

Skagit County Monitoring Program

Annual Report

2005 Water Year (October 2004 – September 2005)



Skagit River east of Hamilton



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Annual Report

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This report is available online at www.skagitcounty.net/SCMP

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2004 Water Year (October 2003-September 2004)

December 30, 2004

Introduction

The Skagit County Monitoring Program was instituted in October, 2003, as part of Skagit County's program to assess the effectiveness of Skagit County Code Chapter 14.24.120, Critical Areas Ordinance for Areas of Ongoing Agriculture. 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 Hearings Board.

The ordinance requires farmers to "do no harm" to adjacent watercourses, and relies on specific Watercourse Protection Measures and more generalized Best Management Practices to protect the watercourses instead of requiring buffers on the streams. The associated Skagit County Resolution R20030210 committed the County to conduct water quality sampling in the agricultural areas as one method of assessing if the County's 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 Growth Hearings Board. This second resolution provided details about the water quality monitoring program in addition to other topics not associated with water quality.

The monitoring program was designed to determine current conditions and long-term trends in water quality in the watercourses being monitored. It was not specifically designed to determine compliance of the watercourses with state water quality standards.

Figure 1 is a map with the sampling sites in the Skagit County Monitoring Program marked. Tables 1 and 2 list the sampling sites and site descriptions for the Skagit County Monitoring Program. Forty sites are currently included in the Program. These sites are located primarily in the agricultural zones (Agriculture-Natural Resource and Rural Resource). Other sites are located 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.

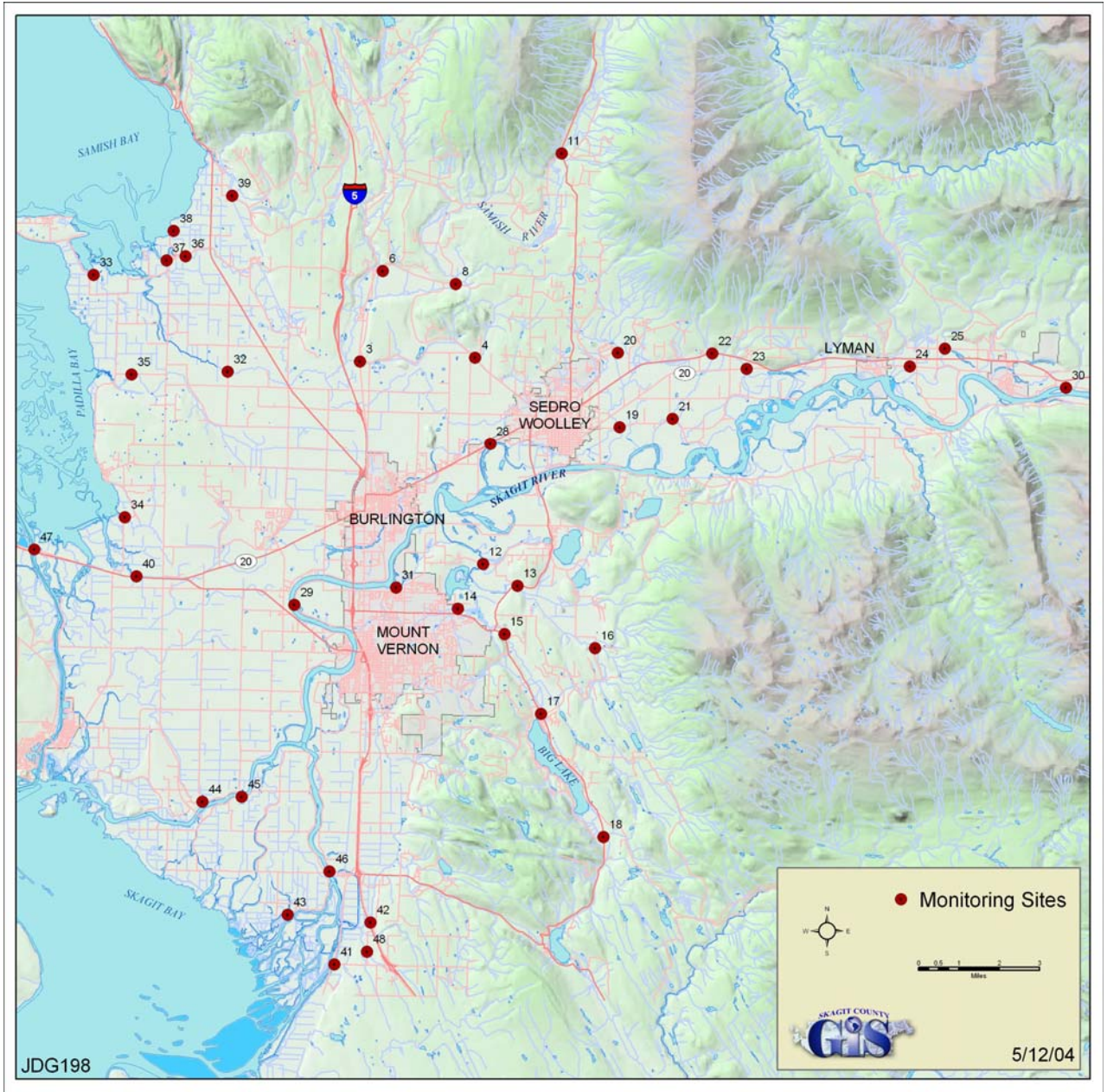


Figure 1. Sample sites in the Skagit County Monitoring Program. Refer to Tables 1 and 2 for site locations and descriptions.

Table 1. Sample sites for Skagit County Monitoring Program.

Site Number	Watercourse	Location	Latitude	Longitude	Site Type ¹
3	Thomas Ck	Old Hwy 99 N	48.526	-122.339	1
4	Thomas Ck	F&S Grade	48.528	-122.276	2
6	Friday Ck	Prairie Rd	48.559	-122.327	4
8	Swede Ck	Grip Rd	48.555	-122.287	3
11	Samish R	State Route 9	48.602	-122.231	1
12	Nookachamps Ck	Swan Rd	48.454	-122.270	3,6
13	E.F. Nookachamps Ck	State Route 9	48.446	-122.251	3,6
14	College Way Ck	College Way	48.436	-122.286	4
15	Nookachamps Ck	Knapp	48.429	-122.258	2,6
16	E.F. Nookachamps Ck	Beaver Lake Rd	48.424	-122.208	1,6
17	Nookachamps Ck	Big Lake Outlet	48.400	-122.237	1,6
18	Lake Ck	State Route 9	48.356	-122.202	1,6
19	Hansen Ck	Hoehn Rd	48.504	-122.197	3,6
20	Hansen Ck	Northern State	48.531	-122.199	1,6
21	Coal Ck	Hoehn Rd	48.507	-122.169	3
22	Coal Ck	Hwy 20	48.531	-122.149	1
23	Wiseman Ck	Minkler Rd	48.526	-122.130	2
24	Mannser Ck	Lyman Hamilton Hwy	48.528	-122.041	2
25	Red Cabin Ck	Hamilton Cem Rd	48.534	-122.023	2
28	Brickyard Ck	Hwy 20	48.497	-122.268	4
29	Skagit R	River Bend Rd	48.439	-122.372	5,6
30	Skagit R	Cape Horn Rd	48.521	-121.960	5
31	Drain Dist 20 floodgate	Francis Rd	48.445	-122.317	3
32	Samish R	Thomas Rd	48.521	-122.410	3
33	Alice Bay Pump Station	Samish Island Rd	48.555	-122.483	3
34	Noname 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	-122.435	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 Ck	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	Rexville Pump Station	Summers Drive	48.366	-122.419	3
	Sullivan Slough	La Conner-Whitney Rd	48.395	-122.485	3
45	Skagit R – North Fork	Moore Rd	48.364	-122.416	5,6
46	Skagit R – South Fork	Fir Island Rd	48.342	-122.349	5,6
47	Swinomish Channel	County Boat Launch	48.455	-122.512	7
48	Fisher Ck	Franklin Rd	48.320	-122.328	3,6

¹See Table 2 for site type descriptions

Table 2. Sample site type descriptions for Skagit County Monitoring Program

Site Type Number	Description	Number of Sites¹
1	Ag-upstream: Located to determine status/trends at upstream end of agricultural areas.	7
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.	19
4	Reference: Located to determine status/trends in a non-agricultural area, such as urban/suburban or rural reserve, for comparison with ag 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 designation

A secondary purpose for some of the sites included in the monitoring program is to provide data to the Department of Ecology in support of their Total Maximum Daily Load (TMDL) 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.

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 will be used to help interpret trends in water quality for sites continued in the Skagit County Monitoring Program. 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. In particular, several intermediate sites on the Samish River were discontinued, leaving one upstream and one downstream site on the Samish.

A proposal was submitted in February, 2003 to the Department of Ecology for consideration in their 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, FY 2004 through FY 2008.

Methods

Standard water quality monitoring methods are used in the Skagit County Monitoring Program. The methods are derived from several sources, including the Department of Ecology and the U.S. Environmental Protection Agency. A brief description of monitoring procedures follows, and detailed monitoring procedures can be found in the Quality Assurance Project Plan developed for the program (Skagit County 2004b).

Each site in the monitoring program is visited every two weeks. At each visit, dissolved oxygen, temperature, pH, turbidity, conductivity, and salinity are measured and samples are obtained for fecal coliform determinations. On alternate visits (every four weeks), additional water samples are obtained for quantifying plant nutrients (total nitrogen, ammonia, nitrate, nitrite, total phosphorus and orthophosphate), and total suspended solids. Stream discharge is measured at selected sites during the alternate visits.

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.

Data collected is entered into a specially-designed database, and then is checked for accuracy against the original data sheets. Output from the database can be exported into Excel[®] spreadsheets for data summary and analysis. These spreadsheets are also published on the County's web site:

<http://www.skagitcounty.net/SCMP>

Activity Summary

Weekly Sampling - All weekly sampling trips were conducted on schedule during the 2005 water year, beginning on October 5, 2004. Sampling normally took place on Tuesdays except during holiday weeks (Thanksgiving and Christmas), when sampling took place on Mondays to accommodate laboratory schedules. Sampling activities are illustrated in Figures 2 and 3.

Grant Activity - Centennial Clean Water grants require a Quality Assurance Program Plan (QAPP). A draft QAPP was submitted to the Department of Ecology in September, 2003. Ecology comments were incorporated into the document and a final QAPP was submitted to Ecology in October, 2003. Ecology accepted the QAPP and a final grant agreement was signed by Ecology and the County Commissioners in January, 2004. At this point expenditures on the Skagit County Monitoring Program became grant-eligible, with reimbursement from the Centennial Clean Water Grant program at a 75% rate.

The grant requires quarterly reports and annual data submissions. Skagit County has submitted quarterly reports for the first, second, and third quarters of 2005. The first annual data submission was made in January, 2005. Another submission will be made in January, 2006.



Figure 2. Stephanie Woolett obtains a water sample from Carpenter Creek (Site 42)

Sample site revisions - Three sample sites were moved from the original location as delineated in the QAPP. Site 35 on Joe Leary Slough was moved approximately 3500 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 2800 feet upstream to solve right-of-entry problems and to move away from the tidegate and associated saltwater intrusion. Site 42 on Hill Ditch/Carpenter Creek was moved approximately 4300 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 the Department of 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 the Department of Ecology

and the Western Washington Agricultural Association because it was determined that the majority of flow from that system discharged through the west end of the system 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 samples 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.

Data Summary

Graphs and tables on the following pages report results from the Skagit County Monitoring Program for dissolved oxygen, temperature, and fecal coliform. Full data listings for each sampling event at sample site are included in Appendix A. A summary of water quality results for each sample site is included in Appendix B.

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.

Temperatures were measured with Stowaway Tidbit[®] dataloggers from Onset Computer Company. These devices were set to measure water temperature every half hour. They were deployed in June and retrieved in late August.

Several of the dataloggers were missing at the end of the monitoring period. Some had apparently been lost due to channel changes associated with heavy rains in August, while others may have been vandalized.

Table 3 shows the daily and 7-day average maximums (7-DAM) for those stations where temperature data was obtained, compared to the state standard for that station. The state temperature standards are based on the 7-DAM so that occasional abnormally hot days do not result in temperature standard violations. The Skagit River and tributaries upstream from Skiyou Slough are held to a lower temperature standard (7-DAM = 16°C) than streams in the rest of the county. Sites 21-25 and 30 are subject to the more stringent standard. Site 47 is held to the “excellent quality” marine standard (also 16°C). All other streams in the county are held to a standard 7-DAM of 17.5 °C. Most watercourses in the Skagit County Monitoring Program exceeded state temperature standards at some point during the summer.

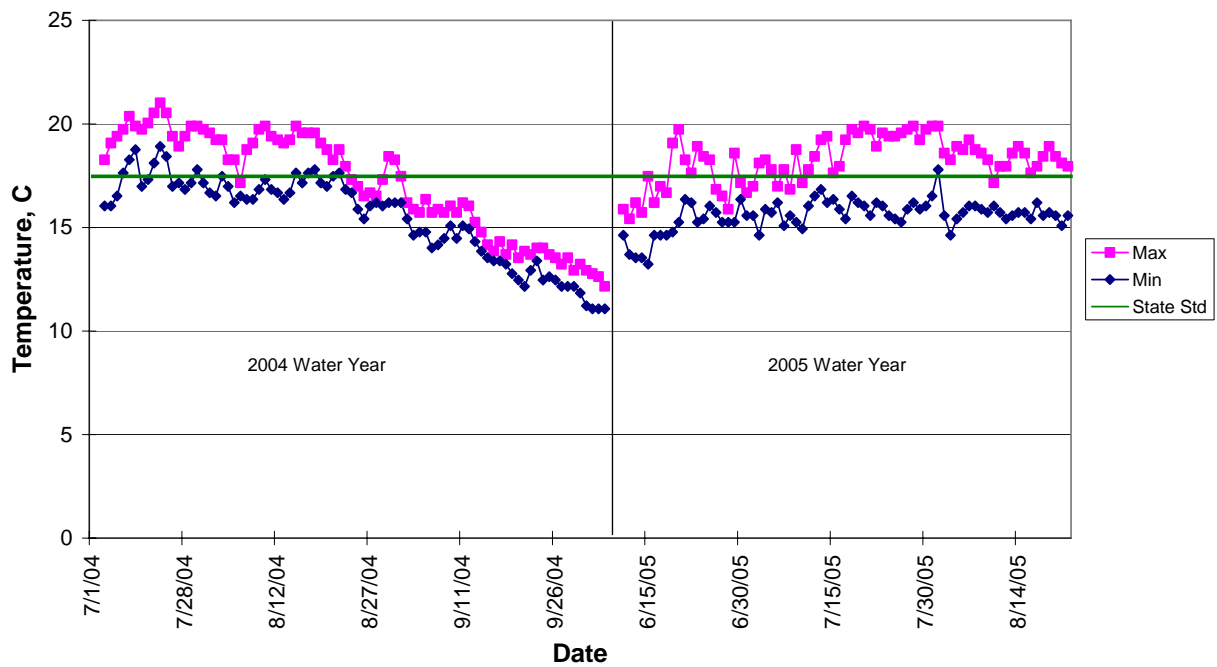
Table 3. Maximum temperature and relationship to state standards for watercourses in the Skagit County Monitoring Program, 2005 water year.

Site Number	Watercourse	Location	Daily Maximum (°C)	Maximum 7-DAM (°C)	State Std¹ (°C)
3	Thomas Ck	Old Hwy 99 N	19.9	19.7	17.5
4	Thomas Ck	F&S Grade	16.8	16.1	17.5
6	Friday Ck	Prairie Rd	20.3	19.6	17.5
8	Swede Ck	Grip Rd	18.2	17.5	17.5
11	Samish R	State Route 9	17.2	16.4	17.5
12	Nookachamps Ck	Swan Rd	N/A	N/A	17.5
13	E.F. Nookachamps Ck	State Route 9	20.7	19.8	17.5
14	College Way Ck	College Way	18.9	17.2	17.5
15	Nookachamps Ck	Knapp	21.9	21.6	17.5
16	E.F. Nookachamps Ck	Beaver Lake Rd	20.5	19.8	17.5
17	Nookachamps Ck	Big Lake Outlet	25.2	24.6	17.5
18	Lake Ck	State Route 9	18.3	17.6	17.5
19	Hansen Ck	Hoehn Rd	20.5	19.7	17.5
20	Hansen Ck	Northern State	19.5	18.9	17.5
21	Coal Ck	Hoehn Rd	18.7	17.3	16.0
22	Coal Ck	Hwy 20	N/A	N/A	16.0
23	Wiseman Ck	Minkler Rd	20.5	20.1	16.0
24	Mannser Ck	Lyman Hamilton Hwy	15.1	14.6	16.0
25	Red Cabin Ck	Hamilton Cem Rd	N/A	N/A	16.0
28	Brickyard Ck	Hwy 20	N/A	N/A	17.5
29	Skagit R	River Bend Rd	N/A	N/A	17.5
30	Skagit R	Cape Horn Rd	N/A	N/A	16.0
31	Drain Dist 20 floodgate	Francis Rd	N/A	N/A	17.5
32	Samish R	Thomas Rd	19.8	19.1	17.5
33	Alice Bay Pump Station	Samish Island Rd	28.2	26.2	17.5
34	Noname Slough	Bayview-Edison Rd	23.7	22.4	17.5
35	Joe Leary Slough	D'Arcy Rd	20.5	19.5	17.5
36	Edison Slough at school	W. Bow Hill Rd	31.4	29.8	17.5
37	Edison Pump Station	Farm to Market Rd	28.6	27.1	17.5
38	North Edison Pump St.	North Edison Rd	N/A	N/A	17.5
39	Colony Ck	Colony Rd	19.5	19.0	17.5
40	Big Indian Slough	Bayview-Edison Rd	20.4	20.2	17.5
41	Maddox Slough/Big Ditch	Milltown Rd	N/A	N/A	17.5
42	Hill Ditch	Cedardale Rd	24.4	23.8	17.5
43	Wiley Slough	Wylie Rd	N/A	N/A	17.5
44	Sullivan Slough	La Conner-Whitney Rd	23.3	22.6	17.5
45	Skagit R – North Fork	Moore Rd	18.7	18.3	17.5
46	Skagit R – South Fork	Fir Island Rd	N/A	N/A	17.5
47	Swinomish Channel	County Boat Launch	N/A	N/A	16.0
48	Fisher Ck	Franklin Rd	15.1	14.5	17.5

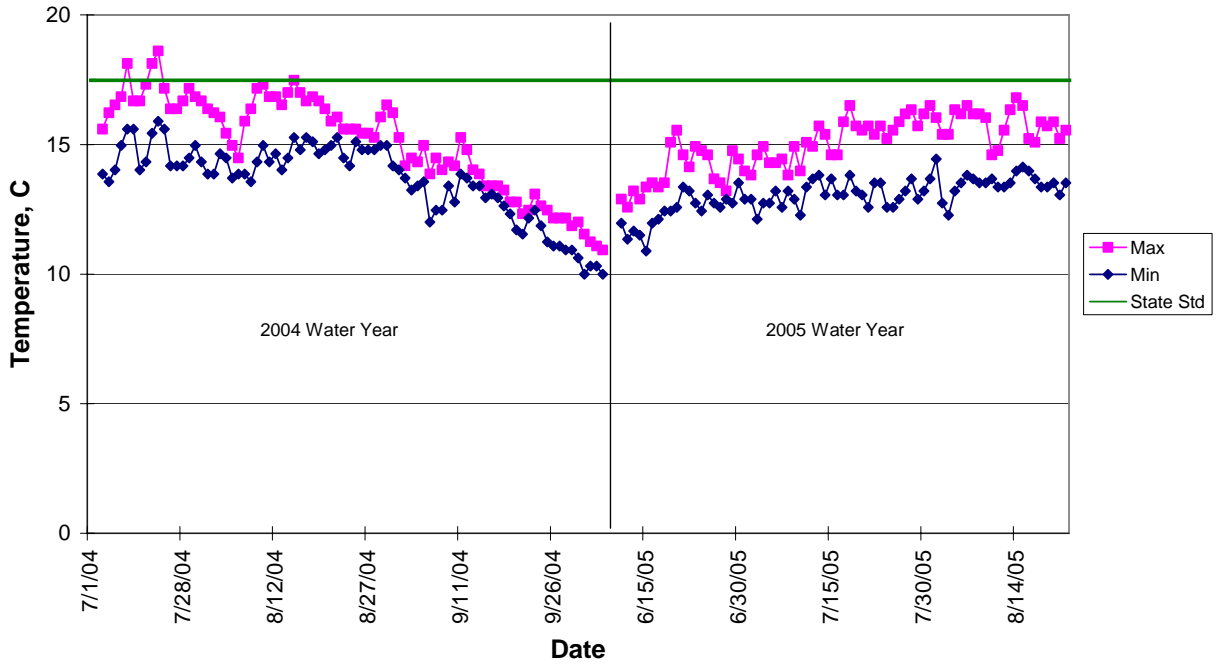
¹Washington State Water Quality Standard per WAC 173-201A

Graphs on the following pages illustrate daily temperature maximums and minimums for the sample sites with temperature data in the Skagit County Monitoring Program. Each graph shows daily high and low temperatures and a line representing the state water quality standard for that water body. The state standard is actually based on the 7-day average maximum temperature, so individual readings over the standard may not constitute a water quality standards violation.

Thomas Creek at Hwy 99 - Site 3 Temperature



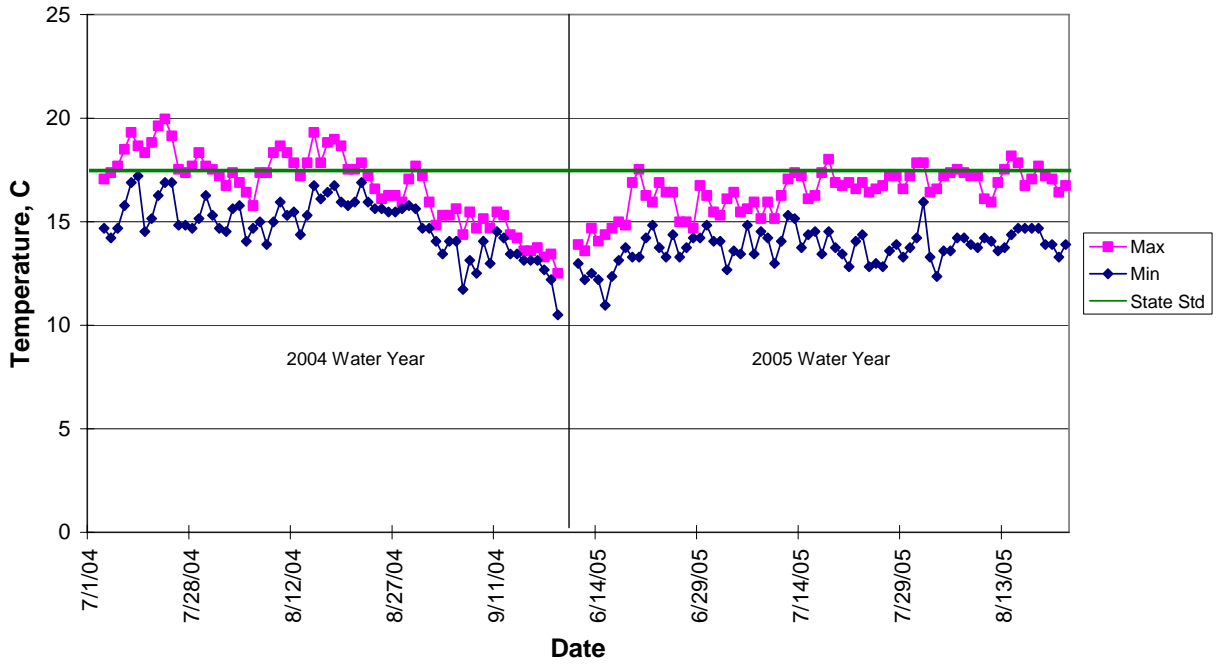
Thomas Creek at F&S Grade Rd - Site 4 Temperature



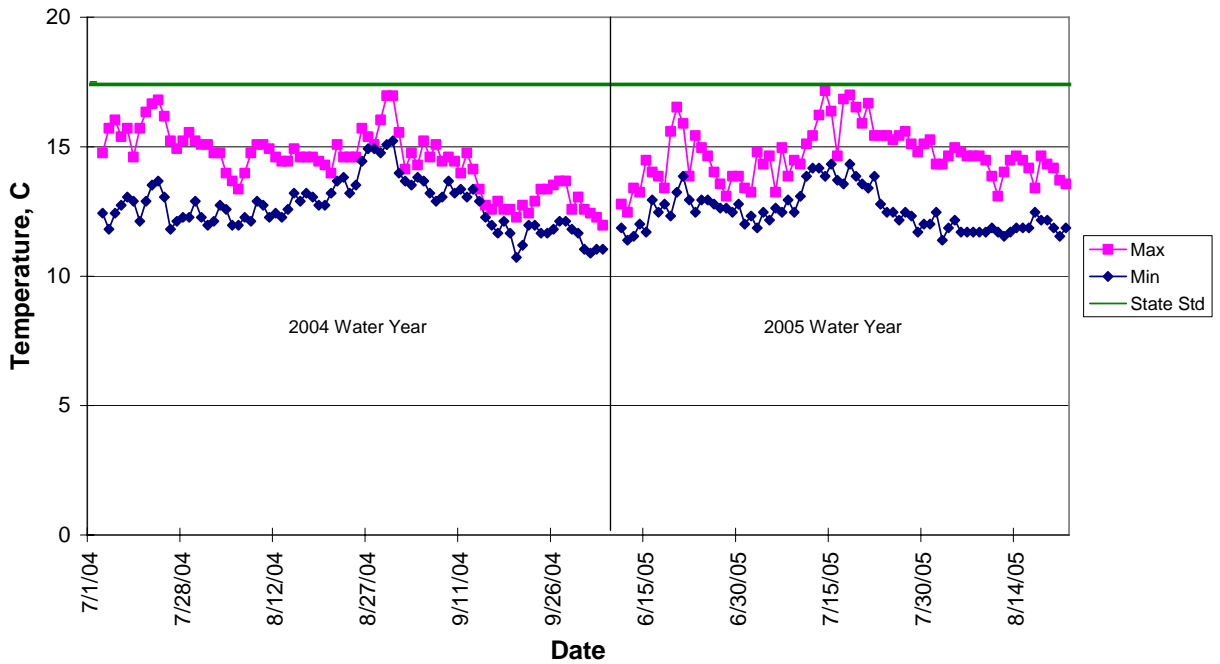
Friday Creek at Prairie Rd - Site 6 Temperature



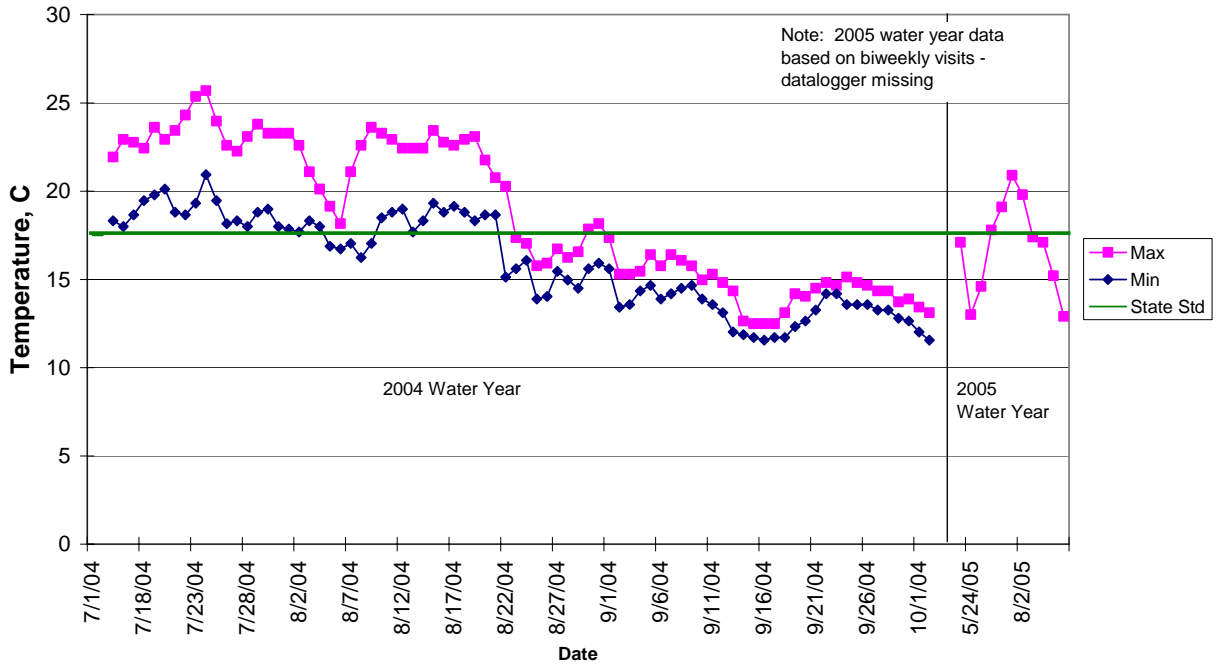
Swede Creek at Grip Rd - Site 8 Temperature



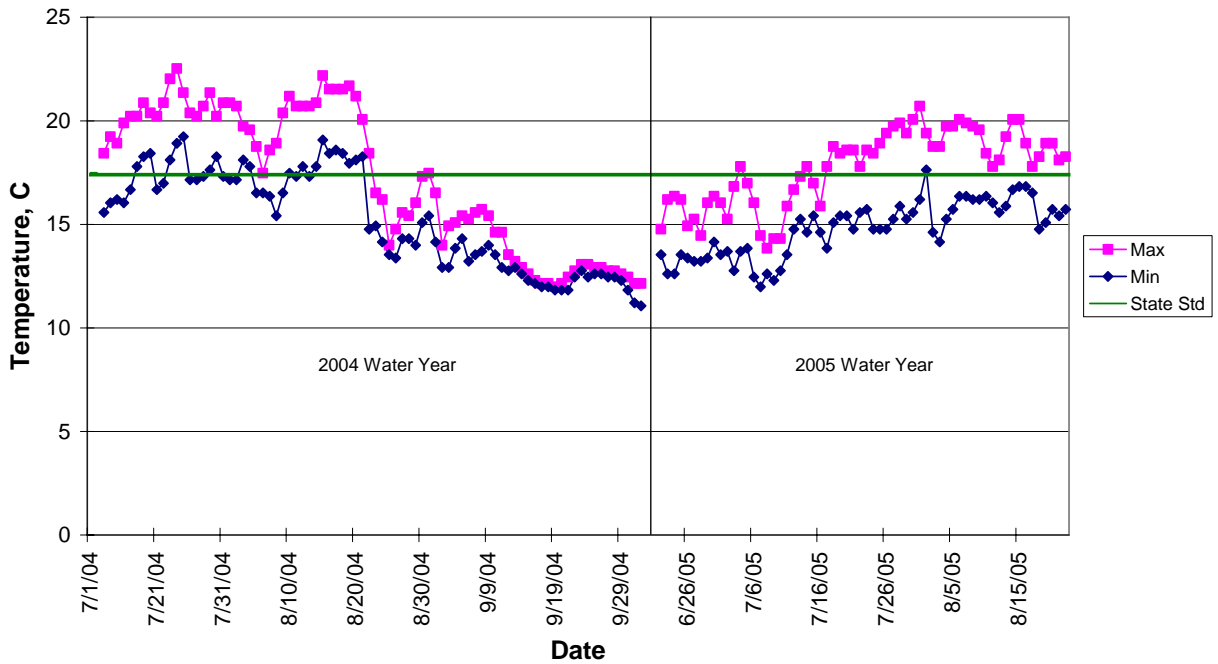
Samish River at Hwy 9 - Site 11 Temperature



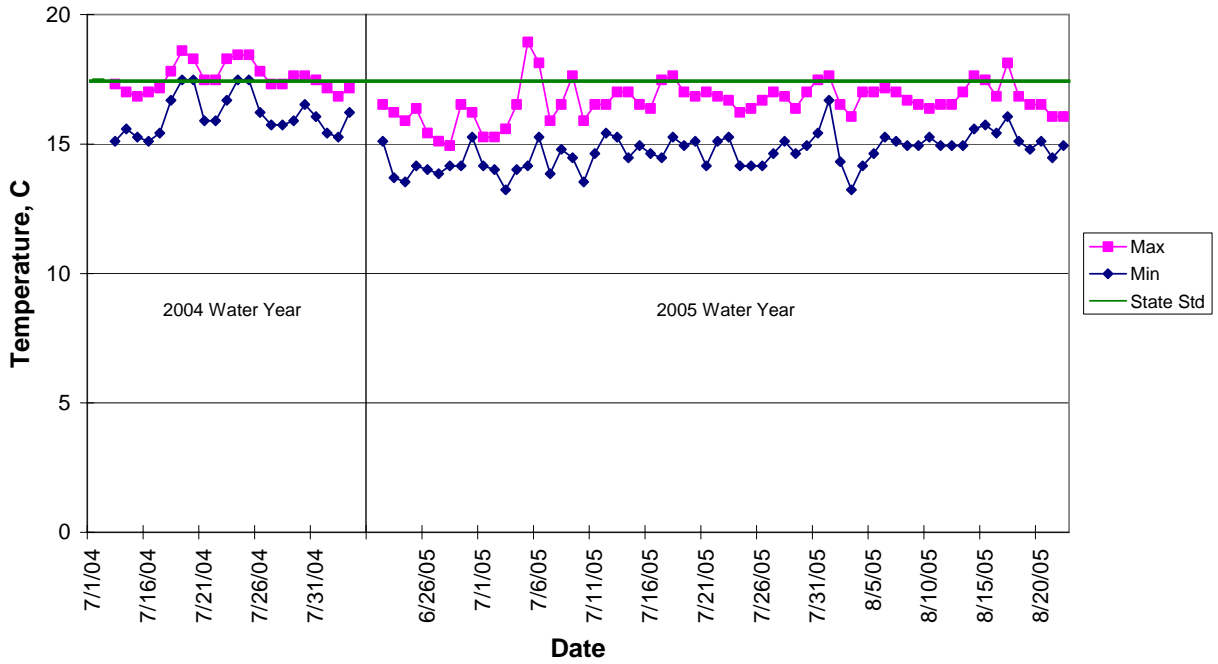
Nookachamps Creek at Swan Rd - Site 12 Temperature



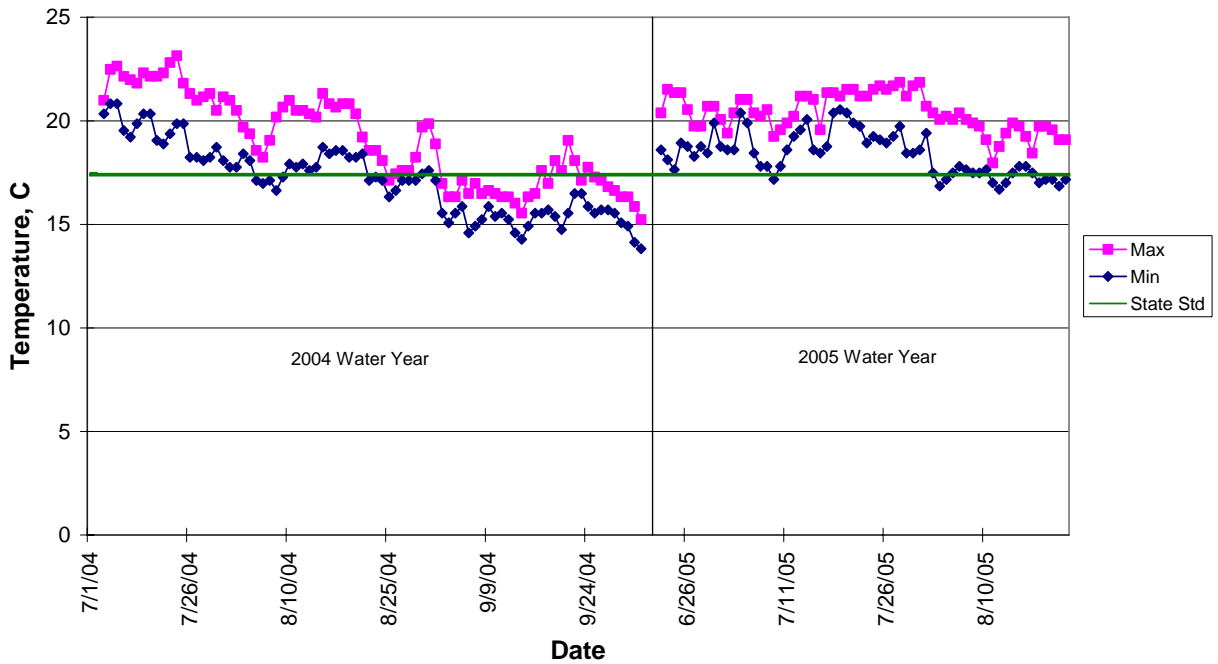
EF Nookachamps Creek at Hwy 9 - Site 13 Temperature



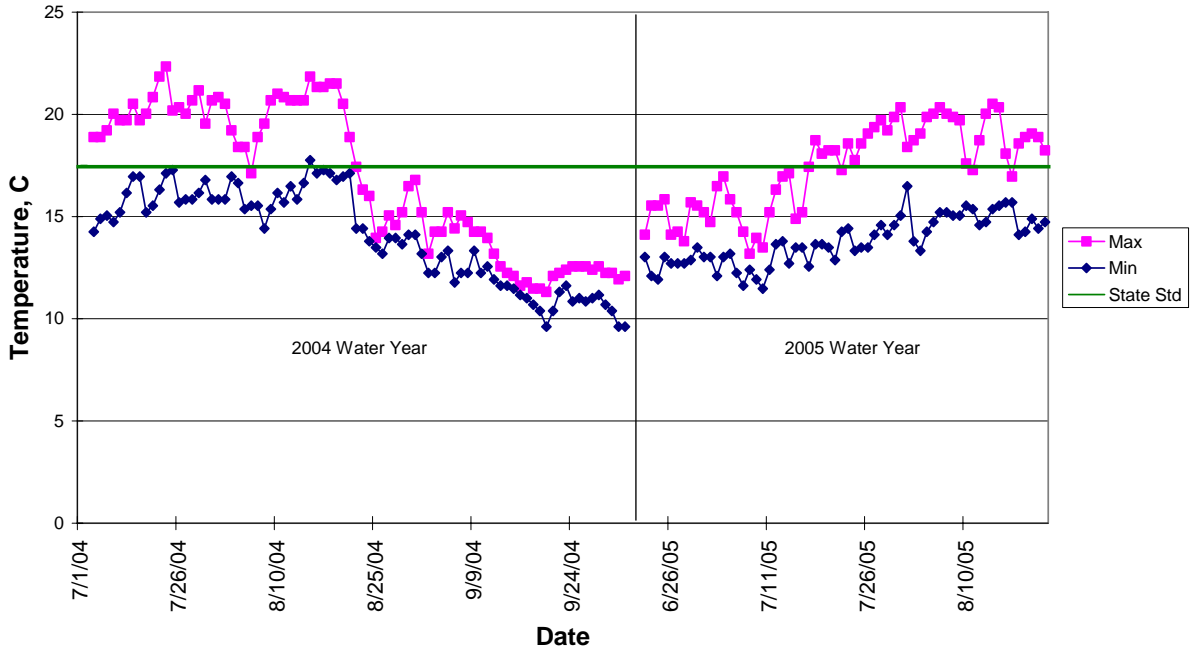
College Way Creek at College Way - Site 14 Temperature



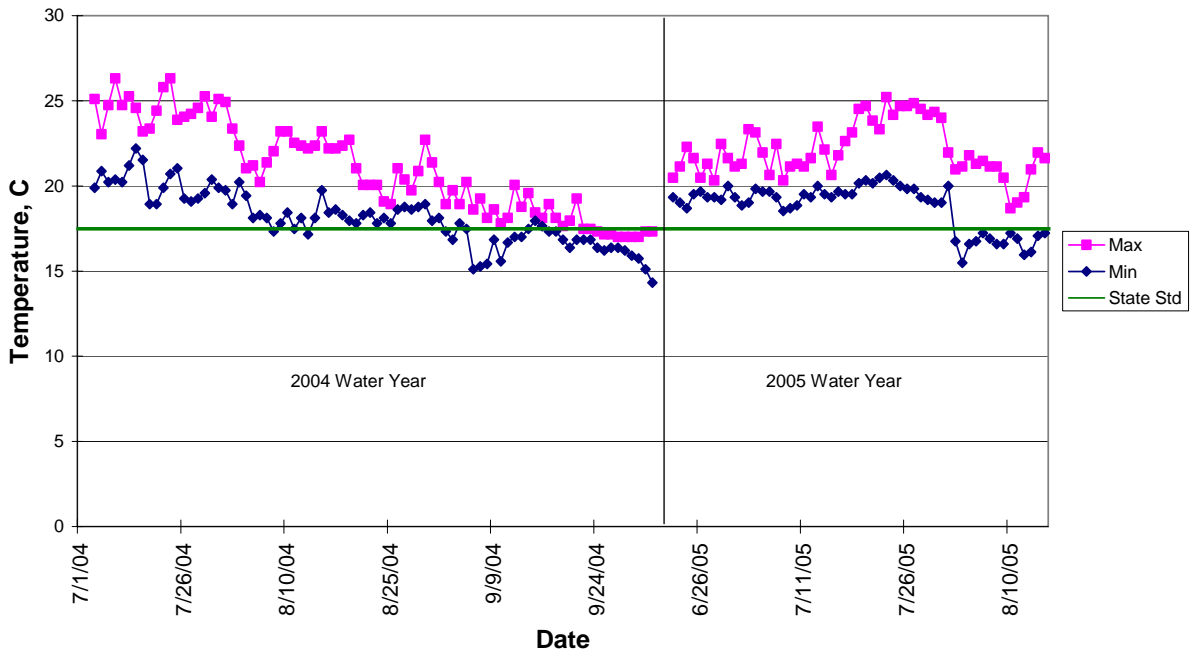
Nookachamps Creek at Knapp Rd - Site 15 Temperature



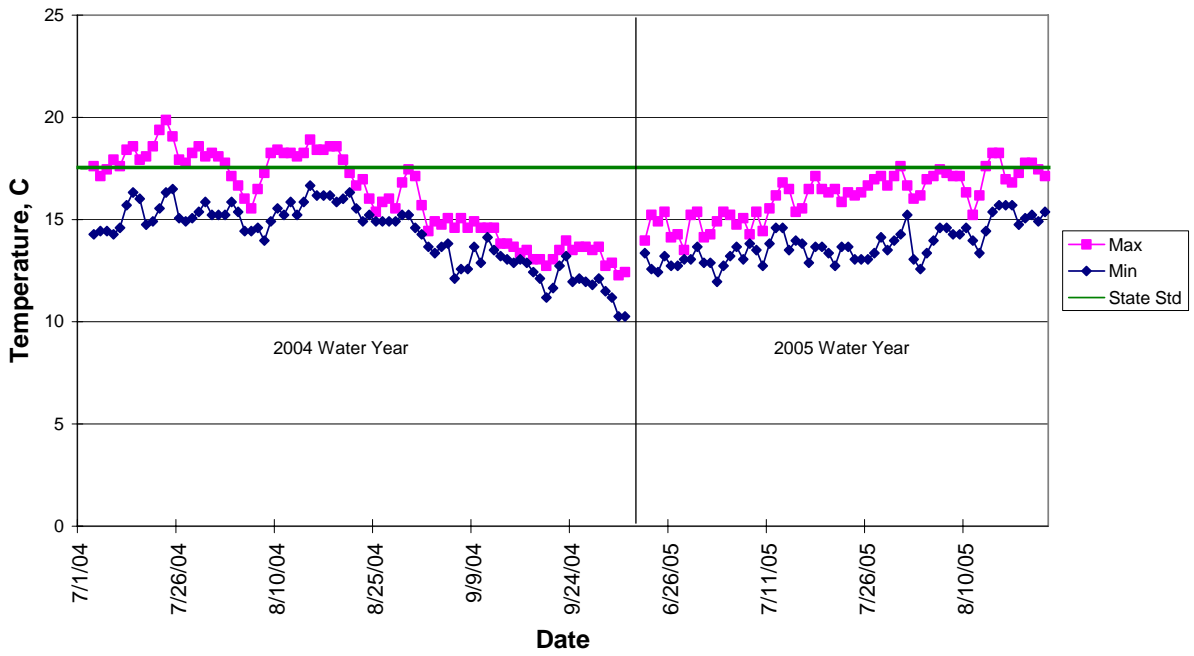
EF Nookachamps Creek at Beaver Lk Rd - Site 16 Temperature



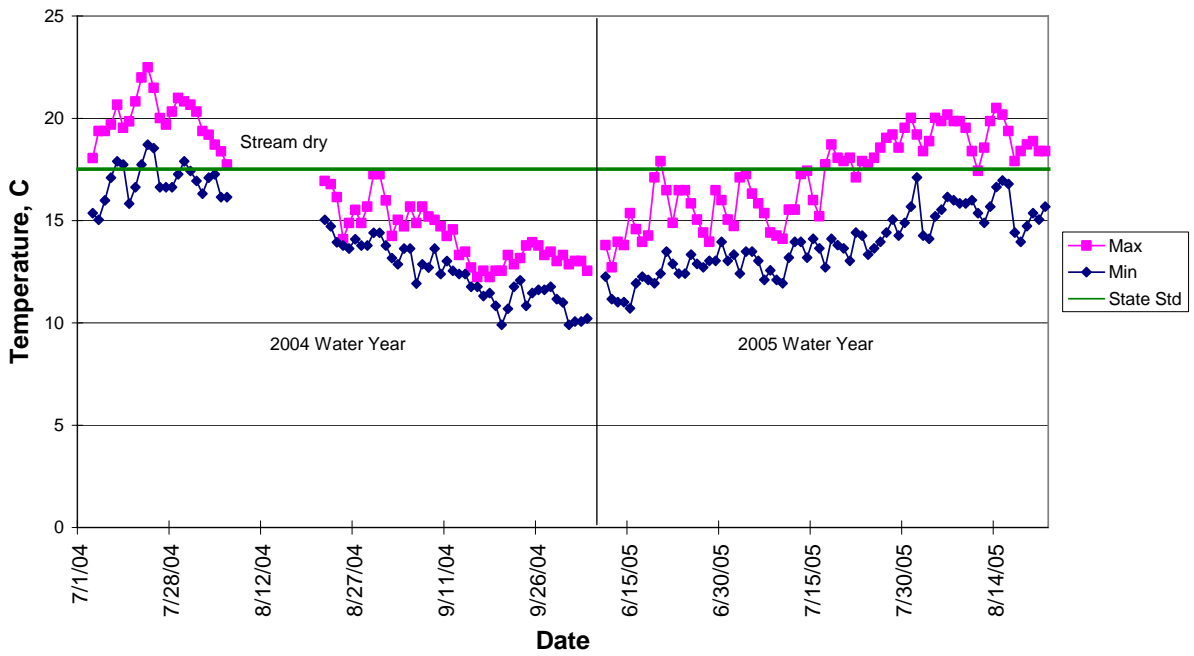
Nookachamps Creek at Big Lake Outlet - Site 17 Temperature



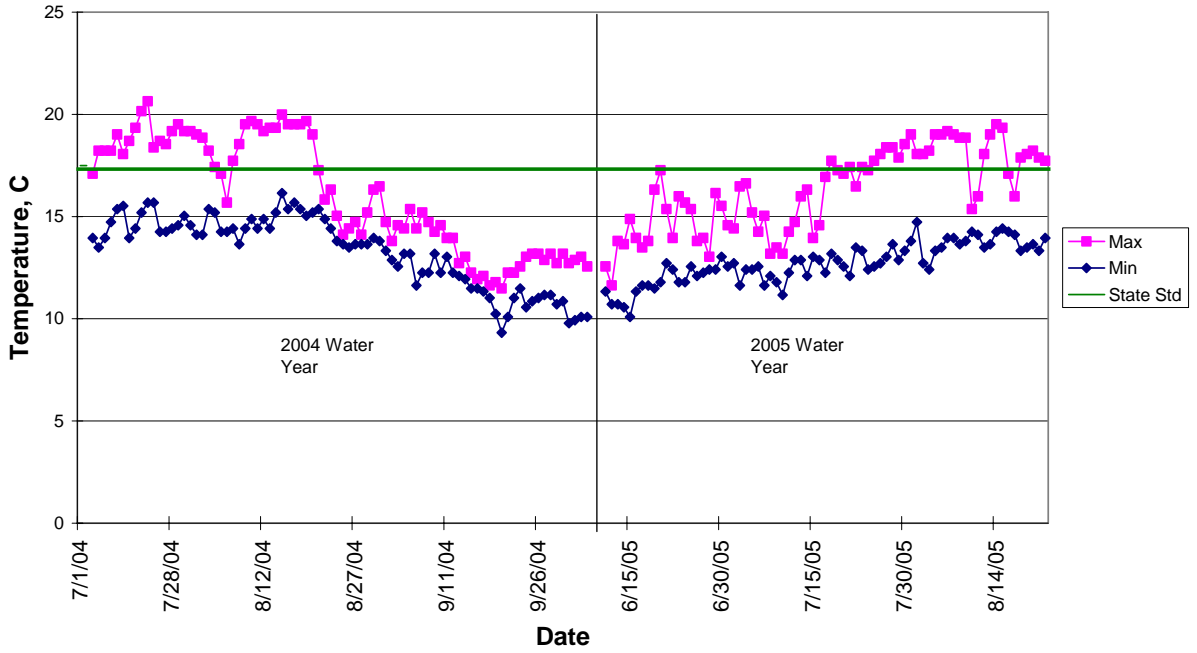
Lake Creek at Hwy 9 - Site 18 Temperature



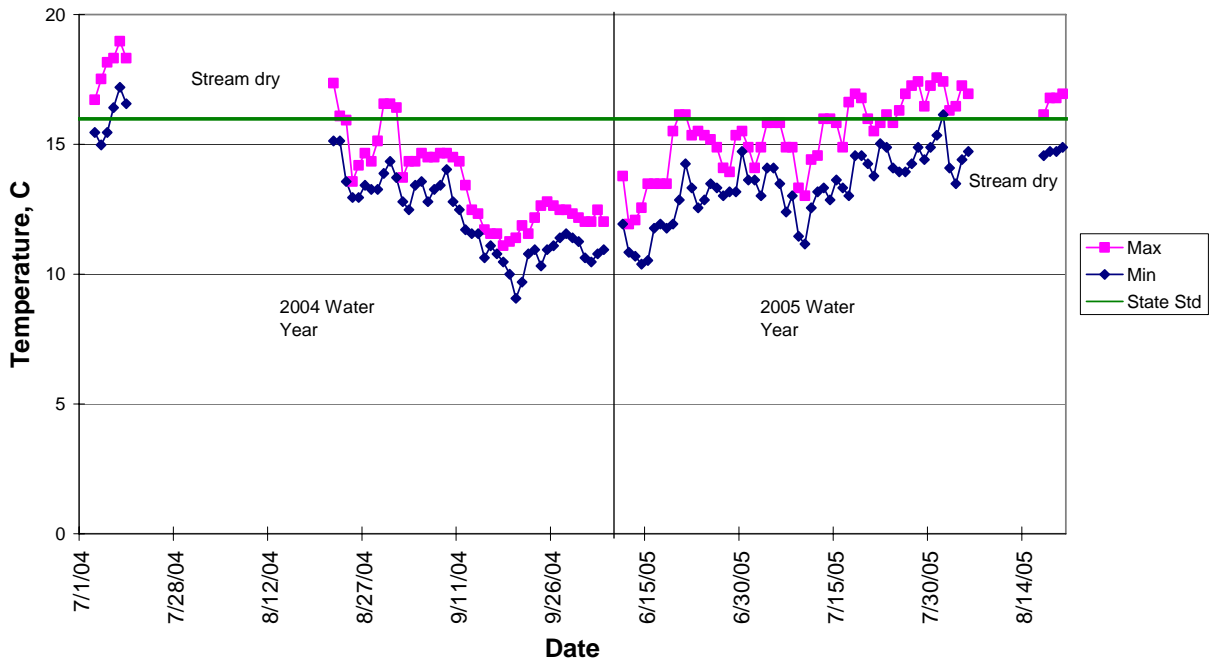
Hansen Creek at Hoehn Rd - Site 19 Temperature



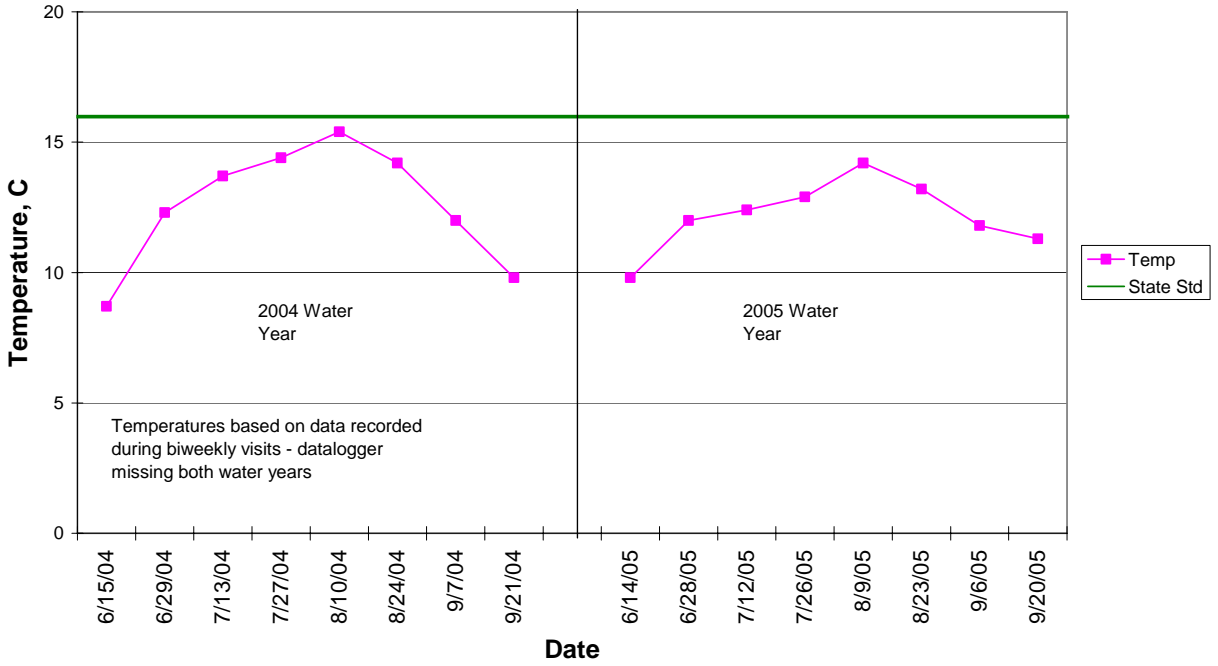
Hansen Creek at Northern State Hospital - Site 20 Temperature



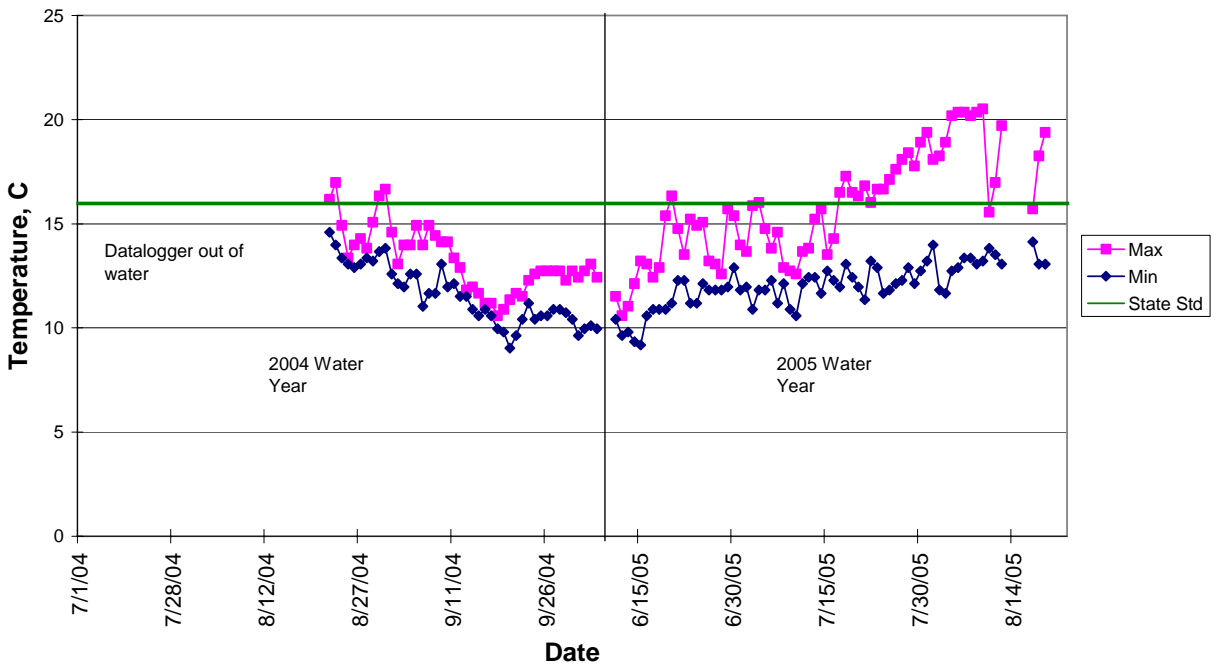
Coal Creek at Hoehn Rd - Site 21 Temperature



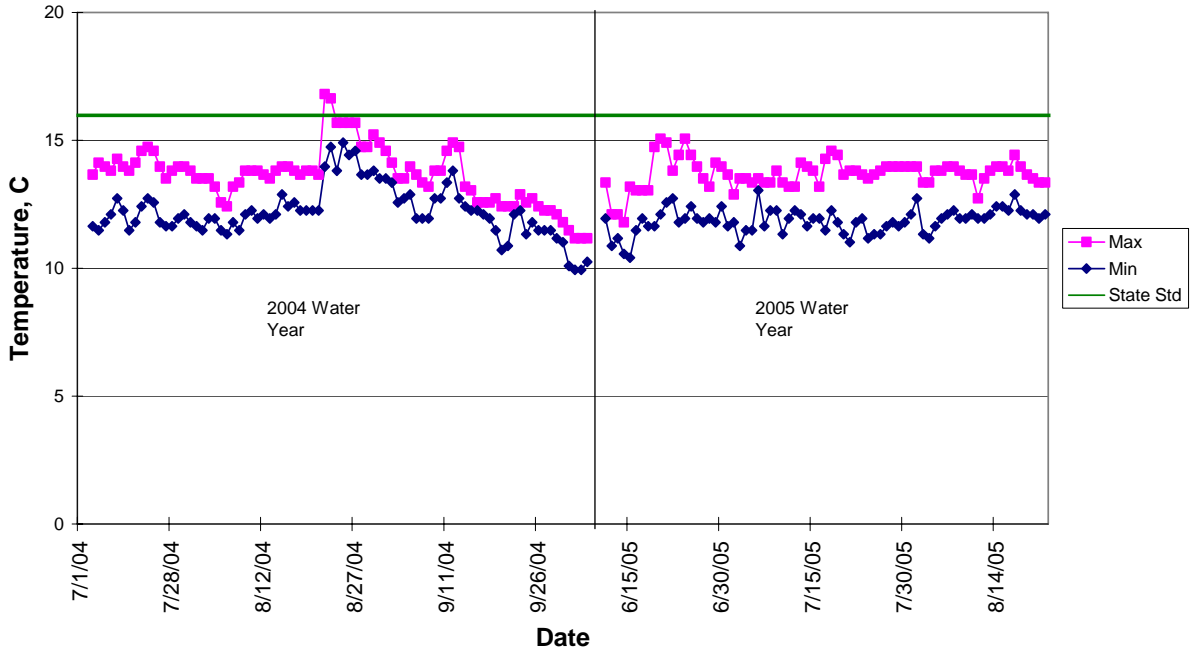
Coal Creek at Hwy 20 - Site 22 Temperature



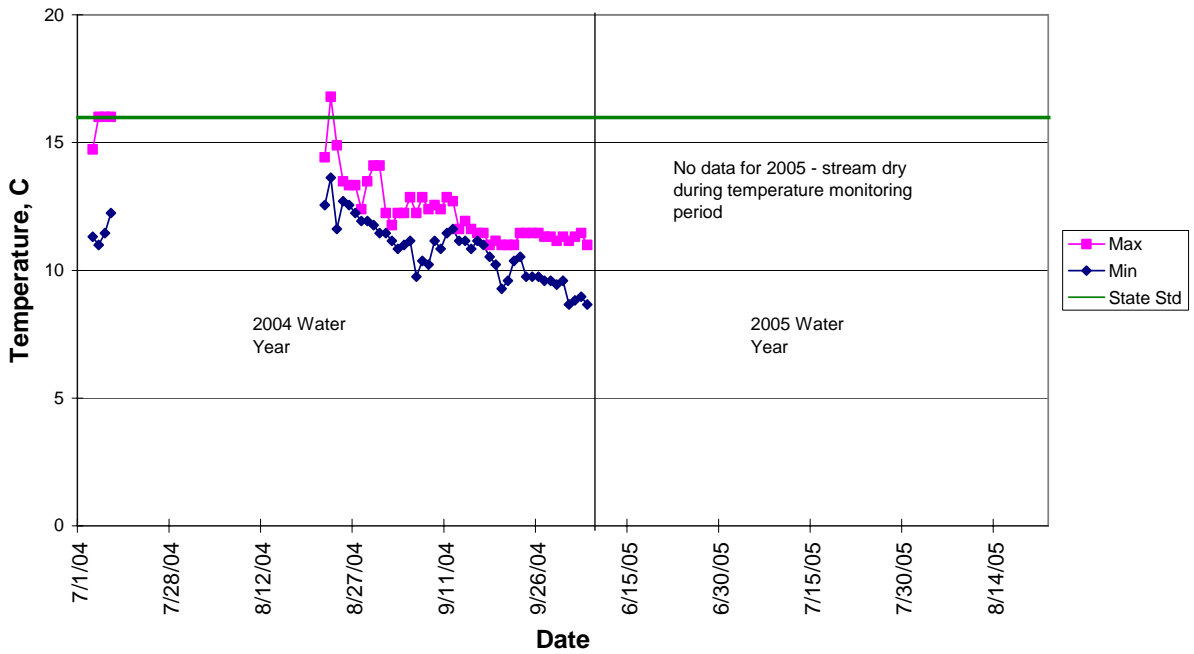
Wiseman Creek at Minkler Rd - Site 23 Temperature



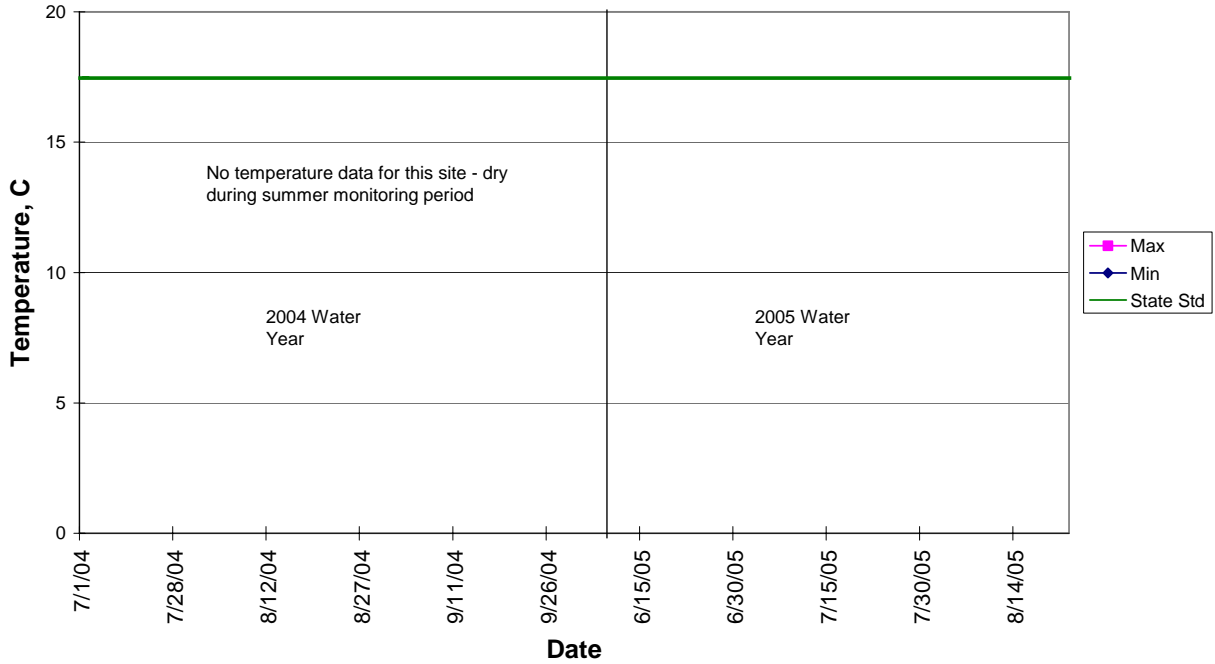
Mannser Creek at Lyman-Hamilton Hwy - Site 24 Temperature



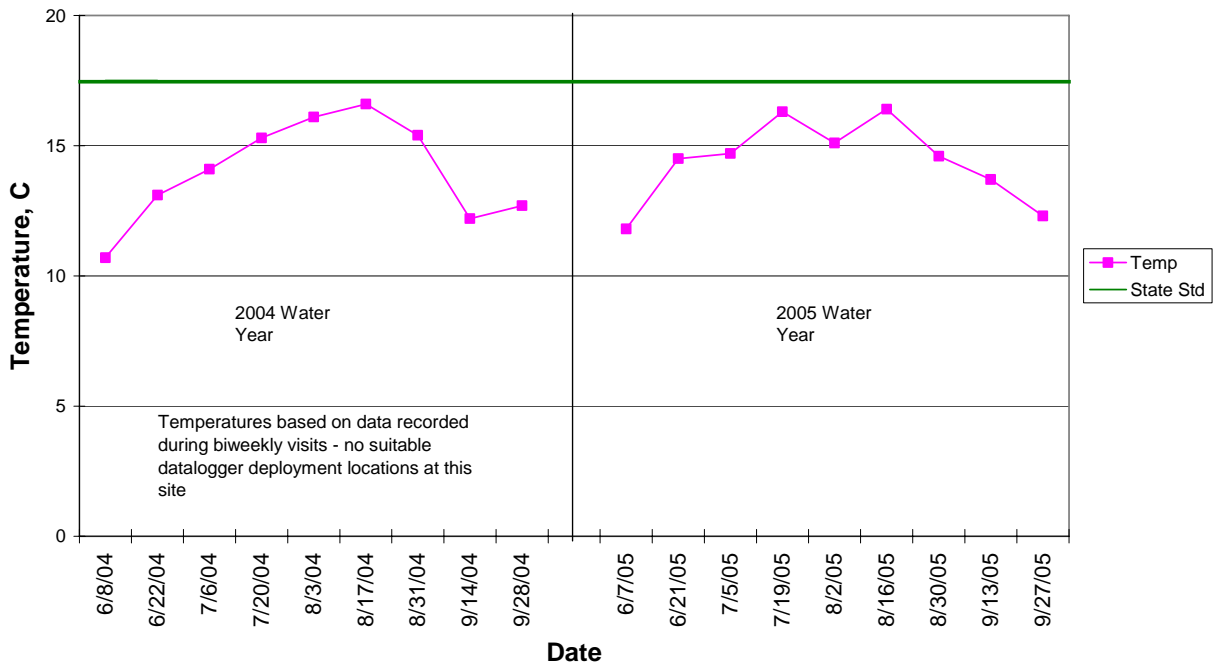
Red Cabin Creek at Hamilton Cemetery Rd - Site 25 Temperature



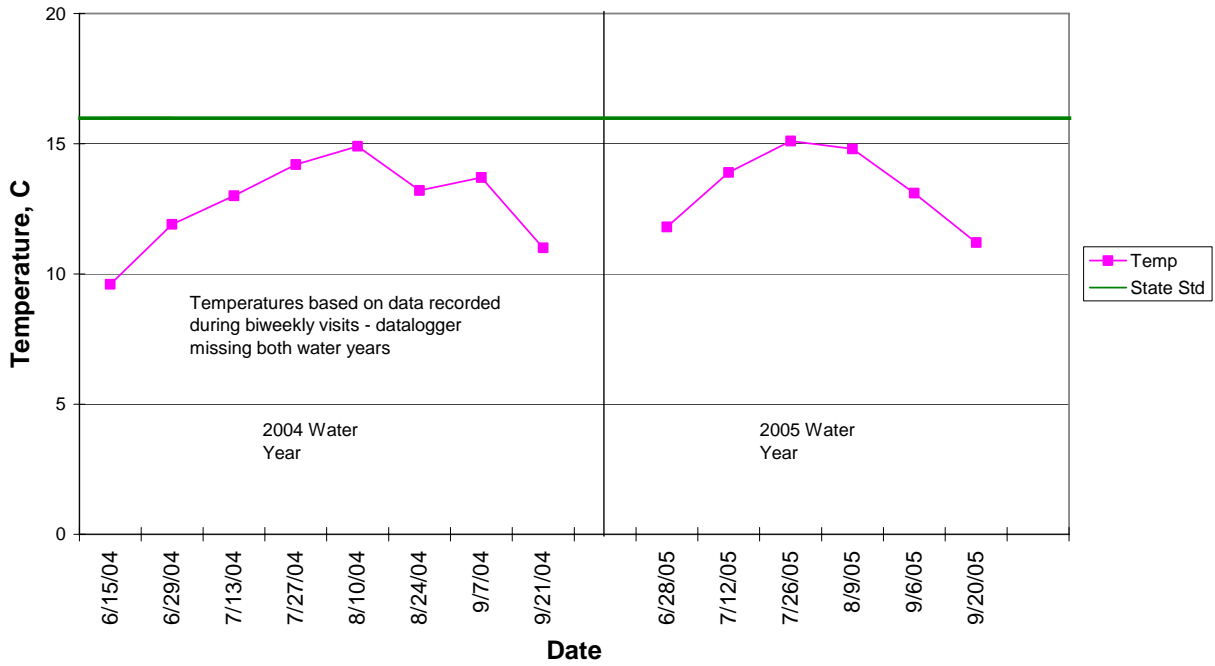
Brickyard Creek at Hwy 20 - Site 28 Temperature



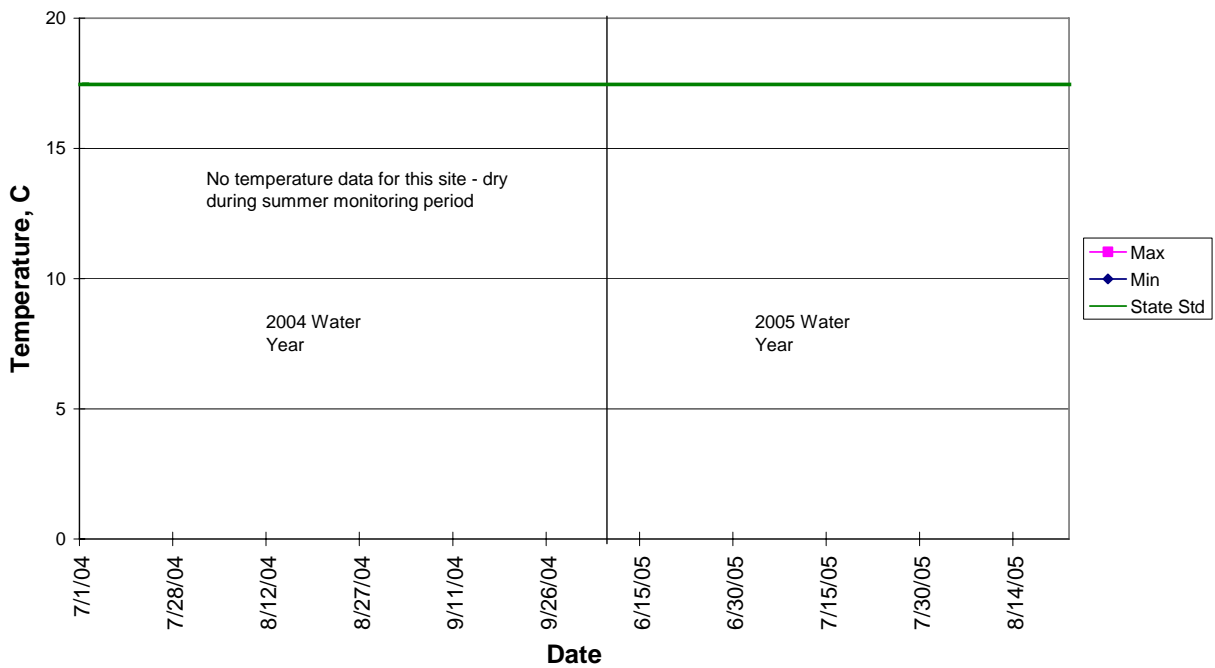
Skagit River at River Bend Rd - Site 29 Temperature



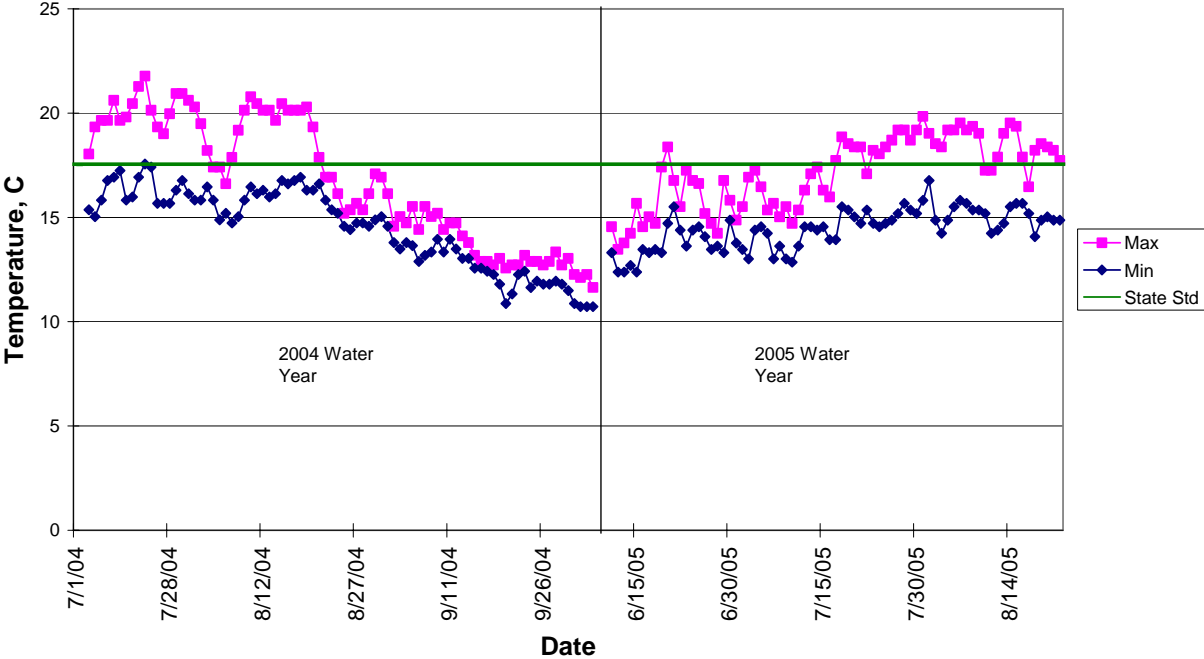
Skagit River at Cape Horn Rd - Site 30 Temperature



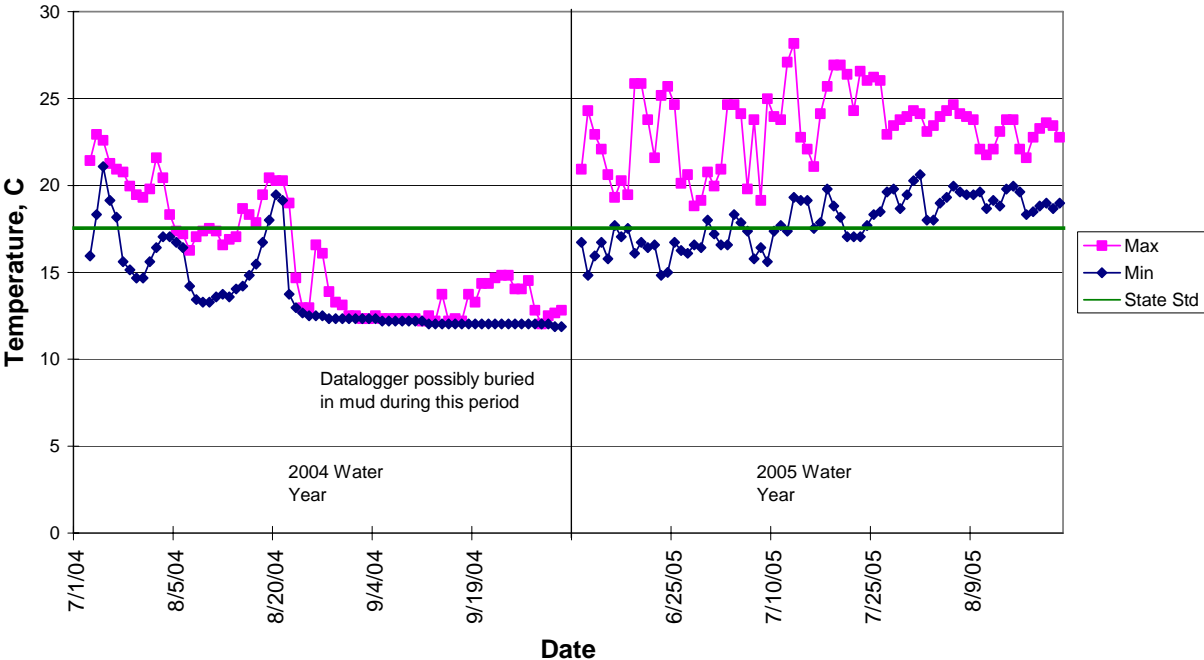
Drainage District 20 Ditch at Floodgate - Site 31 Temperature



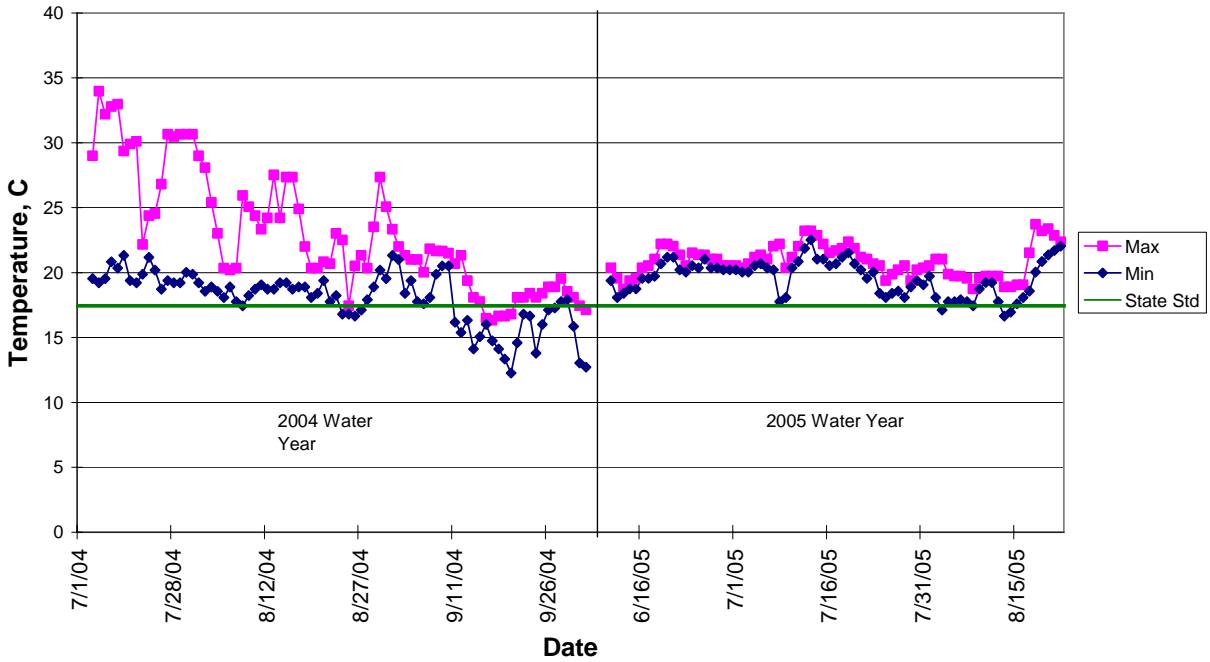
Samish River at Thomas Rd - Site 32 Temperature



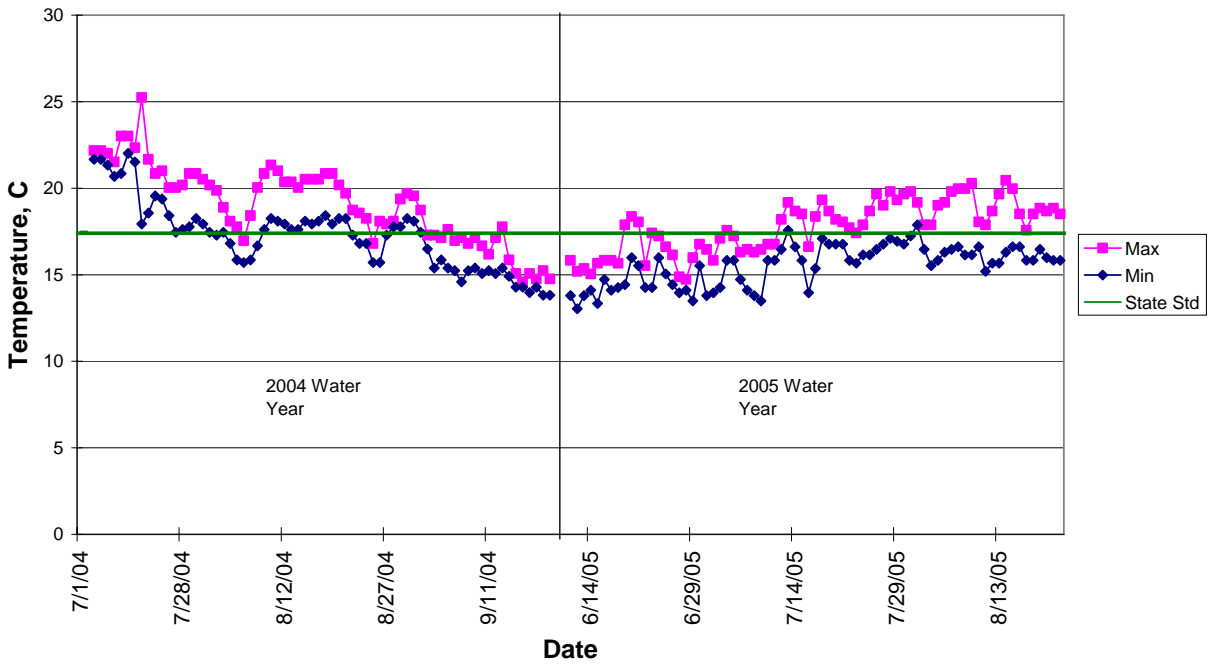
Alice Bay Pump Station - Site 33 Temperature



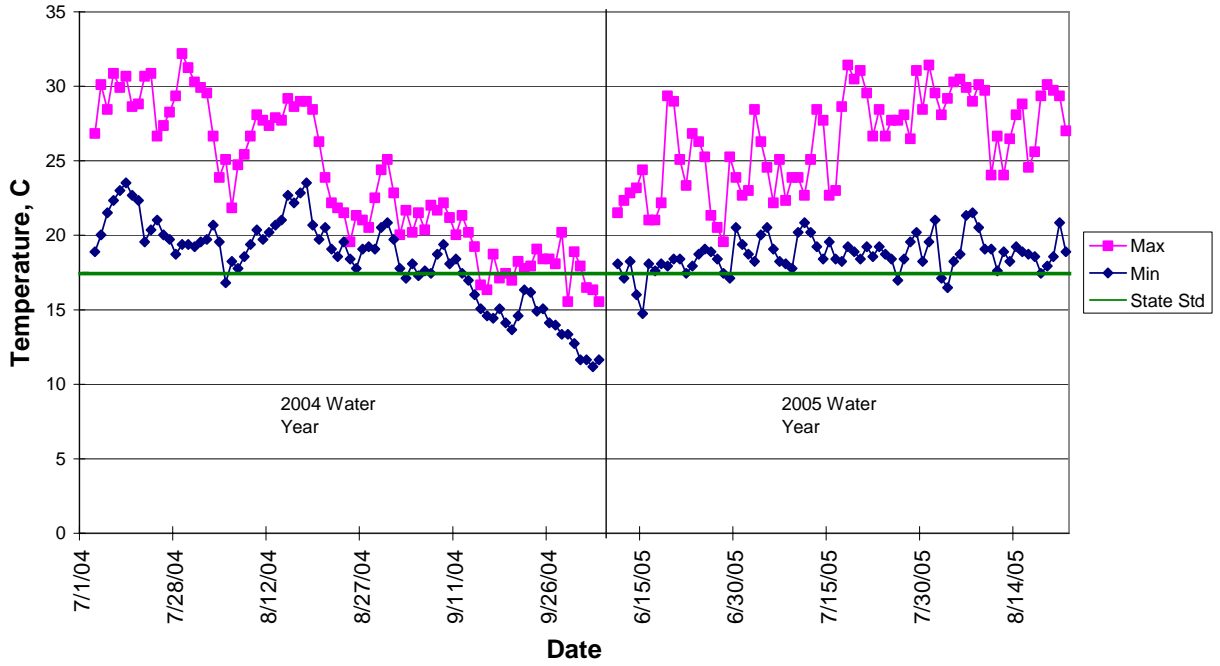
No Name Slough at Bayview-Edison Rd - Site 34 Temperature



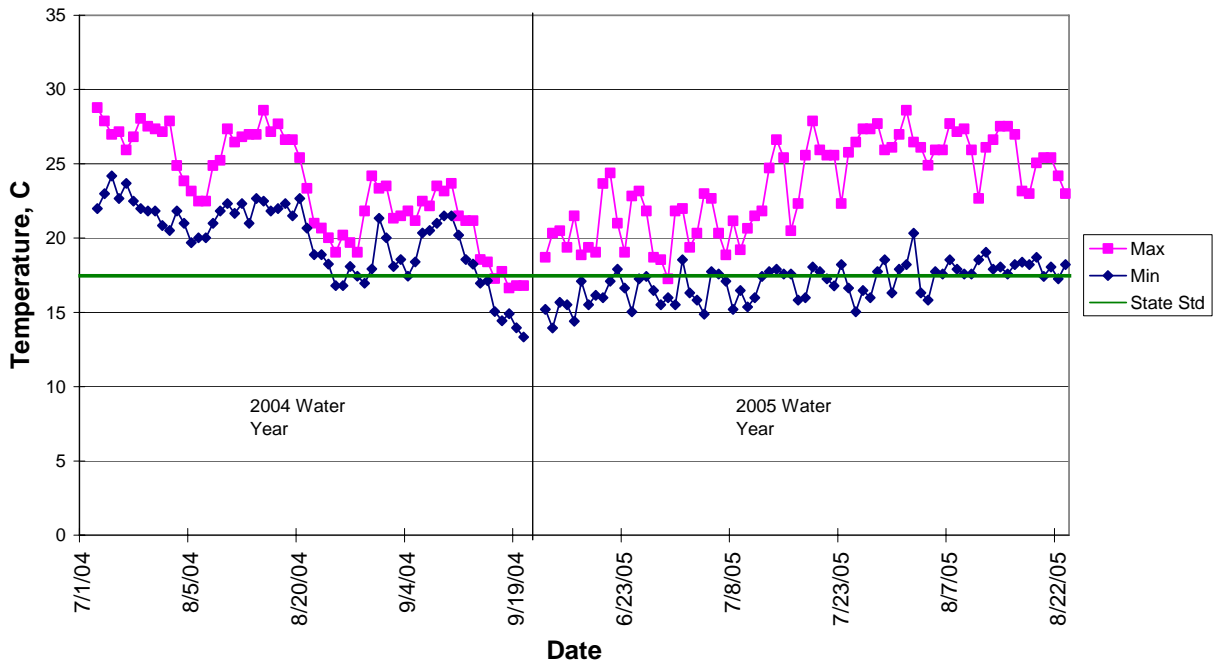
Joe Leary Slough at D'Arcy Rd - Site 35 Temperature



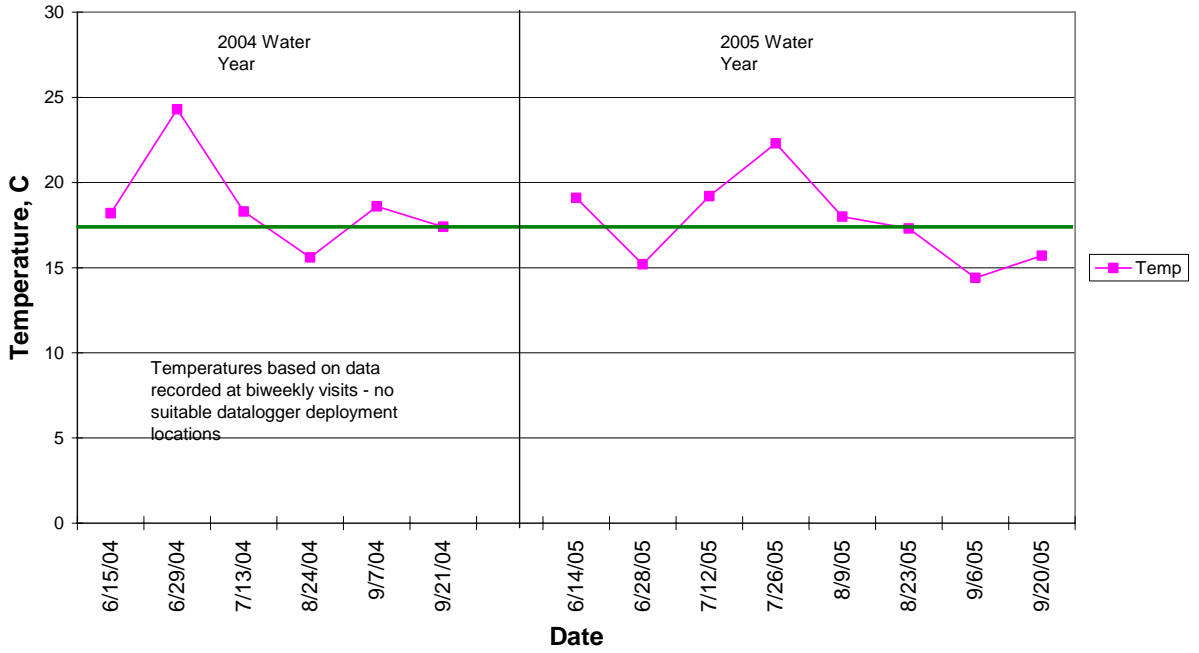
Edison Slough at School - Site 36 Temperature



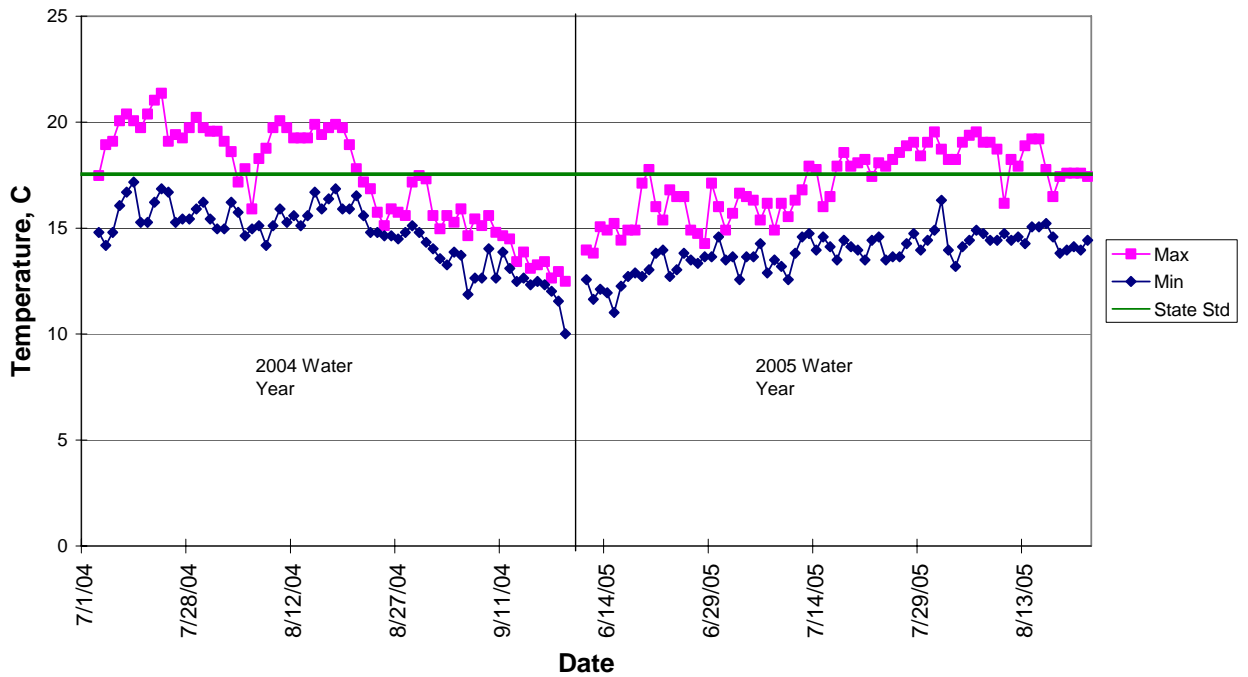
Edison Pump Station - Site 37 Temperature



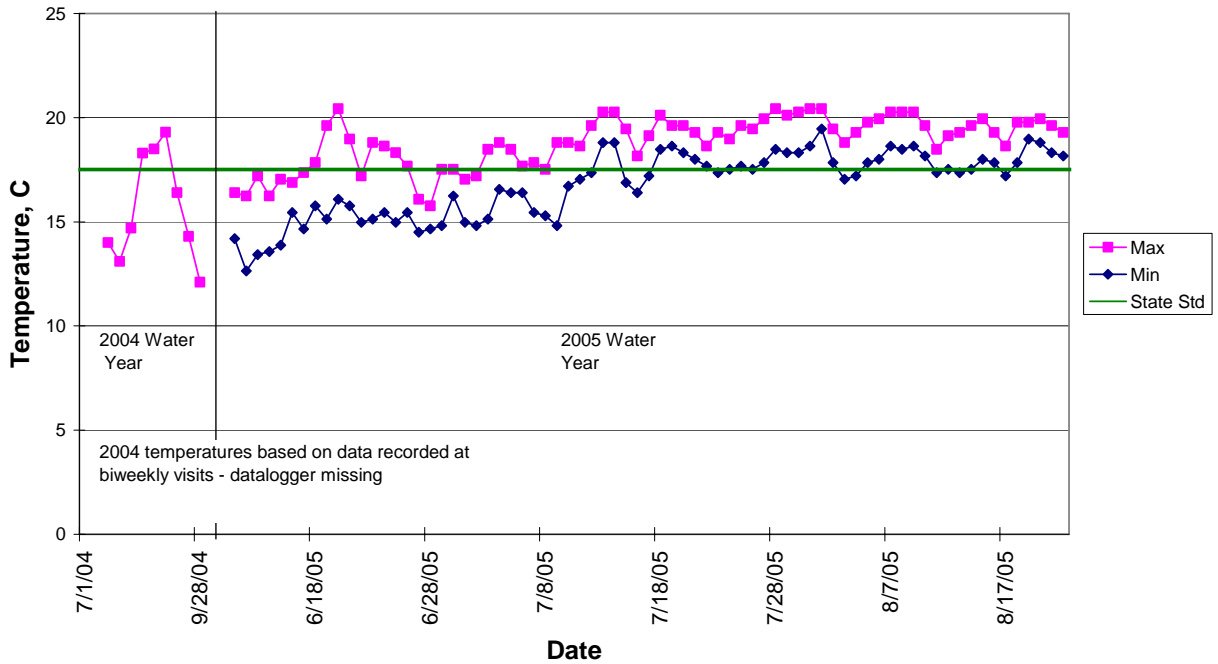
North Edison Pump Station - Site 38 Temperature



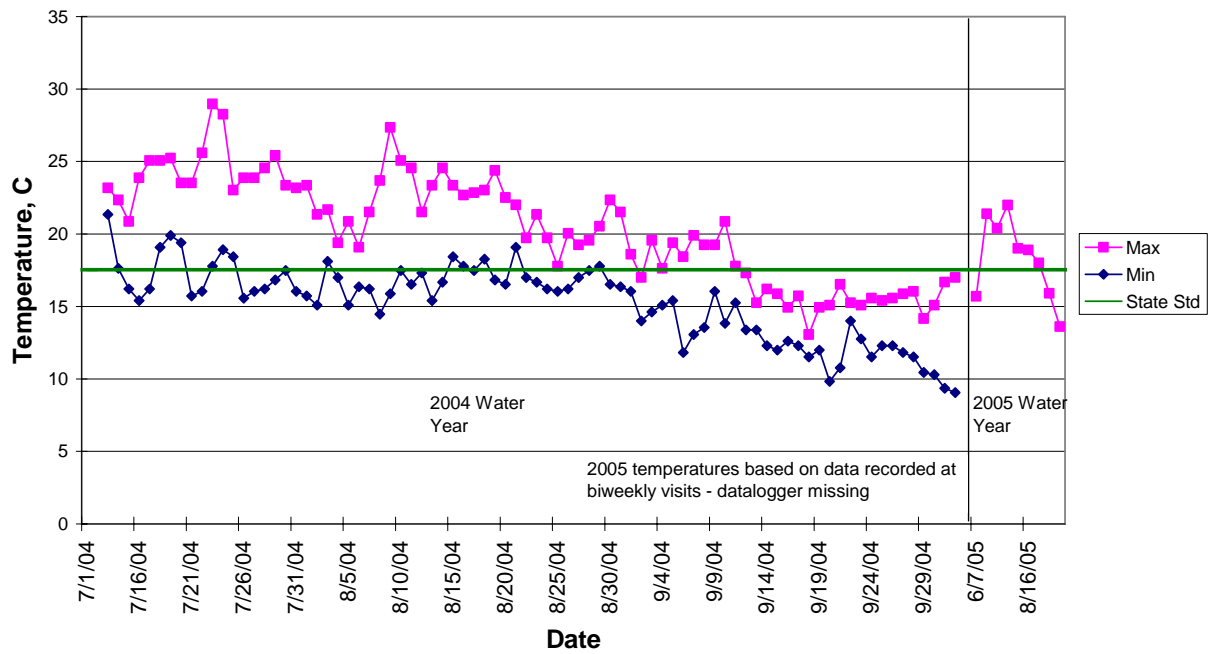
Colony Creek at Colony Rd - Site 39 Temperature



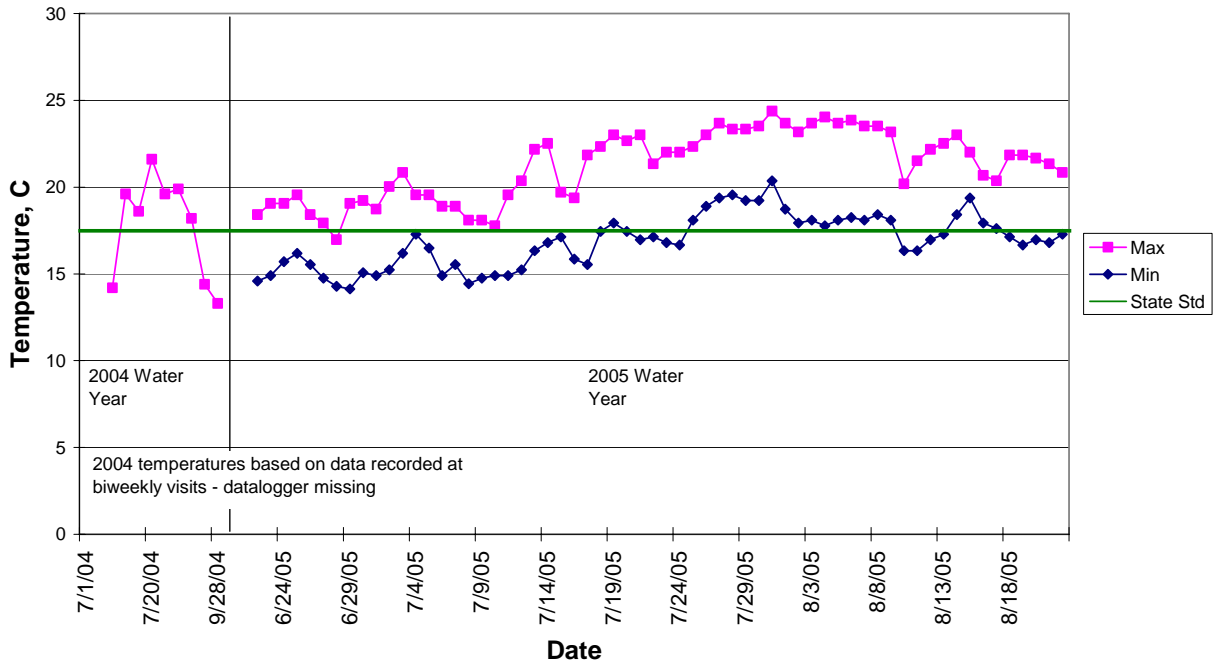
Big Indian Slough at Hwy 20 Truck Scales - Site 40 Temperature



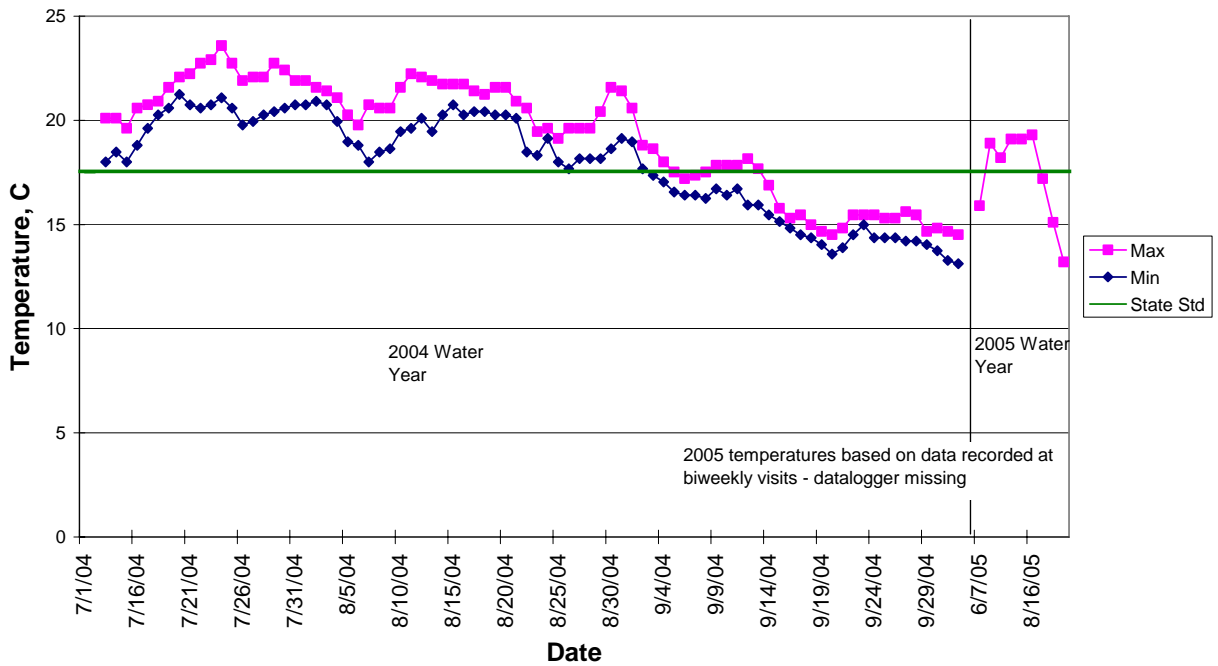
Maddox Creek / Big Ditch at Milltown Rd - Site 41 Temperature



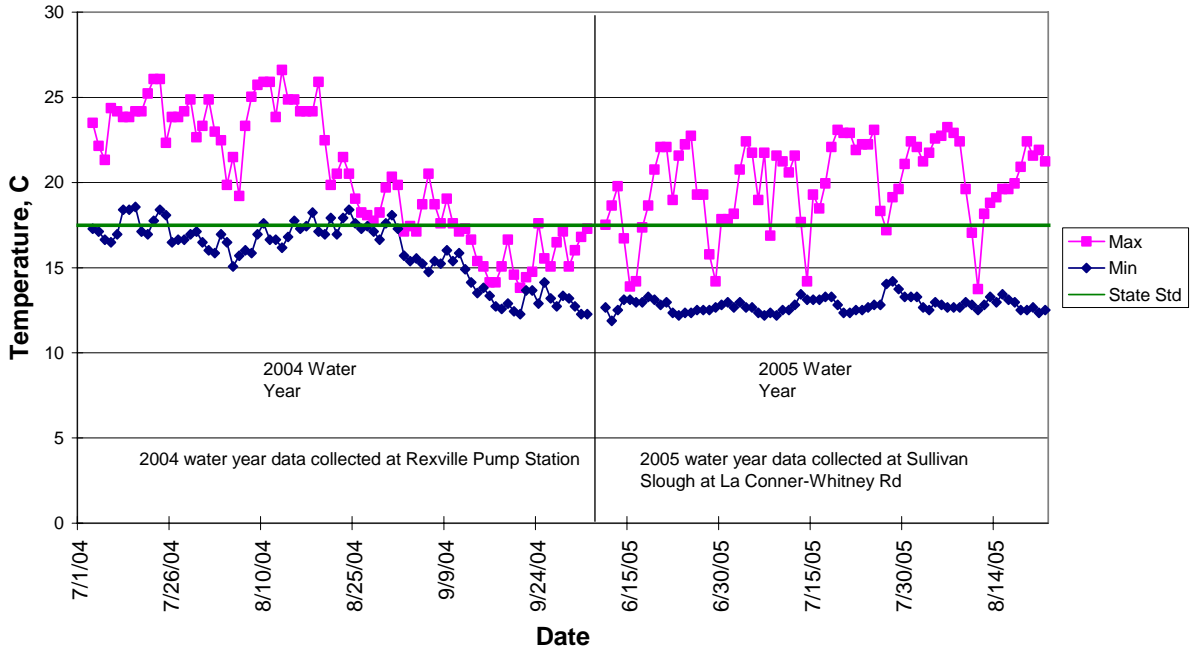
Carpenter Creek/Hill Ditch at Cedardale Rd - Site 42 Temperature



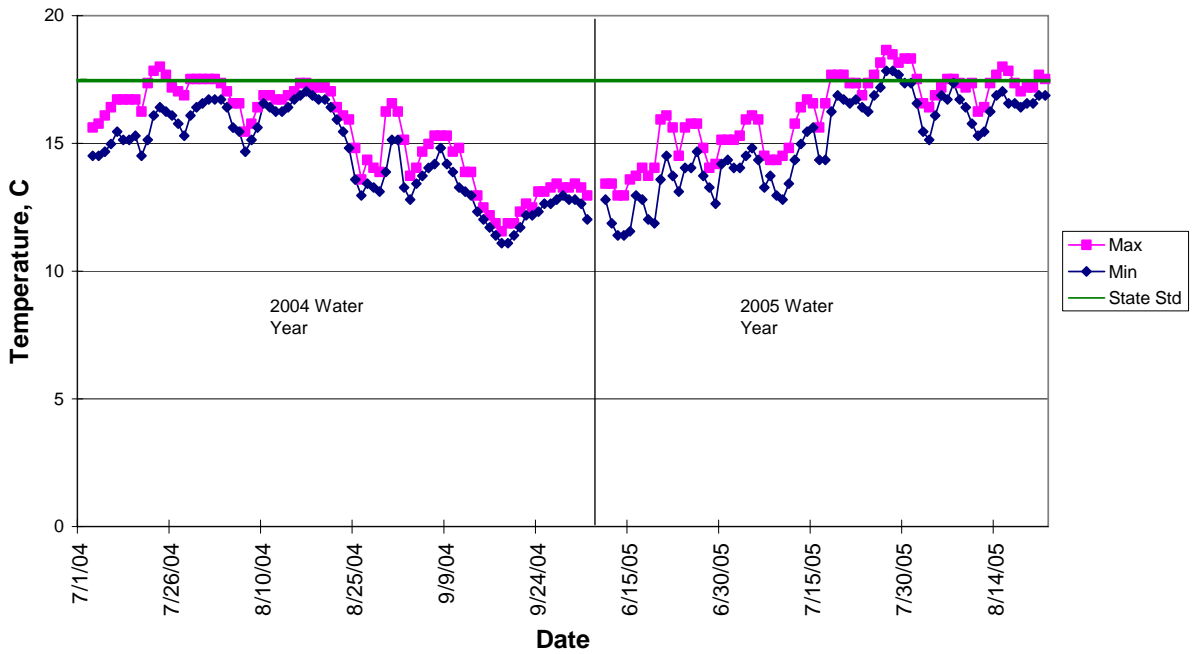
Wiley Slough at Wylie Rd - Site 43 Temperature



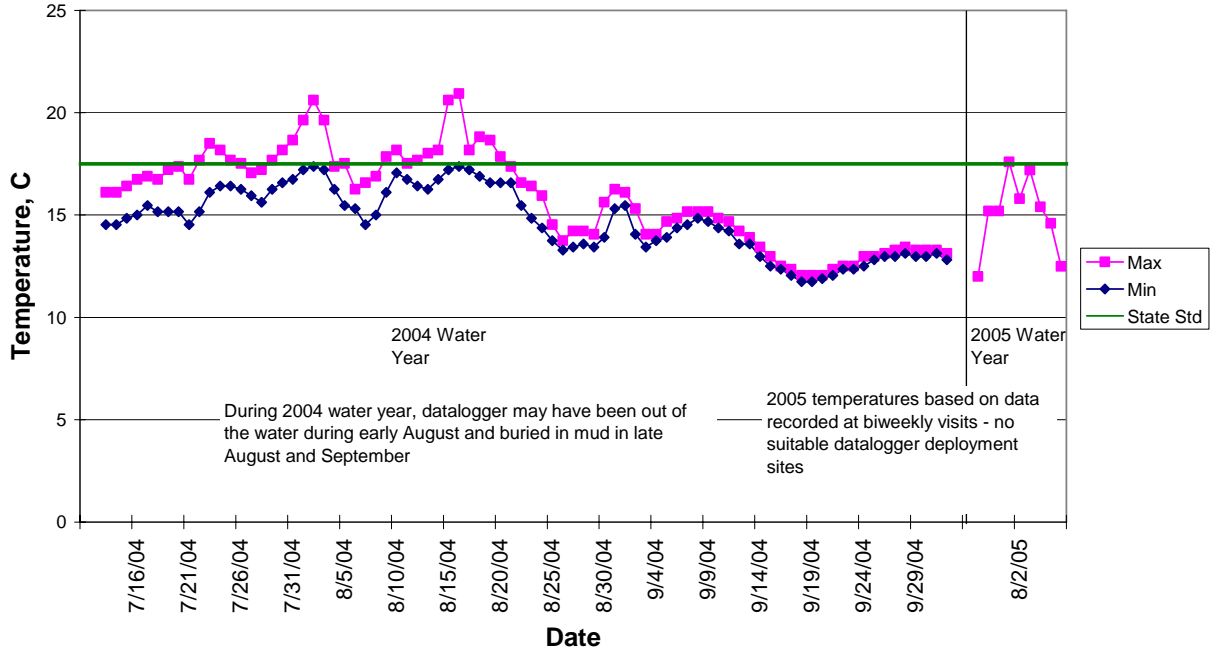
Rexville Pump Station/Sullivan Slough - Site 44 Temperature



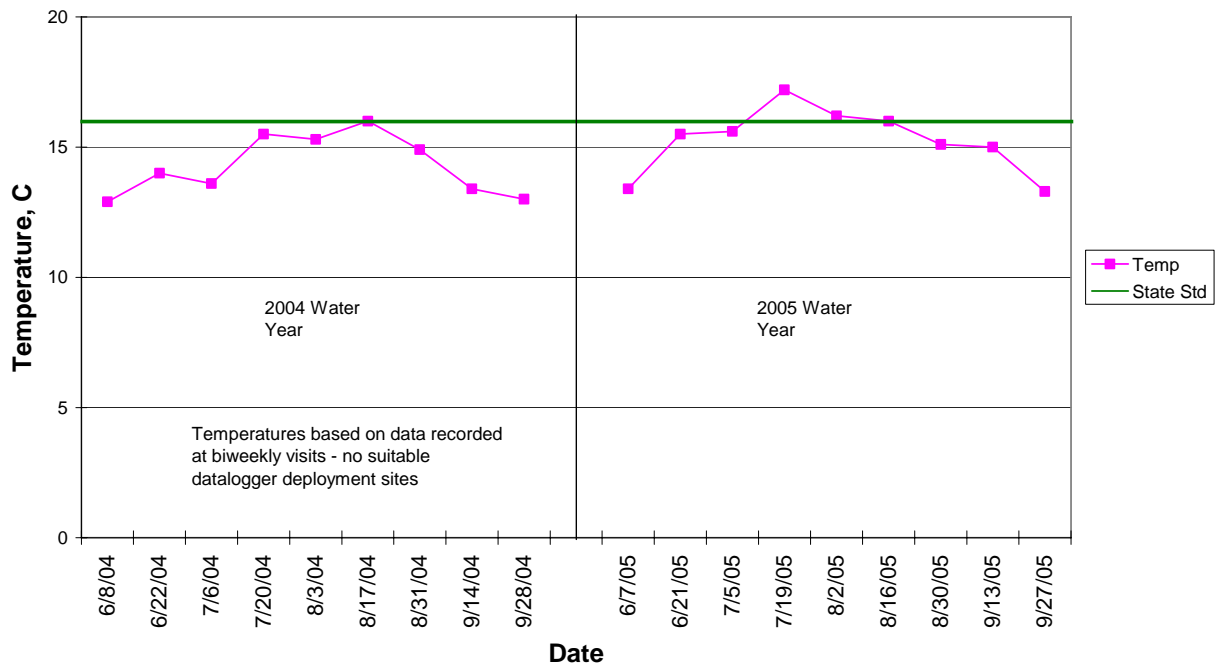
North Fork Skagit River near Moore Rd - Site 45 Temperature



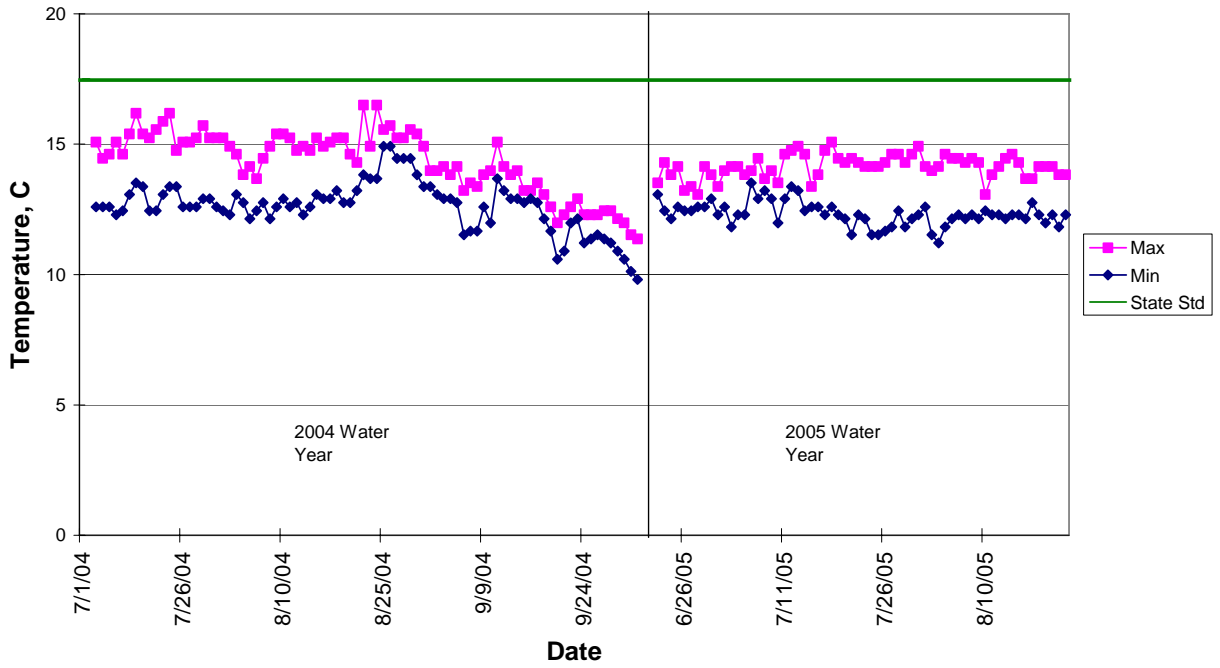
S F Skagit River at Conway Boat Ramp - Site 46 Temperature



Swinomish Channel at County Boat Ramp - Site 47 Temperature



Fisher Creek at Franklin Rd - Site 48 Temperature



Dissolved Oxygen

Dissolved oxygen (DO) measurements determine how much oxygen is available in the water for fish and other organisms. DO measurements were taken at each site during each visit. A summary of DO readings (in mg/L) obtained during the 2005 water year is provided in Table 4. The pages following Table 4 contain graphs illustrating dissolved oxygen levels at all sample sites from both the 2004 and 2005 water years.

The state water quality standards for dissolved oxygen are based on single-day minimum measurements. For most watercourses in the Skagit County Monitoring Program (sites 3-20, 28-29, 31-46, 48), the minimum standard is 8.0 mg/L. For the upriver sites (sites 21-25, 30), the standard is 9.5 mg/L. For the marine site (site 47), the standard is 6.0 mg/L. The solubility of oxygen in water is inversely related to temperature, so that higher temperatures frequently result in lower dissolved oxygen values.

Many streams in the Skagit County Monitoring Program meet oxygen standards all or most of the year. In a few streams, oxygen levels show steep declines in summer. These declines are usually associated with very low flows.

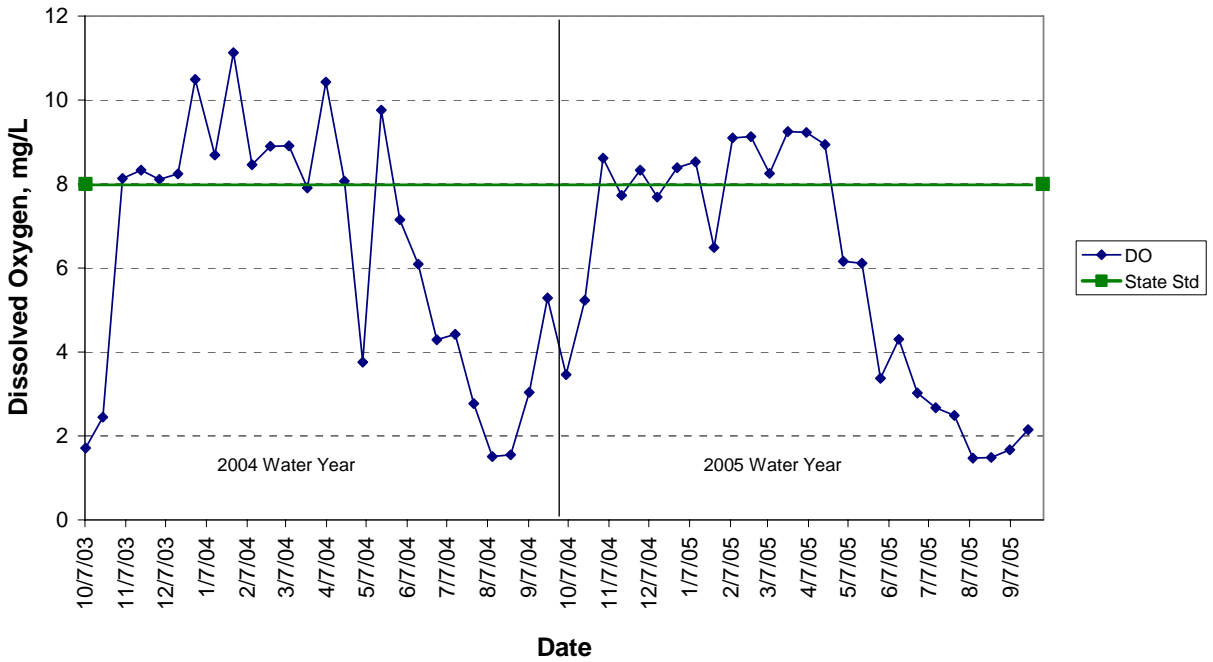
In the drainage infrastructure and lower sloughs, dissolved oxygen levels can be greatly influenced by algal activity. During large algae blooms, the oxygen produced during photosynthesis can lead to very high oxygen levels during the day. However, at those same times, nighttime oxygen levels can be 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 nighttime 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, are widely fluctuating dissolved oxygen levels depending on the state of the algal blooms at sampling time.

Table 4. Dissolved oxygen (DO) measurements in the Skagit County Monitoring Program – 2005 Water Year

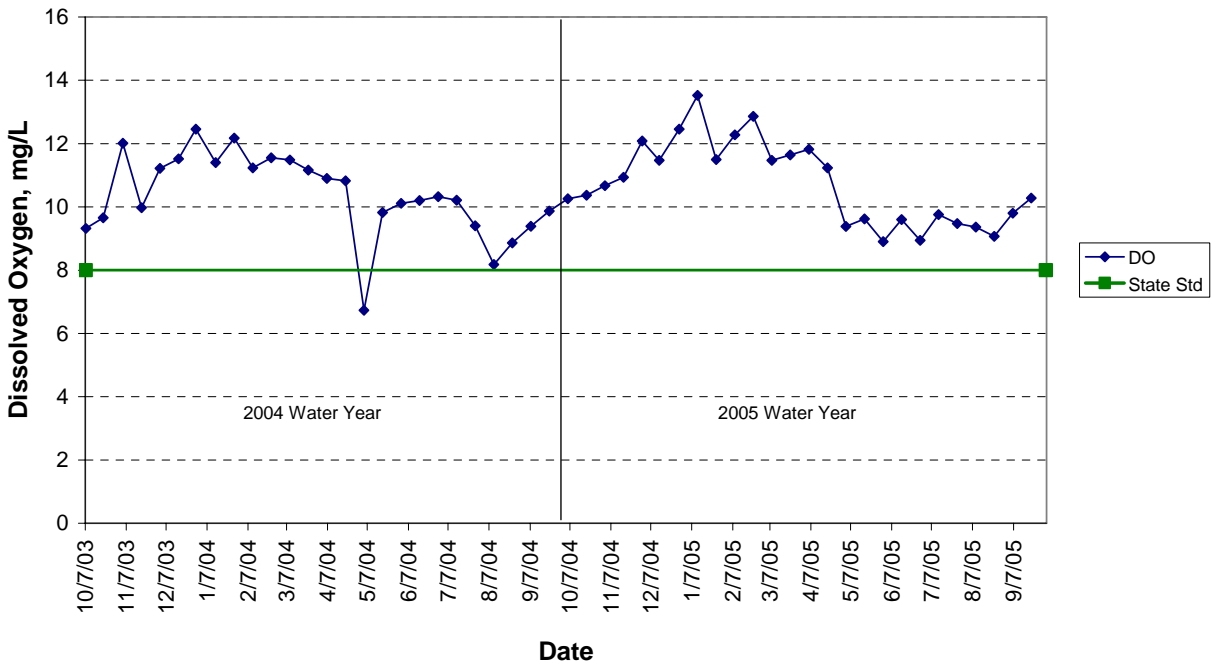
Site Number	Watercourse	Location	Mean DO (mg/L)	Minimum DO (mg/L)	St. Std ¹
3	Thomas Ck	Old Hwy 99 N	5.90	1.47	8.0
4	Thomas Ck	F&S Grade	10.72	8.90	8.0
6	Friday Ck	Prairie Rd	11.23	9.65	8.0
8	Swede Ck	Grip Rd	11.09	8.84	8.0
11	Samish R	State Route 9	8.17	5.05	8.0
12	Nookachamps Ck	Swan Rd	9.43	6.47	8.0
13	E.F. Nookachamps Ck	State Route 9	9.75	7.57	8.0
14	College Way Ck	College Way	9.09	5.04	8.0
15	Nookachamps Ck	Knapp	7.82	1.35	8.0
16	E.F. Nookachamps Ck	Beaver Lake Rd	11.37	9.11	8.0
17	Nookachamps Ck	Big Lake Outlet	9.71	7.22	8.0
18	Lake Ck	State Route 9	11.07	9.01	8.0
19	Hansen Ck	Hoehn Rd	10.12	7.46	8.0
20	Hansen Ck	Northern State	10.97	9.48	8.0
21	Coal Ck	Hoehn Rd	11.05	9.28	9.5
22	Coal Ck	Hwy 20	11.75	9.87	9.5
23	Wiseman Ck	Minkler Rd	11.60	10.12	9.5
24	Mannser Ck	Lyman Hamilton Hwy	6.16	2.66	9.5
25	Red Cabin Ck	Hamilton Cem Rd	11.51	9.73	9.5
28	Brickyard Ck	Hwy 20	9.23	6.04	8.0
29	Skagit R	River Bend Rd	10.76	9.14	8.0
30	Skagit R	Cape Horn Rd	11.07	9.63	9.5
31	Drain Dist 20 floodgate	Francis Rd	8.06	3.33	8.0
32	Samish R	Thomas Rd	10.81	9.03	8.0
33	Alice Bay Pump Station	Samish Island Rd	7.59	2.54	8.0
34	Noname Slough	Bayview-Edison Rd	6.56	0.60	8.0
35	Joe Leary Slough	D'Arcy Rd	4.02	2.30	8.0
36	Edison Slough at school	W. Bow Hill Rd	7.55	2.90	8.0
37	Edison Pump Station	Farm to Market Rd	5.54	0.27	8.0
38	North Edison Pump Station	North Edison Rd	6.97	1.13	8.0
39	Colony Ck	Colony Rd	10.75	7.96	8.0
40	Big Indian Slough	Bayview-Edison Rd	4.56	2.32	8.0
41	Maddox Slough/Big Ditch	Milltown Rd	5.15	2.02	8.0
42	Hill Ditch	Cedardale Rd	7.05	3.11	8.0
43	Wiley Slough	Wylie Rd	4.21	0.12	8.0
44	Rexville PS/Sullivan Slough	La Conner-Bayview Rd	10.37	6.89	8.0
45	Skagit R – North Fork	Moore Rd	11.05	9.21	8.0
46	Skagit R – South Fork	Fir Island Rd	11.03	9.17	8.0
47	Swinomish Channel	County Boat Launch	8.71	7.12	6.0
48	Fisher Ck	Franklin Rd	10.90	8.56	8.0

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

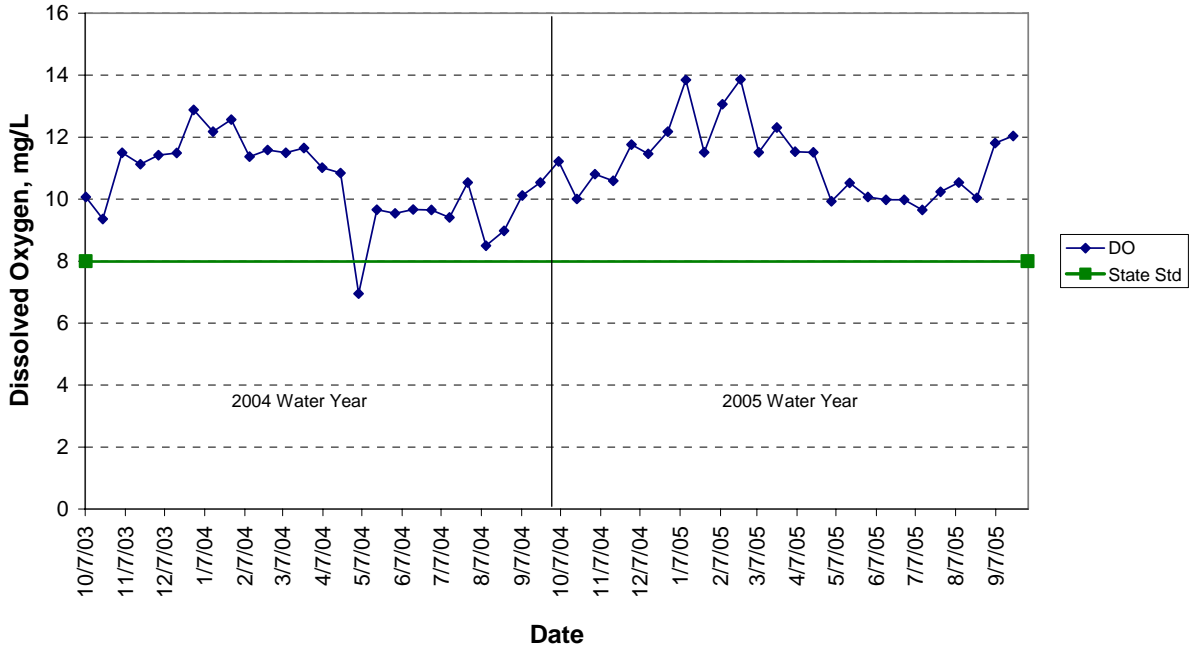
Thomas Creek at Hwy 99 - Site 3 Dissolved Oxygen



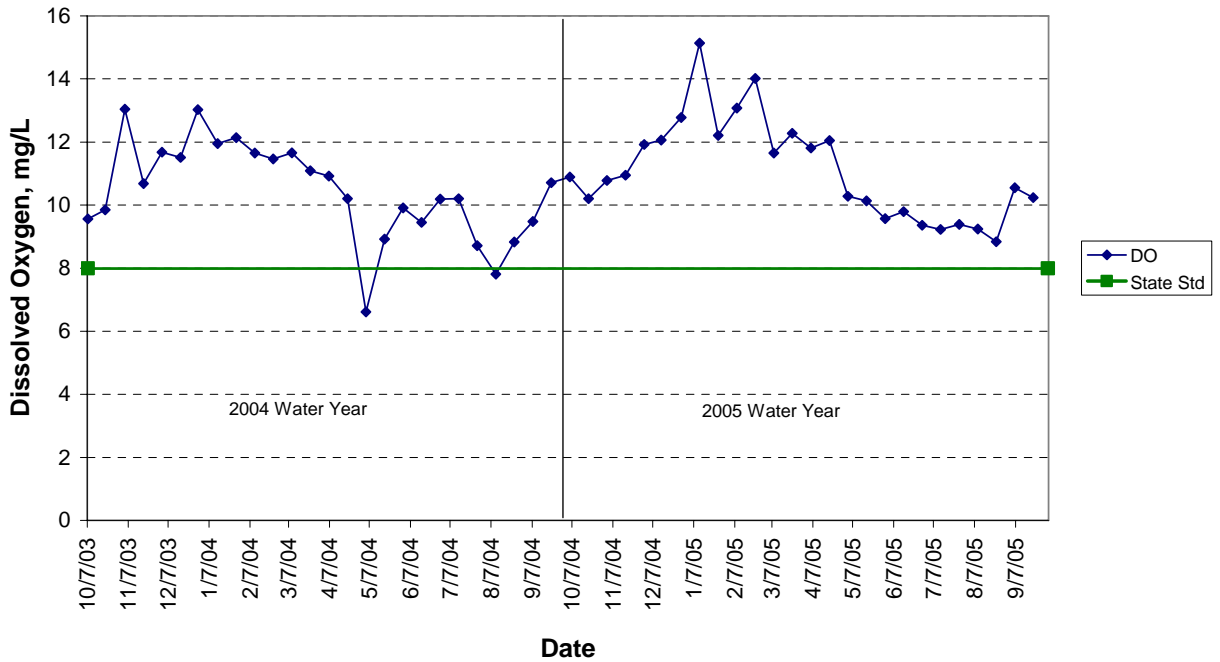
Thomas Creek at F&S Grade Rd - Site 4 Dissolved Oxygen



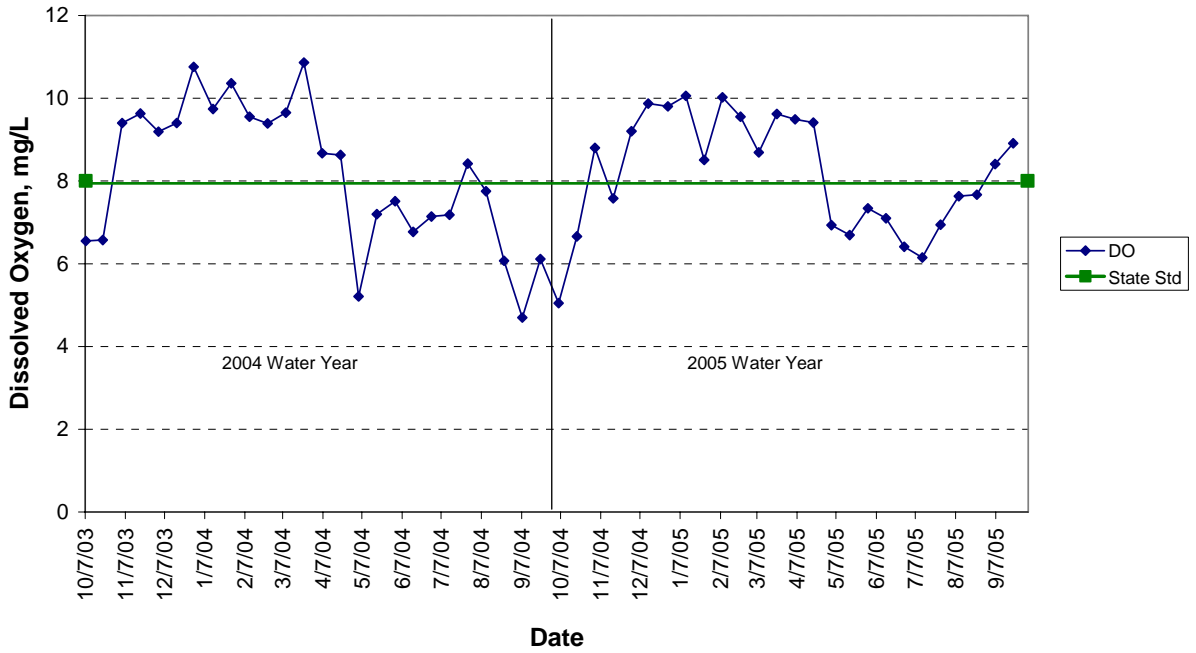
Friday Creek at Prairie Rd - Site 6 Dissolved Oxygen



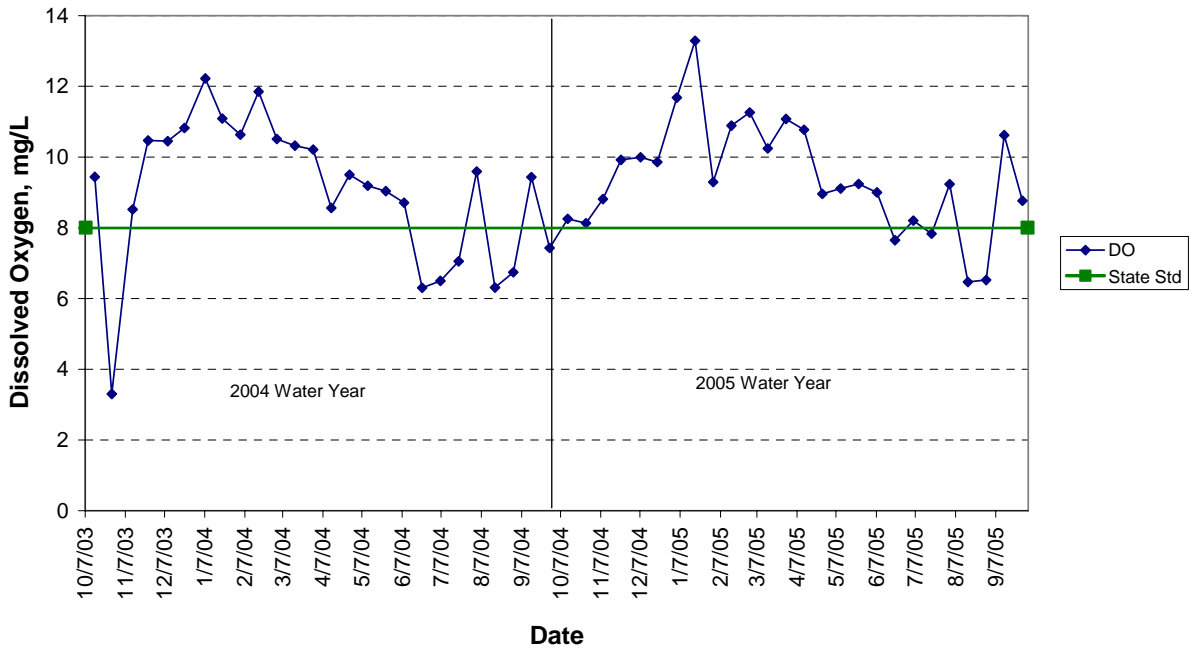
Swede Creek at Grip Rd - Site 8 Dissolved Oxygen



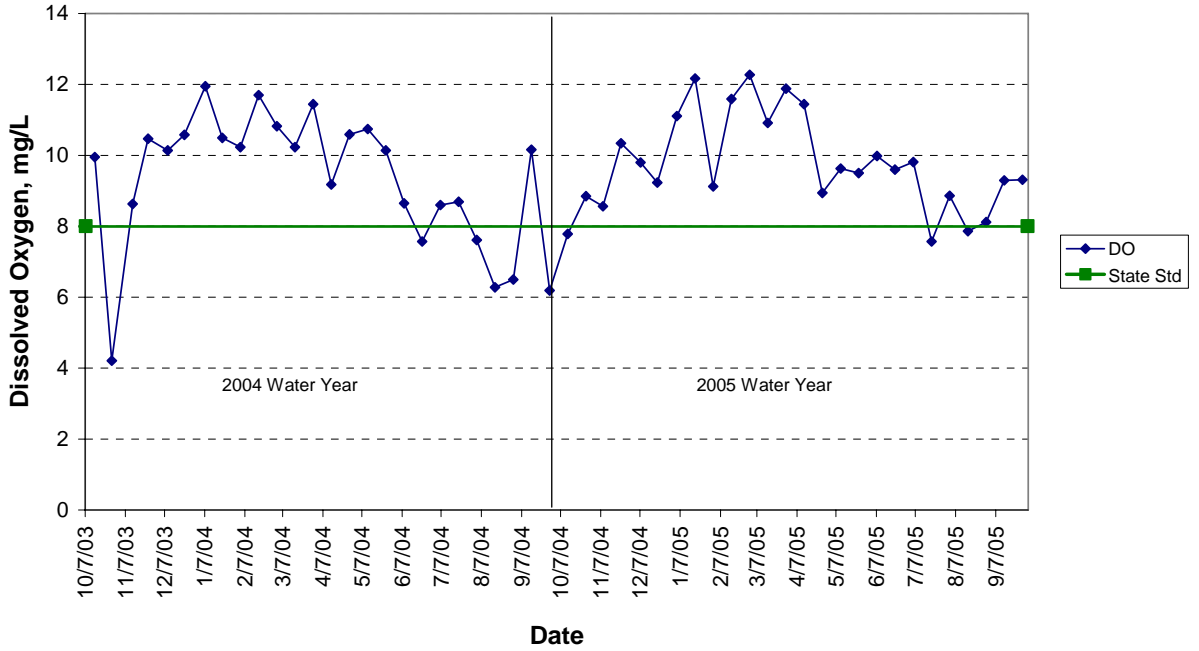
Samish River at Hwy 9 - Site 11 Dissolved Oxygen



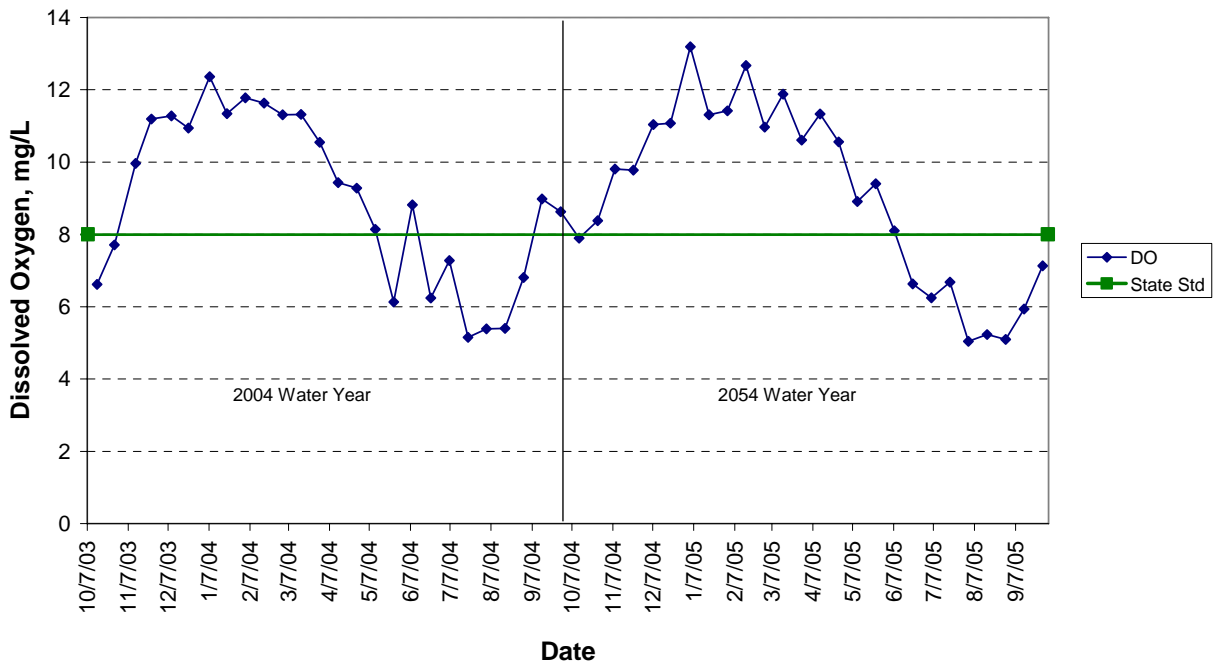
Nookachamps Creek at Swan Rd - Site 12 Dissolved Oxygen



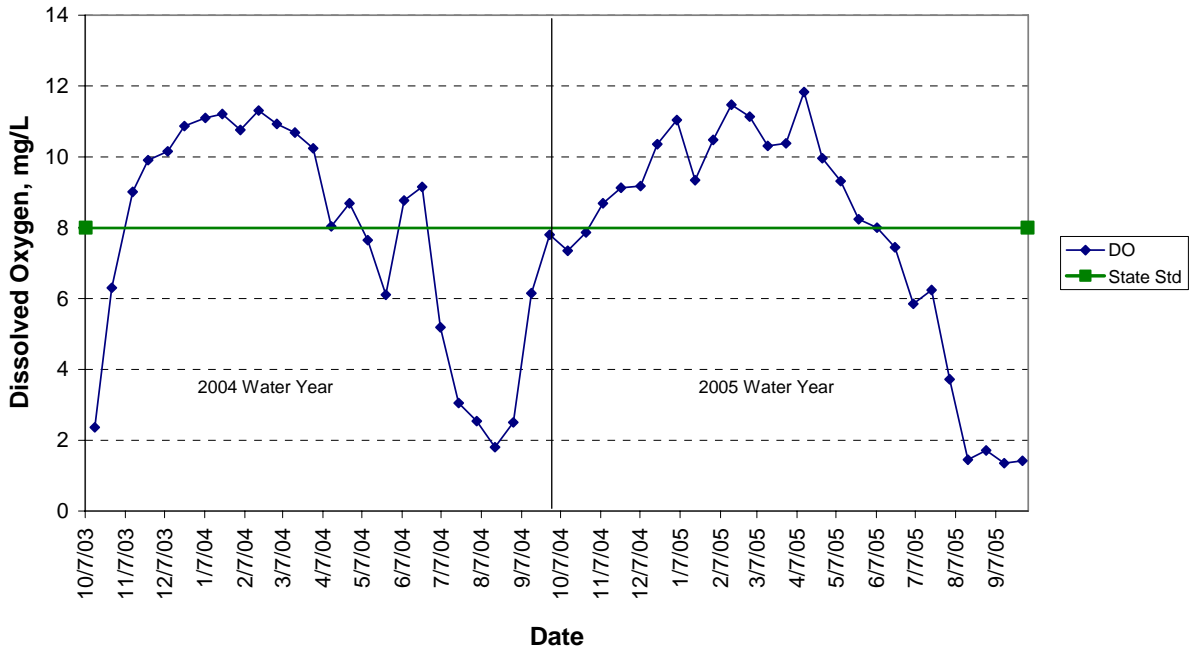
E.F. Nookachamps Creek at Hwy 9 - Site 13 Dissolved Oxygen



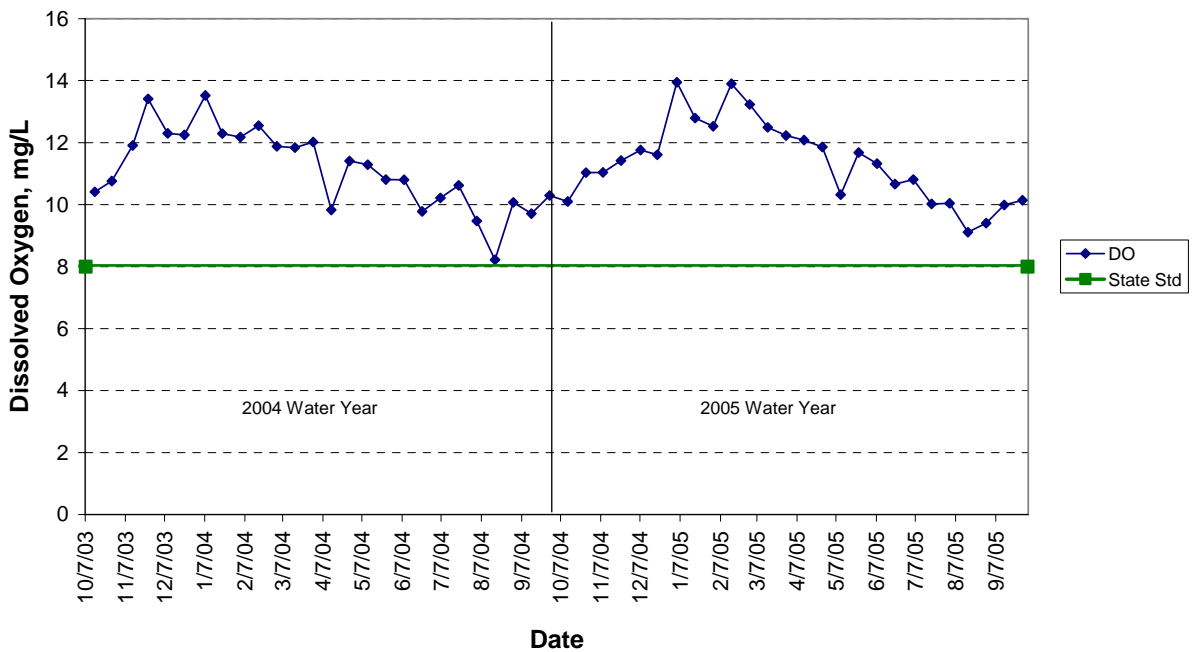
College Way Creek at College Way - Site 14 Dissolved Oxygen



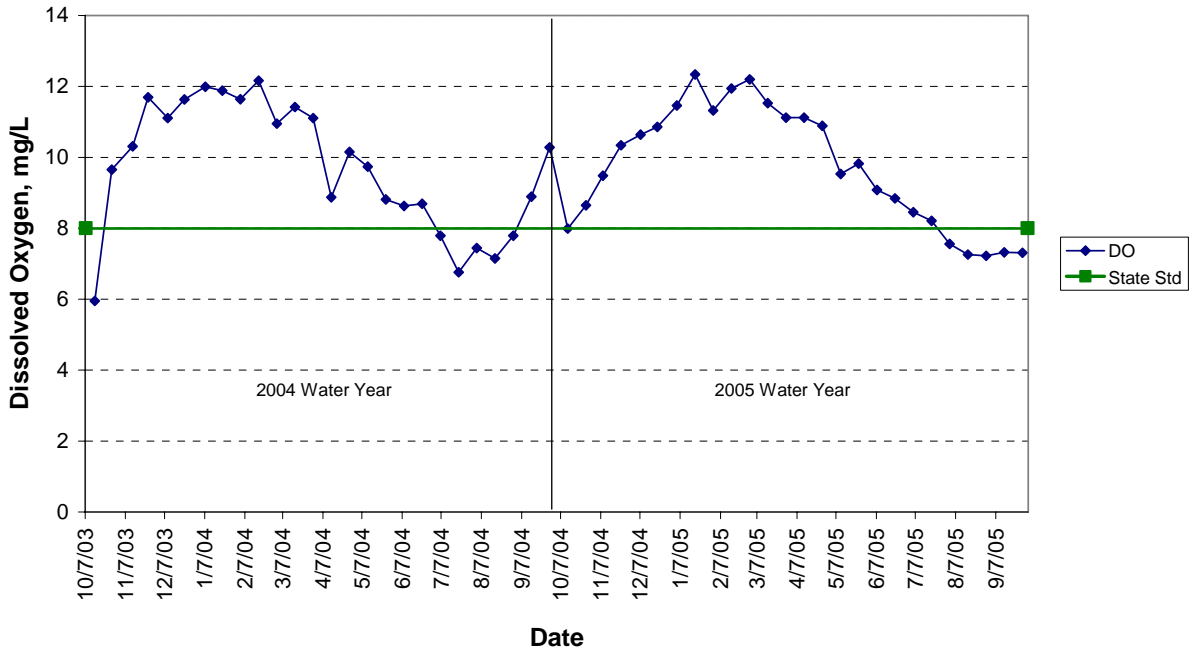
Nookachamps Creek at Knapp Rd - Site 15 Dissolved Oxygen



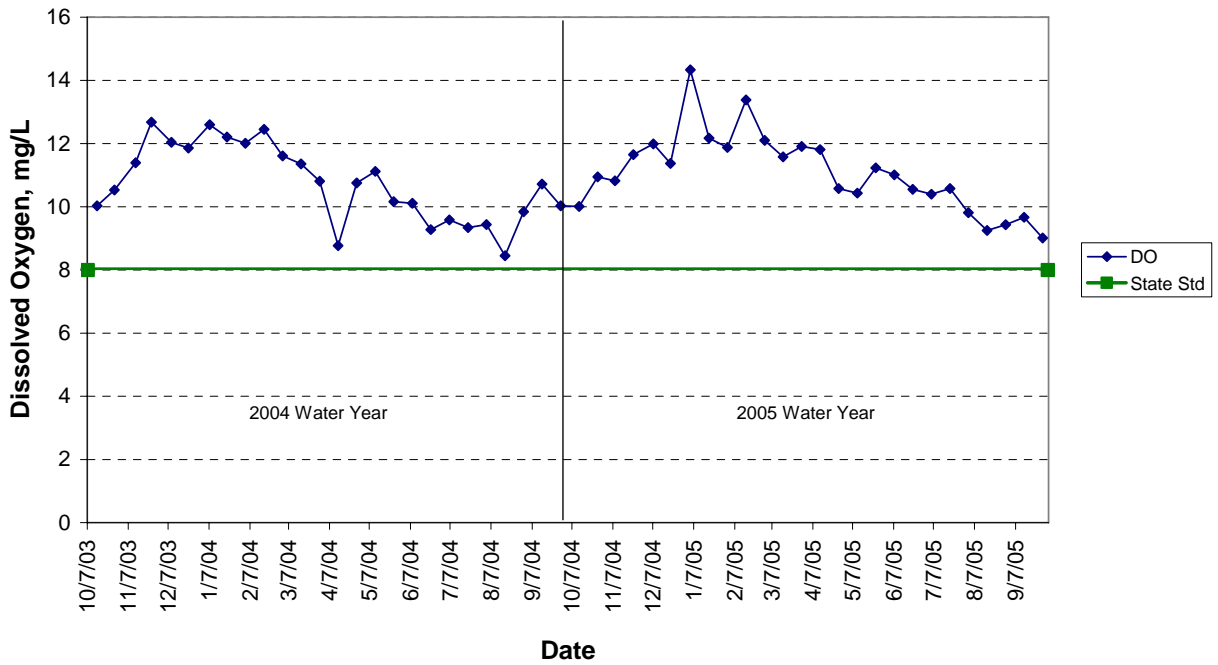
E.F. Nookachamps Creek at Beaver Lk Rd - Site 16 Dissolved Oxygen



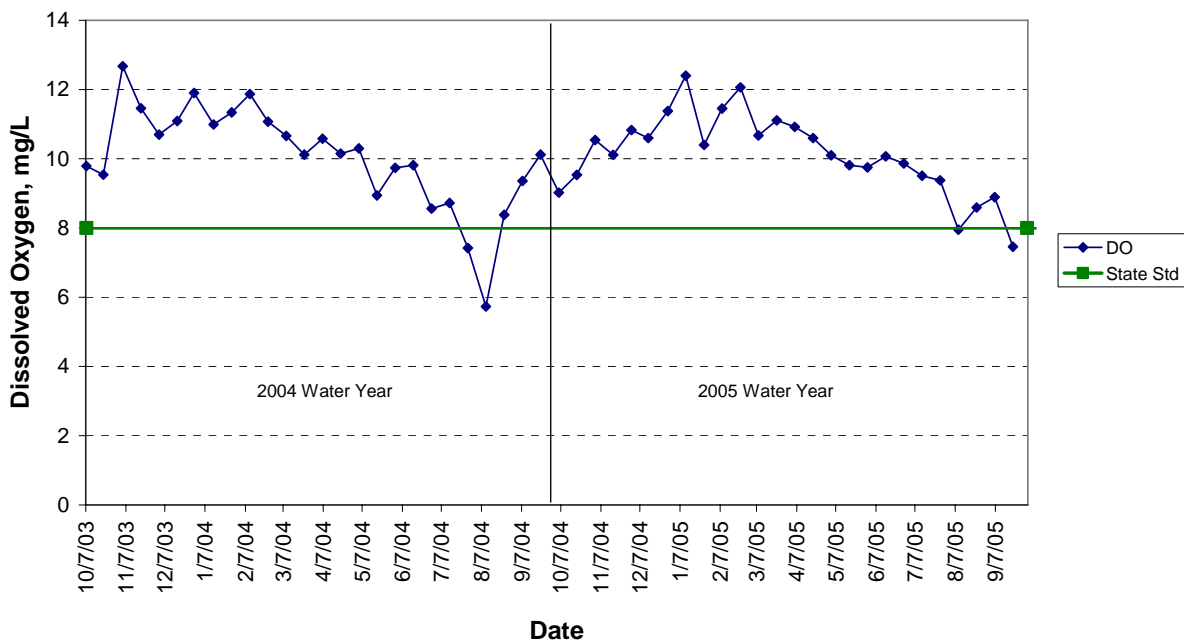
Nookachamps Creek at Big Lake Outlet - Site 17 Dissolved Oxygen



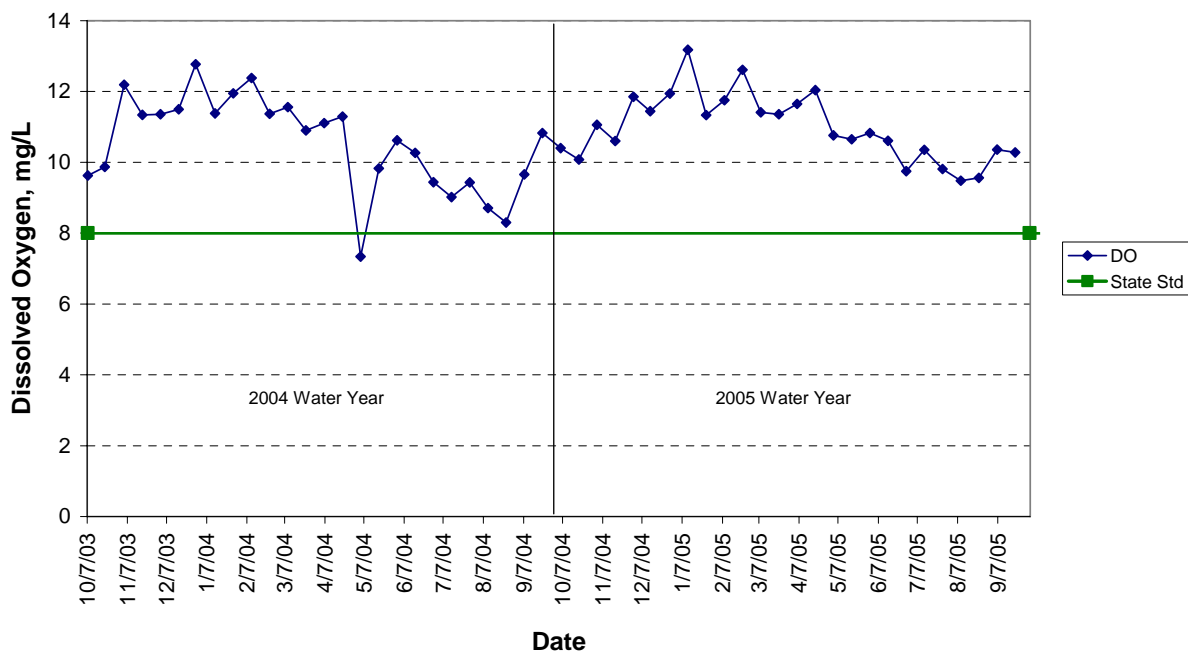
Lake Creek at Hwy 9 - Site 18 Dissolved Oxygen



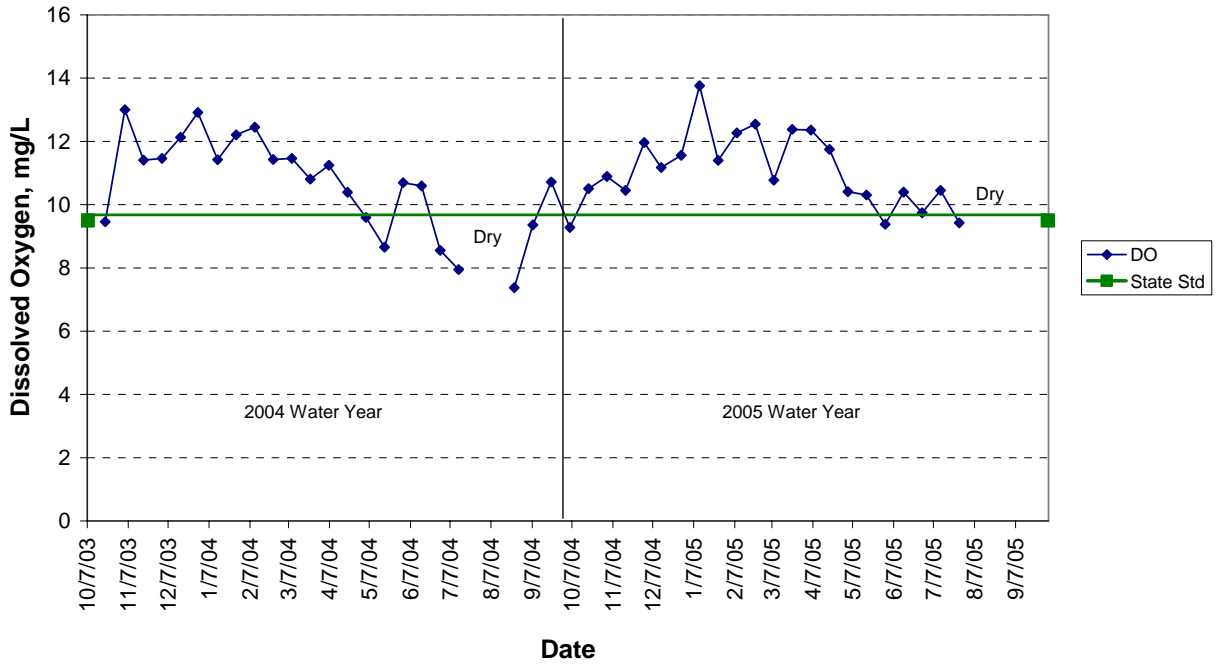
Hansen Creek at Hoehn Rd - Site 19 Dissolved Oxygen



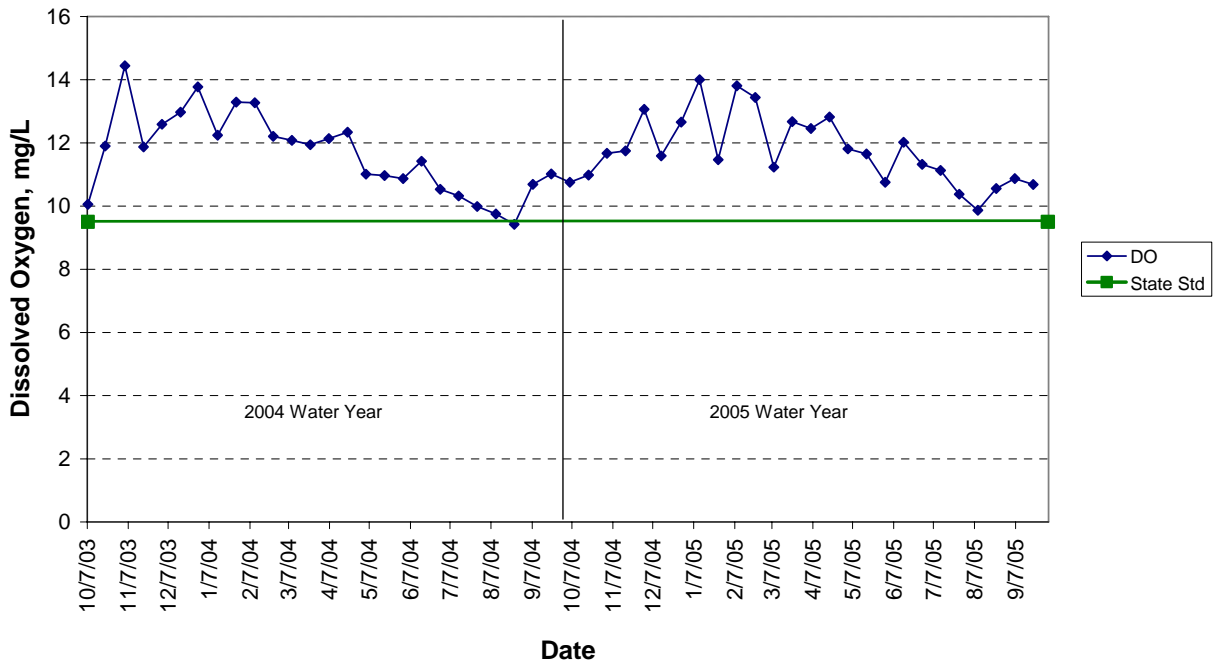
Hansen Creek at Northern State - Site 20 Dissolved Oxygen



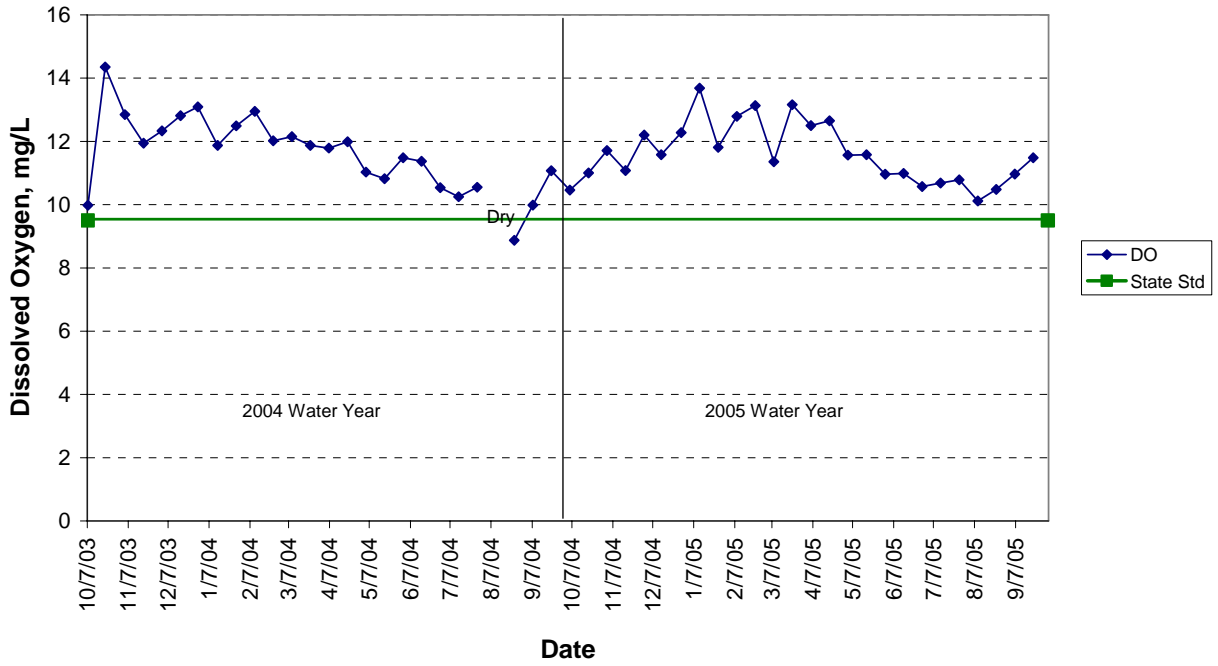
Coal Creek at Hoehn Rd - Site 21 Dissolved Oxygen



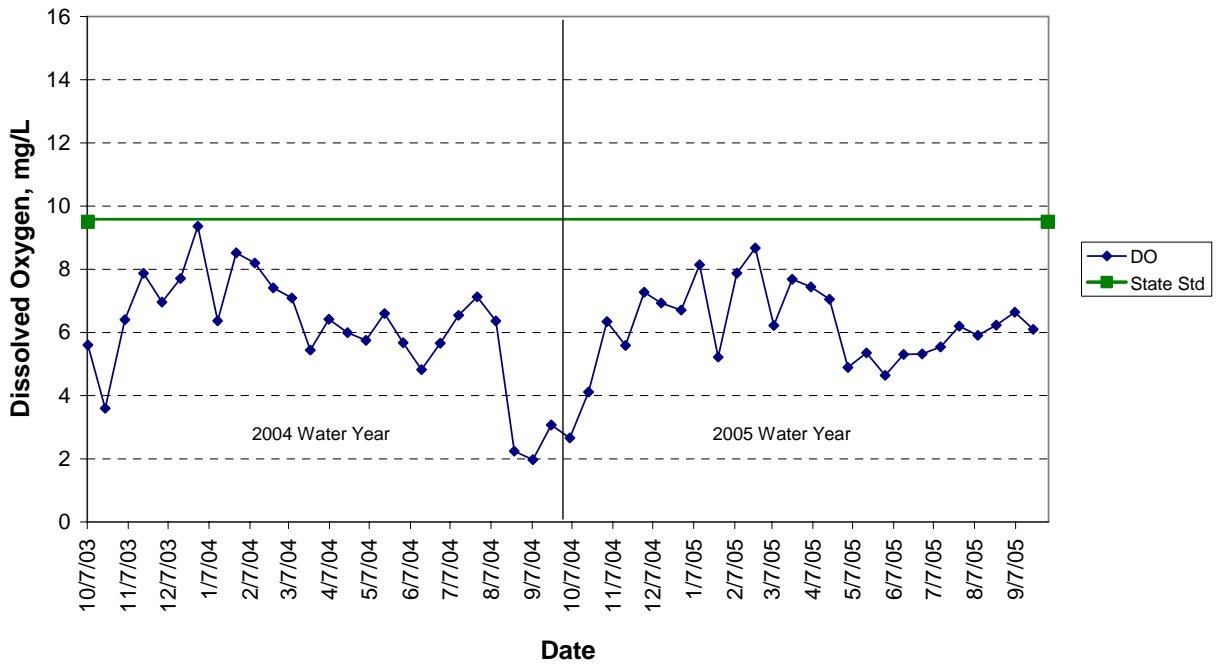
Coal Creek at Hwy 20 - Site 22 Dissolved Oxygen



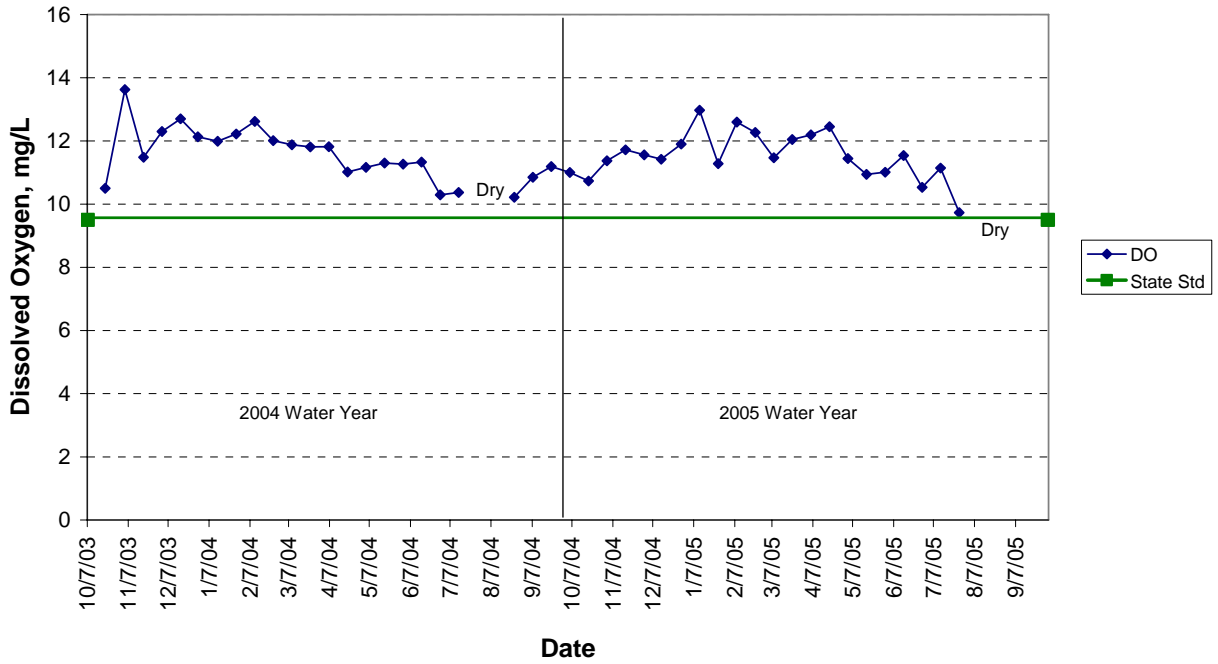
Wiseman Creek at Minkler Rd - Site 23 Dissolved Oxygen



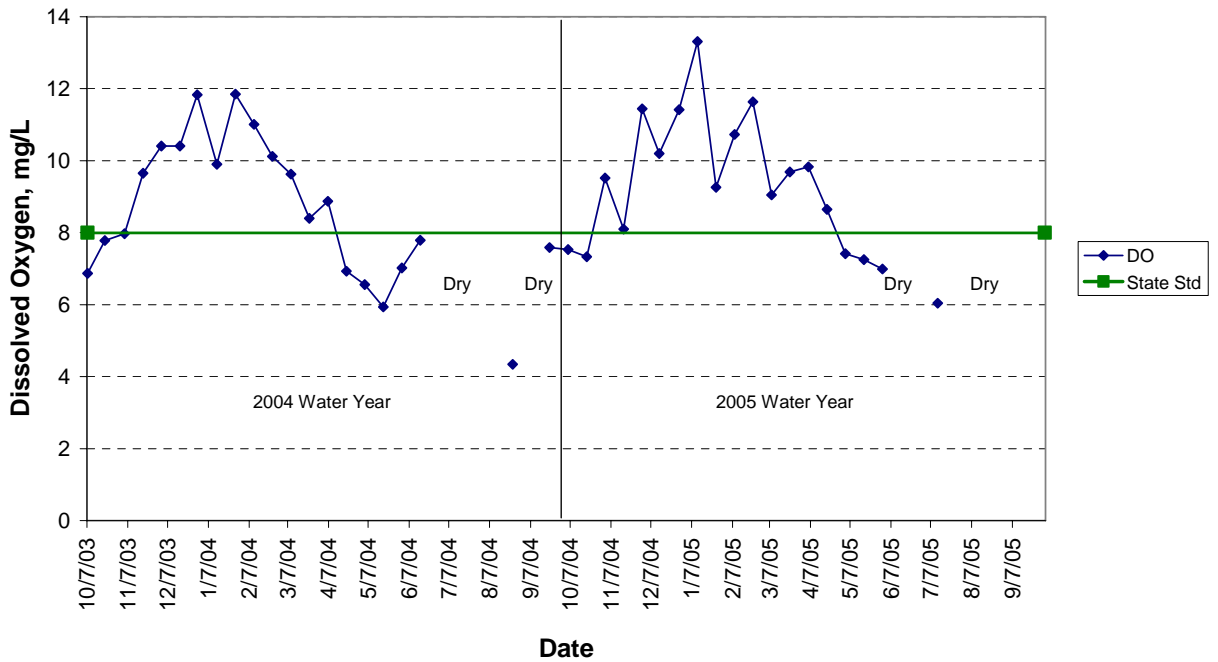
Mannser Creek at Lyman-Hamilton Hwy - Site 24 Dissolved Oxygen



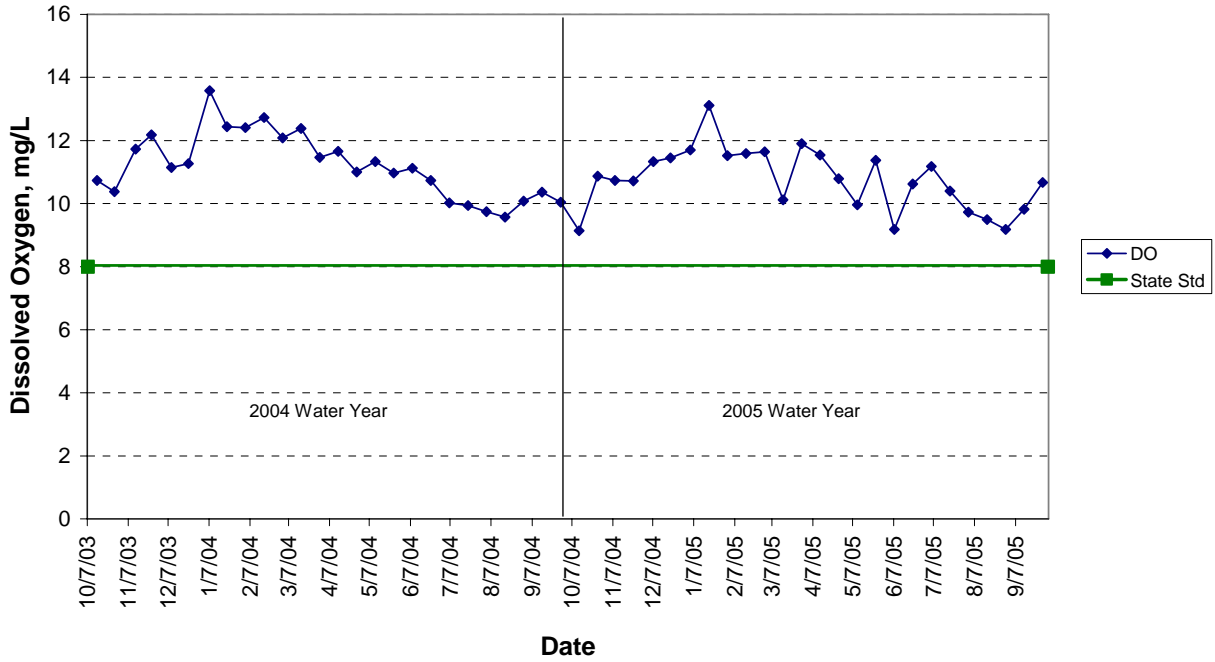
Red Cabin Creek at Hamilton Cemetery Rd - Site 25 Dissolved Oxygen



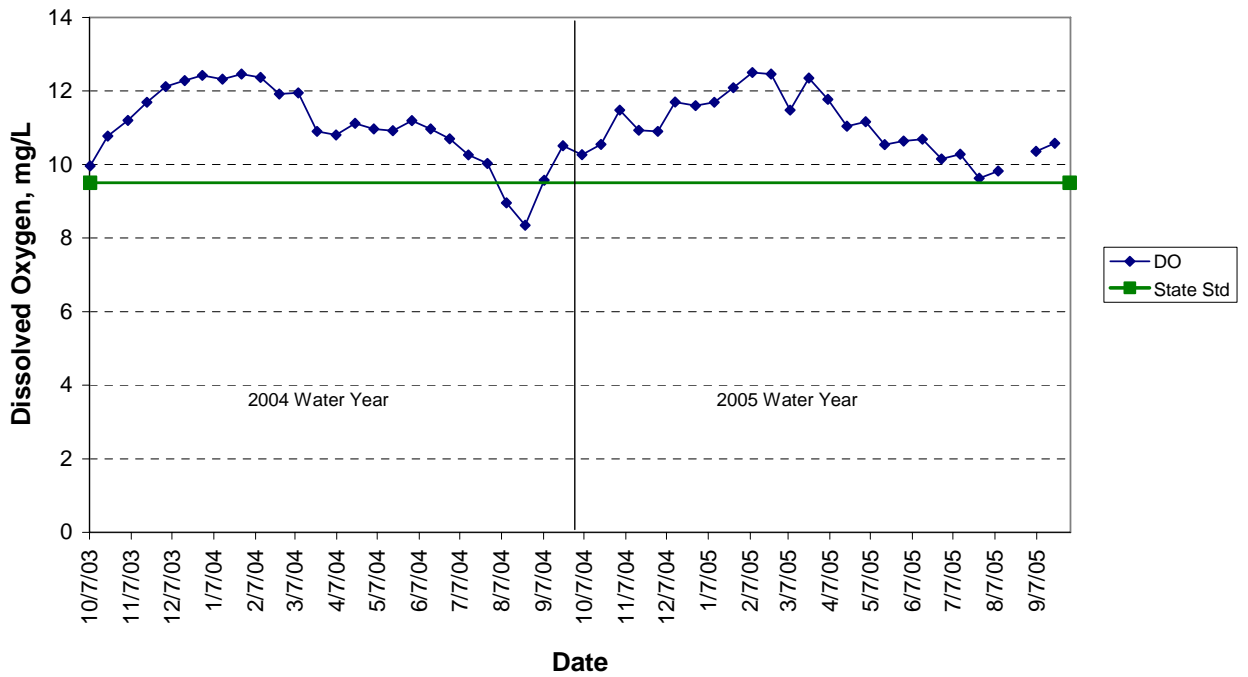
Brickyard Creek at Hwy 20 - Site 28 Dissolved Oxygen



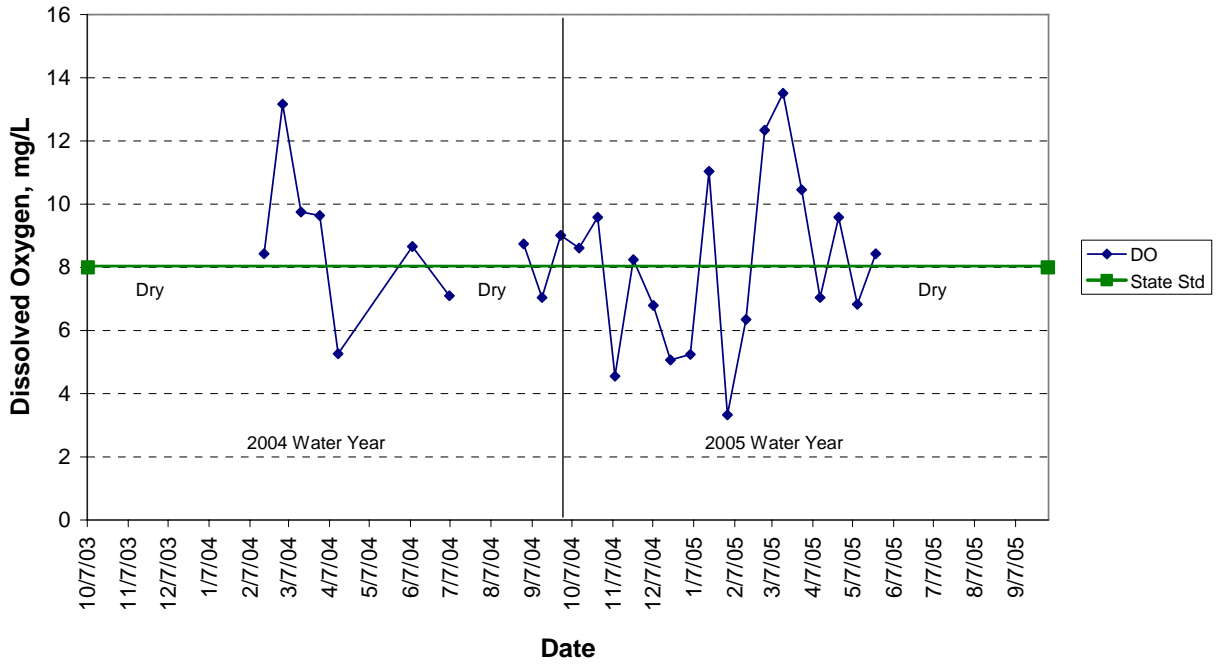
Skagit River at River Bend - Site 29 Dissolved Oxygen



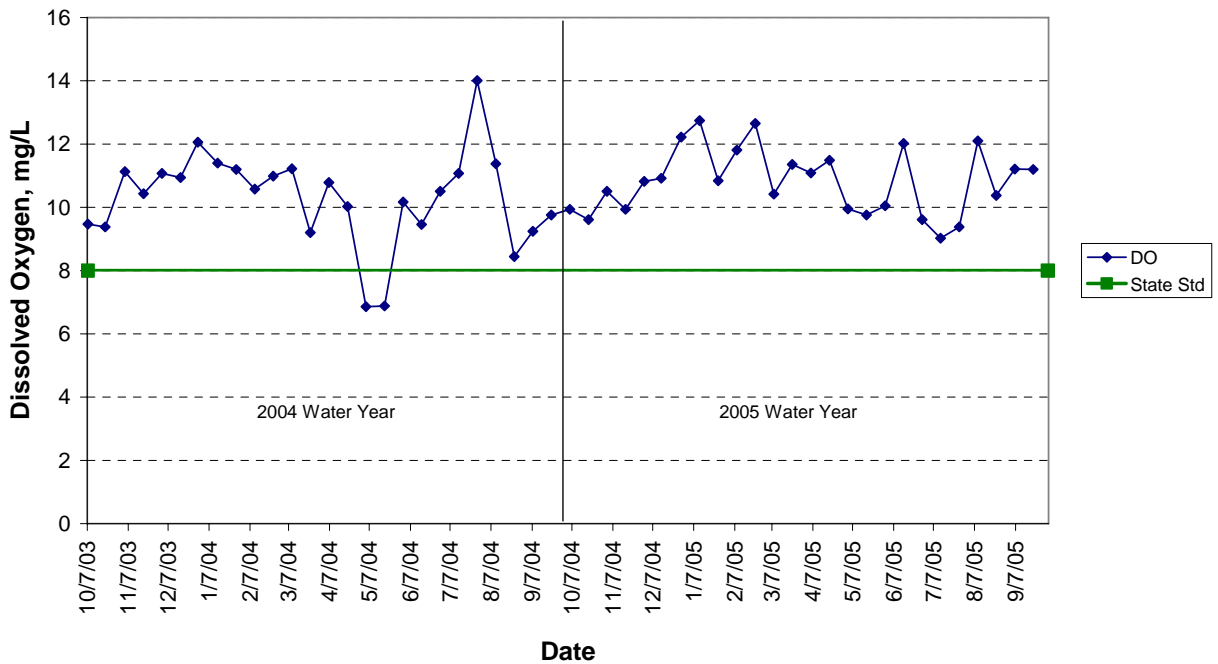
Skagit River at Cape Horn Rd - Site 30 Dissolved Oxygen



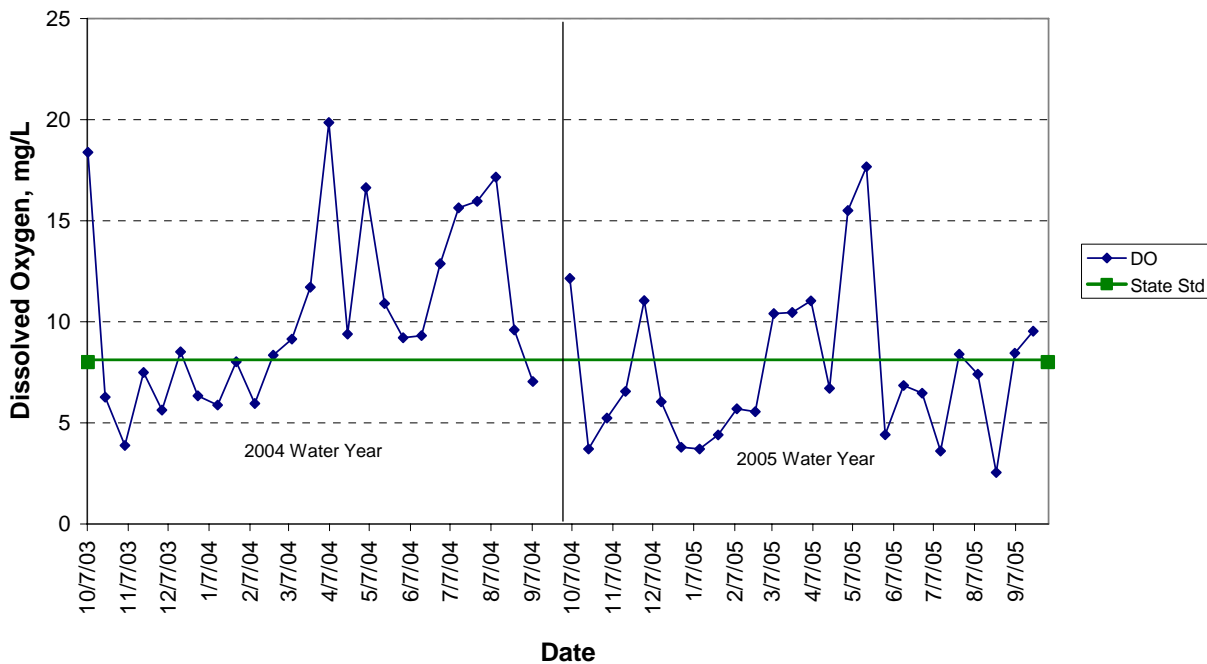
Drainage District 20 Ditch at Floodgate - Site 31 Dissolved Oxygen



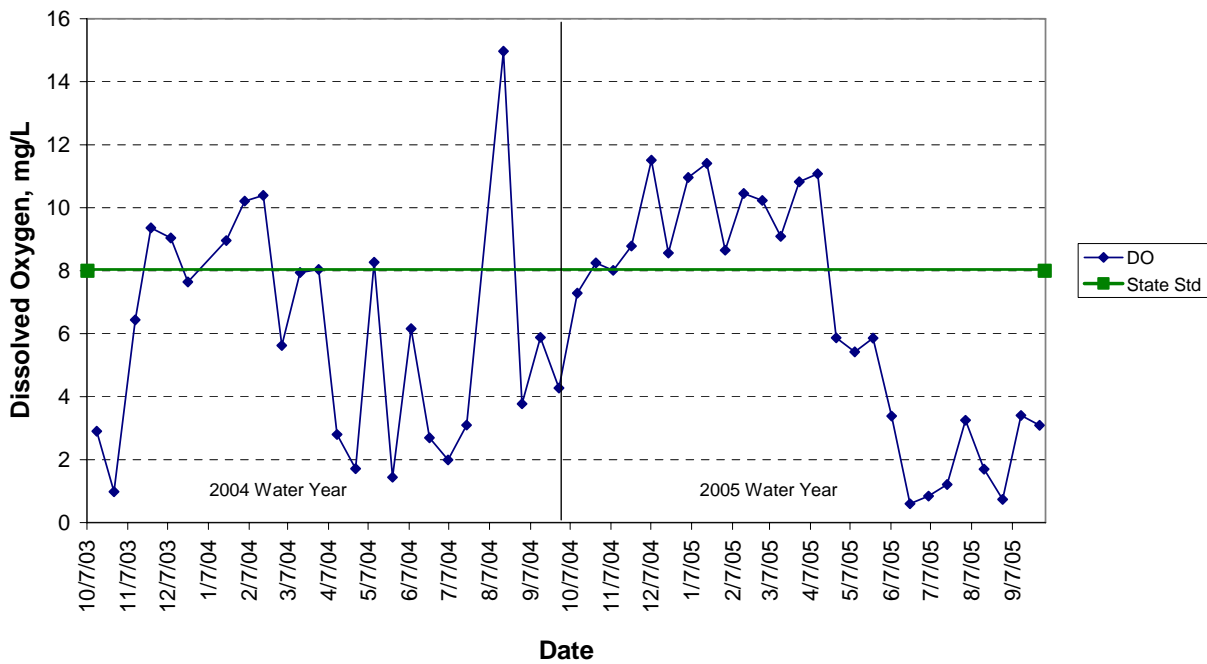
Samish River at Thomas Rd - Site 32 Dissolved Oxygen



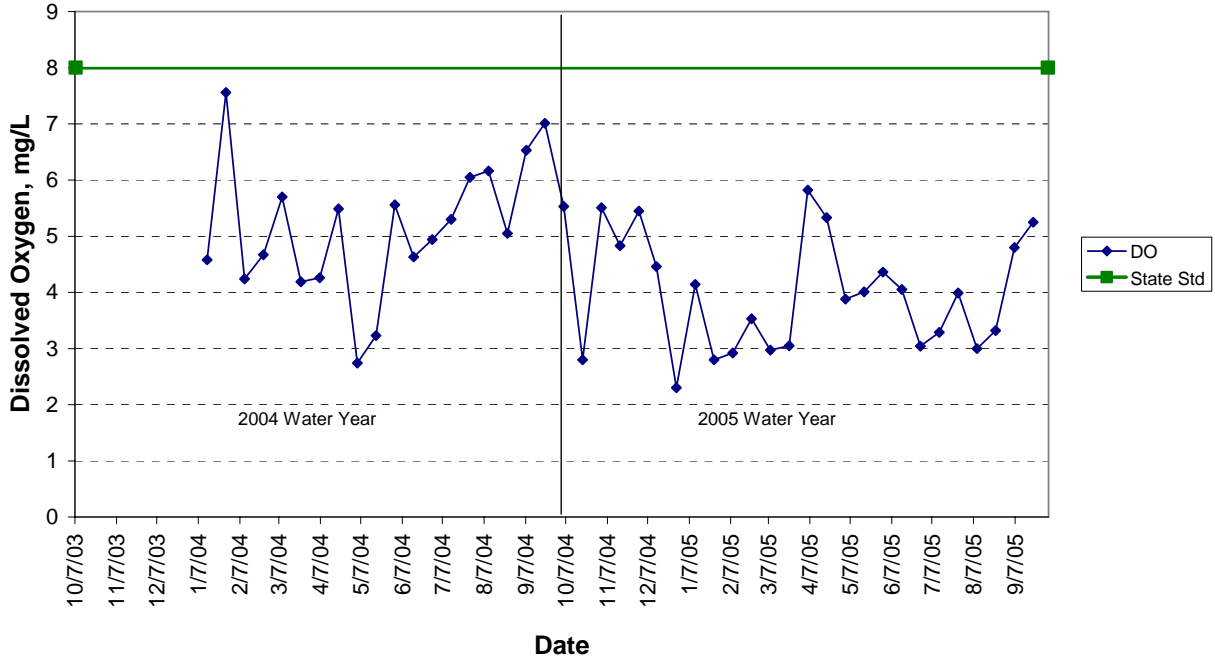
Alice Bay Pump Station - Site 33 Dissolved Oxygen



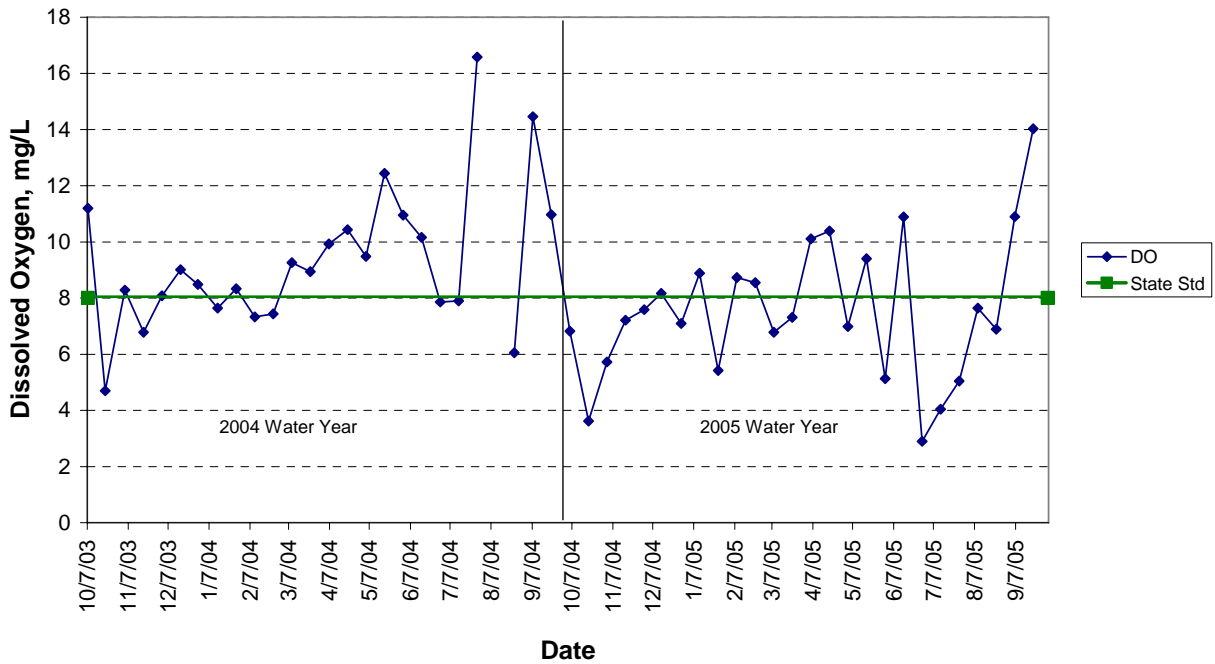
No Name Slough at Bayview-Edison Rd - Site 34 Dissolved Oxygen



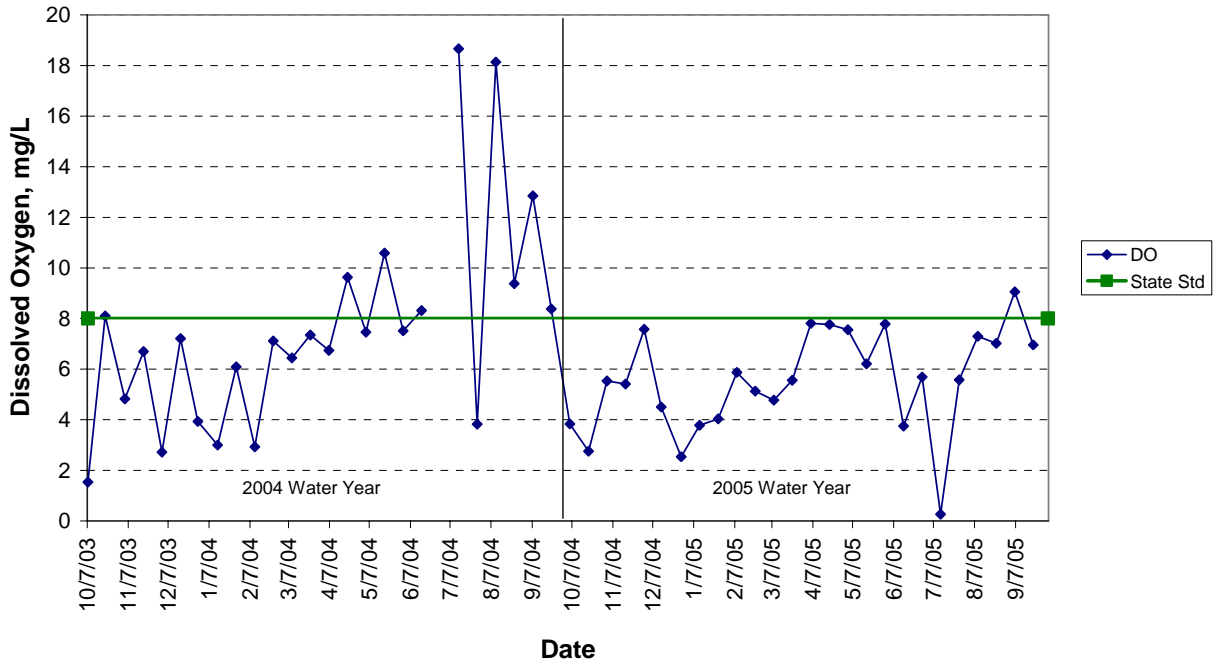
Joe Leary Slough at D'Arcy Rd - Site 35 Dissolved Oxygen



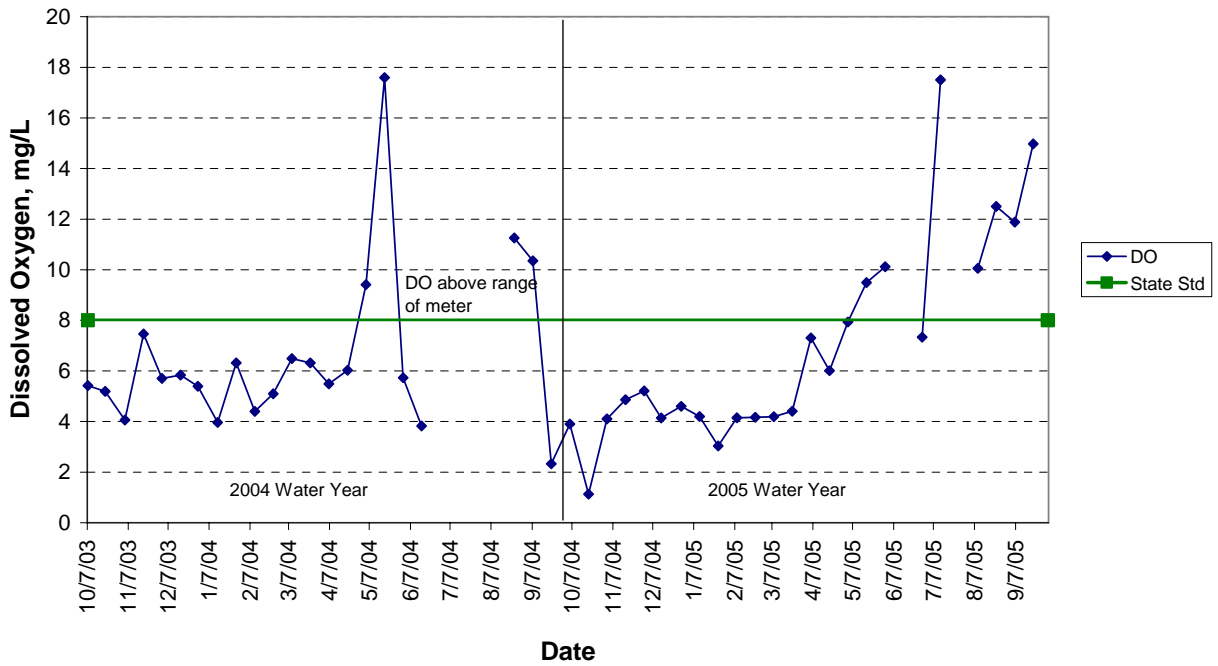
Edison Slough at Edison School - Site 36 Dissolved Oxygen



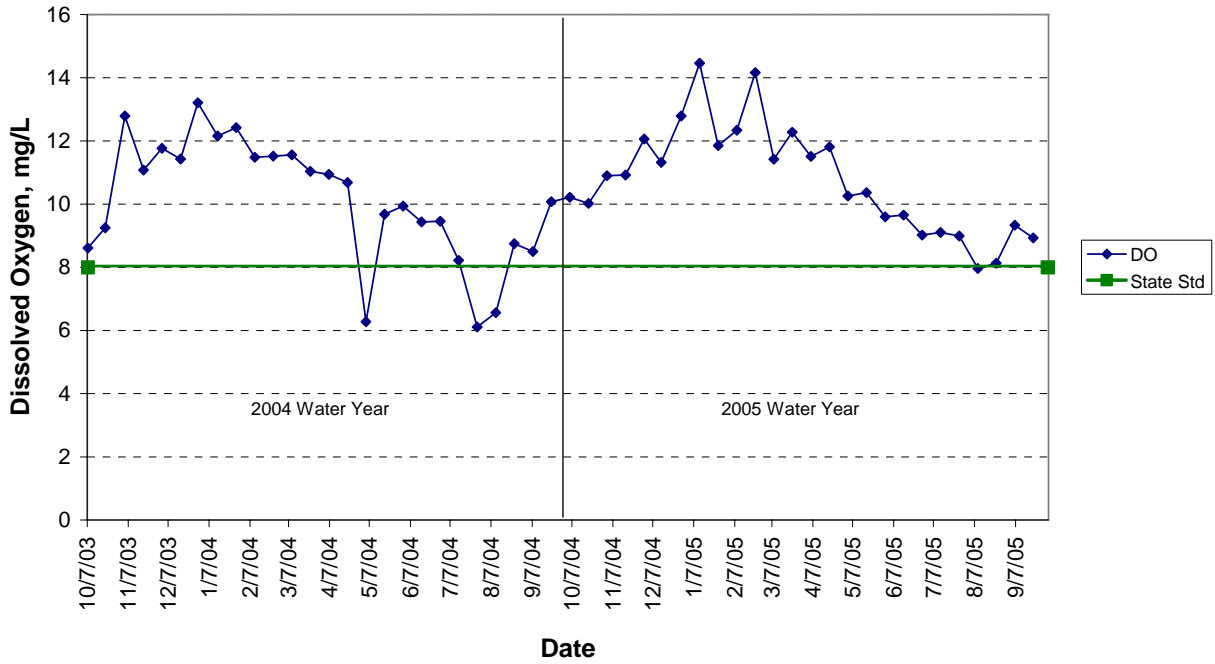
Edison Pump Station - Site 37 Dissolved Oxygen



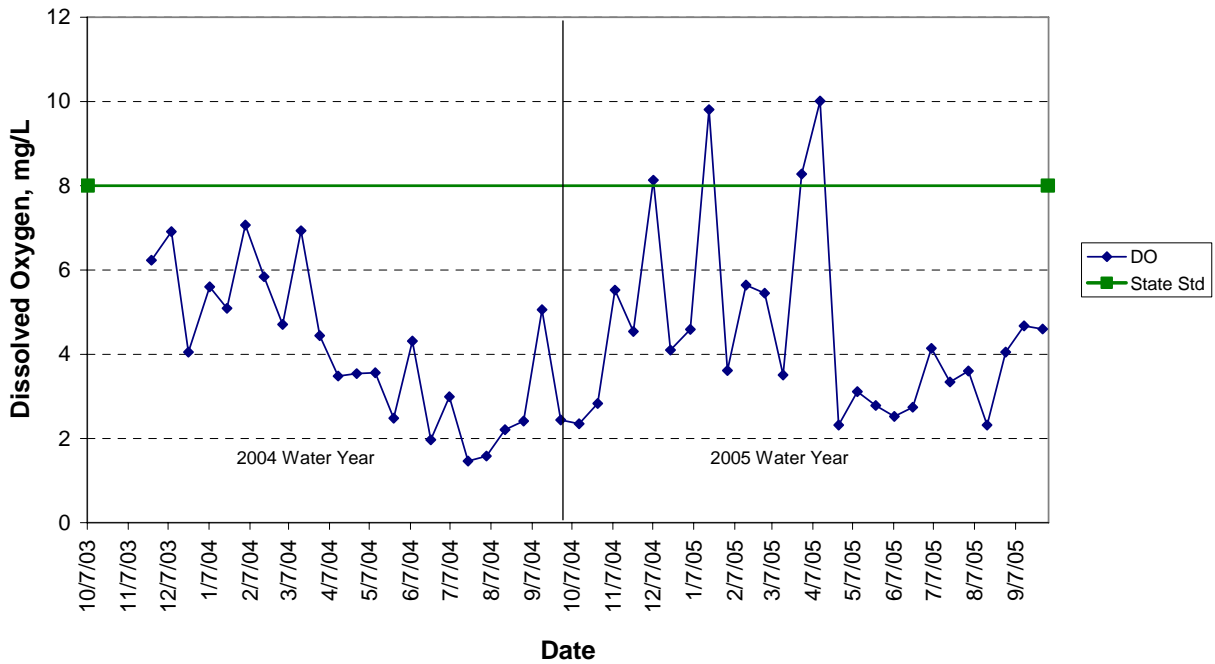
North Edison Pump Station - Site 38 Dissolved Oxygen



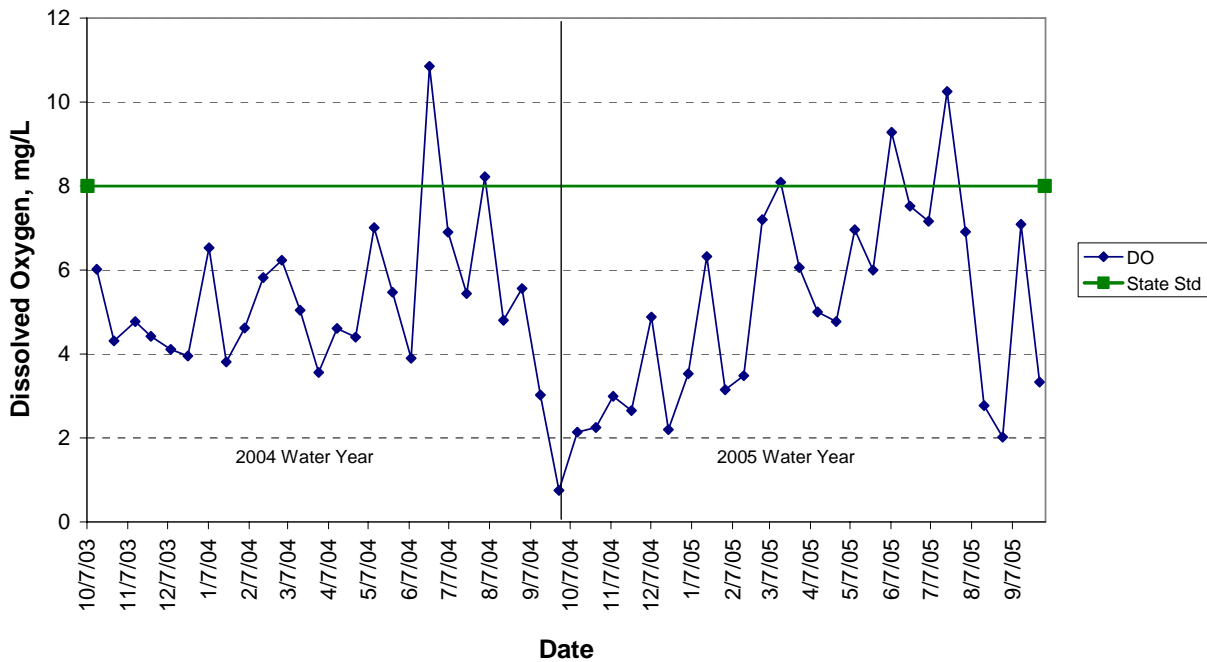
Colony Creek at Colony Rd - Site 39 Dissolved Oxygen



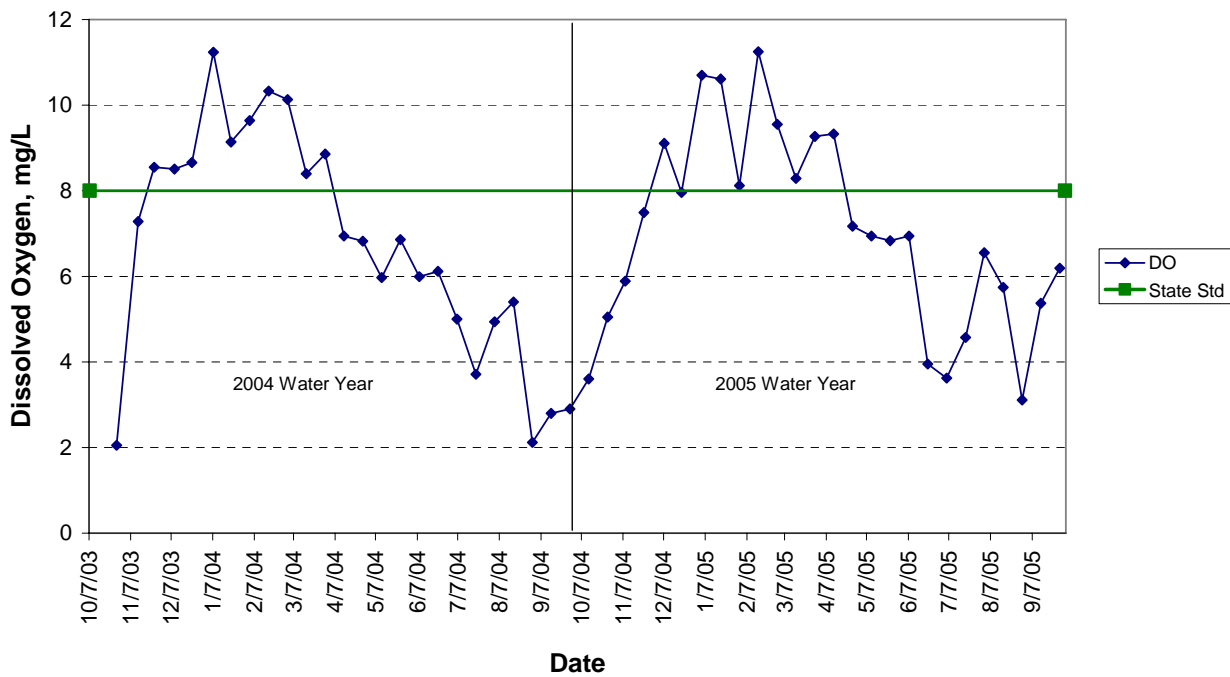
Big Indian Slough at Hwy 20 Truck Scales - Site 40 Dissolved Oxygen



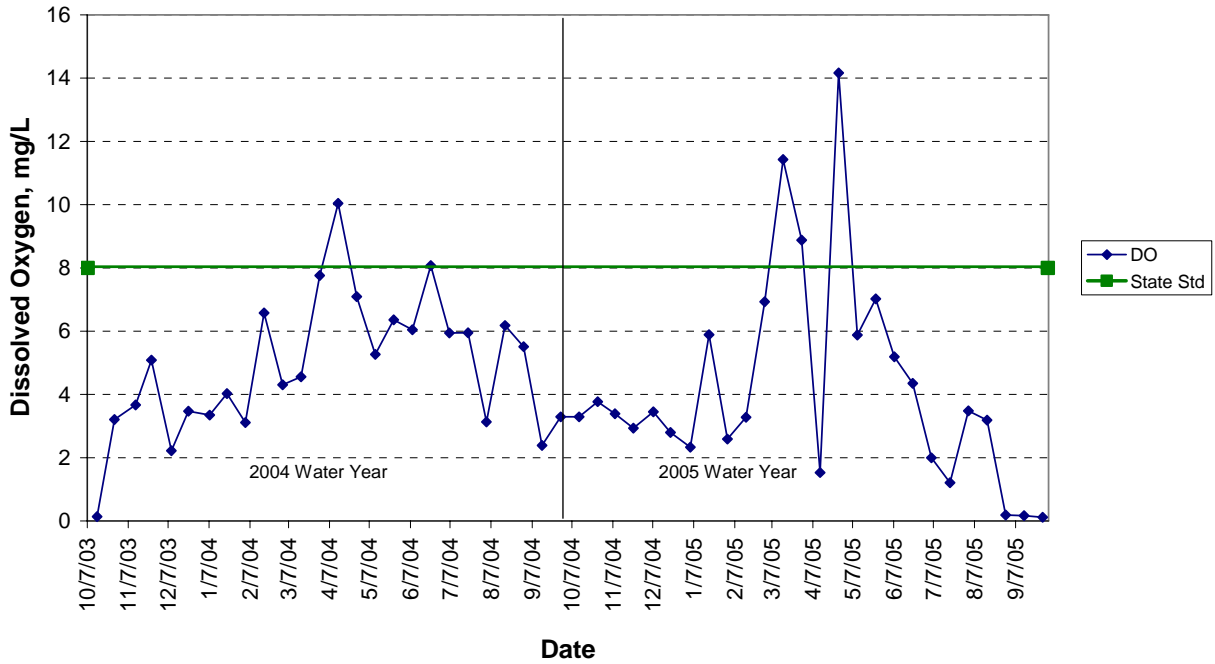
Maddox Creek/Big Ditch at Milltown Rd - Site 41 Dissolved Oxygen



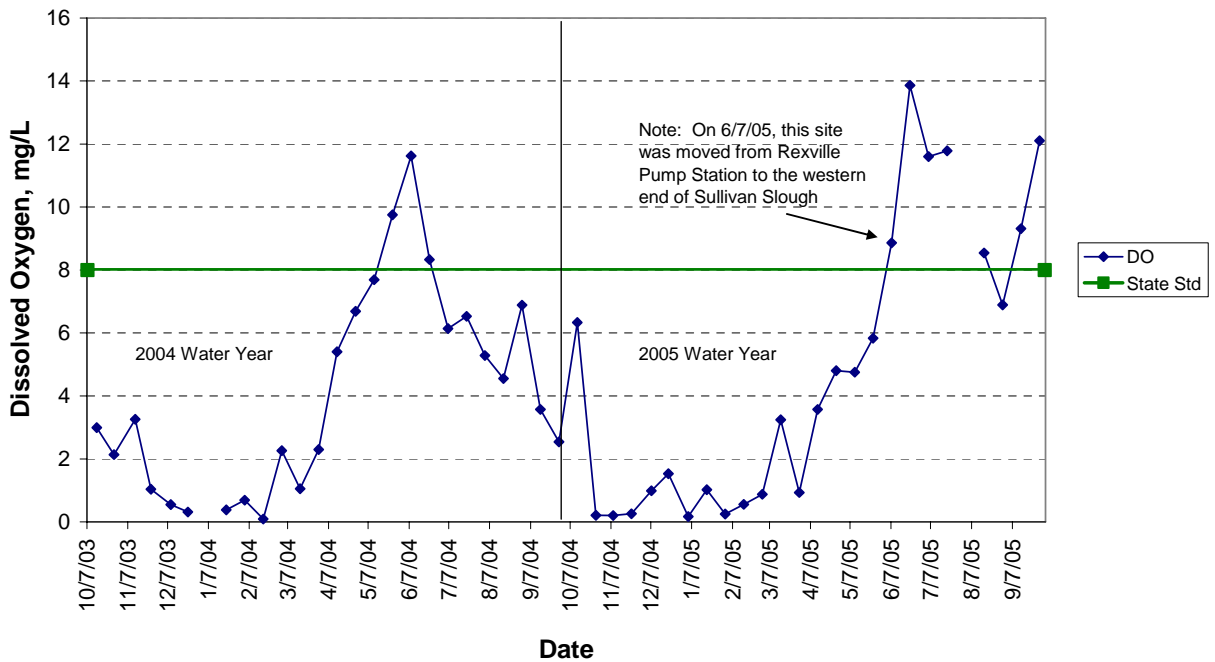
Carpenter Creek/Hill Ditch at Cedardale Rd - Site 42 Dissolved Oxygen



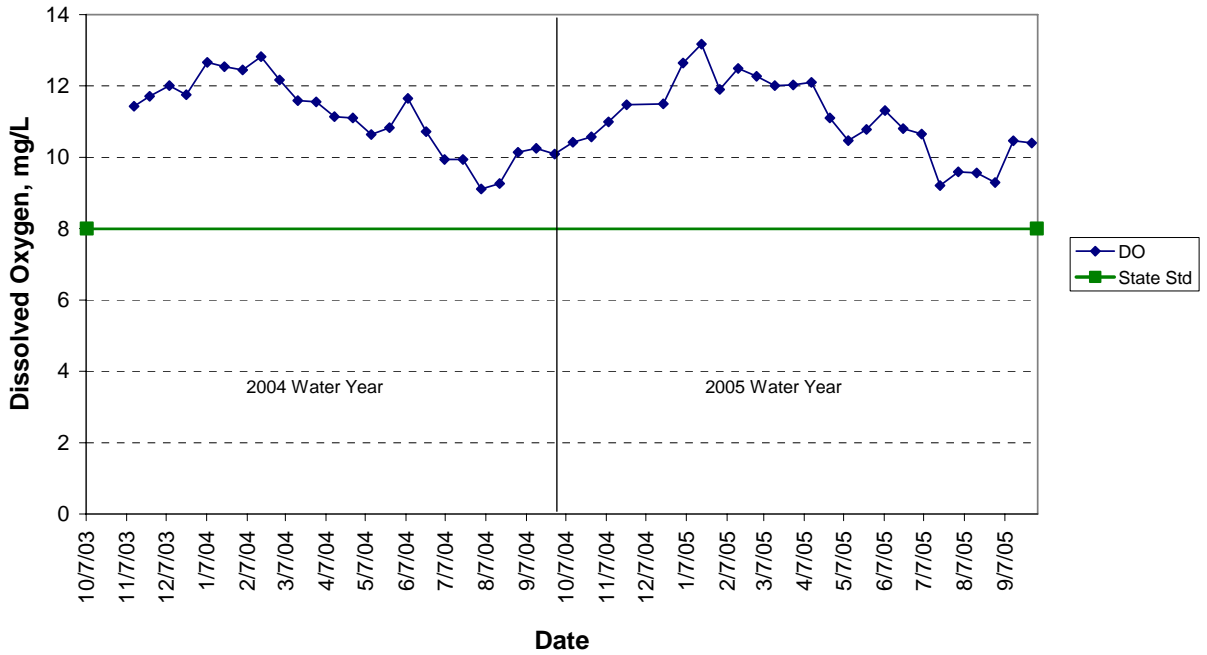
Wiley Slough at Wylie Rd - Site 43 Dissolved Oxygen



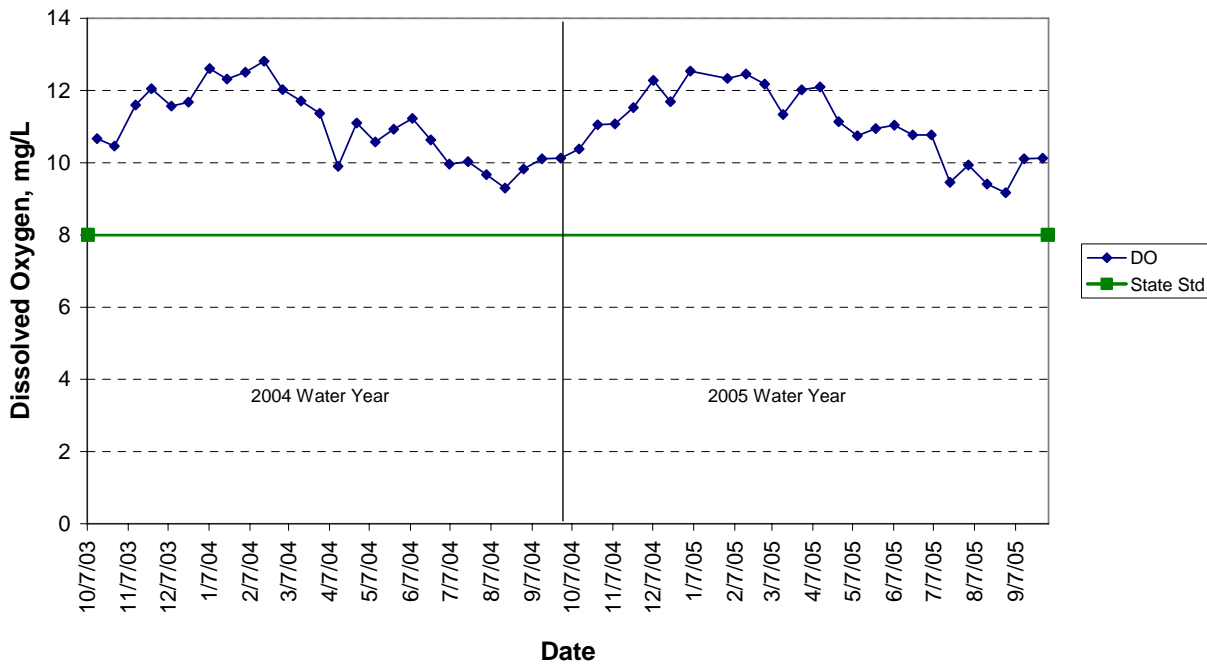
Sullivan Slough at LaConner-Whitney Rd - Site 44 Dissolved Oxygen



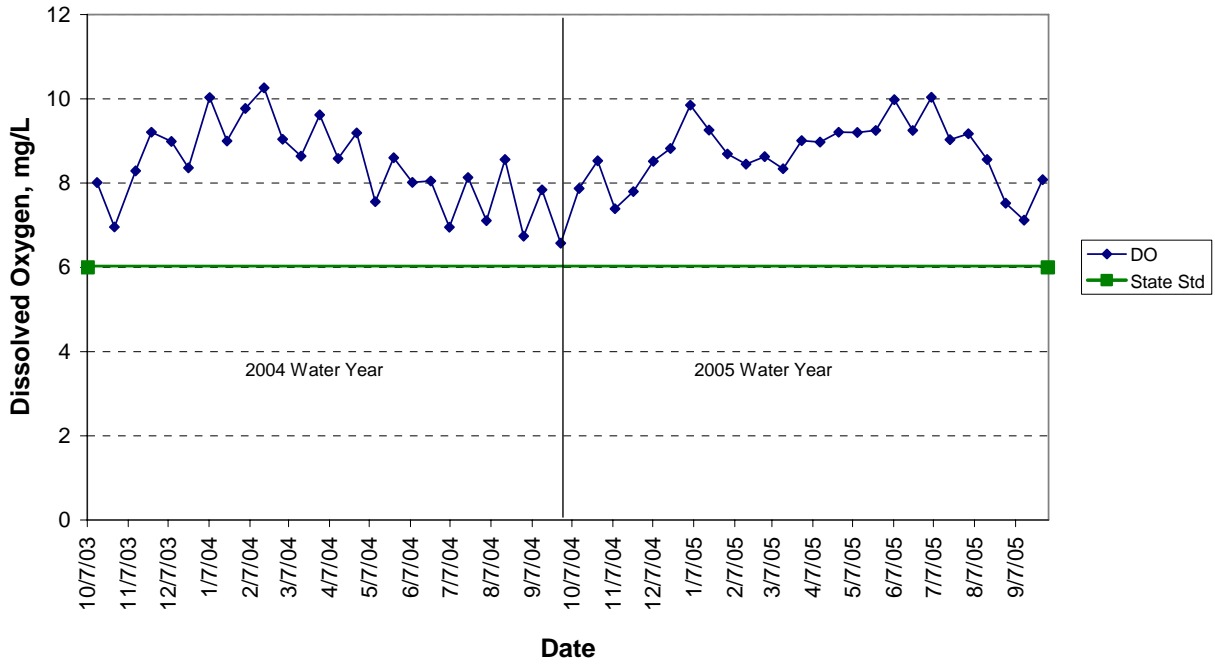
North Fork Skagit near Moore Rd - Site 45 Dissolved Oxygen



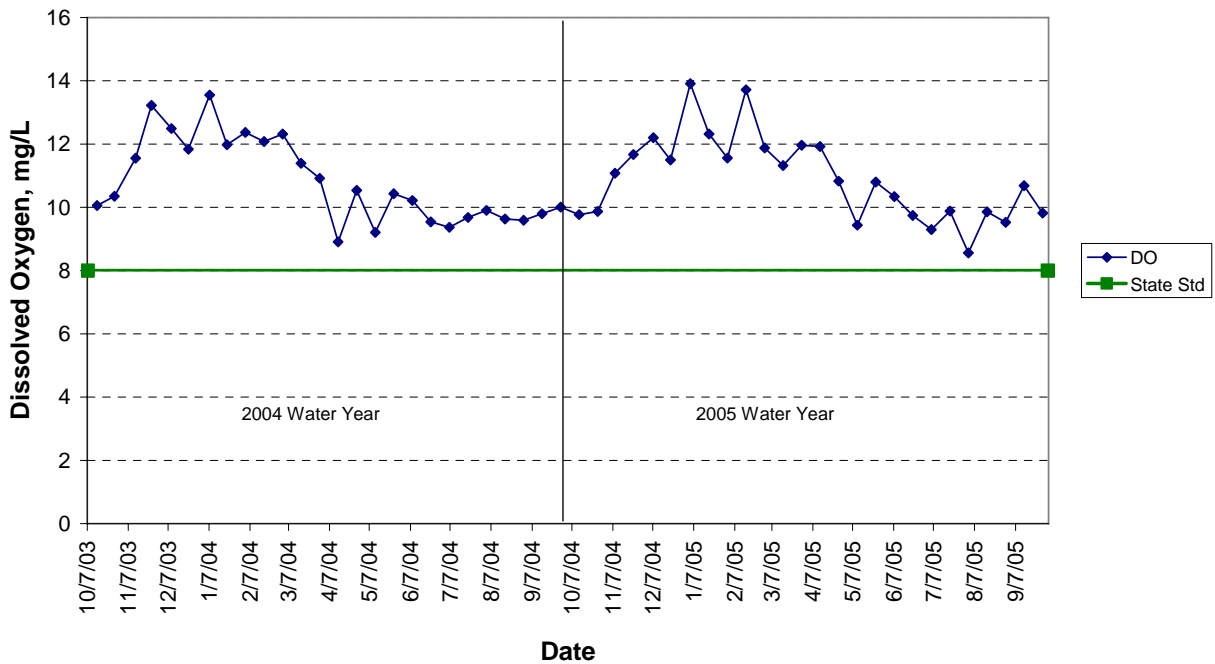
S.F. Skagit River at Conway Boat Ramp - Site 46 Dissolved Oxygen



Swinomish Channel at County Boat Ramp - Site 47 Dissolved Oxygen



Fisher Creek at Franklin Rd - Site 48 Dissolved Oxygen



Fecal Coliform

Fecal coliform is a measurement of the amount of enteric bacteria from warm-blooded animals present in a watercourse. Although fecal coliform measurements do not directly quantify disease-causing organisms, they serve as an indicator of the possible presence of such bacteria. Samples for fecal coliform measurements are taken at each site during each visit and submitted to the Skagit County Health Department Water Lab for analysis by the Most Probable Number method.

Fecal coliform measurements, in colony-forming units per 100 ml (cfu), are summarized in Table 5. State standards for fecal coliform 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 Skagit County Monitoring Program (sites 3-20, 28-29, 31-46, 48), fecal coliform is not to exceed a geometric mean of 100 cfu, with no more than 10% of the measurements exceeding 200 cfu. For the upriver sites (sites 21-25, 30), the standard is a geometric mean of 50 cfu, with no more than 10% of the measurements exceeding 100 cfu. For the marine site (site 47), a more stringent standard of 14 cfu with no more than 10% exceeding 41 cfu is enforced to protect shellfish beds.

All Skagit River sites (sites 29, 30, 45, and 46) and Swinomish Channel (site 47) met the state standard for fecal coliform during both the 2004 and 2005 water years. Most other watercourses in the Skagit County Monitoring Program did not meet the standard.

The sources of fecal coliform organisms reaching the watercourses of Skagit County could include runoff from failing septic tanks, livestock operations, wildlife, and pets. Methods to determine the sources of fecal coliform bacteria are under development but are expensive and not necessarily ready for widespread application.

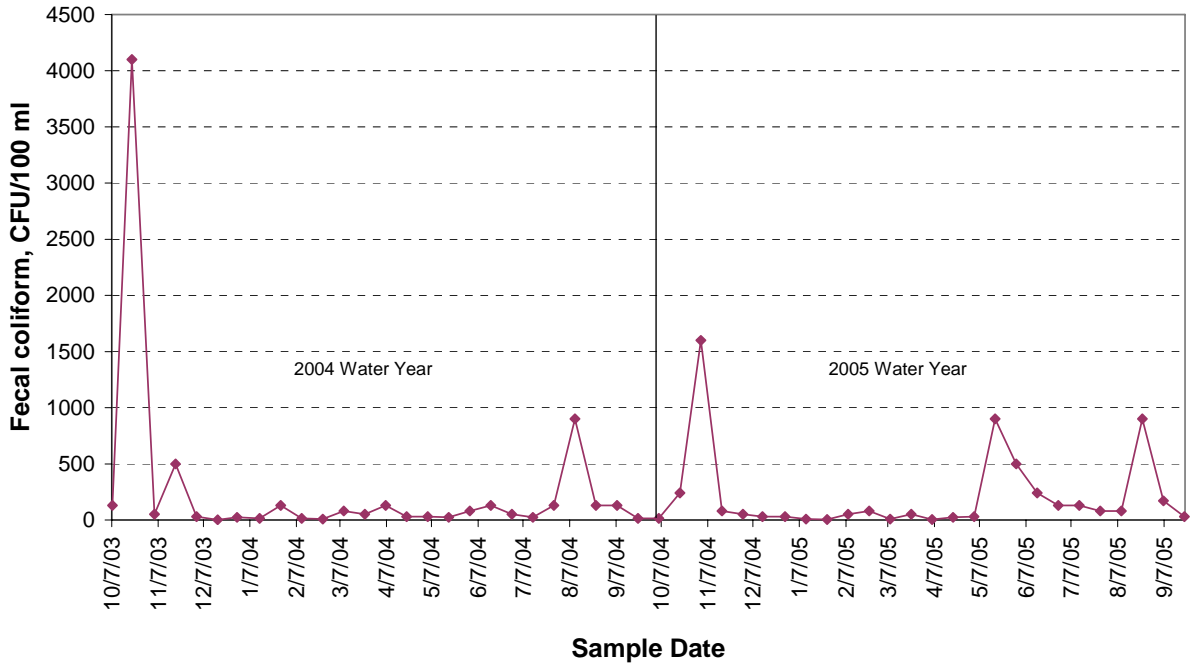
Graphs on the pages following Table 5 illustrate fecal coliform levels for water years 2004 and 2005 at each of the sample sites. The scale on each graph differs in order to fully illustrate the variability at each site.

Table 5. Summary of fecal coliform readings in Skagit County Monitoring Program, 2005 Water Year

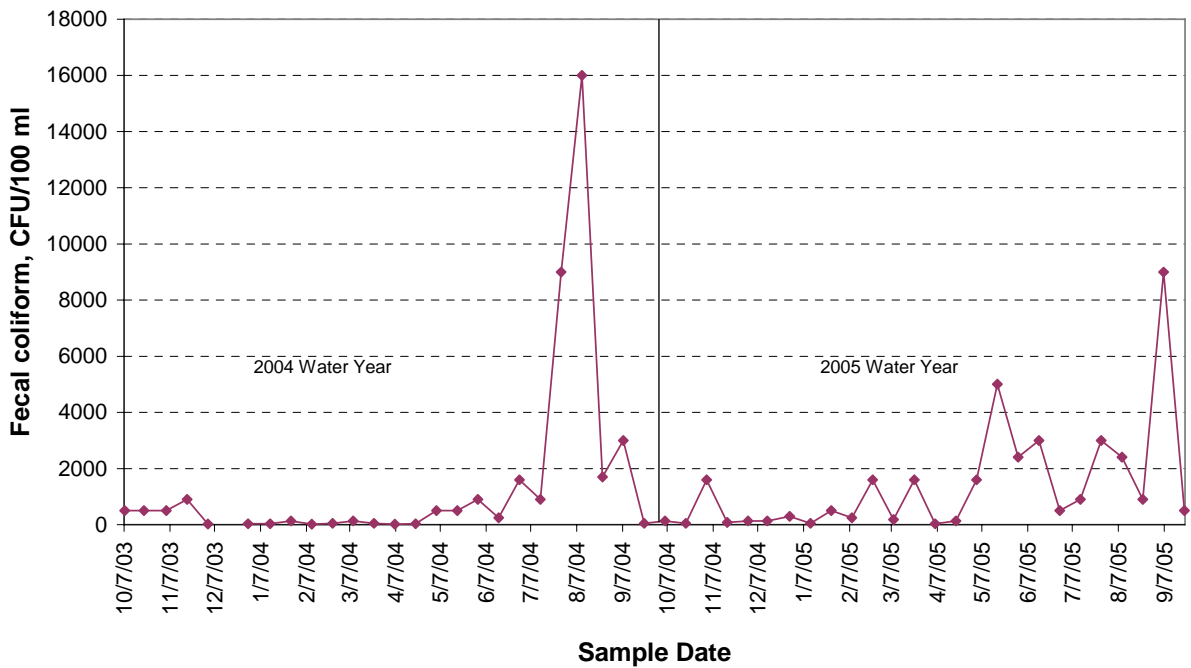
Site Number	Watercourse	Location	N	Geometric mean (cfu) ¹	% > 100 or 200 ¹
3	Thomas Ck	Old Hwy 99 North	26	65	23
4	Thomas Ck	F&S Grade	26	516	65
6	Friday Ck	Prairie Rd	26	24	12
8	Swede Ck	Grip Rd	26	83	31
11	Samish R	State Route 9	26	15	4
12	Nookachamps Ck	Swan Rd	26	64	23
13	E.F. Nookachamps Ck	State Route 9	26	44	15
14	College Way Ck	College Way	26	143	46
15	Nookachamps Ck	Knapp	26	71	15
16	E.F. Nookachamps Ck	Beaver Lake Rd	26	28	19
17	Nookachamps Ck	Big Lake Outlet	25	11	4
18	Lake Ck	State Route 9	26	50	27
19	Hansen Ck	Hoehn Rd	26	54	35
20	Hansen Ck	Northern State	26	43	8
21	Coal Ck	Hoehn Rd	22	112	41
22	Coal Ck	Hwy 20	26	8	8
23	Wiseman Ck	Minkler Rd	26	13	12
24	Mannser Ck	Lyman Hamilton Hwy	26	21	27
25	Red Cabin Ck	Hamilton Cem Rd	22	8	5
28	Brickyard Ck	Hwy 20	19	41	26
29	Skagit R	R Bend Rd	25	10	0
30	Skagit R	Cape Horn Rd	25	3	0
31	Drain Dist 20 near floodgate	Francis Rd	17	46	24
32	Samish R	Thomas Rd	26	86	19
33	Alice Bay Pump Station	Samish Island Rd	26	92	23
34	Noname Slough	Bayview-Edison Rd	26	214	58
35	Joe Leary Slough	D'Arcy Rd	25	108	40
36	Edison Slough at school	W. Bow Hill Rd	26	42	35
37	Edison Pump Station	Farm to Market Rd	26	162	46
38	North Edison Pump Station	North Edison Rd	26	70	31
39	Colony Ck	Colony Rd	26	100	35
40	Big Indian Slough	Bayview-Edison Rd	26	43	31
41	Maddox Slough/Big Ditch	Milltown Rd	26	30	12
42	Hill Ditch	Cedardale Rd	24	18	0
43	Wiley Slough	Wylie Rd	26	80	27
44	Rexville PS/Sullivan Slough	La Conner-Whitney Rd	26	20	15
45	Skagit R – North Fork	Moore Rd	25	9	0
46	Skagit R – South Fork	Fir Island Rd	25	13	4
47	Swinomish Channel	County Boat Launch	26	3	0
48	Fisher Ck	Franklin Rd	25	96	20

¹State water quality standard 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) 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.

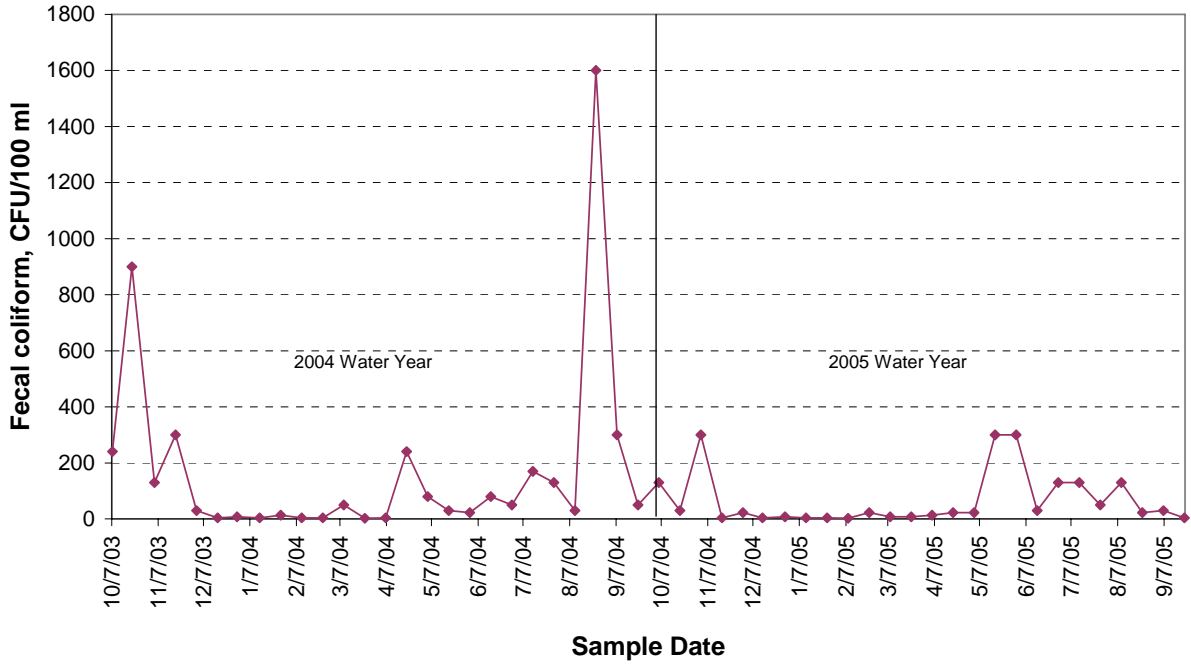
Thomas Creek at Hwy 99 - Site 3 Fecal coliform



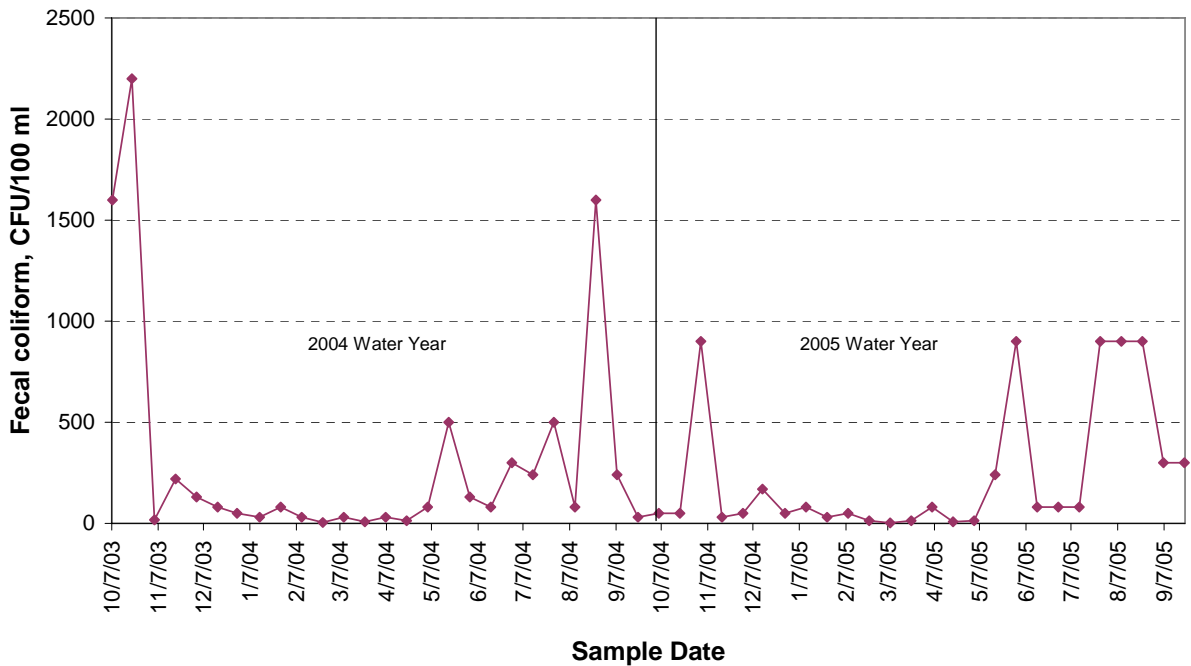
Thomas Creek at F&S Grade Rd - Site 4 Fecal coliform



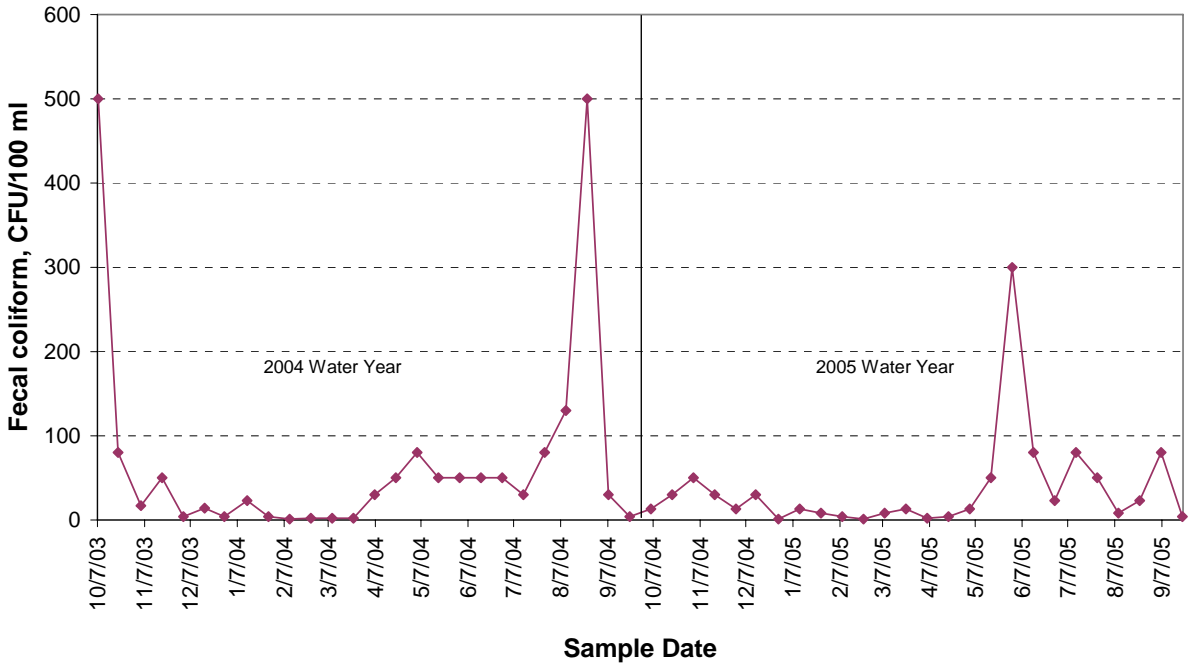
Friday Creek at Prairie Rd - Site 6 Fecal coliform



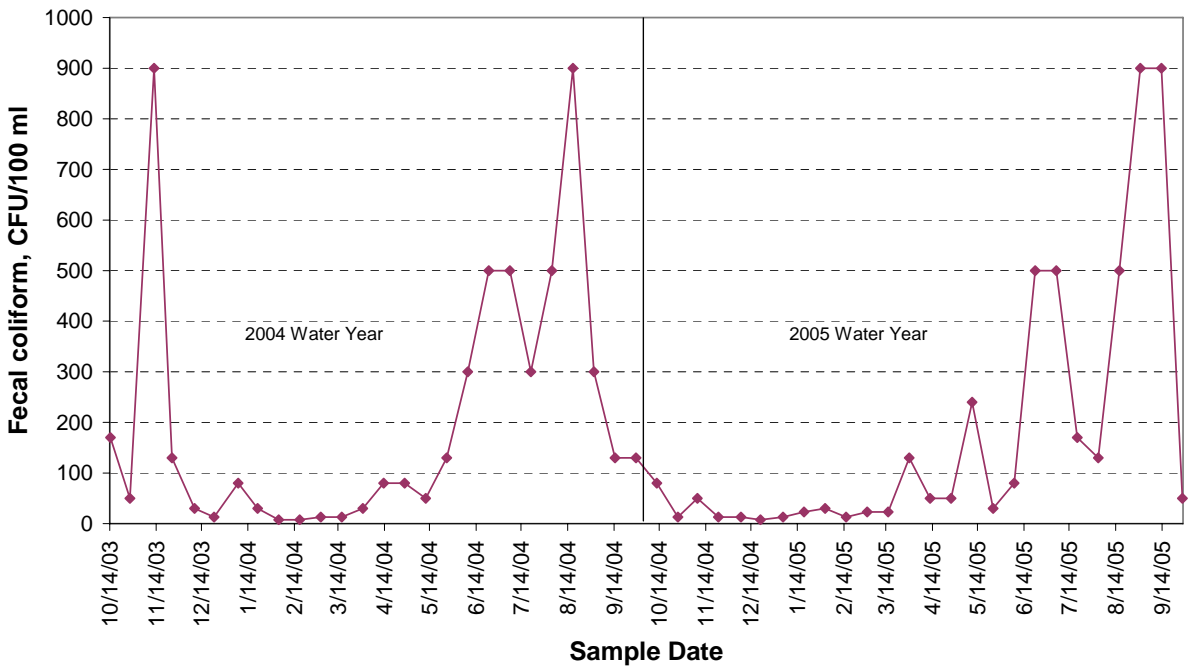
Swede Creek at Grip Rd - Site 8 Fecal coliform



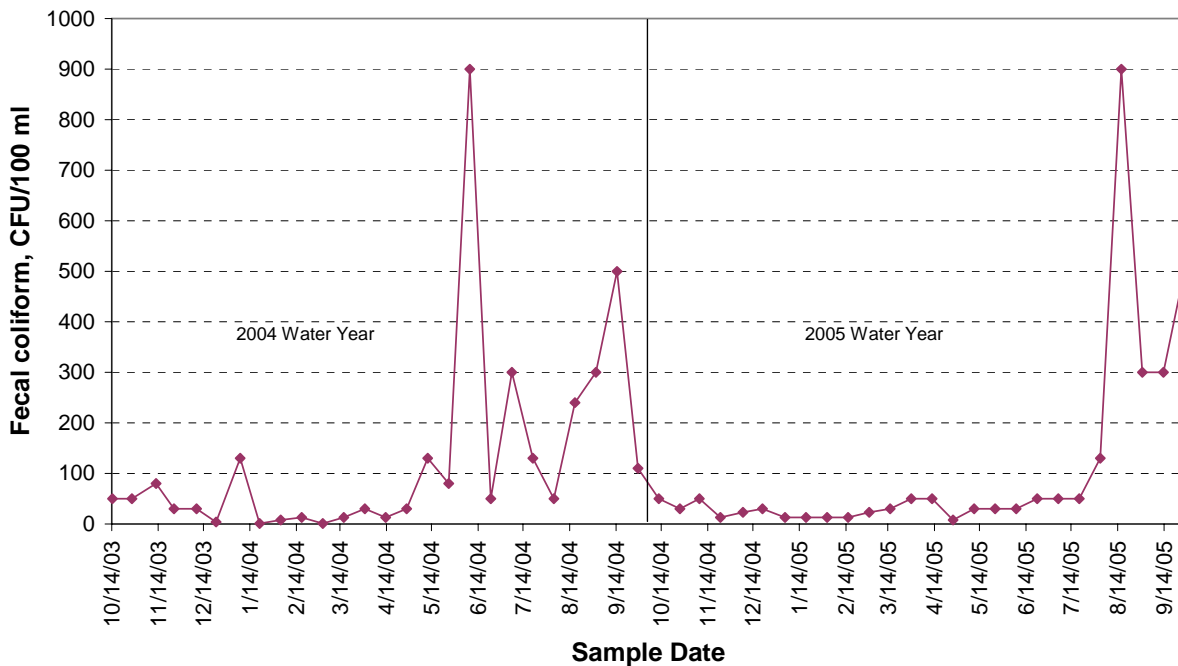
Samish River at Hwy 9 - Site 11 Fecal coliform



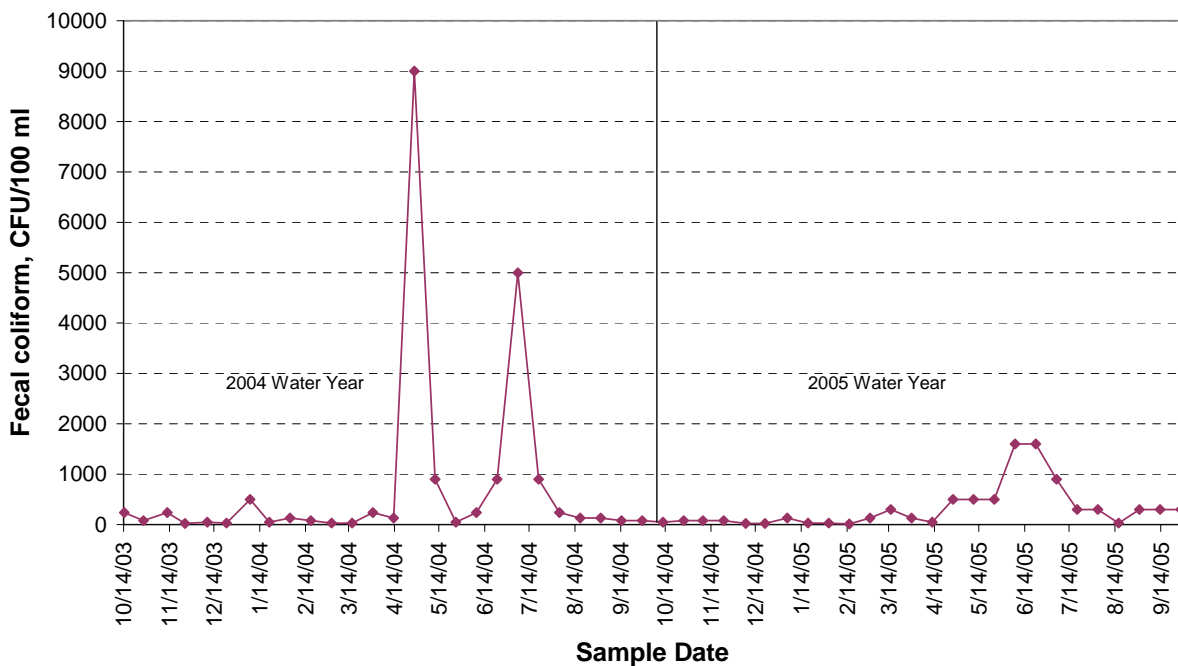
Nookachamps Creek at Swan Rd - Site 12 Fecal coliform



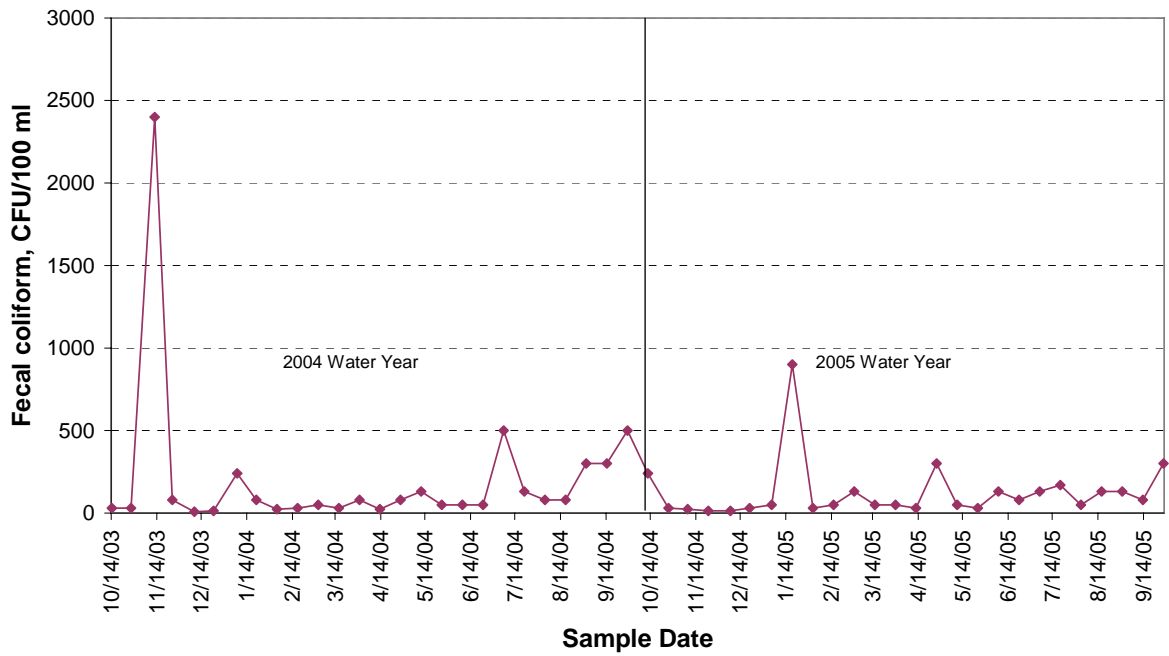
E.F. Nookachamps Creek at Hwy 9 - Site 13 Fecal coliform



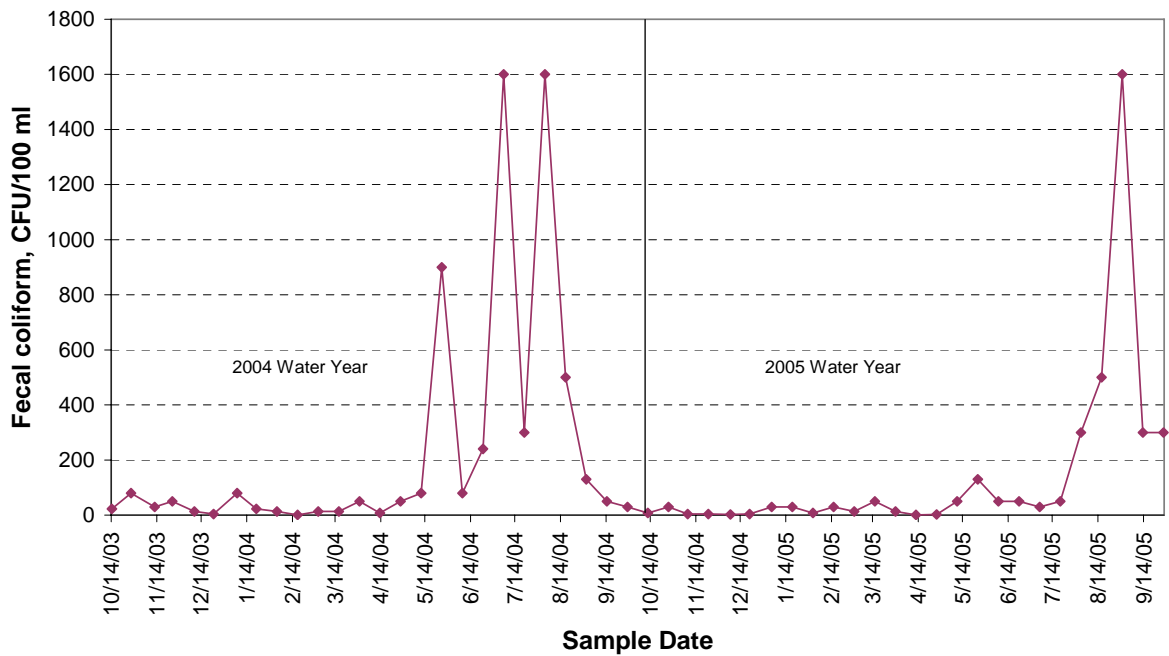
College Way Creek at College Way - Site 14 Fecal coliform



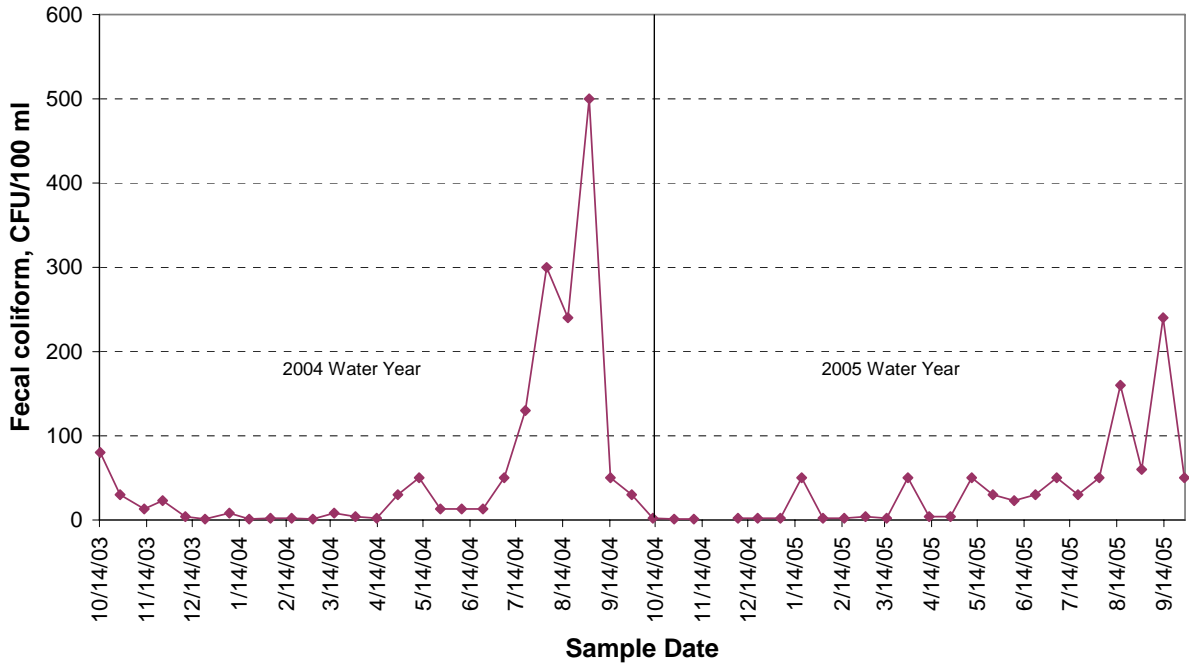
Nookachamps Creek at Swan Rd - Site 15 Fecal coliform



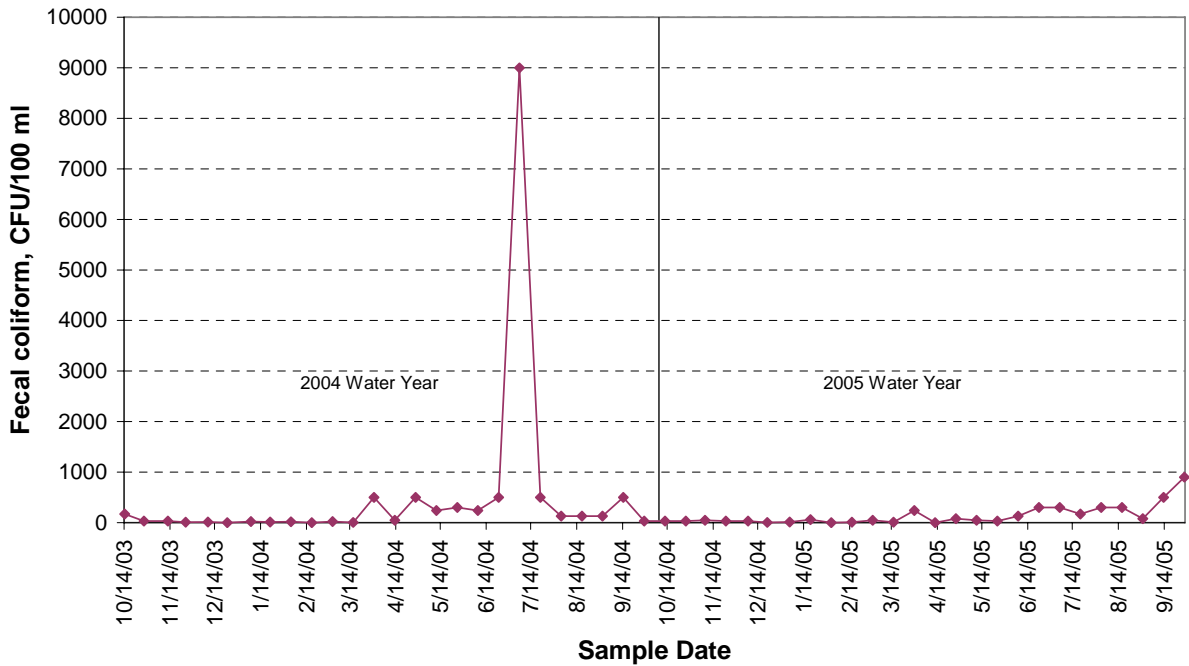
E.F. Nookachamps Creek at Beaver Lake Rd - Site 16 Fecal coliform



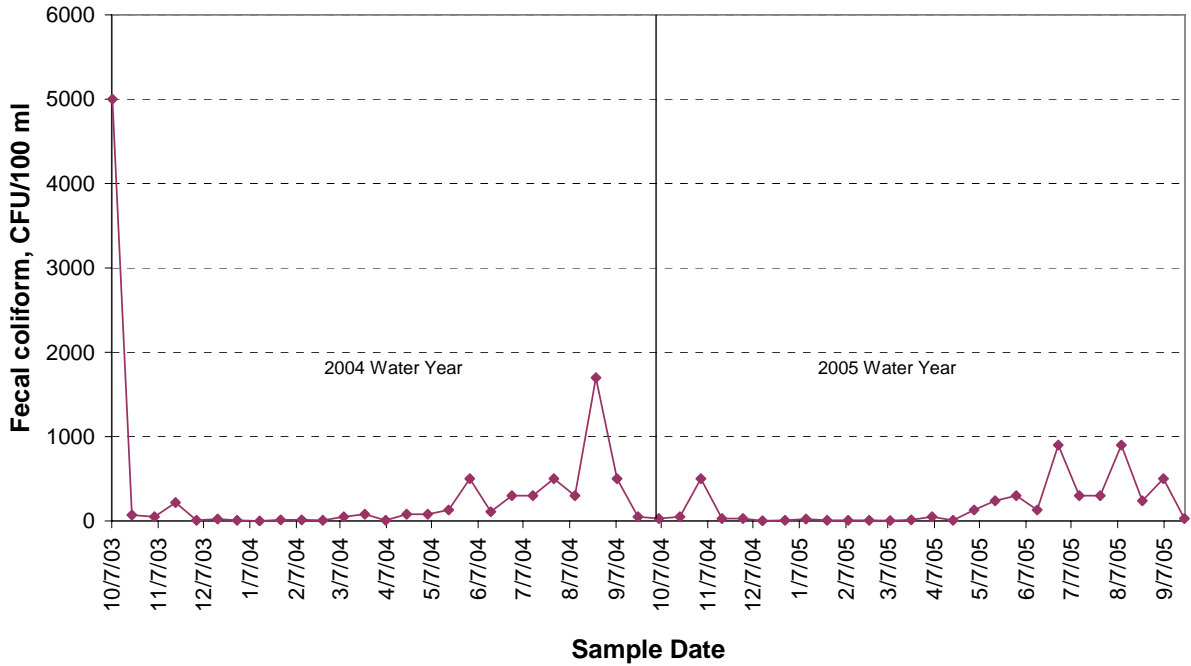
Nookachamps Creek at Big Lake Outlet - Site 17 Fecal coliform



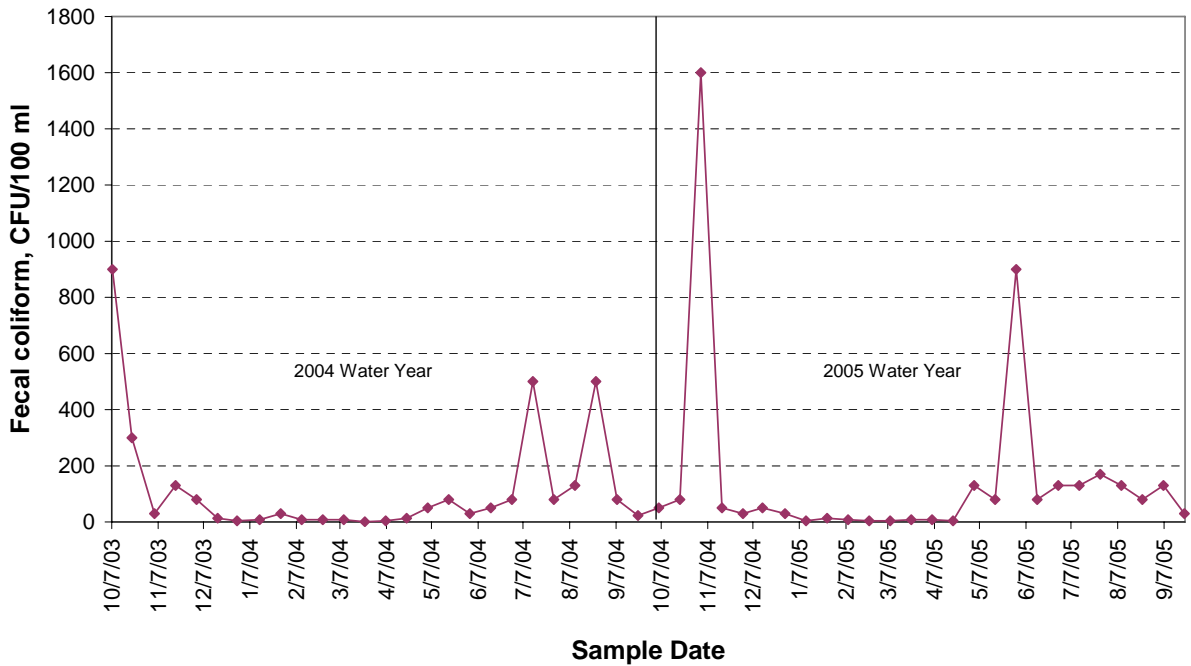
Lake Creek at Hwy 9 - Site 18 Fecal coliform



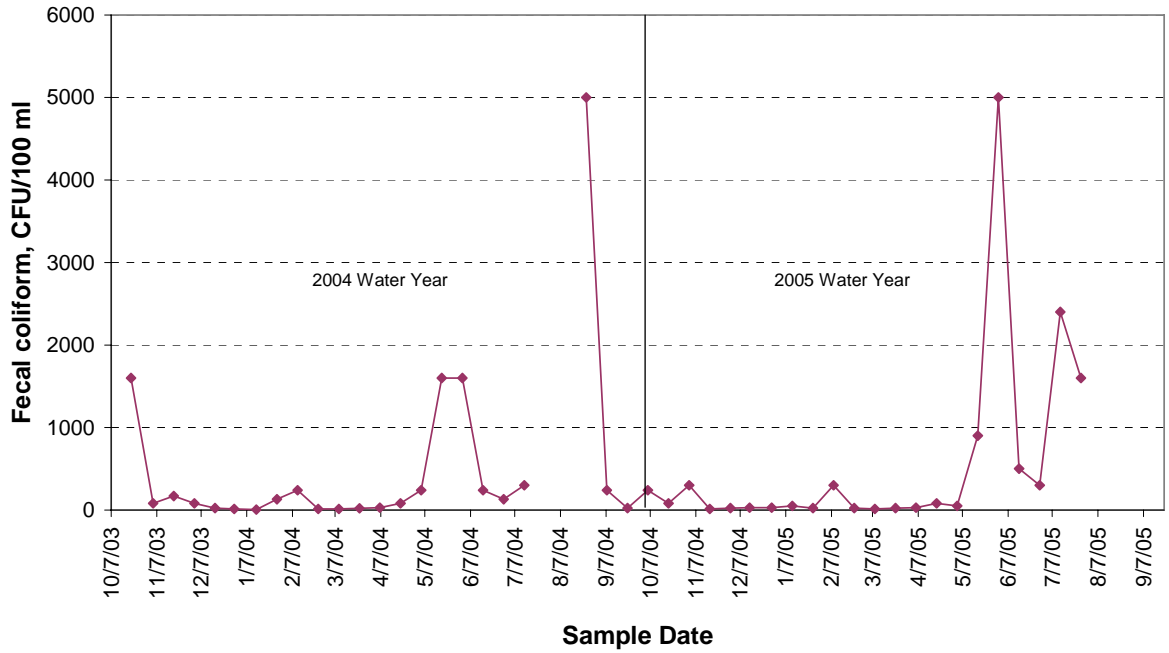
Hansen Creek at Hoehn Rd - Site 19 Fecal coliform



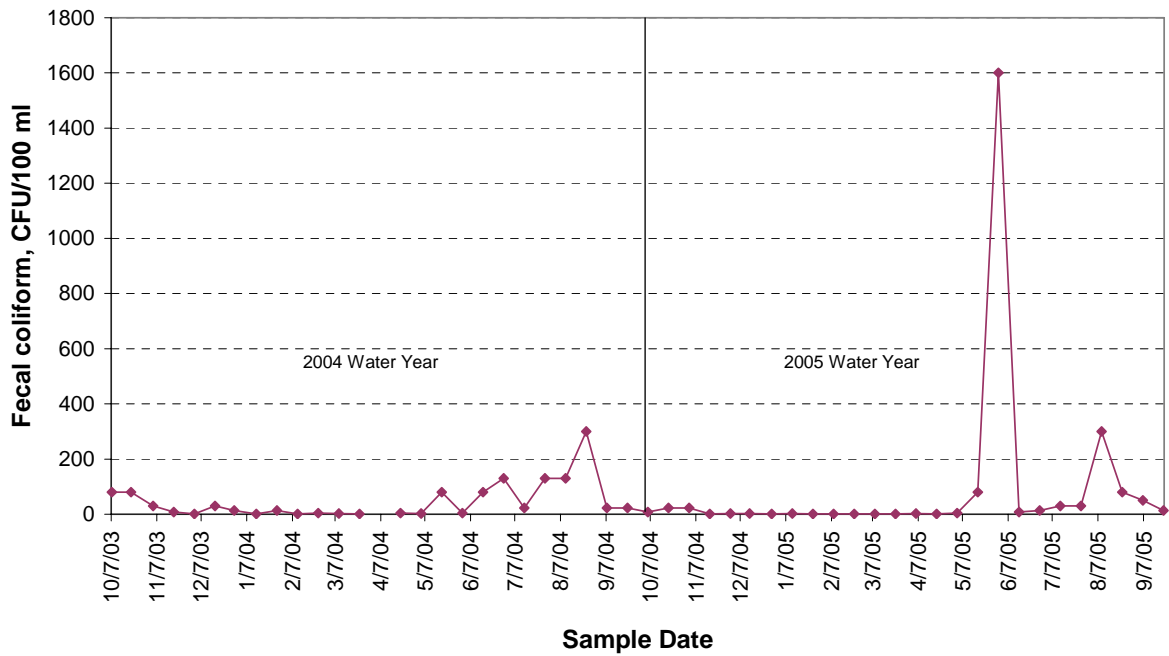
Hansen Creek at Northern State Hospital - Site 20 Fecal coliform



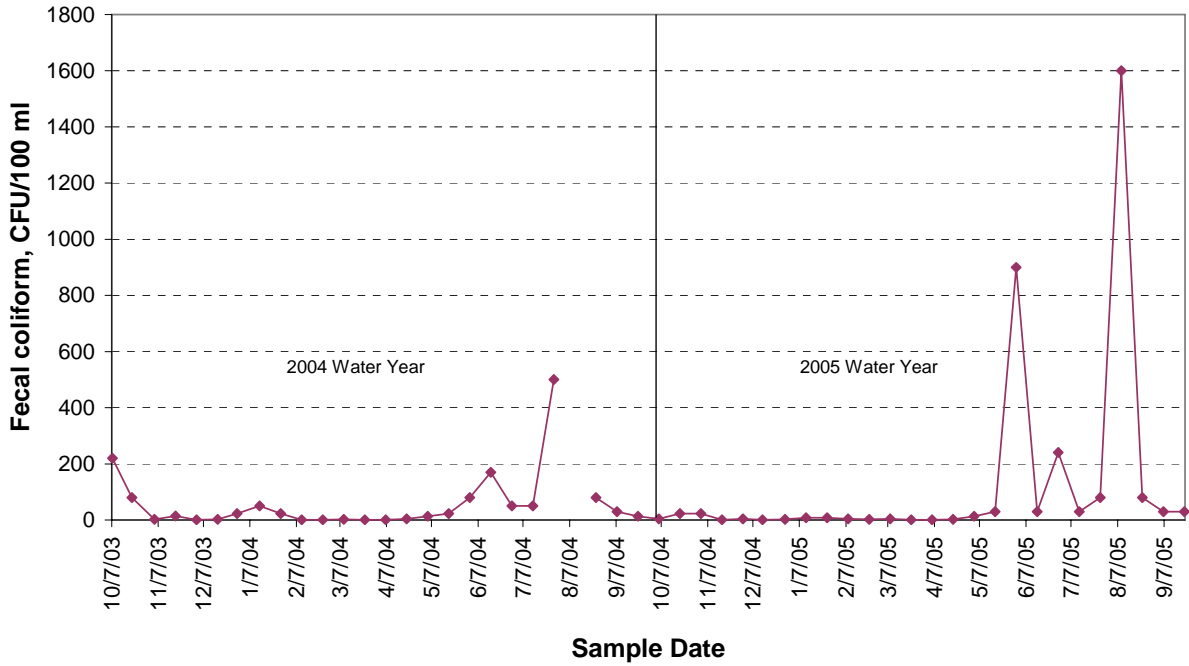
Coal Creek at Hoehn Rd - Site 21 Fecal coliform



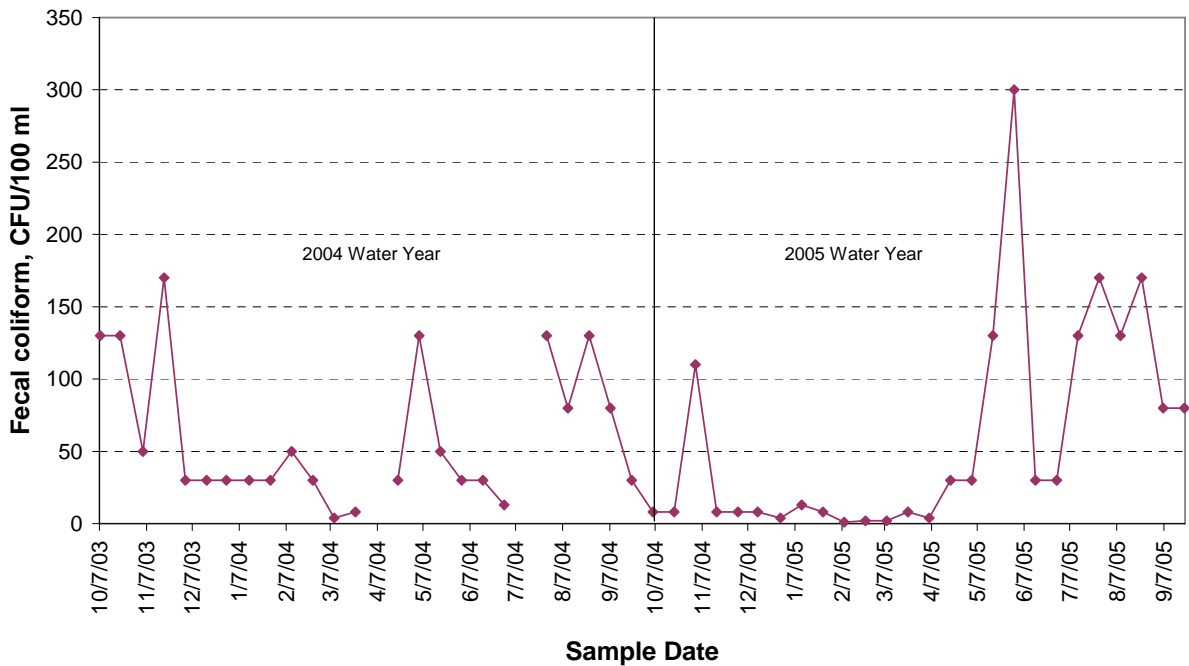
Coal Creek at Hwy 20 - Site 22 Fecal coliform



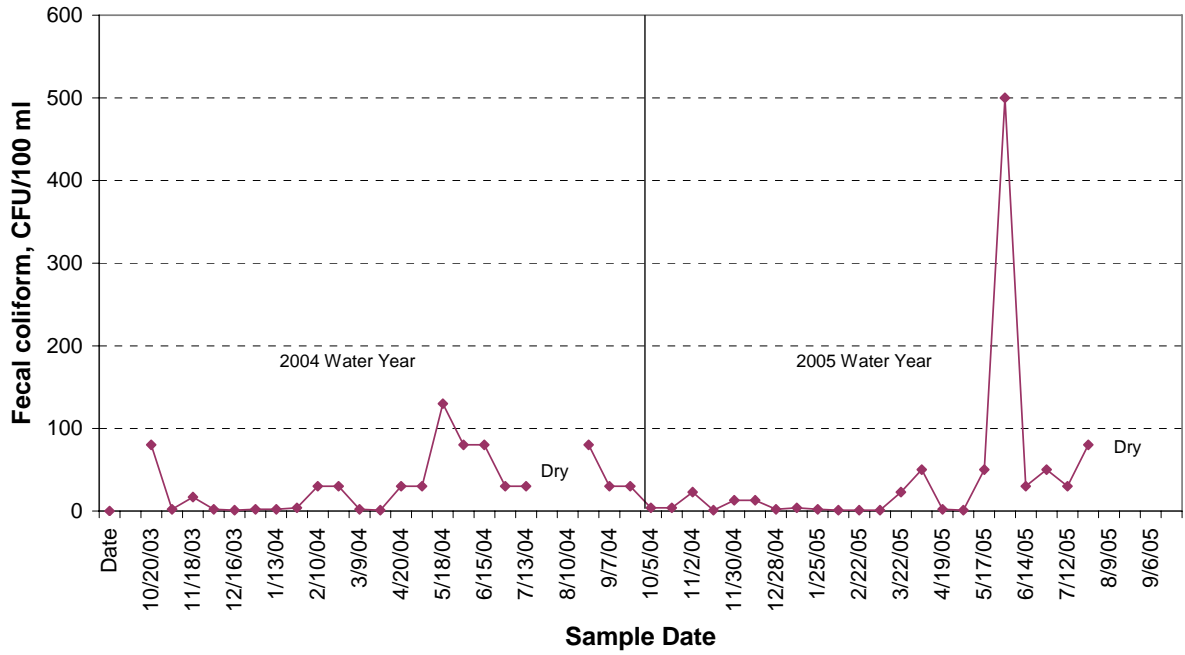
Wiseman Creek at Minkler Rd - Site 23 Fecal coliform



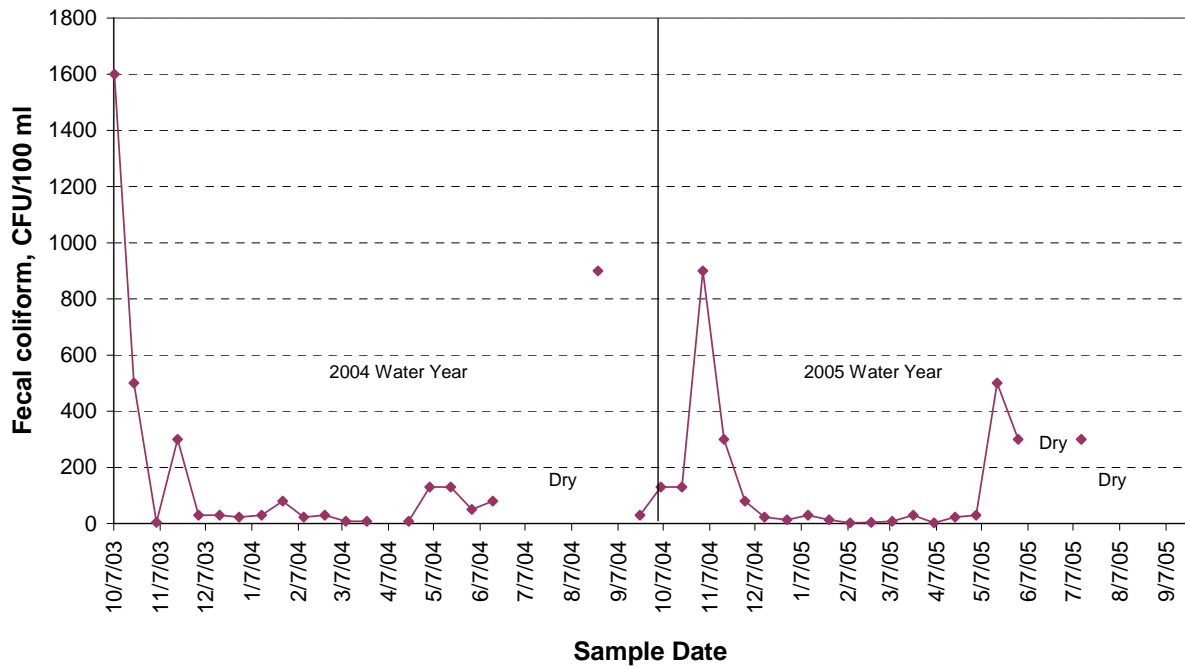
Mannser Creek at Lyman-Hamilton Hwy - Site 24 Fecal coliform



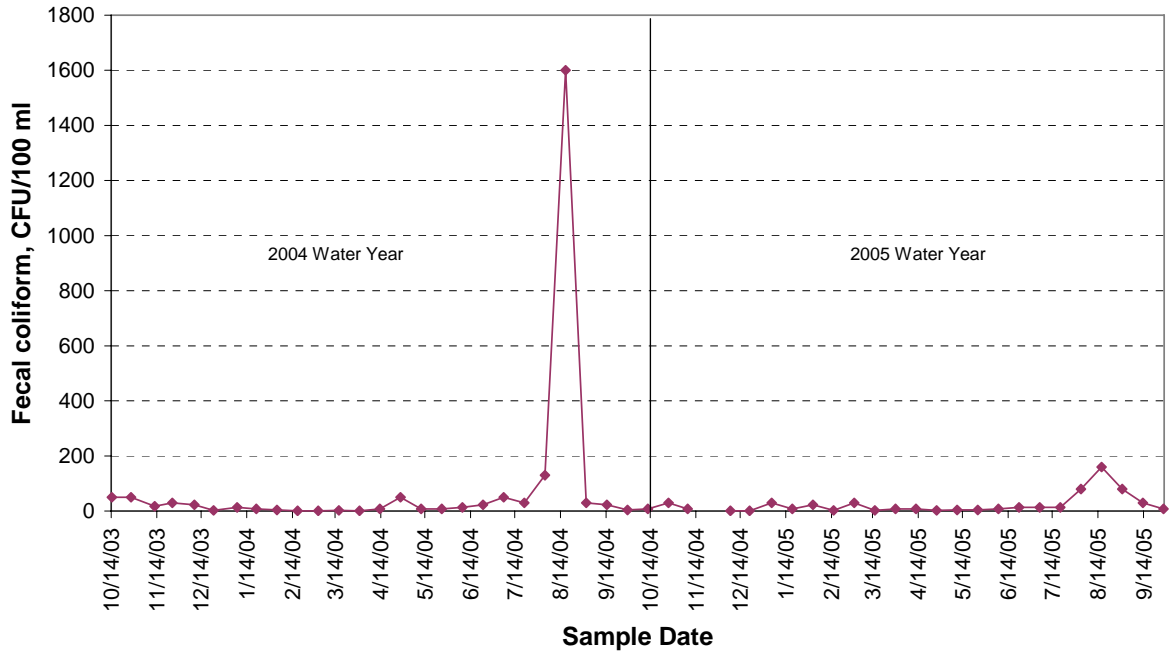
Red Cabin Creek at Hamilton Cemetery Rd - Site 25 Fecal coliform



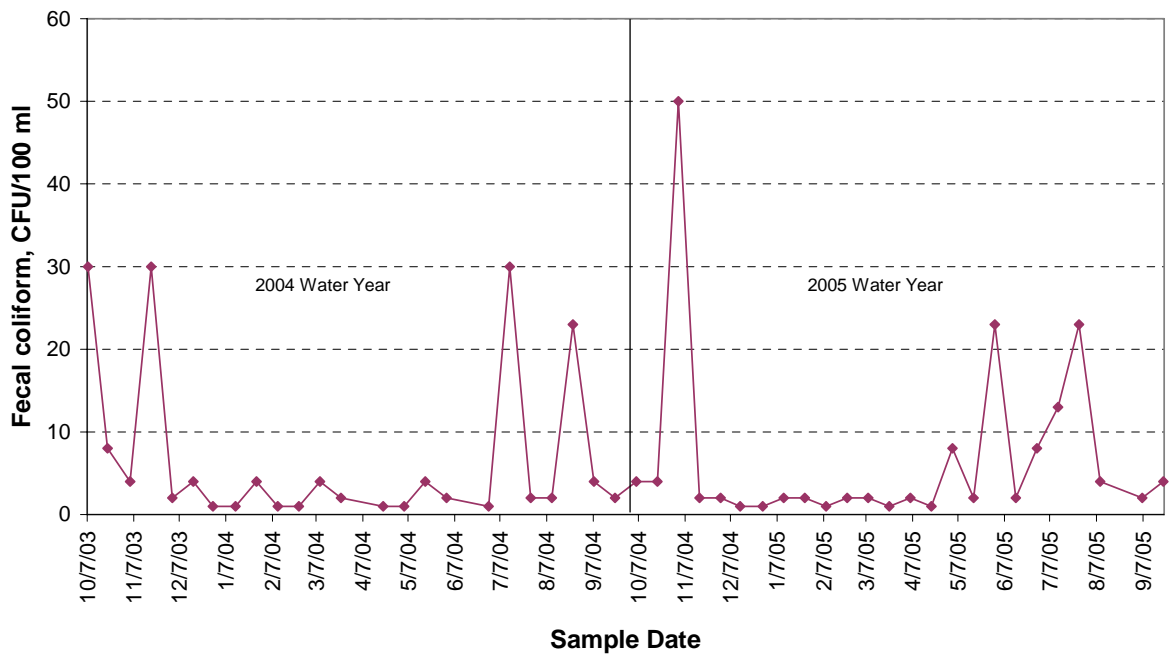
Brickyard Creek at Hwy 20 - Site 28 Fecal coliform



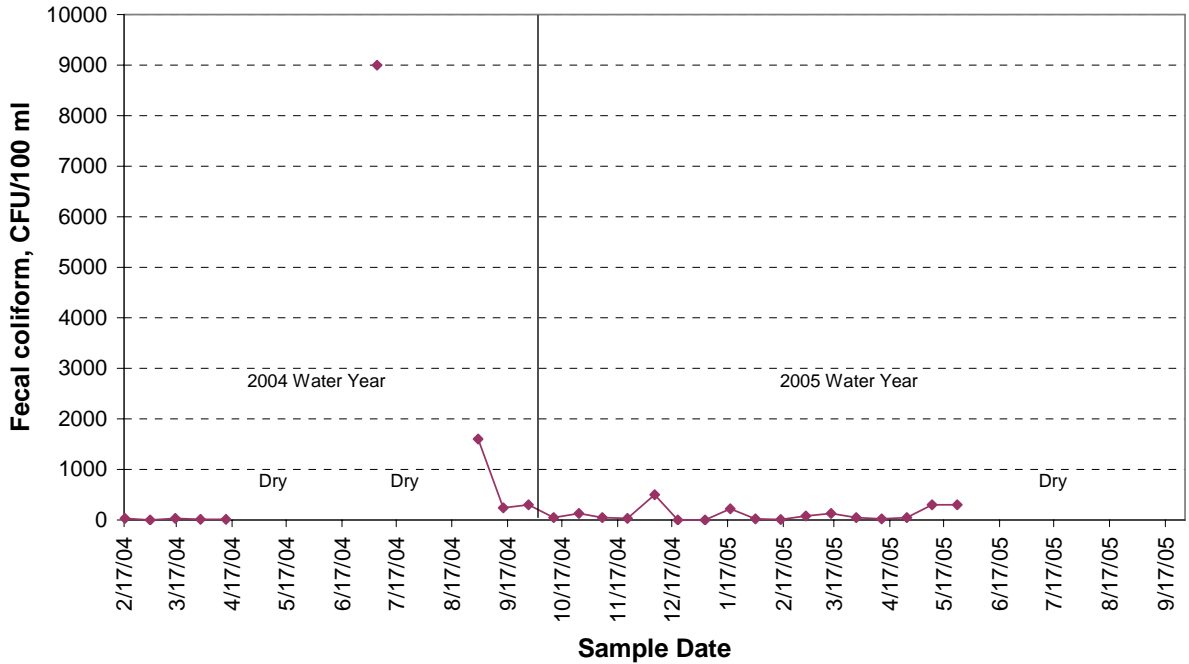
Skagit River at River Bend - Site 29 Fecal coliform



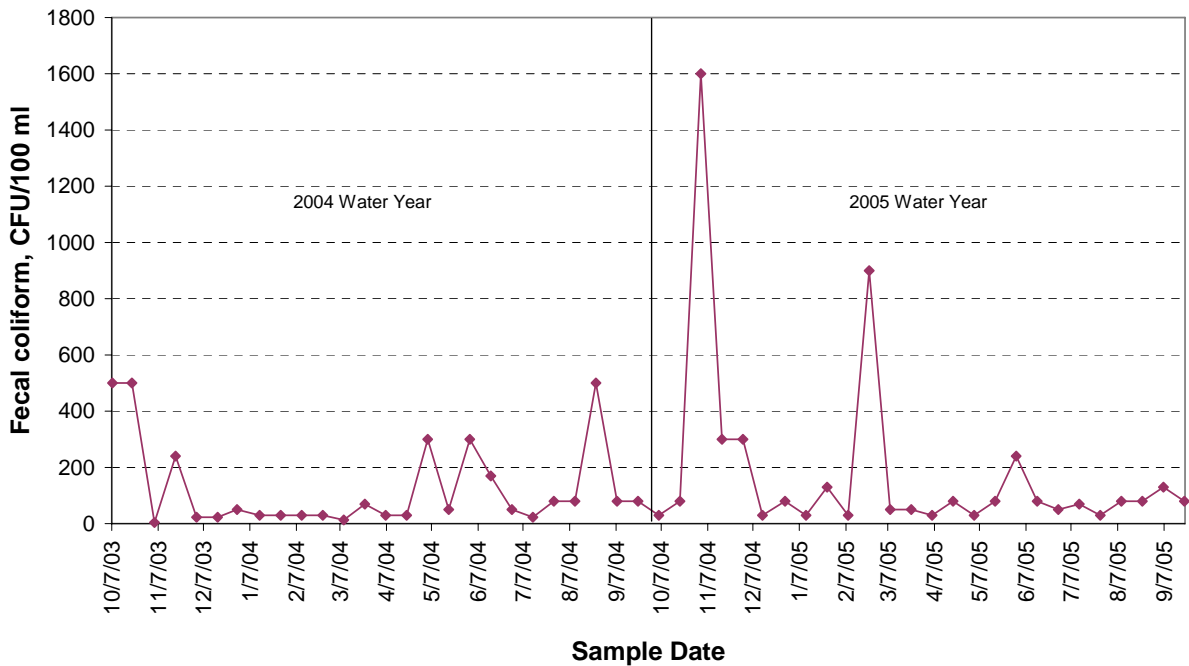
Skagit River at Cape Horn Rd - Site 30 Fecal coliform



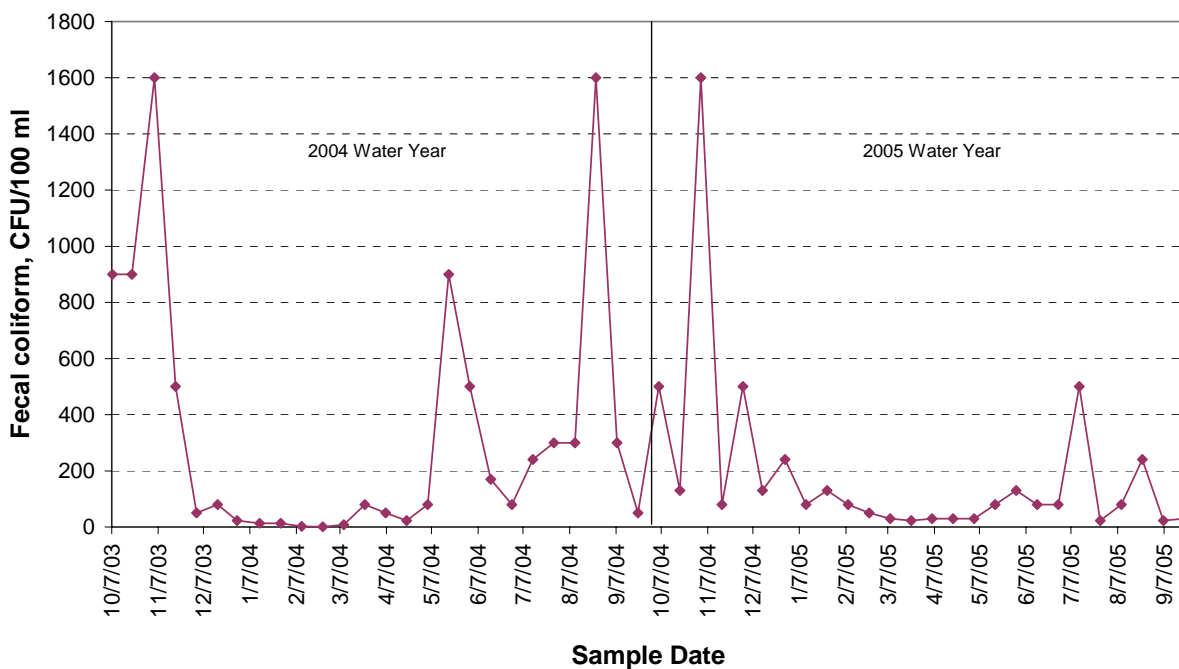
Drainage District 20 Ditch at Floodgate - Site 31 Fecal coliform



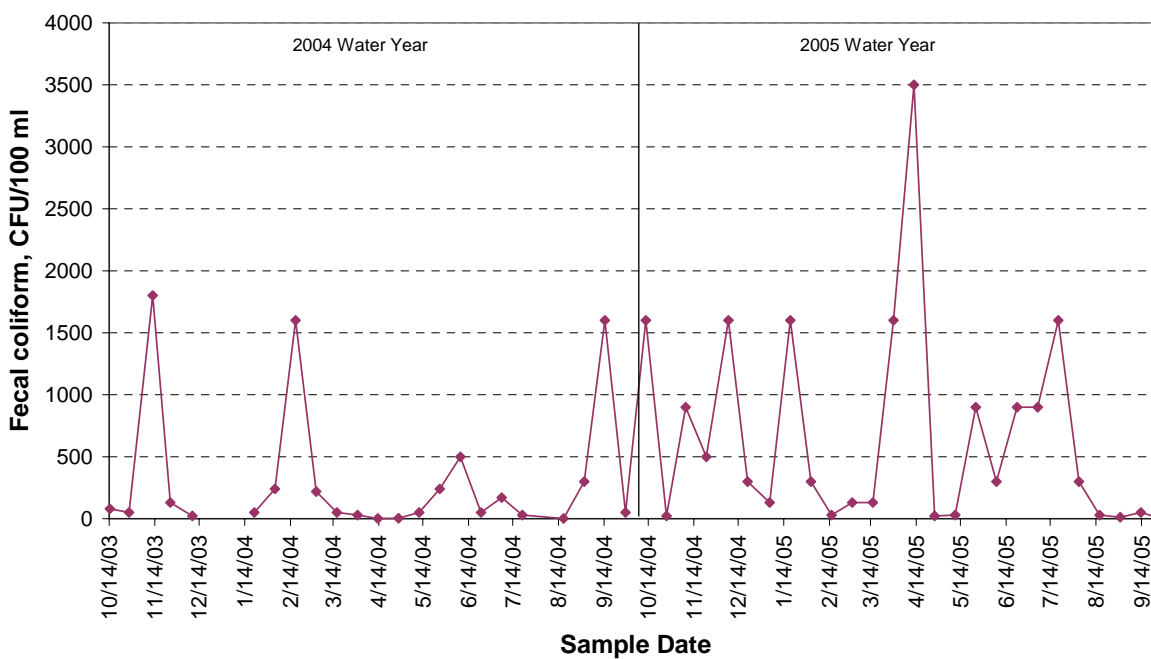
Samish River at Thomas Rd - Site 32 Fecal coliform



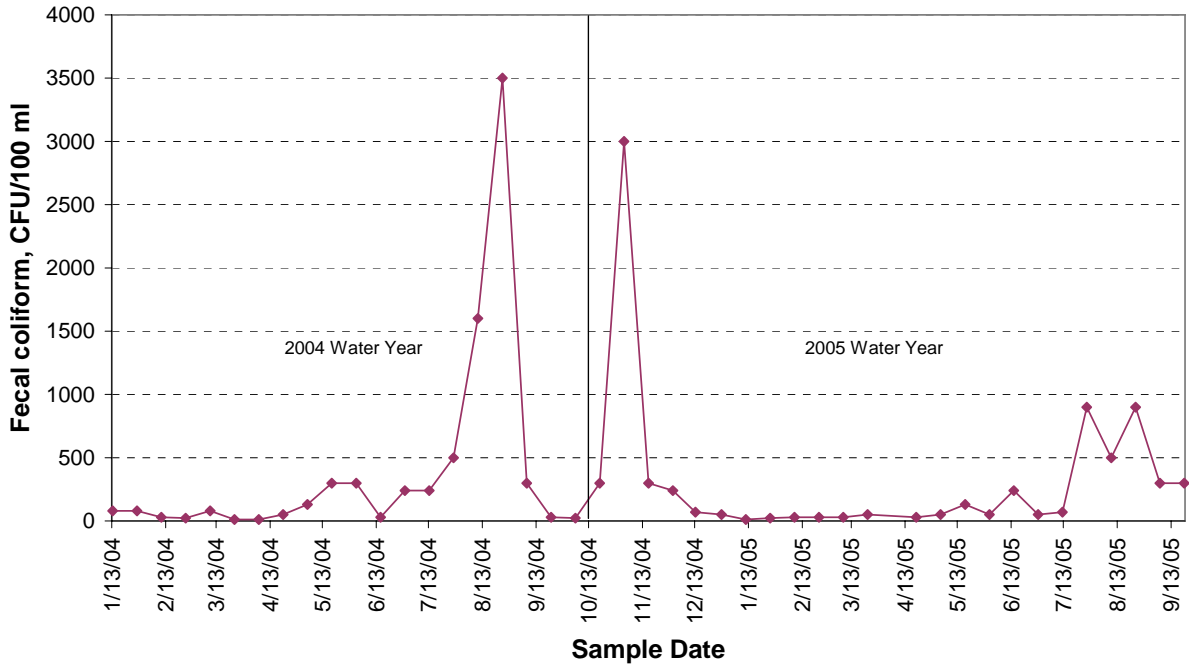
Alice Bay Pump Station - Site 33 Fecal coliform



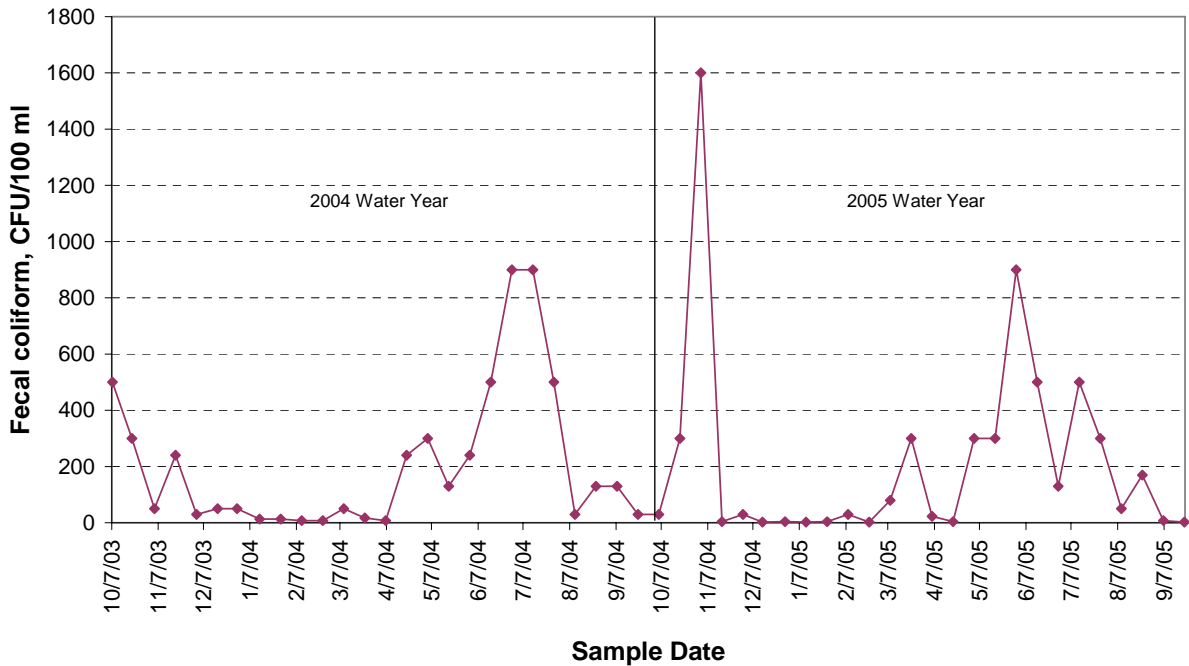
No Name Slough at Bayview-Edison Rd - Site 34 Fecal coliform



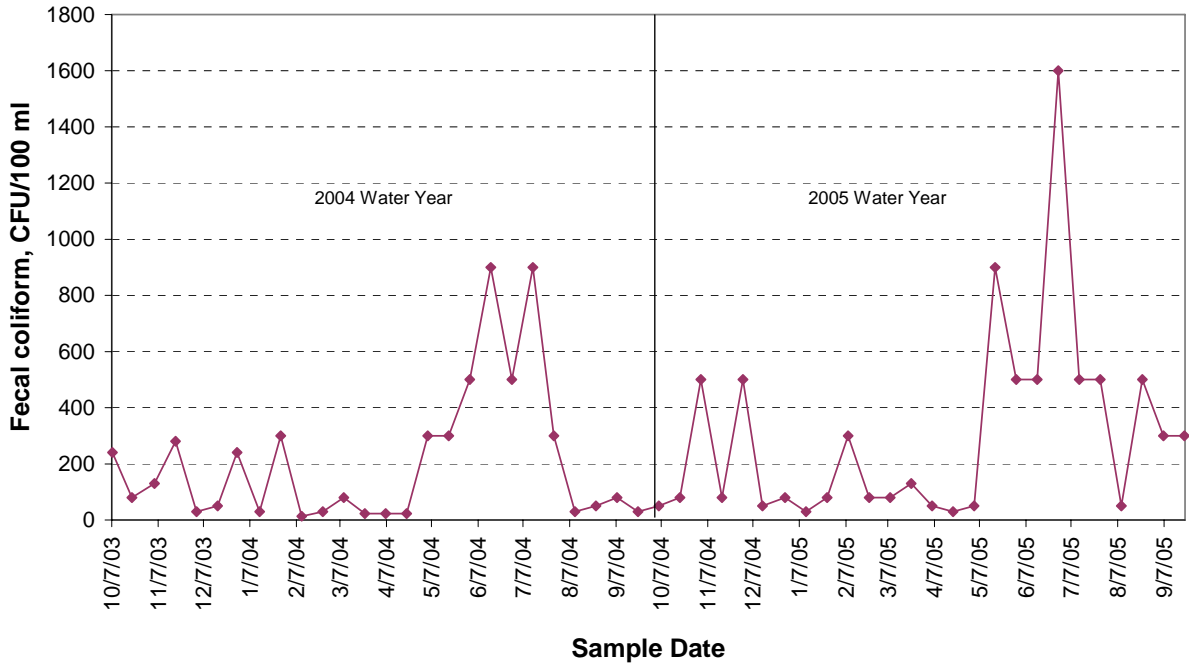
Joe Leary Slough at D'Arcy Rd - Site 35 Fecal coliform



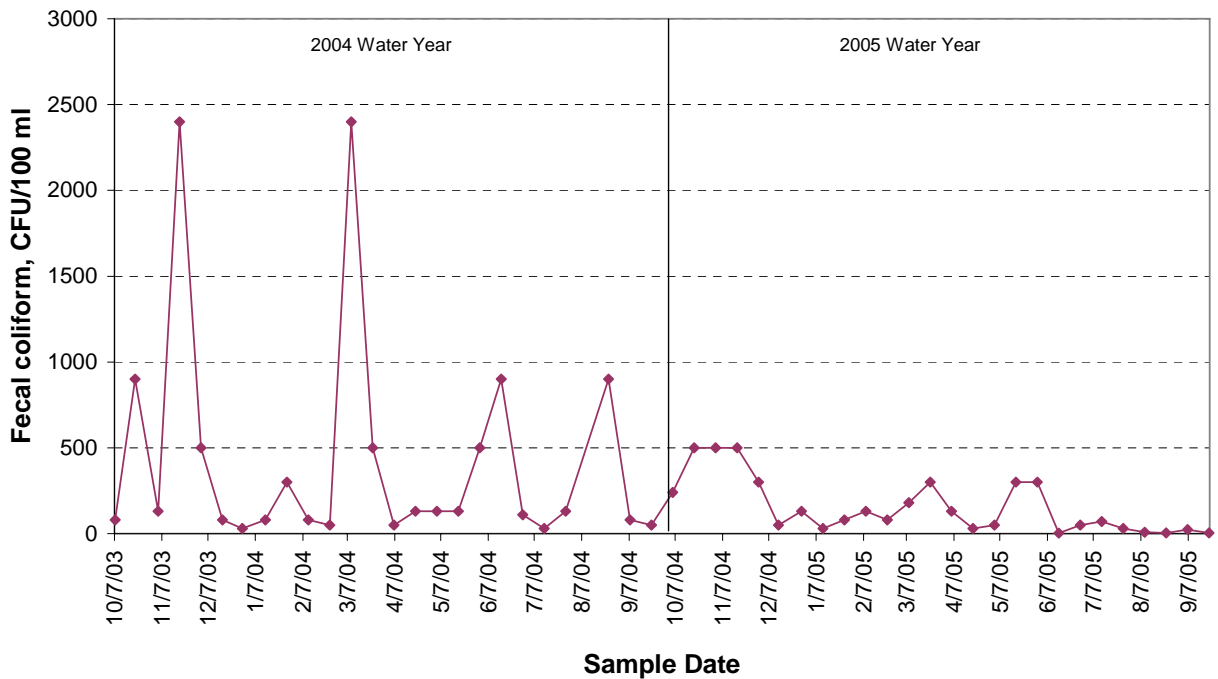
Edison Slough at Edison School - Site 36 Fecal coliform



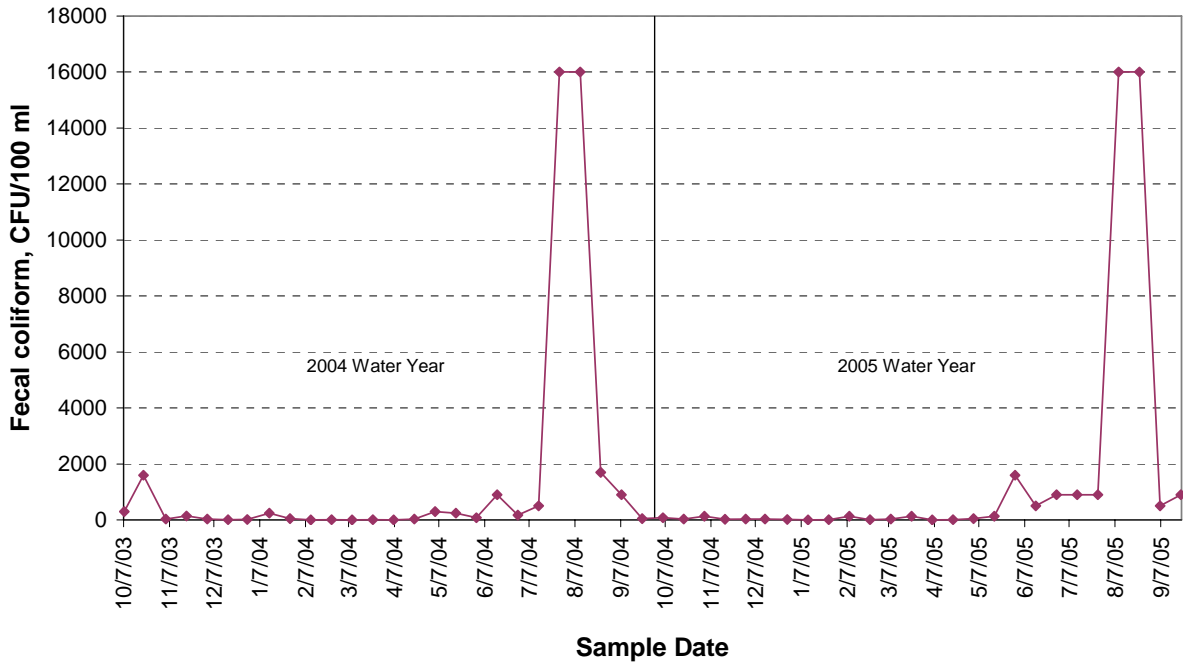
Edison Pump Station - Site 37 Fecal coliform



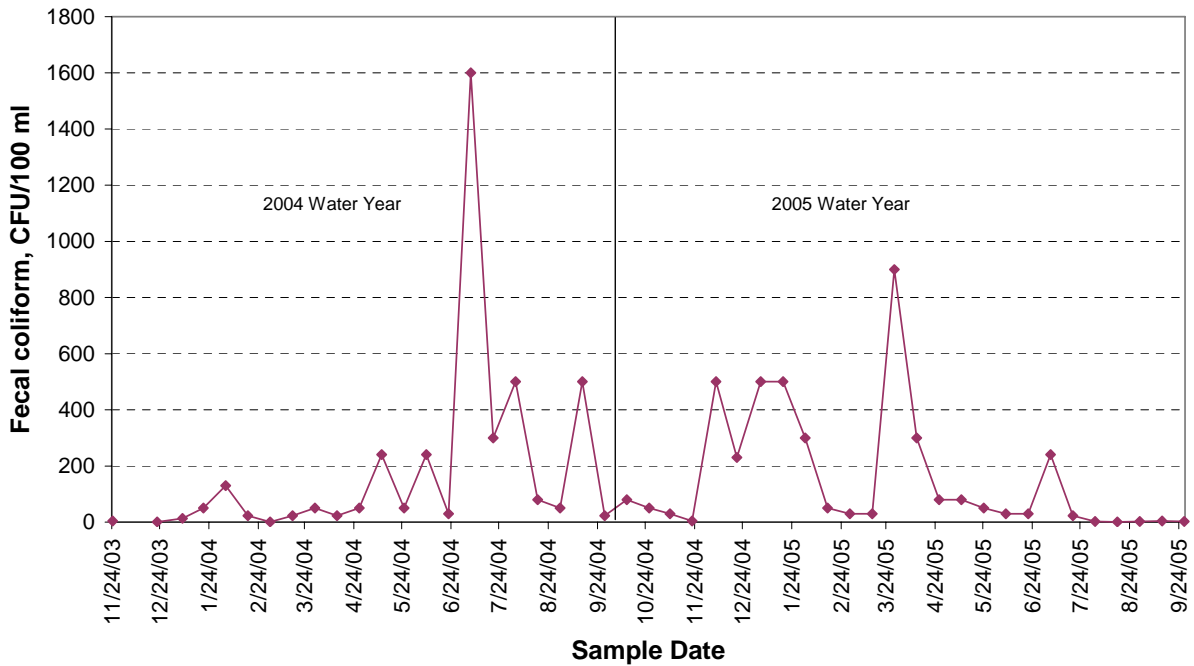
North Edison Pump Station - Site 38 Fecal coliform



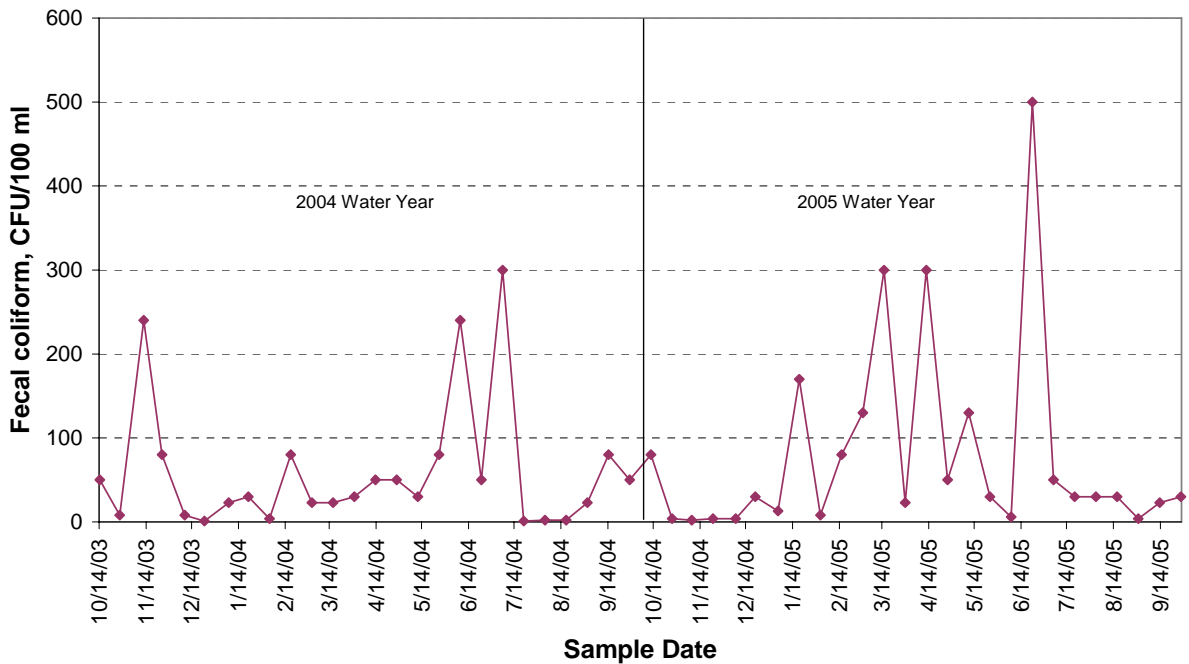
Colony Creek at Colony Rd - Site 39 Fecal coliform



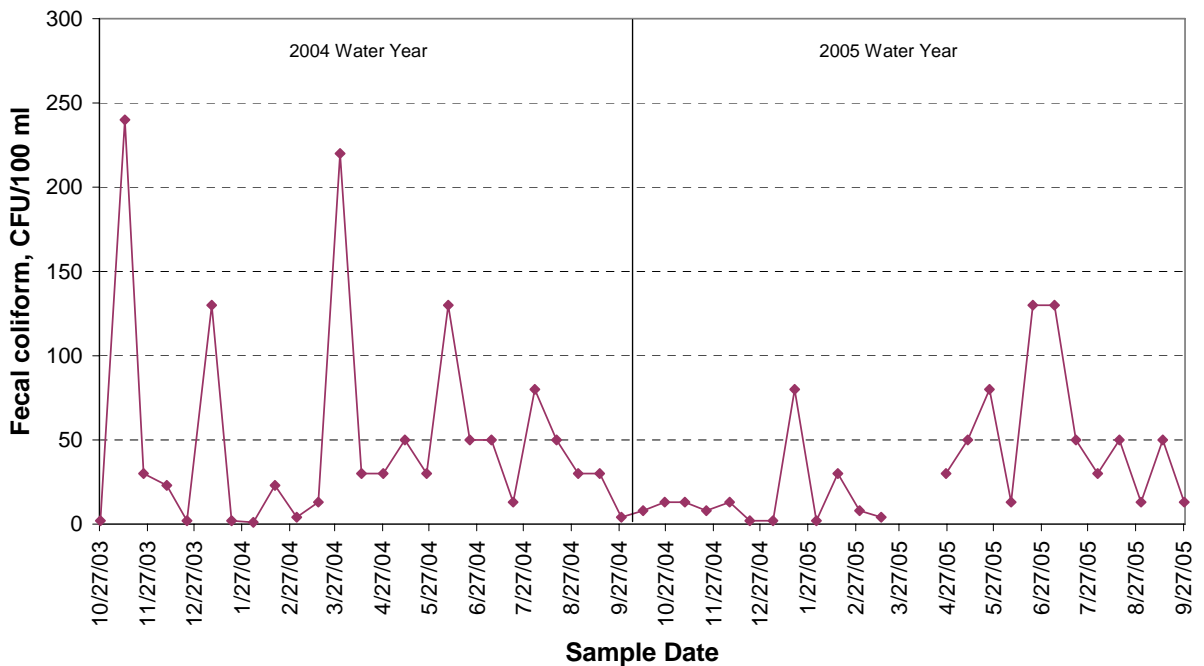
Big Indian Slough at Hwy 20 Truck Scales - Site 40 Fecal coliform



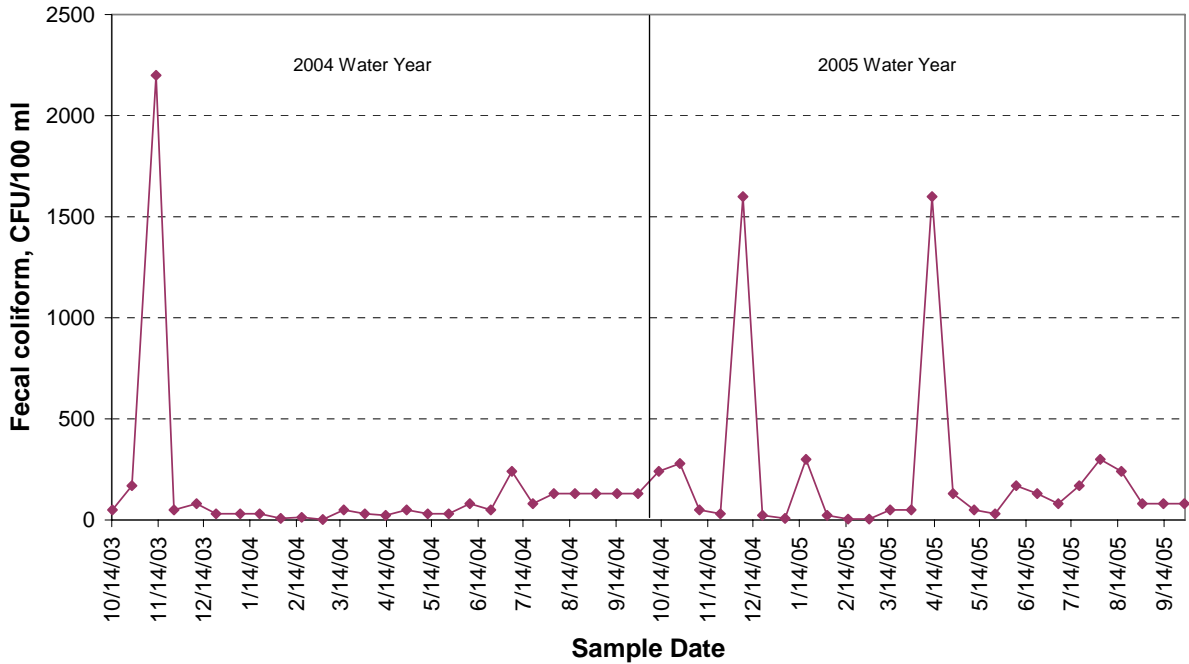
Maddox Creek/Big Ditch at Milltown Rd - Site 41 Fecal coliform



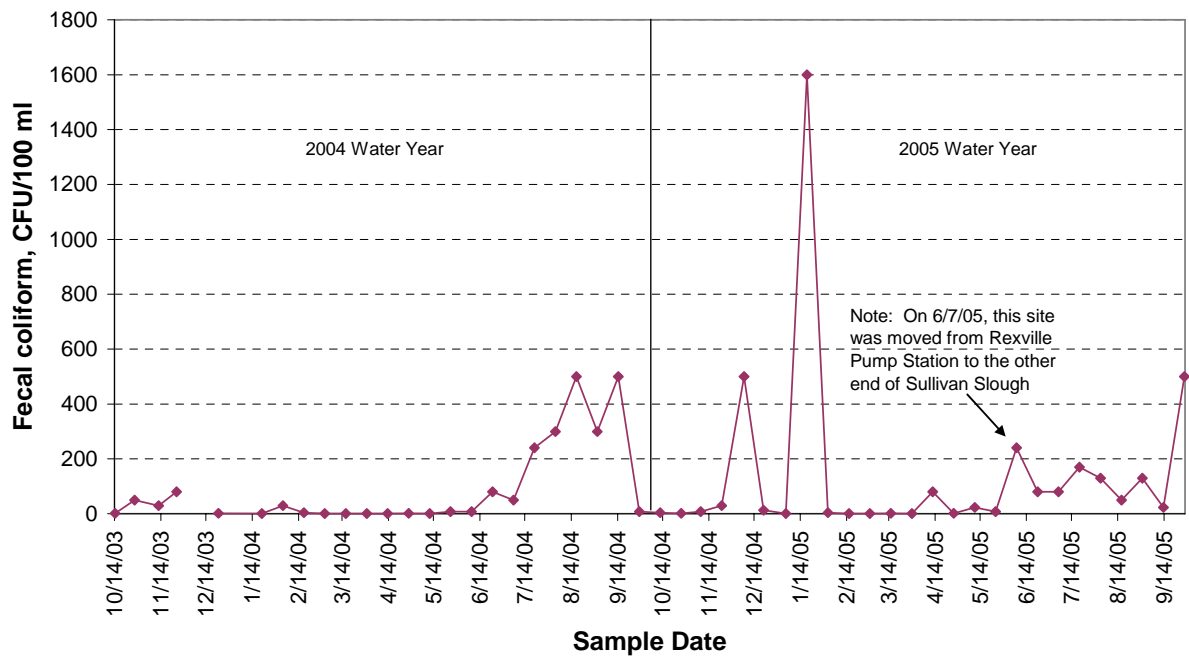
Carpenter Creek/Hill Ditch at Cedardale Rd - Site 42 Fecal coliform



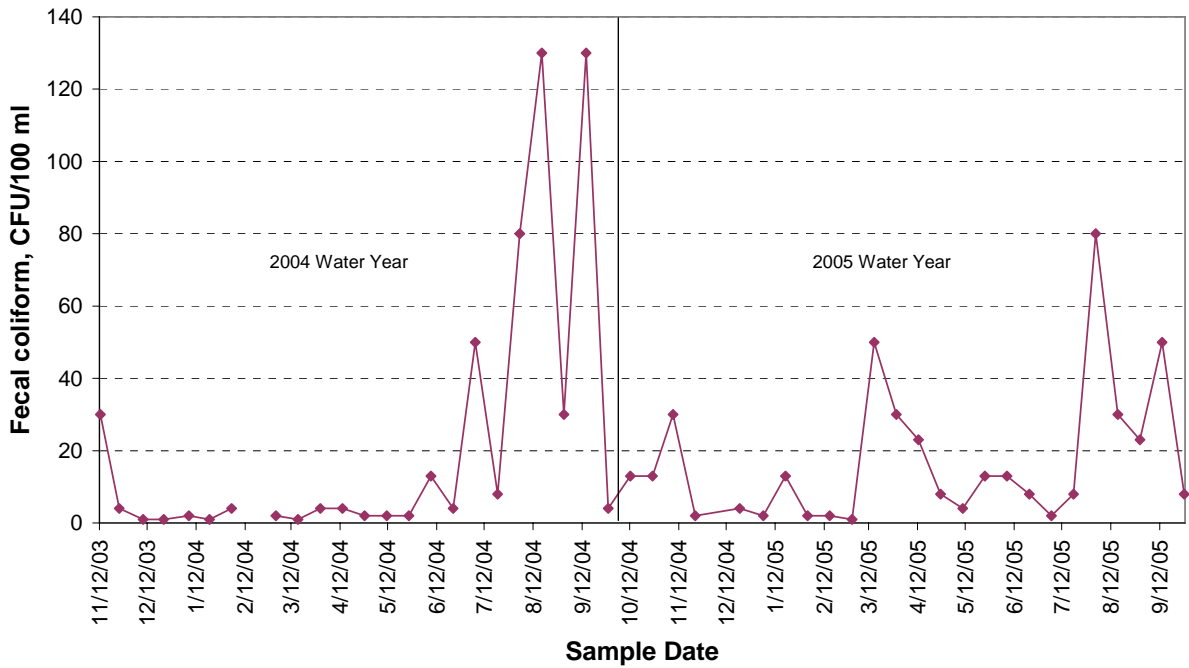
Wiley Slough at Wylie Rd - Site 43 Fecal coliform



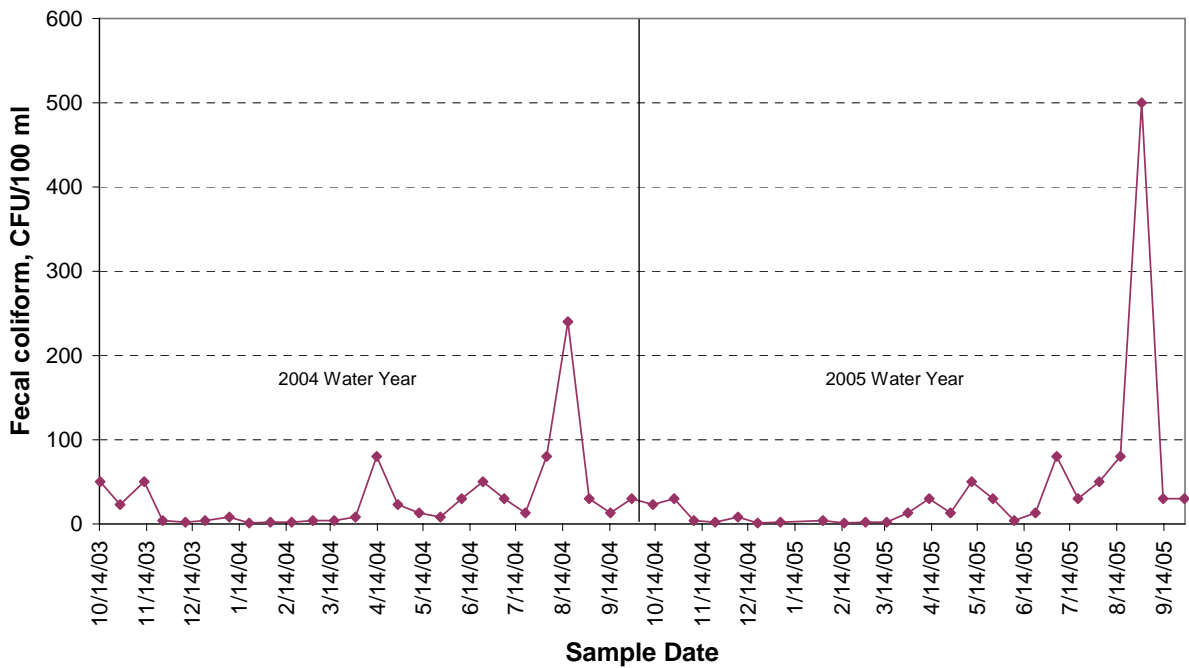
Sullivan Slough/Rexville Pump Station - Site 44 Fecal coliform



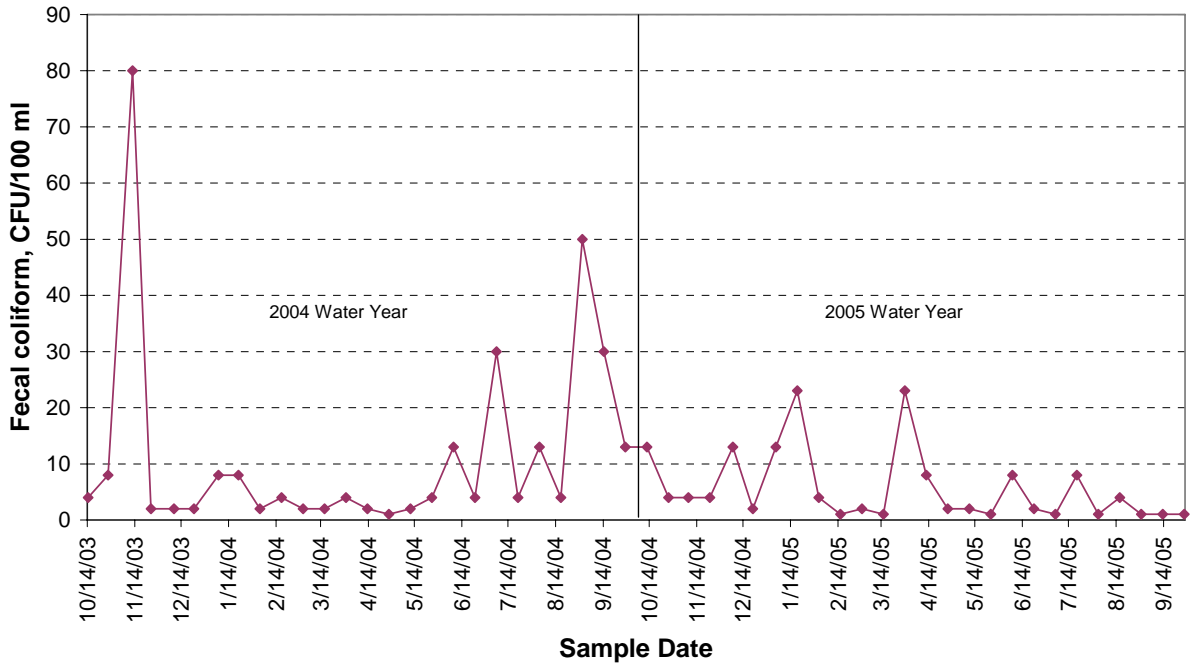
N.F. Skagit River near Moore Rd - Site 45 Fecal coliform



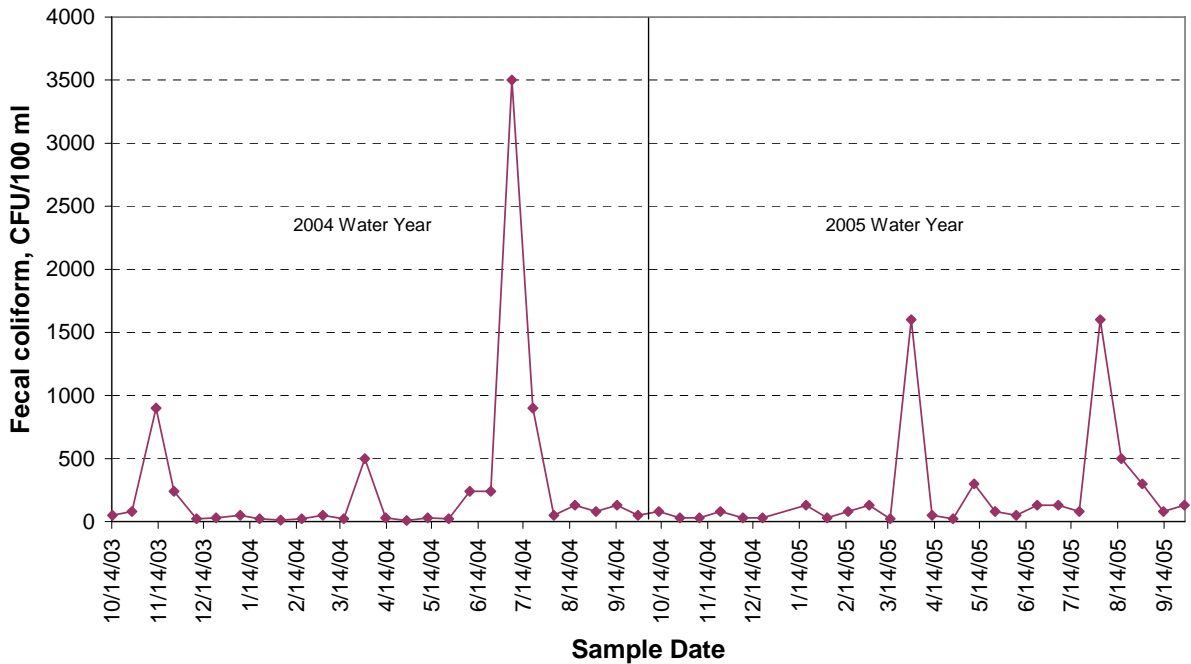
S.F. Skagit River at Conway Boat Ramp - Site 46 Fecal coliform



Swinomish Channel at County Boat Ramp - Site 47 Fecal coliform



Fisher Creek at Franklin Rd - Site 48 Fecal coliform



Nutrients

Water samples for measurement of plant nutrients were taken at each station on every other sampling trip, or once every four weeks. Samples were analyzed by Edge Analytical of Burlington, WA. Table 6 gives mean nutrient values for the sampling stations.

Nutrient levels in watercourses determine the potential for algal activity. Excessive nutrient levels can lead to large blooms of algae, which can increase dissolved oxygen levels during the day but lead to large decreases in dissolved oxygen at night when the algae are respiring, and also when the algae die and decompose.

Most of the streams in the program showed moderate total nitrogen and ammonia values and moderate levels of total phosphorus. The drainage infrastructure sampling sites generally had similar total phosphorus values and higher levels of total nitrogen and ammonia 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 and pH for each individual ammonia measurement. Calculation of ammonia standards for a few individual readings suggests that many Skagit County watercourses would exceed the state standards on many occasions.

Table 6. Mean nutrient values (mg/L) for watercourses in the Skagit County Monitoring Program, 2005 Water Year.

Site Number	Watercourse	Location	Total Nitrogen ¹	Total Phosphorus	Ammonia
3	Thomas Ck	Old Hwy 99 N	0.66	0.07	0.14
4	Thomas Ck	F&S Grade	0.47	0.06	0.05
6	Friday Ck	Prairie Rd	0.37	0.08	0.04
8	Swede Ck	Grip Rd	0.44	0.06	0.06
11	Samish R	State Route 9	0.29	0.06	0.04
12	Nookachamps Ck	Swan Rd	0.46	0.06	0.08
13	E.F. Nookachamps Ck	State Route 9	0.38	0.05	0.06
14	College Way Ck	College Way	0.46	0.07	0.08
15	Nookachamps Ck	Knapp	0.55	0.06	0.11
16	E.F. Nookachamps Ck	Beaver Lake Rd	0.30	0.05	0.04
17	Nookachamps Ck	Big Lake Outlet	0.38	0.05	0.05
18	Lake Ck	State Route 9	0.31	0.05	0.04
19	Hansen Ck	Hoehn Rd	0.36	0.09	0.04
20	Hansen Ck	Northern State	0.46	0.17	0.04
21	Coal Ck	Hoehn Rd	0.17	0.04	0.04
22	Coal Ck	Hwy 20	0.34	0.07	0.03
23	Wiseman Ck	Minkler Rd	0.32	0.09	0.03
24	Mannser Ck	Lyman Hamilton Hwy	0.52	0.05	0.03
25	Red Cabin Ck	Hamilton Cem Rd	0.32	0.07	0.03
28	Brickyard Ck	Hwy 20	0.60	0.05	0.09
29	Skagit R	River Bend Rd	0.43	0.08	0.03
30	Skagit R	Cape Horn Rd	0.26	0.09	0.03
31	Drain Dist 20 floodgate	Francis Rd	1.60	0.08	0.17
32	Samish R	Thomas Rd	0.39	0.07	0.09
33	Alice Bay Pump Station	Samish Island Rd	2.89	0.45	1.30
34	Noname Slough	Bayview-Edison Rd	1.54	0.32	0.42
35	Joe Leary Slough	D'Arcy Rd	1.15	0.19	0.58
36	Edison Slough at school	W. Bow Hill Rd	1.27	0.38	0.39
37	Edison Pump Station	Farm to Market Rd	2.36	0.70	1.30
38	North Edison Pump Station	North Edison Rd	2.73	0.69	1.24
39	Colony Ck	Colony Rd	0.80	0.14	0.07
40	Big Indian Slough	Bayview-Edison Rd	0.98	0.11	0.39
41	Maddox Slough/Big Ditch	Milltown Rd	1.18	0.15	0.36
42	Hill Ditch	Cedardale Rd	0.48	0.08	0.08
43	Wiley Slough	Wylie Rd	1.69	0.40	0.53
44	Rexville PS/Sullivan Slough	Summers Dr/La Conner	1.19	0.43	0.44
45	Skagit R – North Fork	Moore Rd	0.29	0.10	0.03
46	Skagit R – South Fork	Fir Island Rd	0.26	0.06	0.03
47	Swinomish Channel	County Boat Launch	0.37	0.07	0.06
48	Fisher Ck	Franklin Rd	0.66	0.17	0.10

¹Total Kjeldahl nitrogen

Other Parameters

The Skagit County Monitoring Program 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, pHs in the Skagit program have been within state standards.

Discharge measurements are made in selected locations, usually on a four-week basis. Discharge measurements are intended to provide a general indication of the flow regime for that watercourse and as an aid in interpreting other water quality parameters.

Although results for these parameters are not discussed in detail in the main report, all measurements are available in Appendix A and are summarized in Appendix B.

Data Analysis

Summary statistics for all measured parameters at each sampling site can be found in Appendix B.

A primary goal of the Skagit County Monitoring Program 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, we will try to determine if the trends 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 monitoring climate conditions, we should be able to focus on those conditions that seem to be 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 dissolved oxygen. 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 Skagit County Monitoring Program have seasonal variation, caused by our local climate which produces comparatively high water flows in the winter and spring and lower flows in the summer and early fall.

Skagit County has completed trends analysis via the Seasonal Kendall's Test for five key parameters at each sampling location. The parameters tested include dissolved oxygen, temperature, turbidity, fecal coliform, and total Kjeldahl nitrogen (TKN), which is an estimate of the total nitrogen available as ammonia and in organic forms. Temperature data from biweekly sampling visits were used for this analysis instead of continuous data collected during the summer months because the Seasonal Kendall's 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 biweekly

visits was collected at the same time of day for any individual station, the trends analysis should not be biased by differences caused by time of day.

The period used for trends analysis was the two full years of Skagit County Monitoring Program data. This period was chosen to coincide with the implementation of the Critical Areas Ordinance for Areas of Ongoing Agriculture (Skagit County Ordinance O20030020).

A summary of Seasonal Kendall's Test results is provided in Table 7. Of the 200 trends analyzed (five parameters at 40 stations), there were 17 statistically significant trends. Of these, 10 would normally be interpreted as improving trends, while seven would normally be interpreted as worsening trends. Improving trends included increasing dissolved oxygen and decreasing nitrogen, temperature, turbidity, and fecal coliform. Worsening trends included increasing fecal coliform, turbidity, and nitrogen and decreasing dissolved oxygen. Increasing turbidity at Site 44 could be the result of moving the sample station from Rexville Pump Station to the west end of Sullivan Slough.

The combination of improving and worsening trends in the water quality data indicates that there is no clear overall direction in the condition of watercourses in the agricultural areas of Skagit County. The small majority of improving trends suggests that the current ordinance is effective to at least maintain current water quality conditions. Negative trends may indicate local conditions that are in need of improvement.

Trends calculated from two years of data should be interpreted with caution. Changes in weather between one year and the next could have a large influence on the results of trends analysis for this relatively short period.

Table 7. Summary of significant trends detected in Skagit County Monitoring Program
2004-2005 water years

Site No.	Parameter	N	Slope	Z	Improving Trends	Deleterious Trends
4	Fecal coliform	51	217	2.335		Increasing fecal coliform
6	Dissolved oxygen	52	0.541	3.132	Increasing dissolved oxygen	
8	Dissolved oxygen	52	0.427	1.993	Increasing dissolved oxygen	
8	Total kjeldahl nitrogen	26	-0.251	-2.693	Decreasing nitrogen	
29	Turbidity	52	-4.924	-2.577	Decreasing turbidity	
30	Turbidity	51	-2.934	-2.432	Decreasing turbidity	
31	Turbidity	31	-14.63	-1.983	Decreasing turbidity	
33	Dissolved oxygen	52	-2.410	-2.508		Decreasing dissolved oxygen
34	Turbidity	50	6.617	2.645		Increasing turbidity
34	Total kjeldahl nitrogen	25	0.580	2.012		Increasing nitrogen
35	Dissolved oxygen	45	-1.266	-2.679		Decreasing dissolved oxygen
36	Fecal coliform	52	-33.34	-2.513	Decreasing fecal coliform	
38	Fecal coliform	51	-72.74	-2.411	Decreasing fecal coliform	
42	Dissolved oxygen	51	0.871	2.109	Increasing dissolved oxygen	
44	Turbidity	42	17.17	2.038		Increasing turbidity
46	Temperature	51	-4.615	-2.546	Decreasing temperature	
46	Turbidity	51	4.960	2.330		Increasing turbidity

Notes:

N = Number of data points

Slope = Magnitude and direction of trend in original units per year

Z = Calculated Kendall's statistic, Z > 1.960 or < -1.960 means statistically significant trend at 95% confidence level

Data Quality

This section details the steps taken to ensure high quality data in the Skagit County Monitoring Program, and the results of quality control checks.

Quality Control Measures

Field Meter calibration

Field meters are calibrated according to manufacturer's recommendations, or more often as needed.

The turbidity meter (Lamotte 2020) is calibrated the afternoon before each sampling trip. During this water year, Skagit County began recording calibration results. For 10 calibrations during this period, the average deviation from the calibration standard was 11%. This reflects meter drift between the calibration the afternoon before the sampling trip and the next calibration a week later. It is likely that meter drift during the sampling day is substantially less than 11%.

The pH meter (Hanna Instruments 8314) was calibrated on the morning of each sampling trip, then left on throughout the sampling trip. The pH meter was recalibrated during the trip if the meter was turned off or if questionable results were obtained. The meter rarely deviated more than 0.01 pH units from the calibration standard.

The dissolved oxygen/temperature/conductivity meter (YSI 85) is calibrated for dissolved oxygen using the built-in calibration chamber (water-saturated air) to local elevation at the first sample site and several times during each sampling trip as needed. The meter is recalibrated if it reads more than 1% saturation different from the calibration level at the next sample site. The meter is also recalibrated if there are significant elevation changes between sample sites. For several weeks during the 2005 water year, Skagit County recorded the meter deviation from the calibration target for those occasions when calibration was needed. During that period, the meter needed calibration 89 times out of 180 sample sites (49%). Average deviation for those 89 calibrations was 2.6%. Since the meter was never used with a drift of more than 1%, the actual meter drift before use was something less than 1%.

The dissolved oxygen meter probe is deployed in areas with sufficient current (> 1 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 with sample containers rinsed at least twice with sample water, and are analyzed immediately.

Lab samples

Laboratory samples are collected using clean equipment and proper procedures. Samples for nutrient and suspended solids analysis are 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 twice with the water to be sampled. The sample is then obtained and 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 water ice until they are picked up by the lab on the same day.

Samples for fecal coliform are collected and stored in an identical manner and transported to the Skagit County Health Department laboratory on the same day.

Quality Control Review

Data from field sheets and lab reports is entered into the Skagit County Water Quality Database. Once all the data for a given date is entered, a printout from the database is produced and compared to the original field and lab data sheets. Any data entry errors are then corrected in the database.

Personnel

The Project Manager has over 25 years of experience monitoring water quality in the freshwater environment. He is present on over 80% of the sampling trips and personally trained all other personnel involved.

Duplicate Analysis

Because water quality is constantly changing in streams, duplicate analysis is not attempted for parameters determined in the field – dissolved oxygen, temperature, conductivity, salinity, and turbidity. Instead, we rely on maintenance and calibration of the field meters according to manufacturer's recommendations and experienced field staff to produce reliable field data.

Duplicate samples are collected for fecal coliform at a 20% rate and for total phosphorus and nitrate at a 10% rate. Total phosphorus and nitrate duplicates are intended to provide a precision estimate for all the nutrient analyses.

Table 8 summarizes the results of the duplicate analyses for the 2005 water year.

Variability in fecal coliform, nitrate and total phosphorus was above target levels. The fecal coliform data showed particularly high variability. These results are similar to what was found in the first year of the Skagit County Monitoring Program and in Skagit County's previous work in the Baseline and Samish Bay Tributaries studies.

Table 8. Coefficients of Variation for parameters with duplicate samples in the Skagit County Monitoring Program

Parameter	N	Coefficient of Variation ¹	
		2005 Results	Target CV (%) ²
Fecal coliform	198	47.1	33
Total phosphorus	53	11.8	10 ³
Nitrate	59	13.5	10 ³

² Target precision as listed in QAPP

³ 10% CV target was listed for all nutrients

Fecal coliform duplicates are collected as follows: A 200-ml sample collection bottle is filled and emptied twice with water from the sampling site to serve as rinses. The bottle is then filled again, capped, and homogenized. Care is taken to prevent oversampling of the surface film and disturbance of bottom sediments. Two 100-ml samples are then poured from the sample collection bottle, alternating approximately 50-ml aliquots into each sample container, with the sample collection bottle swirled in between aliquots to maintain homogenization. Once both sample bottles are filled, they are capped (leaving air space) and immediately placed in a cooler with ice.

This method of collection should minimize the variability due to changing water quality and uneven distribution of coliform organisms in the water column. What remains should be an estimate of laboratory variability, assuming that the samples are handled the same between the site and the laboratory.

The high variability of the fecal coliform results is at least partially due to the use of the Most Probable Number (MPN) analysis technique (Don Lennartson, Washington State Department of Health, personal communication). This method was chosen for the Skagit County Monitoring Program because the Skagit County Health Department laboratory is certified for the method, and because it is reportedly more reliable for samples with high turbidity, which are often encountered in the Skagit County Monitoring Program (Michaud, 1991). Fecal coliform variability in the Skagit County Monitoring Program, although higher than the initial target level, is similar to that seen in other studies in Washington (Paul Pickett, Washington State Department of Ecology, personal communication).

Data Quality Summary

The Skagit County Monitoring Program produces reliable data that is suitable for inclusion in Ecology's Environmental Information Management system. Data is collected according to an Ecology-approved Quality Assurance Project Plan. Field parameters are analyzed using calibrated meters and consistent sampling methods.

Laboratory samples are handled correctly and analyzed in Ecology-certified laboratories. The database is rechecked for data entry errors. Experienced personnel are involved with every aspect of data collection and analysis. The information collected in the Skagit County Monitoring Program should be considered high quality data.

Annual Report Summary

The Skagit County Monitoring Program completed a second water year of sampling in September, 2005. Standard water quality parameters were collected biweekly at 40 sites in watercourses in both agricultural and non-agricultural areas. Results indicated that many watercourses did not meet state water quality standards for one or more parameters. Trend analysis revealed a pattern of both improving and deteriorating trends, with a slight preponderance of improving trends. The program is substantially funded through the 2008 water year by a Centennial Clean Water Grant from the Washington State Department of Ecology.

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