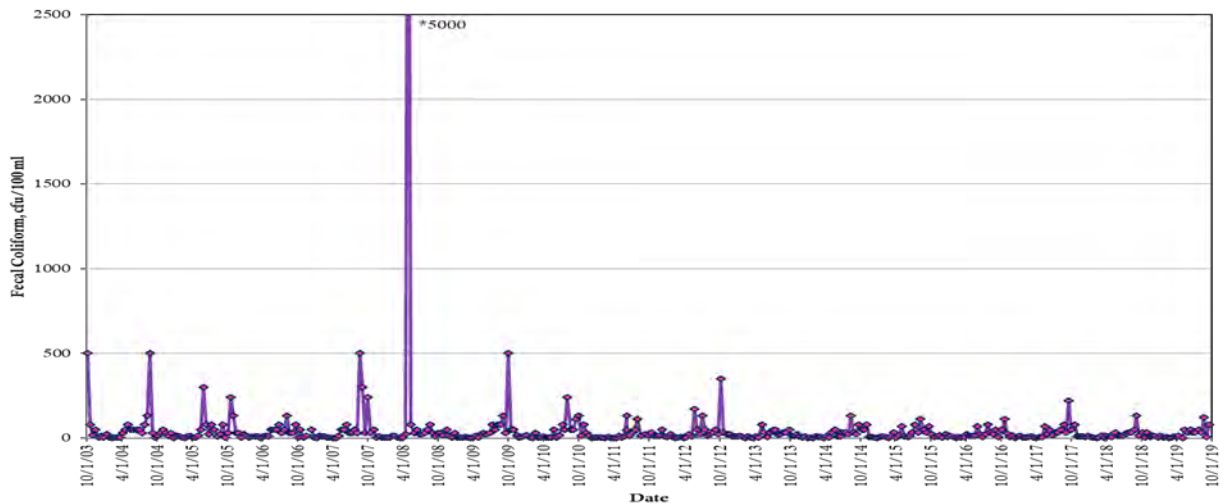
Samish River at Highway 9 - Site 11 Dissolved Oxygen



Samish River at Highway 9 - Site 11 Temperature



Samish River at Highway 9 - Site 11 Fecal Coliform





12

Nookachamps Creek
@ Swan Road

Downstream Ag, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
63	72	38	72	58	68	50	62	58	59	67	59	49	72

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	↑	—	—	↓	—	—	↓

Site 12 is Nookachamps Creek, and is the furthest downstream site of the creek in this program, located just prior to joining the Skagit River. This creek drains a large valley of rural residential and agriculturally-zoned areas. This site is designated as core salmonid habitat.

Over the last five years, dissolved oxygen has increased, temperature has decreased, and fecal coliform counts have decreased. No significant trends in these categories were observed over the longer time periods. WQI scores are regularly in the category of moderate concern.

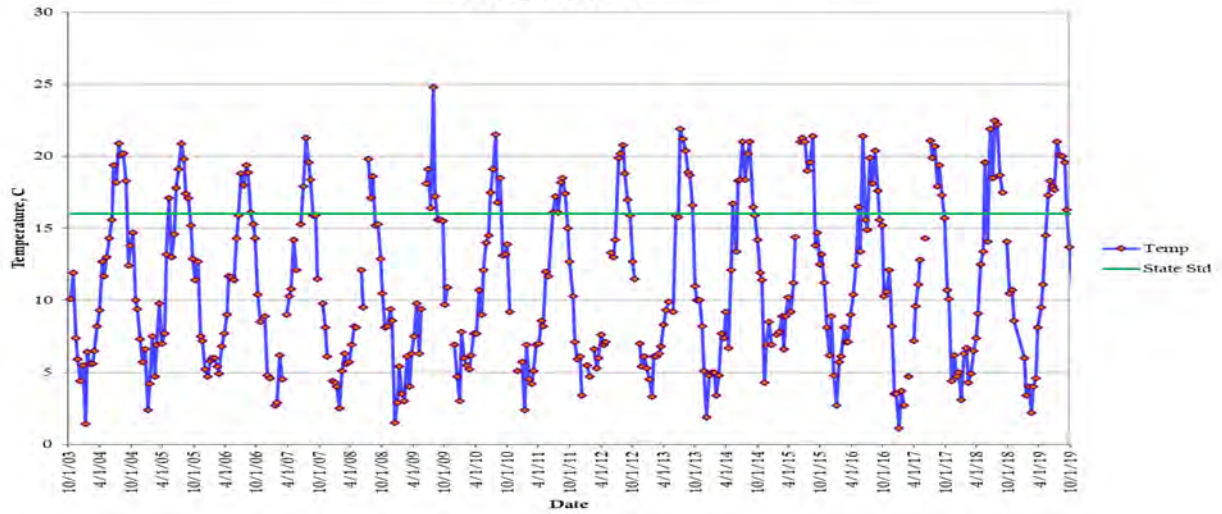
Site 12 regularly fails to meet state standards for DO and temperature during the warmer months. Annual FC levels meet state standards.

Site 12 is tied for 11th out of 39 sites for number of significant trends, with 15, and is tied for 15th out of 39 sites for positive trends, with 67%.

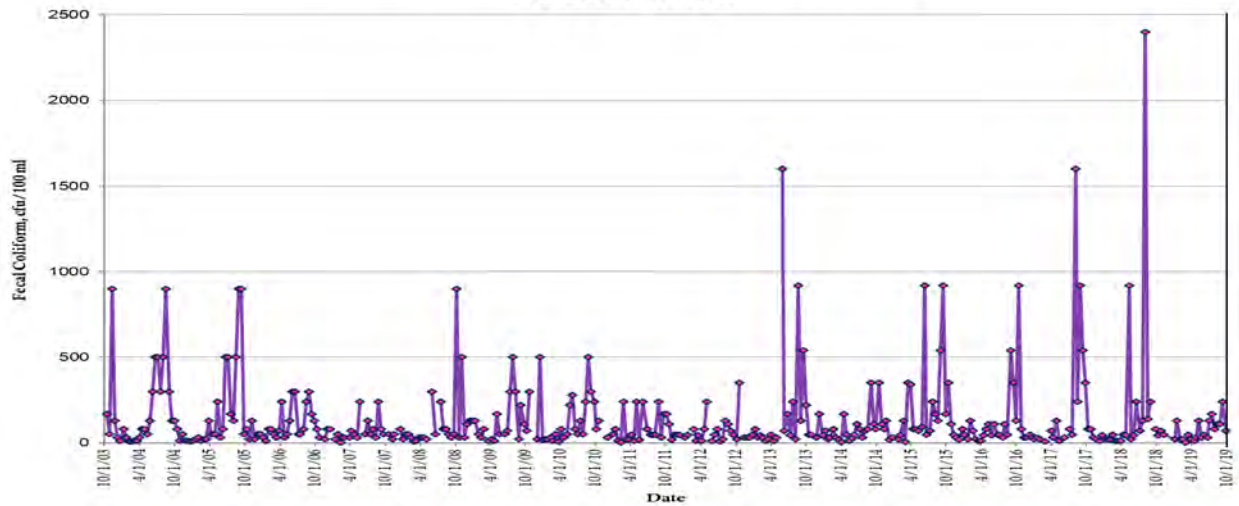
Nookachamps Creek at Swan Road - Site 12 Dissolved Oxygen



Nookachamps Creek at Swan Road - Site 12 Temperature



Nookachamps Creek at Swan Road - Site 12 Fecal Coliform





13

EF Nookachamps Creek
@ Highway 9

Downstream Ag, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
74	77	88	85	85	91	65	70	76	74	75	64	80	74

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↓	—	—	↑	—	↓	—	↓	↓

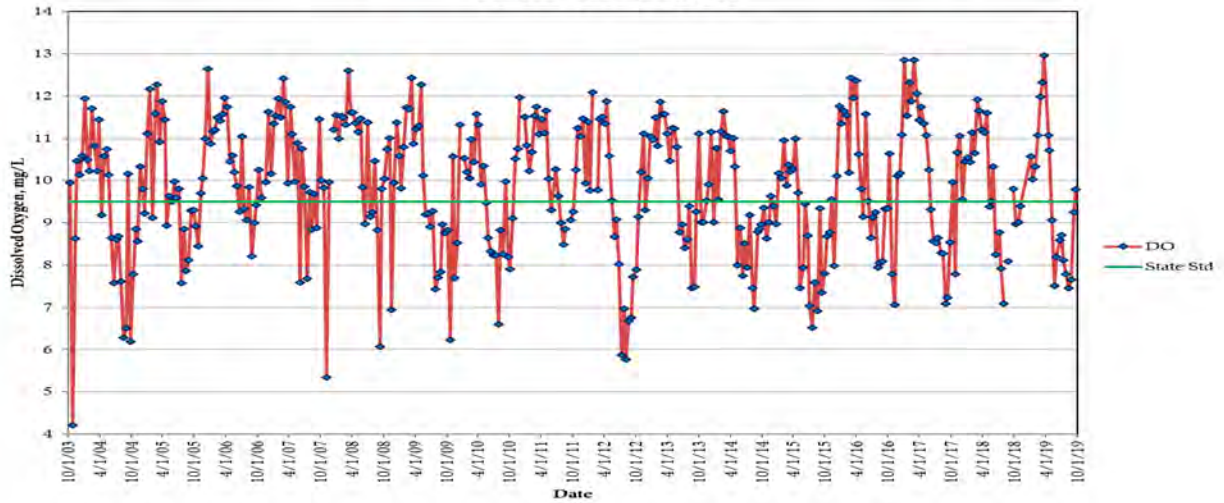
Site 13 is East Fork Nookachamps Creek, downstream of site 16, and sitting just prior to joining Nookachamps Creek and ultimately the Skagit River. It sits downstream of a stretch of agricultural activity. This site is designated as char spawning and rearing status.

Dissolved oxygen has declined since 16 years ago. Temperature is higher than it was 16 years ago, but has declined in the last five. Fecal coliform counts are significantly lower over the last ten years and five years. WQI scores are generally in the higher-scoring end of the moderate concern category, and often score as least concern.

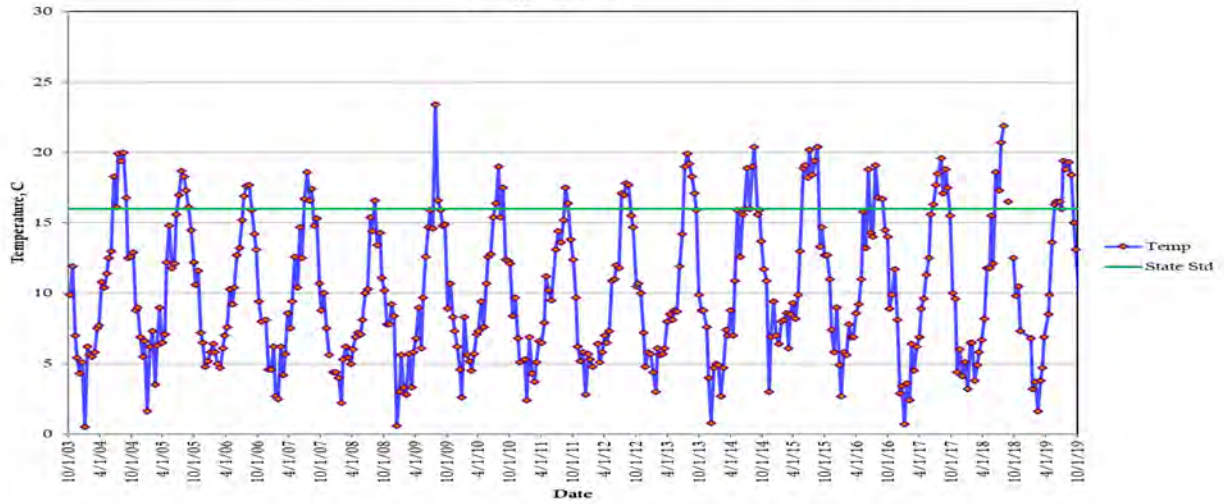
Site 13 regularly fails to meet state standards for DO and temperature during the warmer months. Annual FC levels meet state standards.

Site 13 is tied for 6th out of 39 sites for number of significant trends, with 17, and tied for 17th out of 39 sites for positive trends, with 65%.

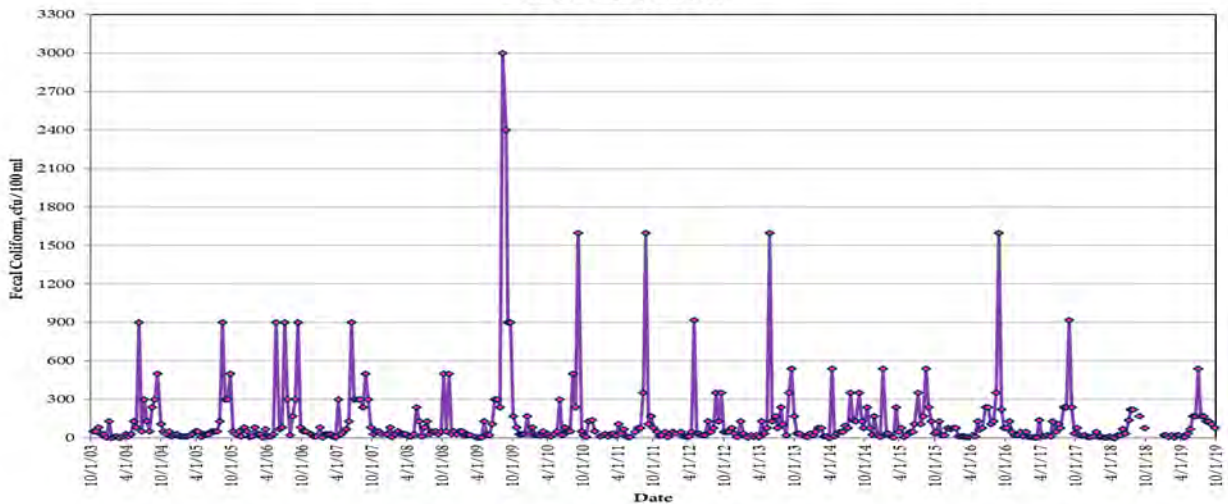
**East Fork Nookachamps Creek at Highway 9 - Site 13
Dissolved Oxygen**



**East Fork Nookachamps Creek at Highway 9 - Site 13
Temperature**



**East Fork Nookachamps Creek at Highway 9 - Site 13
Fecal Coliform**





14

College Way Creek
@ College Way

Reference – Urban/suburban

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
48	35	24	46	44	75	40	47	53	55	73	47	55	54

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	↑	↑	—	—	↓	—	—	—

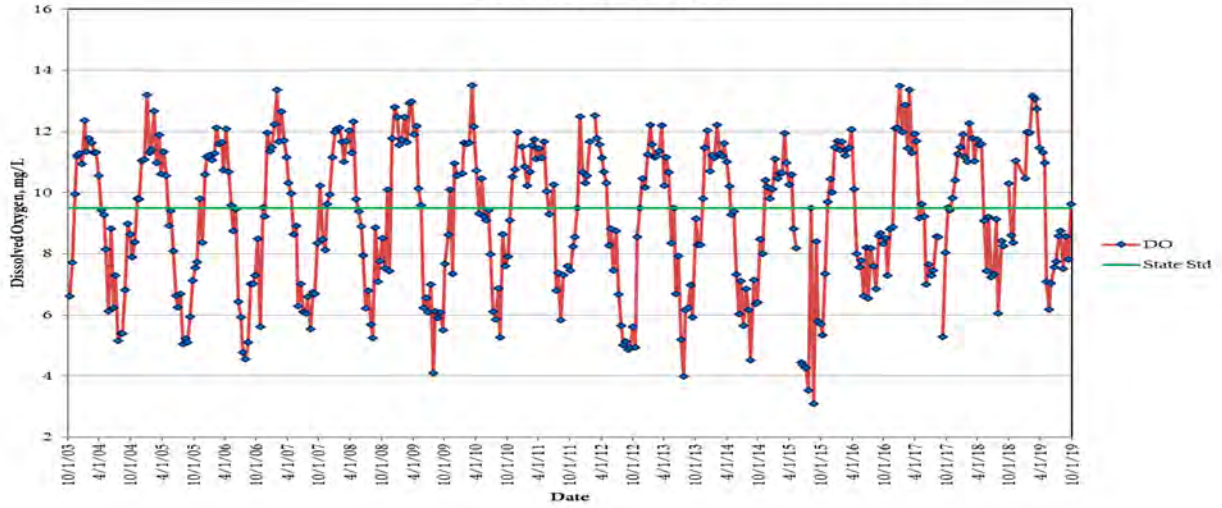
Site 14 is College Way Creek. This creek drains an urban/suburban area of northeast Mount Vernon, and terminates into Nookachamps Creek just prior to Barney Lake, and eventually into the Skagit River. This site is designated as core salmonid habitat.

Dissolved oxygen has significantly increased over the last ten years and five years. Water temperature has decreased over the last five years. WQI scores are regularly in the category of moderate concern.

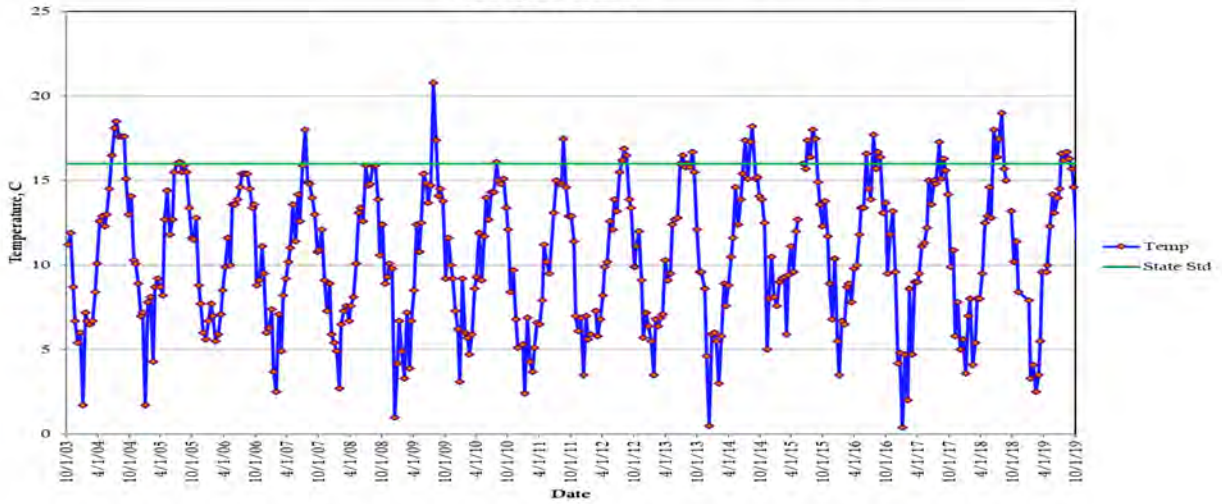
Site 14 regularly fails to meet state standards for DO during the warmer months, and often fails to meet state standards for temperature during the hottest time of the year. Annual FC levels fail to meet state standards.

Site 14 is tied for 14th out of 39 sites for number of significant trends, with 14, and is tied for 11th out of 39 sites for positive trends, with 71%.

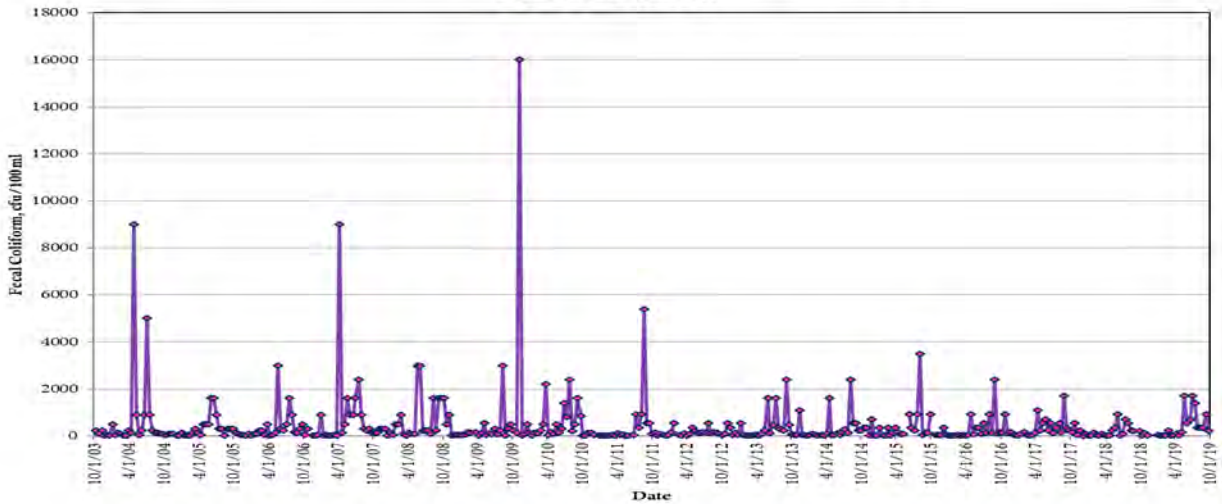
College Way Creek at College Way - Site 14 Dissolved Oxygen



College Way Creek at College Way - Site 14 Temperature



College Way Creek at College Way - Site 14 Fecal Coliform





15

Nookachamps Creek
@ Knapp Road

Midstream Ag, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
22	8	18	15	54	36	31	29	31	56	48	28	50	27

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	↑	↑	—	↓	↑	↓	—

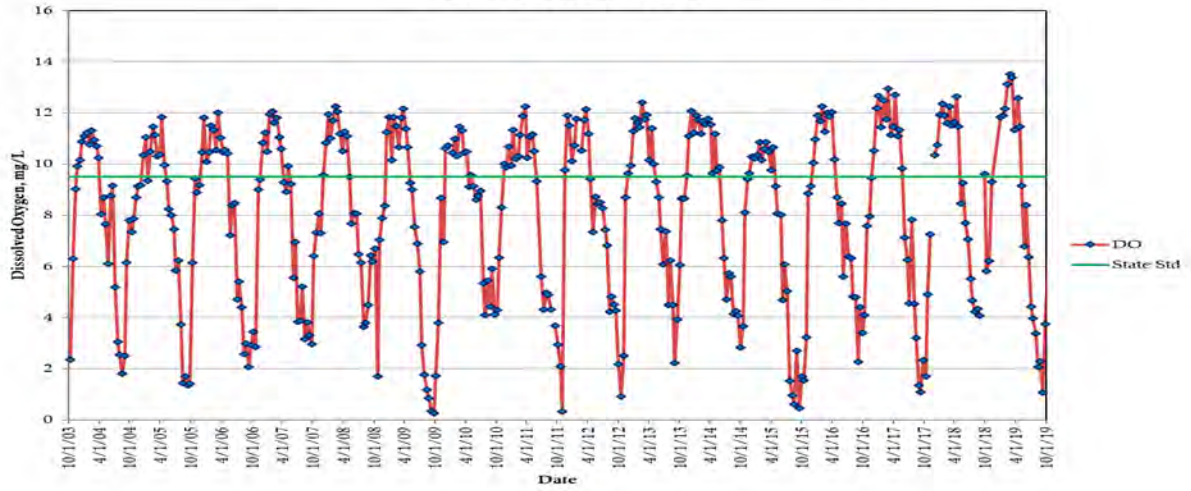
Site 15 is Nookachamps Creek mid-stream, upstream from site 12, and downstream from Big Lake and site 17. This site is designated as core salmonid habitat.

Dissolved oxygen is higher than it was five years ago. Water temperature is higher than it was at the beginning of this study, but lower than it was five years ago. Fecal coliform counts are higher than they were at the beginning of this study, but are lower now than they were ten years ago. WQI scores are consistently in the category of highest concern.

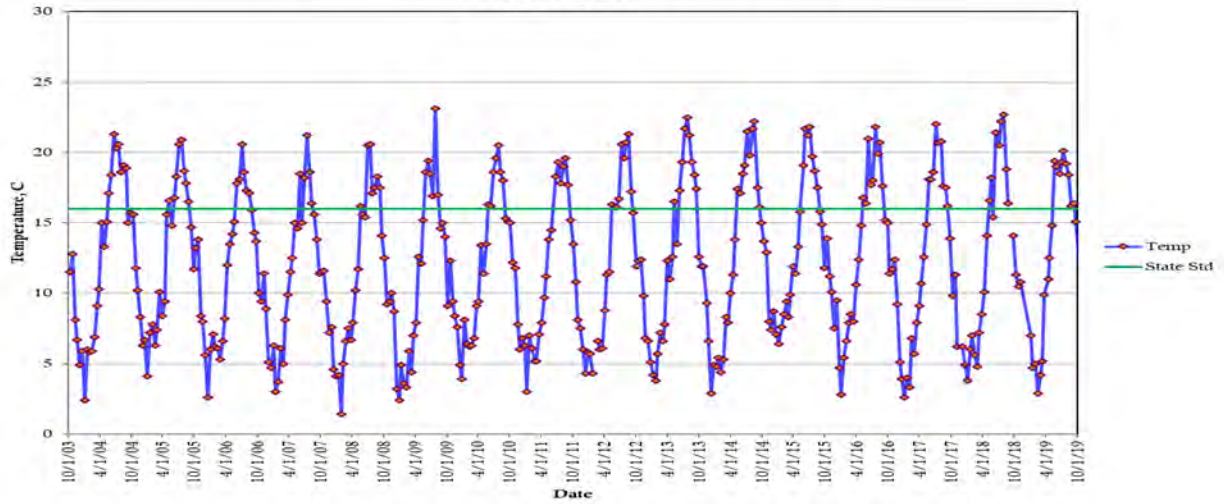
Site 15 regularly fails to meet state standards for DO and temperature during the warmer months. Annual FC levels pass the state standard for geomean of 100, but easily fail the state standard for a 90th percentile of 200.

Site 15 is tied for 11th out of 39 sites for number of significant trends, with 15, and is tied for 9th of 39 sites for positive trends, with 71%.

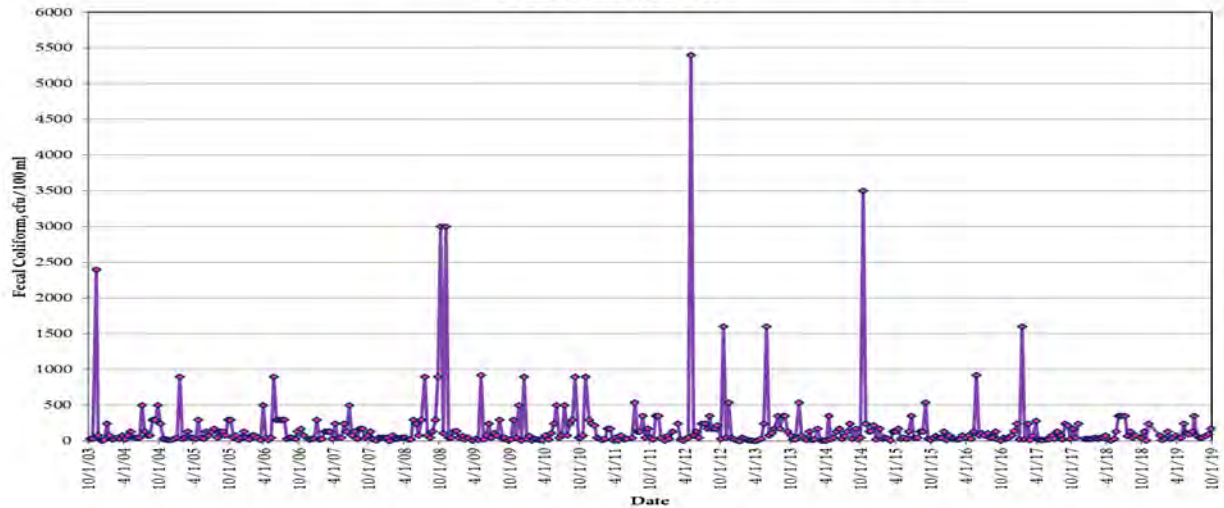
Nookachamps Creek at Knapp Road - Site 15 Dissolved Oxygen

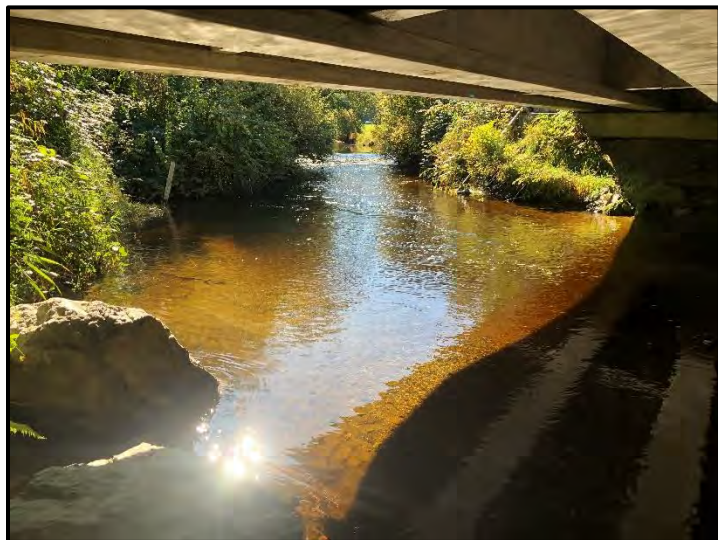


Nookachamps Creek at Knapp Road - Site 15 Temperature



Nookachamps Creek at Knapp Road - Site 15 Fecal Coliform





16

EF Nookachamps Creek
@ Beaver Lake Road

Midstream Ag, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
88	86	89	91	97	84	91	80	92	95	88	83	89	87

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	↑	↑	↑	—	↓	—	—	—

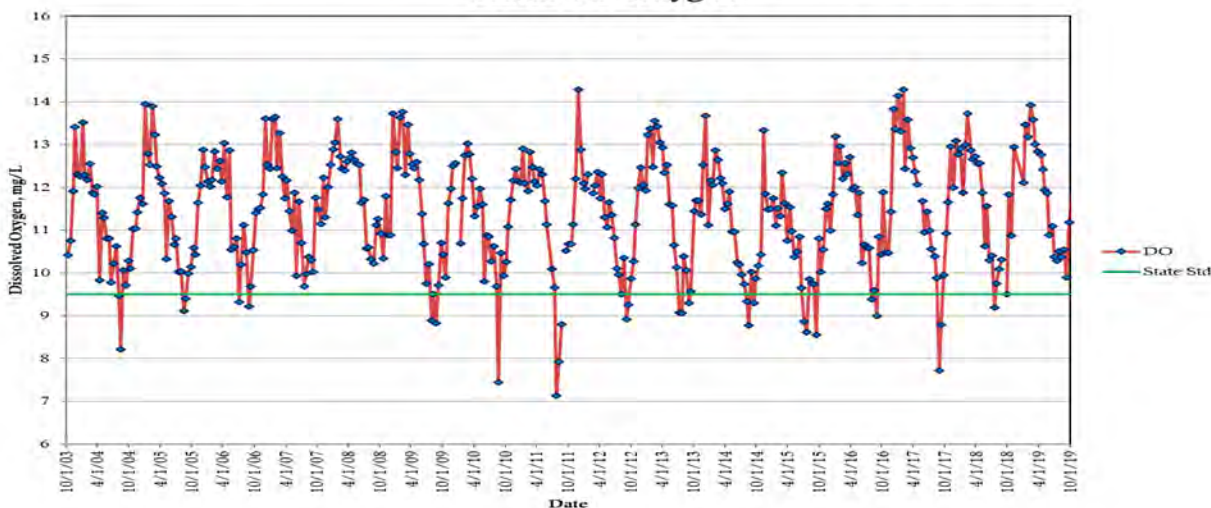
Site 16 is East Fork Nookachamps Creek, upstream of site 13, and immediately after adjoining with Cold Spring Creek. This site is influenced by light agricultural uses and undeveloped land. This site is designated as char spawning and rearing status.

Dissolved oxygen has significantly increased over the last ten years and five years. Water temperatures are higher than sixteen years ago, but have decreased in the most recent five years. There were no significant trends in fecal coliform. WQI scores have never been outside of the category of least concern.

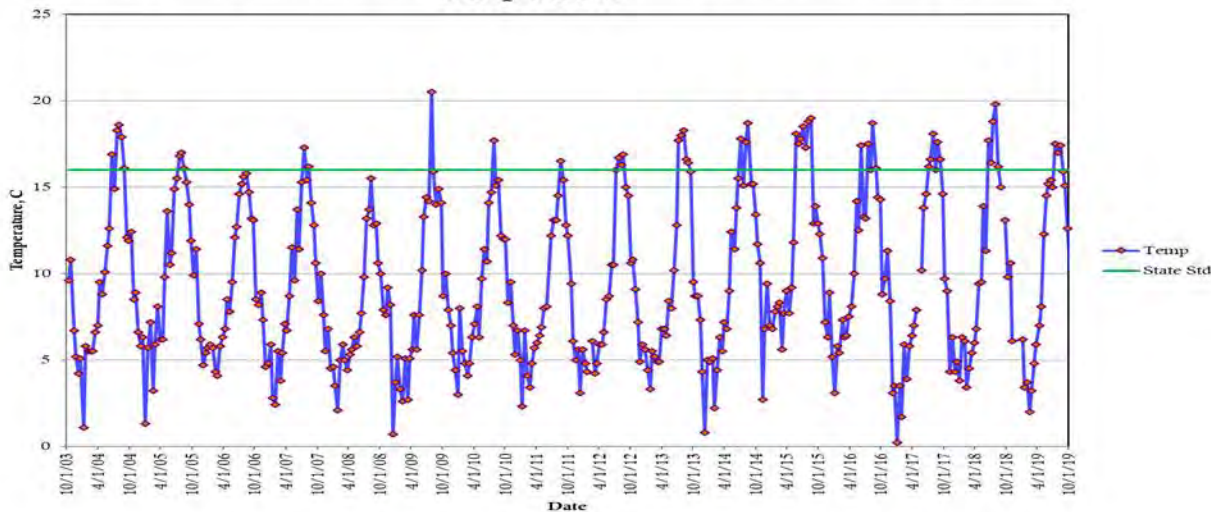
Site 16 rarely fails state standards for DO, but water temperatures can often exceed state standards during the warmest time of year. Annual FC levels easily meet state standards.

Site 16 is tied for 21st out of 39 sites for number of significant trends, with 12, and is tied for 7th out of 39 sites for positive trends, with 75%.

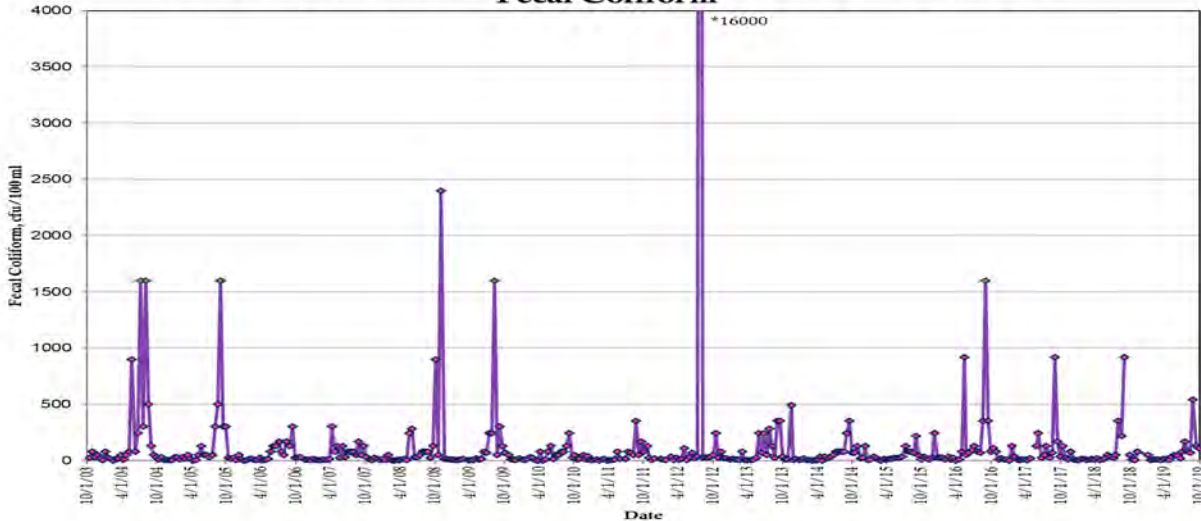
East Fork Nookachamps Creek at Beaver Lake Road - Site 16 Dissolved Oxygen



East Fork Nookachamps Creek at Beaver Lake Road - Site 16 Temperature



East Fork Nookachamps Creek at Beaver Lake Road - Site 16 Fecal Coliform





17

Nookachamps Creek
@ Big Lake Outlet

Upstream Ag, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
60	83	69	84	75	91	74	64	60	79	71	78	67	65

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	↑	↑	—	↓	—	↑	—

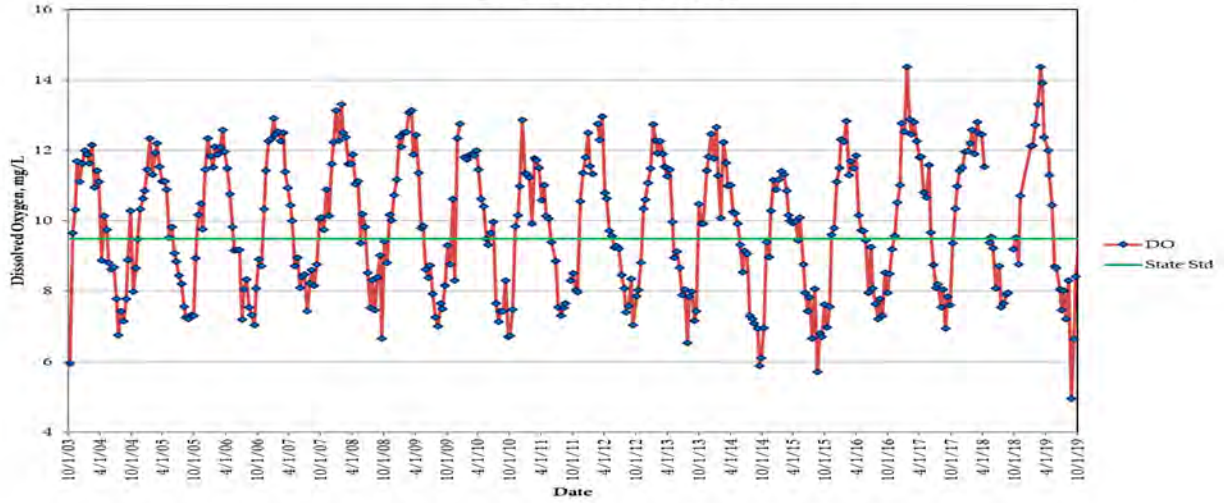
Site 17 is Nookachamps Creek, at its source, immediately after leaving Big Lake. This site is upstream from sties 15 and 12. This site is designated as core salmonid habitat.

Over the most recent five years, dissolved oxygen has increased and water temperature has decreased, though temperature has increased over the sixteen years of the program. Fecal coliform counts are higher than they were ten years ago. WQI scores are generally in the upper-score end of the moderate concern category, and has scored in the least concern category in the past.

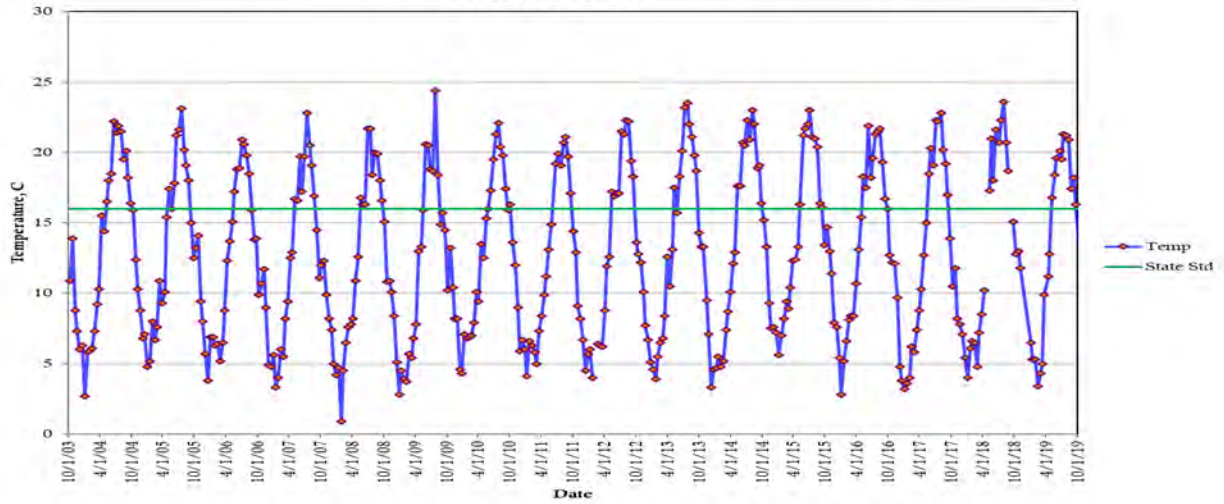
Site 17 regularly fails to meet state standards for DO and temperature during the warmer months. Annual FC levels meet state standards.

Site 17 is tied for 25th out of 39 sites for number of significant trends, with 11, and tied for 31st out of 39 sites for positive trends, with 45%.

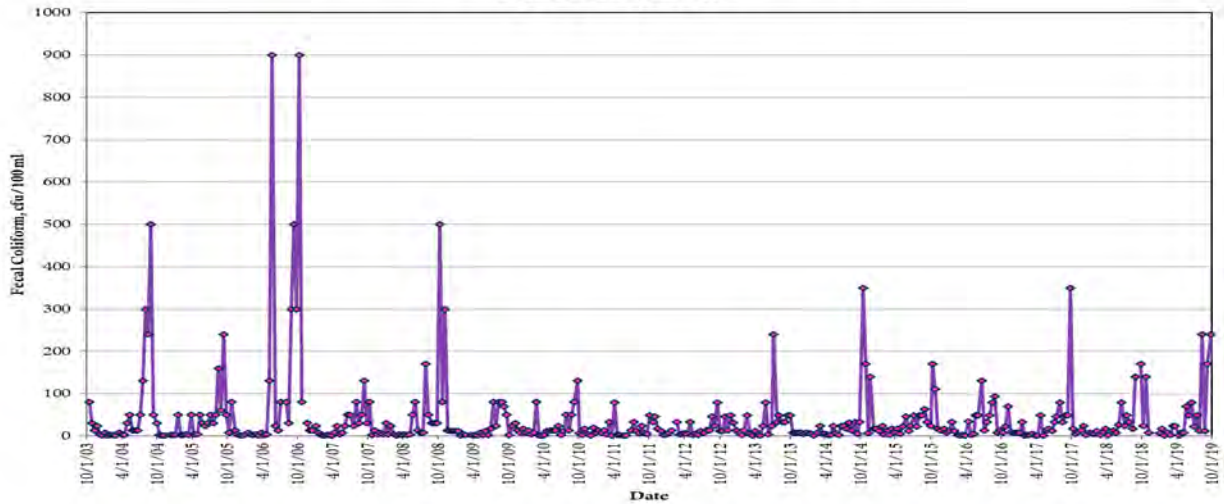
Nookachamps Creek at Big Lake Outlet - Site 17 Dissolved Oxygen



Nookachamps Creek at Big Lake Outlet - Site 17 Temperature



Nookachamps Creek at Big Lake Outlet - Site 17 Fecal Coliform





18

Lake Creek
@ Big Lake Boulevard

Upstream Ag, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
84	66	80	93	63	80	87	80	90	88	84	86	87	82

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	↑	↑	↑	—	↓	↓	—	↓

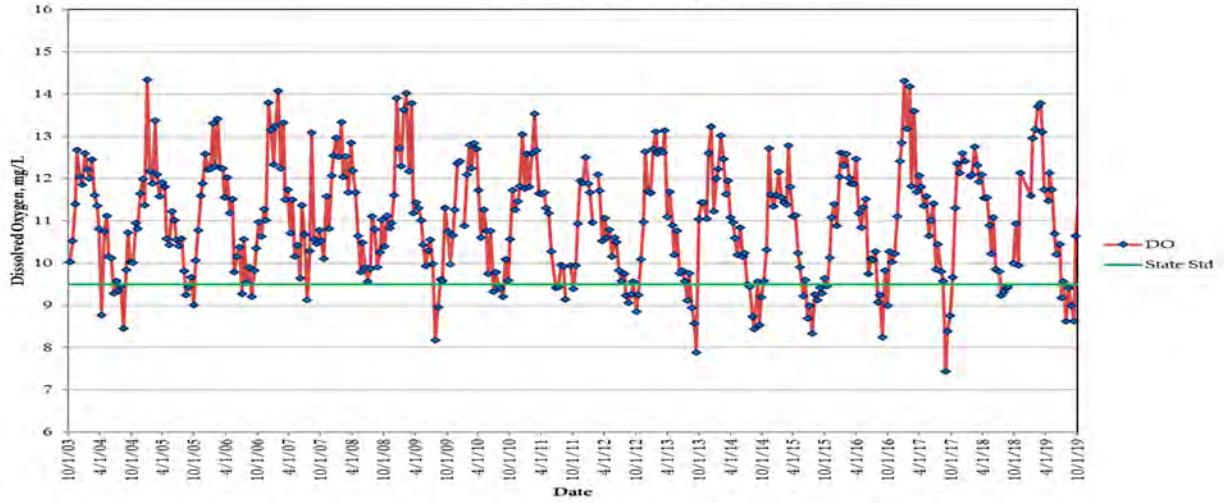
Site 18 is Big Lake Creek, just prior to entering Big Lake. This site also contributes to water quality data bracketing of Big Lake along with site 17. This site is designated as core salmonid habitat.

Dissolved oxygen has increased in the most recent ten years and five years. Water temperature is warmer than it was sixteen years ago, but has decreased in the last five years. Fecal coliform is lower than it was 16 years ago, and has also decreased over the last five years.

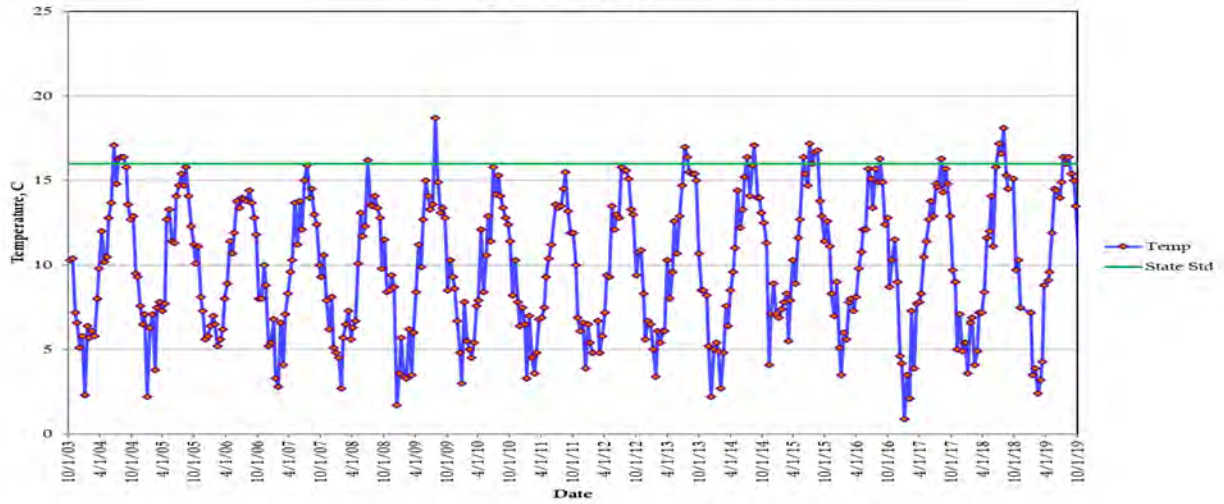
Site 18 typically stays within state standards for DO, and rarely fails state standards for temperature, even in the warmest months. Annual FC levels pass the state standard for geomean of 100, but do closely fail the state standard for a 90th percentile of 200.

Site 18 is tied for 19th out of 39 sites for number of significant trends, with 13, and is 14th out of 39 sites for positive trends, with 69%.

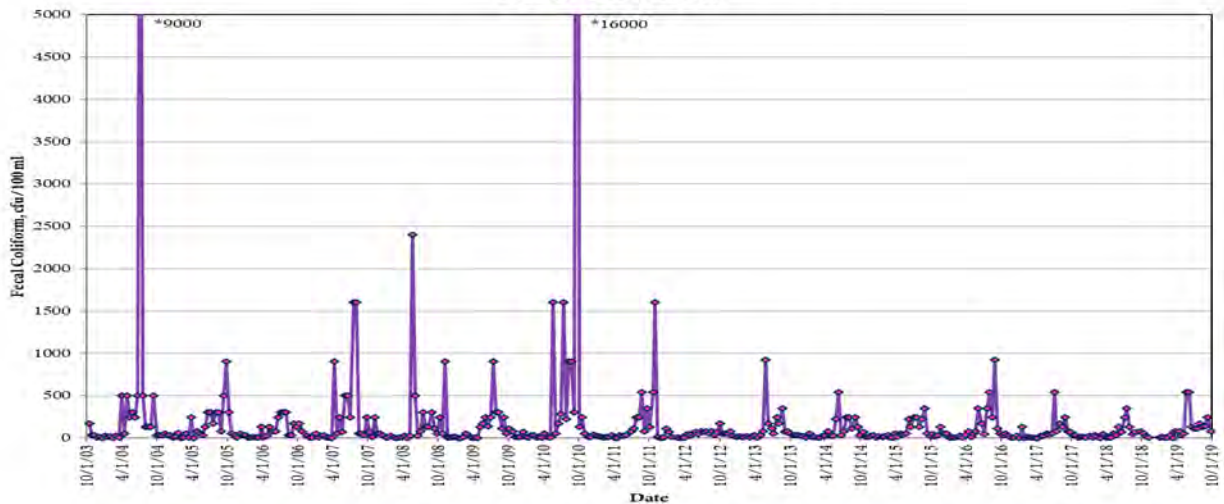
Lake Creek at Highway 9 - Site 18 Dissolved Oxygen



Lake Creek at Highway 9 - Site 18 Temperature



Lake Creek at Highway 9 - Site 18 Fecal Coliform





19

Hansen Creek
@ Hoehn Road

Downstream Ag, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
28	40	58	91	72	78	62	74	63	75	71	85	80	73

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↓	↓	—	↑	↑	—	—	—	—

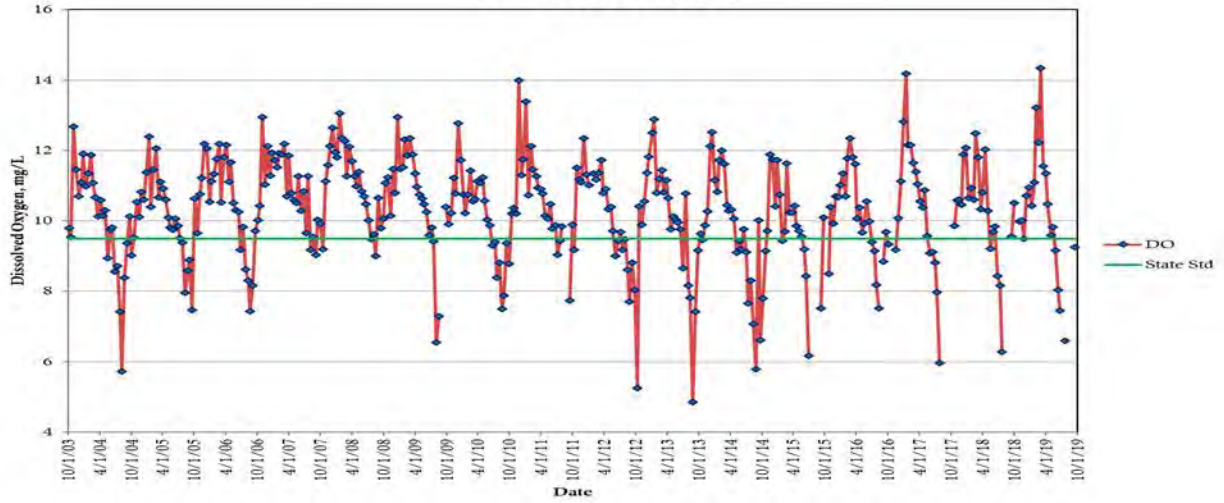
Site 19 is Hansen Creek, downstream from site 20 at the Northern State Recreation Area. This site is pseudo-ephemeral and often can stop flowing by the end of the summer. This site is designated as core salmonid habitat.

Over the sixteen-year life of this program, and over the last ten years, DO has declined and water temperatures have increased. WQI scores are generally in the upper-score end of the moderate concern category, and sometimes score as least concern.

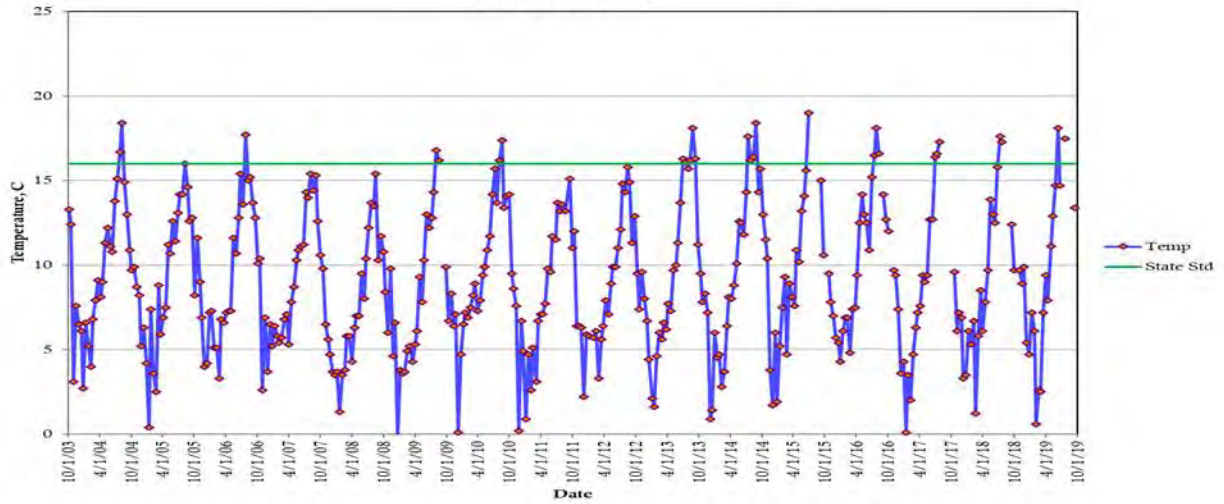
Site 19 regularly fails to meet state standards for DO during the warmer months, and often fails to meet state standards for temperature during the hottest time of the year. Annual FC levels pass the state standard for geomean of 100, but do closely fail the state standard for a 90th percentile of 200.

Site 19 is tied for 19th out of 39 sites for number of significant trends, with 13, and is 39th out of 39 sites for positive trends, with 8%.

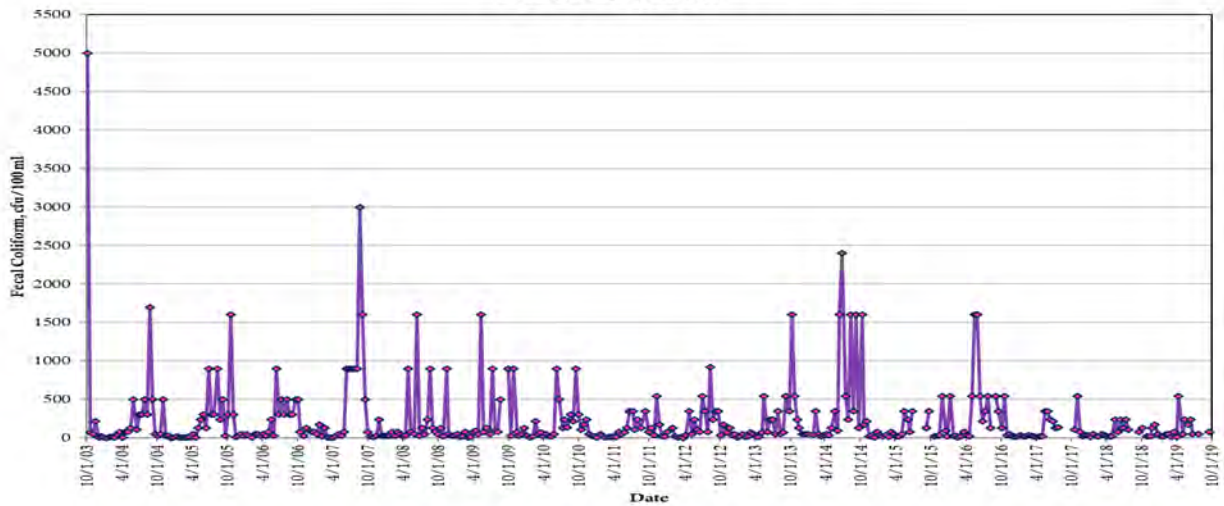
Hansen Creek at Hoehn Road - Site 19 Dissolved Oxygen



Hansen Creek at Hoehn Road - Site 19 Temperature



Hansen Creek at Hoehn Road - Site 19 Fecal Coliform





20

Hansen Creek
@ Northern State

Upstream Ag, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
25	39	67	89	91	90	82	89	82	87	79	84	84	85

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↑	↑	↑	—	—	—	—	—	—

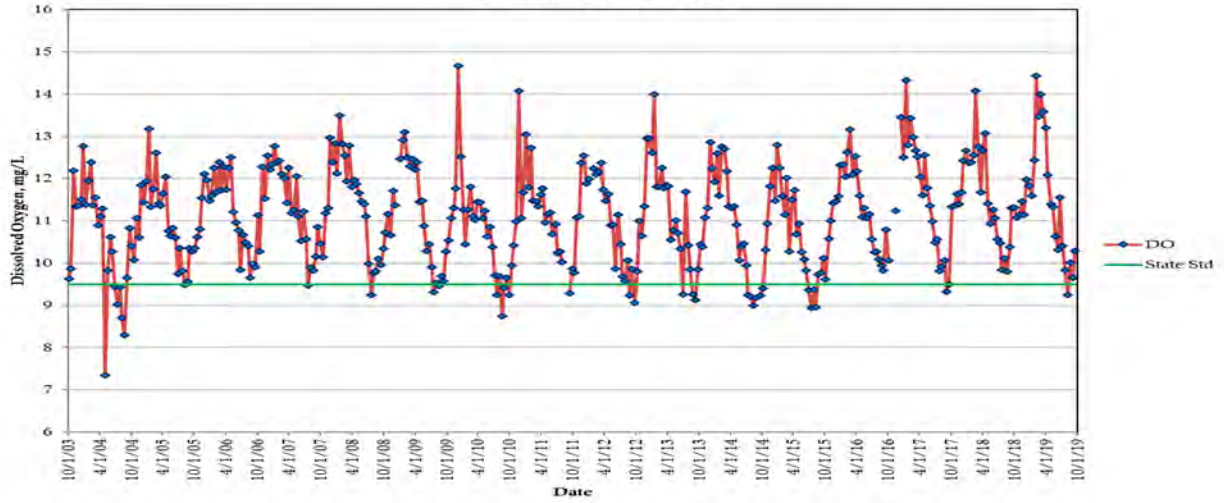
Site 20 is Hansen Creek at the Northern State Recreation Area, upstream from site 19. Water input to this site comes down from Lyman Hill and has very little developed land. This site is designated as core salmonid habitat.

Dissolved oxygen has been increasing over all time periods analyzed by this report. Trends at this site are distinctly different than those downstream at site 19. WQI scores have typically been in the category of least concern over the past ten years.

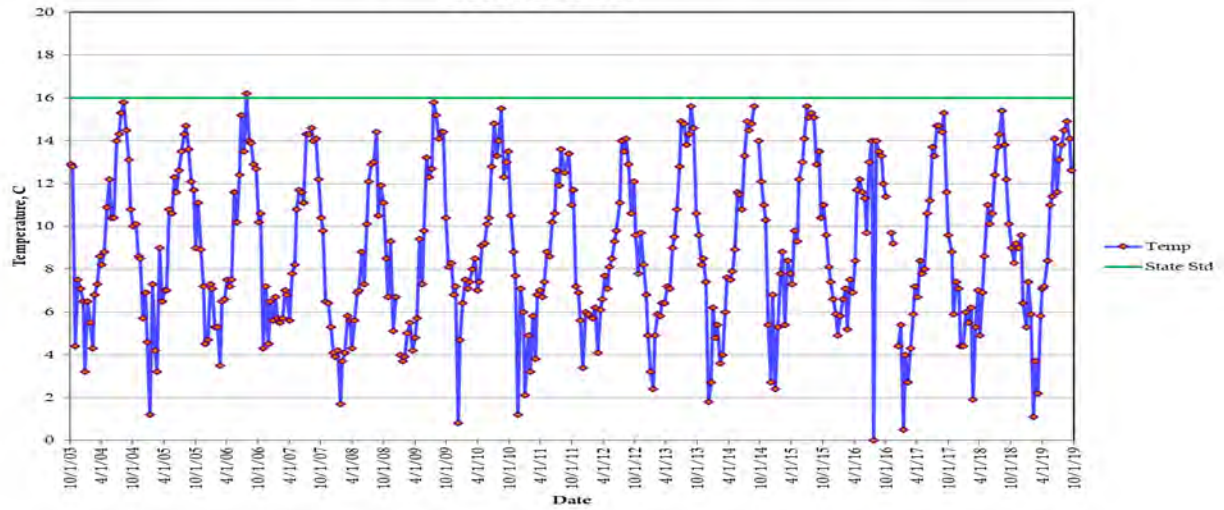
Site 20 rarely fails to pass state standards for both DO and temperature, year-round. Annual FC levels pass the state standard for geomean of 100, but do closely fail the state standard for a 90th percentile of 200.

Site 20 is tied for 21st out of 39 sites for number of significant trends, with 12, and is tied for 5th out of 39 sites for positive trends, with 83%.

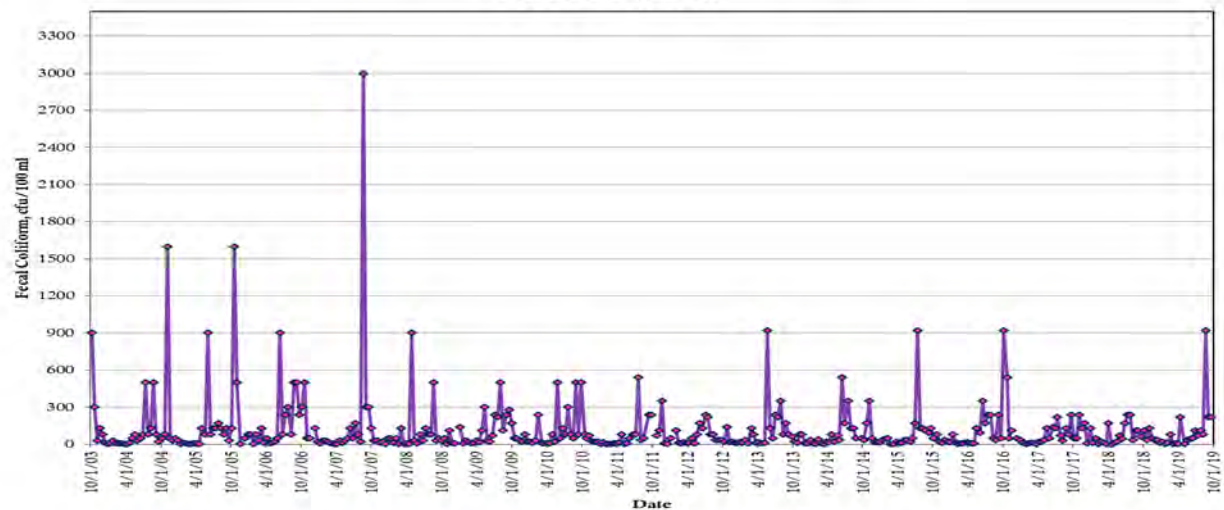
Hansen Creek at Northern State Hospital - Site 20 Dissolved Oxygen



Hansen Creek at Northern State Hospital - Site 20 Temperature



Hansen Creek at Northern State Hospital - Site 20 Fecal Coliform





21

Coal Creek
@ Hoehn Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
36	34	46	87	80	91	82	76	86	68	76	88	80	74

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	↑	↑	—	—	—	↓	—	—

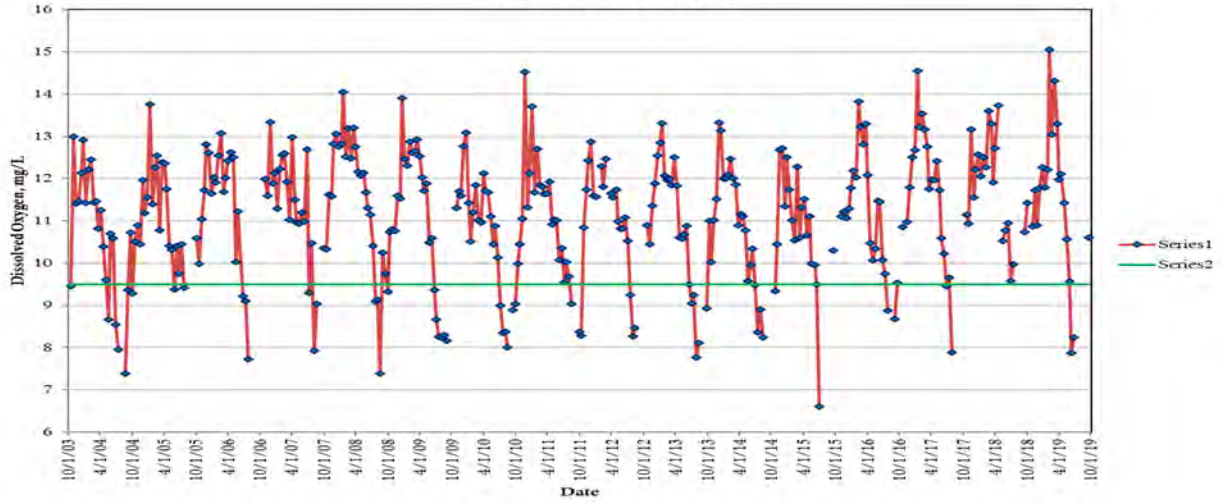
Site 21 is Coal Creek, downstream from site 22, and just prior to arriving in Skiyou Slough and ultimately the Skagit River. This site is pseudo-ephemeral and often can stop flowing by the end of the summer. This site is designated as core salmonid habitat.

Dissolved oxygen has increased over the last ten years and five years. Fecal coliform counts are lower than they were sixteen years ago. WQI scores are generally in the upper-score end of the moderate concern category, and often score as least concern.

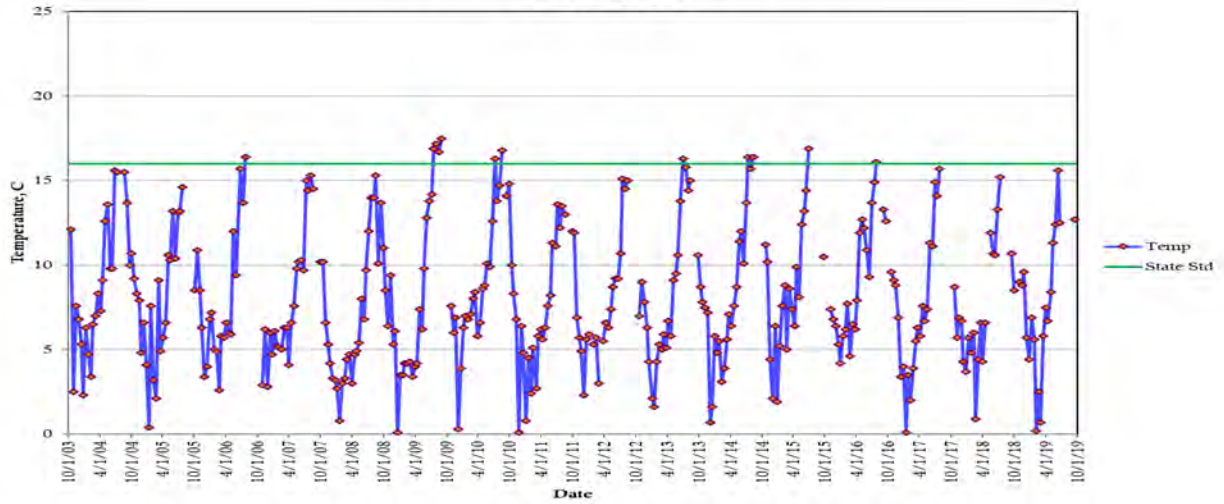
Site 21 regularly fails to meet state standards for DO during the warmest months, but rarely fails to meet state standards for water temperature. Annual FC levels fail state standards.

Site 21 is tied for 30th out of 39 sites for number of significant trends, with 10, and is 13th out of 39 sites for positive trends, with 70%.

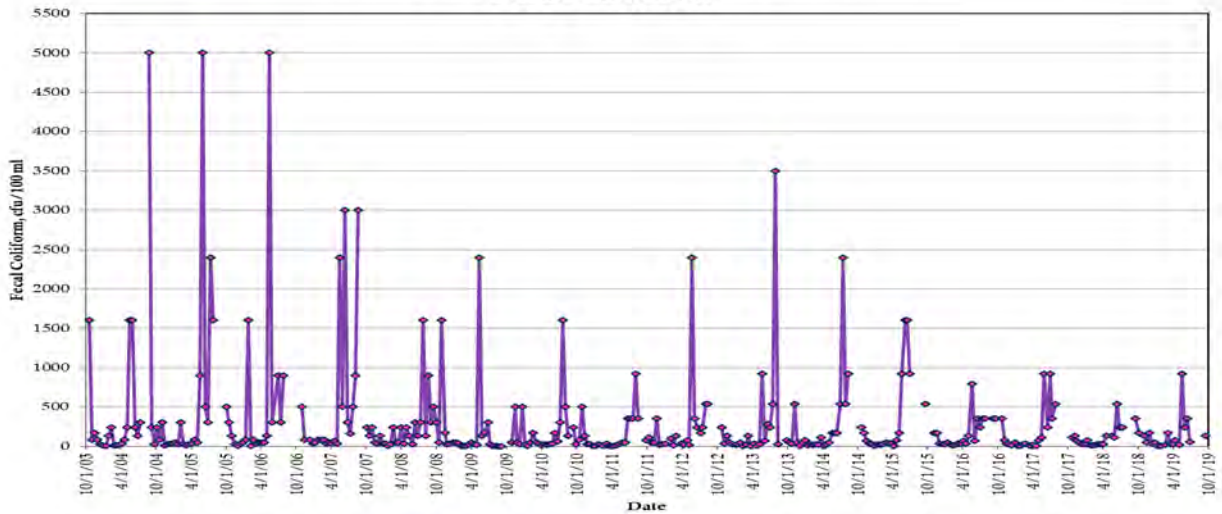
Coal Creek at Hoehn Road - Site 21 Dissolved Oxygen



Coal Creek at Hoehn Road - Site 21 Temperature



Coal Creek at Hoehn Road - Site 21 Fecal Coliform





22

Coal Creek
@ Highway 20

Upstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
37	63	95	96	93	95	89	83	85	87	95	85	93	79

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	↑	—	↑	—	↑	—	—

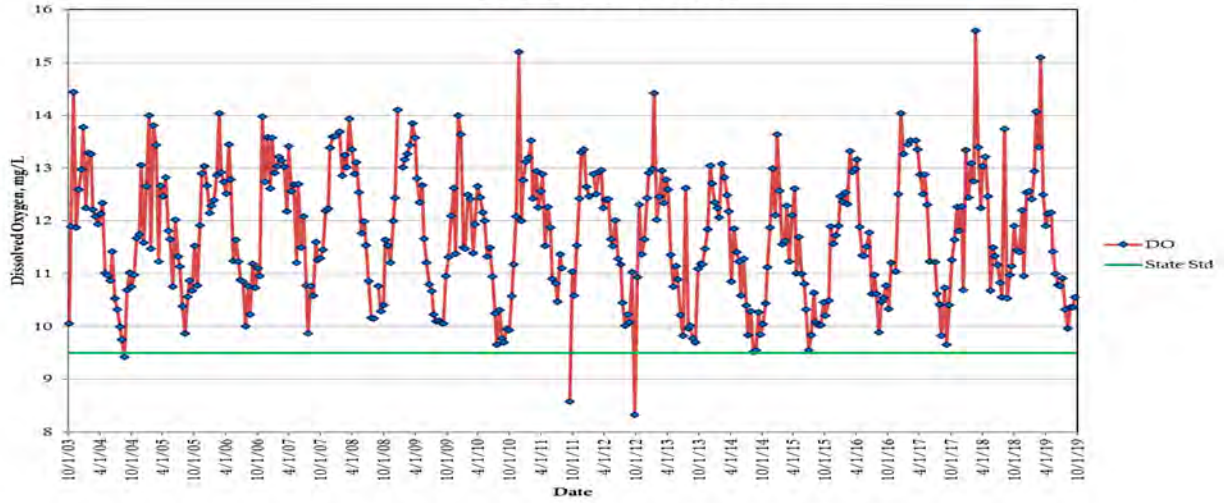
Site 22 is Coal Creek as it comes down off of Lyman Hill, and is upstream of site 21. This site is designated as core salmonid habitat.

Dissolved oxygen has increased over the most recent five years. Temperature increased since ten years ago, and FC counts are higher than they were at the start of this program. WQI scores are regularly in the category of least concern.

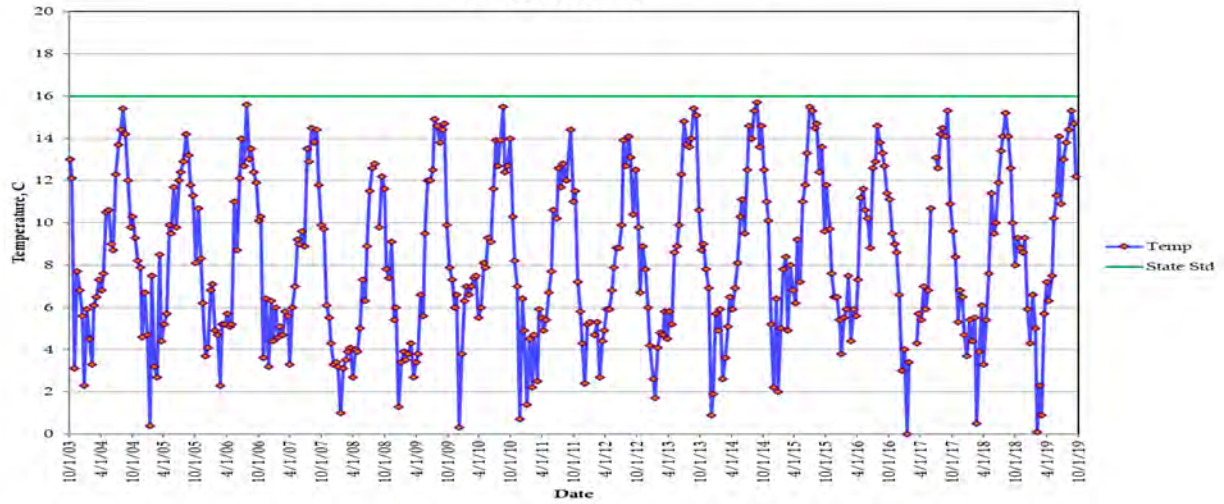
Site 22 rarely fails to meet state standards for DO or temperature, year-round. Annual FC levels pass the state standard for geomean of 100, but do fail the state standard for a 90th percentile of 200.

Site 22 is tied for 25th out of 39 sites for number of significant trends, with 11, and 36th out of 39 sites for positive trends, with 27%.

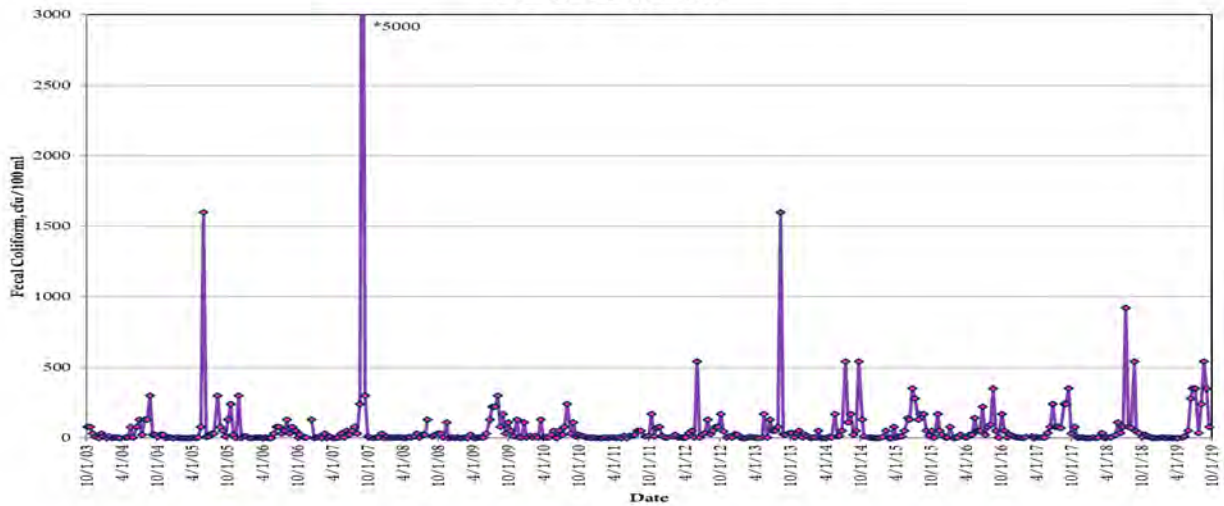
Coal Creek at Highway 20 - Site 22 Dissolved Oxygen



Coal Creek at Highway 20 - Site 22 Temperature



Coal Creek at Highway 20 - Site 22 Fecal Coliform





23

Wiseman Creek
@ Minkler Road

Upstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
27	48	85	98	95	98	95	90	96	83	90	95	85	89

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	—	—	—	—	—	—	—

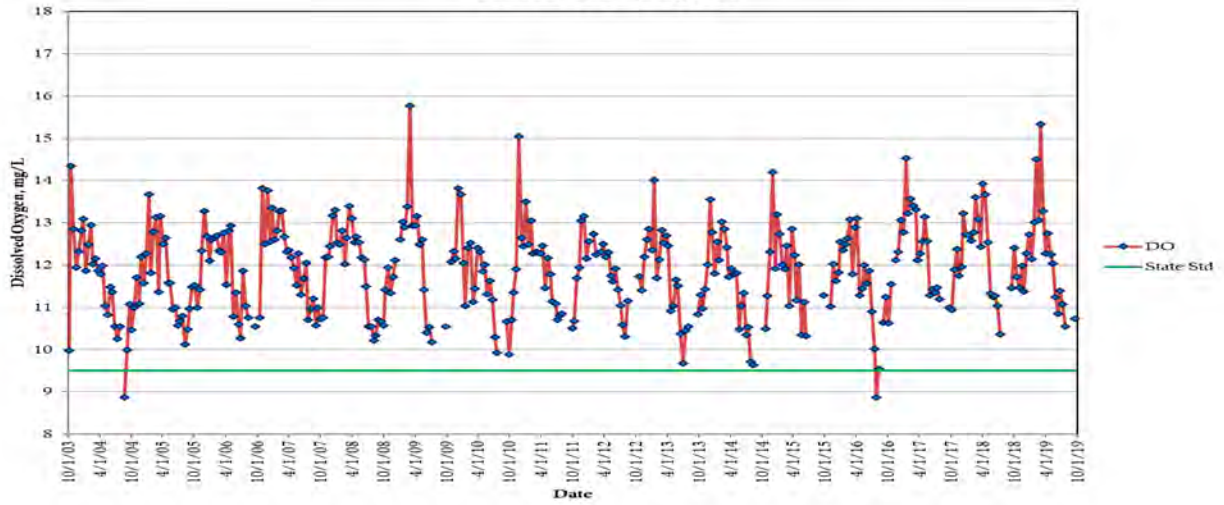
Site 23 is Wiseman Creek as it comes down off Lyman Hill, and prior to entering Skiyou Slough and ultimately the Skagit River. This site is designated as core salmonid habitat.

No significant monthly trends were observed in dissolved oxygen, temperature, or fecal coliform at this site, over any of the time periods analyzed. WQI is consistently in the category of least concern.

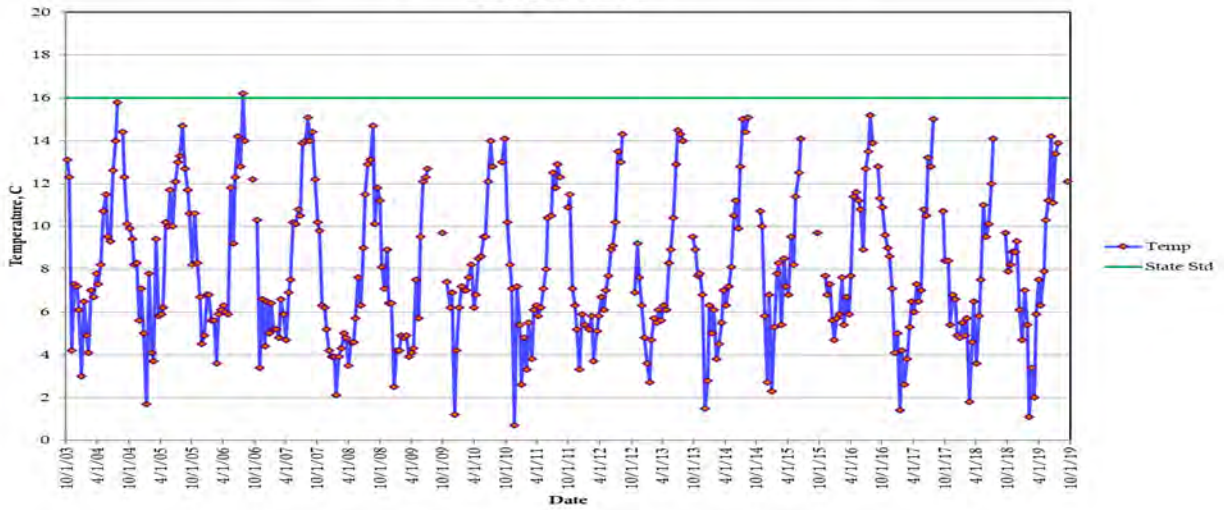
Site 23 rarely, if ever, fails to meet state standards for DO and water temperature, year-round. Annual FC levels easily meet state standards.

Site 23 is tied for 35th out of 39 sites for number of significant trends, with 8, and 20th out of 3 sites for positive trends, with 60%.

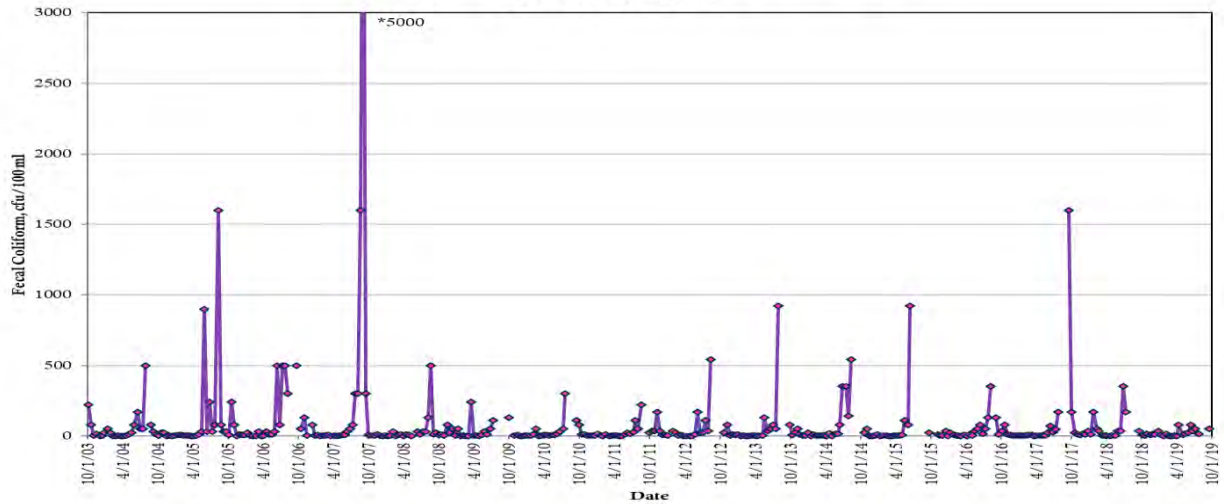
Wiseman Creek at Minkler Road - Site 23 Dissolved Oxygen



Wiseman Creek at Minkler Road - Site 23 Temperature



Wiseman Creek at Minkler Road - Site 23 Fecal Coliform





24

Mannser Creek
@ Lyman-Hamilton Highway

Midstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
35	56	41	69	63	62	45	52	50	62	31	64	71	47

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↑	↑	—	—	—	—	↓	—	—

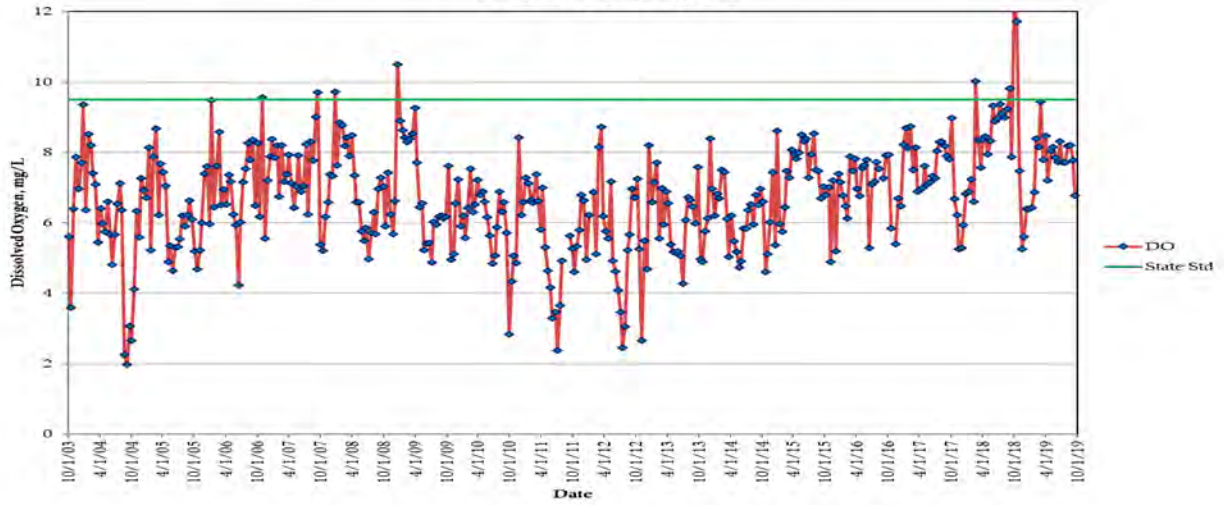
Site 24 is Mannser Creek, after descending off of Mount Josephine and prior to joining the Skagit River, just east of Lyman. This site is designated as core salmonid habitat.

Since this program began, dissolved oxygen has increased and fecal coliform has decreased. Dissolved oxygen has also been increasing for the most recent ten years. WQI scores are regularly in the category of moderate concern.

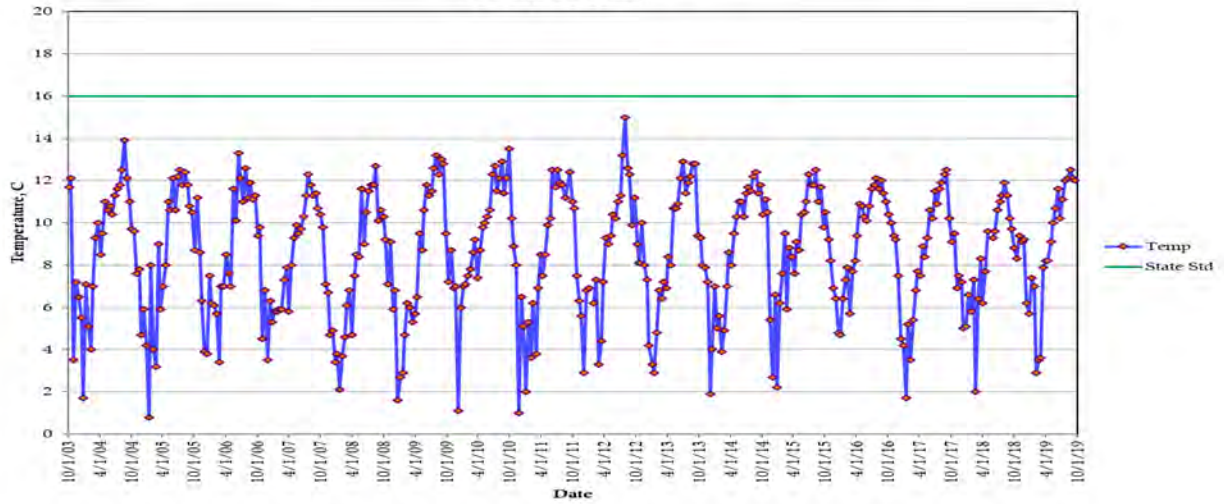
Site 24 is slow-moving and inundated with invasive reed canary grass. This has the effect of lowering DO but also decreasing temperature. As a result, this site is almost always below state standards for DO year-round, but has never exceeded state temperature standards even once in the history of this program. Annual FC levels meet state standards.

Site 24 is tied for 14th out of 39 sites for number of significant trends, with 14, and is tied for 11th out of 39 sites for positive trends, with 71%.

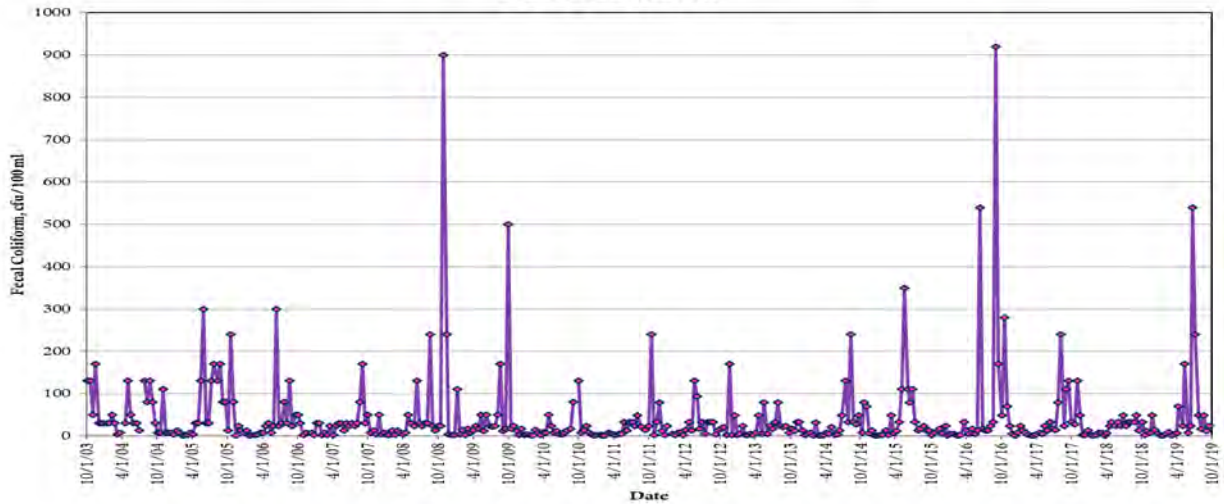
**Mannser Creek at Lyman-Hamilton Highway - Site 24
Dissolved Oxygen**



**Mannser Creek at Lyman-Hamilton Highway - Site 24
Temperature**



**Mannser Creek at Lyman-Hamilton Highway - Site 24
Fecal Coliform**





25

Red Cabin Creek
@ Hamilton Cemetery Road

Reference – Rural Reserve

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
74	90	87	97	97	96	96	97	97	94	93	94	96	91

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	↑	Not Enough Data	—	—	Not Enough Data	—	—	Not Enough Data

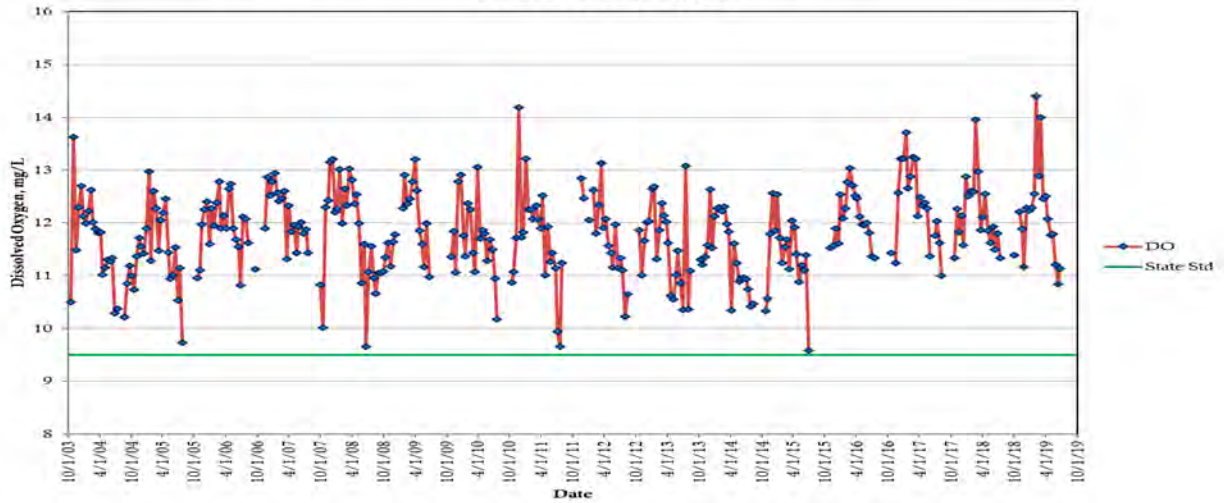
Site 25 is Red Cabin Creek, after it comes off of Mount Josephine, in between Lyman and Hamilton. This is an ephemeral creek that regularly dries up by the end of summer. This site is designated as core salmonid habitat.

Due to the ephemeral nature of this creek, there were not enough data points collected to be sufficient for generating five-year monthly trends. Dissolved oxygen has increased over the most recent ten years. Except for the first year of WQI monitoring, this creek has solely been in the category of least concern.

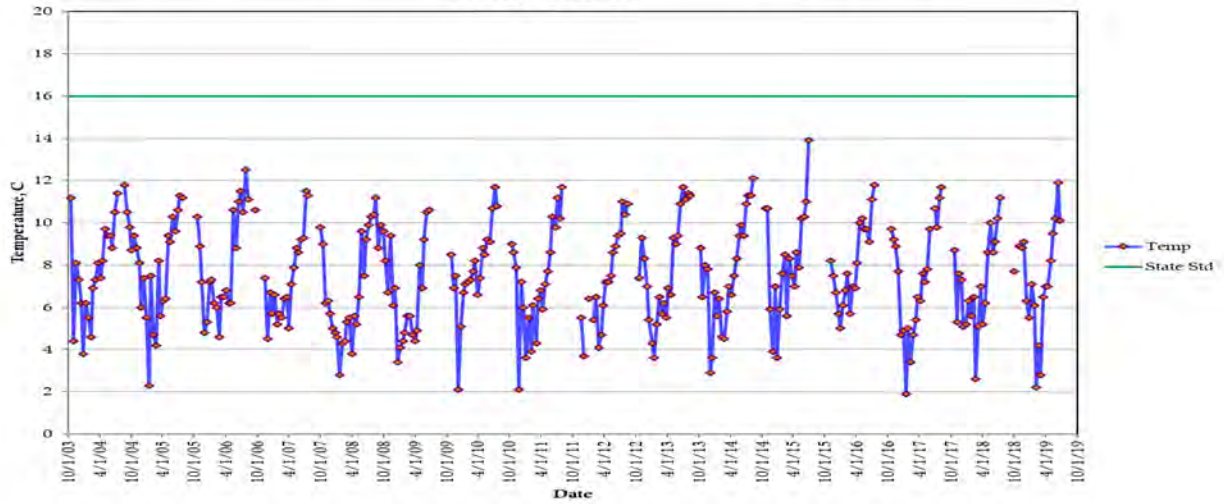
Site 25 has never failed to meet state standards for DO or water temperature on any collection day over the history of this program. Annual FC levels easily meet state standards.

Site 25 is tied for 30th out of 39 sites for number of significant trends, with 10, and is tied for 26th out of 39 sites for positive trends, with 50%.

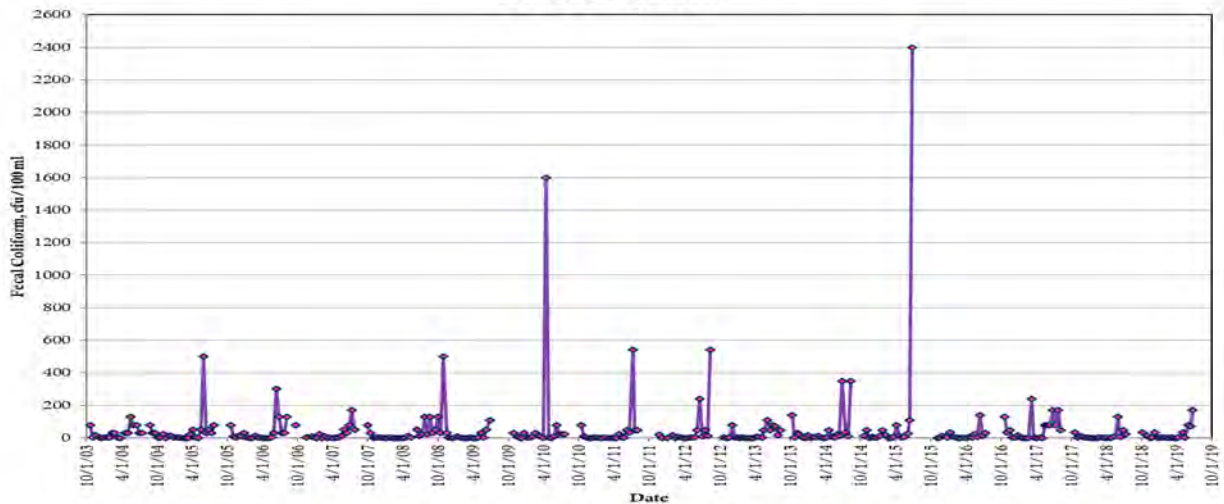
Red Cabin Creek at Hamilton Cemetery Road - Site 25 Dissolved Oxygen



Red Cabin Creek at Hamilton Cemetery Road - Site 25 Temperature



Red Cabin Creek at Hamilton Cemetery Road - Site 25 Fecal Coliform





28

Brickyard Creek
@ Highway 20

Reference – Urban/suburban

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
62	77	56	71	79	83	65	75	84	88	77	93	84	85

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	Not Enough Data	—	—	Not Enough Data	—	—	Not Enough Data

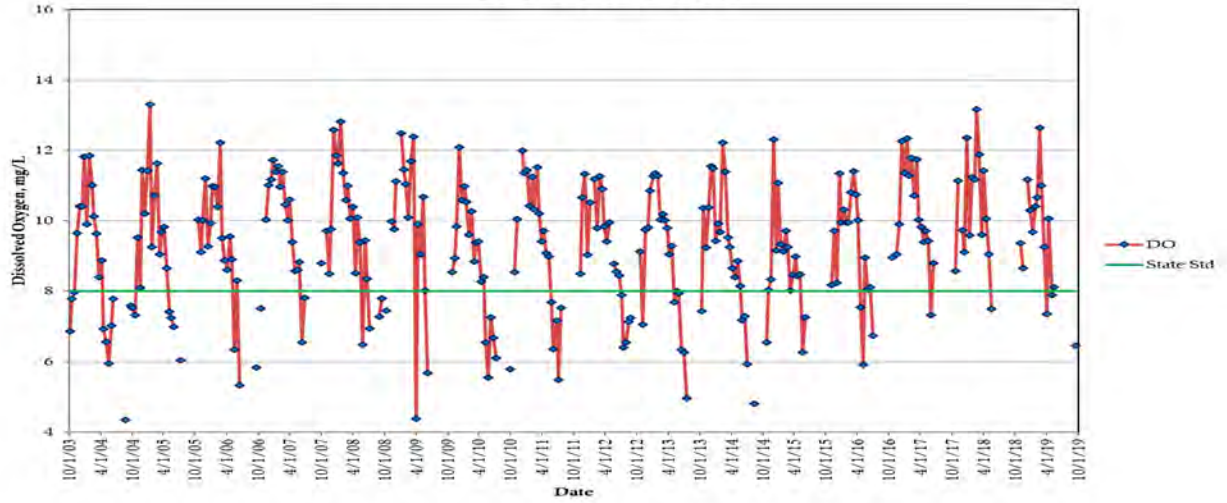
Site 28 is Brickyard Creek, after it has passed through northern Sedro-Woolley, just prior to entering Hart Slough, and eventually the Skagit River. This is an ephemeral creek that regularly dries up by the end of summer. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Due to the ephemeral nature of this creek, there were not enough data points collected to be sufficient for generating five-year monthly trends. No monthly trends for DO, temperature, or FC were observed across any of the time periods analyzed in this report.

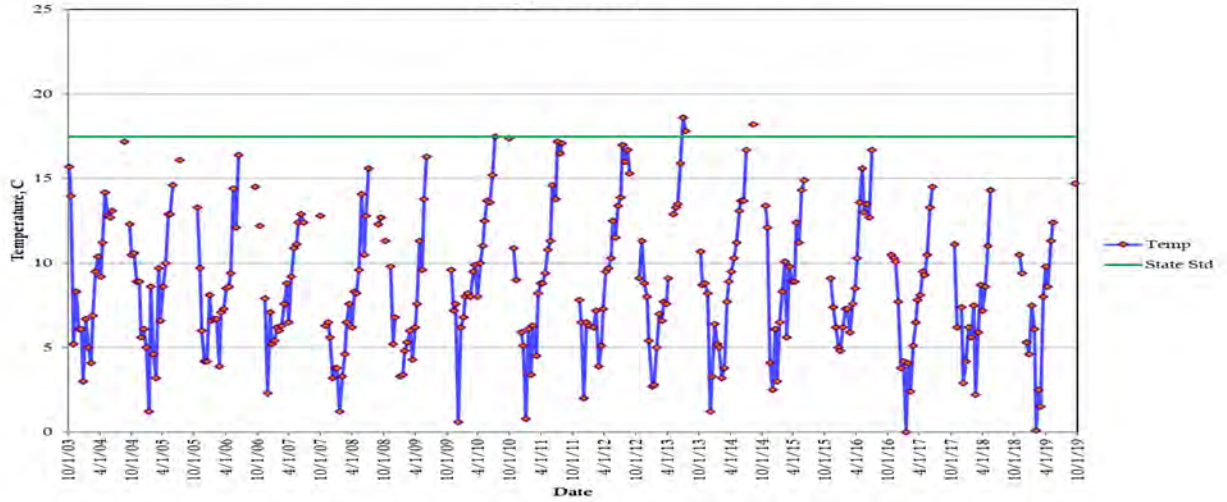
Site 28 regularly fails to meet state standards for DO during the warmer months, but rarely fails state standards for water temperature. Annual FC levels pass the state standard for geomean of 100, but fail the state standard for a 90th percentile of 200.

Site 28 is 39th out of 39 sites for number of significant trends, with four, and is tied for 26th out of 39 sites for positive trends, with 50%.

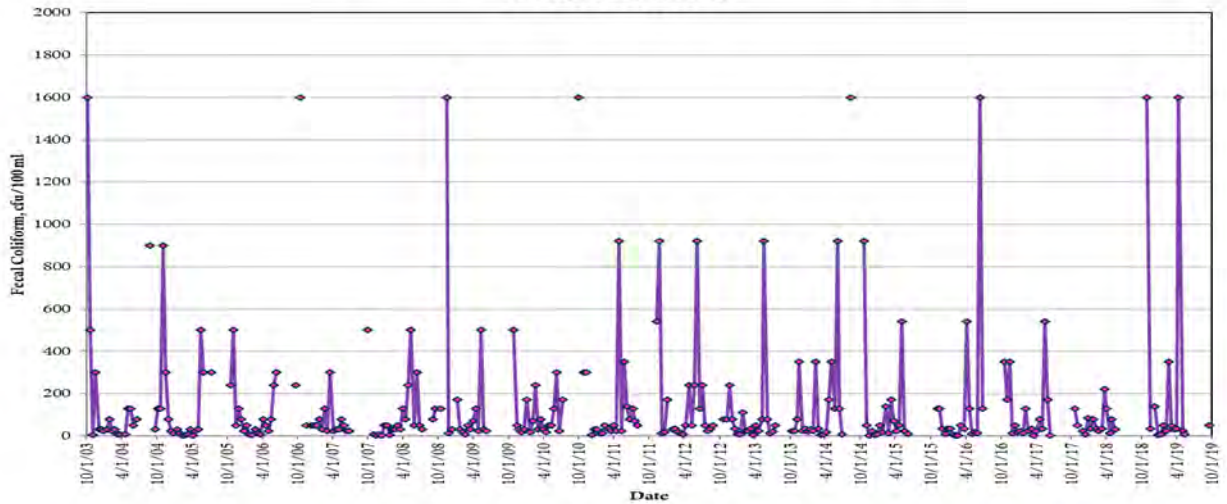
Brickyard Creek at Highway 20 - Site 28 Dissolved Oxygen

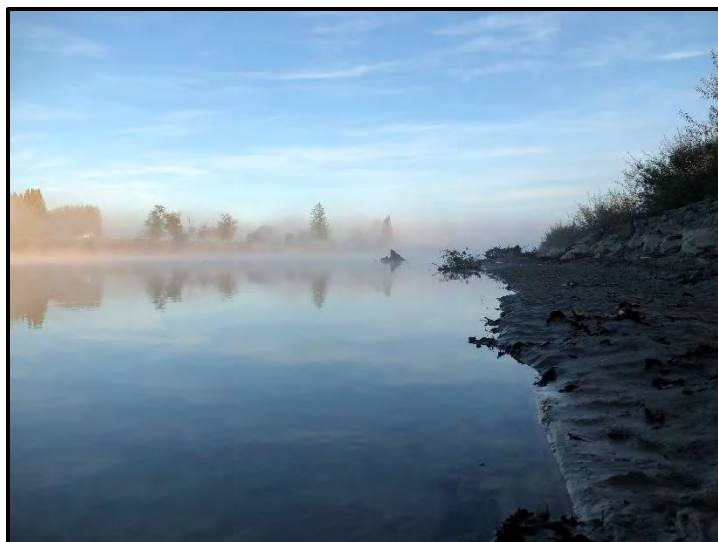


Brickyard Creek at Highway 20 - Site 28 Temperature



Brickyard Creek at Highway 20 - Site 28 Fecal Coliform





29

Skagit River
@ River Bend Road

Mainstem Skagit – Mid, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
76	63	82	94	92	86	82	87	94	93	93	85	92	81

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	↑	—	—	↓	—	—	—

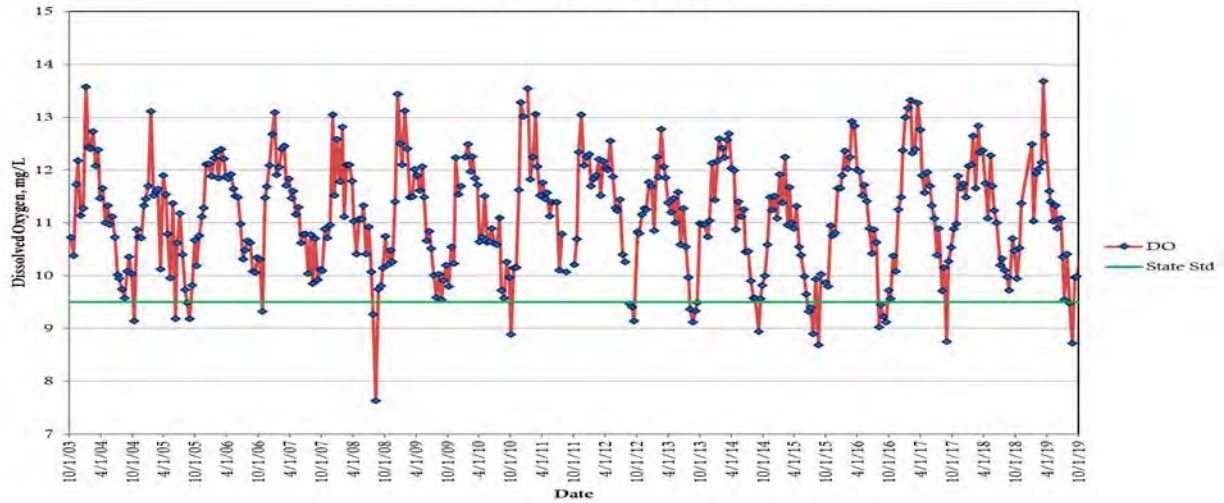
Site 29 is the Skagit River, after it intersects Burlington and Mount Vernon, and prior to the terminal fork. The river is designated as core salmonid habitat and as salmonid spawning, rearing, and migration (SRM) status.

Over the most recent five years, DO has increased and water temperature has decreased. WQI scores are consistently in the category of least concern.

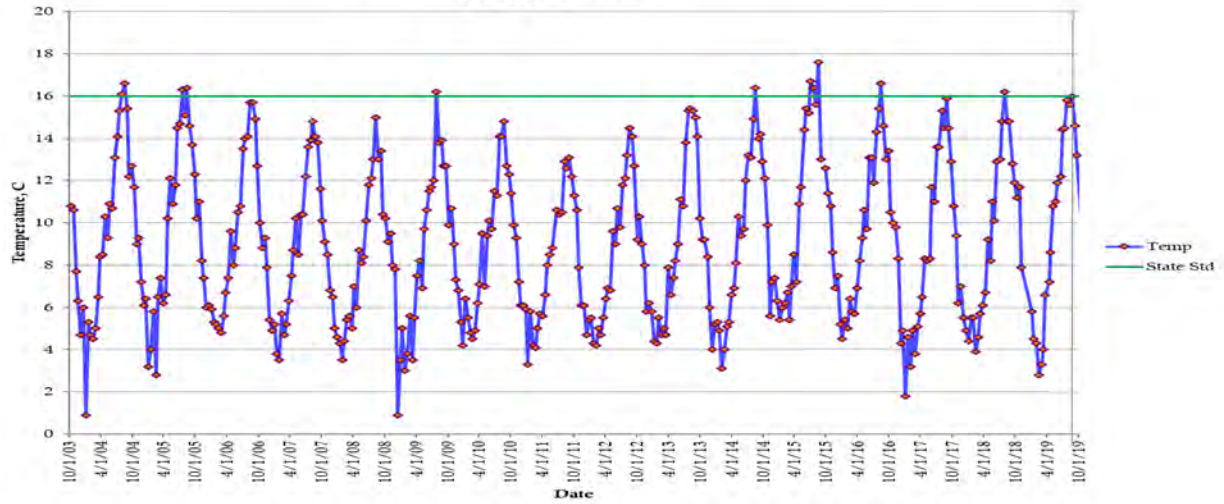
Site 29 rarely fails to meet state standards for DO and water temperature, and only ever at the warmest time of the year. Annual FC levels easily meet state standards.

Site 29 is tied for 35th out of 39 sites for number of significant trends, with eight, and is tied for 26th out of 39 sites for positive trends, with 50%.

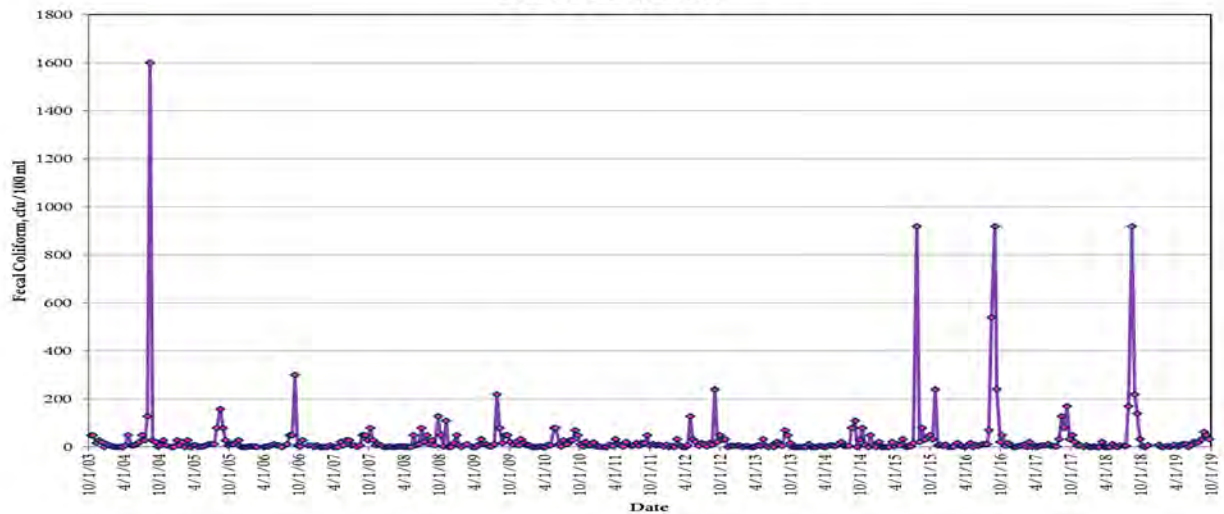
Skagit River at River Bend Road - Site 29 Dissolved Oxygen



Skagit River at River Bend Road - Site 29 Temperature



Skagit River at River Bend Road - Site 29 Fecal Coliform





30

Skagit River
@ Cape Horn Road

Mainstem Skagit - Upper

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
66	78	85	89	93	90	90	94	90	85	92	88	96	93

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	↑	↑	—	↑	—	—	—	—

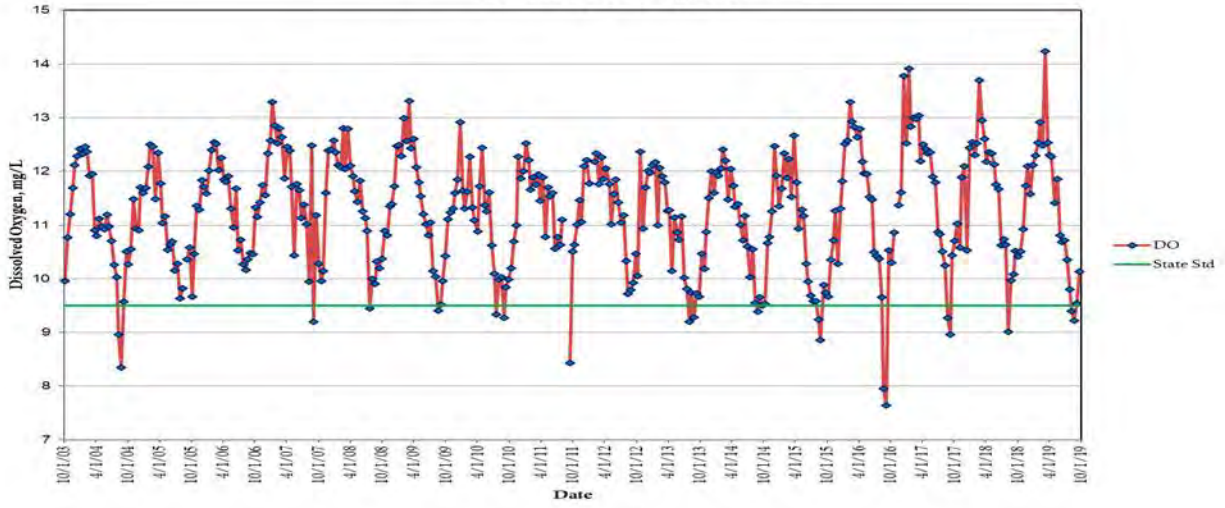
Site 30 is the Skagit River, at its furthest upstream sampling point for this program, east of Hamilton. The river is designated as core salmonid habitat.

Dissolved oxygen has significantly increased over the last ten years and five years. Water temperature is warmer now than it was ten years ago. WQI scores are consistently in the category of least concern.

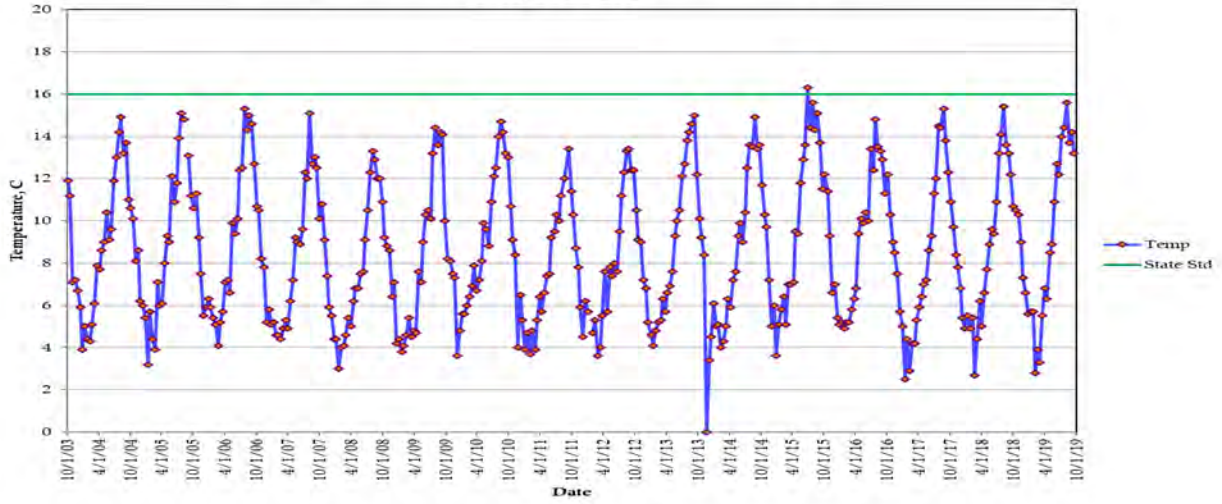
Site 30 rarely fails to meet state standards for DO and water temperature, and only ever at the warmest time of the year. Annual FC levels easily meet state standards.

Site 30 is tied for 16th out of 39 sites for number of significant trends, with 14, and is 19th out of 39 sites for positive trends, with 64%.

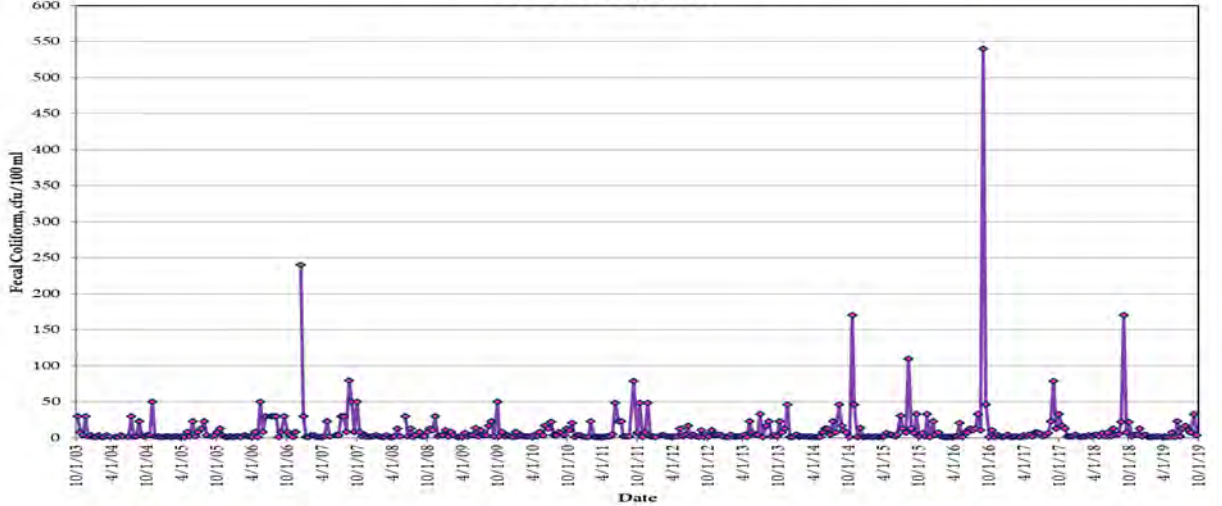
Skagit River at Cape Horn Road - Site 30 Dissolved Oxygen



Skagit River at Cape Horn Road - Site 30 Temperature



Skagit River at Cape Horn Road - Site 30 Fecal Coliform





32

Samish River
@ Thomas Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
34	47	43	75	83	92	70	89	88	83	80	84	93	91

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↑	↑	↑	—	—	↓	↓	—	—

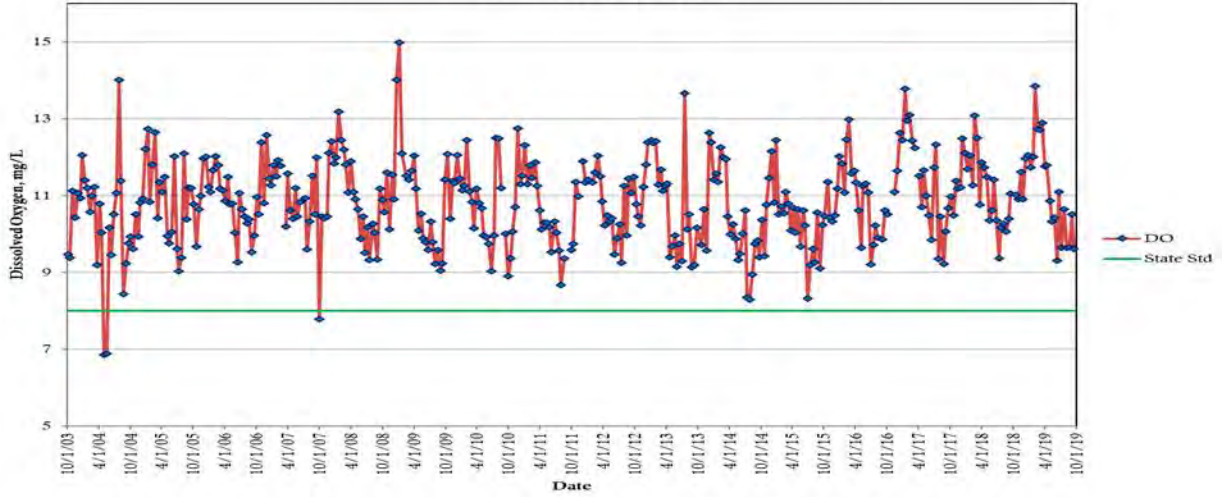
Site 32 is the Samish River, and is the last site that is sampled by this program prior to the river terminating in Samish Bay. The Samish River’s watershed contains expansive agricultural activity. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Dissolved oxygen has increased across all time intervals analyzed in this report. Water temperatures have decreased in the most recent five years. Fecal coliform counts are lower now than they were when this program began. WQI Scores have improved over the length of this program and are now consistently in the category of least concern.

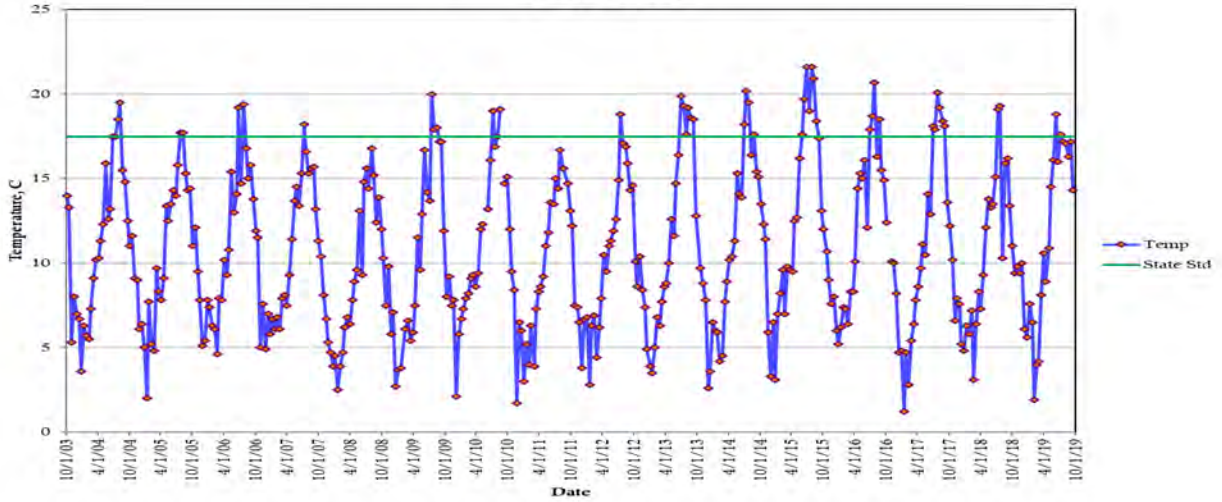
Site 32 almost never fails to meet state standards for DO, but typically exceeds state standards for water temperature during the warmer months of the year. Annual FC levels pass the state standard for geomean of 100, but fail the state standard for a 90th percentile of 200.

Site 32 is 3rd out of 39 sites for number of significant trends, with 19, and is tied for 2nd out of 39 sites for positive trends, with 89%.

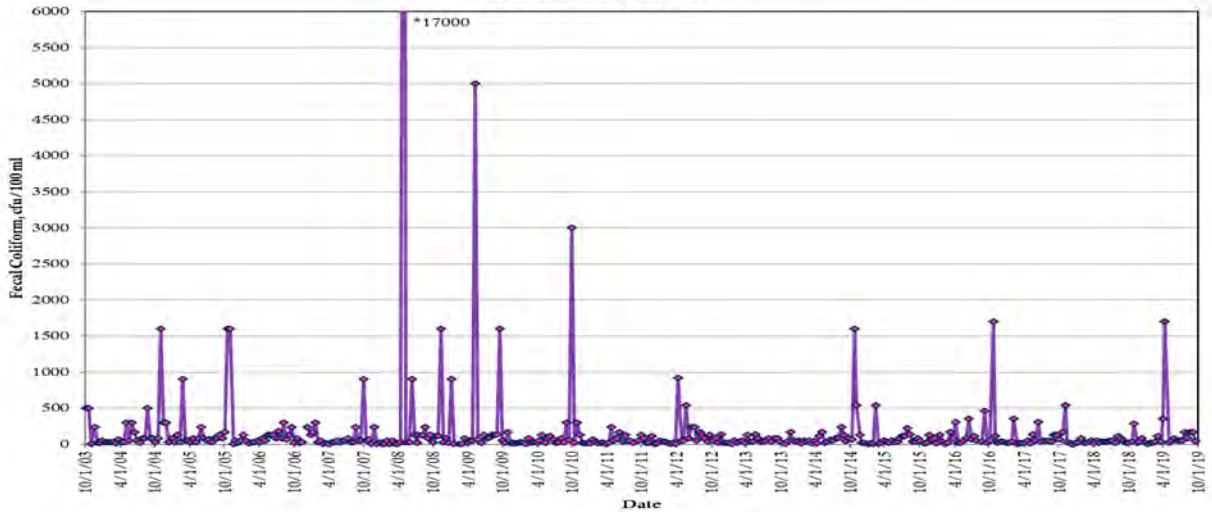
**Samish River at Thomas Road - Site 32
Dissolved Oxygen**



**Samish River at Thomas Road - Site 32
Temperature**



**Samish River at Thomas Road - Site 32
Fecal Coliform**





33

Alice Bay Pump Station
@ Samish Island Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
2	5	6	15	12	33	37	24	17	24	23	35	42	16

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	—	—	—	—	↓	↓	—

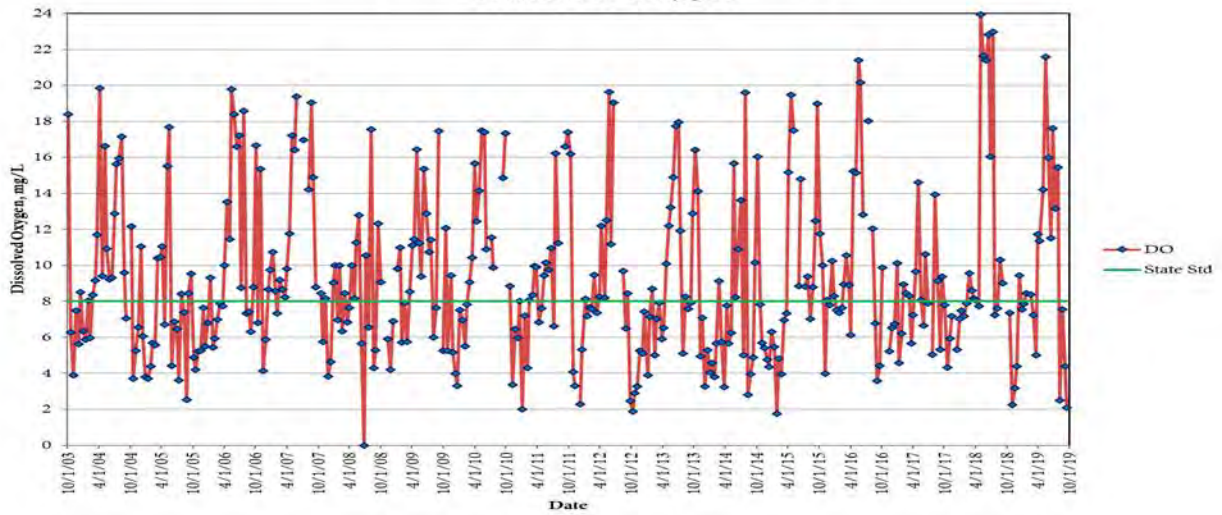
Site 33 is the pump station of agricultural drainage ditches at Alice Bay, just to the west of the mouth of the Samish River. Sites like this are characterized by being stagnant or slow-moving, and are heavily tidally-influenced. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Fecal coliform counts at this site have declined over the last 16 years and the last 10 years. WQI scores are consistently in the category of highest concern.

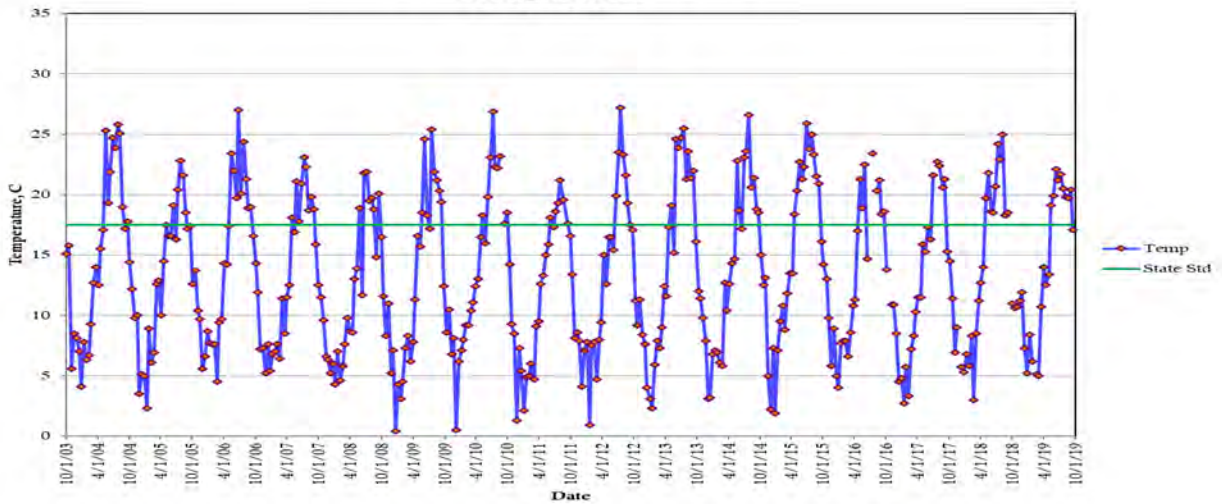
Site 33 regularly fails to meet state standards for DO and water temperature. Annual FC levels pass the state standard for geomean of 100, but narrowly fail the state standard for a 90th percentile of 200.

Site 33 is tied for 25th out of 39 sites for number of significant trends, with 11, and is tied for 9th out of 39 sites for positive trends, with 73%.

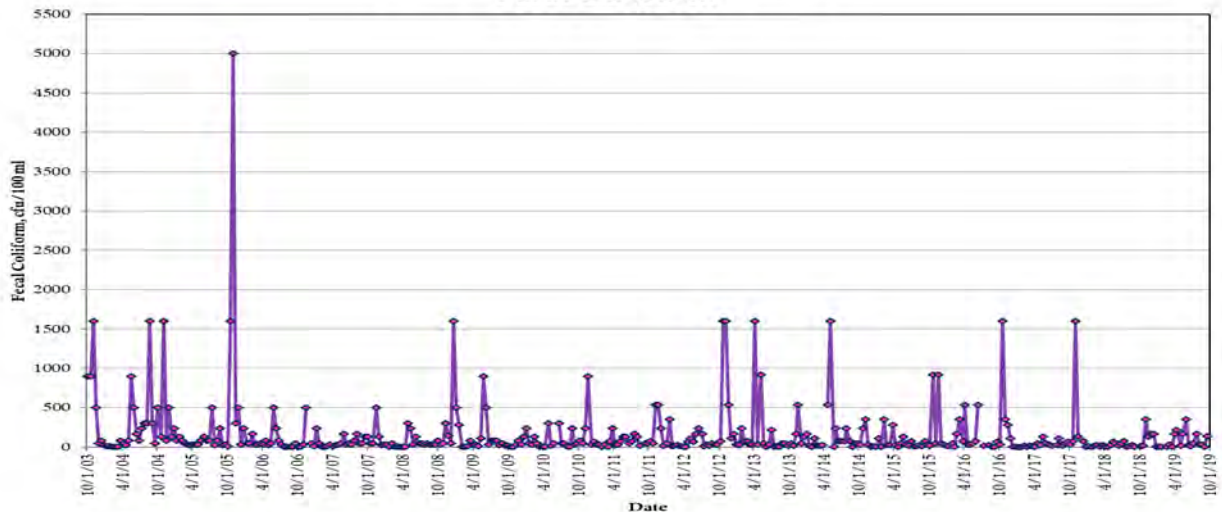
Alice Bay Pump Station - Site 33 Dissolved Oxygen



Alice Bay Pump Station - Site 33 Temperature



Alice Bay Pump Station - Site 33 Fecal Coliform





34

No Name Slough
@ Bayview-Edison Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	1	1	14	11	31	22	13	29	30	51	27	36	27

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↑	↑	↑	↑	↑	↓	↓	↓	—

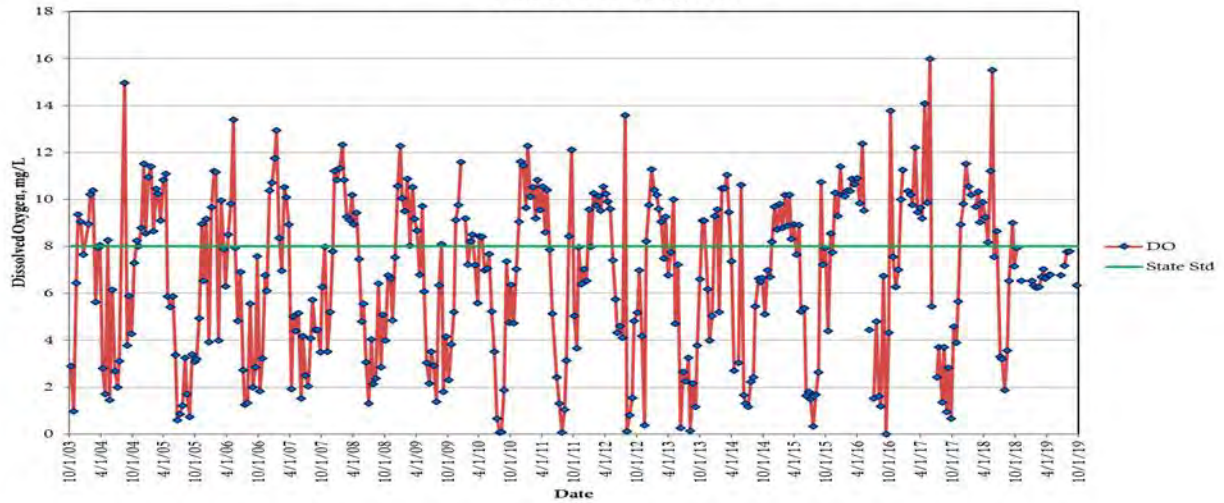
Site 34 is No Name Slough, west of the Skagit Regional Airport, and just prior to terminating in Padilla Bay. Sites like this are characterized by being stagnant or slow-moving, and are heavily tidally-influenced. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Dissolved oxygen has increased across all time periods of this program. Water temperatures are warmer now than they were at the beginning of the program or 10 years ago, but have declined in the most recent five years. Fecal coliform counts are lower than they were at the beginning of this program and ten years ago.

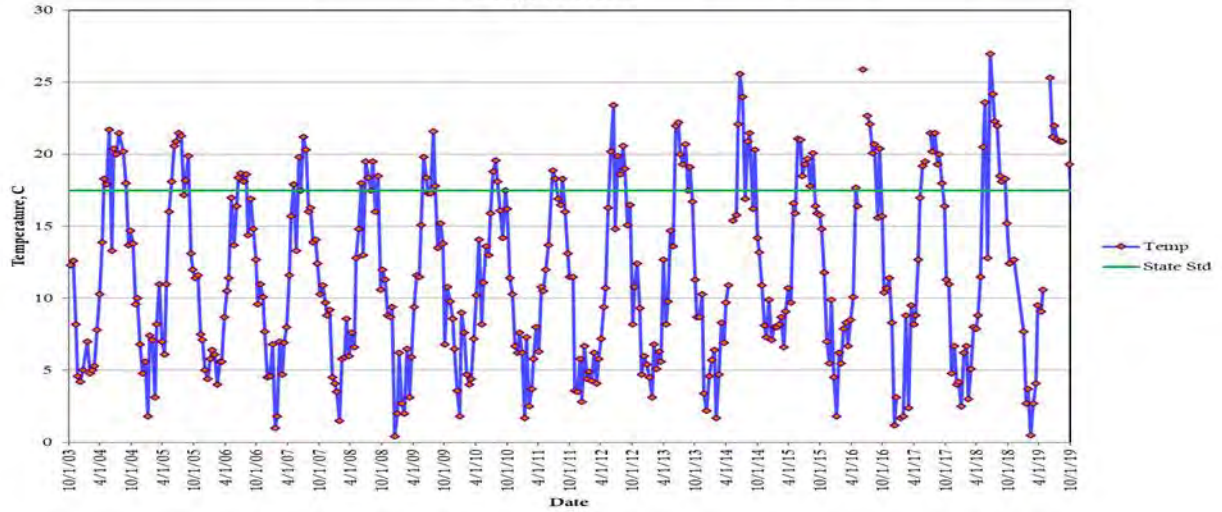
Site 34 regularly fails to meet state standards for DO and water temperature. Annual FC levels pass the state standard for geomean of 100, but fail the state standard for a 90th percentile of 200.

Site 34 is 1st out of 39 sites for number of significant trends, with 24, and is tied for 15th out of 39 sites for positive trends, with 67%.

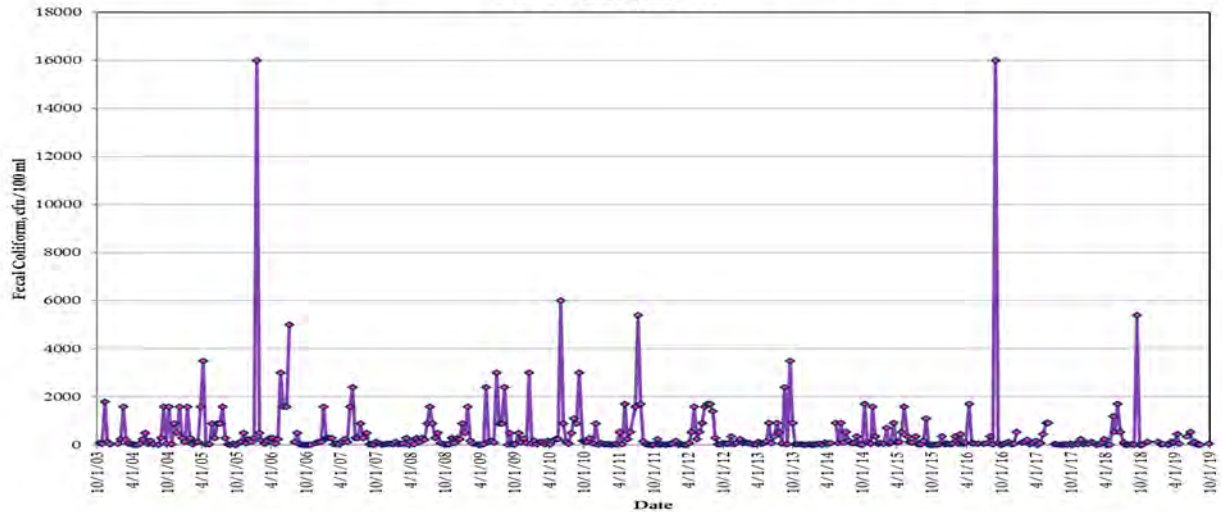
No Name Slough at Bayview-Edison Road - Site 34 Dissolved Oxygen



No Name Slough at Bayview-Edison Road - Site 34 Temperature



No Name Slough at Bayview-Edison Road - Site 34 Fecal Coliform





35

Joe Leary Slough
@ D'Arcy Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	1	6	15	9	24	22	14	8	15	13	24	5	15

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	—	—	↑	—	—	—	—

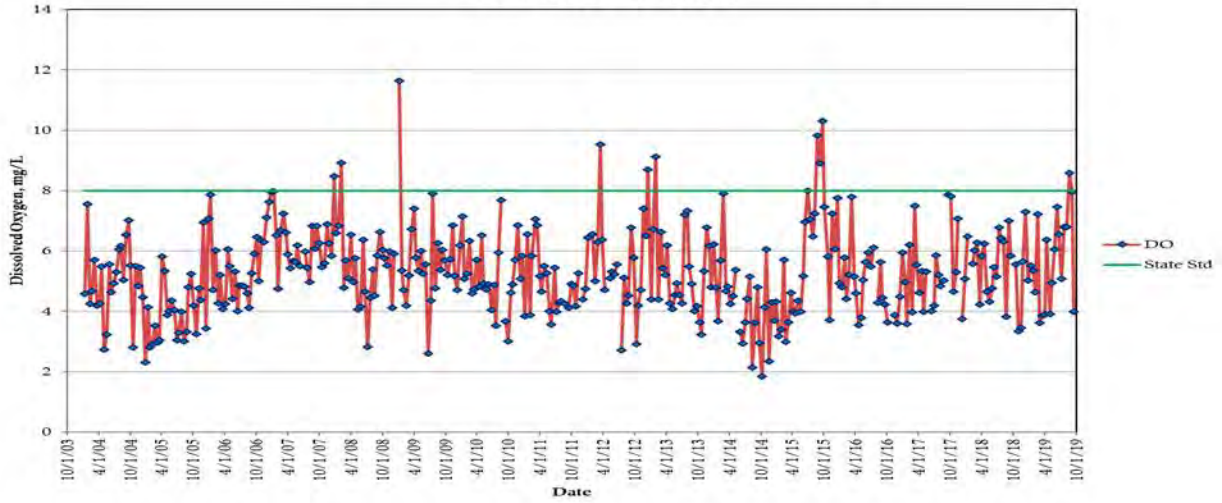
Site 35 is Joe Leary Slough, just prior to where it enters Padilla Bay. This slough was constructed for agricultural drainage and was not naturally formed. Sites like this are characterized by being stagnant or slow-moving, and are heavily tidally-influenced. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Water temperatures are higher now than they were ten years ago. WQI scores are consistently in the category of highest concern.

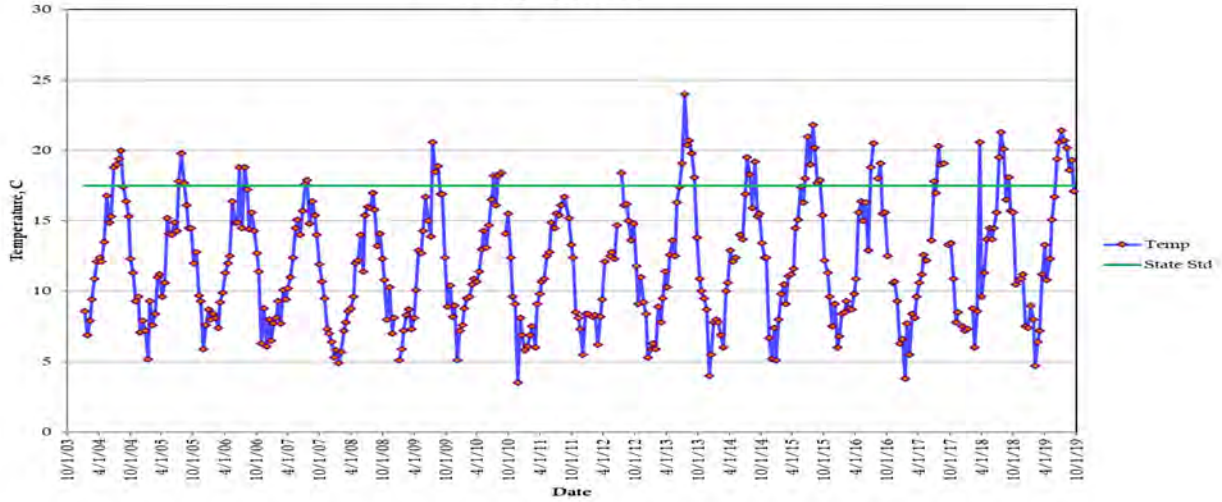
Site 35 very rarely ever meets state standards for DO, and fails to meet state standards for water temperature during the warmer months. Annual FC levels pass the state standard for geomean of 100, but fail the state standard for a 90th percentile of 200.

Site 35 is 38th out of 39 sites for number of significant trends, with seven, and is tied for 23rd out of 39 sites for positive trends, with 57%.

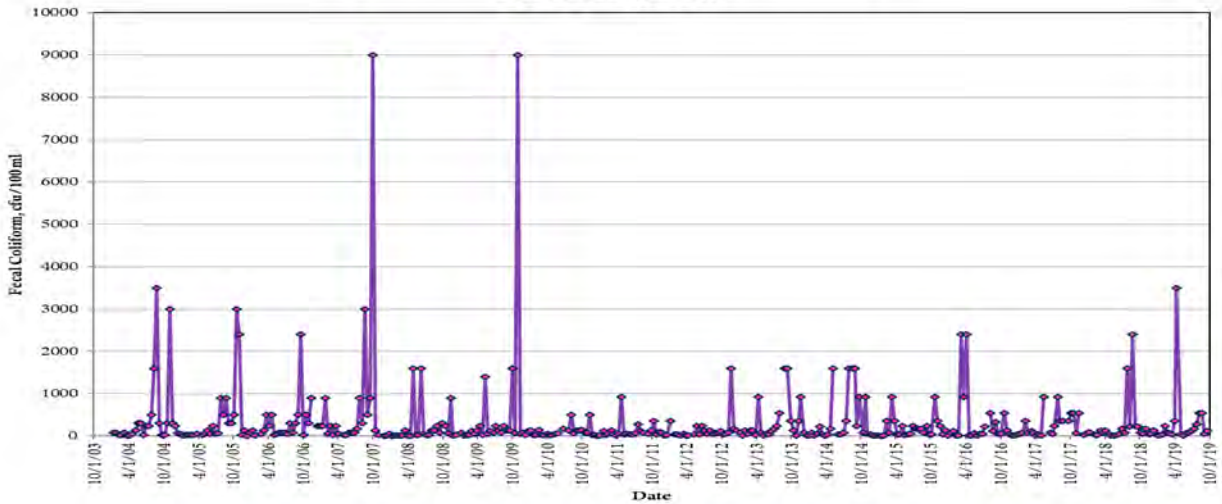
**Joe Leary Slough at D'Arcy Road - Site 35
Dissolved Oxygen**



**Joe Leary Slough at D'Arcy Road - Site 35
Temperature**



**Joe Leary Slough at D'Arcy Road - Site 35
Fecal Coliform**





36

Edison Slough
@ Edison Elementary

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	10	6	30	25	34	21	37	37	23	34	38	38	45

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	—	—	—	—	—	—	—

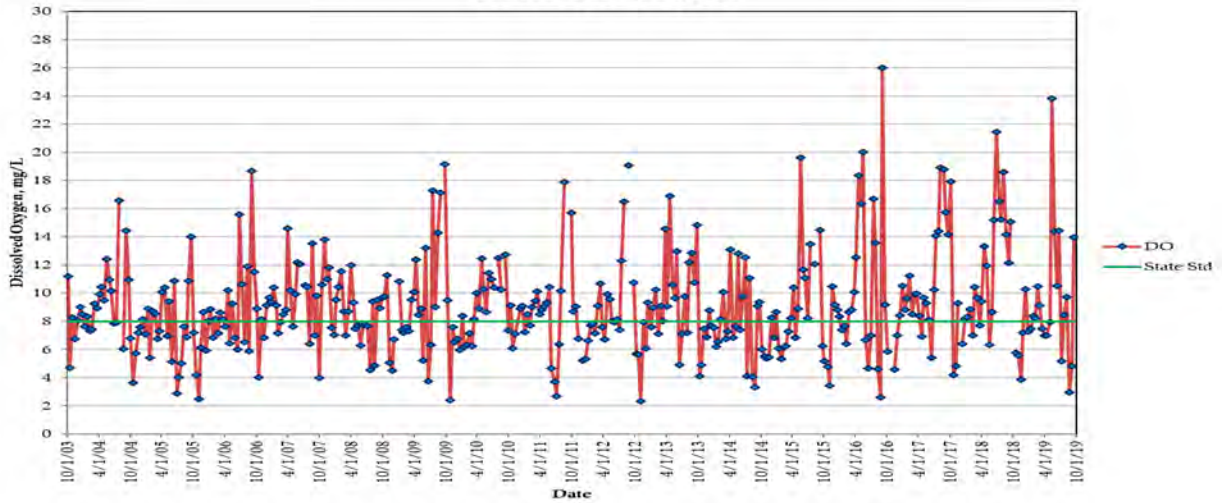
Site 36 is Edison Slough, just prior to the town of Edison and terminal discharge into Samish Bay. Sites like this are characterized by being stagnant or slow-moving, and are heavily tidally-influenced. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

No monthly trends for DO, temperature, or FC were observed across any of the time periods analyzed in this report. WQI scores are consistently in the category of highest concern.

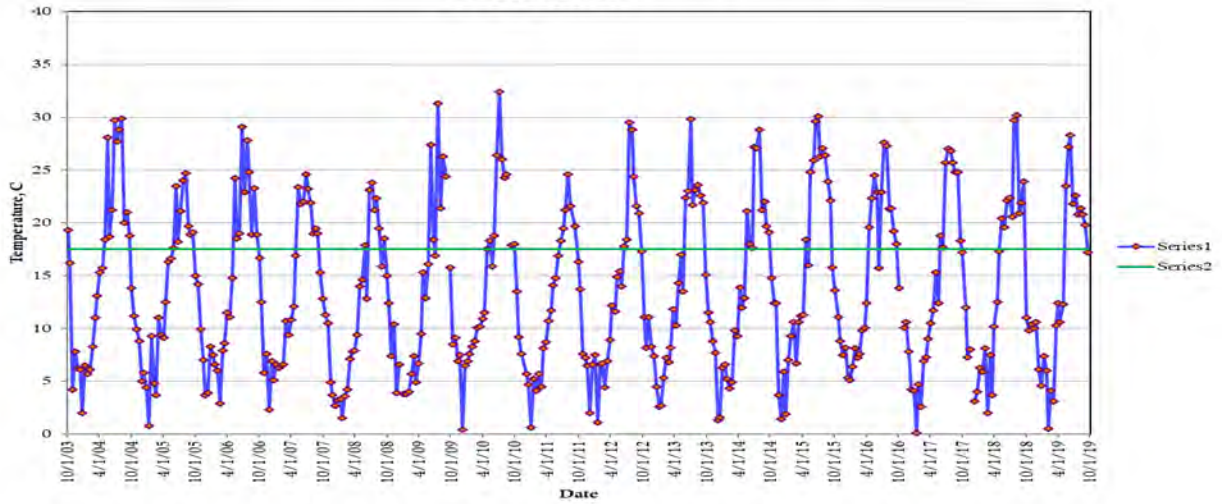
Site 36 regularly fails to meet state standards for DO and water temperature. Annual FC levels pass the state standard for geomean of 100, but fail the state standard for a 90th percentile of 200.

Site 36 is tied for 35th out of 39 sites for number of significant trends, with eight, and is 33rd out of 39 sites for positive trends, with 38%.

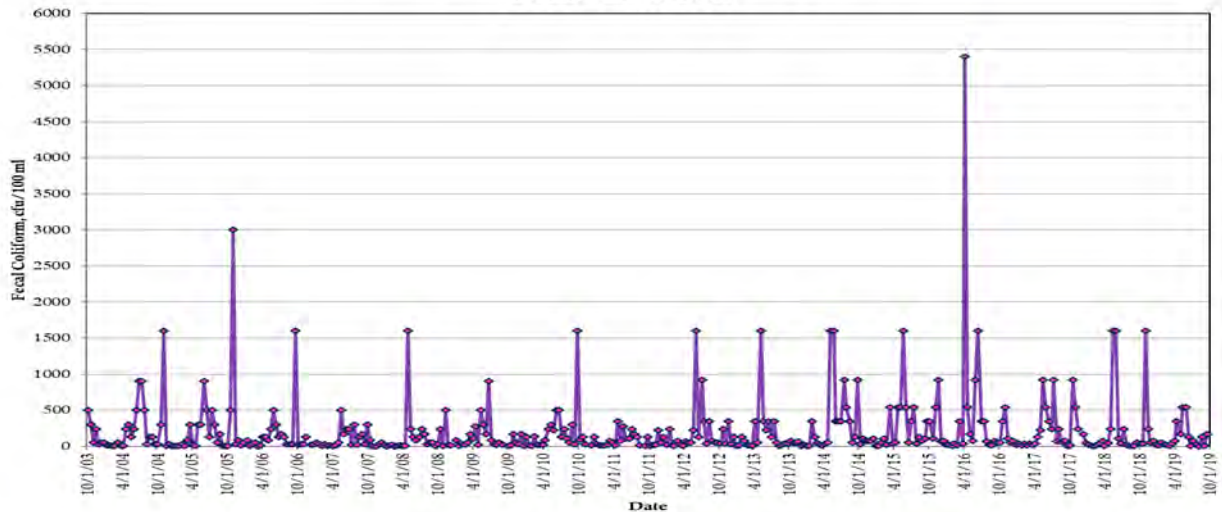
Edison Slough at Edison School - Site 36 Dissolved Oxygen



Edison Slough at Edison School - Site 36 Temperature



Edison Slough at Edison School - Site 36 Fecal Coliform





37

South Edison Drainage
@ Farm to Market Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	1	5	18	1	26	16	2	10	1	7	7	9	11

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	↑	—	—	—	↓	↑	↑	—

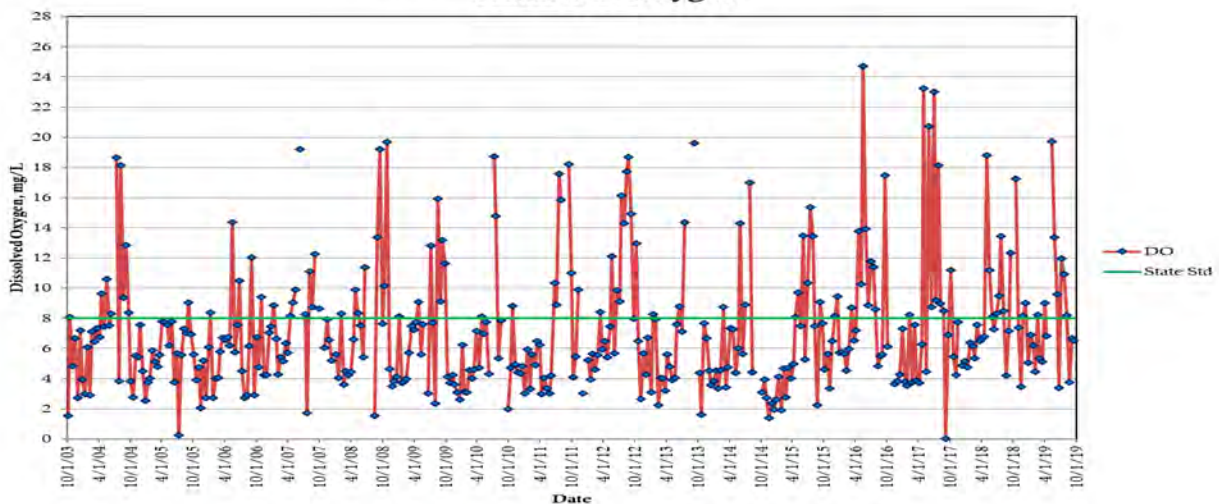
Site 37 is the south pump station of agricultural drainage in the town of Edison, on Samish Bay. Sites like this are characterized by being stagnant or slow-moving, and are heavily tidally-influenced. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Dissolved oxygen has increased in the most recent ten years. Water temperatures have decreased over the most recent five years. Fecal coliform counts are higher now than they were at the beginning of the program, and in the most recent ten years. WQI scores are consistently in the category of highest concern, and often in the single digits.

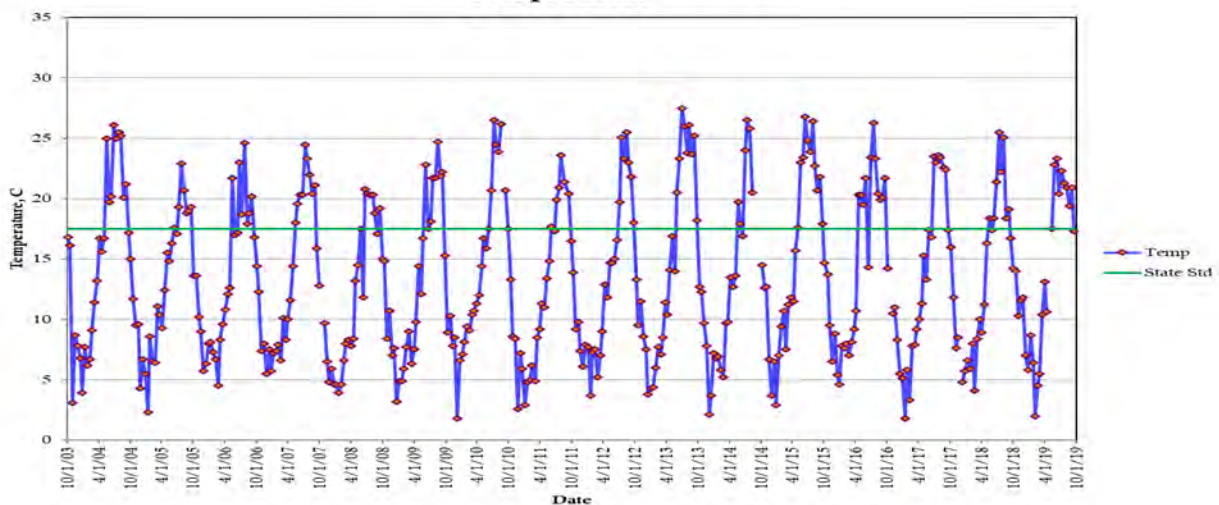
Site 37 regularly fails to meet state standards for DO and water temperature. Annual FC levels strongly fail state standards, and were the highest of all sites recorded in this program.

Site 37 is tied for 30th out of 39 sites for number of significant trends, with ten, and 35th out of 39 sites for positive trends, with 30%.

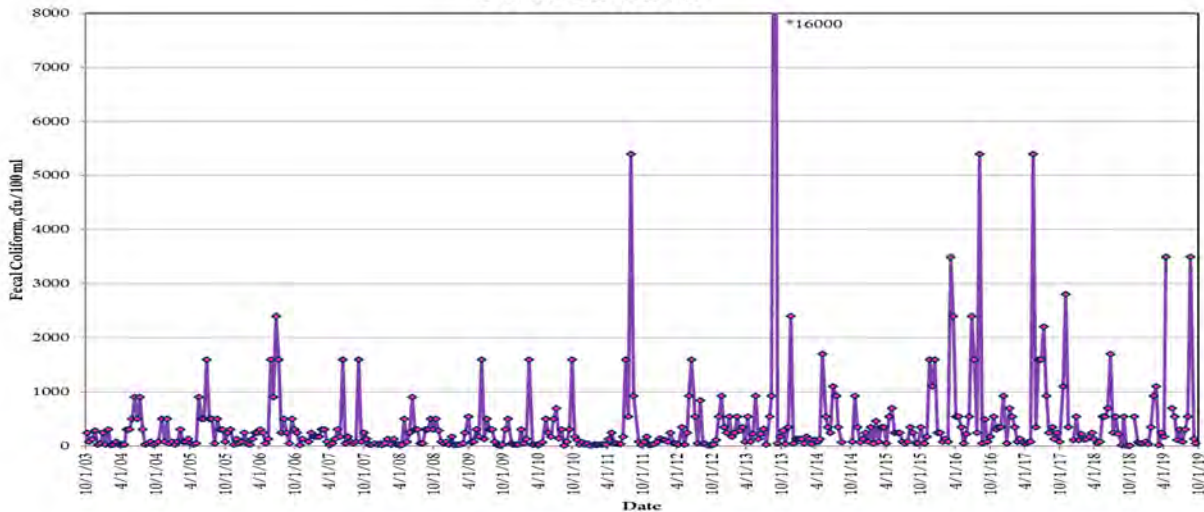
Edison Pump Station - Site 37 Dissolved Oxygen

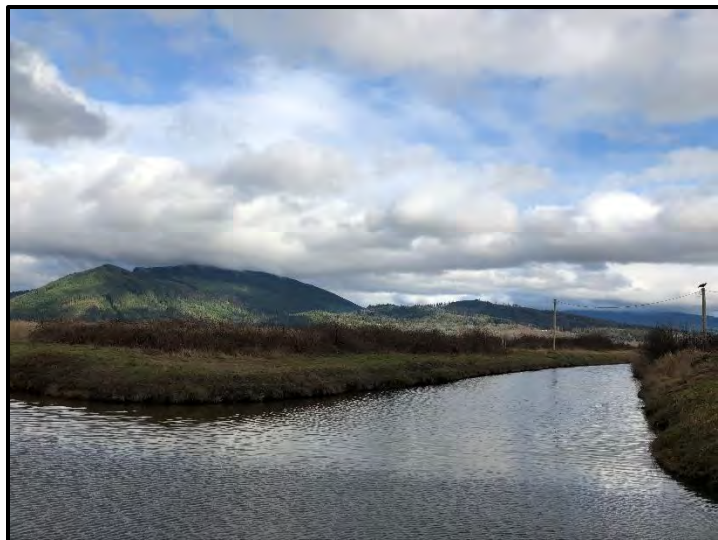


Edison Pump Station - Site 37 Temperature



Edison Pump Station - Site 37 Fecal Coliform





38

North Edison Drainage
@ Smith Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	6	1	13	16	36	12	13	3	6	19	18	20	5

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	—	—	—	—	—	—	↓

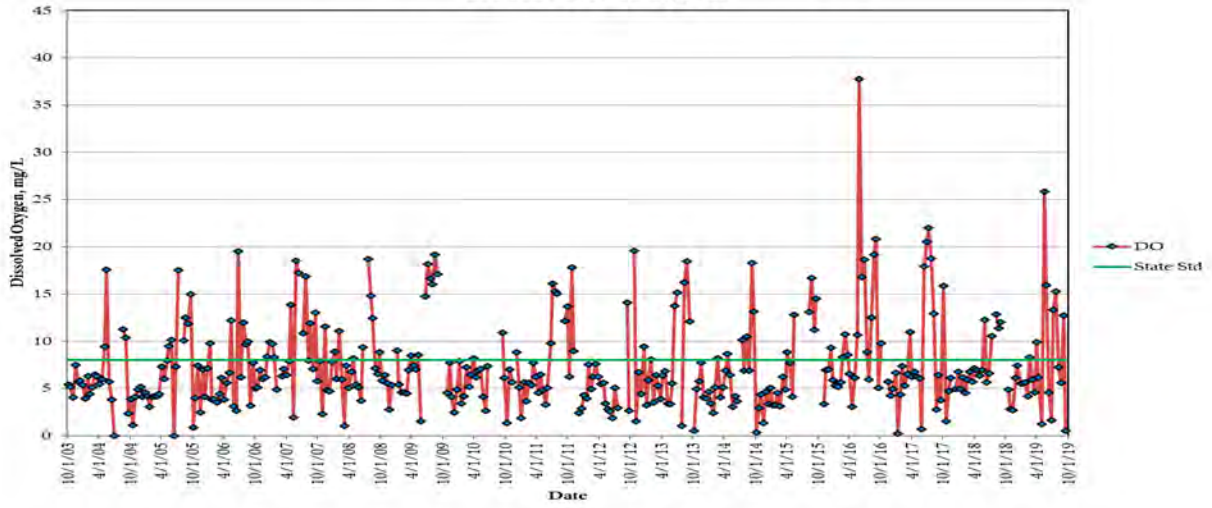
Site 38 is the north pump station of agricultural drainage in the town of Edison, on Samish Bay. Sites like this are characterized by being stagnant or slow-moving, and are heavily tidally-influenced. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Fecal coliform counts are lower now than they were five years ago. WQI scores are consistently in the category of highest concern, and often in the single digits.

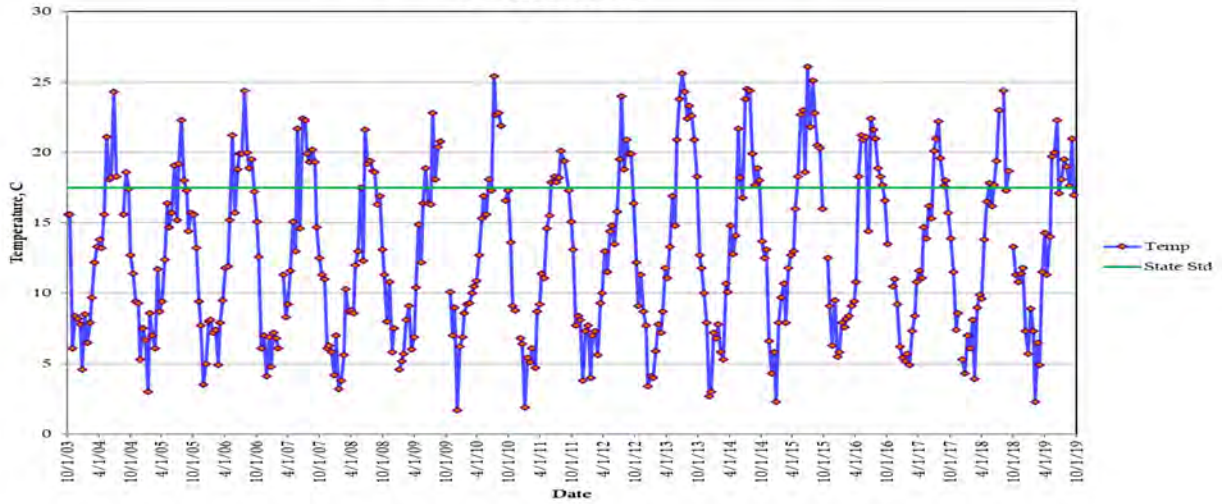
Site 38 regularly fails to meet state standards for DO and water temperature. Annual FC levels fail state standards.

Site 38 is tied for 25th out of 39 sites for number of significant trends, with 11, and tied for 31st out of 39 sites for positive trends, with 45%.

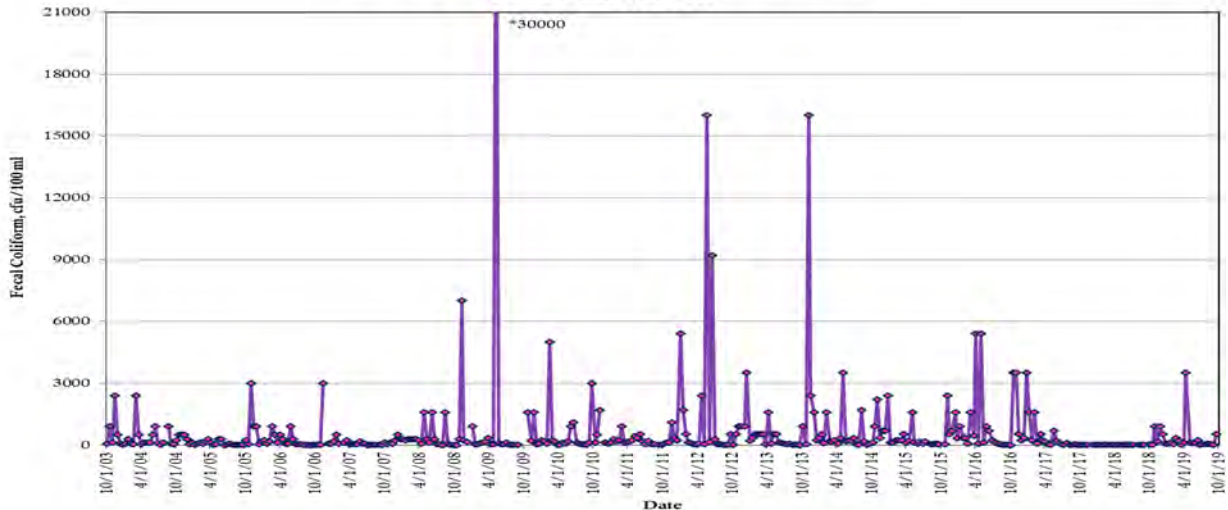
North Edison Pump Station - Site 38 Dissolved Oxygen



North Edison Pump Station - Site 38 Temperature



North Edison Pump Station - Site 38 Fecal Coliform





39

Colony Creek
@ Colony Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
17	39	52	67	63	85	78	81	76	83	83	81	80	58

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	↑	—	—	↓	↓	—	—

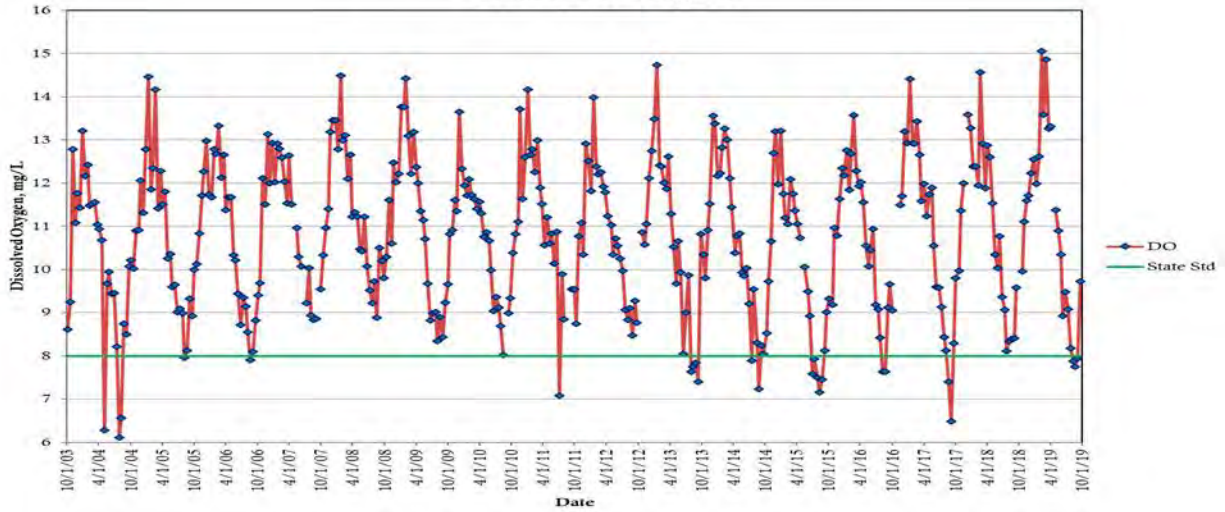
Site 39 is Colony Creek, prior to its convergence with Harrison Creek and terminating in to the north end of Samish Bay, and has rural residential and agricultural influences. This site is designated as core salmonid habitat.

In the most recent five years, DO has increased and water temperature has decreased. Fecal coliform counts are lower than they were sixteen years ago. WQI scores are generally in the upper-score end of the moderate concern category, and often score as least concern.

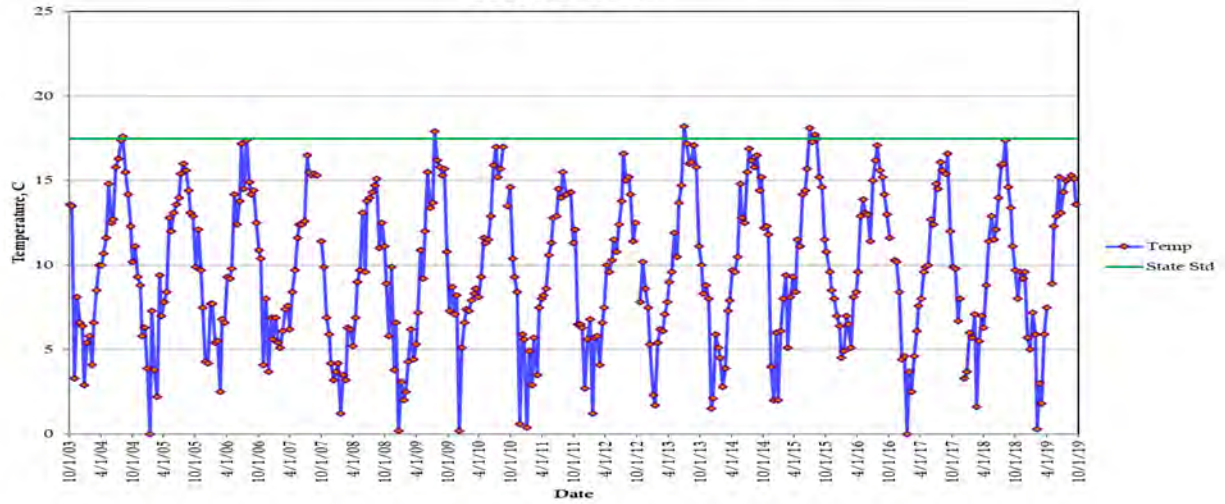
Site 39 rarely fails to meet state standards for DO and water temperature, and only does so at the warmest time of year. Annual FC levels pass the state standard for geomean of 100, but fail the state standard for a 90th percentile of 200.

Site 39 is tied for 33rd out of 39 sites for number of significant trends, with nine, and is 25th out of 39 sites for positive trends, with 56%.

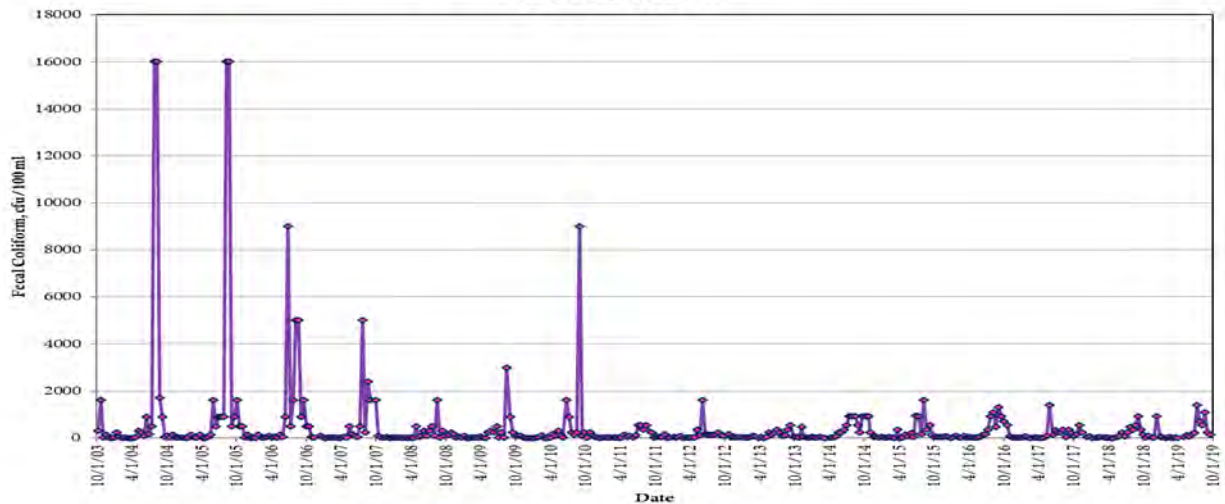
Colony Creek at Colony Road - Site 39 Dissolved Oxygen



Colony Creek at Colony Road - Site 39 Temperature



Colony Creek at Colony Road - Site 39 Fecal Coliform





40

Big Indian slough
@ Highway 20

Midstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
6	36	1	11	3	13	19	4	12	23	15	23	23	16

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	↓	↑	↓	—	↓	—	—	—

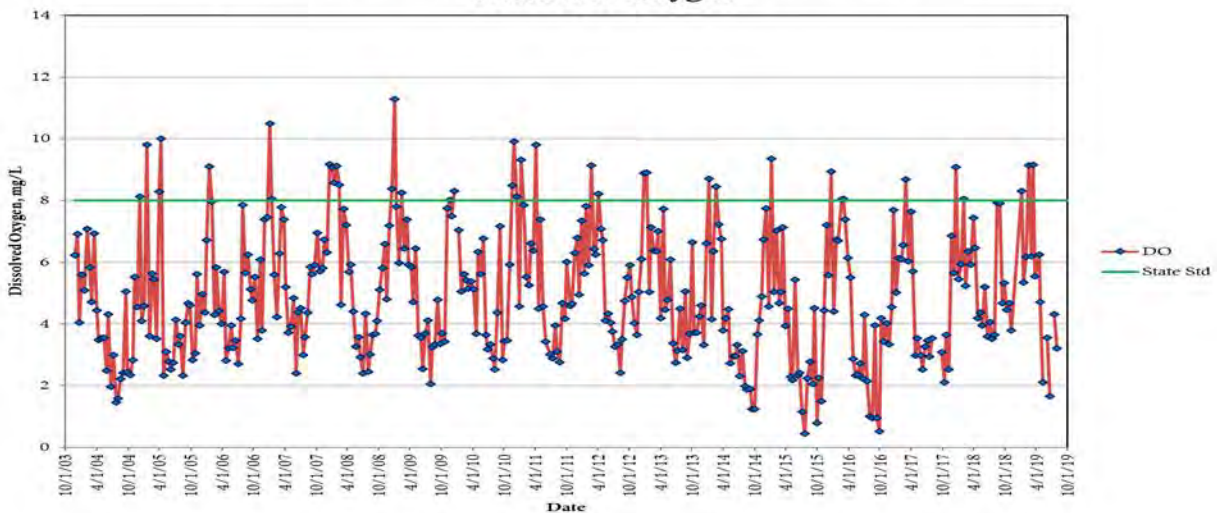
Site 40 is Big Indian Slough, just north of Highway 20 and prior to entering Padilla Bay. This site has industrial, agricultural, and urban influences. Sites like this are characterized by being stagnant or slow-moving, and are heavily tidally-influenced. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Dissolved oxygen levels have decreased since ten years ago, but have increased since five years ago. Water temperature is lower than it was at the beginning of this program, and also lower than it was five years ago. WQI scores are consistently in the category of highest concern.

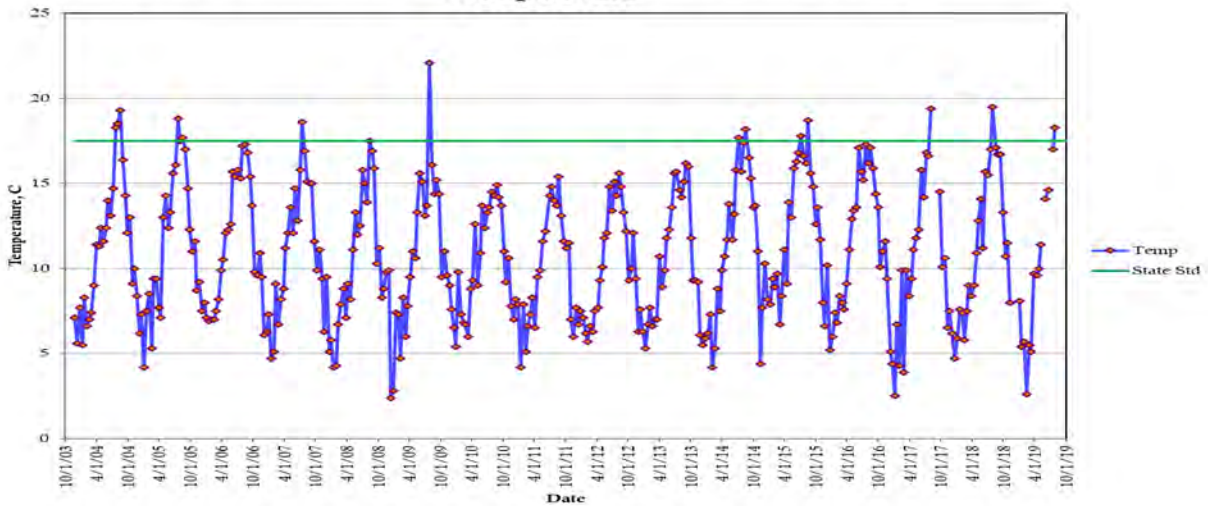
Site 40 regularly fails to meet state standards for DO, and fails to meet state standards for water temperature during the warmer months. Annual FC levels pass the state standard for geomean of 100, but narrowly fail the state standard for a 90th percentile of 200.

Site 40 is tied for 21st out of 39 sites for number of significant trends, with 12, and is tied for 26th out of 39 sites for positive trends, with 50%.

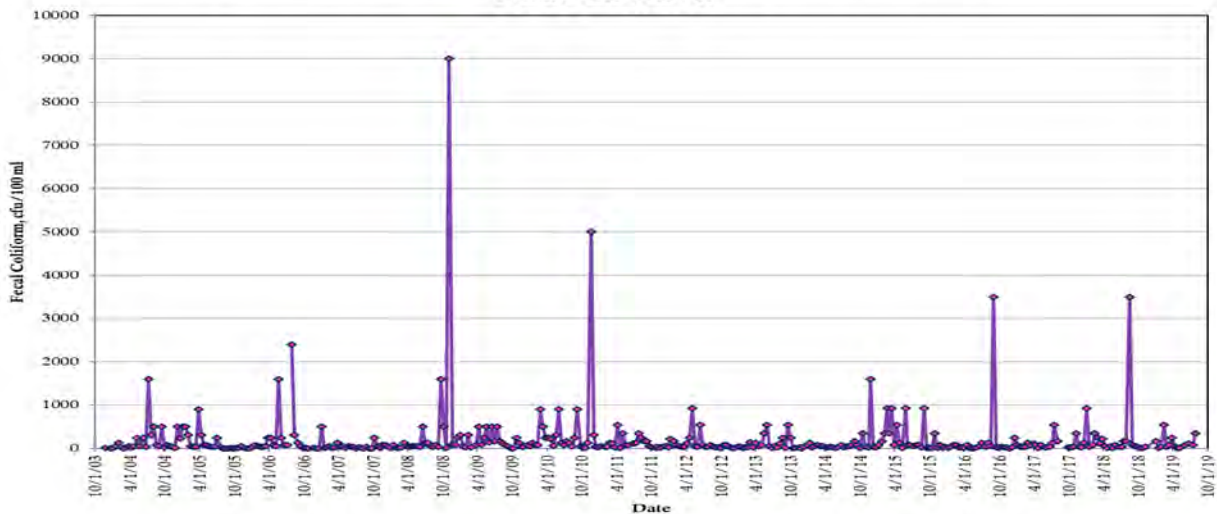
Big Indian Slough at Highway 20 Truck Scales - Site 40 Dissolved Oxygen



Big Indian Slough at Highway 20 Truck Scales - Site 40 Temperature



Big Indian Slough at Highway 20 Truck Scales - Site 40 Fecal Coliform





41

Maddox Slough
@ Milltown Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
15	27	23	56	55	27	34	19	24	30	39	39	25	33

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↑	↑	↓	—	—	↓	↑	—	↓

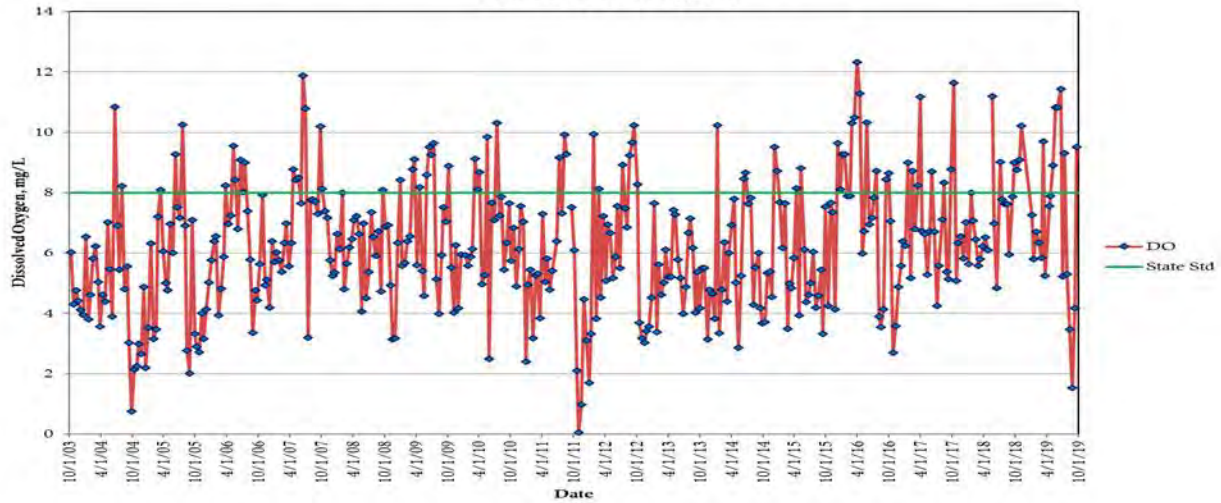
Site 41 is Maddox Slough, or Big Ditch, prior to entering Skagit Bay. Sites like this are characterized by being stagnant or slow-moving, and are heavily tidally-influenced. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Dissolved oxygen is higher than it was 16 years ago and ten years ago, but has decreased over the most recent five years. Water temperature and FC levels are lower than they were five years ago, though FC levels are still higher than they were at the beginning of this program. WQI scores are consistently in the category of highest concern.

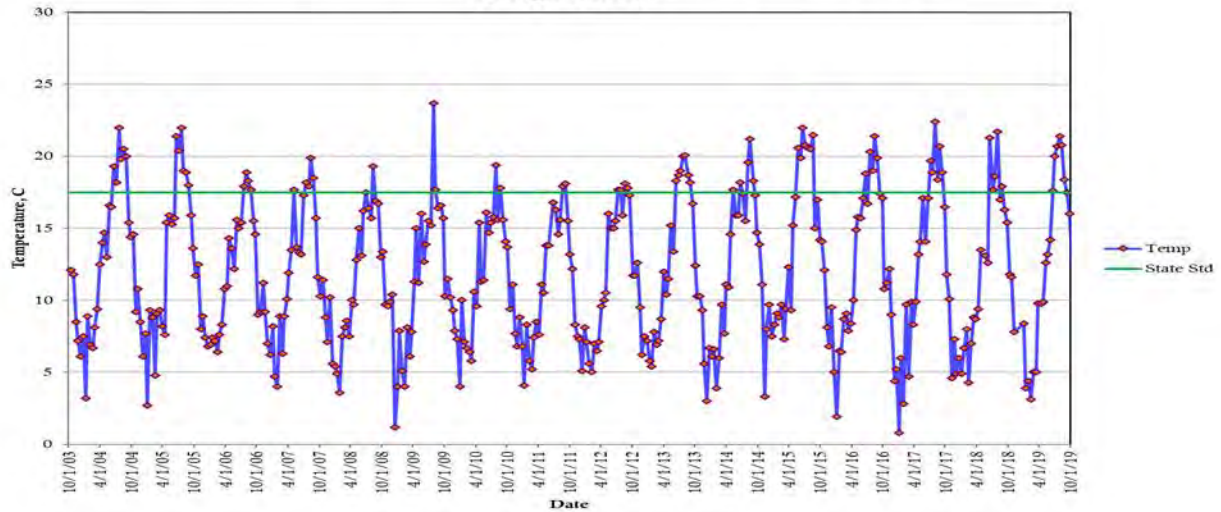
Site 41 rarely meets state standards for DO, and exceeds state standards for water temperature during the warmer months. Annual FC levels pass the state standard for geomean of 100, but narrowly fail the state standard for a 90th percentile of 200.

Site 41 is tied for 4th out of 39 sites for number of significant trends, with 18, and is 21st out of 39 sites for positive trends, with 61%.

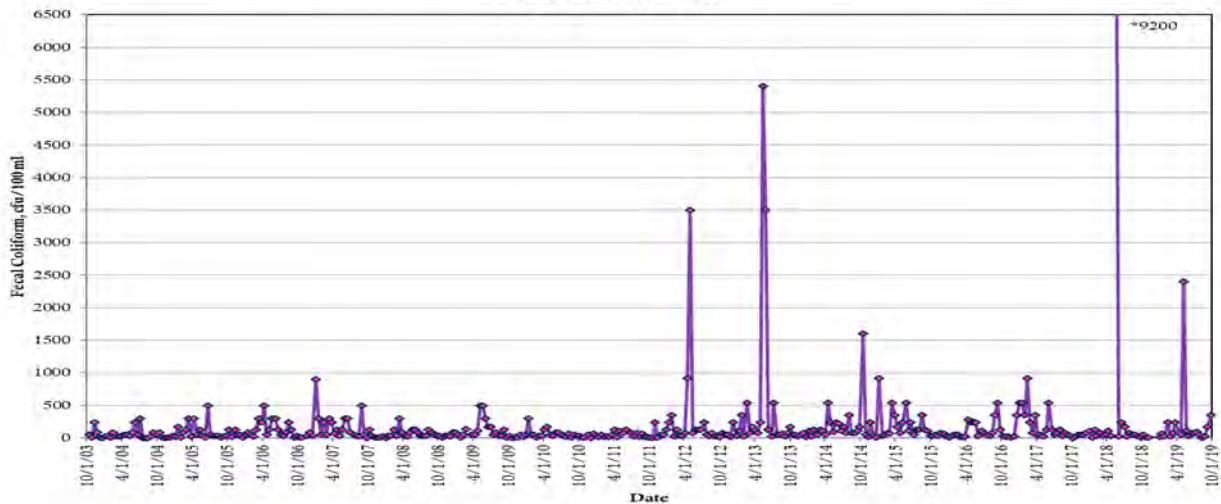
Maddox Creek/Big Ditch at Milltown Road - Site 41 Dissolved Oxygen



Maddox Creek/Big Ditch at Milltown Road - Site 41 Temperature



Maddox Creek/Big Ditch at Milltown Road - Site 41 Fecal Coliform





42

Hill Ditch
@ Cedardale Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
50	35	7	39	58	66	70	60	74	77	75	81	80	73

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↑	—	—	—	—	↓	↑	—	↓

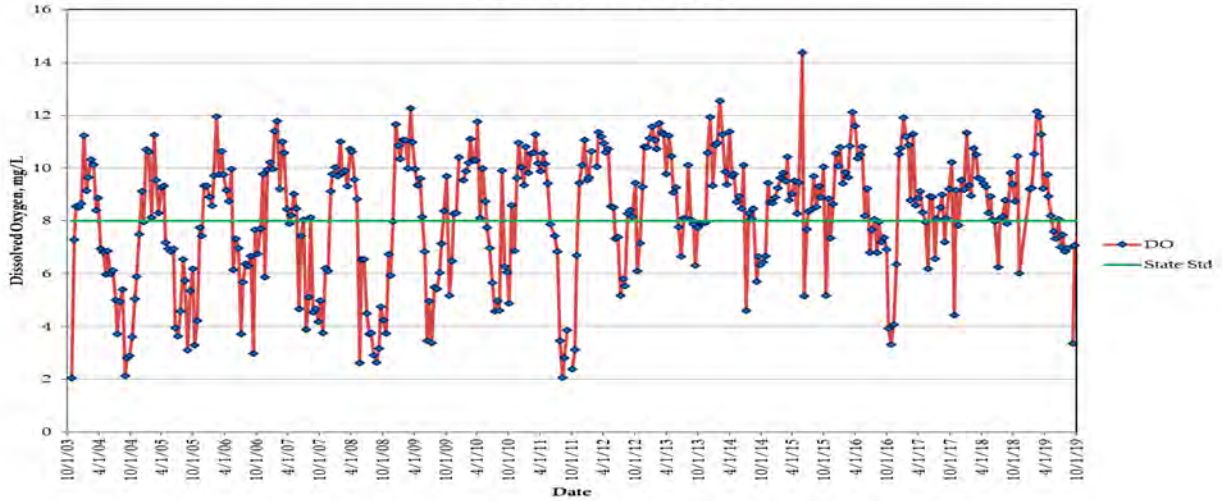
Site 42 is Carpenter Creek, or Hill Ditch, prior to being joined by Fisher Creek and entering Skagit Bay. This watercourse has urban, rural residential, and agricultural influences. This site is designated as core salmonid habitat.

Dissolved oxygen is higher than it was 16 years ago. Water temperatures and FC counts have decreased in the most recent five years, though FC counts are still higher than they were at the beginning of this program. WQI scores have improved over the years from the category of highest concern to the category of least concern.

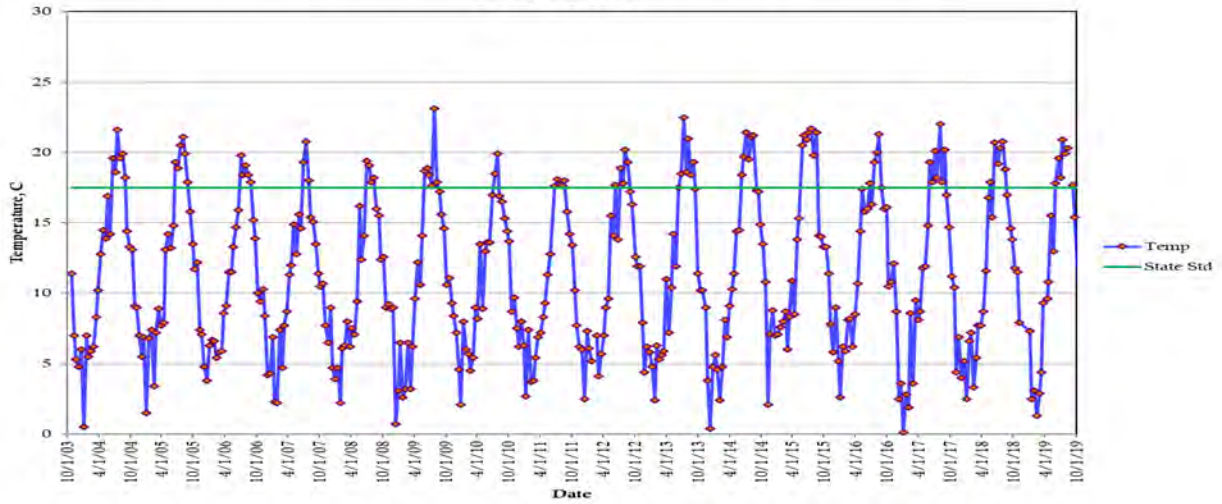
Site 42 fails state standards for DO about half of the year, and fails state standards for water temperature during the warmer months. Annual FC levels meet state standards.

Site 42 is tied for 11th out of 39 sites for number of significant trends, with 15, and is 22nd out of 39 sites for positive trends, with 60%.

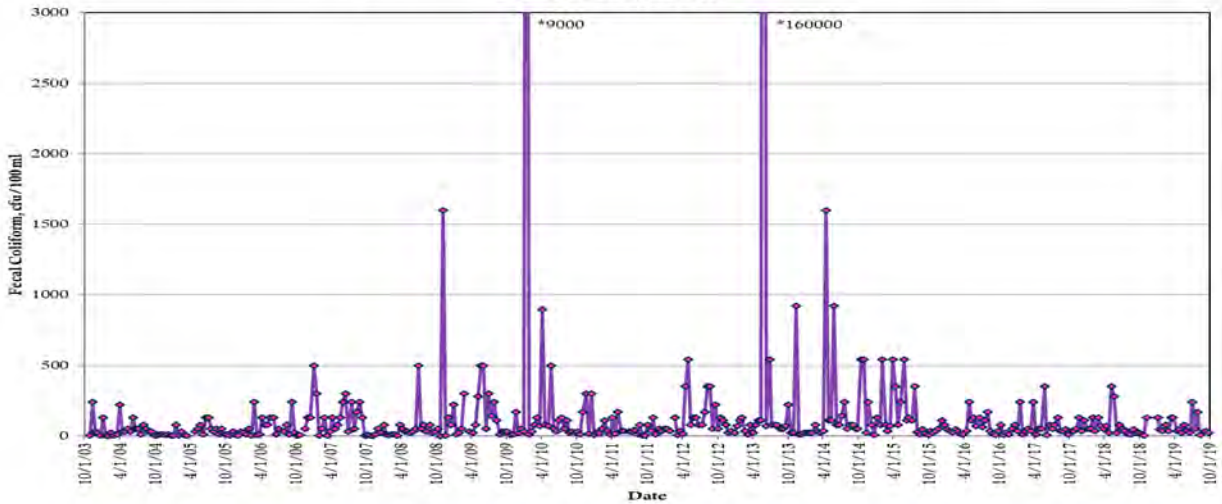
Carpenter Creek/Hill Ditch at Cedardale Road - Site 42 Dissolved Oxygen



Carpenter Creek/Hill Ditch at Cedardale Road - Site 42 Temperature



Carpenter Creek/Hill Ditch at Cedardale Road - Site 42 Fecal Coliform





43

Wiley Slough
@ Wylie Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	19	17	10	22	6	19	11	12	3	13	1	16	26

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	—	—	—	↓	↑	—	—

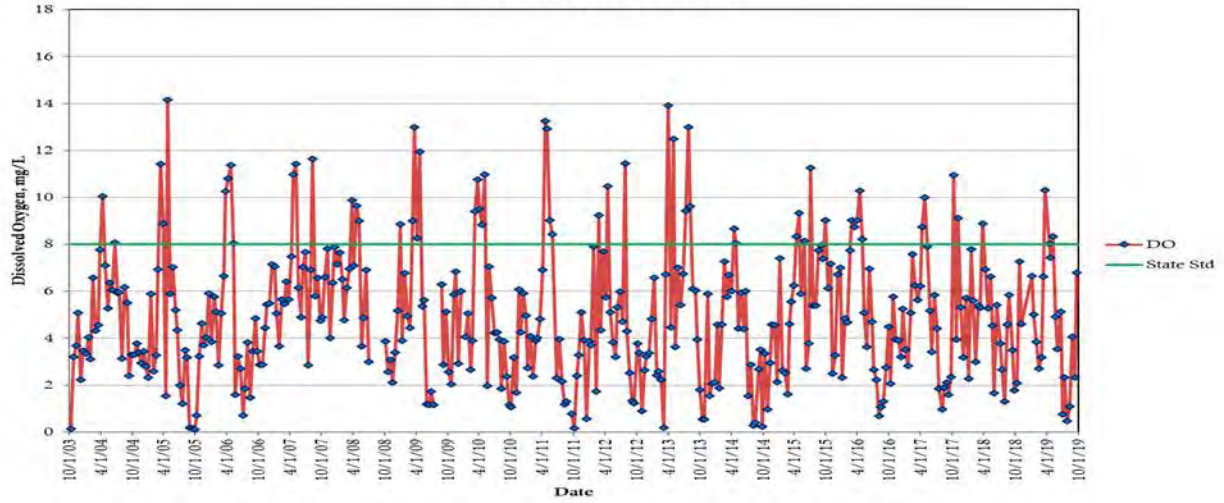
Site 43 is Wiley Slough, prior to its termination into the Skagit Wildlife Area wetlands and Skagit Bay. This site drains a large amount of agricultural area on Fir Island. Sites like this are characterized by being stagnant or slow-moving, and are heavily tidally-influenced. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Water temperatures have decreased in the most recent five years. Fecal coliform levels are higher now than they were at the beginning of this program. WQI scores are consistently in the category of highest concern.

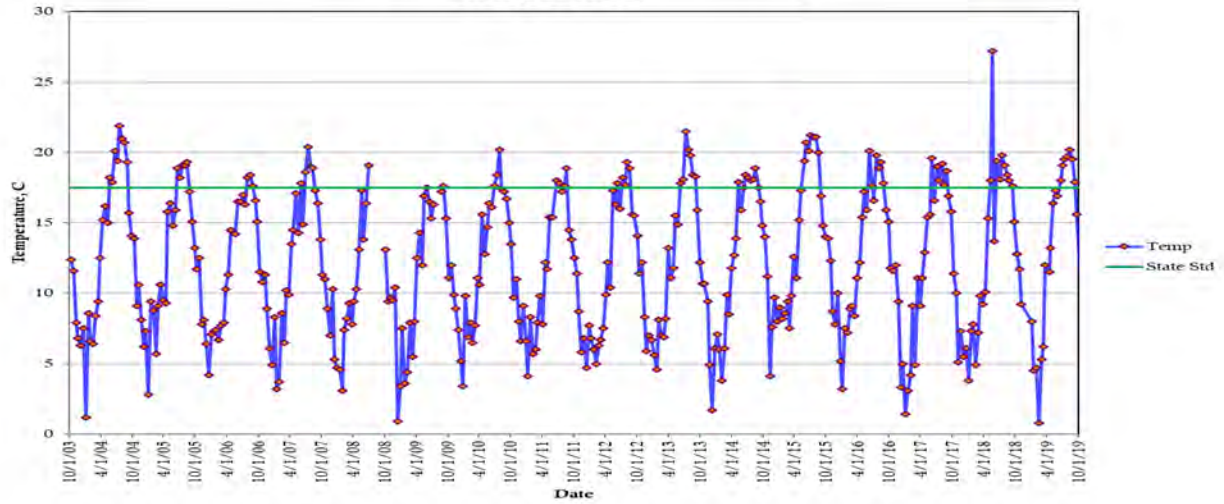
Site 43 rarely meets state standards for DO, and fails to meet state standards for water temperature in the warmer months. Annual FC levels pass the state standard for geomean of 100, but fail the state standard for a 90th percentile of 200.

Site 43 is tied for 32nd out of 39 sites for number of significant trends, with nine, and is 37th out of 39 sites for positive trends, with 22%.

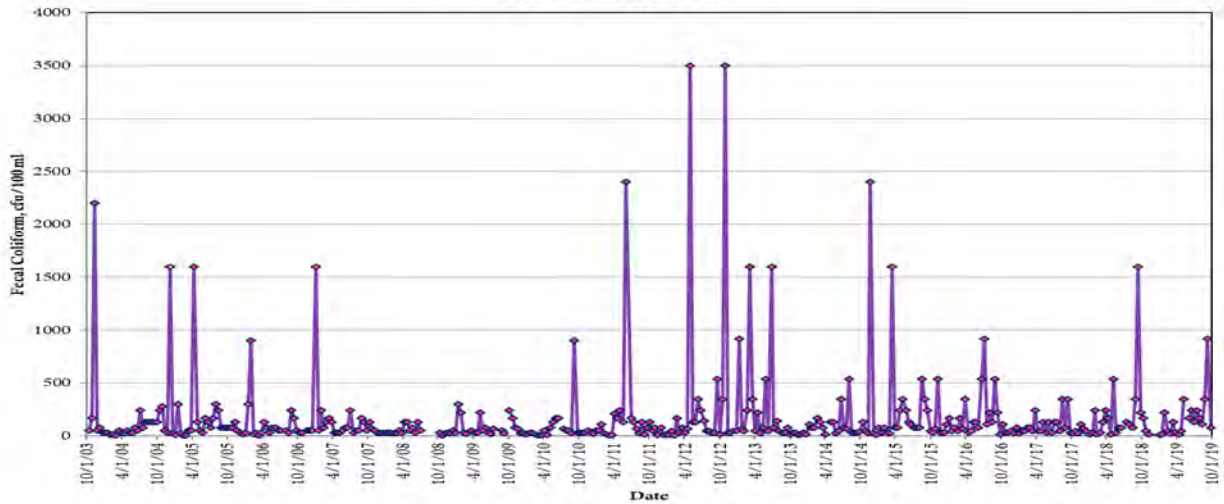
Wiley Slough at Wylie Road - Site 43 Dissolved Oxygen



Wiley Slough at Wylie Road - Site 43 Temperature



Wiley Slough at Wylie Road - Site 43 Fecal Coliform





44

Sullivan Slough
@ La Conner-Whitney Road

Downstream Ag

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
28	21	2	33	47	29	36	25	12	11	8	16	8	32

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↓	—	—	—	—	↓	—	—	↓

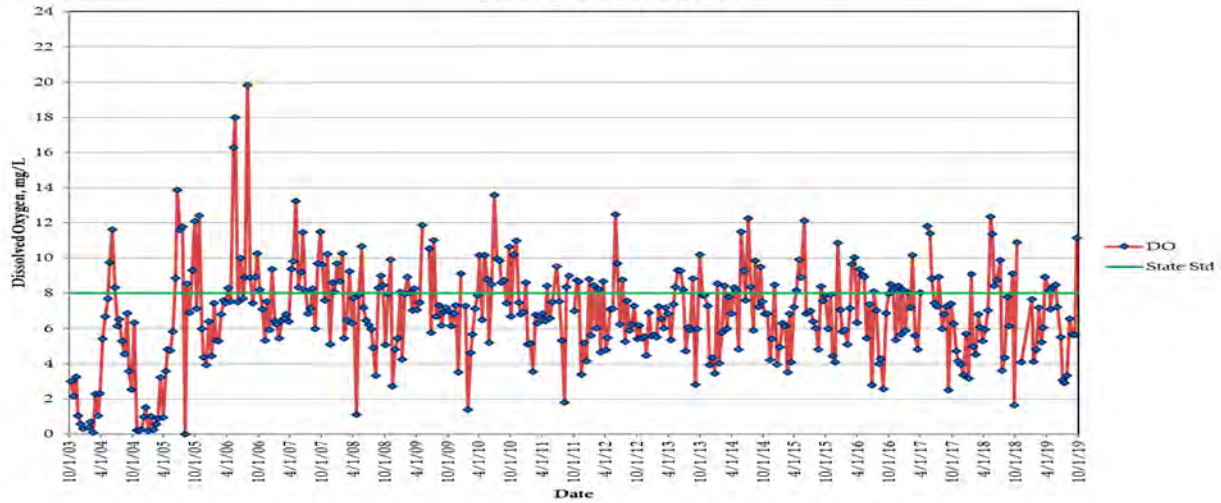
Site 44 is Sullivan Slough, at its west end, just prior to entering the Swinomish Channel. Sites like this are characterized by being stagnant or slow-moving, and are heavily tidally-influenced. This site is designated as salmonid spawning, rearing, and migration (SRM) status.

Dissolved oxygen is lower than it was 16 years ago. In the most recent five years, water temperature and FC counts have decreased. WQI scores are consistently in the category of highest concern.

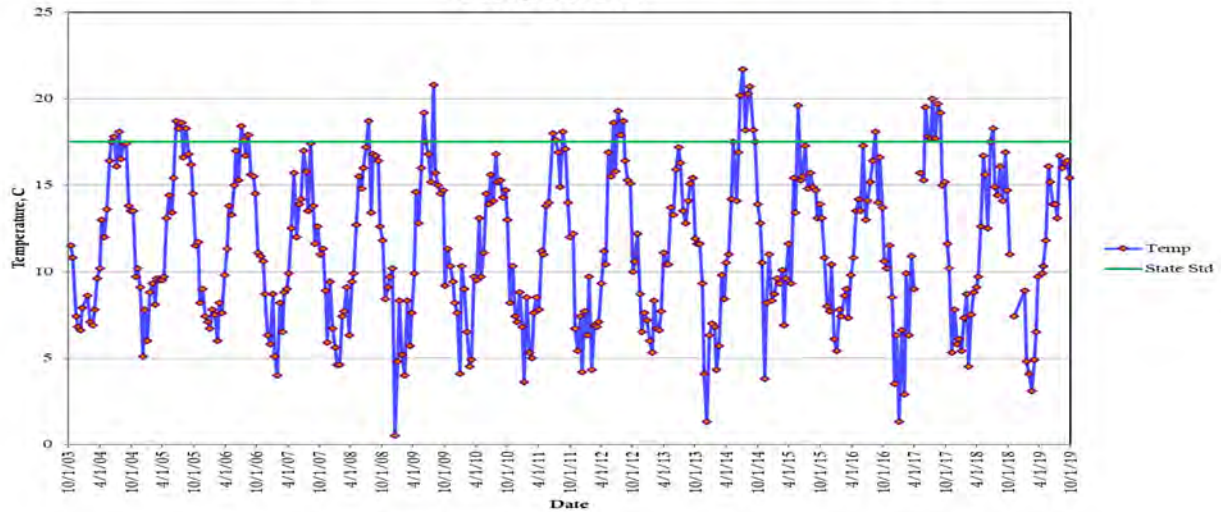
Site 44 spends the majority of the year below state standards for DO, and fails to meet state standards for water temperature during the warmer months. Annual FC levels pass the state standard for geomean of 100, but fail the state standard for a 90th percentile of 200.

Site 44 is tied for 25th out of 39 sites for number of significant trends, with 11, and is 34th out of 39 sites for positive trends, with 36%.

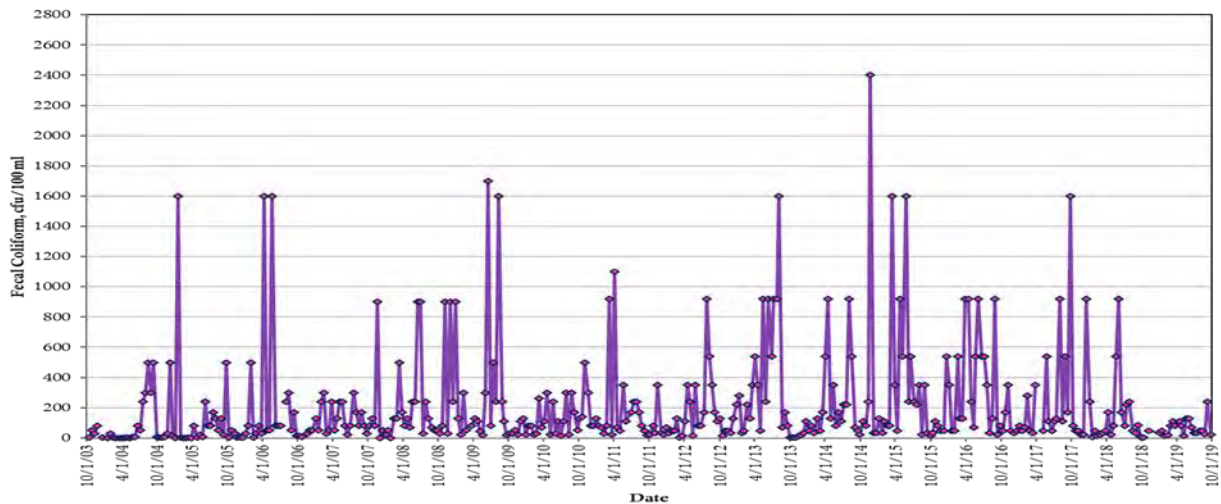
**Sullivan Slough at LaConner-Whitney Road - Site 44
Dissolved Oxygen**



**Sullivan Slough at LaConner-Whitney Road - Site 44
Temperature**



**Sullivan Slough at LaConner-Whitney Road - Site 44
Fecal Coliform**





45

North Fork Skagit River
@ Moore Road

Skagit River – Lower, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
78	71	88	95	95	95	80	86	85	93	89	89	89	88

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	↑	↑	—	—	↓	—	—	—

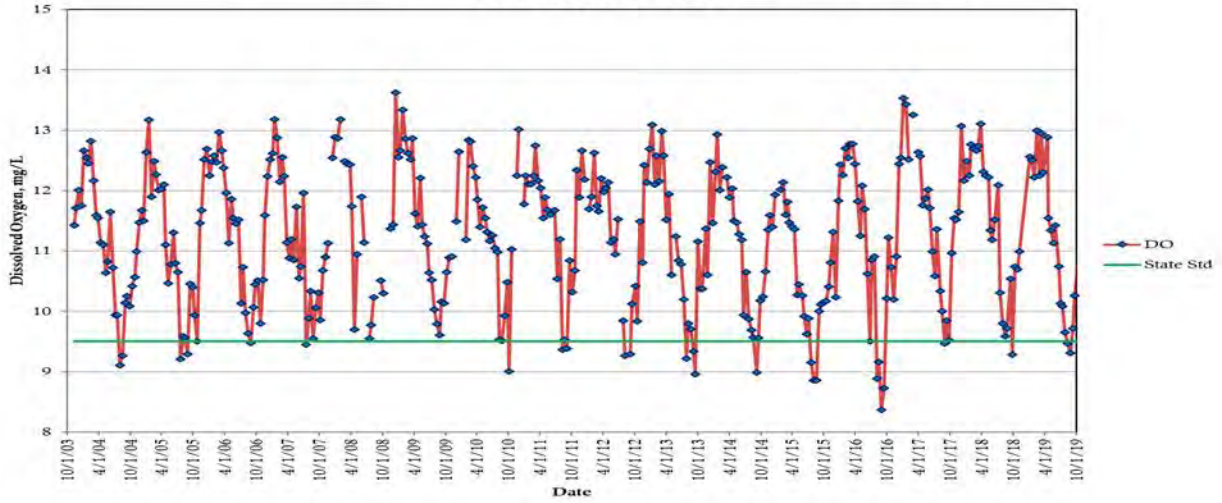
Site 45 is the north fork of the Skagit River, downstream of Mount Vernon. The river is designated as core salmonid habitat and as salmonid spawning, rearing, and migration (SRM) status.

Dissolved oxygen has increased over the most recent ten years and five years. Water temperature has decreased over the most recent five years. WQI scores are consistently in the category of least concern.

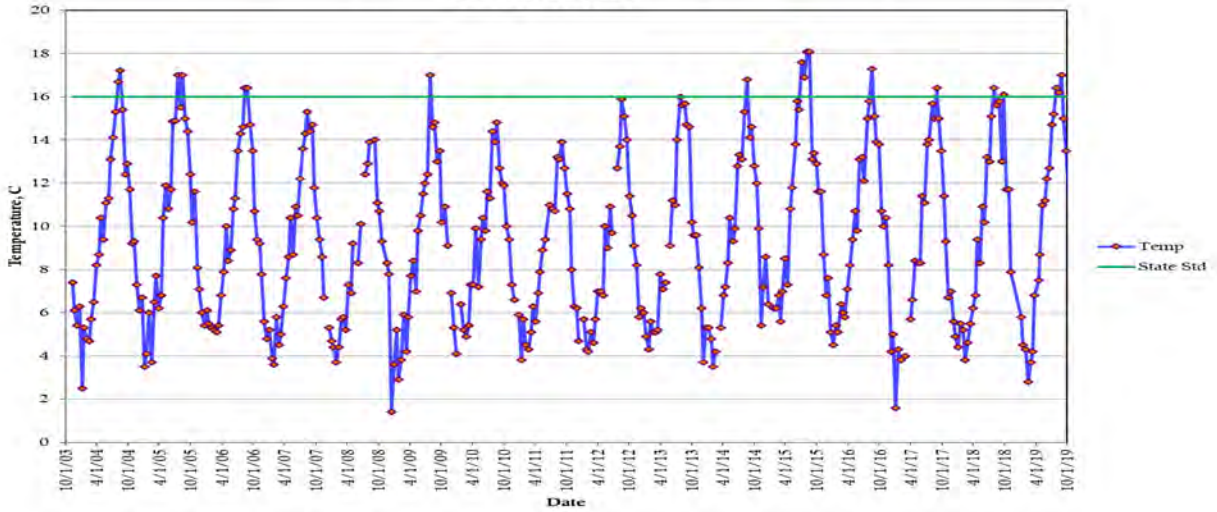
Site 45 rarely fails to meet state standards for DO and water temperature. Annual FC counts easily meet state standards.

Site 45 is tied for 21st out of 39 sites for number of significant trends, with 12, and is tied for 5th out of 39 sites for positive trends, with 83%.

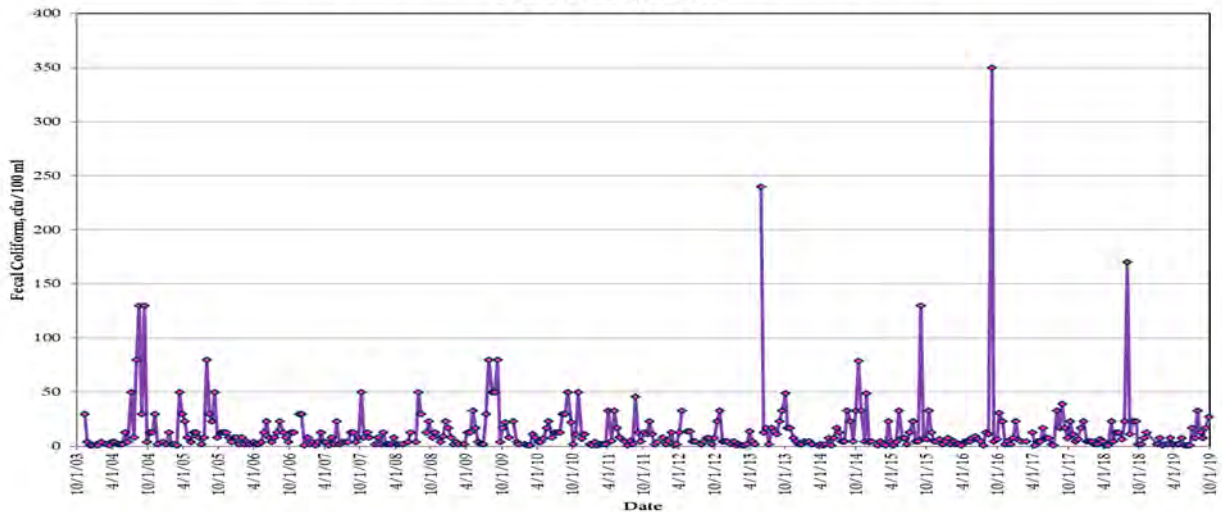
North Fork Skagit River near Moore Road - Site 45 Dissolved Oxygen



North Fork Skagit River near Moore Road - Site 45 Temperature



North Fork Skagit River near Moore Road - Site 45 Fecal Coliform





46

South Fork Skagit River
@ Conway Bridge

Skagit River – Lower, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
81	73	80	93	91	95	89	83	91	91	93	88	92	86

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↑	↑	↑	—	—	↓	—	—	—

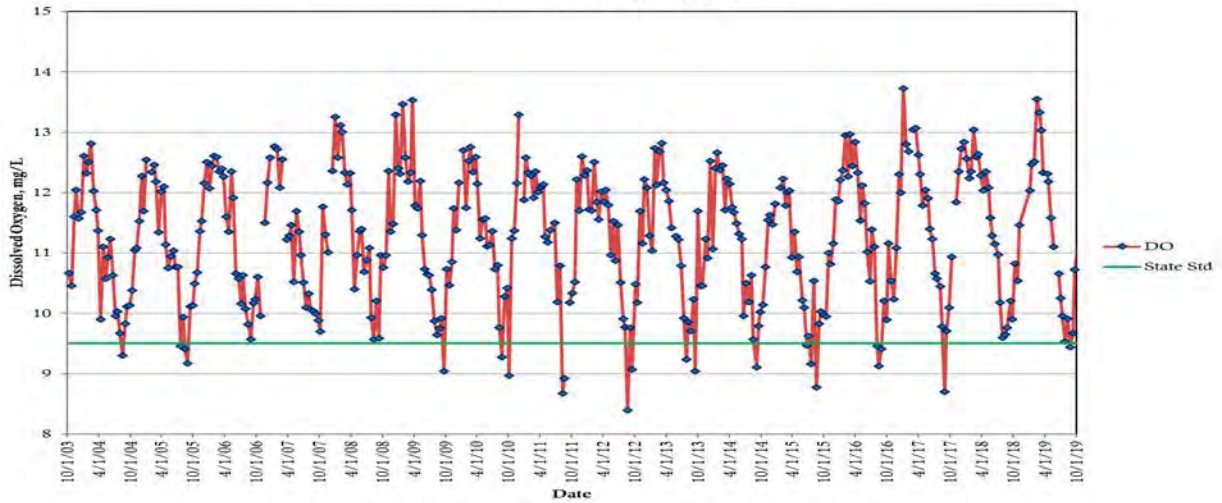
Site 46 is the south fork of the Skagit River, downstream of Mount Vernon. The river is designated as core salmonid habitat and as salmonid spawning, rearing, and migration (SRM) status.

Dissolved oxygen has increased over all analyzed time periods. Water temperature has decreased over the most recent five years. WQI scores are consistently in the category of least concern.

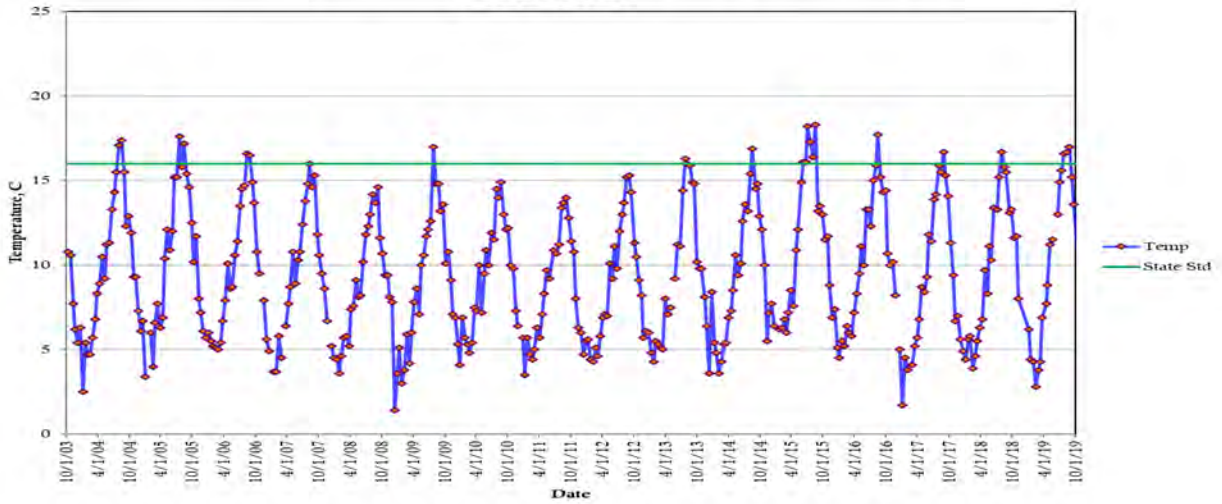
Site 46 rarely fails to meet state standards for DO and water temperature. Annual FC counts easily meet state standards.

Site 46 is tied for 14th out of 39 sites for number of significant trends, with 14, and is 4th out of 39 sites for positive trends, with 86%.

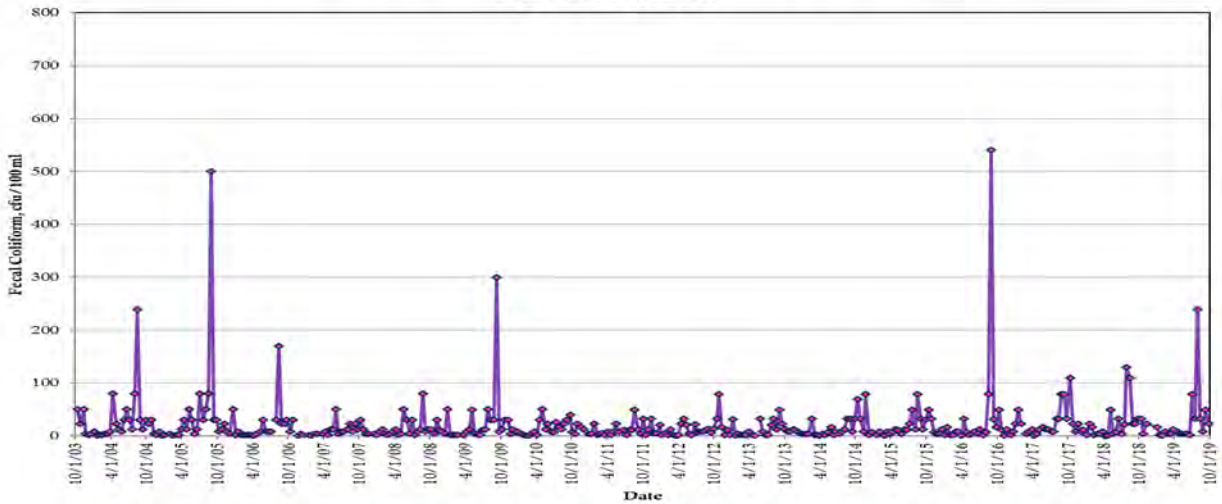
South Fork Skagit River at Conway Boat Ramp - Site 46 Dissolved Oxygen



South Fork Skagit River at Conway Boat Ramp - Site 46 Temperature



South Fork Skagit River at Conway Boat Ramp - Site 46 Fecal Coliform





47

Swinomish Channel
@ Berentson Bridge

Reference - Marine

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
74	82	68	67	83	79	81	77	78	81	88	87	83	80

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
—	—	↑	↑	↑	↓	↑	—	—

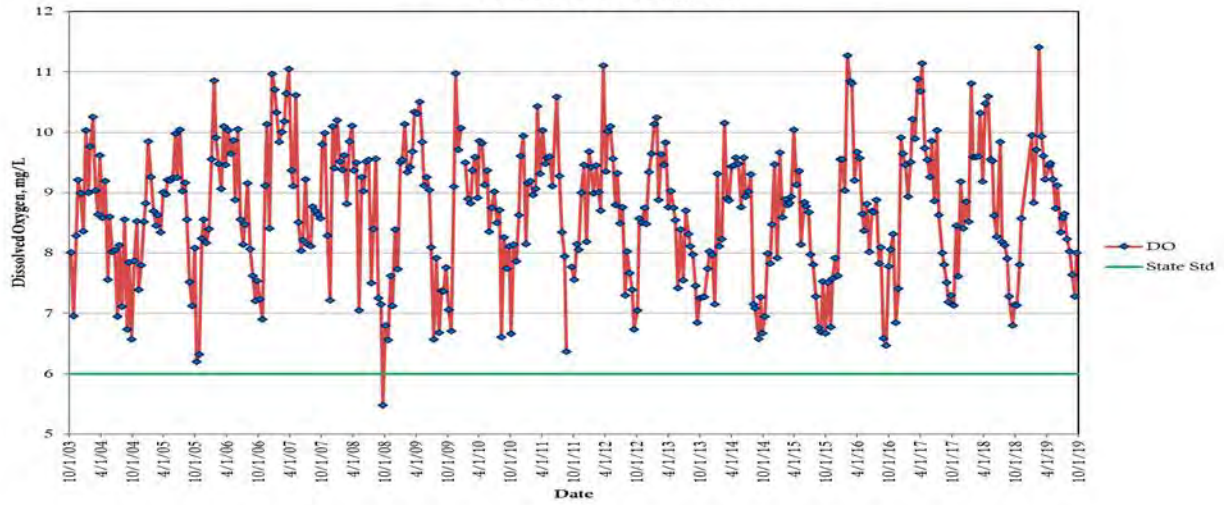
Site 47 is the Swinomish Channel, at the north end, just prior to Padilla Bay, and connects Padilla Bay to Skagit Bay. This site is designated as marine water.

Dissolved oxygen has increased over the most recent five years. Water temperature is higher than it was 16 years ago and ten years ago, but has decreased over the most recent five years. Fecal coliform counts are higher now than they were at the beginning of this program. WQI scores are generally in the higher-scoring end of the moderate concern category, and often score as least concern.

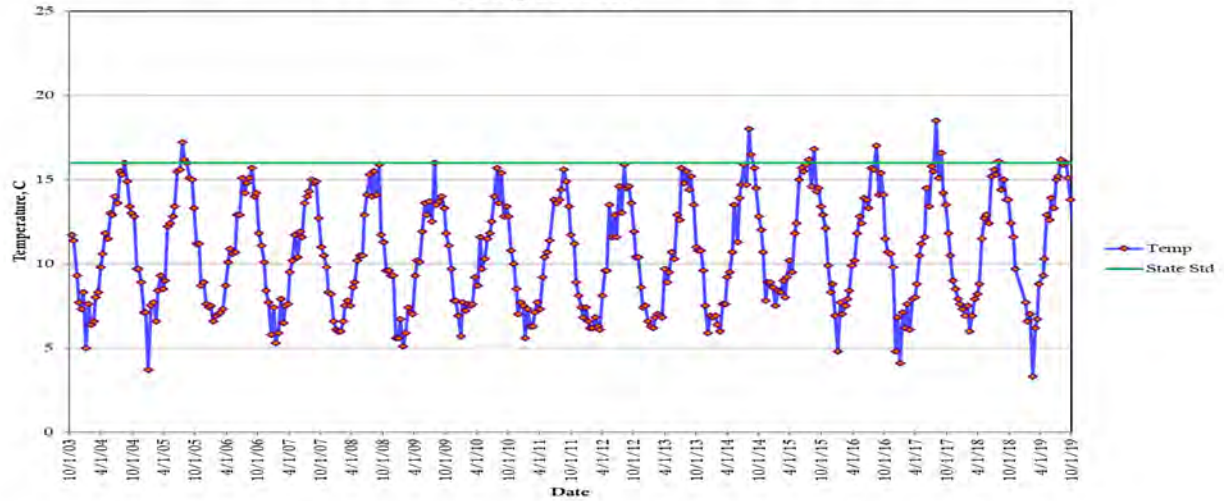
Site 47 rarely fails to meet state standards for DO and water temperature. Annual FC counts easily meet state standards.

Site 47 is 6th out of 39 sites for number of significant trends, with 17, and is 38th out of 39 sites for positive trends, with 18%.

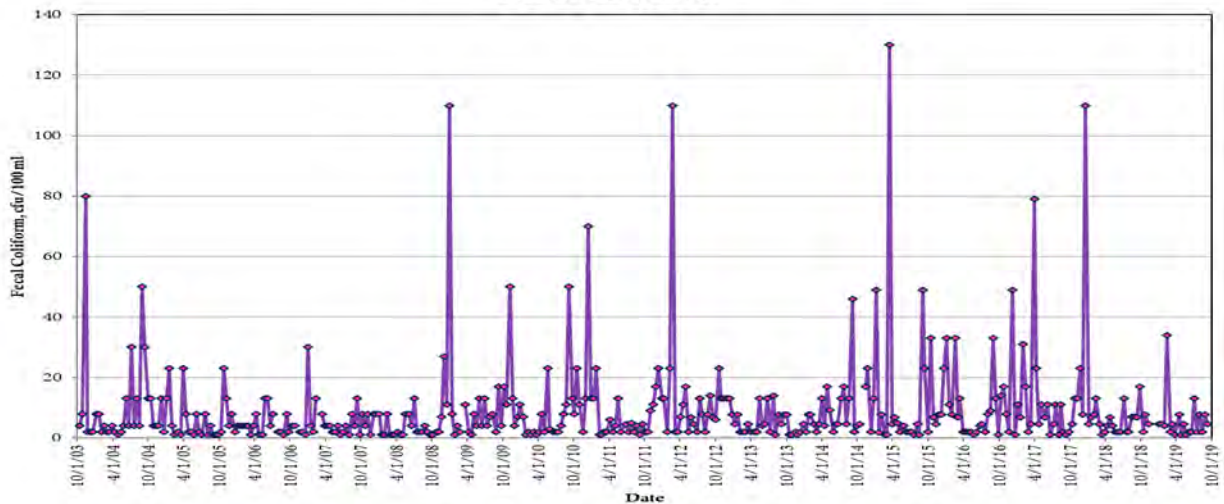
**Swinomish Channel at County Boat Ramp - Site 47
Dissolved Oxygen**



**Swinomish Channel at County Boat Ramp - Site 47
Temperature**



**Swinomish Channel at County Boat Ramp - Site 47
Fecal Coliform**





48

Fisher Creek
@ Franklin Road

Downstream Ag, TMDL

Water Quality Index (WQI)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
75	67	54	81	70	59	77	69	85	89	87	75	84	87

Long Term Trends								
Dissolved Oxygen			Temperature			Fecal Coliform		
16 yr	10 yr	5 yr	16 yr	10 yr	5 yr	16 yr	10 yr	5 yr
↑	↑	↑	↑	—	↓	—	—	↓

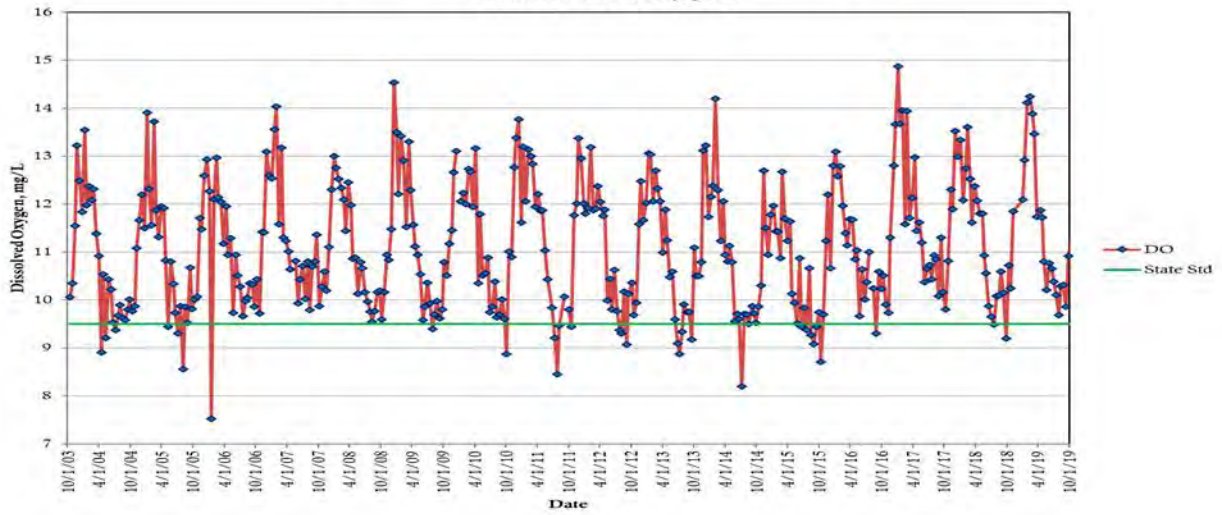
Site 48 is Fisher Creek, just prior to adjoining Carpenter Creek/Hill Ditch, and ultimately Skagit Bay. This site is influenced by rural residential and light agricultural activities. This site is designated as core salmonid habitat.

Dissolved oxygen has been increasing across all analyzed time periods. Over the most recent five years, water temperature and FC counts have decreased, though water temperature is higher now than it was 16 years ago. WQI scores are generally in the higher-scoring end of the moderate concern category, and often score as least concern.

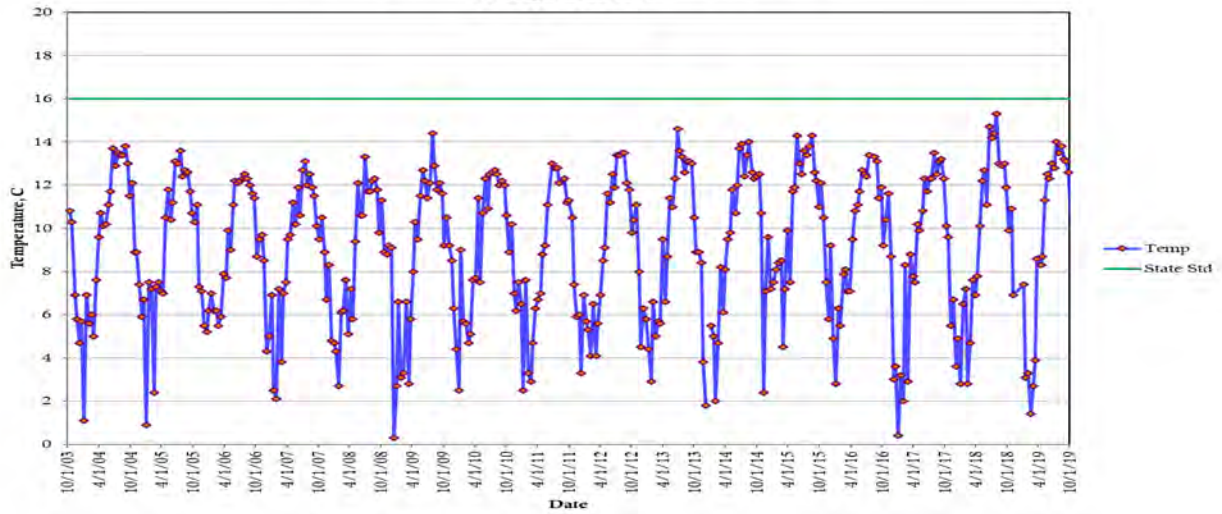
Site 48 rarely fails to meet state standards for DO, and has never failed to meet state standards for water temperature across the life of this program. Annual FC levels pass the state standard for geomean of 100, but do fail the state standard for a 90th percentile of 200.

Site 48 is 2nd out of 39 sites for number of significant trends, with 20, and is tied for 7th out of 39 sites for positive trends, with 75%.

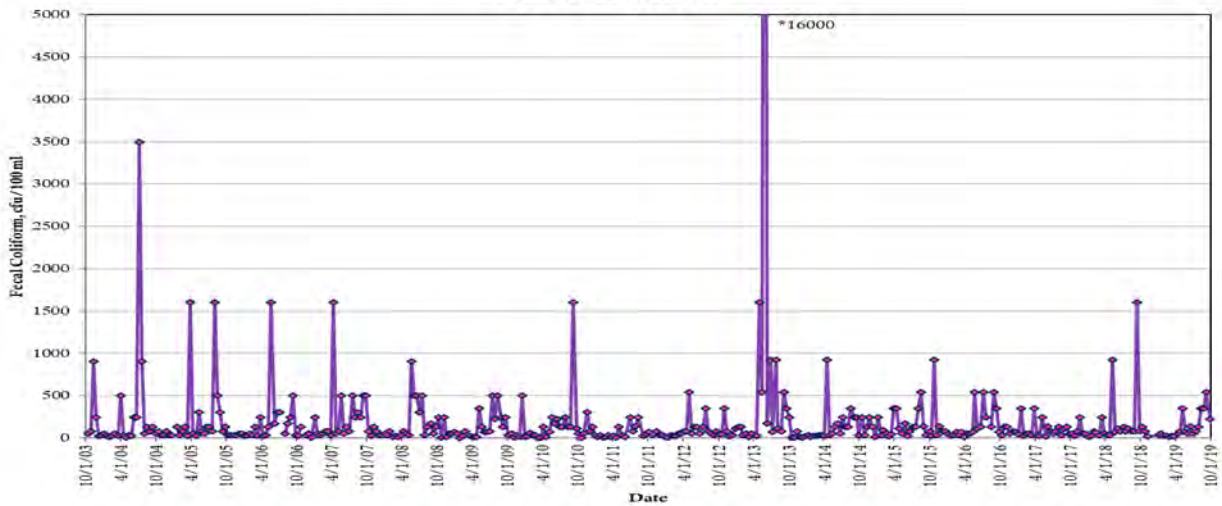
Fisher Creek at Franklin Road - Site 48 Dissolved Oxygen



Fisher Creek at Franklin Road - Site 48 Temperature



Fisher Creek at Franklin Road - Site 48 Fecal Coliform





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