

Thurston County Water Resources Monitoring Report 2009-2010 Water Year 2010-2011 Water Year



Report Includes:

*Water Quality of
Streams and Lakes
In Thurston County*

August 2012

Prepared by:

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Environmental Health Division and Thurston County Resource
Stewardship Department, Water Resources Division

In Cooperation With:

City of Olympia Public Works, Water Resources Program
City of Lacey Public Works, Water Resources Program
City of Tumwater Public Works Department



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Introduction

This report contains water quality data collected by Thurston County Environmental Health Division during the 2009/10 and 2010/11 water years (*Note: A water year is October 1 through September 30*). The surface water monitoring is part of an ambient monitoring program funded by the local storm and surface water utilities of Thurston County and the Cities of Lacey, Olympia, and Tumwater. The report contains a chapter of student volunteer-collected water quality data collected through two education projects called South Sound GREEN and Nisqually River Education Project. This report is prepared every two years. The water quality data produced by the program is posted annually on the website below:
www.co.thurston.wa.us/health/ehswat/swater.html

The objectives of the surface water monitoring program are to:

- Collect baseline information about the water quantity and water quality condition of streams and lakes in Thurston County;
- Identify problem areas and;
- Track trends in stream flow and water quality over time.

The county map on page three shows currently monitored and historically monitored sites.

Report Organization

Surface Water Report Organization

The surface water report is divided into sections by watershed or drainage basin. The eight major drainage basins within Thurston County are as follows:

Puget Sound:

Nisqually River
Budd Inlet/Deschutes River
Henderson Inlet
Eld Inlet
Totten Inlet

Chehalis Drainage to Pacific:

Skookumchuck River
Chehalis River
Black River

The first item at the beginning of each watershed section is a map highlighting the watershed area. Following the watershed maps are descriptive summaries and data for each stream and lake monitored within the watershed. These summaries appear alphabetically by the most common name for that stream, river, or lake. In some cases there is no official name for a stream, so it has been assigned a name by County staff for reference.

On the first page of each stream summary is the name of the stream and its stream catalog number assigned to it by the Washington Department of Fisheries, November 1975, in A Catalog of Washington Streams and Salmon Utilization. On the top half of the page is a map of the stream or lake. If water quality sampling was conducted, the sampling site is identified.

Below the map is a general description of the stream or lake: the watershed it is located in, length of the stream or lake shoreline, and basin size in acres or square miles. Stream order, which is a number from 1 to 6 ranked from headwaters to river mouth that designates the relative position of a stream in the drainage basin system, is listed. U.S. Geological Survey 7.5 minute quadrant maps were used to determine the stream order for this report. Fisheries resources are listed using A Catalog of Washington Streams and Salmon Utilization, November 1975, unless otherwise noted.

A brief description of the area topography is included followed by a general water quality description of "excellent," "good," "fair" or "poor" for the stream. The description is based on the water quality data collected in the water year reported, the number and degree of excursions outside the water quality standards, as well as other water quality indicators. A definition of these categories can be found on page 8. Following the "General Water Quality" category is a listing of sources for additional information.

The remainder of the summary includes summary tables and comparisons of water quality data to water quality standards, with a narrative discussion of water quality and quantity conditions and issues, as well as volunteer data, if any is available. Each summary ends with water quality data and stream flow or lake level records.

Monitoring Methods

Surface Water Quality Monitoring Methods

Streams

In water years 2009/10 & 2010/11, water quality information was collected on thirty eight streams. Sampling sites for streams are generally located close to the mouths of the streams before they discharge into the larger river or marine water body. The stream monitoring was done monthly.

The following parameters were measured at all stream sites:

total phosphorus	temperature
nitrate+nitrite nitrogen	pH
turbidity	specific conductivity
fecal coliform	dissolved oxygen

Ammonia was measured at Moxlie Creek and at Tanglewilde throughout both water years.

Field parameters were measured using a YSI multi-parameter field instrument. Stream discharges were measured by wading method using either a Swoffer or a SonTek FlowTracker water current meter.

Lakes

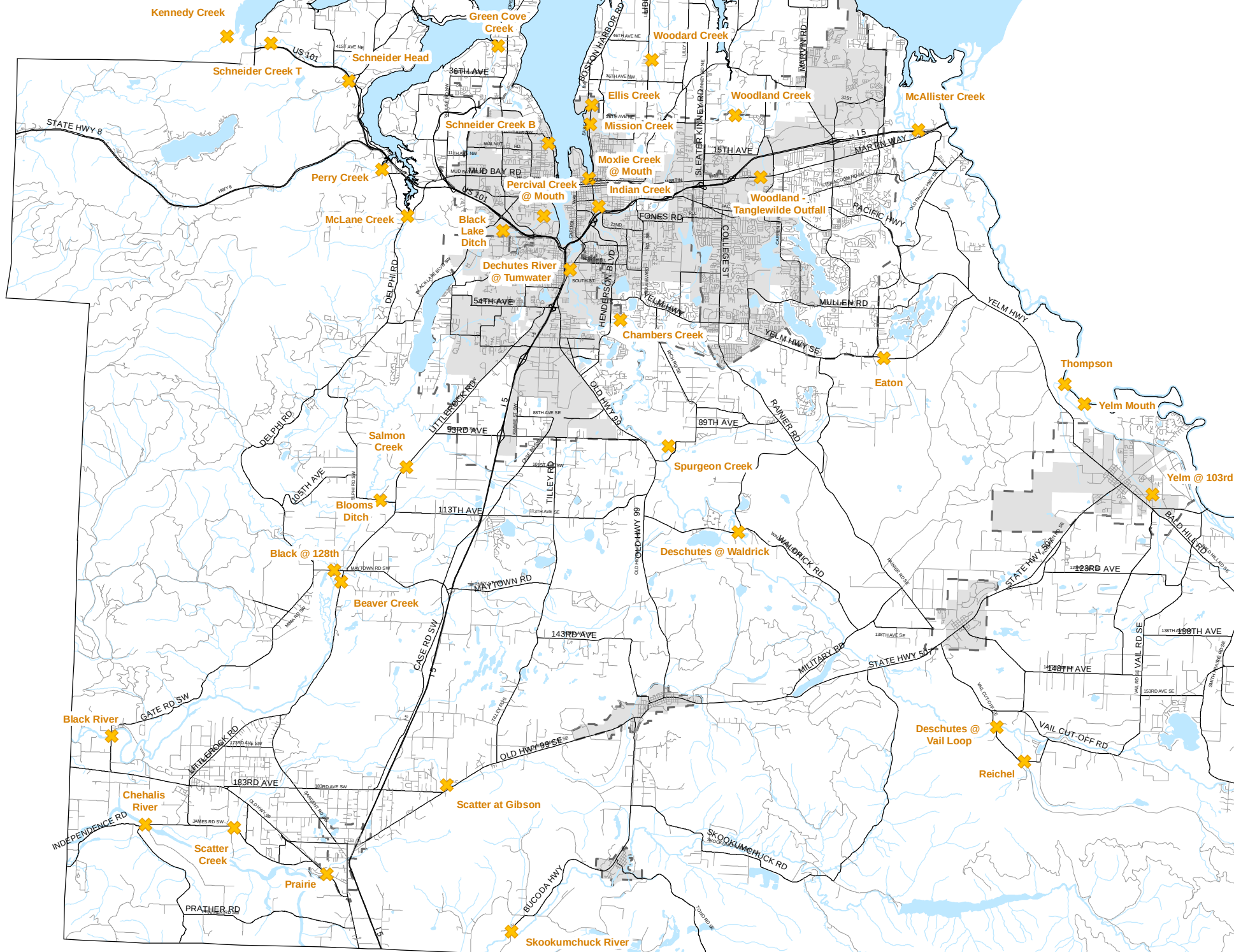
In 2010 and 2011, water quality information was collected at fourteen sites on ten lakes. For lake monitoring, field parameters were measured at one or two meter increments from the surface to the bottom of the lake using the YSI multiparameter field instrument. The nutrients (total phosphorus and total nitrogen) were sampled near the surface and near the bottom. The bottom samples were collected using a Kemmerer sampler. Chlorophyll *a* and algae identification samples were taken as composite samples from the epilimnion (warm surface layer) or the photic zone (the surface area where sunlight can penetrate). Secchi disk visibility (or water clarity) was measured using a standard black and white quadrant disk. Sampling sites in the lakes were located in the deepest area of each lake as determined by available bathymetric maps. Four lakes; Capitol, Lawrence, Long and St. Clair have two sampling sites.

The average summer total phosphorus and chlorophyll *a* concentrations and secchi disk measurements are used to calculate the *Carlson trophic state indices*. The *Carlson trophic state indices (TSI)* are used to express the degree of productivity, or plant and algae growth, in a lake. Average summer total phosphorus concentrations, chlorophyll *a* concentrations, and secchi disk transparency are each used to calculate a TSI for the lake. A TSI of 0 to 40 indicates an oligotrophic, or low productivity, lake. A TSI of 41 to 50 indicates a mesotrophic, or moderately productive lake. A TSI of greater than 50 indicates a eutrophic, or highly productive lake.

The three graphs on the following pages show the 2011 lake sample sites in order of their trophic state by parameter. Lakes toward the bottom of the graph have the clearest water, lowest algae production and low total phosphorus levels. Low productivities lakes are ones that people like to swim and recreate in and associate with “good” water quality. Those lakes toward the top of the graphs have poor water clarity and tend to have frequent and/or prolonged algae blooms. The plant and algae growth on these lakes can interfere with recreational uses at times.

THURSTON COUNTY

Water Quality Monitoring Sites



✕ Water Quality Monitoring Site

— Stream

--- Urban Growth Area

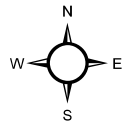
■ City Boundary

0 1 2 4 Miles

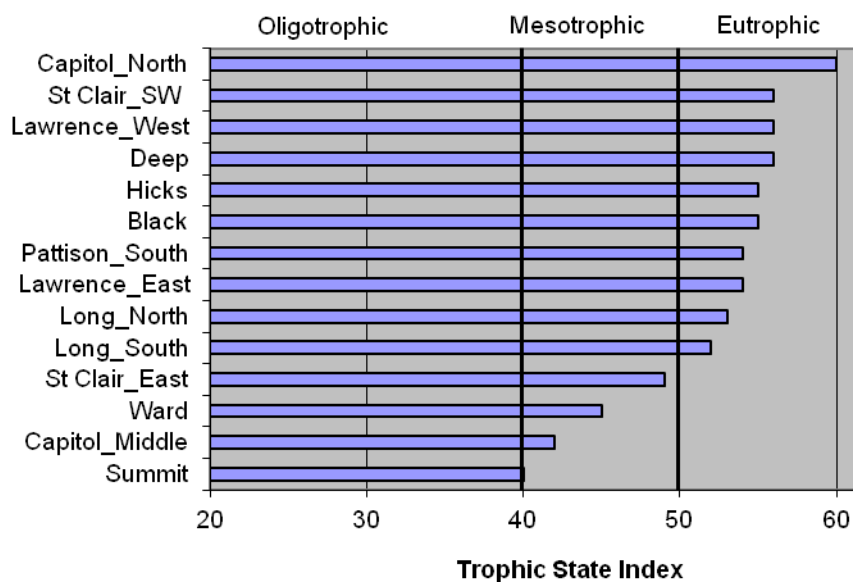
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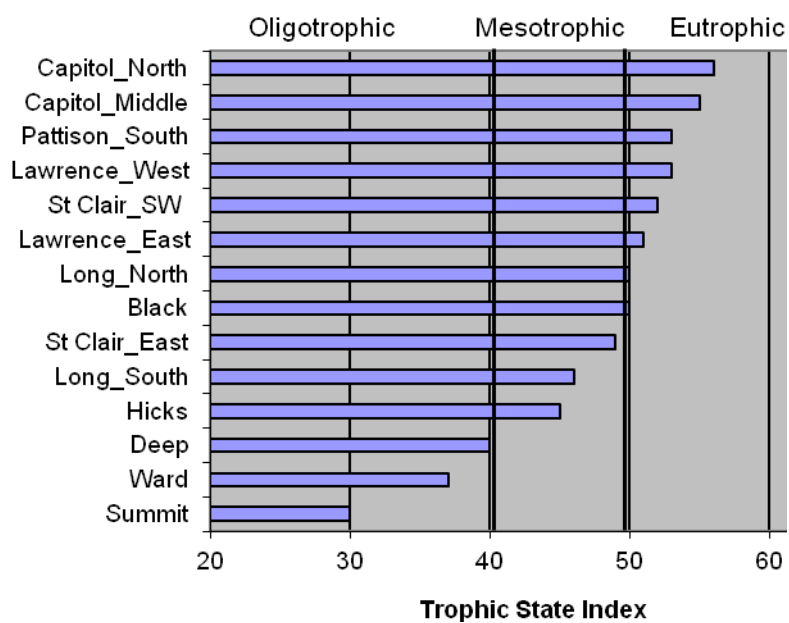
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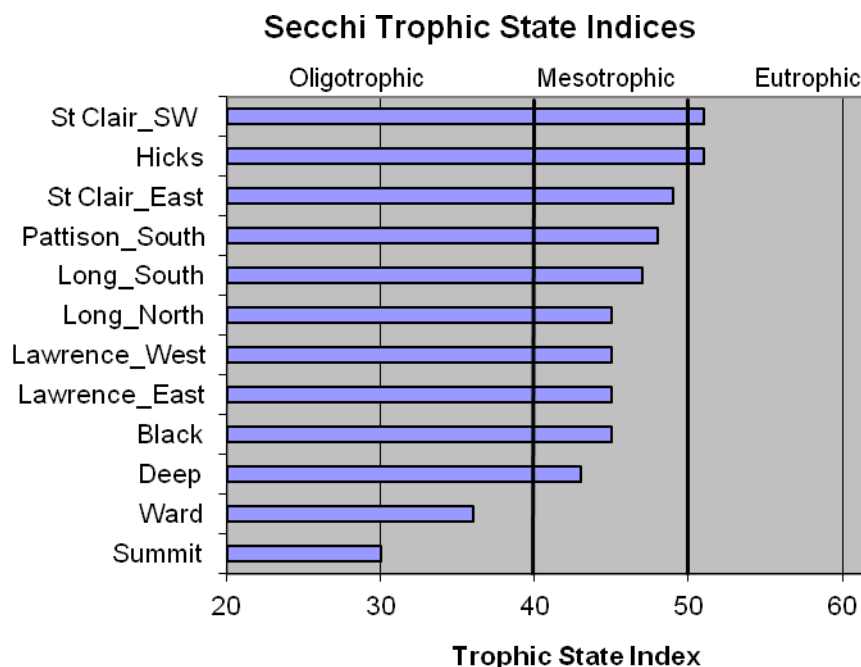


2011 Thurston County Lakes Chlorophyll Trophic State Indices



Total Phosphorus Trophic State Indices





Water Resources Atmospheric and Water Quantity Monitoring

Thurston County's Department of Resource Stewardship, Water Resources Division performs stream flow and stream temperature, lake level, ground water level and atmospheric monitoring. There are currently eleven active stream gauging stations, nineteen multi-parameter rainfall gauging stations, dozens of ground water level recorders, and six lake level gages in the program in 2010.

The data are used for a variety of purposes including calibration of stormwater flow models to micro-scale hydrologic interpretation models. Much of the data is used to validate hydrologic and hydraulic models used to predict and track changes in stream flow resulting from changes in land use and changes in stormwater management activities. More recently, the precipitation data collected now for over ten years is being used for site-specific drainage design using the WWHM 3 runoff modeling software. This allows developers to model stormwater according to actual site conditions and size facilities appropriately, as required the newly adopted Drainage and Erosion Control Manual (2009-10). The river and precipitation data also serves as an early warning of possible flooding, especially the ground water level data and urban streams. There are five real-time weather and river flow stations that can be accessed by the public through the Water Resources Monitoring Data Website, along with all of the other data resources that we manage, at www.co.thurston.wa.us/monitoring

Information regarding all of the data locations, maps, and links to external sites can also be accessed from the website address listed above.

Water Quality Standards

The Washington State water quality standards for all surface water bodies are established in Chapter 173-201A of the Washington Administrative Code (WAC) which was amended November 20, 2006. Water quality standards for surface waters were established consistent with public health and public enjoyment of the waters and the propagation and protection of fish, shellfish, and wildlife. The standards for the parameters that are monitored by Thurston County are shown in Table 1. Refer to WAC 173-201A for a complete description of the water quality standards.

Table 1. Water Quality Standards for Surface Waters

Freshwater Contact Recreation Criteria				
Parameter	Extraordinary Primary Contact Recreation (includes lakes)	Primary Contact Recreation	Secondary Contact Recreation	
Freshwater Fecal Coliform (colonies/100 L) Part 1 – geometric mean $\leq$ X	50	100	200	
Freshwater Fecal Coliform (colonies/100 L) Part 2 - not more than 10% of the samples >XX	100	200	400	
Freshwater Aquatic Life Uses Criteria				
	Char	Salmon & Trout Spawning, Core Rearing, and Migration	Salmon & Trout Spawning, Non- core Rearing, and Migration	Salmon & Trout Rearing and Migration Only
Dissolved Oxygen (mg/l) Lowest 1-Day Minimum	9.5	9.5	8.0	6.5
Temperature (degrees C) Highest 7- DAD* Maximum	12°C (53.6°F)	16°C (60.8°F)	17.5°C (63.5°F)	17.5°C (63.5°F)
pH Within range shown with human- caused variation within the range of less than XX units.	6.5 – 8.5; 0.2	6.5 – 8.5; 0.2	6.5 – 8.5; 0.5	6.5 – 8.5; 0.5
Turbidity (NTUs) Not exceed X over background when background is 50 NTU or less; or a XX% increase in turbidity when background is > 50 NTU.	5; 10%	5; 10%	5; 10%	10; 20%

*7 day average of the daily maximum temperatures

The “General Water Quality” condition stated in the descriptive summary for each stream and lake in this report is made on the basis of the guidelines below.

Stream Water Quality Categories

“Excellent” - No water quality standard violations, and very low fecal coliform and nutrient concentrations.

“Good” - Usually meets water quality standards; OR violates only one part of the two part fecal coliform standard; OR the violation is most likely the result of natural conditions rather than pollution.

“Fair” - Frequently fails one or more water quality standards and other parameters such as nutrients indicate water quality is being impacted by pollution.

“Poor” - Routinely fails water quality standards by a large margin; other parameters such as nutrients are at elevated concentrations.

Lake Water Quality Categories

“Excellent” - Very low nutrient and chlorophyll *a* concentrations, and very high water clarity; Classified as Oligotrophic; Uses not impaired.

“Good” - Low to moderate nutrient and chlorophyll *a* concentrations, and moderate to high water clarity; Classified as Mesotrophic; Uses not impaired.

“Fair” - Moderate to high nutrient and chlorophyll *a* concentrations, and low to moderate water clarity; Classified as Eutrophic; Uses sometimes impaired.

“Poor” - High nutrient and chlorophyll *a* concentrations, and low water clarity; Classified as Eutrophic; Uses impaired during most of the summer season by excess algae and/or aquatic macrophyte (plant) growth.

Black Watershed

WRIA 23

Chapter Includes:

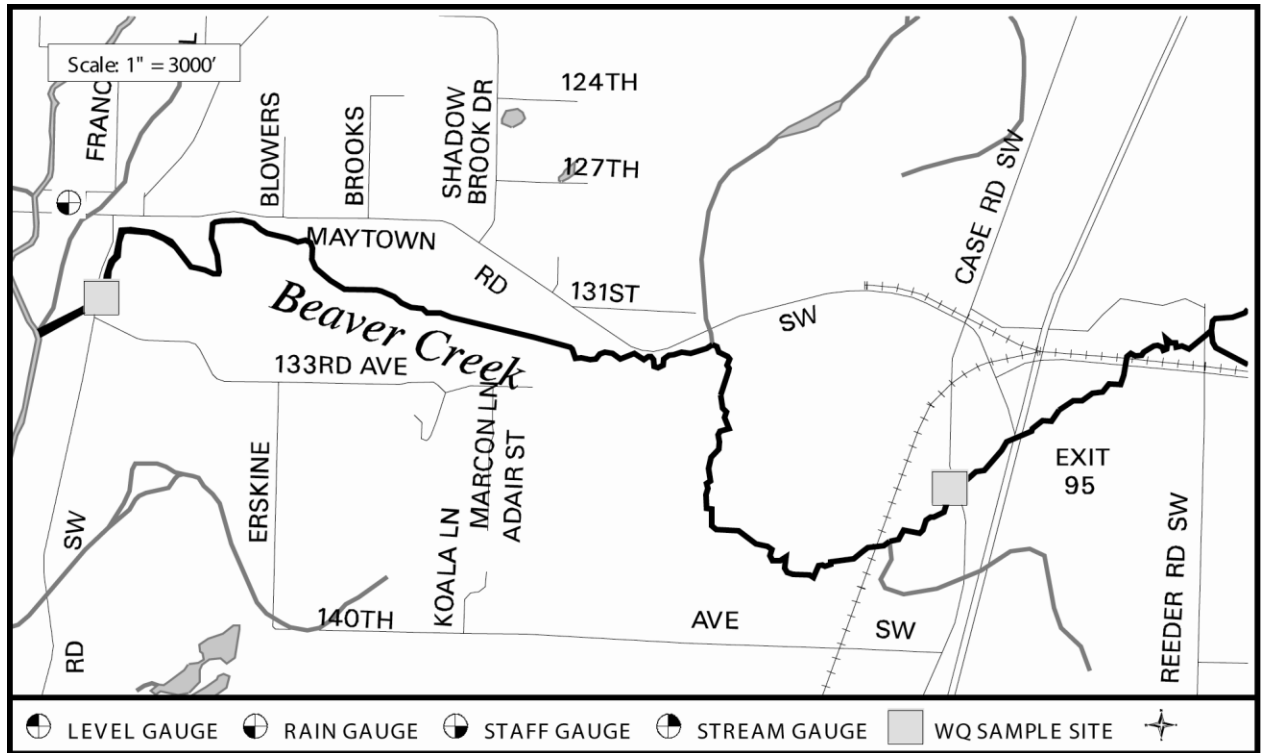
Beaver Creek

Black River

Blooms Ditch

Deep Lake

Salmon Creek



PART OF CHEHALIS RIVER WATERSHED

LENGTH OF RIVER: 11.4 miles

BASIN SIZE: 21 square miles

STREAM ORDER: 3

PRIMARY LAND USES:

Light industrial and commercial in the Maytown and Littlerock communities, agriculture and rural residential

FISHERIES RESOURCES: (From A Catalog of Washington Steams and Salmon Utilization, WDOF)

Coho

GENERAL TOPOGRAPHY:

Beaver Creek is a tributary to the Black River and drains the east side of the river basin,

including Scott and Deep Lakes. It has extensive wetlands associated with it.

GENERAL WATER QUALITY:

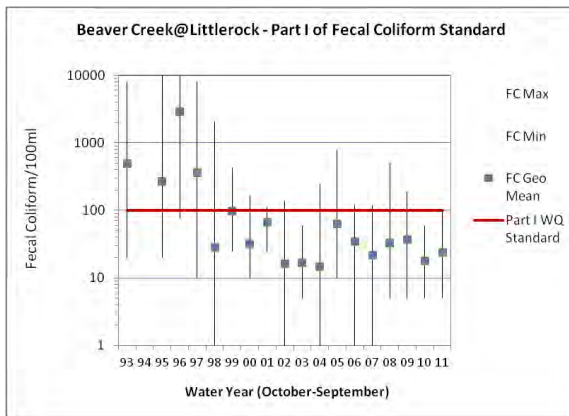
Good – Water quality has improved. Both parts of the fecal coliform standard were met at the Littlerock Rd. site for water years 2009/10 and 2010/11. Turbidity violation in November 2009. Spawning criteria temperature standard may be exceeded at times.

OTHER DATA:

Thurston County Resource Stewardship Department, Water Resources Program, (360) 754-4681 or www.co.thurston.wa.us/monitoring

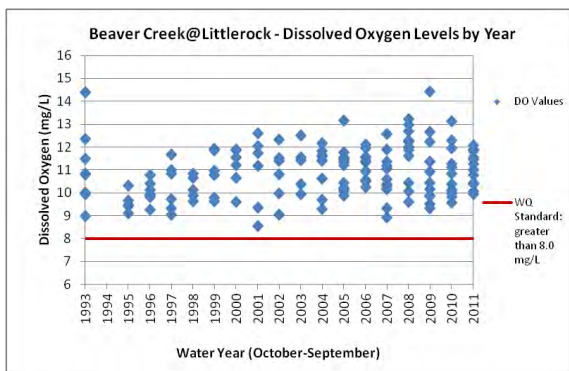
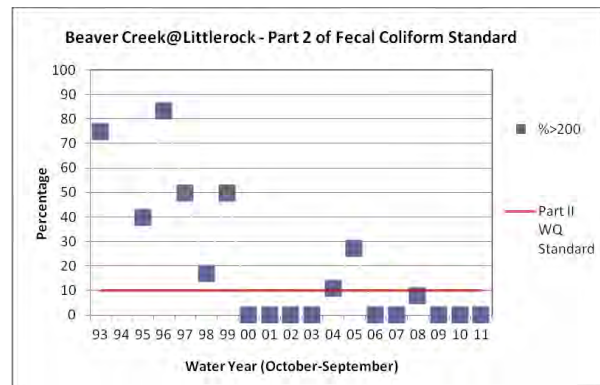
Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

Beaver Creek #667



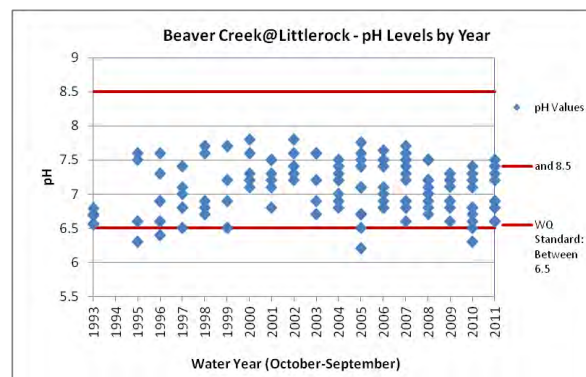
The water quality standard for fecal coliform bacteria has two parts: Part 1 - the geometric mean shall not exceed 100 colony forming units per 100 milliliters of sample *and*, Part 2 - no more than ten percent of the samples shall exceed 200 cfu/100 mL.

Both parts of the fecal coliform bacteria water quality standard have been met in water years 2009/10 and 2010/11.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. There have been no recorded violation of the dissolved oxygen standard at the Littlerock Road site, but low dissolved oxygen has been measured farther upstream at Case Road.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been four violations measured in the period of record since 1993 including one in November 2009.



Discussion:

Beaver Creek was monitored at Littlerock Road Bridge (formerly called Hwy 121 Bridge), the downstream-most location before the creek discharges to the Black River, as part of the ambient monitoring program. Beaver Creek had also been monitored at an upstream site at Case Road but was discontinued in 2005.

A Washington Department of Ecology study on the Black River and Beaver Creek identified a large dairy operation, located downstream of Case Road, as a major contributor of bacteria and nutrients to the creek. In the late 1990's the dairy owner implemented many changes in the farm's operation to mitigate the pollution load to the creek. Those efforts substantially reduced the bacteria levels in the creek and water quality improved. In water years, 2003/04 and 2004/05, part II of the standard was violated again after 4 years of meeting the standard. It is likely that livestock access issues upstream were contributing to the bacteria increase seen. The property where there was livestock access was subdivided and now has several new residences and no animals. The creek has met bacteria standard for the last four years. The nutrient concentrations have also decreased over the period of record demonstrating an improvement in water quality.

There are two temperature standards that apply in the lower reach of Beaver Creek. The primary criteria intended to protect salmonid spawning, rearing and migration is a 7-day average daily maximum of 17.5° C, and an additional temperature criteria of a 7-day average daily maximum of 13 °C to protect salmon and trout spawning and incubation applies between February 15 through July 1. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. Both temperature criteria were met in the 2009/10 water year, However water temperatures above 13° C were measured in June and July of 2011, indicating possible temperature standard violations during that period.

Major Issues:

- Nonpoint source pollution issues are a concern, especially from livestock.
- Development is continuing to increase in the area.

Funding Sources:

- Thurston County

Water Quality Summary
Conventional Parameters
Beaver Creek at Littlerock Road (formerly Hwy 121)

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	°C	Highest 7-DAD Max of 17.5°C ***	09/10 10/11		2.49 – 16.96 3.75 – 15.52			1.06 – 18.25
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		9.55 – 13.13 9.92 – 12.06	0 of 12 0 of 12		8.53 - 14.4
Conductivity	µmhos/cm		09/10 10/11	90 85	63 - 114 57 - 113		88	43 - 160
pH		6.5 - 8.5	09/10 10/11	7.0* 6.9*	6.3 - 7.4 6.6 – 7.5	1 of 12 0 of 12	7.2*	6.2 - 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	2.68 2.38	1.3 – 8.4 1.10 – 5.80	1 of 12 0 of 12	2.57	0.3 - 10.0
Fecal Coliform	colonies/ 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	18** 24**	5 - 60 5 - 100	% exceeding 200	56**	0 – 26000
						0%		
						0%		
Total Phosphorus	mg/L		09/10 10/11	0.044 0.038	0.026 - 0.075 0.023 – 0.052		0.055	0.022 - 0.425
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	0.616 0.538	0.484 – 0.885 0.293 – 0.825		0.821	0.327 – 2.61

* Median

** Geometric mean value (GMV)

*** Supplemental Spawning/Incubation Criteria- Salmon & Trout Spawning: 13°C from Feb. 15 – July 1

Thurston County Water Resources Monitoring Report 2009-2010

Beaver Creek @ Littlerock Road

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/21/2009	3:20:00 PM	12.08	7.2	10.36	114	5	1.3	5.81	0.035	0.555	Salmon; Staff gage broken
11/18/2009	11:00:00 AM	7.12	6.3	11.94	63	60	8.4		0.075	0.504	Too deep to measure flow.
12/14/2009	1:30:00 PM	2.49	6.8	13.13	97	10	2.3	30.65	0.027	0.840	
1/12/2010	10:45:00 AM	7.38	6.5	11.26	65	30	3.2		0.044	0.484	Too deep to measure flow.
2/9/2010	10:25:00 AM	7.61	6.6	11.11	81	8	1.6	53.19	0.030	0.626	Duplicates labeled "L.Rock".
3/15/2010	10:00:00 AM	6.65	6.8	12.29	73	25	2.6	83.54	0.026	0.518	Staff gage - 1.70'
4/20/2010	10:00:00 AM	12.81	6.7	9.95	84	10	1.5	48.90	0.043	0.606	
5/12/2010	10:40:00 AM	11.48	7.2	10.84	87	10	2.1	29.46	0.041	0.585	
6/16/2010	11:20:00 AM	12.98	7.1	10.10	89	5	2.3	33.29	0.053	0.598	
7/14/2010	10:45:00 AM	14.89	7.3	10.11	108	45	2.6	12.86	0.060	0.885	
8/18/2010	10:30:00 AM	16.96	7.4	9.55	110	50	2.2	6.21	0.055	0.616	
9/15/2010	9:00:00 AM	13.52	7.3	9.80	114	32	2.0	5.42	0.043	0.576	Duplicates labeled "L. Grocery".

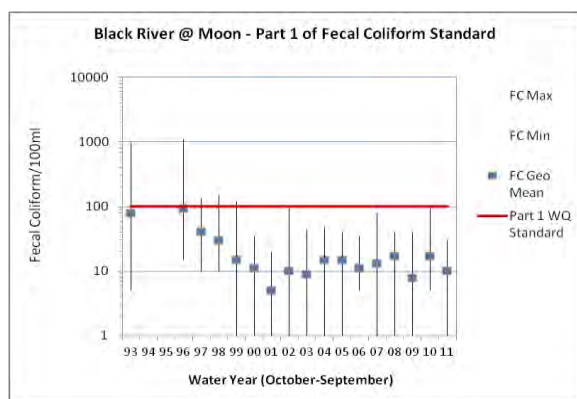
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Beaver Creek @ Littlerock Road

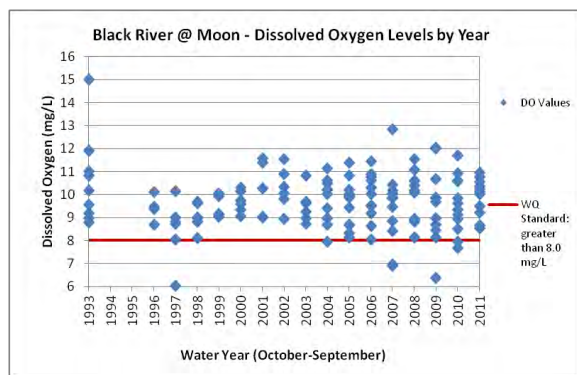
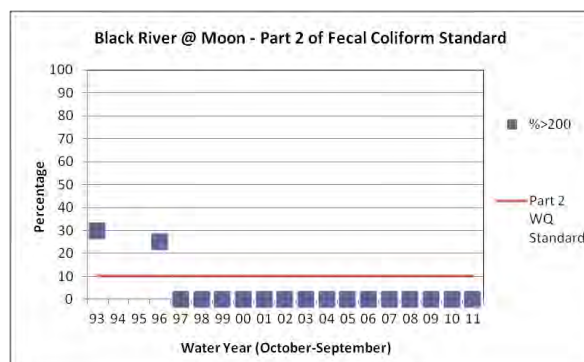
<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2010	11:50:00 AM	8.14	7.3	11.88	108	20	1.2	11.75	0.035	0.825	
11/15/2010	10:10:00 AM	9.46	6.6	10.77	81	20	1.9	67.46	0.041	0.489	
12/15/2010	10:15:00 AM	6.31	6.6	11.23	57	20	2.7		0.041	0.546	Flooding. Too deep to measure flow.
1/10/2011	12:45:00 PM	3.75	6.8	11.82	72	15	1.1	106.75	0.023	0.588	Staff gage - 2.00'.
2/15/2011	11:05:00 AM	6.18	6.8	11.54	69	20	5.8	107.34	0.044	0.455	Staff Gage - 2.06'.
3/15/2011	1:00:00 PM	8.14	6.9	11.46	61	55	3.4		0.026	0.402	No flow measurement, too deep to wade. Duplicates labeled "Coho".
4/13/2011	12:00:00 PM	8.95	6.9	12.06	76	5	1.5	87.12	0.032	0.384	
5/18/2011	11:15:00 AM	11.91	6.9	10.99	73	5	2.9	80.93	0.038	0.293	Staff gage - 1.75'.
6/15/2011	11:45:00 AM	13.18	7.2	10.43	97	30	2.9	24.05	0.052	0.591	
7/13/2011	11:00:00 AM	15.43	7.4	9.92	108	90	2.5	12.15	0.027	0.726	
8/10/2011	1:10:00 PM	15.52	7.5	10.35	104	20	1.5	8.40	0.051	0.513	
9/13/2011	11:50:00 AM	15.11	7.4	10.07	113	100	1.1	3.08	0.041	0.639	



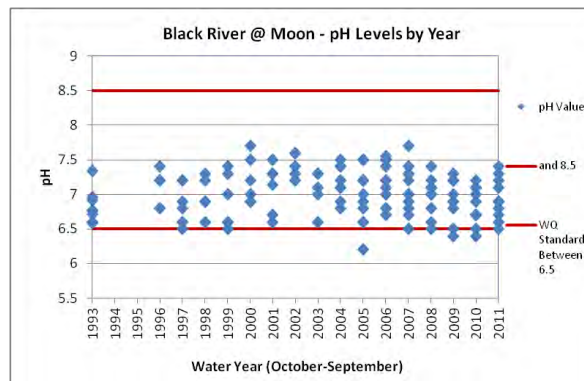
Black River at Moon Road



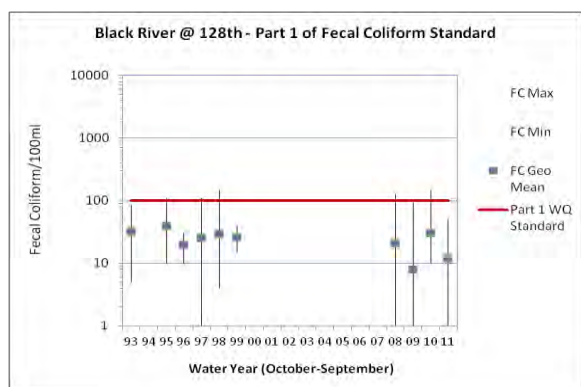
The creek met both parts 1 and 2 of the fecal coliform bacteria water quality standard in 2009/10 and 2010/11. The river at this site has always met part 1. There have been no recorded violations of part 2 since 1996. No data was collected in 1994 and 1995.



The standard requires the pH to be within the range of 6.5 and 8.5. The pH measurement fell below 6.5 once in water years 2004/05, 2008/09 and 2009/10.

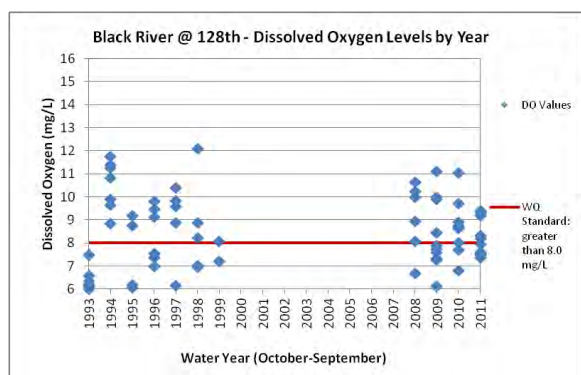
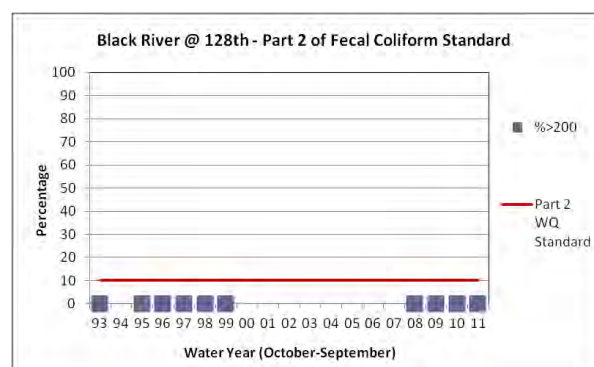


Black River at 128th in Littlerock



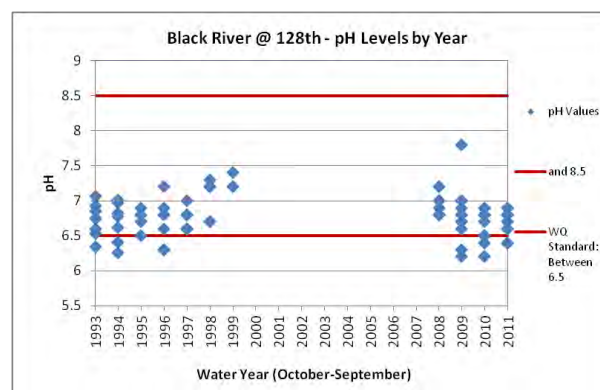
The water quality standard for fecal coliform bacteria has two parts: part 1 - the geometric mean shall not exceed 100 colony forming units per 100 milliliters of sample and, part 2 - no more than 10 percent of the samples shall exceed 200 cfu/100 mL.

There have been no recorded violations of part 1 or part 2 of the fecal coliform standard. No data was collected in water years 1993/94 or 1999/00 through 2006/07.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. Due in part to the physical characteristics of the river, there are many occasions when the dissolved oxygen standard is violated.

The standard requires the pH to be within the range of 6.5 and 8.5. There have been many violations throughout the monitoring periods.



Discussion:

The Black River has been monitored routinely at the Moon Road Bridge as part of the ambient monitoring program since 1996. There is also data for the period from 1991 through 1993 at this location and other upstream sites available at www.co.thurston.wa.us/health/ehswat/swater.htm. There were two dissolved oxygen violations in June and August 2009, one turbidity violation and one pH violation in November 2009.

Beginning in March 2008 an ambient monitoring site at the 128th Avenue SW bridge was added. This site had also been previously monitored between 1992 and 1999. The fecal coliform standard was met at the 128th Avenue site during both water years. However, there were four dissolved oxygen violations during 2009/10 and six violations during 2010/11. There were two pH violations in each water year. The data from both monitoring sites are graphed on the previous page.

There are two temperature standards that apply at both of these monitoring locations on the Black River. The primary temperature criteria of a 7-day average daily (DAD) maximum of 17.5° C, and additional criteria of a 7-DAD maximum of 13° C to protect salmon and trout spawning and incubation applied February 15 through July 1. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. In August 2010 temperatures above 17.5° C were measured at both sites and also in August 2011 at the Moon Road site. In June and July 2010 during both water years at the Moon Road site and in July 2010 and June and July 2011, at the 128th Avenue site, temperatures at or above 13° C were measured, indicating possible temperature standard violations during these periods.

Water quality monitoring will be continued next water year.

Major Issues:

- High temperatures and low dissolved oxygen levels during summer low flow conditions.
- Non-point pollution from rural land uses.

Funding Sources:

- Thurston County

Water Quality Summary
Conventional Parameters
Black River at Moon Road

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C ***	09/10 10/11		2.53 – 17.88 4.27 – 17.51			3.27 – 20.29
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		7.67 – 11.69 8.53 – 10.95	2 of 12 0 of 12		6.04 - 15.00
Conductivity	µmhos/cm		09/10 10/11	89 83	51 - 116 49 - 116		82	41 – 136
pH		6.5 - 8.5	09/10 10/11	6.8* 6.9*	6.4 – 7.2 6.5 – 7.4	1 of 12 0 of 12	7.1*	6.2 - 7.7
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	2.54 1.88	0.4 - 15 0 – 7.2	1 of 12 0 of 12	2.53	0 – 19
Fecal Coliform	colonies/ 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	17** 10**	5 - 100 0 - 30	% exceeding 200	16**	0 – 1100
						0% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.031 0.029	0.025 - 0.051 0.017 – 0.041		0.033	0.014 - 0.071
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	0.688 0.583	0.431 – 0.856 0.316 – 0.866		0.663	0.222 - 1.51

* Median

** Geometric mean value (GMV)

*** Supplemental Spawning/Incubation Criteria – Salmon & Trout Spawning: 13°C from Feb. 15 – July 1

Water Quality Summary
Conventional Parameters
Black River at 128th Avenue Bridge

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C ***	09/10 10/11		1.16 – 18.0 3.19 – 16.49			1.73 – 19.98
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		4.90 – 11.05 7.36 – 9.41	4 of 11 6 of 12		4.57 – 12.1
Conductivity	µmhos/cm		09/10 10/11	79 73	53 - 105 44 - 101		71	37 – 109
pH		6.5 - 8.5	09/10 10/11	6.8* 6.8*	6.2 – 6.9 6.4 – 6.9	2 of 12 2 of 12	6.8*	6.2 - 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	2.42 1.57	0.80 – 8.0 0.40 – 4.5	0 of 7 0 of 12	3.63	0.6 – 36
Fecal Coliform	colonies/ 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	31** 12**	10 - 150 0 - 50	% exceeding 200	20**	0 – 150
						0%		
						0%		
Total Phosphorus	mg/L		09/10 10/11	0.032 0.025	0.02 - 0.051 0.015 – 0.033		0.029	0.008 - 0.099
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	0.196 0.180	0.132 – 0.304 0.100 – 0.284		0.267	0.1 – 0.681

* Median

** Geometric mean value (GMV)

*** Supplemental Spawning/Incubation Criteria – Salmon & Trout Spawning: 13°C from Feb. 15 – July 1

Thurston County Water Resources Monitoring Report 2009-2010

Black River @ Moon Rd Br

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/21/2009	1:15:00 PM	12.42	7.0	8.94	110	20	0.7		0.026	0.826	
11/18/2009	11:30:00 AM	8.19	6.4	10.58	51	100	15.0		0.051	0.554	
12/14/2009	2:15:00 PM	2.53	6.7	11.69	92	5	2.8		0.025	0.808	
1/12/2010	11:00:00 AM	7.25	6.5	9.33	61	10	3.1		0.026	0.431	
2/9/2010	11:20:00 AM	7.96	6.7	9.62	80	15	1.8		0.027	0.686	
3/15/2010	10:45:00 AM	6.80	6.7	10.91	71	25	2.8		0.025	0.524	
4/20/2010	10:45:00 AM	12.52	6.7	9.12	82	25	0.5		0.030	0.700	
5/12/2010	11:20:00 AM	12.46	7.1	10.62	88	10	0.8		0.027	0.678	
6/16/2010	12:00:00 PM	13.77	6.9	7.67	91	5	1.4		0.049	0.519	
7/14/2010	11:40:00 AM	17.10	7.2	9.85	107	25	0.7		0.032	0.850	
8/18/2010	11:15:00 AM	17.88	7.1	7.94	116	15	0.5		0.027	0.856	
9/15/2010	9:55:00 AM	14.87	7.1	8.51	116	15	0.4		0.027	0.825	

Thurston County Water Resources Monitoring Report 2010-2011

Black River @ Moon Rd Br

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2010	11:25:00 AM	9.56	6.9	9.49	103	0	0.5		0.041	0.785	FC reported as <5.
11/15/2010	10:50:00 AM	8.47	6.6	9.23	77	20	1.4		0.033	0.436	
12/15/2010	10:50:00 AM	7.48	6.5	8.53	49	30	7.2		0.040	0.389	
1/10/2011	1:20:00 PM	4.27	6.7	10.21	67	0	1.4		0.021	0.527	FC reported as <5.
2/15/2011	12:00:00 PM	7.02	6.9	10.76	72	30	2.9		0.026	0.624	
3/15/2011	1:30:00 PM	7.81	6.8	10.11	55	10	3.2		0.017	0.404	
4/13/2011	12:45:00 PM	8.80	6.9	10.95	71	0	1.4		0.022	0.410	FC reported as <5.
5/18/2011	11:45:00 AM	12.09	6.8	10.04	71	28	2.3		0.032	0.316	Duplicates labeled "Black @ Gate".
6/15/2011	12:15:00 PM	14.05	7.1	10.35	97	20	1.1		0.032	0.736	
7/13/2011	11:45:00 AM	16.62	7.3	10.23	107	20	0.7		0.029	0.699	
8/10/2011	1:45:00 PM	17.51	7.4	10.54	112	10	0.5		0.028	0.805	
9/13/2011	1:05:00 PM	16.60	7.2	8.65	116	30	0.0		0.027	0.866	

Thurston County Water Resources Monitoring Report 2009-2010

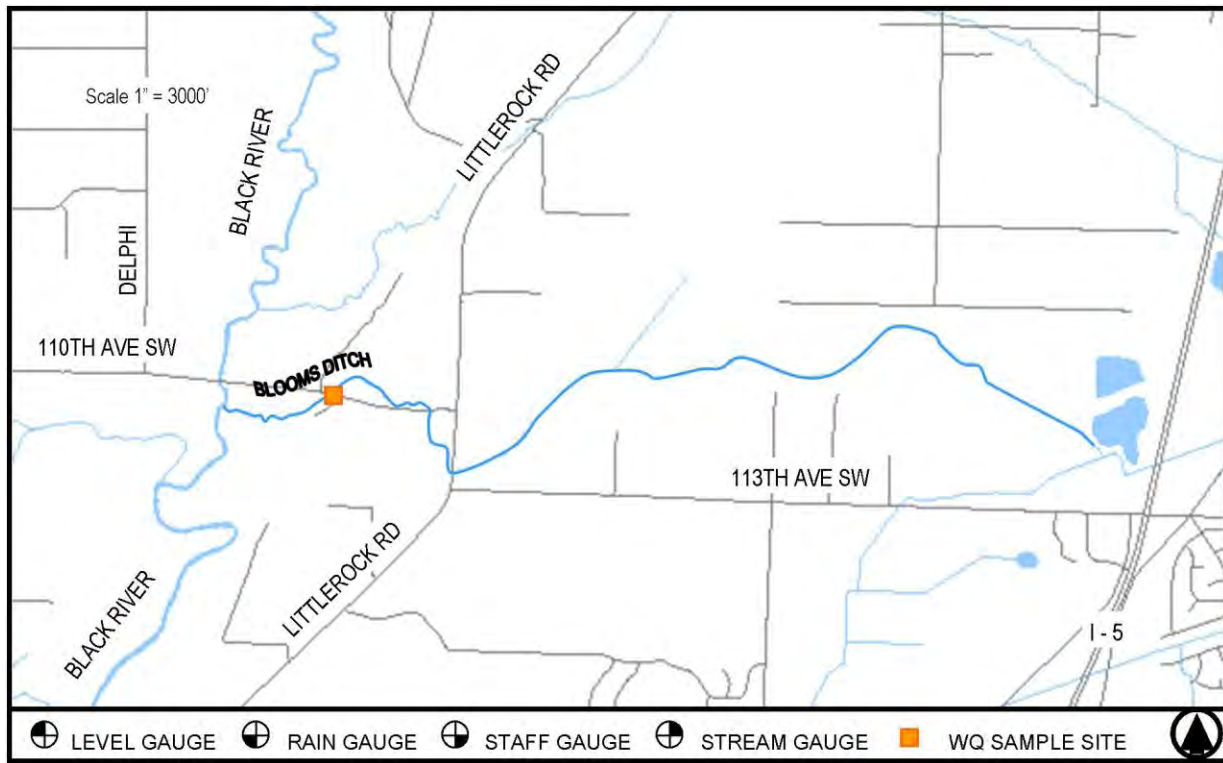
Black River @ 128th Ave Br

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/21/2009	3:10:00 PM	11.89	6.9	4.90	105	10	2.3		0.044	0.168	Staff gage - 1.70'
11/18/2009	10:45:00 AM	7.48	6.2	8.64	54	100	8.0		0.051	0.177	
12/14/2009	1:20:00 PM	1.16	6.5	11.05	79	10	2.2		0.020	0.304	Staff gage reading is approximate: 1.92'
1/12/2010	10:30:00 AM	7.07	6.7	8.91	53	45	2.0		0.020	0.180	Staff gage reading is approximate: 3.30'
2/9/2010	10:10:00 AM	7.48	6.4	8.76	70	15	1.6		0.025	0.249	
3/15/2010	9:45:00 AM	6.12	6.5	9.71	63	20	1.6		0.021	0.187	
4/20/2010	9:50:00 AM	12.87	6.5	8.00	71	25	0.8		0.028	0.132	
5/12/2010	10:25:00 AM	10.72	6.8	8.71	75	35	1.4		0.026	0.188	
6/16/2010	11:10:00 AM	12.76	6.8	7.70	76	50	2.5		0.040	0.190	
7/14/2010	10:30:00 AM	16.43	6.9	6.80	91	25	2.9		0.045	0.203	
8/18/2010	10:10:00 AM	18.00	6.8	5.63	103	150	1.9		0.030	0.174	
9/15/2010	8:40:00 AM	14.30	6.8		103	20	1.8		0.032	0.199	Unable to decipher DO as recorded.

Thurston County Water Resources Monitoring Report 2010-2011

Black River @ 128th Ave Br

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2010	12:25:00 PM	8.40	6.8	8.32	84	10	0.8		0.030	0.202	Couple of salmon.
11/15/2010	10:00:00 AM	8.66	6.4	7.62	69	15	1.4		0.030	0.136	
12/15/2010	10:00:00 AM	7.35	6.4	7.36	44	10	4.5		0.033	0.215	Duplicates labeled "Littlerock".
1/10/2011	12:20:00 PM	3.19	6.6	9.41	60	5	0.4		0.017	0.284	Staff gage - 2.86'.
2/15/2011	10:45:00 AM	6.30	6.7	9.21	63	30	2.0		0.023	0.245	Staff Gage - 2.99'.
3/15/2011	12:50:00 PM	7.67	6.7	9.19	51	30	1.5		0.015	0.177	River flooded into fields upstream. Did not sample in the plume from Waddell Creek, visible on the river bank.
4/13/2011	11:45:00 AM	8.63	6.8	9.31	62	5	1.0		0.020	0.121	
5/18/2011	11:00:00 AM	11.38	6.6	7.94	64	20	1.5		0.030	0.100	Staff gage - 2.68'.
6/15/2011	11:30:00 AM	13.80	6.8	8.20	83	20	1.8		0.033	0.208	Staff gage 1.78'.
7/13/2011	10:40:00 AM	15.72	6.8	7.54	93	50	1.6		0.016	0.188	Staff gage - 1.46'.
8/10/2011	12:45:00 PM	16.49	6.9	7.48	100	0	1.3		0.032	0.163	FC reported as <5. Staff gage - 1.26'.
9/13/2011	11:30:00 AM	16.33	6.9	7.51	101	5	1.0		0.023	0.124	Staff gage 1.14'.



PART OF CHEHALIS RIVER WATERSHED

LENGTH OF RIVER: 8.5 miles

BASIN SIZE: 7.8 square miles

STREAM ORDER: 2

PRIMARY LAND USES:

Agriculture
Rural Residential

FISHERIES RESOURCES: (From A Catalog of Washington Steams and Salmon Utilization, WDOF)
Coho

GENERAL TOPOGRAPHY:

Blooms Ditch is a tributary to the Black River and drains an area to the east side of the river basin. The topography is very flat, except for an area of rolling hills in the eastern-most part of the basin. Groundwater in much of the basin is very shallow.

GENERAL WATER QUALITY:

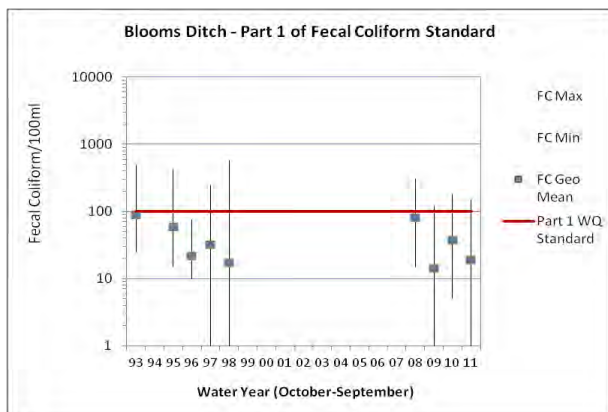
Fair to Good – Met both parts of the fecal coliform standard in 2009/10 and 2010/11. There was one violation of the turbidity standard and three pH violations in 2009/10. Nitrate levels are low, but total phosphorus levels are above regional reference conditions.

OTHER DATA:

Washington Dept. of Ecology, Environmental Assessment Program (360) 407-6000.

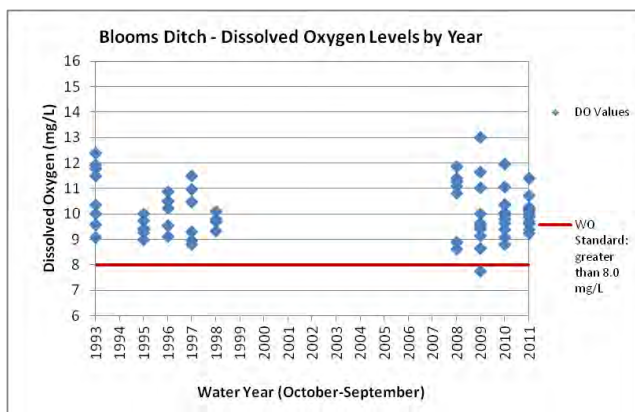
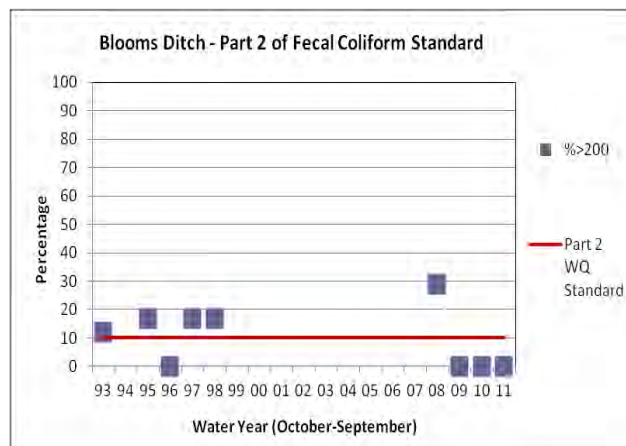
Thurston County Public Health and Social Services Dept., Environmental Health Division, Resource Protection (360) 867-2626 (water quality data from 1991) or www.co.thurston.wa.us/health/ehswat/swater.html

Blooms Ditch #684



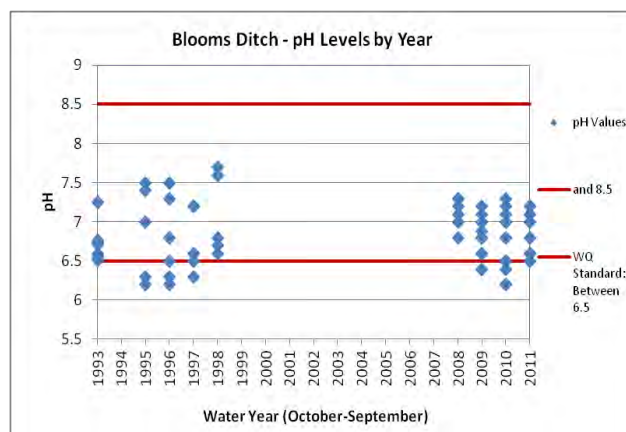
Blooms Ditch has met Part 1 of the fecal coliform standard every water year. There have been no violations of Part 2 for the past three water years.

The water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 100 colonies/100mL *and* Part 2 - no more than 10% of the samples shall exceed 200 colonies/100 mL.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 8.0 mg/L. The dissolved oxygen fell below the standard one time in May of 2009.

The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. Throughout the period of record there have been several measurements below the standard. There were no violations in water year 2010/11.



Discussion:

Blooms Ditch was monitored between 1992 and 1998 as part of the ambient monitoring program, and then discontinued. Monitoring resumed at this site in 2008. The data for water years 2009/10 and 2010/11 are summarized in the table on the next page.

The creek met both parts of the fecal coliform standard in both water years 2009/10 and 2010/11. There were three pH standard violations in November and December of 2009 and January of 2010; and a turbidity violation in July 2010.

The recent nitrate data indicates that there continues to be a decrease when compared to the 1993 to 1998 nitrate data set (0.235 mg/l). While there is no water quality standard for nitrate in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015). The average nitrate concentration for Blooms Ditch is below the regional reference condition. The total phosphorus regional reference condition is 0.019 mg/l, according to the EPA report. The Blooms Ditch average total phosphorus concentration is 0.043 mg/l, which is similar to nearby Beaver and Salmon Creeks.

The temperature standard that applies in Blooms Ditch is intended to protect salmonid spawning, rearing and migration, and is a 7-day average daily maximum of 17.5 ° C. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. The temperature measurements were all below the maximum temperature criteria of 17.5 ° C.

Major Issues:

- Non-point pollution rural land use activities
- Development pressures are increasing in the area

Funding Sources:

- Thurston County stormwater utility

Water Quality Summary
Conventional Parameters
Blooms Ditch

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		2.46 – 15.49 3.01 – 14.42			2.02 – 17.08
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		8.81 – 11.96 9.25 – 11.41	0 of 12 0 of 12		7.78 – 13.0
Conductivity	µmhos/cm		09/10 10/11	85 69	55 - 158 27 - 104		73	30 - 113
pH		6.5 - 8.5	09/10 10/11	6.6* 6.8*	6.2 – 7.3 6.5 – 7.2	3 of 12 0 of 12	6.8*	6.2 - 7.7
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	6.78 3.68	1.0 - 38 1.0 – 7.7	1 of 12 0 of 12	4.40	0.5 - 19
Fecal Coliform	colonies/ 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	37** 19**	5 - 180 0 - 150	% exceeding 200	33**	0 – 580
						0%		
						0%		
Total Phosphorus	mg/L		09/10 10/11	0.052 0.042	0.03 – 0.166 0.025 – 0.080		0.043	0.013 – 0.101
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	0.112 0.124	0.032 – 0.314 0.019 – 0.304		0.195	0.019 – 0.482

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

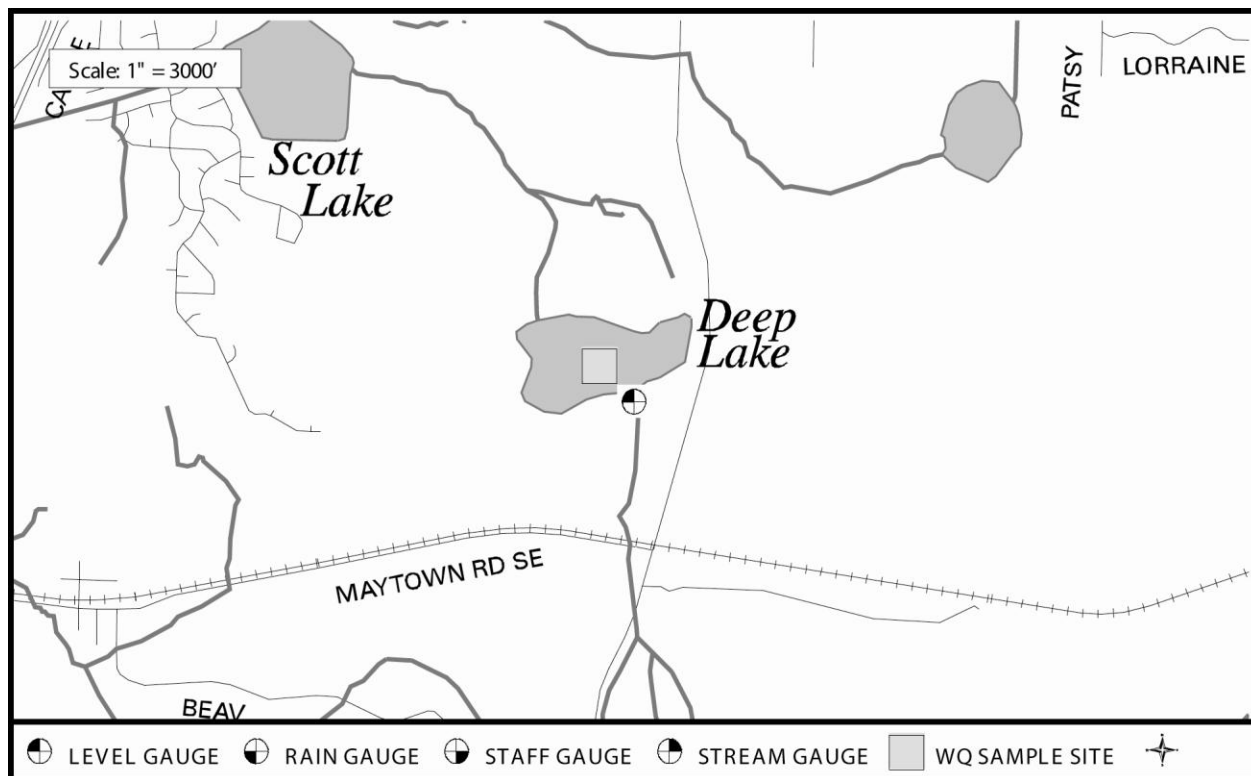
Blooms Ditch @ 110th Ave

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/21/2009	3:55:00 PM	11.81	7.1	10.07	158	55	4.8	1.04	0.034	0.098	
11/18/2009	10:15:00 AM	6.83	6.2	10.07	59	160	6.0	41.26	0.060	0.043	
12/14/2009	12:40:00 PM	2.46	6.4	11.96	90	5	3.6	10.62	0.042	0.084	Duplicates labeled "Littlerock & 110th"
1/12/2010	10:00:00 AM	7.20	6.2	9.97	55	15	4.1	54.77	0.038	0.062	
2/9/2010	9:45:00 AM	7.28	6.5	10.36	68	5	2.2	19.17	0.033	0.094	
3/15/2010	9:30:00 AM	6.18	6.5	11.08	60	95	2.3	26.86	0.030	0.065	
4/20/2010	9:25:00 AM	12.15	6.5	9.10	69	20	1.0	15.09	0.040	0.032	
5/12/2010	10:00:00 AM	10.42	7.0	10.40	78	35	2.6	8.56	0.042	0.066	
6/16/2010	10:00:00 AM	12.60	6.8	8.81	77	15	9.4	10.51	0.080	0.052	
7/14/2010	10:10:00 AM	13.42	7.0	9.64	95	75	38.0	2.74	0.166	0.120	Duplicates labeled "BPA". Very Turbid.
8/18/2010	9:55:00 AM	15.49	7.2	9.41	102	85	3.5	0.56	0.035	0.312	
9/14/2010	4:10:00 PM	14.98	7.3	9.82	104	180	3.9	0.51	0.030	0.314	

Thurston County Water Resources Monitoring Report 2010-2011

Blooms Ditch @ 110th Ave

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2010	12:40:00 PM	8.04	7.1	11.41	27	20	3.8	3.13	0.048	0.105	Swoffer malfunctioned at first increment. Flow is estimate.
11/15/2010	9:30:00 AM	9.06	6.5	9.63	67	20	2.4	22.73	0.053	0.058	
12/15/2010	9:45:00 AM	6.10	6.5	9.42	51	90	2.0		0.043	0.076	Flooding. Too deep to measure flow.
1/10/2011	12:00:00 PM	3.01	6.6	10.73	59	0	1.0	30.94	0.025	0.101	FC reported as <5.
2/15/2011	10:25:00 AM	5.87	6.6	10.13	65	150	3.5	28.86	0.048	0.114	Duplicates labeled "110th@ L."
3/15/2011	12:00:00 PM	8.14	6.8	9.90	52	30	3.3	54.09	0.025	0.062	Flow is estimate. Marginal cross-section.
4/12/2011	1:15:00 PM	9.49	6.8	10.19	57	5	1.5	35.10	0.032	0.035	
5/18/2011	10:15:00 AM	11.98	6.6	9.25	57	15	2.2	27.36	0.049	0.019	
6/15/2011	10:55:00 AM	12.37	7.0	9.98	86	0	7.2	6.01	0.080	0.136	FC reported as <5.
7/13/2011	10:10:00 AM	13.61	7.2	9.73	103	90	7.1	1.22	0.043	0.218	
8/10/2011	12:30:00 PM	14.42	7.2	10.27	104	125	7.7	0.76	0.035	0.255	
9/13/2011	10:30:00 AM	14.30	7.1	9.90	102	10	2.5	0.36	0.026	0.304	Duplicates labeled "L.+110th".



PART OF Black River WATERSHED

LENGTH OF LAKE: 0.4 miles

SHORELINE LENGTH: 1.4 miles

LAKE SIZE: 66 acres

BASIN SIZE: 1.2 square miles

MEAN DEPTH: 12 feet

MAXIMUM DEPTH: 17 feet

VOLUME: 770 acre-feet

PRIMARY LAND USES:

Most of the watershed is inside Millersylvania State Park. It is forested, but is a heavily used recreation area.

PRIMARY LAKE USES:

Swimming, boating, and fishing

PUBLIC ACCESS:

The state park has three swimming beaches that are used heavily in the summer. A private resort is located on the east side of the lake.

GENERAL TOPOGRAPHY:

The approximate altitude of the lake is 198 feet. The lake is situated between gentle hills (elevation 300 feet). There is a small unnamed inlet on the southeast side of the lake and an unnamed outlet on the northwest side of the lake. The outlet creek flows into Scott Lake.

GENERAL WATER QUALITY:

(Excellent, Good, Fair, Poor)

Good – Water clarity is good, nutrient levels are low.

OTHER AVAILABLE DATA:

Water quality data - Thurston County Environmental Health Division, (360) 867-2626
www.co.thurston.wa.us/health/ehswat/swater.htm

GENERAL DISCUSSION:

Deep Lake is a small, shallow lake in central Thurston County that is a popular recreation area. Approximately two-thirds of the shoreline is within Millersylvania State Park. Most of the watershed is forested and undeveloped. The most developed shoreline area on the lake is a small RV resort on the east side of the lake.

In 2011 Deep Lake was sampled monthly, May through October. Field parameters included temperature, dissolved oxygen, pH, conductivity, and secchi disk readings for water clarity. Samples were collected near the surface and near the lake bottom and analyzed for total phosphorus and total nitrogen. Composite samples from the epilimnion (warm surface layer), or photic zone, were collected and analyzed for chlorophyll *a* and algae identification.

Field Parameters

Temperature, dissolved oxygen, pH, and conductivity profile graphs are included on page 7. The term “thermal stratification” refers to a condition in the lake when there are two distinct layers of water, an upper layer warmed by solar radiation and a cold bottom layer. In 2011, Deep Lake was thermally stratified from May through September. The surface temperature reached 23 degrees Celsius in August, while the temperature near the lake bottom was only 13 degrees C. By October the lake was nearly mixed from surface to bottom.

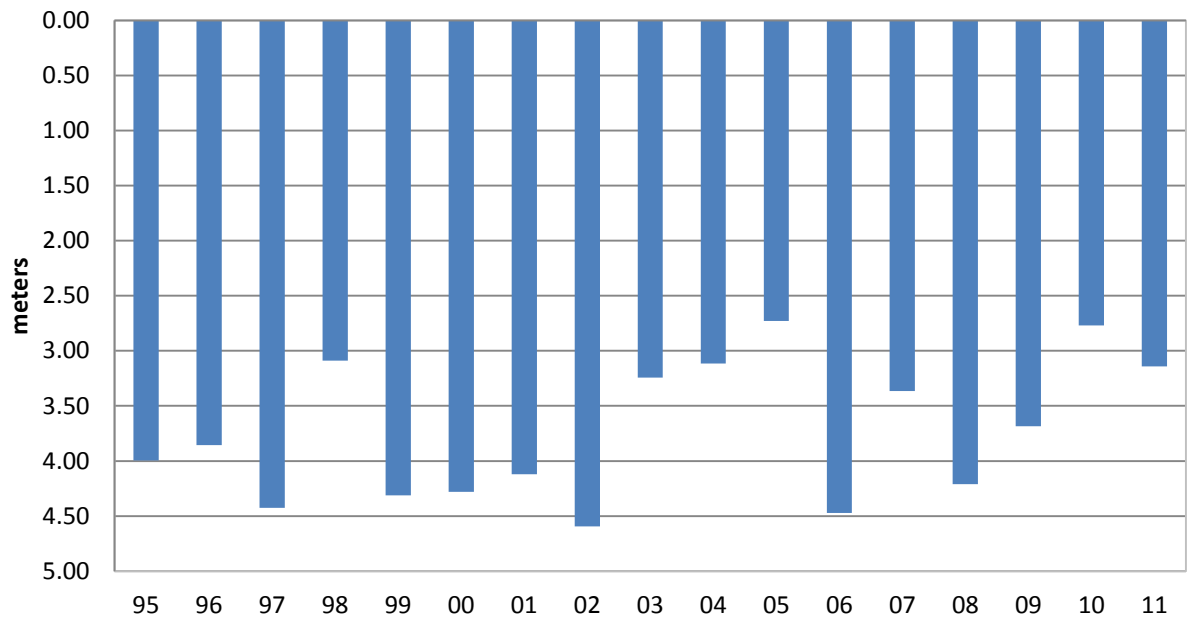
The lake’s shallow depth (average depth of 12 feet or 3.7 meters) and generally good water clarity results in a dense population of rooted aquatic plants along the lake bottom. During the day while these plants are photosynthesizing they keep the lake well oxygenated at all depths. In 2011 at a depth from three meters and below the water was actually supersaturated with oxygen from June through September, which is the peak growing season for aquatic plants.

Secchi Disk Water Clarity

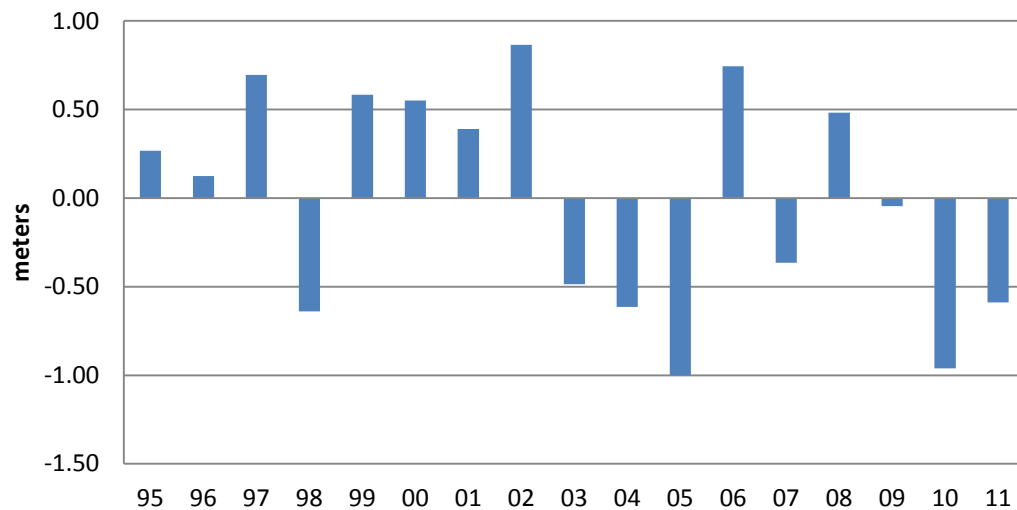
Water clarity in a lake is measured with a device called a secchi disk. The 2011 average water clarity was 3.1 meters (10.3 feet). The range of measurements was from 1.75 meters (5.7 feet) in October to 3.7 meters (12 feet) in June. A graph of annual average summer secchi disk measurements from 1995 through 2011 is included on the next page.

A water clarity trend graph is also shown on the next page. This graph shows the difference between each year’s average secchi reading and the average secchi reading for the entire period of record. A positive number indicates that the water clarity that year was better than the overall average. A negative number indicates that the clarity was less than the overall average. Graphing the water clarity data in this way helps to visually see trends in water quality versus normal annual fluctuations. For Deep Lake, there is no clear upward or downward trend in water clarity over the past 17 years, rather there is random variability, plus or minus one meter, around the overall average.

Water Clarity Annual Average Secchi Readings



Water Clarity Trend Annual Average Minus Long-Term Average

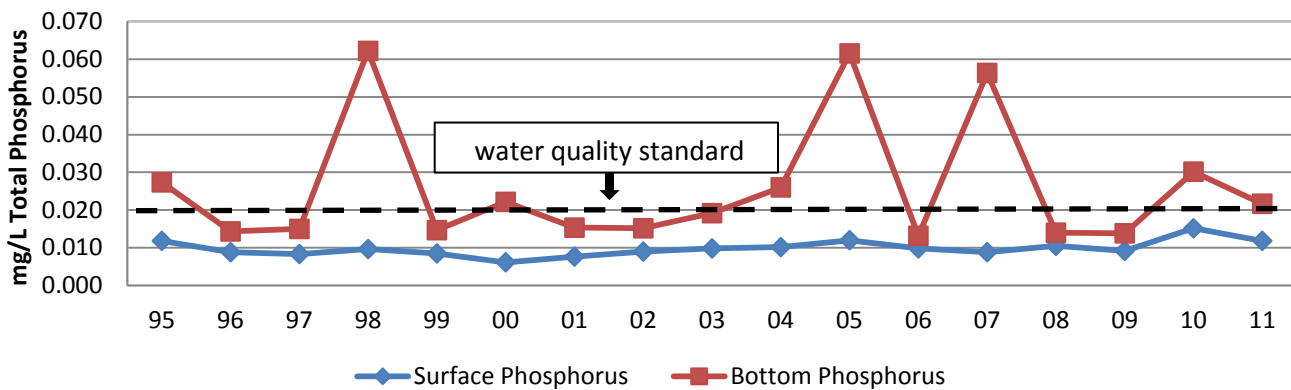


Total Phosphorus and Total Nitrogen

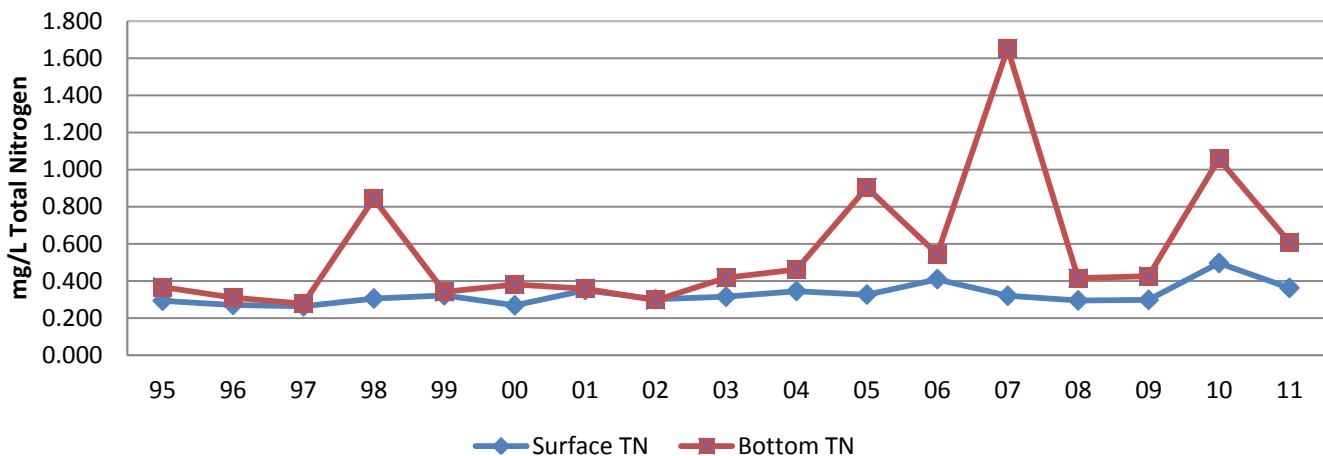
Generally, lakes in the Puget Sound region with summer average surface total phosphorus concentrations greater than 0.030 mg/l experience undesirable algae growth which interferes with recreational uses of the lake (USGS Water Supply Paper 2240). The action level established in WAC 173-201A, "Water Quality Standards for Surface Water of the State of Washington" is 0.020 milligrams per liter (mg/l).

In 2011 the average surface total phosphorus concentration in Deep Lake was 0.012 mg/l, and the individual monthly results were all below the action level. As is the case in most Thurston County Lakes, the total phosphorus concentration at the bottom is typically higher than at the surface, especially during periods of stratification. In most lakes, including Deep Lake, the algae growth is limited by the amount of available phosphorus. The two graphs below shows the annual average total phosphorus and total nitrogen concentrations at the surface and near the bottom for the period of record.

Total Phosphorus Annual Averages

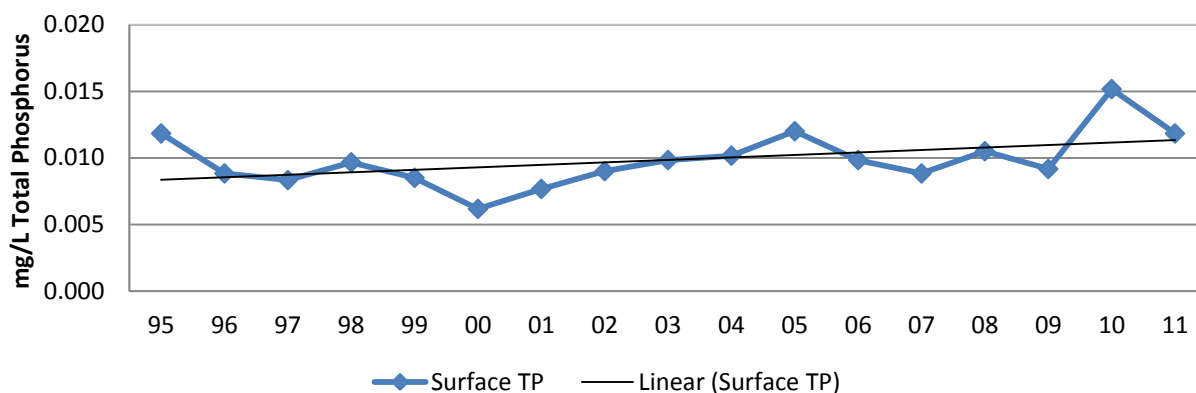


Total Nitrogen Annual Averages

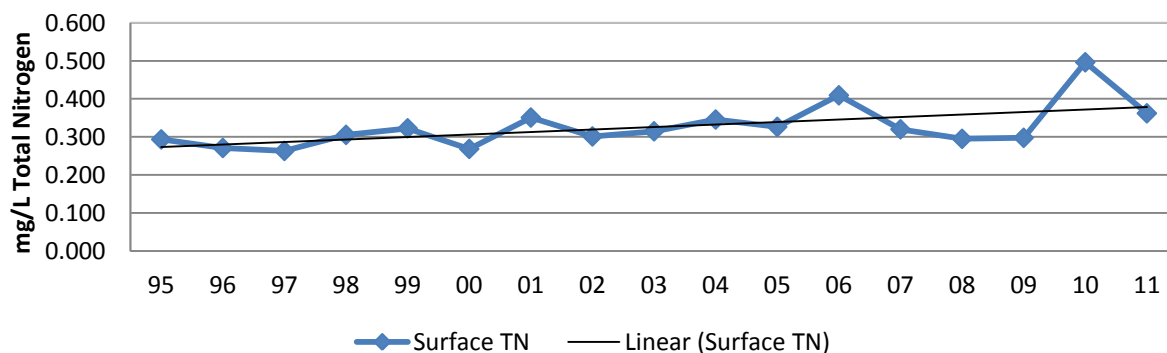


The three graphs below show the surface concentrations for phosphorus, nitrogen, and chlorophyll *a* along with a linear trend line. It appears from these graphs that nutrients and algae productivity have been slowly increasing over time, indicating that pollution may be incrementally increasing.

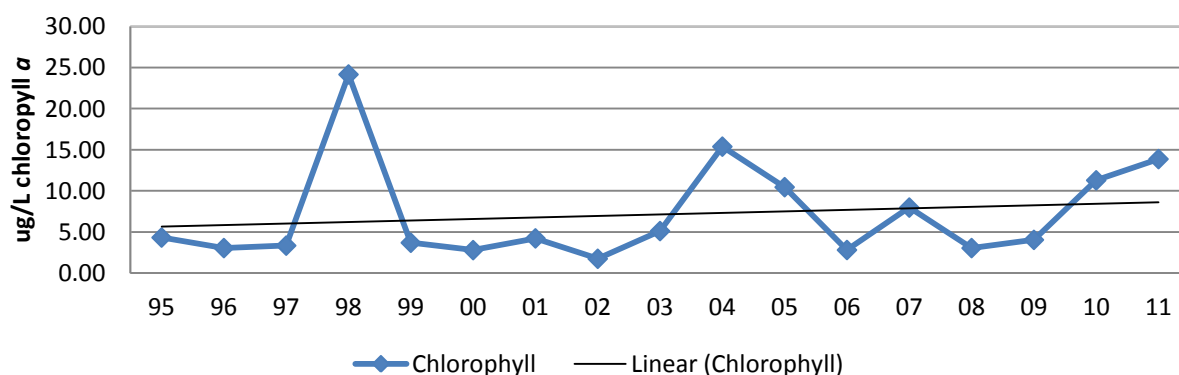
Total Phosphorus Annual Average at Surface



Total Nitrogen Annual Average at Surface



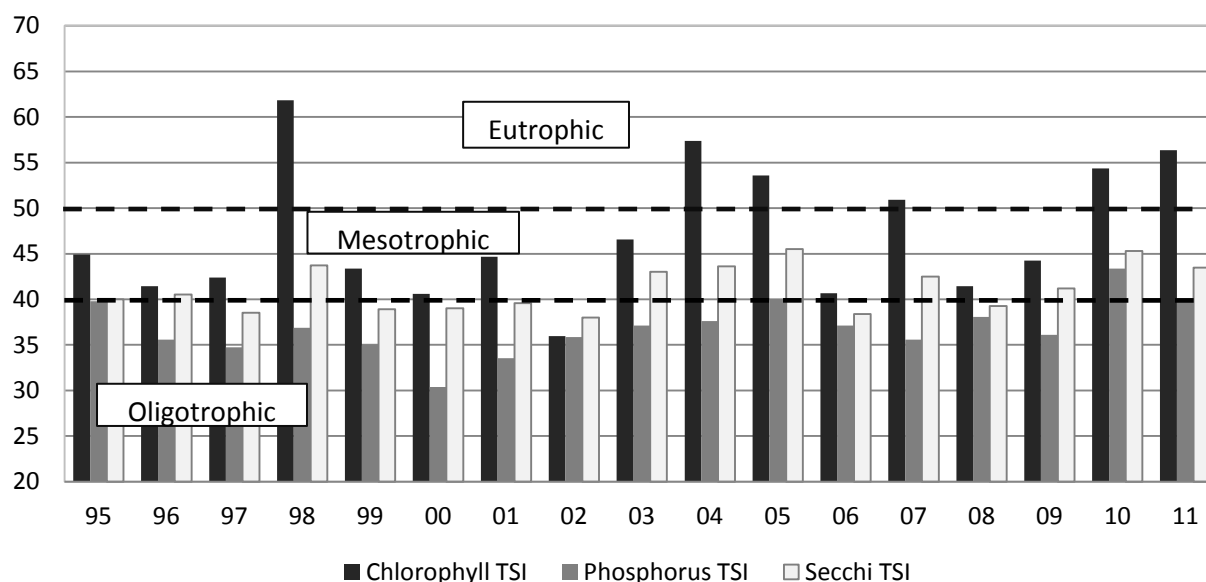
Chlorophyll *a* Annual Average at Surface



Trophic State Indices

The Carlson trophic state indices (TSI), are used to express the degree of productivity of a lake. Average summer total phosphorus concentrations, chlorophyll *a* concentrations, and secchi disk transparency are each used to calculate a TSI for the lake. A TSI of 0 to 40 indicates an oligotrophic, or low productivity, lake. A TSI of 41 to 50 indicates a mesotrophic, or moderately productive lake. A TSI of greater than 50 indicates a eutrophic, or highly productive lake.

Deep Lake Trophic State Indices



The trophic state indices for the years of record are graphed above. For 2011, the Deep Lake TSI's for chlorophyll *a*, total phosphorus, and secchi disk visibility are 56, 40, and 43, respectively. The chlorophyll index was in the eutrophic range for the past two years, indicating high productivity of algae and plants. The total phosphorus and secchi indices were in the mesotrophic range, indicating moderate productivity. In the past, Deep Lake TSIs have been near the upper end of the oligotrophic range and the lower range of the mesotrophic indicating low to moderate productivity. However in the past two years, the TSI's indicate a more productive lake environment.

Chlorophyll and Algae

The monitoring program includes sampling for chlorophyll *a* and identification of algae types present in the lake. Chlorophyll *a* is the green pigment found in plants, including algae, and is used as a measure of the amount of algae growth in a lake. The average 2011 chlorophyll *a* concentration was 13.9 micrograms per liter ($\mu\text{g/l}$), which is the third highest chlorophyll average in the record. A very high chlorophyll concentration of 60 $\mu\text{g/l}$ measured in October, caused the average to be high this year.

There are a variety of algae types present in Deep Lake including green, diatoms, blue-green, and yellow. Blue-green algae species are most common in nutrient-rich lakes and are known to cause

visible algae “blooms”. Lakes with high nutrient levels and poor water quality tend to be dominated by blue-green algae, while green algae are more common in oligotrophic lakes. In 2011, blue-green species were present in all but the May sample. A report of the algae species present in the monthly samples is located at the end of the chapter.

Some species of blue-green algae can produce toxins that can cause illness, or even death, in people, pets, and wildlife if ingested. Pets are particularly vulnerable to poisoning from toxic algae blooms due to their smaller body weight and their tendency to ingest higher doses by drinking lake water and licking their fur after swimming. In recent years there has been an increase in documented toxic blue-green algae blooms occurring in lakes within Washington State.

Because toxicity cannot be determined through visual observations, in 2009 Thurston County Environmental Health began using screening test kits to test for the presence of the most common algae toxin, microcystin. When the screening indicates the presence of microcystin, a sample is sent to a laboratory to quantify the amount of toxin present. The laboratory services are a statewide program sponsored by Washington Department of Ecology. Although toxin testing is now possible, lake residents and users should always observe lake conditions and avoid contact with lake water where an algae bloom is occurring.

In 2010, a health advisory was posted for Deep Lake after a sample collected in September showed that the algae toxin, microcystin was present in the lake at a concentration of 2.97 µg/L. The state recreational guidance limit for microcystin established by the Washington State Department of Health is 6 µg/L. The county health department continued to monitor the toxin concentration in the lake. When toxin levels continued to be below the established limit and finally was no longer detected at the end of October, the advisory was lifted. There was no advisory issued in 2011.

More information about blue-green algae and swimming safety information is available through the Thurston County website: www.co.thurston.wa.us/health/ehadm/swimming/swimming_index.html

Major Issues:

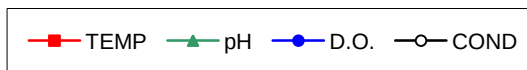
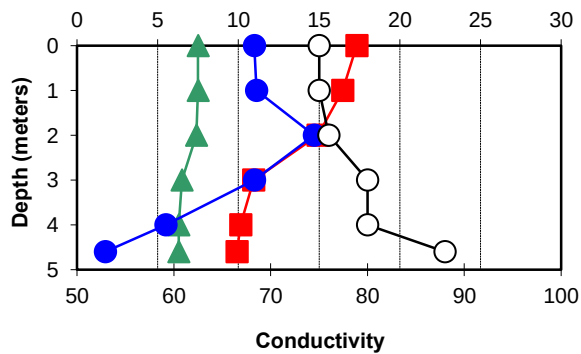
- Heavy recreational usage in the summer increases the risk of the spread of a communicable disease associated with poor personal hygiene and facility over-usage.
- Swimmer’s itch is reported to be a regular summer problem in this lake, so preventative measures should be taken by bathers.
- An invasive, non-native aquatic plant, Eurasian water milfoil, was discovered in the lake in 2003. Washington State Parks and Recreation is taking steps to control its spread in the lake.

Funding Sources:

Thurston County funding will continue to support sampling in 2012.

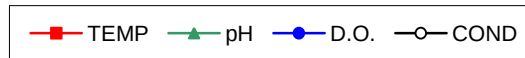
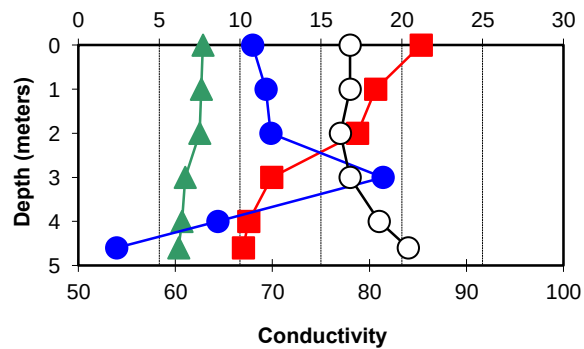
May 24, 2011

Temperature, pH, Dissolved Oxygen



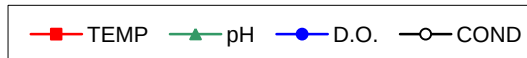
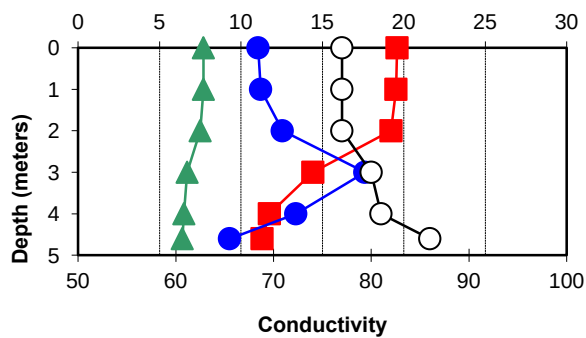
June 21, 2011

Temperature, pH, Dissolved Oxygen



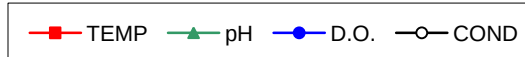
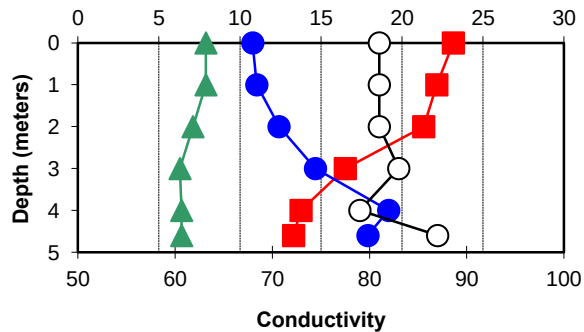
July 20, 2011

Temperature, pH, Dissolved Oxygen



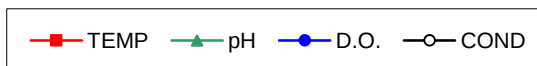
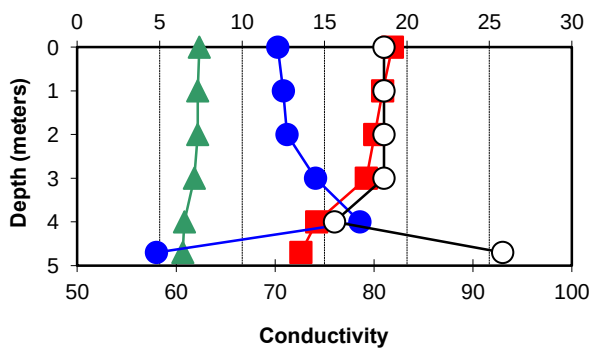
August 23, 2011

Temperature, pH, Dissolved Oxygen



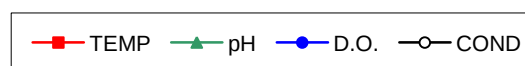
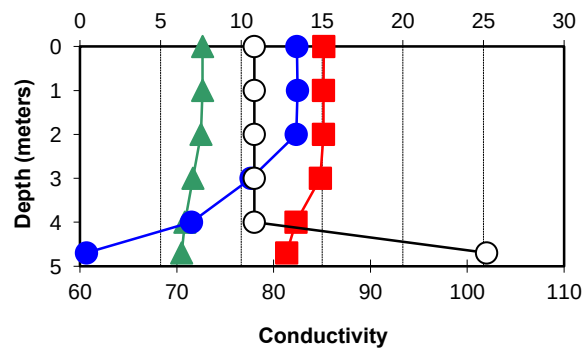
September 19, 2011

Temperature, pH, Dissolved Oxygen



October 10, 2011

Temperature, pH, Dissolved Oxygen



Thurston County Water Resources Annual Report - 2011

Deep Lake

Site ID# BLADEL000

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water	Lake Notes
05/24/2011	3:15:00 PM	4.6	4.0	0.009	0.023	0.418	0.745	3.09	2.7	0.05	#7 yellow-orange	Chl a & algae composite @ 1 & 2M. Phaeo a was < detection at 0.1ug/L.
06/21/2011	2:45:00 PM	4.6	4.0	0.010	0.030	0.328	0.535	3.67	2.6	0.05	#7 yellow	Chl a & algae composite @ 1, 2 & 3M. Phaeo a was < detection at 0.1ug/L.
07/20/2011	11:15:00 AM	4.6	4.0	0.013	0.029	0.358	0.573	3.56	5.9	1.6	#6 greenish-yellow	Chl a & algae composite @ 1, 2, & 3M.
08/23/2011	2:30:00 PM	4.6	4.0	0.010	0.013	0.368	0.649	3.26	5.6	0.9	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
09/19/2011	3:15:00 PM	4.7	4.0	0.015	0.023	0.308	0.581	3.52	6.4	0.3	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
10/10/2011	3:30:00 PM	4.7	4.0	0.014	0.012	0.392	0.564	1.75	60	4.5	#3 pea-green	Chl a & algae composite @ 1, 2, & 3M. No algae scum present.

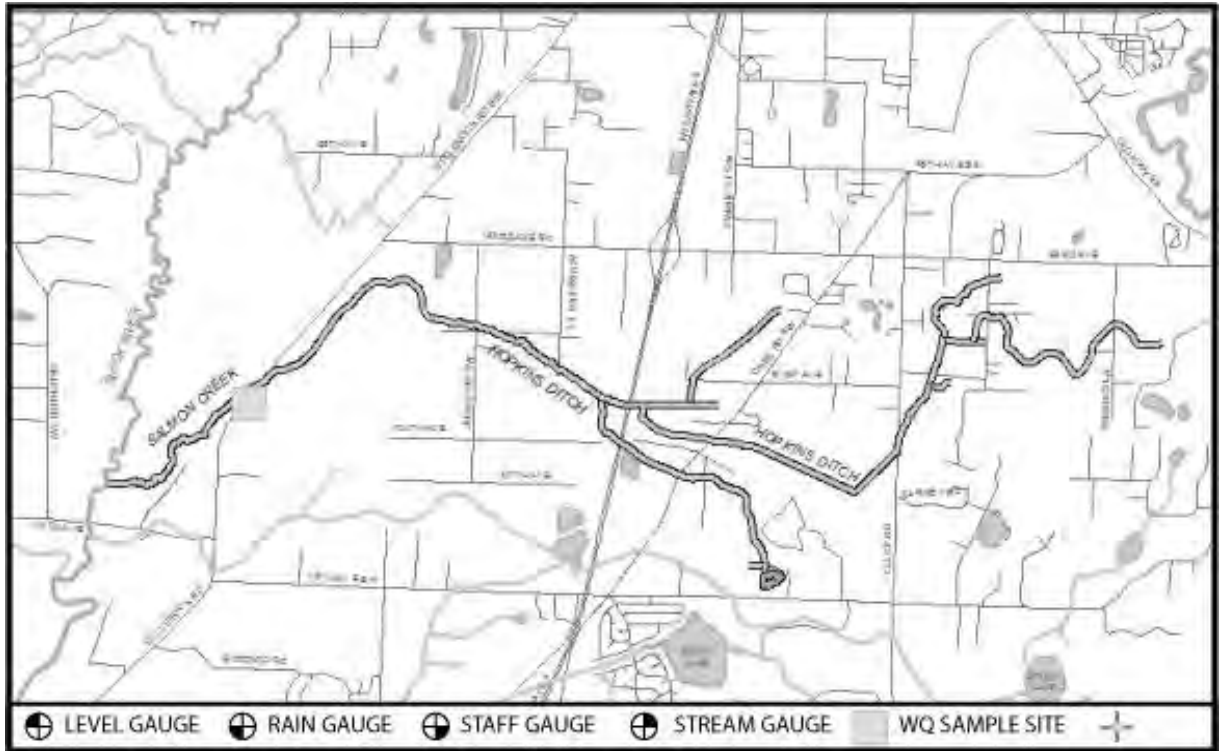
Summary for 'Site Description' = Deep Lake (6 detail records)

Averages: Sur TP 0.012
Secchi 3.14
Chl a 13.9

Algae data: Deep Lake

	Type	Description	Dominant in Sample
05/24/2011			
	DF	Ceratium species	☐
	GR	Botryococcus species	☐
	GR	Sphaerocystis species	☐
06/21/2011			
	BG	Anabaena species	☐
	CP	Cryptomonads	☐
	DF	Ceratium species	☐
	DT	Asterionella species	☐
	DT	Cocconeis pediculus	☐
	DT	Cymbella species	☐
	GR	Botryococcus species	☐
	GR	Crucigenia species	☐
	GR	Quadrigula species	☐
	GR	Scenedesmus species	☐
	GR	Sphaerocystis species	☐
	YL	Dinobryon species	☐
07/20/2011			
	BG	Anacystis species	☐
	BG	Chroococcus species	☐
	CP	Cryptomonads	☐
	GR	Elakatothrix species	☐
	GR	Radiococcus nimbatus	☐
	GR	Sphaerocystis species	☐
	YL	Dinobryon species	☐
	YL	Synura species	☐
08/23/2011			
	BG	Anacystis species	☐
	CP	Cryptomonads	☐
	GR	Oocystis species	☐
	GR	Sphaerocystis species	☐
	YL	Dinobryon species	☒

	<i>Type</i>	<i>Description</i>	<i>Dominant in Sample</i>
<i>09/19/2011</i>			
	BG	Anabaena species	☐
	CP	Cryptomonads	☐
	DT	Asterionella species	☐
	YL	Dinobryon species	☒
	YL	Synura species	☐
<i>10/10/2011</i>			
	BG	Anabaena species	☐
	BG	Woronichinia species	☐
	CP	Cryptomonads	☐
	DF	Ceratium species	☐
	YL	Dinobryon species	☒
Key: <i>BG = Blue green</i> <i>EU = Euglenophyte</i> <i>CP = Cryptophyte</i> <i>GR = Green</i> <i>DF = Dinoflagellate</i> <i>YL = Yellow</i> <i>DT = Diatom</i>			



PART OF BLACK RIVER WATERSHED

LENGTH OF RIVER: 7.4 miles

BASIN SIZE: 7500 acres

PRIMARY LAND USES:

Agriculture including a large government forestry nursery, rural residential and light industrial near highway interchange.

FISHERIES RESOURCES: (From A Catalog of Washington Steams and Salmon Utilization, WDOF)

Coho

GENERAL TOPOGRAPHY:

Salmon Creek is a tributary to the Black River and drains the prairie on the east side of the river basin and includes Hopkins Ditch.

The basin is a flat glacial outwash plain with low-lying areas prone to groundwater flooding during periods of prolonged above average rainfall.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

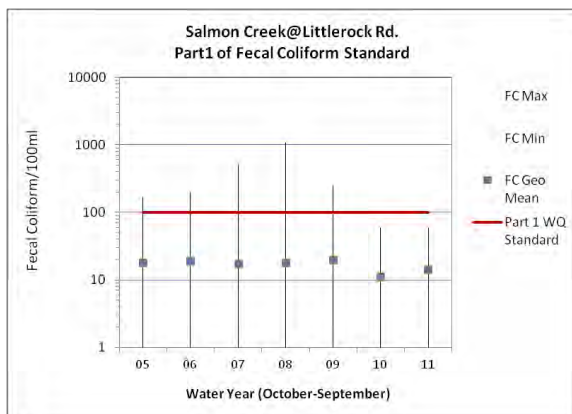
Fair – Met both part 1 and part 2 of the fecal coliform bacteria standard both water years. Dissolved oxygen is low in dry months.

OTHER DATA:

Thurston County Environmental Health Division (360) 867-2626 (water quality data for 1991-1993). www.co.thurston.wa.us/health/ehswat/swater.html

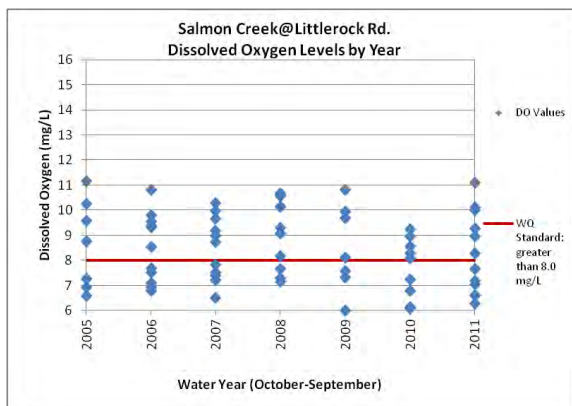
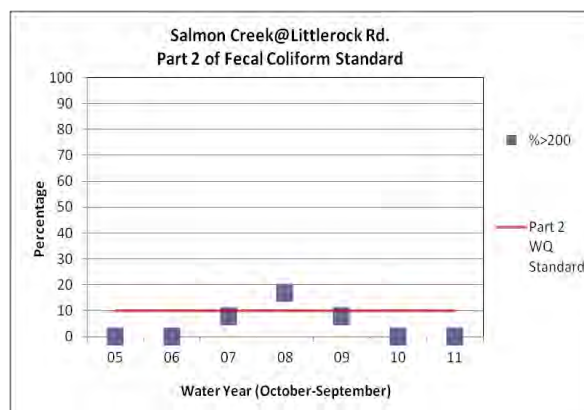
Thurston County Resource Stewardship Department (360) 754-4681, Salmon Creek and groundwater monitoring. Salmon Creek Drainage Basin Plan, www.co.thurston.wa.us/monitoring

Salmon Creek #685



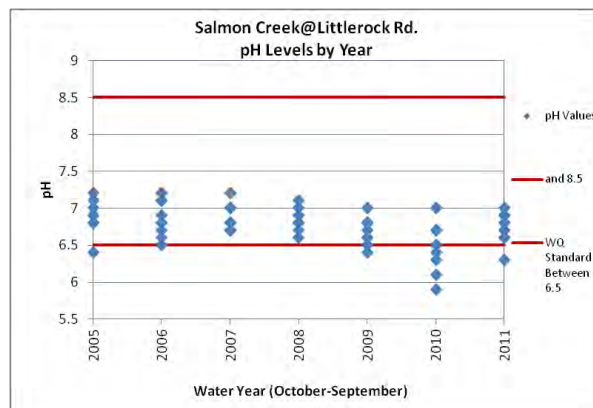
Salmon Creek has met Part 1 of the fecal coliform standard every water year. The creek has met Part 2 for the past three water years.

The water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 100 colonies/100mL *and* Part 2 - no more than 10% of the samples shall exceed 200 colonies/100 mL.



The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been violations of the standard in 2005 and the last three water years.

The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. Due in part to the physical characteristics of the creek, there are numerous occasions when the dissolved oxygen standard is violated. Violations have occurred in every water year.



Discussion:

Salmon Creek drainage basin is naturally prone to groundwater flooding because of the geology and topography. The land is virtually flat and surface drainage is slow. Standing water can remain on the surface for months. Monthly water quality monitoring of Salmon Creek began in January 2005. The creek met both parts of the fecal coliform bacteria standard in both water years 2009/10 and 2010/11. During both water years, the dissolved oxygen fell below the standard six times. There were four pH violations in 2009/10 and one in 2010/11.

The temperature standard that applies in Salmon Creek is intended to protect salmonid spawning, rearing and migration, and is a 7-day average daily maximum of 17.5° C. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. In August, 2010 the instantaneous temperature measurement was slightly above 17.5° C indicating possible temperature standard violations during that period.

Water quality monitoring will continue.

Major Issues:

- During the rainy seasons of 1996/97 and 1998/99, above average rainfall caused localized flooding, failed septic systems, contaminated drinking water and restricted access to property. Flooding is expected to occur again when there is above average rainfall.
- Salmon Creek Comprehensive Drainage Basin Plan, developed to address flooding problems was approved by Thurston County and City of Tumwater in June 2004.

Funding Sources:

- Thurston County

Water Quality Summary
Conventional Parameters
Salmon Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				2005-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		0.30 – 17.63 2.88 – 15.17			1.07 – 17.65
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		4.83 – 9.23 6.27 – 11.10	6 of 12 6 of 12		5.21 – 11.2
Conductivity	µmhos/m		09/10 10/11	96 87	63 - 126 52 - 116		96	61 - 136
pH		6.5 - 8.5	09/10 10/11	6.6* 6.8*	5.9 – 7.0 6.3 – 7.0	4 of 12 1 of 12	6.8*	6.4 – 7.2
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	2.3 1.48	0.2 – 5.0 0.2 – 3.3	0 of 12 0 of 12	3.4	0 – 18.2
Fecal Coliform	Colonies/ 100ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	11** 14**	0 – 60 0 - 60	% exceeding 200	18**	0 - 1095
						0% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.036 0.032	0.016 – 0.073 0.012 – 0.054		0.041	0.014 – 0.099
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	0.090 0.106	<0.010 – 0.244 0.013 – 0.304		0.179	<0.010 – 0.714

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

Salmon Creek @ Littlerock Rd. by Quarry

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/21/2009	4:10:00 PM	11.74	6.7	6.15	126	22	2.8	1.76	0.043	0.026	Duplicates labeled "Quarry"
11/18/2009	9:30:00 AM	6.58	6.3	8.55	67	40	4.6	36.28	0.040	0.026	Three salmon.
12/14/2009	12:00:00 PM	0.30	5.9	8.07	99	10	1.3	7.01	0.018	0.228	
1/12/2010	9:00:00 AM	7.26	6.4	8.97	63	10	2.0	45.08	0.020	0.221	Duplicates labeled "Quarry".
2/9/2010	9:05:00 AM	7.20	6.5	8.28	85	0	0.6	14.30	0.020	0.244	FC reported as <5.
3/15/2010	9:15:00 AM	5.98	6.1	9.23	78	10	0.7	18.85	0.016	0.159	
4/20/2010	9:00:00 AM	12.52	6.5	5.77	89	5	0.2	16.23	0.026	< 0.005	NOx <0.010
5/12/2010	9:15:00 AM	10.13	6.7	7.24	93	5	0.9	8.65	0.027	< 0.005	NOx <0.010
6/16/2010	9:40:00 AM	12.06	6.7	6.07	93	30	1.8	7.89	0.041	< 0.005	NOx <0.010
7/14/2010	9:30:00 AM	15.29	6.7	5.85	111	55	5.0	1.70	0.061	< 0.005	NOx <0.010.
8/18/2010	9:30:00 AM	17.63	7.0	4.83	121	0	4.4	0.17	0.073	0.091	FC reported as <5.
9/14/2010	3:45:00 PM	14.64	7.0	6.80	124	60	3.3	0.31	0.052	0.061	

Thurston County Water Resources Monitoring Report 2010-2011

Salmon Creek @ Littlerock Rd. by Quarry

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2010	1:20:00 PM	8.12	6.8	8.27	98	12	1.2	1.79	0.030	0.018	Duplicates labeled "Quarry".
11/15/2010	9:15:00 AM	8.65	6.3	7.19	82	10	0.6		0.027	0.013	No flow measurement. Coho spawning.
12/15/2010	9:30:00 AM	6.23	6.6	8.97	52	60	1.2		0.027	0.185	Flooding. Too deep to measure flow.
1/10/2011	11:30:00 AM	2.88	6.7	10.00	74	5	0.2	21.38	0.012	0.304	
2/15/2011	9:30:00 AM	5.85	6.7	9.26	77	20	1.3	33.28	0.021	0.245	
3/15/2011	11:30:00 AM	7.86	7.0	10.12	63	30	1.3	63.63	0.015	0.166	Flow is estimate.
4/12/2011	12:30:00 PM	8.57	6.9	11.10	79	0	0.4	31.35	0.015	0.060	FC reported as <5.
5/18/2011	9:45:00 AM	10.39	6.6	7.66	79	10	1.3	22.83	0.029	0.031	
6/15/2011	10:25:00 AM	12.23	6.8	6.63	99	10	2.1	6.31	0.052	0.065	
7/13/2011	9:30:00 AM	15.17	6.8	6.27	112	30	2.5	2.37	0.052	0.034	Duplicates labeled "Quarry".
8/10/2011	12:00:00 PM	14.68	6.9	7.05	113	20	2.4	1.24	0.046	0.050	
9/13/2011	9:35:00 AM	15.12	6.9	6.59	116	25	3.3	0.33	0.054	0.106	

Budd/Deschutes Watershed

WRIA 13

Chapter Includes:

Black Lake

Black Lake Ditch

Capitol Lake

Chambers Creek

Deschutes River

Ellis Creek

Indian Creek

Lawrence Lake

Mission Creek

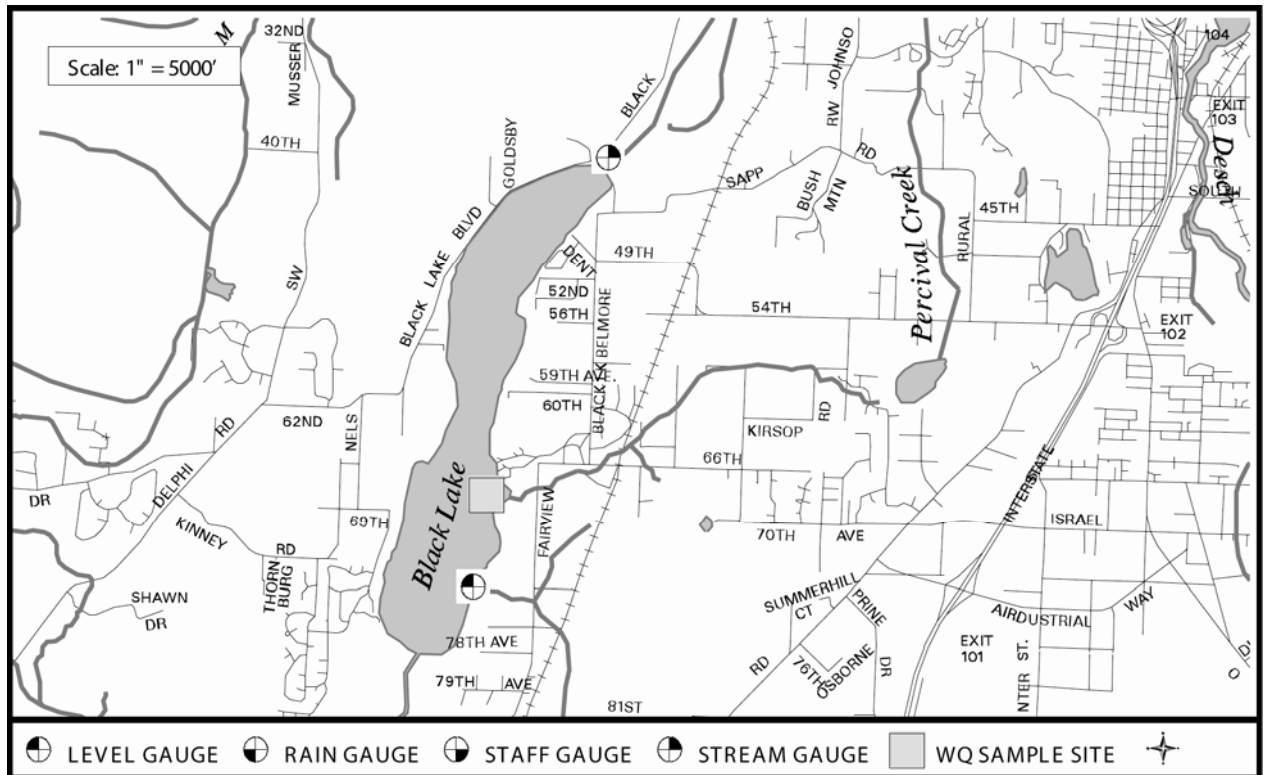
Moxlie Creek

Percival Creek

Schneider Creek (Budd)

Spurgeon Creek

Ward Lake



PART OF BUDD INLET WATERSHED

LENGTH OF LAKE: 2.4 miles

SHORELINE LENGTH: 6 miles

LAKE SIZE: 570 acres

BASIN SIZE: 10.1 square miles

MEAN DEPTH: 19 feet

MAXIMUM DEPTH: 29 feet

VOLUME: 11,000 acre-feet

PRIMARY LAND USES:

A large percentage of the lake shore is moderate density residential. There are two large mobile home parks on the east shoreline and two RV commercial resorts on the west side of the lake. The south and north ends are dominated by extensive wetland systems.

PUBLIC ACCESS:

Washington Department of Fish and Wildlife
public boat launch
Kenneydell County Park
1 church camp
2 private resorts
3 small private community accesses

GENERAL TOPOGRAPHY:

The approximate altitude of the lake is 130 feet. The terrain to the east of the lake is very flat. Two tributaries originate in wetlands on the east side of the lake. On the west side, there is one larger tributary and several intermittent streams that flow into the lake. The lake outlet is through a ditch on the north end of the lake, which flows to Percival Creek. The historic outlet was to the south via the Black River, which is now obstructed by numerous beaver dams and vegetation.

GENERAL WATER QUALITY:

(Excellent, Good, Fair, Poor)

Fair - The lake has moderate to high nutrient concentrations which often result in nuisance blue-green algae growth in late summer and fall. The algae blooms result in pea-green water color and thick scums on the water which often interfere with recreational uses.

(360) 867-2626

www.co.thurston.wa.us/health/ehswat/swater.htm

Thurston County Resource Stewardship
Department, Water Resources Program
(360) 754-4681

www.co.thurston.wa.us/monitoring

OTHER AVAILABLE DATA:

Water quality data since 1992 -Thurston
County Environmental Health Division,

Washington Department of Ecology,
Environmental Assessment Programs, (360)
407-6700 (water quality data)

GENERAL DISCUSSION:

Black Lake is one of the largest lakes in Thurston County. It is oriented in a north-south direction with several small creeks flowing into it from the east and west. Historically the lake outlet was to the south, down the Black River system. However, in 1922 Black Lake Ditch was excavated in order to drain the potential agricultural land north of Black Lake, linking Black Lake to Percival Creek. The series of drainage easements established to provide for construction and a permanent maintenance easement for the drainage ditch, in addition to other easements surrounding the Black River at the south end of Black Lake, were combined to establish Black Lake Drainage Ditch District # 101. In 1976, the abandonment of Drainage Improvement District # 101 led to Thurston County becoming the responsible owner of the Black Lake Ditch corridor. Despite the drainage ditches, there are still extensive wetlands around Black Lake. These wetlands and the shallow groundwater system have an influence on the water quality characteristics of the lake.

Water quality monitoring of the lake has been conducted on Black Lake by Thurston County since 1992. In 2011 monthly sampling was done, May through October, at one site located in a deep area of the lake just west of the County Park. Field measurements include temperature, dissolved oxygen, pH, conductivity, secchi disk readings. Water samples were collected near the lake surface and near the lake bottom and were analyzed for total phosphorus and total nitrogen. Composite samples from the epilimnion (warm surface layer), or photic zone, were collected and analyzed for chlorophyll *a* and algae identification. The monitoring data is located at the end of this chapter.

Field Parameters

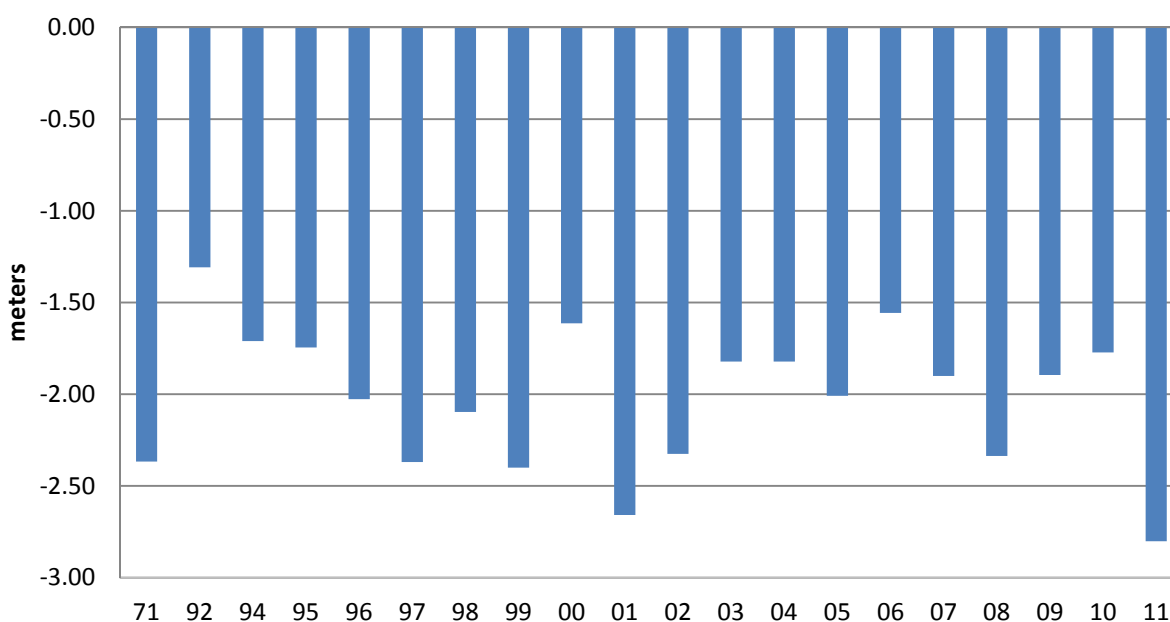
The monthly temperature, dissolved oxygen, pH, and conductivity data is displayed in profile graphs on page 8. Thermal stratification is when there are two distinct layers of water in the lake, the upper layer being warmer than the lower layer. In 2011 the lake was thermally stratified from May through August. This means that the lake developed a warm surface layer as solar radiation warmed the upper water, but the bottom water stayed cool. The surface water reached a high of nearly 23 degrees Celsius in August, while the bottom layer of water (hypolimnion) remained cooler, at 15 degrees. The surface of the lake began cooling off in September, and by October the lake was fully mixed.

During the summer the lower layer of cooler water, generally below 6 meters, was very low in oxygen. This condition results in a slow release of phosphorus from the sediments into the water near the lake bottom. This can be seen in the higher concentrations of phosphorus in the bottom samples (see “Bott TP” data on page 9). When the lake mixes in early fall, the phosphorus released from the sediments stimulates algae growth in the lake. In September and October 2011 a blue-green algae bloom began, as evidenced by the increased chlorophyll *a* (the green pigment produced by plants and algae) concentrations and the decreased water clarity.

Secchi Disk Water Clarity

Water clarity in a lake is measured with a device called a secchi disk. The average water clarity for the 2011 season was 2.8 meters (9.2 feet). The clarity ranged from 2.4 meters in September to 3.6 meters in August (7.7 to 11.8 feet). The 2011 average water clarity was the clearest on record. The graph below shows the annual averages of water clarity for the period of record. There is variability from year to year, but no upward or downward trend is apparent.

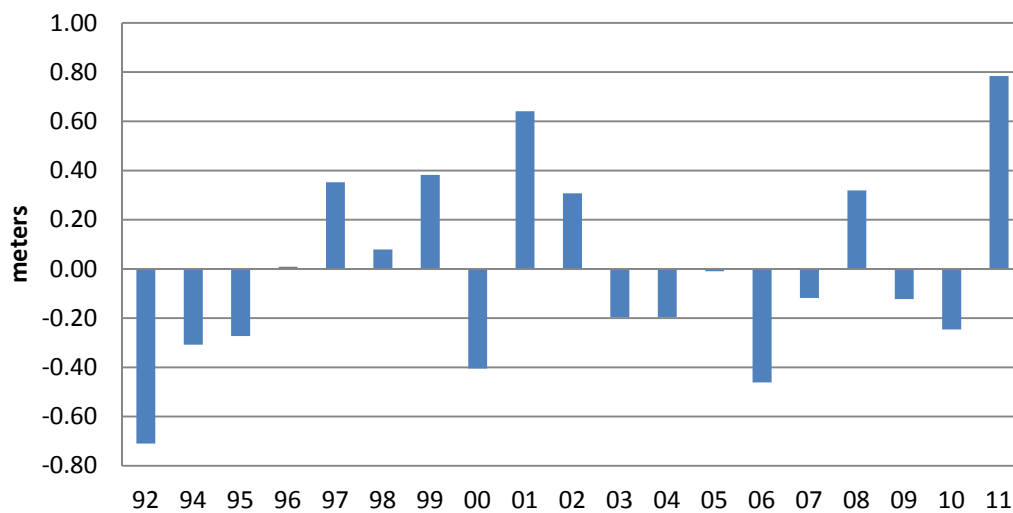
Black Lake Secchi Disk Readings
Season Average



Water clarity trends can more easily be seen on the trend graph on the next page. The graph shows the difference between each year's average secchi reading and the long-term average for the entire period of record. When the bar is above the “0” line, it indicates that the average water clarity for that year was better than the long-term average. A bar below the “0” line indicates that the water clarity for that year was poorer than the long-term average. Graphing the water clarity data in this way helps to show trends in water quality versus normal yearly fluctuations. For Black Lake, it appears there is no upward or downward trend in water clarity over the past 19 years, just variation plus or minus 0.8 meter around the long-term average.

Water Clarity Trend

Annual Mean Minus Long-Term Average



"0" axis represents the long-term secchi average.

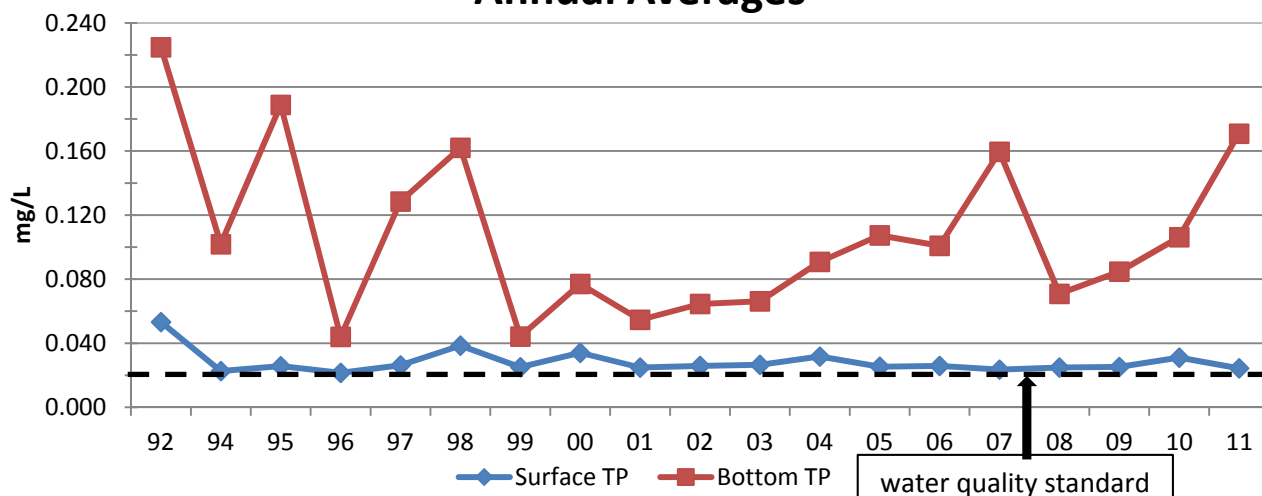
Total Phosphorus and Nitrogen

Generally, lakes in the Puget Sound region with summer average surface total phosphorus concentrations greater than 0.030 mg/l experience undesirable algae growth which interferes with recreational uses of the lake (USGS Water Supply Paper 2240). The action level established in WAC 173-201A, "Water Quality Standards for Surface Water of the State of Washington" is 0.020 mg/l.

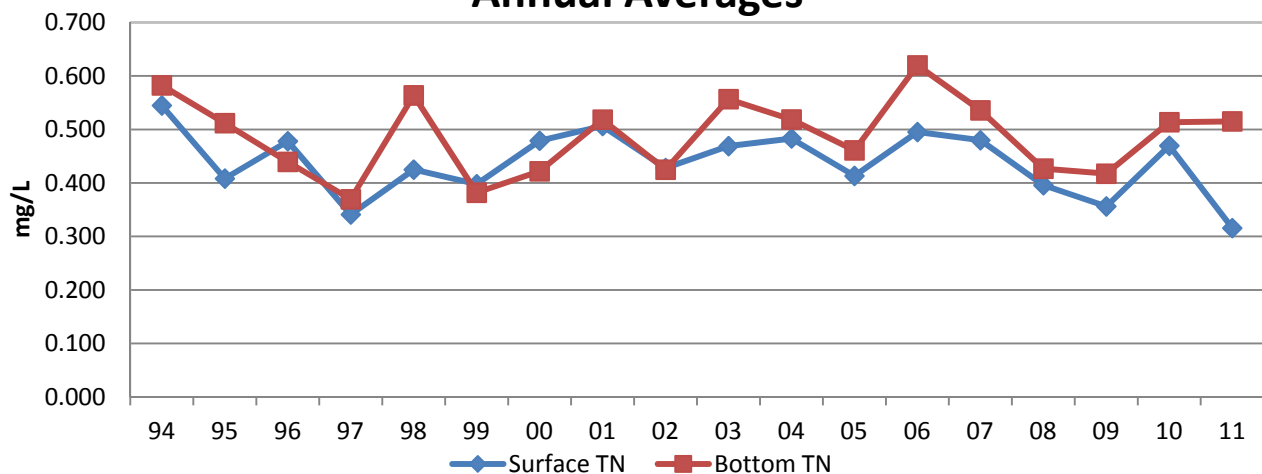
In 2011 the average surface total phosphorus (TP) concentration was 0.024 milligrams per liter (mg/l). From May through August the phosphorus concentration at the surface ranged from 0.010 to 0.016 mg/l. During September and October, after the lake had mixed, the total phosphorus concentrations at the surface increased to 0.049 and 0.043 mg/l respectively. This is more than double the state water quality action level of 0.020 mg/L. In response to the available phosphorus near the surface, an algae bloom began.

Graphs of the annual average surface and bottom phosphorus and nitrogen concentrations for the period of record are shown on the following page. In Black Lake, as with most freshwater lakes, algae production is limited by the amount of available phosphorus. The more phosphorus available in the water column, the more plant and algae growth will occur. The graphs clearly show a difference between phosphorus concentrations at the surface and the bottom. The nitrogen concentration in the water are not influenced by the anoxic (no oxygen) conditions at the lake bottom as is phosphorus.

Total Phosphorus Annual Averages



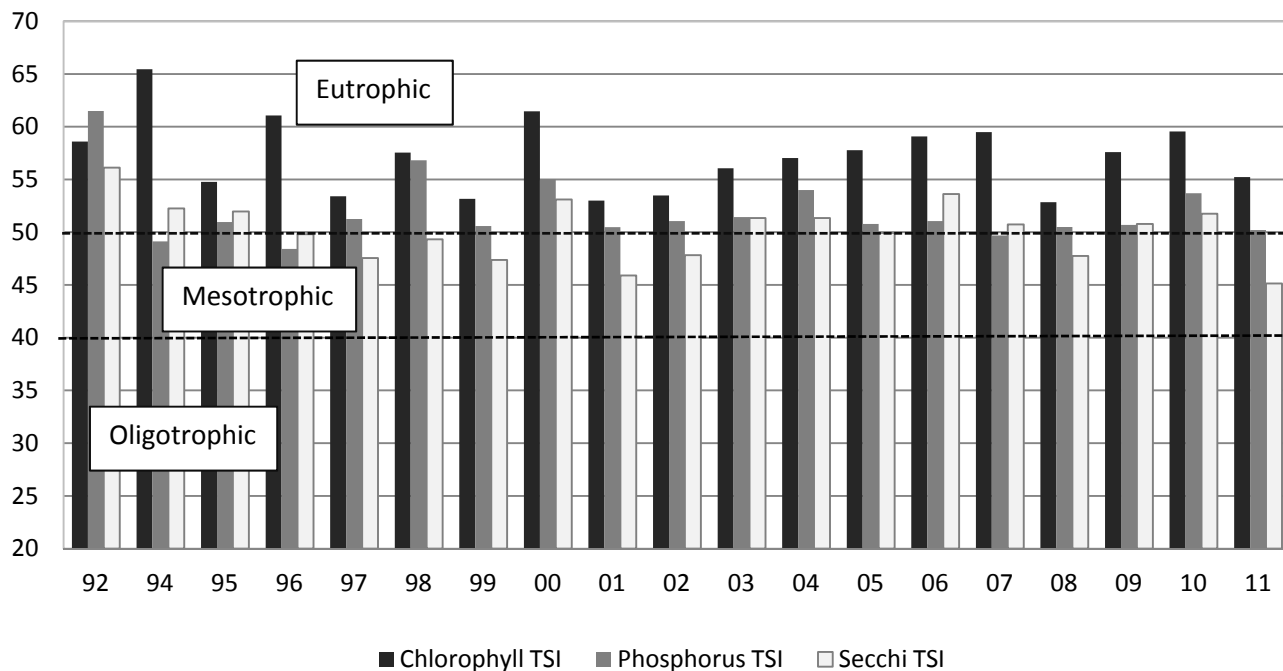
Total Nitrogen Annual Averages



Trophic State Indices

The Carlson trophic state indices (TSI) are used to express the degree of productivity of a lake. Average summer total phosphorus, chlorophyll *a*, and secchi disk readings are each used to calculate TSIs for the lake. A TSI of 0 to 40 indicates an oligotrophic, or low productivity, lake. A TSI of 41 to 50 indicates a mesotrophic, or moderately productive lake. A TSI of greater than 50 indicates a eutrophic, or highly productive lake. The TSI's for the period of record are graphed on the following page.

Black Lake Trophic State Indices



In 2011, the TSI's for total phosphorus, chlorophyll *a*, and secchi disk (water clarity) were 50, 55, and 45, respectively. All three indices were slightly lower than in 2010, indicating better water quality conditions. The chlorophyll TSI was within the eutrophic, or highly productive, category. But the TSIs for phosphorus and secchi disk were within the mesotrophic, or moderately productive range. The graph above shows no clear pattern of increasing or decreasing productivity. Rather the pattern looks somewhat cyclical, and may be more closely related to weather and climate conditions.

Algae

The monitoring program includes identification of algae types present in the lake. The 2011 data can be found at the end of this chapter. There are a variety of algae types present in Black Lake including diatoms, green and blue-green. However, the algae blooms that typically occur in the fall are caused by blue-green algae, such as *Aphanizomenon* or *Anabaena*. Dominance by blue-green algae is a sign of nutrient-rich conditions. At times algal growth impairs recreational uses due to poor water clarity, algae scums on the water surface, and odor. This was particularly true in 1992, 1994, and 2000. In September 2000, a spectacular blue-green algae bloom occurred that covered much of the western shore of the lake. When the algae died, it resembled a turquoise-blue paint spill, which drew citizen and media attention. In 2004, 2006, and 2007 less dramatic algae blooms occurred, and advisory signs were posted in the swimming area at the Kenneydell County Park.

Some species of blue-green algae can produce toxins that can cause illness, or even death, in people, pets, and wildlife if ingested. Pets are particularly vulnerable to poisoning from toxic algae blooms due to their smaller body weight and their tendency to ingest higher doses by drinking lake water and licking their fur after swimming. In recent years there has been an increase in documented toxic blue-green algae blooms occurring in lakes within Washington State.

Algae species known to produce toxins are present in Black Lake, but most of the time they are not producing toxins. However because toxicity cannot be determined through visual observations, Thurston County Environmental Health began using screening test kits in 2009 to test for the presence of the most common algae toxin, microcystin. When the screening indicates the presence of microcystin, a sample is sent to a laboratory to determine the amount of toxin present. The laboratory services are a statewide program sponsored by Washington Department of Ecology. Although toxin testing is now possible, lake residents and users should always observe lake conditions and avoid contact with lake water where an algae bloom is occurring.

In September 2011, an algae bloom was seen on the eastern shore of the lake. A laboratory analyst determined the toxin was present at a concentration of 13.9 µg/L, which is above the state recreational guidance limit of 6 µg/L. So on September 28th a lake-wide health advisory was issued. Weekly observations of the lake were made throughout October and November. Samples collected at various locations around the lake during that time showed that the toxic level fluctuated between non-detectable to 7.7 µg/L on October 13th. The health advisory was lifted on November 22th after five weeks of sampling showed that the toxin was still present but remained consistently below the advisory level of 6 µg/L.

Information about blue-green algae and swimming safety information is available through the Thurston County website: www.co.thurston.wa.us/health/ehadm/swimming/swimming_index.html

Major Issues:

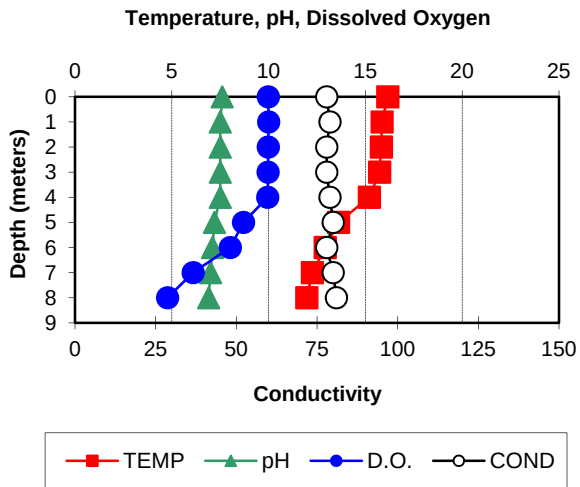
- Blue-green algae blooms during late summer and fall interfere with the recreational uses of the lake. Lake residents and users should avoid recreation activities and keep children and pets out of the lake during these severe algae blooms.
- Swimmer's itch is reported to be a regular summer problem in this lake, so preventative measures should always be taken by bathers.
- Beaver activity in the lake outlet ditch can cause the lake level to rise resulting in flooding of yards and docks. Thurston County Public Works is responsible for maintaining the ditch.

Funding Sources:

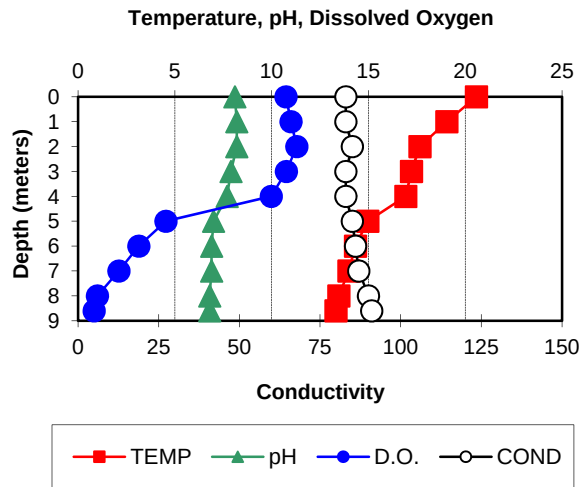
Sampling was funded by Thurston County, and will continue to be supported in 2012.

BLACK LAKE PROFILE GRAPHS

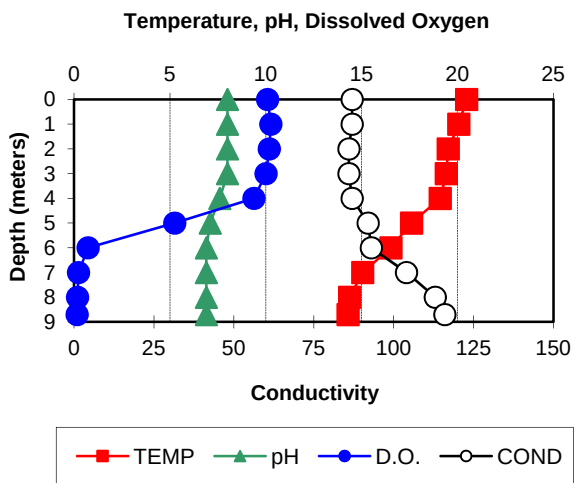
May 24, 2011



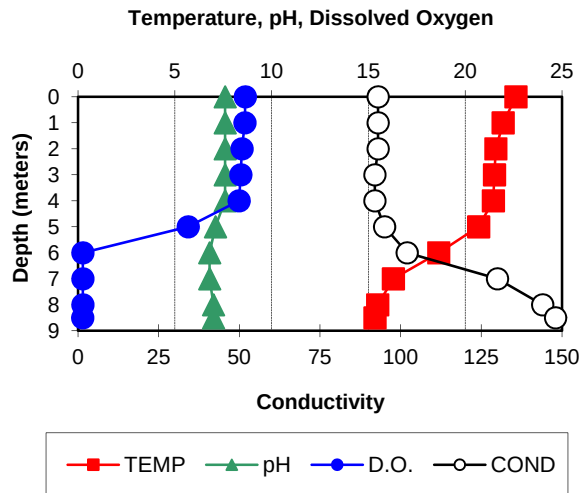
June 21, 2011



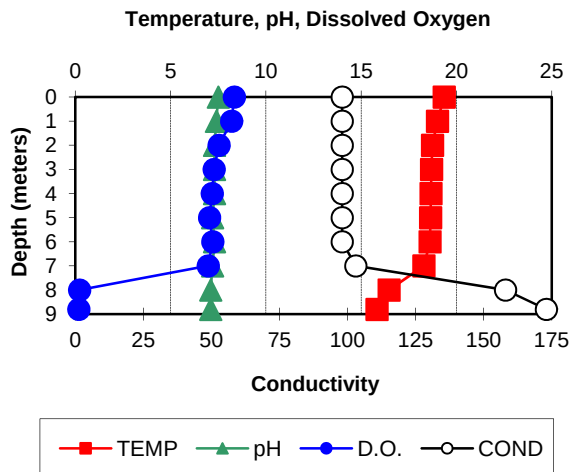
July 18, 2011



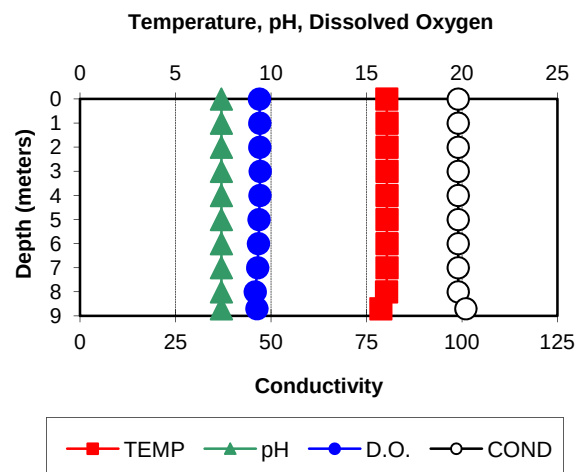
August 23, 2011



September 19, 2011



October 10, 2011



Thurston County Water Resources Annual Report - 2011

Black Lake @ South Basin

Site ID# BUDBLL020

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water	Lake Notes
05/24/2011	1:50:00 PM	8.7	8.0	0.010	0.015	0.497	0.478	3.46	2.8	0.05	#7 yellow-orange	Chl a & algae composite @ 1, 2.5 & 4M. Phaeo a was < detection at 0.1ug/L.
06/21/2011	1:30:00 PM	8.6	8.0	0.016	0.022	0.284	0.330	2.56	13	1	#7 yellow	Chl a & algae composite @ 1, 2 & 3M.
07/18/2011	1:45:00 PM	8.7	8.0	0.013	0.133	0.246	0.528	2.39	10	1.4	#7 yellow	Chl a & algae composite @ 1, 2, & 3M.
08/23/2011	1:15:00 PM	8.5	7.5	0.015	0.386	0.260	0.858	3.64	5.3	0.5	#6 yellow-green	Chl a & algae composite @ 1, 2.5, & 4M.
09/19/2011	2:00:00 PM	8.8	8.0	0.049	0.430	0.289	0.583	2.35	18	1	#7 orangish-yellow	Chl a & algae composite @ 1, 2, & 3M.
10/10/2011		8.7	8.0	0.043	0.039	0.318	0.313	2.41	25	3.1	#7 yellow	Chl a & algae composite @ 1, 2, & 3M. No surface scum.

Summary for 'Site Description' = Black Lake @ South Basin (6 detail records)

Averages: Sur TP 0.024
 Secchi 2.80
 Chl a 12.4

Algae data: Black Lake @ South Basin

	<i>Type</i>	<i>Description</i>	<i>Dominant in Sample</i>
<i>05/24/2011</i>			
	BG	Aphanizomenon species	☐
	CP	Cryptomonads	☐
	DT	Asterionella species	☐
	DT	Diatoms species	☐
	GR	Ankyra species	☐
	GR	Eudorina species	☐
<i>06/21/2011</i>			
	BG	Anabaena species	☐
	BG	Aphanizomenon species	☐
	CP	Cryptomonads	☐
	DF	Ceratium species	☐
	DT	Asterionella species	☐
	DT	Cyclotella species	☐
	DT	Fragilaria species	☐
	GR	Cosmarium species	☐
	GR	Elakatothrix species	☐
	GR	Eutetramorus globosus	☐
	GR	Sphaerocystis species	☐
	YL	Dinobryon species	☐
<i>07/18/2011</i>			
	BG	Anabaena species	☐
	CP	Cryptomonads	☐
	DF	Ceratium species	☐
	DT	Cyclotella species	☐
	DT	Fragilaria species	☐
	GR	Dictyosphaerium species	☐
	GR	Oocystis species	☐
	GR	Sphaerocystis species	☐
	GR	Staurastrum species	☐

08/23/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Cyclotella species	☐
DT	Diatoms species	☐
DT	Fragilaria species	☐
EU	Euglena species	☐
EU	Trachelomonas species	☐
GR	Ankyra species	☐
GR	Cosmarium species	☐
GR	Elakatothrix species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

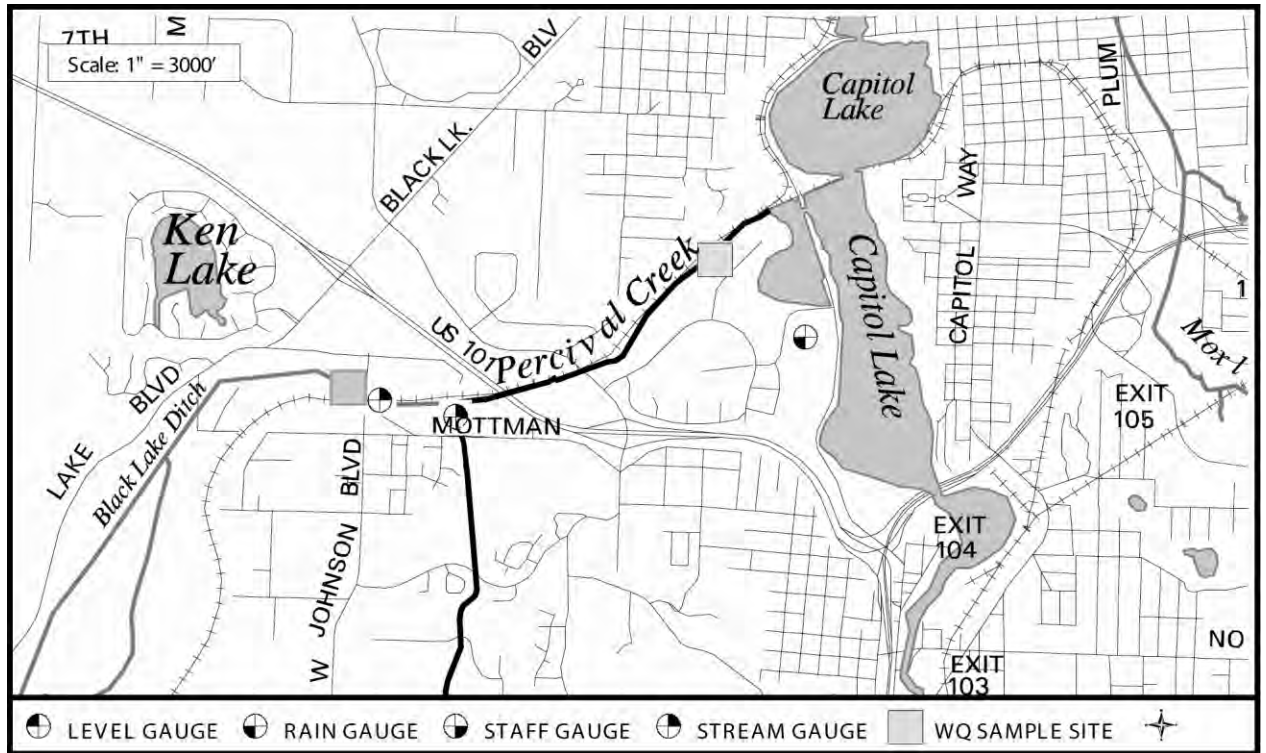
09/19/2011

BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
BG	Aphanocapsa species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Aulacoseira species	☐
DT	Cyclotella species	☐
DT	Fragilaria species	☐
EU	Trachelomonas species	☐
YL	Dinobryon species	☐
YL	Mallomonas species	☐

10/10/2011

<i>Type</i>	<i>Description</i>	<i>Dominant in Sample</i>
BG	Anabaena species	☐
BG	Aphanizomenon species	☐
BG	Woronichinia species	☐
CP	Cryptomonads	☐
DT	Aulacoseira species	☐
DT	Fragilaria species	☐
DT	Stephanodiscus species	☐
EU	Trachelomonas species	☐
GR	Pandorina species	☐
GR	Sphaerocystis species	☐
GR	Staurastrum species	☐

Key: BG = Blue green EU = Euglenophyte
 CP = Cryptophyte GR = Green
 DF = Dinoflagellate YL = Yellow
 DT = Diatom



PART OF BUDD INLET WATERSHED

LENGTH OF CREEK: 2.2 miles from the Black Lake outlet to the confluence with Percival Creek.

BASIN SIZE: 5,300 Acres

STREAM ORDER: 2

PRIMARY LAND USES:

Urban
Suburban residential
Commercial

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)

Coho (However, Chinook have been seen in the ditch.)

GENERAL TOPOGRAPHY:

Percival Basin is located between Black Hills on the west and Interstate 5 on the East. It flows north into Capitol Lake/Budd Inlet. The

drainage area is moderately sloped. Black Lake Ditch is a major tributary to Percival Creek and originates from Black Lake. It is fairly low gradient in upper wetland-dominated reach and has a moderate gradient in an incised canyon before its confluence with Percival Creek. Elevations range from sea level to 500 feet.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

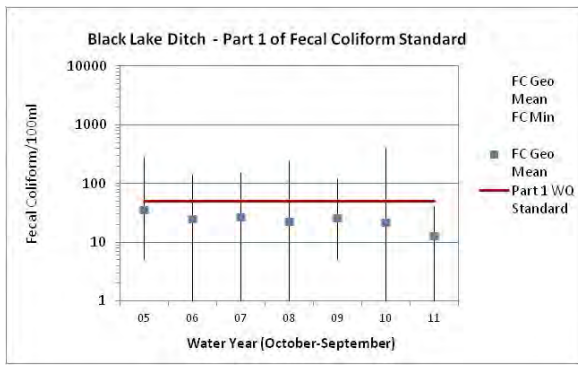
Fair – Met both parts of the fecal coliform standard. Violated dissolved oxygen standards during summer months. Violated turbidity standard once in both water years. Temperature standard may be violated during the summer.

OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

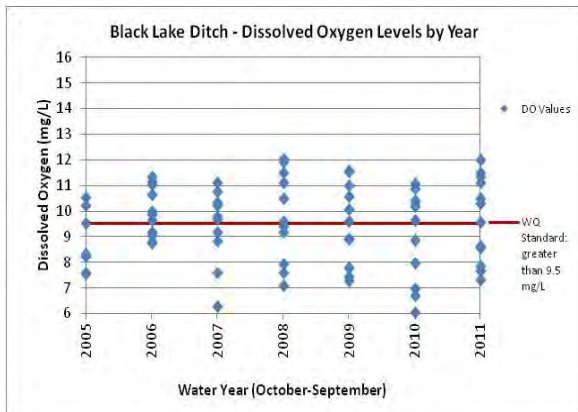
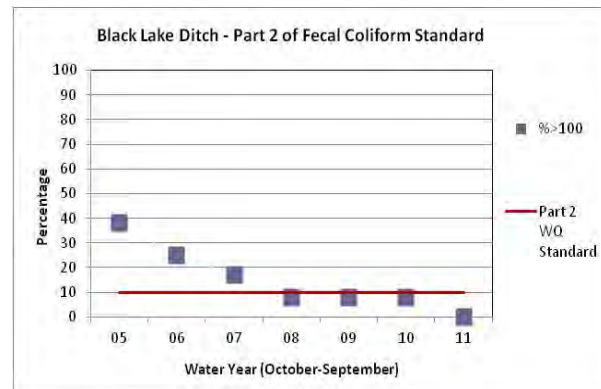
Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 or www.co.thurston.wa.us/monitoring

Black Lake Ditch #0030



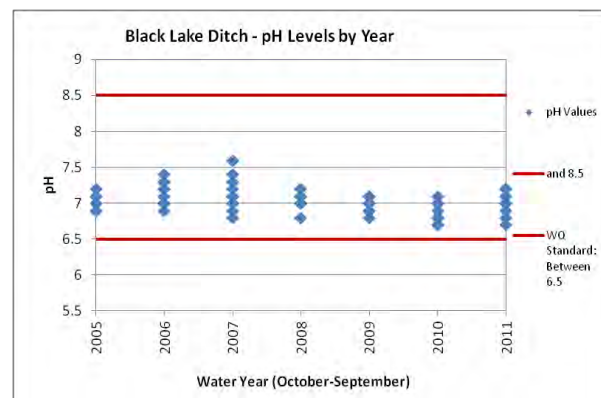
The water quality standard for fecal coliform has two parts: part 1 - the geometric mean shall not exceed 50 org/100mL *and*, part 2 - no more than 10% of the samples shall exceed 100 org/100mL.

Both parts of the fecal coliform standard were met in the past four water years.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. There are several dissolved oxygen measurements that have fallen below the standard during the summer months.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. No violations have occurred since 2005.



Discussion:

The water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 50 colonies/100mL *and* Part 2 - no more than 10% of the samples shall exceed 100 colonies/100mL. Both parts of the fecal coliform standard were met both years. The turbidity standard was exceeded in November 2009 and January of 2011.

The temperature and dissolved oxygen water quality standards are intended to protect core summer salmonid habitat. Because the ditch originates from Black Lake, high water temperatures and low dissolved oxygen measurements are common and reflect conditions typical of the lake environment. The dissolved oxygen measurements were below the water quality standard of the lowest one-day minimum of 9.5 mg/l four of eleven times in 2009/10 and four of twelve times in 2010/11.

The temperature criterion is a 7-day average daily maximum of 16° C. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data is used only as an indicator of possible temperature violations. Water temperatures above 16° C were measured in July through September of both water years, indicating possible temperature standard violations during both summer periods.

Major Issues:

- The basin is within the urban growth boundary and is rapidly developing. The City of Olympia has a major regional stormwater facility along Black Lake Ditch that treats and detains storm water that comes from commercial development on the west side of Olympia.
- Black Lake Ditch is included in a total maximum daily load study (TMDL) begun in 2003 by the Washington Department of Ecology to identify pollution sources and develop a plan to correct them. Because Black Lake is the origin of the Black Lake Ditch, high summer temperatures and low dissolved oxygen are a common condition.
- Homeless encampments within the riparian corridor are a common occurrence and could be contributing to water quality problems.

Funding Sources:

- Local stormwater utility rates

Water Quality Summary
Conventional Parameters
Black Lake Ditch at RW Johnson Boulevard

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 2005 - 2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16° C	09/10 10/11		4.22 – 20.24 4.19 – 20.51			4.16 – 21.47
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		6.07 – 11.08 7.33 – 12.02	4 of 11 4 of 12		6.3 – 12.1
Conductivity	µmhos/cm		09/10 10/11	94 92	86 – 108 75 - 125		92	69 - 153
pH		6.5 - 8.5	09/10 10/11	6.8 7.0	6.7 – 7.1 6.7 – 7.2	0 of 12 0 of 12	7.1	6.8 – 7.6
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	4.2 4.82	0.60 – 23.1 0 - 28	1 of 12 1 of 12	2.8	0.5 – 11.8
Fecal Coliform	colonies/ 100 mL	GMV ≤50 and ≤ 10% not to exceed 100	09/10 10/11	22 13	0 – 400 0 - 40	% exceeding 100	26	0 - 280
						8 % 0%		
Total Phosphorus	mg/L		09/10 10/11	0.296 0.038	0.021 – 3.14 0.019 – 0.072		0.031	0.017 – 0.052
Nitrate+Nitrite-nitrogen	mg/L		09/10 10/11	0.196 0.208	0.058 – 0.407 0.034 – 0.374		0.176	0.038 – 0.416

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

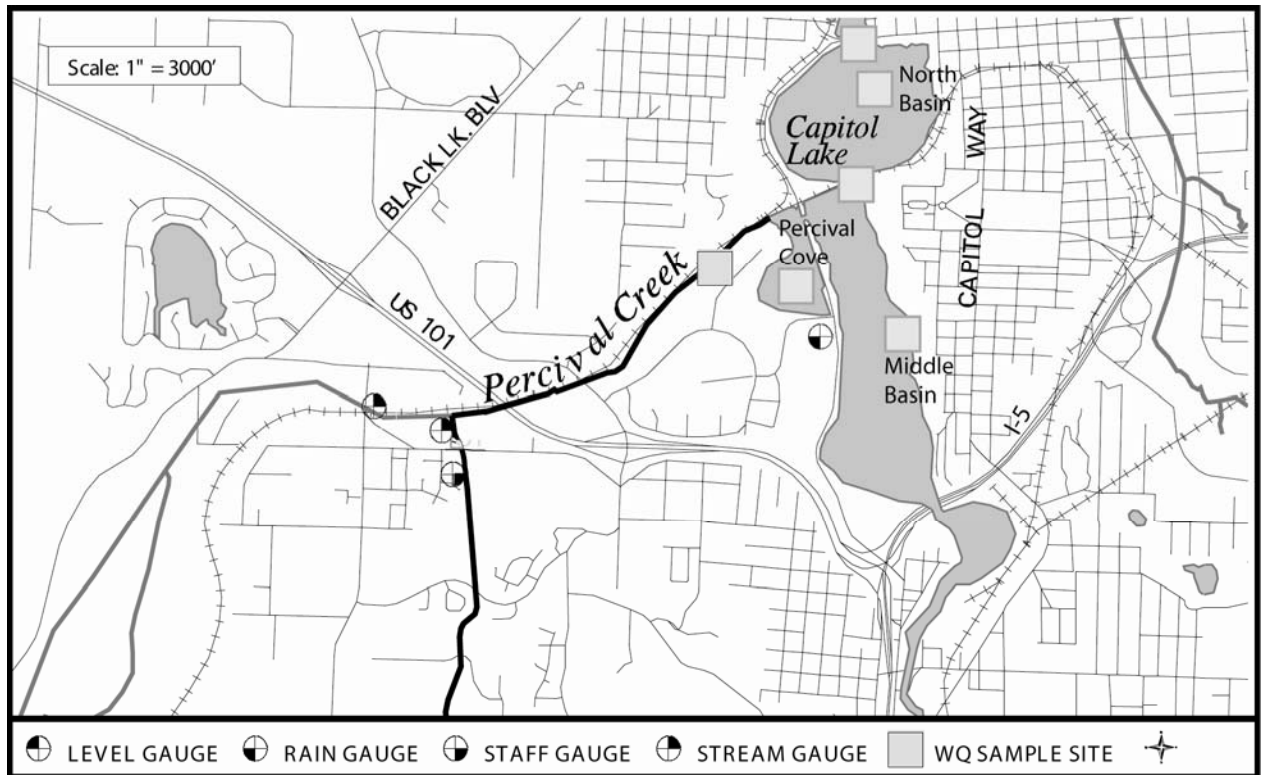
Black Lake Ditch @ RW Johnson Blvd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	9:45:00 AM	13.23	6.9	6.07	108	60	4.8	10.63	0.083	0.101	
11/17/2009	9:30:00 AM	9.09	6.7	10.36	86	400	23.1		0.060	0.407	No flows measurement: too deep to wade.
12/16/2009	9:30:00 AM	4.22	6.7	10.89	93	70	3.9	46.81	0.032	0.238	Several whiffs of solvent while measuring flow.
1/11/2010	9:45:00 AM	5.91	6.8	11.08	86	20	3.0	72.78	0.027	0.251	
2/10/2010	9:30:00 AM	6.61	6.7	10.21	91	20	1.5	39.35	0.022	0.321	
3/16/2010	9:30:00 AM	8.00	6.8	10.44	87	0	1.7	41.36	3.140	0.287	FC reported as <5.
4/19/2010	9:30:00 AM	11.73	6.7	9.66	87	70	1.5	41.83	0.021	0.278	
5/10/2010	9:30:00 AM	13.90	6.9	8.89	90	0	1.8	30.66	0.025	0.165	FC reported as <5.
6/15/2010	9:30:00 AM	17.14	7.0	8.01	93	30	0.8	24.73	0.028	0.058	
7/12/2010	9:30:00 AM	20.05	7.0		100	25	0.6	13.74	0.028	0.070	DO did not post calibrate.
8/16/2010	10:35:00 AM	20.24	7.1	6.97	104	30	0.7	5.97	0.023	0.067	
9/13/2010	10:00:00 AM	17.07	7.0	6.72	108	10	6.4	6.28	0.057	0.113	

Thurston County Water Resources Monitoring Report 2010-2011

Black Lake Ditch @ RW Johnson Blvd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	3:45:00 PM	13.38	7.0	8.58	104	2	3.7	21.00	0.046	0.034	Duplicates labeled "Johnson".
11/16/2010	3:00:00 PM	10.25	6.9	9.57	99	20	6.5	38.01	0.067	0.089	
12/14/2010	4:30:00 PM	7.24	6.7	10.50	78	40	7.2		0.045	0.276	Flooding. Too deep to measure flow.
1/12/2011	3:30:00 PM	4.19	6.8	11.36	89	25	28.0	59.27	0.072	0.328	
2/16/2011	2:45:00 PM	6.41	7.0	11.14	84	10	3.2	57.39	0.030	0.374	
3/14/2011	3:30:00 PM	7.00	7.0	12.02	75	20	3.8		0.022	0.344	No flow measurement, too deep to wade.
4/12/2011	2:15:00 PM	11.00	7.1	11.52	79	5	1.1	65.40	0.019	0.304	
5/17/2011	4:00:00 PM	15.22	7.0	10.31	82	0	0.5	49.03	0.021	0.278	FC reported as <5.
6/14/2011	4:10:00 PM	17.60	7.2	8.66	89	30	1.3	19.99	0.029	0.240	
7/12/2011	3:15:00 PM	20.15	7.1	7.67	95	30	2.1	12.35	0.036	0.075	
8/8/2011	4:55:00 PM	20.51	7.2	7.86	100	10	0.4	7.06	0.030	0.069	
9/12/2011	9:00:00 AM	16.09	7.0	7.33	125	28	0.0	0.85	0.036	0.080	Duplicates labeled "Meadows". Turbidity read -0.4.



PART OF Budd Inlet WATERSHED

LENGTH OF LAKE: 1.6 miles

SHORELINE LENGTH: 5.3 miles

LAKE SIZE: 270 acres

BASIN SIZE: 185 square miles

MEAN DEPTH: 9 feet

MAXIMUM DEPTH: 20 feet

VOLUME: 2400 acre-feet

PRIMARY LAND USES:

The Deschutes River/Capitol Lake basin includes commercial forestry in the upper basin and agriculture and rural residential in the middle of the watershed. Urban land uses

in the lower watershed include portions of the Cities of Tumwater and Olympia.

PRIMARY LAKE USES:

Shoreline trails are used by walkers, joggers, and bird watchers. The lake is closed to boating and fishing to prevent the spread of an invasive species, New Zealand Mudsnaill.

PUBLIC ACCESS:

All of the northern basin and much of the western sides of the middle and southern basins are publicly owned. There are four parks along the lake, including Marathon Park, Tumwater Historical Park, Heritage Park, and the Capitol Lake Interpretive Center. There is a trail system along much of the western shoreline and around the north basin.

The public boat launch at Tumwater Historical Park on the south side of the Interstate 5 bridge is currently closed to help prevent the spread of an invasive snail species, New Zealand Mudsnaill.

GENERAL TOPOGRAPHY:

The approximate altitude of the lake is 0 feet. Capitol Lake now covers much of the former saltwater estuary that was at the mouth of the Deschutes River. In 1951 a tide gate was constructed at 5th Avenue, creating a freshwater lake and preventing saltwater from flowing into the lake under all but extreme high tide conditions. The lake is divided into three basins, constricted by fill at the Interstate 5 overpass and the railroad trestle near Marathon Park.

GENERAL WATER QUALITY:

(Excellent, Good, Fair, Poor)

Poor: The lake is listed on the state's 303(d) list of water quality impaired water bodies for total phosphorus and fecal coliform. Sediment deposition in the lake from the Deschutes

River, Percival Creek, shoreline erosion, and landslides has been an on-going issue since the lake was created. Excessive aquatic plant and algae growth in the summer severely impedes navigation on the lake. Control is on-going for an infestation of the noxious aquatic plant, Eurasian water milfoil. In 2009 another invasive species, the New Zealand mudsnail, was discovered in the lake. Efforts are underway to control the spread of the mudsnail.

OTHER AVAILABLE DATA:

Thurston County Environmental Health Division, (360) 867-2626, (historical water quality data) or www.co.thurston.wa.us/health/ehswat/swater.htm

GENERAL DISCUSSION:

Background

The area of Capitol Lake was formerly an estuary of Budd Inlet. The lake was formed by the construction of a tide gate in 1951, which impounded the Deschutes River. The tide gate was constructed to create a reflection pond for the state capitol building. The resulting body of water looks like a lake, however the exchange of water into and out of the lake occurs fairly quickly compared to most lakes. During high winter flows in the Deschutes River the water exchange in the lake can be as fast as a few hours. During the summer low-flow period the exchange rate is much slower, and can be as slow as 9 days.

Capitol Lake has several water quality problems. As an impoundment of the Deschutes River, Capitol Lake shares some of the river's characteristics, such as elevated nutrient levels, and high turbidity during winter storms. The lake is gradually filling with sediments transported into it by the Deschutes River and Percival Creek and other smaller sources. The wide shallow basins result in high surface water temperatures and allow light to reach the bottom of most of the lake. This provides excellent habitat for aquatic plants and algae, which impair recreational uses of the lake and further contributes to water quality problems. Until 1985, a swimming area was operated by the City of Olympia at the north end of the lake. However, poor water clarity and high fecal coliform bacteria levels forced the closure of the swimming area. Water circulation into and out of the swim area was poor, and likely contributed to its chronic water quality problems. There are numerous stormwater discharges into the lake along the shoreline in all three basins.

Likely sources of bacteria and nutrient pollution to the lake include: agricultural activities along the Deschutes River and its tributaries, septic systems, resident waterfowl on the lake, highway and

urban stormwater runoff, accidental spills, illicit sewage discharges, and other nonpoint pollution sources.

To reduce the water quality impact on Percival Creek from stormwater discharges, the City of Olympia constructed a regional stormwater detention/wetland system along Black Lake Ditch in the early 1990's. In 2003, the City of Olympia initiated an illicit discharge detection and elimination program to identify and eliminate sewer connections to the city storm sewer systems. Since the program inception several illicit connections have been found and eliminated. The City of Tumwater currently has plans to build regional stormwater facilities to address discharges into both Percival Creek and the Deschutes River. These facilities are in the design phase.

Capitol Lake is the responsibility of the Washington Department of Enterprise Services (formerly General Administration). Management of the lake has been guided by a 10-year Capitol Lake Adaptive Management Plan adopted in 2003. In September 2009, the Capitol Lake Steering Committee delivered a majority recommendation to the Director of Enterprise Services to remove the tidegate and restore the Deschutes River estuary in place of the existing lake. The community is divided regarding the estuary recommendation, and some residents support maintaining the lake. In 2010, the decision regarding restoration of the Deschutes estuary was suspended.

2011 Ambient Monitoring Program

In 2011 the sampling locations for ambient monitoring program were two mid-lake sites in the north and middle basins. The sampling program was to include monthly sampling at those two locations, May through October. However, an equipment malfunction prevented completion of sampling in May. And in July the lake level was raised to accommodate maintenance work which prevented access to the north basin site for sampling. Sampling is done with the assistance of the Department of Enterprise Services staff, using a boat that is dedicated to Capitol Lake. Procedures are used when sampling to prevent the spread of the New Zealand mudsnail.

Sample parameters included temperature, pH, dissolved oxygen, specific conductivity, water clarity, total phosphorus, total nitrogen, nitrate, ammonia, chlorophyll *a*, fecal coliform bacteria, and algae identification. Nutrient, chlorophyll, and algae samples were collected at a depth of one-meter. Nitrate and ammonia are included in the nutrient analyses to further document the affect the lake has on nutrient utilization as the river water passes through the lake. The water quality data is located at the end of this narrative.

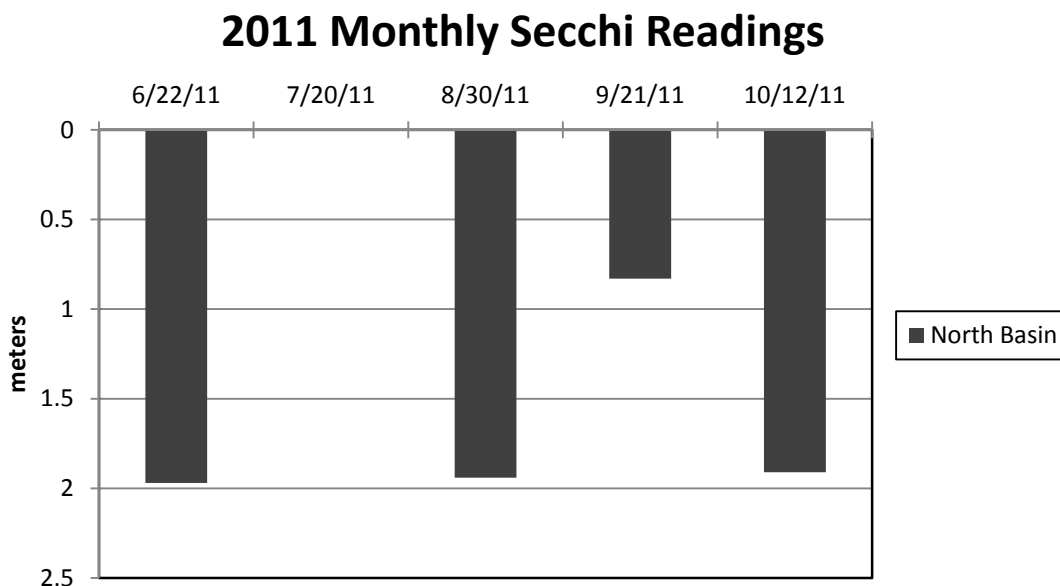
Field Parameters

Profile graphs of the field measurements are located on pages 14 and 15. Capitol Lake does not thermally stratify as do most Thurston County lakes due to its shallow depth and riverine influence. In mid-summer, the temperature at the bottom, in both basins, tended to be just three to four degrees cooler than at the surface. High conductivity (saline water) was sometimes measured near the bottom in the north basin. This was the result of marine water from Budd Inlet flowing over the fish ladder and into the lake during tides higher than 14 feet, where the heavier saltwater settles in the deepest part of the lake.

Capitol Lake typically has high day time dissolved oxygen levels during late summer that are associated with peak algae and aquatic plant growth. In 2011 highest dissolved oxygen levels were measured in the north basin in September with a concentration of 16.25 mg/L near the surface at 2:30 PM. On that day the chlorophyll *a* concentration was the highest measured for the season, 33 µg/L, which indicates that algae was influencing the dissolved oxygen levels. Rooted aquatic plants were also likely contributing to the high dissolved oxygen levels. It is during this time that dissolved oxygen sags, or deficits, would be expected to occur during the nighttime hours and be at the lowest just before sunrise. However, there was no 24-hour monitoring conducted in 2011.

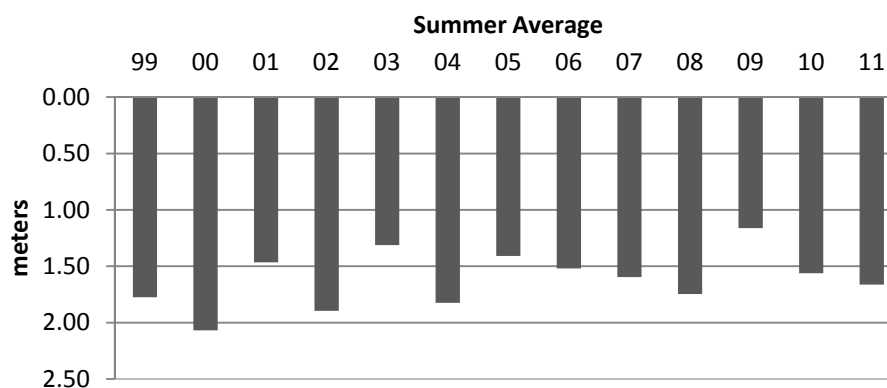
Water Clarity

The graph below shows the 2011 monthly water clarity measurements in the north basin. The water clarity standard that is applied to bathing beaches is four (4) feet or greater. The poorest water clarity this season was measured in September at 0.83 meters (or 2.7 feet). The highest water clarity was measured in June at 1.97 meters (or 6.5 feet).



The season average clarity in the north basin in 2011 was 1.66 meters (5.4 feet). On the next page is a graph of the average summer water clarity in the north basin for the past thirteen years. Generally the averages were calculated using four to six monthly measurements collected within the May through October period. The exception is 1999, where the only data collected was in September and October. The graph shows that the yearly average water clarity has varied by up to 0.9 meters, from 2.1 meters in 2000 to 1.2 meters in 2009.

North Basin - Capitol Lake Water Clarity



Fecal Coliform Bacteria

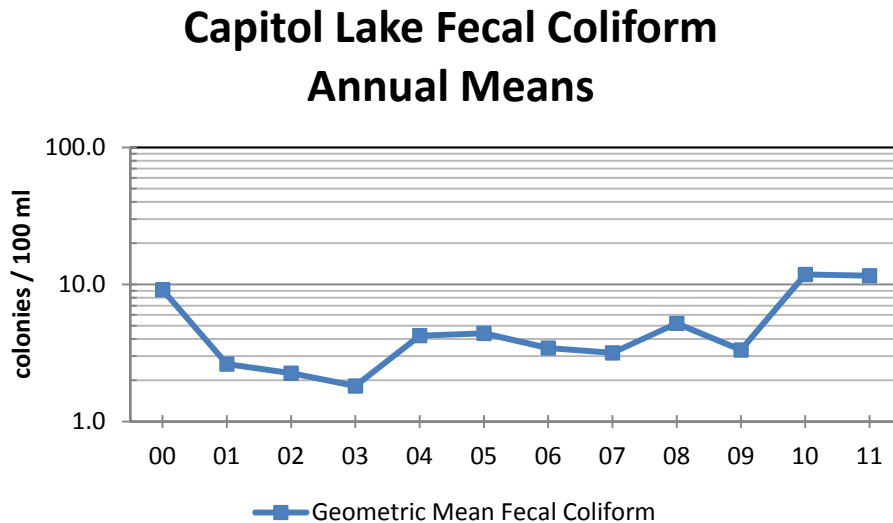
Fecal coliform bacteria samples are collected as part of the monitoring program because of the historic use of the lake for water contact recreation. Additionally, the lake is listed on the Washington Department of Ecology 303(d) list of impaired water bodies for fecal coliform bacteria standard violations. The results from this year's bacteria sampling are shown in the table below.

Capitol Lake Fecal Coliform Bacteria Sampling Results

Date	North Basin	Middle Basin
6/22/11	20	30
7/20/11	No sample	15
8/30/11	<5	5
9/21/11	<5	5
10/12/11	60	163

The state water quality standard for primary contact recreation is a geometric mean of 50 fecal coliform colonies per 100 ml with not more than ten (10) percent of the samples exceeding 100. The county policy regarding closure of a bathing beach sets the fecal coliform standard at a geometric mean of 200 colonies per 100 ml. All sample results in 2011 were below the beach closure threshold of 200. The geometric mean for the year was 11, which was within the part one of the state fecal coliform standard of 50. However, part two of the fecal coliform standard was not met because one of the nine samples collected had a result greater than 100 colonies per 100 ml, so 11 percent of the samples collected were greater than 100.

Individual sample results from the past twelve years are included in a table on pages 12 and 13. The graph below shows the geometric mean of all the fecal coliform results collected at both the north and middle basin sites for each year since 2000. The results for the last two years appear to be slightly higher than previous years, but still within the standard of 50 colonies per 100 ml.



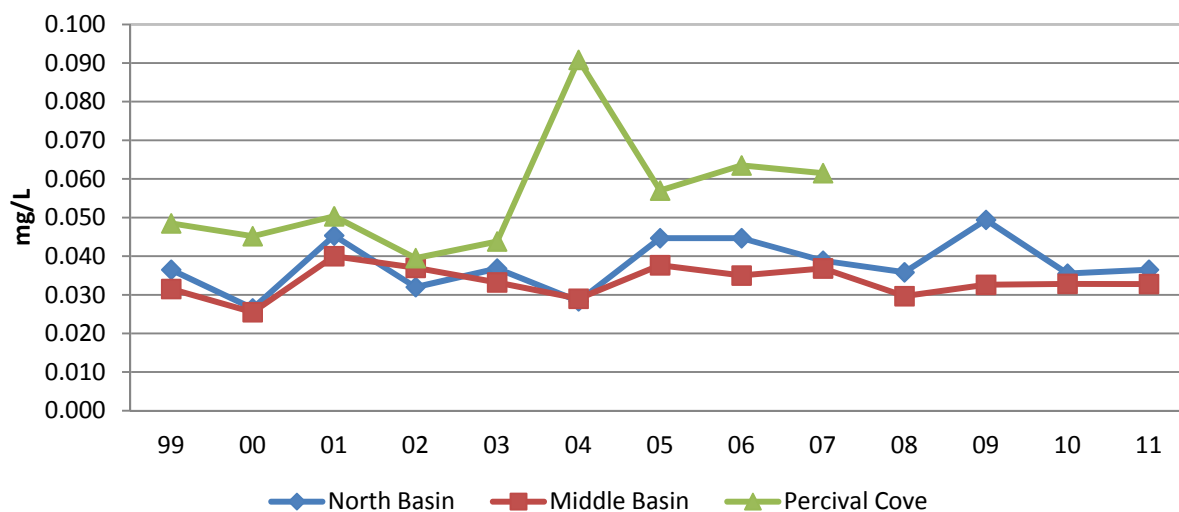
Nutrients

Generally, lakes in the Puget Sound region with summer average surface total phosphorus concentrations greater than 0.030 mg/l experience undesirable algae growth which interferes with recreational uses of the lake (USGS Water Supply Paper 2240). The action level established in WAC 173-201A, “Water Quality Standards for Surface Water of the State of Washington” is 0.020 mg/l.

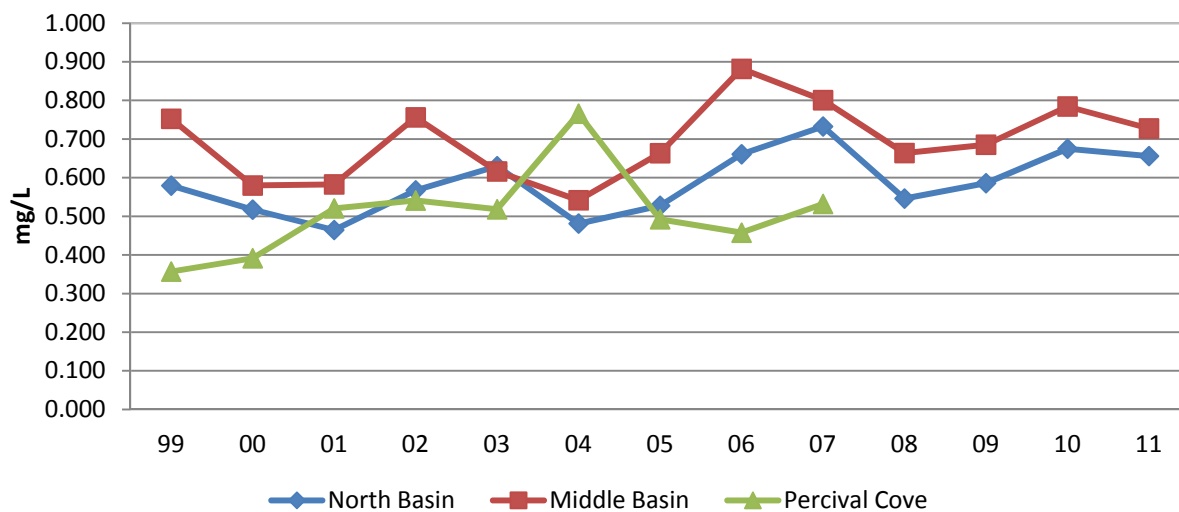
The average 2011 surface total phosphorus (TP) concentration in the north basin was 0.037 milligrams per liter (mg/l), and the middle basin’s average was 0.033 mg/l. Every individual sample in 2011 had a total phosphorus concentration greater than the 0.020 mg/L state action level. A graph of the annual average total phosphorus concentrations for the north and middle basins and Percival Cove (up to year 2007) since 1999 is shown on page 7. Generally, the phosphorus concentration in the north and middle basins were similar. Percival Cove had notably higher phosphorus than the main lake basins.

Annual average total nitrogen concentrations for both basins are also graphed on page 7. In 2011, the north basin average total nitrogen concentration was 0.656 milligrams per liter (mg/l) and the middle basin concentration was 0.727 milligrams per liter (mg/l). The graph shows that the middle basin consistently has higher nitrogen concentrations than the north basin. The total nitrogen to total phosphorus ratio in the both basins indicate that the lake is phosphorus limited during the summer.

Capitol Lake Total Phosphorus Average Annual Surface Concentrations

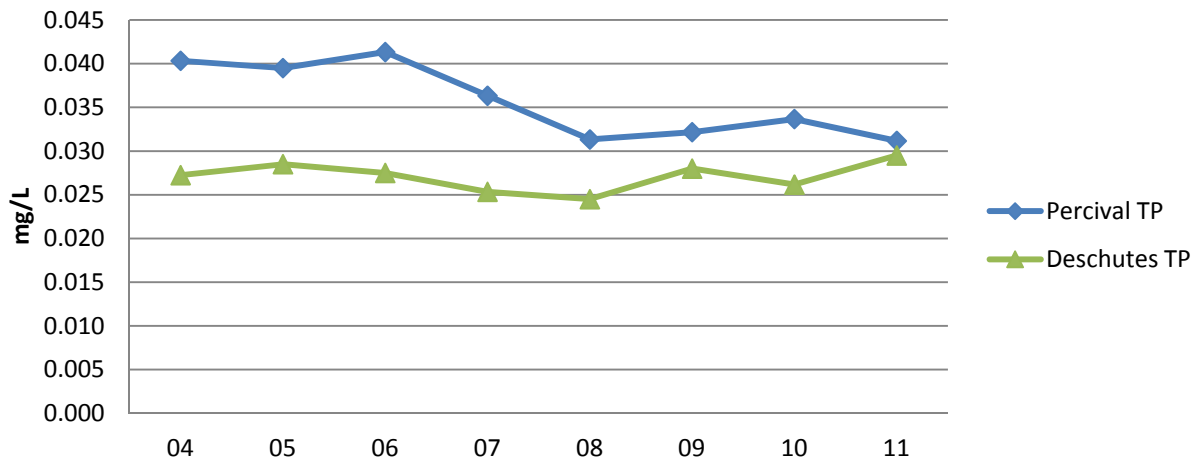


Capitol Lake Total Nitrogen Average Annual Surface Concentrations



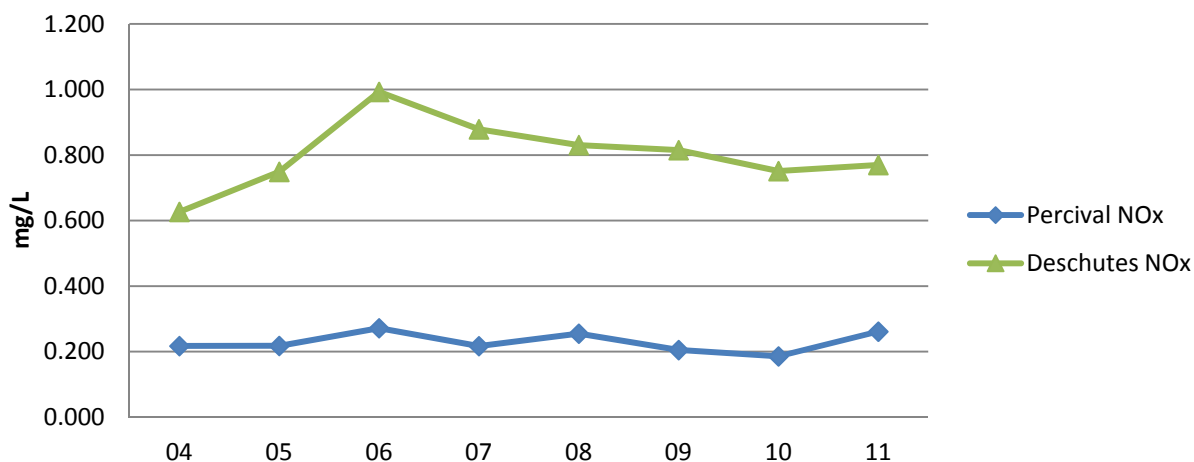
The Deschutes River and Percival Creek are the two primary tributaries to the lake. The average summer total phosphorus and nitrate concentrations from 2004 to 2011 for the Deschutes River and Percival Creek are graphed below. Percival Creek has higher phosphorus concentrations than the river, and the range is similar to the average concentrations measured in the lake.

Average Summer Total Phosphorus



The Deschutes River has higher nitrate-nitrogen concentrations than Percival Creek. The average ranged from 0.63 mg/l in 2004 to 0.99 mg/l in 2006. The average **total** nitrogen concentrations in the middle basin of the lake for the 2004 to 2011 time period followed a very similar pattern as the river, although at slightly lower levels. The range of the average **total** nitrogen in the middle basin for that same time period was 0.48 mg/l in 2004 and 0.73 mg/l in 2006.

Average Summer Nitrate



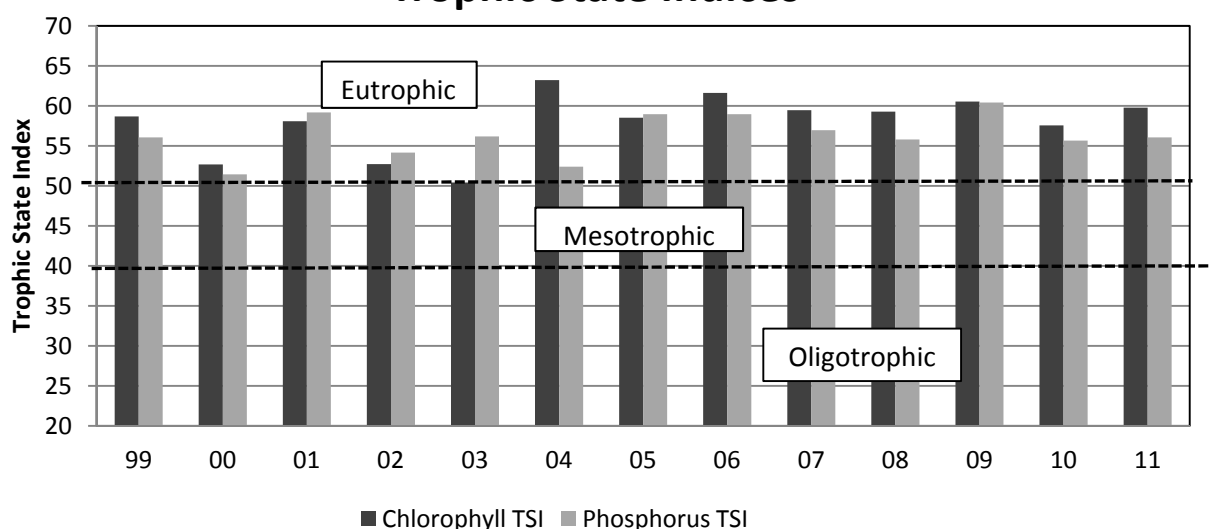
Trophic State Indices

The Carlson trophic state indices (TSI), are used to express the degree of productivity (algae, etc.) of a lake. Average summer total phosphorus and chlorophyll *a* concentrations and secchi disk transparency are each used to calculate TSIs for a lake. TSIs of 0 to 40 indicate an oligotrophic, or low productivity, lake. TSIs of 41 to 50 indicate a mesotrophic, or moderately productive lake.

TSIs of greater than 50 indicate a eutrophic, or highly productive lake. Due to the shallow condition of Capitol Lake and the dense rooted aquatic plant growth that occurs, the secchi disk often either reaches the bottom of the lake or is obscured by plants, especially in the middle basin. Therefore, secchi TSIs are not a good indicator of trophic status and were not calculated for either basin.

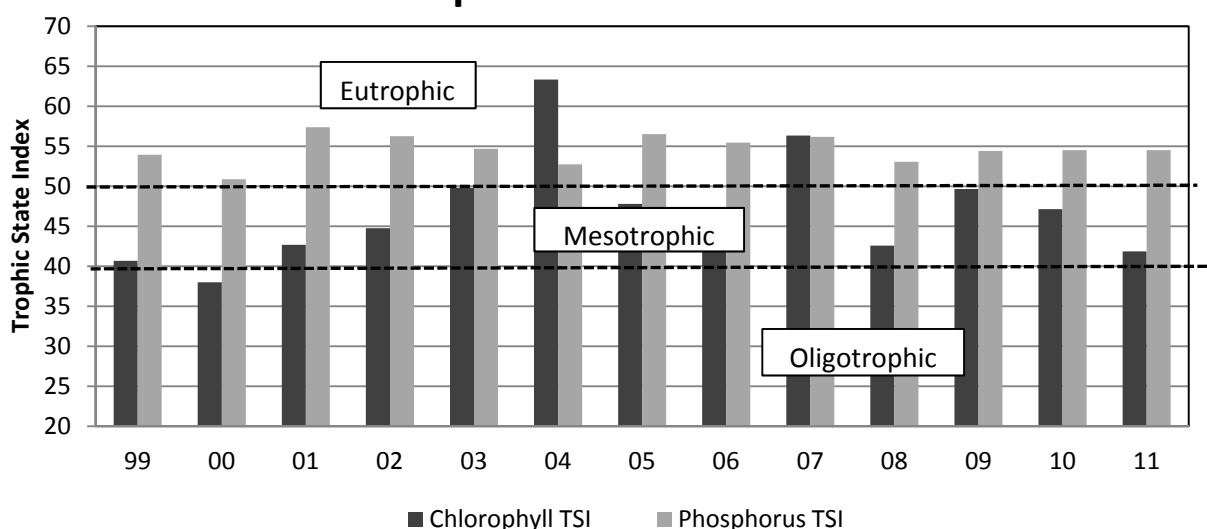
The north basin's 2011 TSIs for chlorophyll *a* and total phosphorus were 60 and 56, respectively. The middle basin had TSI values of 42 and 55 for chlorophyll *a* and total phosphorus, respectively. The TSIs from 1999 to 2011 for the north and middle basins are shown on the graphs below.

Capitol Lake - North Basin Trophic State Indices



Note: '99 indices calculated from Sept and Oct data only

Capitol Lake - Middle Basin Trophic State Indices



Note: '99 indices calculated from Sept and Oct data only

The TSIs show that both basins are nutrient-rich with phosphorus TSIs in the eutrophic range. The chlorophyll TSI for the north basin is also consistently in the eutrophic range indicating a highly productive system. The chlorophyll TSI for the middle basin TSIs is much lower and consistently within the mesotrophic range, indicating less algae production. This is an effect of the riverine-like characteristics of the lake. The middle basin, being upstream of the north basin and closer to incoming river water, has a less developed algae community than farther downstream in the lake.

The 2004 TSIs were artificially high as a result of the effects of an herbicide treatment in the lake for the control of the invasive aquatic plant, Eurasian water milfoil.

Algae

In most nutrient-rich Thurston County lakes, blue-green algae tend to be the dominant algae group and the ones associated with “algae blooms”. The algae composition in Capitol Lake is different, in that it tends to have more diatom species present than most other eutrophic lakes in this county. This is likely due to the lake’s location at the downstream end of the Deschutes River system. In G.W. Prescott’s, “The Algae: A Review”, it says that water current is a major factor in the algae composition of flowing water environments. The organisms must be able to physically survive the rigors of current, be able to assimilate nutrients readily from flowing water, and be able to reproduce under those conditions. The diatom group is a diverse group, and many of the diatom species have characteristics that allow them to inhabit flowing water environments. The blue-green algae, typical of a eutrophic lake, appear more often in the north basin than the middle basin, and during late summer and early fall.

The 2011 algae data is included at the end of this report. It is a list of those genus present in the sample, in alphabetical order by category. The order listed does not reflect dominance.

Major Issues:

- A 10-year plan (for 2003 to 2013) for adaptively managing Capitol Lake was developed by the Washington Department of Enterprise Services and a multi-agency steering committee. The goal of the plan is to achieve measurable improvements in flood control, water quality, sediment management and infrastructure improvements. The plan identifies fourteen management objectives, which have been adopted by the State Capitol Committee and are being implemented by the Washington State Department of Enterprise Services and the other participating agencies.
- In 2009 the Capitol Lake steering committee made a recommendation to the Washington Department of Enterprise Services to return the lake to a naturally functioning estuary after reviewing the results of several scientific studies conducted to determine the feasibility of estuary restoration. However, in May 2010, Enterprise Services, at the directive of the Legislature, suspended the Capitol Lake adaptive management planning process, due to budget limitations.

- The Washington State Department of Ecology is conducting a total maximum daily load study in the Deschutes River/Budd Inlet system. This includes modeling the effects of the lake on Budd Inlet. Discharge limits for pollution sources will also be established. The draft technical report was released in October 2008. A stakeholder committee was convened in 2009 and has begun development of a water quality cleanup plan. The plan is anticipated to be completed in January 2013.
- Some of the past and present Capitol Lake management issues include:
 - Sediment deposition and dredging
 - Poor water quality
 - Controlling the population of resident Canada and domestic geese
 - Accidental sewage and chemical spills
 - Excessive aquatic plant and algae growth
 - Invasive species such as purple loosestrife, Eurasian water milfoil, New Zealand mudsnail
 - Flooding and lake shoreline erosion
 - Chinook salmon hatchling and rearing operation
 - Stormwater discharges
- In 2001 Eurasian water milfoil, a non-native, invasive aquatic plant, was discovered in the lake. In summer 2004, the herbicide, triclopyr, was applied to the lake to control the milfoil infestation. In 2005, some surviving milfoil plants were discovered in the south basin and in the wetland near the Interpretive Center. Since then hand pulling and other alternative means of control are being used to help control the plant's spread.
- In 2009 the invasive species, New Zealand mudsnail was discovered in the lake. The Department of Enterprise Services has restricted lake access to prevent the spread of the snail to other water bodies. They are trying various control techniques including lake draw down during freezing weather conditions.

Funding Sources:

Funds for water quality monitoring in 2011 were provided by the State of Washington Department of Enterprise Services (formerly the Department of General Administration)

Capitol Lake Fecal Coliform Bacteria Sample Results

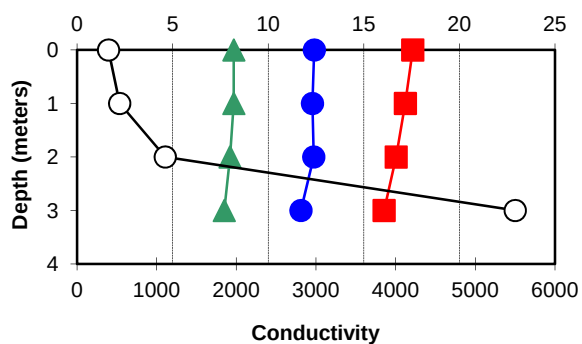
Date	North Basin	Middle Basin	Percival Cove
6/21/00	5	5	10
7/19/00	5	3	10
8/23/00	<5	5	<5
9/21/00	25	20	5
10/25/00	40	35	5
5/16/01	35	45	10
6/20/01	<5	<5	5
7/17/01	5	<5	<5
8/15/01	<5	<5	<5
9/20/01	10	<5	5
10/19/01	<5	<5	10
5/20/02	<5	5	<5
6/17/02	<5	13	5
8/28/02	<5	<5	–
9/26/02	<5	7	–
6/19/03	–	--	5
7/17/03	<5	<5	5
8/19/03	<5	5	<5
9/24/03	5	<5	5
5/25/04	8	<5	<5
6/14/04	6	11.5	5
7/13/04	2	3	5
8/18/04	1	1	<5
9/29/04	4.5	9	10
10/13/04	<5	15	5
5/18/05	50	45	60
6/22/05	5	38	<5
7/20/05	<5	<5	<5
8/17/05	<5	5	<5
9/14/05	<5	<5	<5
10/18/05	<5	15	<5
5/24-25/06	10	105	40
6/21-22/06	5	<5	<5
7/26/06	<5	<5	<5
8/16/06	<5	<5	5
9/20/06	5	10	10
10/11/06	<5	5	<5
5/23/07	<5	<5	15
6/18/07	<5	20	10
9/12/07	<5	<5	--
9/26/07	5	<5	--
10/17/07	15	50	--

Date	North Basin	Middle Basin	Percival Cove
5/21/08	50	25	--
6/16/08	5	5	--
7/15/08	<5	5	--
8/12/08	20	<5	--
9/17/08	<5	<5	--
10/15/08	5	10	--
5/26/09	10	20	--
6/24/09	<5	<5	--
8/19/09	<5	5	--
9/14/09	<5	10	--
10/14/09	<5	10	--
5/27/10	45	60	--
6/23/10	45	10	--
7/22/10	10	45	--
8/25/10	<5	80	--
9/22/10	--	10	--
10/21/10	<5	<5	--
6/22/11	20	30	--
7/20/11	--	15	--
8/30/11	<5	5	--
9/21/11	<5	5	--
10/12/11	60	163	--
Mean (GMV)	3	6	4
# of records	61	63	37

CAPITOL LAKE - NORTH BASIN

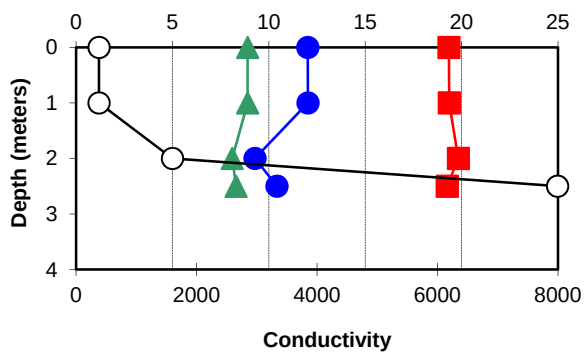
June 22, 2011

Temperature, pH, Dissolved Oxygen



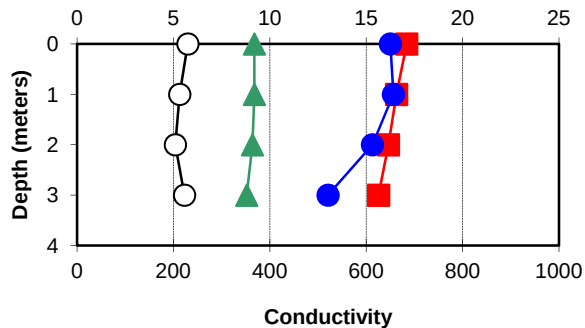
August 30, 2011

Temperature, pH, Dissolved Oxygen



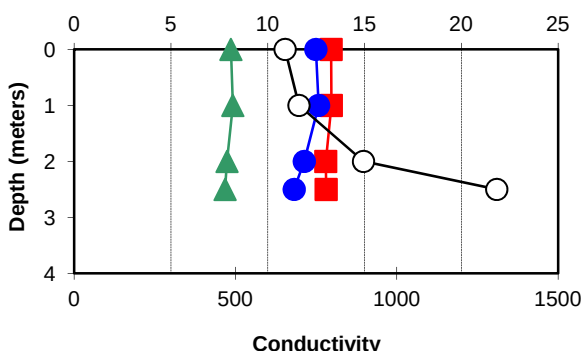
September 21, 2011

Temperature, pH, Dissolved Oxygen

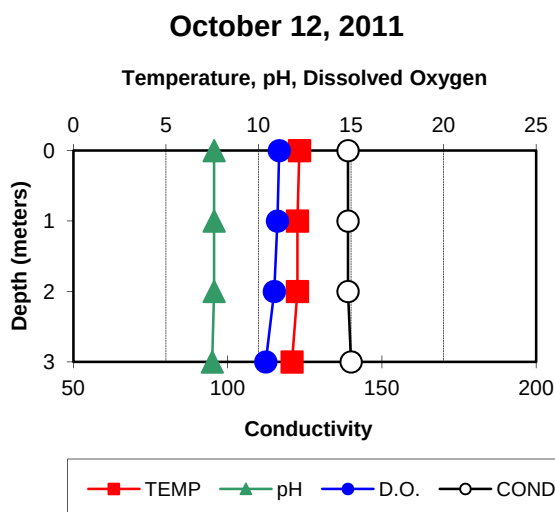
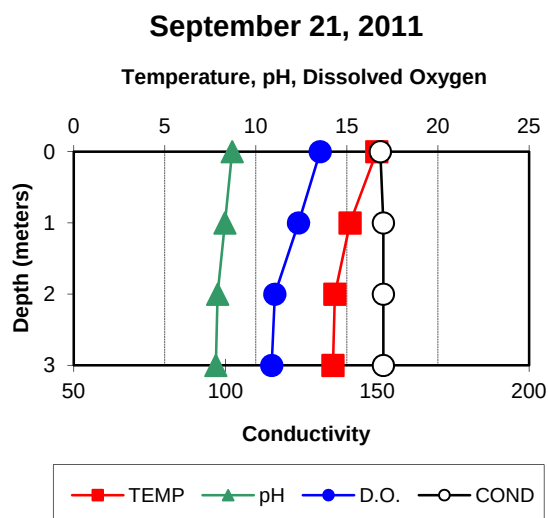
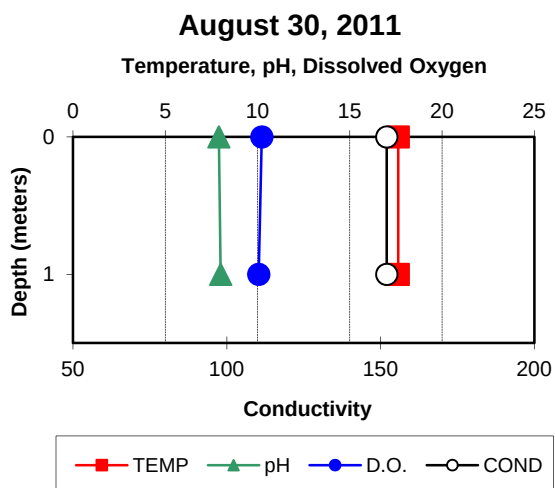
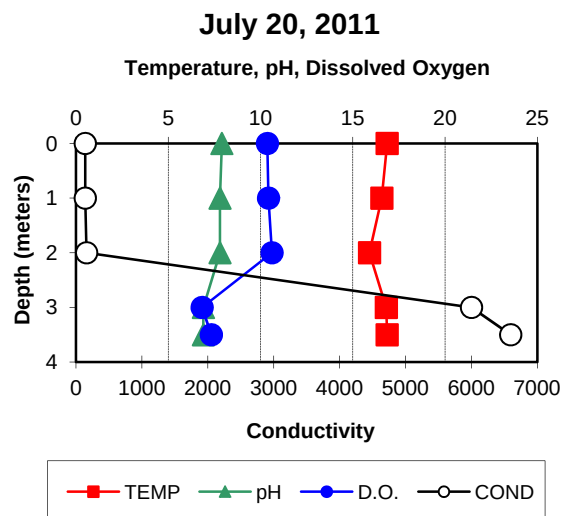
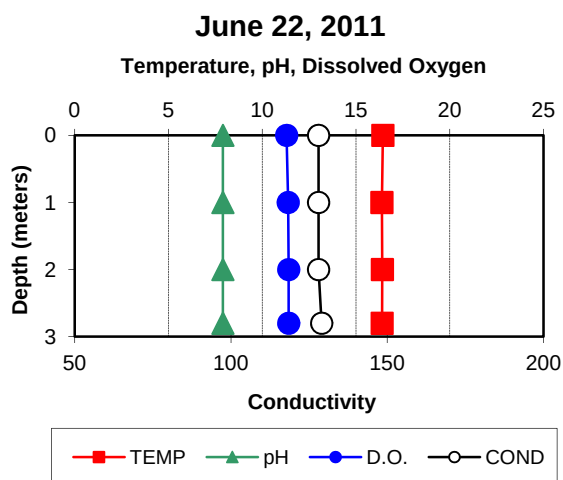


October 12, 2011

Temperature, pH, Dissolved Oxygen



CAPITOL LAKE - MIDDLE BASIN



Thurston County Water Resources Annual Report - 2011

Capitol Lake @ Mid- North Basin

Site ID# BUDCAL005

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water	Lake Notes
06/22/2011	2:30:00 PM	3	1.0	0.026		0.471		1.97	8.5	1.2	#6 yellow-green	Samples collected at 1M depth. Ammonia<0.010
07/20/2011												GA raised lake level for fish ladder repairs. Too high to get under RR tressel.
08/30/2011	8:45:00 AM	2.5	1.0	0.044		0.663		1.94	17	3.5	#6 yellow-green	Sample collected at 1M depth.
09/21/2011	2:30:00 PM	3.2	1.0	0.042		0.711		0.83	33	1.7	#6 murky yellow-green	Sample collected at 1M depth. Ammonia<0.010
10/12/2011	1:30:00 PM	2.5	1.0	0.034		0.779		1.91	20	1.9	#6 yellow-green	Sample collected at 1M depth.

Summary for 'Site Description' = Capitol Lake @ Mid- North Basin (5 detail records)

Averages: Sur TP 0.037
 Secchi 1.66
 Chl a 19.6

Thurston County Water Resources Annual Report - 2011

Capitol Lake @ Mid- Middle Basin

Site ID# BUDCAL015

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water	Lake Notes
06/22/2011	2:15:00 PM	2.8	1.0	0.031		0.587		2.10	3.7	2.6	#6 yellow-green	Samples collected at 1M depth.
07/20/2011	1:00:00 PM	3.5	1.0	0.031		0.782		2.72	4.3	2.5	#6 greenish-yellow	Samples collected at 1M depth.
08/30/2011	8:30:00 AM	1.2	0.8	0.041		0.522			2.7	2.6	#6 yellow-green	Samples collected at 0.75M depth. Visibility to bottom.
09/21/2011	2:00:00 PM	3	1.0	0.028		0.845			1.9	1.1	#6 yellow-green	Sample collected at 1M depth. Visibility to bottom.
10/12/2011	1:00:00 PM	3	1.0	0.033		0.901		2.05	3.2	1.3	#6 yellow-green	Sample collected at 1M depth.

Summary for 'Site Description' = Capitol Lake @ Mid- Middle Basin (5 detail records)

Averages: Sur TP 0.033
 Secchi 2.29
 Chl a 3.2

Algae data: Capitol Lake @ Mid- Middle Basin

	Type	Description	Dominant in Sample
06/22/2011			
	BG	Oscillatoria species	☐
	DT	Cocconeis pediculus	☐
	DT	Cymbella species	☐
	DT	Diatoms species	☒
	DT	Gyrosigma species	☐
	GR	Staurostrum species	☐
07/20/2011			
	BG	Oscillatoria species	☐
	CP	Cryptomonads	☐
	DF	Peridinium species	☐
	DT	Cyclotella species	☐
	DT	Cymbella species	☐
	DT	Diatoms species	☐
	DT	Fragilaria species	☐
	DT	Navicula species	☐
	GR	Ankistrodesmus species	☐
08/30/2011			
	CP	Cryptomonads	☐
	DF	Peridinium species	☐
	DT	Cocconeis pediculus	☐
	DT	Diatoms species	☐
	EU	Trachelomonas species	☐
	GR	Scenedesmus species	☐
09/21/2011			
	CP	Cryptomonads	☐
	DF	Peridinium species	☐
	DT	Cocconeis pediculus	☐
	DT	Cyclotella species	☐
	DT	Diatoms species	☐

10/12/2011

Type	Description	Dominant in Sample
DT	Cocconeis pediculus	☐
DT	Diatoms species	☐
DT	Fragilaria species	☐
DT	Rhoicosphenia species	☐
DT	Synedra species	☐

Key: BG = Blue green EU = Euglenophyte
CP = Cryptophyte GR = Green
DF = Dinoflagellate YL = Yellow
DT = Diatom

Algae data: Capitol Lake @ Mid- North Basin

06/22/2011

Type	Description	Dominant in Sample
BG	Aphanizomenon species	☐
DT	Cocconeis pediculus	☐
DT	Cyclotella species	☐
DT	Cymbella species	☐
DT	Diatoms species	☐
DT	Fragilaria species	☐
DT	Synedra species	☐
DT	Tabellaria species	☐
GR	Ankistrodesmus species	☐
GR	Crucigenia species	☐
GR	Pandorina species	☐
GR	Sphaerocystis species	☐
YL	Dinobryon species	☐

08/30/2011

BG	Pseudanabaena species	☐
CP	Cryptomonads	☐
DF	Peridinium species	☐
DT	Aulacoseira species	☐
DT	Cyclotella species	☐
DT	Diatoms species	☐
DT	Rhizosolenia eriensis	☐
DT	Synedra species	☐
GR	Ankistrodesmus species	☐
GR	Golenkinia species	☐
GR	Scenedesmus species	☐

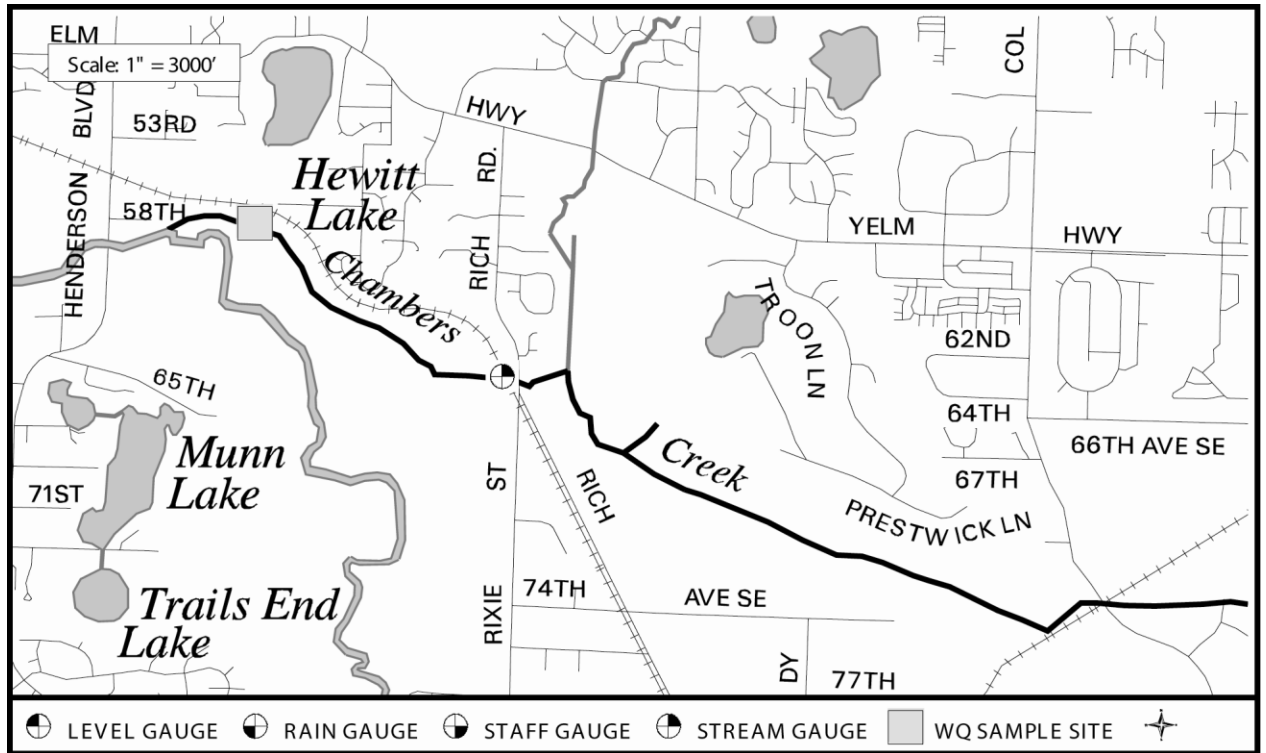
09/21/2011

Type	Description	Dominant in Sample
BG	Pseudanabaena species	☐
CP	Cryptomonads	☐
DT	Aulacoseira species	☐
DT	Cocconeis pediculus	☐
DT	Cyclotella species	☐
DT	Diatoms species	☐
DT	Synedra species	☐
GR	Actinastrum species	☐
GR	Ankistrodesmus species	☐

10/12/2011

BG	Pseudanabaena species	☐
DT	Cocconeis pediculus	☐
DT	Cyclotella species	☐
DT	Synedra species	☐
GR	Actinastrum species	☐
GR	Spondylosium species	☐

Key: BG = Blue green EU = Euglenophyte
CP = Cryptophyte GR = Green
DF = Dinoflagellate YL = Yellow
DT = Diatom



PART OF BUDD INLET/DESCHUTES RIVER WATERSHED

LENGTH OF CREEK: Chambers Creek and ditch - 4.15 miles
Chambers Creek (Tributary) - 3.6 miles

BASIN SIZE:
8400 Acres

STREAM ORDER: 2

PRIMARY LAND USES: Suburban and rural residential

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)
Coho in mainstem
Unknown in Tributary

GENERAL TOPOGRAPHY: Elevations vary from about 200 feet around the lakes, 190 feet in the creek bed and 130 feet towards the mouth where the creek enters the Deschutes River. Moderately sloped with rolling terraces

and occasional small glacial depressions, (kettles). These kettles often contain lakes which are groundwater fed and commonly have no surface inlets or outlets. Chambers Lake is the exception with Chambers ditch originating at the south portion of Little Chambers Lake.

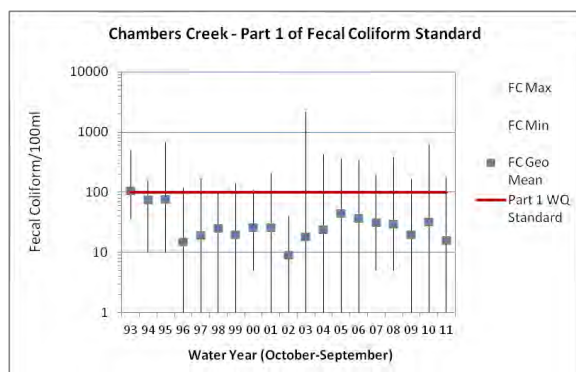
GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Good – The creek meets water quality standards. However, nitrate concentrations are very high.

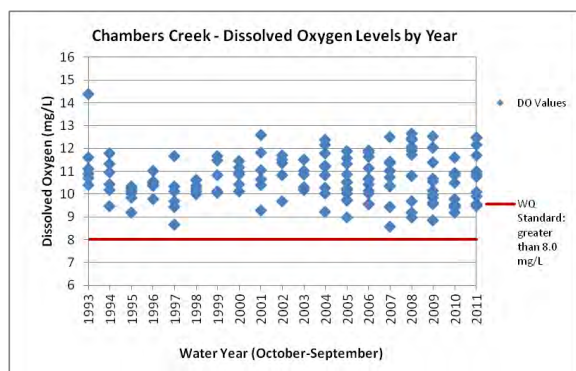
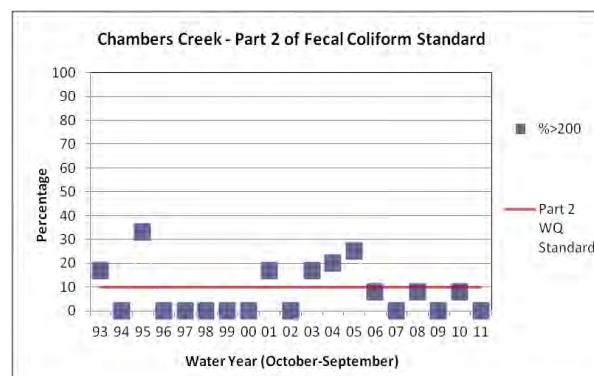
OTHER WATER RESOURCE DATA:
Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 or
www.co.thurston.wa.us/monitoring

Thurston County Environmental Health Division, (360) 867-2626 or
www.co.thurston.wa.us/health/ehswat/swater.html

Chambers Creek #0033

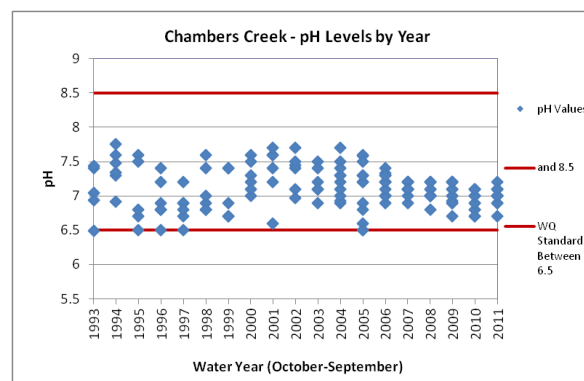


Part 1 of the fecal coliform bacteria standard has been violated only one time in 1993. Part 2 of the standard has been violated numerous years. The creek has met the standard since 2006.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 8.0 mg/L. There have been no violations of the dissolved oxygen standard.

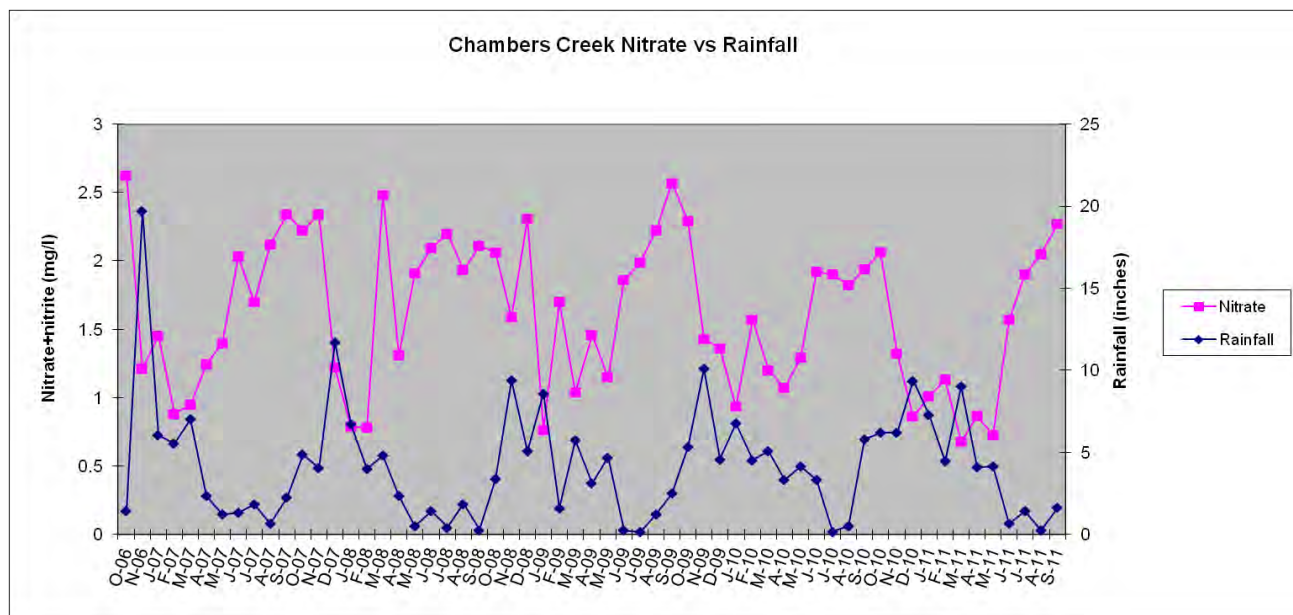
The water quality standard for pH requires the pH to be within a range of 6.5 to 8.5. There have been several instances where the measurement was just at 6.5, which is still within the acceptable range.



Discussion:

Nitrate concentrations in Chambers Creek are high. While there is no water quality standard for nitrates in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (US EPA Publication 822-B-00-015). In water year 2009/10 the average was 1.56 mg/L and the highest result was October, 2009 at 2.29 mg/L. In water year 2010/11 the average was 1.37 mg/L and the highest result was September 2011 at 2.27 mg/L. The source of the nitrates in the creek is most likely from contamination of the shallow groundwater that provides the base flow for the creek.

The figure below graphs monthly nitrate concentrations and monthly rainfall. The graph illustrates that nitrate concentrations tend to be higher during periods of low rainfall. In this system rainfall is likely diluting the nitrate contamination in the ground water.



Major Issues:

- The creek has high nitrate concentrations due to contamination of the groundwater.
- Most of the basin is within the urban growth area. Continued development can be expected to have an increasing effect on stream quality.

Funding Sources:

- Local stormwater utility

Water Quality Summary

Conventional Parameters

Chambers Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		4.80 – 15.20 5.05 – 14.03			3.99 – 14.67
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		9.19 – 11.61 9.47 – 12.48	0 of 11 0 of 12		8.57 – 14.4
Conductivity	µmhos/cm		09/10 10/11	128 117	82 - 166 61 - 165		120	53 – 170
pH		6.5 - 8.5	09/10 10/11	7.0* 7.0*	6.7 – 7.1 6.7 – 7.2	0 of 12	7.1*	6.49 – 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	1.60 1.47	0.70 – 4.7 0 – 2.4	0 of 12 0 of 12	1.71	0.1 – 9
Fecal Coliform	colonies/ 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	32** 16**	0 - 630 0 - 175	% exceeding 200	30**	0 – 2200
						8% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.024 0.025	0.016 – 0.030 0.016 – 0.036		0.022	0.002 – 0.09
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	1.56 1.37	0.935 – 2.290 0.677 – 2.27		1.678	0.556 – 3.66

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

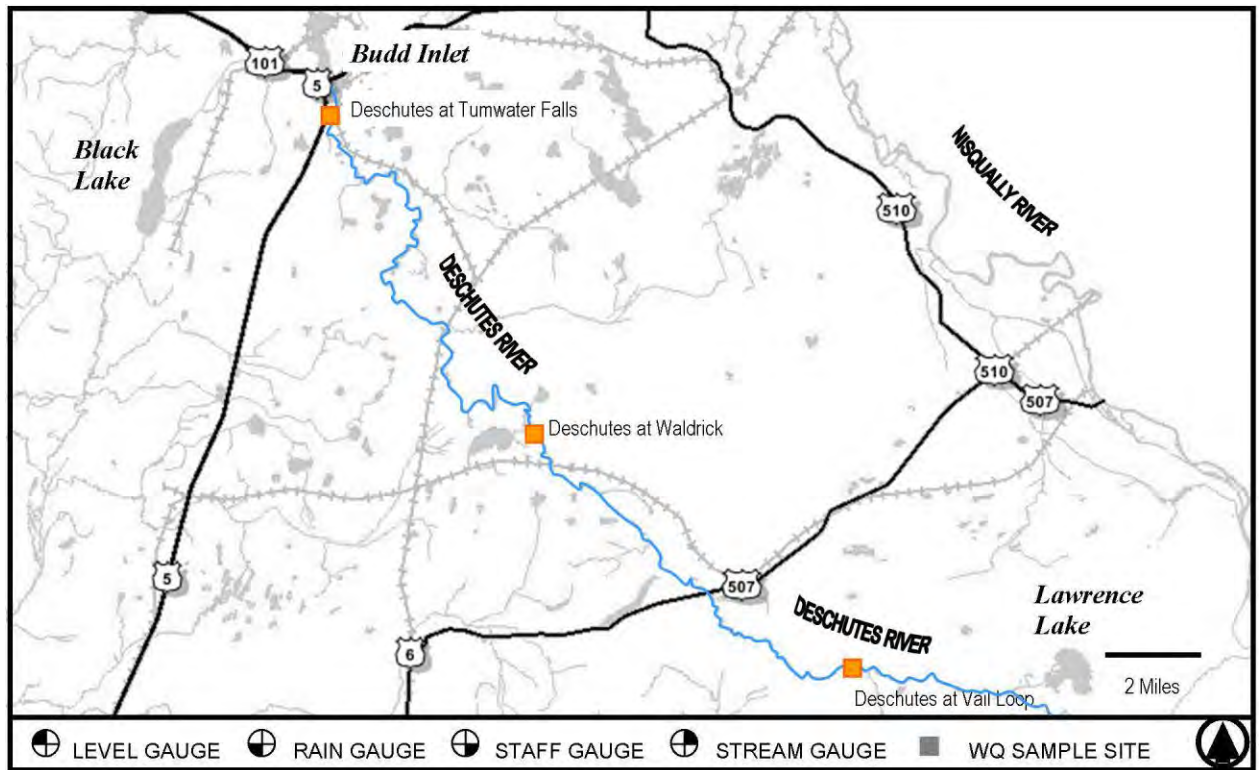
Chambers Creek off Henderson Blvd & 58th

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	10:45:00 AM	10.88	7.0	9.54	166	10	1.2	1.32	0.016	2.290	
11/17/2009	10:30:00 AM	9.15	6.8	9.79	122	175	4.7	8.37	0.029	1.430	Flows collected across culvert and beyond to left bank.
12/16/2009	10:30:00 AM	4.80	6.9	11.61	103	630	2.0	5.48	0.028	1.360	Duplicates labeled "Pioneer Park". FC duplicates were an order of magnitude different.
1/11/2010	10:45:00 AM	7.48	6.7	10.93	82	40	3.2	11.09	0.030	0.935	
2/10/2010	10:40:00 AM	6.67	6.8	10.50	115	5	1.0	6.11	0.023	1.570	
3/16/2010	10:15:00 AM	9.08	6.9	10.82	104	18	1.4	9.08	0.022	1.200	Duplicates labeled "Pioneer"
4/19/2010	10:10:00 AM	12.93	6.7	9.54	102	0	1.4	15.68	0.024	1.070	FC reported as <5.
5/10/2010	10:15:00 AM	11.64	7.0	9.19	121	50	1.0	7.49	0.028	1.290	
6/15/2010	10:15:00 AM	11.95	7.0	9.50	144	40	0.8	4.89	0.026	1.920	
7/12/2010	10:30:00 AM	14.09	7.1		151	45	0.7	3.05	0.025	1.900	DO did not post calibrate. Duplicates labeled "Pioneer".
8/16/2010	11:20:00 AM	15.20	7.1	9.40	161	70	0.8	2.07	0.022	1.820	
9/13/2010	11:00:00 AM	12.72	7.1	9.47	162	30	1.0	1.66	0.020	1.940	

Thurston County Water Resources Monitoring Report 2010-2011

Chambers Creek off Henderson Blvd & 58th

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	2:45:00 PM	9.69	7.2	10.87	153	90	0.0	1.97	0.016	2.060	Turb read -0.3.
11/16/2010	2:00:00 PM	9.85	6.9	9.57	115	0	0.6	4.30	0.025	1.320	FC reported as <5.
12/14/2010	3:30:00 PM	7.71	6.7	10.98	61	22	2.3		0.036	0.861	Duplicates labeled "Pioneer". Flooding. Too deep to measure flow. Field parameters measured from top of culvert.
1/12/2011	2:30:00 PM	5.05	6.9	12.46	95	15	2.4	19.99	0.021	1.010	
2/16/2011	1:45:00 PM	6.99	7.0	11.69	103	0	1.2	19.09	0.025	1.130	FC reported as <5.
3/14/2011	2:15:00 PM	8.20	7.0	12.16	78	20	2.3	41.34	0.021	0.677	
4/11/2011	3:30:00 PM	11.25	7.0	12.48	98	0	1.4	27.07	0.020	0.865	FC reported as <5.
5/17/2011	2:40:00 PM	13.50	7.0	10.76	96	50	1.7	25.56	0.029	0.725	
6/14/2011	3:00:00 PM	13.70	7.1	9.91	135	30	2.0	8.66	0.031	1.570	Field measurement & samples on 6/14/11. SW# rod jammed; flow measured 6/15/11.
7/12/2011	2:15:00 PM	14.03	7.0	9.54	153	60	1.3	5.09	0.026	1.900	Duplicates labeled "Henderson".
8/8/2011	3:50:00 PM	13.93	7.1	10.08	157	30	1.1	3.68	0.032	2.050	
9/13/2011	4:30:00 PM	13.44	7.1	9.47	165	175	1.3	2.30	0.020	2.270	



PART OF BUDD INLET WATERSHED

LENGTH OF CREEK: 57 miles

BASIN SIZE: 162 sq miles

STREAM ORDER: 4

PRIMARY LAND USES:

Upper watershed is primarily forested; mid-watershed is a mix of rural residential, agriculture and forestry. Lower watershed is urban land uses, which includes portions of the cities of Tumwater, Olympia and Lacey.

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)

Coho, Chinook, and probably Chum.

GENERAL TOPOGRAPHY:

Upper watershed is at roughly 3,800 feet elevation with steep slopes of over 70 percent at places. The mid and lower watershed has more gentle topography with slopes between 5-30 percent and an alluvial flood plain. The

upper 11 miles of the river has a steep gradient, and the lower 40 miles has a fairly uniform moderate gradient.

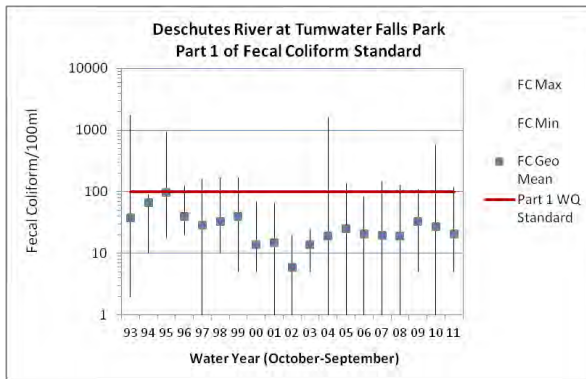
GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Good – Failed part 2 of fecal coliform standard for water year 2009/10 but met both parts in 2010/11. Turbidity is often high in winter. Summer temperature violations occur. Low in-stream flow and habitat deficiencies are concern for fisheries resources.

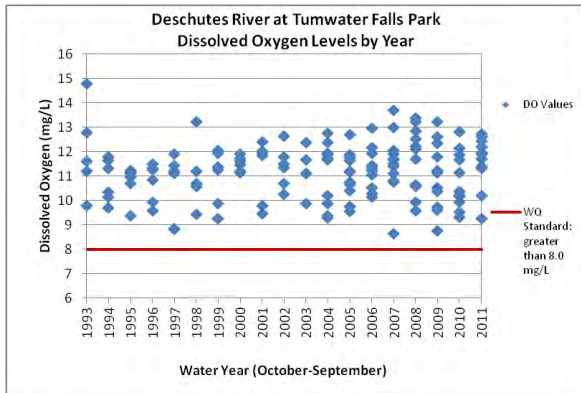
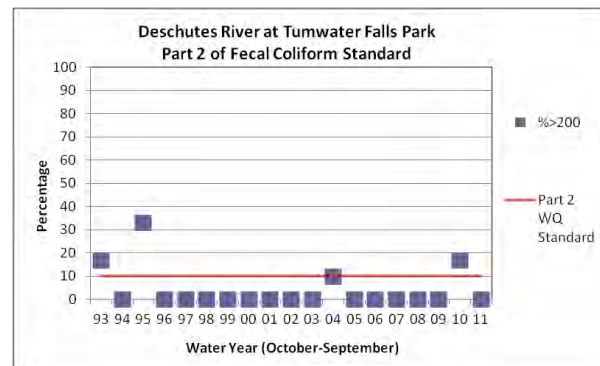
OTHER WATER RESOURCE DATA:

Thurston County Resource Stewardship Department, (360) 754-4681 or www.co.thurston.wa.us/monitoring
Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html
Washington Department of Ecology, (360) 407-6000: water quality data.
US Geological Survey, Tacoma, (253) 593-6510: river discharge data.

Deschutes River at Tumwater Falls Park

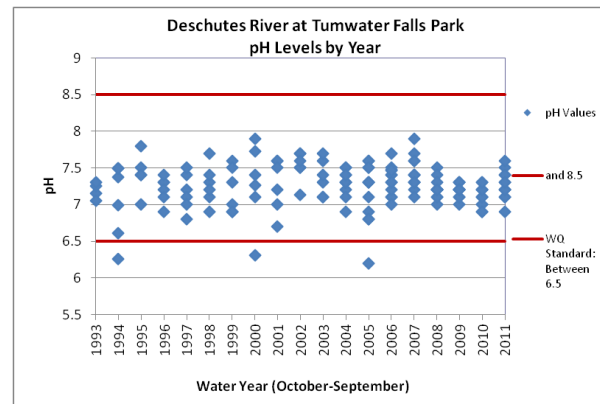


The river met Part 1 but failed Part 2 in 2009/10. Both parts of the water quality standard were met in water year 2010/11.

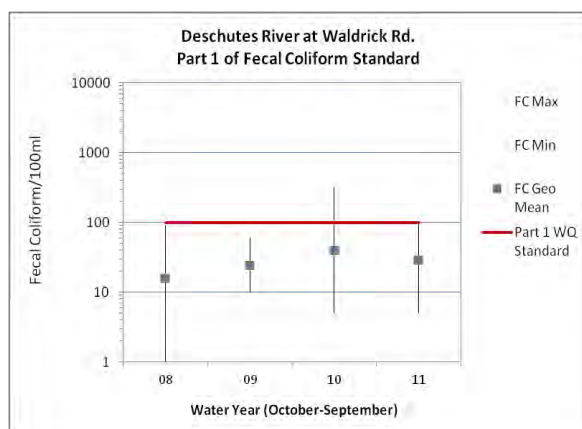


The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. All dissolved oxygen measurements in the period of record have been above 8 mg/L.

The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been only occasional pH measurements below 6.5 throughout the period of record.

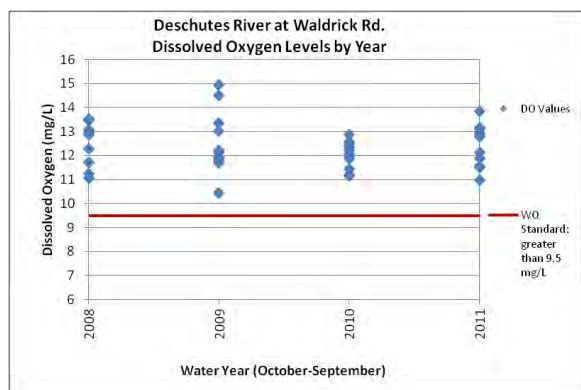
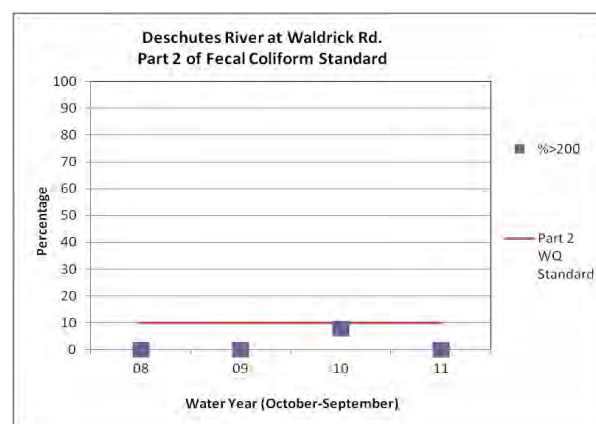


Deschutes River at Waldrick Rd.



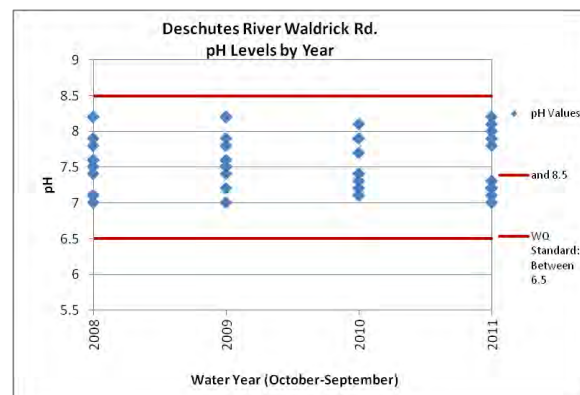
The river at Waldrick Rd. met both parts of the fecal coliform standard in the past four water years.

The state water quality standard for fecal coliform bacteria has two parts: Part 1 - the geometric mean shall not exceed 100 colonies per 100 milliliters of sample *and* Part 2 - no more than 10% of the samples shall exceed 200 colonies per 100 mL.

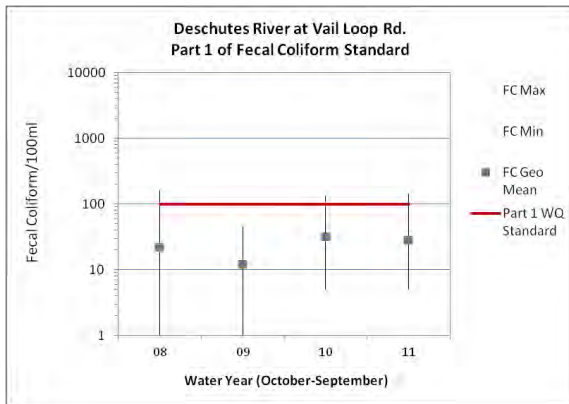


The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. The pH measurements in the past four water years have fallen within this range.

At Deschutes River at Waldrick Rd., the water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. There have been no violations in the past four water years.

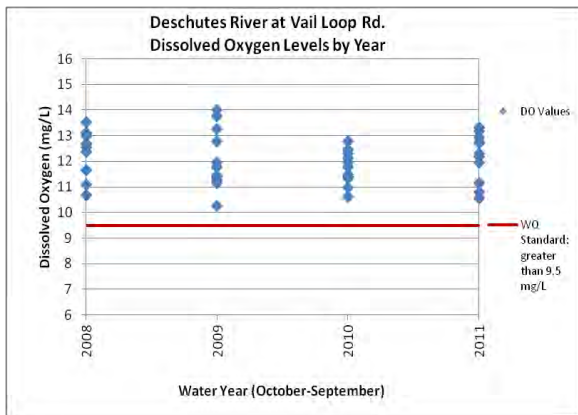
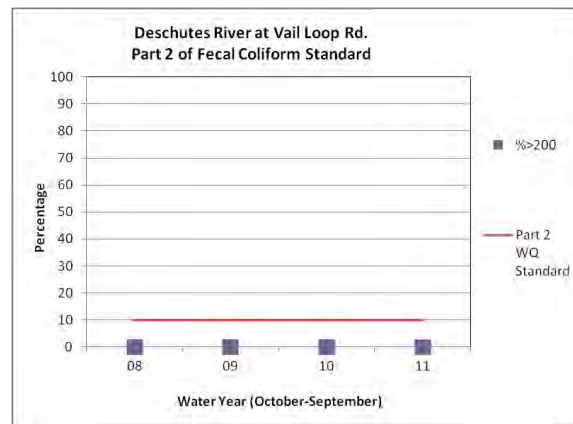


Deschutes River at Vail Loop Rd.



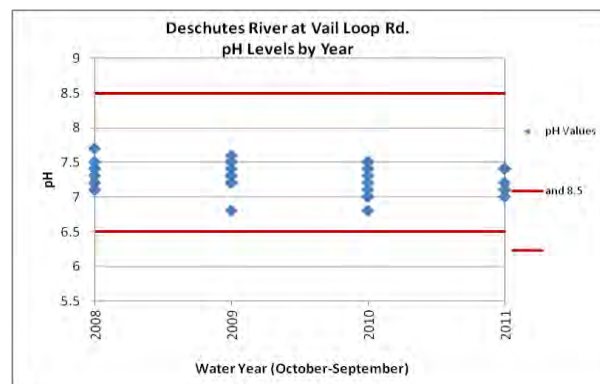
The river at Vail Loop Rd. met both parts of the fecal coliform standard in the past four water years.

The state water quality standard for fecal coliform bacteria has two parts: Part 1 - the geometric mean shall not exceed 100 colonies per 100 milliliters of sample *and* Part 2 - no more than 10% of the samples shall exceed 200 colonies per 100 mL.



The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. The pH measurements in the past four water years have fallen within this range.

At Deschutes River at Vail Loop Rd., the water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. There have been no violations in the past four water years.



Discussion:

Parts of the Deschutes River are listed on the Washington State Department of Ecology's 1998 Section 303(d) list of impaired and threatened water bodies for violating temperature, pH, and fecal coliform water quality standards, as well as in-stream flow, fine sediments and large woody debris deficiencies. In response to those listings the Washington Department of Ecology began a total maximum daily load study (TMDL) in 2003 to identify pollution sources and develop a plan to correct them. A draft TMDL technical study report was published in October 2008. An advisory committee began meeting in early 2009 to develop the water clean-up plan. The purpose of the water clean-up plan is to identify the actions needed to bring the water bodies within the Deschutes Watershed into compliance with the state water quality standards.

Thurston County currently monitors the water quality of the river at three locations; near the mouth above Tumwater Falls at Tumwater Falls Park, at Waldrick Road, and at Vail Loop Road near Rainier. The monitoring site near Tumwater Falls has been part of the ambient monitoring program since 1993. The other two locations were added to the program in 2007.

The temperature and dissolved oxygen standards that apply at the most downstream site at Tumwater Falls are different than the standards that apply at the two upstream sampling sites located at Waldrick and Vail loop Roads. At the Tumwater Falls site, temperature criteria of a 7-day average daily (DAD) maximum of 17.5° C and a dissolved oxygen criteria of the lowest one-day minimum of 8.0 mg/l is intended to protect salmonid spawning, rearing, and migration. Upstream of the Offut Lake tributary, temperature criteria of a 7-day average daily (DAD) maximum of 16° C and a dissolved oxygen criteria of the lowest one-day minimum of 9.5 mg/l is intended to protect core summer salmonid habitat.

The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. Temperatures above 16° C were measured at the Waldrick site in July and August of 2010 and September 2011. At the Vail Loop site, a temperature above 16° C was measured in August 2010. This indicates that possible temperature standard violations may have occurred during these periods. At the Tumwater Falls site the temperature criterion of 17.5 ° C was met both years.

Except for occasional high turbidity measurements during high winter storm events and the summer temperature concerns in the upper river, other water quality standards were met at the three sites during this reporting period.

Tables summarizing the water quality data for each sampling site can be found on the following page.

Water Quality Summary
Conventional Parameters
Deschutes River at Tumwater Falls

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# of samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		5.97 – 15.68 5.43 – 15.39			3.49 – 19.16
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		9.31 – 12.83 9.27 – 12.75	0 of 11 0 of 12		8.65 – 14.8
Conductivity	µmhos/cm		09/10 10/11	111 105	58 - 147 55 - 152		106	45 - 159
pH		6.5 - 8.5	09/10 10/11	7.1* 7.2*	6.9 – 7.3 6.9 – 7.6	0 of 12	7.3*	6.2 – 7.9
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	4.51 19.79	1.4 – 12.40 0.60 – 90.90	1 of 12 3 of 12	6.46	0.5 - 57
Fecal Coliform	colonies/ 100 ml	GMV: ≤100 and ≤10% of samples not to exceed 200	09/10 10/11	27** 21**	0 - 570 5 - 120	% exceeding 200	24**	0 – 1745
						0%		
						0%		
Total Phosphorus	mg/L		09/10 10/11	0.048 0.065	0.019 – 0.265 0.019 – 0.256		0.033	0.013 - 0.192
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.700 0.695	0.392 – 0.877 0.456 – 0.977		0.704	0.244 – 1.18

*Median

**Geometric Mean Value

Water Quality Summary
Conventional Parameters
Deschutes River at Waldrick Road

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 2007-2009	
			Water Year	Mean	Range	# of samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		5.70 – 18.44 5.22 – 16.33			2.93 – 17.31
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		11.14 – 12.87 10.98 – 13.84	0 of 11 0 of 12		10.5 - 15
Conductivity	µmhos/cm		09/10 10/11	108 103	46 - 160 47 - 167		112	66 - 168
pH		6.5 - 8.5	09/10 10/11	7.7* 7.2*	7.1 – 8.1 7.0 – 8.2	0 of 12 0 if 12	7.6*	7 – 8.2
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	21 15	0 - 230 0 - 103	1 of 12 4 of 12	4.65	0.2 – 21.4
Fecal Coliform	colonies/ 100 ml	GMV: ≤100 and ≤10% of samples not to exceed 200	09/10 10/11	40** 29**	5 - 320 5 - 100	% exceeding 200	20**	0 - 90
						8% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.065 0.049	0.012 - 0.521 0.012 – 0.237		0.021	0.012 – 0.046
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.670 0.664	0.519 – 0.979 0.400 – 1.12		0.745	0.423 – 1.24

*Median

**Geometric Mean Value

Water Quality Summary
Conventional Parameters
Deschutes River at Vail Loop Road

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 2007-2009	
			Water Year	Mean	Range	# of samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		4.88 – 17.13 4.99 – 15.53			2.58 – 16.89
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		10.61 – 12.79 10.56 – 13.32	0 of 11 0 of 12		10.3 – 14.0
Conductivity	µmhos/cm		09/10 10/11	89 85	44 - 128 44 - 133		90	57 - 133
pH		6.5 - 8.5	09/10 10/11	7.2* 7.2*	6.8 – 7.5 7.0 – 7.4	0 of 12 0 of 12	7.3*	6.8 – 7.7
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	16 14	0.7 - 164 0 - 85	1 of 12 4 of 12	3.81	0.3 – 17.3
Fecal Coliform	colonies/ 100 ml	GMV: ≤100 and ≤10% of samples not to exceed 200	09/10 10/11	32** 28**	5 - 135 5 - 140	% exceeding 200	16**	0 - 160
						0%		
						0%		
Total Phosphorus	mg/L		09/10 10/11	0.055 0.046	0.014 – 0.422 0.016 – 0.183		0.021	0.011 – 0.043
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.478 0.452	0.302 – 0.641 0.302 – 0.687		0.488	0.191 – 0.687

*Median

**Geometric Mean Value

Thurston County Water Resources Monitoring Report 2009-2010

Deschutes River @ Tumwater Falls Park

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	10:25:00 AM	11.29	7.1	9.93	143	50	2.2	136.00	0.030	0.771	USGS flow data
11/17/2009	10:00:00 AM	8.69	7.0	12.14	58	300	12.4	1740.00	0.265	0.392	USGS flow data
12/16/2009	10:15:00 AM	5.97	7.2	12.83	113	570	5.3	339.00	0.035	0.738	USGS flow data
1/11/2010	10:15:00 AM	7.51	7.0	11.89	82	60	9.0	738.00	0.037	0.606	USGS flow data
2/10/2010	10:10:00 AM	6.69	6.9	11.16	116	0	2.9	306.00	0.025	0.877	FC reported as <5. USGS flow data
3/16/2010	10:00:00 AM	8.22	7.1	11.68	95	10	7.3	437.00	0.030	0.685	USGS flow data
4/19/2010	9:50:00 AM	11.64	6.9	10.24	101	15	4.1	415.00	0.026	0.678	USGS flow data
5/10/2010	10:00:00 AM	11.64	7.2	10.18	105	10	2.1	340.00	0.019	0.613	Duplicates labeled "Falls". USGS flow data
6/15/2010	10:00:00 AM	11.92	7.1	10.37	103	35	3.5	392.00	0.031	0.637	USGS flow data
7/12/2010	10:00:00 AM	15.83	7.3		132	20	1.9	180.00	0.029	0.743	DO did not post calibrate. USGS flow data
8/16/2010	11:00:00 AM	16.58	7.2	9.31	136	10	2.0	127.00	0.028	0.791	USGS flow data
9/13/2010	10:30:00 AM	13.27	7.3	9.52	147	20	1.4	108.00	0.026	0.872	USGS flow data

Thurston County Water Resources Monitoring Report 2010-2011

Deschutes River @ Tumwater Falls Park

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	3:35:00 PM	9.39	7.4	12.20	141	10	0.6	117	0.024	0.852	USGS flow data
11/16/2010	2:45:00 PM	9.61	7.3	11.33	102	20	4.3	422	0.032	0.613	USGS flow data
12/14/2010	4:10:00 PM	7.79	6.9	11.71	56	120	90.9	2210	0.256	0.524	USGS flow data
1/12/2011	3:00:00 PM	5.43	7.2	12.45	102	12	5.1	389	0.029	0.794	USGS flow data. Duplicates labeled "Falls". Bacteria and nutrient results are the average of field duplicates.
2/16/2011	2:00:00 PM	6.25	7.1	12.20	80	15	18.5	670	0.057	0.721	USGS flow data
3/14/2011	3:00:00 PM	7.10	7.1	12.75	55	20	82.0	1990	0.181	0.456	USGS flow data
4/11/2011	4:20:00 PM	9.87	7.2	12.63	91	5	10.7	749	0.044	0.605	USGS flow data
5/17/2011	3:30:00 PM	10.76	7.2	11.96	79	25	18.0	964	0.048	0.500	USGS flow data
6/14/2011	3:40:00 PM	13.68	7.5	11.90	122	20	1.9	268	0.019	0.605	USGS flow data
7/12/2011	2:45:00 PM	15.38	7.6	11.42	139	20	1.8	159	0.023	0.761	USGS flow data
8/8/2011	4:30:00 PM	15.39	7.4	10.21	146	25	2.3	139	0.034	0.932	USGS flow data
9/15/2011	9:00:00 AM	13.54	7.3	9.27	152	30	1.4	115	0.028	0.977	USGS flow data

Thurston County Water Resources Monitoring Report 2009-2010

Deschutes River @ Waldrick Rd.

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	12:10:00 PM	11.22	7.7	12.21	144	30	1.2		0.014	0.670	
11/17/2009	11:45:00 AM	8.43	7.1	12.50	46	320	230.0		0.521	0.647	Staff Gage #2 - 7.58'. River in flood. Samples taken near gage. Large stumps and trees being carried downstream.
12/16/2009	12:00:00 PM	5.70	7.4	12.87	98	150	5.5		0.032	0.588	
1/11/2010	12:50:00 PM	7.75	7.1	12.08	76	5	6.1		0.030	0.554	
2/10/2010	12:00:00 PM	5.88	7.2	12.38	110	10	1.4		0.020	0.770	
3/16/2010	12:00:00 PM	8.36	7.3	12.59	88	30	4.2		0.022	0.585	
4/19/2010	11:15:00 AM	11.35	7.2	11.45	92	20	2.1		0.018	0.566	
5/10/2010	11:45:00 AM	11.26	7.7	11.86	98	75	1.1		0.012	0.519	
6/15/2010	11:45:00 AM	11.82	7.4	11.22	96	28	3.8		0.060	0.560	Duplicates labeled "Stone H."
7/12/2010	11:30:00 AM	16.22	7.9		134	70	0.0		0.015	0.723	DO did not post calibrate. Turbidity read -1.0.
8/16/2010	12:40:00 PM	18.44	8.1	11.14	155	70	0.7		0.018	0.878	
9/13/2010	12:15:00 PM	13.54	7.9	11.56	160	20	0.8		0.018	0.979	

Thurston County Water Resources Monitoring Report 2010-2011

Deschutes River @ Waldrick Rd.

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	1:55:00 PM	8.53	7.9	13.84	147	45	0.0		0.013	0.858	Turb read -0.3.
11/16/2010	12:50:00 PM	9.54	7.2	11.88	90	40	4.3		0.027	0.518	
12/14/2010	2:45:00 PM	7.39	7.0	12.14	53	40	32.7		0.089	0.498	
1/12/2011	1:15:00 PM	5.22	7.3	12.94	94	55	3.4		0.024	0.690	
2/16/2011	12:50:00 PM	5.50	7.2	12.80	72	20	14.0		0.047	0.620	
3/14/2011	1:30:00 PM	6.62	7.1	13.10	47	5	103.0		0.237	0.400	
4/11/2011	2:15:00 PM	8.52	7.2	13.17	76	18	7.8		0.036	0.444	Duplicates labeled "Leedy".
5/17/2011	1:20:00 PM	9.42	7.2	12.79	73	15	11.2		0.037	0.440	
6/14/2011	1:35:00 PM	13.28	8.2	13.10	118	10	1.5		0.012	0.537	
7/12/2011	1:00:00 PM	15.46	7.8	10.98	146	100	1.2		0.016	0.836	
8/8/2011	3:05:00 PM	15.88	8.1	11.50	156	45	0.8		0.024	1.010	
9/12/2011	5:10:00 PM	16.33	8.0	10.98	167	35	0.1		0.022	1.120	

Thurston County Water Resources Monitoring Report 2009-2010

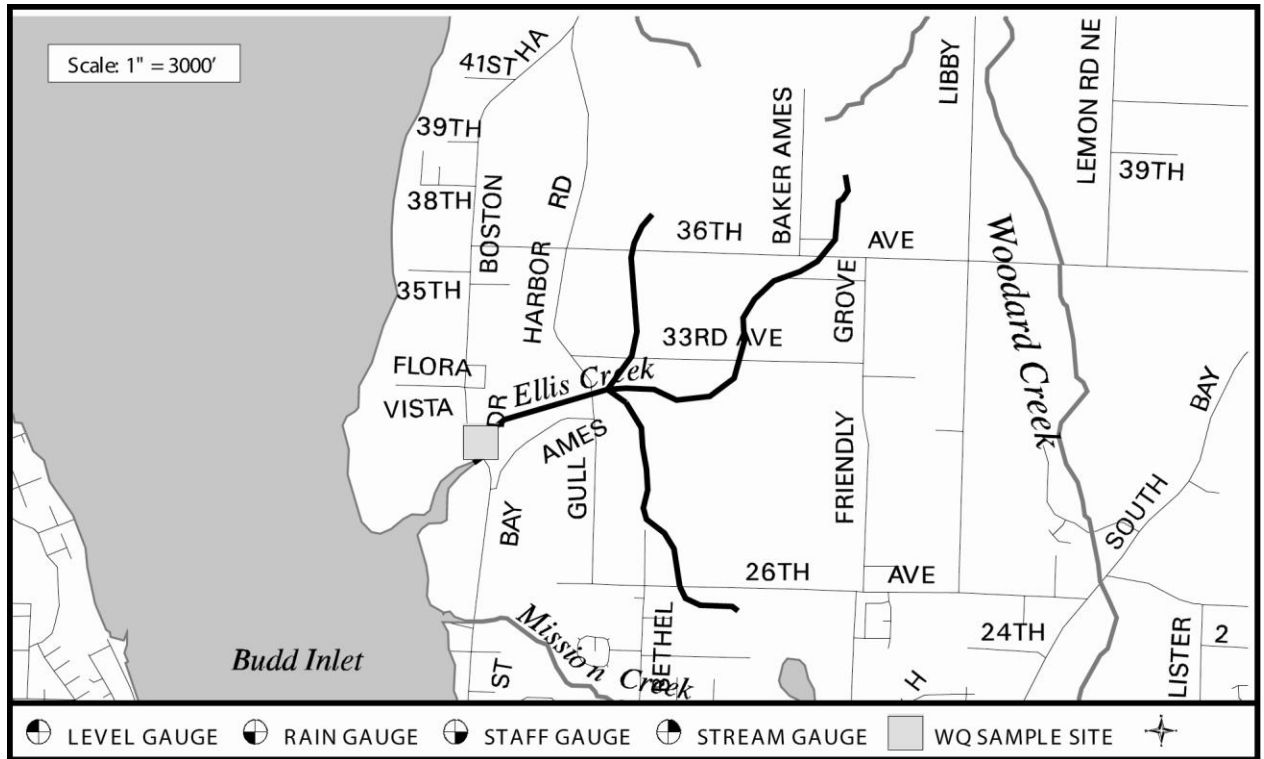
Deschutes River @ Vail Loop Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	12:25:00 PM	10.78	7.4	11.78	118	58	1.4	43.00	0.014	0.459	Duplicates labeled "Deschutes at WH". USGS flow data.
11/17/2009	12:15:00 PM	8.19	7.0	12.79	44	135	164.5	1840.00	0.422	0.637	USGS flow data.
12/16/2009	12:20:00 PM	4.88	7.2	12.32	77	80	7.0	246.00	0.030	0.387	USGS flow data.
1/11/2010	1:15:00 PM	7.84	7.0	11.94	66	20	6.1	441.00	0.029	0.458	USGS flow data.
2/10/2010	12:30:00 PM	5.18	7.0	12.12	90	5	1.9	130.00	0.018	0.572	USGS flow data.
3/16/2010	12:15:00 PM	8.06	7.0	12.45	75	15	4.0	241.00	0.021	0.437	USGS flow data.
4/19/2010	11:30:00 AM	10.18	6.8	11.32	77	5	4.1	264.00	0.026	0.431	USGS flow data.
5/10/2010	12:00:00 PM	9.83	7.3	11.48	80	75	1.4	217.00	0.015	0.302	USGS flow data.
6/15/2010	12:00:00 PM	10.84	7.1	11.40	81	45	1.8	215.00	0.023	0.371	USGS flow data.
7/12/2010	12:00:00 PM	15.07	7.4		106	25	1.0	93.00	0.019	0.480	DO did not post calibrate. USGS flow data.
8/16/2010	1:10:00 PM	17.13	7.5	10.61	124	60	0.7	45.00	0.018	0.565	USGS flow data.
9/13/2010	12:40:00 PM	13.38	7.5	10.98	127	30	0.8	48.00	0.020	0.641	USGS flow data.

Thurston County Water Resources Monitoring Report 2010-2011

Deschutes River @ Vail Loop Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	1:30:00 PM	8.23	7.4	12.92	116	30	0.4	43.00	0.017	0.455	Dead salmon carcass planted in river. USGS flow data
11/16/2010	12:30:00 PM	8.91	7.1	11.94	75	60	7.8	256.00	0.027	0.382	USGS flow data
12/14/2010	2:30:00 PM	7.16	7.0	12.20	49	40	35.0	1540.00	0.109	0.445	USGS flow data
1/12/2011	12:50:00 PM	5.23	7.1	12.71	76	5	4.8		0.027	0.488	
2/16/2011	11:45:00 AM	4.99	7.1	12.75	64	15	12.8		0.041	0.528	Duplicates labeled "WeyCo".
3/14/2011	1:00:00 PM	6.55	7.1	13.18	44	30	85.0		0.183	0.379	High, fast, and turbid.
4/11/2011	1:45:00 PM	7.77	7.2	13.32	63	10	7.7	572.00	0.034	0.302	USGS flow data
5/17/2011	12:55:00 PM	8.83	7.1	12.72	65	15	9.7	550.00	0.035	0.341	USGS flow data
6/14/2011	1:10:00 PM	11.87	7.4	12.30	96	20	1.2		0.016	0.338	
7/12/2011	12:00:00 PM	14.30	7.4	11.15	114	140	0.8	68.00	0.017	0.472	
8/8/2011	2:45:00 PM	15.09	7.4	10.80	122	30	0.7	47.00	0.024	0.610	USGS flow data
9/12/2011	4:50:00 PM	15.53	7.4	10.56	133	65	0.0	33.00	0.021	0.687	USGS flow data



PART OF BUDD INLET WATERSHED

LENGTH OF CREEK: 1.1 miles plus tributaries from the north and south.

BASIN SIZE: 1667 Acres

STREAM ORDER: 1

PRIMARY LAND USES:

Rural residential
Suburban residential

FISHERIES RESOURCES:

(From A Catalog of Washington Streams and Salmon Utilization, WDOF)

Coho, (Chum)

GENERAL TOPOGRAPHY:

Rolling hills, rural landscape, frequent wetlands. Elevations range from 170 feet at

the highest portion of the watershed gradually sloping to Gull Harbor Road where the arms of the creek meet and follow a steep gully down to Budd Inlet.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

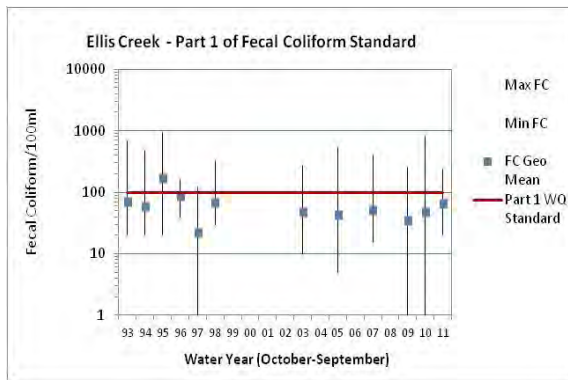
Good- Failed part 2 of fecal coliform standard in 2009/10 and met both parts in 2010/11. Two elevated turbidity measurements in 2009/10 and four in 2010/11.

OTHER DATA:

City of Olympia, Stream Team, (360) 570-5841

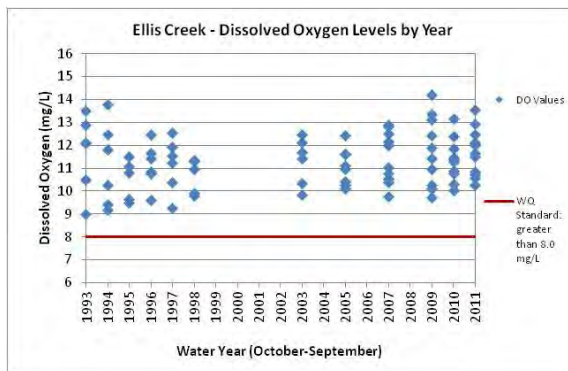
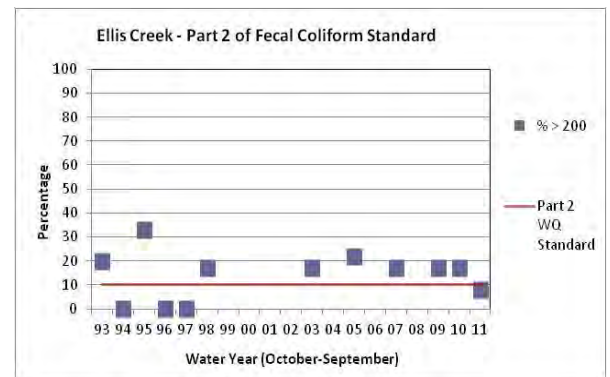
Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

Ellis Creek #0022



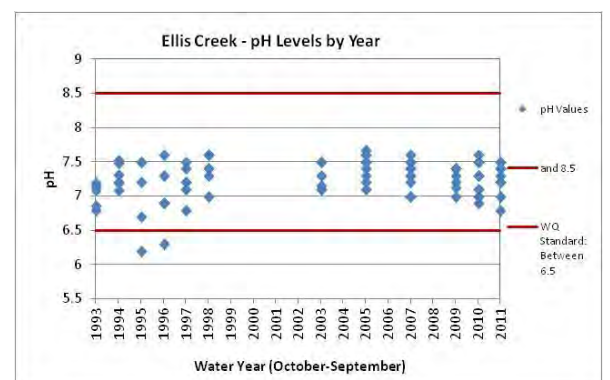
Ellis Creek met Part 1 of the water quality standard in most years sampled. The creek has often failed Part 2 of the standard however it was met in 2010/11.

The water quality standard for fecal coliform bacteria has two parts: Part 1 – the geometric mean shall not exceed 100 colony forming units per 100 milliliters of sample *and* Part 2 – no more than ten percent of the samples shall exceed 200 cfu/100mL.



The standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been only two violations of the pH standard in 1995 and 1996.

The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. There have been no recorded dissolved oxygen violations.



Discussion:

Between 1992 and 1998, Ellis Creek was monitored each water year as part of the ambient monitoring program funded by the local storm and surface water utilities. In December 2002 sampling began again on an every-other-year basis, resulting in data for water years 2002/03, 2004/05, 2006/07, and 2008/09. Monitoring each year has resumed as of 2009/10.

The table on the next page compares the year's data with the state water quality standards. The creek usually meets part 1 of the fecal coliform standard but often fails part 2 however it was met in 2010/11. The turbidity was elevated two times in water year 2009/10; November and December 2009 and four times in 2010/11; December 2010 and February, March and May 2011. Visual observations of field staff are that the bottom substrate of the stream channel has been changing over time from predominantly gravel to predominantly sand.

Major Issues:

- Because of its proximity to the city limits, new development is occurring in the watershed. Full development of the basin could have an appreciable impact on flood volumes.
- Water quality is threatened by erosion from high stream flows and nonpoint source pollution in the watershed.
- Stream bed appears to be changing from predominantly gravel to sand.
- City of Olympia has worked to improve fish passage at the East Bay Drive crossing.

Funding Sources:

- Local Stormwater Utility Rates

Water Quality Summary

Conventional Parameters

Ellis Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		3.07 – 15.17 3.89 – 13.48			1.83 – 15.2
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		10.05 – 13.19 10.26 – 13.54	0 of 12 0 of 12		9.2 – 14.2
Conductivity	µmhos/cm		09/10 10/11	116 102	72 – 162 60 - 161		110	47 - 181
pH		6.5 - 8.5	09/10 10/11	7.3* 7.4*	6.9 – 7.6 6.8 – 7.5	0 of 12 0 of 12	7.3*	6.2 - 7.7
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	4.89 8.08	1.60 – 13.70 0.70 – 30.0	2 of 12 4 of 12	5.25	0.5 – 37
Fecal Coliform	colonies / 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	48** 66**	0 – 820 20 - 240	% exceeding 200	52**	0 - 935
						17% 8%		
Total Phosphorus	mg/L		09/10 10/11	0.058 0.058	0.037 – 0.077 0.039 – 0.094		0.047	0.025 – 0.109
Nitrate Nitrite- nitrogen	mg/L		09/10 10/11	0.759 0.747	0.511 – 0.968 0.435 – 1.00		0.823	0.458 - 1.14

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

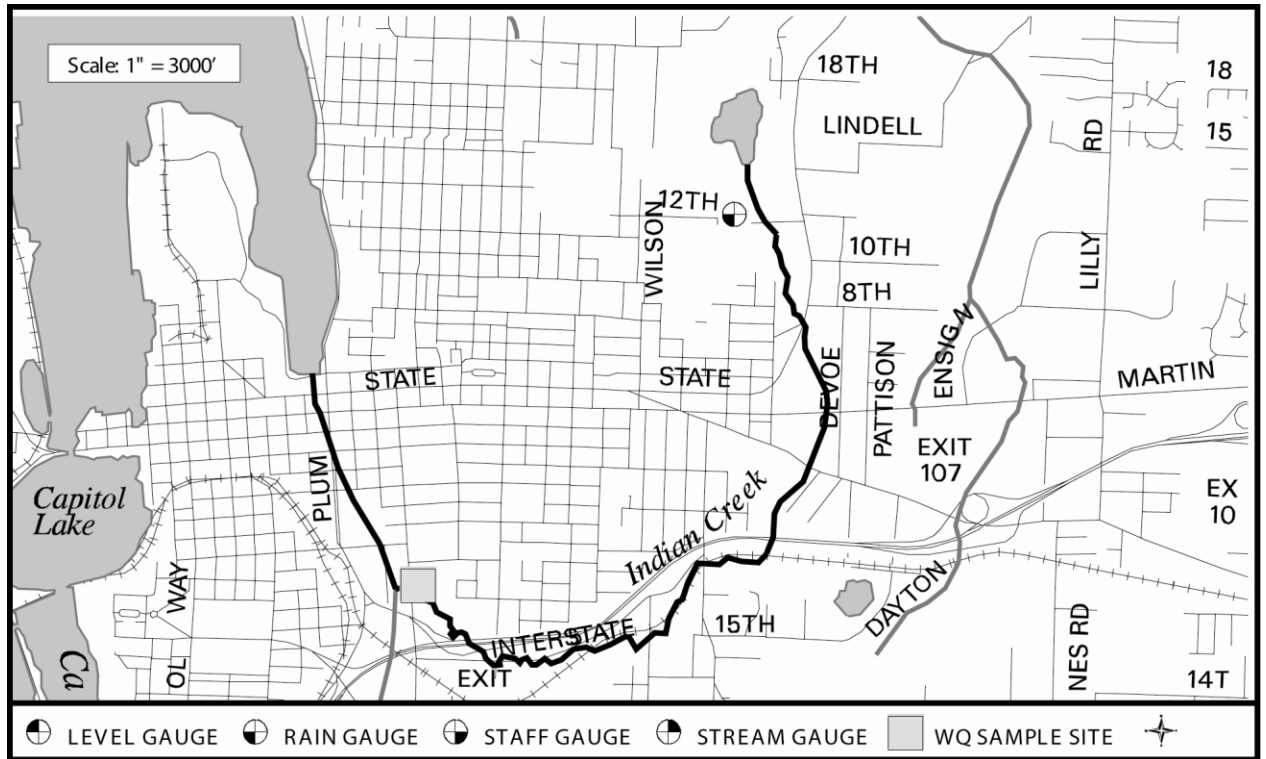
Ellis Creek @ East Bay Dr

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009	2:45:00 PM	11.47	7.3	10.05	162	0	1.6	0.51	0.054	0.710	FC reported as <5
11/16/2009	12:00:00 PM	8.92	7.1	11.47	113	225	12.6	3.72	0.077	0.511	Duplicates labeled "Priest Point"
12/15/2009	1:20:00 PM	3.07	7.0	13.19	97	820	13.7	6.16	0.077	0.758	
1/13/2010	11:45:00 AM	8.03	6.9	11.87	72	100	9.7	12.55	0.054	0.748	
2/8/2010	2:30:00 PM	7.95	7.1	11.38	100	10	3.1	3.46	0.037	0.700	
3/17/2010	1:45:00 PM	8.28	7.3	12.38	78	25	3.7	6.16	0.040	0.614	Flow measurement is estimate: Flow meter acting erratically. Duplicates labeled "Priest Point".
4/21/2010	12:05:00 PM	9.85	7.3	11.38	114	50	2.7	2.76	0.045	0.677	
5/11/2010	1:00:00 PM	9.69	7.5	11.28	107	45	2.7	1.49	0.046	0.759	
6/14/2010	4:45:00 PM	12.23	7.5	10.77	121	40	2.5	2.11	0.057	0.772	
7/13/2010	2:45:00 PM	13.62	7.6	10.89	101	40	2.8	1.02	0.070	0.968	
8/17/2010	2:10:00 PM	15.17	7.5	10.05	161	185	1.9	0.71	0.068	0.952	
9/14/2010	1:40:00 PM	12.47	7.5	10.32	161	40	1.7	0.65	0.065	0.938	

Thurston County Water Resources Monitoring Report 2010-2011

Ellis Creek @ East Bay Dr

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	11:20:00 AM	8.61	7.4	11.67	154	35	0.7	0.60	0.054	0.815	
11/17/2010	10:00:00 AM	8.74	7.2	11.51	109	35	4.1	3.16	0.056	0.578	Duplicates labeled "East Bay".
12/13/2010	1:00:00 PM	9.19	6.8	12.10	60	240	30.0	26.55	0.094	1.000	
1/11/2011	10:55:00 AM	3.89	7.3	13.54	62	20	4.0	3.10	0.039	0.738	Swoffer post cal low blow test, flow rate likely underreported.
2/14/2011	2:15:00 PM	7.27	7.2	12.03	88	90	14.0	7.88	0.064	0.561	
3/16/2011	9:45:00 AM	7.05	7.0	12.95	64	50	14.0	21.10	0.051	0.557	
4/12/2011	2:15:00 PM	9.14	7.4	12.46	94	20	4.5	3.85	0.041	0.570	
5/16/2011	3:00:00 PM	10.76	7.2	12.12	73	120	14.7	9.41	0.076	0.435	Stream unusually turbid compared to other streams.
6/13/2011	11:00:00 AM	11.63	7.5	10.74	135	120	3.3	1.60	0.057	0.819	
7/11/2011	10:45:00 AM	12.33	7.5	10.58	115	70	2.5	0.85	0.051	0.961	
8/9/2011	10:45:00 AM	12.09	7.5	10.87	110	55	2.7	0.79	0.056	0.970	
9/14/2011	3:00:00 PM	13.48	7.5	10.26	161	170	2.5	0.48	0.053	0.962	



PART OF BUDD INLET WATERSHED

LENGTH OF CREEK: Approximately 3 miles (14% piped underground)

BASIN SIZE: 1459 Acres

STREAM ORDER: 1

PRIMARY LAND USES:

Within Olympia city limits, it is urban-moderate to high density residential and commercial.

Within the county, it is rural to moderate residential intermixed with businesses.

FISHERIES RESOURCES: (From [A Catalog of Washington Streams and Salmon Utilization](#), WDOF)

None from catalog but Washington Department of Fish and Wildlife plants Coho in Indian Creek near the Boulevard Street bridge. NED (Northwest Environmental Data Base) indicates resident fish are found in the entire length of Indian Creek. Species include

coastal cutthroat, cottids, and three-spined stickleback.

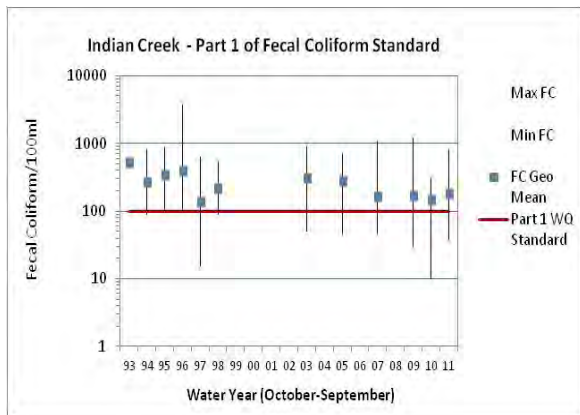
GENERAL TOPOGRAPHY:

Indian Creek originates in Bigelow Lake, a sphagnum bog lake. There are low to medium channel gradients in areas of rolling terraces and numerous small depressions. The upper portion of the creek flows in a wide flood plain with extensive streamside wetlands. Downstream reaches of the stream are confined by steeper upper banks. Numerous year round and seasonal tributaries, springs and seeps enter the creek.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

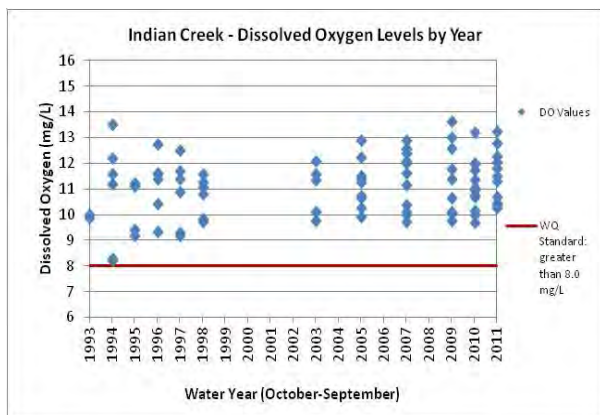
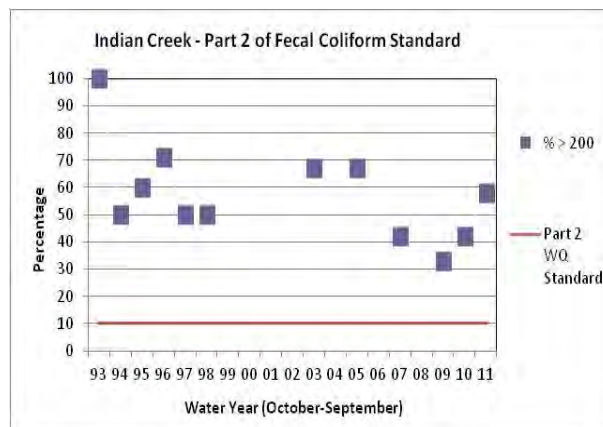
Poor - Fecal coliform concentrations are consistently high and fail both parts of the standard. Elevated metals and organics detected in creek sediments in past studies. Nitrate concentrations are high.

Indian Creek #0026

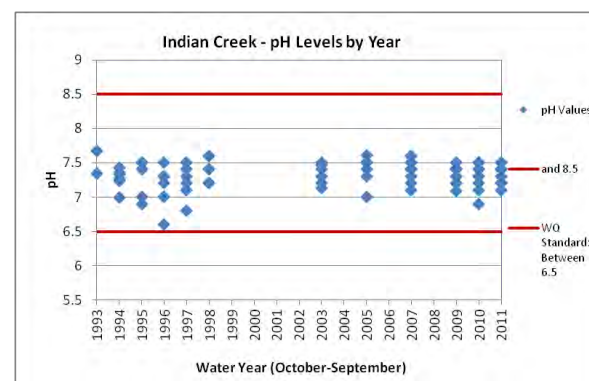


Indian Creek consistently fails both parts of the fecal coliform bacteria standard.

The water quality standard for fecal coliform bacteria has two parts: Part 1 – the geometric mean shall not exceed 100 colony forming units per 100 milliliters of sample *and*, Part 2 – no more than ten percent of the samples shall exceed 200 cfu/100 mL.



The standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been no recorded pH violations.



OTHER DATA:

City of Olympia, Stream Team,
(360) 570- 5841

Thurston County Environmental Health Division,
(360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

Discussion:

From 1993-1998, Indian Creek was monitored each water year as part of the long-term ambient monitoring program. In December 2002 sampling began again on an every-other-year basis, resulting in data for water years 2002/03, 2004/05, 2006/07, and 2008/09. Monitoring each year resumed with water year 2009/10.

The table on the next page compares the year's data with the state water quality standards. In water years 2009/10 and 2010/11, both parts of the fecal coliform state standard were violated. There was one turbidity violation in the 2009/10 water year; in November 2009 and two in the 2010/11 water year; December 2010 and January 2011. The nitrate concentrations are higher than background surface water concentrations.

Major Issues:

- Fecal coliform bacteria contamination continues to be a problem in this urban stream.
- Storm water runoff from city streets and Interstate Highway 5 discharges into the creek and contributes to water quality problems.

Funding Sources:

- Local Stormwater Utility Rate

Water Quality Summary

Conventional Parameters

Indian Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1993 – 2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		3.89 – 15.72 4.58 – 13.60			3.11 - 15.00
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		9.71 – 13.21 10.27 – 13.24	0 of 12 0 of 12		8.22 - 13.60
Conductivity	µmhos/cm		09/10 10/11	144 139	89 – 176 84 - 175		145	64 - 197
pH		6.5 - 8.5	09/10 10/11	7.4* 7.4*	6.9 – 7.5 7.1 – 7.5	0 of 12 0 of 12	7.4*	6.6 - 7.7
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	9.64 7.99	2.40 – 58.90 1.60 – 18.60	1 of 12 2 of 12	7.52	1.1 – 60.2
Fecal Coliform	colonies / 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	145** 183**	10 – 300 38 - 820	% exceeding 200	229**	15 - 3700
						42% 58%		
Total Phosphorus	mg/L		09/10 10/11	0.065 0.056	0.041 – 0.142 0.033 – 0.084		0.055	0.024 - 0.198
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.888 0.932	0.342 – 1.15 0.577 – 1.26		0.930	0.297 - 1.84

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

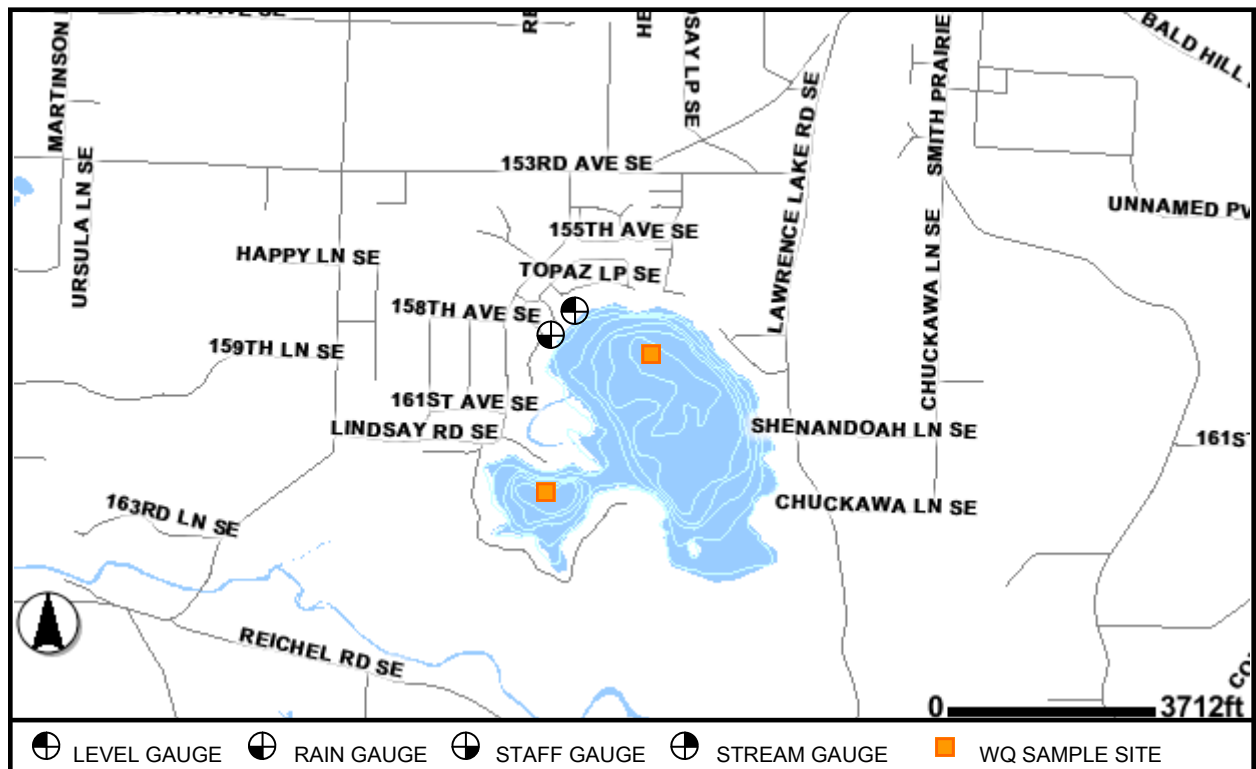
Indian Creek @ Quince Ave

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009	2:00:00 PM	12.04	7.4	10.00	166	110	2.4	1.54	0.047	0.792	
11/16/2009	12:40:00 PM	9.14	6.9	11.97	89	1300	58.9	10.16	0.142	0.342	
12/15/2009	2:45:00 PM	3.89	7.2	13.21	135	700	10.4	4.39	0.071	0.729	
1/13/2010	10:45:00 AM	7.95	7.3	12.00	113	120	5.0	5.66	0.057	0.610	
2/8/2010	1:30:00 PM	8.19	7.1	11.37	137	40	4.3	3.23	0.051	0.946	
3/17/2010	4:20:00 PM	9.95	7.4	11.76	133	10	4.6	3.57	0.051	0.845	
4/21/2010	2:45:00 PM	11.05	7.3	11.04	144	65	4.5	2.37	0.066	1.140	
5/11/2010	3:00:00 PM	10.82	7.4	10.98	149	60	5.1	1.99	0.062	1.040	
6/14/2010	1:45:00 PM	12.26	7.5	10.70	150	120	5.9	2.43	0.073	0.953	
7/13/2010	1:35:00 PM	13.30	7.5	10.79	162	455	7.3	1.38	0.068	1.150	
8/17/2010	3:50:00 PM	15.72	7.5	9.71	176	315	4.3	1.04	0.055	1.080	
9/14/2010	1:00:00 PM	12.97	7.5	10.15	174	230	3.0	1.54	0.041	1.030	

Thurston County Water Resources Monitoring Report 2010-2011

Indian Creek @ Quince Ave

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	11:40:00 AM	9.07	7.4	11.49	165	45	1.6	1.36	0.047	0.900	
11/17/2010	9:10:00 AM	9.03	7.2	11.32	138	250	12.0	2.90	0.064	0.719	
12/13/2010	4:10:00 PM	9.24	7.2	12.29	84	240	18.6	16.18	0.084	0.590	
1/11/2011	2:15:00 PM	4.58	7.3	13.24	138	38	2.8	3.28	0.033	1.060	Duplicates labeled "Quince". Bacteria and nutrient results are the average of field duplicates.
2/14/2011	1:30:00 PM	7.60	7.2	11.82	124	120	16.3	6.21	0.059	0.761	
3/16/2011	12:30:00 PM	7.64	7.1	12.78	101	40	8.4	13.62	0.049	0.664	
4/12/2011	4:30:00 PM	10.30	7.4	12.05	133	70	4.5	5.03	0.043	1.020	
5/16/2011	2:15:00 PM	10.73	7.3	12.05	120	520	5.9	8.66	0.065	0.577	
6/13/2011	10:00:00 AM	12.33	7.4	10.45	155	440	7.5	3.30	0.066	1.190	
7/11/2011	9:45:00 AM	12.97	7.5	10.39	166	630	5.3	1.98	0.058	1.230	
8/9/2011	9:45:00 AM	12.54	7.4	10.69	171	300	8.3	1.77	0.059	1.260	
9/14/2011	2:00:00 PM	13.60	7.5	10.27	175	820	4.7	1.10	0.050	1.210	



PART OF Deschutes River WATERSHED

SHORELINE LENGTH: 4.0 miles

LAKE SIZE: 330 acres

BASIN SIZE: 3.35 square miles

MEAN DEPTH: 13 feet

MAXIMUM DEPTH: 26 feet

VOLUME: 4,617 acre-feet

PRIMARY LAND USES:

The land use is primarily rural with some agriculture and undeveloped forest land.

PRIMARY LAKE USES:

Swimming, boating, and fishing

PUBLIC ACCESS:

There is a Washington Dept. of Fish and Wildlife public boat launch adjacent to undeveloped County-owned property.

There are also three privately owned community areas on the lake.

GENERAL TOPOGRAPHY:

Lawrence Lake is north of the Bald Hills, at an approximate altitude of 421 feet. It is very close to the Deschutes River. Under normal conditions the lake discharges to the river via a small stream. Under extreme flooding conditions the river water backs up into the lake.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Fair - The lake is eutrophic. Uses are sometimes impaired by excessive algae and aquatic plants.

OTHER AVAILABLE DATA:

Thurston County Environmental Health Division
(360) 867-2626 (water quality data)
www.co.thurston.wa.us/health/ehswat/swater.htm

Thurston County Resource Stewardship Dept,
Water Resources Program, (360) 754-4681 or
www.co.thurston.wa.us/stormwater/lakes/lakes-home.html

GENERAL DISCUSSION:

Lawrence Lake is located in the Deschutes River Watershed approximately 10 miles south of Yelm. The lake has two distinct basins, a large basin on the east side and a smaller basin to the west. It has no surface water inlet. There is a small outlet channel that discharges out of the west basin through a control structure across the floodplain to the Deschutes River. The lake is relatively shallow with an average depth of about 12.5 feet. The lake is in continuity with the shallow groundwater.

The lake is nutrient-rich and has extensive plant and algae growth. The lake has had an active lake management district since 1986, which supports aquatic weed control and fisheries management activities. In the early 1990s a lake restoration study was funded by a state water quality grant and the community-supported lake management district. Some of the recommendations from the study were incorporated into an Integrated Aquatic Vegetation Management Plan, which is currently being implemented.

The ambient water quality monitoring in 2011 consisted of monthly sampling May through October at monitoring sites located in the deepest areas of the two lake basins, referred to as the “big basin” and “west basin”. The field parameters included temperature, dissolved oxygen, pH, conductivity, and secchi disk readings. Water samples were collected near the lake surface and near the lake bottom, and were analyzed for total phosphorus and total nitrogen. Composite samples from the epilimnion (warm surface layer) or photic zone were collected and analyzed for chlorophyll *a* and algae identification. The data from the monitoring program is located at the end of this report.

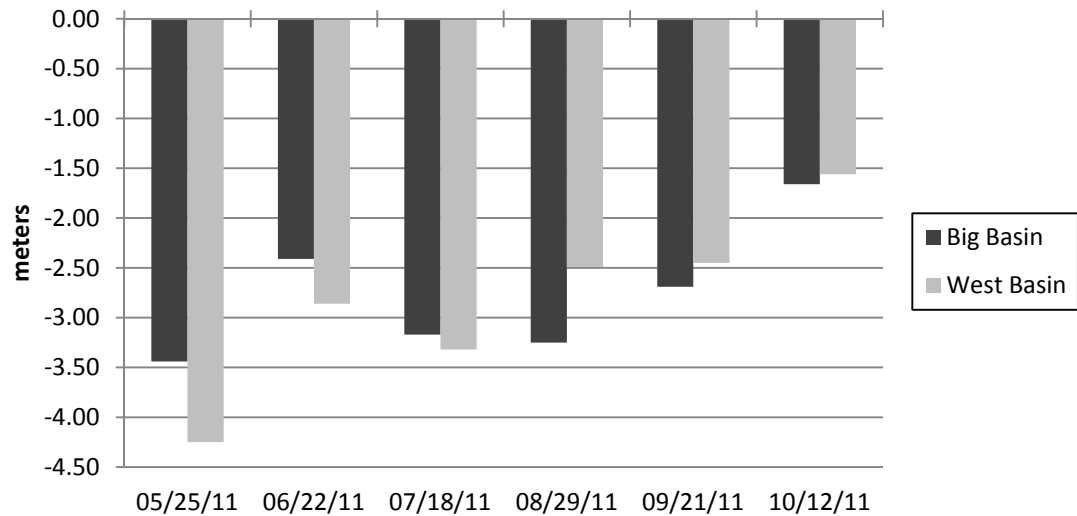
Field Parameters

Temperature, dissolved oxygen, pH, and conductivity profile graphs for each month are shown on pages 8 and 9. The term “thermal stratification” means that there are two distinct layers of water in the lake, a warm upper layer and a colder bottom layer. The monthly graphs show that the lake was stratified from May through August in both basins. In July and August the lake was about seven degrees warmer at the surface than at the bottom. During the period when the lake was stratified the dissolved oxygen concentrations at the bottom were near zero in both basins. Under those anoxic, or “no oxygen” conditions, phosphorus is released from the sediments into the water column in a soluble form readily used by algae cells. The results from the bottom samples show higher phosphorus concentrations at the lake bottom water than at the surface. The samples results are included in data tables on pages 10 and 11.

Water Clarity

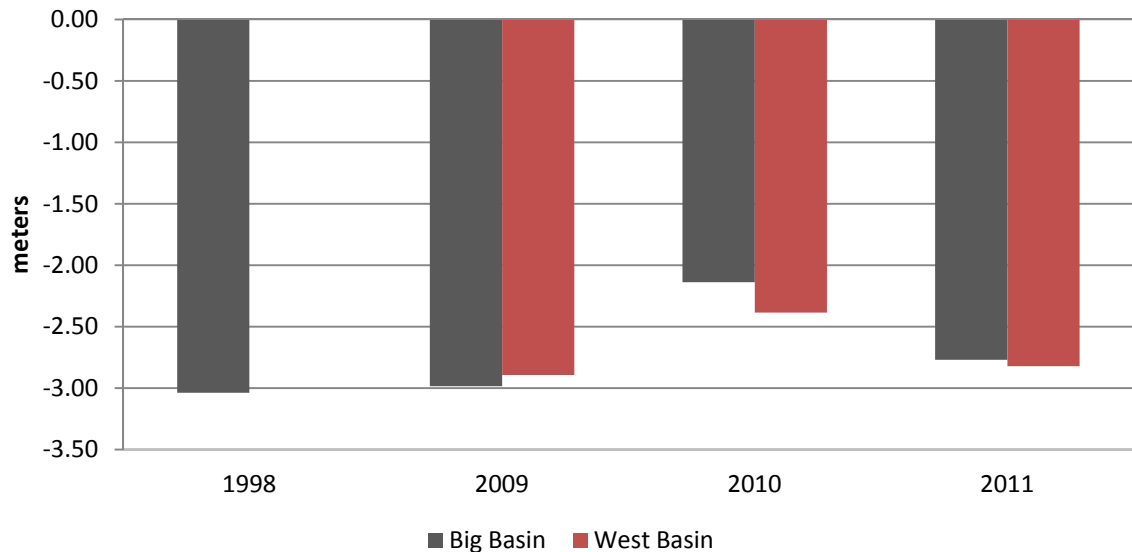
Water clarity is measured with a device called a secchi disk. The water clarity in the big basin ranged from 1.7 meters (5.4 feet) in October to 3.4 meters (11 feet) in May. The big basin’s season average was 2.8 meters (9 feet). The water clarity in the west basin ranged from 1.6 meters (5.1 feet) in October to 4.2 meters (13.8 feet) in May. The season average in the west basin was 2.8 meters (9.2 feet). A graph on the following page shows the monthly secchi disk readings in each basin. The graph shows that the water clarity in both basins followed a similar pattern throughout the summer, and was generally similar. The clarity differed the most between the two basins in May with 4.2 meters in the west basin but only 3.4 meters in the big basin.

2011 Monthly Secchi Readings



This year the algae growth increased in the September and October, as measured by chlorophyll *a*, and caused a decrease the water clarity during those months. Overall, the water clarity in 2011 was better than it was in 2010. The graph below shows the annual average water clarity for the period of record.

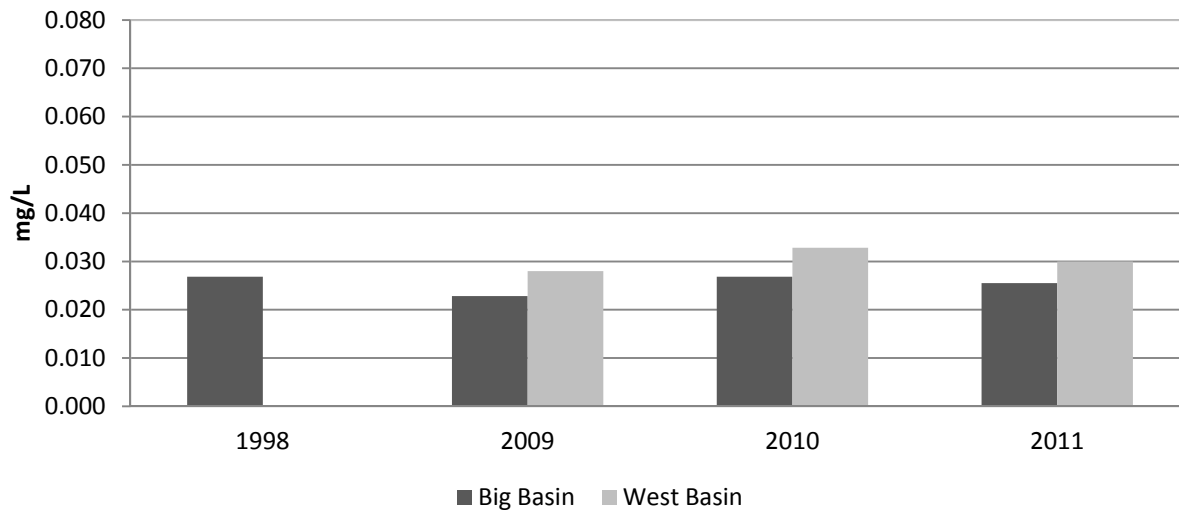
Lawrence Lake Annual Average Secchi Disk



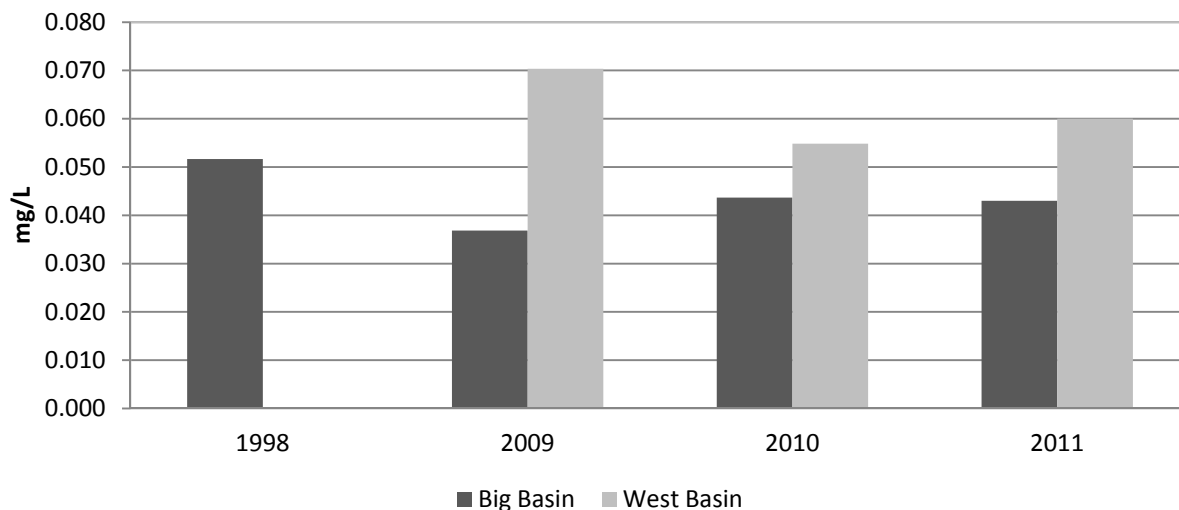
Total Phosphorus

Generally, lakes in the Puget Sound region with summer average surface total phosphorus concentrations greater than 0.030 mg/l experience undesirable algae growth which interferes with recreational uses of the lake (USGS Water Supply Paper 2240). The state action level established in WAC 173-201A, "Water Quality Standards for Surface Water of the State of Washington" is 0.020 mg/L total phosphorus at the lake surface. The 2011 average surface total phosphorus concentration in the big basin was 0.026 milligrams per liter (mg/l) and 0.030 mg/l in the west basin. In the big basin in June, September, and October phosphorus was above the state action level. In the west basin in June, August, September, and October, phosphorus was above the state action level. The graphs below compare the phosphorus concentrations in each basin at the surface and at the bottom. The west basin appears to have high slightly higher phosphorus levels than the big basin

Lawrence Lake Total Phosphorus Annual Average at SURFACE



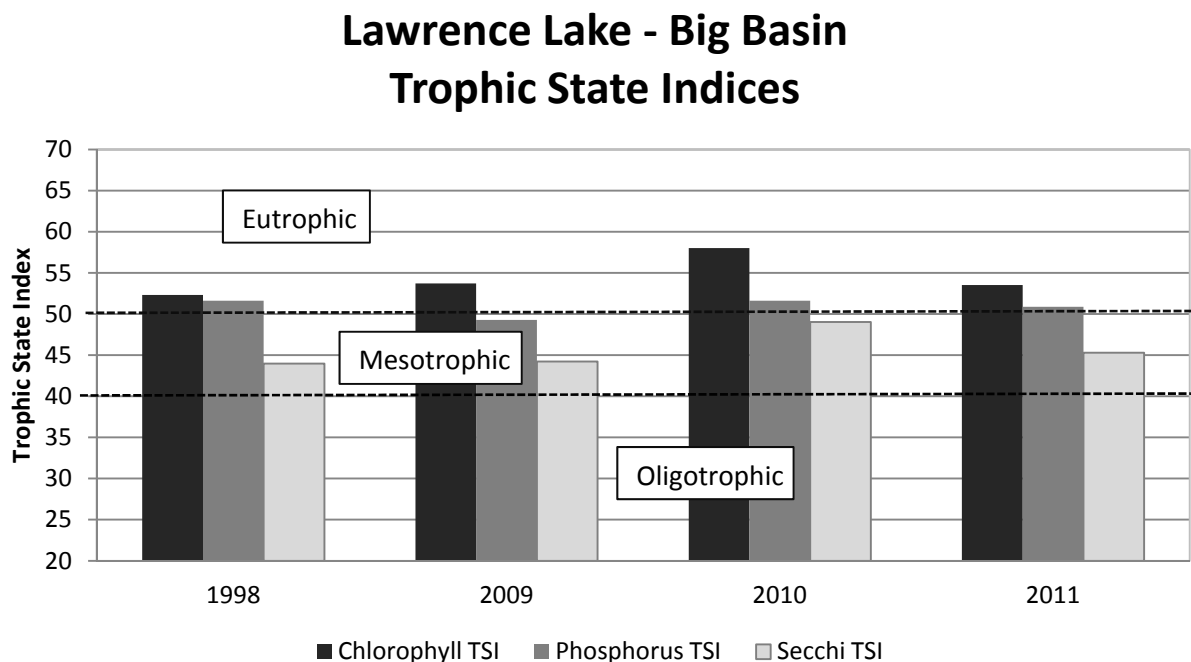
Lawrence Lake Total Phosphorus Annual Average at BOTTOM



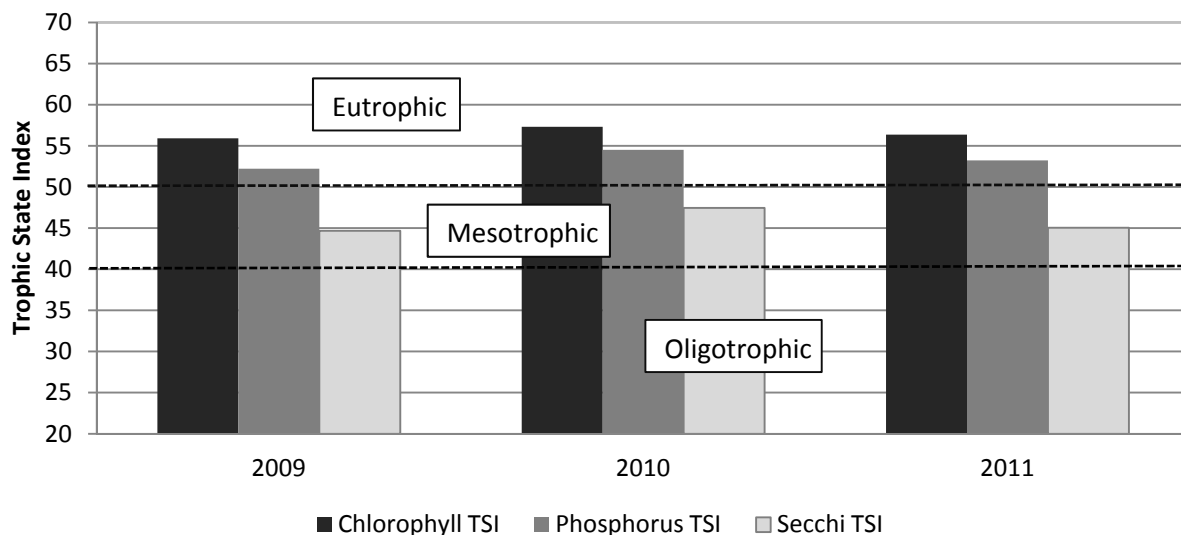
Trophic State Indices

The Carlson Trophic State Indices (TSI) are used to express the degree of productivity of a lake. Average summer total phosphorus concentrations, chlorophyll *a* concentrations, and secchi disk transparency are each used to calculate a TSI for the lake. A TSI of 0 to 40 indicates an oligotrophic, or low productivity, lake. This is generally perceived as a lake with good water quality. A TSI of 41 to 50 indicates a mesotrophic, or moderately productive, lake. A TSI of greater than 50 indicates a eutrophic, or highly productive lake. A eutrophic lake is generally considered to have poor water quality and undesirable characteristics, such as excess plant and algae growth that interferes with recreational uses.

The 2011 TSIs for the big basin for total phosphorus, chlorophyll *a*, and secchi disk are 51, 54, and 45, respectively. The west basin TSIs for total phosphorus, chlorophyll *a*, and secchi disk are 53, 56, and 45, respectively. Two of the three indices for both basins are above 50 indicating eutrophic, or highly productive, conditions. The Trophic State Indices for 2011 and previous years are graphed below and on page 6. The indices are slightly higher for the west basin than for the big basin indicating slightly higher nutrient concentrations and algae production in that basin. At this time, there is insufficient data to determine trends. However, the phosphorus and secchi TSI's calculated from 1998 data in the big basin are within the same range as the recent TSIs. The chlorophyll TSI from 1998 is slightly lower than those calculated in recent years, but is still in the "eutrophic" category.



Lawrence Lake - West Basin Trophic State Indices



Algae

The monitoring program includes identification of algae types present in the lake. The 2011 data can be found at the end of this chapter. The common algae types present in Lawrence Lake include diatoms, green, yellow, dinoflagellates and blue-green algae. However, it is the blue-green algae that typically cause nuisance “blooms” which can impair recreational activities. Dominance by blue-green algae is a sign of nutrient-rich conditions.

Some species of blue-green algae can produce toxins that can cause illness, or even death, in people, pets, and wildlife if ingested. Pets are particularly vulnerable to poisoning from toxic algae blooms due to their smaller body weight and their tendency to ingest higher doses by drinking lake water and licking their fur after swimming. In recent years there has been an increase in documented toxic blue-green algae blooms occurring in Washington State lakes.

Because toxicity cannot be determined through visual observations, Thurston County Environmental Health began using screening test kits in 2009 to test the water for the presence of the most common algae toxin, microcystin. When screening results indicates the presence of the toxin, samples are sent to a laboratory confirm the presence and quantify the amount. The laboratory services are sponsored by Washington Department of Ecology. Although toxin testing is now possible, lake residents and users should always observe lake conditions and avoid contact with lake water when an algae bloom is occurring.

A toxin-producing algae bloom that began in 2010 persisted into 2011. Samples collected in January and February 2011 had microcystin toxin above the state recreational guidance limit of 6 µg/L. Samples in March showed the toxin had decreased to less than 1 µg/L, however the algae bloom continued to be present. The health advisory was finally lifted on June 2.

During the 2011 summer season the algae bloom was not as severe as in 2010. Results from toxin screening in May and October 2011 showed low levels of toxin. Laboratory analysis of a May sample confirmed that the toxin was present but at levels below the state recreational advisory. No algae toxin health advisory was issued for the 2011 summer season.

More information about blue-green algae and swimming safety information is available through the Thurston County website: www.co.thurston.wa.us/health/ehadm/swimming/swimming_index.html

Major Issues:

- The Lawrence Lake Steering Committee is implementing the Lake Lawrence Integrated Aquatic Vegetation Management Plan. Activities included the following:
 - Pursue a multi-faceted strategy to eradicate noxious aquatic plants, reduce native and non-native nuisance aquatic plants to improve recreational and aesthetic conditions, while maintaining fish and wildlife habitat.
 - Provide public education opportunities to the lake area residents, focusing on nutrient reduction, maintaining and improving the lake's water quality.
- The Washington State Department of Ecology is conducting a total maximum daily load study in the Deschutes River/Budd Inlet system. Discharge limits for pollution sources will be established to bring the streams, river, and Budd Inlet into compliance with the water quality standards. The draft technical report was released in November 2008. A stakeholder committee was convened in 2009 and has begun development of a water cleanup plan.
- 2010 was the second time that a toxic blue-green algae bloom was documented in Lawrence Lake. The first documented toxic algae bloom occurred in 2004.

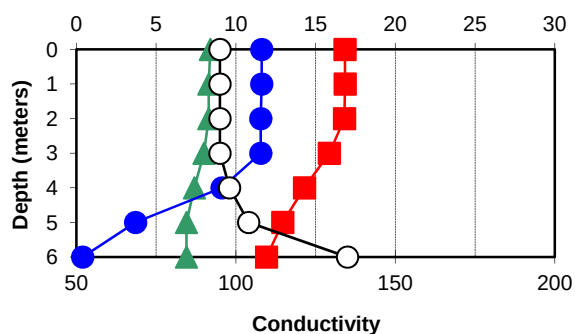
Funding Sources:

Thurston County's Water Resources Division funded water quality monitoring in 2011.

LAWRENCE LAKE – BIG BASIN

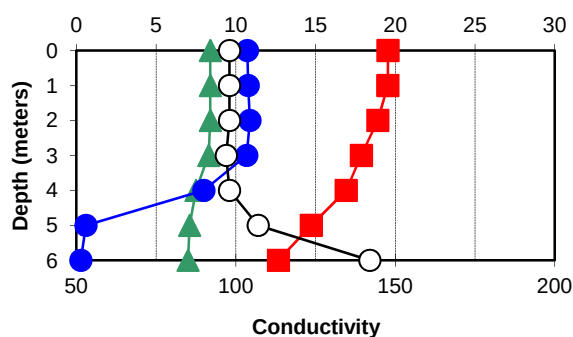
May 25, 2011

Temperature, pH, Dissolved Oxygen



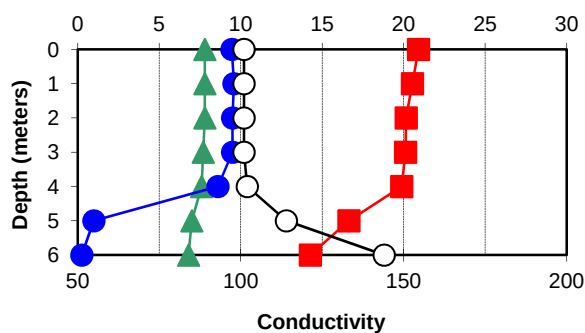
June 22, 2011

Temperature, pH, Dissolved Oxygen



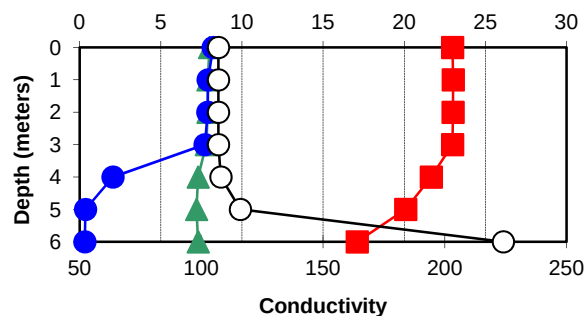
July 18, 2011

Temperature, pH, Dissolved Oxygen



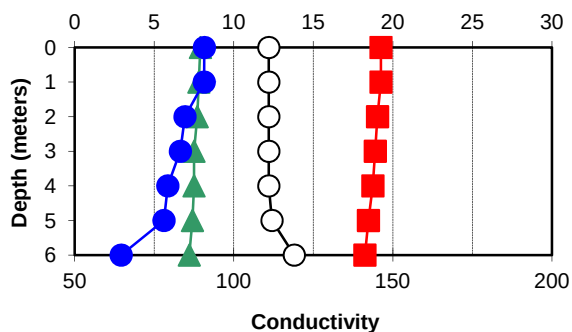
August 29, 2011

Temperature, pH, Dissolved Oxygen



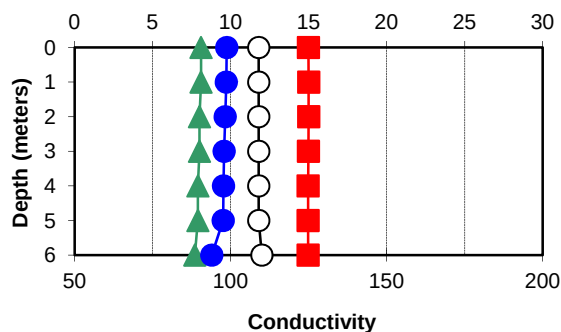
September 21, 2011

Temperature, pH, Dissolved Oxygen



October 12, 2011

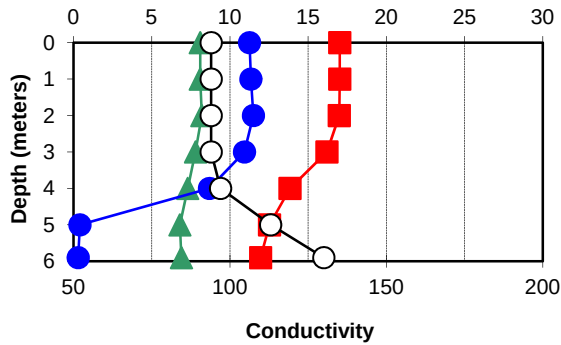
Temperature, pH, Dissolved Oxygen



LAWRENCE LAKE – WEST BASIN

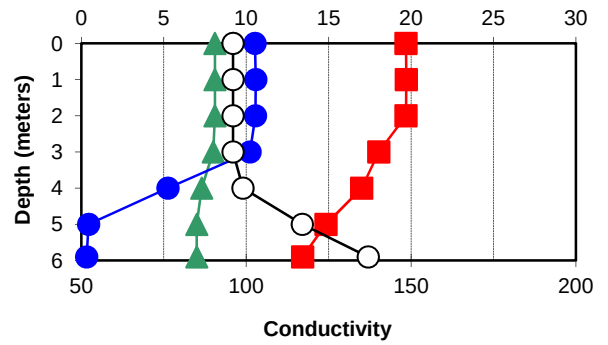
May 25, 2011

Temperature, pH, Dissolved Oxygen



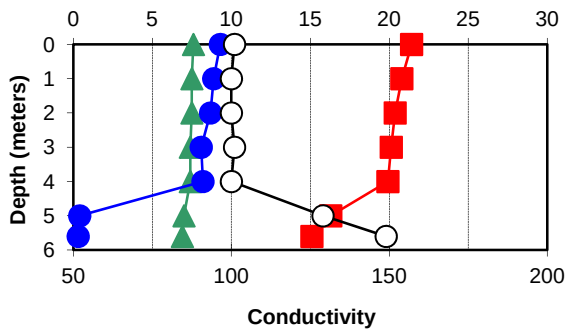
June 22, 2011

Temperature, pH, Dissolved Oxygen



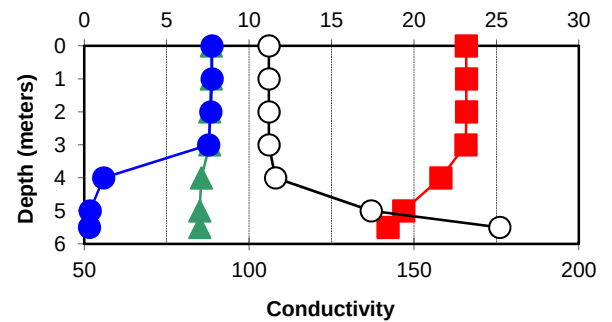
July 18, 2011

Temperature, pH, Dissolved Oxygen



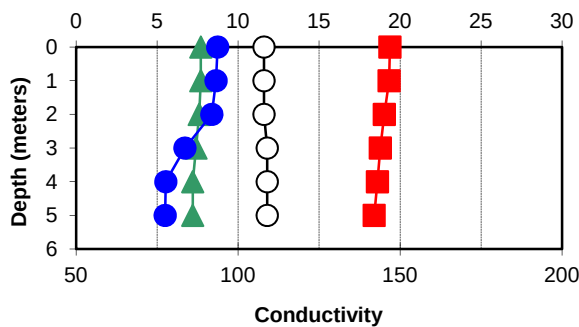
August 29, 2011

Temperature, pH, Dissolved Oxygen



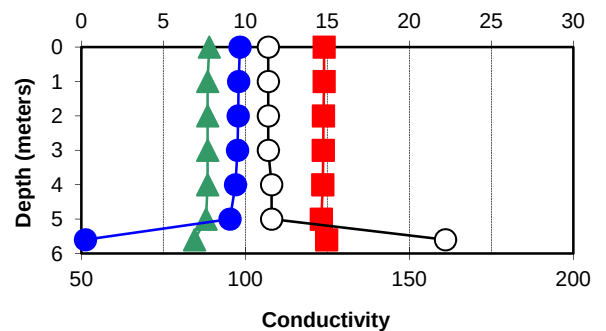
September 21, 2011

Temperature, pH, Dissolved Oxygen



October 12, 2011

Temperature, pH, Dissolved Oxygen



Thurston County Water Resources Annual Report - 2011

Lawrence Lake @ Big Basin

Site ID# DESLAL020

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water Color	Lake Notes
05/25/2011	11:00:00 AM	6.3	5.5	0.019	0.052	0.408	0.411	3.44	6.7	0.4	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
06/22/2011	11:00:00 AM	6.4	5.5	0.036	0.048	0.404	0.432	2.41	5.3	0.05	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M. Phaeo a was < detection at 0.1ug/L.
07/18/2011	2:45:00 PM	6.3	5.5	0.016	0.033	0.446	0.524	3.17	5.3	1.4	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
08/29/2011	11:00:00 AM	6	5.5	0.018	0.059	0.441	0.674	3.25	6.9	0.5	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
09/21/2011	10:00:00 AM	6	5.0	0.033	0.027	0.613	0.710	2.69	13	0.7	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
10/12/2011	10:30:00 AM	6	5.0	0.031	0.043	0.678	0.688	1.66	25	3.7	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.

Summary for 'Site Description' = Lawrence Lake @ Big Basin (6 detail records)

Averages	Sur TP	0.026
	Secchi	2.77
	Chl a	10.4

Thurston County Water Resources Annual Report - 2011

Lawrence Lake @ West Basin

Site ID# DESLAL030

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water Color	Lake Notes
05/25/2011	11:30:00 AM	5.9	5.0	0.017	0.040	0.384	0.407	4.25	5.3	0.05	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M. Phaeo a was < detection at 0.1ug/L.
06/22/2011	11:30:00 AM	5.9	5.0	0.029	0.069	0.372	0.449	2.86	5.3	0.3	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
07/18/2011	3:15:00 PM	5.6	5.0	0.018	0.047	0.461	0.578	3.32	5.3	1	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
08/29/2011	11:45:00 AM	5.5	5.0	0.029	0.070	0.488	0.771	2.49	5.3	2.1	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
09/21/2011	10:30:00 AM	5.4	4.5	0.037	0.071	0.612	0.652	2.45	21	1.1	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
10/12/2011	11:00:00 AM	5.6	5.0	0.050	0.063	0.632	0.643	1.56	41	4.3	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.

Summary for 'Site Description' = Lawrence Lake @ West Basin (6 detail records)

Averages	Sur TP	0.030
	Secchi	2.82
	Chl a	13.9

Algae data: Lawrence Lake @ Big Basin

05/25/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Fragilaria species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Ankyra species	☐
GR	Crucigenia species	☐
GR	Oocystis species	☐
GR	Pandorina species	☐
GR	Scenedesmus species	☐
GR	Sphaerocystis species	☐
GR	Spinocosmarium species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

06/22/2011

BG	Anabaena species	☐
BG	Aphanizomenon species	☐
BG	Lyngbya species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Cocconeis pediculus	☐
DT	Fragilaria species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Closterium species	☐
GR	Pandorina species	☐
YL	Dinobryon species	☐

07/18/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DT	Asterionella species	☐
EU	Trachelomonas species	☐
GR	Schroederia species	☐
YL	Dinobryon species	☐
YL	Mallomonas species	☐

08/29/2011

BG	Anacystis species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Fragilaria species	☐
GR	Botryococcus species	☐
GR	Sphaerocystis species	☐
YL	Dinobryon species	☐

09/21/2011

Type	Description	Dominant in Sample
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
BG	Chroococcus species	☐
CP	Cryptomonas species	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Fragilaria species	☐
EU	Trachelomonas species	☐
GR	Ankyra species	☐
GR	Cosmarium species	☐
GR	Elakatothrix species	☐
GR	Oocystis species	☐
GR	Scenedesmus species	☐
GR	Sphaerocystis species	☐
YL	Dinobryon species	☐
YL	Synura species	☐

10/12/2011

BG	Anabaena species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Aulacoseira species	☐
DT	Fragilaria species	☐
EU	Trachelomonas species	☐
GR	Botryococcus species	☐
GR	Closterium species	☐
GR	Oocystis species	☐
GR	Sphaerocystis species	☐
GR	Staurastrum species	☐
YL	Chrysomonad species	☐
YL	Dinobryon species	☐
YL	Mallomonas species	☐

Algae data: Lawrence Lake @West Basin

05/25/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Aphanizomenon species	☐
BG	Chroococcus species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Fragilaria species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Botryococcus species	☐
GR	Elakatothrix species	☐
GR	Eutetramorus globosus	☐
GR	Gonium species	☐
GR	Oocystis species	☐
GR	Pandorina species	☐
GR	Sphaerocystis species	☐
GR	Spinocosmarium species	☐
GR	Staurastrum species	☐

06/22/2011

BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Pediastrum species	☐
GR	Sphaerocystis species	☐
YL	Dinobryon species	☐

07/18/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DT	Asterionella species	☐
DT	Diatoms species	☐
DT	Fragilaria species	☐
EU	Trachelomonas species	☐
GR	Schroederia species	☐
YL	Dinobryon species	☐
YL	Mallomonas species	☐

08/29/2011

BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Fragilaria species	☐
EU	Euglena species	☐
EU	Trachelomonas species	☐
GR	Botryococcus species	☐
GR	Closterium species	☐
GR	Elakatothrix species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

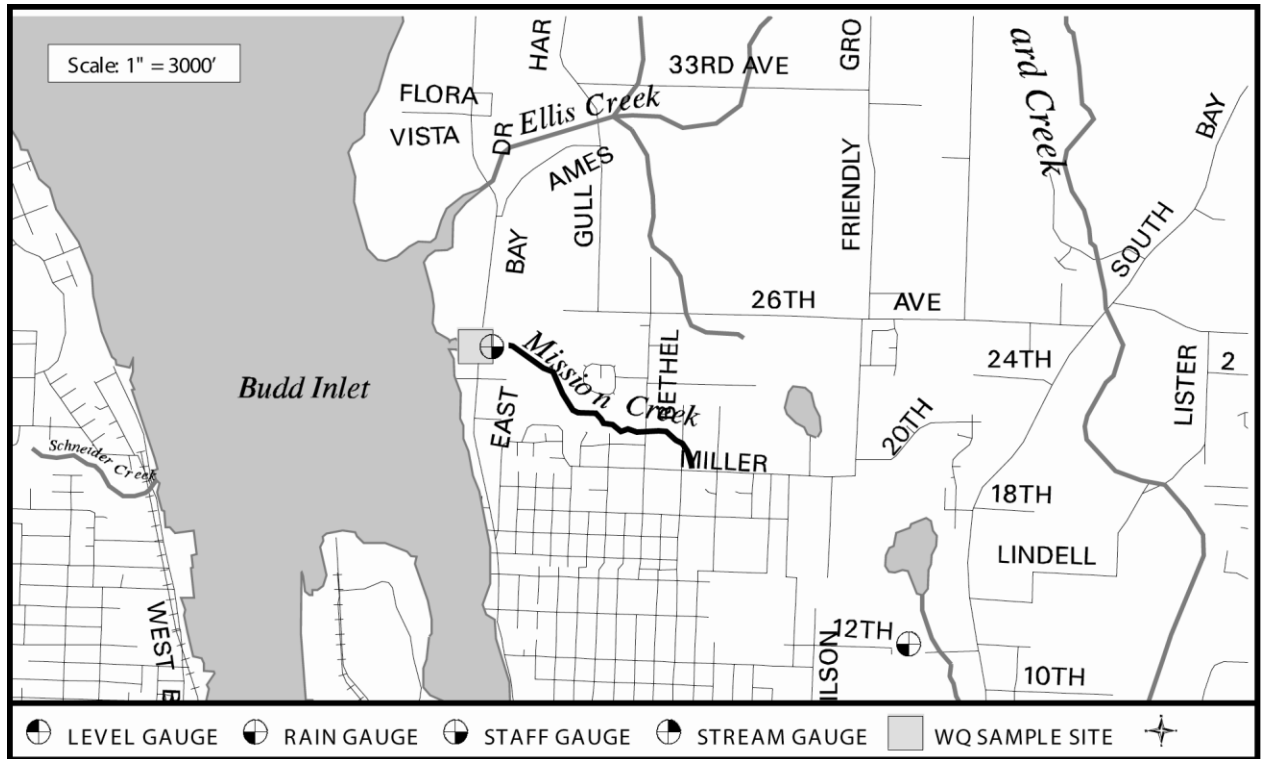
09/21/2011

Type	Description	Dominant in Sample
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonas species	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
EU	Trachelomonas species	☐
GR	Ankyra species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐
YL	Synura species	☐

10/12/2011

BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DT	Asterionella species	☐
DT	Fragilaria species	☐
EU	Euglena species	☐
EU	Trachelomonas species	☐
GR	Botryococcus species	☐
GR	Scenedesmus species	☐
YL	Dinobryon species	☐
YL	Synura species	☐

Key: BG = Blue green EU = Euglenophyte
CP = Cryptophyte GR = Green
DF = Dinoflagellate YL = Yellow
DT = Diatom



PART OF BUDD INLET WATERSHED

LENGTH OF RIVER: 1.5 miles

BASIN SIZE: 360 square miles

STREAM ORDER: 1

PRIMARY LAND USES:

Residential
Forest cover, public parks

FISHERIES RESOURCES: (From A Catalog of Washington Steams and Salmon Utilization, WDOF)

Coho, Chum

GENERAL TOPOGRAPHY:

The creek runs through a large relatively flat area at 180 feet elevation at the top of the ridge above East Bay Drive. It originates in a wetland in the southern part of the basin and flows northwest to its mouth at the south boundary of Priest Point Park.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

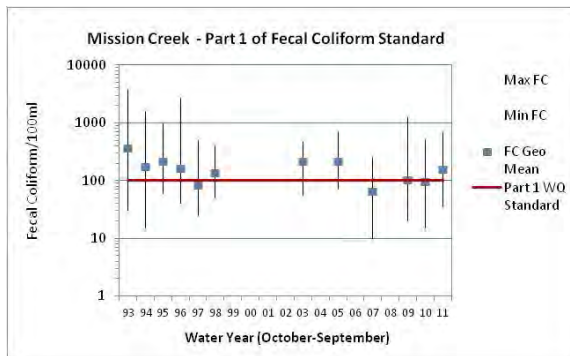
Fair - Failed both parts of the fecal coliform standard. Nutrients are elevated, particularly nitrates.

OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

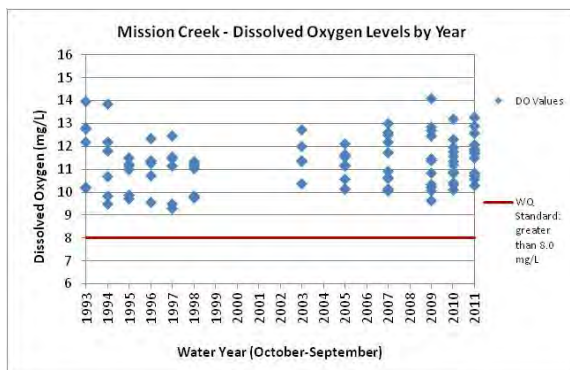
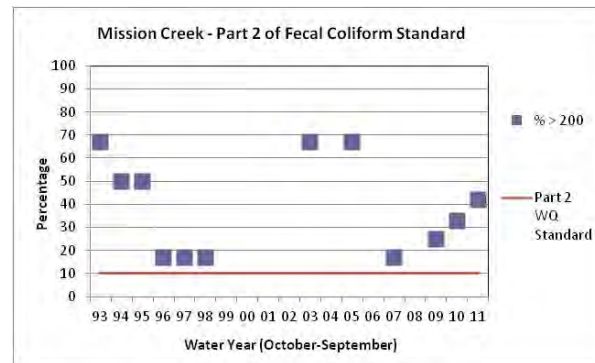
City of Olympia, Stream Team, (360) 570-5841

Mission Creek #0025



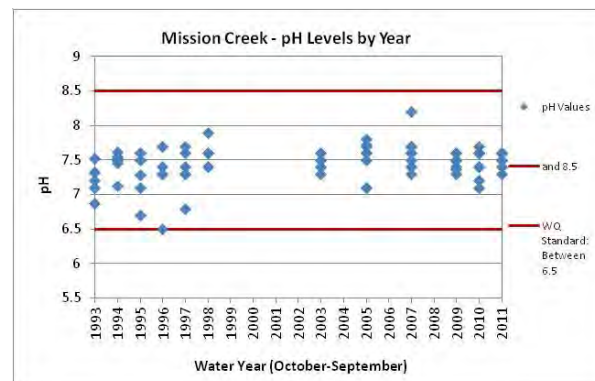
Mission Creek has failed both parts of the fecal coliform standard every year it was sampled except for 1997, 2007 and 2009 when only Part 2 was violated. It has failed Part 2 every year it was sampled.

The water quality standard for fecal coliform bacteria has two parts: part 1 - the geometric mean shall not exceed 100 colony forming units per 100 milliliters of sample *and*, part 2 - no more than ten percent of the samples shall exceed 200 cfu/100 mL.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. There have been no recorded dissolved oxygen violations.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been no violations of the pH standard.



Discussion:

In the past, Mission Creek was monitored as part of the Budd/Deschutes Water Quality Study, 1993. The creek was found to contain one of the highest loadings of fecal coliform bacteria to Budd Inlet of all tributaries to Budd Inlet. This creek was intensively monitored during storms. The intensive monitoring revealed that there were excessively high levels of bacterial contamination throughout the creek system and that stormwater was the major source of bacterial contamination to the creek. A septic system survey done as a follow-up to the intensive monitoring did not identify major septic system failures that would explain the high levels of bacteria in the creek.

Between water years 1993 and 1998, monitoring of Mission Creek was conducted as part of the ambient monitoring program. In December 2002 sampling began again on an every-other-year basis, resulting in data for water years 2002/03, 2004/05, 2006/07, and 2008/09. Monitoring every year has resumed as of 2009/10.

The table on the next page and the graphs on the previous page compare the year's data with state water quality standards. In water years 2009/10 and 2010/11, the creek met temperature, pH, dissolved oxygen, and turbidity standards. In 2009/10 it failed part 2 of the fecal coliform bacteria standard and failed both parts in 2010/11. Nutrients, particularly nitrates, are also elevated in this creek.

Major Issues:

- High levels of bacterial contamination throughout the creek system, including stormwater discharges.
- The watershed has potential for future development which may further impact water quality.

Funding Sources:

- Local stormwater utility rate

Water Quality Summary

Conventional Parameters

Mission Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		3.29 – 15.07 4.25 – 13.60			2.33 – 15.41
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		10.13 – 13.20 10.32 – 13.29	0 of 12 0 of 12		9.29 – 14.1
Conductivity	µmhos/cm		09/10 10/11	124 123	71 – 143 83 - 144		116	53 – 145
pH		6.5 - 8.5	09/10 10/11	7.5* 7.6*	7.1 – 7.7 7.3 – 7.6	0 of 12 0 of 12	7.5*	6.5 – 8.2
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	3.80 3.55	1.5 – 15.0 0.70 – 11.30	0 of 12 0 of 12	10.01	0.5 - 456
Fecal Coliform	colonies / 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	96** 157**	15 – 512 35 - 680	% exceeding 200	141**	10 - 3844
						33% 42%		
Total Phosphorus	mg/L		09/10 10/11	0.088 0.074	0.058 – 0.120 0.039 – 0.125		0.092	0.015 - 1.12
Nitrate Nitrite- nitrogen	mg/L		09/10 10/11	1.156 1.284	0.328 – 1.470 0.940 – 1.750		1.227	0.532 - 3.01

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

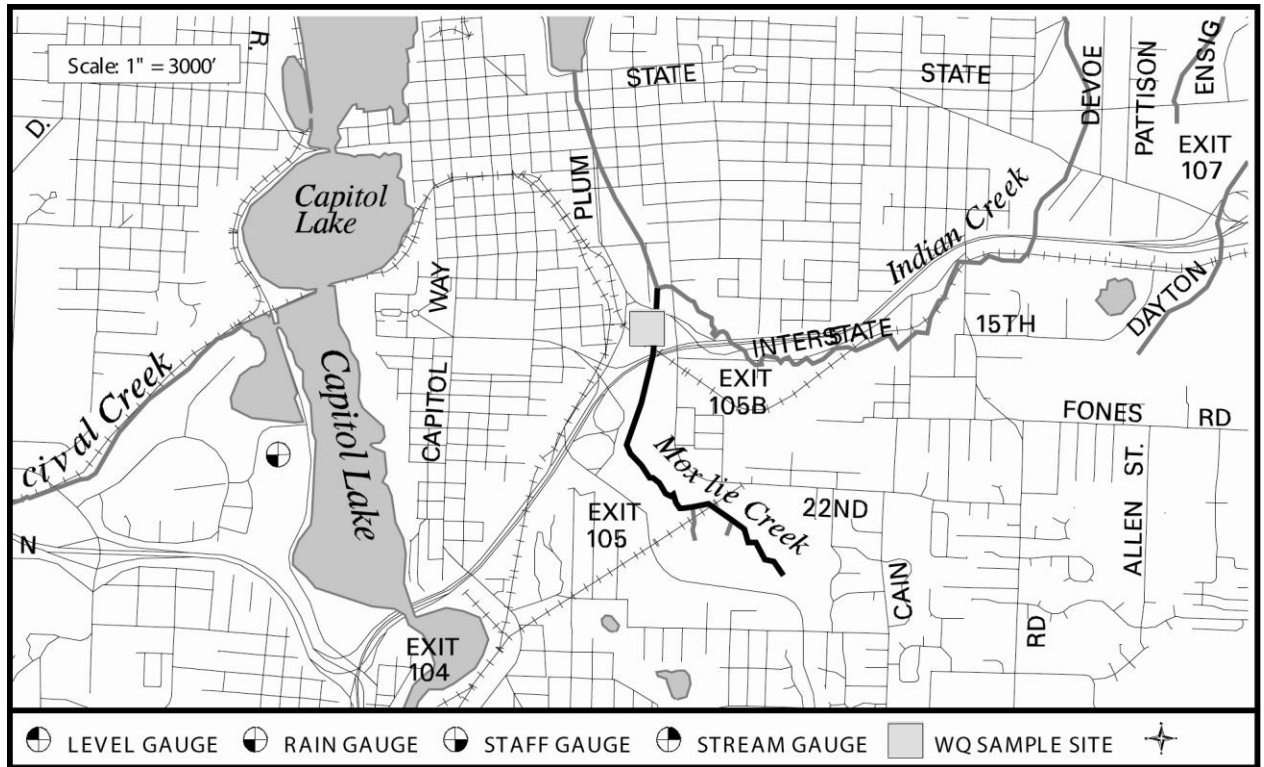
Mission Creek @ East Bay Drive

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009	2:30:00 PM	11.66	7.4	10.35	143	45	1.9	0.64	0.101	0.819	
11/16/2009	11:45:00 AM	9.08	7.2	11.97	71	190	15.0	2.81	0.119	0.328	
12/15/2009	1:00:00 PM	3.29	7.4	13.20	112	510	7.8	2.22	0.091	0.867	
1/13/2010	11:20:00 AM	8.47	7.1	11.77	100	40	3.8	1.90	0.058	1.210	
2/8/2010	1:45:00 PM	8.12	7.4	11.57	124	50	2.4	1.25	0.066	1.290	
3/17/2010	1:25:00 PM	8.26	7.6	12.34	120	55	2.7	1.35	0.061	1.160	
4/21/2010	11:45:00 AM	9.83	7.4	11.37	129	35	2.0	0.96	0.071	1.420	
5/11/2010	12:35:00 PM	9.82	7.6	11.20	131	15	2.3	0.82	0.075	1.310	Did not capture small seep on right bank.
6/14/2010	4:15:00 PM	11.87	7.6	10.85	137	115	1.5	0.73	0.081	1.340	
7/13/2010	2:20:00 PM	13.59	7.7	10.89	140	205	2.0	0.38	0.094	1.430	
8/17/2010	1:45:00 PM	15.07	7.6	10.13	142	205	2.3	0.47	0.120	1.470	
9/14/2010	1:15:00 PM	12.66	7.6	10.43	143	390	1.9	0.34	0.119	1.230	

Thurston County Water Resources Monitoring Report 2010-2011

Mission Creek @ East Bay Drive

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	11:00:00 AM	8.88	7.6	11.70	140	165	0.7	0.35	0.078	1.160	
11/17/2010	9:40:00 AM	8.83	7.5	11.51	129	210	5.3	1.19	0.099	0.986	
12/13/2010	12:45:00 PM	9.35	7.3	11.88	92	85	11.3	3.54	0.063	1.750	
1/11/2011	10:25:00 AM	4.25	7.5	13.29	125	50	1.8	1.10	0.045	1.370	Swoffer post cal low blow test, flow rate likely underreported.
2/14/2011	1:50:00 PM	7.81	7.4	11.83	105	170	4.8	1.98	0.056	0.972	Duplicates labeled "Priest Point".
3/16/2011	9:30:00 AM	7.04	7.4	12.90	83	110	5.9	4.33	0.039	0.979	
4/12/2011	1:50:00 PM	8.82	7.6	12.60	121	35	1.7	1.42	0.047	1.260	
5/16/2011	2:45:00 PM	10.66	7.6	12.09	110	40	2.5	1.89	0.058	0.940	
6/13/2011	10:30:00 AM	11.65	7.6	10.74	136	410	2.4	0.82	0.084	1.750	Sampled manhole on road above creek. FC<5.
7/11/2011	10:20:00 AM	12.42	7.6	10.58	142	680	2.1	0.62	0.097	1.440	
8/9/2011	10:15:00 AM	12.23	7.6	10.85	143	620	1.9	0.46	0.099	1.450	
9/14/2011	2:45:00 PM	13.60	7.6	10.32	144	310	2.2	0.40	0.125	1.350	



PART OF BUDD INLET WATERSHED

LENGTH OF CREEK: Approximately 1.8 miles (36% is piped underground)

BASIN SIZE: 1391 Acres

STREAM ORDER: 1

PRIMARY LAND USES:

Urban City
Urban residential
Public parks (heavily forested park)
Suburban residential

FISHERIES RESOURCES:

Olympia Stream Team has sighted cut throat trout, chinook and coho in Moxlie Creek. There was some limited numbers of Coho juveniles planted in the creek in Watershed Park.

GENERAL TOPOGRAPHY:

The stream originates at an artesian spring in Olympia's Watershed Park, has low to medium channel gradients, and is located in

areas of rolling terraces with numerous small depressions. Upper banks are deeply incised with slopes that commonly exceed 30%. The adjacent upland terrace in the southern portion of the basin has numerous glacial depressions commonly called kettles or potholes. Surface water in this portion of the basin typically drains to the kettles rather than to Moxlie Creek. Many small springs and tributaries enter the creek at various locations. Indian Creek flows into Moxlie Creek near Plum Street and Henderson Boulevard. The creek flows through downtown Olympia in a 72 inch culvert and discharges into East Bay in Budd Inlet. The creek is tidally influenced throughout most of the culverted segment.

GENERAL WATER QUALITY:

(Excellent, Good, Fair, Poor)

Poor - Failed both parts of the fecal coliform water quality standard; total phosphorus and ammonia levels are moderately high. The creek is heavily impacted by urban land uses.

Moxlie Creek #0027

OTHER DATA:

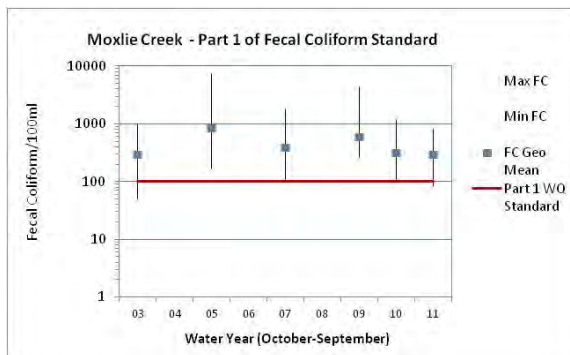
City of Olympia, Stream Team,
(360) 570-5841.

Thurston County Environmental Health
Division, (360) 867-2626 or
www.co.thurston.wa.us/health/ehswat/swater.html

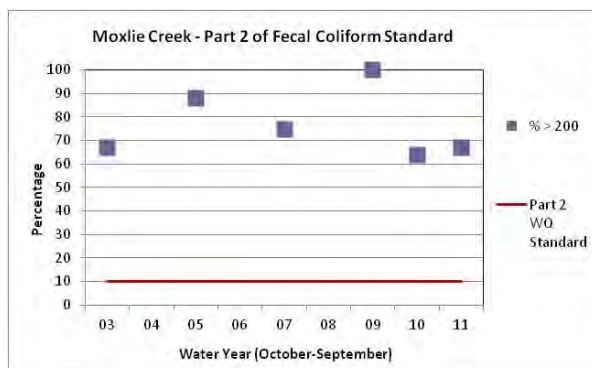
Discussion:

Moxlie Creek has been sampled as part of the ambient monitoring program in water years 2002/03, 2004/05, 2006/07, and 2008/09. Monitoring every year began in 2009/10. The sampling site is at the outfall pipe at Marine Drive where the creek discharges into Budd Inlet. The site at Marine Drive can only be monitored during low tide, otherwise the outfall pipe is submerged. Because of the influence of the marine water, no field measurements are taken at this location.

The creek consistently fails both parts of the fecal coliform bacteria standard. Fecal coliform bacteria concentrations are very high in this creek. Total phosphorus concentrations are elevated above levels measured in the majority of Thurston County streams. The presence of ammonia in the creek is an indication of sewage contamination.



Moxlie Creek has failed both parts of the fecal coliform standard every year it was sampled. The water quality standard for fecal coliform bacteria has two parts: part 1 - the geometric mean shall not exceed 100 colony forming units per 100 milliliters of sample *and*, part 2 - no more than ten percent of the samples shall exceed 200 cfu/100 mL



Major Issues:

- Stormwater discharges to the creek threaten the integrity of the natural creek channel in the upper watershed and degrade water quality throughout its length.
- The lower portion of the creek is confined in a 72" culvert under the city, which provides little habitat value.
- Illicit connections of sewer lines to the culverted portion of the creek are an on-going problem.
- Stormwater runoff from highways and city streets impact water quality.

Funding Sources:

- Local Stormwater Utility Rate

Water Quality Summary

Conventional Parameters

Moxlie Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 2003 - 2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C					3 readings	7.83 – 12.19
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0					2 readings	9.84 – 11.3
Conductivity	µmhos/cm						3 readings	800 - 2140
pH		6.5 - 8.5					3 readings	6.9 – 7.4
Turbidity	NTU	not to exceed 5 NTU over background					7 readings	1.5 – 33
Fecal Coliform	colonies/ 100 mL	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	312** 296**	105 – 1200 85 - 820	% exceeding 200	510**	50 - 7400
						58% 67%		
Total Phosphorus	mg/L		09/10 10/11	0.080 0.12	0.07 – 0.113 0.061 – 0.383		0.090	0.055 – 0.2
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	0.678 0.659	0.275 – 0.842 0.437 – 0.799		0.681	0.371 – 0.856
Ammonia	mg/L		09/10 10/11	0.034 0.042	<0.010 – 0.089 0.018 – 0.136		0.041	0.015 – 0.15

** Geometric mean value (GMV)

Shaded area – these parameters are not measured at this site

Thurston County Water Resources Monitoring Report 2009 - 2010

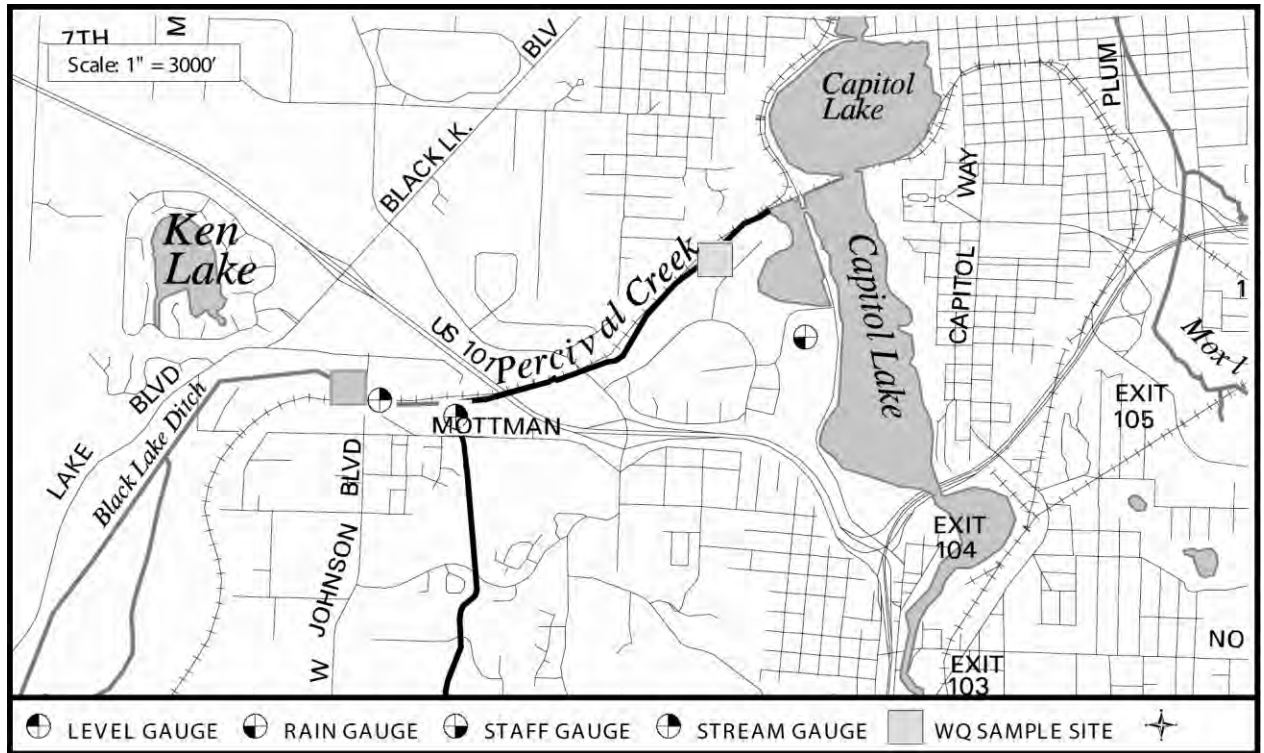
Moxlie Creek @ Marine Dr. (outfall pipe)

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>NH4</i>	<i>COMMENTS</i>
10/19/2009	12:15:00 PM					470			0.070	0.630	0.029	Borrowed YSI display. YSI #1 sonde
11/16/2009	11:30:00 AM					1200			0.113	0.275	0.016	
12/15/2009	11:50:00 AM					740			0.075	0.531	0.089	
1/13/2010	11:05:00 AM											No sample: water 1/2' over culvert at low tide.
2/8/2010	4:45:00 PM					120			0.078	0.778	0.027	
3/16/2010	11:45:00 AM					105			0.070	0.752	0.03	
4/19/2010	3:30:00 PM					135			0.077	0.842	0.037	
5/11/2010	11:10:00 AM					185			0.084	0.807	0.037	
6/14/2010	1:15:00 PM					470			0.073	0.772	< 0.005	NH4 <0.010
7/13/2010	2:00:00 PM					250			0.081	0.744	0.038	
8/17/2010	8:40:00 AM					615			0.087	0.657	0.028	
9/14/2010	8:20:00 AM					270			0.077	0.669	0.034	

Thurston County Water Resources Monitoring Report 2010 - 2011

Moxlie Creek @ Marine Dr. (outfall pipe)

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>NH4</i>	<i>COMMENTS</i>
10/19/2010	10:45:00 AM					85			0.061	0.69	0.038	
11/17/2010	9:30:00 AM					450			0.149	0.46	0.031	
12/13/2010	4:30:00 PM					820			0.383	0.44	0.069	
1/10/2011	4:30:00 PM					125			0.069	0.80	0.136	
2/14/2011	4:50:00 PM					640			0.211	0.45	0.036	
3/16/2011	8:50:00 AM					760			0.099	0.51		
4/11/2011	5:15:00 PM					100			0.073	0.79	0.022	
5/16/2011	1:15:00 PM					200			0.075	0.70	0.023	
6/13/2011	10:20:00 AM					500			0.072	0.80	0.018	
7/11/2011	10:00:00 AM					380			0.084	0.78	0.026	
8/9/2011	10:00:00 AM					210			0.080	0.77	0.032	
9/14/2011	1:40:00 PM					280			0.084	0.74	0.028	



PART OF BUDD INLET WATERSHED

LENGTH OF CREEK: Percival Creek 3.6 miles and Black Lake ditch 2 miles

BASIN SIZE: 5,300 Acres

STREAM ORDER: 2

PRIMARY LAND USES:

Urban
Suburban residential
Commercial

FISHERIES RESOURCES: (From [A Catalog of Washington Streams and Salmon Utilization](#), WDOF)

Chinook, Coho, (probably Chum)

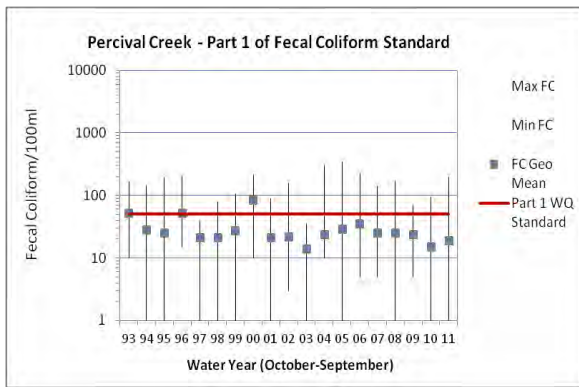
GENERAL TOPOGRAPHY:

Percival Basin is located between Black Hills on the west and Interstate 5 on the East. It flows north into Capitol Lake/Budd Inlet. The drainage area is moderately sloped. Two main channels: Black Lake Ditch and Percival Creek generate low gradients in upper wetland creek segments and medium gradients within the deeply incised Percival Creek canyon. Numerous year round and seasonal tributaries, springs and seeps enter the creek. Elevations range from sea level to 500 feet.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

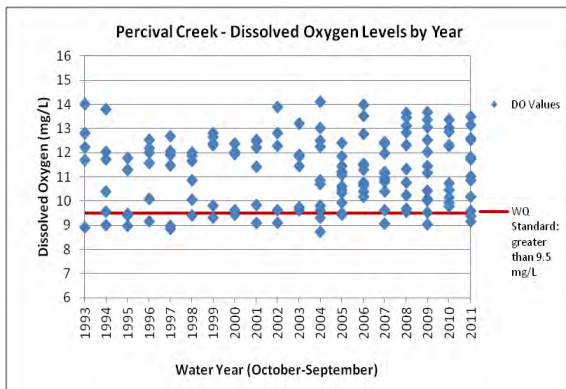
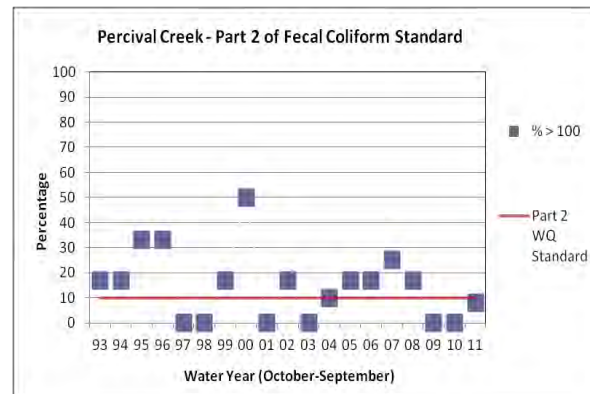
Fair - Met both parts of the fecal coliform standard both water years. Elevated turbidity occurred in November 2009 and January 2011. There were two mid-summer DO violations in 2011, and measurements indicated possible summer temperature violations.

Percival Creek #0029



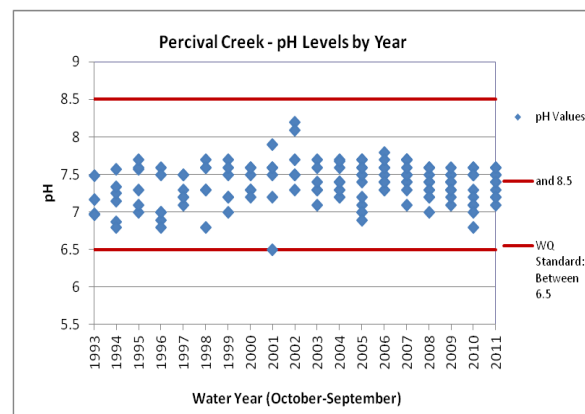
The water quality standard for fecal coliform has two parts: part 1 - the geometric mean shall not exceed 50 org/100mL *and*, part 2 - no more than 10% of the samples shall exceed 100 org/100mL.

Throughout the period of record, there has been only one violation of part 1 of the fecal coliform standard, in water year 1999/00. However, Part 2 of the standard is often violated. Both parts of the fecal coliform standard were met in the past three water years.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. There are several dissolved oxygen measurements that have fallen below the standard during the summer.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. No violations have occurred since 1992.



OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

City of Olympia, Stream Team, (360) 570-5841.

Thurston County Resource Stewardship Department, Water Resources Program, (360) 754-4681 or www.co.thurston.wa.us/monitoring

Discussion:

The temperature and dissolved oxygen water quality standards are intended to protect core summer salmonid habitat. Two dissolved oxygen measurements were below the water quality standard of the lowest one-day minimum of 9.5 mg/l in 2011.

The temperature criteria is a 7-day average daily maximum of 16° C. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because these are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data is used only as an indicator of possible temperature violations. Water temperatures above 16° C were measured in July and August of 2010 and in June, July and August of 2011, indicating possible temperature standard violations during these periods.

Major Issues:

- The basin is within the urban growth boundary and is rapidly developing. Increases in stormwater runoff could impact the stream through degraded water quality, stream bank erosion, hillslope failures, and channel scour.
- Concerns have been raised regarding the effect of Black Lake water quality on Percival Creek and Percival Cove.
- In 1996, a fish passage blockage at the Mottman Road crossing was corrected, and salmon have since been observed spawning in the creek above the road crossing.
- Percival Creek was included in a total maximum daily load study (TMDL) begun in 2003 by the Washington Department of Ecology to identify pollution sources and develop a plan to correct them.
- Homeless camps are often built within the riparian corridor.

Funding Sources:

- Local stormwater utility rates

Water Quality Summary
Conventional Parameters
Percival Creek at the Foot Bridge

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		4.35 – 17.94 4.43 – 18.04			4.2 – 19.41
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		9.77 – 13.35 9.17 – 13.50	0 of 10 2 of 12		8.72 - 14.1
Conductivity	µmhos/cm		09/10 10/11	106 99	84 - 128 82 - 122		97	56 – 154
pH		6.5 - 8.5	09/10 10/11	7.2* 7.4*	6.8 – 7.6 7.1 – 7.6	0 of 12 0 of 12	7.4**	6.5 – 8.2
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	5.05 4.22	0.80 – 28.80 0 - 22	1 of 12 1 of 12	3.44	0.6 - 28.5
Fecal Coliform	colonies/ 100 ml	GMV ≤50 and ≤ 10% not to exceed 100	09/10 10/11	15** 19**	0 - 95 0 - 200	% exceeding 100	27**	0 - 350
						0%		
						8%		
Total Phosphorus	mg/L		09/10 10/11	0.037 0.036	0.023 – 0.075 0.020 – 0.064		0.032	0.013 - 0.107
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.272 0.287	0.155 – 0.423 0.111 – 0.408		0.299	0.127 - 0.509

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

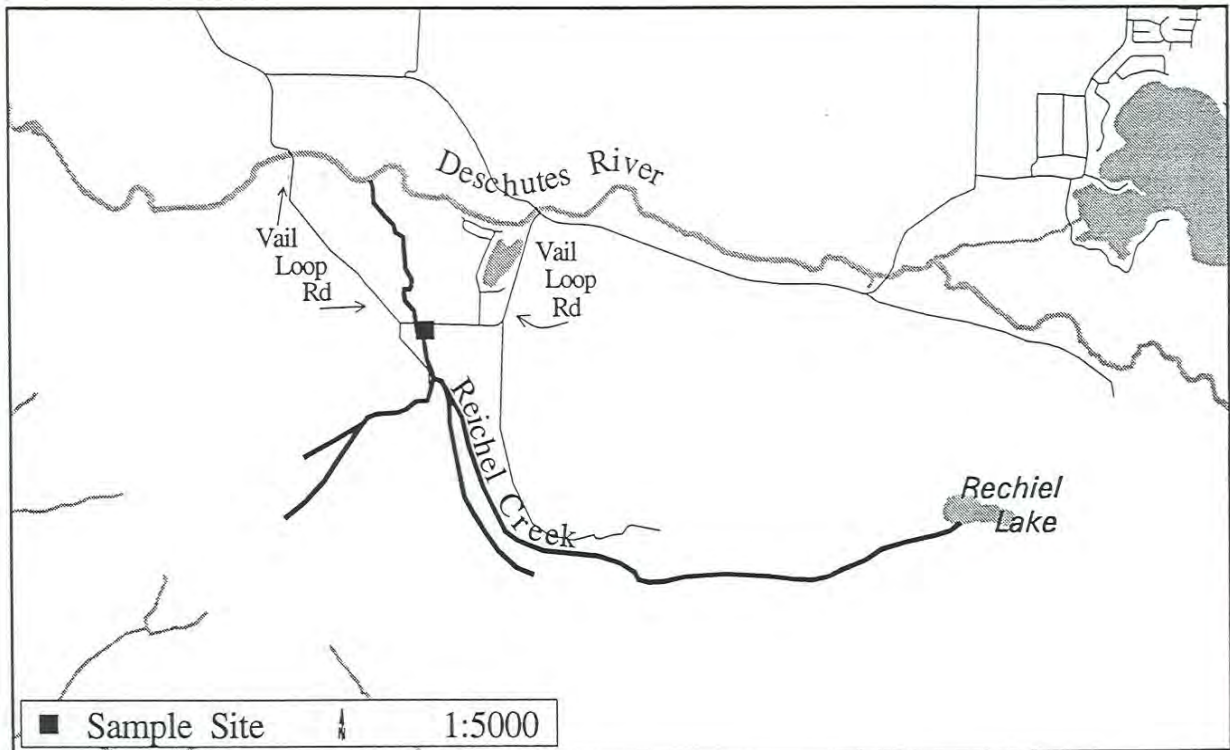
Percival Creek @ Foot Bridge below Evergreen Park

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	9:05:00 AM	12.39	7.3	10.46	123	30	4.7	16.98	0.057	0.213	
11/17/2009	9:15:00 AM	9.09	7.1	13.01	84	95	28.8		0.075	0.423	No flow measurement: too deep to wade.
12/16/2009	9:10:00 AM	4.35	7.2	13.35	97	0	9.2	59.20	0.047	0.292	Creek rising during cross section. FC reported as <5.
1/11/2010	9:15:00 AM	6.36	6.8	12.86	91	0	3.9	99.31	0.028	0.312	FC reported as <5.
2/10/2010	9:00:00 AM	6.65	7.1	12.28	100	15	1.6	48.47	0.024	0.380	
3/16/2010	8:50:00 AM	8.23	7.1	12.31	96	5	2.0	55.36	0.024	0.323	
4/19/2010	8:45:00 AM	11.88	7.0	10.75	98	20	1.8	50.29	0.023	0.317	
5/10/2010	9:00:00 AM	13.41	7.5	10.14	101	15	2.1	38.13	0.028	0.231	
6/15/2010	8:30:00 AM	15.59	7.5	9.94	105	70	1.2	32.31	0.033	0.155	
7/12/2010	8:45:00 AM	17.94	7.6		116	45	1.0	19.92	0.032	0.218	DO did not post calibrate.
8/16/2010	9:30:00 AM	17.25	7.6		128	35	0.8	9.99	0.026	0.184	DO probe not working.
9/13/2010	9:20:00 AM	15.35	7.5	9.77	128	10	3.5	12.13	0.042	0.216	

Thurston County Water Resources Monitoring Report 2010-2011

Percival Creek @ Foot Bridge below Evergreen Park

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	4:15:00 PM	12.41	7.5	11.02	114	15	3.1	23.89	0.041	0.111	
11/16/2010	3:45:00 PM	10.18	7.4	11.73	106	20	5.3	47.56	0.060	0.156	
12/15/2010	2:00:00 PM	6.95	7.1	12.60	85	200	6.4		0.041	0.302	Flooding. Too deep to measure flow.
1/12/2011	4:00:00 PM	4.43	7.2	13.50	95	50	22.0	98.70	0.064	0.371	
2/16/2011	3:15:00 PM	6.52	7.3	12.54	92	15	3.1	77.33	0.028	0.408	
3/14/2011	3:45:00 PM	7.40	7.2	13.14	82	10	4.1	163.60	0.021	0.360	
4/12/2011	3:00:00 PM	10.94	7.5	11.83	89	5	1.3	88.02	0.020	0.321	
5/17/2011	4:30:00 PM	14.59	7.5	10.87	92	0	1.1	65.14	0.023	0.311	FC reported as <5.
6/14/2011	4:40:00 PM	16.31	7.5	9.17	104	20	1.7	28.61	0.031	0.315	
7/12/2011	3:45:00 PM	18.04	7.6	9.38	114	30	1.9	18.54	0.036	0.209	
8/8/2011	5:00:00 PM	17.89	7.6	9.58	122	30	0.6	12.67	0.031	0.211	Duplicates labeled "Long Day".
9/12/2011	10:00:00 AM	14.73	7.4	10.17	96	30	0.0	4.84	0.030	0.369	Turbidity read -0.2



**PART OF Budd Inlet/Deschutes River
WATERSHED**

LENGTH OF RIVER: 4.5 miles

BASIN SIZE: est. 5150 acres

STREAM ORDER: 2

PRIMARY LAND USES:

Agriculture
Commercial Forestry
Forestry-Related Operations

FISHERIES RESOURCES: (From A Catalog of Washington Steams and Salmon Utilization, WDOF)

Coho, cut-throat trout

GENERAL TOPOGRAPHY:

The creek's origin is Reichel Lake; it flows through drained pasture land and wetland throughout much of its length. The valley, at approximately 500' elevation, is bounded by very steep slopes up to 1600' in elevation.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

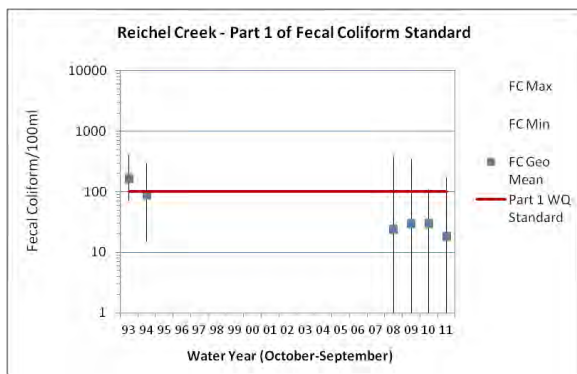
Fair – Met both parts of fecal coliform standard both water years 2009/10 and 2010/11. There were numerous dissolved oxygen violations. Temperature criteria may be exceeded at times.

OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

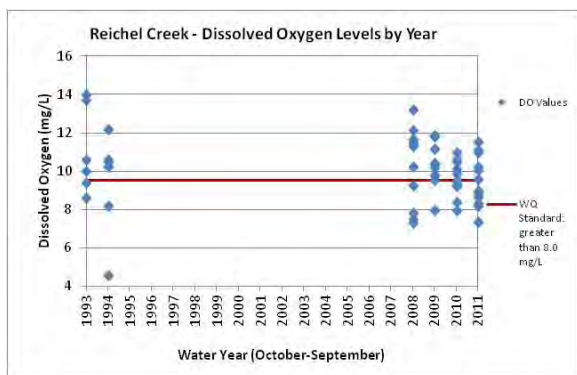
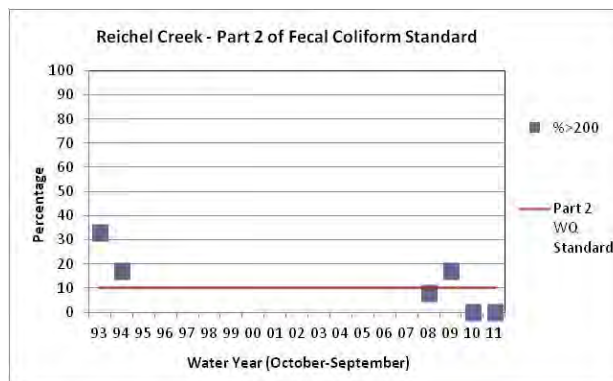
Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 or www.co.thurston.wa.us/monitoring

Reichel Creek #0046



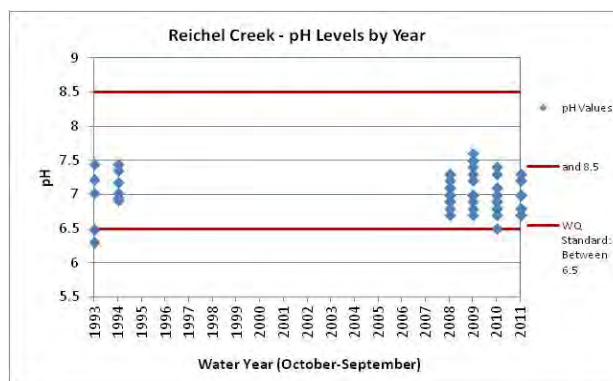
The water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 100 colonies/100mL and Part 2 - no more than 10% of the samples shall exceed 200 colonies/100 mL.

Parts 1 and 2 of the fecal coliform water quality standard were both met in the last two water years.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. The DO has fallen below the standard several times.

The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. Throughout the period of record there have been a few violations.



Discussion:

Reichel Creek has a history of water quality problems. It was monitored as part of a watershed-wide water quality study in the early 1990's. Storm event monitoring showed that a major source of turbidity loading was from runoff from a log yard adjacent to the creek. Fecal coliform contamination was the result of poor agricultural practices. Since that time, the log yard has been abandoned. The Thurston Conservation District and U.S. Fish and Wildlife Service worked with cooperative land owners to implement agricultural best management practices and restore the creek riparian area.

Because of the violations of the fecal coliform standards, Reichel Creek was placed on the Washington State Department of Ecology Section 303(d) list of impaired and threatened water bodies in 1998. And in 2003 Department of Ecology began a total maximum daily load study (TMDL) to identify the pollution sources for numerous water quality violations within the Deschutes watershed and to develop a plan to correct them.

The table below shows bacteria data from the TMDL study. The historic and the most recent fecal coliform data are summarized in the summary table at the end of this narrative. The fecal coliform standard was met in both water years 2009/10 and 2010/11. Overall fecal coliform contamination appears to have decreased since the 1994 sampling, but occasional high bacteria results have occurred in past years. Agriculture continues to be the primary activity in the valley.

Reichel Creek Fecal Coliform Bacteria Data

TMDL Data Collection	
Date	Fecal Coliform (#/100ml)
01/14/2004	2
01/28/2004	14
02/11/2004	3
02/25/2004	8
03/10/2004	4
03/24/2004	420
04/05/2004	57
04/21/2004	120
05/05/2004	3900
05/19/2004	150
06/23/2004	87
07/07/2004	470
07/21/2004	200
08/11/2004	43
08/25/2004	760
09/15/2004	23
09/29/2004	18
10/13/2004	32
10/26/2004	35
11/16/2004	52
11/30/2004	15
12/14/2004	30
12/28/2004	10
n = 23	
GMV = 45	
% > 200 = 17%	

Reichel Creek #0046

A temperature criteria of a 7-day average daily (DAD) maximum of 16 ° C and a dissolved oxygen criteria of the lowest one-day minimum of 9.5 mg/l is intended to protect core summer salmonid habitat. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. In August 2010 and September 2011 temperatures above 16 ° C were measured indicating that possible temperature standard violations may have occurred during these periods.

Low dissolved oxygen concentrations are a concern in this creek. In October and November of 2009 and June, August and September of 2010 as well as November 2010 and Jan through September 2011, the dissolved oxygen measurements were less than the required standard of 9.5 mg/L. The source of this stream is a small lake and an extensive wetland complex, and it is a very low gradient stream. Riparian restoration may be needed to improve summer temperature and dissolved oxygen conditions.

Major Issues:

- Agricultural activities within the riparian area
- Degraded fish habitat.

Funding Sources:

- County Stormwater utility

Water Quality Summary

Conventional Parameters

Reichel Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/2010 & 2010/2011				Cumulative Data: 1993 - 2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		2.84 – 16.73 4.03 – 16.39			1.43 – 17.75
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		7.95 – 11.0 7.37 – 11.54	5 of 11 6 of 12		4.56 - 14
Conductivity	µmhos/cm		09/10 10/11	110 104	74 - 152 69 - 159		110	57 - 169
pH		6.5 - 8.5	09/10 10/11	6.9* 7.0*	6.5 – 7.4 6.7 – 7.3	0 of 12 0 of 12	7.0*	6.3 – 7.6
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	8.44 9.13	3.50 – 24.50 3.30 – 14.40	1 of 12 0 of 12	10.33	2.45 - 34
Fecal Coliform	Colonies/100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	30** 18**	0 – 108 0 - 170	% exceeding 200	44**	0 - 415
						0% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.060 0.061	0.044 – 0.103 0.044 – 0.087		0.058	0.023 – 0.1
Nitrate + Nitrite-nitrogen	mg/L		09/10 10/11	0.340 0.366	0.060 – 0.726 0.022 – 0.811		0.334	<0.010 – 0.775

*Median

**Geometric Mean Value

Thurston County Water Resources Monitoring Report 2009-2010

Reichel Creek @ Vail Loop Rd

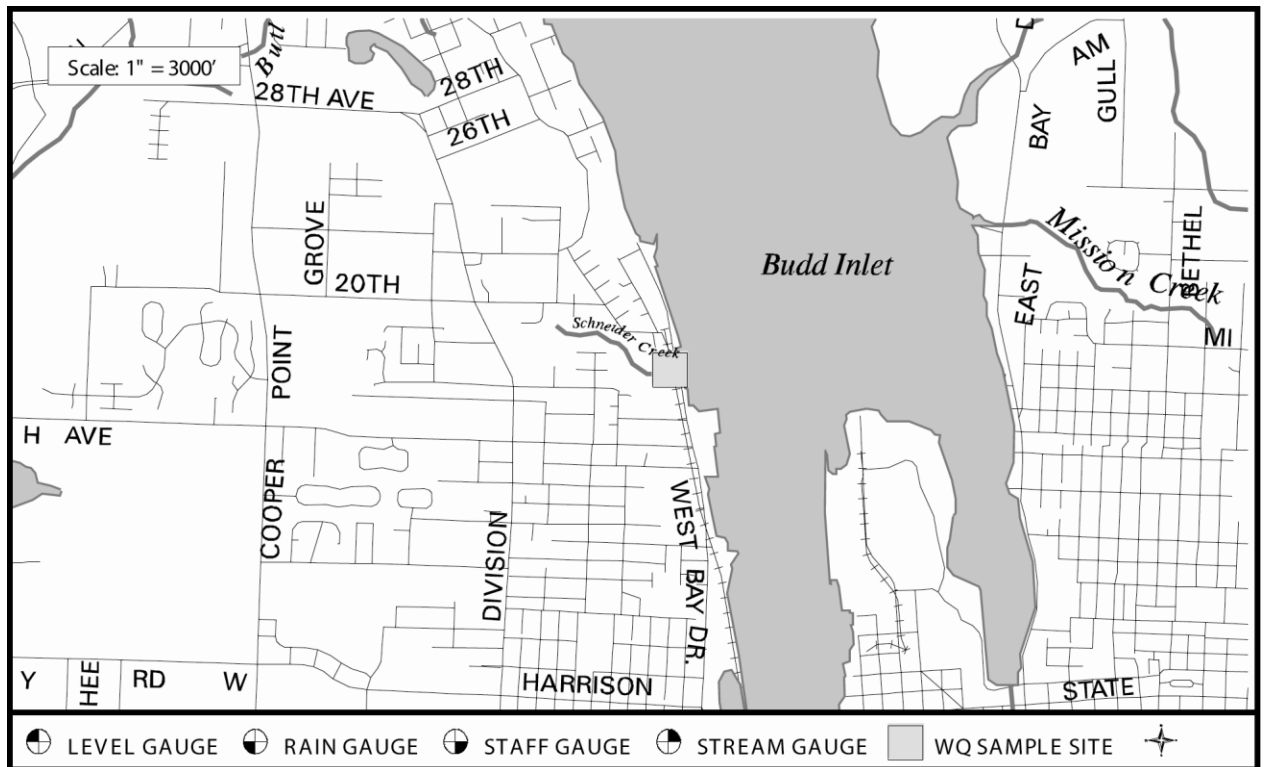
<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	12:40:00 PM	10.37	7.1	9.31	151	20	9.4	1.22	0.052	0.160	
11/17/2009	12:30:00 PM	8.28	6.5	9.48	76	80	24.5	37.20	0.103	0.726	Gage gone.
12/16/2009	12:50:00 PM	2.84	6.8	11.00	96	40	7.3	9.39	0.056	0.348	
1/11/2010	1:30:00 PM	7.60	6.7	10.13	74	8	9.3	33.56	0.044	0.549	Duplicates labeled "Weyerhaeuser".
2/10/2010	12:45:00 PM	4.16	6.8	10.62	101	30	5.5	6.19	0.049	0.502	
3/16/2010	12:45:00 PM	8.90	6.8	10.53	92	0	7.6	10.56	0.053	0.442	FC reported as <5.
4/19/2010	11:50:00 AM	12.04	6.9	9.89	104	100	5.6	8.24	0.059	0.387	
5/10/2010	12:30:00 PM	10.48	7.0	9.50	97	90	6.8	8.01	0.064	0.307	Slight smell of manure.
6/15/2010	12:30:00 PM	12.20	6.9	7.95	102	10	4.2	11.67	0.065	0.300	
7/12/2010	12:15:00 PM	15.13	7.1		126	40	3.5	2.78	0.064	0.235	DO did not post calibrate.
8/16/2010	1:20:00 PM	16.73	7.4	9.21	144	108	11.5	1.04	0.050	0.062	Duplicates labeled "Weyco".
9/13/2010	12:55:00 PM	13.00	7.3	8.38	152	50	6.1	0.98	0.056	0.060	

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Reichel Creek @ Vail Loop Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	1:00:00 PM	7.09	7.2	10.24	147	0	3.3	1.28	0.045	0.091	FC reported as <5.
11/16/2010	12:05:00 PM	9.21	6.7	7.37	90	50	8.7	13.96	0.071	0.534	
12/14/2010	2:00:00 PM	7.39	6.8	9.58	69	0	12.1	70.55	0.056	0.811	FC reported as <5. Flow is based on 5 measurements and is estimate only.
1/12/2011	12:30:00 PM	4.03	6.8	10.99	85	20	8.7	12.65	0.052	0.658	
2/16/2011	11:30:00 AM	4.12	6.8	10.07	88	35	10.7	16.75	0.069	0.543	
3/14/2011	12:30:00 PM	7.89	7.0	11.14	70	60	14.4	56.40	0.044	0.507	
4/11/2011	1:15:00 PM	9.72	7.0	11.54	83	0	7.9	26.83	0.052	0.261	FC reported as <5.
5/17/2011	12:30:00 PM	10.60	6.7	8.86	74	20	10.6	30.53	0.063	0.337	
6/14/2011	12:30:00 PM	13.18	7.0	8.33	111	40	7.6	4.81	0.087	0.248	
7/12/2011	11:30:00 AM	13.96	7.2	8.67	123	40	5.9	1.44	0.069	0.263	USGS flow data
8/8/2011	2:20:00 PM	14.51	7.3	9.00	143	170	13.6	0.98	0.064	0.117	
9/12/2011	4:30:00 PM	16.39	7.3	8.20	159	60	6.0		0.059	0.022	Too shallow to measure flow.

Schneider Creek #0009 (Budd Inlet Watershed)



PART OF BUDD INLET WATERSHED

LENGTH OF CREEK: Approximately 1.25 miles

BASIN SIZE: 662 Acres

STREAM ORDER: 1

PRIMARY LAND USES:

Urban residential and Commercial

FISHERIES RESOURCES:

Salmon have been observed in lower segment by City of Olympia staff.

GENERAL TOPOGRAPHY:

The upper watershed is relatively flat. The creek originates in a ditch in an urban residential neighborhood. The lower segment of the creek flows through a deep-cut ravine. The creek discharges to Budd Inlet via a culvert under West Bay Drive.

GENERAL WATER QUALITY:

(Excellent, Good, Fair, Poor)

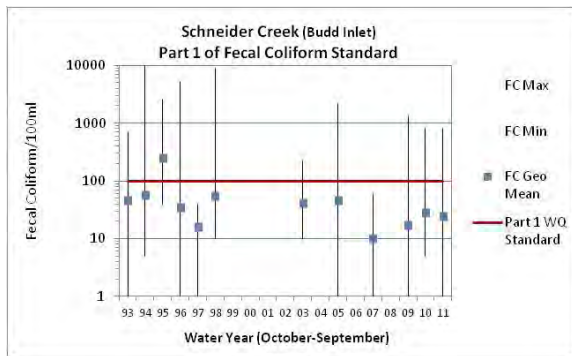
Good – Failed part 2 of the fecal coliform water quality standard in 2009/10 but met both parts in 2010/11. Stream channel is severely impacted by peak stormwater flows.

OTHER DATA:

City of Olympia, Stream Team, (360) 570-5841.

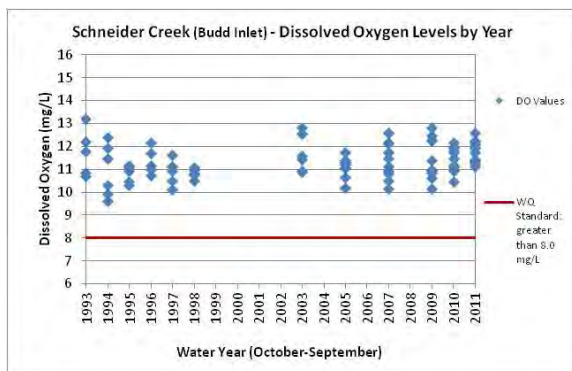
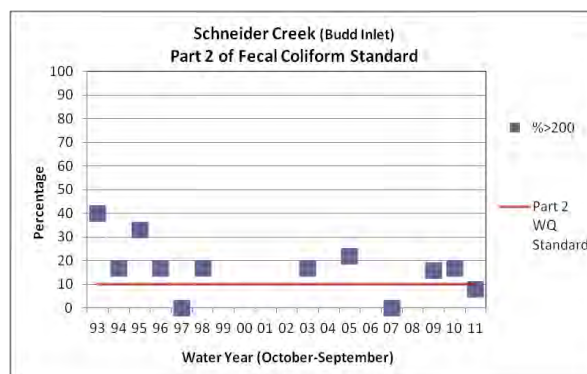
Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

Schneider Creek #0009 (Budd Inlet Watershed)



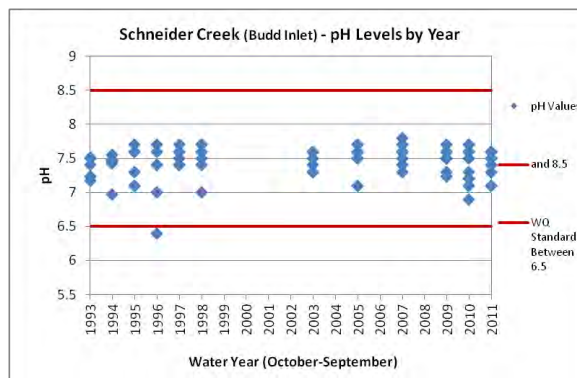
Schneider Creek has met Part 1 of the fecal coliform standard every year except 1995. Part 2 of the standard has been violated almost every year sampled with a few exceptions including 2010/11.

The state water quality standard for fecal coliform bacteria has two parts: Part 1 - the geometric mean shall not exceed 100 colonies per 100 milliliters of sample and, Part 2 - no more than 10% of the samples shall exceed 200 colonies per 100 mL.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. There have been no violations of the dissolved oxygen standard.

The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. There is only one pH measurement in the data set that fell outside of the pH standard range.



Discussion:

Monitoring began on Schneider Creek in 1993 as part of the long-term ambient monitoring program. It was discontinued in 1998, but resumed in water year 2002/03.

Generally the creek meets water quality standards with the exception of part 2 of the fecal coliform standard. There were turbidity violations in November of each water year. The nitrate concentration in the creek is higher than impacted surface water levels, with an average concentration of 1.5 milligrams per liter. The nitrate concentrations in the creek are high year-round reflecting contamination in the shallow ground water, which provides base flow, as well as in surface runoff. During the winter months the creek channel is highly impacted by peak storm water flows which scour and alter the stream channel.

Major Issues:

- High volumes of stormwater discharging directly to the creek are causing bank failures, streambank erosion, flooding, stream channel scour, and water quality degradation.
- City of Olympia constructed a stormwater treatment facility at the headwaters of the creek to improve the quality of urban stormwater discharging to the creek.
- High nitrate levels are high and indicate contamination of both shallow groundwater and surface runoff.

Funding Sources:

- Local Stormwater Utilities

Water Quality Summary
Conventional Parameters
Schneider Creek (in Budd Inlet Watershed)

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		7.20 – 12.18 7.32 – 11.35			5.94 – 13.57
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		10.48 – 12.15 11.13 – 12.58	0 of 12 0 of 12		9.62 – 13.2
Conductivity	µmhos/cm		09/10 10/11	136 137	45 – 162 60 - 164		136	58 - 170
pH		6.5 - 8.5	09/10 10/11	7.6* 7.4*	7.3 – 7.8 7.1 – 7.6	0 of 12 0 of 12	7.5*	6.4 - 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	4.03 1.69	0 – 44.1 0 – 10.20	1 of 12 1 of 12	4.36	0 – 146
Fecal Coliform	colonies / 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	28** 24**	5 – 500 0 - 820	% exceeding 200	31**	0 – 181,500
						17% 8%		
Total Phosphorus	mg/L		09/10 10/11	0.030 0.028	0.011 - 0.104 0.016 – 0.065		0.03	0.013 - 0.21
Nitrate+Nitrite nitrogen	mg/L		09/10 10/11	1.53 1.51	0.405 – 1.92 0.508 – 1.84		1.46	0.597 – 2.28

* Median

** Geometric mean value (GMV)

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Schneider Creek @ West Bay Dr

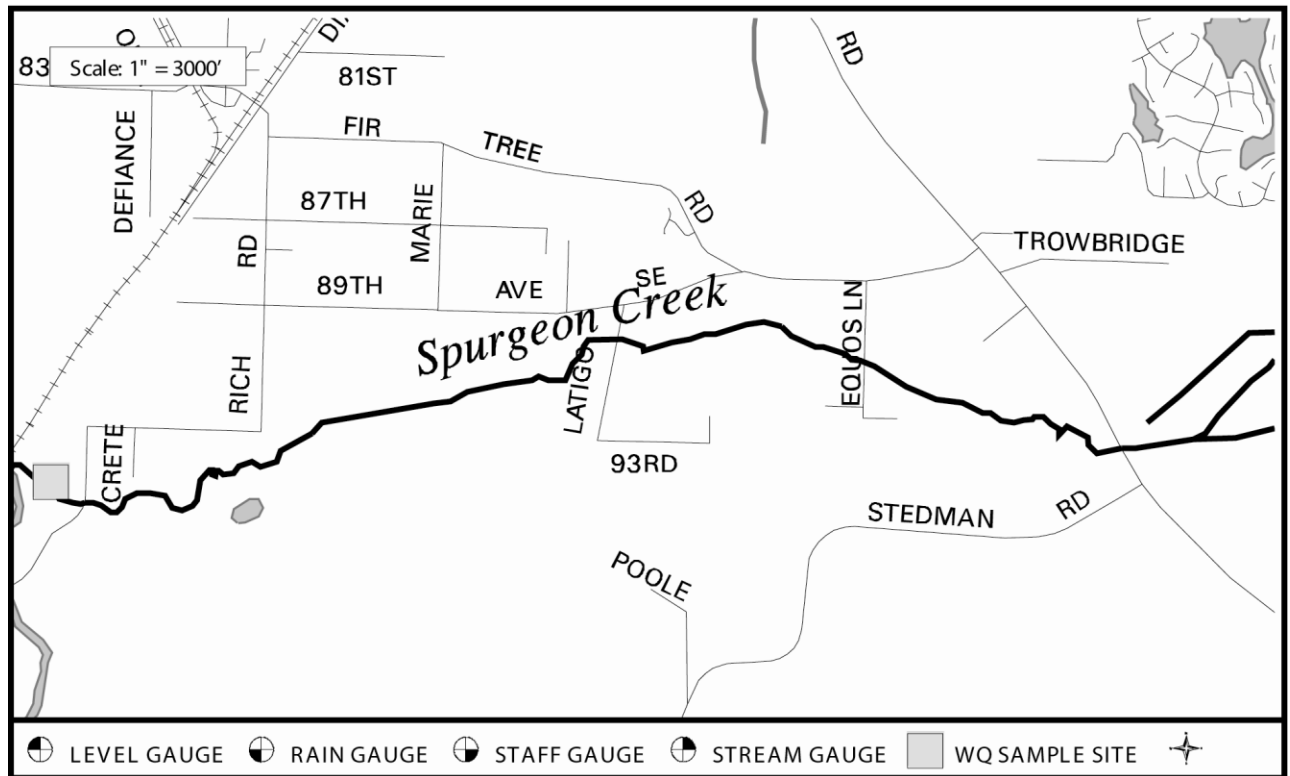
<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009	1:40:00 PM	10.99	7.5	10.48	156	10	0.6	1.15	0.027	1.460	
11/16/2009	1:30:00 PM	9.55	6.9	12.15	45	450	44.1	15.42	0.104	0.405	
12/17/2009	8:45:00 AM	7.20	7.2	11.92	106	800	1.6	3.72	0.026	1.440	
1/13/2010	8:45:00 AM	8.75	7.1	11.81	105	40	1.5	4.00	0.024	1.400	Duplicates labeled "Tugboat"
2/8/2010	12:15:00 PM	9.03	7.2	10.98	141	10	0.0	2.08	0.021	1.640	Turbidity read -0.1
3/17/2010	12:15:00 PM	9.61	7.5	11.96	142	10	0.2	2.16	0.022	1.530	
4/21/2010	11:00:00 AM	10.04	7.3	11.47	150	5	0.1	2.83	0.022	1.920	
5/10/2010	4:00:00 PM	10.55	7.7	11.07	153	15	0.0	2.65	0.024	1.850	Did not capture seepage coming off of right bank.
6/14/2010	12:30:00 PM	10.93	7.6	11.18	155	75	0.0	2.45	0.033	1.830	Turbidity read -0.7
7/13/2010	11:45:00 AM	11.25	7.7	11.76	159	10	0.0	1.99	0.011	1.780	Did not capture seepage coming off right bank.
8/17/2010	12:30:00 PM	12.18	7.6	11.18	161	10	0.0	1.46	0.025	1.540	
9/14/2010	11:40:00 AM	11.23	7.6	10.94	162	15	0.2	1.54	0.024	1.520	Duplicates labeled "West Bay".

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Schneider Creek @ West Bay Dr

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	1:00:00 PM	10.04	7.6	11.45	160	20	0.0	1.34	0.026	1.520	Turb read -0.7
11/17/2010	3:15:00 PM	8.68	7.1	12.07	60	820	10.2	10.90	0.065	0.508	
12/13/2010	11:30:00 AM	9.60	7.1	11.93	105	60	3.8	9.19	0.030	1.840	Photos from previous day show creek in high flood.
1/11/2011	9:00:00 AM	7.32	7.5	12.25	144	0	0.2	2.03	0.022	1.580	FC reported as <5. Swoffer post cal low blow test, flow rate likely underreported.
2/14/2011	12:15:00 PM	8.74	7.3	11.75	118	30	2.7	4.73	0.024	1.400	
3/16/2011	4:00:00 PM	8.60	7.3	12.58	112	35	1.5	7.32	0.016	1.360	Duplicates labeled "Westbay".
4/12/2011	1:30:00 PM	10.30	7.5	12.22	148	5	0.0	3.73	0.017	1.640	Turb read -0.3
5/16/2011	1:00:00 PM	10.60	7.4	11.93	141	30	0.5	4.83	0.023	1.570	
6/13/2011	4:50:00 PM	10.80	7.4	11.40	160	10	0.0	3.92	0.026	1.750	
7/11/2011	4:00:00 PM	11.12	7.6	11.13	163	100	1.4	3.56	0.038	1.720	
8/9/2011	3:30:00 PM	11.35	7.6	11.36	164	15	0.0	3.00	0.026	1.680	
9/15/2011	8:00:00 AM	10.81	7.5	11.24	164	10	0.0	2.67	0.026	1.580	

Spurgeon Creek #0037



PART OF BUDD INLET/DESCHUTES RIVER WATERSHED

LENGTH OF CREEK: 5.8 miles

BASIN SIZE: 7,050 Acres

STREAM ORDER: 2

PRIMARY LAND USES:

Rural residential, small commercial and non-commercial agriculture, Fort Lewis Military Reservation

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)

Coho and Chinook

GENERAL TOPOGRAPHY:

This is a low gradient stream with large areas of associated wetlands. The elevations in the watershed are from 180 feet to approximately 360 feet. The creek is a tributary to the Deschutes River.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

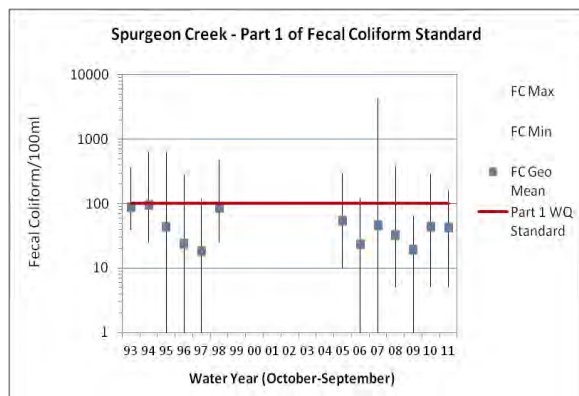
Good – Met both parts of fecal coliform standard in 2009/10 but failed part 2 in 2010/11. There was one turbidity violation in November 2009. Nutrient levels are fairly low.

OTHER DATA:

Thurston County Environmental Health Division, Surface Water Section, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

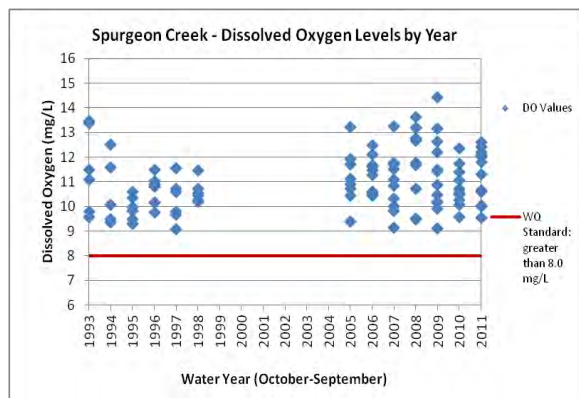
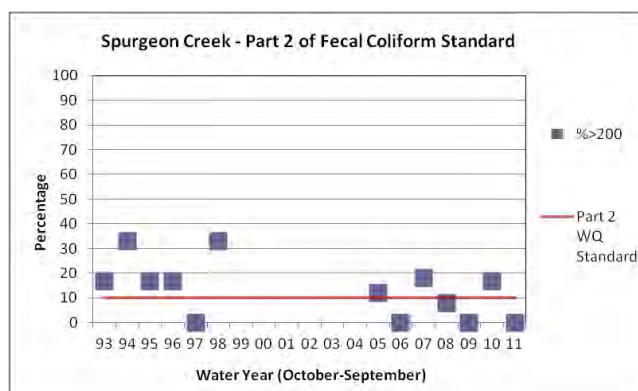
Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 or www.co.thurston.wa.us/monitoring

Spurgeon Creek #0037



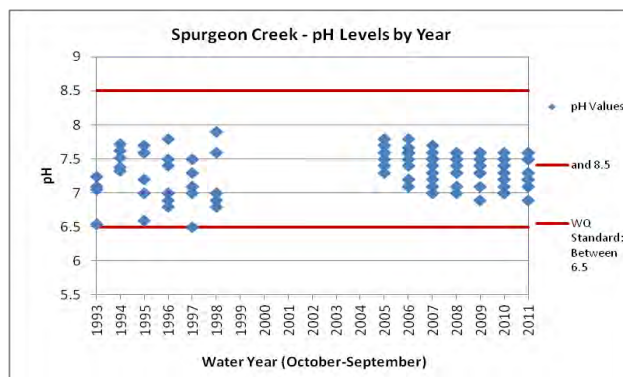
The water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 100 colonies/100mL and Part 2 - no more than 10% of the samples shall exceed 200 colonies/100 mL.

Parts 1 and 2 of the fecal coliform water quality standard were both met in water year 2010/11 but only part 1 was met in 2009/10. Spurgeon creek has failed part 2 several times in past years.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 8.0 mg/L. The DO has never fallen below the standard.

The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. Throughout the period of record there have been no violations.



Discussion:

Monitoring was conducted on Spurgeon Creek between water years 1991 and 1998. Monitoring of Spurgeon Creek was resumed as part of Thurston County's ambient monitoring program in 2005. The creek is also part of a water quality study being conducted by the Washington Department of Ecology.

While there is no water quality standard for nitrates in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (US EPA Publication 822-B-00-015). The average nitrate concentration in Spurgeon Creek falls between 0.21 and 0.26 mg/l, which is similar to the reference condition. The total phosphorus regional reference condition is 0.019 mg/l, according to the EPA report. The Spurgeon Creek average total phosphorus concentration is roughly 0.030 mg/l, which is above the regional reference condition.

The temperature water quality standard of a 7-day average daily (DAD) maximum of 17.5° C is intended to protect salmonid spawning, rearing, and migration. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. All measurements at this site were below the 17.5° C maximum in both water years indicating that the temperature standard was probably met.

Thurston County intends to continue long-term ambient monitoring of this creek.

Major Issues:

- Nonpoint pollution from rural residential and agricultural activities.
- Encroachment on wetlands and natural riparian areas for livestock grazing and other uses may impact water quality.
- Spurgeon Creek was included in a total maximum daily load study of the Deschutes Watershed (TMDL) begun in 2003 by the Washington Department of Ecology to identify pollution sources and develop a plan to correct them.

Water Quality Summary

Conventional Parameters

Spurgeon Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		4.82 – 18.33 5.21 – 15.86			1.33 – 18.67
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		9.6 – 12.37 9.57 – 12.63	0 of 11 0 of 12		9.1 – 14.4
Conductivity	µmhos/cm		09/10 10/11	105 100	86 - 118 74 - 116		101	57 - 131
pH		6.5 - 8.5	09/10 10/11	7.3* 7.3*	7.0 – 7.6 6.9 – 7.6	0 of 12 0 of 12	7.4*	6.5 - 7.9
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	3.62 2.10	0.8 – 10.88 0 – 6.0	1 of 12 0 of 12	2.36	0 – 8.1
Fecal Coliform	colonies / 100 ml	GMV ≤100 and ≤ 10% not to exceed 200	09/10 10/11	43** 42**	5 - 290 5 - 160	% exceeding 200	36**	0 - 4300
						17% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.035 0.032	0.025 – 0.048 0.019 – 0.047		0.033	0.015 - 0.26
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.207 0.261	0.012 – 0.465 0.044 – 0.447		0.262	<0.010 - 0.704

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

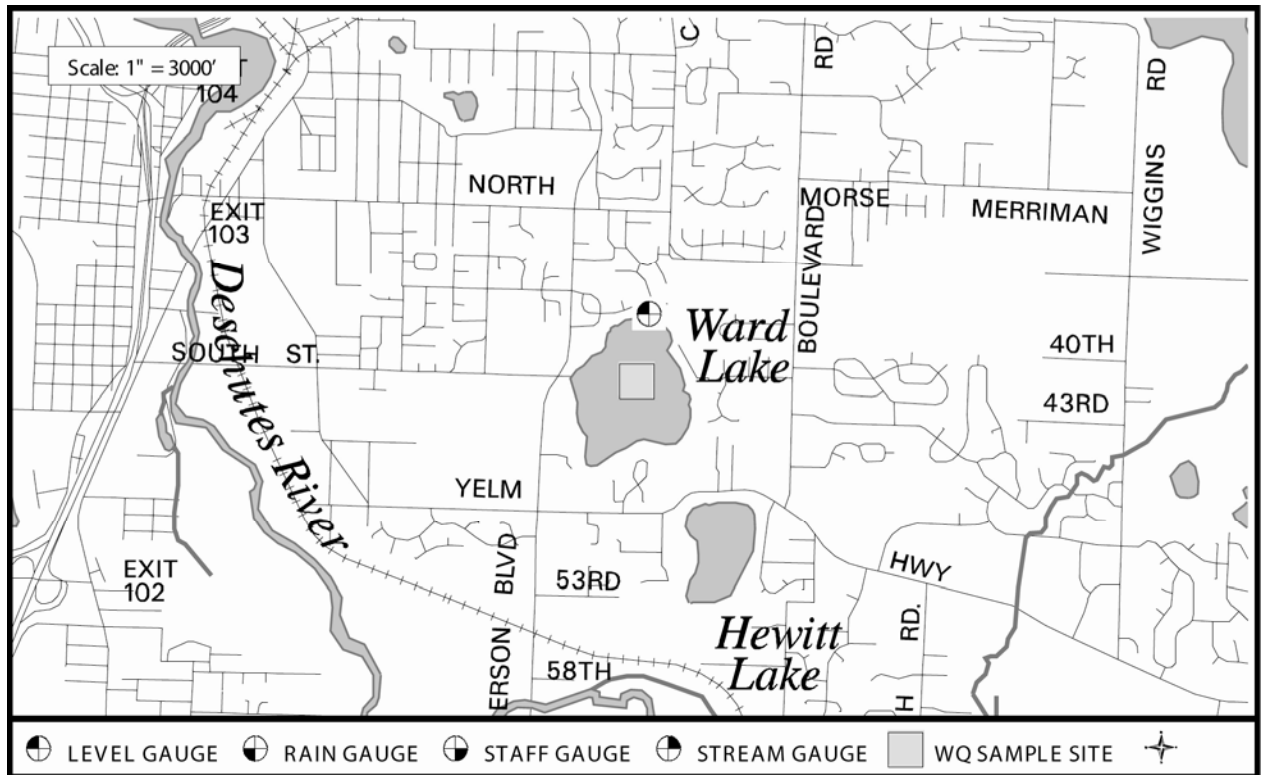
Spurgeon Creek Mouth @ Boe's

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	11:30:00 AM	10.71	7.3	10.74	113	290	1.6	8.14	0.030	0.068	
11/17/2009	11:15:00 AM	8.59	7.1	10.28	88	110	10.8		0.036	0.138	No flow measurement: creek flooded. Data collected from standing water.
12/16/2009	11:20:00 AM	4.82	7.2	12.37	106	240	6.5	17.92	0.041	0.423	
1/11/2010	11:15:00 AM	7.39	7.0	11.07	86	40	7.1	33.21	0.034	0.358	Flow is ESTIMATE: high water.
2/10/2010	11:20:00 AM	5.70	7.0	11.41	104	5	3.5	16.24	0.035	0.465	
3/16/2010	11:15:00 AM	8.78	7.2	11.75	102	25	3.0	19.42	0.031	0.371	
4/19/2010	10:45:00 AM	12.05	7.0	10.57	101	10	3.2	19.91	0.035	0.271	
5/10/2010	11:15:00 AM	11.60	7.4	10.53	107	35	1.1	15.03	0.030	0.180	
6/15/2010	11:00:00 AM	12.23	7.4	10.50	108	25	0.8	15.00	0.029	0.156	
7/12/2010	11:00:00 AM	16.34	7.5		113	60	2.4	11.07	0.048	0.018	DO did not post calibrate.
8/16/2010	12:10:00 PM	18.33	7.6	9.60	116	60	2.0	5.39	0.040	0.024	
9/13/2010	11:30:00 AM	13.58	7.5	10.09	118	20	1.4	6.37	0.025	0.012	

Thurston County Water Resources Monitoring Report 2010-2011

Spurgeon Creek Mouth @ Boe's

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	2:20:00 PM	7.96	7.5	12.63	113	5	0.0	6.31	0.019	0.212	
11/16/2010	1:15:00 PM	9.87	7.3	11.31	110	35	0.9	15.79	0.026	0.310	Duplicates labeled "Trains".
12/14/2010	3:10:00 PM	7.67	6.9	10.67	74	160	1.1		0.030	0.396	No flow measurement. Field flooded. Field parameters measured ~ 100 feet from main channel.
1/12/2011	1:30:00 PM	5.21	7.1	12.22	95	85	6.0	25.19	0.035	0.447	
2/16/2011	1:15:00 PM	6.06	7.2	12.02	98	20	1.9	26.24	0.034	0.439	Flow estimate only.
3/14/2011	1:45:00 PM	8.15	7.1	12.11	78	30	2.2		0.027	0.365	Boe's totally flooded. Too deep to reach bridge. Sampled at Rich Road culverts, downstream side.
4/11/2011	2:45:00 PM	10.33	7.2	12.43	95	25	1.8	27.00	0.026	0.347	Flow estimate only.
5/17/2011	2:00:00 PM	11.60	7.3	11.83	89	25	1.4	29.46	0.029	0.218	Bank full, flows from bridge, estimate.
6/14/2011	2:00:00 PM	14.11	7.5	10.61	107	80	2.0	12.81	0.038	0.147	
7/12/2011	1:30:00 PM	15.54	7.6	10.03	112	90	2.8	10.59	0.042	0.130	
8/8/2011	3:20:00 PM	15.80	7.6	10.07	114	40	3.6	8.00	0.047	0.044	
9/12/2011	5:40:00 PM	15.86	7.5	9.57	116	80	1.5	6.95	0.030	0.076	



PART OF DESCHUTES RIVER WATERSHED

LENGTH OF LAKE: Approximately 1/3 mile

SHORELINE LENGTH: 1.4 miles

LAKE SIZE: 65 acres

BASIN SIZE: 0.95 square miles

MEAN DEPTH: 33 feet

MAXIMUM DEPTH: 67 feet

VOLUME: 2,100 acre-feet

PRIMARY LAND USES:

The majority of the basin is suburban with moderate to high density residential and a large plant nursery on the west side.

PUBLIC ACCESS:

Washington Department of Fish and Wildlife public boat launch, four private community accesses.

PRIMARY LAKE USE:

Fishing, boating and swimming.

GENERAL TOPOGRAPHY:

The lake is located at an altitude of 126 feet. The topography of the basin is lowlands and rolling hills with occasional glacial depressions. The lake is located in a deep glacial depression. It is fed by ground water springs and has no surface water inlet or outlet channel.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Good - the lake has low levels of nutrients. Uses are not impeded by rooted aquatic plants, however spring algae blooms have been occurring in recent years. The lake is on the WDOE 303(d) list of impaired waterbodies for PCB contamination in fish.

Ward Lake

OTHER AVAILABLE DATA:

Water Quality data since 1992 - Thurston County Environmental Health Division, www.co.thurston.wa.us/health/ehswat/swater.htm. (360) 867-2626

Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681
www.co.thurston.wa.us/monitoring

Washington Department of Ecology, Environmental Assessment Program (360) 407-6700, (water quality data)

GENERAL DISCUSSION:

Ward Lake is a steep-sided spring-fed glacial depression, or kettle. It has no surface inlet or outlet, but is ground water fed. Nutrient levels are fairly low. The lake supports a light growth of aquatic plants, limited in large part by the depth of the lake.

In 2011 the ambient monitoring consisted of monthly sampling, May through October, at one monitoring site located in a deep area of the lake. The parameters included temperature, dissolved oxygen, pH, conductivity, and secchi disk readings. Samples were collected near the surface and near the lake bottom and analyzed for total phosphorus and total nitrogen. Composite samples from the epilimnion (warm surface layer) or photic zone were collected and analyzed for chlorophyll *a* and algae identification. The data is located at the end of this report.

Field Parameters

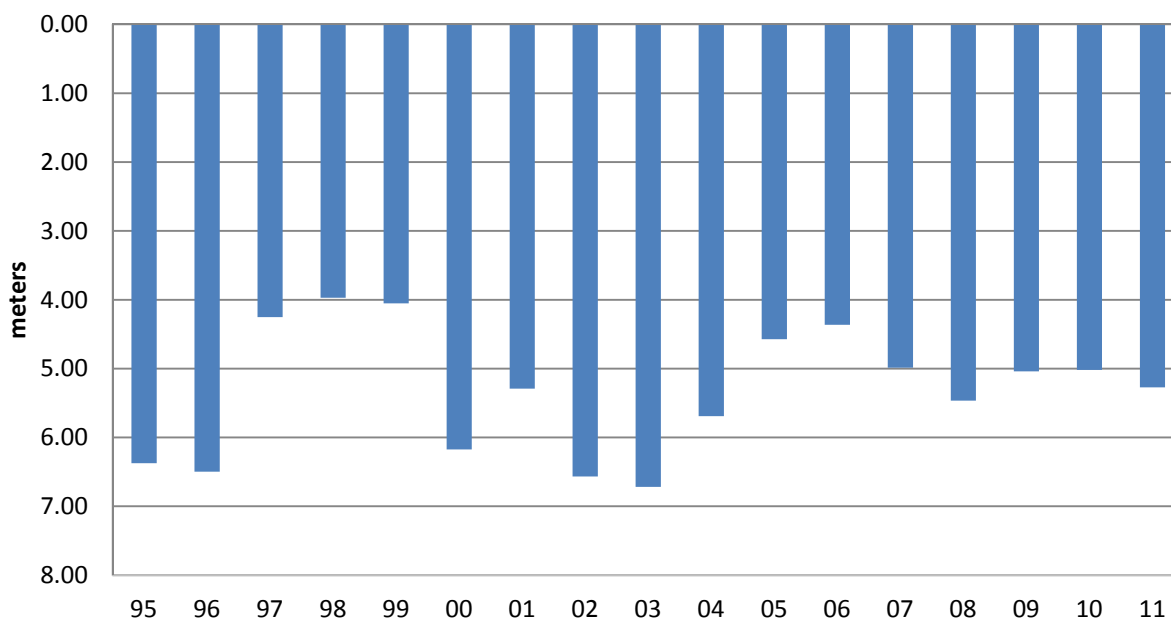
Monthly temperature, dissolved oxygen, pH, and conductivity profile graphs are included on page 8. The term “thermal stratification” refers to a condition in the lake when there are two distinct layers of water, a warm upper layer and a cold bottom layer. In 2011 Ward Lake was already stratified in May, and remained stratified throughout the sampling season. The surface temperature reached 22.5 degrees Celsius in August and was warm to a depth of about four meters. Below four meters the temperature quickly cooled, and was about 6 degrees Celsius in the bottom five meters of the lake.

When the lake is thermally stratified, there is no exchange of oxygen from the atmosphere into the bottom waters. During that time, bacterial decomposition of material in the lake sediment, such as aquatic plants, algae, and other organic matter, depletes the available dissolved oxygen in the bottom water. This condition is called “anoxic”, and the lake was anoxic at the bottom throughout the sampling season. The low oxygen levels near the lake bottom can be seen in the monthly profile graphs. Low oxygen conditions near the lake bottom allow the nutrients to be released from the sediment into the water in a form easily utilized by algae cells. When the lake finally mixes, sometime in winter or early spring, the nutrient-rich water brought up from the bottom can stimulate algae growth resulting in visible algae “blooms”. This phenomenon has been observed more frequently in recent years on Ward Lake.

Secchi Disk Water Clarity

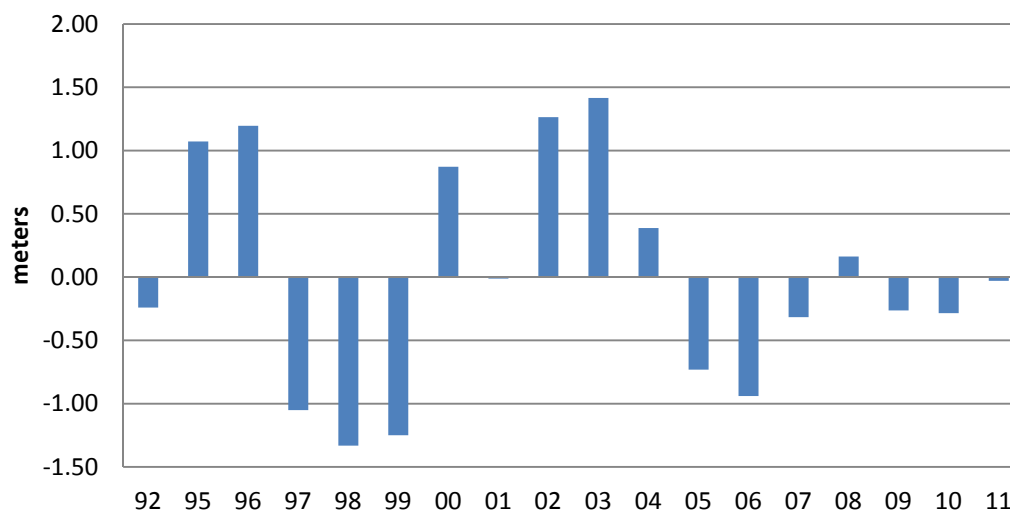
Water clarity in a lake is measured with a device called a secchi disk. In 2011, the water clarity ranged from 4.7 meters (15.4 feet) in July to 6.3 meters (20.6 feet) in June. The average for the season was 5.3 meters (17.3 feet). The graph on the following page shows the annual average secchi disk results for 17 years of record. The graph shows that the average water clarity has varied up to 2.5 meters from year to year and appears somewhat cyclical in nature, but with slightly decreased water clarity in the past seven years.

Ward Lake Water Clarity Average Secchi Readings



This trend is more clearly illustrated with the graph below entitled 'Water Clarity Trend'. The trend graph shows the difference between each year's annual average secchi readings and the average secchi reading for the entire period of record. Graphing the water clarity data in this way helps to visually see true trends in water quality versus normal annual fluctuations. For Ward Lake, the water clarity seems to fluctuate one to one and an half meters better than or lower than the overall average. However, for the past 7 years the water clarity has been at or less than the overall average.

Water Clarity Trend Annual Average Minus Long-Term Average



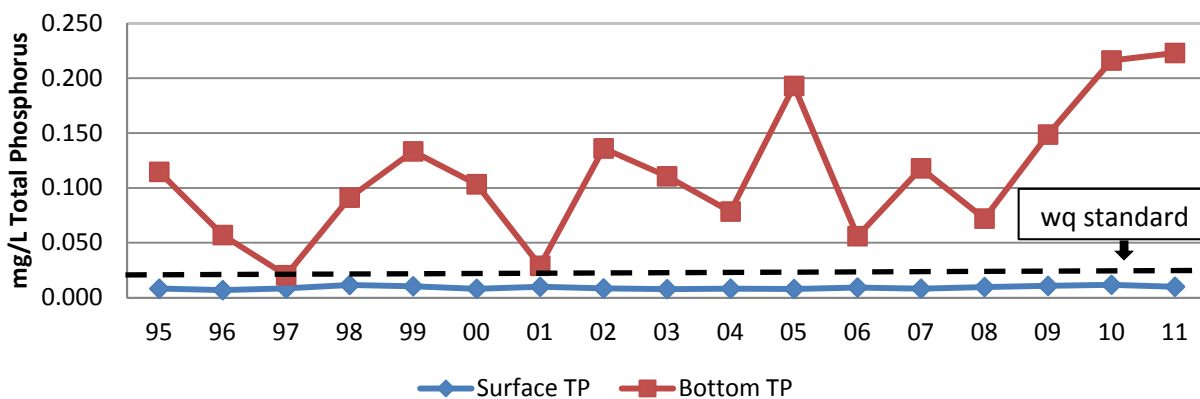
Ward Lake

Total Phosphorus Levels

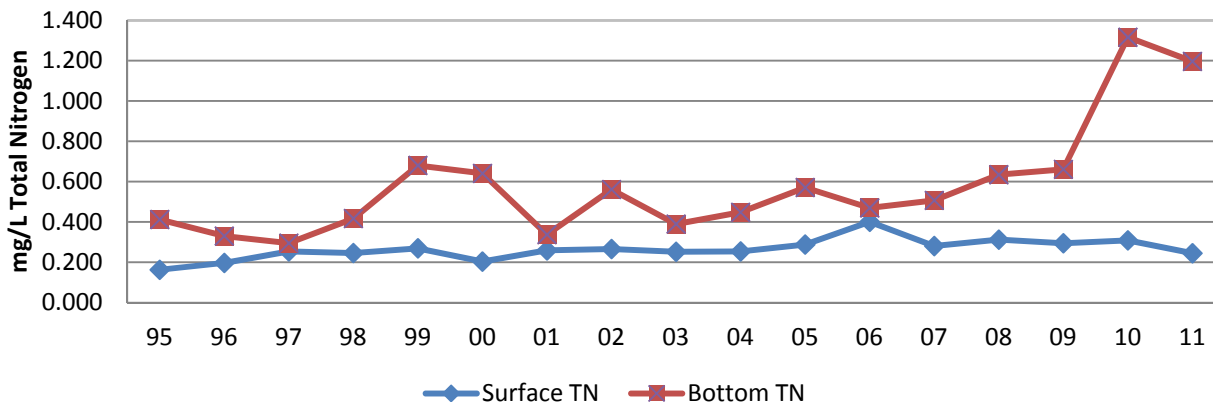
Generally, lakes in the Puget Sound region with summer average surface total phosphorus concentrations greater than 0.030 mg/l experience undesirable algae growth which interferes with recreational uses of the lake (USGS Water Supply Paper 2240). The action level established in WAC 173-201A, "Water Quality Standards for Surface Water of the State of Washington" is 0.020 milligrams per liter (mg/l).

In 2011 the average surface total phosphorus concentration in Ward Lake was 0.010 mg/l, and the individual monthly results were all below the action level. As is the case in most Thurston County Lakes, the total phosphorus concentration at the bottom is typically higher than at the surface, especially during periods of stratification. In most lakes, including Ward Lake, the algae growth is limited by the amount of available phosphorus. The two graphs below shows the annual average total phosphorus and total nitrogen concentrations at the surface and near the bottom for the period of record.

Total Phosphorus Annual Averages

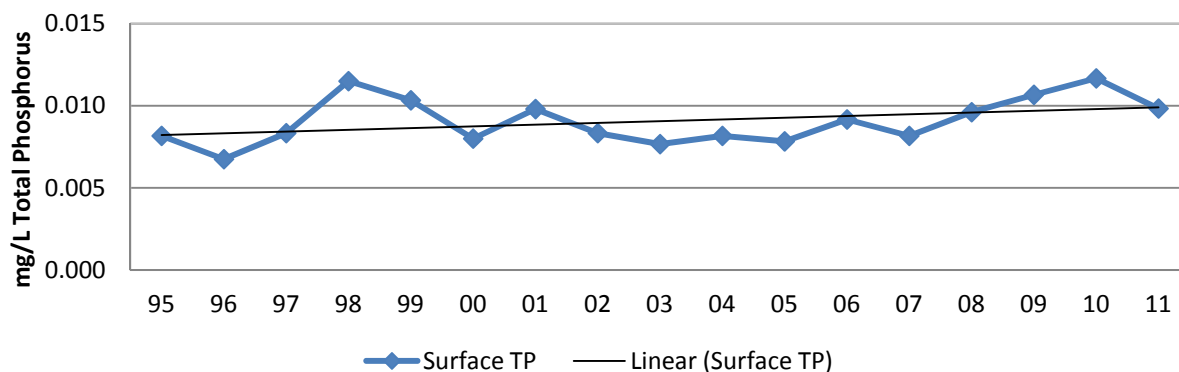


Total Nitrogen Annual Averages

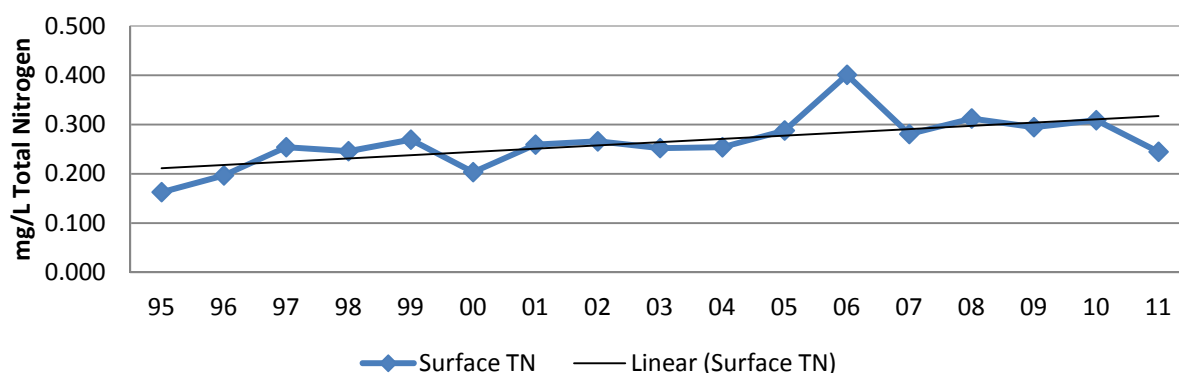


The three graphs below show the only the surface concentrations for phosphorus, nitrogen, and chlorophyll *a* along with a linear trend line. It appears, from these graphs, that nutrients and algae productivity are steadily increasing, which is an indication that pollution is increasing.

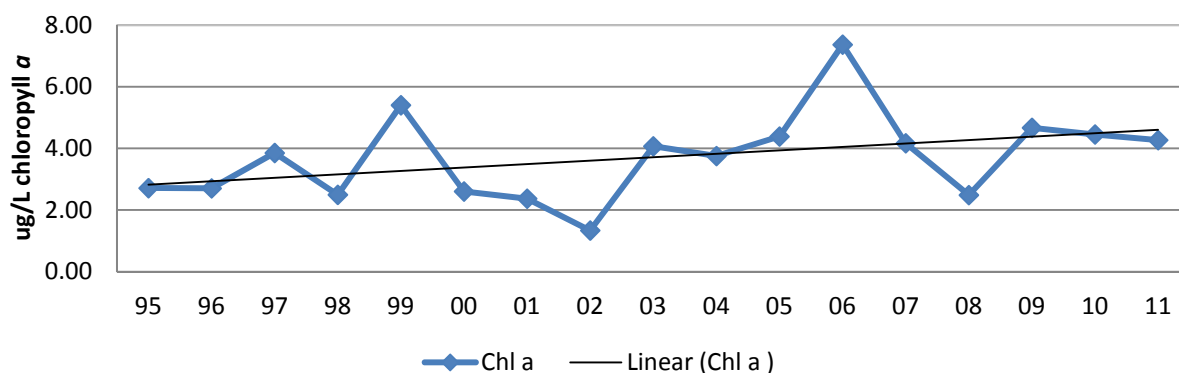
Total Phosphorus Annual Average at Surface



Total Nitrogen Annual Average at Surface



Chlorophyll *a* Annual Average at Surface



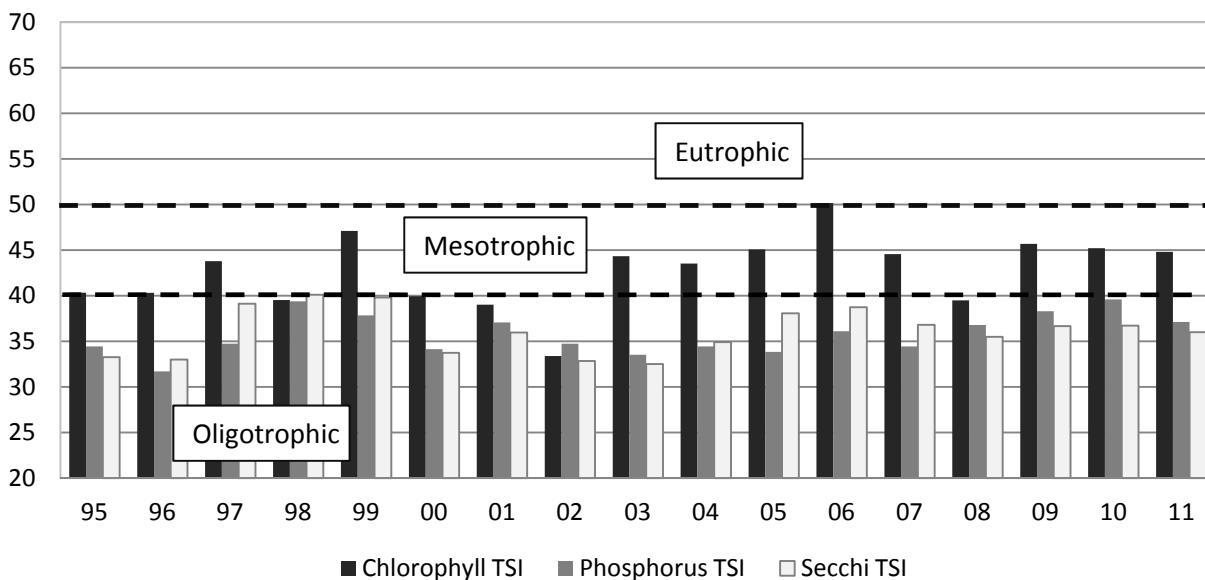
Ward Lake

Trophic State Indices

The Carlson trophic state indices (TSI) are used to express the degree of productivity of a lake. Average summer total phosphorus concentrations, chlorophyll *a* concentrations, and secchi disk transparency are each used to calculate a TSI. A TSI of 0 to 40 indicates an oligotrophic, or low productivity, lake. A TSI of 41 to 50 indicates a mesotrophic, or moderately productive lake. A TSI of greater than 50 indicates a eutrophic, or highly productive lake. Eutrophic lakes have high nutrient levels, high plant and algae growth, low clarity, and are general considered to have poor water quality.

The 2011 TSIs for total phosphorus, chlorophyll *a*, and secchi disk transparency measurements were 37, 45, and 36 respectively. The 2011 TSIs for phosphorus and secchi disk were in oligotrophic range, or low productivity, but the chlorophyll TSI was in the mesotrophic, or moderately productive range. The graph below shows the TSIs for each year since 1995. The graph shows that the chlorophyll TSI index has consistently been in or near the mesotrophic range since 2003. Reports of the occurrence of late winter / early spring algae blooms since 2005 may be an indication of a gradual shift in water quality conditions to a more productive system.

Ward Lake Trophic State Indices



Chlorophyll and Algae

The monitoring program includes sampling for chlorophyll *a* and identification of algae types present in the lake. Chlorophyll *a* is the green pigment found in plants, including algae, and is used as a measure of the amount of algae growth in a lake. The average 2011 chlorophyll *a* concentration was 4.27 micrograms per liter ($\mu\text{g/l}$), which is low. This year the highest chlorophyll level measured was in August, 9.6 micrograms per liter. The annual average chlorophyll is graphed on page 5.

There are a variety of algae types present in Ward Lake including green, yellow, and blue-green. Blue-green algae species are most common in nutrient-rich lakes and are known to cause visible algae “blooms”. Lakes with high nutrient levels and poor water quality tend to be dominated by

blue-green algae, while green algae are more common in oligotrophic lakes. In 2011, blue-green species were present in every monthly sample. A shift from green algae dominance to blue-green dominance may be an indication that the lake is becoming more nutrient-rich and changing from a low productivity state to a higher productivity state. A list of the algae species present in the monthly lake samples is located at the end of the chapter.

Some species of blue-green algae can produce toxins that can cause illness, or even death, in people, pets, and wildlife if ingested. Pets are particularly vulnerable to poisoning from toxic algae blooms due to their smaller body weight and their tendency to ingest higher doses by drinking lake water and licking their fur after swimming. In recent years there has been an increase in documented toxic blue-green algae blooms occurring in lakes within Washington State.

Because toxicity cannot be determined through visual observations, in 2009 Thurston County Environmental Health began using screening test kits to test for the presence of the most common algae toxin, microcystin. When the screening indicates the presence of microcystin, a sample is sent to a laboratory to quantify the amount of toxin present. The laboratory services are a statewide program sponsored by Washington Department of Ecology. Although toxin testing is now possible, lake residents and users should always observe lake conditions and avoid contact with lake water where an algae bloom is occurring.

More information about blue-green algae and swimming safety information is available through the Thurston County website: www.co.thurston.wa.us/health/ehadm/swimming/swimming_index.html

Major Issues:

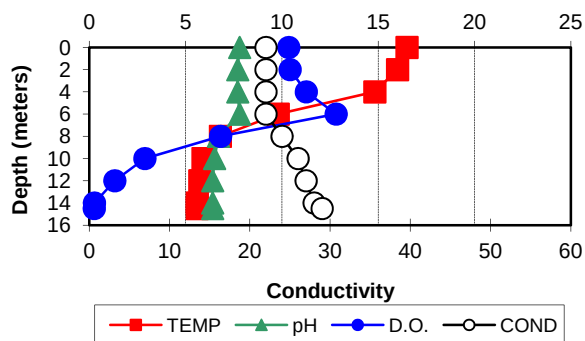
- The lake is located in a basin that is developing rapidly. Stormwater flows directly into Ward Lake in at least three locations from high density residential areas. Conversion of a former plant nursery on the west side on the lake to a planned urban village has been under way for several years. Accidental sewage spills and storm-related soil erosion incidents into Ward Lake have occurred in the past.
- Conflict between lake users at the Washington Department of Fish and Wildlife public access has been a controversial issue. However, the City of Olympia is developing a public park on the south east end of the lake.
- Ward Lake is listed on Washington State's Clean Water Act Section 303(d) list of impaired water bodies for excursion above the edible fish tissue criteria for polychlorinated biphenyls (PCB's). The source of the PCB's is undetermined. The contact agency for this listing is the Washington State Department of Ecology.
- The increasing occurrence of late winter/early spring algae blooms and apparent increases in nutrients and chlorophyll a production may be an indication of water quality degradation and possible impacts from development.

Funding Sources:

County funds will continue to support monitoring in 2012.

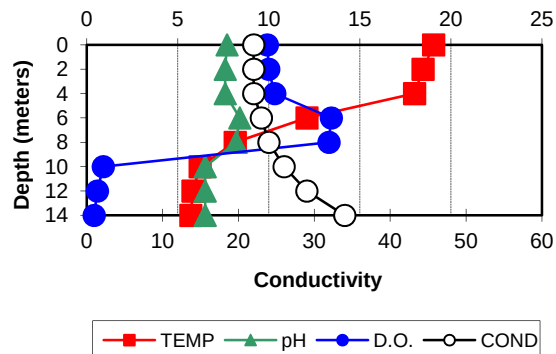
May 24, 2011

Temperature, pH, Dissolved Oxygen



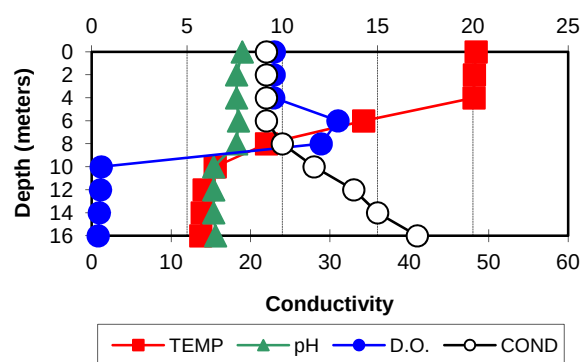
June 21, 2011

Temperature, pH, Dissolved Oxygen



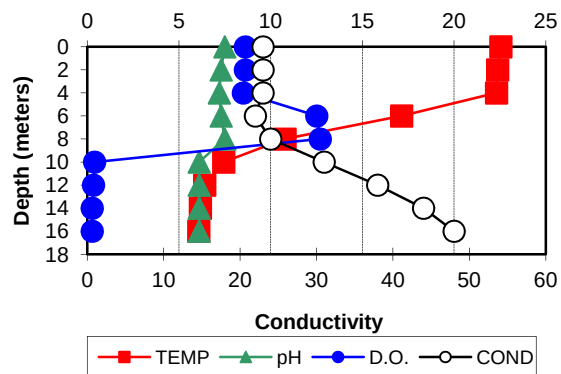
July 18, 2011

Temperature, pH, Dissolved Oxygen



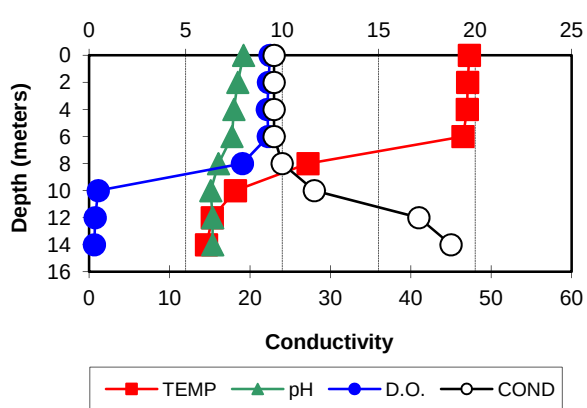
August 23, 2011

Temperature, pH, Dissolved Oxygen



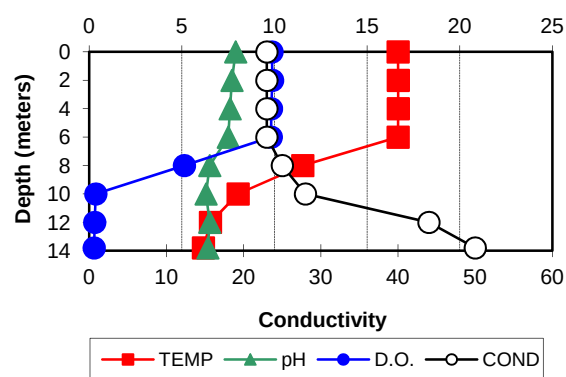
September 19, 2011

Temperature, pH, Dissolved Oxygen



October 10, 2011

Temperature, pH, Dissolved Oxygen



Thurston County Water Resources Annual Report - 2011

Ward Lake

Site ID# DESWAL000

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water	Lake Notes
05/24/2011	11:00:00 AM	14.5	13.5	0.013	0.107	0.266	0.606	5.18	1.6	0.05	#6 yellow-green	Chl a & algae composite @ 1, 3 & 5M. Phaeo a was < detection at 0.1ug/L.
06/21/2011	10:30:00 AM	14.2	13.0	0.012	0.149	0.189	0.574	6.28	2.1	0.1	#3 yellow-green	Chl a & algae composite @ 2, 4 & 6M.
07/18/2011	10:30:00 AM	16	15.0	0.010	0.054	0.246	0.700	4.70	3.8	0.05	#2 lt green	Chl a & algae composite @ 2, 4 & 6M. Phaeo a was < detection at 0.1ug/L. Lots of algae suspended in H2O column. Looks like fuzzy balls.
08/23/2011	10:30:00 AM	16.7	16.0	0.006	0.429	0.275	1.880	5.45	9.6	0.7	#2 lt green	Chl a & algae composite @ 2, 5 & 8M.
09/19/2011	11:45:00 AM	14	13.0	0.010	0.280	0.229	1.500	4.83	3.2	0.3	#6 yellow-green	Chl a & algae composite @ 2, 4 & 6M.
10/10/2011	11:30:00 AM	13.8	13.0	0.008	0.319	0.263	1.920	5.20	5.3	0.3	#2 lt green	Chl a & algae composite @ 2, 4 & 6M.

Summary for 'Site Description' = Ward Lake (6 detail records)

Averages: Sur TP 0.010
 Secchi 5.27
 Chl a 4.3

Algae data: Ward Lake

	Type	Description	Dominant in Sample
05/24/2011			
	BG	Anabaena species	☐
	BG	Aphanizomenon species	☐
	CP	Cryptomonads	☐
	GR	Botryococcus species	☒
	GR	Closterium species	☐
	GR	Elakatothrix species	☐
06/21/2011			
	BG	Anabaena species	☐
	BG	Aphanizomenon species	☐
	DT	Asterionella species	☐
	GR	Botryococcus species	☐
	GR	Closterium species	☐
	GR	Cosmarium species	☐
	GR	Crucigenia species	☐
	GR	Elakatothrix species	☐
	GR	Gloeocystis species	☐
07/18/2011			
	BG	Aphanizomenon species	☐
	CP	Cryptomonads	☐
	GR	Crucigenia species	☐
	GR	Oocystis species	☐
	GR	Quadrigula species	☐
	YL	Dinobryon species	☐
	YL	Synura species	☐
08/23/2011			
	BG	Aphanizomenon flos-aquae	☒
	EU	Trachelomonas species	☐
	YL	Dinobryon species	☐

09/19/2011

Type	Description	Dominant in Sample
BG	Aphanizomenon species	☐
BG	Merismopedia species	☐
CP	Cryptomonads	☐
GR	Botryococcus species	☐
GR	Elakatothrix species	☐
GR	Eutetramorus globosus	☐
GR	Scenedesmus species	☐
YL	Dinobryon species	☐

10/10/2011

BG	Anabaena species	☐
BG	Aphanothece species	☐
BG	Chroococcus species	☐
BG	Gloeocapsa species	☐
BG	Merismopedia species	☐
CP	Cryptomonads	☐
EU	Trachelomonas species	☐
GR	Botryococcus species	☐
GR	Elakatothrix species	☐
GR	Eudorina species	☐
GR	Eutetramorus globosus	☐
YL	Dinobryon species	☐

Key: BG = Blue green EU = Euglenophyte
CP = Cryptophyte GR = Green
DF = Dinoflagellate YL = Yellow
DT = Diatom

Chehalis Watershed

WRIA 23

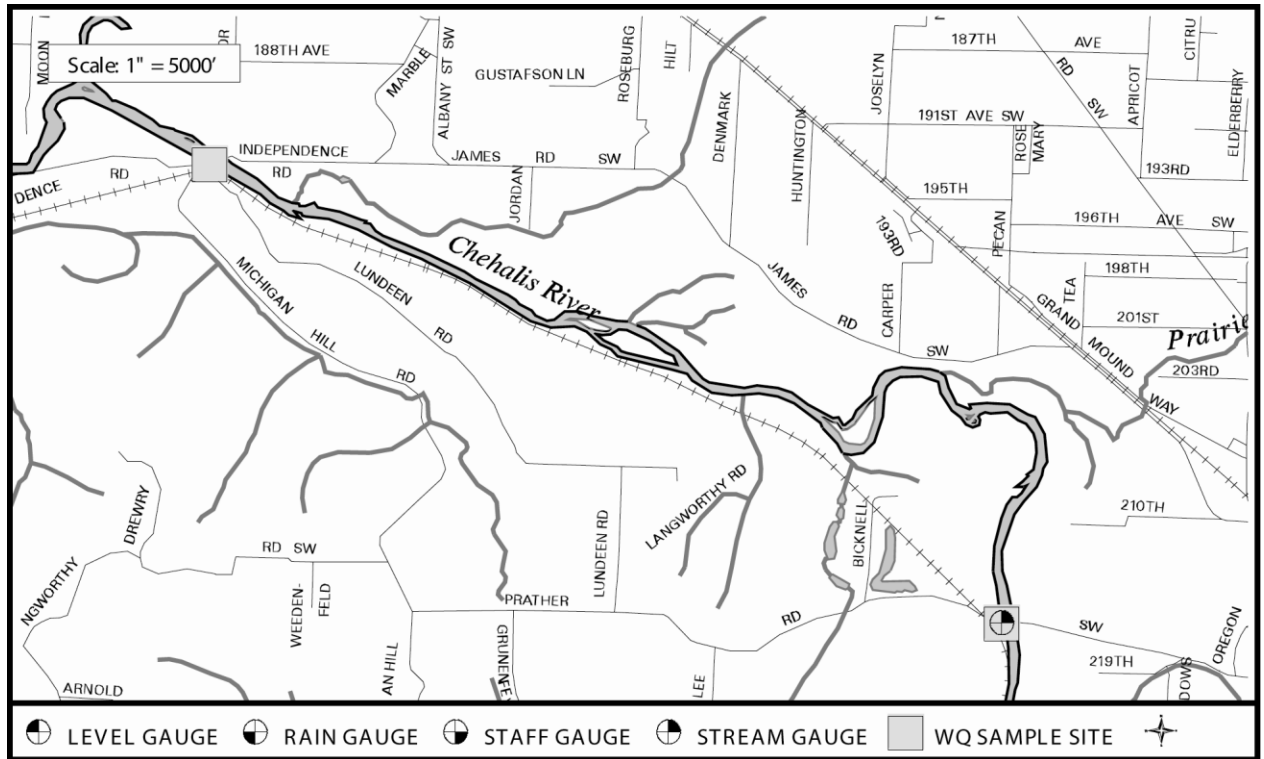
Chapter Includes:

Chehalis River

Prairie Creek

Scatter Creek

Skookumchuck River



PART OF CHEHALIS WATERSHED

LENGTH OF RIVER: 126 miles

BASIN SIZE: 2,660 square miles

PRIMARY LAND USES: In Thurston County, the land uses are primarily agriculture, rural residential, and forest land. The small communities of Rochester and Grand Mound are located within the Chehalis drainage basin.

FISHERIES RESOURCES: (From A Catalog of Washington Steams and Salmon Utilization, WDOF)

Coho, Chum, Chinook

GENERAL TOPOGRAPHY: The Chehalis River basin is the second largest river basin in Washington outside the Columbia River basin. The basin includes forested headwaters in the Gifford Pinchot and Olympic National Forests as well as private timber lands. The river discharges into the Pacific Ocean via Grays Harbor in the Aberdeen area.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Good – Met fecal coliform, dissolved oxygen and pH standard. High mid-summer temperatures occur. Turbidity violations occurred in both the 2009/10 & 2010/11 water years during the winter.

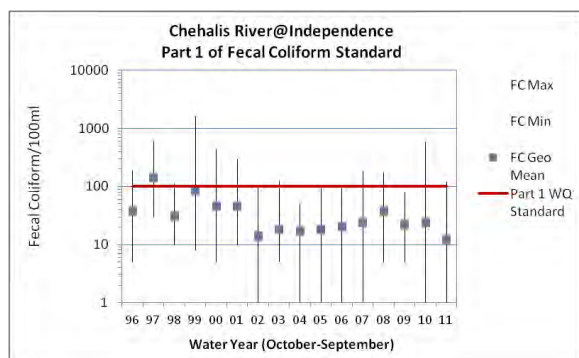
OTHER DATA:

Washington State Department of Ecology, Environmental Assessment Program (360) 407-6000.

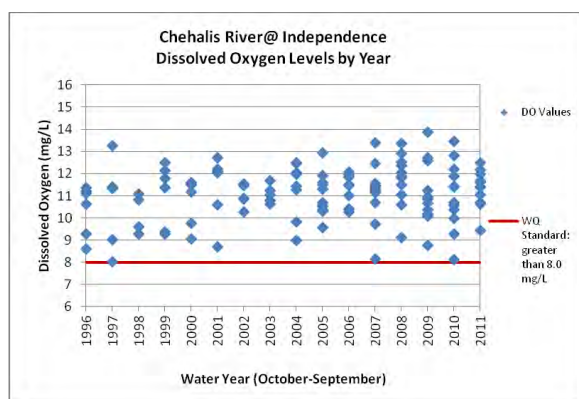
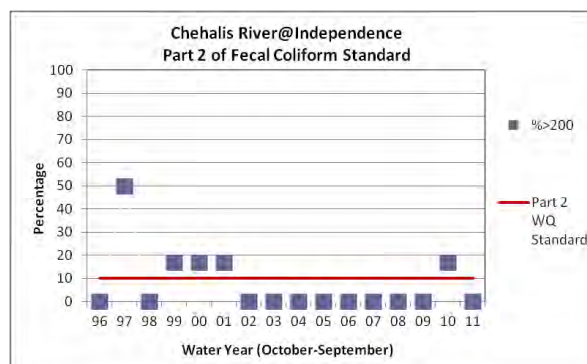
Thurston County Environmental Health Division (360) 867-2626 (water quality data for 1991-1993) or www.co.thurston.wa.us/health/ehswat/swater.html

Thurston County Resource Stewardship Department, Water Resources Program, (360) 754-4681 (flow data from 1992) or www.co.thurston.wa.us/monitoring

Chehalis River #0190

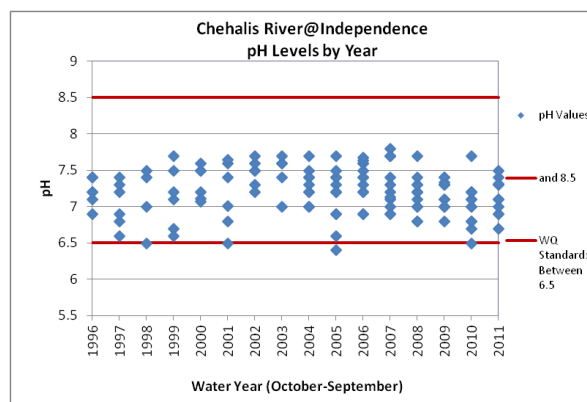


The river has met Part 1 of the fecal coliform standard since 1997 but failed Part 2 in five water years in the period of record including 2009/10.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. The dissolved oxygen standard has been met every water year of the record.

The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. There has been one occurrence of the pH dropping outside the allowable range in 2005.



Discussion:

The Chehalis River has been monitored as part of the ambient monitoring program since 1996. It is monitored at the Independence Road bridge, which is at river mile 54. There is historic water quality data for the Chehalis at Prather Road for 1996-1998, available on the web site at www.co.thurston.wa.us/health/ehswat/swater.html.

There are two temperature standards that apply at both of these monitoring locations on the Chehalis River. The primary temperature criteria of a 7-day average daily (DAD) maximum of 17.5° C, and additional criteria of a 7-DAD maximum of 13° C to protect salmon and trout spawning and incubation period between October 1 through May 15. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. There was one measurement slightly over 13° C in October 2009, indicating possible temperature standard violations. Water temperatures above 17.5° C were measured in July and August of both of the last two water years, as well as September in 2011 indicating probable temperature standard violations during the mid-summer period.

The Washington Department of Ecology completed a total maximum daily load study in the Chehalis River in 1994 to address water quality problems that included high temperatures and low dissolved oxygen.

Major Issues:

- During summer low-flow conditions, high water temperatures and low dissolved oxygen levels exist.
- Non-point pollution from rural land-uses and point discharges to the river in the Centralia and Chehalis area contributes to water quality problems.

Funding Sources:

- Thurston County

Water Quality Summary
Conventional Parameters
Chehalis River at Independence Road

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1996-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		1.88 – 19.91 4.56 – 19.28			2.1 - 20.88
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		8.13 – 13.47 9.46 – 12.49	0 of 12 0 of 11		8.04 - 13.9
Conductivity	µmhos/cm		09/10 10/11	103 100	66 - 153 63 - 133		94	42 – 176
pH		6.5 - 8.5	09/10 10/11	7.0* 7.2*	6.5 - 7.7 6.7 – 7.5	0 of 12 0 of 11	7.2*	6.4 – 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	31.5 14	0.90 - 317 0.50 – 88.4	2 of 12 2 of 11	12.6	0 - 228
Fecal Coliform	colonies/ 100 mL	GMV: ≤ 100 and ≤ 10% not to exceed 200	09/10 10/11	24** 12**	0 - 580 0 - 120	% exceeding 200	29**	0 - 1600
						17% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.083 0.073	0.020 – 0.568 0.015 – 0.275		0.058	0.017 - 0.58
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	0.574 0.544	0.294 – 0.829 0.354 – 0.733		0.690	0.295 – 1.06

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

Chehalis River @ Independence Rd

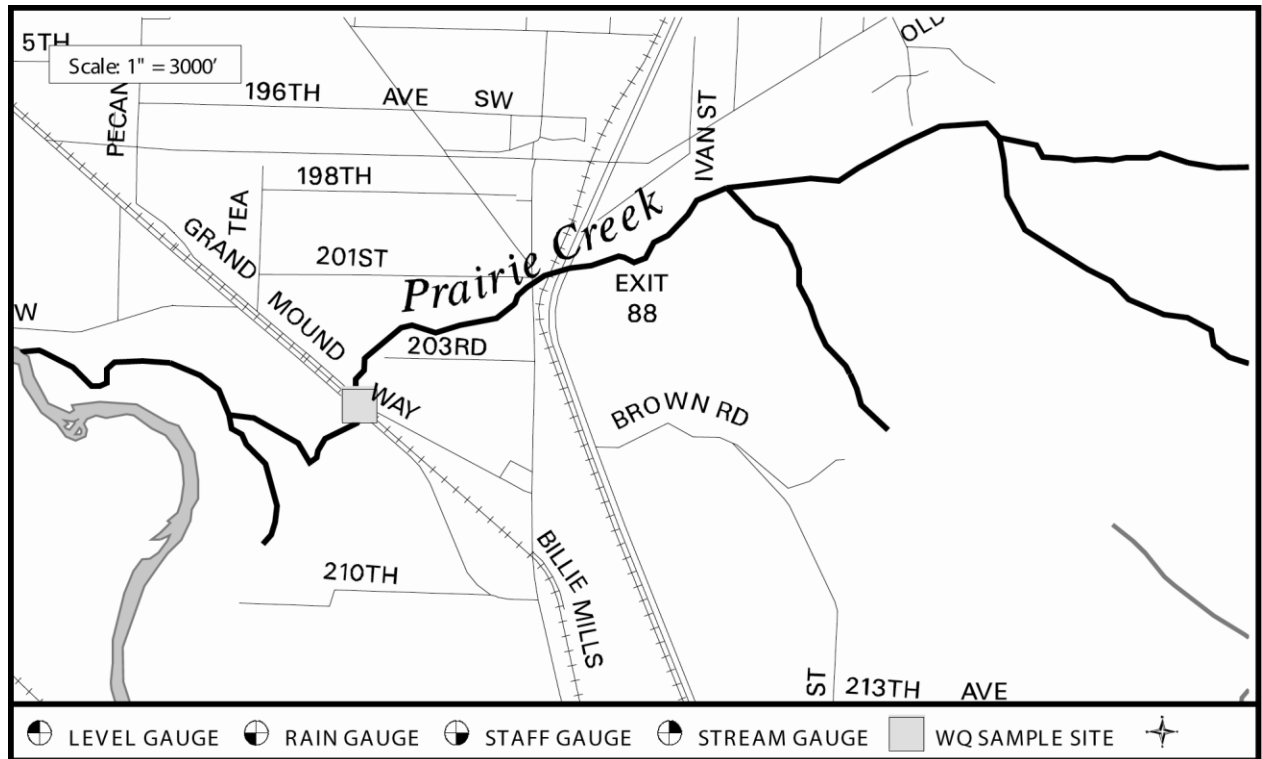
<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/21/2009	1:00:00 PM	13.15	7.2	10.01	105	15	2.5	581	0.043	0.527	USGS flow data
11/18/2009	12:00:00 PM	8.06	6.5	12.21	66	380	317.0	18700	0.568	0.829	USGS flow data
12/14/2009	2:55:00 PM	1.88	7.0	13.47	153	10	7.0	1430	0.041	0.558	USGS flow data
1/12/2010	11:30:00 AM	7.56	6.7	11.88	83	580	20.3	6860	0.069	0.629	USGS flow data
2/9/2010	11:50:00 AM	7.67	6.8	11.43	121	10	4.9	2090	0.033	0.610	USGS flow data
3/15/2010	11:00:00 AM	6.42	7.0	12.82	84	25	10.2	3410	0.037	0.605	USGS flow data
4/20/2010	11:00:00 AM	12.22	6.8	10.37	100	15	3.8	2280	0.033	0.572	USGS flow data
5/12/2010	11:50:00 AM	11.92	7.1	10.70	94	15	3.3	1750	0.047	0.294	USGS flow data. Duplicates labeled "Independence".
6/16/2010	12:10:00 PM	12.85	7.1	10.57	80	40	6.0	2210	0.041	0.449	USGS flow data
7/14/2010	12:00:00 PM	19.85	7.7	11.40	108	10	1.1	537	0.020	0.444	USGS flow data
8/18/2010	11:30:00 AM	19.91	7.2	8.13	122	30	0.9	200	0.027	0.691	USGS flow data
9/15/2010	10:20:00 AM	15.97	7.2	9.30	118	0	1.0	261	0.032	0.684	USGS flow data. FC reported as <5.

Thurston County Water Resources Monitoring Report 2010-2011

Chehalis River @ Independence Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2010	11:10:00 AM	10.02	7.3	11.40	133	0	0.7	516	0.033	0.587	USGS flow data. FC reported as <5.
11/15/2010	11:10:00 AM	9.04	6.9	11.71	93	55	6.8	3230	0.045	0.464	USGS flow data
12/15/2010	11:10:00 AM	7.17	6.7	11.42	63	50	88.4	18300	0.275	0.719	USGS flow data
1/10/2011	1:45:00 PM	4.56	6.9	11.99	97	15	9.1	4190	0.039	0.661	USGS flow data
2/15/2011	12:40:00 PM	6.83	7.1	12.19	91	120	30.0	5450	0.102	0.518	USGS flow data
3/15/2011	2:00:00 PM					60		14500	0.168	0.572	USGS flow data. No field measurements. Unable to change cords on YSI. Running bank full and turbid.
4/13/2011	1:00:00 PM	8.48	7.0	12.49	90	5	8.6	4400	0.053	0.465	USGS flow data
5/18/2011	12:15:00 PM	12.33	7.1	11.65	107	10	7.4	3260	0.040	0.354	USGS flow data
6/15/2011	12:40:00 PM	14.21	7.3	11.05	93	0	1.9	1040	0.023	0.359	USGS flow data. FC reported as <5.
7/13/2011	12:00:00 PM	17.93	7.4	10.64	101	0	1.4	593	0.015	0.462	USGS flow data. FC reported as <5.
8/10/2011	2:00:00 PM	19.28	7.5	10.72	115	25	1.2	327	0.046	0.630	USGS flow data
9/13/2011	1:45:00 PM	17.78	7.3	9.46	119	10	0.5	199	0.032	0.733	USGS flow data

Prairie Creek #0729



PART OF CHEHALIS WATERSHED

LENGTH OF CREEK: 5.5 miles

BASIN SIZE: Undetermined

STREAM ORDER: 2

PRIMARY LAND USES:

Rural Residential
Agriculture

FISHERIES RESOURCES: (From [A Catalog of Washington Streams and Salmon Utilization](#), WDOF)
Coho and Chum

GENERAL TOPOGRAPHY: Moderately sloped forested headwaters, middle and lower basins are predominantly prairie with slopes less than 15%. Stream gradient is fairly low.

Portions of the stream lose water to the groundwater, due to the extremely porous nature of prairie soils in the area. The creek is dry during the summer months at the sampling station off Old Highway 9.

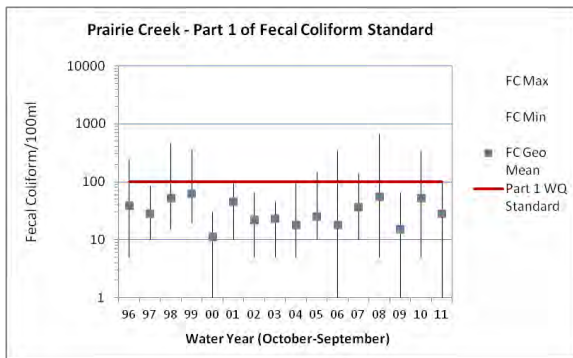
GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Good. Part 2 of the fecal coliform standard was violated in 2009/10. There were three pH standard violations in 2009/10 and one in 2010/11. The creek met all other standards.

OTHER DATA:

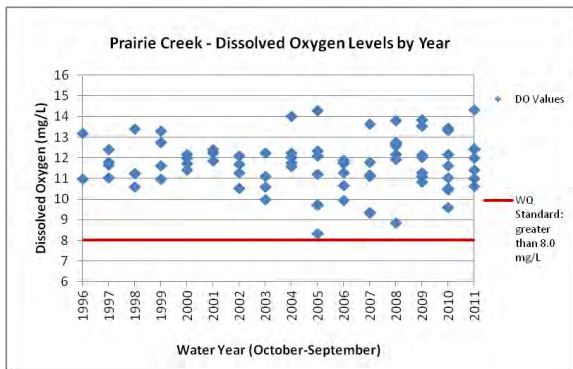
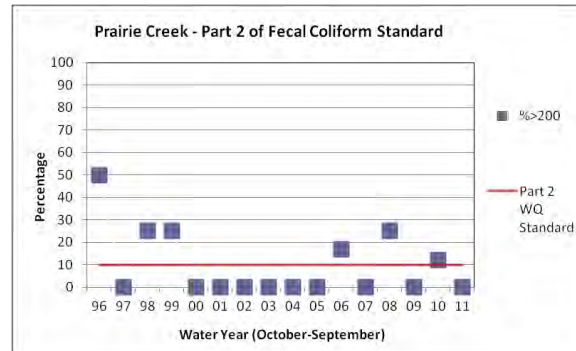
Thurston County Environmental Health Division, (360) 867-2626,
www.co.thurston.wa.us/health/ehswat/swater.html

Prairie Creek #0729



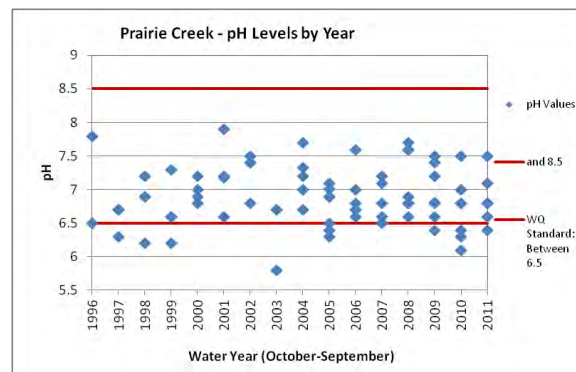
Prairie Creek has met part 1 of the fecal coliform water quality standard to date. However, Part 2 has been violated six times since monitoring began in 1996 including 2009/10.

The water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 100 colonies/100mL *and* Part 2 - no more than 10% of the samples shall exceed 200 colonies/100 mL.



The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. Throughout the period of record there are several measurements below the standard. There were five measurements below the standard over the last two water years.

The water quality standard for dissolved oxygen is a lowest one-day minimum of 8.0 mg/L. The dissolved oxygen in Prairie Creek has never gone below the standard for the period of record.



Discussion:

The Thurston County Health Department has been monitoring Prairie Creek since March 1996. Prairie is a seasonal creek and does not flow in the summer months. The creek is primarily groundwater fed. Nitrate levels were lower in the last four years than in past years. The lower nitrate levels were most likely the result of a decrease in groundwater concentrations. The water quality failed part 2 of the fecal coliform standard in 2009/10. It met both parts of the standard in 2010/11. There were three pH standard violations in 2009/10 and one in 2010/11. Overall the water quality is good.

Funding Sources:

- Thurston County Stormwater Utility

Water Quality Summary

Conventional Parameters

Prairie Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1996-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		-0.15 – 13.12 3.36 – 12.76			-0.02 – 13.81
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		9.6 – 13.44 10.62 – 14.34	0 of 8 0 fo 7		8.33 – 14.3
Conductivity	µmhos/cm		09/10 10/11	51 49	44 - 57 47 - 51		49	38 – 78
pH		6.5 - 8.5	09/10 10/11	6.8* 6.8*	6.1 – 7.5 6.4 – 7.5	3 of 8 1 of 7	6.8*	5.8 – 7.9
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	4.8 5.6	2.8 – 9.4 3.6 – 8.7	0 of 8 0 of 7	6.4	2.4 - 28
Fecal Coliform	colonies / 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	53** 28**	5 - 340 0 - 100	% exceeding 200	28**	0 - 665
						12% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.038 0.026	0.024 – 0.063 0.018 – 0.033		0.040	<0.002 - 0.161
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	0.338 0.699	<0.010 – 0.903 0.229 – 1.33		0.766	<0.010 - 2.07

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

Prairie Creek @ Old Hwy 9

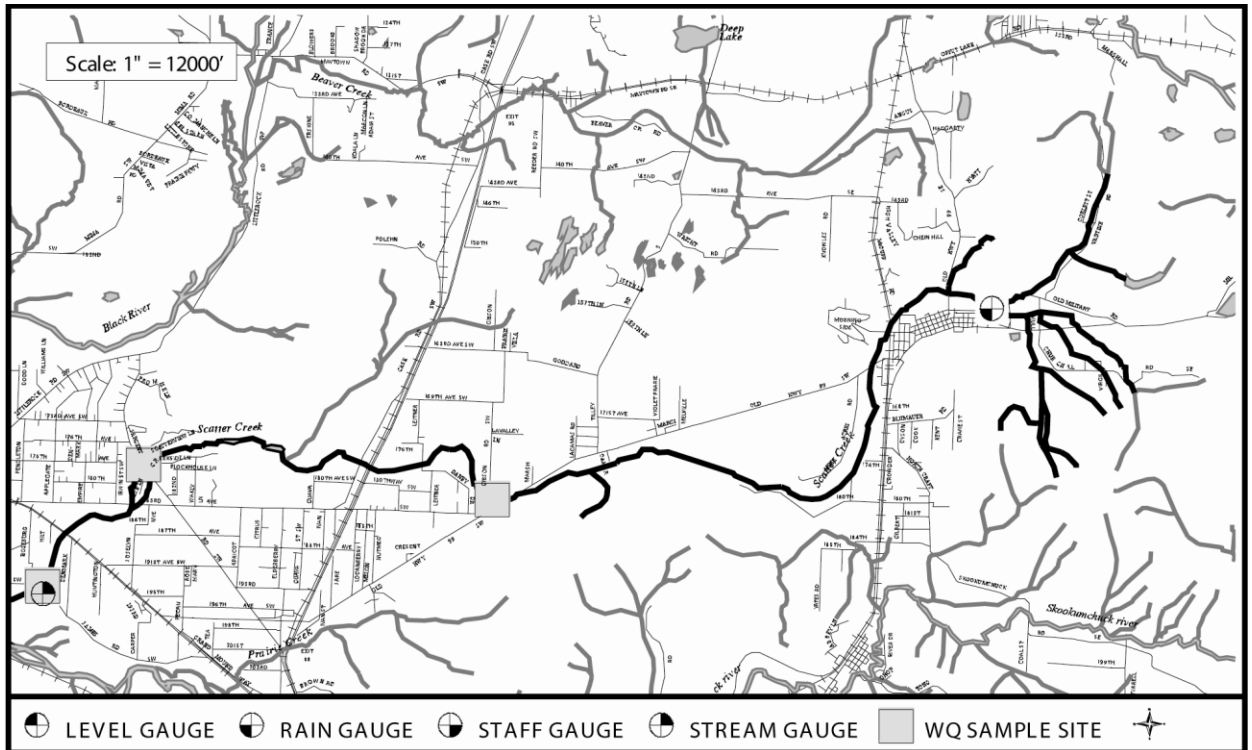
<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/21/2009	11:40:00 AM										Dry
11/18/2009	1:10:00 PM	7.25	6.3	10.46	50	340	9.4	38.42	0.046	0.854	
12/14/2009	4:00:00 PM	-0.15	6.4	13.33	56	80	6.0	1.71	0.039	0.257	
1/12/2010	12:30:00 PM	7.47	6.1	10.52	45	50	5.2	20.73	0.026	0.903	
2/9/2010	1:20:00 PM	7.27	6.8	11.62	48	5	3.9	4.06	0.024	0.347	
3/15/2010	12:50:00 PM	6.62	6.8	13.44	44	30	5.0	6.74	0.029	0.285	
4/20/2010	12:05:00 PM	12.23	7.0	11.04	51	40	2.9	3.08	0.035	0.019	
5/12/2010	12:50:00 PM	12.73	7.5	12.16	54	60	2.8	1.42	0.038	< 0.005	NOX reported <0.010
6/16/2010	1:15:00 PM	13.12	7.0	9.60	57	100	3.5	4.08	0.063	0.045	
7/14/2010	12:35:00 PM										Dry
8/18/2010	12:20:00 PM										Dry.
9/15/2010	11:00:00 AM										Dry.

Thurston County Water Resources Monitoring Report 2010-2011

Prairie Creek @ Old Hwy 9

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2010	10:25:00 AM										Dry.
11/15/2010	12:00:00 PM	9.35	6.8	10.99	51	40	5.2	3.08	0.033	0.229	
12/15/2010	11:55:00 AM	6.32	6.4	10.62	48	50	6.9		0.026	1.330	No flow measurement. Coho present
1/10/2011	2:45:00 PM	3.36	6.6	12.44	49	40	3.6	13.33	0.018	1.020	
2/15/2011	1:50:00 PM	6.13	6.8	11.98	48	100	8.7	15.24	0.032	0.722	
3/15/2011	2:40:00 PM	8.24	6.8	11.43	47	20	5.6	26.24	0.019	1.020	
4/13/2011	2:45:00 PM	8.83	7.5	14.34	48	0	4.0	5.34	0.023	0.306	FC reported as <5.
5/18/2011	1:00:00 PM	12.76	7.1	12.42	49	70	4.9	11.10	0.028	0.268	
6/15/2011	1:15:00 PM										Dry.
7/13/2011	12:40:00 PM										Dry.
9/13/2011	3:00:00 PM										Dry.

Scatter Creek #0716



PART OF CHEHALIS WATERSHED

LENGTH OF CREEK: 20.6 miles

BASIN SIZE: 43 square miles

STREAM ORDER: 3

PRIMARY LAND USES:

Rural Residential
Agriculture

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)

Coho, Chum, Cutthroat

GENERAL TOPOGRAPHY:

Moderately sloped forested headwaters, middle and lower basins are predominantly prairie with slopes less than 15 percent. Stream gradient is fairly low. Portions of the stream are losing reaches to the groundwater system, due to the extremely porous nature of soils in the area.

GENERAL WATER QUALITY:

(Excellent, Good, Fair, Poor)

Good – Meets most water quality standards. The creek has elevated nutrients and possible temperature violations.

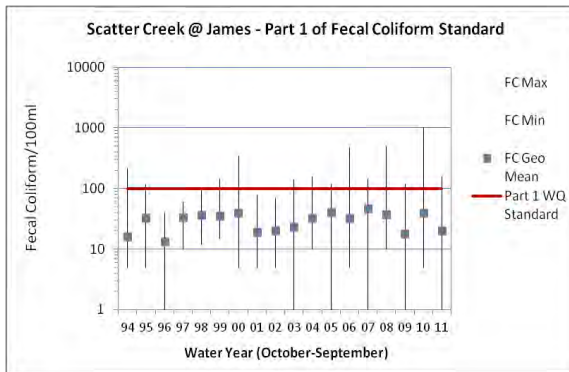
OTHER DATA:

Washington State Department of Ecology
SWRO (360) 407-6000
(Ground water level data 1981-1986,
Ground water quality data 1989-1990,
Stream flow data 1981-1990).

Thurston County Environmental Health
Division (360) 867-2626 (Surface and
groundwater quality data).
www.co.thurston.wa.us/health/ehswat/swater.html

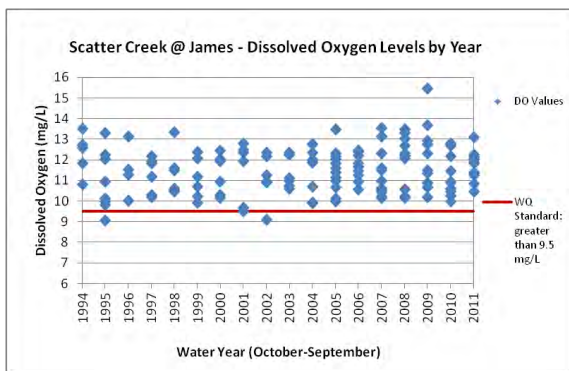
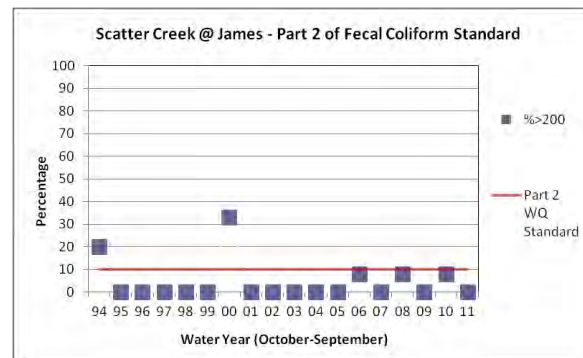
Thurston County Resource Stewardship
Department, Water Resources Program, Storm
Water Utility (360) 754-4681 or
www.co.thurston.wa.us/monitoring

Scatter Creek #0716



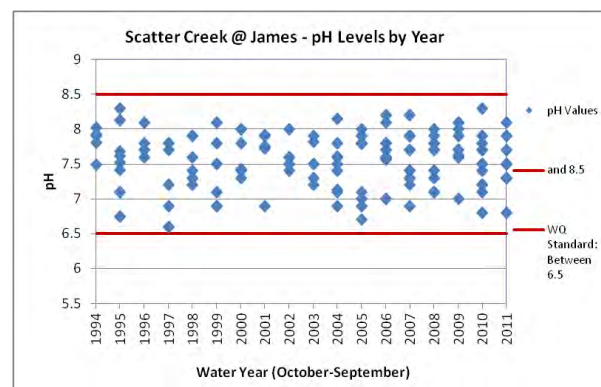
The state water quality standard for fecal coliform bacteria has two parts: Part 1 - the geometric mean shall not exceed 100 colonies per 100 milliliters of sample *and*, Part 2 - no more than 10% of the samples shall exceed 200 colonies per 100 mL.

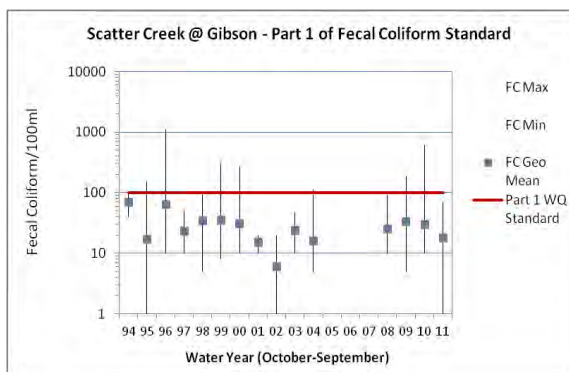
Both parts of the fecal coliform standard have been met since 2000.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. There have been no violations since 2002.

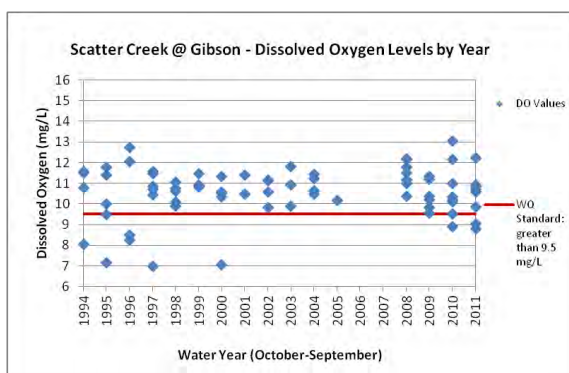
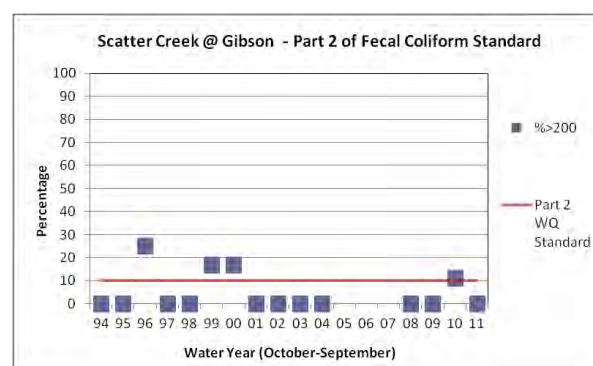
The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. The creek has met the pH standard every water year.





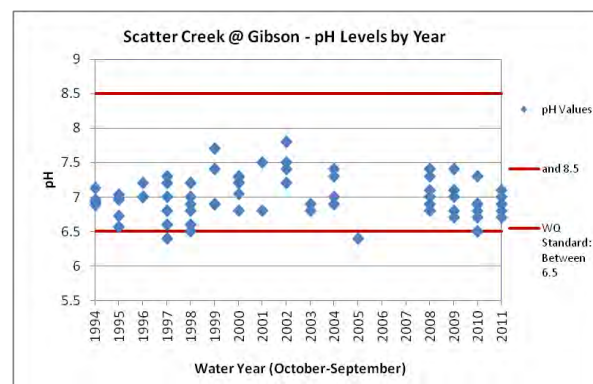
Part 1 of the fecal coliform standard has been met in every water year on record. The creek failed Part 2 in 2009/10.

Scatter Creek at Gibson Road Bridge is located at approximately stream mile 8. The same fecal coliform standards apply at this site as at James Road.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. There have been no violations since 2000.

The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. The creek has met the pH standard for the past four water years.



Discussion:

Thurston County Environmental Health Division began monitoring Scatter Creek in September 1993. The current monitoring program consists of two sampling sites. The downstream-most station is located at James Road near Scatter Creek's confluence with the Chehalis River. The upstream sampling site at stream mile 8 is located at the Gibson Road crossing on Violet Prairie. Monitoring done between 1993 and 2002 generally consisted of sample collection during the wet season, December through March, and during late summer and early fall. In December 2003, the sampling frequency was increased to monthly, which now generates twelve data points per year.

At Gibson Road the creek is in a losing reach, and becomes stagnant, isolated pools during the summer and early fall. When that condition exists, no sampling is done. The data from the James Road and Gibson Road sampling sites for water years 2009/10 and 2010/11 are included at the end of this chapter.

There are two temperature standards that apply in the lower reach of Scatter Creek at the James Road site. The primary criteria, intended to protect core summer salmonid habitat, is a 7-day average daily maximum (DAD-Max) of 16° C. An additional temperature criterion of a 7-day average daily maximum of 13° C to protect salmon and trout spawning and incubation applies between February 15 and July 1. The 16° C DAD-Max applies to the Gibson Road site. Temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations.

At James Road, water temperatures slightly above 13° C were measured in May 2010 and May and June 2011. Temperatures were above 16° C in August 2010, indicating possible temperature standard violations during those periods. During the months when the creek was flowing at the Gibson Road site, the temperature measurements were cooler than the maximum temperature criterion.

Scatter Creek has elevated nutrient levels, especially nitrate. The high nitrate levels are generally a reflection of the groundwater quality which provides the base flow for the creek. While there is no water quality standard for nitrate in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015). The nitrate concentration for Scatter Creek at James Road is often more than ten times the regional reference condition.

The total phosphorus regional reference condition is 0.019 mg/l, according to the EPA report. Total phosphorus is high in Scatter Creek at James Road. The total phosphorus concentration tends to be closer to the reference condition upstream at Gibson Road.

Major Issues:

- Non-point source pollution from agriculture, septic systems, and rural residential land uses.
- Habitat loss from sedimentation and reed canary grass infestations.
- Native riparian vegetation is lacking in some areas
- Ground water samples show nitrate and coliform bacteria contamination in the Scatter Creek aquifer

Funding Sources:

- Thurston County Stormwater Utility

Water Quality Summary
Conventional Parameters
Scatter Creek at James Road

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1994-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		3.84 – 16.16 5.34 – 15.64			-0.09 – 18.94
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		9.97 – 12.78 10.47 – 13.09	0 of 12 0 of 12		9.04 – 15.4
Conductivity	µmhos/cm		09/10 10/11	149 146	84 - 268 73 - 259		139	61 – 219
pH		6.5 - 8.5	09/10 10/11	7.5* 7.5*	6.8 – 8.3 6.8 – 8.1	0 of 12 0 of 12	7.6*	6.6 - 8.3
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	1.55 1.53	0 – 5.3 0 – 4.2	0 of 12 0 of 12	1.91	0 - 12.2
Fecal Coliform	colonies/ 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	40** 20**	5 - 1025 0 - 160	% exceeding 200	30**	0 – 498
						8% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.065 0.063	0.043 - 0.109 0.024 – 0.122		0.081	0.023 - 0.590
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	1.82 1.73	0.861 – 3.09 0.594 – 3.07		2.54	0.726 - 7.57

*Median

**Geometric mean value (GMV)

Water Quality Summary
Conventional Parameters
Scatter Creek at Gibson Road

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1994-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		4.89 – 14.03 5.81 – 13.74			4.6 – 20.29
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		8.9 – 13.05 8.82 – 12.25	1 of 8 2 of 9		2.4 – 12.8
Conductivity	µmhos/cm		09/10 10/11	88 87	71 - 98 70 - 104		84	56 - 104
pH		6.5 - 8.5	09/10 10/11	6.8* 6.9*	6.5 – 7.3 6.7 – 7.1	0 of 9 0 of 9	7.0*	6.4 – 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	1.46 1.57	0 – 6.1 0 – 3.7	0 of 9 0 of 9	2.64	0 - 15
Fecal Coliform	colonies/ 100 ml	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	30** 18**	10 - 620 0 - 70	% exceeding 200	30**	0 – 2015
						11% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.030 0.031	0.016 – 0.067 0.013 – 0.046		0.040	0.008 – 0.54
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	0.607 0.635	0.315 – 0.964 0.218 – 0.924		0.697	<0.010 – 1.27

*Median

**Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

Scatter Creek @ James Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/21/2009	11:45:00 AM	11.40	7.4	10.47	199	40	0.1	18.08	0.106	3.090	Staff gage - 1.36'
11/18/2009	12:30:00 PM	7.32	7.1	12.78	109	40	5.0	21.34	0.096	1.900	Staff gage - 1.42' . Coho.
12/14/2009	3:15:00 PM	3.84	7.7	12.68	164	30	1.5	14.35	0.109	2.210	Staff gage - 1.30
1/12/2010	12:00:00 PM	7.95	6.8	10.91	84	20	5.3		0.045	0.861	Staff gage - 2.79'. No flow. Too deep to wade.
2/9/2010	12:15:00 PM	8.17	7.2	11.45	119	35	1.2	53.21	0.052	1.560	Staff gage - 1.87'
3/15/2010	11:30:00 AM	7.58	7.5	12.77	113	25	2.3	57.88	0.048	1.300	
4/20/2010	11:25:00 AM	11.96	7.2	10.58	116	15	0.0	58.98	0.046	1.400	Staff gage - 1.96'
5/12/2010	12:15:00 PM	13.03	8.3	12.16	134	5	0.5	38.65	0.046	1.370	Staff gage - 1.63'
6/16/2010	12:45:00 PM	12.22	7.5	10.58	119	35	0.5	52.28	0.048	1.070	Staff gage - 1.88'
7/14/2010	12:25:00 PM	15.76	7.9	10.92	171	60	0.4	22.00	0.043	1.930	Staff gage - 1.44'
8/18/2010	11:55:00 AM	16.16	7.8	9.97	191	70	0.6	18.93	0.061	2.130	Staff gage - 1.42'.
9/15/2010	10:40:00 AM	13.25	7.7	10.24	268	1025	1.2	15.88	0.083	3.000	Staff gage - 1.39'

Thurston County Water Resources Monitoring Report 2010-2011

Scatter Creek @ James Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2010	10:35:00 AM	8.78	7.5	11.35	259	15	0.0	16.52	0.111	3.070	Staff gage - 1.44'.
11/15/2010	11:30:00 AM	9.53	7.5	12.22	181	20	0.6	4.35	0.122	1.820	Staff gage - 1.03'. Creek very low.
12/15/2010	11:40:00 AM	6.97	6.8	11.24	73	130	4.2		0.056	0.891	Flooding. Staff gage 3.6'
1/10/2011	2:00:00 PM	5.34	7.3	12.02	106	5	0.8	91.34	0.042	1.280	Duplicates labeled "Hay"
2/15/2011	1:10:00 PM	7.41	7.3	11.98	106	40	2.7	76.79	0.052	1.410	Staff Gage - 2.20'.
3/15/2011	2:30:00 PM	8.97	7.3	12.14	85	10	3.1		0.026	0.960	No flow measurement, too deep to wade. Staff gage - 3.10'.
4/13/2011	2:00:00 PM	9.58	7.5	13.09	107	0	1.3	119.38	0.034	1.050	FC reported as <5. Staff gage - 2.58'.
5/18/2011	12:30:00 PM	13.22	7.5	11.83	95	55	3.1	125.52	0.054	0.594	Staff gage - 2.50'.
6/15/2011	1:00:00 PM	13.01	7.9	11.85	149	0	0.9	31.98	0.050	1.780	FC reported as <5. Staff gage - 1.61'.
7/13/2011	12:20:00 PM	14.60	7.9	10.84	189	160	0.7	24.35	0.024	2.330	
8/10/2011	2:30:00 PM	15.64	8.1	11.39	201	48	0.5	21.34	0.076	2.690	Staff gage - 1.44. Duplicates labeled "Leedy".
9/13/2011	2:00:00 PM	14.21	7.7	10.47	199	55	0.4	21.93	0.108	2.870	

Thurston County Water Resources Monitoring Report 2009-2010

Scatter Creek @ Gibson Rd

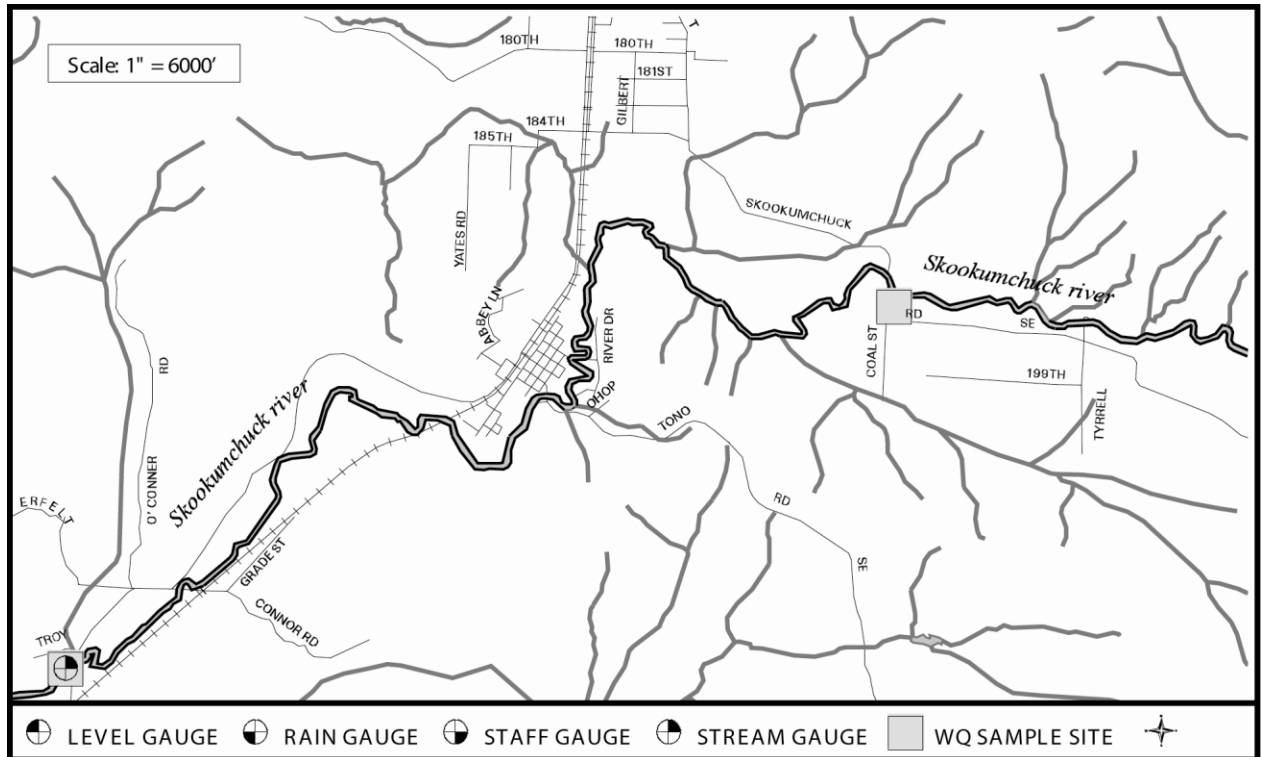
<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/21/2009	11:35:00 AM										Stagnant.
11/18/2009	2:30:00 PM	7.27	6.5	11.00	71	620	6.1		0.067	0.537	
12/14/2009	11:00:00 AM	4.89	6.8		98	20	1.0		0.016	0.964	DO not working.
1/12/2010	1:30:00 PM	8.45	6.5	10.35	75	10	1.7		0.025	0.657	Osprey.
2/9/2010	2:00:00 PM	8.54	6.7	10.13	93	20	1.1		0.032	0.893	
3/15/2010	1:00:00 PM	7.88	6.9	12.15	84	35	2.5		0.033	0.643	
4/20/2010	1:10:00 PM	11.54	6.9	10.17	91	25	0.0		0.026	0.629	
5/12/2010	1:55:00 PM	12.29	7.3	13.05	92	10	0.5		0.025	0.413	
6/16/2010	2:20:00 PM	11.93	6.9	8.90	90	30	0.2		0.031	0.315	
7/14/2010	2:00:00 PM	14.03	6.9	9.53	98	20	0.0		0.019	0.415	
8/18/2010											Stagnant.
9/15/2010	11:15:00 AM										Stagnant.

Thurston County Water Resources Monitoring Report 2010-2011

Scatter Creek @ Gibson Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2010	10:15:00 AM										Stagnant
11/15/2010	1:10:00 PM	10.02	6.8	8.82	93	10	0.0		0.024	0.385	
12/15/2010	12:15:00 PM	6.81	6.7	10.58	70	30	2.8		0.040	0.824	
1/10/2011	3:20:00 PM	5.81	6.8	10.86	88	10	0.6		0.030	0.871	
2/15/2011	2:30:00 PM	7.62	6.9	10.72	89	40	3.7		0.046	0.924	
3/15/2011	3:15:00 PM	8.71	6.9	10.95	75	20	3.1		0.025	0.626	
4/13/2011	3:15:00 PM	9.52	7.0	12.25	87	0	1.1		0.030	0.591	FC reported as <5.
5/18/2011	2:15:00 PM	12.96	6.9	10.90	77	65	2.2		0.038	0.218	
6/15/2011	2:15:00 PM	12.04	7.1	9.87	96	10	0.4		0.029	0.653	USGS flow data
7/13/2011	1:40:00 PM	13.74	6.9	9.04	104	70	0.2		0.013	0.626	Staff gage - 1.48'
8/10/2011	3:10:00 PM										Stagnant.
9/13/2011	3:30:00 PM										Stagnant.

Skookumchuck River #0761



PART OF CHEHALIS WATERSHED

LENGTH OF CREEK: 21.9 miles to dam

BASIN SIZE: 181 square miles

STREAM ORDER: 4

PRIMARY LAND USES:

Commercial Forestry
Rural Residential
Agriculture

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)

Chinook, Coho, Chum, Steelhead

GENERAL TOPOGRAPHY:

Moderately to steeply sloped forested headwaters and prairie, alluvial valley, and rolling hills in the middle and lower basin. A

dam located in the upper watershed controls downstream flow to some degree.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

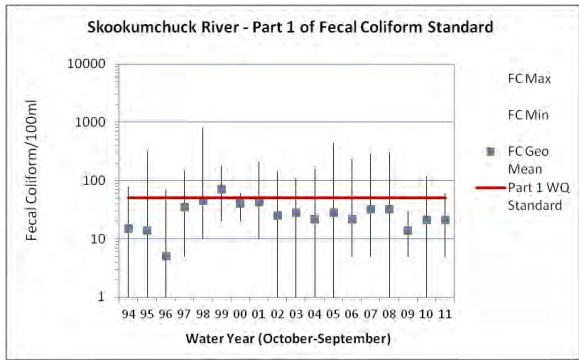
Good. Both parts of the fecal coliform standard were met each water year. There were two and three turbidity measurements above the water quality standard during the winter in 2009/10 and 2010/11 respectively. Temperature measurement in August 2010 and July and September of both water years indicate possible temperature violations.

OTHER DATA:

U.S. Geological Survey National Water Information System (river flows)
<http://waterdata.usgs.gov/nwis/rt>

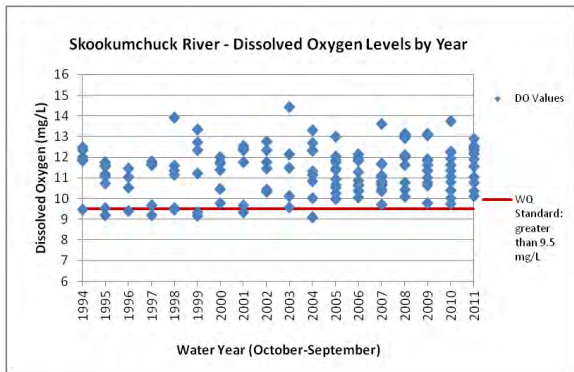
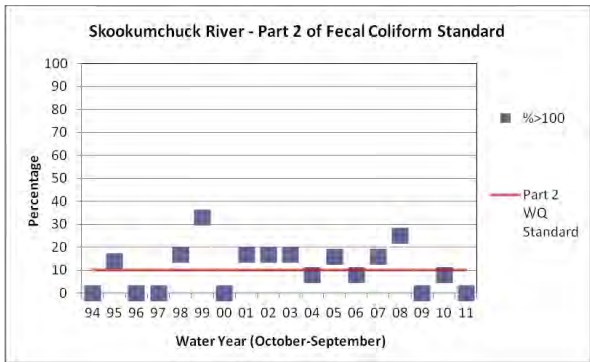
Thurston County Environmental Health Division, (360) 867-2626.
www.co.thurston.wa.us/health/ehswat/swater.html

Skookumchuck River #0761



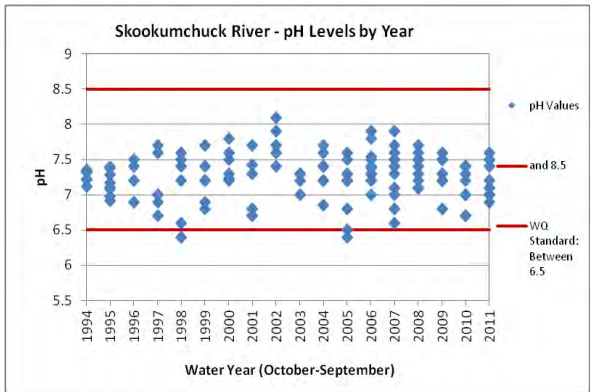
The Skookumchuck River has met Part 1 of the fecal coliform standard all water years but 1998/99. It fails Part 2 in half of the water years since sampling has been conducted, however it met Part 2 over the past three water years.

The state water quality standard for fecal coliform bacteria has two parts: Part 1 - the geometric mean shall not exceed 50 colonies per 100 milliliters of sample *and*, Part 2 - no more than 10% of the samples shall exceed 100 colonies per 100 mL.



The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been two violations, one in 1998 and one in 2005.

The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. The river has met the dissolved oxygen standard since 2005.



Discussion:

Thurston County conducted water quality sampling of the Skookumchuck River from 1982-1985 in response to concerns about high bacteria levels in the river at Schafer Park by the Lewis County Health Department. Monitoring began again on the river in September 1993 at five locations between the Highway 507 bridge, southwest of Bucoda, and the Skookumchuck Dam near Bloody Run Creek. The number of sampling sites was reduced to two in March 1996: the downstream site at Highway 507 (aka USGS Gage or SKOSK0000), and an upstream site near Coal Street (SKOSK0020). Beginning in water year 1999-2000, monitoring was reduced to one location at the Highway 507 bridge. This site is now sampled monthly. River discharge is continuously recorded by the US Geological Survey at a gage located just downstream of the sampling site.

Both parts of the fecal coliform standard were met in water years 2009/10 and 2010/11. Turbidity measurements were elevated more than 5 NTU above background conditions on two occasions in mid-winter of 2009/10 on three occasions in 2010/11.

There are two temperature standards that apply to the Skookumchuck River. The primary criteria of a 7-day average daily (DAD) maximum of 16° C to protect core summer salmonid habitat, and an additional temperature criteria of a 7-DAD maximum of 13° C applied between September 15 through July 1 to protect salmon and trout spawning and incubation. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. There was one temperature measurement greater than the 16° C DAD standard in August 2010. In July and September of both water years, the temperature measurement was greater than the 13° C DAD standard and indicates that there may have been temperature violations during this period. The other water quality standards were met during both water years at this site.

Water quality monitoring will continue as funding is available.

Major Issues:

- Non-point source pollution
- Habitat loss from erosion and sedimentation
- Native riparian vegetation is lacking in some areas along the shoreline
- Flooding, especially in the town of Bucoda and the cities of Centralia and Chehalis

Funding Sources:

- Thurston County

Water Quality Summary
Conventional Parameters
Skookumchuck River at USGS gage

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 1994-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max 16 °C ***	09/10 10/11		5.34 – 17.3 5.11 – 15.28			3.74- 17.66
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		9.74 – 13.73 10.11 – 12.90	0 of 11 0 of 12		9.1 – 14.4
Conductivity	µmhos/cm		09/10 10/11	64 59	54 - 73 48 - 69		59	42 – 77
pH		6.5 - 8.5	09/10 10/11	7.1* 7.2*	6.7 – 7.4 6.9 – 7.6	0 of 12 0 of 12	7.3*	6.4 – 8.1
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	7.8 9.2	1.7 – 25.9 2 - 28	2 of 12 3 of 12	9.5	1.1 - 99
Fecal Coliform	colonies / 100 ml	GMV: ≤ 50 and ≤ 10% not to exceed 100	09/10 10/11	21** 21**	0 - 120 5 - 60	% exceeding 100	26**	0 - 800
						8%		
						0%		
Total Phosphorus	mg/L		09/10 10/11	0.035 0.036	0.017 – 0.071 0.016 – 0.061		0.036	0.01 - 0.220
Nitrate + Nitrite- nitrogen	mg/L		09/10 10/11	0.456 0.392	0.193 – 0.972 0.175 – 0.669		0.492	0.078 - 1.25

* Median

** Geometric mean value (GMV)

*** Supplemental Spawning/Incubation Criteria – Salmon & Trout Spawning: 13°C from Sept. 15 – July 1

Thurston County Water Resources Monitoring Report 2009-2010

Skookumchuck @ USGS Gage near Hwy 507

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/21/2009	11:15:00 AM	11.99	7.0	10.40	73	30	6.8	110.00	0.032	0.195	USGS flow data
11/18/2009	3:00:00 PM	7.82	6.7	12.23	59	120	25.9	911.00	0.071	0.972	USGS flow data
12/14/2009	10:15:00 AM	5.34	7.0		60	10	10.0	273.00	0.033	0.495	DO not working. USGS flow data
1/12/2010	2:00:00 PM	7.27	6.7	11.92	54	100	19.2	1050.00	0.068	0.678	USGS flow data
2/9/2010	2:30:00 PM	6.47	7.0	12.27	60	10	5.6	324.00	0.028	0.561	USGS flow data
3/15/2010	1:30:00 PM	7.24	7.3	13.73	68	10	6.4	185.00	0.027	0.653	USGS flow data
4/20/2010	1:30:00 PM	10.35	7.0	11.33	62	10	4.4	267.00	0.029	0.524	Duplicates labeled "Lewis". USGS flow data
5/12/2010	2:40:00 PM	11.53	7.4	11.61	62	0	4.4	211.00	0.028	0.351	FC reported as <5. USGS flow data
6/16/2010	2:50:00 PM	12.13	7.2	11.07	61	85	4.4	327.00	0.044	0.344	USGS flow data
7/14/2010	2:30:00 PM	15.61	7.4	10.81	72	15	1.9	62.00	0.017	0.264	USGS flow data
8/18/2010	1:20:00 PM	17.30	7.4	9.74	70	25	1.7	38.00	0.022	0.239	Duplicates labeled "Bucoda". USGS flow data
9/15/2010	11:40:00 AM	14.80	7.4	10.02	67	30	2.6	113.00	0.021	0.193	USGS flow data

Thurston County Water Resources Monitoring Report 2010-2011*Skookumchuck @ USGS Gage near Hwy 507*

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2010	9:40:00 AM	10.14	7.5	10.77	69	20	2.0	125.00	0.024	0.206	USGS flow data
11/15/2010	1:45:00 PM	9.82	7.1	11.55	62	15	6.9	462.00	0.035	0.468	USGS flow data
12/15/2010	12:55:00 PM	6.89	6.9	12.49	53	20	19.3	2280.00	0.056	0.616	Flooding. USGS flow data
1/10/2011	3:45:00 PM	5.11	7.0	12.34	61	15	8.7	445.00	0.035	0.614	USGS flow data
2/15/2011	2:40:00 PM	6.40	7.0	12.18	59	60	16.4	393.00	0.059	0.669	USGS flow data
3/15/2011	3:45:00 PM	6.90	7.1	12.53	48	50	28.3	2290.00	0.061	0.541	River flooding some fields. USGS flow data
4/12/2011	11:30:00 AM	6.79	7.2	12.90	52	20	10.5	674.00	0.038	0.440	USGS flow data
5/18/2011	2:30:00 PM	12.22	7.2	12.17	55	20	6.2	682.00	0.028	0.262	USGS flow data
6/15/2011	2:40:00 PM	11.36	7.5	11.88	60	5	2.8	218.00	0.016	0.241	Duplicates labeled "James". USGS flow data
7/13/2011	2:00:00 PM	14.86	7.4	10.34	61	30	2.7	173.00	0.027	0.208	USGS flow data
8/10/2011	3:30:00 PM	13.99	7.5	11.04	63	25	4.0	108.00	0.026	0.260	USGS flow data
9/13/2011	3:50:00 PM	15.28	7.6	10.11	67	10	2.9	97.00	0.025	0.175	USGS flow data

Eld Watershed

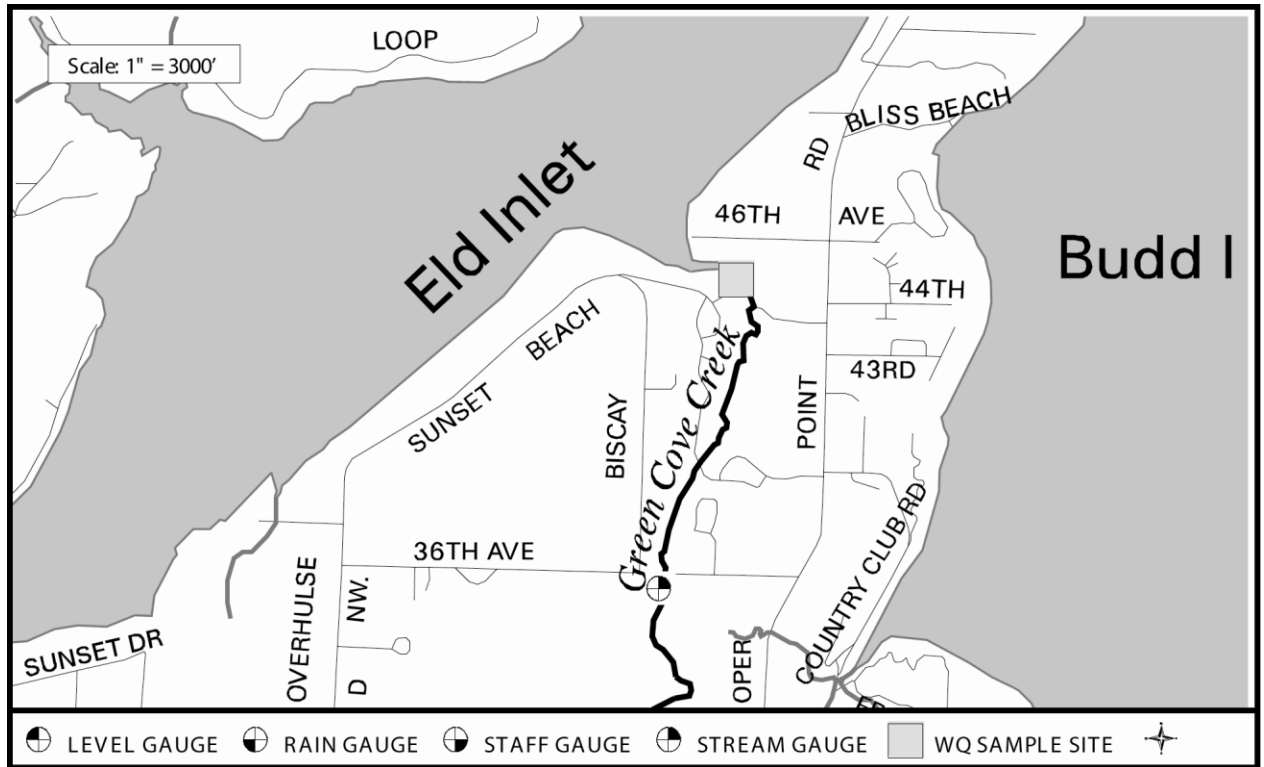
WRIA 13

Chapter Includes:

Green Cove Creek

McLane Creek

Perry Creek



PART OF ELD WATERSHED

LENGTH OF CREEK: 3.6 miles

BASIN SIZE: 3.5 square miles

STREAM ORDER: 2

PRIMARY LAND USES:

Agriculture
Rural residential

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)

Coho
Chum

GENERAL TOPOGRAPHY:

This creek originates in Lake Louise and associated wetlands and flows under Evergreen Parkway; the creek then flows through a ravine and empties into Eld Inlet at Green Cove.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

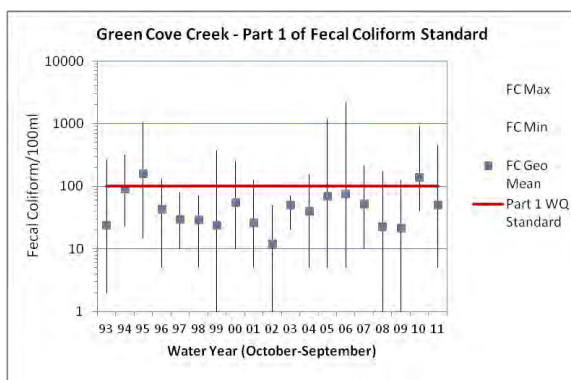
Good – Failed both parts of the fecal coliform standard in 2009/10 but met both parts in 2010/11. There were turbidity violations in November 2009, November & December 2010. All other standards were met.

OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

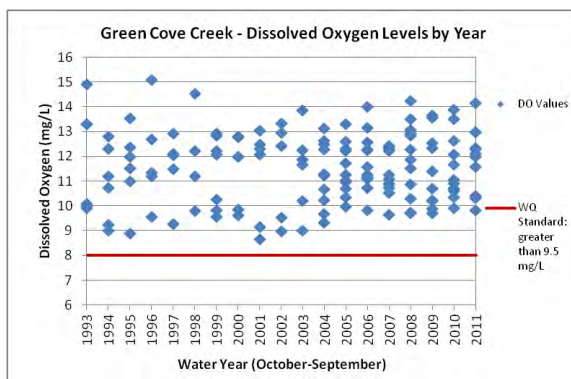
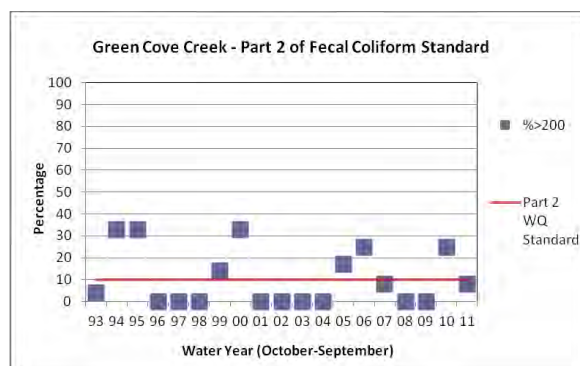
Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 or www.co.thurston.wa.us/monitoring

Green Cove Creek #0133



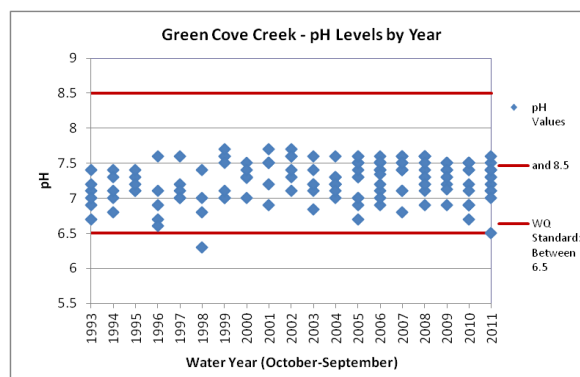
Green Cove Creek usually meets part 1 of the fecal coliform bacteria water quality standard however it failed both parts of the fecal coliform in 2009/10. In 2010/11, both parts were met.

The water quality standard for fecal coliform bacteria has two parts: part 1 - the geometric mean shall not exceed 100 colonies/100 mL of sample *and*, part 2 - no more than 10% of the samples shall exceed 200 colonies/100 mL.



The standard for pH requires the pH to be within the range of 6.5 to 8.5. The pH measurements have met the standard every year since 1998 when one measurement was below the acceptable range.

The water quality standard for dissolved oxygen is a lowest one-day minimum of 8.0 mg/L. There have been no recorded dissolved oxygen violations.



Discussion:

Green Cove Creek has been monitored by Thurston County since 1988, when the Early Action Watershed Planning effort was underway for Eld Inlet. The creek flows through rural areas as well as the more densely developed residential areas. The City of Olympia and Thurston County have adopted special stormwater and land use regulations to protect Green Cove Creek from being degraded.

While there is no water quality standard for nitrate in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015). The average nitrate concentration for Green Cove Creek is above the regional reference condition, with an overall average of 0.622 mg/l. The total phosphorus regional reference condition is 0.019 mg/l, according to the EPA report. The Green Cove Creek average total phosphorus concentration is 0.039 mg/l, which is also above the regional reference condition.

The temperature standard that applies in Green Cove Creek is intended to protect salmonid spawning, rearing and migration, and is a 7-day average daily maximum of 17.5 ° C. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. The temperature measurements were all below the maximum temperature criteria of 17.5 ° C.

Thurston County intends to continue long-term ambient monitoring of this creek.

Major Issues:

- Urban development and stormwater runoff are the biggest threats to water quality in this stream.

Funding Sources:

- Local Storm and Surface Water Utilities

Water Quality Summary

Conventional Parameters

Green Cove Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		1.40 – 15.11 2.27 – 14.37			0.4 – 17.4
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		9.90 – 13.88 9.82 – 14.14	0 of 12 0 of 12		8.67 – 15.1
Conductivity	µmhos/cm		09/10 10/11	98 87	54 - 141 47 - 138		97	33 – 239
pH		6.5 - 8.5	09/10 10/11	7.3* 7.3*	6.7 – 7.5 6.5 – 7.6	0 of 12 0 of 12	7.3*	6.3 - 7.7
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	3.49 3.58	0.30 – 22.80 0 – 12	1 of 12 2 of 12	3.1	0 - 60
Fecal Coliform	colonies/ 100 mL	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	141** 51**	40 - 900 5 - 450	% exceeding 200	38**	0 - 2181
						25% 8%		
Total Phosphorus	mg/L		09/10 10/11	0.043 0.043	0.023 – 0.083 0.020 – 0.068		0.039	0.011 - 0.170
Nitrate + Nitrite-nitrogen	mg/L		09/10 10/11	0.673 0.613	0.156 – 1.31 0.213 – 1.47		0.622	0.169 - 1.56

* Median

** Geometric mean value (GMV)

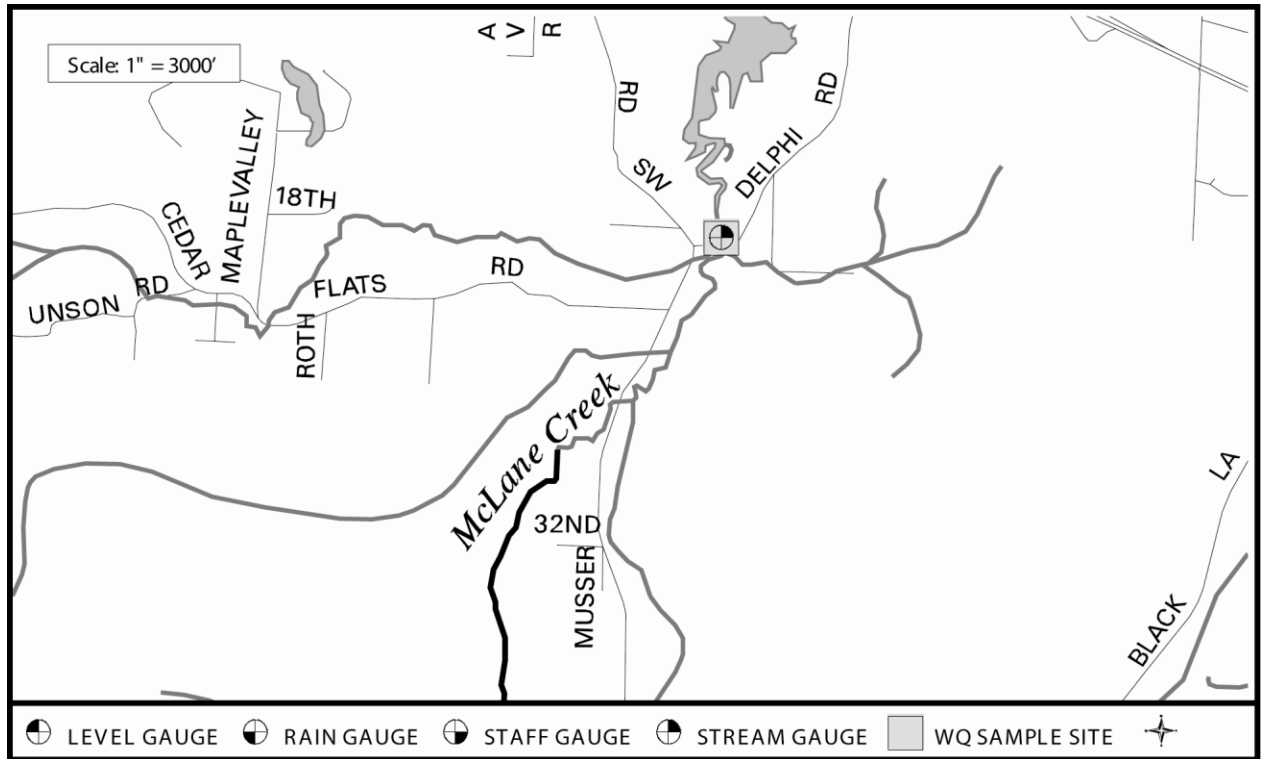
Thurston County Water Resources Monitoring Report 2009-2010

Green Cove Creek @ 4300 blk Cooper Pt Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009	11:30:00 AM	11.26	7.4	10.62	134	40	1.3	0.58	0.046	0.797	Borrowed YSI display. YSI #1 sonde
11/16/2009	2:15:00 PM	7.90	6.9	13.88	67	95	22.8	8.84	0.083	0.156	
12/15/2009	4:30:00 PM	1.40	6.9	13.52	68	510	7.2	10.89	0.049	0.329	
1/13/2010	9:30:00 AM	7.47	6.7	12.07	54	60	3.2	17.59	0.027	0.322	
2/8/2010	11:30:00 AM	6.94	6.9	11.67	74	50	0.9	3.99	0.023	0.420	
3/17/2010	11:45:00 AM	7.10	7.2	12.62	76	80	1.4	4.04	0.025	0.400	
4/21/2010	9:50:00 AM	10.48	7.1	11.05	96	95	1.6	2.36	0.041	0.606	
5/11/2010	3:30:00 PM	10.97	7.5	10.91	116	140	1.2	0.96	0.035	0.955	
6/14/2010	11:45:00 AM	11.98	7.4	10.69	105	185	0.3	1.29	0.042	0.733	
7/13/2010	11:10:00 AM	13.64	7.5	10.71	133	290	0.7	0.52	0.041	1.080	
8/17/2010	11:40:00 AM	15.11	7.5	9.90	108	900	0.6	0.42	0.050	1.310	Flow is estimate.
9/14/2010	11:10:00 AM	12.80	7.5	10.34	141	180	0.7	0.30	0.049	0.963	

Thurston County Water Resources Monitoring Report 2010-2011*Green Cove Creek @ 4300 blk Cooper Pt Rd*

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	1:30:00 PM	9.02	7.4	11.58	114	80	0.0	1.29	0.036	0.594	Turb read -0.3.
11/17/2010	2:50:00 PM	8.10	7.1	11.99	67	450	9.6	9.62	0.068	0.218	
12/13/2010	10:50:00 AM	8.03	6.5	12.35	47	160	12.0	54.22	0.052	0.408	Water is tea colored.
1/11/2011	9:30:00 AM	2.27	7.2	14.14	76	10	0.9	3.93	0.020	0.465	Swoffer post cal low blow test, flow rate likely underreported.
2/14/2011	11:45:00 AM	6.43	7.1	12.27	65	10	4.4	10.49	0.030	0.353	
3/16/2011	3:15:00 PM	7.48	7.0	12.97	52	20	8.1	32.33	0.023	0.259	
4/12/2011	12:15:00 PM	7.54	7.3	12.99	73	5	0.8	6.04	0.021	0.320	
5/16/2011	12:20:00 PM	10.67	7.3	12.12	65	70	3.6	10.38	0.039	0.213	
6/13/2011	4:25:00 PM	13.72	7.4	10.41	118	165	1.3	1.61	0.058	0.733	
7/11/2011	3:30:00 PM	14.37	7.5	9.82	135	110	1.0	0.83	0.054	0.996	
8/9/2011	3:00:00 PM	13.92	7.6	10.33	138	50	0.8	0.51	0.055	1.330	
9/14/2011	11:40:00 AM	13.70	7.4	10.31	98	55	0.4	2.86	0.056	1.470	



PART OF ELD WATERSHED

LENGTH OF CREEK: 14.5 miles

BASIN SIZE: 11.5 square miles

STREAM ORDER: 3

PRIMARY LAND USES:

Rural residential
Agriculture
Forestry

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)

Coho
Chum

GENERAL TOPOGRAPHY: This creek originates in the Alpine Hills area and flows through fairly level terrain, including wooded areas and open pastures. The creek empties into Eld Inlet in the Mud Bay estuary.

GENERAL WATER QUALITY:(Excellent, Good, Fair, Poor)

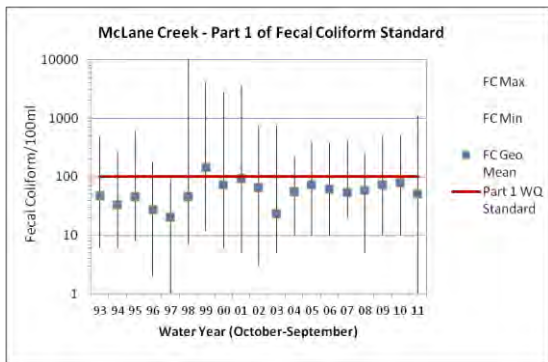
Fair – The creek usually meets Part 1 but fails Part 2 of the fecal coliform standard. Failed turbidity standard in November 2009 and November, December 2010. Phosphorus average is above the reference condition.

OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

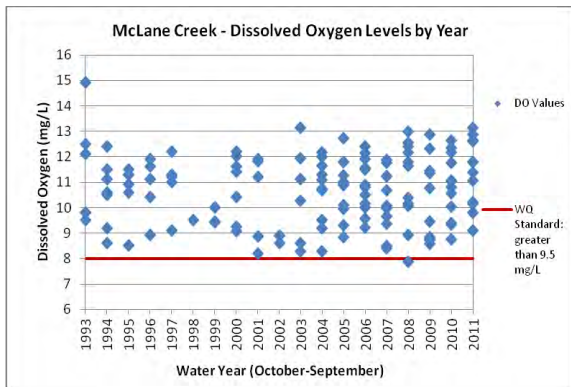
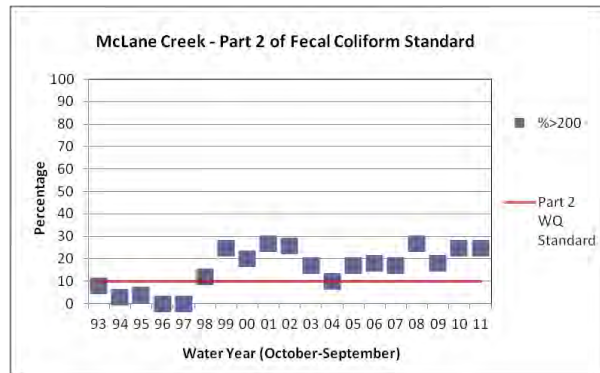
Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 or www.co.thurston.wa.us/monitoring

McLane Creek #0138



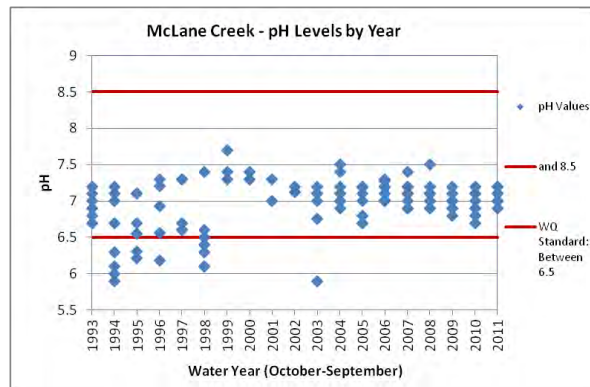
The creek has met Part 1 of the bacteria standard since 2000. The creek has met part 2 of the bacteria standard only once in the last fourteen years.

The water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 100 colonies/100mL *and* Part 2 - no more than ten percent of the samples shall exceed 200 colonies/100mL.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 8.0 mg/L. There has been only one violation of the standard in 2007/08.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. No pH violations were recorded since 2003. However, there were numerous measurements outside the pH standard range between 1994 and 1998.



Discussion:

McLane Creek has been monitored by Thurston County since 1983 when the first comprehensive water quality study work was done. This creek supports significant salmon runs, especially chum. It is impacted primarily by agricultural sources of nonpoint pollution and forestry activities. During the 1990's many of the land owners in the basin adopted best management practices to reduce fecal coliform bacteria concentrations.

As more summer low flow samples are collected, there appears to be a pattern of higher fecal coliform results during the dry season. Dry season segmenting of McLane Creek was done in 2006 and 2007. The fecal coliform data collected shows that the bacteria load may be impacting the creek between river mile 2.75 and 3.0. Part 2 of the fecal coliform water quality standard continues to be violated.

While there is no water quality standard for nitrate in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015). The average nitrate concentration for McLane Creek is slightly above the regional reference condition at 0.340 mg/l. The total phosphorus regional reference condition is 0.019 mg/l, according to the EPA report. The McLane Creek average total phosphorus concentration is 0.030 mg/l, which is also above the reference condition.

The temperature standard that applies in McLane Creek is intended to protect salmonid spawning, rearing and migration, and is a 7-day average daily maximum of 17.5 ° C. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. There were no temperature measurements above the maximum temperature criteria of 17.5 ° C in either water year.

Thurston County intends to continue long-term ambient monitoring of this creek.

Major Issues:

- Agricultural nonpoint sources and forest practices have the potential to impact water quality in this stream.
- There has been extensive beaver activity in the lower reaches of the stream during the past two water years.
- A flood event in December 2007 had a significant impact on the creek channel.

Funding Sources:

- Local Storm and Surface Water Utility

Water Quality Summary
Conventional Parameters
McLane Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		4.38 – 15.93 4.68 – 14.88			2.3 – 18.17
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		8.75 – 12.63 9.09 – 13.13	0 of 12		7.87 - 14.9
Conductivity	µmhos/cm		09/10 10/11	70 65	49 - 92 45 - 92		66	27 – 205
pH		6.5 - 8.5	09/10 10/11	7.0* 7.1*	6.7 – 7.2 6.9 – 7.2	0 of 12 0 of 12	7.1*	5.9 - 7.7
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	9.9 10.33	1.4 - 83 0.90 – 59.6	1 of 12 2 of 12	5.6	0 – 135
Fecal Coliform	colonies/ 100 mL	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	78** 50**	10 - 500 0 - 1100	% exceeding 200	57**	1 – 17000
						25% 25%		
Total Phosphorus	mg/L		09/10 10/11	0.044 0.043	0.018 – 0.247 0.010 – 0.198		0.030	<0.002 - 0.140
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.300 0.341	0.158 – 0.483 0.220 – 0.650		0.340	0.104 – 0.931

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

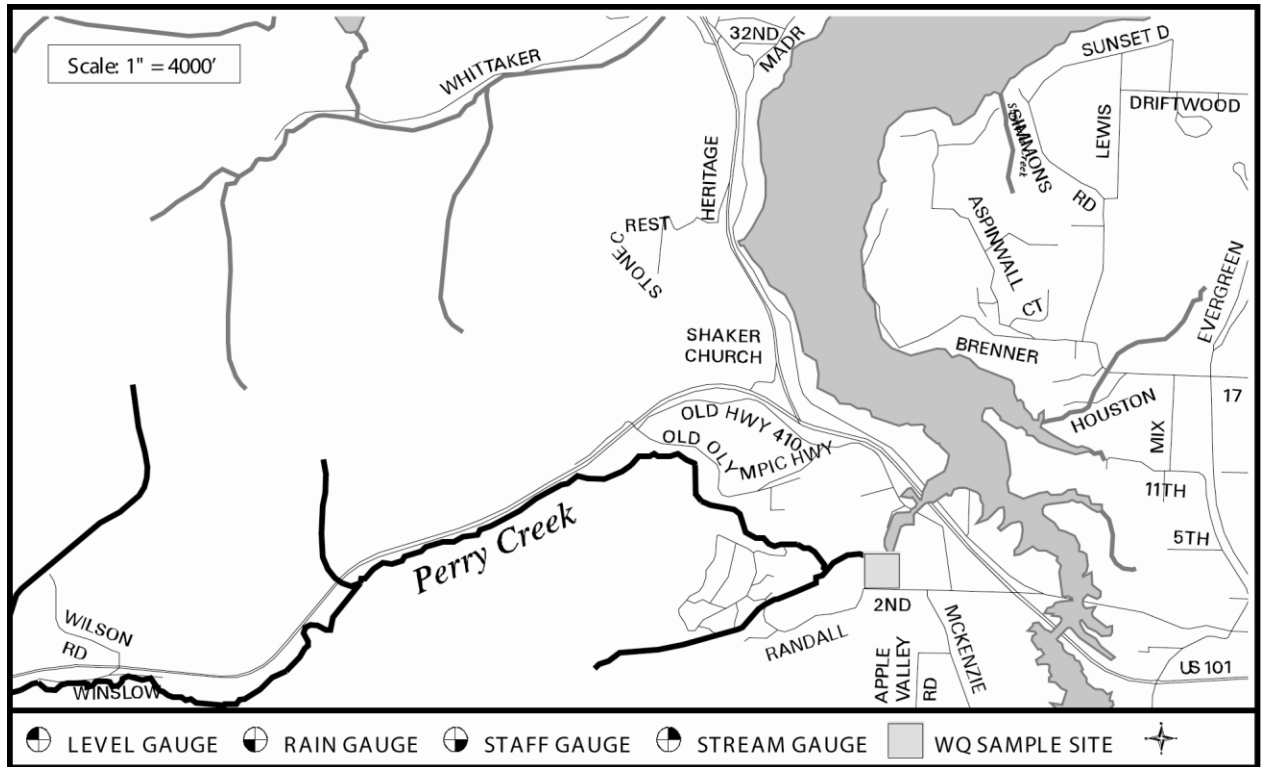
McLane Creek @ Delphi Bridge

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009	11:10:00 AM	11.50	7.0	9.32	90	110	4.0		0.025	0.265	Borrowed YSI display. YSI #1 sonde. Beavers altered creek flow, no flow measurement.
11/16/2009	2:45:00 PM	8.75	6.8	12.63	51	500	83.0		0.247	0.453	No flow measurement: too deep and muddy to wade.
12/15/2009	3:45:00 PM	4.38	6.9	11.76	57	260	6.4	58.68	0.060	0.483	Staff gage - 1.58'
1/13/2010	3:30:00 PM	8.52	7.1	12.15	49	20	3.5		0.021	0.364	No flow measurement: too deep to wade.
2/8/2010	11:00:00 AM	7.19	6.7	11.04	63	50	2.1	31.67	0.021	0.368	TC Stormwater staff measured flow at same time: 30.7 cfs
3/17/2010	11:10:00 AM	7.23	6.9	12.34	62	10	2.3	33.93	0.018	0.309	
4/21/2010	9:15:00 AM	9.86	6.8	10.78	67	20	2.1	24.45	0.021	0.306	Duplicates labeled "Delphi"
5/11/2010	10:45:00 AM	9.39	7.1	11.02	69	30	2.6	19.20	0.018	0.230	Staff gage - 0.72'
6/14/2010	11:15:00 AM	11.40	7.1	10.56	70	45	1.4	21.55	0.019	0.255	Staff gage facing right bank and just D.S. of gage - 4.84'
7/13/2010	10:40:00 AM	13.67	7.2	10.02	82	335	2.6	6.91	0.025	0.228	
8/17/2010	11:10:00 AM	15.93	7.1	8.75	92	200	3.9	3.76	0.027	0.182	
9/14/2010	10:40:00 AM	12.77	7.1	9.39	91	140	4.8	4.18	0.026	0.158	

Thurston County Water Resources Monitoring Report 2010-2011

McLane Creek @ Delphi Bridge

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	2:00:00 PM	8.46	7.1	11.38	79	80	3.7	8.15	0.030	0.299	
11/17/2010	2:30:00 PM	8.49	7.0	11.04	54	1100	59.6		0.198	0.282	Staff gage 2.12'. Very turbid. No flow measurement. Salmon present.
12/13/2010	10:30:00 AM	8.71	6.9	11.78	45	60	38.0		0.107	0.650	Duplicates labeled "Delphi". Too deep to measure flow. Staff gage 3.44'.
1/11/2011	1:40:00 PM	4.68	7.1	12.88	56	70	0.9	48.60	0.018	0.515	Staff gage - 1.62'.
2/14/2011	11:15:00 AM	7.06	7.0	11.79	55	20	3.2	58.00	0.018	0.475	Staff gage - 1.80'.
3/16/2011	3:00:00 PM	7.43	7.1	13.13	46	0	4.1		0.016	0.359	No flow measurement, too deep to wade. FC reported as <5.
4/12/2011	11:30:00 AM	7.26	7.2	12.60	52	0	1.6	67.50	0.010	0.275	FC reported as <5.
5/16/2011	11:50:00 AM	9.42	7.2	12.63	56	45	1.2	58.41	0.014	0.298	Duplicates labeled "Delphi".
6/13/2011	3:45:00 PM	14.41	7.0	10.20	76	270	2.0	14.25	0.023	0.235	Staff gage - 1.12'.
7/11/2011	3:00:00 PM	14.88	7.2	9.80	84	80	2.4	5.69	0.027	0.227	Staff gage - 0.97'.
8/9/2011	2:30:00 PM	13.26	7.1	10.15	88	75	3.0	4.42	0.027	0.252	Staff gage - 1.12'. New beaver dam down stream.
9/14/2011	11:00:00 AM	13.57	7.0	9.09	92	350	4.3	2.59	0.031	0.220	



PART OF ELD WATERSHED

LENGTH OF CREEK: 4.5 miles

BASIN SIZE: 4,064 acres

STREAM ORDER: 2

PRIMARY LAND USES:

Rural residential

Agriculture and Forestry

FISHERIES RESOURCES: (From [A Catalog of Washington Streams and Salmon Utilization](#), WDOF)

Coho and Chum

GENERAL TOPOGRAPHY:

This creek originates in wetlands and flows through a forested area. It winds through a gently rolling rural/residential area before dropping through wooded ravines. The creek has two falls within a mile of the mouth. The

creek empties into Eld Inlet in the Mud Bay estuary.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

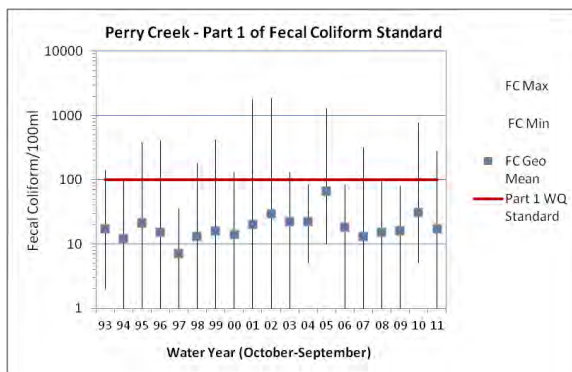
Good – Failed part 1 of the fecal coliform standard in 2009/10 but met both parts in 2010/11. Failed turbidity standard in November 2009 and November, December 2010. Met all other water quality standards.

OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

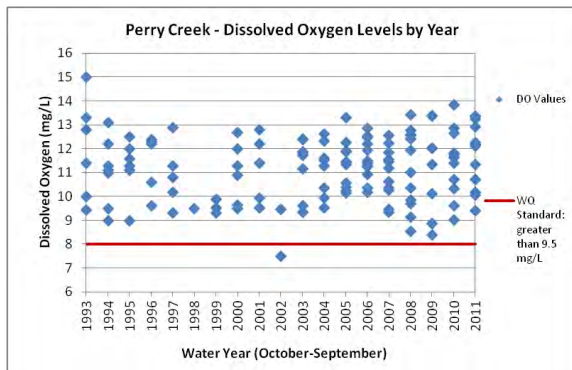
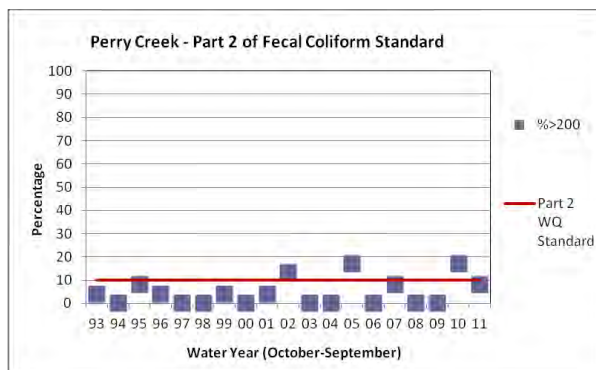
Washington Department of Ecology, Environmental Assessment Program, National Monitoring Program Project, (360) 407-6447

Perry Creek #0001



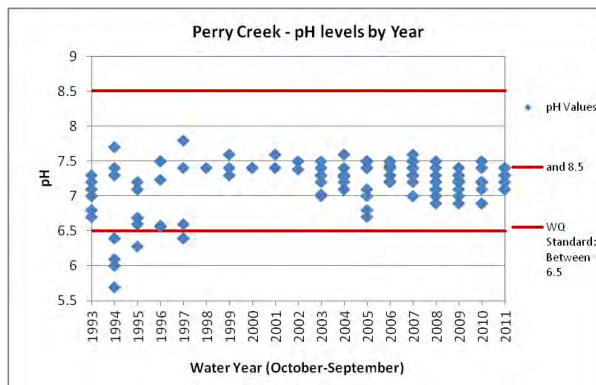
The water quality standard for fecal coliform bacteria has two parts: Part 1 – the geometric mean shall not exceed 100 colonies/100 mL *and* Part 2 – no more than 10% of the samples shall exceed 200 colonies/100 mL.

There have been no violations of Part 1 of the fecal coliform water quality standard. Part 2 of the standard was violated in 2009/10.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 8.0 mg/L. There has been only one violation in July, 2002.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. Measurements have been within the pH standard range since 1997.



Discussion:

Perry Creek has been monitored by Thurston County since 1983. In the past, agricultural practices and septic systems have impacted this creek. In the early 1990's, a number of failing septic systems were identified and repaired. This creek supports a significant coho and chum fishery. The Washington Department of Ecology's Environmental Assessment Program had a ten year monitoring project that ended in 2002.

While there is no water quality standard for nitrate in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015). The average nitrate concentration for Perry Creek, 0.360 mg/l, is slightly above the regional reference condition. The total phosphorus regional reference condition is 0.019 mg/l, according to the EPA report. The Perry Creek average total phosphorus concentration is 0.025 mg/l, which is very close to the reference condition.

The temperature standard that applies in Perry Creek is intended to protect salmonid spawning, rearing and migration, and is a 7-day average daily maximum of 17.5 ° C. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. The temperature measurements were all below the maximum temperature criteria of 17.5 ° C.

Thurston County intends to continue long-term ambient monitoring of this creek.

Major Issues:

- Agricultural practices, on-site septic systems in close proximity to the stream, and forest practices have the greatest potential to impact the water quality of this stream.

Funding Sources:

- County Storm and Surface Water Utility

Water Quality Summary

Conventional Parameters

Perry Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 17.5 ° C	09/10 10/11		4.69 – 14.84 4.36 – 14.24			1.7 - 16.7
Dissolved Oxygen	mg/L	Lowest one-day minimum of 8.0	09/10 10/11		9.02 – 13.84 9.41 – 13.38	0 of 12 0 of 12		7.5 - 15.0
Conductivity	µmhos/cm		09/10 10/11	76 77	58 - 100 57 - 111		71	34 - 243
pH		6.5 - 8.5	09/10 10/11	7.2* 7.3*	6.9 – 7.5 7.1 – 7.4	0 of 12 0 of 12	7.3*	5.7 – 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	6.83 3.97	0 – 65 0 - 25	1 of 12 2 of 12	3.97	0 - 160
Fecal Coliform	colonies/ 100 mL	GMV: ≤100 and ≤ 10% not to exceed 200	09/10 10/11	31** 17**	5 - 770 0 - 280	% exceeding 200	17**	0 - 1900
						17%		
						8%		
Total Phosphorus	mg/L		09/10 10/11	0.028 0.022	0.007 – 0.176 0.008 – 0.086		0.025	<0.002 - 0.193
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.369 0.400	0.234 - 0.526 0.267 – 0.562		0.360	0.125 - 0.732

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

Perry Creek off Perry Creek Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009	10:40:00 AM	11.13	7.2	10.34	100	5	0.9	2.20	0.012	0.476	Borrowed YSI display. YSI #1 sonde
11/16/2009	3:00:00 PM	8.74	6.9	13.84	58	770	65.0		0.176	0.526	No flow measurement: too deep to wade. Fish present.
12/15/2009	3:15:00 PM	4.69	7.2	12.67	73	380	8.3		0.042	0.496	Duplicates labeled "Gull". No flow measurement: too deep to wade. Fish present.
1/13/2010	3:45:00 PM	8.49	7.2	11.82	58	20	4.0	74.97	0.016	0.349	
2/8/2010	10:30:00 AM	6.85	6.9	11.78	67	5	0.8	17.33	0.010	0.341	Duplicates labeled "Gull".
3/17/2010	10:50:00 AM	6.90	7.2	12.86	64	10	1.6	22.05	0.015	0.319	
4/21/2010	8:45:00 AM	9.18	7.1	11.66	69	25	0.5	12.29	0.013	0.311	
5/11/2010	10:20:00 AM	9.07	7.4	11.66	72	5	0.7	9.09	0.010	0.242	
6/14/2010	10:45:00 AM	11.12	7.5	11.40	73	35	0.0	11.70	0.009	0.234	Turbidity read -0.4.
7/13/2010	10:10:00 AM	13.32	7.4	10.71	85	75	0.0	3.68	0.007	0.341	
8/17/2010	10:45:00 AM	14.84	7.2	9.02	97	20	0.0	1.39	0.016	0.422	Duplicates labeled "Gull"
9/14/2010	10:15:00 AM	12.40	7.2	9.61	97	30	0.1	1.01	0.010	0.366	

Thurston County Water Resources Monitoring Report 2010-2011

Perry Creek off Perry Creek Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	3:10:00 PM	8.28	7.4	12.12	85	0	0.0	4.96	0.009	0.500	FC reported as <5. Turb read -0.6.
11/17/2010	2:00:00 PM	8.52	7.1	11.34	66	280	25.0		0.086	0.348	Hundreds of chum, no flow measurement.
12/13/2010	10:10:00 AM	8.73	7.1	12.26	58	0	12.7		0.047	0.562	FC reported as <5. Too deep to measure flow.
1/11/2011	1:15:00 PM	4.36	7.3	13.37	68	10	0.8	19.71	0.012	0.445	
2/14/2011	10:50:00 AM	6.95	7.2	12.17	67	50	3.0	30.86	0.015	0.438	
3/16/2011	2:30:00 PM	7.25	7.2	13.26	57	160	3.5	108.46	0.008	0.357	
4/12/2011	11:00:00 AM	6.46	7.3	13.38	63	0	1.0	31.39	0.009	0.301	FC reported as <5.
5/16/2011	11:15:00 AM	9.11	7.3	12.92	67	50	1.4	29.50	0.012	0.270	
6/13/2011	3:30:00 PM	13.46	7.3	10.73	83	25	0.0	5.86	0.012	0.267	
7/11/2011	2:30:00 PM	14.24	7.4	10.18	95	10	0.0	2.71	0.016	0.330	
8/9/2011	2:00:00 PM	13.79	7.3	10.08	103	50	0.0	2.05	0.022	0.459	Duplicates labeled "Gull".
9/14/2011	10:15:00 AM	12.95	7.1	9.41	111	35	0.2	0.71	0.020	0.518	Duplicates labeled "Gull".

Henderson Watershed

WRIA 13

Chapter Includes:

Hicks Lake

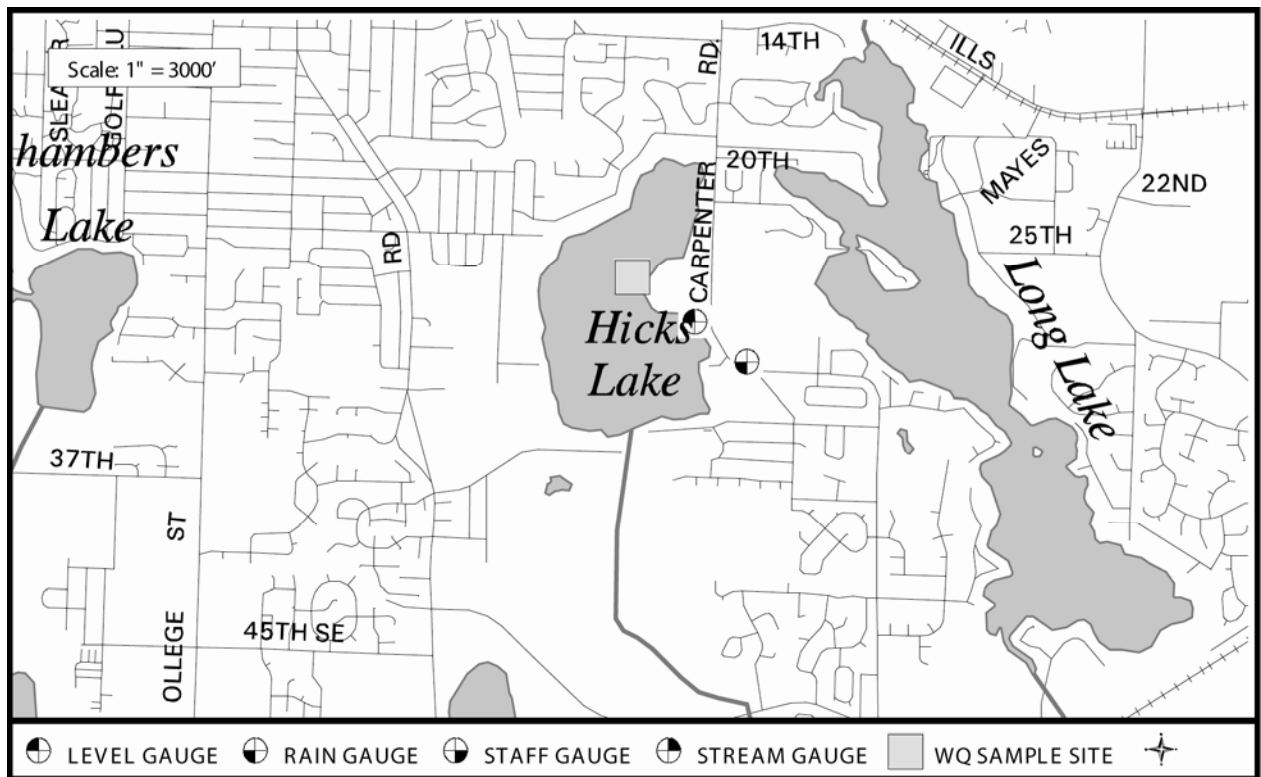
Long Lake

Pattison Lake

Tanglewilde Stormwater Outfall

Woodard Creek

Woodland Creek



PART OF HENDERSON INLET WATERSHED

SHORELINE LENGTH: 2.4 miles

LAKE SIZE: 160 acres

BASIN SIZE: 1.8 square miles

MEAN DEPTH: 18 feet

MAXIMUM DEPTH: 35 feet

VOLUME: 2,700 acre-feet

PRIMARY LAND USES:

The watershed is primarily urban and sub-urban residential with a small percentage in undeveloped forest cover.

PRIMARY LAKE USES:

Fishing, boating, water skiing, swimming, and other water recreation.

PUBLIC ACCESS:

Washington Department of Fish and Wildlife public boat launch;
City of Lacey public park.

GENERAL TOPOGRAPHY:

The approximate altitude of the lake is 162 feet. Hicks Lake is first in a series of four lakes, which ultimately discharges to Henderson Inlet through Woodland Creek. The watershed is relatively flat with extensive wetlands between the lakes. There is an extensive wetland to the south of Hicks Lake.

GENERAL WATER QUALITY: (Excellent, Good, Fair, and Poor)

Good – The water quality is generally good and supports the beneficial uses of the lake. The phosphorus concentration is below state standards.

OTHER AVAILABLE DATA:

Washington Department of Ecology,
Environmental Assessment Program
(360) 407-6700 (water quality data).

Thurston County Resource Stewardship
Department, Water Resources Program

(360) 754-4681 or
www.co.thurston.wa.us/monitoring

Thurston County Environmental Health
Division, (360) 867-2626 or
www.co.thurston.wa.us/health/ehswat/swater.htm

GENERAL DISCUSSION:

Hicks Lake is the first lake in a chain of four lakes (Hicks, Pattison, Long, and Lois Lakes) which eventually discharge to Henderson Inlet via Woodland Creek. Hicks Lake is a relatively small lake which is popular for fishing, boating, and swimming. The City of Lacey has a public park on the west side of the lake, which is relatively undeveloped at this time.

In 2011 the ambient monitoring consisted of monthly sampling, May through October, at a site located in the deepest area of the lake. The parameters included temperature, dissolved oxygen, pH, conductivity, and secchi disk readings. Samples, collected near the lake's surface and bottom, were analyzed for total phosphorus and total nitrogen. Composite samples from the epilimnion (warm surface layer) or photic zone were collected and analyzed for chlorophyll *a* and algae identification. The water quality data is located at the end of this report.

Field Parameters

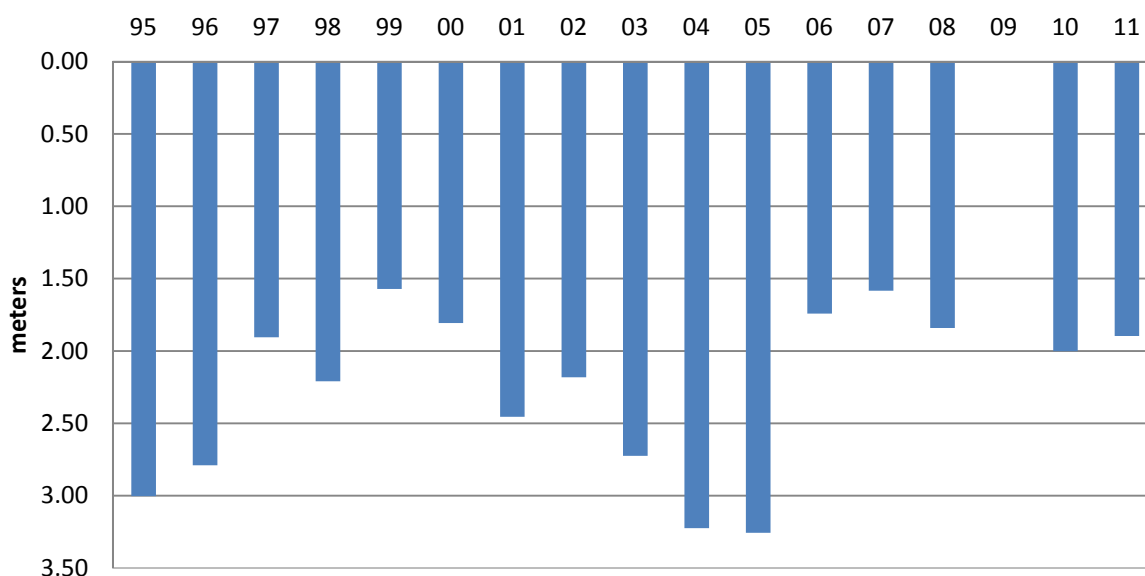
The monthly temperature, dissolved oxygen, pH, and conductivity data measured from the lake surface to the lake bottom is displayed in profile graphs at the end of this chapter. *Thermal stratification* is when there are two distinct layers of water in the lake, the upper layer being warmer than the lower layer. The graphs show that in 2011 the lake was stratified throughout the entire season, May through October. This means that the lake developed a warm surface layer as solar radiation warmed the upper water, but the bottom water stayed cool. The surface water reached a high of 23.5 degrees Celsius in August, but the bottom layer of water (hypolimnion) remained much colder, at 9.9 degrees. The lower layer of colder water, generally below 4 to 5 meters, was very low in oxygen throughout the summer. This anoxic (no oxygen) condition results in a slow release of phosphorus from the sediment into the water near the bottom. (See phosphorus data on page 8) The release of nutrients from the sediments often stimulates algae productivity in the lake, especially in fall when the lower and upper waters in the lake mix.

Secchi Disk Water Clarity

Water clarity in a lake is measured with a device called a secchi disk. In 2011, the average water clarity or secchi disk depth was 1.9 meters (or 6.2 feet) with a range from 1.5 meters (5 feet) in August to 2.4 meters (8 feet) in June. A graph showing the average summer water clarity since 1995 is shown on the next page.

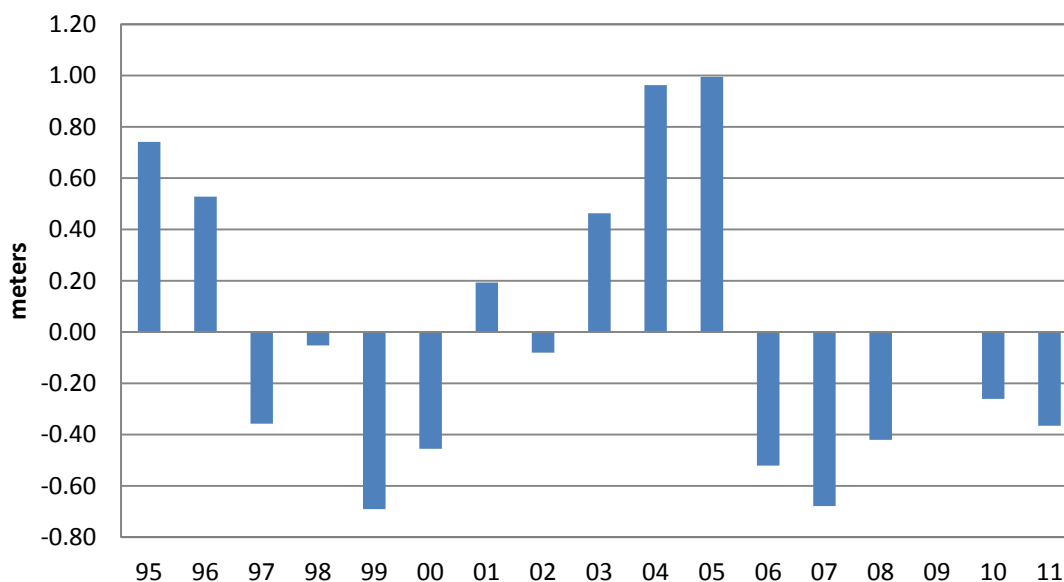
To better examine trends in water clarity, the average water clarity for the entire period of record can be subtracted from the annual average water clarity. The difference is then graphed. A bar above the "0" line on the graph indicates that the average clarity for that year was better than the overall

Hicks Lake Secchi Disk Readings



average. A bar below the “0” line, indicates that the average water clarity that year was poorer than the overall average. Graphing the water clarity data in this way helps to visually see trends in water quality versus normal annual fluctuations. The water clarity trend graph for Hicks Lake is shown below. The graph shows no definite upward or downward trend, but rather a cyclical pattern of up to one meter around the long-term average. However every year since 2006 the annual averages were below the overall average. This data will continue to be monitored to determine if a trend develops in the future.

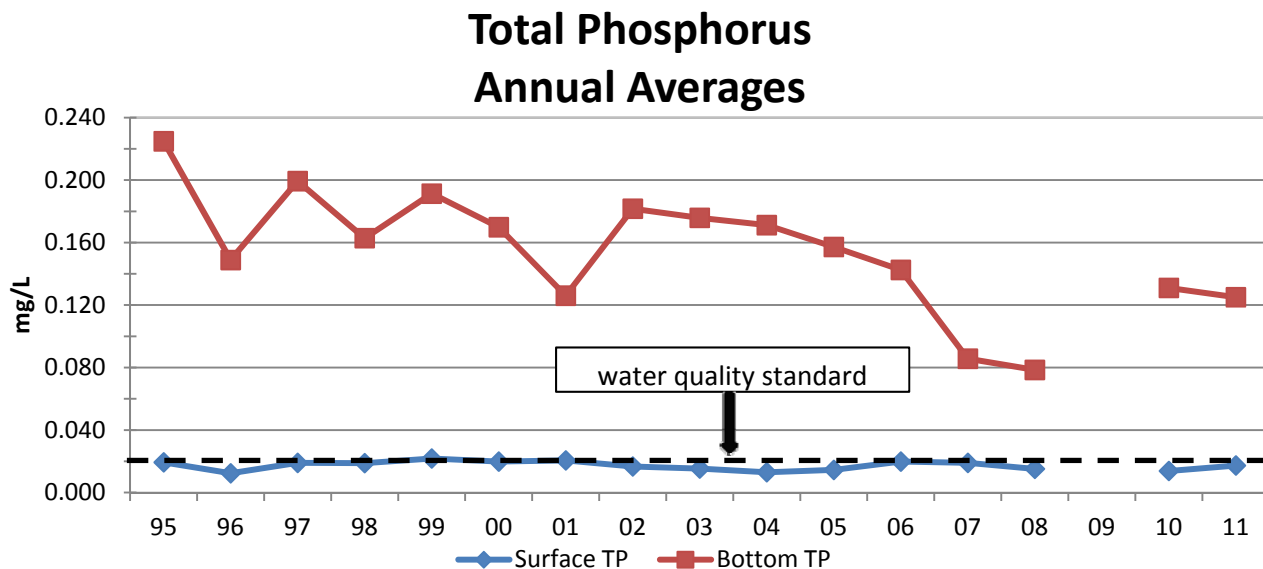
Water Clarity Trend Annual Average Minus Long-Term Average



Total Phosphorus

Generally, lakes in the Puget Sound region with summer average surface total phosphorus concentrations greater than 0.030 mg/l experience undesirable algae growth which interferes with recreational uses of the lake (USGS Water Supply Paper 2240). The action level established in WAC 173-201A, “Water Quality Standards for Surface Water of the State of Washington” is 0.020 mg/l. The 2011 season average surface total phosphorus concentration in Hicks Lake was 0.017 milligrams per liter (mg/l), which is below the state action level. Only in July did the surface total phosphorus concentrations reach, but not exceed, the 0.020 mg/l action level.

The graph below compares the average surface total phosphorus concentrations with the bottom total phosphorus concentrations. The higher phosphorus concentrations at the lake bottom are a result of the release of phosphorus from the lake sediment during periods of stratification.

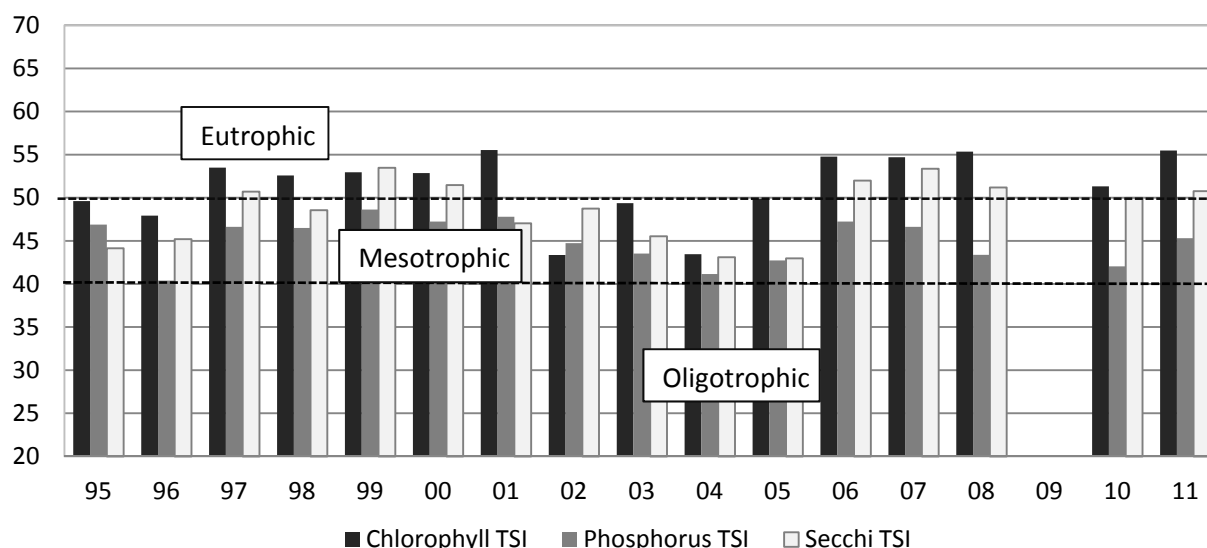


Trophic State Indices

The Carlson trophic state indices (TSI) are used to express the degree of productivity of a lake. Average summer total phosphorus, chlorophyll *a*, and secchi disk readings are each used to calculate TSIs for the lake. A TSI of 0 to 40 indicates an oligotrophic, or low productivity, lake. A TSI of 41 to 50 indicates a mesotrophic, or moderately productive lake. A TSI of greater than 50 indicates a eutrophic, or highly productive lake. The annual TSI's are graphed on the next page.

The 2011 TSI's for total phosphorus, chlorophyll *a*, and secchi disk are 45, 55, and 51, respectively. In 2011, two of the three indices were within the eutrophic, or highly productivity range. From 2006 to present the graph shows that the productivity has been higher and water clarity lower than it had been during the period from 2002 through 2005. However, the lake conditions in these most recent six years are similar to those seen in the late 1990's, and could be a reflection of external influences such as weather. Sampling conducted in 1981 by the US Geological Survey also found Hicks Lake to be in the mesotrophic to eutrophic state.

Hicks Lake Trophic State Indices



Algae

The monitoring program includes identification of algae types present in the lake each month. The 2011 data is located at the end of this chapter. Common types of algae present in Hicks Lake include blue-green algae, diatoms, yellow and green algae. However, it is blue-green algae that typically cause nuisance “blooms” which can impair recreational activities. Dominance by blue-green algae is a sign of nutrient-rich conditions.

Some species of blue-green algae can produce toxins that can cause illness, or even death, in people, pets, and wildlife if ingested. Pets are particularly vulnerable to poisoning from toxic algae blooms due to their smaller body weight and their tendency to ingest higher doses by drinking lake water and licking their fur after swimming. In recent years there has been an increase in documented toxic blue-green algae blooms in Washington lakes. In response to this pattern, the Washington Department of Health established a state recreational guidance limit of 6 µg/L for microcystin, and the Washington Department of Ecology now funds a statewide laboratory service to test for algae toxins during algae blooms.

Algae species known to produce toxins, such as *Aphanizomenon* and *Anabaena*, are present in Hicks Lake, but to date there has not been a toxic bloom documented. Because toxicity cannot be determined through visual observations, Thurston County Environmental Health began using screening test kits to test for the presence of the microcystin toxin. When screening results indicate the toxin is present, samples are sent to a laboratory to confirm the presence and quantify the amount.

In February 2011, an algae bloom was noticed along the north shore of Hicks Lake by a resident. The screening result was negative for the toxin, and the algae bloom was short-lived.

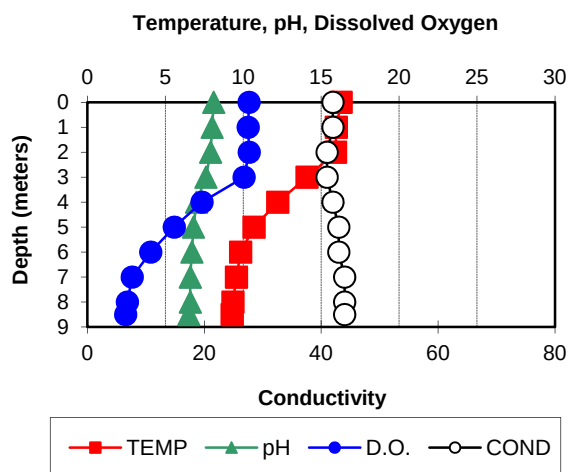
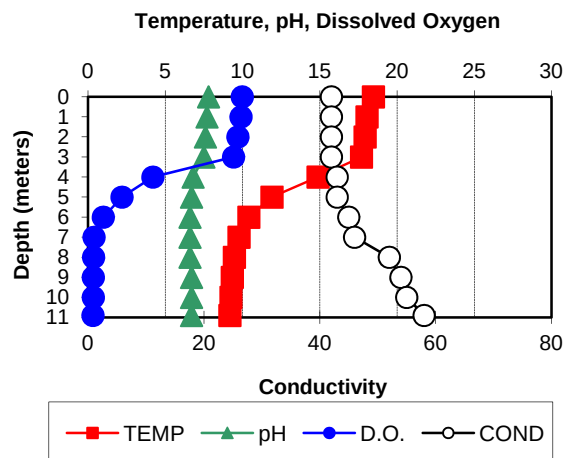
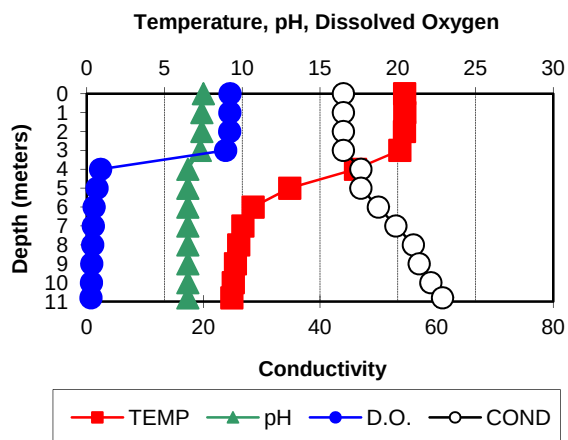
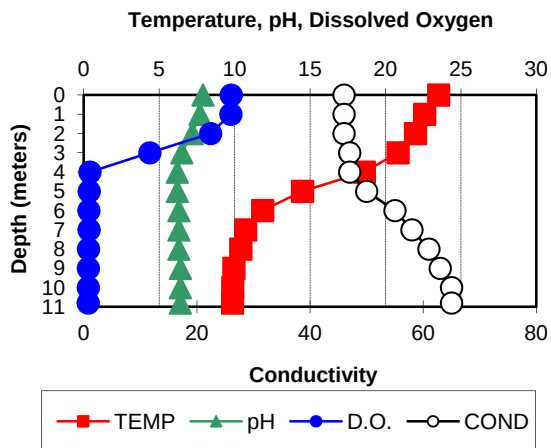
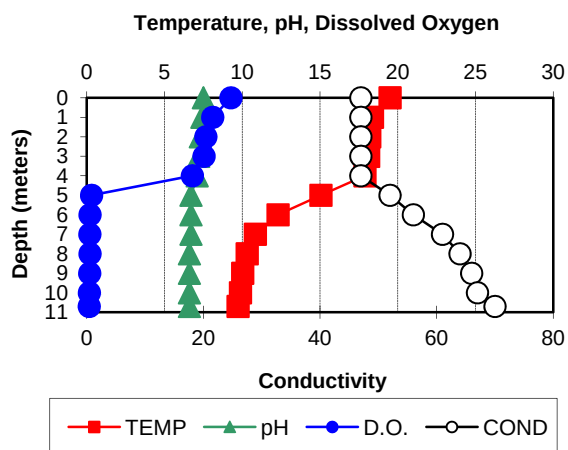
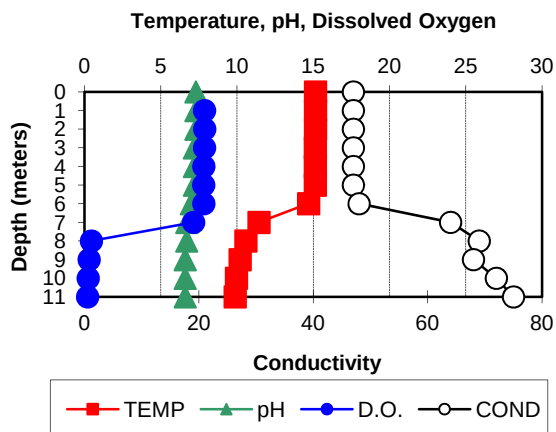
Although toxin testing is now possible, lake residents and users should always observe lake conditions and avoid contact with lake water when an algae bloom is occurring. More information about blue-green algae and swimming safety information is available through the Thurston County website: www.co.thurston.wa.us/health/ehadm/swimming/swimming_index.html

Major Issues:

- Low water levels occur during summer months, especially during periods of drought such as in 2001. High lake levels can also occur during higher than normal winter rainfall conditions. Extreme high lake levels cause flooding of some lakeshore structures. The outlet channel is on private property, is not maintained, and restricts the flow of water out of the lake.
- High density residential land use, storm water discharges, and other non-point pollution in this urban setting could degrade water quality if measures are not taken to prevent it.

Funding Sources:

The City of Lacey funded water quality monitoring of Hicks Lake in 2011 and will continue to fund monitoring in 2012.

May 23, 2011**June 20, 2011****July 19, 2011****August 24, 2011****September 20, 2011****October 11, 2011**

Thurston County Water Resources Annual Report - 2011

Hicks Lake

Site ID# HENHIL000

<i>Date</i>	<i>Time</i>	<i>Bottom Depth m</i>	<i>Bottom Sample Depth m</i>	<i>Sur TP mg/L</i>	<i>Bott TP mg/L</i>	<i>Sur TN mg/L</i>	<i>Bott TN mg/L</i>	<i>Secchi m</i>	<i>Chl a ug/L</i>	<i>Phae a ug/L</i>	<i>Water</i>	<i>Lake Notes</i>
05/23/2011	10:30:00 AM	8.5	7.5	0.015	0.018	0.360	0.349	2.18	11	0.05	#7 yellow-orange	Chl a & algae composite @ 1, 2, & 3M. Anchored closer to shore, hence, less deep. Phaeo a was < detection at 0.1ug/L.
06/20/2011	11:00:00 AM	10.9	10.0	0.019	0.091	0.321	0.406	2.44	8	1.3	#8 orange	Chl a & algae composite @ 1, 2, & 3M.
07/19/2011	10:00:00 AM	10.8	10.0	0.020	0.106	0.497	0.610	1.73	11	2.8	#8 yellow-orange	Chl a & algae composite @ 1, 2, & 3M.
08/24/2011	2:15:00 PM	10.8	10.0	0.017	0.158	0.599	1.040	1.51	19	0.4	#7 orangish-yellow	Chl a & algae composite @ 1 & 2M.
09/20/2011	12:00:00 PM	10.7	9.5	0.017	0.148	0.469	0.892	1.78	16	3	#7 orange	Chl a & algae composite @ 1, 2, & 3M. Algae scum forming at boat launch.
10/11/2011		11	10.0	0.016	0.229	0.457	1.180	1.74	11	2.8	#7 yellow-orange	Chl a & algae composite @ 1, 2, & 3M.

Summary for 'Site Description' = Hicks Lake (6 detail records)

Averages: **Sur TP** 0.017
Secchi 1.90
Chl a 12.7

Algae data: Hicks Lake

05/23/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Aphanizomenon species	☒
CP	Cryptomonads	☐
DT	Cyclotella species	☐
DT	Tabellaria species	☐
GR	Elakatothrix species	☐
GR	Radiococcus nimbatus	☐
GR	Sphaerocystis species	☐
GR	Spondylosium species	☐
YL	Dinobryon species	☐

06/20/2011

BG	Anabaena species	☐
BG	Aphanizomenon species	☒
CP	Cryptomonads	☐
DT	Cocconeis pediculus	☐
DT	Cyclotella species	☐
DT	Tabellaria species	☐
GR	Closterium species	☐
GR	Crucigenia species	☐
GR	Dictyosphaerium species	☐
GR	Oocystis species	☐
YL	Dinobryon species	☐

07/19/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon flos-aquae	☐
BG	Chroococcus species	☐
BG	Gomphosphaeria species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Synedra species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Ankistrodesmus species	☐
GR	Cosmarium species	☐
GR	Dictyosphaerium species	☐
GR	Elakatothrix species	☐
GR	Eutetramorus globosus	☐
GR	Schroederia species	☐
GR	Sphaerocystis species	☐
GR	Staurastrum species	☐
GR	Staurodesmus species	☐
YL	Dinobryon species	☐

08/24/2011

BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Cyclotella species	☐
GR	Botryococcus species	☐
GR	Dictyosphaerium species	☐
GR	Nephrocytium species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

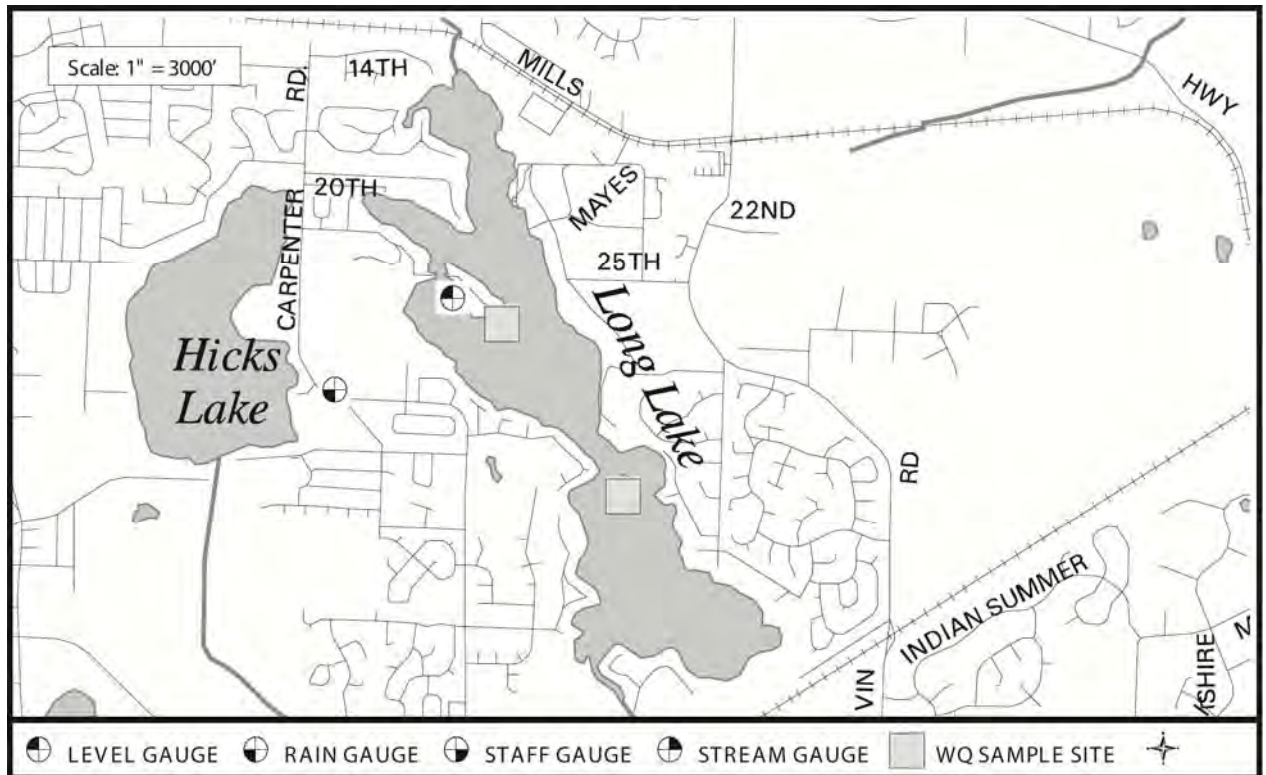
09/20/2011

<i>Type</i>	<i>Description</i>	<i>Dominant in Sample</i>
BG	Anabaena species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Asterionella species	☒
EU	Trachelomonas species	☐
GR	Elakatothrix species	☐
GR	Scenedesmus species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☒

10/11/2011

BG	Anabaena species	☐
BG	Aphanizomenon species	☐
BG	Woronichinia species	☐
CP	Cryptomonads	☐
DT	Asterionella species	☐
DT	Synedra species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Actinastrum species	☐
GR	Ankistrodesmus species	☐
GR	Closterium species	☐
GR	Dictyosphaerium species	☐
GR	Scenedesmus species	☐
YL	Dinobryon species	☐

Key: BG = Blue green EU = Euglenophyte
 CP = Cryptophyte GR = Green
 DF = Dinoflagellate YL = Yellow
 DT = Diatom



PART OF HENDERSON INLET WATERSHED

LENGTH OF LAKE: 1.9 miles

SHORELINE LENGTH: 7.1 miles

LAKE SIZE: 330 acres

BASIN SIZE: 8.25 square miles

MEAN DEPTH: 12 feet

MAXIMUM DEPTH: 21 feet

VOLUME: 3,900 acre-feet

PRIMARY LAND USES:

The watershed is primarily urban and suburban residential use, with a small percentage in agriculture and forest. Dense residential development exists along the lake shore.

PRIMARY LAKE USE:

Fishing, boating, swimming and other water sports.

PUBLIC ACCESS:

Washington Department of Fish and Wildlife public boat launch; City of Lacey, Long Lake Park; 10 small private community accesses.

GENERAL TOPOGRAPHY:

The approximate altitude of the lake is 150 feet. Long Lake is third in a series of four lakes beginning with Hicks Lake, then Pattison Lake, Long Lake, and Lois Lake, which drain to Woodland Creek. The watershed is relatively flat with extensive wetlands between the lakes. One stream flows into Long Lake at the south end, and a surface outlet exits at the north end. The outlet stream is Woodland Creek which flows to Henderson Inlet.

Long Lake

GENERAL WATER QUALITY:

(Excellent, Good, Fair, Poor)

Fair - The lake experiences nuisance blue-green algae blooms and many areas of the lake have emergent aquatic plants that interfere with recreational activities. The north basin has better water quality than the south basin. The invasive aquatic plants, Eurasian water milfoil and fragrant waterlily are present in the lake and are being controlled through a combination of chemical and non-chemical methods.

OTHER AVAILABLE DATA:

Water Quality data - Thurston County
Environmental Health Division,
(360) 867-2643
www.co.thurston.wa.us/health/ehswat/swater.htm

Thurston County Resource Stewardship
Department, Water Resources Program
(360) 754-4681
www.co.thurston.wa.us/stormwater/lakes/lakes-long.html

GENERAL DISCUSSION:

Long Lake is third in a chain of lakes which discharge to Woodland Creek and finally Henderson Inlet. Long Lake has two major basins, a north and south basin, which are connected by a narrow, shallow channel. The south basin has a maximum depth of about 13 feet, and the north basin has a maximum depth of about 20 feet. A small creek enters in the south basin, and the outlet channel is at the north end of the lake. The lake is also in continuity with the shallow groundwater.

There has been a lake management district for many years, which supports activities, such as aquatic weed harvesting, Eurasian water milfoil surveys, alum treatments and water quality monitoring. In 2008 an alum treatment was made to the south basin of the lake to reduce phosphorus and subsequently reduce nuisance algae blooms.

In 2011 the ambient monitoring consisted of monthly sampling, May through October, at monitoring sites located in the deepest areas of the two main basins, referred to as the north and south basins. The parameters included temperature, dissolved oxygen, pH, conductivity, and secchi disk readings. Samples, collected near the lake's surface and bottom, were analyzed for total phosphorus and total nitrogen. Composite samples from the epilimnion (warm surface layer) or photic zone were collected and analyzed for chlorophyll *a* and algae identification. The water quality data is located at the end of this report.

Field Parameters

The monthly temperature, dissolved oxygen, pH, and conductivity profile graphs are located on pages 12 and 13 at the end of this narrative. *Thermal stratification* is when there are two distinct layers of water in the lake, the upper layer being warmer than the lower layer. The graphs show that in 2011 both the north and south basins were stratified from May through August. Stratification was weak in September, and by October the lake was thoroughly mixed. In both basins, the dissolved oxygen concentrations at the bottom were below 2 mg/L during the period of thermal stratification from May through September. Under those anoxic, or low oxygen conditions, phosphorus is released from the sediments into the water column in a form readily used by algae. When the lake mixes in late summer, the nutrient-rich water fuels algae growth, which is measured by chlorophyll analysis.

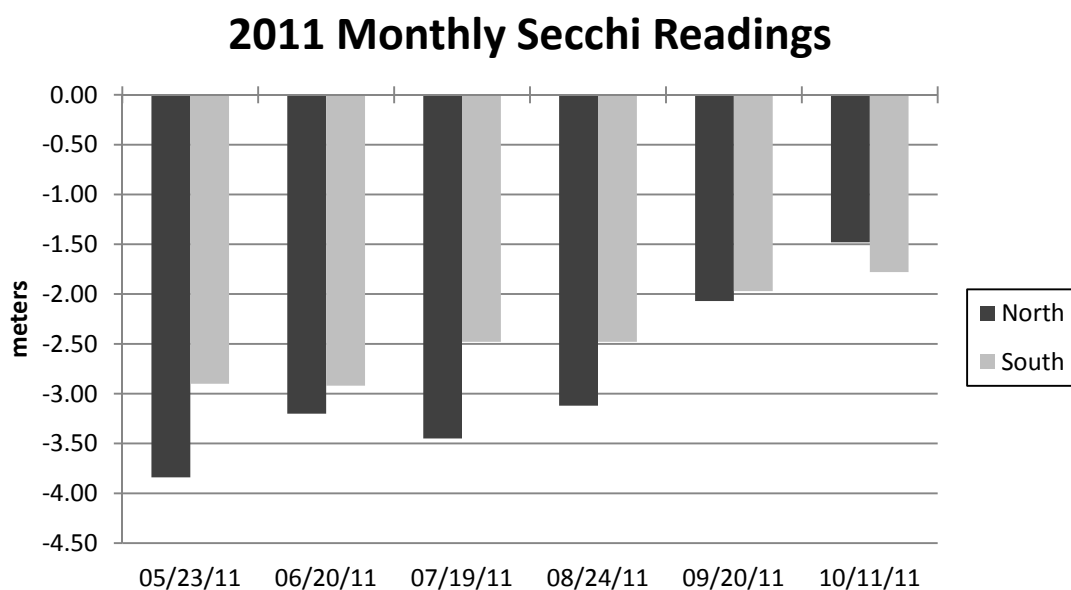
Secchi Disk Water Clarity

The monthly water clarity measurements for the 2011 season are shown on the graph below. The water clarity in the north basin ranged from 1.5 meters (4.8 feet) in October to 3.8 meters (12.6 feet) in May. The north basin's season average was 2.9 meters (9.4 feet), which is close to the overall long term average of 2.64 meters (8.7 feet) for the north basin.

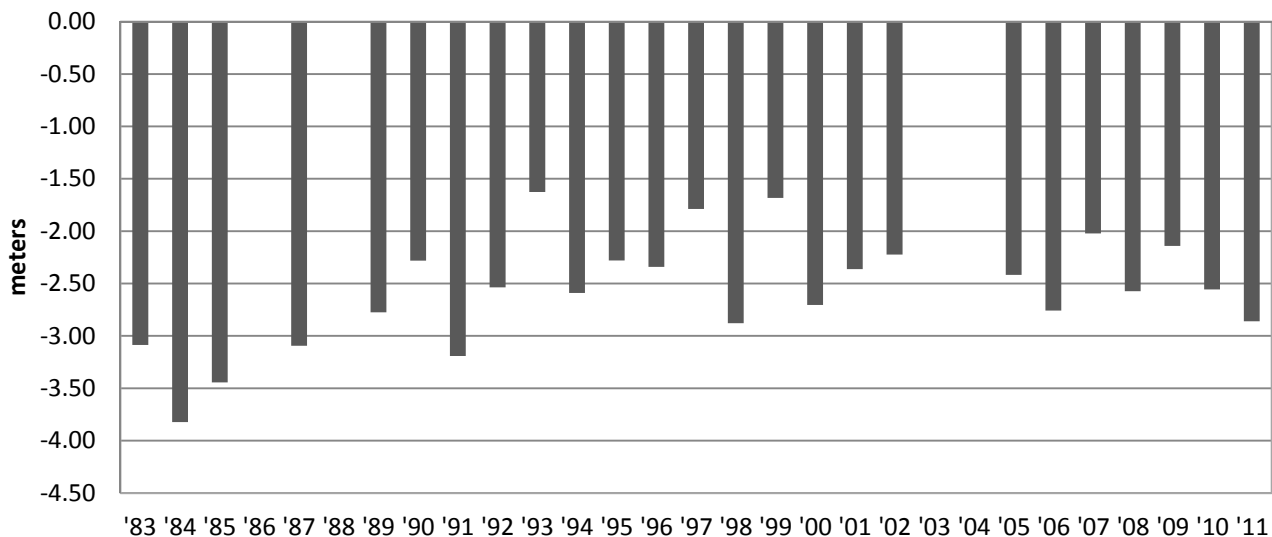
The water clarity in the south basin ranged from 1.8 meters (5.8 feet) in October to 2.9 meters (9.6 feet) in June. The season average in the south basin was 2.4 meters (7.9 feet), and the overall long term average for the basin is 2.06 meters (6.8 feet). The annual averages for both basins for the period of record are graphed on the next page.

To examine trends in water clarity, the annual average (mean) secchi disk reading can be normalized by subtracting the average secchi reading for the entire record from the annual average. A 'positive' bar on the graph indicates that the average clarity for that year was better than the overall average. A 'negative' bar indicates that the average water clarity that year was poorer than the overall average. These graphs are found on page 5 and are titled "Water Clarity Trend."

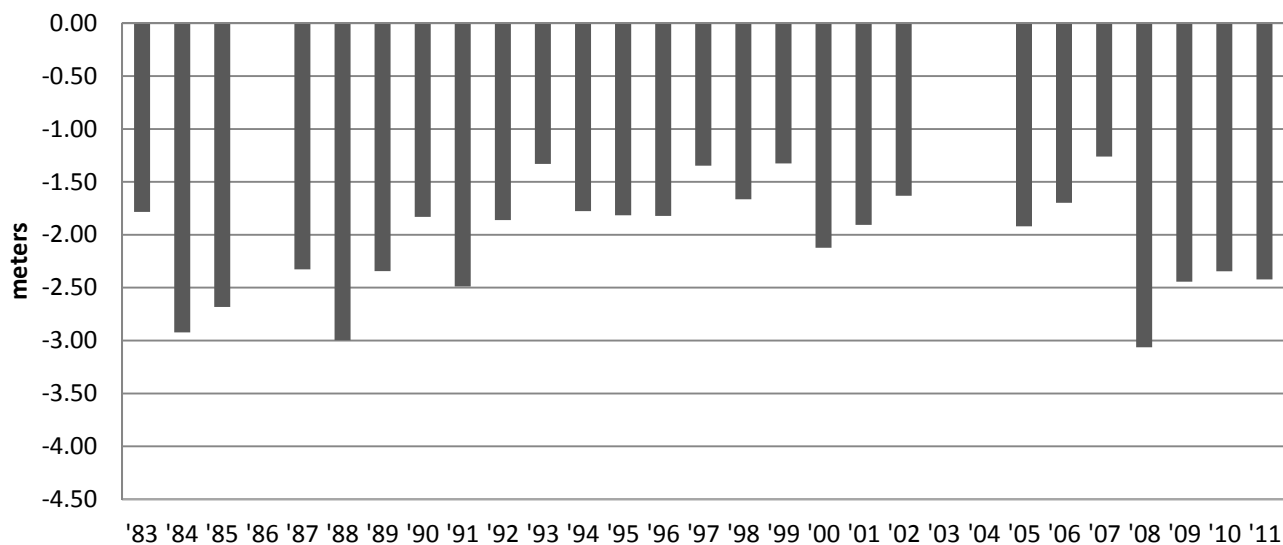
The clarifying effects of a whole lake alum treatment in 1983 is evident by the tall, positive bars above the "0" line on the graphs for both lake basins for several years following 1983. Improved water clarity in the south basin following the partial south basin alum treatment in 2008 can also be seen. However, the south basin alum treatment appears to have had little effect on the water clarity in the north basin.



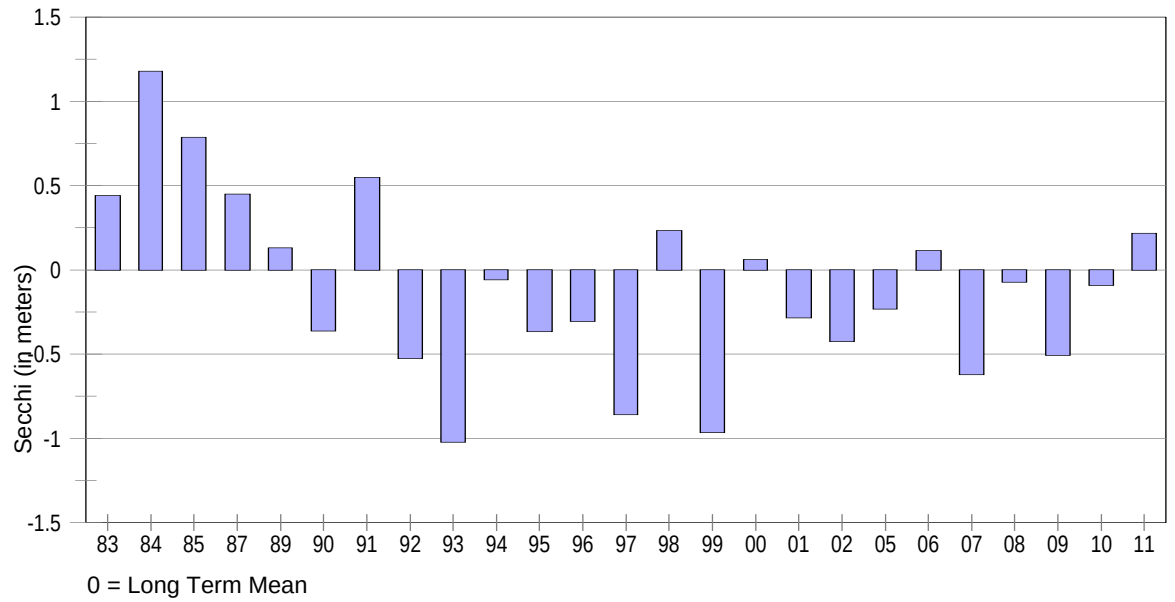
Long Lake - North Basin 2011 Secchi Disk Readings



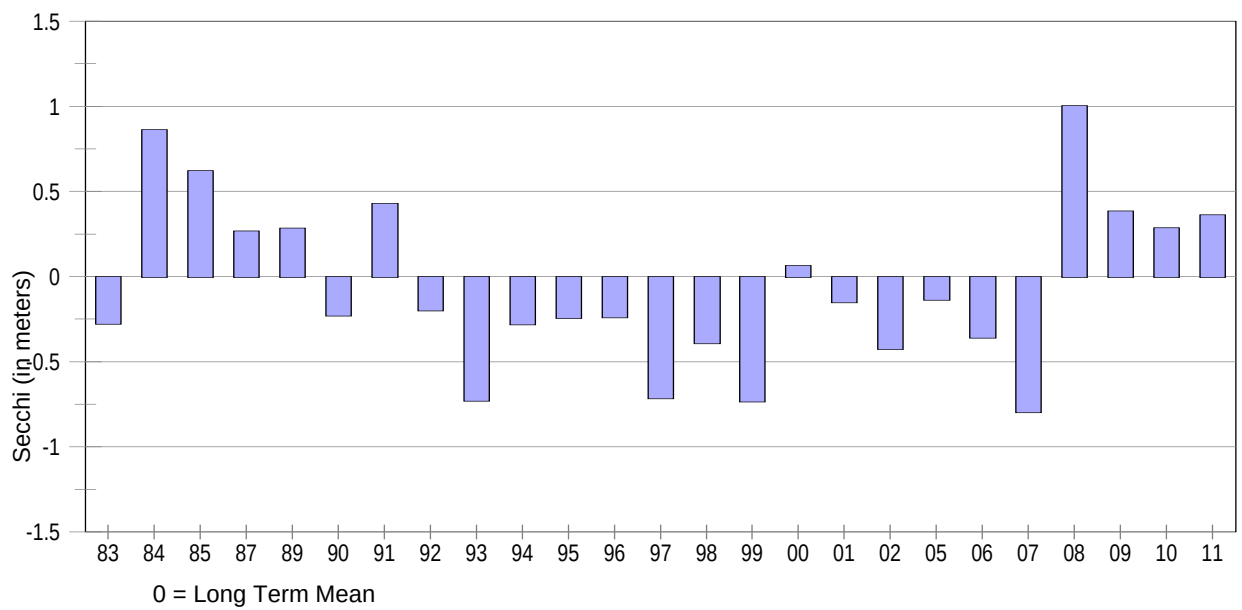
Long Lake - South Basin 2011 Secchi Disk Readings



Long Lake North Water Clarity Trend
Annual Mean Secchi Minus Overall Mean

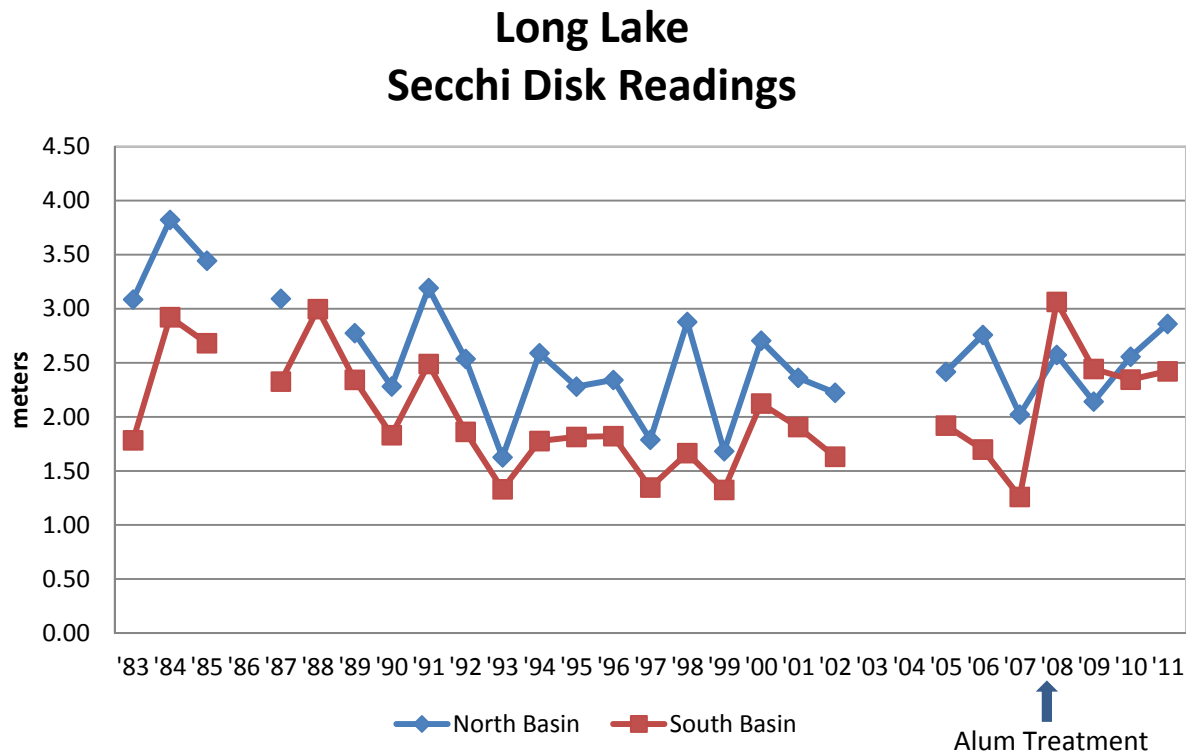


Long Lake South Water Clarity Trend
Annual Mean Secchi Minus Overall Mean



Long Lake

The graph below compares the seasonal average water clarity of the north and south basins. The water clarity is consistently higher in the north basin. The exception is in 2008 and 2009, where the clarity in the south basin improved after a partial basin alum treatment in spring 2008.



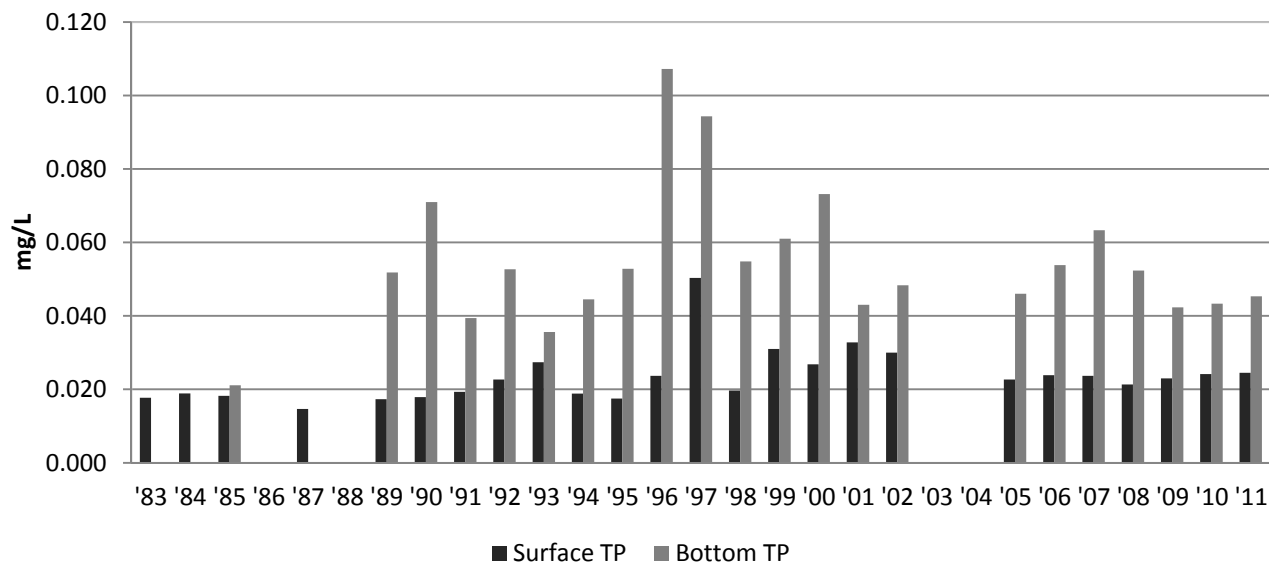
Total Phosphorus Levels

Generally, lakes in the Puget Sound region with summer average surface total phosphorus concentrations greater than 0.030 mg/l experience undesirable algae growth which interferes with recreational uses of the lake (USGS Water Supply Paper 2240). The action level established in WAC 173-201A, “Water Quality Standards for Surface Water of the State of Washington” is 0.020 mg/l.

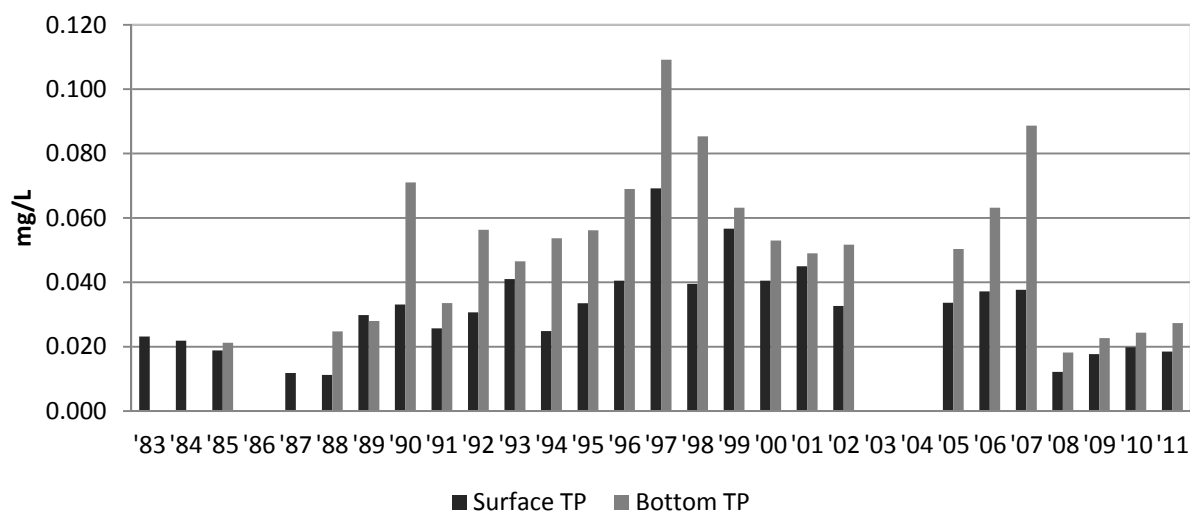
Graphs of the annual average phosphorus concentrations for each lake basin are shown on page 7. In 2011 the average surface total phosphorus (TP) concentration in the north basin was 0.025 milligrams per liter (mg/l). During September and October after the lake had mixed, the total phosphorus concentrations were above the state water quality action level of 0.020 mg/L. The south basin’s average surface TP was 0.019 mg/l, which is just below the state water quality action level. In the months of June, September and October the phosphorus concentrations measured slightly above the state action level of 0.02 mg/l. However, the south basin still appeared to be benefitting from the 2008 alum treatment.

In the north basin, the poorest water clarity and the greatest algae growth, as measured by chlorophyll *a* concentration, corresponded with the highest phosphorus levels in September and October. In the south basin the chlorophyll production and water clarity had less variability throughout the season than was measured in the north basin.

Long Lake - North Basin Total Phosphorus (TP)



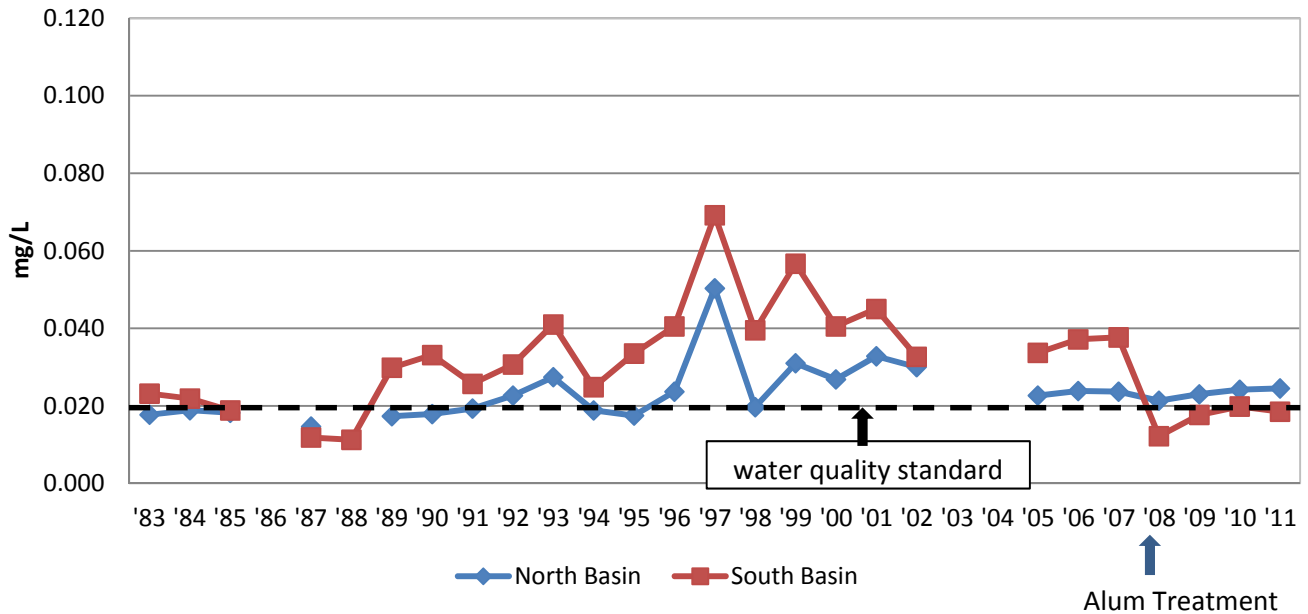
Long Lake - South Basin Total Phosphorus (TP)



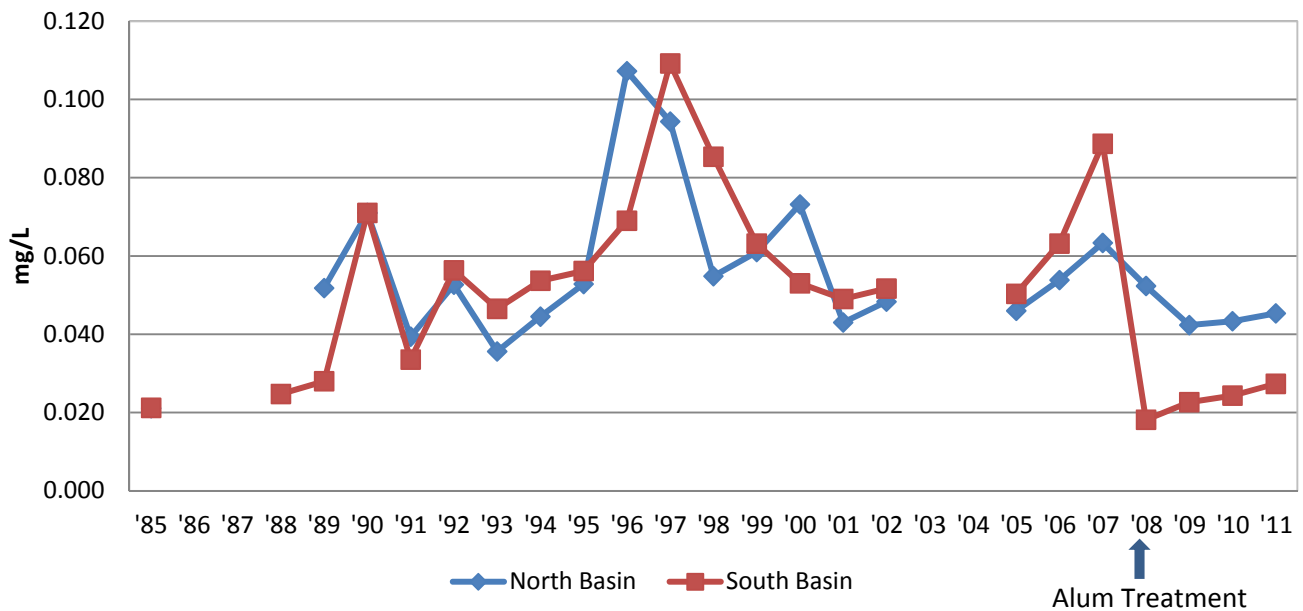
Long Lake

The graphs below compare the average total phosphorus concentrations at the surface and near the bottom in the north and south basins. The south basin has had higher phosphorus levels than the north basin at both the surface and bottom, until the 2008 partial basin alum treatment. The effects of the alum treatment were still evident in 2011.

Long Lake Surface Total Phosphorus



Long Lake Bottom Total Phosphorus



Trophic State Indices

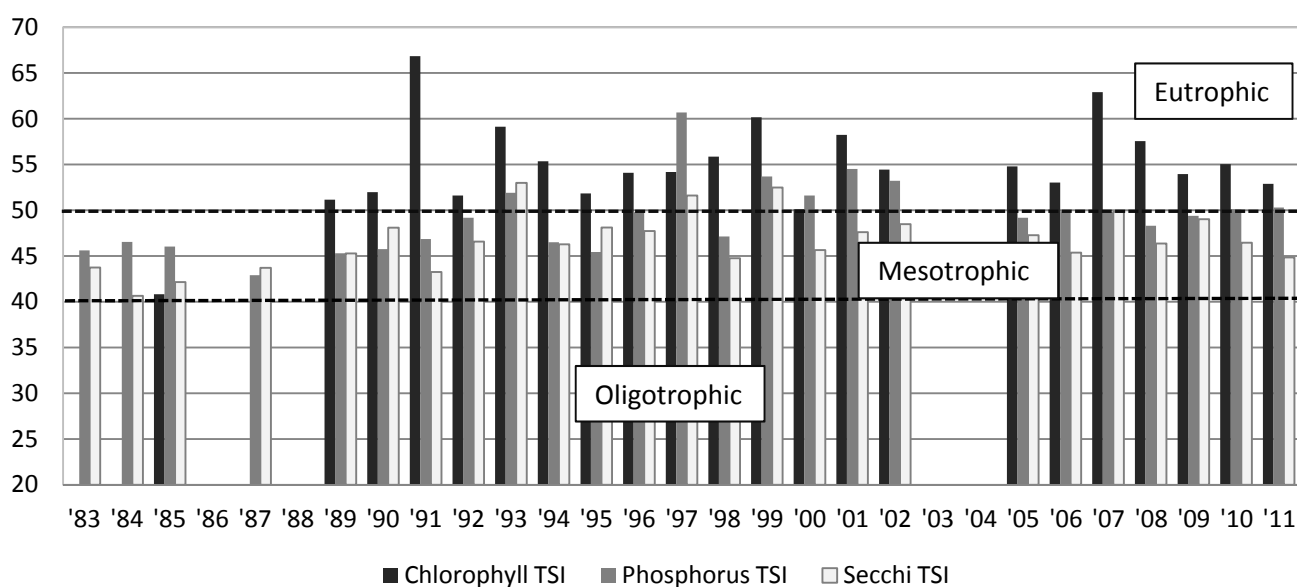
The Carlson Trophic State Indices (TSI) are used to express the degree of productivity of a lake. Average summer total phosphorus concentrations, chlorophyll *a* concentrations, and secchi disk transparency are each used to calculate a TSI for the lake. A TSI of 0 to 40 indicates an oligotrophic, or low productivity, lake. A TSI of 41 to 50 indicates a mesotrophic, or moderately productive lake. A TSI of greater than 50 indicates a eutrophic, or highly productive lake. The characteristics of a eutrophic lake include poor water clarity and excessive aquatic plant and algae growth.

The north basin 2011 TSIs for total phosphorus, chlorophyll *a*, and secchi disk are 50, 53, and 45, respectively. Two of the three TSIs are in the eutrophic range indicating moderate to highly productive conditions.

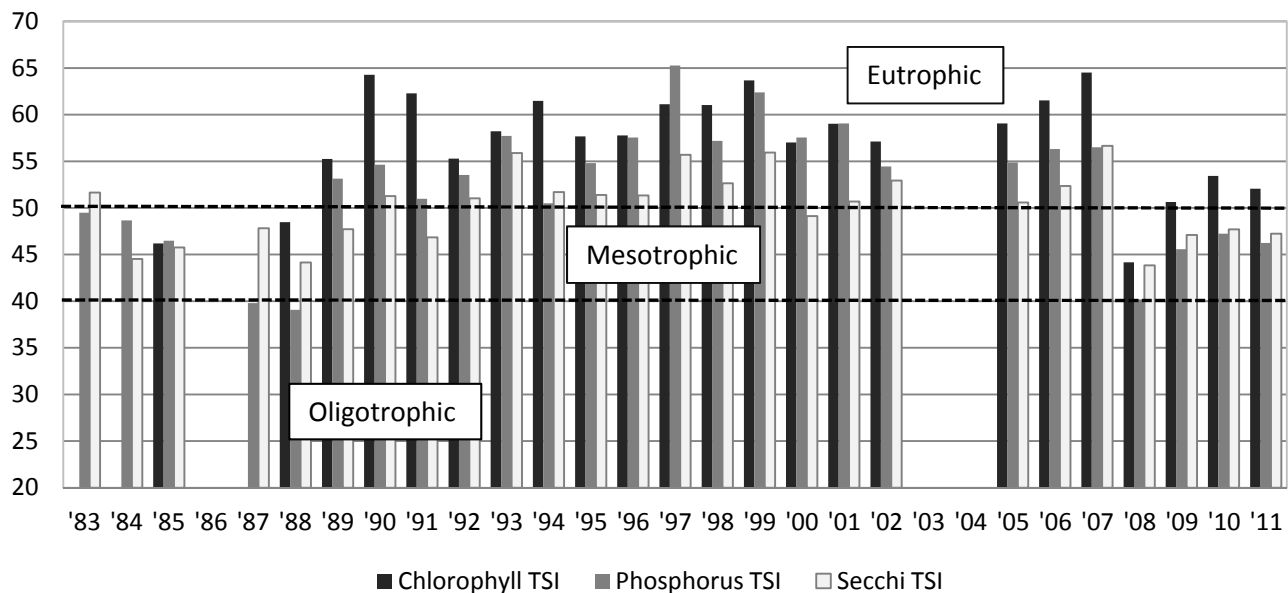
The south basin TSIs for total phosphorus, chlorophyll *a*, and secchi disk are 46, 52, and 47, respectively. Two of the three TSIs are in the mesotrophic range indicating moderately productive conditions.

Graphs showing the trophic state indices for both basins since 1983 are on the following page. Once again the lower TSIs in the 1980's show the water quality improvements realized from a 1983 alum treatment. The same effect is also visible in the south basin graph following the 2008 partial south basin alum treatment.

Long Lake - North Basin Trophic State Indices



Long Lake - South Basin Trophic State Indices



Algae

The monitoring program includes identification of algae types present in the lake each month. The 2011 data can be found at the end of this chapter. The common algae types present in Long Lake include diatoms, green, yellow, dinoflagellates and blue-green algae. However, it is the blue-green algae that typically cause nuisance “blooms” which can impair recreational activities. Dominance by blue-green algae is a sign of nutrient-rich conditions.

Some species of blue-green algae can produce toxins that can cause illness, or even death, in people, pets, and wildlife if ingested. Pets are particularly vulnerable to poisoning from toxic algae blooms due to their smaller body weight and their tendency to ingest higher doses by drinking lake water and licking their fur after swimming. In recent years there has been an increase in documented toxic blue-green algae blooms occurring in lakes within Washington State.

Algae species known to produce toxins, such as *Aphanizomenon* and *Anabaena*, are present in Long Lake, but most of the time they are not producing toxins. However because toxicity cannot be determined through visual observations, Thurston County Environmental Health began using screening test kits in 2009 to test for the presence of the most common algae toxin, microcystin. When screening results indicates the presence of the toxin, samples are sent to a laboratory to confirm the presence and quantify the amount. The laboratory services are sponsored by Washington Department of Ecology. Although toxin testing is now possible, lake residents and users should always observe lake conditions and avoid contact with lake water when an algae bloom is occurring.

In October 2011, an algae bloom was noticed in the south basin near the inlet creek. Five samples collected between October 6th and November 8th contained the toxin, microcystin, at levels ranging from 1.2 to 166 µg/L. The state recreational guidance limit is 6 µg/L. Because the toxin was

measured at levels above the state recreational limit, the county health department issued a health advisory and posted warning signs at public access points around the lake to alert residents and lake users to the toxic algae bloom. The health advisory was lifted on November 22th after the algae bloom died off and sample results showed the toxin was no longer present.

More information about blue-green algae and swimming safety information is available through the Thurston County website: www.co.thurston.wa.us/health/ehadm/swimming/swimming_index.html

Major Issues:

- The Long Lake Steering Committee is implementing the Long Lake Integrated Management Plan. Activities include the following:
 - Monitor and manage any recurrence of milfoil or emergence of other aquatic plants to meet recreational and aesthetic needs, fishery and wildlife habitat requirements, and watershed concerns.
 - Conduct water quality monitoring.
 - Investigate and promote best management practices and shoreline enhancement to decrease phosphorus loading.
 - Investigate, advise, and report upon impacts caused by the increased population and popular use of Long Lake, while maintaining quality of life on and around the lake.
 - Maintain a steering committee responsible for directing LMD activities, overseeing finances and communicating with property owners.
- In spring 2008, the south basin was treated with alum to reduce the available phosphorus concentration in the water column to reduce algae production. The water quality effects of that treatment were still evident in 2011 in the south basin.

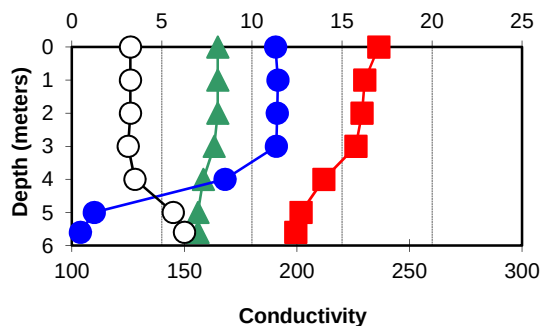
Funding Sources:

The Long Lake Management District (LMD No. 19) funds water quality monitoring so that the information needed to make lake management decisions is available. The lake management district assesses an annual charge to lake-front and lake-access properties within an established boundary for the purpose of funding specific lake management activities. The district is established by a vote of the property owners within the proposed boundary. The current district sunsets on December 31, 2015.

LONG LAKE – NORTH BASIN (LO3)

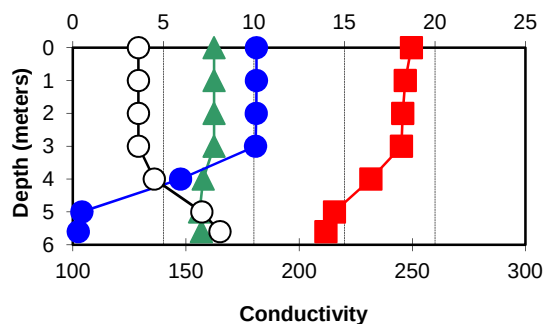
May 23, 2011

Temperature, pH, Dissolved Oxygen



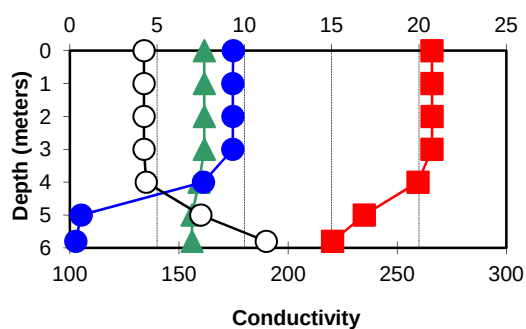
June 20, 2011

Temperature, pH, Dissolved Oxygen



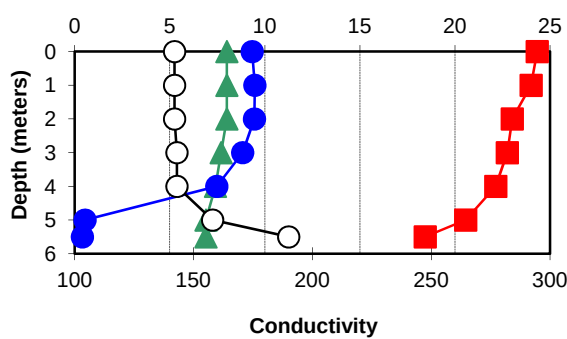
July 19, 2011

Temperature, pH, Dissolved Oxygen



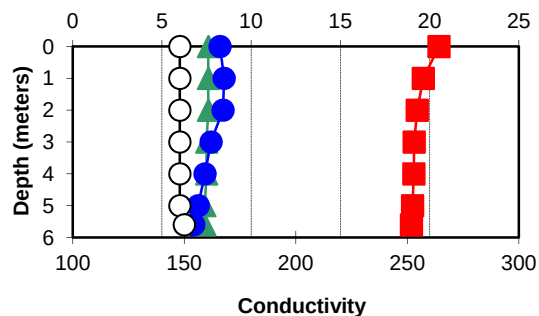
August 24, 2011

Temperature, pH, Dissolved Oxygen



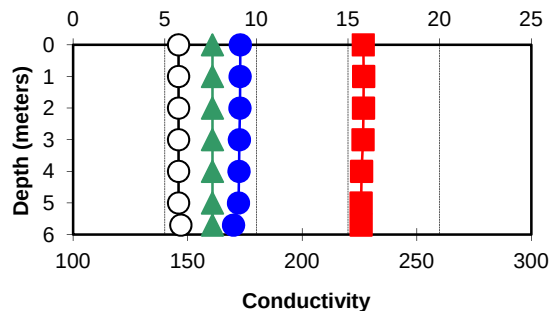
September 20, 2011

Temperature, pH, Dissolved Oxygen

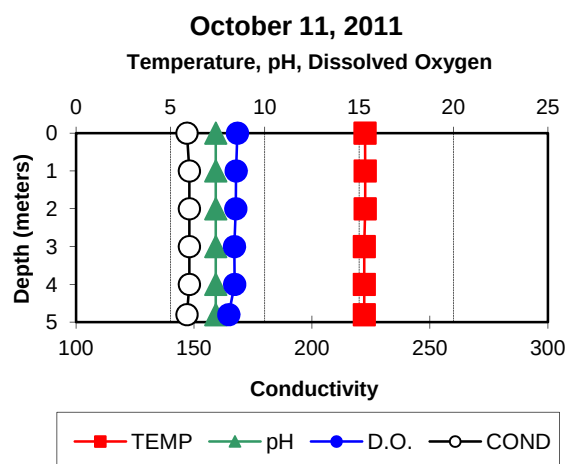
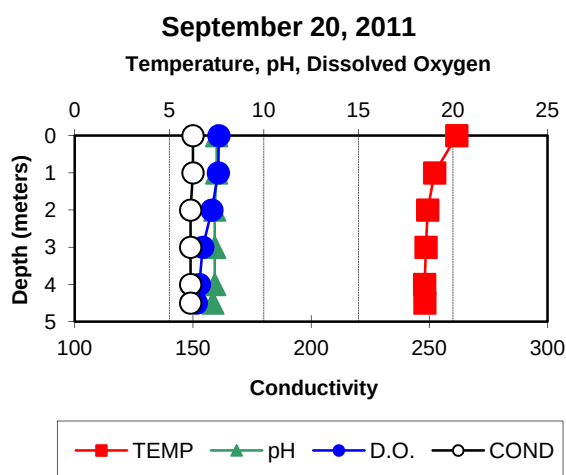
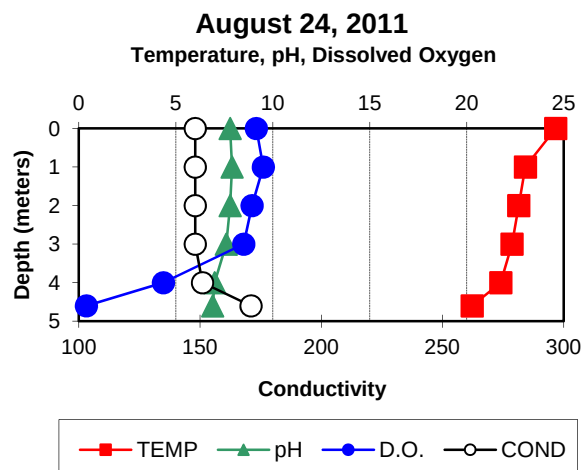
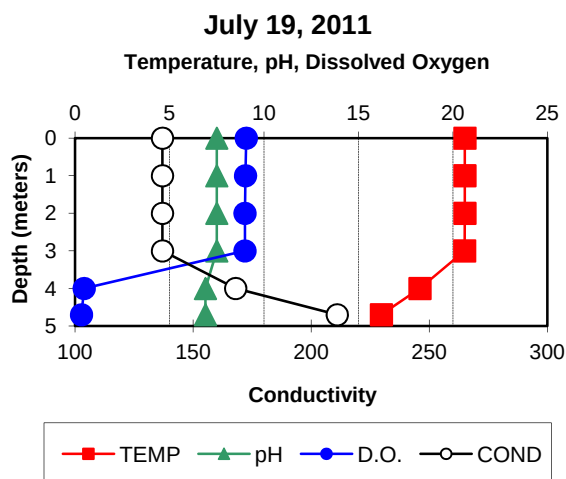
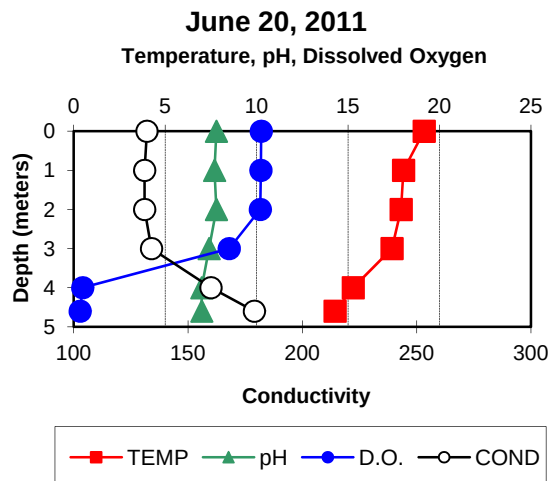
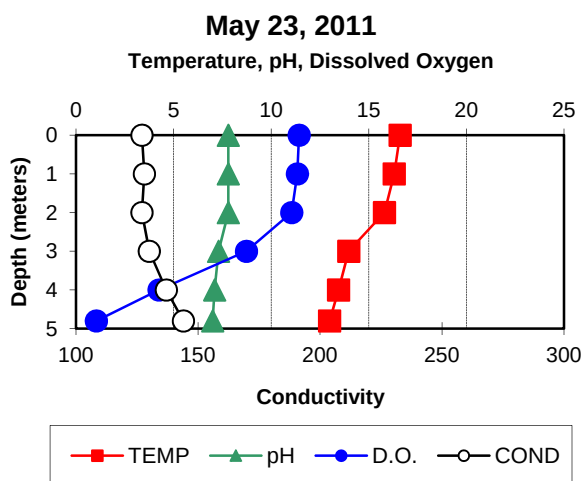


October 11, 2011

Temperature, pH, Dissolved Oxygen



LONG LAKE – SOUTH BASIN (LO4)



Thurston County Water Resources Annual Report - 2011

Long Lake @ LO#3 (North Basin)

Site ID# HENLOL030

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water	Lake Notes
05/23/2011	12:30:00 PM	5.6	5.0	0.019	0.027	0.264	0.291	3.84	6.4	0.3	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
06/20/2011	12:30:00 PM	5.6	5.0	0.018	0.049	0.210	0.249	3.20	5.3	0.6	#6 yellow-green	Chl a & algae composite @ 1, 2 & 3M.
07/19/2011	11:30:00 AM	5.8	5.0	0.015	0.073	0.279	0.320	3.45	5.3	1	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
08/24/2011	3:30:00 PM	5.5	4.8	0.018	0.036	0.361	0.521	3.12	6.4	0.05	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M. PHAEO_a was < detection at 0.1 ug/L.
09/20/2011	1:00:00 PM	5.6	5.0	0.034	0.041	0.330	0.359	2.07	14	2.6	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.
10/11/2011	12:00:00 PM	5.7	5.0	0.043	0.046	0.354	0.359	1.48	21	5.7	#6 murky yellow-green	Chl a & algae composite @ 1, 2, & 3M.

Summary for 'Site Description' = Long Lake @ LO#3 (North Basin) (6 detail records)

Averages: Sur TP 0.025
Secchi 2.86
Chl a 9.7

Thurston County Water Resources Annual Report - 2011

Long Lake @ LO#4 (South Basin)

Site ID# HENLOL040

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water	Lake Notes
05/23/2011	11:50:00 AM	4.8	4.0	0.012	0.019	0.308	0.369	2.90	6.9	0.2	#6 yellow-green	Chl a & algae composite @ 1 & 2M.
06/20/2011		4.6	4.0	0.021	0.026	0.296	0.563	2.92	12	0.2	#7 yellow	Chl a & algae composite @ 1, 2 & 3M.
07/19/2011	11:00:00 AM	4.7	4.0	0.016	0.039	0.401	0.570	2.48	6	0.05	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M. Phaeo a was < detection at 0.1ug/L.
08/24/2011	3:00:00 PM	4.6	4.0	0.015	0.022	0.430	0.377	2.48	8.5	0.05	#6 greenish-yellow	Chl a & algae composite @ 1, 2, & 3M. PHAEO_a was < detection at 0.1 ug/L.
09/20/2011	12:45:00 PM	4.5	4.0	0.023	0.031	0.425	0.398	1.97	8.3	1.6	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M. Algae like "fuzzy balls" in water column.
10/11/2011	11:30:00 AM	4.8	4.0	0.024	0.027	0.353	0.368	1.78	12	2.7	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M.

Summary for 'Site Description' = Long Lake @ LO#4 (South Basin) (6 detail records)

Averages: Sur TP 0.019
 Secchi 2.42
 Chl a 9.0

Algae data: Long Lake @ LO#3 (North Basin)

	<i>Type</i>	<i>Description</i>	<i>Dominant in Sample</i>
<i>05/23/2011</i>			
	BG	Anabaena species	☐
	BG	Aphanizomenon species	☐
	CP	Cryptomonads	☐
	DF	Ceratium species	☐
	DT	Asterionella species	☐
	DT	Cyclotella species	☐
	DT	Fragilaria species	☐
	DT	Stephanodiscus species	☐
	GR	Oocystis species	☐
	GR	Pandorina species	☐
	GR	Sphaerocystis species	☐
	YL	Dinobryon species	☐
<i>06/20/2011</i>			
	BG	Anabaena species	☐
	BG	Aphanizomenon species	☐
	CP	Cryptomonads	☐
	DF	Ceratium species	☐
	DT	Aulacoseira species	☐
	DT	Cyclotella species	☐
	DT	Fragilaria species	☐
	DT	Tabellaria species	☐
	GR	Crucigenia species	☐
	GR	Dimorphococcus lunatus	☐
	GR	Oocystis species	☐
	GR	Sphaerocystis species	☐
	GR	Staurastrum species	☐
	YL	Dinobryon species	☐
	YL	Synura species	☐

07/19/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
BG	Lyngbya species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Aulacoseira species	☐
DT	Cyclotella species	☐
DT	Fragilaria species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Elakatothrix species	☐
GR	Schroederia species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

08/24/2011

BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Aulacoseira species	☐
DT	Tabellaria species	☐
GR	Ankyra species	☐
GR	Cosmarium species	☐
GR	Sphaerocystis species	☐
YL	Dinobryon species	☐

09/20/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Acanthoceras species	☐
DT	Aulacoseira species	☐
DT	Fragilaria species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Ankistrodesmus species	☐
GR	Sphaerocystis species	☐
YL	Dinobryon species	☐

10/11/2011

BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Aulacoseira species	☐
DT	Diatoms species	☐
DT	Fragilaria species	☐
DT	Stephanodiscus species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Botryococcus species	☐
GR	Closterium species	☐
GR	Pediastrum species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

Key: BG = Blue green EU = Euglenophyte
 CP = Cryptophyte GR = Green
 DF = Dinoflagellate YL = Yellow
 DT = Diatom

Algae data: Long Lake @ LO#4 (South Basin)

05/23/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Aulacoseira species	☐
DT	Cyclotella species	☐
DT	Fragilaria species	☐
DT	Synedra species	☐
DT	Tabellaria species	☐
GR	Oocystis species	☐
GR	Pandorina species	☐
GR	Sphaerocystis species	☐
YL	Dinobryon species	☒

06/20/2011

BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Aulacoseira species	☐
DT	Cyclotella species	☐
DT	Fragilaria species	☐
DT	Tabellaria species	☐
GR	Closterium species	☐
GR	Cosmarium species	☐
GR	Dimorphococcus lunatus	☐
GR	Oocystis species	☐
GR	Sphaerocystis species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐
YL	Synura species	☐

07/19/2011

<i>Type</i>	<i>Description</i>	<i>Dominant in Sample</i>
BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DT	Cyclotella species	☐
DT	Navicula species	☐
EU	Trachelomonas species	☐
GR	Botryococcus species	☐
GR	Eutetramorus globosus	☐
YL	Dinobryon species	☐

08/24/2011

BG	Anacystis species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Ankyra species	☐
GR	Botryococcus species	☐
GR	Cosmarium species	☐
GR	Sphaerocystis species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

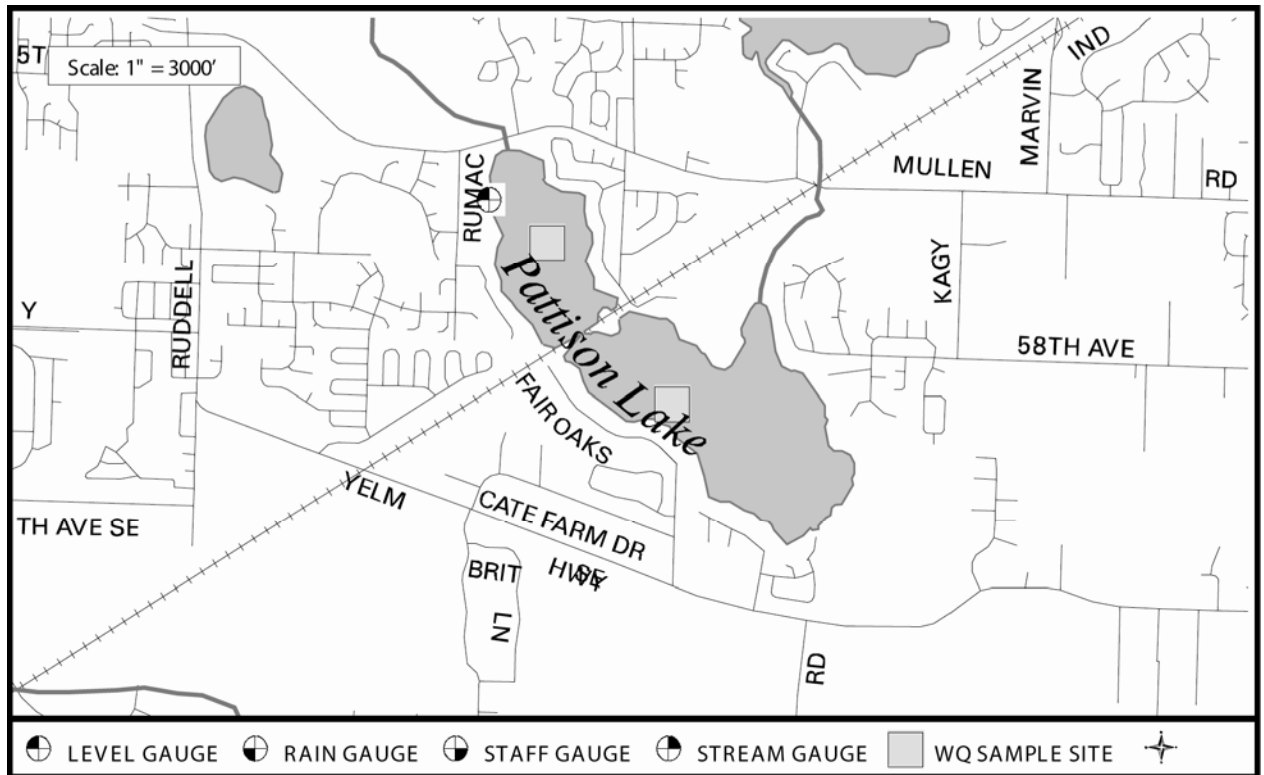
09/20/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Acanthoceras species	☐
DT	Asterionella species	☐
DT	Aulacoseira species	☐
DT	Fragilaria species	☐
DT	Rhizosolenia eriensis	☐
DT	Stephanodiscus species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Oocystis species	☐
GR	Sphaerocystis species	☐
YL	Dinobryon species	☐

10/11/2011

BG	Anabaena species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Acanthoceras species	☐
DT	Aulacoseira species	☐
DT	Cyclotella species	☐
DT	Melosira species	☐
DT	Rhizosolenia eriensis	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Scenedesmus species	☐
YL	Dinobryon species	☐

Key: BG = Blue green EU = Euglenophyte
 CP = Cryptophyte GR = Green
 DF = Dinoflagellate YL = Yellow
 DT = Diatom



PART OF HENDERSON INLET WATERSHED

SHORELINE LENGTH: 6.3 miles

LAKE SIZE: 270 acres

BASIN SIZE: 3.8 square miles

MEAN DEPTH: 13 feet

MAXIMUM DEPTH: 22 feet

VOLUME: 3,600 acre-feet

PRIMARY LAND USES:

The watershed is primarily suburban residential with some undeveloped forest cover primarily in wetland areas.

PRIMARY LAKE USES:

Fishing, swimming, and boating (under 5 mph).

PUBLIC ACCESS:

Washington Department of Fish and Wildlife public boat launch on the south basin.

GENERAL TOPOGRAPHY:

Pattison Lake is a Puget Sound lowland lake at an elevation of 154 feet. Decades ago it was divided into two basins, north and south, by placement of fill material for a railroad. Pattison Lake is second in a series of four lakes that begins with Hicks Lake. Hicks Lake drains into Pattison, and Pattison drains to Long Lake. The outlet from Long Lake flows through Lois Lake and becomes Woodland Creek, a tributary stream to Henderson Inlet.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Fair - Algae blooms, filamentous algae growth, and aquatic plant growth, at times, impair water clarity and fishing and boating activities, especially in the south basin.

OTHER DATA:

Washington Department of Ecology,
Environmental Assessment Program, (360)
407-6700 (historic DOE and volunteer
collected water quality data).

Thurston County Resource Stewardship
Department, Water Resources Program
(360) 754-4681
www.co.thurston.wa.us/monitoring

Water Quality Data - Thurston County
Environmental Health Division,
[www.co.thurston.wa.us/health/ehswat/swater.
htm](http://www.co.thurston.wa.us/health/ehswat/swater.htm) (360) 867-2626

GENERAL DISCUSSION:

Pattison Lake is separated into two distinct basins by a fill material for the railroad. Water quality is generally better in the north basin than it is in the south basin. Algae blooms often impair water clarity in both the north and south basins. However, the south basin usually has more severe algae blooms and occasionally experiences filamentous algae growth that floats to the surface and interferes with boating and fishing. Pattison Lake was part of a lake restoration project initiated by citizens in 1976. In 1983 the lake was treated with aluminum sulfate (alum) to reduce the phosphorus concentration in the lake. Aquatic plant harvesting was done for two years after the alum treatment, and was resumed in the north basin for a few years in the early 90's. There have been no major lake management activities since that time. However, water quality monitoring has been conducted by Thurston County during the summer months since 1994. In 2009 monitoring was reduced from the previous two sites, one in each basin, to just one site in the south basin.

In 2011 monthly sampling was done, May through October, at a site located in the south basin. Temperature, dissolved oxygen, pH, and conductivity were measured at one-meter increments from the surface to the bottom. Water clarity was measured using a standard secchi disk. Water samples were collected near the lake surface and bottom and were analyzed for total phosphorus and total nitrogen. Composite samples from the epilimnion (warm surface layer), or photic zone, were collected and analyzed for chlorophyll *a* and algae identification. The water quality data and the algae identification data can be found at the end of this chapter.

Field Parameters

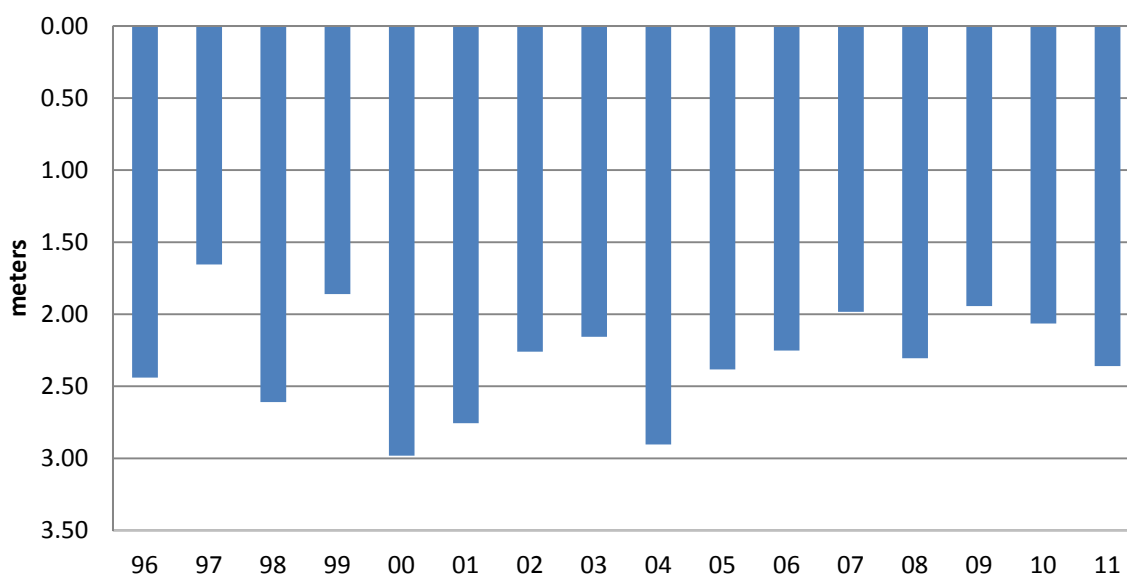
The monthly temperature, dissolved oxygen, pH, and conductivity data is displayed on graphs on page 7 of this chapter. *Thermal stratification* is when the lake develops a warm surface layer as solar radiation warms the upper water, but a layer of colder water remains at the bottom. Because Pattison Lake is fairly shallow, the warm upper water and the colder lower water are not always very distinct layers and sometimes mix during the summer. In 2011 the south basin was thermally stratified from May through September. The maximum temperature difference between the surface and the bottom occurred in August, with a 10 degree Celsius difference. By October the lake was fully mixed.

From May through September, the dissolved oxygen level near the bottom was reduced to nearly zero. Under anoxic, or low oxygen conditions, phosphorus is released from the sediments into the water column in a form readily used by algae. When mixed up in the water column in fall, this phosphorus often stimulates fall algae blooms.

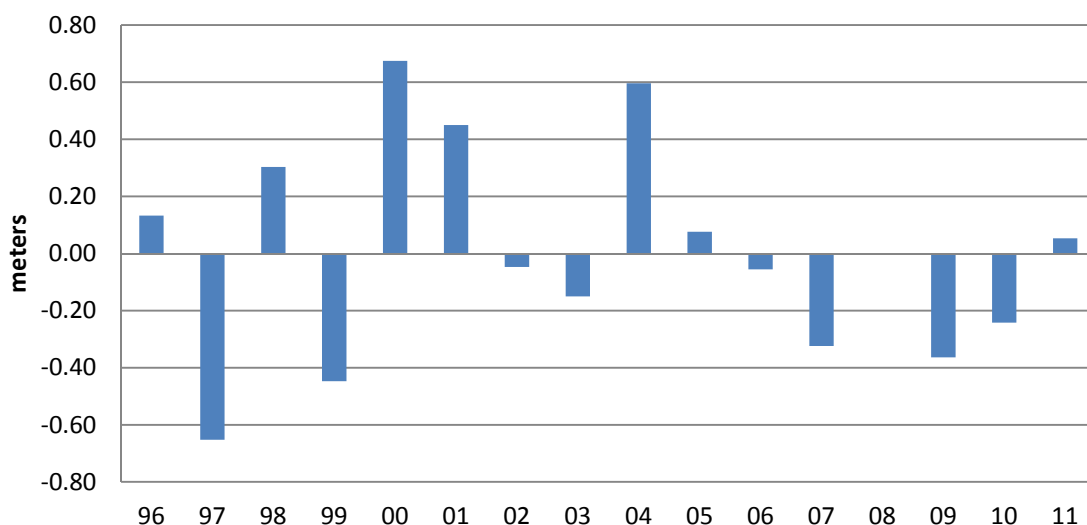
Secchi Disk Water Clarity

Water clarity is measured with a device called a secchi disk, and is a good measure of the long-term trend in water quality. The 2011 the average secchi disk transparency in the south basin was 2.4 meters (or 7.7 feet), with a range from 1.7 meters in October to 3.3 meters in August (5.6 to 10.9 feet). The average water clarity measured over the past sixteen years is shown on graph below.

South Pattison Lake Water Clarity Average Secchi Readings



Water Clarity Trend Annual Average Minus Long-Term Average

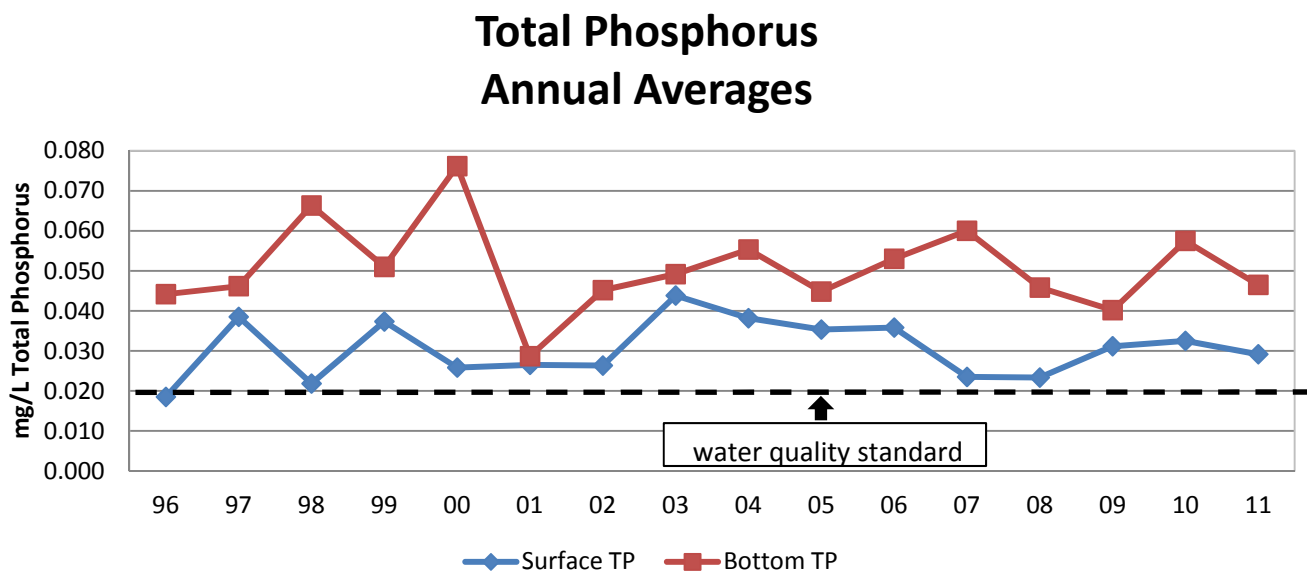


To examine trends in water clarity, the annual average secchi disk reading can be normalized by subtracting the average secchi reading for the entire period of record from the annual averages. A 'positive' bar on the graph indicates that the average clarity for that year was better than the overall average. A 'negative' bar indicates that the average water clarity that year was poorer than the overall average. The water clarity trend graph on the previous page shows no definite upward or downward trend in water clarity. Rather there appears to be random variation, plus or minus two-thirds of a meter, around the overall average for the period of record.

Total Phosphorus and Chlorophyll a Levels

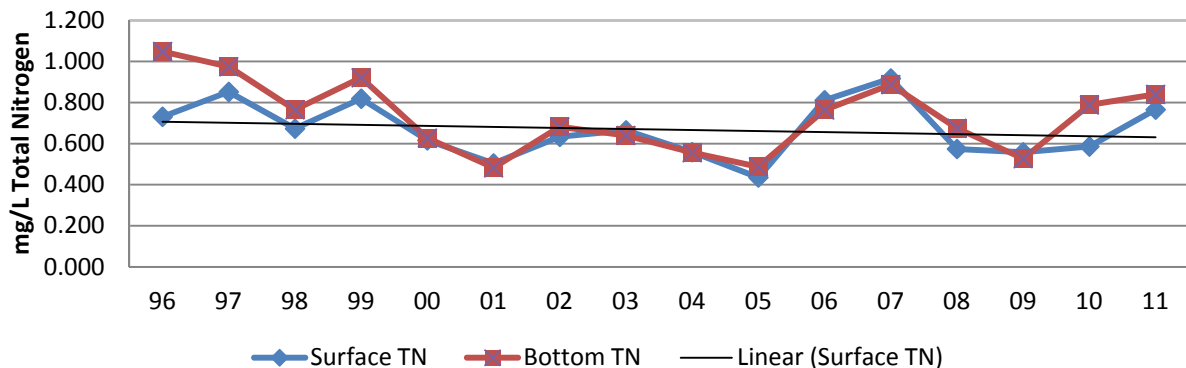
Generally, lakes in the Puget Sound region with summer average surface total phosphorus concentrations greater than 0.030 mg/l experience undesirable algae growth which interferes with recreational uses of the lake (USGS Water Supply Paper 2240). The action level established in WAC 173-201A, "Water Quality Standards for Surface Water of the State of Washington" is 0.020 mg/l.

The 2011 average surface total phosphorus concentration in the south basin of Pattison Lake was 0.029 milligrams per liter (mg/l), which fails to meet the state water quality standard. For individual months, the total phosphorus concentrations were above the action level in May, September, and October. The concentration was the highest, at 0.065 mg/l, in October, just after the lake mixed. This high level of phosphorus also corresponds with the poorest water clarity for the season. The graph below shows the annual average total phosphorus concentrations at the surface and at the bottom for the period of record.



The annual average total nitrogen concentrations at the lake surface and bottom for the period of record is graphed on the next page. While phosphorus is typically the limiting nutrient that drives algae production in a lake environment, some plants and algae thrive on a nitrogen-rich environment. High nitrate-nitrogen was documented in the groundwater around the lakes in the 1980's, however the graph shows that the in-lake nitrogen trend may be declining.

Total Nitrogen Annual Averages

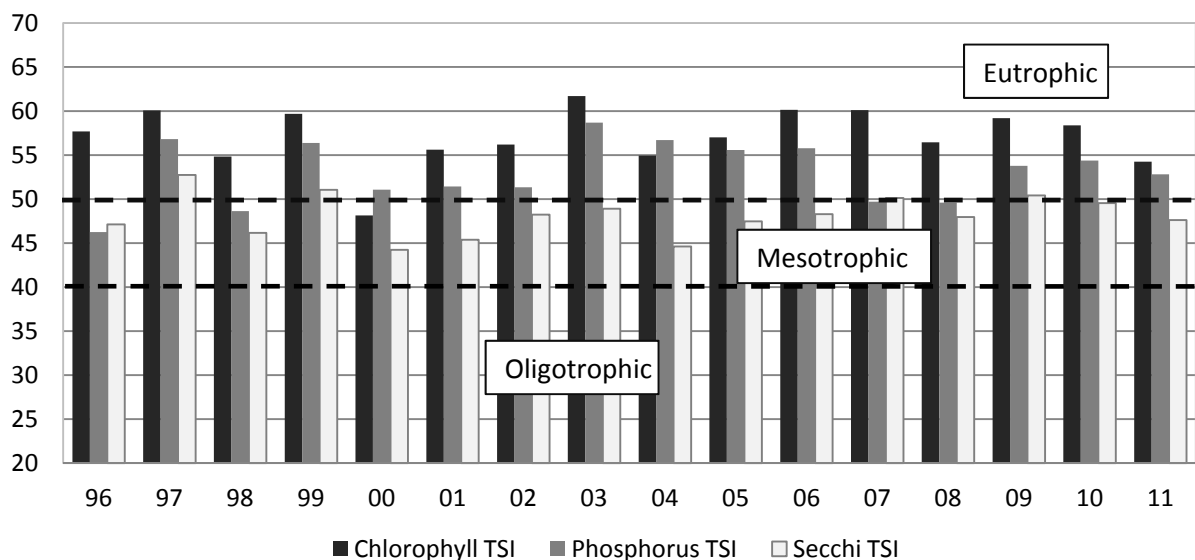


Trophic State Indices

Carlson trophic state indices (TSI) are used to express the degree of productivity in a lake. Average summer total phosphorus concentrations, chlorophyll *a* concentrations, and secchi disk transparency are each used to calculate a TSI for the lake. A TSI of 0 to 40 indicates an oligotrophic, or low productivity, lake. A TSI of 41 to 50 indicates a mesotrophic, or moderately productive lake. A TSI of greater than 50 indicates a eutrophic, or highly productive lake. A graph of the trophic state indices for each year of data is shown below.

The 2011 South Pattison Lake TSIs for total phosphorus, chlorophyll *a*, and secchi disk are 53, 54, and 48, respectively. Two of the three indices were in the eutrophic range in 2011, indicating a highly productive and nutrient-rich lake. The Trophic State Indices graph below shows variation from year to year, but overall indicates that the lake has been moderately high in nutrients and algae productivity throughout the period of record.

South Pattison Lake Trophic State Indices



Algae

The monitoring program includes identification of algae types present in the lake. The 2011 data can be found at the end of this chapter. There are a variety of algae types present in Pattison Lake including blue-green, diatoms, and green algae. Blue-green algae species are most common in nutrient-rich lakes and are known to cause visible algae “blooms”. They are present in this lake and commonly cause “blooms”.

Some species of blue-green algae can produce toxins that can cause illness, or even death, in people, pets, and wildlife if ingested. Pets are particularly vulnerable to poisoning from toxic algae blooms due to their smaller body weight and their tendency to ingest higher doses by drinking lake water and licking their fur after swimming. In recent years there has been an increase in documented toxic blue-green algae blooms occurring in lakes within Washington State.

Because toxicity cannot be determined through visual observations, in 2009 Thurston County Environmental Health began using screening test kits to test for the presence of the most common algae toxin, microcystin. When the screening indicates the presence of microcystin, a sample is sent to a laboratory to quantify the amount of toxin present. The laboratory services are a statewide program sponsored by Washington Department of Ecology. Although toxin testing is now possible, lake residents and users should always observe lake conditions and avoid contact with lake water where an algae bloom is occurring.

In September 2011, an algae bloom was noticed in the south basin at the public boat launch. The sample was analyzed for the microcystin toxin, and the result was 38 µg/L. The state recreational guidance limit is 6 µg/L. Because the toxin concentration was above the state recreational limit, the county health department issued a health advisory and posted warning signs at access points around the lake to alert residents and lake users to the toxic algae bloom. Weekly samples showed that the toxic bloom persisted from September 21 to October 25th when the toxin concentration decreased to 5 µg/L, which is below the recreational limit. During this event, the toxin level reached a high of 55 µg/L on October 4th. The health advisory was lifted on November 22th after sample results showed the toxin concentration had been below the limit of 6 µg/L for three consecutive weeks and the recreation season was at a close for the year.

More information about blue-green algae and swimming safety information is available through the Thurston County website: www.co.thurston.wa.us/health/ehadm/swimming/swimming_index.html

Major Issues:

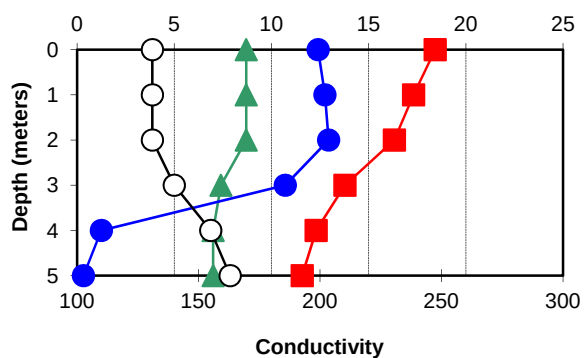
- Blockages in the outlet channel in past years have caused the lake level to rise, flooding docks and yards.
- Abundant nutrients often cause algae blooms, which in recent years have been shown to be producing a toxin. Nutrients also stimulate filamentous algae growth in the south basin, which form floating mats on the surface that impair recreational uses.

Funding Sources:

Thurston County funding will support continued sampling in 2011 in the south basin.

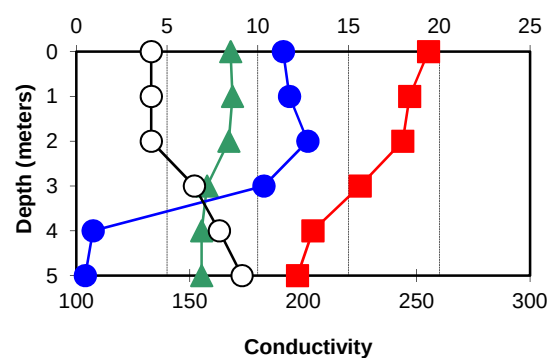
May 24, 2011

Temperature, pH, Dissolved Oxygen



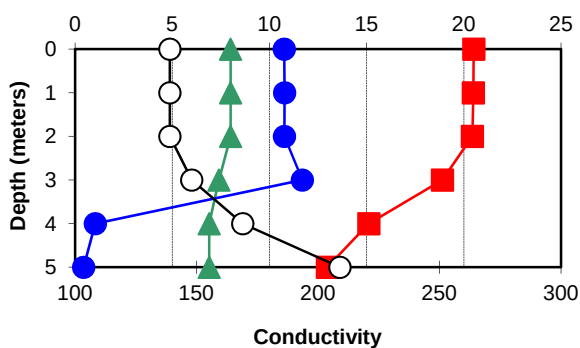
June 20, 2011

Temperature, pH, Dissolved Oxygen



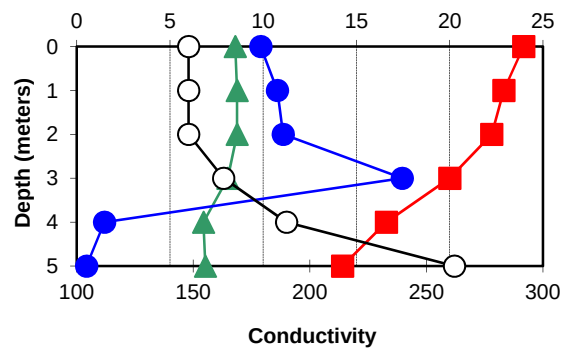
July 19, 2011

Temperature, pH, Dissolved Oxygen



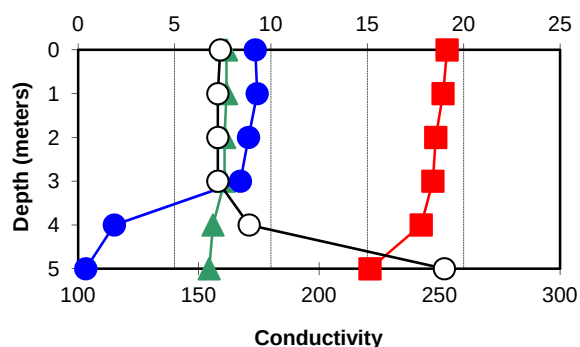
August 24, 2011

Temperature, pH, Dissolved Oxygen



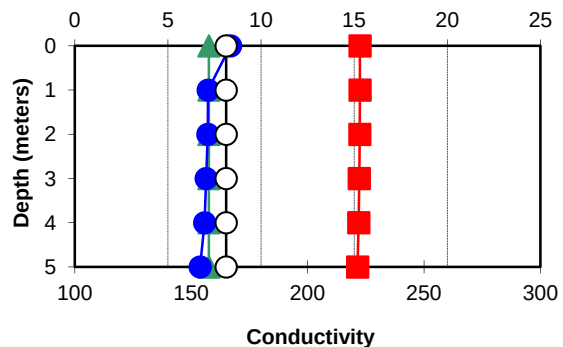
September 21, 2011

Temperature, pH, Dissolved Oxygen



October 11, 2011

Temperature, pH, Dissolved Oxygen



Thurston County Water Resources Annual Report - 2011

South Pattison Lake

Site ID# HENSPL010

<i>Date</i>	<i>Time</i>	<i>Bottom Depth m</i>	<i>Bottom Sample Depth m</i>	<i>Sur TP mg/L</i>	<i>Bott TP mg/L</i>	<i>Sur TN mg/L</i>	<i>Bott TN mg/L</i>	<i>Secchi m</i>	<i>Chl a ug/L</i>	<i>Phae a ug/L</i>	<i>Water</i>	<i>Lake Notes</i>
05/24/2011	4:50:00 PM	5.1	4.5	0.027	0.027	0.822	0.944	2.00	14	1.1	#7 yellow-orange	Chl a & algae composite @ 1 & 2M.
06/20/2011	3:50:00 PM	5.2	4.5	0.019	0.027	0.694	0.909	1.86	14	0.7	#6 yellow-green	Chl a & algae composite @ 1 & 2M.
07/19/2011	3:30:00 PM	5	4.5	0.020	0.034	0.814	0.923	2.42	11	0.5	#6 greenish-yellow	Chl a & algae composite @ 1, 2, & 3M.
08/24/2011	4:30:00 PM	5	4.5	0.014	0.065	0.634	0.528	3.32	5	0.05	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M. PHAEO_a was < detection at 0.1 ug/L.
09/21/2011	12:00:00 PM	5	4.5	0.030	0.058	0.752	0.855	2.84	10	0.6	#3 pea-green	Chl a & algae composite @ 1, 2, & 3M. Large algae scum at boat launch.
10/11/2011	4:00:00 PM	5	4.5	0.065	0.068	0.879	0.881	1.72	13	2.1	#6 yellow-green	Chl a & algae composite @ 1, 2, & 3M. No scum anywhere due to wind.

Summary for 'Site Description' = South Pattison Lake (6 detail records)

Averages: **Sur TP** 0.029
 Secchi 2.36
 Chl a 11.2

Algae data: South Pattison Lake

05/24/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DT	Asterionella species	☐
DT	Aulacoseira species	☐
DT	Cyclotella species	☐
DT	Stephanodiscus species	☐
DT	Tabellaria species	☐
GR	Crucigenia species	☐
GR	Oocystis species	☐
GR	Sphaerocystis species	☐
GR	Staurastrum species	☐

06/20/2011

CP	Cryptomonads	☐
DT	Asterionella species	☐
DT	Aulacoseira species	☐
DT	Cyclotella species	☐
DT	Fragilaria species	☐
DT	Stephanodiscus species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Pediastrum species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

07/19/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
BG	Chroococcus species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Cyclotella species	☐
DT	Fragilaria species	☐
EU	Trachelomonas species	☐
GR	Botryococcus species	☐
GR	Crucigenia species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

08/24/2011

BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon flos-aquae	☐
BG	Gomphosphaeria species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Fragilaria species	☐
DT	Stephanodiscus species	☐
GR	Ankyra species	☐
GR	Crucigenia species	☐
GR	Elakatothrix species	☐
GR	Sphaerocystis species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

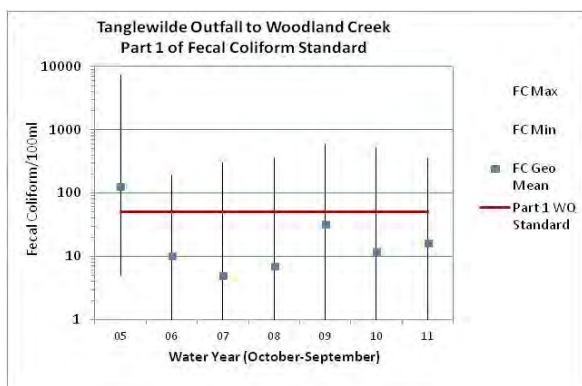
09/21/2011

<i>Type</i>	<i>Description</i>	<i>Dominant in Sample</i>
BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
BG	Lyngbya species	☐
BG	Woronichinia species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Fragilaria species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Cosmarium species	☐
GR	Crucigenia species	☐
GR	Staurastrum species	☐

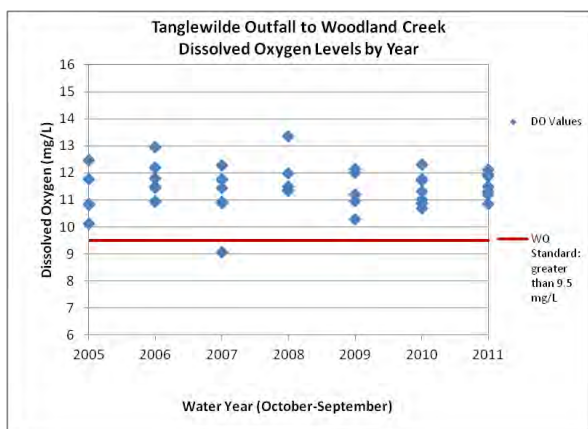
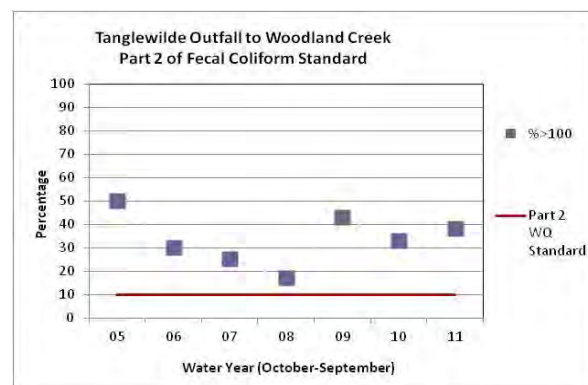
10/11/2011

<i>Type</i>	<i>Description</i>	<i>Dominant in Sample</i>
BG	Anabaena species	☐
BG	Anabaena species	☐
BG	Aphanizomenon species	☐
BG	Aphanizomenon species	☐
BG	Woronichinia species	☐
BG	Woronichinia species	☐
CP	Cryptomonads	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Asterionella species	☐
DT	Aulacoseira species	☐
DT	Aulacoseira species	☐
DT	Fragilaria species	☐
DT	Fragilaria species	☐
DT	Stephanodiscus species	☐
DT	Stephanodiscus species	☐
EU	Trachelomonas species	☐
EU	Trachelomonas species	☐
GR	Ankyra species	☐
GR	Ankyra species	☐
GR	Staurastrum species	☐
GR	Staurastrum species	☐
YL	Chrysomonad species	☐
YL	Chrysomonad species	☐

Key: BG = Blue green EU = Euglenophyte
 CP = Cryptophyte GR = Green
 DF = Dinoflagellate YL = Yellow
 DT = Diatom

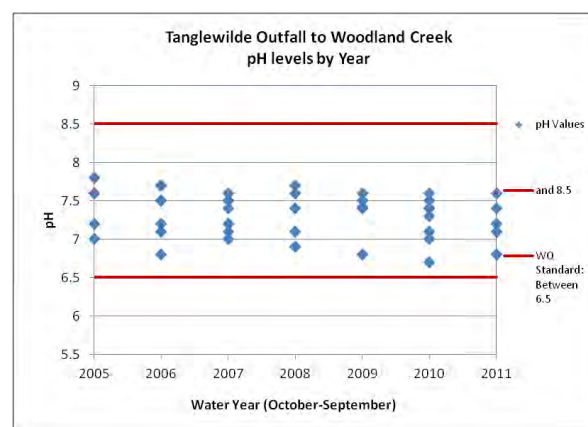


The water quality meets Part 1 of the fecal coliform bacteria standard but has consistently failed Part 2.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. No violations occurred in water years 2010 and 2011. Since 2005 there has only been one measurement below the dissolved oxygen standard.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been no violations since 2005.



Discussion:

The Tanglewilde stormwater outfall was added to the ambient monitoring network in 2005. This stormwater outfall discharges into Woodland Creek, which is the largest tributary to Henderson Inlet. Woodland Creek is listed on the 303d Section of the Clean Water Act for fecal coliform, temperature and dissolved oxygen standards violations. A Total Maximum Daily Load (TMDL) study completed by Washington Department of Ecology in March 2006 identified the Tanglewilde stormwater outfall as one of the major sources of bacteria and nitrogen pollution to Woodland Creek.

During the 2009/10 water year, nine samples were collected at this site and in water year 2010/11, eight samples were collected. The outfall is usually dry during summer months. The water quality standard for fecal coliform bacteria at this site is as follows: part 1 - the geometric mean shall not exceed 50 colony forming units per 100 milliliters of sample, *and* part 2 - no more than 10 percent of the samples shall exceed 100 colonies per 100 mL of sample. The outfall met part 1 of the fecal coliform standard but did not meet part 2. This is because during storm events the bacteria level typically exceeds 100 organisms per 100 ml. But when it is not raining, the source of the base flow in the outfall is groundwater, which is low in bacteria but high in nitrate. During storm events turbidity exceeds background conditions.

Nitrate results are consistently very high in this discharge. While there is no water quality standard for nitrates in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015). The average was 8.47 mg/l for 2009/10 and 7.55 mg/l for 2010/11. In this stormwater system, shallow ground water infiltrates into the pipe. The high nitrate values reflect local contamination of the shallow ground water, primarily from on-site sewage systems.

Major Issues:

- Stormwater discharged from this outfall is a major source of bacteria and nutrient pollution to Woodland Creek.
- On-site septic systems and other urban activities are contributing to contamination of the shallow ground water in the area, which is infiltrating into the stormwater system.
- Thurston County has a project underway to reduce the stormwater volume and improve water quality through rehabilitation of dry wells, restoration of lawns, and installation of bioswales and rain gardens in the Tanglewilde neighborhood.

Funding Sources:

- Local Storm and Surface Water Utility

Water Quality Summary
Conventional Parameters
Tanglewilde Stormwater Outfall

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Water Year Data 2005 - 2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		7.63 – 16.03 10.23 – 11.95			7.79 – 18.91
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		10.67 – 12.30 10.84 – 12.10	0 of 8 0 of 7		9.07 – 13.4
Conductivity	µmhos/cm		09/10 10/11	143 149	44 - 203 88 - 183		159	27 - 229
pH		6.5 - 8.5	09/10 10/11	7.4* 7.3*	6.7 – 7.6 6.8 – 7.6	0 of 9 0 of 7	7.4	6.8 – 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	11.06 5.16	0 – 52 0 - 18	2 of 9 1 of 7	6.22	0 – 45
Fecal Coliform	colonies / 100 ml	GMV: ≤50 and ≤ 10% not to exceed 100	09/10 10/11	12** 16**	0 - 520 0 -360	% exceeding 100	16	0 - 7300
						33% 38%		
Total Phosphorus	mg/L		09/10 10/11	0.136 0.125	0.095 – 0.161 0.098 – 0.166		0.132	0.067 – 0.208
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	8.47 7.55	2.44 – 11.80 3.24 – 14.3		6.85	0.608 – 12.4
Ammonia	mg/L		09/10 10/11	0.020 0.006	<0.010 – 0.092 <0.010 – 0.014		0.020	<0.010 – 0.208

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

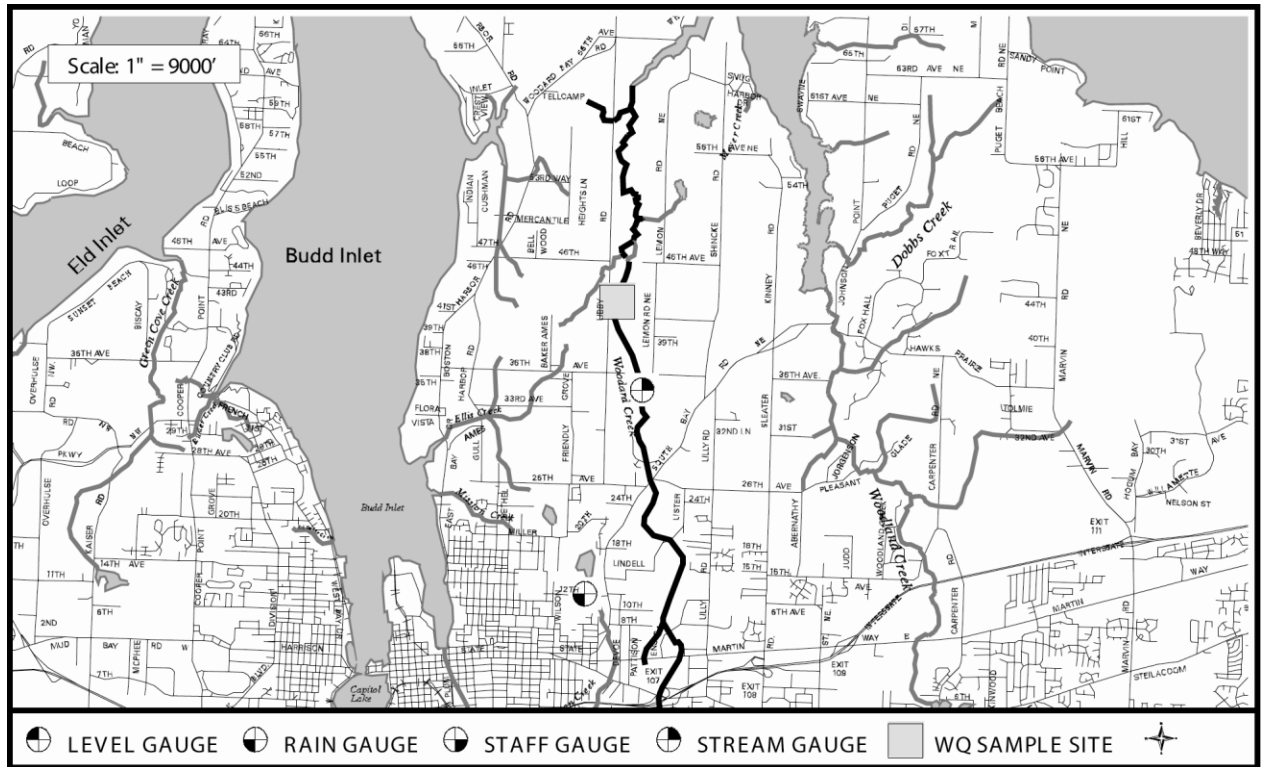
Tanglewilde Outfall to Woodland Creek

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009											Dry.
11/16/2009	10:45:00 AM	10.63	6.7	11.75	44	520	37.6	0.91	0.095	2.440	
12/15/2009	11:10:00 AM	7.63	7.1	12.30	115	220	52.1	0.42	0.126	4.570	
1/13/2010	2:40:00 PM	11.36	7.0	11.30	164	145	9.6	0.69	0.143	7.480	
2/8/2010	4:00:00 PM	11.44	7.4	10.87	196	0	0.0	0.15	0.143	9.740	FC reported as <5. NH4 < 0.010. Turbidity read -0.4
3/17/2010	4:00:00 PM	11.11	7.5	11.71	203	0	0.0	0.16	0.134	9.940	FC reported as <5. NH4 <0.010. Turbidity read -0.2
4/21/2010	2:15:00 PM	11.97	7.3	11.01	142	0	0.0	0.21	0.139	11.800	FC reported as <5. NH4 < 0.010. Turbidity read -0.4
5/11/2010	2:30:00 PM	12.39	7.6	10.88	134	5	0.1	0.03	0.148	9.850	NH4 <0.010
6/14/2010	2:40:00 PM	13.44	7.4	10.67	146	40	0.0	0.07	0.137	10.600	No NH4 sample. Turbidity read -1.2
7/12/2010	3:30:00 PM	16.03	7.4		143	0	0.1		0.161	9.780	DO did not post calibrate. FC reported as <5. No NH4 sample. No flow measurement.
8/17/2010	3:40:00 PM										Dry.
9/14/2010											Dry.

Thurston County Water Resources Monitoring Report 2010 - 2011

Tanglewilde Outfall to Woodland Creek

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>NH4</i>	<i>COMMENTS</i>
10/19/2010	10:25:00 AM											Dry.
11/17/2010	11:15:00 AM	11.79	7.1	10.84	150	290	11.0	0.2	0.166	6.16	0.014	
12/13/2010	2:45:00 PM	11.95	6.8	11.48	153	360	6.8	1.3	0.119	7.06	< 0.005	NH4 <0.010
1/11/2011	3:50:00 PM	11.26	7.6	11.31	183	0	0.0	0.2	0.136	7.18	< 0.005	FC reported as <5. Turb read -0.2. Ammonia <0.010.
2/14/2011	4:10:00 PM	10.23	7.1	11.20	88	180	18.0	0.3	0.106	3.24	< 0.005	Ammonia<0.010.
3/16/2011	11:30:00 AM	10.63	6.8	11.95	171	20	0.3	1.2	0.098	7.41	< 0.005	Ammonia <0.010
4/12/2011	3:55:00 PM	10.98	7.2	12.10	179	0	0.0	0.6	0.119	14.30	< 0.005	FC reported as <5. Ammonia < 0.010. Turbidity reading was -0.5
5/16/2011	4:30:00 PM	11.84	7.4	11.87	118	10	0.0	0.4	0.125	7.21	< 0.005	Turbidity read -0.6. NH4 reported as <0.010
6/13/2011	9:30:00 AM					0			0.133	7.82	< 0.005	FC reported as <5. Ammonia reported as <0.010. Too shallow to get flow measurement.
7/11/2011												Dry.
8/9/2011												Dry.
9/14/2011												Dry.



PART OF HENDERSON WATERSHED

LENGTH OF CREEK: 7.5 miles

BASIN SIZE: 5,090 acres

STREAM ORDER: 2

PRIMARY LAND USES:

Urban residential
Rural residential
Commercial

FISHERIES RESOURCES: (From [A Catalog of Washington Streams and Salmon Utilization](#), WDOF)

Coho
Chum

GENERAL TOPOGRAPHY:

The length of the creek is characterized by wetlands and wooded terrain. The gradual rises and depressions of land contain many small wetlands.

GENERAL WATER QUALITY:

(Excellent, Good, Fair, Poor)

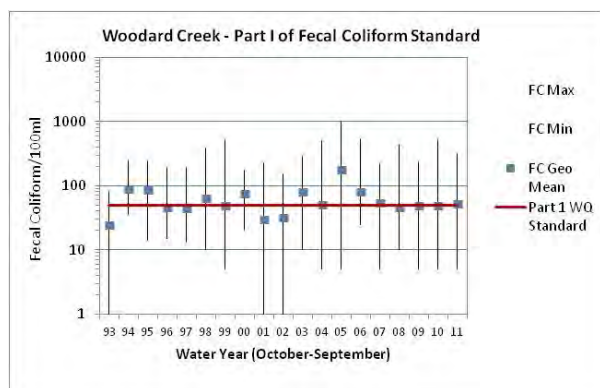
Fair – Met Part 1 of the fecal coliform standard in 2009/10 but failed it in 2010/11 and consistently fails Part 2. This creek is listed on 303 d list for past violations of fecal coliform, dissolved oxygen and pH standards. Nitrate and total phosphorus levels are high.

OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

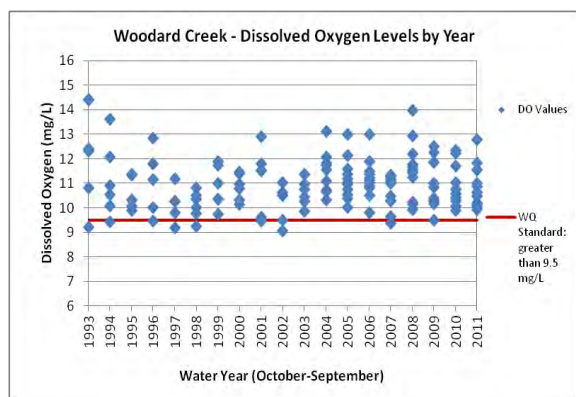
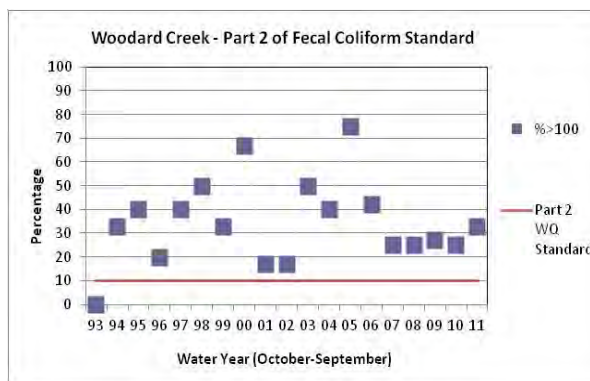
Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 (flow data) or www.co.thurston.wa.us/monitoring.

Woodard Creek #0012



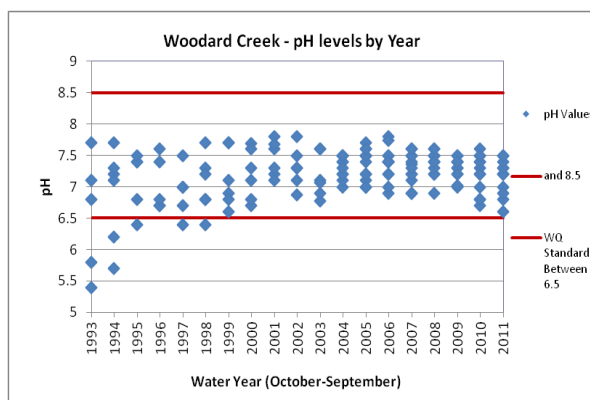
The water quality standard for fecal coliform bacteria has two parts: Part 1 – the geometric mean shall not exceed 50 colonies/100 mL *and* Part 2 – no more than 10% of the samples shall exceed 100 colonies/100 mL.

The creek met Part 1 of the fecal coliform standard in 2009/10 and failed Part 1 in 2010/11. It failed Part 2 both water years. Woodard Creek has a history of failing the bacteria standard. It is included on a list of impaired water bodies that is prepared every two years by the Washington Department of Ecology.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. No measurements were below the standard for the past two water years. There have been occasional measurements below the dissolved oxygen standard in the summer.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been no measurements outside the standard since 1999.



Discussion:

Woodard Creek has been monitored by Thurston County since 1983. Pollution reduction efforts have been underway for several years, and particularly since formation of the Henderson Shellfish Protection District in 2001. Some of the pollution reduction activities include construction of stormwater treatment facilities, septic system inspections and repairs, farm planning and installation of agricultural best management practices, installation of pet waste collection stations, and public education.

The headwaters of the creek are a wetland complex within the urban area of Olympia and Lacey, where stormwater has the greatest potential to impact water quality. The mid-reaches of the creek are in the rural area where agriculture, livestock-keeping and septic systems are the most likely pollution sources. The creek is listed on the Washington Department of Ecology list of impaired water bodies for fecal coliform, dissolved oxygen and pH violations. The Washington Department of Ecology completed a Total Maximum Daily Load (TMDL) study of the Henderson Inlet watershed, including Woodard Creek, in March 2006, which establish pollutant reductions that are necessary in order for the creek to meet water quality standards.

The water quality data are summarized and compared against the state water quality standards in the table on the following page and graphed for trends on the previous page.

While there is no water quality standard for nitrate in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015). The average nitrate concentrations for Woodard Creek for the last two years of monitoring are 0.703 and 0.682 mg/l, which are above the regional reference condition. The total phosphorus regional reference condition is 0.019 mg/l, according to the EPA report. The average total phosphorus concentrations for the past two years in Woodard Creek are also above the regional reference condition at 0.053 and 0.041 mg/l.

Major Issues:

- Impacts from stormwater runoff in the urban area
- Impacts from agricultural practices and septic systems in the rural area
- Continuing development within the urban growth area makes efforts to reduce pollution and meet the water quality standards challenging

Funding Source:

- Local Storm and Surface Water Utilities

Water Quality Summary

Conventional Parameters

Woodard Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		1.83 – 15.71 4.18 – 13.82			2.00 - 16.21
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		9.87 – 12.34 9.92 – 12.76	0 of 12		9.04 - 14.40
Conductivity	µmhos/cm		09/10 10/11	134 128	100 - 159 72 - 161		128	52 - 163
pH		6.5 - 8.5	09/10 10/11	7.2* 7.2*	6.7 – 7.6 6.6 – 7.5	0 of 12 0 of 12	7.3*	5.4 - 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	4.00 3.11	1.60 – 14.10 0.30 – 6.0	1 of 12 0 of 12	3.25	0.4 - 19
Fecal Coliform	colonies/ 100 ml	GMV: ≤50 and ≤ 10% not to exceed 100	09/10 10/11	48** 52**	5 - 520 5 - 320	% exceeding 100	58**	0 - 1000
						25% 33%		
Total Phosphorus	mg/L		09/10 10/11	0.053 0.041	0.036 – 0.098 0.025 – 0.060		0.038	0.011 - 0.112
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.703 0.682	0.489 – 0.890 0.405 – 0.898		0.754	0.253 - 1.56

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

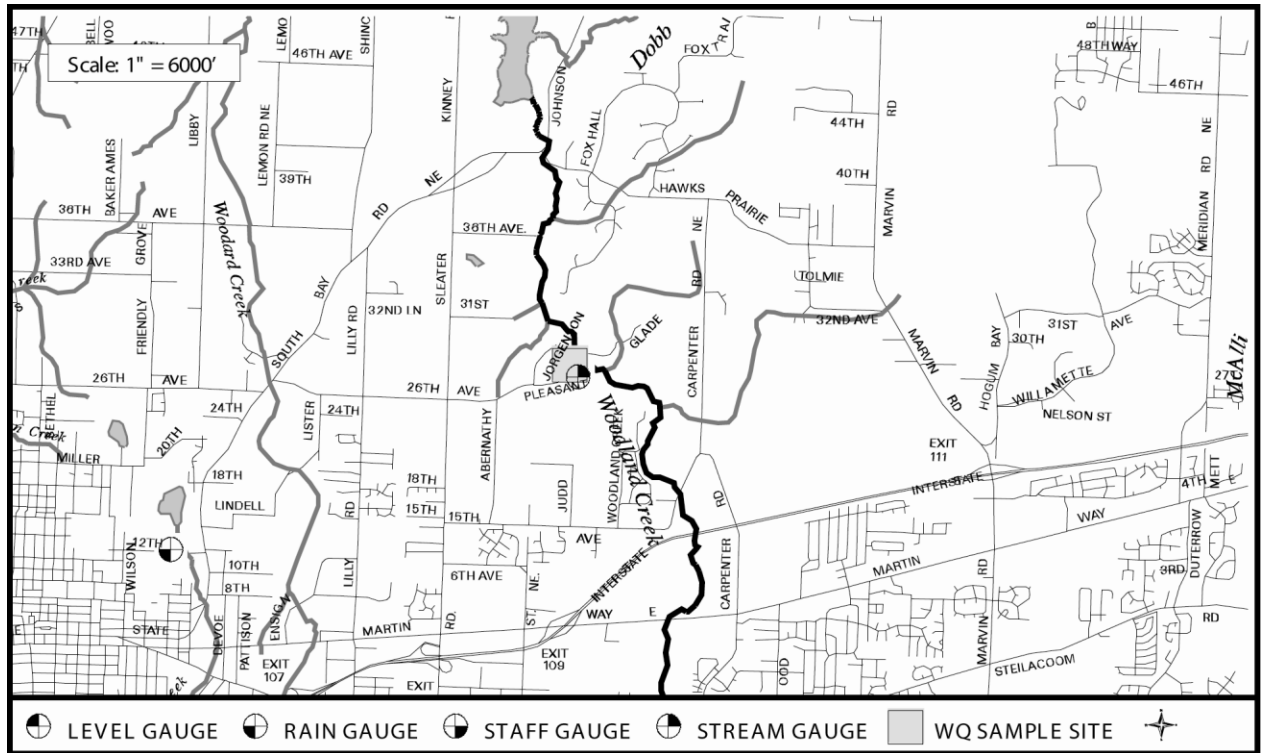
Woodard Creek @ 4100 blk Libby Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009	3:00:00 PM	11.77	7.3	10.06	140	45	1.6	4.00	0.040	0.567	
11/16/2009	4:00:00 PM	8.70	6.7	12.21	107	215	14.1	13.50	0.080	0.489	
12/15/2009	2:00:00 PM	1.83	6.8	12.34	117	520	7.2	14.71	0.070	0.562	
1/13/2010	1:20:00 PM	8.22	6.8	11.01	100	5	3.0	16.18	0.039	0.516	
2/8/2010	3:00:00 PM	8.22	7.0	10.75	130	50	2.7	9.94	0.036	0.729	
3/17/2010	2:25:00 PM	8.91	7.2	11.70	127	10	3.4	10.47	0.039	0.661	
4/21/2010	12:30:00 PM	10.81	7.2	10.56	137	20	3.3	10.17	0.045	0.740	
5/11/2010	1:30:00 PM	10.50	7.4	10.75	138	60	3.1	7.99	0.043	0.752	
6/14/2010	3:45:00 PM	12.98	7.4	10.29	139	50	2.1	7.55	0.098	0.777	Duplicates labeled "Libby"
7/13/2010	3:20:00 PM	14.01	7.5	10.56	158	40	2.6	5.35	0.056	0.870	Duplicates labeled "Libby Lab"
8/17/2010	2:40:00 PM	15.71	7.6	9.87	159	105	3.2	3.68	0.049	0.882	
9/14/2010	2:10:00 PM	12.35	7.5	10.40	155	30	1.7	3.77	0.039	0.890	

Thurston County Water Resources Monitoring Report 2010-2011

Woodard Creek @ 4100 blk Libby Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	9:05:00 AM	8.23	7.3	11.53	146	30	0.3	3.64	0.026	0.798	
11/17/2010	10:30:00 AM	8.67	7.2	11.00	132	15	1.4	6.41	0.032	0.584	
12/13/2010	1:30:00 PM	9.20	6.6	10.18	72	120	6.0	47.16	0.038	0.405	
1/11/2011	3:00:00 PM	4.18	7.2	12.76	130	5	1.7	11.04	0.025	0.840	
2/14/2011	2:45:00 PM	7.50	7.0	10.86	113	70	5.0	26.55	0.041	0.690	
3/16/2011	10:30:00 AM	7.29	6.8	11.55	95	50	3.8	34.21	0.027	0.498	
4/12/2011	2:45:00 PM	9.40	7.2	11.80	128	10	2.8	15.62	0.030	0.654	Duplicates labeled "Libby Lab".
5/16/2011	3:30:00 PM	11.11	6.9	10.63	104	320	3.6	24.51	0.049	0.481	
6/13/2011	11:30:00 AM	12.86	7.3	9.92	144	105	3.5	10.70	0.057	0.712	
7/11/2011	11:10:00 AM	13.45	7.4	10.03	152	90	3.5	7.46	0.060	0.777	
8/9/2011	11:00:00 AM	12.89	7.5	10.45	159	55	3.0	6.03	0.059	0.847	
9/14/2011	3:30:00 PM	13.82	7.5	10.13	161	160	2.7	3.72	0.052	0.898	



PART OF HENDERSON WATERSHED

LENGTH OF CREEK: 11 miles

BASIN SIZE: 18,900 acres

STREAM ORDER: 2

PRIMARY LAND USES:

Urban residential
Rural residential
Commercial

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)
Coho, Chum

GENERAL TOPOGRAPHY:

The stream originates in a lakes system in the Lacey environs in the southern portion of the Henderson watershed. The lake chain empties into a series of wetlands on St. Martin's campus. The creek crosses under I-5 and flows through rolling hills before discharging into Henderson Inlet.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Fair – Mouth station failed both parts of the fecal coliform standard in 2009/10 but met both parts in 2010/11. This creek is listed on the 303 d list for violations of fecal coliform, dissolved oxygen, and temperature in the upper reach. Nitrate and total phosphorus is high.

OTHER DATA:

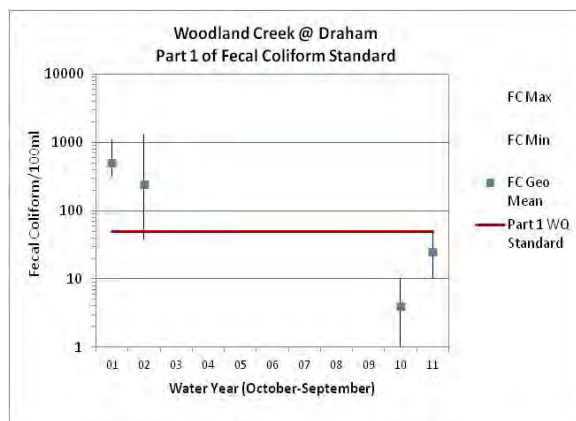
Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

Washington Department of Ecology, Water quality data from Henderson TMDL study, (360) 407-6000.

Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 or www.co.thurston.wa.us/monitoring

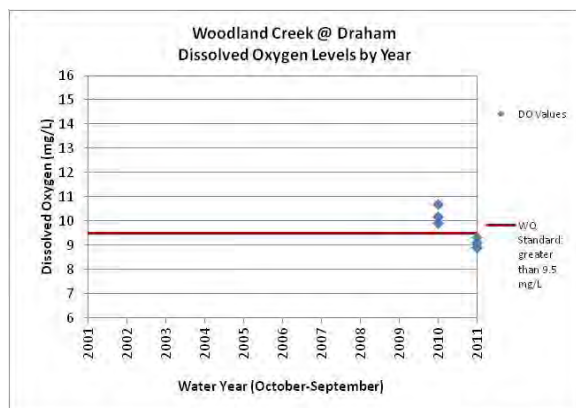
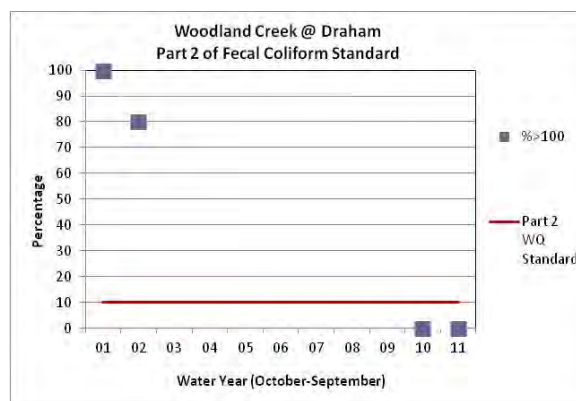
Woodland Creek #0006

Woodland Creek at Draham Rd.



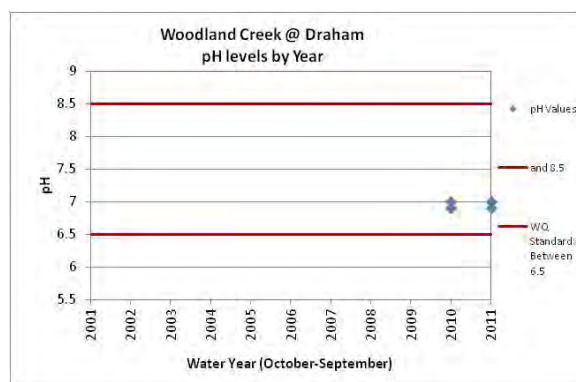
The water quality standard for fecal coliform bacteria has two parts: Part 1 – the geometric mean shall not exceed 50 colonies/100 mL *and* Part 2 – no more than 10% of the samples shall exceed 100 colonies/100 mL.

Woodland Creek at Draham Rd. met both parts of the bacteria standard in water years 2009/10 and 2010/2011 based on three samples the first year and six the second year.

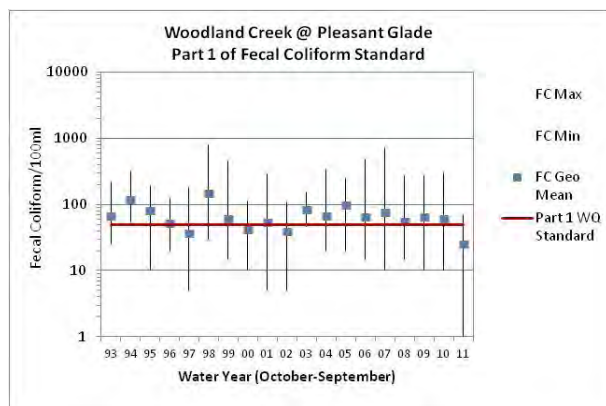


The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. Three measurements were taken in 2009/10 in the winter months that all met the standard. Three measurements were also taken in 2010/11 in the summer months and all failed the standard.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been no violations.

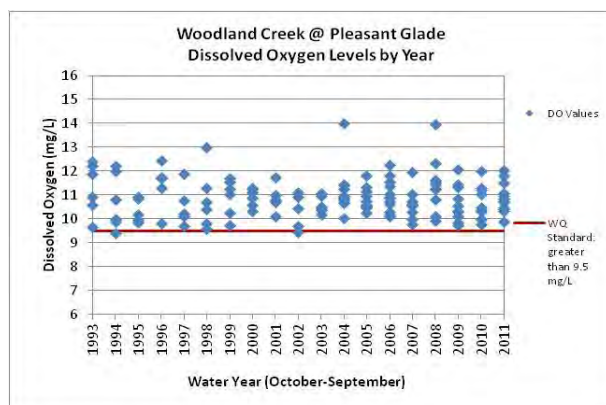
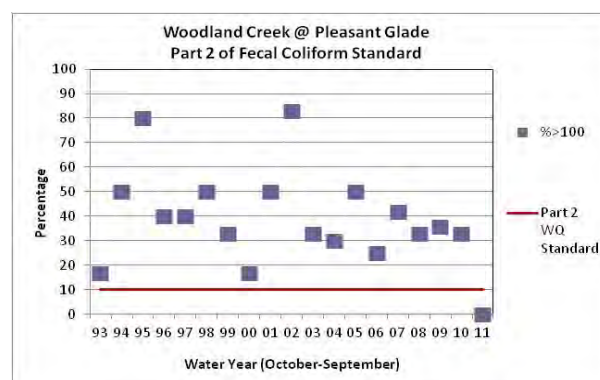


Woodland Creek at Pleasant Glade



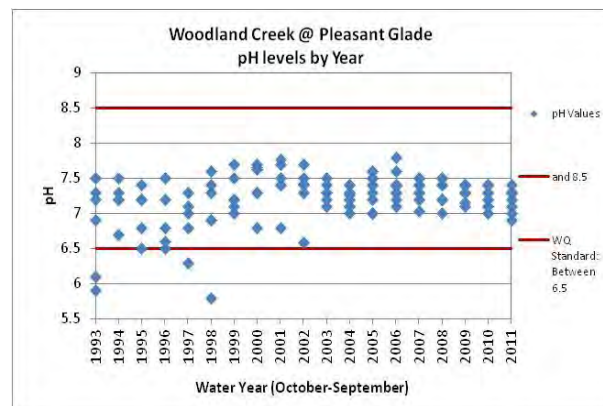
The water quality standard for fecal coliform bacteria has two parts: Part 1 – the geometric mean shall not exceed 50 colonies/100 mL *and* Part 2 – no more than 10% of the samples shall exceed 100 colonies/100 mL.

Woodland Creek at Pleasant Glade has consistently failed part 2 of the fecal coliform standard. It has failed both parts of the standard since 2003 and it always failed part 2. However, both parts were met in 2010/11.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. No violations occurred in water years 2010 / 11. During the entire data record there have only been a few measurements below the dissolved oxygen standard.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been no violations since 1998.



Discussion:

Woodland Creek at Pleasant Glade (the mouth station) has been monitored by Thurston County since 1983. There have been numerous intensive study efforts, including DNA ribotyping of *E. coli* in 2000 and a Total Maximum Daily Load (TMDL) study by Washington Department of Ecology completed in 2006. A shellfish harvesting area downgrade in October 2000 due to bacterial pollution triggered a legal requirement to form a shellfish protection district. In December 2001, Thurston County created the Henderson Shellfish Protection District and a stakeholder committee was convened to consider the actions needed to improve water quality and reopen the shellfish beds. This report was completed in July 2003 and can be found on-line at www.co.thurston.wa.us/shellfish.

Some of the resulting pollution reduction activities include construction of stormwater treatment facilities, septic system inspections and repairs, farm planning and installation of agricultural best management practices, installation of pet waste collection stations, and public education. In 2005 the Thurston County Board of Health created an “area of special concern” called the Henderson Watershed Protection Area, which established inspection requirements for all on-site sewage systems within the area. The requirements went into effect in this area in 2007. In 2010, water quality improvements in the marine waters of the Inlet resulted in an upgrade of 240 acres of commercial shellfish harvest areas to *approved* status.

Monitoring at a second site on Woodland Creek; Woodland at Draham, resumed in January, 2010. The water quality data are summarized and compared against the state water quality standards in the table on the following page and graphed for trends on the previous page.

While there is no water quality standard for nitrate in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015). The average nitrate concentrations for Woodland Creek at Pleasant Glade for 2009/10 and 2010/11 are 1.34 and 1.23 mg/l, which are substantially above the regional reference condition. A pollutant load reduction study attributed much of the nitrate pollution to impacts from older, high-density development served by on-site sewage systems contaminating groundwater. Since the source of the water for the base flow in the creek is springs, the high nitrate values reflect the groundwater quality condition.

The total phosphorus regional reference condition is 0.019 mg/l, according to the EPA report. The average total phosphorus concentrations for 2009/10 and 2010/11 in Woodland Creek at the mouth station are also above the regional reference condition at 0.061 and 0.054 mg/l.

Major Issues:

- Urban stormwater discharges are contributing to water quality problems.
- Failing on-site sewage systems and poor livestock-keeping practices are a source of pollution in the rural part of the watershed.
- Improved water quality in the marine water resulted in an upgrade of 240 acres of commercial shellfish harvest area in Henderson Inlet in 2010.

Funding Source:

- Local Storm and Surface Water Utilities

Water Quality Summary
Conventional Parameters
Woodland Creek at Draham Rd.

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 2001-2002	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		9.11 – 10.61 11.72 – 12.09			
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		9.9 – 10.68 8.9 – 9.31	0 of 3 3 of 3		
Conductivity	µmhos/cm		09/10 10/11	145 165	136 – 150 163 - 166			
pH		6.5 - 8.5	09/10 10/11	6.9* 7.0*	6.9 – 7.0 6.9 – 7.0	0 of 3 0 of 3		
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	3.6 1.2	2.7 – 4.1 1.1 – 1.3	No background established		
Fecal Coliform	colonies/ 100 ml	GMV: ≤50 and ≤ 10% not to exceed 100	09/10 10/11	4** 25**	0 – 10 10 - 50	% exceeding 100	324	38 - 1325
						0% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.058 0.064	0.054 – 0.064 0.055 – 0.088			
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	1.16 1.32	1.03 – 1.25 0.835 – 1.64			

* Median

**Geometric Mean Value (GMV)

Water Quality Summary
Conventional Parameters
Woodland Creek at Pleasant Glade

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		6.09 – 14.11 6.09 – 13.21			5.9 – 13.81
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		9.77 – 11.99 9.87 – 12.02	0 of 11 0 of 12		9.39 - 14
Conductivity	µmhos/cm		09/10 10/11	155 148	129 - 172 112 - 171		144	12 – 181
pH		6.5 - 8.5	09/10 10/11	7.3* 7.3*	7.0 – 7.4 6.9 – 7.4	0 of 12 0 of 12	7.3*	5.9 - 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	3.42 4.16	1.1 – 6.8 0.60 – 8.20	0 of 12 0 of 12	3.53	0.6 – 20.3
Fecal Coliform	colonies/ 100 ml	GMV: ≤50 and ≤ 10% not to exceed 100	09/10 10/11	60** 25**	10 - 295 0 - 70	% exceeding 100	66**	5 - 805
						33% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.061 0.054	0.052 – 0.078 0.045 – 0.063		0.057	0.026 - 0.172
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	1.34 1.23	1.02 – 1.68 0.875 – 1.68		1.4	0.466 - 3.42

* Median

**Geometric Mean Value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

Woodland Creek @ Draham Rd.

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
1/13/2010	2:10:00 PM	9.11	6.9	10.16	136	5	4.1	27.91	0.064	1.030	Staff gage - 0.82'
2/8/2010	3:45:00 PM	9.63	6.9	9.90	150	10	2.7	23.02	0.055	1.250	Staff gage - 0.78'
3/17/2010	3:30:00 PM	10.61	7.0	10.68	148	0	4.0	25.82	0.054	1.190	FC < 5. Staff gage - 0.79'

Thurston County Water Resources Monitoring Report 2010-2011

Woodland Creek @ Draham Rd.

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
3/16/2011	11:00:00 AM					40					
5/16/2011	4:15:00 PM					50			0.088	0.835	Staff gage - 0.94'.
6/13/2011	12:00:00 PM					10		31.20	0.055	1.100	YSI #2 not working. Grab samples only. Staff gage 0.78', unclear if it is maintained.
7/11/2011	12:00:00 PM	12.09	6.9	8.90	166	10	1.1	15.85	0.062	1.640	Staff gage - 0.54' (May not be maintained). Brown fungus on rocks and concrete.
8/9/2011	11:50:00 AM	11.72	7.0	9.31	165	25	1.3	13.02	0.058	1.540	Staff gage - 0.62'
9/14/2011	5:00:00 PM	11.93	7.0	9.09	163	40	1.3	10.21	0.059	1.470	Staff gage - 0.51'.

Thurston County Water Resources Monitoring Report 2009-2010

Woodland Creek @ Pleasant Glade

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009	3:40:00 PM	11.25	7.3	10.00	163	130	1.8	11.80	0.071	1.520	
11/16/2009	3:30:00 PM	9.98	7.1	11.99	147	295	6.8	18.77	0.078	1.200	
12/15/2009	2:20:00 PM	6.09	7.2	11.30	146	260	6.3	24.74	0.075	1.120	
1/13/2010	1:50:00 PM	8.90	7.0	11.03	129	40	6.0	41.37	0.066	1.070	
2/8/2010	3:15:00 PM	9.32	7.1	10.49	152	30	3.0	28.27	0.054	1.290	
3/17/2010	3:00:00 PM	10.22	7.3	11.20	149	10	4.0	30.82	0.055	1.200	
4/21/2010	1:30:00 PM	11.59	7.2	10.38	152	25	3.2	29.03	0.052	1.370	
5/11/2010	2:00:00 PM	11.34	7.4	10.33	161	35	2.8	21.25	0.057	1.540	
6/14/2010	3:00:00 PM	14.11	7.3	9.77	148	155	2.9	31.87	0.053	1.020	
7/12/2010	4:00:00 PM	13.24	7.4		165	65	1.7	18.69	0.063	1.490	DO did not post calibrate.
8/17/2010	3:10:00 PM	13.26	7.4	10.32	172	75	1.4	12.17	0.057	1.540	
9/14/2010	2:30:00 PM	11.62	7.4	10.33	171	20	1.1	13.19	0.054	1.680	

Thurston County Water Resources Monitoring Report 2010-2011

Woodland Creek @ Pleasant Glade

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	9:40:00 AM	9.18	7.3	10.96	170	42	0.6	12.46	0.049	1.560	Duplicates labeled "Draham".
11/17/2010	11:00:00 AM	9.57	7.3	10.68	151	45	4.1		0.053	0.919	No flow measurement. Chum present. Staff gage 1.41'.
12/13/2010	2:00:00 PM	9.39	6.9	11.07	112	20	8.2	64.62	0.057	1.220	
1/11/2011	3:15:00 PM	6.09	7.2	12.02	147	15	4.7	41.35	0.049	1.130	Staff gage - 1.36'.
2/14/2011	3:15:00 PM	8.57	7.1	10.84	138	0	6.8	49.29	0.049	1.170	FC reported as <5. Staff gage - 1.40'.
3/16/2011	10:45:00 AM	8.08	7.0	11.80	116	20	8.0	89.98	0.051	0.959	
4/12/2011	3:15:00 PM	11.26	7.3	11.52	140	15	2.6	51.15	0.045	0.999	Staff gage on bank 1.48'.
5/16/2011	3:45:00 PM	12.58	7.1	10.74	131	50	4.2	55.34	0.052	0.875	Staff gage - 1.50'.
6/13/2011	11:50:00 AM	13.21	7.3	9.87	154	45	2.7	35.72	0.060	1.140	YSI #2 not working. Grab samples only. Field parameters measured on 6/15/11. Staff gage - 1.28'. Flow for this date obtained from H. Hama, Resource Stewardship
7/11/2011	11:30:00 AM	11.92	7.3	10.32	170	30	1.9	20.35	0.063	1.680	Staff gage - 1.04'.
8/9/2011	11:30:00 AM	11.70	7.4	10.46	170	70	2.6	18.85	0.059	1.580	
9/14/2011	4:30:00 PM	11.98	7.3	10.39	171	60	3.5	13.80	0.063	1.580	Staff gage - 0.96'.

Nisqually Watershed

WRIA 13

Chapter Includes:

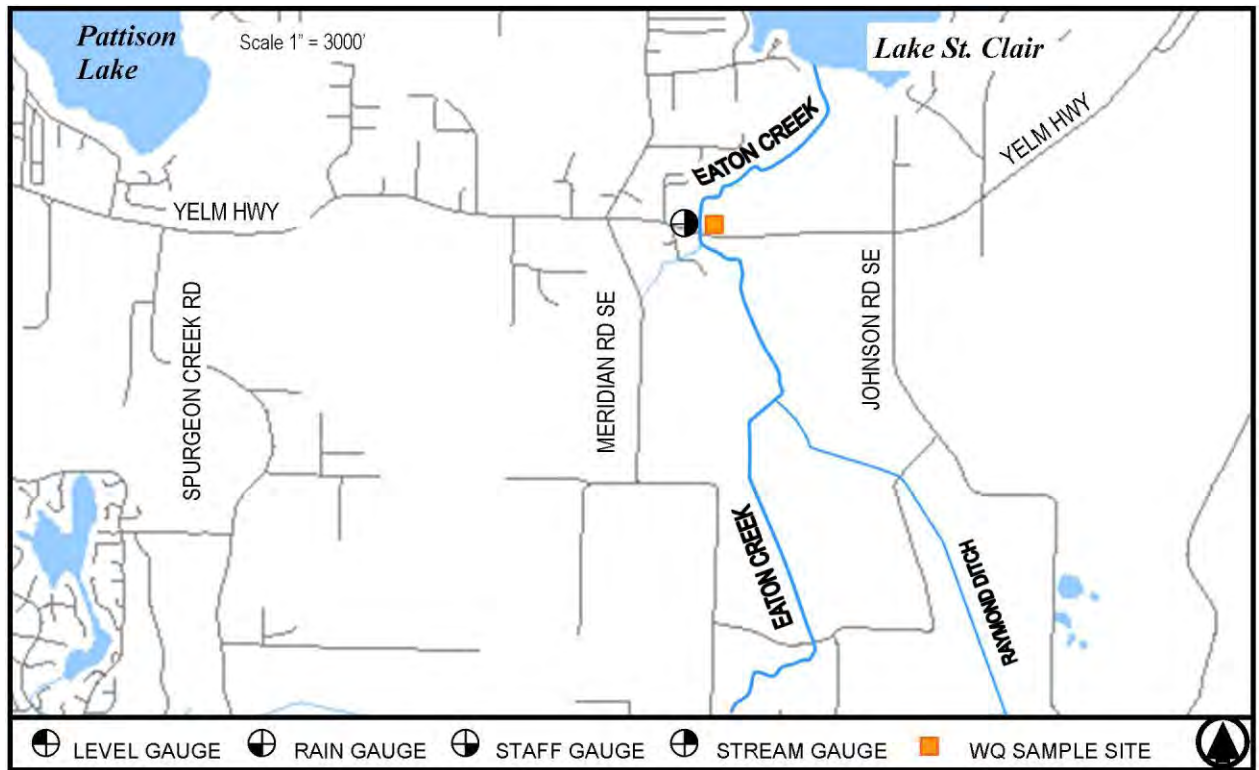
Eaton Creek

Lake St. Clair

McAllister Creek

Thompson Creek

Yelm Creek



PART OF NISQUALLY REACH WATERSHED

LENGTH OF CREEK: 3.25 miles

BASIN SIZE: 4608 Acres

STREAM ORDER: 2

PRIMARY LAND USES:

Military reservation
Agriculture
Rural residential

FISHERIES RESOURCES:

(From A Catalog of Washington Streams and Salmon Utilization, WDOF)

No anadromous fish

GENERAL TOPOGRAPHY:

Elevation of the watershed is 200 ft. to 500 ft. It begins in a wetland and has a fairly low gradient through the evergreen Valley. The gradient steepens the last one-half mile as it flows to Lake St. Clair.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

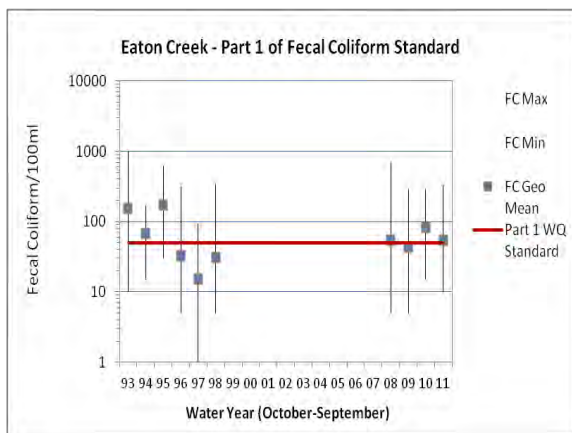
Fair – Failed Part 1 and Part 2 of the fecal coliform standard in 2009/10 and Part 1 in 2010/11. Nutrient levels are high.

OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

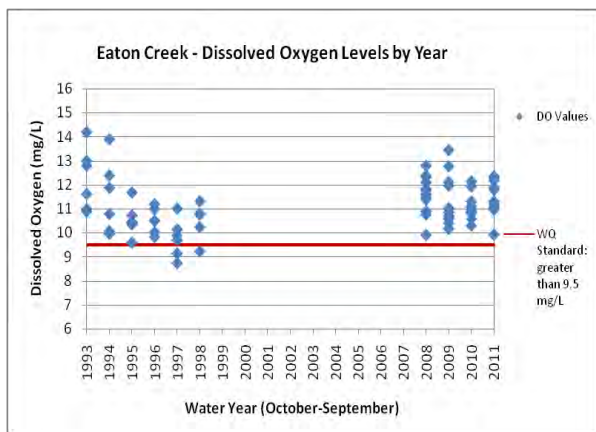
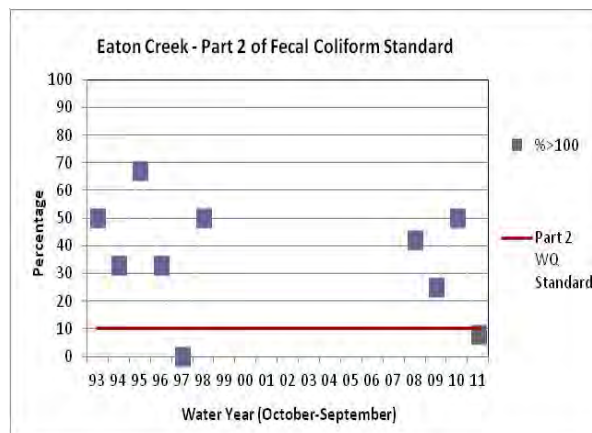
Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 or www.co.thurston.wa.us/monitoring

Eaton Creek #0330



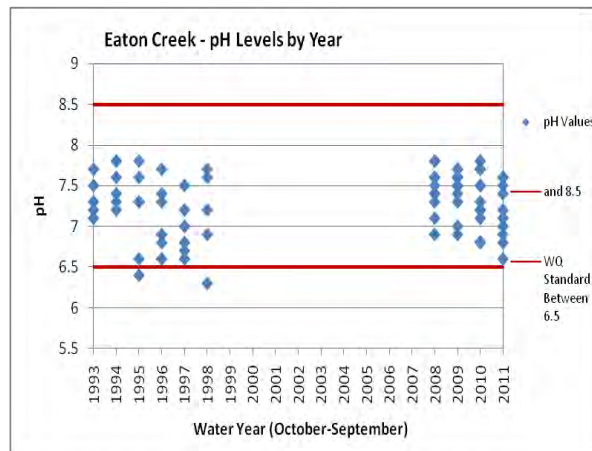
Eaton Creek failed both parts of the fecal coliform standard in the 2009/10 water year and part 1 in water year 2010/11.

The water quality standard for fecal coliform bacteria has two parts: the geometric mean shall not exceed 50 org/100mL *and* no more than 10% of the samples shall exceed 100 org/100mL.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. No violations occurred in the water years 2009/10 and 2010/11.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. There were no violations in water years 2009/10 and 2010/11.



Discussion:

Eaton Creek was monitored between 1993 and 1998. Data collected during that time period showed fecal coliform bacteria contamination, likely from agricultural practices in the Evergreen Valley. In response, Thurston Conservation District, property owners and Stream Team volunteers took actions to improve Eaton Creek and Raymond Ditch. Actions included stream fencing, changes to animal-keeping practices, and restoration of the riparian area with native plant species.

The McAllister/Eaton Creek Drainage Basin Plan was adopted in 1994. The plan included many recommendations for actions within the basin to address flooding, erosion and water quality.

Monitoring resumed on Eaton Creek in October 2007. The most recent data shows little improvement in the bacteria concentration. All other standards were met.

There are no water quality standards for nutrients in surface water. However, a US EPA study determined that the regional reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015), and is 0.019 mg/l for total phosphorus. The average nitrate and total phosphorus concentrations in Eaton Creek are above the regional reference conditions at 0.648 and 0.057, respectively.

Major Issues:

- Fecal coliform and nutrient contamination, likely from agricultural practices.
- Concern about the stream's influence on Lake St. Clair and McAllister Springs water quality.

Funding Sources:

- Local Stormwater Utility

Water Quality Summary

Conventional Parameters

Eaton Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		4.94 – 13.29 5.48 – 11.36			3.49 – 13.88
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		10.31 – 12.14 9.94 – 12.36	0 of 11 0 of 12		8.75 – 14.2
Conductivity	µmhos/cm		09/10 10/11	114 109	82 - 131 69 - 132		109	64 - 145
pH		6.5 - 8.5	09/10 10/11	7.2* 7.2*	6.8 – 7.8 6.6 – 7.6	0 of 12	7.3*	6.3 – 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	3.4 3.1	1.3 – 7.5 0 – 7.4	0 of 12 0 of 12	3.3	0.83 - 10
Fecal Coliform	colonies/ 100 ml	GMV: ≤50 and ≤ 10% not to exceed 100	09/10 10/11	83** 54**	15 - 292 10 - 335	% exceeding 100	53**	0 - 1000
						50% 8%		
Total Phosphorus	mg/L		09/10 10/11	0.055 0.057	0.040 – 0.080 0.028 – 0.083		0.053	0.02 – 0.078
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.645 0.648	0.406 – 0.853 0.438 – 0.935		0.594	0.233 – 0.895

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

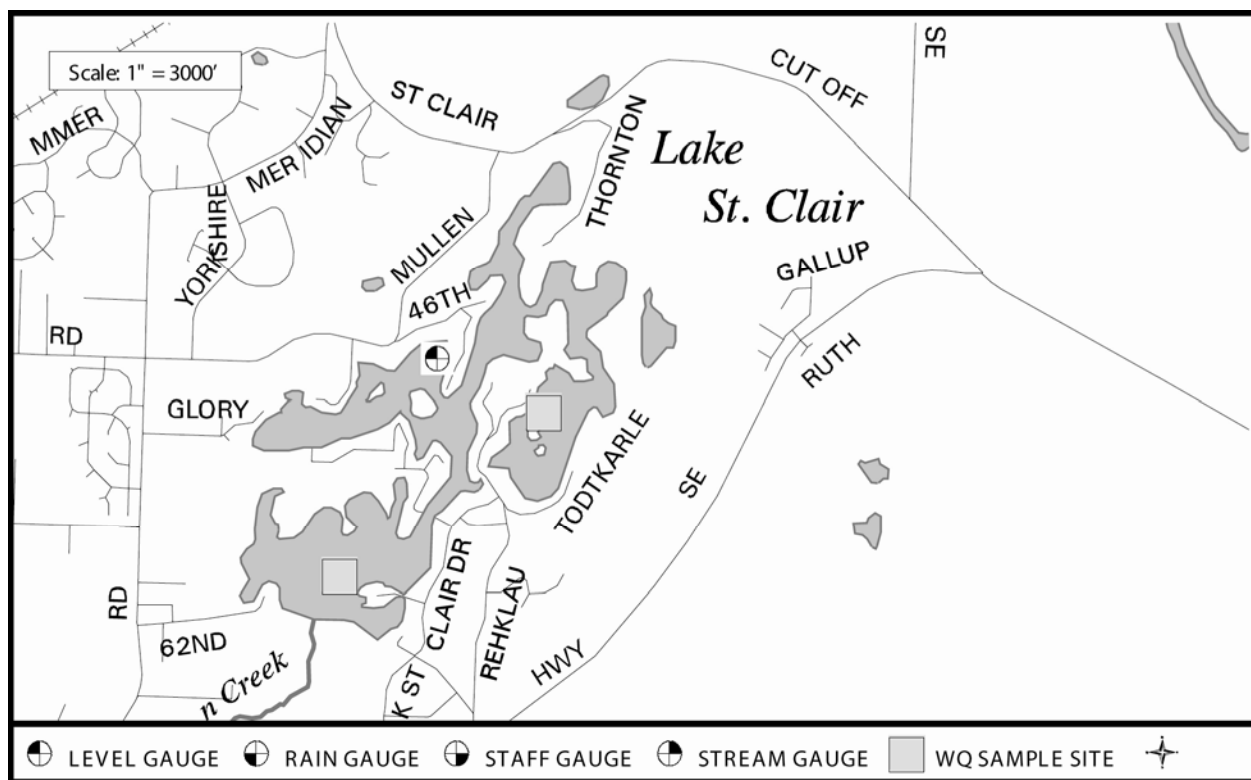
Eaton Creek @ Yelm Highway

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	3:50:00 PM	10.37	7.3	11.07	131	15	1.7	5.40	0.044	0.698	Staff gage 1.01'
11/17/2009	3:50:00 PM	8.61	6.8	10.88	82	292	7.5	22.54	0.066	0.406	Duplicates labeled "Eaton at Yelm Hwy". Staff gage - 1.22'
12/16/2009	4:00:00 PM	4.94	7.1	12.14	105	30	6.2	11.26	0.080	0.567	Staff gage - 1.12'
1/11/2010	3:40:00 PM	7.65	6.8	11.11	86	140	6.9	21.15	0.070	0.559	Staff gage -- 1.20'
2/10/2010	3:30:00 PM	6.76	7.2	11.31	115	35	3.9	8.54	0.060	0.678	Staff gage - 1.07'
3/15/2010	2:00:00 PM	8.55	7.2	11.94	110	35	3.8	10.02	0.057	0.582	Staff gage - 1.08'; Duplicates labeled "Evergreen".
4/19/2010	2:30:00 PM	12.12	7.2	10.31	114	70	2.6	9.41	0.051	0.620	Staff gage - 1.07'
5/10/2010	3:30:00 PM	11.04	7.5	10.60	117	225	2.5	8.24	0.050	0.510	Staff gage - 1.07'
6/15/2010	3:30:00 PM	11.22	7.5	10.84	124	50	1.3	7.02	0.055	0.701	Staff gage - 1.07'
7/12/2010	3:00:00 PM	11.90	7.8		131	130	1.4	5.52	0.042	0.853	DO did not post calibrate. Staff gage 1.00'.
8/16/2010	4:15:00 PM	13.29	7.7	10.98	131	230	1.7	4.34	0.042	0.764	Staff gage 0.99'.
9/13/2010	3:45:00 PM	11.55	7.7	10.81	121	160	1.3	4.77	0.040	0.801	Staff gage 1.00'.

Thurston County Water Resources Monitoring Report 2010-2011

Eaton Creek @ Yelm Highway

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	9:45:00 AM	7.32	7.4	12.31	130	35	0.0	5.86	0.028	0.502	Staff gage - 1.01'.
11/16/2010	9:30:00 AM	9.37	7.2	10.96	121	10	1.1	8.37	0.050	0.598	Staff gage 1.10'.
12/13/2010	3:15:00 PM	9.33	6.6	9.94	69	100	6.6	29.01	0.083	0.619	Staff gage 1.26'
1/12/2011	9:45:00 AM	5.48	7.1	12.19	92	40	4.9	11.95	0.068	0.666	Staff gage - 1.14'.
2/16/2011	9:15:00 AM	5.48	7.0	11.80	103	40	3.0	13.82	0.067	0.610	Staff Gage - 1.14'.
3/14/2011	9:15:00 AM	6.97	6.8	11.90	78	100	7.4	27.74	0.068	0.438	Staff gage - 1.26'.
4/11/2011	9:35:00 AM	8.08	7.1	12.36	102	20	4.0	13.67	0.051	0.439	Staff gage - 1.17'.
5/17/2011	9:25:00 AM	8.41	6.9	11.32	95	335	3.4	18.64	0.068	0.450	Staff gage - 1.20".
6/14/2011	9:15:00 AM	10.95	7.5	11.11	127	35	2.5	9.01	0.058	0.784	Staff gage - 1.07'. Duplicates labeled "Evergreen".
7/12/2011	9:30:00 AM	11.13	7.6	11.03	132	60	1.8	6.97	0.051	0.859	Staff gage - 1.06'.
8/8/2011	9:30:00 AM	11.08	7.6	11.24	132	65	1.9	6.92	0.046	0.881	Staff gage -1.05. Flow as measured by flowtracker: 5.94cfs.
9/12/2011	11:55:00 AM	11.36	7.6	11.22	132	90	0.2	5.35	0.046	0.935	Staff gage - 1.03'.



PART OF Nisqually Inlet WATERSHED

SHORELINE LENGTH: 10.4 miles

LAKE SIZE: 268 acres

BASIN SIZE: 20.9 square miles

MEAN DEPTH: 34 feet

MAXIMUM DEPTH: 110 feet

VOLUME: 8,700 acre-feet

PRIMARY LAND USES:

Forestry and agriculture upland, with dense residential development along the shoreline. Some homeowners still use the lake as their domestic water source.

PRIMARY LAKE USES:

Fishing, boating, swimming, and domestic water supply.

PUBLIC ACCESS:

Two Department of Fish and Wildlife public boat launches.

GENERAL TOPOGRAPHY:

The approximate altitude of the lake is 73 feet. It is an irregularly shaped lake formed by ice blocks left during the glacial age. It has steep sides, numerous narrow arms, and four islands. Eaton Creek flows into the lake from the south, and water seeps out of the lake to the north and discharges to McAllister Springs, the City of Olympia water supply.

GENERAL WATER QUALITY: (Excellent, Good, Fair, and Poor)

Fair to Good - This lake is mesotrophic to eutrophic, or moderately to highly productive. The phosphorus concentration sometimes violates the state water quality standard. Toxic algae blooms have occurred in recent years.

OTHER DATA:

Washington Department of Ecology,
Environmental Assessment Program, (360)
407-6700 (water quality data).

Water Quality Data - Thurston County
Environmental Health Division,
www.co.thurston.wa.us/health/ehswat/swater.htm (360) 867-2626.

City of Olympia, Public Works Department,
(360) 753-8314, (lake level data)

GENERAL DISCUSSION:

Due to the irregular shape of the lake with somewhat isolated basins, steep shorelines, and water depths of over 100 feet, water quality conditions between basins vary. Eaton Creek is the only surface water input, which discharges into the lake in the largest and deepest, southwest basin. The outlet of the lake is via groundwater discharge to the north toward McAllister Springs, a City of Olympia water source. The lake is a natural dark brown "tea-color" which restricts light penetration, limiting aquatic plant and algae growth. Many of the land owners along this lake have maintained the shoreline in its natural condition, providing valuable wildlife and fish habitat. However, increased shoreline development could threaten to alter that condition.

In 2011 the ambient monitoring consisted of monthly sampling, May through October, at two locations in the deepest area of the large southwest basin ("Big") and the eastern basin ("East"). The parameters included temperature, dissolved oxygen, pH, conductivity, and secchi disk readings. Samples were collected near the lake surface and lake bottom and analyzed for total phosphorus and total nitrogen. Composite samples from the epilimnion (warm surface layer) or photic zone were collected and analyzed for chlorophyll *a*, the green pigment found in plants and algae, and algae species identification.

Field Parameters

Temperature, dissolved oxygen, pH, and conductivity are measured at two meter increments from the surface of the lake to the bottom. The term "thermal stratification" refers to a condition in the lake when there are two distinct layers of water in the lake, an upper layer warmed by solar radiation and a cold bottom layer. Both the southwest and the east basins were strongly thermally stratified throughout the entire sampling period. The surface water temperature reached 22.5 and 24 degrees Celsius in the big basin and east basin, respectively, in August. In Lake St. Clair, typically, the warm surface water layer (or epilimnion) is only approximately two meters deep before the water temperature begins to drop. The water temperature from approximately an 8-meter depth to the bottom in both basins was only 5 to 6 degrees Celsius from May through October. Monthly graphs of the temperature, dissolved oxygen, pH, and conductivity profiles are shown on pages 12 and 13 of this chapter.

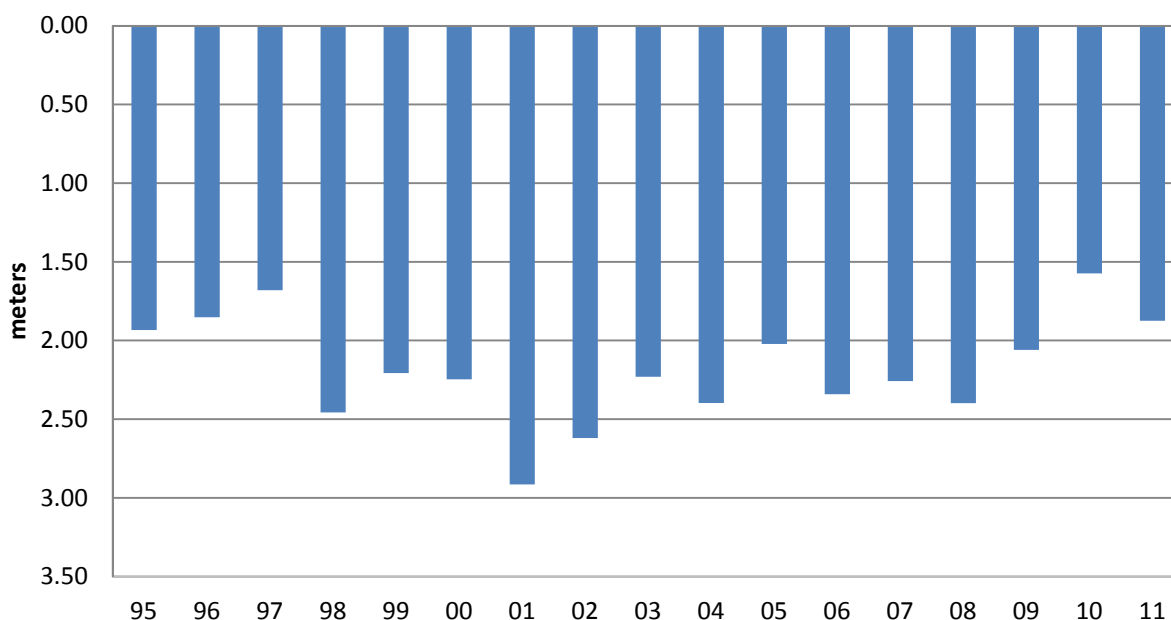
The cold bottom layer of water, called the hypolimnion, is nearly devoid of oxygen (or anoxic) May through October in the big basin. The southwest basin was anoxic in the lower eight meters in May, and by August the anoxic zone increased to about fourteen meters. The east basin had a much smaller anoxic zone of about two to four meters up from the bottom throughout the sampling season. Both basins had a notable drop in dissolved oxygen at a depth between four and six meters followed by a slight increase, and then a decrease to anoxic conditions to the bottom. The "oxygen sag" at 4 to 6 meters may be due to the decomposition of organic matter settling to the lowest depth of the warm surface layer where the temperature and density differences between the two water layers prevents

the material from sinking further into the colder denser water. This is an annual phenomenon in Lake St. Clair which is not observed in any other Thurston County lakes.

Secchi Disk Water Clarity

Water clarity in a lake is measured with an instrument called a secchi disk. The 2011 season average secchi disk measurement in the “big” southwest basin was 1.9 meters (6.2 feet). Water clarity in the east basin is usually better than in the big basin. In 2011, the average secchi disk measurement for in the east basin was 2.2 meters (7.2 feet). The average annual water clarity for the big basin for the past seventeen years is graphed below. A similar graph for the east basin is on the next page. The graphs show no strong trend in water clarity in either basin, although the water clarity for the last two years was some of the poorest on record. The graphs do show that the east basin is consistently clearer than the big basin by about one-half to one meter.

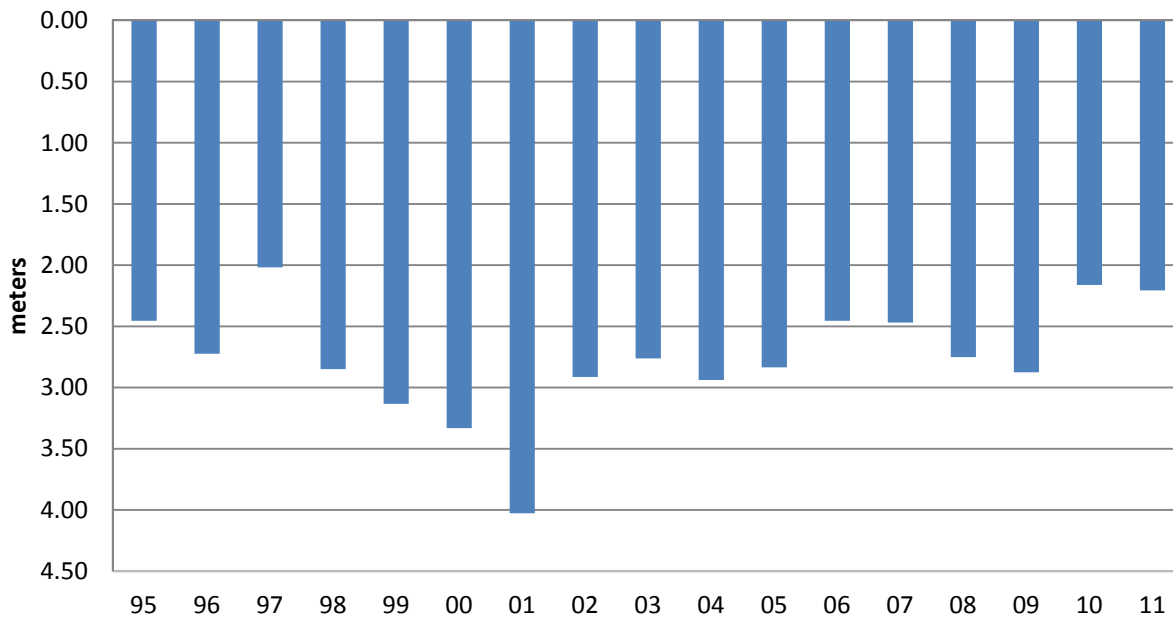
Big Basin Annual Average Water Clarity



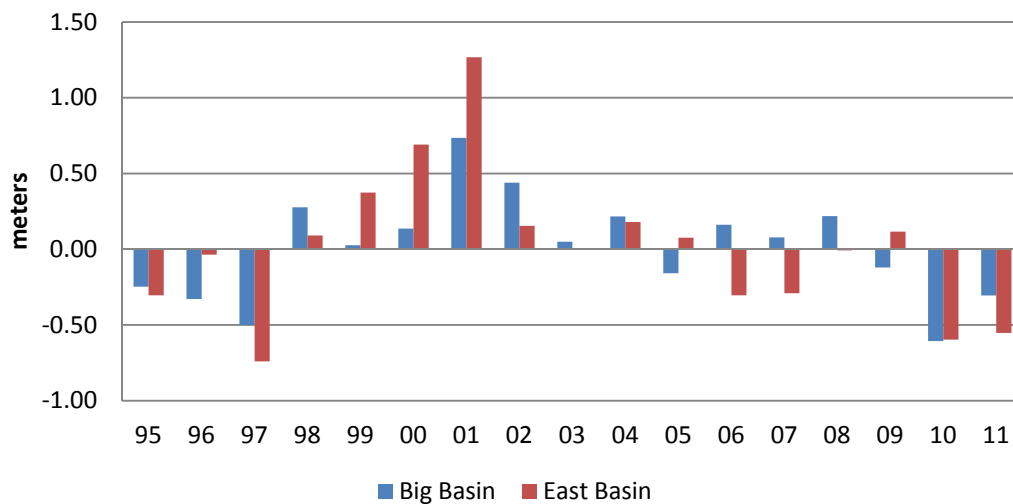
Water clarity trends can more easily be seen when the **difference** between each year’s average secchi reading and the long-term average for the entire record is graphed. This water clarity trend graph can be found at the bottom of the next page. When the bar is above the “0” line, it indicates that the average water clarity for that year was better than the long-term average. A bar below the “0” line indicates that the water clarity for that year was poorer than the long-term average.

Graphing the water clarity data in this way helps to show trends in water quality versus normal yearly fluctuations. Again, there is no obvious upward or downward trend in water clarity in either basin. Although it is notable that the water clarity the past two years in both basins was about one-half meter poorer than the long term averages for those basins.

East Basin Annual Average Water Clarity



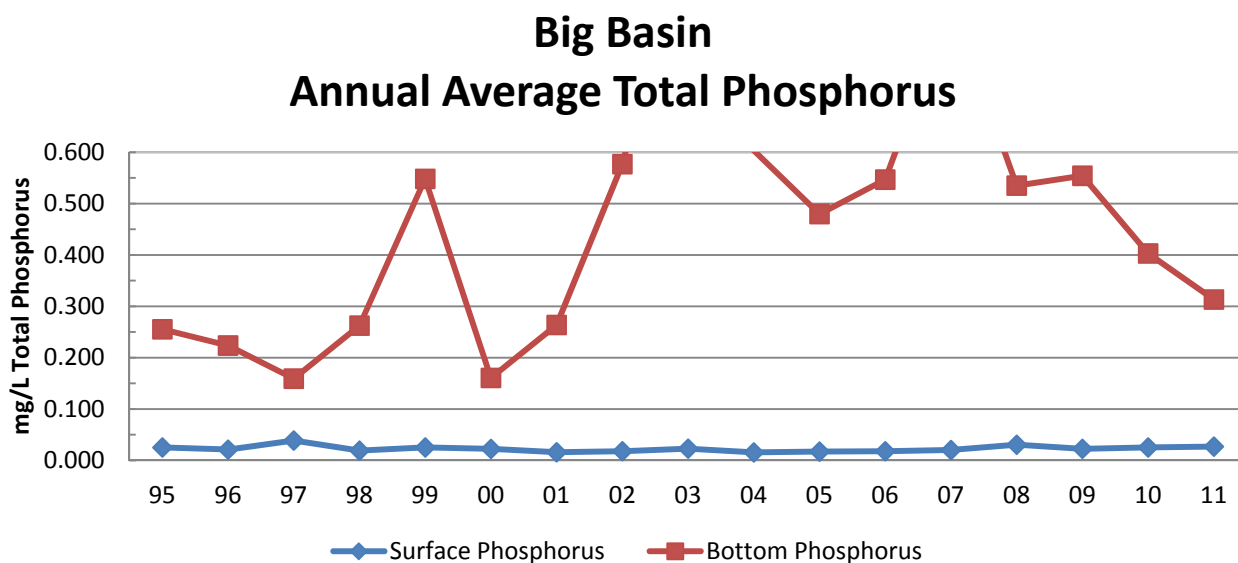
Water Clarity Trend Annual Average Minus Long-Term Average



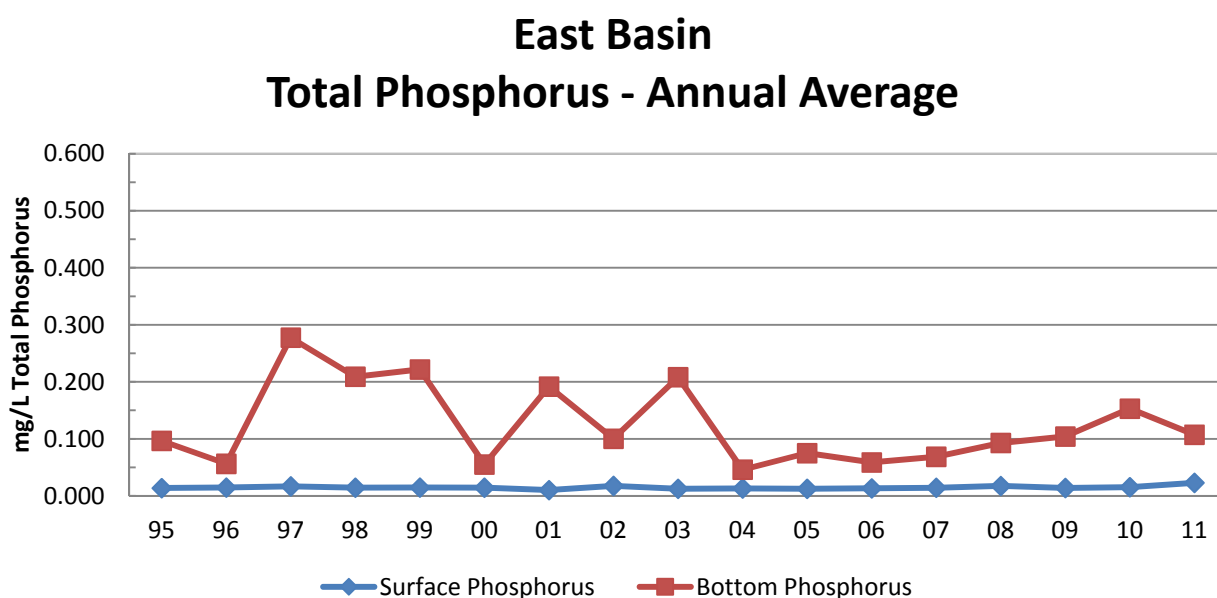
Total Phosphorus and Nitrogen

Generally, lakes in the Puget Sound region with summer average surface total phosphorus concentrations greater than 0.030 mg/l experience undesirable algae growth which interferes with recreational uses of the lake (USGS Water Supply Paper 2240). The action level established in WAC 173-201A, "Water Quality Standards for Surface Water of the State of Washington" is 0.020 mg/l.

In 2011 the average surface total phosphorus (TP) concentration in the big basin was 0.027 milligrams per liter (mg/l), and ranged from 0.020 in September to 0.035 mg/l in May. The total phosphorus concentration was in violation of the state action level every month except September. Below is a graph of the average annual total phosphorus concentration at the surface and bottom of the lake. The graph that shows a high concentration of phosphorus exists in the bottom water of the big basin.

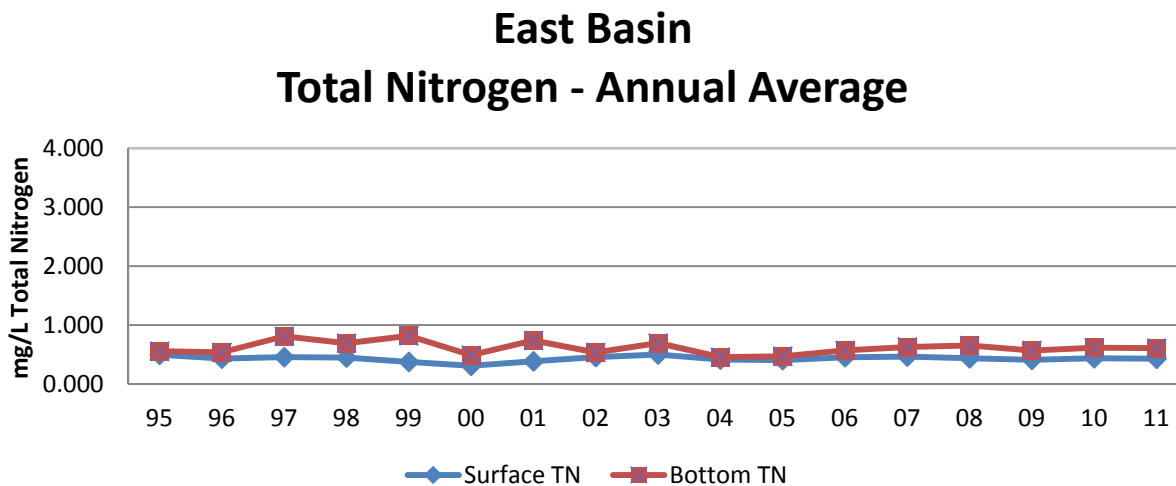
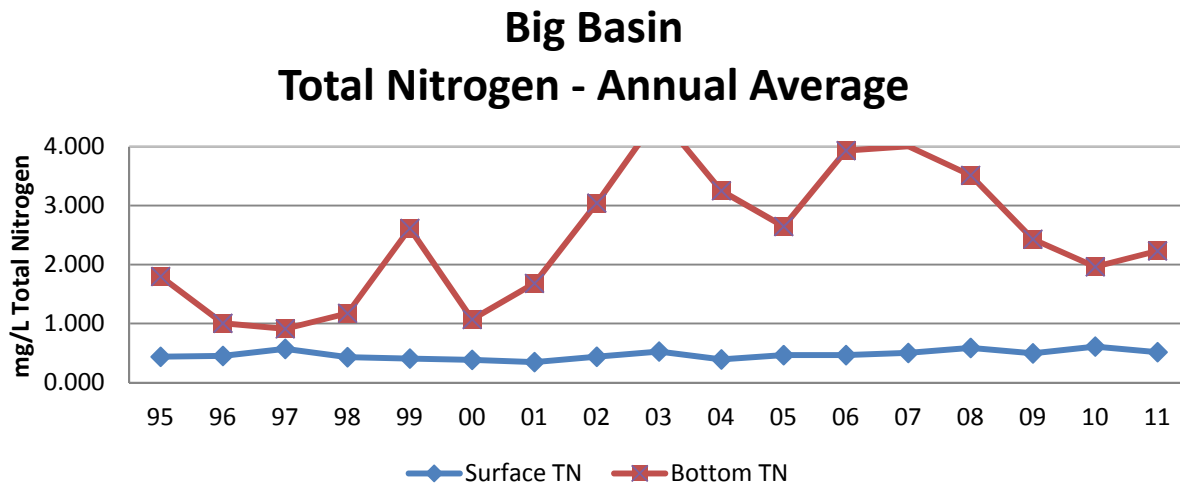


In the east basin, the average surface total phosphorus concentration was 0.023 milligrams per liter, and ranged from 0.012 in October to 0.036 mg/l in June. The total phosphorus concentration met the state action level in August, September, and October; but failed in May, June, and July. You can see from the graphs that the bottom phosphorus concentration in the east basin is much lower than in the big basin.



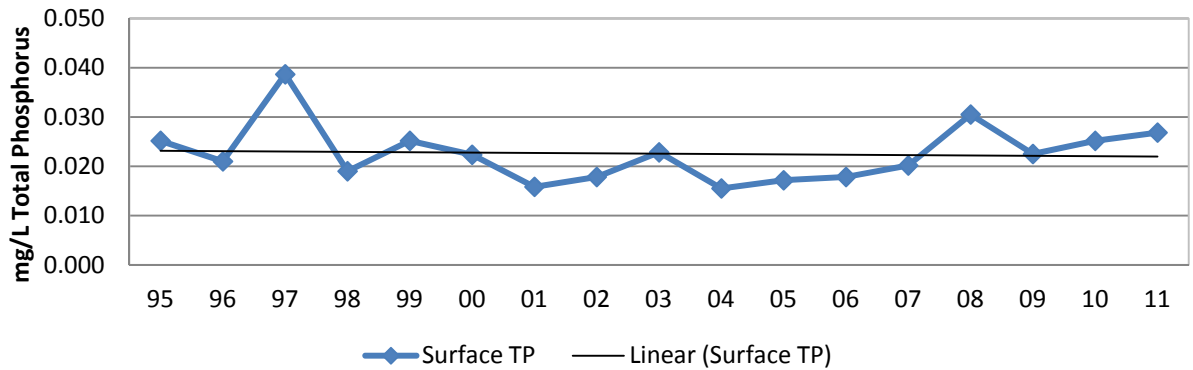
Lake St. Clair

The algae growth in most freshwater lakes is driven by the addition of available phosphorus. However, nitrogen is also an essential nutrient that influences production in lakes. The annual average nitrogen concentrations in both basins are shown on graphs below. As with phosphorus, the nitrogen concentration at the bottom of the big basin is much higher than in the east basin.

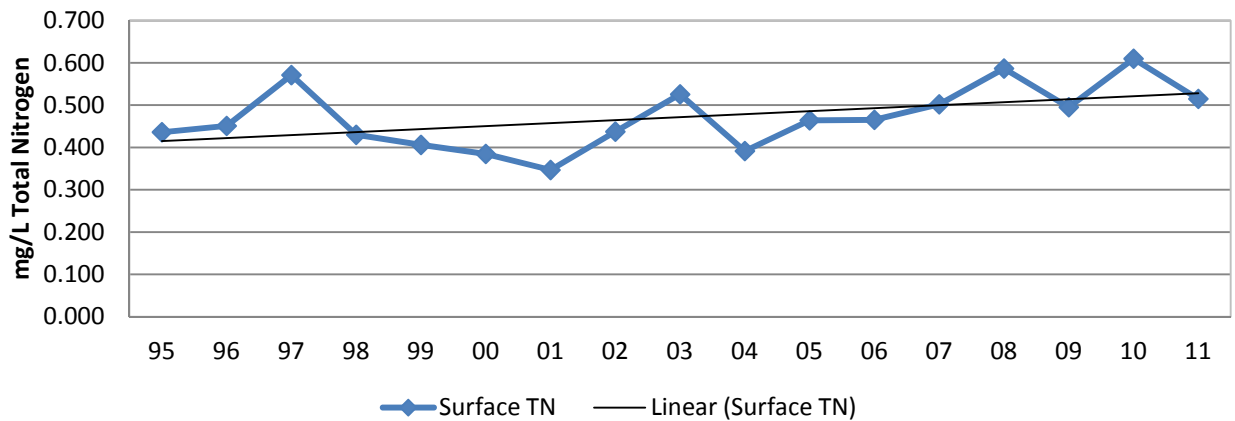


The three graph sets on the next two pages show the only the surface concentrations for phosphorus, nitrogen, and chlorophyll *a* along with a linear trend line. It appears, from these graphs, that in the big basin the phosphorus concentrations are remaining relatively steady, but the nitrogen has increased slightly and the chlorophyll has notably increased. In the east basin, the phosphorus showed minor fluctuations but little overall change until 2011. The nitrogen has remained relatively steady, but the chlorophyll appears to have increased slightly.

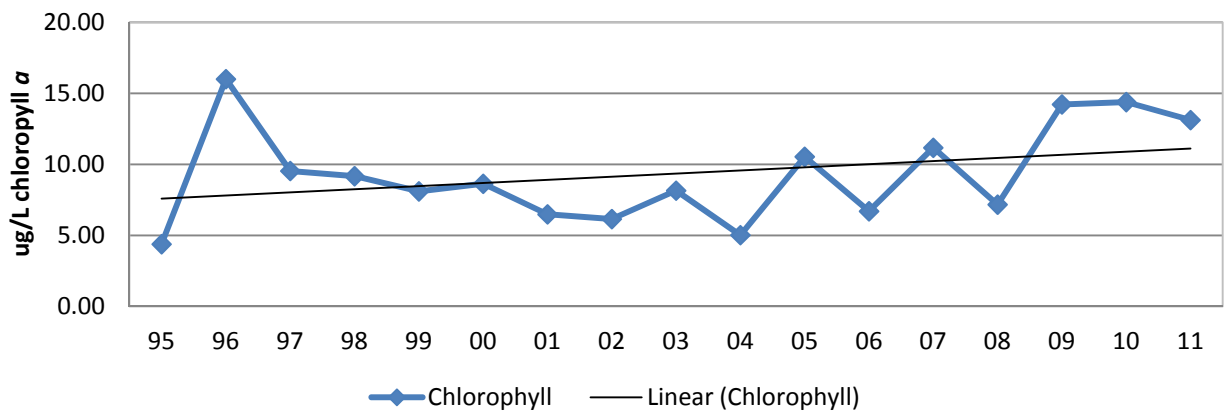
Big Basin - Total Phosphorus Annual Average at Surface



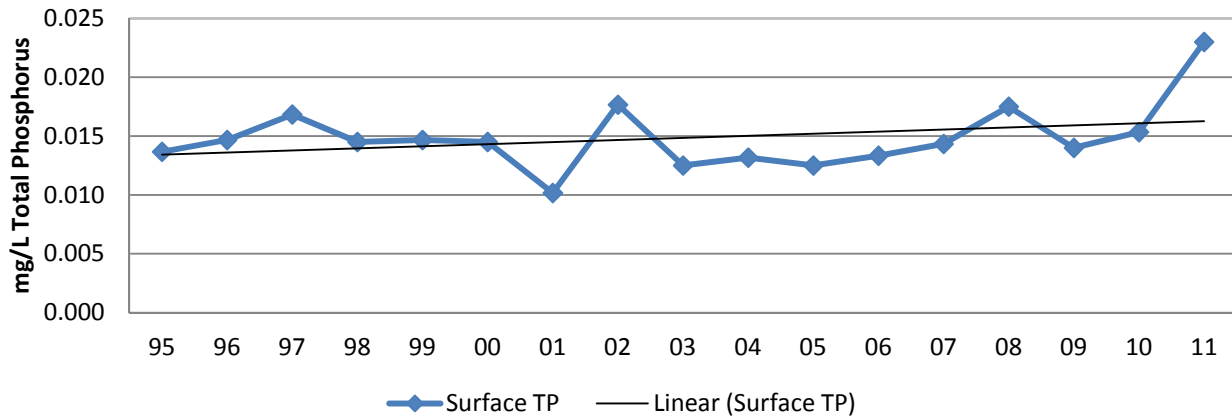
Big Basin - Total Nitrogen Annual Average at Surface



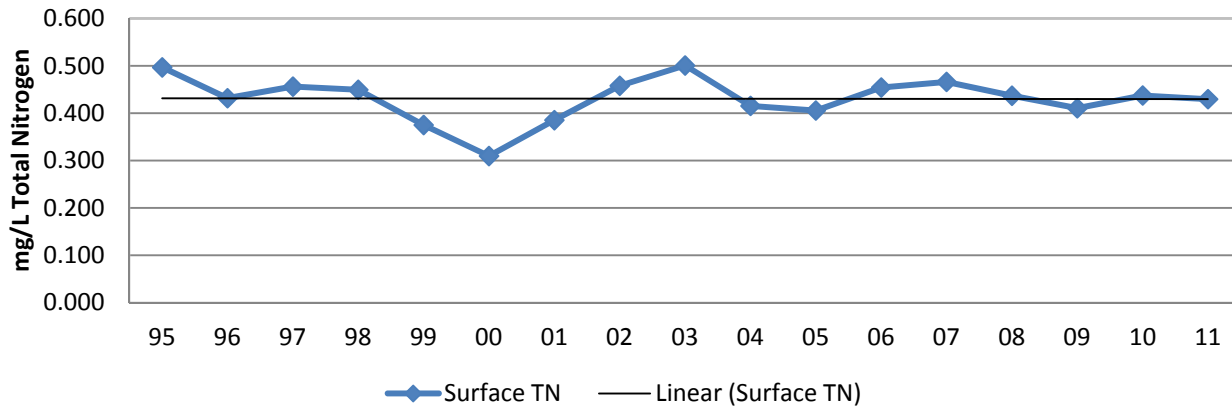
Big Basin - Chlorophyll *a* Annual Average at Surface



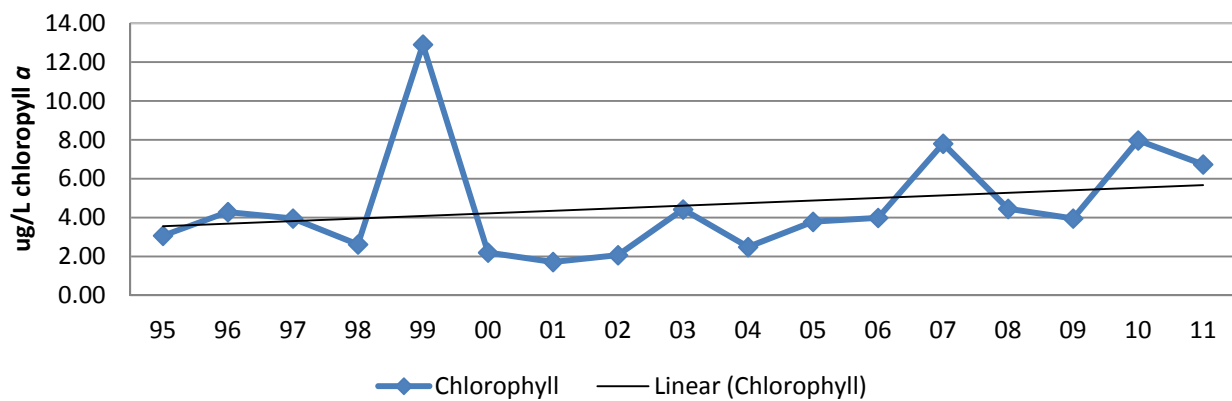
East Basin - Total Phosphorus Annual Average at Surface



East Basin - Total Nitrogen Annual Average at Surface



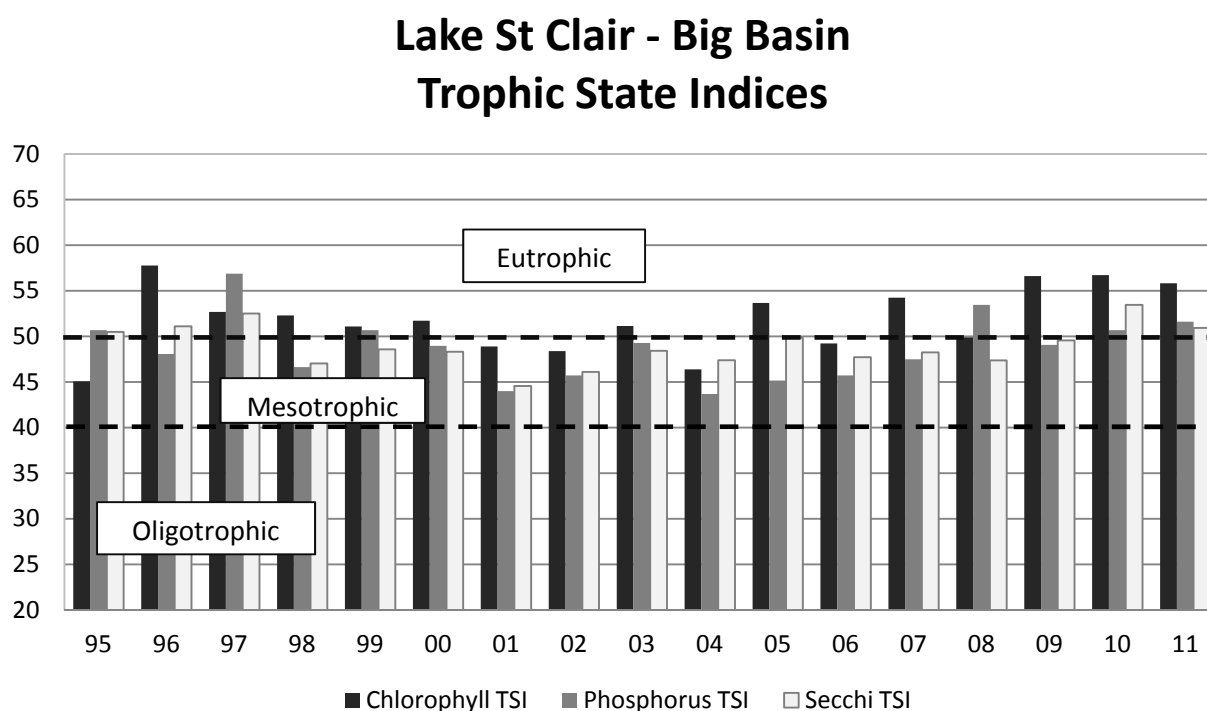
East Basin - Chlorophyll a Annual Average at Surface



Trophic State Indices

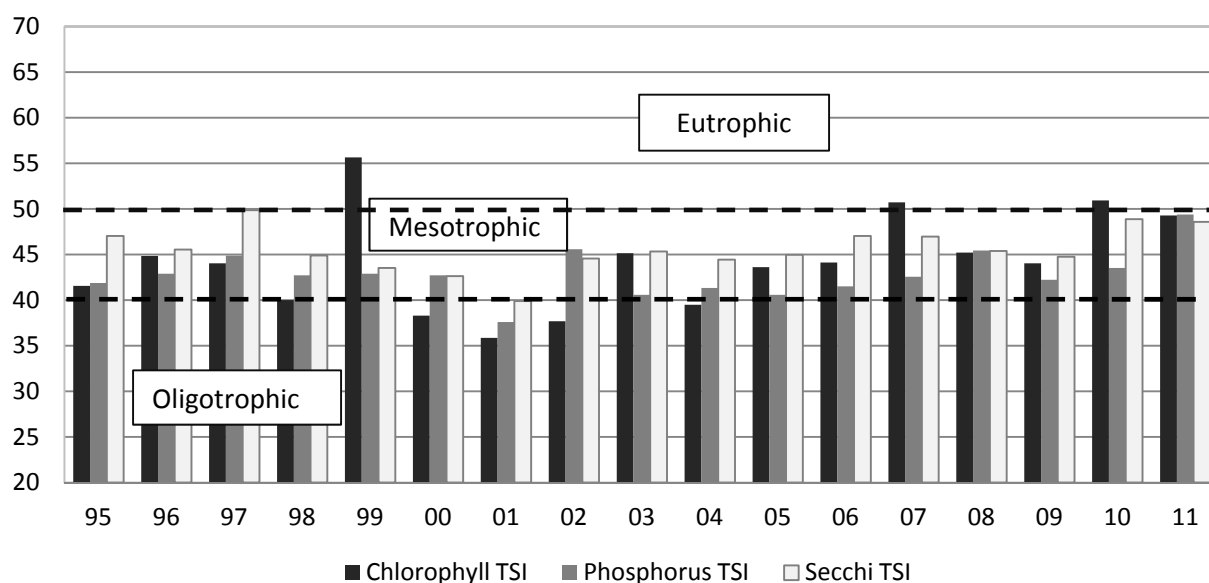
Carlson trophic state indices (TSI) are used to express the degree of productivity of a lake. Average summer total phosphorus concentrations, chlorophyll *a* concentrations, and secchi disk transparency are each used to calculate a TSI for the lake. A TSI of 0 to 40 indicates an oligotrophic, or low productivity lake. A TSI of 41 to 50 indicates a mesotrophic, or moderately productive lake. A TSI of greater than 50 indicates a eutrophic, or highly productive lake.

The 2011 TSIs for the southwest (big) basin of Lake St. Clair for total phosphorus, chlorophyll *a*, and secchi disk are 52, 56, and 51, respectively. These TSIs fall with the eutrophic, or highly productive, range. Graphs of TSIs for the past seventeen years are shown below and on the next page.



The 2011 TSIs for the east basin for total phosphorus, chlorophyll, and secchi disk transparency are 49, 49, and 49, respectively. These TSIs at the upper end of the moderately productive, or mesotrophic, range, and are some of the highest TSIs for this basin during the entire period of record. In past years the east basin TSIs were usually lower than for the big basin, but in 2011 they were fairly similar.

Lake St Clair - East Basin Trophic State Indices



Algae

The monitoring program includes identification of algae types present in the lake. The 2011 data can be found at the end of this chapter. There are a variety of algae types present in Lake St Clair including diatoms, green, yellow, and blue-green. Blue-green algae species are most common in nutrient-rich lakes and are known to cause visible algae “blooms”. They are present in both basins in this lake and do create visible algae blooms and surface scums at times.

Some species of blue-green algae can produce toxins that can cause illness, or even death, in people, pets, and wildlife if ingested. Pets are particularly vulnerable to poisoning from toxic algae blooms due to their smaller body weight and their tendency to ingest higher doses by drinking lake water and licking their fur after swimming. In recent years there has been an increase in documented toxic blue-green algae blooms occurring in lakes within Washington State.

Because toxicity cannot be determined through visual observations, in 2009 Thurston County Environmental Health began using screening test kits to test for the presence of the most common algae toxin, microcystin. When the screening indicates the presence of microcystin, a sample is sent to a laboratory to quantify the amount of toxin present. The laboratory services are a statewide program sponsored by Washington Department of Ecology. Although toxin testing is now possible, lake residents and users should always observe lake conditions and avoid contact with lake water where an algae bloom is occurring.

In October 2011, an algae bloom was reported near the boat launch and along Rehklau Drive. A sample collected at the boat launch was sent to the laboratory for microcystin toxin analysis, and the result was 50 µg/L. The state recreational guidance limit is 6 µg/L. Because the toxin concentration was above the state recreational limit, the county health department issued a health advisory on

Lake St. Clair

October 24. Warning signs were posted at access points around the lake to alert residents and lake users and a notice posted on the county website. Weekly samples showed that the toxic levels decreased after the initial week and the algae bloom was short-lived. The health advisory was lifted on November 22th.

More information about blue-green algae and swimming safety information is available through the Thurston County website: www.co.thurston.wa.us/health/ehadm/swimming/swimming_index.html

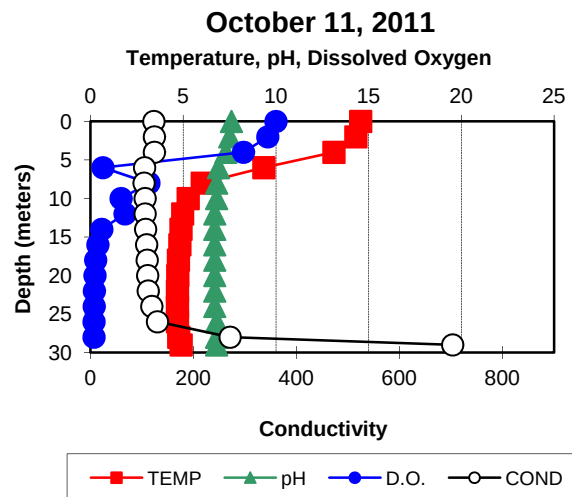
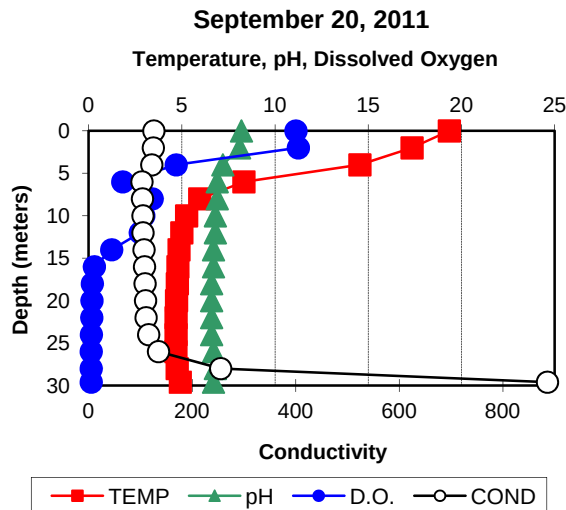
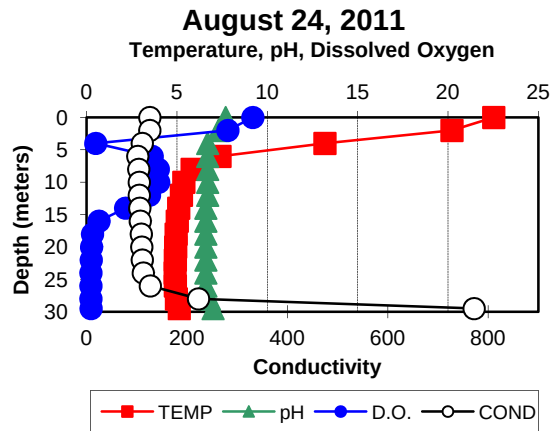
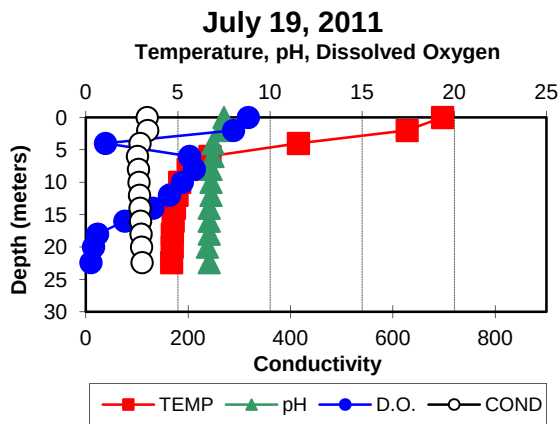
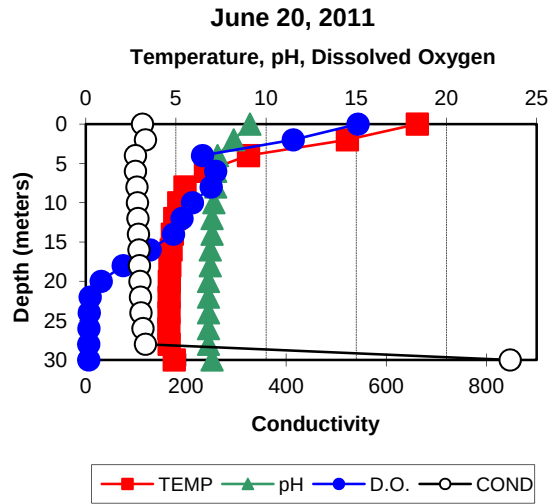
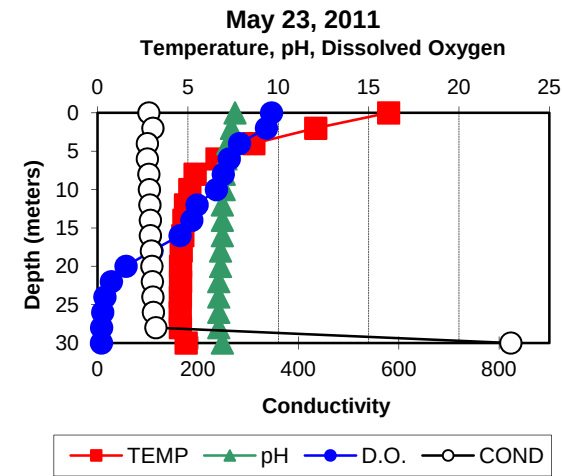
Major Issues:

- Lake St. Clair is a major source of water to McAllister Springs, a City of Olympia water supply.
- High water levels in wet years cause concerns about erosion and property damage along the shoreline from boat and jet ski wakes in the big basin.
- Toxic blue-green algae blooms have occurred in 2009 and 2011.

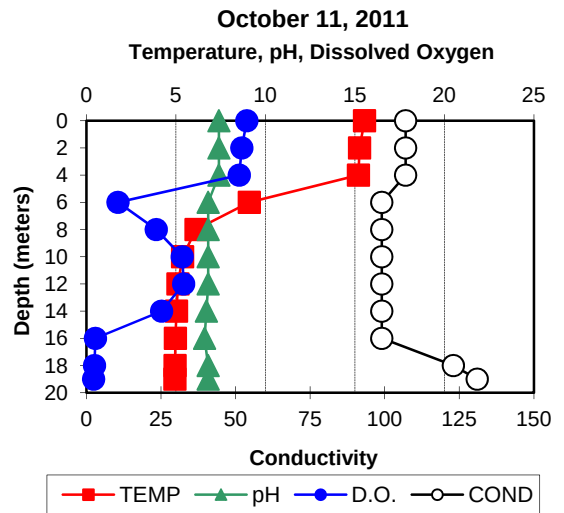
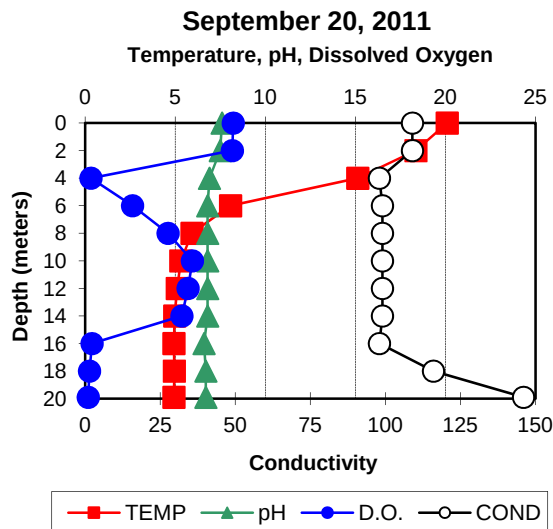
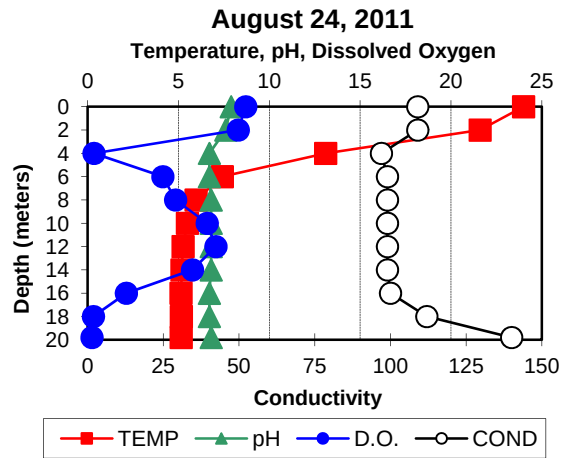
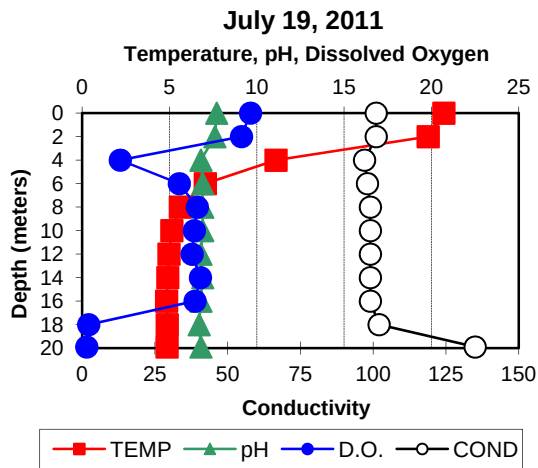
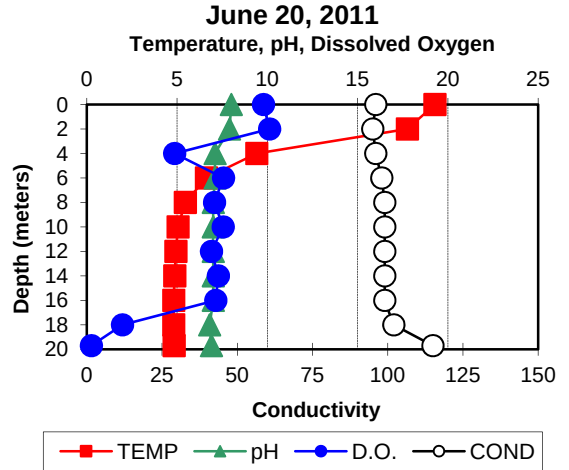
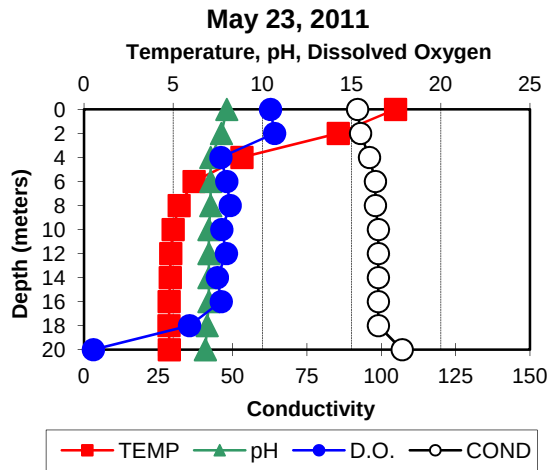
Funding Sources:

Monitoring was funded by Thurston County and will be continued in 2012.

Big Basin – Profile Graphs



East Basin – Profile Graphs



Thurston County Water Resources Annual Report - 2011

St. Clair Lake @ SW Basin

Site ID# NISSTL010

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water	Lake Notes
05/23/2011	1:50:00 PM		28.0	0.035	0.061	0.797	0.932	1.50	4.8	0.4	#10 brown	Chl a & algae composite @ 1 & 2M. Staff gage 69.82. Bottom below end of cable.
06/20/2011	1:30:00 PM		29.0	0.029	0.197	0.362	4.310	1.25	36	2	#9 dk-orange	Chl a & algae composite @ 0.5 & 1M. Staff gage 69.44. Bottom below end of cable.
07/19/2011	12:45:00 PM	22.4	22.0	0.027	0.062	0.559	0.931	1.93	6.4	1.4	#8 yellow-orange	Chl a & algae composite @ 1 & 2M. Staff gage 69.14.
08/24/2011	11:30:00 AM	29.5	28.0	0.028	0.362	0.526	1.710	2.46	4.5	0.3	#7 yellow	Chl a & algae composite @ 1 & 2M. Staff gage 68.62.
09/20/2011	2:00:00 PM	29.6	28.0	0.020	0.592	0.401	2.750	2.11	13	1.3	#7 yellow-orange	Chl a & algae composite @ 1 & 2M. Staff gage 68.38.
10/11/2011	1:45:00 PM	29	28.0	0.022	0.606	0.443	2.750	2.00	14	3.7	#7 yellow	Chl a & algae composite @ 1, 2, & 3M. Staff gage 68.56.

Summary for 'Site Description' = St. Clair Lake @ SW Basin (6 detail records)

Averages: Sur TP 0.027
Secchi 1.88
Chl a 13.1

Thurston County Water Resources Annual Report - 2011

St. Clair Lake @ East Basin

Site ID# NISSTL020

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water	Lake Notes
05/23/2011	3:00:00 PM	20.4	19.0	0.027	0.038	0.564	0.497	1.64	10	0.05	#10 brown	Chl a & algae composite @ 1 & 2M. Phaeo a was < detection at 0.1ug/L.
06/20/2011	2:30:00 PM	19.7	19.0	0.036	0.051	0.362	0.453	2.12	7.5	0.05	#9 dk-orange	Chl a & algae composite @ 1 & 2M. Phaeo a was < detection at 0.1ug/L.
07/19/2011	1:45:00 PM	19.9	19.0	0.032	0.027	0.447	0.477	1.93	7.5	0.7	#8 yellow-orange	Chl a & algae composite @ 1 & 2M.
08/24/2011	12:30:00 PM	19.8	19.0	0.014	0.159	0.391	0.783	2.68	3.7	0.05	#7 yellow	Chl a & algae composite @ 1 & 2M. PHAEO_a was < detection at 0.1 ug/L.
09/20/2011	2:45:00 PM	19.9	19.0	0.017	0.192	0.431	0.829	2.73	5.3	0.05	#7 yellow-orange	Chl a & algae composite @ 1 & 2M. PHAEO_a was < detection at 0.1 ug/L.
10/11/2011	2:30:00 PM	19	18.0	0.012	0.177	0.382	0.611	2.14	6.4	0.05	#8 orange	Chl a & algae composite @ 1, 2, & 3M. PHAEO_a was < detection at 0.1 ug/L.

Summary for 'Site Description' = St. Clair Lake @ East Basin (6 detail records)

Averages: Sur TP 0.023
 Secchi 2.21
 Chl a 6.7

Algae data: St. Clair Lake @ SW Basin

	Type	Description	Dominant in Sample
<i>05/23/2011</i>			
	BG	Aphanizomenon species	☐
	CP	Cryptomonads	☐
	DT	Asterionella species	☐
	DT	Diatoms species	☐
	EU	Euglena species	☐
	GR	Ankyra species	☐
	GR	Dictyosphaerium species	☐
	GR	Sphaerocystis species	☐
<i>06/20/2011</i>			
	BG	Anabaena species	☐
	BG	Aphanizomenon species	☒
	CP	Cryptomonas species	☐
	DF	Ceratium species	☐
	DT	Asterionella species	☐
	GR	Oocystis species	☐
<i>07/18/2011</i>			
	BG	Aphanocapsa species	☐
	DT	Asterionella species	☐
	DT	Aulacoseira species	☐
	DT	Cyclotella species	☐
	DT	Fragilaria species	☐
	GR	Botryococcus species	☐
	GR	Radiococcus nimbatus	☐
	YL	Dinobryon species	☐

07/19/2011

Type	Description	Dominant in Sample
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Diatoms species	☐
DT	Fragilaria species	☐
GR	Elakatothrix species	☐
GR	Sphaerocystis species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

08/24/2011

BG	Anabaena species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Cyclotella species	☐
DT	Fragilaria species	☐
GR	Ankyra species	☐
GR	Oocystis species	☐
GR	Sphaerocystis species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐

09/20/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Aphanizomenon species	☐
CP	Cryptomonads	☐
DF	Ceratium species	☐
DT	Aulacoseira species	☐
DT	Fragilaria species	☐
DT	Tabellaria species	☐
EU	Trachelomonas species	☐
GR	Cosmarium species	☐
GR	Crucigenia species	☐
GR	Sphaerocystis species	☐
YL	Dinobryon species	☐
YL	Mallomonas species	☐
YL	Synura species	☐

10/11/2011

BG	Anabaena species	☐
BG	Aphanizomenon species	☒
BG	Chroococcus species	☐
BG	Woronichinia species	☐
CP	Cryptomonas species	☐
DF	Ceratium species	☐
DT	Asterionella species	☐
DT	Tabellaria species	☐
EU	Euglena species	☐
EU	Trachelomonas species	☐
GR	Ankyra species	☐
GR	Sphaerocystis species	☐
YL	Dinobryon species	☐
YL	Mallomonas species	☐

Key: BG = Blue green EU = Euglenophyte
 CP = Cryptophyte GR = Green
 DF = Dinoflagellate YL = Yellow
 DT = Diatom

Algae data: St. Clair Lake @ East Basin

	<i>Type</i>	<i>Description</i>	<i>Dominant in Sample</i>
<i>05/23/2011</i>			
	BG	Aphanizomenon species	☐
	CP	Cryptomonads	☐
	DT	Asterionella species	☐
	DT	Cyclotella species	☐
	DT	Fragilaria species	☐
	DT	Tabellaria species	☐
	EU	Euglena species	☐
	GR	Closterium species	☐
	GR	Staurastrum species	☐
	YL	Mallomonas species	☐
<i>06/20/2011</i>			
	BG	Anabaena species	☐
	BG	Aphanizomenon species	☐
	CP	Cryptomonads	☐
	DF	Ceratium species	☐
	DT	Asterionella species	☐
	DT	Aulacoseira species	☐
	DT	Cyclotella species	☐
	DT	Fragilaria species	☐
	DT	Tabellaria species	☐
	GR	Ankyra species	☐
	GR	Botryococcus species	☐
	GR	Oocystis species	☐
	GR	Sphaerocystis species	☐
	GR	Staurastrum species	☐
	YL	Mallomonas species	☐

07/19/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Aphanizomenon species	☐
BG	Chroococcus species	☐
BG	Gomphosphaeria species	☐
CP	Cryptomonads	☐
DT	Cyclotella species	☐
DT	Tabellaria species	☐
GR	Cosmarium species	☐
GR	Crucigenia species	☐
GR	Staurastrum species	☐
YL	Synura species	☐

08/24/2011

BG	Anacystis species	☐
BG	Aphanizomenon species	☐
BG	Chroococcus species	☐
BG	Gomphosphaeria species	☐
CP	Cryptomonas species	☐
DT	Cyclotella species	☐
DT	Fragilaria species	☐
EU	Trachelomonas species	☐
GR	Cosmarium species	☐
GR	Radiococcus nimbatus	☐
GR	Sphaerocystis species	☐
GR	Staurastrum species	☐
YL	Dinobryon species	☐
YL	Mallomonas species	☐

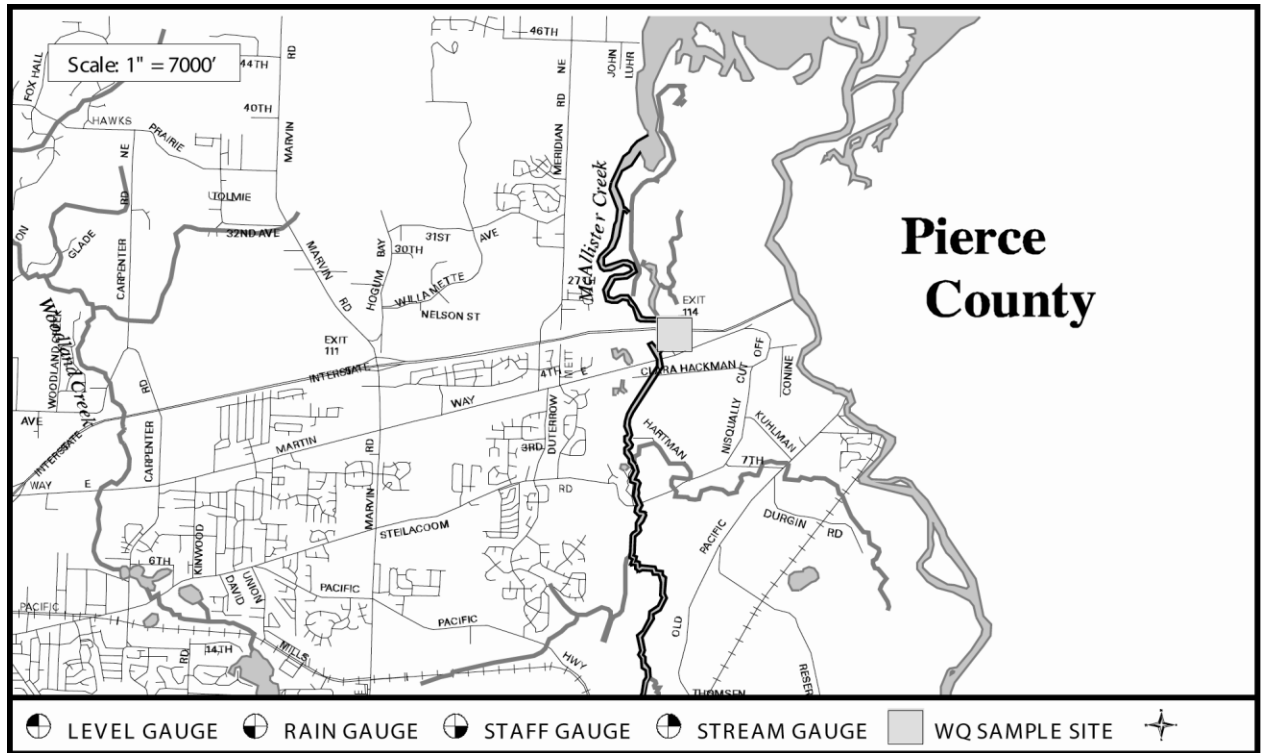
09/20/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Anacystis species	☐
BG	Aphanizomenon species	☐
BG	Chroococcus species	☐
BG	Gomphosphaeria species	☐
CP	Cryptomonads	☐
DT	Asterionella species	☐
EU	Trachelomonas species	☐
GR	Cosmarium species	☐
YL	Dinobryon species	☐
YL	Mallomonas species	☐
YL	Synura species	☐

10/11/2011

BG	Anabaena species	☐
BG	Aphanizomenon species	☐
BG	Woronichinia species	☐
CP	Cryptomonads	☐
DT	Melosira species	☐
GR	Pandorina species	☐

Key: BG = Blue green EU = Euglenophyte
CP = Cryptophyte GR = Green
DF = Dinoflagellate YL = Yellow
DT = Diatom



PART OF NISQUALLY REACH WATERSHED

LENGTH OF CREEK: 6 miles

BASIN SIZE: 7,078 Acres

STREAM ORDER: 2

Significantly influenced by public water withdrawal for City of Olympia.

PRIMARY LAND USES:

Rural residential
Commercial and non-commercial agriculture
Timber
Commercial development near I-5 interchange
Wildlife refuge

FISHERIES RESOURCES: (From [A Catalog of Washington Streams and Salmon Utilization](#), WDOF)

Coho, chum

GENERAL TOPOGRAPHY:

Watershed varies from 200 foot bluffs to sea level, but the entire creek is below 20 feet. The creek is tidally influenced throughout its length. Its sources are springs, which are used by the City of Olympia for public water supply.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Fair - Failed both parts of the fecal coliform standard for both water years. The dissolved oxygen and pH standard is often violated.

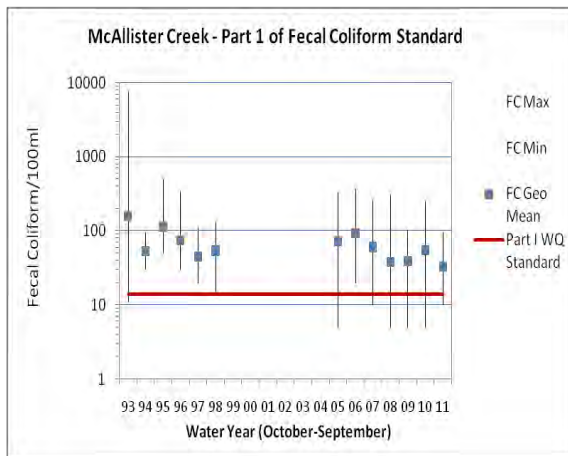
OTHER DATA:

Nisqually Tribe, 438-8687 (Water Quality Data)

Washington Dept. of Health, Office of Food Safety and Shellfish, (360) 236-3330

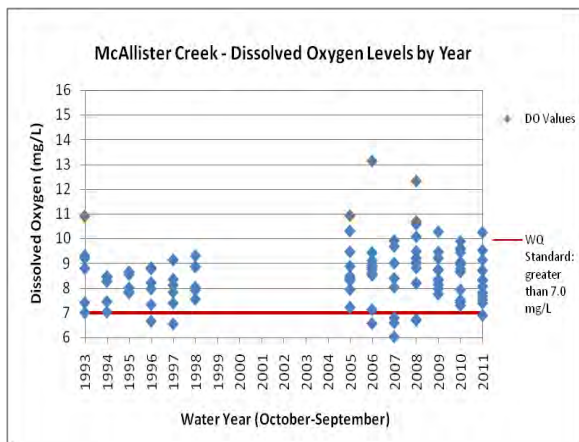
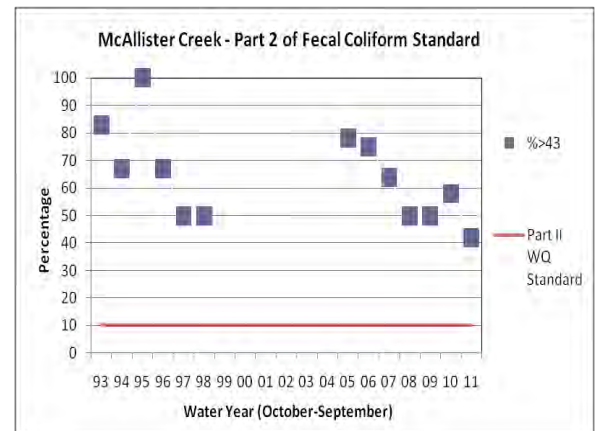
Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

McAllister Creek #0324



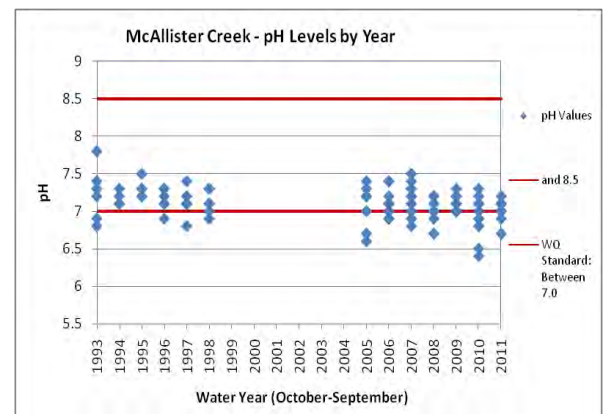
The marine water quality standard for fecal coliform bacteria has two parts: Part 1 - the geometric mean shall not exceed 14 org/100mL *and* Part 2 - no more than 10% of the samples shall exceed 43 org/100mL.

Throughout the period of record the creek failed both part 1 and part 2 of the marine water quality standard for fecal coliform bacteria.



In 2009/10 the dissolved oxygen standard was met however it was exceeded one of the twelve times it was measured in 2010/11.

The water quality standard for pH is within the range of 7.0 to 8.5. The pH at McAllister Creek was below a pH of 7.0 six times in water year 2009/10 and twice in 2010/11.



Discussion:

McAllister Creek is sampled as part of the long-term ambient monitoring program. McAllister Creek is within the Nisqually Reach Shellfish Protection District, which was created in 2001 after a downgrade of commercial shellfish growing areas. McAllister Creek was also sampled extensively throughout its length in 2002 and 2003 as part of a total maximum daily load study conducted by the Washington Department of Ecology. As a result of the total maximum daily load study, a water quality clean-up plan was completed in June 2005.

The creek is tidally influenced throughout most its length and has a very low gradient, both of which influence the water quality. From river mile 4.2 and downstream, McAllister Creek must meet the marine water quality standard for fecal coliform because RM 4.2 is the point where 95% of the daily maximum vertically averaged salinity values are 10 ppt or greater. The ambient sampling site is located at river mile 3.1, and therefore the marine standard applies. The creek has continuously failed to meet either part of the marine fecal coliform standard.

For all other parameters, the marine water quality standards are applied at RM 4.7 where 95% of the daily maximum vertically averaged salinity values are 1 ppt or greater. The water quality standard for dissolved oxygen is a lowest one-day minimum of 7.0 mg/L. All of the instantaneous dissolved oxygen measurements made in water year 2009/10 met the marine dissolved oxygen standard. In the 2010/11 water year, one measurement below 7 mg/l was recorded.

For dissolved oxygen, the water quality standard is a lowest one-day minimum of 7.0 mg/L. The pH standard was exceeded six times in 2009/10 and two times in 2010/11. The standard for temperature was exceeded three times in 2009/10 and two times in 2010/11, all in the summer months.

Major Issues:

- Improvement and protection of McAllister Creek water quality is critical to maintain the “open” classification of the shellfish growing area in Nisqually Reach near the mouth of the creek.
- Non-point pollution problems from agriculture, on-site sewage systems, and stormwater runoff influence the water quality. There are on-going efforts by local, state, and tribal agencies to protect and improve water quality.
- The McAllister Geologically Sensitive Area and City of Olympia wellhead protection program are intended to protect groundwater and McAllister Springs, which is the headwater of McAllister Creek.
- In 2001, the Nisqually Reach Shellfish Protection District was formed as a result of a commercial shellfish harvest area downgrade.

Funding Sources:

- Local Stormwater Utility Rate

Water Quality Summary

Conventional Parameters

McAllister Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 1-DMax of 13 ° C	09/10 10/11		6.64 – 14.30 6.66 – 13.53	3 of 12 2 of 12		4.61 – 16.37
Dissolved Oxygen	mg/L	Lowest one-day minimum of 7.0	09/10 10/11		7.29 – 9.88 6.89 – 10.24	0 of 12 1 of 12		3.42 – 13.1
Conductivity	µmhos/cm		09/10 10/11	4657 2166	443 - 20500 310 - 133000		3335	11 - 33960
pH		7.0 - 8.5	09/10 10/11	7.0* 7.0*	6.4 – 7.3 6.7 – 7.2	6 of 12 2 of 12	7.1*	6.6 - 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	2.95 2.12	0.40 – 8.40 0.10 – 6.70	0 of 12 0 of 12	4.76	1.2 - 38
Fecal Coliform	colonies/ 100 ml	GMV: ≤14 and ≤ 10% not to exceed 43	09/10 10/11	55** 33**	5 - 250 10 - 95	% exceeding 43	63**	5 - 7500
						58% 42%		
Total Phosphorus	mg/L		09/10 10/11	0.141 0.143	0.107 – 0.163 0.126 – 0.183		0.159	0.112 - 0.229
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	1.265 1.364	0.820 – 1.60 1.1 – 1.63		1.21	0.517 - 1.93

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

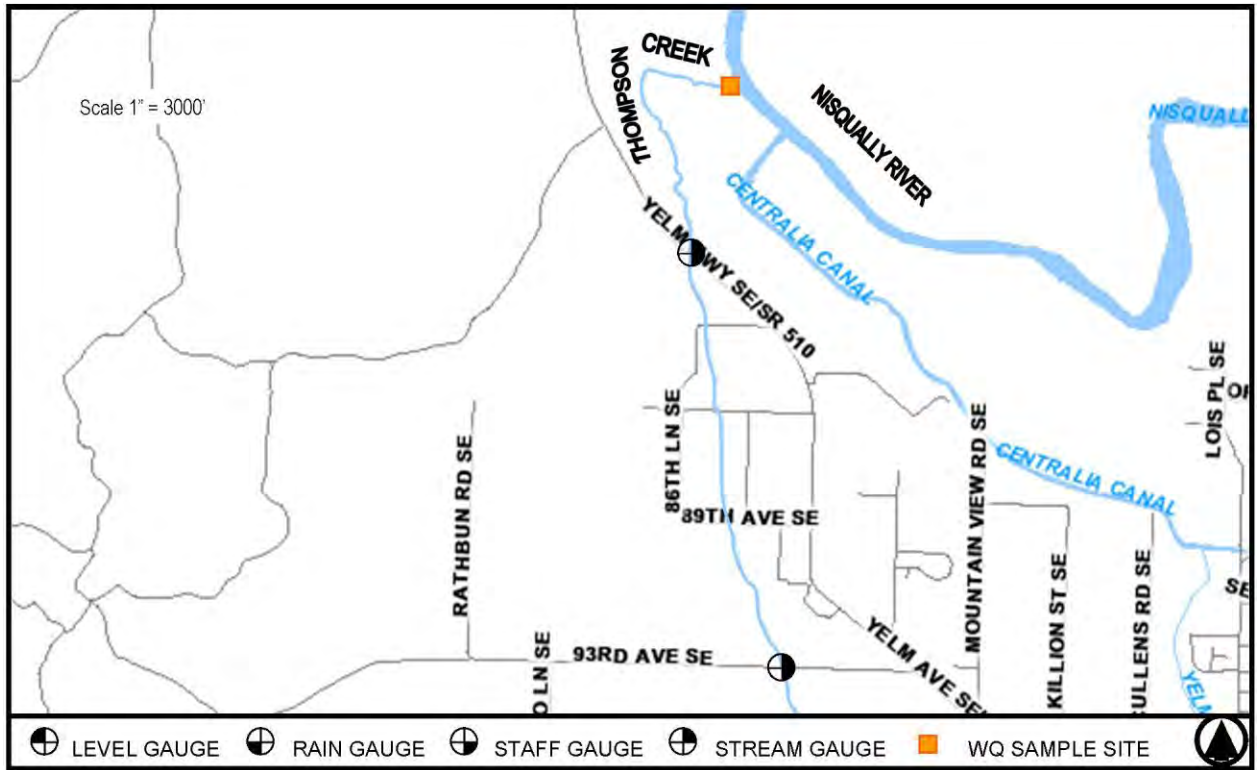
McAllister Creek @ I-5 Southbound on-ramp

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/21/2009	2:30:00 PM	11.43	6.9	7.41	4900	55	2.9		0.163	1.220	
11/16/2009	11:00:00 AM	9.35	6.5	9.04	8179	40	7.4		0.131	1.130	Salinity - 4.53
12/15/2009	11:20:00 AM	6.64	7.0	9.43	13580	90	8.4		0.107	1.040	
1/13/2010	10:30:00 AM	8.82	6.4	8.77	20500	20	4.9		0.111	0.820	
2/8/2010	4:30:00 PM	9.62	6.8	7.92	1803	50	1.8		0.156	1.490	
3/16/2010	12:15:00 PM	10.61	6.8	8.64	1360	5	2.9		0.143	1.440	
4/19/2010	3:10:00 PM	12.99	6.9	8.94	778	35	1.6		0.143	1.600	
5/11/2010	11:30:00 AM	11.35	7.1	9.59	443	20	0.7		0.144	1.470	
6/14/2010	2:20:00 PM	13.56	7.2	9.56	476	125	0.4		0.140	1.380	
7/13/2010	1:10:00 PM	14.30	7.3	9.88	1020	210	1.2		0.139	1.310	
8/18/2010	7:45:00 AM	14.22	7.1	7.50	949	250	1.4		0.149	1.110	
9/14/2010	3:15:00 PM	12.70	7.1	7.29	1900	110	1.8		0.161	1.170	Salinity 1.0.

Thurston County Water Resources Monitoring Report 2010-2011

McAllister Creek @ I-5 Southbound on-ramp

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	10:10:00 AM	9.18	7.0	7.80	310	10	0.2		0.143	1.360	
11/17/2010	8:45:00 AM	9.60	7.0	6.89	389	10	0.8		0.183	1.420	
12/13/2010	4:00:00 PM	10.01	6.7	7.66	13300	80	6.7		0.130	1.100	Salinity 7.7%
1/11/2011	4:30:00 PM	6.66	7.1	9.13	979	30	2.8		0.157	1.630	
2/14/2011	4:25:00 PM	9.24	6.9	8.06	4590	20	4.0		0.142	1.610	Salinity 2.46 ppt
3/14/2011	4:50:00 PM	9.66	7.0	9.52	583	25	3.3		0.132	1.420	Duplicates labeled "Refuge".
4/11/2011	4:50:00 PM	11.60	7.1	10.24	360	15	1.2		0.139	1.430	
5/16/2011	9:20:00 AM	11.21	7.0	8.32	2060	90	2.8		0.132	1.250	Salinity 1.05
6/13/2011	9:40:00 AM	13.50	7.1	8.30	990	95	1.6		0.129	1.360	
7/11/2011	9:20:00 AM	13.53	7.2	8.70	939	50	0.8		0.126	1.240	
8/9/2011	9:30:00 AM	12.59	7.0	7.52	774	30	1.1		0.155	1.250	
9/12/2011	11:15:00 AM	12.85	7.0	7.38	723	45	0.1		0.145	1.300	



PART OF NISQUALLY REACH WATERSHED

LENGTH OF CREEK: ~ 4 miles

BASIN SIZE: 10,295 acres, approximately 16 square miles

STREAM ORDER: 2

PRIMARY LAND USES:

Forest Land
Urban and rural residential

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)

Coho

GENERAL TOPOGRAPHY: The headwaters are a wetland system near residential areas within the City of Yelm. The creek has a low gradient and is often dry in the upper reaches. It flows throughout its entire length only after significant or sustained wet

season precipitation when shallow groundwater levels are high. The creek starts at approximate elevation of 330 feet at the headwaters and flows across the prairie to elevation 308 feet. It then drops off the prairie through a forested ravine to the Nisqually River at an approximate elevation of 106 feet.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

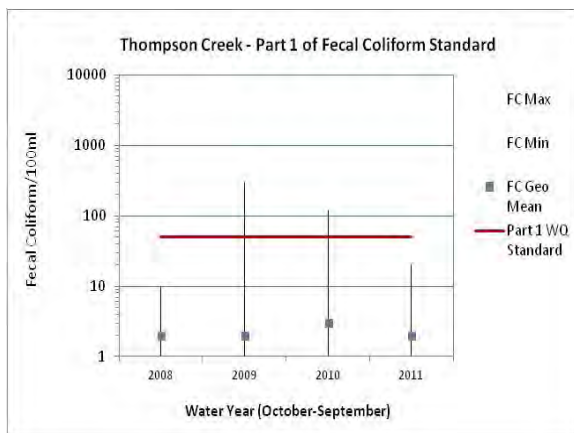
Good: Met water quality standards. Nitrate concentrations are high.

OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

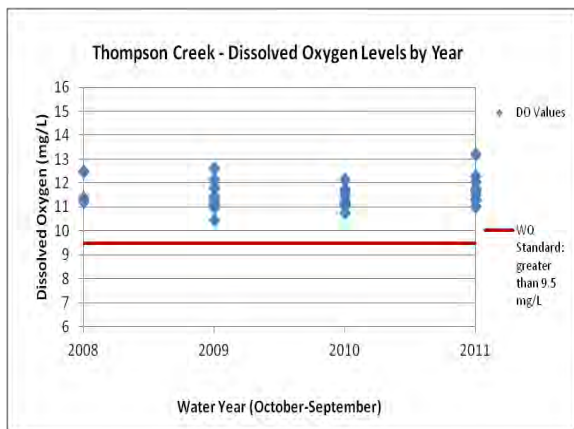
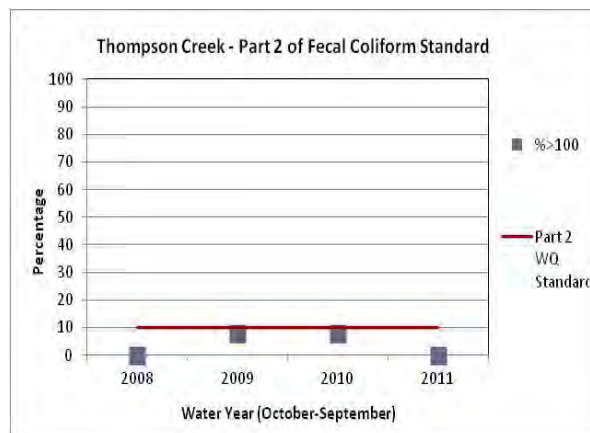
Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 or www.co.thurston.wa.us/monitoring

Thompson Creek #0041



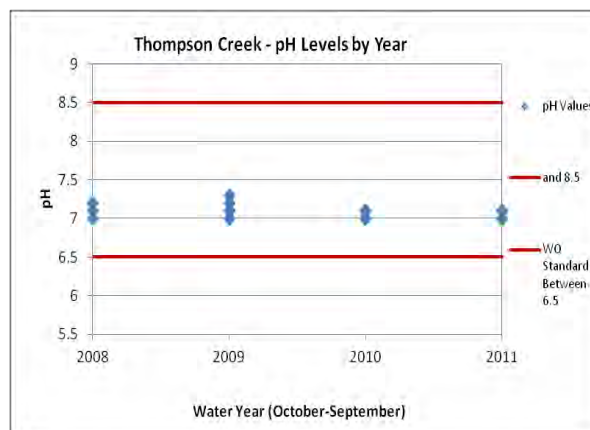
Thompson Creek mouth station has met both parts of the fecal coliform standard since monitoring began in 2008.

The state water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 50 colonies/100mL *and* Part 2 - no more than 10% of the samples shall exceed 100 colonies/100 mL.



The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. The creek has met the pH standard consistently since 2008.

The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. There have been no violations for the past 4 water years at the Thompson Creek mouth station.



Discussion:

Monthly monitoring near the mouth of Thompson Creek began in July of 2008. The water quality data is summarized and compared against the state water quality standard in the table on the following page.

The creek met all of the water quality standards for the parameters measured. The temperature standard that applies in Thompson Creek is intended to protect core summer salmonid habitat, and is a 7-day average daily maximum of 16 ° C. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. There were no temperature measurements above the maximum criteria during either water year.

Nitrate concentrations in Thompson Creek were high year-round, which is most likely a reflection of the groundwater quality in the area. While there is no water quality standard for nitrate in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015). The average nitrate concentrations for Thompson Creek are ten times higher at 2.64 and 2.09 mg/l. for water years 2009/10 and 2010/11 respectively. The total phosphorus regional reference condition is 0.019 mg/l, according to the EPA report. The average total phosphorus concentrations are similar to the regional reference condition at 0.020 and 0.019 mg/l for each water year.

Major Issues:

- Development in the Thompson Creek watershed could increase stormwater runoff and further affect the groundwater quality that provides the base flow for the creek.

Funding Sources:

- County Storm and Surface Water Utility

Water Quality Summary
Conventional Parameters
Thompson Creek @ Centralia Power Park

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 2008 - 2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		8.95 – 10.28 8.55 – 9.91			8.3 – 10.23
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		10.76 – 12.16 11.01 – 13.19	0 of 12 0 of 12		10.4 – 12.6
Conductivity	µmhos/cm		09/10 10/11	136 123	124 - 140 90 - 138		135	117 - 139
pH		6.5 - 8.5	09/10 10/11	7.0* 7.0*	7.0 – 7.1 7.0 – 7.1	0 of 12 0 of 12	7.1*	7 – 7.3
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	0.73 0.79	0 – 4.30 0 – 3.30		0.65	0 – 2.4
Fecal Coliform	colonies/ 100 ml	GMV: ≤50 and ≤ 10% not to exceed 100	09/10 10/11	3** 2**	0 - 120 0 - 20	% exceeding 100	2**	0 - 295
						8% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.020 0.019	0.016 – 0.032 0.016 – 0.027		0.017	0.012 – 0.021
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	2.64 2.09	2.17 – 2.99 0.920 – 2.76		2.55	1.94 – 2.97

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

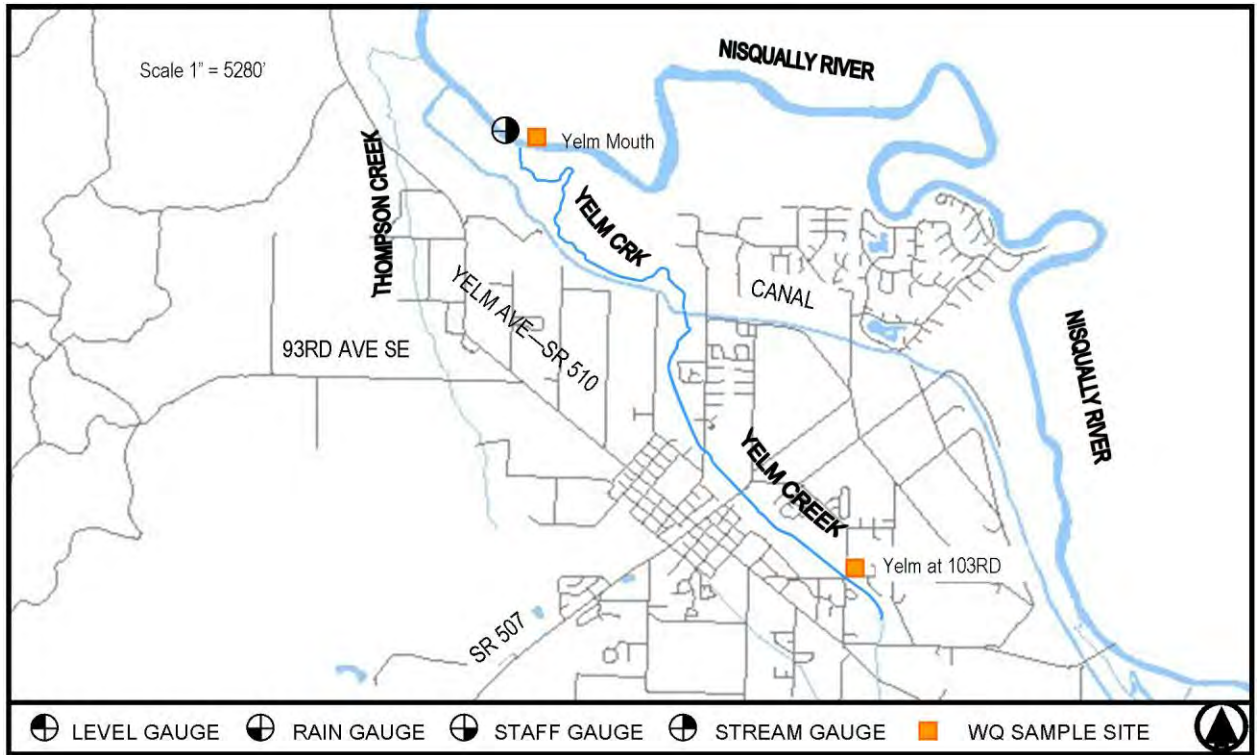
Thompson Creek @ Centralia Power Park

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	3:00:00 PM	9.72	7.0	11.16	139	0	0.9	1.54	0.016	2.700	Duplicates labeled "Power Plant" FC reported as <5
11/17/2009	3:00:00 PM	9.32	7.0	11.75	124	0	1.4	2.35	0.017	2.170	FC reported as <5
12/16/2009	3:00:00 PM	8.95	7.1	11.23	135	120	0.5	1.62	0.026	2.390	
1/11/2010	3:00:00 PM	9.12	7.0	11.53	130	5	4.3	2.11	0.022	2.380	
2/10/2010	2:45:00 PM	8.99	7.0	10.76	137	8	0.4	1.84	0.019	2.890	Duplicates labeled "Power Plant".
3/16/2010	3:00:00 PM	9.22	7.1	12.16	137	0	0.8	1.90	0.017	2.780	FC reported as <5.
4/19/2010	2:00:00 PM	9.85	7.0	11.09	137	0	0.4	2.07	0.016	2.960	Duplicates labeled "Power Plant"
5/10/2010	2:45:00 PM	9.54	7.1	11.04	139	0	0.1	2.39	0.019	2.930	FC reported as <5.
6/15/2010	2:45:00 PM	9.68	7.0	11.26	138	0	0.0	3.03	0.032	2.990	FC reported as <5. Downstream flow altered by rock dams.
7/12/2010	2:15:00 PM	9.71	7.1		138	0	0.0	2.00	0.017	2.730	DO did not post calibrate. FC reported as <5.
8/16/2010	3:20:00 PM	10.28	7.0	11.67	140	5	0.0	2.17	0.017	2.330	Lots of channel disturbance; rock movement, pool building.
9/13/2010	2:50:00 PM	9.97	7.1	11.08	140	30	0.0	1.85	0.017	2.450	Rock dam built at mouth into Nisqually.

Thurston County Water Resources Monitoring Report 2010-2011

Thompson Creek @ Centralia Power Park

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	10:30:00 AM	9.11	7.0	11.66	136	0	0.0	1.91	0.016	2.460	Turb read -0.6. FC reported as <5.
11/16/2010	10:00:00 AM	9.33	7.1	11.52	90	0	0.0	1.51	0.017	2.360	FC reported as <5. Rock dam at mouth.
12/14/2010	10:45:00 AM	9.03	7.0	11.67	126	0	3.3	2.83	0.027	2.120	FC reported as <5.
1/12/2011	10:30:00 AM	9.10	7.1	11.32	136	0	0.8	2.72	0.019	2.360	FC reported as <5.
2/16/2011	9:45:00 AM	8.55	7.1	11.75	136	0	0.5	3.00	0.018	2.760	FC reported as <5.
3/14/2011	10:15:00 AM	8.89	7.0	12.29	100	10	3.2	4.91	0.019	1.220	
4/11/2011	10:30:00 AM	8.98	7.1	13.19	99	0	0.7	4.35	0.019	0.920	FC reported as <5.
5/17/2011	10:10:00 AM	9.30	7.1	12.04	113	5	0.8	4.86	0.021	1.520	
6/14/2011	10:10:00 AM	9.35	7.0	11.31	132	0	0.1	3.57	0.017	2.210	FC reported as <5.
7/12/2011	10:00:00 AM	9.86	7.0	11.01	138	20	0.1	3.08	0.020	2.310	
8/8/2011	11:10:00 AM	9.91	7.1	11.29	138	0	0.0	1.93	0.018	2.390	FC reported as <5.
9/12/2011	1:45:00 PM	9.83	7.0	11.30	137	0	0.0	1.68	0.018	2.400	FC reported as <5. Turbidity read -0.8



PART OF NISQUALLY REACH WATERSHED

LENGTH OF CREEK: 9 miles

BASIN SIZE: 15,667 acres; 31.5 square miles

STREAM ORDER: 2

PRIMARY LAND USES:

Urban and Rural Residential
Forestland

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)
Coho, Chum

GENERAL TOPOGRAPHY: Yelm Creek originates in rural residential and forested land south of the City of Yelm at an elevation of 380'. Wetlands in glacial till plains provide year round spring flow in the upper reaches. The lower reaches of the creek lie on permeable glacial outwash terraces between 350' to 300' elevation, flowing through rural

residential and urban areas of Yelm. The creek is fed by springs near the Centralia diversion canal, the largest being Crystal Spring and flows into the Nisqually River.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

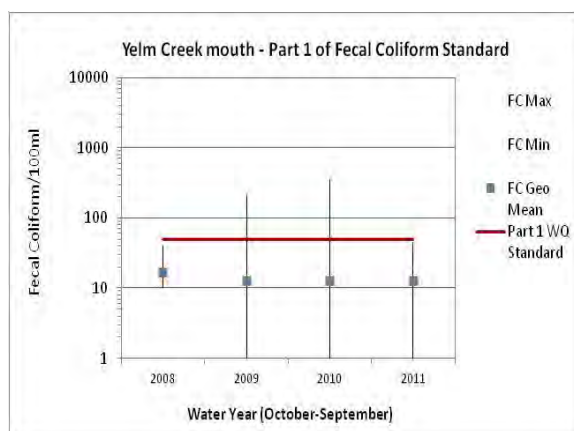
Mouth site is Good – High nitrate levels. 103rd Site is Fair – Failed both parts of the fecal coliform standard in 2010 but met both in 2011. Total phosphorus is high. Temperature and dissolved oxygen violations.

OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

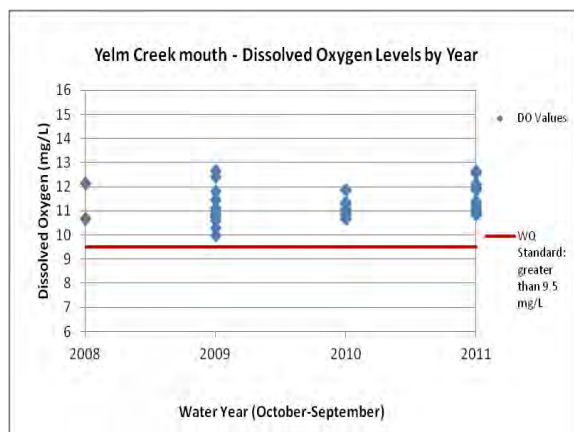
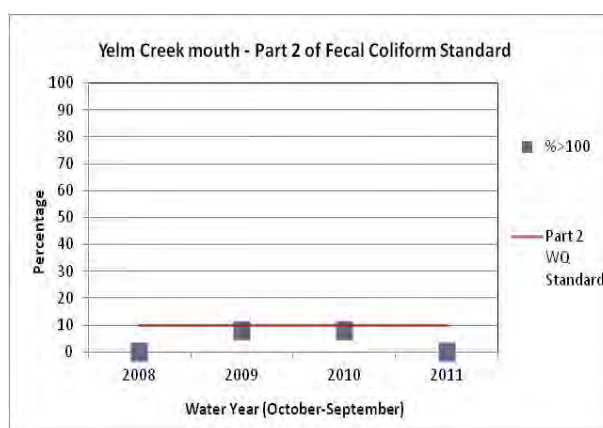
Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 or www.co.thurston.wa.us/monitoring

Yelm Creek @ end of Mud Run Rd (Mouth)



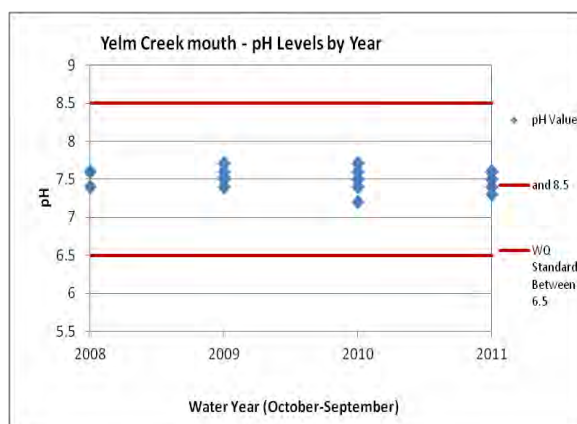
The Yelm Creek mouth station has met both parts of the fecal coliform standard in the last four water years.

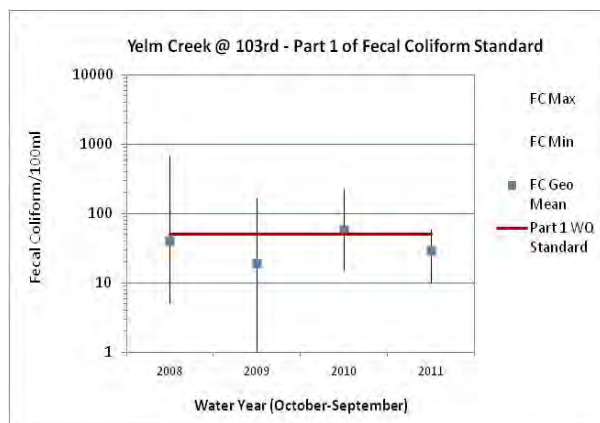
The state water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 50 colonies/100mL *and* Part 2 - no more than 10% of the samples shall exceed 100 colonies/100 mL.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. There have been no violations for the past 4 water years at the Yelm Creek mouth station.

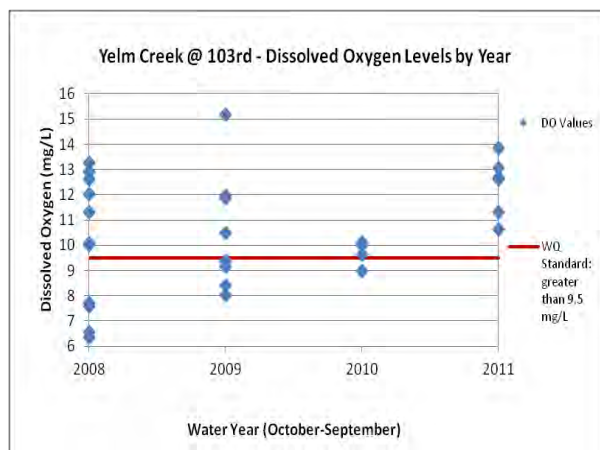
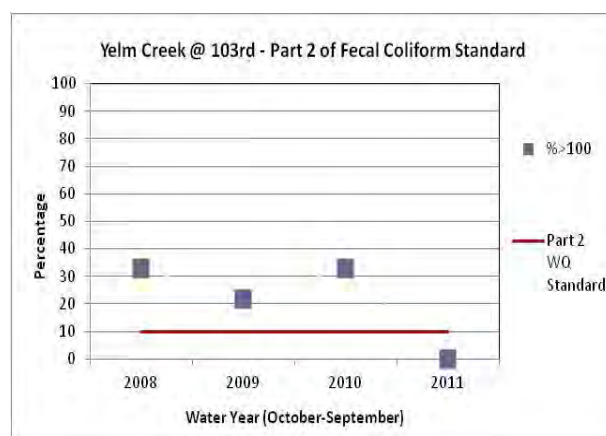
The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. The pH standard has been consistently met since 2008 at the Yelm Creek mouth station.



Yelm Creek @ 103rd & Creek St.

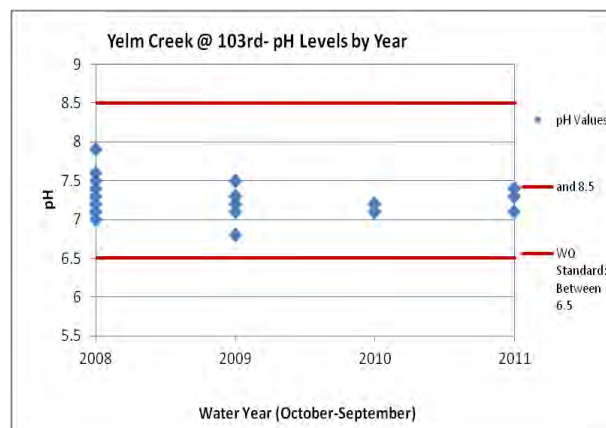
The state water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 50 colonies/100mL and Part 2 - no more than 10% of the samples shall exceed 100 colonies/100 mL.

Yelm Creek @ 103rd met the first part of the fecal coliform standard in water years 2007/08 and 2008/09 but failed the second part. In 2009/10, it failed both parts and in 2010/11 both parts were met.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. In water years 2007/08 and 2008/09, there were several violations of this standard. In water year 2009/10, one of five measurements violated the standard. There were no violations in water year 2010/11 at the Yelm Creek @103rd station.

The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. The pH standard has been consistently met since 2008 at the Yelm Creek @103rd station.



Discussion:

Water quality monitoring is done at two sites on Yelm Creek. The upstream site is on the prairie within the City of Yelm at the intersection of 103rd and Creek Streets. The creek is very low gradient, and often stagnant or dry in summer and early fall. The downstream site is at the creek mouth just upstream of its confluence with the Nisqually River. The source of water at the mouth site is primarily groundwater discharged as springs from the hillside below the prairie. Monitoring began at the 103rd site in October 2007 and at the mouth site in July 2008.

The water quality data for each site is summarized and compared against the state water quality standards in the tables on the following pages. The state water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 50 colonies/100mL *and* Part 2 - no more than 10% of the samples shall exceed 100 colonies/100 mL. The water quality at the mouth site easily met the fecal coliform standard. However, the water quality at the 103rd station failed both parts of the fecal coliform bacteria standard in 2009/10 and met both parts in 2010/11.

The temperature and dissolved oxygen standards that apply to Yelm Creek are intended to protect core summer salmonid habitat. The temperature standard is a 7-day average daily (DAD) maximum of 16 ° C, and the dissolved oxygen standard is a lowest one-day minimum of 9.5 mg/l. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because these are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. At the mouth site the temperature and dissolved oxygen easily met the water quality standards. At the 103rd site there was one measurement above the maximum temperature criteria of 16 ° C in July of 2010, indicating likely temperature violations. One of five dissolved oxygen measurements fell below the minimum criteria of 9.5 mg/L in June of 2010. There were no dissolved oxygen violations in 2010/11 at the 103rd site.

While there are no water quality standards for nitrate and total phosphorus in surface water, a US EPA study determined that the reference conditions in streams and rivers of the Puget Sound Lowland ecoregion for nitrate+nitrite is 0.26 mg/l and for total phosphorus is 0.019 mg/l (EPA Publication 822-B-00-015). The average nitrate concentrations for Yelm Creek at 103rd are 0.005 and 0.059 mg/l for 2009/10 and 2010/11 respectively, which are below the regional reference condition. However, the average total phosphorus concentrations at the 103rd site are 0.132 and 0.094 mg/l which are above the regional reference condition. In contrast, the mouth site had average nitrate concentrations of 2.49 and 1.94 mg/l, which is about ten times the regional reference condition. The high nitrate condition is a reflection of the groundwater quality in the area. The total phosphorus concentrations at the mouth site essentially met the regional reference condition, with average concentrations of 0.022 and 0.024 mg/l for each water year.

Major Issues:

- Groundwater contamination is resulting in high nitrate concentrations at the mouth site.
- Habitat and flow conditions are poor in the creek in the upper and mid-reaches.

Funding Sources:

- County Storm and Surface Water Utility

Water Quality Summary
Conventional Parameters
Yelm Creek @ end of Mud Run Rd (Mouth)

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 2008 - 2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		8.89 – 13.09 8.32 – 11.83			4.92 – 13.02
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		10.66 – 11.86 10.82 – 12.64	0 of 12 0 of 12		9.99 – 12.7
Conductivity	µmhos/cm		09/10 10/11	133 126	120 - 143 116 - 134		124	57 - 136
pH		6.5 - 8.5	09/10 10/11	7.5* 7.6*	7.2 – 7.7 7.3 – 7.6	0 of 12 0 of 12	7.5*	7.4 – 7.7
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	0.92 0.67	0 – 2.60 0 – 2.10	0 of 12 0 of 12	0.95	0 - 3
Fecal Coliform	colonies/ 100 ml	GMV: ≤50 and ≤ 10% not to exceed 100	09/10 10/11	13** 13**	0 - 350 0 - 45	% exceeding 100	14	0 - 210
						8% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.022 0.024	0.016 – 0.037 0.018 – 0.039		0.023	0.016 – 0.058
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	2.49 1.94	1.90 – 3.01 1.49 – 2.57		2.29	1.88 – 2.8

* Median

** Geometric mean value (GMV)

Note: this site sampled only three times in water year 07/08; July, August & September, 2008

Water Quality Summary
Conventional Parameters
Yelm Creek @ 103rd & Creek St.

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 2008-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		8.56 – 17.71 2.94 – 11.34			0.27 – 20.43
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		8.99 – 10.10 10.61 – 13.83	1 of 5 0 of 6		6.34 – 15.2
Conductivity	µmhos/cm		09/10 10/11	126 97	87 - 165 75 - 111		135	76 - 203
pH		6.5 - 8.5	09/10 10/11	7.2* 7.4*	7.1 – 7.2 7.1 – 7.4	0 of 5 0 of 6	7.2*	6.8 – 7.9
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	0.78 1.47	0 – 2.0 0.30 – 3.0	0 of 5 0 of 6	2.06	0.7 – 7.2
Fecal Coliform	colonies/ 100 ml	GMV: ≤50 and ≤ 10% not to exceed 100	09/10 10/11	58** 29**	15 - 225 10 - 60	% exceeding 100	30	0 - 680
						33% 0%		
Total Phosphorus	mg/L		09/10 10/11	0.132 0.094	0.055 – 0.362 0.057 – 0.141		0.086	0.044 – 0.164
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.005 0.059	All <0.010 <0.010 – 0.159		0.145	<0.010 – 0.601

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

Yelm Creek @ end of Mud Run Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	2:30:00 PM	10.62	7.4	10.82	134	5	0.9	2.52	0.019	2.490	Staff gage - 1.49'
11/17/2009	2:10:00 PM	9.46	7.2	11.29	120	55	1.2	4.18	0.019	1.900	Staff gage - 1.84'
12/16/2009	2:20:00 PM	9.34	7.5	10.84	127	350	2.3	6.53	0.037	1.990	Staff gage - 1.62'
1/11/2010	2:15:00 PM	9.68	7.5	11.35	127	0	2.6	13.24	0.033	2.450	FC reported as <5. Staff gage - 1.78'
2/10/2010	2:10:00 PM	8.89	7.5	11.02	133	5	1.2	15.70	0.020	3.010	Staff gage - 1.85'
3/16/2010	2:15:00 PM	10.30	7.7	11.86	135	15	1.3	16.03	0.016	2.880	Staff gage - 1.83'
4/19/2010	1:30:00 PM	11.75	7.4	10.84	134	15	0.6	15.64	0.019	2.940	Staff gage - 1.86'
5/10/2010	2:00:00 PM	10.89	7.7	10.94	136	25	0.3	12.84	0.018	2.820	Staff gage - 1.80'
6/15/2010	2:00:00 PM	10.86	7.6	11.07	134	65	0.2	11.61	0.025	2.510	Staff gage - 1.79'
7/12/2010	1:45:00 PM	11.82	7.7		134	80	0.3	10.51	0.017	2.450	Staff gage - 1.75'; DO did not post calibrate.
8/16/2010	2:50:00 PM	13.09	7.5	10.87	140	0	0.1	5.15	0.020	2.130	FC reported as <5. Staff gage - 1.61'.
9/13/2010	2:15:00 PM	11.62	7.6	10.66	143	0	0.0	4.00	0.020	2.310	FC reported as <5. Staff gage - 1.55'.

Thurston County Water Resources Monitoring Report 2010-2011

Yelm Creek @ end of Mud Run Rd

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	11:00:00 AM	8.55	7.4	11.86	133	5	0.0	4.60	0.018	1.990	Turb read -0.7. Staff gage - 1.56'.
11/16/2010	10:40:00 AM	9.90	7.4	10.93	133	0	0.0	4.64	0.018	2.050	FC reported as <5. Staff gage - 1.60' Turb read -0.1
12/14/2010	11:35:00 AM	9.06	7.3	11.02	126	40	1.6	10.19	0.039	2.210	Staff gage 2.47'. Deschutes backed up into creek, fish jumping.
1/12/2011	11:00:00 AM	9.16	7.6	11.25	134	5	0.9	13.81	0.030	2.500	Staff gage - 1.84'.
2/16/2011	10:15:00 AM	8.32	7.6	11.95	127	10	0.5	22.59	0.020	2.570	Staff Gage - 1.98'.
3/14/2011	11:00:00 AM	8.98	7.5	12.53	116	10	2.1	34.65	0.028	1.580	Staff gage - 2.14'.
4/11/2011	11:20:00 AM	9.91	7.6	12.64	121	10	0.6	30.94	0.026	1.660	Staff gage - 2.12'.
5/17/2011	10:50:00 AM	10.24	7.6	12.10	116	38	1.2	27.70	0.030	1.490	Duplicates labeled "MudRun". Staff gage - 2.10'.
6/14/2011	11:00:00 AM	10.86	7.5	11.37	124	20	0.3	17.13	0.019	1.830	Staff gage - 1.90'.
7/12/2011	10:30:00 AM	11.39	7.6	10.99	123	10	0.5	12.66	0.019	1.800	Staff gage - 1.78'.
8/8/2011	11:55:00 AM	11.57	7.6	11.15	127	20	0.3	8.53	0.019	1.770	Staff gage - 1.71'. Flow as measured by flowtracker: 8.12cfs.
9/12/2011	2:55:00 PM	11.83	7.5	10.82	126	45	0.0	5.93	0.020	1.870	Turbidity read -0.5. Staff gage - 1.60'.

Thurston County Water Resources Monitoring Report 2009-2010

Yelm Creek @ 103rd and Creek St.

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/20/2009	2:15:00 PM										Stagnant.
11/17/2009	2:00:00 PM										No flow. No samples.
12/16/2009											Stagnant.
1/11/2010	2:00:00 PM										Stagnant/trickle. No samples or flow.
2/10/2010	1:50:00 PM										Trickle. No samples or flow.
3/16/2010	1:15:00 PM	8.56	7.1	10.10	87	15	1.5	0.01	0.062	< 0.005	NOX - < 0.010.
4/19/2010	1:00:00 PM	15.48	7.1	10.02	122	225	0.4	0.04	0.093	< 0.005	Staff gage - 0.78' Nox - <0.010
5/10/2010	1:30:00 PM	12.68	7.2	9.63	127	40	0.0		0.055	< 0.005	Staff gage - 0.79'. No flow measurement: Swoffer not working. NOX - <0.010
6/15/2010	1:10:00 PM	13.77	7.2	8.99	128	25	0.0		0.088	< 0.005	No flow registered on Swoffer though flow was observed. NOX - <0.010
7/12/2010	1:20:00 PM	17.71	7.2		165	170	2.0		0.362	< 0.005	DO did not post calibrate. NOX - <0.010.
8/16/2010											Dry.
9/13/2010	2:00:00 PM										Dry.

Thurston County Water Resources Monitoring Report 2010-2011

Yelm Creek @ 103rd and Creek St.

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/18/2010	11:45:00 AM										Stagnant.
11/16/2010	11:20:00 AM										Stagnant. No samples or flow.
12/14/2010	1:00:00 PM	6.72	7.3	11.32	93	60	1.1	0.02	0.141	< 0.005	NOx <0.010
1/12/2011	11:30:00 AM	2.94	7.4	12.68	108	20	0.4	0.02	0.057	0.159	Flow<0.1, estimate only. Staff gage - 0.78'.
2/16/2011	10:45:00 AM	3.55	7.3	12.62	75	20	3.0	0.15	0.084	0.063	Staff gage - 0.90'.
3/14/2011	11:30:00 AM	7.70	7.4	13.04	103	40	2.0	13.35	0.082	0.117	Staff gage - 1.66'. Measured at bridge, downstream side.
4/11/2011	12:10:00 PM	9.70	7.4	13.83	111	10	0.3	4.90	0.065	< 0.005	Staff gage - 1.44'. Measured at bridge, downstream side. Nox < 0.010.
5/17/2011	11:40:00 AM	11.34	7.1	10.61	94	50	2.0	12.52	0.135	< 0.005	Staff gage - 1.73'. NOx reported as<0.010
6/14/2011	11:55:00 AM										Stagnant.
7/12/2011											Stagnant.
8/8/2011											Stagnant.
9/12/2011	4:00:00 PM										Stagnant.

Totten Watershed

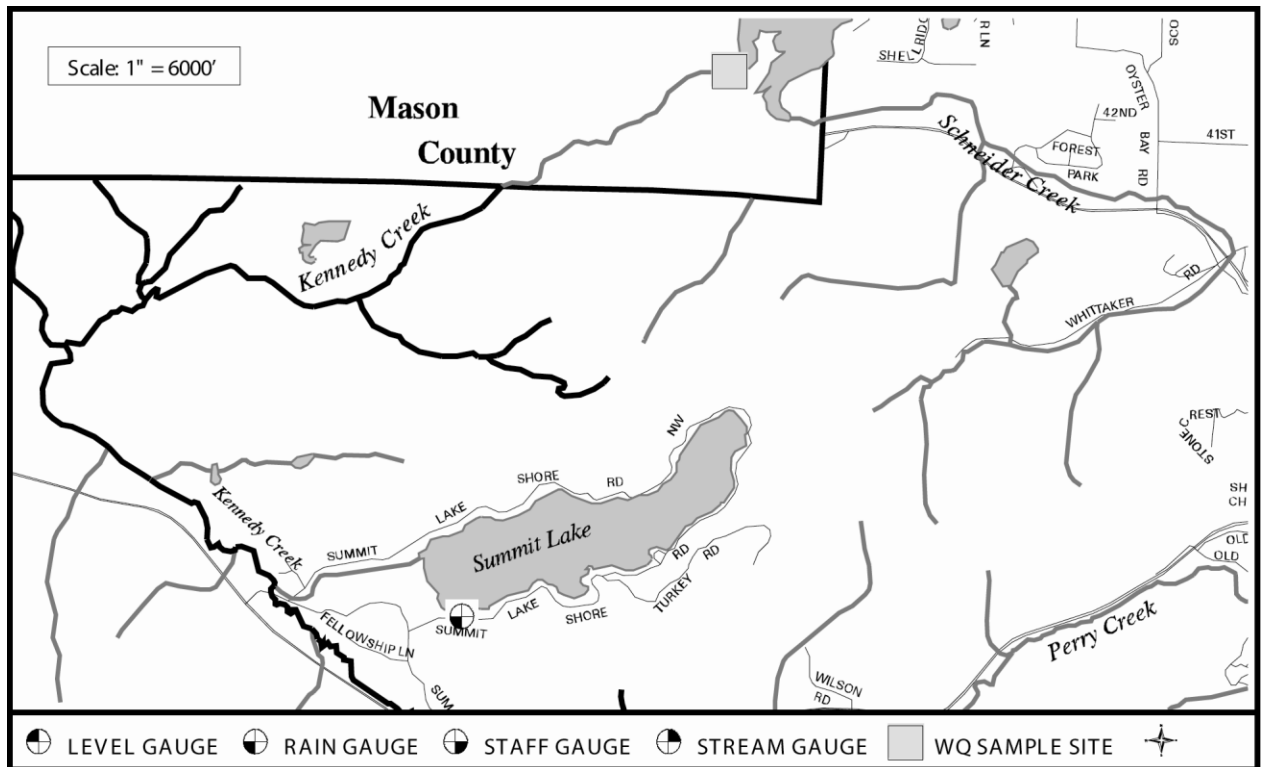
WRIA 13

Chapter Includes:

Kennedy Creek

Schneider Creek (Totten)

Summit Lake



PART OF TOTTEN/LITTLE SKOOKUM WATERSHED

LENGTH OF CREEK: 10 miles

BASIN SIZE: 19 square miles

STREAM ORDER: 3

PRIMARY LAND USES:

Rural residential
Forestry and some farming

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)

Chinook (probable not proven)
Coho, Chum salmon

GENERAL TOPOGRAPHY:

The creek originates in Black Hills; falls gradually to lowlands except for a series of falls, cascades, and log jams 2.5 miles from the mouth. It discharges into the head of Totten Inlet.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Good – Met part 1 and failed part 2 of the fecal coliform water quality standard both water years. Occasional dissolved oxygen violations during summer low flow period. Turbidity exceeded the standard during periods of high flow in December 2009 & 2010 and March 2011.

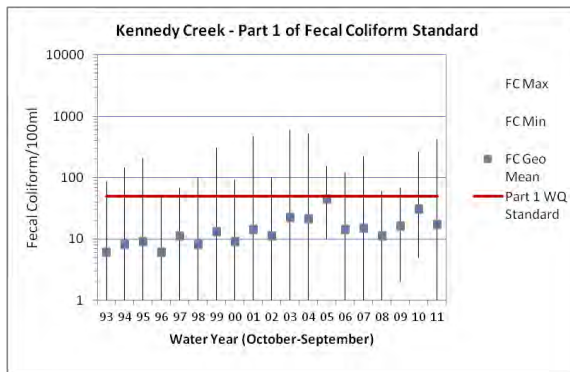
OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

Thurston County Resource Stewardship Department, Water Resources Program (360) 754-4681 or www.co.thurston.wa.us/monitoring

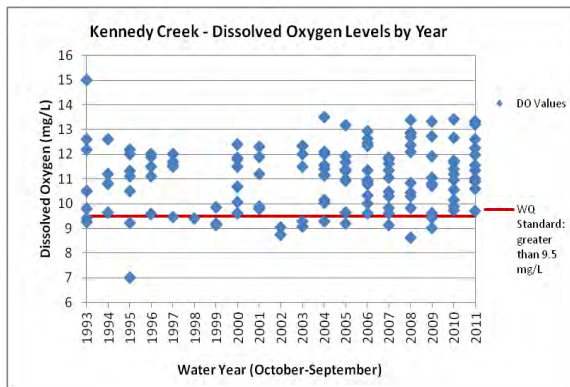
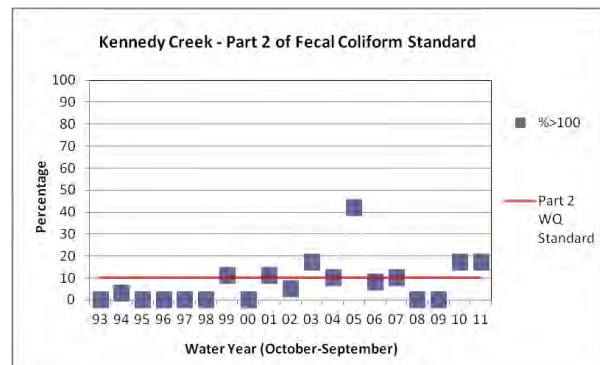
Washington Department of Ecology, Environmental Assessment Program, National Monitoring Program Project, Intensive wet season data between 1992 and 2002, (360) 407-6000.

Kennedy Creek #0012



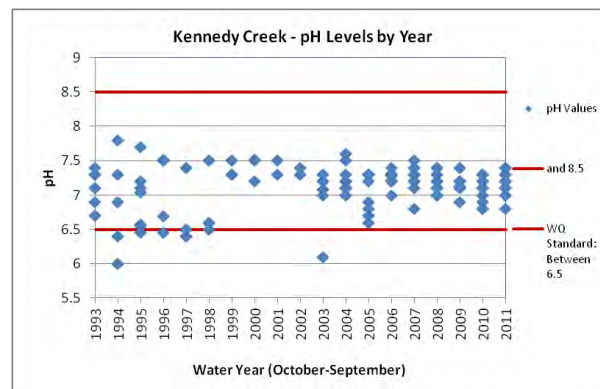
In the past, the water quality of this stream has been excellent with the exception of water year 2004/05 when the geometric mean was the highest on record and 43% of the samples exceeded 100 fecal coliform colonies/100 mL. For both water years 2009/10 and 2010/11, the creek met part 1 and failed part 2 of the standard.

The water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 50 colonies/100mL *and* Part 2 - no more than 10% of the samples shall exceed 100 colonies/100 mL.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. The DO has frequently fallen below the standard during summer low-flow periods. There have been no violations of the standard in the last two water years.

The water quality standard for pH requires the pH to be within the range of 6.5 to 8.5. In the past, there have been measurements below the standard. However, the pH standard has been consistently met since 2004.



Discussion:

Kennedy Creek has been monitored by the County since 1984 when the first water quality study was conducted in the Totten Inlet watershed. A ten-year national monitoring project designed to document water quality change as a result of implementing best management practices was completed by the Washington Department of Ecology in 2002. The total maximum daily load “Water Quality Implementation Plan” for tributaries to Totten, Eld and Little Skookum Inlets, completed in November 2007, identifies fecal coliform bacteria concentrations in Kennedy Creek during the late summer (August and September) period as a problem. The plan includes recommended actions to reduce the bacteria load.

While there is no water quality standard for nitrate in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015). The average nitrate concentration for Kennedy Creek is roughly two times the regional reference condition, with an average of 0.566 mg/l. The total phosphorus regional reference condition is 0.019 mg/l, according to the EPA report. Kennedy Creek is slightly above the reference condition with an average total phosphorus concentration of 0.026 mg/l.

The temperature standard that applies in Kennedy Creek is intended to protect core summer salmonid habitat, and is a 7-day average daily maximum of 16 ° C. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. The temperature measurements were all below the maximum temperature criteria of 16 ° C.

Thurston County intends to continue long-term ambient monitoring of this creek.

Major Issues:

- A Washington Department of Ecology total maximum daily load study determined that fecal coliform bacteria levels during the late summer season in Kennedy Creek need to be reduced to ensure compliance with part 2 of the water quality standard. Investigation for potential sources was conducted in 2006 and 2007. A water quality implementation plan was completed in November 2007, and includes recommended actions for Kennedy Creek.
- The chum salmon run in Kennedy Creek continues to be a valued local resource. Various private and public entities worked together to build salmon spawning viewing areas for the public along a lower portion of the creek.

Funding Sources:

- County storm and surface water utility

Water Quality Summary

Conventional Parameters

Kennedy Creek

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 and 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		3.48 – 15.08 4.35 – 14.70			1.09 - 17.53
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		9.73 – 13.42 9.70 – 13.33	0 of 11 0 of 12		7 – 13.5
Conductivity	µmhos/cm		09/10 10/11	72 68	56 - 97 39 - 99		70	37 – 202
pH		6.5 - 8.5	09/10 10/11	7.1* 7.2*	6.8 – 7.3 7.0 – 7.4	0 of 12 0 of 12	7.2*	6 - 7.8
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	3.17 5.89	0.10 – 15.8 0 – 38.8	1 of 12 2 of 12	4.45	0 – 120
Fecal Coliform	colonies/ 100 mL	GMV: ≤50 and ≤ 10% not to exceed 100	09/10 10/11	31** 18**	5 – 260 0 - 420	% exceeding 100	12**	0 – 605
						17% 17%		
Total Phosphorus	mg/L		09/10 10/11	0.017 0.028	0.009 - 0.039 0.010 – 0.106		0.026	0.006 - 0.23
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.499 0.528	0.333 – 0.778 0.373 – 0.905		0.566	0.185 - 1.57

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

Kennedy Creek @ Old Olympic Hwy

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009	10:00:00 AM	11.08	7.1	10.16	69	5	1.7	8.37	0.012	0.424	Borrowed YSI display. YSI #1 sonde
11/16/2009	10:00:00 AM	8.72	6.8	11.20	66	30	8.0		0.039	0.778	No flow measurement. Fish present.
12/15/2009	9:40:00 AM	3.48	7.1	13.42	65	260	15.8	95.76	0.035	0.568	Cross section at RB angle post about 1000 yards upstream of bridge.
1/12/2010	3:45:00 PM	8.33	6.9	11.74	56	20	5.1		0.021	0.507	No flow measurement: too deep to wade.
2/8/2010	9:45:00 AM	7.07	6.8	11.69	66	10	1.7	66.19	0.012	0.517	
3/17/2010	9:45:00 AM	6.83	7.1	12.67	62	25	2.1	77.19	0.013	0.515	
4/20/2010	3:05:00 PM	10.74	7.0		69	10	0.5	40.85	0.013	0.572	Failed to record DO.
5/11/2010	9:20:00 AM	9.17	7.3	11.41	69	8	1.8	39.95	0.012	0.500	Duplicates labeled "Dunlin".
6/14/2010	9:45:00 AM	11.04	7.3	10.95	70	35	0.2	41.55	0.010	0.474	Sampled under bridge.
7/13/2010	9:25:00 AM	13.24	7.3	10.57	84	80	0.1	14.61	0.009	0.430	
8/17/2010	10:00:00 AM	15.08	7.2	9.73	94	65	0.5	7.32	0.014	0.371	
9/14/2010	9:45:00 AM	12.58	7.2	9.88	97	160	0.5	6.06	0.010	0.333	

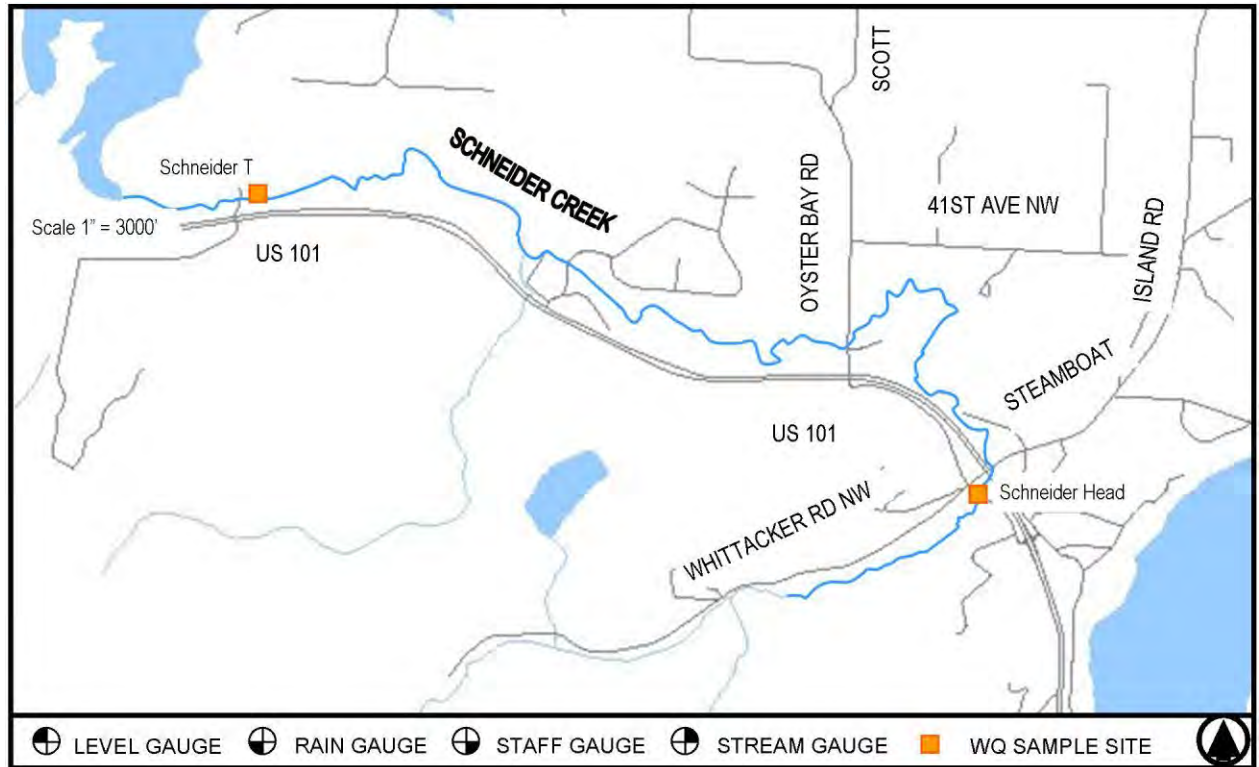
Thurston County Water Resources Monitoring Report 2010-2011

Kennedy Creek @ Old Olympic Hwy

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	3:35:00 PM	9.79	7.3	11.34	77	5	0.8	28.15	0.026	0.373	
11/17/2010	1:00:00 PM	9.02	7.1	10.89	39	420	4.9	88.45	0.054	0.538	
12/13/2010	9:30:00 AM	8.59	7.0	12.25	50	5	38.8		0.106	0.905	Too deep to measure flow.
1/11/2011	12:20:00 PM	4.35	7.2	13.20	63	0	1.8	79.82	0.013	0.657	FC reported as <5.
2/14/2011	10:00:00 AM	7.00	7.0	11.99	60	55	7.6	115.79	0.023	0.616	
3/16/2011	1:45:00 PM	6.88	7.1	13.33	51	5	10.0		0.023	0.514	No flow measurement, too deep to wade. Staff gage - 2.72'.
4/12/2011	9:50:00 AM	6.14	7.2	13.32	59	5	2.3	125.41	0.012	0.457	
5/16/2011	10:20:00 AM	9.39	7.2	12.62	60	20	3.7	106.92	0.019	0.478	
6/13/2011	2:45:00 PM	14.10	7.3	10.91	79	10	0.0	20.97	0.010	0.460	
7/11/2011	1:50:00 PM	14.70	7.4	10.61	89	45	0.4	11.05	0.013	0.440	Duplicates labeled "Olympic".
8/9/2011	1:30:00 PM	14.20	7.4	11.02	95	20	0.1	8.26	0.014	0.445	
9/14/2011	9:15:00 AM	13.36	7.1	9.70	99	160	0.3	4.87	0.017	0.447	

Schneider Creek #0009

(In Totten/Little Skookum Inlet Watershed)



PART OF TOTTEN/LITTLE SKOOKUM WATERSHED

LENGTH OF CREEK: 5.3 miles

BASIN SIZE: 4,738 Acres

STREAM ORDER: 3

PRIMARY LAND USES:

Rural residential
Agriculture
Forestry

FISHERIES RESOURCES: (From A Catalog of Washington Streams and Salmon Utilization, WDOF)

Coho, Chum salmon

GENERAL TOPOGRAPHY:

The stream originates on Schneider Prairie and flows through generally flat and level

pastures and forest land. The stream gradient is gentle throughout its length.

WASHINGTON D.O.E. WATER QUALITY CLASSIFICATION: Class AA

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Good – Often fails Part 2 of the fecal coliform standard. There are summer dissolved oxygen violations. There were turbidity violations in November & December 2010. Other parameters are usually within standards.

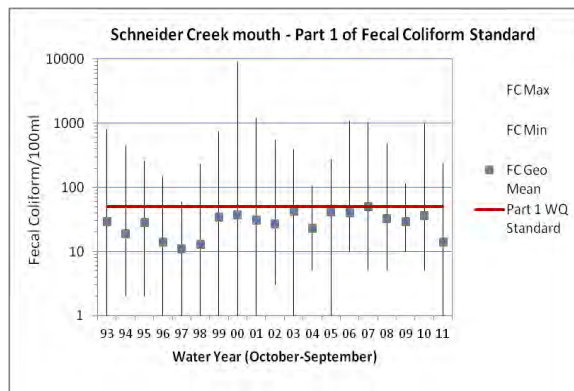
OTHER DATA:

Thurston County Environmental Health Division, (360) 867-2626 or www.co.thurston.wa.us/health/ehswat/swater.html

Washington Department of Ecology, Environmental Assessment Program, National Monitoring Program Project, Intensive wet season data between 1992 and 2002, (360) 407-6000.

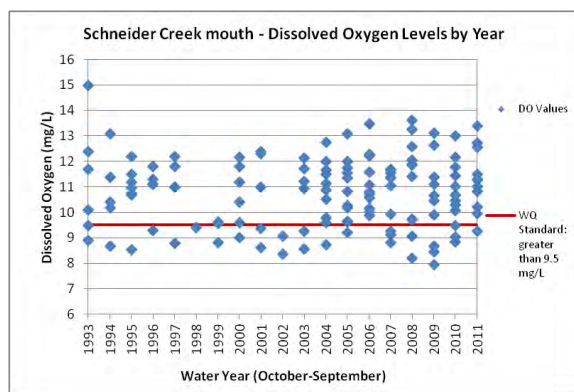
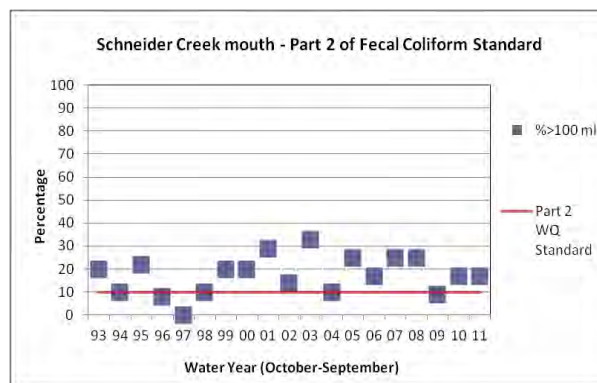
Schneider Creek #0009 (In Totten/Little Skookum Inlet Watershed)

Schneider Creek off Hwy 101 (mouth)



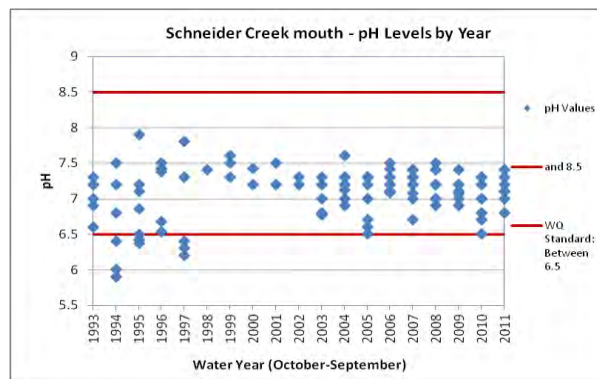
The water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 50 colonies/100mL and Part 2, no more than 10% of the samples shall exceed 100 colonies/100 mL.

Part 1 of the standard has been met since 1993 at Schneider Creek mouth, but Part 2 of the standard has been violated in several of the water years on record including 2009/10 and 2010/11.



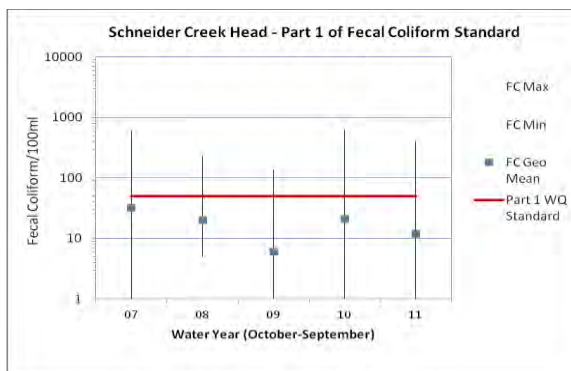
The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. Over the period of record, the dissolved oxygen standard is often below the water quality standard during the summer low flow period.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been no violations since 1997.



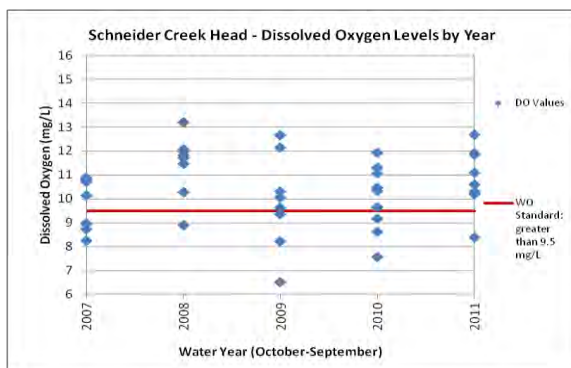
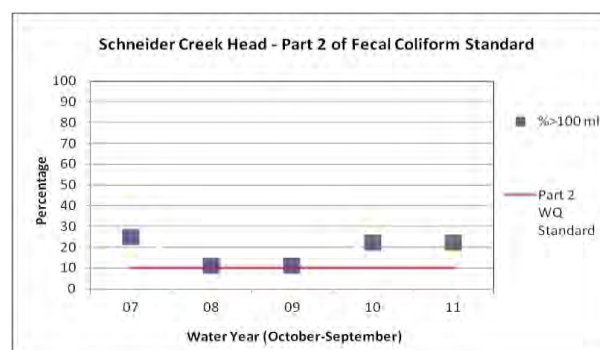
Schneider Creek #0009 (In Totten/Little Skookum Inlet Watershed)

Schneider Creek at Steamboat Interchange (head)



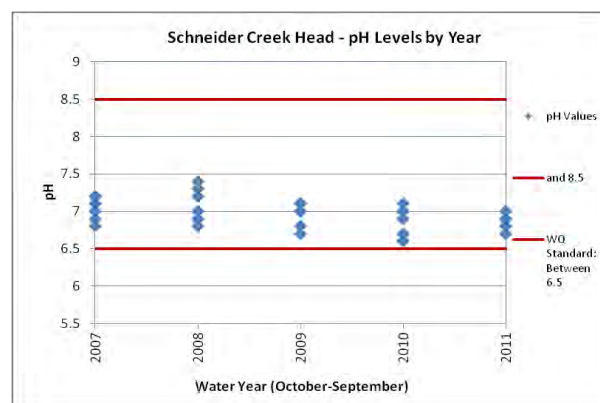
The water quality standard for fecal coliform has two parts: Part 1 - the geometric mean shall not exceed 50 colonies/100mL *and* Part 2, no more than 10% of the samples shall exceed 100 colonies/100 mL.

Part 1 of the standard has been met at Schneider Creek Head since monitoring began in 2007, but Part 2 of the standard has been violated every year on record.



The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. Over the period of record, the dissolved oxygen standard is often below the water quality standard.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. There have been no violations over the period of record at the Schneider Creek Head monitoring site.



Discussion:

Schneider Creek has been monitored by the County since 1985 when the first water quality study was conducted in the watershed. A ten-year national monitoring project designed to document water quality change as a result of implementing best management practices was completed by the Washington Department of Ecology in 2002. There is currently a total maximum daily load study which recommends actions to improve water quality. Schneider Creek has consistently met Part 1 of the fecal coliform standard but fails Part 2 in most years. There are violations of the dissolved oxygen standard during the low flow summer months.

In December 2006, monitoring began at a second site on Schneider Creek. This site is located where the creek flows into a culvert on the south side of the Steamboat Island Rd. Hwy 101 interchange. This site discharges from a wetland complex, and typically stops flowing during the summer. The data is summarized on the table entitled *Schneider Creek Head*. This site failed Part 2 of the fecal coliform standard for both water years with one sample exceeding the 100 fecal coliform threshold. Dissolved oxygen fell below the standard three times out of nine measurements in 2009/10 and one of nine in 2010/11.

While there is no water quality standard for nitrate in surface water, a US EPA study determined that the reference condition for nitrate+nitrite concentrations in streams and rivers of the Puget Sound Lowland ecoregion is 0.26 mg/l (EPA Publication 822-B-00-015). The average nitrate concentration for Schneider Creek is below the regional reference condition. The total phosphorus regional reference condition is 0.019 mg/l, according to the EPA report. The Schneider Creek average total phosphorus concentration at the mouth site is 0.032 mg/l, which is above the reference condition.

The temperature standard that applies in Schneider Creek is intended to protect core summer salmonid habitat, and is a 7-day average daily maximum of 16° C. The temperature data collected through this ambient monitoring program are instantaneous measurements. Because there are not continuous temperature recordings from which the 7-day average daily maximum can be calculated, the instantaneous data can only be used as an indicator of possible temperature violations. The temperature measurements were all below the maximum temperature criteria of 16° C.

Thurston County intends to continue long-term ambient monitoring of this creek.

Major Issues:

- The creek has the potential to be impacted by animal keeping practices, logging practices and stream-side development.

Funding Sources:

- County Storm and Surface Water Utility

Water Quality Summary

Conventional Parameters

Schneider Creek Mouth (in Totten/Little Skookum Inlet Watershed)

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 1993-2009	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	°C	Highest 7-DAD Max of 16°C	09/10 10/11		1.91 – 15.36 3.24 – 14.35			1.5 – 18.15
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		8.85 – 13.01 9.26 – 13.40	3 of 12 1 of 12		7.96 – 15
Conductivity	µmhos/cm		09/10 10/11	85 83	58 - 116 52 - 112		78	37 – 169
pH		6.5 - 8.5	09/10 10/11	7.0* 7.1*	6.5 – 7.3 6.8 – 7.4	0 of 12 0 of 12	7.2*	5.9 – 7.9
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	3.09 5.84	0.80 – 9.40 0.20 - 28	0 of 12 2 of 12	5.87	0.3 - 100
Fecal Coliform	colonies/ 100 mL	GMV: ≤50 and ≤ 10% not to exceed 100	09/10 10/11	36** 14**	5 - 1000 0 - 240	% exceeding 100	27**	0 – 9100
						25% 17%		
Total Phosphorus	mg/L		09/10 10/11	0.027 0.043	0.018 – 0.047 0.019 – 0.142		0.032	0.010 - 0.134
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.153 0.190	0.025 – 0.262 0.099 – 0.381		0.202	0.015 - 0.781

* Median

** Geometric mean value (GMV)

Water Quality Summary

Conventional Parameters

Schneider Creek Head (in Totten/Little Skookum Inlet Watershed)

Parameter	Units	WQ Standard WAC 173-201A	Water Year Data: 2009/10 & 2010/11				Cumulative Data: 2006/09	
			Water Year	Mean	Range	# samples violating standard	Mean	Range
Temperature	° C	Highest 7-DAD Max of 16 ° C	09/10 10/11		2.01 – 15.99 2.68 – 15.04			2.33 – 15.82
Dissolved Oxygen	mg/L	Lowest one-day minimum of 9.5	09/10 10/11		7.58 – 11.93 8.39 – 12.69	3 of 9 1 of 9		6.53 – 13.2
Conductivity	µmhos/cm		09/10 10/11	74 66	53 - 116 49 - 93		88	52 - 163
pH		6.5 - 8.5	09/10 10/11	6.7* 6.9*	6.6 – 7.1 6.7 – 7.0	0 of 9 0 of 9	7.0*	6.7 – 7.4
Turbidity	NTU	not to exceed 5 NTU over background	09/10 10/11	2.76 2.68	0.70 – 7.60 0.90 – 5.30	0 of 9 0 of 9	4.49	0.2 - 13
Fecal Coliform	colonies / 100 ml	GMV: ≤50 and ≤ 10% not to exceed 100	09/10 10/11	21** 12**	0 - 620 0 - 410	% exceeding 100	16**	0 - 605
						22% 22%		
Total Phosphorus	mg/L		09/10 10/11	0.020 0.018	0.013 – 0.033 0.008 – 0.030		0.019	0.008 – 0.036
Nitrate+Nitrite- nitrogen	mg/L		09/10 10/11	0.035 0.075	<0.010 – 0.057 <0.010 – 0.299		0.056	<0.010 – 0.142

* Median

** Geometric mean value (GMV)

Thurston County Water Resources Monitoring Report 2009-2010

Schneider Creek @ Pneumonia gulch off 101

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009	9:45:00 AM	11.05	7.0	8.85	116	5	1.1	1.46	0.022	0.025	Borrowed YSI display. YSI #1 sonde
11/16/2009	9:40:00 AM	7.74	6.8	11.45	74	5	9.4	16.13	0.047	0.159	Fish.
12/15/2009	9:15:00 AM	1.91	6.5	13.01	88	340	7.8	23.41	0.047	0.262	Cross section at split alder by trampoline
1/12/2010	3:00:00 PM	8.42	6.7	11.03	58	20	7.3	58.77	0.031	0.189	
2/8/2010	9:15:00 AM	7.29	6.7	11.77	74	10	1.9	16.66	0.019	0.192	
3/17/2010	9:20:00 AM	7.18	7.0	12.16	70	25	2.1	19.79	0.018	0.140	
4/20/2010	2:40:00 PM	11.88	7.0	10.48	81	10	1.6	10.64	0.024	0.178	
5/11/2010	9:00:00 AM	9.63	7.2	10.69	85	20	1.9	7.11	0.022	0.136	
6/14/2010	9:15:00 AM	11.65	7.3	10.30	87	40	1.1	7.06	0.023	0.134	
7/13/2010	9:00:00 AM	13.40	7.3	10.08	103	1000	0.8	2.37	0.024	0.178	
8/17/2010	9:35:00 AM	15.36	7.3	9.05	109	90	1.2	1.28	0.031	0.149	
9/14/2010	9:20:00 AM	12.65	7.3	9.48	75	70	0.9	1.16	0.021	0.098	

Thurston County Water Resources Monitoring Report 2010-2011

Schneider Creek @ Pneumonia gulch off 101

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	3:20:00 PM	8.58	7.3	11.50	104	20	0.2	2.89	0.026	0.099	
11/17/2010	12:30:00 PM	8.60	7.1	11.04	75	240	13.1	19.17	0.085	0.189	
12/13/2010	9:15:00 AM	8.49	6.8	11.31	52	0	28.0		0.142	0.381	FC reported as <5. Very turbid. Too deep to measure flow.
1/11/2011	12:00:00 PM	3.24	7.1	13.40	75	5	2.0	15.07	0.019	0.310	
2/14/2011	9:30:00 AM	6.72	6.8	11.55	72	10	8.4	27.44	0.037	0.220	
3/16/2011	1:30:00 PM	7.42	7.0	12.56	53	0	9.9	88.14	0.026	0.200	FC reported as <5.
4/12/2011	9:20:00 AM	6.69	7.1	12.73	69	0	2.0	23.72	0.020	0.138	FC reported as <5.
5/16/2011	10:00:00 AM	10.51	7.0	11.28	71	160	4.8	32.82	0.025	0.105	
6/13/2011	2:30:00 PM	13.52	7.2	10.82	96	22	0.4	4.04	0.026	0.198	Duplicates labeled "Gulch".
7/11/2011	1:45:00 PM	14.35	7.4	9.97	105	10	0.4	1.83	0.031	0.170	
8/9/2011	1:10:00 PM	13.82	7.4	10.23	107	45	0.5	1.48	0.039	0.151	
9/14/2011	8:30:00 AM	13.81	7.1	9.26	112	100	0.4	0.88	0.034	0.124	

Thurston County Water Resources Monitoring Report 2009-2010

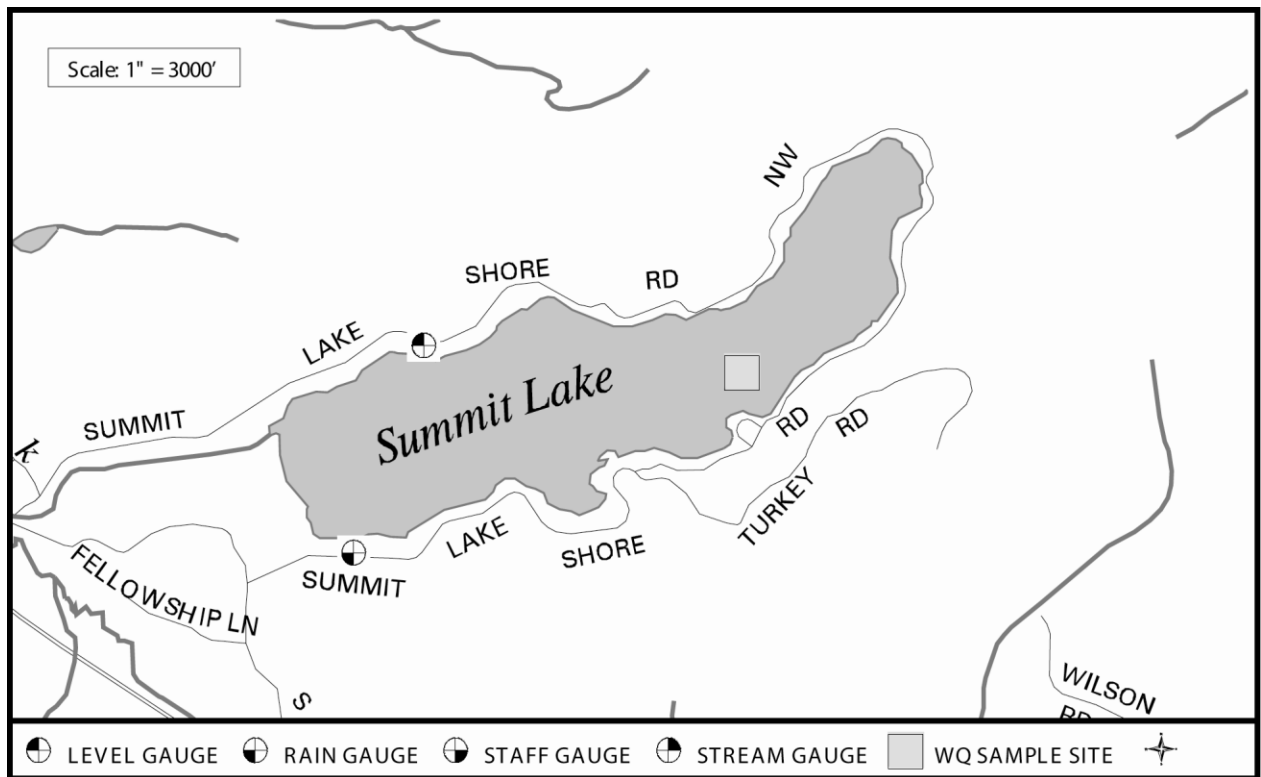
Schneider Creek Upstream of Steamboat Interchange

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2009											Stagnant.
11/16/2009	10:15:00 AM	7.34	6.6	11.07	60	30	6.0		0.030	0.054	
12/15/2009	10:30:00 AM	2.01	6.7	11.93	75	510	2.6		0.022	0.047	
1/12/2010	4:00:00 PM	8.44	6.6	10.34	53	10	2.2		0.013	0.054	
2/8/2010	10:15:00 AM	7.03	6.6	10.48	66	0	0.9		0.013	0.055	FC reported as <5.
3/17/2010	10:20:00 AM	7.18	6.7	11.32	61	5	1.4		0.013	0.057	Flowing well.
4/20/2010	3:45:00 PM	13.17	6.9	9.17	72	5	0.9		0.021	0.017	
5/11/2010	9:55:00 AM	11.33	7.0	9.67	79	15	2.5		0.022	0.019	
6/14/2010	10:15:00 AM	13.98	7.1	8.64	83	10	0.7		0.017	< 0.005	Flowing well. NOx <0.010
7/13/2010	9:55:00 AM	15.99	7.0	7.58	116	620	7.6		0.033	< 0.005	Still flowing fairly well. NOx <0.010.
8/17/2010	10:25:00 AM										Trickle only. No sample.
9/14/2010	9:30:00 AM										Did not sample.

Thurston County Water Resources Monitoring Report 2010-2011

Schneider Creek Upstream of Steamboat Interchange

<i>Date</i>	<i>Time</i>	<i>Temp C</i>	<i>pH</i>	<i>DO mg/L</i>	<i>Cond @25c umhos/cm</i>	<i>FC cfu/100mL</i>	<i>Turb NTU</i>	<i>Flow cfs</i>	<i>TP mg/L</i>	<i>NOx mg/L</i>	<i>COMMENTS</i>
10/19/2010	4:05:00 PM	8.22	6.9	10.61	93	0	1.6		0.020	< 0.005	Too shallow for flow measurement. FC reported as <5. NOx <0.010
11/17/2010	1:30:00 PM	8.50	6.8	10.28	67	190	2.6		0.021	0.017	
12/13/2010	9:45:00 AM	8.48	6.7	10.21	50	5	5.3		0.019	0.299	The stormwater pond is overflowing into the creek just above the culvert.
1/11/2011	12:50:00 PM	2.68	6.9	12.69	50	10	0.9		0.010	0.102	
2/14/2011	10:30:00 AM	6.38	6.9	11.10	68	0	2.6		0.016	0.050	FC reported as <5.
3/16/2011	2:00:00 PM	7.76	6.9	11.90	49	5	1.6		0.008	0.114	
4/12/2011	10:30:00 AM	7.63	7.0	11.86	60	5	1.0		0.012	0.021	
5/16/2011	10:50:00 AM	11.57	6.8	10.31	67	20	4.6		0.030	0.021	
6/13/2011	3:15:00 PM	15.04	6.9	8.39	93	410	3.9		0.027	0.043	Flowing, slightly cloudy.
7/11/2011											Stagnant.
8/9/2011											Stagnant.
9/14/2011	10:00:00 AM										Stagnant.



PART OF TOTTEN INLET WATERSHED

LENGTH OF LAKE: 2.2 miles

SHORELINE LENGTH: 5.6 miles

LAKE SIZE: 530 acres

BASIN SIZE: 2.8 square miles

MEAN DEPTH: 53 feet

MAXIMUM DEPTH: 100 feet

VOLUME: 28,000 acre-feet

PRIMARY LAND USES:

The majority of the basin is commercial forest with dense development concentrated along the shoreline. There are approximately 400 homes along the shoreline.

PRIMARY LAKE USE:

Domestic water supply, fishing, boating, swimming, and other water sports.

PUBLIC ACCESS:

Washington Department of Fish and Wildlife public boat launch; three small private community accesses; 126-acre boy scout camp at the west end of the lake.

GENERAL TOPOGRAPHY:

The approximate altitude of the lake is 460 feet. The drainage is steep and rugged with slopes up to 80 percent. There are numerous springs and intermittent streams that flow into the lake. The outlet, at the west end of the lake, is controlled by flash boards and flows into Kennedy Creek.

GENERAL WATER QUALITY: (Excellent, Good, Fair, Poor)

Excellent - The lake has low nutrient and chlorophyll *a* levels and good water clarity. Good water quality is important because the lake is used as a drinking water source for most of the lake residents. Uses are not impeded by aquatic weeds or algal growth.

OTHER DATA:

Thurston County Resource Stewardship Department, Water Resources Program;
(360) 754-4681; www.co.thurston.wa.us/monitoring

Washington Department of Ecology, Environmental Assessment Program, (water quality data);
(360) 407-6700

Water quality data - Thurston County Environmental Health Division;
(360) 867-2626; www.co.thurston.wa.us/health/ehswat/swater.htm

GENERAL DISCUSSION:

Summit Lake is one of the deepest lakes in Thurston County, with a maximum depth of 30 meters (100 feet). In 2011 the ambient monitoring consisted of monthly sampling, May through October, at one monitoring site located at deepest area of the lake. Temperature, dissolved oxygen, pH, and conductivity were measured at 2-meter increments from the lake surface to the bottom. Water clarity was measured using a standard secchi disk. Water samples were collected near the lake surface and near the bottom, and analyzed for total phosphorus and total nitrogen. Composite samples from the epilimnion (warm surface layer), or photic zone, were collected and analyzed for chlorophyll *a* and algae types present.

Field Parameters

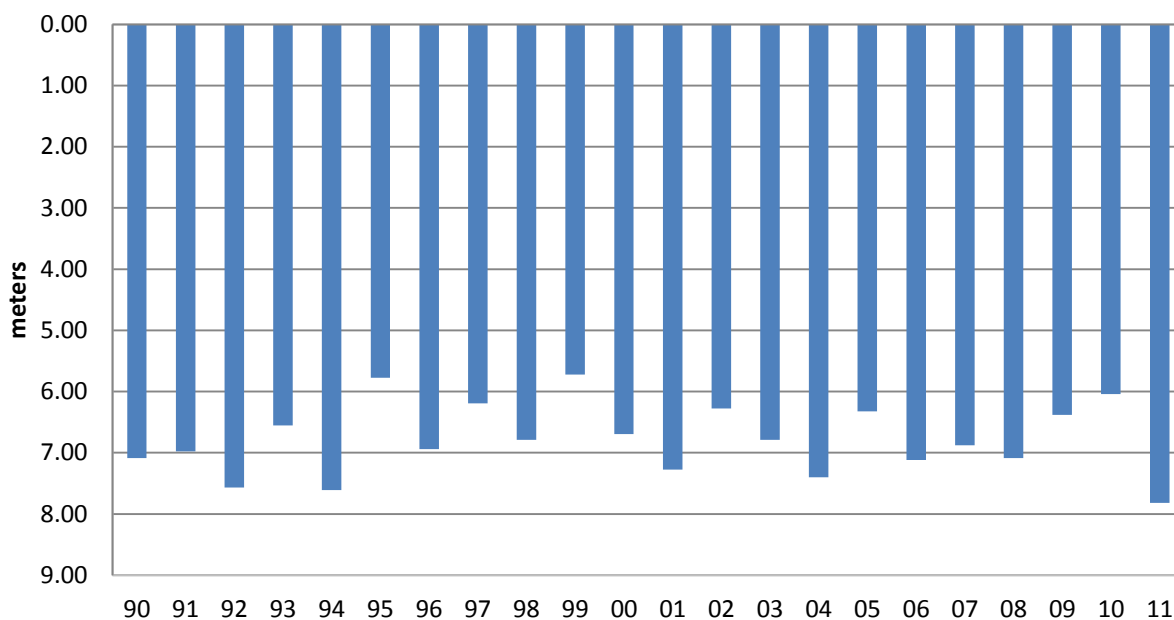
Monthly graphs of the temperature, dissolved oxygen, pH, and conductivity profiles are shown on page 7 of this chapter. The term “thermal stratification” refers to a condition in the lake when there are two distinct layers of water in the lake, a warm upper layer and a cold bottom layer. Summit Lake strongly stratifies in the summer, as can be seen in the profile graphs. In May 2011 the lake was already stratified, with the temperature in the upper water at 14 degrees Celsius and the bottom temperature at 8 degrees Celsius. By August the surface layer had warmed to 21 degrees C, and was about 8 meters deep. However, the temperature at the bottom remained cold, at about 9 degrees C.

During periods when the lake is thermally stratified, there is no exchange of oxygen from the atmosphere into the bottom waters. During that time, bacterial decomposition of material in the lake water and sediment, such as aquatic plants, algae, and other organic matter, depletes the available dissolved oxygen in the bottom waters. In 2012 the oxygen at the bottom had nearly been depleted by July and lasted throughout the sampling season, as can be seen in the profile graphs. Anoxic conditions cause phosphorus from the sediments to be released into the water near the lake bottom. The 2011 samples results on page 8 show the higher concentrations of phosphorus in the bottom samples than in the surface samples during the anoxic periods. When the lake mixes in late fall or early winter and the phosphorus from the bottom is mixed up into sunlight zone near the surface, it can stimulate algae growth in the lake at that time.

Secchi Disk Water Clarity

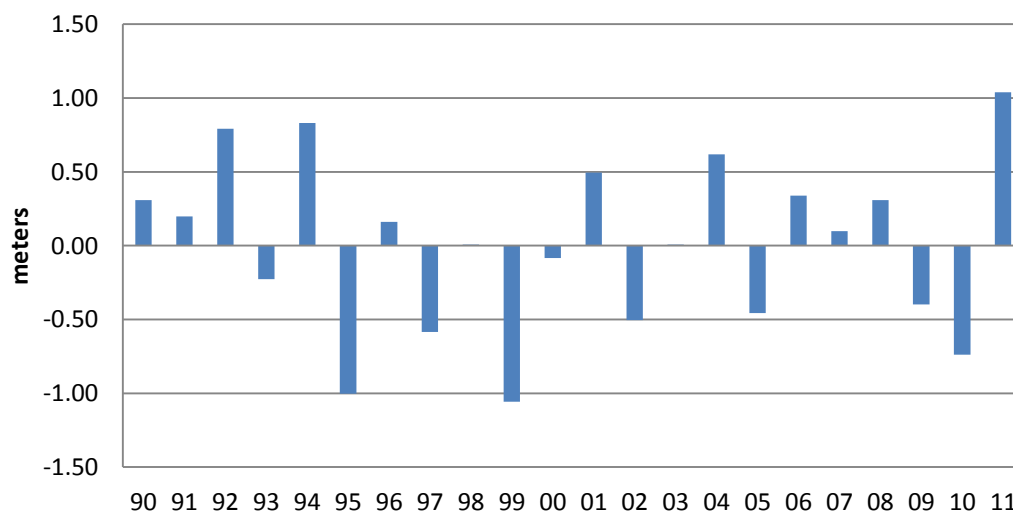
Water clarity in a lake is measured with a device called a secchi disk. Summit Lake is one of the clearest lakes in Thurston County. The average water clarity for the 2011 season was 7.8 meters (25.6 feet), which was the clearest on record. The water clarity ranged from 5.7 meters in October to 8.6 meters in August (18.6 to 28 feet). The graph on the next page shows the annual averages for water clarity over the past 22 years.

Summit Lake Water Clarity Average Secchi Readings



Water clarity trends can more easily be seen on the trend graph below. The graph shows the difference between each year's average secchi reading and the long-term average for the entire period of record. When the bar is above the "0" line, it indicates that the average water clarity for that year was better than the long-term average. A bar below the "0" line indicates that the water clarity for that year was poorer than the long-term average. Graphing the water clarity data in this way helps to show trends in water quality versus normal yearly fluctuations. For Summit Lake, there is no obvious upward or downward trend in water clarity, just variation plus or minus one meter around the long-term average.

Water Clarity Trend Annual Average Minus Long-Term Average



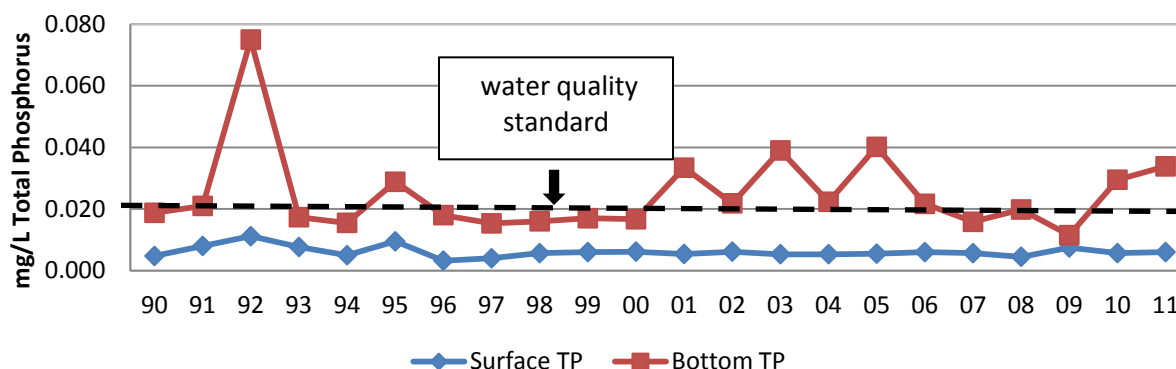
Total Phosphorus and Nitrogen

Generally, lakes in the Puget Sound region with summer average surface total phosphorus concentrations greater than 0.030 mg/l experience undesirable algae growth which interferes with recreational uses of the lake (USGS Water Supply Paper 2240). The action level established in WAC 173-201A, "Water Quality Standards for Surface Water of the State of Washington" is 0.020 mg/l.

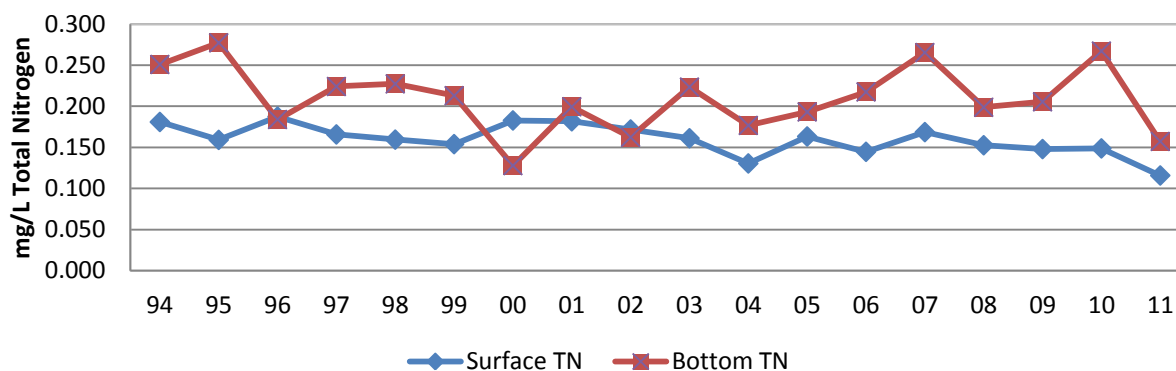
In 2011 the average surface total phosphorus (TP) concentration was 0.006 milligrams per liter (mg/l). The total phosphorus concentration at the surface ranged from 0.002 to 0.010 mg/l, which is well below the state action level. In Summit Lake, as with most freshwater lakes, algae production is limited by the amount of available phosphorus. Overall Summit Lake is low in nutrients, both phosphorus and nitrogen, and as a result has low algae and aquatic plant production.

Below are graphs of the annual average total phosphorus and total nitrogen concentrations at the lake surface and bottom for the period of record.

Total Phosphorus Annual Averages



Total Nitrogen Annual Averages

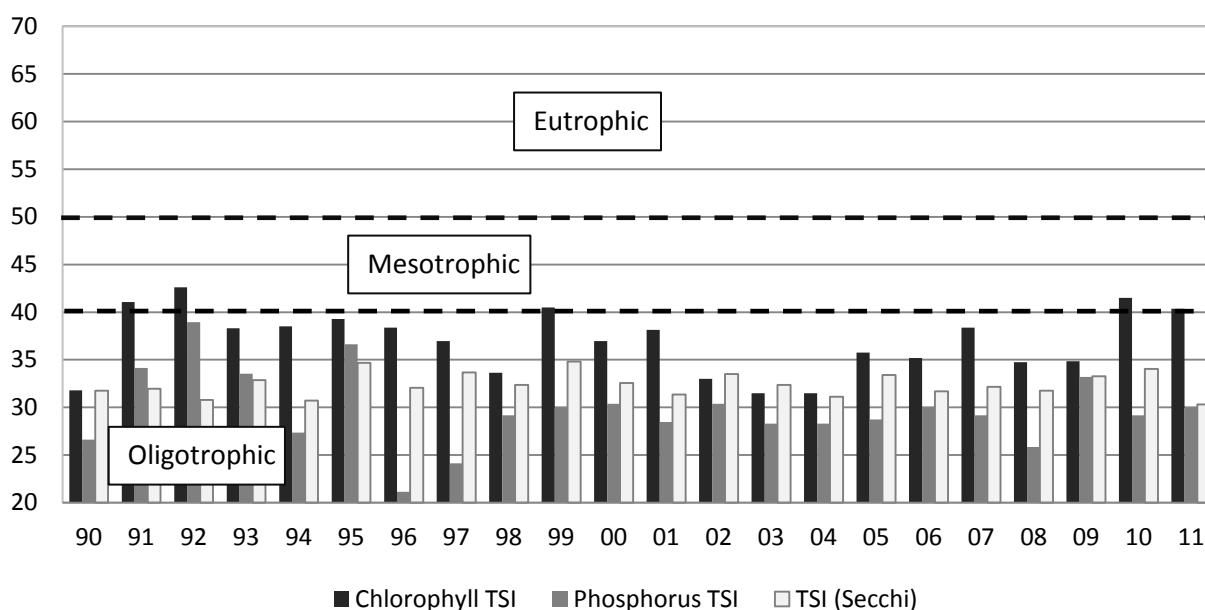


Trophic State Indices

The Carlson trophic state indices (TSI) are used to express the degree of productivity of a lake. Average summer total phosphorus, chlorophyll *a*, and secchi disk readings are each used to calculate TSIs for the lake. A TSI of 0 to 40 indicates an oligotrophic, or low productivity, lake. A TSI of 41 to 50 indicates a mesotrophic, or moderately productive, lake. A TSI of greater than 50 indicates a eutrophic, or highly productive lake.

Summit Lake is an oligotrophic, or low productivity, lake. The Summit Lake TSI's for total phosphorus, chlorophyll *a*, and secchi disk for 2011 are 30, 40, and 30, respectively. The trophic state indices graphed below show that the lake is generally within the oligotrophic range for all three parameters. An oligotrophic lake, such as Summit Lake, is characterized by low nutrient levels, low algae growth, and good water clarity. Because this lake is clear and low in algae and aquatic plant growth, it is popular with recreational users. It is also used as a domestic water source for the majority of residences around the lakeshore due to the absence of an adequate ground water supply.

Summit Lake Trophic State Indices



Algae

The monitoring program includes identification of algae types present in the lake. The 2011 data can be found at the end of this chapter. There are a variety of algae types present in Summit Lake including diatoms, green, yellow, and blue-green. Blue-green algae species are most common in nutrient-rich lakes and are known to cause visible algae “blooms”. They are present in this lake but are rarely dominant. To date, only relatively minor and localized blue-green algae blooms have been observed.

Some species of blue-green algae can produce toxins that can cause illness, or even death, in people, pets, and wildlife if ingested. Pets are particularly vulnerable to poisoning from toxic algae blooms due to their smaller body weight and their tendency to ingest higher doses by drinking lake water and licking their fur after swimming. In recent years there has been an increase in documented toxic blue-green algae blooms occurring in lakes within Washington State.

Summit Lake

Because toxicity cannot be determined through visual observations, in 2009 Thurston County Environmental Health began using screening test kits to test for the presence of the most common algae toxin, microcystin. When the screening indicates the presence of microcystin, a sample is sent to a laboratory to quantify the amount of toxin present. The laboratory services are a statewide program sponsored by Washington Department of Ecology. Although toxin testing is now possible, lake residents and users should always observe lake conditions and avoid contact with lake water where an algae bloom is occurring.

More information about blue-green algae and swimming safety information is available through the Thurston County website: www.co.thurston.wa.us/health/ehadm/swimming/swimming_index.html

Major Issues:

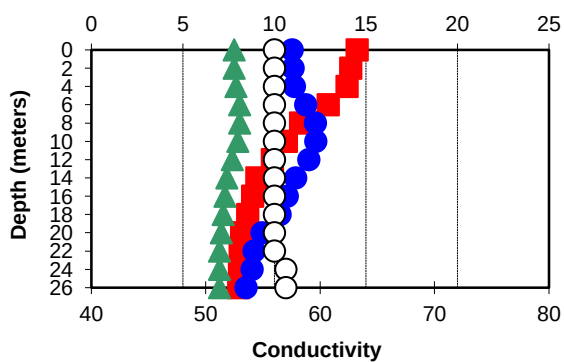
- Steep slopes, shallow soils, and generally small lots sizes make siting and functioning of on-site sewage systems around the lake difficult. A 1992-1997 sanitary survey of 330 on-site sewage systems around the lake perimeter found 58 systems were failing (18%). Nearly all of the 58 failing systems were repaired. However, a systematic evaluation of the septic systems surrounding the lake has not been done in over fifteen years.
- The majority of lakeshore residents use lake water as their domestic water supply, and many do not disinfect it prior to use. Surface waters cannot be adequately protected from contamination to be safely used as a domestic water supply without treatment. A public health advisory issued in 1987 advises against consumption of untreated lake water at Summit Lake.
- The high density residential activities along the shoreline and forestry activities in the upper watershed pose a concern for water quality.

Funding Sources:

Thurston County funds will continue to support monitoring in 2012.

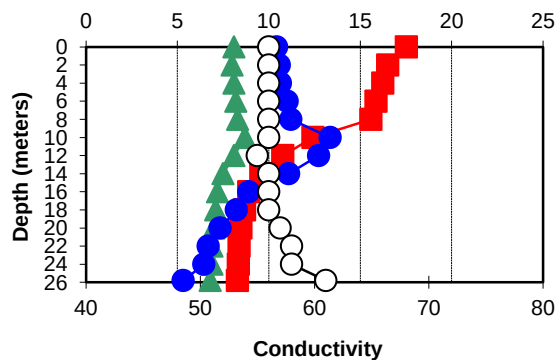
May 24, 2011

Temperature, pH, Dissolved Oxygen



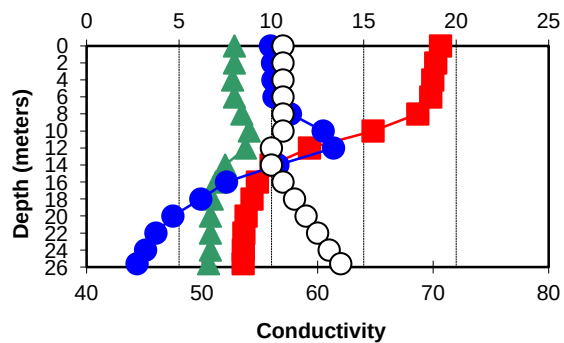
June 21, 2011

Temperature, pH, Dissolved Oxygen



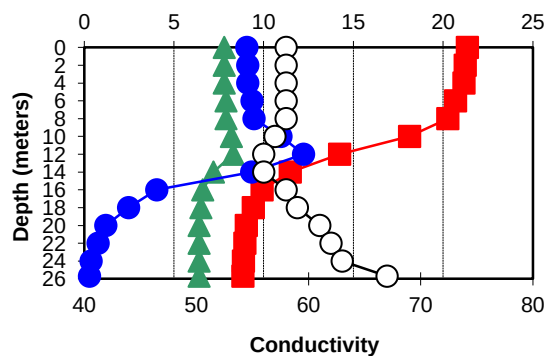
July 18, 2011

Temperature, pH, Dissolved Oxygen



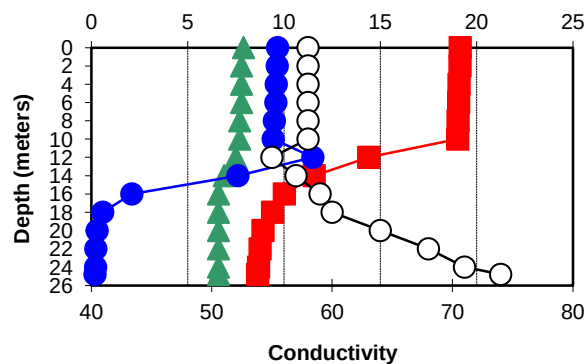
August 23, 2011

Temperature, pH, Dissolved Oxygen



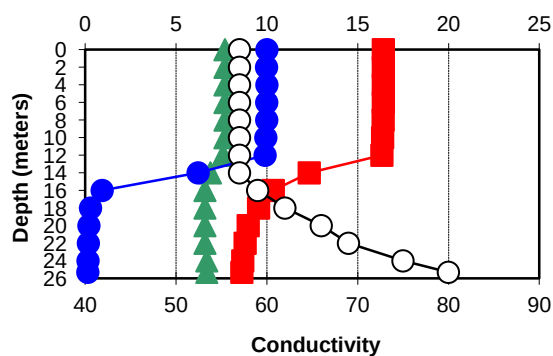
September 19, 2011

Temperature, pH, Dissolved Oxygen



October 10, 2011

Temperature, pH, Dissolved Oxygen



Thurston County Water Resources Annual Report - 2011

Summit Lake, Main (North) Basin

Site ID# TOTSUL010

Date	Time	Bottom Depth m	Bottom Sample Depth m	Sur TP mg/L	Bott TP mg/L	Sur TN mg/L	Bott TN mg/L	Secchi m	Chl a ug/L	Phae a ug/L	Water	Lake Notes
05/24/2011	12:30:00 PM	26	25.0	0.005	0.006	0.106	0.162	8.19	2.4	0.05	#2 lt green	Chl a & algae composite @ 2, 6 & 10M. Phaeo a was < detection at 0.1ug/L.
06/21/2011	12:00:00 PM	25.8	24.5	0.007	0.012	0.080	0.113	8.45	3.4	0.05	#2 lt green	Chl a & algae composite @ 2, 6 & 10M. Phaeo a was < detection at 0.1ug/L.
07/18/2011	12:45:00 PM	25.6	24.0	0.002	0.020	0.110	0.133	8.30	4.8	0.05	#2 lt green	Chl a & algae composite @ 2, 7 & 12M. Phaeo a was < detection at 0.1ug/L.
08/23/2011	11:30:00 AM	25.7	24.0	0.005	0.044	0.146	0.179	8.56	2.1	0.05	#2 lt green	Chl a & algae composite @ 2, 7 & 12M. PHAEO_a was < detection at 0.1 ug/L.
09/19/2011	12:30:00 PM	24.8	23.0	0.010	0.043	0.111	0.133	7.74	1.5	0.05	#2 lt green	Chl a & algae composite @ 2, 6 & 10M. PHAEO_a was < detection at 0.1 ug/L.
10/10/2011	1:00:00 PM	25.3	24.0	0.007	0.078	0.142	0.224	5.67	2.1	0.1	#2 lt green	Chl a & algae composite @ 2, 5 & 8M.

Summary for 'Site Description' = Summit Lake, Main (North) Basin (6 detail records)

Averages: Sur TP 0.006
 Secchi 7.82
 Chl a 2.7

Algae data: Summit Lake, Main (North) Basin

	Type	Description	Dominant in Sample
05/24/2011			
	CP	Cryptomonads	☐
	DT	Aulacoseira species	☐
	DT	Cyclotella species	☐
	DT	Tabellaria species	☐
	GR	Elakatothrix species	☐
	YL	Dinobryon species	☒
06/21/2011			
	DT	Cyclotella species	☐
	DT	Fragilaria species	☐
	DT	Tabellaria species	☐
	GR	Ankistrodesmus species	☐
	YL	Dinobryon species	☐
07/18/2011			
	BG	Aphanocapsa species	☐
	DT	Asterionella species	☐
	DT	Aulacoseira species	☐
	DT	Cyclotella species	☐
	DT	Fragilaria species	☐
	GR	Botryococcus species	☐
	GR	Radiococcus nimbatus	☐
	YL	Dinobryon species	☐

08/23/2011

Type	Description	Dominant in Sample
BG	Anabaena species	☐
BG	Aphanocapsa species	☐
CP	Cryptomonads	☐
DT	Asterionella species	☐
DT	Aulacoseira species	☐
DT	Cyclotella species	☐
DT	Fragilaria species	☐
EU	Trachelomonas species	☐
GR	Cosmarium species	☐
GR	Eutetramorus globosus	☐
YL	Dinobryon species	☐

09/19/2011

BG	Aphanothece species	☐
CP	Cryptomonads	☐
DT	Asterionella species	☐
YL	Dinobryon species	☐

10/10/2011

BG	Anabaena species	☐
BG	Aphanothece species	☐
BG	Chroococcus species	☐
CP	Cryptomonas species	☐
DT	Asterionella species	☐
DT	Fragilaria species	☐
DT	Stephanodiscus species	☐
EU	Trachelomonas species	☐
GR	Cosmarium species	☐
YL	Dinobryon species	☐

Key: BG = Blue green EU = Euglenophyte
 CP = Cryptophyte GR = Green
 DF = Dinoflagellate YL = Yellow
 DT = Diatom

Volunteer Monitoring

Chapter Includes:

Project “GREEN” Monitoring

2009-2011 Volunteer Monitoring Activities

Project "GREEN" Program

South Sound GREEN (Global Rivers Environmental Education Network) is a watershed education program of the Thurston Conservation District. Currently, more than 40 teachers and their students from schools in the North Thurston, Olympia, Tumwater, Griffin, and Rainier School Districts as well as St. Martin's College and other private schools are involved in this community-based, action-oriented program. The Nisqually River Education Project (NREP), which also gathers water quality data based on the GREEN protocols, currently has 34 teachers and their students participating, including schools from Eatonville, Yelm, North Thurston, Clover Park and Steilacoom. As participants, students monitor the chemical parameters of the Deschutes and Nisqually Rivers and several of their tributaries, and streams in the Henderson, Eld and Totten watersheds. Monitoring sites also may include lakes and wetlands. Monitoring data, coupled with information about cultural, economic, and environmental aspects of the watershed, help students identify and prioritize issues facing the community.

Data is collected by students twice yearly, once in autumn and once in late winter. Students usually also conduct EPA Stream Walks on these monitoring days. Data and recommendations for addressing issues facing the local watershed are presented by students at a student Congress held each spring. At this Congress, students attend workshop sessions to gain skills needed to implement their recommendations. Working with community members, students plan and implement environmental research and action projects designed to enhance and protect local water resources. South Sound GREEN is funded by a combination of public and private funding sources including: Thurston County, Thurston Conservation District, the Cities of Olympia, Lacey and Tumwater, North Thurston School District, and Trout Unlimited.

On monitoring day, students collect grab samples at their monitoring sites. Generally, the tests are conducted in the field. In some instances, students may transport the collected samples in a cooler and conduct the tests in their classroom. Taking the potential for operator error into consideration, three split samples are run from the same collection bottle for pH, nitrate and turbidity. For dissolved oxygen and biochemical oxygen demand, two or three samples are collected from the river in the same place at the same time. A sterile bottle is used to collect a sample for fecal coliform and three split samples are run if time and materials allow. The chemical parameters are measured using a variety of monitoring equipment. Dissolved oxygen and biochemical oxygen demand are measured using primarily LaMotte test kits. Komachin Middle School uses Hach kits for these parameters. Fecal coliform tests are conducted by the standard membrane filtration method using the Millipore Sterifil Aseptic filter system. The samples are incubated for 24 hours and the numbers of bacteria colonies visible on the petri dishes are counted directly. The data indicates number of fecal coliform colonies

present in 100ml of water sample. Wide range indicator pH kits from HACH are used to measure pH while LaMotte kits are used to measure turbidity.

Total solids samples collected by South Sound GREEN students use sampling bottles from the LOTT Wastewater Treatment Facility. Samples are kept in a cooler and delivered to LOTT for analysis. The Yelm Wastewater Treatment Facility provides the total solids bottles and the analysis for the Nisqually River Education Project students.

For more information on South Sound GREEN, contact Stephanie Bishop, Program Coordinator, Thurston Conservation District, at (360) 754-3588, ext. 108, sbishop@thurstoncd.com or ssgreen@thurstoncd.com. For Nisqually River Education Project, contact Sheila Wilson, Program Coordinator, (360) 438-8687 ext. 2153 or sheila@nisquallyriver.org.

The data collected for the water years 2009-10 and 2010-11 follows.

South Sound GREEN
Water Quality Data 2009-2010

Parameter	DO		DO sat		FC		pH		BOD		Water Temp.		Nitrates		Turbidity		Total Solids**		Weather/Notes		School	Teacher		
	(mg/l)		(%)		(# /100ml)				(mg/l)		(°C)				(JTU)		(mg/l)					Advisor		
Optimal Standard					50		7.0-8.0		0		9.0-12.0				0		<25							
Acceptable Standard	7.0-8.0				50-100		6.5-8.5		lower the better		12-18C				lower the better		25-80							
Deschutes Watershed	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct		Mar	School	Teacher	
Deschutes River @ Rich Rd (Petit)		10.3		85		20	5.0	7.0		1.6		8	1.00	0.00	10	11.6		4.31			12pm, partly cloudy, air 52F	Black Hills HS	St. Clair/Glenn	
Deschutes River @ Plant Ctr (The Barn)	10	9.9	87	85	122	27	7.3	7.0	6.00	4.4	10	8	0.32	0.50	0	5	1.3	74.11	10/14/09 3:00pm; overcast, air temp 54 F		1:00pm; overcast, air temp 10C	St Martins University	Hartman	
Deschutes River @ Pioneer Park 1	8	10.5	75.0%	90.0%	19 TC^ 15	14	7.5	7.5		-2.5	12	10	0.00	0.00	5	6.66		5.65	10/22/09, 3:15pm; overcast, air temp 50s F		12:15; cloudy, air temp 54F	Komachin MS	Leonard	
Deschutes River @ Tumwater Falls	3.7	10.2	32.0%	90.0%	5	4	7.5	7.5	0	0.8	11	9	0.33	1.50	16.7	10		3.19	10/8/09 3pm; sunny; air - 64° 3 pm		3pm; cloudy, air temp 55F	Olympia HS	Kirk	
Deschutes River @ Historical Park	9.1	11.66	82.6%	99.0%	25	360	7.5	7.5	0.74	1.33	12	9	1.00	1.33	5	11.66	6.5	26.8	10-22-09; 10 am; Cloudy; Air 11°		11:30am, cloudy, air temp 12C	McKenny Elem	Brewer	
Deschutes River @ Military Road	15.83	16	127.0%	128.0%			4.3	4.5			7	7	0.33	0.00	5	0			10/15/09 1:45pm; overcast,air temp 55° F		2pm, overcast, air 58F	Rainier HS	Evan	
Spurgeon Creek @ Emricks	8.6	8.5	74.0%	70.0%	112	12	6.6	6.4	NAF		9.6	7.9	0.60	0.60	2.3	2.7	1.4	5.4	10/15/09 12pm; overcast, air temp 13°C; electronic		12:31; overcast, air temp 11.2C	New Market	Baker	
Spurgeon Creek @ Latigo-Chehalis Trai	8.3	8.2	70.0%	67.0%	153	6	6.0	5.8	NAF		8.8	7.5	0.40	0.55	16.3	1.05	3.4	5.45	10/15/09 8:45 am; overcast, air temp 9.4°C; electronic		8:40; overcast, air temp 8C	New Market	Baker	
Spurgeon Creek @ Circle Hawk Farm	11	12	95.0%	101.0%	NAF		7.0	7.1	NAF		10	9	0.33	1.0	13.33	5		2.11	10/15/2009; 2:16 pm; Air 49° F; Overcast			Komachin	Condon	
Black River/Percival Creek Watershed	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct		Mar	School	Teacher	
Percival Creek @ Alderbrook (duck pond)	4.4	7.5	41.0%	59.0%	78		7.5	7.0	0.90	0.2	12	6	1.00	1.7	5	0	12.1		10/22/09, 9:15 am; low clouds; air temp 11 C		9am, overcast, air temp 7C	Tumwater MS	Fullington	
Percival Creek@ Alderbrook (woods)	6	8.13	55.0%	64.0%			7.0	7.2	1.20	1	11	6	1.30	1.0	5	1.16	5.2	6.59	10/22/09, 10:15 am; overcast; air temp 10 C		10am, overcast, air temp 7C	Tumwater MS	Fullington	
Percival Creek @ Chapparel	8.6	10.9	76.0%	90.0%			7.0	7.0	1.10	2.3	10	7	1.00	1.0	8.3	2.5	1.5	0.86	10/21, 10 am; overcast/foggy 10 C			Tumwater MS	Harris	
Percival Creek @ Sapp Rd		9.6		80.0%	79			7.0		0.8		7			1.0		2.5	4.18				Tumwater MS	Harris	
Ken Lake @ Rec. Area		10.2		80.0%		38		7.0		0.87		9			0.7		0				10am, light rain, air temp 6C	Avanti HS	Sogn	
Black River @ WDFW boat Launch(110TH)		8		66.0%		40		6.3		2.5		8			0.0		0		9.25			9am, partly cloudy, 51F	BHHS/Club Green	St. Clair/Glenn
Ashley Creek @ Sands (93rd)	14						2.5		7.00				1.0		2.5				10/22/09 11:30am; cloudy			Secondary Options	Holocher	
Henderson /Nisqually Reach Watershed	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct		Mar	School	Teacher	
Southwick Lake @ Lakeview Day Care	6.5	9.9	62.0%	88.0%	50	6	6.2	6.5	2.1	2.10	13	10	0.50	0.00	5	5	1.5	3.88	10/22/09, 12:15 pm; Overcast skies, calm wind; air temp 11 C		11:15am; scattered clouds, air temp 11C	Aspire Middle	Crowell	
Woodland Creek @ Community Center	2.1	8.1	20.0%	38.0%		38	7.0	7.5	.86	2.24	10	8	0.90	0.50	5	5	2.7	3.97	10-15-09 Cloudy - Air 15° Water level much lower than March		10:45am; overcast, air 12C	Mount View Elem	Kiekhaefer	
Woodland Creek @ Draham Rd	8.1	8.3	70.1%	70.0%	49	E	7.2	7.0	1	1.40	10	8	1.00	1.00	0	5	0.9	5.84	10-15-09 Overcast ; Air 13° Rain previous day		overcast, air temp 12	Mountain View Elem	Stevens	
Woodland @ Mark St Bridge 10-15/ 2-24	9.3	9.0	80.5%	76.0%	40	9	7.0	7.0	.3	1.00	10	9	1.70	1.00	0	2	1.1	4	10-15-09 cloudy -		1:30pm; sunny, air temp 47F	Lydia Hawk Elem	Poole	
Woodland @ Mark St Bridge 10-22/ 2-25	10.5	10.0	93.0%	84.5%	6	17	7.0	6.0	3.5	4.00	11	9	1.50	1.00	1.7	7			10-22-09 1:30 pm Cloudy;		1:30pm; sunny, air temp 47F	Pleasant Glade ES	Thielen	
Woodland Creek @ Pleasant Glade am	3.7	12.7	31.0%	105.0%	74	14	7.5	7.5	.73	4.07	9	7	1.00	0.50	6.6	5.83	2	11.24	10-15 09 9 am Air 10°		9am, rainy/cloudy, air temp 9C	Pleasant Glade ES	Thielen	
Woodland Creek @ Pleasant Glade pm	5.3		46.0%		naf		6.0		NA		10		1.00		10				10-15-09 Cloudy; Air - 15° 12:40 pm			Pleasant Glade ES	Thielen	
Woodland Creek @ Hollywood	5.1	7.7	44.0%	65.0%	105		7.0	7.5	1.6	-0.70	10	9	1.00	0.75	6.25	7.5	2.5	17.92	10-15-09 mostly cloudy; Air 52° F		12:45pm; partly sunny, air temp 54F	South Bay Elem	Rayburn	
Beachcrest	11.0	10.0	95.0%	86.5%	124	4	7.5	8.0	2	1.00	10	10	1.00	0.67	5	5	20	8.09	10/15/09; cloudy - very light rain		9am, cloudy; air 40F	Olympic View Elem	Crain	
Woodard Creek @ 41st and Libby (Prose)	12.6						7.5				NAF		0.00		15		8.6		10/23/09 8:45am; Rainy Air 11°			Northwest Christian HS	Daniel	
Tolmie State Park																								
Parameter	DO		DO sat		FC		pH		BOD		Water Temp.		Nitrates		Turbidity		Total Solids**		Weather/Notes		School	Teacher		
	(mg/l)		(%)		(# /100ml)				(mg/l)		(°C)				(JTU)		(mg/l)					Advisor		
Budd Inlet Watershed	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct		Mar	School	Teacher	
Ellis Creek @ East Bay	9.7	12.3	82.0%	98.5%	174		7.3	7.0	-0.1	0.5	9	8	1.70	0.0	0	5			10/22/09 12pm; overcast, air temp 12°C		12pm, overcast, air 52F	Roosevelt Elem	Nied	
Schneider Creek@ Yantis/West Olympia	4.67	12	50.0%	102.0%	11		7.0	7.0	-2.33	-1.5	10.5	9	1.25	1.0	0	0	0.6		10/22/09 10am; cloudy, no rain; air temp 12°C		9:30am, cloudy, air temp 11C	Garfield Elem	Koster	
Capitol Lake @ 5th & Water at the Steps	13	12.84	120.0%	107.0%			8.0	7.5	2.7	1.67	12.2	7.7	0.30	0.7	8.3	6.6	2.8	2.83	10/15/09 9:30am; cloudy, air temp 53 F			LP Brown Elem	Hayes	
Garfield Creek @ Nature Trail	8.5	10.1	75.0%	87.0%	74	8	7.0	7.0	2.42	-0.2	10	10	0.16	1.0	8.5	15		2.83	10/22/09 1:00pm, cloudy, air temp 11 C		12:30, partly sunny	Garfield Elem	Dodge	
Moxlie Creek @Spring	8.2	NAF	69.3%			0	7.0	7.0	2.00	NAF	9	9	8.80	1.6	0	15		0.65	10/22/09 10am; overcast, air temp 9-C		partly sunny, air 12C	Hansen Elem	Samson	
Moxlie Creek @ Storm Pipe	8.73	NAF	73.8%		328	132	7.5	7.0	4.13	NAF	9	9	7.30	0.6	15	10		3.04	10/22/09 11am;overcast, air temp 9-C		partly sunny, air 12C	Hansen Elem	Samson	
Indian Creek @ Fredrick St	4.17	9.27	36.0%	75.0%		188	7.3	7.0	-.43	-0.76	10	7	1.17	1.6	5	5	1.2	11.73	10-22-09; 9:40 am; Overcast Air 13°		9:50, partly cloudy, air 10C	McKenny Elem	Corrick	
Indian Creek @ Boulevard Bridge	6.26	8.63	55.0%	71.0%	88	108	6.5	7.0	1.96	1.37	11	8	0.93	1.2	3.3	4.16	6.5	5.65	10-22-09; 10:30 am; Overcast-foggy - 13°			McKenny Elem	Nelson	
Indian Creek @ Fredrick St	9.1		81.00%		568		7		2.20		10		0		15		1.7		10/15/09, 9:30 am; cool, overcast, air temp 6 C			Avanti HS	Sogn	
Indian Creek @ Quince St	9.25	9.1	85.0%	72.0%	296	300	7.5	7.0	0.85	-0.1	12	10	0.66	1.7	15	10	34.3		10/22/09, 1pm; cool, overcast, air temp 10.5 C		light rain, air temp 6	Avanti HS	Sogn	
Mission Creek @ East Bay Dr.																						Roosevelt Elem	Ferguson	
Mission Creek @ Ethridge/ Central (Park) 1																						Roosevelt Elem	Ferguson	
Mission Creek Wetlands @ Ethridge/ Central (Park) 2																						Roosevelt Elem	Baker	
Chambers Lake		4						6.5		1.34				0.0		10		1.89	9:25 am, slight rainfall, air temp 48F					

****BOD result should not be a negative number. Error can occur from light, leakage of air into sample, or bubbles in sample.

South Sound GREEN
Water Quality Data 2009-2010

Parameter	DO		DO sat		FC		pH		BOD		Water Temp.		Nitrates		Turbidity		Total Solids**		Weather/Notes		School	Teacher Advisor
	(mg/l)		(%)		(# /100ml)				(mg/l)		(°C)				(JTU)		(mg/l)					
Optimal Standard					50		7.0-8.0		0		9.0-12.0				0		<25					
Acceptable Standard	7.0-8.0				50-100		6.5-8.5		lower the better		12-18C				lower the better		25-80					
Eld Inlet Watershed	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	School	Teacher
Beatty Creek @ Arneson Lane	9.8	10.6	82.8%	85.0%	23	3	6.5	6.5	.6	0.5	9	7	0.50	0.6	1.63	0	2.4	0.89	10/15/09 10:20 am; Cloudy; air temp 12°	1pm, cloudy, air temp 9C	McLane Elem	Schilter
McLane Creek @ The Nature Trail	9.3	12.73	77.7%	102.0%	2	1	7.0	7.0	1.13	2.53	8.4	7	0.00	0.0	1.3	1	0	1.09	10/15/09 11am overcast; air temp 11.5°	1:15, overcast, air temp 9C	McLane Elem	Hahn
Cooper Crest Creek @ the bridge	6.1	6.1	52.8	104.0%	46		7	6.5	1.20	1.4	10	8	1	1.3	<5	5	201.4	24.12	10/15/09 10am; overcast, air temp 13°	12pm, overcast, air 10C	Marshall MS	Trafton
Green Cove Creek@ Cedrona	2.6	4.23	23.0%	37.0%	98		6.5	6.0	1.77		11	9	0.50	0.6	11.66	3.33	5.6	3.4	10/22/09 9am; overcast, air temp 12°	overcast; 9am, air temp 11	Marshall MS	
Green Cove Creek@ Fire Station (36th)	13.3	3			530		7	6.5	7.3	E			0.00	3.0	3	5	46.3		10/15/09 8:30 am; cloudy, mild, air temp 8.5 C	9:30am; partly cloudy, air temp 14C	Marshall MS	Cook
Green Cove Creek@ Carol Burns	10.6	13.3	92.0%	106.0%	89		6	7.0	2.1	1.7	10	6.5	1.00	0.5	0	5	2.9	6.24		10am, overcast; air 15C	Marshall MS	Huff
Snyder Creek @ TESC					147												1.5				Capital HS	Hook
Totten Inlet Watershed	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	Oct	Mar	School	Teacher
Kennedy Creek @ Salmon Trai	9.1	11.4	80.0%	95.0%	0	16	6.8	6.8	.7	0	10	8.5			15	0		2.29	10/16/09, 9:30 am; overcast, air temp 11 C; not enough time to run more tests	3pm, overcast, air temp 10.5C	Capital HS	Watts
Schneider Creek@ Reroute	6.1	11.3	54.0%	93.0%	30	4	7.0	7.0	0.0	3.2	10	7	0.00	0.0	8.3	6.7		2.88	10/22/09, 1:15-3:00; cloudy, air temp 13 C	2:15pm, partly cloudy, air temp 13C	Griffin MS	Temple
Schneider Creek @ Griffinwooc	7.8	11.1	69.0%	94.0%	44		7.0	7.0	0.6	0	10	8	1.00	0.0	10	5	0.2	3.29	10/22/09, 11:30-1:00pm; overcast; air temp 13 C	12:30, cloudy, air temp 7C	Griffin MS	Temple
Schneider Creek @ Oyster Bay & 38th Lane	3.9	12.3	34.0%	101.0%	15		7.0	7.0	3.9	1.7	10	8	0.50	0.0	43.3	4.2	12	5.39	10-22-09 Overcast; Air 10°;	12:30pm; overcast, air temp 13C	Marshall MS	Huff
Schneider Creek @ Bridges	8.8	13.8	77.0%	106.0%	143		7.0	7.0	2.3	4.1	10	5	0.00	0.0	5	5	0.2	5.51	10/22/09, 9-10:45 am; cloudy, air temp 12 C	9:25am, mostly clear, air temp 10C	Griffin MS	Temple
KEY																						
NAF = Not analyzed for																						
TC^= Quality Control Lab Results																						
E = Error																						
#R = Number of Replicates																						

****BOD result should not be a negative number. Error can occur from light, leakage of air into sample, or bubbles in sample.

South Sound GREEN Water Quality Data 2010-2011

Parameter		DO (mg/l)		DO sat (%)		FC (# /100ml)		pH		BOD (mg/l)		Water Temp. (°C)		Nitrates		Turbidity (JTU)		Total Solids** (mg/l) LOTT Lab		Weather/Notes		School	Teacher Advisor	
	Optimal Value	>9				50		7.0-8.0		0		9.0-12.0				<20		<25						
	Acceptable Value	7.0-8.0				50-100		6.5-8.5		lower the better		12-18C				lower the better		25-80						
Deschutes Watershed		Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct		Feb		School	Teacher	
2013	Deschutes River @ Rich Rd (Petit)	9.3	10.66	69	87	32	0	7.0	7.5	NAF	0.66	8	6	0.00	0.00	15	0	NAF	13.85	Overcast, drizzly; FC: On the second trial there was a dry spot indicating improper seating of the filter, only two replicates; 13° C		Black Hills HS	St. Clair/Glenn	
2011	Deschutes River @ Plant Ctr (The Barn)	8.15	10.9	68	80	75	14	6.8	6.8	8.15	2.03	8	4	0.50	0.45	6.67	18.3	22.18	NAF	Clear but high rains in preceding week; 9:00; 50° F		St Martins University	Hartman	
2014	Deschutes River @ Pioneer Park 1	9.1	9.6	80.0%	75.0%	81	16	7.1	7.0	0.20	0.4	9.5	5	0.80	0.00	7.5	11.6	9.67	10.32	Light showers; 1:00		Komachin MS	Leonard	
2009	Deschutes River @ Tumwater Falls	8.6	11	75.0%	87.0%	82	8	7.0	7.0	-0.10	0.9	10	6	1.00	1.00	5.8	15	8.94	13.12	Cloudy, rainy; smelled like sewer; DO # 3 abnormal size of brown flakes and starch indicator did not turn liquid purple; 3:00; 52 °F		Olympia HS	Kirk	
2012	Deschutes River @ Historical Park	10.4	13.33	110.0%	140.0%	304	40	7.0	7.5	1.60	2.63	10	6	0.33	1.00	31.66	15	23.82	16.7	Cloudy, drizzle; Spilled 3rd BOD sample bottle; filter problem on first fecal test; 9:30; 13°c		McKenny Elem	Brewer	
2010	Deschutes River @ Military Road	8.1		71.0%		NAF		7.3		-2.90		9		0.33		6.3		5.25		Overcast and slight sprinkle; 9:00; 50 ° F		Rainier HS	Evan	
2008	Chambers Lake	6	8.66	65.0%	77.0%	28	22	6.5	6.5	3.34	3.66	10	10	0.00	0.0	6.66	7	7.47	2.77	Overcast; 9:00; 43°F		Mountain View	Weimeister	
2048	Spurgeon Creek @ Circle Hawk Farm	11.8	9.1	92.0%	77.0%	NAF	NAF	6.9	7.1	NAF	NAF	6	8	0.00	1.0	18	10	2.2	3.67	Overcast/windy; 1:30; 41°F		Komachin	Raven	
Black River/Percival Creek Watershed		Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct		Feb		School	Teacher	
2041	Percival Creek @ Alderbrook (grass/bridge)	6.4	9.4	55.0%	72.0%	0	1	7.0	7	1.00	0.9	10	5	0.66	1.3	1.66	3.3	5.05	2.55	Overcast; FC: Only two replicates; 9:00; 11° c		Tumwater MS	Fullington	
2042	Percival Creek@ Alderbrook (woods)	7.6	8.5	65.0%	65.0%	NAF	NAF	7.0	7.0	-0.90	-0.3	8	4	0.66	1.2	0	0	5.71	3.47	Overcast; 9:00; 8° C		Tumwater MS	Fullington	
2043	Percival Creek @ Chapparel	8.3	9.9	72.0%	77.0%	NAF	NAF	7.0	7.0	1.40	1.7	9	5	0.00	0.0	1.66	0	2.09	4.3	10/27/10; Sunny and clear; 10:09; 6° c		Tumwater MS	Harris	
2044	Percival Creek @ Sapp Rd	7.4	9.1	65.0%	71.0%	21	3	7.0	7.0	0.40	0.6	10	5	0	0.0	1.66	0	1.76	1.51	Overcast and heavy rain week prior; FC: Only two replicates; 10:00; 9° c		Tumwater MS	Harris	
1001	Black River @ WDFW boat Launch(110TH)	5	7	43.0%	55.0%	125 +	4	5.8	7.0	NAF	1.33	9	5	0.00	0.5	10	0	NAF	5.33	Overcast and drizzly; FC: Only two replicates; 10° c		BHHS/Club Green	St. Clair/Glenn	
Henderson /Nisqually Reach Watershed		Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct		Feb		School	Teacher	
4010	Southwick Lake @ Aspire Middle	4.6	NAF	38.0%	NAF	12	NAF	6.5	NAF	0.40	NAF	8	NAF	0.00	NAF	5	NAF	2	NAF	Overcast and calm wind; 11:15; 10 °c		Aspire Middle	Crowell	
4023	Woodland Creek @ Community Center	7.06	9.5	64.0%	74.0%	152	14	7.0	7.0	2.80	3.07	11	5	0.33	1.00	0	5	10	1.26	Overcast, damp, cool; 10:00; 10° c		Mount View Elem	Kiekhaefer	
4019	Woodland Creek @ Draham Rd	8.9	8.4	79.0%	68.0%	128	15	7.0	7.0	2.10	1.00	10	7	1.00	<1	2.5	<5	3.58	6.09	Overcast; Heavy rain earlier in week; 10:30; 12° c		Mountain View Elem	Stevens	
4021	Woodland @ Mark St Bridge	10.3	9.6	90.0%	77.0%	100	110	7.0	7.0	0.30	-0.40	10.5	7	1.00	1.00	0	6.3	1.74	5.59	Windy and Cloudy; 1:00; 53 ° c		Lydia Hawk ES	Poole	
4022	Woodland Creek @ Pleasant Glade (2/17/11)	10.6	11.3	90.0%	85.0%	TMTC	88	7.5	7.5	3.00	2.47	9	5	1.00	0.50	5	16.67	17.89	9.5	Overcast; 9:00; 12° c		Pleasant Glade ES	Thielen	
4022	Woodland Creek @ Pleasant Glade (2/18/11)		10.0		80.0%		NAF		7.5		NAF		6.67		0.67		5		NAF	Scattered clouds/breezy; 9:00; 2°c		Pleasant Glade ES	Thielen	
4020	Woodland Creek @ Hollywood	9.6	10.5	90.0%	57.0%	TMTC	34	7.5	7.0	1.80	3.40	10	6	1.30	1.00	8.3	7.5	17.39	29.33	Overcast; 1:00		Cloudy w/partial sun; BOD: floc did not settle for one replicate; 1:30; 43 °F	South Bay Elem	Rayburn
5001	Beachcrest	12.8	11.4	115.0%	99.0%	20	45	7.5	8.0	3.30	2.40	10.5	9	2.00	2.10	2.5	2.9	2.92	7.5	Cloudy and rainy; 12:45; 13° c		Olympic View Elem	Crain	
4016	Woodard Creek @ 41st and Libby (Prose)	9.6	NAF	86.0%	NAF	190	NAF	7.0	NAF	1.20	NAF	11	NAF	2.00	NAF	5	NAF	8.21	NAF	Cloudy; 1:00; 10.5° c		Chinook Middle	Heidenreich	
4015	Unnamed Creek @ Bergvall	6.6	11.2	55.0%	90.0%	TMTC	TMTC	7.5	7.5	-1.10	1.10	9	6.67	0.00	0.33	25	30	62.09	30.74	Overcast; 12:00; 12° c		Scattered Clouds/breezy; 12:00; 8 °c	Pleasant Glade ES	Thielen
4009	Pattison Lake Ditch @ Mullen & RR	4.4	8.2	42.0%	65.0%	TMTC	104	7.0	7.5	2.80	0.90	12	6	0.00	1.00	0	5	4.63	8.3	Overcast; Creek is wider at test site by 8 feet on one side. Night shade is becoming more dense at bridge over water; 3:00; 12°c		Overcast; 4:30 pm; 8°c	Timberline HS	Marshall
5003	Tomie State Park	10	9.7	92.0%	82.0%	184	188	7.5	7.0	2.20	-0.1	12	9	1.00	1.0	9	6.9	9.13	6.53	Overcast;Tide 14+, influence on results; 10:00; 12° C		Overcast w/sunbreaks; 10:30; 5°c	Timberline HS	Marshall
Budd Inlet Watershed		Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct		Feb		School	Teacher	
2021	Ellis Creek @ East Bay	9.97	19.7	85.0%	NAF	115	34	7.0	7.0	-3.00	7.9	9	9	1.30	0.3	0	0	38.75	23.66	Overcast and not raining; 12pm; 12°c		Cool/Cloudy; DO & BOD:questionable data; 12:00	Roosevelt Elem	Nied
2007	Capitol Lake @ 5th & Water at the Steps	11.13	15.3	95.0%	112.0%	NAF		7.3	7.5	3.27	1.7	9	5.5	1.50	1.0	15	11.6	6.29	NAF	Overcast, cool; 9:30; 10.5 ° c		Cloudy and cold; 10:00; 42°F	LP Brown Elem	Schmidt
2005	Capitol Lake @ Marathon Park	8.75	12	80.0%	95.0%	NAF	38	7.5	7.5	0.02	2.17	9.5	6	2.25	4.0	5	10	4.84	NAF	Overcast, cold; 1st DO replicate:floc took longer then 5 mins;10:30; 4°c			LP Brown Elem	Walsh
2006	Capitol Lake @Interpretive Center	9.13	12.33	78.0%	105.0%	NAF	10	7.0	7.5	9.23	2.33	10	9	1.00	0.7	5	5.23	2.22	6.02	Overcast		All three FC samples turned pink.	Garfield Elem	Dodge
2024	Garfield Creek @ Nature Trail	10	11.1	85.0%	85.0%	60	10	6.5	7.0	0.53	NAF	9	4	0.50	1.7	5	2.33	11.4	NAF	Cloudy; 11°c		Rainy/cold; 9:00; 6°c	Garfield Elem	Stine
2038	Moxlie Creek @Spring	9.8	8.75	87.0%	77.0%	35	22	6.0	6.0	NAF	NAF	10.2	9.1	1.90	1.5	11.1 NTU	2.8 NTU	NAF	NAF	Overcast, off and on showers; Used Vernier Lab Quest Kits with a 30 second avg; Ammonium 0.2 mg/L, Ammonia 0.25 ppm, Flow rate 0.225 m/s; 12:42; 10.4 °c		Overcast/Cold; Used lab quest; Flow rate 0.138 m/s; Salinity 0 ppt; Ammonia 0.12 mg/L; 12:00; 6.65°	New Market	Baker
2037	Moxlie Creek @ Storm Pipe	8.7	10.9	78.0%	90.0%	5	12.3	6.4	6.0	NAF	NAF	10	8.1	1.20	1.2	4 NTU	0.7 NTU	NAF	NAF	Overcast, off and on showers; Used Vernier Lab Quest Kits with a 30 second avg; Ammonium 0.2 mg/L, Ammonia 0.0 ppm, Flow rate 0.195 m/s; 8:53; 9.8 °c		Overcast/cold; Used Lab Quest; Flow Rate 0.68 m/s; salinity 0 ppt; ammonium 0.7 mg/L; ammonia 0.25 mg/L; 8:30; 2.4°C	New Market	Baker
2027	Indian Creek @ Fredrick St	9.6	NAF	85.0%	NAF	NAF	NAF	7.4	NAF	1.02	NAF	9.5	NAF	0.33	NAF	5.8	NAF	4.49	NAF	Cloudy and rainy; 9:00; 12.5° c			Centennial Elem	Corrick
2028	Indian Creek @ Boulevard Bridge	8.6	9.67	76.0%	75.0%	4	40	6.5	6.5	1.60	1.92	10	5	0.50	0.0	5	30	3.01	10.21	Cloudy; Ran out of time for 3rd Nitrates test; 10:10; 15 ° c		Overcast; BOD:only two replicates ran FC: Control and sample #1 switched; 10:00; 8°c	McKenny Elem	Nelson
2026	Indian Creek @ Quince St	8.4	NAF	75.0%	NAF	188	NAF	7.2	NAF	1.60	NAF	10.5	NAF	1.66	NAF	10	NAF	2.16	NAF	Overcast; 9:30; 9.8° c			Avanti HS	Sogn
Eld Inlet Watershed		Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb	Oct	Feb											

Nisqually Data-	10/15/2009								
		D.O.	FC	pH	BOD	Temp.	Nitrates	Turbidity	Total Solids
Site	School	mg/l	Col/100ml		mg/l	Celsius	mg/l	JTU	mg/l
Nisqually@Tahoma Woods	CC elem.(Johnstone 5th/6th)	10.6	14	7.5	0.6	7	0.7	30	41
Muck Creek@Morse Preserve	Rocky Ridge(Case/Jones-5th)	3.3	n.a.	7	n.a.	10	1	1.33	n.a.
Muck Creek @ Jim's Ufish -1	Cougar Mt JH (Todyn- 7th/8th)	8.17	n.a.	7.5	1.17	11	0	5	n.a.
Muck Creek @ Jim's Ufish -2	Cougar Mt JH (Aoki/7th/8th)	15	n.a.	7.5	5	11	1.75	5	n.a.
Muck Creek@8th Ave. East	Ft. Stevens (Ross - 5th)	7	TMC	7.5	3.5	10	1.75	5	55
Horn Creek @ Hart's Lake	McKenna (Dahlberg-6th)	9	n.a.	n.a.	0	n.a.	0	0	<1
Tobotton Creek	Lackamas (McGinnis-5th)	7	n.a.	7.1	0	6	4.6	5	1
Elbow Lake Creek	Lackamas (Verbanac-5th)	7	n.a.	6.6	0.7	6	4.6	5	1
Nisqually@Centralia Park	Clarkmoor(Fowler-5th/6th)	16.6	8	7	n.a.	13	0	26.6	0.19
Nisqually@McKenna/Tressle Farm	Mill Pond (Overhauser-5th)	11.5	126	6.5	10	8	0	11.6	n.a.
Nisqually@Nisqually Pines	Yelm Prairie (Shirley-5th)	10	17	7	1.3	12.5	0	1.17	18
Yelm Creek@Sheasleys	McKenna (Arnold-5th)	7.5	48	6.5	0	10	0	0	1
Yelm Creek@Countryman's	Prairie(Shepherd-Gawe-5th)	5.2	19	7	0.8	9	0	0	1
Yelm Creek @ Folley's	Prairie(Duning- 5th)	5.75	0	7	5.08	9	0	38.3	892
Yelm Creek@ Ft. Steven's	Fort Stevens (Garrison-5th)	8.6	48	7	6	13	1.8	1.6	3
Yelm Creek@Mouth	Mill Pond (Cie-5th)	10	n.a.	7.5	N.A.	10	0	0	<1
Nisqually@Powerhouse	Southworth Elem.(Tatro-5th)	7.5	63	7	2	12	0.6	21.6	16
Nisqually@ Tank Bridge	Yelm HS (Wood-9th-12th)	10.7	112	7	1.6	13	0.18	15	6
Lacamas Creek@Roy	WA VA(Roth/Rasmussen 3rd-12th)	9.7	135	7	1.025	9	0	0	<1
Lackamas Creek @ 288th	McKenna (Pederson-4th)	8	180	7	2.4	12	1	10	7
Kalama Creek @ mouth	Fort Stevens (Sheaffer-5th)	8.6	12	7	-0.9	10	5	6.6	<1
Eaton Creek	Southworth (Murphy-5th)	7.6	61	n.a.	0.3	10	0	5	1
Eaton Creek @ Hall's	Lydia Hawk (Poole-5th)	8	14	7.5	0	10	1	5	0.4
Nisqually@6th Ave	Mill Pond (Schouweiller-5th)	11.9	10	7	n.a.	n.a.	0	15	16
Nisqually@Frank's Landing	Wa He Lut School(Montrose-6th)	10.3	43	7	1.3	13	0	10	16
Little McAllister@ Meadows	Meadows (Johnson4th)	8.16	34	7	0.16	12	4.5	2.6	11
McAllister@ Steilacoom	River Ridge (Gradoville-9-12th)	9.2	112	6.5	4.5	11	0	0	2
Red Salmon@ bridge	Meadows (Melton-4th)	10	14	7.5	2.2	n.a.	0	1.6	16
McAllister Creek @ I-5	Meadows (Taft-4th)	7.3	34	7	1.05	n.a.	0.66	0	1
Sequalitchew Creek - North	Chloe Clark (Bradshaw/Salgado-3rd)	9.2	1	7.5	-1.7	9	0	7	<1
*T.M.C=Too Many to Count									
n.a. = not available									
** = estimate									

Nisqually Data-	2/25/2010								
		D.O.	FC	pH	BOD	Temp.	Nitrates	Turbidity	Total Solids
Site	School	mg/l	Col/100ml		mg/l	Celsius	mg/l	JTU	mg/l
Nisqually@Tahoma Woods	CC elem.(Johnstone 5th/6th)	9.5	0	7.5	0	6	0	5	1
Ohop Creek@Kjelstad Rd.	Eatonville Elem(Bewley-5th)	13	16	7	0	6	0	15	14
Tanawax Creek@Cutoff Rd.	Weyerhaeuser(Bewley5th)	13	4	7	0	10	0	15	7
Muck Creek@Morse Preserve	Rocky Ridge(Case/Jones-5th)	13.5	10	7	5.5	6	0	0	11
Muck Creek @ Jim's Ufish -1	Cougar Mt JH (Tomin- 7th/8th)	10.3	25	7.5	1	7	2	5	11
Muck Creek @ Jim's Ufish -2	Cougar Mt JH (Aoki/7th/8th)	10	25	7.5	0	7	1.67	6.67	7
Muck Creek@8th Ave. East	Ft. Stevens (Ross - 5th)	7	100	7	3.83	10	2	5	6
Horn Creek @ Hart's Lake	McKenna (Dahlberg-6th)	8.6	21	7.5	0	9	0	0	3
Nisqually@Centralia Park	Clarkmoor(Fowler-5th/6th)	4.8	6	7.5	0.24	7	0	10	2
Nisqually@McKenna/Tressle Farm	Mill Pond (Overhauser-5th)	10.5	9	7.5	n.a.	n.a.	0.66	3.33	1
Nisqually@Nisqually Pines	Yelm Prairie (Shirley-5th)	10	24	7.5	0	8	0	1	2
Yelm Creek@Sheasleys	McKenna (Arnold-5th)	9.6	16	6.5	0.6	6	1	3.3	2
Yelm Creek@Countryman's	Prairie(Shepherd-Gawe-5th)	6.4	10	6.5	0.8	7.5	1	0	1
Yelm Creek @ Folley's	Prairie(Duning- 5th)	8	41	7	0.14	8	0	5	2
Yelm Creek@ Ft. Steven's	Fort Stevens (Garrison-5th)	11.3	<20	7	2	10	1.6	3.3	<1
Yelm Creek@Mouth	Mill Pond (Cie-5th)	9.9	<20	7.5	0.5	10	0	5	4
Nisqually@Powerhouse	Southworth Elem.(Tatro-5th)	8.9	20	7	0	8	1.5	8	1
Nisqually@ Tank Bridge	Yelm HS (Wood-9th-12th)	11.8	13	7	0.6	5	0	5	1
Lacamas Creek@Roy	WA VA(Roth/Rasmussen 3rd-12th)	11	11	7	4	6	0	0	2
Lackamas Creek @ 288th	McKenna (Pederson-4th)	9.83	<20	9.5	0.66	9	0	6.7	6
Kalama Creek @ mouth	Fort Stevens (Sheaffer-5th)	11.8	<10	7.5	1.8	n.a.	1	6.67	2
Eaton Creek	Southworth (Murphy-5th)	11	5	7	0	10	2	5	3
Eaton Creek @ Hall's	Lydia Hawk (Poole-5th)	10	6	7	1	9	1	5	2
Nisqually@ 6th Ave	Mill Pond (Schouweiller-5th)	11.3	n.a.	7	0.3	n.a.	0.33	3.3	1
Nisqually@Frank's Landing	Wa He Lut School(Montrose-6th)	12.7	3	7	3.7	7	0	15	5
Little McAllister@ Meadows	Meadows (Johnson4th)	7	9	7	1	9	3	5	1
McAllister@ Steilacoom	River Ridge (Gradoville-9-12th)	8.9	15	7	0	8	1.5	8	1
Red Salmon Creek @ McBride's	Meadows (Melton-4th)	10.7	24	7.5	9	10	0	6.67	5
Wash Creek @ McBride's	Meadows (Taft-4th)	12.3	25	4	3.63	11	0.33	0	3
Sequalitchew Creek - North	Chloe Clark (Bradshaw/Salgado-3rd)	9.2	0	7.5	0.3	n.a.	0	0	2
Key									
n.a. = data not available	FC = Fecal Coliform								
TMC = too many to count	DO = Dissolved Oxygen								
<# =	BOD= Biochemical Oxygen Demand								

Nisqually River Education Project	Data: 10/28/2010								
		D.O.	FC	pH	BOD	Temp.	Nitrates	Turbidity	Total Solids
Site	School	mg/l	Col/100ml		mg/l	Celsius	mg/l	JTU	mg/l
	OPTIMAL STANDARDS	9	<50	7 to 8	0	<18	<1	20	<25
Nisqually@Tahoma Woods	CC elem.(Johnstone 5th/6th)	10.84	3	7	0.74	7	0.8	0	25
Mashel River @ Smallwood Park	Eatonville Elem (Andrascik -4th)	9.73	8	7	-1.07	7	0	9.17	3
Ohop Creek @ Orville Rd	Eatonville Elem (Trumbly- 4th)	7	16	7	0.7	18	0	25	2
Ohop Creek @ Mettlers	Eatonville Elem(Van Cleve- 4th)	9.3	17	7	1.65	10	1	5	125
Ohop Creek @ Mouth	Eatonville Ind. Study Center (Needham)	10.06	n.a.	7.3	1.26	10.5	4.4	1.4	44
Tanawax Creek@Cutoff Rd.	Weyerhaeuser(Bewley5th)	8	20	7	0	10	0	55	n.a.
Muck Creek @ 320th	Shining Mountain (Hendrickson)	8.2	105	7	-6.4	8.5	0	0	2
Muck Creek@Morse Preserve	Rocky Ridge(Case/Jones-5th)	4.5	n.a.	6.5	0.5	12	0	0	n.a.
Muck Creek @ Jim's Ufish -1	Cougar Mt JH (Tomyn- 7th/8th)	8.83	38	7	0.4	13	2	5	2
Muck Creek @ Jim's Ufish -2	Cougar Mt JH (Aoki/7th/8th)	8.63	31	7	0.33		2	5	4
Horn Creek @ Hart's Lake	McKenna (Dahlberg-6th)	10	34	7.2	9.63	9	1.47	0	2
Tobotton Creek @ Peissner Rd	Lackamas (Halpin-5th)	10.66	22	7	3	8	0	17.5	2
Elbow Lake Creek @ Peissner Rd	Lackamas (Verbanac-5th)	9.2	3	7.5	1.5	11	0	3	1
Nisqually@Centralia Park	Clarkmoor(Fowler-5th/6th)	9	1	7.5	1.5	11	0	10	13
Nisqually@ Trestle Farm	Yelm HS (Wood-9th-12th)	11.3	58	7.5	0.9	11	0.26	10	n.a.
Nisqually@Nisqually Pines	Southworth (Tatro-5th)	9.4	74	7	0.8	9	1.5	20	10
Yelm Creek@Sheasleys	McKenna (Arnold-5th)	7	46	7	2	9	0	5	3
Yelm Creek@Countryman's	Prairie(Shepherd-Gawe/Oakes-5th)	6.2	63	6.5	2.5	8	1.5	0	2
Yelm Creek@ Ft. Steven's	Fort Stevens (Ross-5th)	13	220	7	7.5		5	15	11
Yelm Creek@Mouth	The Evergreen State College (Harrison)	11.83	4	7.5	2.23	9	3	0	<1
Nisqually@Powerhouse	Southworth Elem.(Lima-5th)	10.8	22	7	2.5	11	0	1.5	8
Nisqually@ Tank Bridge	Yelm HS (Wood-9th-12th)	11.5	112	7	1.2	11	0.352	5	n.a.
Muck Creek@Roy Park	WA VA(Roth/Rasmussen 3rd-12th)	8.2	n.a.	7	0.8	8	1	5	<1
Lackamas Creek @ 288th	McKenna (Pederson-4th)	5.2	4	7.5	0.4	9	0	8.3	3
Kalama Creek @ mouth	Fort Stevens (Garrison-5th)	10.3	104	7	1	9	1.3	0	<1
Eaton Creek@ Evergreen Valley Rd.	Southworth (Murphy-5th)	9	48	7	0	9	1	6.6	22
Eaton Creek @ Hall's	Lydia Hawk (Poole-5th)	9	20	7	1	9.5	1	8.3	2
Nisqually @ Riverbend Cmpgrnd	Nisqually MS (Soles/Stave - 7/8th)	10.3	29	7	0.7	11	0	4	8
Nisqually@6th Ave	The Evergreen State College (Harrison)	10	27	7.3		11	0	6.67	12
Nisqually@Frank's Landing	Wa He Lut School(Montrose-6th)	10.3	22	7	2	10	0	85	12
McAllister@ Steilacoom	River Ridge (Gradoville-9-12th)	5.5	1	7	0.5	10	0	3.3	3
Red Salmon Creek @ McBride's	Meadows Moore-4th)	6	32	7.5	6	11	0	0.5	1
Wash Creek @ McBrides	Meadows (Taft-4th)	8	76	7.5	-0.9	11	2	8.3	2
Sequalitchew Creek - North	Chloe Clark/Pioneer MS (Bradshaw - 3rd)	10.33	n.a.	7.5	1.1	9	0.33	5	n.a.

NREP

Data: 2/17/2011

Site	School	D.O. mg/l	FC Col/100ml	pH	BOD mg/l	Temp. Celsius	Nitrates mg/l	Turbidity JTU	Total Solids mg/l
optimal standards		9	<50	7 to 8	0	<18	<1	<20	<25
Nisqually@Tahoma Woods	CC elem.(Johnstone 5th/6th)	10.5	2	7.25		4	1.5	4	1
Mashel River @ Smallwood Park	Eatonville Elem (Andrascik -4th)	10.8	8	7	0.5	2	1	5	2
Ohop Creek @ Orville Rd	Eatonville Elem (Trumbly- 4th)	9.9		7	0.2		1	25	5
Ohop Creek @ Mettlers	Eatonville Elem(Van Cleve- 4th)	9.3		7	1	5.3	1	8.3	5
Ohop Creek@Kjelstad Rd.	Eatonville Elem(Bewley-5th)								5
Ohop Creek @ Mouth	Eatonville Alt. HS (Needham -9-12th)	12.2	4	6.8	1.7	6.1	0	2.3	7
Tanawax Creek@Cutoff Rd.	Weyerhaeuser(Bewley5th)	10.3	16	7	-2	5	0	10	11
Muck Creek@ 320th S	Shining Mountain (Hendrickson-)	11.2		6.5	1.2	4	0	0	
Muck Creek@Morse Preserve	Rocky Ridge(Case/Jones-5th)	8	42	6.5	0.8	4	0.3	0.3	
Muck Creek @ Jim's Ufish -1	Cougar Mt JH (Tomyon- 7th/8th)	10.5	38	7	1	3.7	2	5	
Muck Creek @ Jim's Ufish -2	Cougar Mt JH (Aoki/7th/8th)	14	48	7	1.9	3.6	1.7	11.7	
Muck Creek @ Roy	WA VA(Roth/Rasmussen 3rd-12th)	10.6	19	7.5	3.7	6	0		1
Horn Creek @ Hart's Lake	McKenna (Dahlberg-6th)	9.8	0	7.5	-0.8	2	0	0	34
Tobotton Creek @ Peisner Rd	Lackamas (Halpin-5th)		TMC						10
Elbow Lake Creek @ Peisner Rd	Lackamas (Verbanac-5th)	10	3	7.5	1.1	8	2	0	3
Nisqually@Centralia Park	Clarkmoor(Fowler-5th/6th)	13.5	0	7	35.2	4.5	0	10	
Nisqually@Trestle Farm	Yelm HS (Wood-9th-12th)		5						5
Nisqually@Nisqually Pines	Southworth (Tatro-5th)	10.8		7	0.9	5	0.3	10	6
Yelm Creek@Sheasleys	McKenna (Arnold-5th)	6.8	34	7.5	-1.9	10	1	5	3
Yelm Creek@Countryman's	Prairie(Shepherd-Gawe/Oakes-5th)	7.5	24	7	0.5	4	1.5	3.3	1
Yelm Creek@ Ft. Steven's	Fort Stevens (Ross-5th)	10	8	7.5	5		5	10	1
Nisqually@Powerhouse	Southworth Elem.(Lima-5th)	11.2	10	7	0.2	5.8	0.3	1.5	5
Nisqually@ Tank Bridge	Yelm HS (Wood-9th-12th)		22						
Lackamas Creek @ 288th	McKenna (Pederson-4th)	8.3	5	7	0.6	10	1	5	4
Kalama Creek @ mouth	Fort Stevens (Garrison-5th)	9.3	10	7	2.3	8	0.3	3.3	<1
Eaton Creek @ Hall's	Lydia Hawk (Poole-5th)	12.2	2	7	2.9	8	1.8	3	6
Eaton Creek @Evergreen Valley F	Southworth (Murphy-5th)	11.7	120	7	2.4	5	0.66	20	3
Nisqually @ Riverbend Cmpgrnd	Nisqually MS (Soles/Stave - 7/8th)	10	8	7.5	0.4	5.5	0	16.6	5
Nisqually@Frank's Landing	Wa He Lut School(Montrose-6th)	13.6	7	7	1.6	6	0	9.1	11
McAllister@ Steilacoom	River Ridge (Gradoville-9-12th)	6	32	7	-0.9	10	0	6.7	14
Red Salmon@ bridge	Meadows (Moore-4th)	4.3	52	7.5	-0.7	4	0.3	0	3
Wash Creek @ McBride's	Meadows (Taft-4th)	11	17	7.5	1.6	8	0	3.3	3
Sequalitchew Creek - North @ Mouth	Chloe Clark/Pioneer(Bradshaw-Salgado3Foyil-7/8th)								1

mystery @ yhs = FC = 8

NREP Fecal Coliform Data - Shellfish Protection Project

D. Wood, Yelm HS and K. Johnstone Columbia Crest Elementary

Location	Replicate	10/3/2008	12/4/2008	4/30/2009	6/9/2009	11/30/2009	1/4/2010	3/2/2010	4/11/2011
Ohop Creek @ mouth	1	n.a.	6	0	152	n.a.	n.a.	13	0
RM 0.1	2	n.a.	28	30	117	n.a.	n.a.	13	0
	3	n.a.	44	9	134	n.a.	n.a.	11	0
Ohop Creek-Oroville Rd.	1	0	0	0	5	17	1	2	6
RM 6.0	2	8	4	0	4	10	0	2	0
	3	14	4	7	6	0	1	1	2
Ohop Creek @ Peterson Rd.	1	24	8	0	37	0	18	5	0
RM 2.2	2	62	16	50	23	11	17	43	11
	3	66	32	6	54	1	11	30	20
Lynch Creek - Ski Park	1	36	20	44	17	3	55	6	14
RM 6.2T	2	51	20	11	16	2	47	4	1
	3	72	26	56	15	7	47	2	10
25 Mile Creek	1	23	4	113	19	1	1	9	26
RM 10.2T	2	52	4	139	19	4	1	4	21
	3	56	8	108	15	9	1	2	22

C. Gradoville, River Ridge HS

	Replicate	2/12/2008	4/22/2008	5/15/2008	10/6/2008	11/18/2008	4/14/2009	5/13/2009	6/4/2009	11/19/2009	12/15/2009	1/18/2011
McAllister Creek @ Salmon Ln	1	0	10	0	42	27	71	30	57	17	68	0
	2	63	0	0	19	40	65	29	n.a.	23	57	17
	3	76	0	2	23	35	51	38	51	19	1	0
Little McAllister Cr. @ Mallard Ct.	1	0	2	0	n.a.	51	0	4	58	49	n.a.	1
	2	0	5	0	n.a.	34	0	0	24	43	n.a.	3
	3	2	4	TMC	n.a.	42	0	0	60	62	n.a.	3
Little McAllister Cr. Near mouth	1	n.a.	11	19	n.a.	20	64	46	75	n.a.	n.a.	7
	2	n.a.	6	11	n.a.	0	64	35	45	n.a.	n.a.	12
	3	n.a.	9	17	n.a.	0	TMC	13	87	n.a.	n.a.	13
McAllister Cr @ I-5	1	9	32	2	TMC	cont.	72	41	98	73	2	21
	2	8	37	3	TMC	12	71	39	91	63	n.a.	15
	3	3	28	4	TMC	18	96	24	n.a.	74	0	19
Nisqually @ 6th Ave	1	14	4	0	0	1	18	10	15	19	16	14
	2	19	1	17	0	0	17	12	14	25	6	9
	3	18	3	32	14	0	16	0	11	27	2	12
Red Salmon Creek	1	5	0	38	123	n.a.	32	29	39	0	n.a.	29
	2	0	0	49	107	n.a.	28	24	44	0	n.a.	16
	3	4	0	50	113	n.a.	38	13	47	0	n.a.	10

n.a. = data not available

TMC = too many to count

cont. = contaminated

Benthic Macroinvertebrates Monitoring

Chapter Includes:

Streams Sampled

Procedures

Results

Benthic Macroinvertebrates Monitoring

Collecting data on macroinvertebrates helps to determine the biological health of streams and to identify areas where degradation is occurring due to human impacts. This is clearly discussed and illustrated in the following *Field Guide to Freshwater Invertebrates* by Leska Fore.

This report includes sample results for 2010 and 2011. There were 28 samples collected in 2010 and 27 collected in 2011. The sample sites are listed below and the results are included at the end of the chapter.

Samples were collected by Thurston County Environmental Health staff and by volunteers of the local Stream Teams for Thurston County and the cities. The sampling procedures and analysis procedure used were developed by Dr. James R. Karr, University of Washington. The samples were analyzed by Aquatic Biology Associates, Inc., Corvallis, Oregon using a species level B-IBI scoring criteria developed by Leska Fore. (Fore, L.S., K. Paulsen and K. O’Laughlin, 2000, “Assessing the Performance of Volunteers in Monitoring Streams.” *Freshwater Biology*. In press.) A benthic index of biological integrity, or B-IBI, was generated for each sample. A B-IBI is a multimetric index approach which results in each stream receiving a “score” of low, medium or high biological integrity.

The aquatic insects are sorted from the organic debris in the sample by the analytical lab rather than by field sample collection staff and volunteers. In 2003 the sample area was tripled, from 3 square feet to 9 square feet, to ensure an adequate number of insects to accurately represent the stream.

Included in this chapter is a listing of the sites sampled for macroinvertebrates, excerpts from a field guide on macroinvertebrates and their use as an indicator of stream health, Stream Team and Thurston County sampling and lab procedure, and the results sheets with benthic index of biological integrity scores for the creeks sampled.

Streams Sampled

The stream sites sampled by the Stream Team volunteers in 2010 and 2011 are as follows:

Black Lake Ditch @ R. W. Johnson Road
Deschutes River @ Pioneer Park
Eaton Creek @ Yelm Hwy.
Ellis Creek @ Priest Point Park - east side of East Bay Drive
Fox Creek @ Pleasant Glade NE
Green Cove Creek @ 36th Ave NW
Indian Creek @ Wheeler Ave SE
Little McAllister Creek @ Meadows
McAllister Creek @ Steilacoom Rd
McLane Creek @ DNR Nature Trail
Mission Creek @ Bethel Street NE & East Bay Drive
Moxlie Creek @ Watershed Park

Palm Creek @ Pleasant Glade NE
Percival Creek @ SPSCC Artist's Bridge
Schneider Creek @ West Bay Drive
Thompson Creek @ Centralia Canal & Powerhouse
Woodland Creek @ Draham Rd. & Pleasant Glade Rd.
Yelm Creek @ Peterson's & Sheasley's

Eight streams were sampled by Thurston County Environmental Health staff in 2010 and 2011. The samples were collected at the ambient monitoring locations. They are as follows:

Chambers Creek off end of 58th Avenue off Henderson Blvd
Green Cove Creek off Cooper Point Rd at 4300 block
Kennedy Creek near Hwy 101
McLane Creek @ Delphi Rd./McKenzie Rd. bridge
Percival Creek at foot bridge below Evergreen Park Ct.
Perry Creek @ Perry Creek Rd. SW
Schneider Creek @ Pneumonia Gulch Ln NW
Woodard Creek off Libby Rd. at 4100 block

Field Guide to Freshwater Invertebrates

Leska S. Fore

Annabel Wildrick (Illustrations)

The animals living in a stream provide the best indicators of that stream's overall health and ecological condition. Human activities that alter a watershed and interfere with the natural processes of a stream have immediate as well as long-lasting effects on the animals that live in the stream. We monitor invertebrates because they represent an enormous diversity of body shapes, survival strategies, and adaptations. Many invertebrates require clear, cool water, adequate oxygen, stable flows, and a steady source of food in order to complete their life cycles. These animals, in turn, provide food for trout, salmon, herons, and kingfishers. Below are descriptions of the invertebrates you might expect to find at an excellent stream site (i.e., a site unchanged by humans), a moderate site, and a poor (i.e., degraded) site.

Excellent stream site

Here we find a variety of organisms with very different body shapes and ways of making a living. High biodiversity (or taxa richness) indicates a site with low human influence: most of the animals on this guide sheet should be present in a riffle sample. Several different types (or taxa) of stoneflies, mayflies, and caddisflies indicate a healthy site. More than one type of riffle beetle may also be identifiable, some are longer and skinnier than others. Some caddisflies are tolerant of degradation, so a large number of caddisflies does not necessarily indicate a good site, especially if they are the same species.

Moderate stream site

The total number of different types of organisms (taxa richness) declines as degradation increases. About half to two-thirds the number of taxa found at an excellent site are found in a moderate site. The primary change from an excellent site is that there will be many fewer taxa of stoneflies. Mayflies will be present, but probably fewer taxa as well. Several types of caddisflies may be present depending on the type of degradation. The relative proportions of soft-bodied worms, baetid mayflies, simuliid flies, or amphipods may increase. Beetles are probably still present; molluscs are not.

Poor stream site

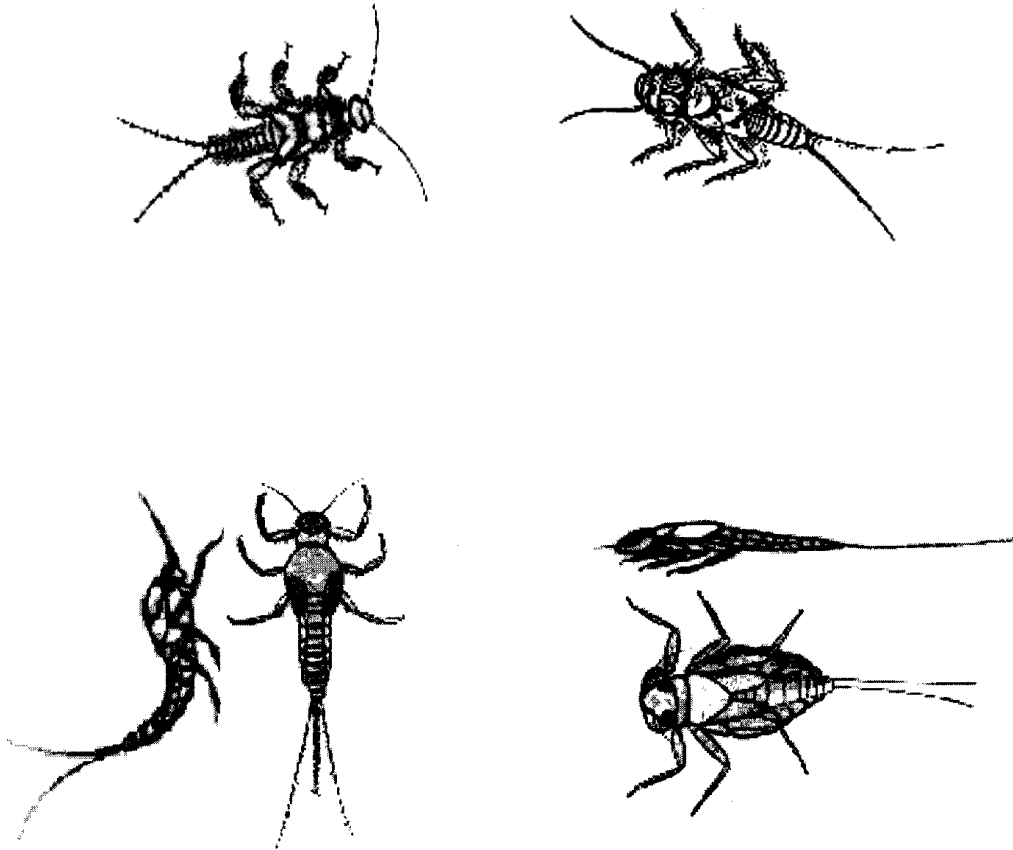
The total number of taxa will be low. Most of the taxa found are soft-bodied animals, e.g., fly larvae, oligochaetes, nematodes, and in very poor sites, leeches and planaria. Worms are often difficult to distinguish from each other because their shapes are similarly adapted to living in soft sediments. Stoneflies are absent entirely. The only mayflies present are probably baetids (a family of mayflies). Caddisflies may be present, but only a few tolerant types. Amphipods are often present. There may be a large proportion of a single type of animal. In general, animals present may be smaller than those found at an excellent site.

Mayfly nymphs (*Order Ephemeroptera*)

Mayflies are insects that spend most of their lives in streams, emerging briefly as adults ("ephemerally") to mate and lay eggs. Gills are often visible along the abdomen. If an animal has three tails it's a mayfly; but some mayflies have two tails. Mayfly nymphs are strong swimmers and move like dolphins. As immature nymphs many mayflies feed on algae; as adults they do not eat. Mayfly diversity declines as streams are degraded; mayflies are particularly sensitive to mine waste.

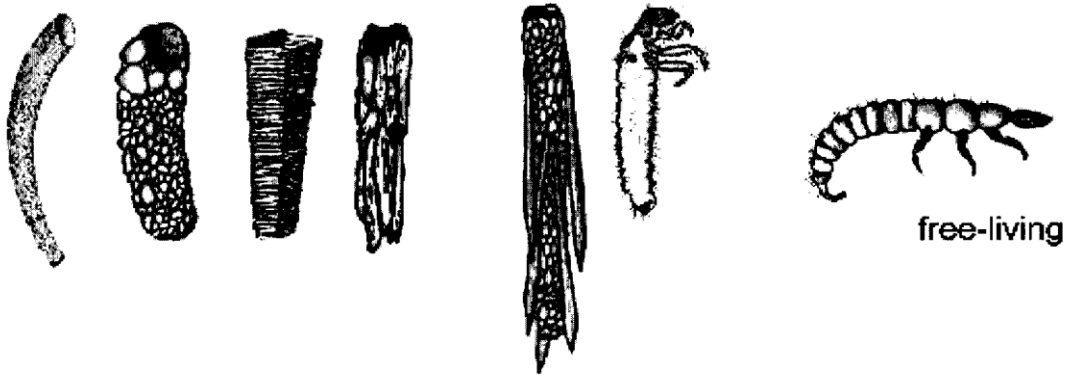
Stonefly nymphs (*Order Plecoptera*)

Stonefly nymphs are typically found on or near stones in the stream. They are rather primitive and may have been among the first insects to develop flight. Adult males and females emerge from the water to mate and locate each other by drumming with their abdomens. Stoneflies move like turtles and many are predators that hide and stalk their prey between stones and cobble. Stoneflies look similar to mayflies but are stockier. Diversity of these animals declines rapidly at the first signs of human disturbance.



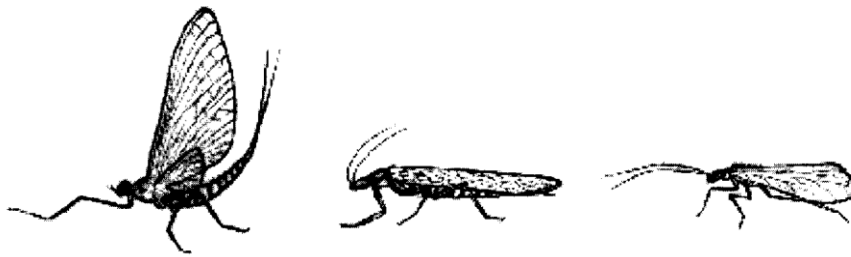
Caddisfly larvae (*Order Trichoptera*)

Caddisflies use silk (like butterflies) to build cases from gravel, twigs, needles, or sand. Different species build distinct cases, but they often lose them when removed from a stream. Caddisflies are insects that emerge to mate as winged adults. Caddisfly larvae make a living in a variety of ways: some capture food in nets, others scrape algae or shred leaf litter. Free-living caddisfly larvae do not build cases; many are predators and need to move quickly to capture other animals for food. Some caddisflies are very sensitive to human disturbance; others are tolerant.



Adult mayfly, stonefly, caddisfly

All three of these groups leave the water to mate as winged adults. Large swarms of mating mayflies and caddisflies often occur when all the individuals of a single species emerge at the same time. Stoneflies crawl out of the water and mate on the ground. The females of all three groups fly upstream and drop their eggs onto the water or dive into the stream to attach them to rocks or leaves.



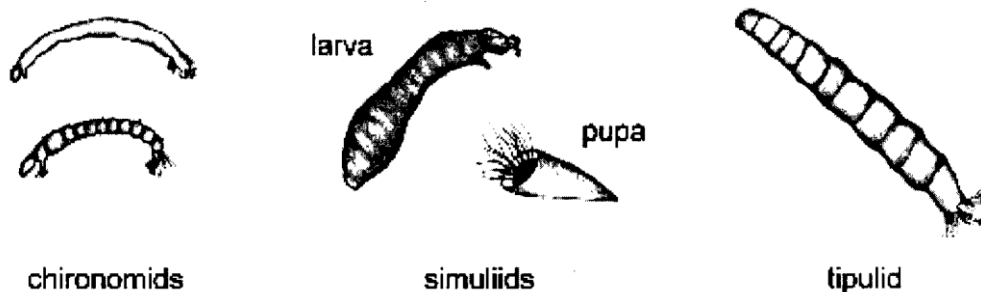
Riffle beetles (*Order Coleoptera*)

Riffle beetle larvae are specially adapted to cling to smooth rocks in fast-flowing water (riffles). After emergence, adults fly for a short time but return to the water to feed in the same habitat as the larvae. Both the larvae and adults are rather small, dark-colored, and tend to drift to the bottom of a sample so they may be hard to see. Riffle beetles collect and gather a variety of different foods.



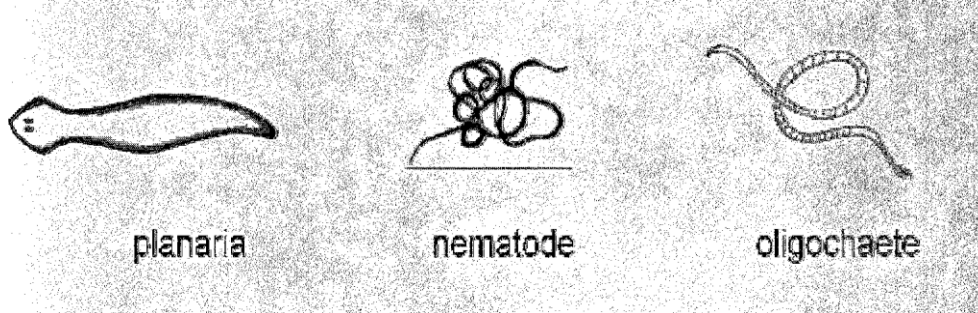
Fly larvae (*Order Diptera*)

There are many species of true flies, but you are likely to recognize three main groups or families. Midge larvae (or chironomids) are very small, often C-shaped, and have a spastic squirming movement. They are often attached to debris by their tiny legs. Black fly larvae (or simuliids) are dumb-bell shaped and soft. They attach themselves to the substrate and prefer soft sediment. Crane fly larvae (or tipulids) are large and fleshy with very short "tentacles" at one end.



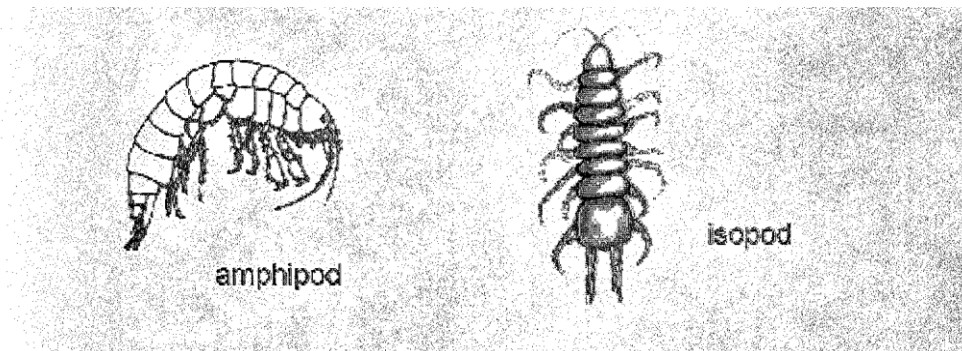
Aquatic worms

Flatworms (planaria), roundworms (nematodes), and freshwater earthworms (oligochaetes) are properly called worms; but don't confuse them with the soft-bodied larvae of flies, for examples, which are not. Nematodes and oligochaetes are long and thin and writhe like snakes. Note that these animals do not have legs.

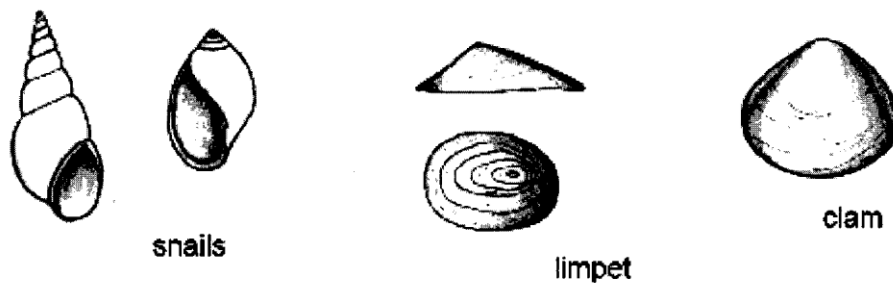


Crustaceans

Amphipods (or “scuds”) are very fast swimmers that look like shrimp. They have many appendages and look fuzzy. High proportions of these animals are present in very degraded sites. Isopods (or sowbugs) are usually found creeping through leaf litter.

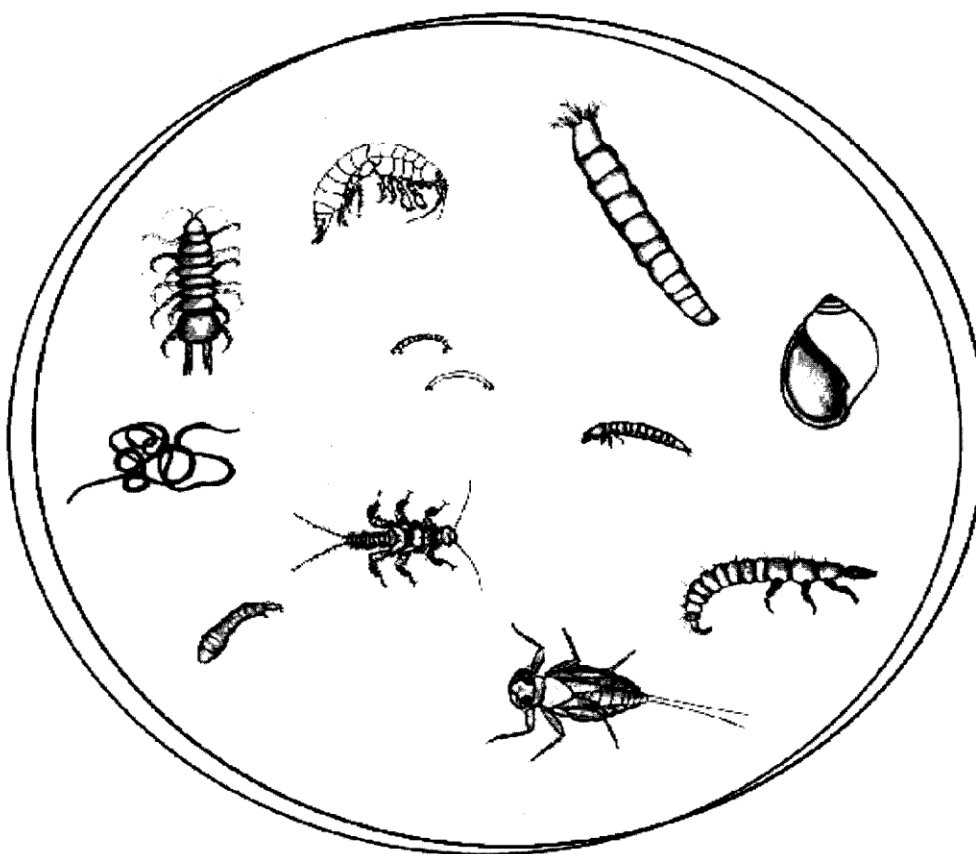


Molluscs (Classes Gastropoda & Pelecypoda)



Most snails and limpets eat algae they scrape from rocks. Check to see if the animal is still in the shell. As larvae, freshwater mussels (or clams) may hitch a ride by attaching themselves to migrating fish. Mussels are very sensitive to sediment because they feed by filtering stream water through their shells. Mature mussels indicate an undisturbed site and may be up to 40 years old.

Petri dish of invertebrates illustrates their approximate, relative size.



About this guide. Funding was provided through a King County Regional Water Quality Block Grant and the Bellevue Utilities Department (Seattle, WA). The guide was developed in 1998 for volunteers in the Pacific Northwest; therefore, the invertebrates illustrated are common to this area and the site descriptions may be specific to this region. This guide is published on the internet at www.seanet.com/~leska. You may download, copy, or distribute this guide for educational purposes but not for resale. For more information contact leska@seanet.com.

PROCEDURES (adapted from Stream Team Benthic Macroinvertebrate Monitoring Packet 2002)

When to sample: Species composition and population sizes of macroinvertebrates vary substantially through a stream's seasonal cycles. Because the goal is to assess the influence of human actions, not natural variation through time, samples are collected during a "window". For Pacific Northwest streams, that window is between July 1 and October 15. This gives representative sampling of stream invertebrates, avoids endangering from seasonal high water, and avoids the salmon spawning season.

Checklist of Equipment:

clipboard & reporting sheet	trash bags	big plastic scoop
pencil and permanent marker	flashlight	2 magnifying glasses
map of site	meter tape	stopwatch
500 micron mesh Surber sampler	waders (opt.)	first aid kit
flagging (use rocks or weights)	squirt bottle	small spray bottle
weed fork for stirring sample	2 buckets	bottle of alcohol
metric ruler	forceps	tarp
screened rinsing jug	3 plastic containers with lids	
insect repellent (opt.)	rubber gloves	

Selecting a Riffle:

Sampling should be done in a riffle environment (fast moving water over rock or cobble substrate; surface water should be broken) near the middle of the stream. The water should be 10-40 cm in depth. Three riffles will be needed to complete the protocol. Each riffle (A, B, and C) will be sampled in three places to produce a "composite sample" for that riffle. Ideally, a riffle should be long enough to accommodate three samples. The first sample should be taken a few feet from the end of the riffle; the second sample in the middle of the riffle; and the third sample a few feet from the top of the riffle. Ideally, the samples would be at least 5 feet apart, and riffles A, B, and C would be separated by areas of quiet water such as "pools" or "glides." (The three riffles may be only a few feet apart, or may be much farther apart, depending on the site.) Avoid bridges and other large human-made structural features if possible. (If you encounter such a feature, sampling would ideally be done at least 50 meters upstream and 200 meters downstream of it.)

Sampling Procedure:

Approach the riffle from downstream. If three people are available to work in the water, one can hold the net and read the instructions; one can perform the sampling; and one can hold the bucket and tools (weed fork, flagging, and big plastic scoop) and be the "timer". If there is a fourth person, he/she can stay on the shore and be the instruction-reader.

1. Place the Surber sampler on the streambed with the opening of the net facing upstream, parallel to the current. Hold the brass frame firmly on the substrate to prevent invertebrates from slipping under the net.

2. While one person holds the net, another person should lift any large rocks (2+ inches) within the frame and wash into the net any organisms crawling on or attached to the rocks. Put the washed rock into the bucket for further “picking” onshore. If a large rock is half inside the sample grid and half outside, only wash the part of the rock that is inside the grid. In such a case, make sure you remove all organisms from the inside half of the rock and then place it in the stream, away from the net, instead of in the bucket.
3. Using both hands, **vigorously** stir the remaining substrate with the weed fork. Stir to a depth of 10 cm (4 inches) for **60 seconds** to loosen organisms. If you encounter more large rocks that interfere with stirring, stop the clock, wash any organisms off the large rocks and into the net, and put the rocks in the bucket. Then start the clock and continue stirring. (The three samples should be stirred in the same way, so observe each other’s stirring technique.) When finished stirring, check to see if some small rocks have entered the net during the stirring. If so, scoop them up, “wash” them in the stream at the mouth of the net, and put the rocks back in the stream.
4. Slowly lift the brass frame off the substrate, tilting the net up and out of the water. Place a flagged weight exactly where the Surber sampling grid was placed. Move upstream to the middle of the riffle and repeat steps 1-3. Again lift the brass frame off the substrate, tilting the net up and out of the water, and place a second flagged weight. Move upstream to the top of the riffle, and repeat steps 1-3 for a third time.
5. After sampling at the third location in the riffle, slowly lift the brass frame off the substrate, tilting the net up and out of the water once more. Keeping the opening of the net above water, use the large plastic scoop to pour water through the net, **from the outside in**, to wash trapped or clinging organisms into the Surber sampler’s “cod”. Place a flagged weight exactly where the Surber grid was placed during the third sample.
6. Carry the net and the bucket to shore. (Avoid standing in the creek whenever possible.) Set the net down on the tarp and twist it to prevent bugs from escaping. Using the magnifying glass and forceps, examine all the rocks in the bucket. Pick off any organisms and place them in the first plastic sample container. **Make sure that any water you use to rinse rocks, equipment, or your hands comes from the screened rinsing jug.** After having a second person check the rocks, return the rocks to the stream. Check the bucket for any “escaped” bugs too.
7. Now remove the cod end of the net and dump it into the plastic sample container. If the cod is “overflowing” with leaf debris, make sure all material is captured from the inside of the net. Use water from the screened rinsing jug, the spray bottle, the flashlight, and long forceps to make sure all bugs are removed from the cod and placed in the plastic sample container. Turn the net inside out and use small forceps to pick off any bugs still clinging to the net and add them to the sample. (If a bug is clinging so tightly to the cod screen or net that you cannot dislodge it, use a tiny drop of alcohol to make it release its “grip”.)
8. Snap the lid on securely, making sure that lid “A” goes onto the composite sample from the first riffle (Riffle A). If the net seems “gritty” or “filmy”, it can be rinsed in the stream (without the cod attached) as long as you check to make sure no new organisms are caught on it.
9. Move upstream to the next riffle suitable for sampling. Repeat entire procedure for Riffle B and again for Riffle C, storing each composite sample in a separate plastic container.

10. Fill in the Macroinvertebrate Sampling Report. Record the riffle locations by measuring, in a straight line, from a reference point to the downstream ends of Riffle A, Riffle B, and Riffle C. Gather the 9 flagged weights and take all equipment immediately to the Stream Team lab. We need to put the organisms in alcohol as soon as possible to prevent deterioration.

Lab Protocol

Equipment:

shallow pans	forceps
magnifying glasses	alcohol
mailing bottles	labels and pens
squirt bottles	500 micron sieve
rubber spatula	plastic spoon

Procedure:

1. Choose a station for preparing your samples for mailing. Keep all bugs at that station only.
2. **ONLY WORK ON ONE PLASTIC CONTAINER AT A TIME.** Open container A and prepare that sample for mailing before opening up container B.
3. Remove any debris or rocks which are larger than the mailing bottle and put them in a shallow pan. Use a magnifying glass and forceps to pick any bugs off the debris or rocks. Place bugs in mailing bottle.
4. “Decant” the remaining sample by swirling the contents of the plastic container and pouring it off through the sieve. (This can be done at a sink or outside.) Add water to the container, swirl, and pour at least five times, until all the organic matter is in the sieve. Check through the remaining sand and rocks to make sure there are no caddis fly cases, snails, or other bugs remaining. Discard the sand and rocks and rinse the plastic container.
5. Use water to wash organic matter to the side of the sieve. Use the rubber spatula or a spoon to transfer contents of the sieve into the mailing bottle. Check the sieve for any clinging organisms, and use alcohol to dislodge any remaining bugs.
6. Fill the mailing bottle to the top with alcohol and put the lid on tightly.
7. Label the mailing bottle with:
Creek Name & Site Location
Date
Stream Team, 360-357-2491
Riffle A B C (*Circle one*)

Black Lake Ditch at RW Johnson Blvd SW

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Station Client Date	Black Lake Ditch RW Johnson Blvd Stream Team 8/22/04		Black Lake Ditch RW Johnson Blvd Stream Team 8/10/05		Black Lake Ditch RW Johnson Blvd Stream Team 6/21/06		Black Lake Ditch RW Johnson Blvd Stream Team 6/21/07		Black Lake Ditch RW Johnson Blvd Stream Team 6/19/08		Black Lake Ditch RW Johnson Blvd Stream Team 7/2/09	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	34	3	34	3	37	3	35	3	36	3	42	5
D Number Ephemeroptera taxa	3	1	4	1	3	1	3	1	3	1	4	1
D Number Plecoptera taxa	4	3	2	1	3	1	5	3	4	3	4	3
D Number Trichoptera taxa	6	3	5	3	6	3	6	3	7	3	8	3
D Number of long-lived taxa	2	1	2	1	1	1	2	1	1	1	2	1
D Number of intolerant taxa	0	1	0	1	0	1	1	1	1	1	1	1
I % Tolerant taxa	29.04	3	21.32	3	14.54	5	9.62	5	6.82	5	22.75	3
D % Predator	1.49	1	26.96	5	1.28	1	2.83	1	1.72	1	3.51	1
D Number of clinger taxa	20	3	21	5	20	3	21	5	21	5	24	5
I % Dominance (3 taxa)	54.73	3	57.46	3	87.2	1	83.63	1	88.43	1	70.89	3
TOTAL SCORE		22		26		20		24		24		23
BIOLOGICAL CONDITION CATEGORY		low		moderate		low		low		low		low

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	3160	1252	12726	8667	28059	7451
D EPT taxa richness	13	11	12	14	14	16
D Predator richness	9	9	10	9	11	11
D Scraper richness	8	8	7	7	5	9
D Shredder richness	3	3	3	5	5	4
D %Intolerant taxa	0	0	0	0.03	0.03	1.16
I Hilsenhoff Biotic Index	4.95	5.2	5.35	5.29	6.06	6.09
I % <i>Baetis tricaudatus</i>					4.4	18.63
I %Collector	75.98	83.47	91.54	86.45	93.17	82.05
I %Parasite	1.04	0.29	0	0.25	0.24	0.45
I %Oligochaeta	4.31	7.93	0.45	0.86	0.72	1.57
I Number tolerant taxa	8	10	8	6	9	10
I %Simuliidae	40.98	43.69	63.12	59.18	76.22	24.06
I %Chironomidae	1.55	1.53	3.69	3.29	5.56	7.9

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.

D= Metric value generally decreases with declining biological integrity.

L= Low biological integrity.

M= Moderate biological integrity.

H= High biological integrity.



BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Black Lake Ditch at RW Johnson Blvd SW

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body
Station
Client
Date

Black Lake Ditch
RW Johnson Blvd
Stream Team
6/21/10

Black Lake Ditch
RW Johnson Blvd
Stream Team
6/21/11

METRIC	Value	Score	Value	Score
D Total number of taxa	34	3	40	3
D Number Ephemeroptera taxa	2	1	3	1
D Number Plecoptera taxa	4	3	6	3
D Number Trichoptera taxa	7	3	7	3
D Number of long-lived taxa	1	1	2	1
D Number of intolerant taxa	0	1	0	1
I % Tolerant taxa	5.39	5	15.45	5
D % Predator	3.2	1	7.78	1
D Number of clinger taxa	20	3	24	5
I % Dominance (3 taxa)	80.97	1	60.17	3
TOTAL SCORE		22		26
BIOLOGICAL CONDITION CATEGORY		low		moderate

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	18309		9197	
D EPT taxa richness	13		16	
D Predator richness	9		13	
D Scraper richness	6		3	
D Shredder richness	4		3	
D %Intolerant taxa	0		0	
I Hilsenhoff Biotic Index	6.01			
I % <i>Baetis tricaudatus</i>	1.27		8.75	
I %Collector	86.82		82.72	
I %Parasite	0		0.64	
I %Oligochaeta	1.26		2.87	
I Number tolerant taxa	10		10	
I %Simuliidae	74.76		51.37	
I %Chironomidae	9.2		15.69	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

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Chambers Creek off 58th Ave. SE

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Station Client Date	Chambers Creek off 58th Ave. SE Public Health 9/23/04		Chambers Creek off 58th Ave. SE Public Health 9/15/05		Chambers Creek off 58th Ave. SE Public Health 9/7/06		Chambers Creek off 58th Ave. SE Public Health 9/20/07		Chambers Creek off 58th Ave. SE Public Health 8/28/08		Chambers Creek off 58th Ave. SE Public Health 8/4/09		Chambers Creek off 58th Ave. SE Public Health 7/13/10		Chambers Creek off 58th Ave. SE Public Health 7/7/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	57	5	59	5	39	3	54	5	54	5	45	5	51	5	51	5
D Number Ephemeroptera taxa	7	3	9	5	6	3	8	3	7	3	7	3	8	3	5	3
D Number Plecoptera taxa	10	5	7	3	7	3	10	5	9	5	5	3	6	3	6	3
D Number Trichoptera taxa	11	5	11	5	11	5	10	5	11	5	11	5	12	5	14	5
D Number of long-lived taxa	9	5	6	5	4	3	5	5	5	5	3	3	4	3	4	3
D Number of intolerant taxa	1	1	2	1	0	1	0	1	0	1	0	1	0	1	0	1
I % Tolerant taxa	12.83	5	17.53	5	16.57	5	20.48	3	14.36	5	13.49	5	10.22	5	4.59	5
D % Predator	35.6	5	14.4	3	17.15	3	23.02	5	17.81	3	13.16	3	14.07	3	8.13	1
D Number of clinger taxa	>20	5	>20	5	>20	5	>20	5	36	5	31	5	33	5	33	5
I % Dominance (3 taxa)	42.78	5	39.05	5	43.15	5	30.76	5	31.66	5	41.95	5	34.66	5	44.4	5
TOTAL SCORE		44	42		36		42		42		38		38		36	
BIOLOGICAL CONDITION CATEGORY		high	high		moderate		high		high		moderate		moderate		moderate	

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	1855	2561	419	1580	2151	4232	3490	2188
D EPT taxa richness	28	27	24	28	27	23	26	25
D Predator richness	15	15	12	17	14	12	14	13
D Scraper richness	15	15	10	12	14	13	14	6
D Shredder richness	10	9	6	8	9	6	6	3
D %Intolerant taxa	3.16	4.14	0	0	0	0	0	0
I Hilsenhoff Biotic Index	3.07	4.27	4	3.57	5.9	5.94	5.94	
I % Baetis tricaudatus					10.24	26.72	5.52	1.69
I %Collector	38.24	65.16	67.43	43.2	58.16	59.55	57.45	51.18
I %Parasite	1.1	1.41	1.15	2.65	10.35	0.92	0.7	5.79
I %Oligochaeta	4.97	20.89	9.14	2.58	6.51	13.09	12.84	17
I Number tolerant taxa	8	7	3	6	8	8	6	7
I %Simuliidae	9.81	6.01	20.29	4.62	11.96	1.9	9.57	7.5
I %Chironomidae	4.26	9.76	8	3.56	7.68	5.17	12.84	12.21

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.
BIBI scores between 25-39.
BIBI scores >40.

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Deschutes River @ Pioneer Park

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Deschutes River		Deschutes River		Deschutes River		Deschutes River		Deschutes River		Deschutes River	
Station	Pioneer Park		Pioneer Park		Pioneer Park		Pioneer Park		Pioneer Park		Pioneer Park	
Client	Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team	
Date	8/19/06		8/18/07		8/16/08		8/8/09		8/14/10		8/13/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	69	5	56	5	66	5	50	5	64	5	66	5
D Number Ephemeroptera taxa	11	5	11	5	9	5	7	3	8	3	13	5
D Number Plecoptera taxa	9	5	5	3	7	3	5	3	9	5	7	3
D Number Trichoptera taxa	11	5	8	3	11	5	7	3	8	3	14	5
D Number of long-lived taxa	5	5	2	1	3	3	3	3	5	5	6	5
D Number of intolerant taxa	1	1	1	1	0	1	1	1	0	1	0	1
I % Tolerant taxa	11.62	5	24.16	3	34.27	3	34.44	3	33.7	3	32.34	3
D % Predator	5.52	1	1.51	1	2.41	1	2.31	1	2.17	1	3.61	1
D Number of clinger taxa	>20	5	>20	5	40	5	29	5	35	5	42	5
I % Dominance (3 taxa)	27.43	5	45.09	5	39.24	5	59.19	3	63.23	3	41.2	5
TOTAL SCORE		42		32		36		30		34		38
BIOLOGICAL CONDITION CATEGORY		low		moderate		moderate		moderate		moderate		moderate

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	5037		14446		14978		2756		13250		20659	
D EPT taxa richness	31		24		27		19		25		34	
D Predator richness	18		8		13		10		15		16	
D Scraper richness	18		13		18		14		13		10	
D Shredder richness	5		4		5		4		4		4	
D %Intolerant taxa	0.1		0.07		0		0.09		0		0	
I Hilsenhoff Biotic Index	4.59		4.63		6.12		6.12		6			
I % <i>Baetis tricaudatus</i>					23.84		29.4		28.04		28.41	
I %Collector	55.69		71.78		62.49		61.36		58.63		77.25	
I %Parasite	3.75		2.62		3.45		1.04		0.64		0.65	
I %Oligochaeta	0.33		0.17		2.21		4.65		0.87		0.97	
I Number tolerant taxa	13		10		19		13		14		13	
I %Simuliidae	13.17		5.43		3.52		14.03		17.23		5.89	
I %Chironomidae	37.95		40.79		21.96		6.25		10.27		25.9	

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BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Eaton Creek at Yelm Highway

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Eaton Creek		Eaton Creek		Eaton Creek	
Station	Yelm Highway		Yelm Highway		Yelm Highway	
Client	Stream Team		Stream Team		Stream Team	
Date	7/27/09		7/15/10		7/14/11	
METRIC	Value	Score	Value	Score	Value	Score
D Total number of taxa	55	5	42	5	43	5
D Number Ephemeroptera taxa	4	1	3	1	5	3
D Number Plecoptera taxa	7	3	5	3	6	3
D Number Trichoptera taxa	12	5	12	5	10	5
D Number of long-lived taxa	4	3	3	3	5	5
D Number of intolerant taxa	2	1	2	1	1	1
I % Tolerant taxa	21.08	3	1.11	5	22.64	3
D % Predator	11.72	3	7.29	1	3.82	1
D Number of clinger taxa	33	5	28	5	27	5
I % Dominance (3 taxa)	51.79	3	70.35	3	72.84	3
TOTAL SCORE		32		32		34
BIOLOGICAL CONDITION CATEGORY		moderate		moderate		moderate

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	3436		7793		8267	
D EPT taxa richness	23		20		21	
D Predator richness	14		12		12	
D Scraper richness	11		6		3	
D Shredder richness	10		7		7	
D %Intolerant taxa	0.23		0.3		0.12	
I Hilsenhoff Biotic Index	5.98		5.78			
I % <i>Baetis tricaudatus</i>	19.36		0.41		22.41	
I %Collector	63.09		78.82		86.97	
I %Parasite	1.95		1.17		2.32	
I %Oligochaeta	5.13		5.33		8.22	
I Number tolerant taxa	5		3		2	
I %Simuliidae	4.42		58.52		42.33	
I %Chironomidae	10.11		7.71		5.21	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.

D= Metric value generally decreases with declining biological integrity.

L= Low biological integrity.

M= Moderate biological integrity.

H= High biological integrity.



BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Ellis Creek @ Priest Point Park

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Ellis Creek		Ellis Creek		Ellis Creek		Ellis Creek		Ellis Creek		Ellis Creek		Ellis Creek	
Station	Priest Point Park		Priest Point Park		Priest Point Park		Priest Point Park		Priest Point Park		Priest Point Park		Priest Point Park	
Client	Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team	
Date	8/10/05		8/2/06		7/14/07		7/15/08		7/23/09		7/22/10		7/19/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	52	5	57	5	52	5	59	5	66	5	67	5	55	5
D Number Ephemeroptera taxa	5	3	6	3	4	1	3	1	3	1	4	1	3	1
D Number Plecoptera taxa	9	5	9	5	12	5	10	5	13	5	14	5	12	5
D Number Trichoptera taxa	10	5	10	5	10	5	6	3	14	5	13	5	9	3
D Number of long-lived taxa	4	3	7	5	6	5	4	3	5	5	8	5	5	5
D Number of intolerant taxa	3	3	4	5	4	5	5	5	5	5	7	5	5	5
I % Tolerant taxa	3.77	5	5.67	5	10.88	5	8.98	5	7.34	5	5.55	5	7.78	5
D % Predator	32.76	5	30.16	5	37.65	5	34.1	5	37.73	5	25	5	28.75	5
D Number of clinger taxa	>20	5	>20	5	33	5	26	5	39	5	39	5	32	5
I % Dominance (3 taxa)	40.44	5	36.09	5	46.53	5	53.79	3	35.87	5	29.52	5	33.74	5
TOTAL SCORE	44		48		46		40		46		46		44	
BIOLOGICAL CONDITION CATEGORY	high		high		high		high		high		high		high	

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	983	1476	1431	1451	2482	3880	2764
D EPT taxa richness	24	25	26	19	30	31	24
D Predator richness	18	20	18	18	26	22	21
D Scraper richness	9	12	7	5	7	8	5
D Shredder richness	5	7	8	5	10	13	6
D %Intolerant taxa	0.48	0.48	1.09	1.65	1.27	1.04	1.37
I Hilsenhoff Biotic Index	3.69	3.74	3.05	5.17	5.36	5.5	
I % <i>Baetis tricaudatus</i>				8	5.98	3.89	7.28
I %Collector	49.7	47.27	29.53	23.05	34.63	44.67	41.07
I %Parasite	1.71	0.49	0.75	3.13	0.96	1.49	1.37
I %Oligochaeta	0.49	0.65	0.25	0.83	0.87	5.29	3.64
I Number tolerant taxa	4	4	2	5	5	6	3
I %Simuliidae	2.56	9.57	5.36	0.17	8	5.15	4.09
I %Chironomidae	17.54	18.49	16.57	16.09	16.01	20.52	20.95

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.
BIBI scores between 25-39.
BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Fox Creek @ Pleasant Glade NE

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Fox Creek		Fox Creek		Fox Creek		Fox Creek		Fox Creek		Fox Creek		Fox Creek	
Station	Pleasant Glade		Pleasant Glade		Pleasant Glade		Pleasant Glade		Pleasant Glade		Pleasant Glade		Pleasant Glade	
Client	Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team	
Date	8/10/04		8/16/05		8/2/06		8/15/07		7/11/09		6/26/10		7/11/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	39	3	31	3	38	3	33	3	47	5	51	5	54	5
D Number Ephemeroptera taxa	3	1	2	1	3	1	2	1	3	1	4	1	4	1
D Number Plecoptera taxa	2	1	2	1	2	1	1	1	3	1	8	5	5	3
D Number Trichoptera taxa	2	1	0	1	3	1	1	1	6	3	7	3	8	3
D Number of long-lived taxa	1	1	1	1	1	1	0	1	1	1	1	1	3	3
D Number of intolerant taxa	0	1	1	1	3	3	0	1	1	1	3	3	0	1
I % Tolerant taxa	11.87	5	8.09	5	8.53	5	18.08	5	12.35	5	32.56	3	14.75	5
D % Predator	3.22	1	2.93	1	5.5	1	8.82	1	5.85	1	5.1	1	5.2	1
D Number of clinger taxa	16	3	13	3	15	3	12	3	21	5	26	5	26	5
I % Dominance (3 taxa)	71.32	3	75.75	1	58.49	3	62.38	3	53.44	3	51.4	3	44.41	5
TOTAL SCORE		20		18		22		20		26		30		32
BIOLOGICAL CONDITION CATEGORY		low		low		low		low		moderate		moderate		moderate

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	7221	12419	8299	3634	11659	8081	17626
D EPT taxa richness	7	4	8	4	12	19	17
D Predator richness	7	5	9	12	11	14	16
D Scraper richness	7	5	4	2	5	7	7
D Shredder richness	5	4	6	1	6	9	8
D %Intolerant taxa	0	0.03	0.6	0	0.15	0.7	0
I Hilsenhoff Biotic Index	6.69	6.58	6.18	6.61	6.37	6.65	
I % <i>Baetis tricaudatus</i>					3.91	20.57	7.26
I %Collector	81.47	82.72	73.55	76.19	74.53	66.63	81.77
I %Parasite	0.54	0.9	0.82	0.22	2.74	4.2	2.39
I %Oligochaeta	0.51	2.65	10.92	0.38	4.03	15.62	11.33
I Number tolerant taxa	13	13	9	10	13	13	14
I %Simuliidae	24.28	31.02	17.8	43.56	25.55	11.28	9.14
I %Chironomidae	63.87	54.38	52.84	41.61	40.39	15.44	42.42

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Green Cove Creek at Mouth & 36th Ave. NE

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Public Health and Social Services Department and Resource Stewardship-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Green Cove Creek		Green Cove Creek		Green Cove Creek		Green Cove Creek		Green Cove Creek		Green Cove Creek	
Station	Mouth Site		Mouth Site		Mouth Site		Mouth Site		Mouth Site		Mouth Site	
Client	Public Health		Public Health		Public Health		Public Health		Public Health		Public Health	
Date	8/23/06		9/12/07		7/24/08		7/9/09		7/20/10		7/16/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	32	3	58	5	61	5	54	5	58	5	66	5
D Number Ephemeroptera taxa	3	1	5	3	5	3	4	1	4	1	6	3
D Number Plecoptera taxa	5	3	8	5	10	5	8	5	9	5	13	5
D Number Trichoptera taxa	6	3	9	3	8	3	9	3	10	5	11	5
D Number of long-lived taxa	5	5	7	5	3	3	6	5	6	5	5	5
D Number of intolerant taxa	1	1	3	3	4	5	3	3	5	5	4	5
I % Tolerant taxa	10.06	5	29.67	3	22.92	3	30.34	3	13.24	5	18.81	5
D % Predator	17.88	3	17.13	3	17.62	3	18.59	3	11.54	3	12.59	3
D Number of clinger taxa	18	3	>20	5	30	5	30	5	33	5	38	5
I % Dominance (3 taxa)	56.24	3	47.21	5	53.51	3	50.84	3	55.04	3	36.71	5
TOTAL SCORE		30		40		38		36		42		46
BIOLOGICAL CONDITION CATEGORY		moderate		high		moderate		moderate		high		high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION												
Total abundance (m2)	643		1651		5869		2502		5766		3547	
D EPT taxa richness	14		22		23		21		23		30	
D Predator richness	12		16		16		18		16		18	
D Scraper richness	5		11		8		10		9		8	
D Shredder richness	4		7		9		6		8		9	
D %Intolerant taxa	0.37		1.38		0.48		1.79		1.2		1.06	
I Hilsenhoff Biotic Index	4.06		3.71		5.8		5.81		5.63			
I % <i>Baetis tricaudatus</i>					18.52		29.17		11.12		18.01	
I %Collector	51.21		29.76		49.88		53.2		52.08		64.52	
I %Parasite	0		1.38		4		0.96		2.49		4.18	
I %Oligochaeta	3.91		0.15		3.59		2.85		2.7		5.87	
I Number tolerant taxa	4		5		9		5		8		6	
I %Simuliidae	4.84		0.73		11.42		5.31		23.08		1.73	
I %Chironomidae	25.88		9.06		13.09		12.91		17.81		28.71	

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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H= High biological integrity.



BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Green Cove Creek at Mouth & 36th Ave. NE

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Public Health and Social Services Department and Resource Stewardship-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Green Cove Creek		Green Cove Creek		Green Cove Creek		Green Cove Creek		Green Cove Creek		Green Cove Creek	
Station	36th Ave. NW		36th Ave. NW		36th Ave. NW		36th Ave. NW		36th Avenue		36th Avenue	
Client	Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team	
Date	7/22/06		8/11/07		7/31/08		6/28/09		7/28/10		6/28/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	50	5	53	5	63	5	52	5	68	5	62	5
D Number Ephemeroptera taxa	3	1	5	3	5	3	4	1	5	3	6	3
D Number Plecoptera taxa	7	3	9	5	9	5	8	5	9	5	8	5
D Number Trichoptera taxa	9	3	10	5	11	5	9	3	10	5	17	5
D Number of long-lived taxa	2	1	2	1	3	3	5	5	4	3	6	5
D Number of intolerant taxa	2	1	3	3	4	5	2	1	5	5	4	5
I % Tolerant taxa	1.74	5	7.77	5	4.87	5	12.12	5	5.87	5	7.81	5
D % Predator	18.47	3	19.36	3	19.75	3	19.53	3	17.94	3	13.42	3
D Number of clinger taxa	>20	5	30	5	34	5	31	5	34	5	38	5
I % Dominance (3 taxa)	57.85	3	48.51	5	56.84	3	49.23	5	33.17	1	39.2	5
TOTAL SCORE		30		40		42		38		40		46
BIOLOGICAL CONDITION CATEGORY		moderate		high		high		moderate		high		high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION												
Total abundance (m2)	7003		9640		4969		8099		3949		12290	
D EPT taxa richness	19		24		25		21		24		31	
D Predator richness	15		17		20		16		18		21	
D Scraper richness	6		10		10		9		13		8	
D Shredder richness	7		7		10		6		10		5	
D %Intolerant taxa	0.08		1.66		0.73		0.18		1.63		0.5	
I Hilsenhoff Biotic Index	4.03		3.66		5.42		5.78		5.68			
I % <i>Baetis tricaudatus</i>					0.67		8.45		1.47		7.19	
I %Collector	46.7		42.77		33.25		62.47		45.23		56.52	
I %Parasite	1.13		2.61		1.97		1		5.84		5.22	
I %Oligochaeta	0.56		0.1		0.63		0.41		9.26		8.46	
I Number tolerant taxa	6		5		8		7		12		4	
I %Simuliidae	0.58		0.05		0.19		28.84		0.16		4.18	
I %Chironomidae	40.57		29.15		33.14		29.96		24.78		27.05	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Indian Creek @ Wheeler Avenue SE

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Indian Creek		Indian Creek		Indian Creek		Indian Creek		Indian Creek		Indian Creek		Indian Creek	
Station	Wheeler Ave SE		Wheeler Ave SE		Wheeler Ave SE		Wheeler Ave SE		Wheeler Ave SE		Wheeler Ave. SE		Wheeler Ave. SE	
Client	Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team	
Date	8/14/03		8/10/04		8/17/05		8/5/06		7/6/07		7/21/09		7/14/10	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	41	5	36	3	40	3	40	3	40	3	39	3	42	5
D Number Ephemeroptera taxa	4	1	3	1	3	1	4	1	3	1	4	1	4	1
D Number Plecoptera taxa	6	3	5	3	6	3	5	3	5	3	4	3	5	3
D Number Trichoptera taxa	8	3	6	3	5	3	5	3	6	3	6	3	5	3
D Number of long-lived taxa	4	3	2	1	4	3	5	5	4	3	6	5	5	5
D Number of intolerant taxa	2	1	1	1	3	3	1	1	2	1	2	1	2	1
I % Tolerant taxa	10.22	5	7.66	5	3.08	5	3.67	5	6.83	5	1.74	5	7	5
D % Predator	23.53	5	24.52	5	24.38	5	21.51	5	24.42	5	13.62	3	16.4	3
D Number of clinger taxa	>20	5	20	3	21	5	22	5	24	5	21	5	22	5
I % Dominance (3 taxa)	36.07	5	42.88	5	55.33	3	52.29	3	37.94	5	49.61	5	51.31	3
TOTAL SCORE		36		30		34		34		34		34		34
BIOLOGICAL CONDITION CATEGORY		moderate		moderate		moderate		moderate		moderate		moderate		moderate

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	1921		547		1045		1435		789		1100		1975	
D EPT taxa richness	18		14		14		14		14		14		14	
D Predator richness	12		10		9		11		9		9		9	
D Scraper richness	6		7		7		8		10		7		8	
D Shredder richness	6		5		7		5		8		7		6	
D %Intolerant taxa	8.48		0.22		4.57		0.33		0.45		0.22		0.29	
I Hilsenhoff Biotic Index	3.86		3.58		3.67		3.49		3.75		5.46		5.72	
I % <i>Baetis tricaudatus</i>											0.22		4.8	
I %Collector	49.96		55.36		59.41		60.07		55.98		51.26		51.31	
I %Parasite	1.06		0.22		0.68		0.42		0.45		0.76		0.83	
I %Oligochaeta	5.98		11.16		21.08		3.34		5.31		7.4		20.13	
I Number tolerant taxa	2		3		3		4		5		5		4	
I %Simuliidae	14.45		5.47		4.35		2		8.5		14.25		7.51	
I %Chironomidae	9.41		3.06		6.99		10.93		13.35		8.16		7.9	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.
BIBI scores between 25-39.
BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Indian Creek @ Wheeler Avenue SE

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Indian Creek
Station Wheeler Ave. SE
Client Stream Team
Date 7/25/11

METRIC	Value	Score
D Total number of taxa	47	5
D Number Ephemeroptera taxa	4	1
D Number Plecoptera taxa	8	5
D Number Trichoptera taxa	6	3
D Number of long-lived taxa	4	3
D Number of intolerant taxa	2	1
I % Tolerant taxa	2.31	5
D % Predator	17.51	3
D Number of clinger taxa	28	5
I % Dominance (3 taxa)	44.53	5

TOTAL SCORE **36**
BIOLOGICAL CONDITION CATEGORY moderate

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	1611	
D EPT taxa richness	18	
D Predator richness	14	
D Scraper richness	3	
D Shredder richness	5	
D %Intolerant taxa	0.29	
I Hilsenhoff Biotic Index		
I % <i>Baetis tricaudatus</i>	1.14	
I %Collector	55.81	
I %Parasite	3.35	
I %Oligochaeta	20.2	
I Number tolerant taxa	5	
I %Simuliidae	2.51	
I %Chironomidae	8.6	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.

D= Metric value generally decreases with declining biological integrity.

L= Low biological integrity.
M= Moderate biological integrity.
H= High biological integrity.



BIBI scores between 0-24.
BIBI scores between 25-39.
BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Kennedy Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Kennedy Creek		Kennedy Creek		Kennedy Creek		Kennedy Creek		Kennedy Creek		Kennedy Creek		Kennedy Creek		Kennedy Creek	
Station	Old Olympic Hwy		Old Olympic Hwy		Old Olympic Hwy		Old Olympic Hwy		Old Olympic Hwy		Old Olympic Hwy		Old Olympic Hwy		Old Olympic Hwy	
Client	Public Health		Public Health		Public Health		Public Health		Public Health		Public Health		Public Health		Public Health	
Date	9/3/03		8/31/04		9/2/05		8/29/06		8/30/07		8/5/08		7/27/09		8/4/10	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	48	5	42	5	64	5	32	3	49	5	57	5	55	5	57	5
D Number Ephemeroptera taxa	9	5	8	3	9	5	5	3	8	3	12	5	9	5	9	5
D Number Plecoptera taxa	10	5	9	5	10	5	6	3	8	5	7	3	8	5	11	5
D Number Trichoptera taxa	6	3	5	3	9	3	4	1	6	3	9	3	7	3	7	3
D Number of long-lived taxa	6	5	6	5	5	5	5	5	5	5	6	5	5	5	7	5
D Number of intolerant taxa	3	3	3	3	1	1	0	1	3	3	6	5	2	1	4	5
I % Tolerant taxa	18.13	5	11.42	5	16.85	5	21.84	3	10.34	5	12.39	5	19.57	5	14.61	5
D % Predator	14.27	3	12.78	3	8.04	1	22.88	5	14.29	3	14.43	3	16.92	3	12.32	3
D Number of clinger taxa	>20	5	>20	5	>20	5	21	5	>20	5	35	5	36	5	37	5
I % Dominance (3 taxa)	52.64	3	51.84	3	40.04	5	45.12	5	49.52	5	49.04	5	52.99	3	61.8	3
TOTAL SCORE		42		40		40		34		42		44		40		44
BIOLOGICAL CONDITION CATEGORY		high		high		high		moderate		high		high		high		high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	1818		3550		3345		920		4234		4124		5061		6298	
D EPT taxa richness	25		22		28		15		22		28		24		27	
D Predator richness	14		13		16		8		11		18		14		13	
D Scraper richness	17		13		17		8		15		18		18		18	
D Shredder richness	4		4		6		3		5		4		4		6	
D %Intolerant taxa	1.37		0.24		0.43		0		0.29		2.01		2.01		1.49	
I Hilsenhoff Biotic Index	2.78		3		3.85		3.37		3.17		5.51		5.34		5.69	
I % <i>Baetis tricaudatus</i>											4.73		10.25		7.77	
I %Collector	25.5		40.28		53.03		39.91		35.74		50.24		42.74		65.17	
I %Parasite	0.07		0.34		0.14		0.26		2.04		1.19		1.53		1.58	
I %Oligochaeta	1.56		0.61		2.9		2.73		1.36		0.96		0.62		0.65	
I Number tolerant taxa	5		5		9		4		4		7		9		8	
I %Simuliidae	1.97		7.52		12.31		7.15		3.45		14.51		18.97		46.7	
I %Chironomidae	7.42		21.17		16.71		2.21		16.68		22.03		7.78		6.4	

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Kennedy Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Kennedy Creek
Station Old Olympic Hwy
Client Public Health
Date 8/5/2011

METRIC	Value	Score
D Total number of taxa	52	5
D Number Ephemeroptera taxa	10	5
D Number Plecoptera taxa	8	5
D Number Trichoptera taxa	6	3
D Number of long-lived taxa	7	5
D Number of intolerant taxa	4	5
I % Tolerant taxa	30.4	3
D % Predator	26.76	5
D Number of clinger taxa	35	5
I % Dominance (3 taxa)	41.87	5
TOTAL SCORE	46	
BIOLOGICAL CONDITION CATEGORY	high	

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	2123	
D EPT taxa richness	24	
D Predator richness	15	
D Scraper richness	9	
D Shredder richness	2	
D %Intolerant taxa	0.46	
I Hilsenhoff Biotic Index		
I % <i>Baetis tricaudatus</i>	21.74	
I %Collector	53.55	
I %Parasite	1	
I %Oligochaeta	1.02	
I Number tolerant taxa	8	
I %Simuliidae	5.42	
I %Chironomidae	5.63	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Little McAllister Creek @ Meadows

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Little McAllister		Little McAllister		Little McAllister		Little McAllister		Little McAllister		Little McAllister		Little McAllister	
Station	Meadows		Meadows		Meadows		Meadows		Meadows		Meadows		Meadows	
Client	Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team	
Date	8/11/05		2006 Aug		8/4/07		7/19/08		7/22/09		7/10/10		7/5/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	44	5	48	5	44	5	51	5	54	5	55	5	49	5
D Number Ephemeroptera taxa	1	1	2	1	2	1	2	1	3	1	3	1	1	1
D Number Plecoptera taxa	6	3	3	1	4	3	5	3	4	3	3	1	3	1
D Number Trichoptera taxa	3	1	5	3	8	3	8	3	9	3	9	3	8	3
D Number of long-lived taxa	3	3	3	3	2	1	5	5	3	3	2	1	5	5
D Number of intolerant taxa	1	1	0	1	1	1	2	1	2	1	2	1	0	1
I % Tolerant taxa	35.28	3	6.82	5	9.1	5	23.59	3	33.7	3	40.05	3	11.22	5
D % Predator	11.34	3	10.76	3	44.91	5	19.04	3	30.57	5	7.83	1	5.35	1
D Number of clinger taxa	21	5	21	5	26	5	24	5	28	5	22	5	28	5
I % Dominance (3 taxa)	44.51	5	63.95	3	37.59	5	49.96	5	48.6	5	40.78	5	63	3
TOTAL SCORE		30		30		34		34		34		26		30
BIOLOGICAL CONDITION CATEGORY	moderate		moderate		moderate		moderate		moderate		moderate		moderate	

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	960		1893		882		1579		8197		12086		11955	
D EPT taxa richness	10		10		14		15		16		15		12	
D Predator richness	12		14		14		13		14		13		16	
D Scraper richness	4		5		7		6		7		7		4	
D Shredder richness	5		5		5		9		7		9		3	
D %Intolerant taxa	0.62		0		0.14		0.53		0.1		0.23		0	
I Hilsenhoff Biotic Index	5.03		5.89		4.09		6.5		6.54		7.18			
I % <i>Baetis tricaudatus</i>							1.29		0.49		0.04		0.36	
I %Collector	44.49		74.66		36.66		35.73		38.06		47.48		67.81	
I %Parasite	9.1		1.03		2.44		2.43		2.59		1.71		0.78	
I %Oligochaeta	8.35		0.8		2.58		5.23		2.65		3.03		32.85	
I Number tolerant taxa	9		9		9		13		12		17		13	
I %Simuliidae	0.75		53.75		10.72		1.29		2.06		1.37		0.66	
I %Chironomidae	15.59		25.09		21.57		24.79		31.33		19.78		27.57	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

McAllister Creek @ Steilacoom Rd.

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	McAllister Creek		McAllister Creek		McAllister Creek	
Station	Steilacoom Road		Steilacoom Road		Steilacoom Road	
Client	Stream Team		Stream Team		Stream Team	
Date	8/5/09		7/8/10		7/26/11	
METRIC	Value	Score	Value	Score	Value	Score
D Total number of taxa	47	5	55	5	46	5
D Number Ephemeroptera taxa	0	1	2	1	2	1
D Number Plecoptera taxa	4	3	6	3	6	3
D Number Trichoptera taxa	9	3	11	5	9	3
D Number of long-lived taxa	4	3	6	5	2	1
D Number of intolerant taxa	6	5	8	5	2	1
I % Tolerant taxa	1.28	5	6.17	5	3.64	5
D % Predator	13.75	3	14.21	3	14.76	3
D Number of clinger taxa	24	5	30	5	26	5
I % Dominance (3 taxa)	63.43	3	53.58	3	53.02	3
TOTAL SCORE		36		40		30
BIOLOGICAL CONDITION CATEGORY	moderate		high		moderate	

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	1766	2687	5189
D EPT taxa richness	13	19	17
D Predator richness	7	12	11
D Scraper richness	10	12	7
D Shredder richness	9	11	8
D %Intolerant taxa	17.16	5.29	9.75
I Hilsenhoff Biotic Index	5.33	5.51	
I % <i>Baetis tricaudatus</i>	0	0.14	0.28
I %Collector	60.64	61.52	57.47
I %Parasite	0.42	0.62	0.44
I %Oligochaeta	1.43	5.17	1.85
I Number tolerant taxa	5	6	7
I %Simuliidae	0.09	0.05	0
I %Chironomidae	9.89	39.55	17.92

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

McLane Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team and Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Station Client Date	McLane Creek DNR Trail Stream Team 2006 August		McLane Creek DNR Trail Stream Team 7/28/07		McLane Creek DNR Trail Stream Team 7/30/08		McLane Creek DNR Trail Stream Team 7/19/09		McLane Creek DNR Trail Stream Team 7/17/10		McLane Creek DNR Trail Stream Team 7/25/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	55	5	62	5	61	5	78	5	53	5	61	5
D Number Ephemeroptera taxa	8	3	10	5	8	3	12	5	8	3	8	3
D Number Plecoptera taxa	10	5	11	5	9	5	14	5	9	5	11	5
D Number Trichoptera taxa	12	5	12	5	10	5	15	5	13	5	10	5
D Number of long-lived taxa	4	3	4	3	3	3	6	5	5	5	6	5
D Number of intolerant taxa	6	5	7	5	7	5	9	5	5	5	3	3
I % Tolerant taxa	14.58	5	24.66	3	14.64	5	29.77	3	26.59	3	33.28	3
D % Predator	31.66	5	16.95	3	30.82	5	14.49	3	27.74	5	10.32	3
D Number of clinger taxa	>20	5	>20	5	32	5	51	5	37	5	36	5
I % Dominance (3 taxa)	60.63	3	49.6	5	46.38	5	58.28	3	58.84	3	74.5	3
TOTAL SCORE		44		44		46		44		44		40
BIOLOGICAL CONDITION CATEGORY		high		high		high		high		high		high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	3006		2558		2051		5359		4141		5818	
D EPT taxa richness	30		33		27		41		30		29	
D Predator richness	14		17		16		23		18		19	
D Scraper richness	12		16		13		20		13		5	
D Shredder richness	10		6		7		9		5		5	
D %Intolerant taxa	0.81		1.26		4.1		2.17		2.56		0.16	
I Hilsenhoff Biotic Index	3.11		4.05		4.99		5.37		5.16			
I % <i>Baetis tricaudatus</i>					12.19		29.12		26.3		32.46	
I %Collector	25.29		53.57		37.6		43.43		41.98		48.62	
I %Parasite	0.89		0.84		0.47		1.07		0.7		1.19	
I %Oligochaeta	0.34		0.23		0.76		0.85		2.25		0.53	
I Number tolerant taxa	5		5		7		8		3		2	
I %Simuliidae	1.7		15.86		7		5.09		4.05		2.88	
I %Chironomidae	11.88		22.79		18.73		13.31		8.27		10.57	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

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McLane Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team and Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Station Client Date	McLane Creek Mouth at Delphi Rd Public Health 9/6/06		McLane Creek Mouth at Delphi Rd Public Health 9/14/07		McLane Creek Mouth at Delphi Rd Public Health 8/7/08		McLane Creek Mouth at Delphi Rd Public Health 8/6/09		McLane Creek Mouth at Delphi Rd Public Health 8/6/10		McLane Creek Mouth at Delphi Rd Public Health 7/26/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	47	5	58	5	59	5	59	5	53	5	60	5
D Number Ephemeroptera taxa	6	3	9	5	6	3	5	3	8	3	6	3
D Number Plecoptera taxa	9	5	7	3	11	5	11	5	8	5	9	5
D Number Trichoptera taxa	3	1	6	3	8	3	9	3	8	3	8	3
D Number of long-lived taxa	4	3	4	3	6	5	5	5	6	5	4	3
D Number of intolerant taxa	0	1	2	1	6	5	2	1	4	5	1	1
I % Tolerant taxa	9.91	5	10.53	5	19.27	5	21.9	3	18.13	5	18.13	5
D % Predator	24.88	5	18.48	3	28.44	5	9.93	1	19.46	3	14.79	3
D Number of clinger taxa	>20	5	>20	5	36	5	37	5	37	5	35	5
I % Dominance (3 taxa)	35.61	5	50.94	3	37.05	5	36.17	5	40.67	5	38.79	5
TOTAL SCORE		38		36		46		36		44		38
BIOLOGICAL CONDITION CATEGORY		moderate		moderate		high		moderate		high		moderate

Maximum score of 50.

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	736		3493		2559		8854		2630		6115	
D EPT taxa richness	18		22		25		25		24		23	
D Predator richness	11		15		16		17		16		16	
D Scraper richness	10		15		13		14		18		7	
D Shredder richness	6		5		6		7		5		4	
D %Intolerant taxa	0		0.14		2.21		1.35		1.29		0.46	
I Hilsenhoff Biotic Index	3.42		2.84		5.56		5.97		5.77			
I % Baetis tricaudatus					15.48		5.73		11.78		16.28	
I %Collector	38.69		31.24		40.14		53.29		49.02		68.54	
I %Parasite	0.65		1.2		1.17		0.82		0.73		0.89	
I %Oligochaeta	7.48		1.68		12.77		10.73		17.93		8.24	
I Number tolerant taxa	8		11		11		15		14		9	
I %Simuliidae	0.81		0.99		0.65		11.67		4.5		2.09	
I %Chironomidae	14.63		6		8.79		16.91		4.23		34.16	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Mission Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Mission Creek		Mission Creek		Mission Creek		Mission Creek		Mission Creek		Mission Creek		Mission Creek	
Station	Bethel Street NE		Bethel Street NE		Bethel Street NE		Bethel Street NE		Bethel Street NE		Bethel Street NE		East Bay Dr NE	
Client	Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team	
Date	8/4/03		8/5/04		8/20/05		7/15/06		8/18/07		7/23/08		7/30/09	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	64	5	62	5	44	5	62	5	58	5	69	5	66	5
D Number Ephemeroptera taxa	6	3	4	1	4	1	3	1	6	3	4	1	5	3
D Number Plecoptera taxa	10	5	14	5	6	3	10	5	9	5	13	5	10	5
D Number Trichoptera taxa	11	5	11	5	9	3	10	5	9	3	12	5	12	5
D Number of long-lived taxa	4	3	7	5	3	3	6	5	7	5	6	5	4	3
D Number of intolerant taxa	6	5	8	5	2	1	4	5	3	3	5	5	6	5
I % Tolerant taxa	5.41	5	3.6	5	2.87	5	4.24	5	4.34	5	8.36	5	6.44	5
D % Predator	12.55	3	32.06	5	15.9	3	24.79	5	16.42	3	13.47	3	13.35	3
D Number of clinger taxa	>20	5	>20	5	23	5	>20	5	>20	5	38	5	35	5
I % Dominance (3 taxa)	56.75	3	61.65	3	55.89	3	44.19	5	63.35	3	58.85	3	54.46	3
TOTAL SCORE		42		44		32		46		40		42		42
BIOLOGICAL CONDITION CATEGORY		high		high		moderate		high		high	high	high		high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	5332		2794		1167		1527		5572		3923		5836	
D EPT taxa richness	27		29		19		23		24		29		27	
D Predator richness	22		24		13		23		19		22		22	
D Scraper richness	10		7		5		7		9		6		9	
D Shredder richness	9		11		6		10		9		10		7	
D %Intolerant taxa	1.41		0.78		0.51		0.63		0.69		0.92		0.76	
I Hilsenhoff Biotic Index	5.19		4.23		4.95		4.09		4.7		5.57		5.96	
I % <i>Baetis tricaudatus</i>											7.75		5.22	
I %Collector	66.75		54.94		65.32		42.96		61.99		39.83		58.83	
I %Parasite	0.92		0.26		0.62		1.1		0.43		1		0.51	
I %Oligochaeta	5.22		1.84		11.79		1.65		0.86		1.4		6.54	
I Number tolerant taxa	5		2		2		3		2		4		5	
I %Simuliidae	0.6		1.2		1.33		3.45		1.33		0.73		1.32	
I %Chironomidae	57.27		41.95		53.95		40.13		47.12		30.93		46.8	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.

D= Metric value generally decreases with declining biological integrity.

L= Low biological integrity.

M= Moderate biological integrity.

H= High biological integrity.



BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Mission Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Mission Creek	Mission Creek @
Station	Bethel Street NE	Bethel Street NE
Client	Stream Team	Stream Team
Date	7/6/10	7/6/11

METRIC	Value	Score	Value	Score
D Total number of taxa	64	5	67	5
D Number Ephemeroptera taxa	5	3	7	3
D Number Plecoptera taxa	10	5	11	5
D Number Trichoptera taxa	12	5	12	5
D Number of long-lived taxa	7	5	6	5
D Number of intolerant taxa	6	5	7	5
I % Tolerant taxa	9.62	5	13.93	5
D % Predator	20.7	5	15.97	3
D Number of clinger taxa	35	5	38	5
I % Dominance (3 taxa)	39.35	5	46.85	5
TOTAL SCORE		48		46
BIOLOGICAL CONDITION CATEGORY		high		high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	2473		3098	
D EPT taxa richness	27		30	
D Predator richness	18		21	
D Scraper richness	9		9	
D Shredder richness	13		10	
D %Intolerant taxa	1.53		2.03	
I Hilsenhoff Biotic Index	5.78			
I % <i>Baetis tricaudatus</i>	7.87		11.04	
I %Collector	56.53		65.01	
I %Parasite	1		0.66	
I %Oligochaeta	14.71		18.24	
I Number tolerant taxa	6		7	
I %Simuliidae	1.41		1.19	
I %Chironomidae	27.23		33.98	

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Moxlie Creek @ Watershed Park

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Station Client Date	Moxlie Creek Watershed Park Stream Team 8/4/03	Moxlie Creek Watershed Park Stream Team 8/5/04	Moxlie Creek Watershed Park Stream Team 8/17/05	Moxlie Creek Watershed Park Stream Team 8/2/06	Moxlie Creek Watershed Park Stream Team 8/25/07	Moxlie Creek Watershed Park Stream Team 7/22/08	Moxlie Creek Watershed Park Stream Team 7/23/09
METRIC	Value Score	Value Score	Value Score	Value Score	Value Score	Value Score	Value Score
D Total number of taxa	23 3	28 3	33 3	26 3	37 3	31 3	44 5
D Number Ephemeroptera taxa	1 1	0 1	2 1	2 1	2 1	2 1	3 1
D Number Plecoptera taxa	5 3	2 1	4 3	2 1	2 1	3 1	4 3
D Number Trichoptera taxa	0 1	1 1	2 1	5 3	3 1	5 3	7 3
D Number of long-lived taxa	1 1	2 1	3 3	5 5	3 3	4 3	5 5
D Number of intolerant taxa	1 1	1 1	3 3	1 1	1 1	0 1	3 3
I % Tolerant taxa	18.92 5	29.56 3	10.99 5	6.63 5	10.16 5	5.88 5	10.54 5
D % Predator	20.26 5	6.94 1	16.17 3	15.28 3	27.1 5	18.93 3	23.33 5
D Number of clinger taxa	11 3	9 1	16 3	15 3	14 3	16 3	20 5
I % Dominance (3 taxa)	27.03 5	78.7 1	54.69 3	76.09 1	37.71 5	40.52 5	39.1 5
TOTAL SCORE	28	14	28	26	28	28	40
BIOLOGICAL CONDITION CATEGORY	moderate	low	moderate	moderate	moderate	moderate	high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	89	275	370	416	283	183	319
D EPT taxa richness	6	3	8	9	7	10	14
D Predator richness	5	6	7	8	9	9	13
D Scraper richness	1	1	5	5	6	4	5
D Shredder richness	7	3	6	5	5	4	8
D %Intolerant taxa	1.35	0.43	0.96	0.29	0.42	0	1.14
I Hilsenhoff Biotic Index	5.08	6.56	5.3	5.23	5.04	5.67	5.86
I % Baetis tricaudatus						5.23	7.52
I %Collector	41.89	39.97	57.89	71.77	37.27	46.39	56.05
I %Parasite	2.7	0.43	1.29	0.86	1.27	4.58	3.01
I %Oligochaeta	8.11	1.74	7.44	3.17	6.78	13.07	14.29
I Number tolerant taxa	3	4	7	2	6	2	5
I %Simuliidae	9.46	1.74	37.86	63.98	11.86	16.99	16.92
I %Chironomidae	31.08	81.3	26.21	6.63	33.47	23.53	12.41

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.
BIBI scores between 25-39.
BIBI scores >40.

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Moxlie Creek @ Watershed Park

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Moxlie Creek	Moxlie Creek
Station	@ Watershed Park	@ Watershed Park
Client	Stream Team	Stream Team
Date	7/29/10	7/26/11

METRIC	Value	Score	Value	Score
D Total number of taxa	51	5	48	5
D Number Ephemeroptera taxa	3	1	3	1
D Number Plecoptera taxa	6	3	3	1
D Number Trichoptera taxa	4	1	6	3
D Number of long-lived taxa	5	5	5	5
D Number of intolerant taxa	4	5	3	3
I % Tolerant taxa	4.76	5	4.03	5
D % Predator	9.47	1	9.56	1
D Number of clinger taxa	21	5	17	3
I % Dominance (3 taxa)	61.69	3	64.68	3

TOTAL SCORE	34	30
BIOLOGICAL CONDITION CATEGORY	moderate	moderate

Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	1433	864
D EPT taxa richness	13	12
D Predator richness	12	10
D Scraper richness	6	3
D Shredder richness	9	7
D %Intolerant taxa	0.32	0.42
I Hilsenhoff Biotic Index	6.21	
I % <i>Baetis tricaudatus</i>	0.77	1.52
I %Collector	80.7	71.47
I %Parasite	1.44	5.54
I %Oligochaeta	12.43	41
I Number tolerant taxa	9	8
I %Simuliidae	14.38	1.25
I %Chironomidae	9.1	17.17

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.
BIBI scores between 25-39.
BIBI scores >40.

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Palm Creek @ Pleasant Glade NE

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Station Client Date	Palm Creek Pleasant Glade Stream Team 8/27/04		Palm Creek Pleasant Glade Stream Team 8/22/05		Palm Creek Pleasant Glade Stream Team 8/14/06		Palm Creek Pleasant Glade Stream Team 7/31/07		Palm Creek Pleasant Glade Stream Team 7/22/09		Palm Creek Pleasant Glade NE Stream Team 6/29/10		Palm Creek Pleasant Glade NE Stream Team 7/6/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	57	5	61	5	56	5	54	5	52	5	55	5	48	5
D Number Ephemeroptera taxa	6	3	6	3	4	1	6	3	4	1	4	1	3	1
D Number Plecoptera taxa	8	5	9	5	11	5	9	5	8	5	11	5	9	5
D Number Trichoptera taxa	11	5	11	5	9	3	10	5	13	5	10	5	9	3
D Number of long-lived taxa	6	5	5	5	5	5	4	3	5	5	8	5	2	1
D Number of intolerant taxa	2	1	4	5	3	3	5	5	2	1	9	5	1	1
I % Tolerant taxa	3.58	5	1.07	5	3.17	5	2.04	5	5.15	5	8.17	5	5.86	5
D % Predator	27.31	5	26.93	5	26.58	5	45.93	5	33.53	5	32.53	5	11.52	3
D Number of clinger taxa	>20	5	>20	5	>20	5	>20	5	33	5	29	5	27	5
I % Dominance (3 taxa)	36.95	5	39.05	5	32.56	5	36.56	5	45.94	5	34.84	5	59.74	3
TOTAL SCORE		44		48		42		46		42		46		32
BIOLOGICAL CONDITION CATEGORY		high		high		high		high		high		high		moderate

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	968		1849		1136		1175		1835		880		5049	
D EPT taxa richness	25		26		24		25		25		25		21	
D Predator richness	16		20		17		15		18		18		16	
D Scraper richness	11		8		6		7		8		5		2	
D Shredder richness	11		11		12		11		9		10		6	
D %Intolerant taxa	0.37		5.33		0.64		1.83		0.33		3.15		0.09	
I Hilsenhoff Biotic Index	3.5		4.03		4.07		3.23		5.2		5.05			
I % Baetis tricaudatus									0.98		7.89		5.56	
I %Collector	39.4		49.64		56.16		33.92		36.27		37.7		83.33	
I %Parasite	9.39		7.13		4.96		2.44		6.32		2.58		0.99	
I %Oligochaeta	2.72		1.81		1.26		0.71		1.24		2.59		3.28	
I Number tolerant taxa	7		2		6		4		6		3		5	
I %Simuliidae	1.24		1.34		3.58		2.55		0.74		1.9		52.64	
I %Chironomidae	18.79		34.13		32.46		19.04		30.89		21.5		14.8	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.
BIBI scores between 25-39.
BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Percival Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team and Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Percival Creek		Percival Creek		Percival Creek		Percival Creek		Percival Creek		Percival Creek	
Station	SPSCC		SPSCC		SPSCC		SPSCC		SPSCC		SPSCC	
Client	Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team	
Date	8/5/06		8/4/07		8/9/08		8/1/09		8/7/10		8/6/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	40	3	39	3	39	3	24	3	46	5	42	5
D Number Ephemeroptera taxa	5	3	4	1	4	1	4	1	4	1	4	1
D Number Plecoptera taxa	9	3	7	3	7	3	5	3	8	5	6	3
D Number Trichoptera taxa	7	3	7	3	6	3	4	1	7	3	7	3
D Number of long-lived taxa	5	5	5	5	3	3	5	5	5	5	3	3
D Number of intolerant taxa	1	1	1	1	0	1	0	1	1	1	0	1
I % Tolerant taxa	18.42	5	9.45	5	15.13	5	10.41	5	14.4	5	16.11	5
D % Predator	15.66	3	21.21	5	18.41	3	38.02	5	19.1	3	9.49	1
D Number of clinger taxa	>20	5	27	5	23	5	17	3	28	5	25	5
I % Dominance (3 taxa)	53.81	3	60.97	3	61.68	3	56.25	3	47.46	5	48.49	5
TOTAL SCORE		34		34		30		30		38		32
BIOLOGICAL CONDITION CATEGORY		moderate		moderate		moderate		moderate		moderate		moderate

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	1255		988		1281		230		1321		1041	
D EPT taxa richness	21		18		17		13		19		17	
D Predator richness	11		11		10		5		13		11	
D Scraper richness	8		8		7		6		8		3	
D Shredder richness	8		9		5		6		9		5	
D %Intolerant taxa	0.1		0.12		0		0		0.09		0	
I Hilsenhoff Biotic Index	3.46		3.53		6.04		5.36		6.01			
I % <i>Baetis tricaudatus</i>					0.28		1.04		1.54		1.53	
I %Collector	49.91		59.86		58.97		43.22		58.88		67.96	
I %Parasite	0.86		1.33		2.05		2.6		1.36		5.01	
I %Oligochaeta	5.73		4.36		18.41		9.9		23.28		20.18	
I Number tolerant taxa	4		5		5		3		7		6	
I %Simuliidae	1.81		1.21		0.47		0		10.78		15.68	
I %Chironomidae	3.44		3.03		6.73		2.08		5.71		8	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

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Percival Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team and Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Percival Creek		Percival Creek		Percival Creek		Percival Creek		Percival Creek		Percival Creek	
Station	Mouth @ ft bridge		Mouth @ ft bridge		Mouth @ ft bridge		Mouth @ ft bridge		Mouth @ ft bridge		Mouth @ ft bridge	
Client	Public Health		Public Health		Public Health		Public Health		Public Health		Public Health	
Date	8/31/06		9/19/07		8/26/08		7/30/09		8/12/10		8/25/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	23	3	37	3	43	5	43	5	43	5	46	5
D Number Ephemeroptera taxa	3	1	4	1	4	1	3	1	3	1	5	3
D Number Plecoptera taxa	7	3	10	5	9	5	8	5	10	5	10	5
D Number Trichoptera taxa	4	1	7	3	8	3	7	3	7	3	7	3
D Number of long-lived taxa	3	1	3	3	5	5	4	3	4	3	4	3
D Number of intolerant taxa	0	1	1	1	2	1	1	1	2	1	3	3
I % Tolerant taxa	8.35	5	22.67	3	6.52	5	11.17	5	5.39	5	6.55	5
D % Predator	10.19	3	3.94	1	11.64	3	11.65	3	9.63	1	9.65	1
D Number of clinger taxa	18	3	28	5	30	5	29	5	30	5	37	5
I % Dominance (3 taxa)	69.6	3	69.24	3	61.39	3	52.58	3	68.02	3	56.25	3
TOTAL SCORE	24		28		36		34		32		36	
BIOLOGICAL CONDITION CATEGORY	low		moderate		moderate		moderate		moderate		moderate	

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	516		1596		2731		3557		5081		2226	
D EPT taxa richness	14		21		21		18		20		22	
D Predator richness	9		10		11		15		12		14	
D Scraper richness	6		9		10		9		9		5	
D Shredder richness	3		6		8		5		6		4	
D %Intolerant taxa	0		0.08		0.26		0.13		1.57		7.63	
I Hilsenhoff Biotic Index	2.81		1.96		5.4		5.47		5.24			
I % <i>Baetis tricaudatus</i>					2.5		7.63		2.13		4.3	
I %Collector	55.44		23.44		45.45		35.28		23.03		35.49	
I %Parasite	0		0.23		0.74		1.84		0.96		1.11	
I %Oligochaeta	6.26		0.38		2.15		1.73		0.4		2.47	
I Number tolerant taxa	4		6		9		8		7		6	
I %Simuliidae	2.09		1.65		3.7		6.5		10.21		16.32	
I %Chironomidae	0.93		1.13		1.45		9.74		8.55		4.14	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

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Perry Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Station Client Date	Perry Creek Perry Creek Rd Public Health 9/4/03		Perry Creek Perry Creek Rd Public Health 9/8/04		Perry Creek Perry Creek Rd Public Health 8/26/05		Perry Creek Perry Creek Rd Public Health 8/30/06		Perry Creek Perry Creek Rd Public Health 8/8/07		Perry Creek Perry Creek Rd Public Health 8/6/08		Perry Creek Perry Creek Rd Public Health 7/24/09	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	55	5	58	5	59	5	48	5	61	5	60	5	65	5
D Number Ephemeroptera taxa	9	5	8	3	10	5	7	3	9	5	9	5	7	3
D Number Plecoptera taxa	11	5	11	5	9	5	6	3	12	5	10	5	10	5
D Number Trichoptera taxa	8	3	9	3	8	3	7	3	9	3	10	5	10	5
D Number of long-lived taxa	4	3	6	5	4	3	4	3	7	5	5	5	5	5
D Number of intolerant taxa	3	3	6	5	4	5	2	1	5	5	6	5	7	5
I % Tolerant taxa	7.95	5	16.1	5	9.33	5	10.68	5	11.84	5	8.89	5	20.28	3
D % Predator	21.69	5	32.97	5	8.17	1	36.92	5	18.09	3	30.18	5	18.04	3
D Number of clinger taxa	>20	5	>20	5	>20	5	>20	5	>20	5	36	5	40	5
I % Dominance (3 taxa)	45.65	5	45.31	5	59.37	3	38.17	5	38.84	5	37.58	5	37.11	5
TOTAL SCORE		44		46		40		38		46		50		44
BIOLOGICAL CONDITION CATEGORY		high		high		high		moderate		high		high		high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	3689		3644		3947		941		6468		3526		2396	
D EPT taxa richness	28		28		27		20		30		29		27	
D Predator richness	15		14		17		11		17		17		21	
D Scraper richness	16		18		17		15		18		14		15	
D Shredder richness	7		9		6		4		8		7		9	
D %Intolerant taxa	1.78		0.98		0.73		0.89		0.87		0.88		1.25	
I Hilsenhoff Biotic Index	2.55		3.04		4.46		3.31		3.45		5.12		5.43	
I % <i>Baetis tricaudatus</i>											4.01		16.08	
I %Collector	27.26		37.84		60.21		31.91		39.37		37.58		39.47	
I %Parasite	0.21		0.34		0.24		0.76		1.96		3.39		1.6	
I %Oligochaeta	7.32		4.83		11.31		7.63		3.81		2.17		3.95	
I Number tolerant taxa	9		7		10		8		8		8		9	
I %Simuliidae	1.1		1.79		0.15		1.78		0.09		2.07		6.99	
I %Chironomidae	6.84		14.08		36.72		14.89		23.35		25.8		13.44	

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.

D= Metric value generally decreases with declining biological integrity.

L= Low biological integrity.

M= Moderate biological integrity.

H= High biological integrity.

BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Perry Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Perry Creek	Perry Creek
Station	Perry Creek Rd	Perry Creek Rd
Client	Public Health	Public Health
Date	7/28/10	7/27/11

METRIC	Value	Score	Value	Score
D Total number of taxa	58	5	67	5
D Number Ephemeroptera taxa	8	3	8	3
D Number Plecoptera taxa	9	5	12	5
D Number Trichoptera taxa	11	5	9	3
D Number of long-lived taxa	4	3	6	5
D Number of intolerant taxa	7	5	7	5
I % Tolerant taxa	23.47	3	22.41	3
D % Predator	27.09	5	28.73	5
D Number of clinger taxa	37	5	40	5
I % Dominance (3 taxa)	48.57	5	43.78	5

TOTAL SCORE	44	44
BIOLOGICAL CONDITION CATEGORY	high	high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	3540		6965	
D EPT taxa richness	28		29	
D Predator richness	17		20	
D Scraper richness	15		6	
D Shredder richness	5		6	
D %Intolerant taxa	1.54		0.76	
I Hilsenhoff Biotic Index	5.29			
I % <i>Baetis tricaudatus</i>	18.08		19.93	
I %Collector	45.74		54.71	
I %Parasite	1.26		2.13	
I %Oligochaeta	2.3		7.01	
I Number tolerant taxa	10		7	
I %Simuliidae	14.97		7.77	
I %Chironomidae	6.79		14.09	

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Schneider Creek (Budd Inlet)

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Schneider Creek		Schneider Creek		Schneider Creek		Schneider Creek		Schneider Creek		Schneider Creek	
Station	West Bay Drive		West Bay Drive		West Bay Drive		West Bay Drive		West Bay Drive		West Bay Drive	
Client	Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team	
Date	8/14/06		7/5/07		7/30/08		7/24/09		7/23/10		7/27/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	37	3	32	3	44	5	52	5	46	5	43	5
D Number Ephemeroptera taxa	2	1	3	1	6	3	5	3	3	1	3	1
D Number Plecoptera taxa	6	3	8	5	5	3	10	5	8	5	5	3
D Number Trichoptera taxa	3	1	2	3	5	3	5	3	6	3	3	1
D Number of long-lived taxa	1	1	2	3	2	1	3	3	3	3	2	1
D Number of intolerant taxa	2	1	2	3	0	1	4	5	5	5	1	1
I % Tolerant taxa	10.23	5	18.77	5	12.06	5	16.85	5	40.12	3	27.01	3
D % Predator	11.92	3	13.7	3	15.01	3	6.36	1	7.83	1	7.91	1
D Number of clinger taxa	17	3	19	3	22	5	29	5	23	5	20	3
I % Dominance (3 taxa)	42.97	5	50.25	3	34.57	5	43.65	5	54.09	3	60.65	3
TOTAL SCORE		26		32		34		40		34		22
BIOLOGICAL CONDITION CATEGORY		moderate		moderate		moderate		high		moderate		low

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	1217		472		1101		2822		2036		3205	
D EPT taxa richness	11		13		16		20		17		11	
D Predator richness	11		8		12		20		15		14	
D Scraper richness	5		6		8		8		5		5	
D Shredder richness	3		5		5		6		4		4	
D %Intolerant taxa	0.99		0.76		0		0.27		0.76		0.1	
I Hilsenhoff Biotic Index	4.99		3.86		5.43		5.82		6.21			
I % Baetis tricaudatus					5.33		15.2		34.12		26.05	
I %Collector	56.65		44.92		33.39		59.45		65.14		87.18	
I %Parasite	1.08		0.76		1.52		0.87		0.25		0.28	
I %Oligochaeta	4.13		1.02		3.04		13.82		11.71		25.03	
I Number tolerant taxa	1		3		3		4		5		7	
I %Simuliidae	17.7		3.05		4.35		5.48		2.84		1.92	
I %Chironomidae	46.51		41.37		45.43		42.66		34.67		34.38	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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L= Low biological integrity.

M= Moderate biological integrity.

H= High biological integrity.



Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Schneider Creek (Totten Inlet Watershed)

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Station	Schneider Creek at Pneumonia Gulch Ln Public Health 8/24/06		Schneider Creek at Pneumonia Gulch Ln Public Health 9/10/07		Schneider Creek at Pneumonia Gulch Ln Public Health 7/29/08		Schneider Creek at Pneumonia Gulch Ln Public Health 7/16/09		Schneider Creek at Pneumonia Gulch Ln Public Health 8/11/10		Schneider Creek at Pneumonia Gulch Ln Public Health 7/21/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	41	5	55	5	63	5	71	5	62	5	57	5
D Number Ephemeroptera taxa	7	3	7	3	7	3	9	5	7	3	7	3
D Number Plecoptera taxa	7	3	10	5	11	5	12	5	9	5	11	5
D Number Trichoptera taxa	6	3	8	3	7	3	13	5	12	5	7	3
D Number of long-lived taxa	4	3	7	5	6	5	8	5	7	5	7	5
D Number of intolerant taxa	2	1	5	5	6	5	9	5	7	5	4	5
I % Tolerant taxa	22.16	3	32.52	3	8.89	5	21.58	3	21.27	3	17.11	5
D % Predator	26.3	5	17.76	3	20.91	5	17.62	3	16.55	3	15.56	3
D Number of clinger taxa	>20	5	>20	5	37	5	45	5	39	5	39	5
I % Dominance (3 taxa)	49.21	5	40.48	5	51.85	3	48.68	5	33.99	5	42.85	5
TOTAL SCORE		36		42		44		46		44		44
BIOLOGICAL CONDITION CATEGORY		moderate		high		high		high		high		high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	1301		4950		7640		4958		3851		4782	
D EPT taxa richness	20		25		25		34		28		25	
D Predator richness	12		16		20		20		17		18	
D Scraper richness	12		16		14		17		17		6	
D Shredder richness	4		4		6		11		6		7	
D %Intolerant taxa	0.18		0.91		2.41		4.55		3.85		0.5	
I Hilsenhoff Biotic Index	2.87		3.14		4.99		5.25		5.4			
I % Baetis tricaudatus			4.01		3.56		16.34		6.03		11.57	
I %Collector	13.59		25.44		19.62		37.21		28.54		46.51	
I %Parasite	0.18		0.82		1.64		1.23		1.34		1.33	
I %Oligochaeta	4.42		2.32		3.45		4.63		6.99		14.49	
I Number tolerant taxa	6		4		11		8		9		8	
I %Simuliidae	0.64		0.87		0.63		4.95		0.81		1.18	
I %Chironomidae	1.84		1.93		7.97		7.46		8.92		11.13	

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.

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L= Low biological integrity.

M= Moderate biological integrity.

H= High biological integrity.



BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Thompson Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Station	Thompson Creek Centralia Powerhouse Canal		Thompson Creek Centralia Powerhouse Canal		Thompson Creek Centralia Powerhouse Canal		Thompson Creek Centralia Powerhouse Canal	
Client	Stream Team		Stream Team		Stream Team		Stream Team	
Date	7/24/08		8/2/09		7/25/10		7/23/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	62	5	57	5	59	5	62	5
D Number Ephemeroptera taxa	6	3	5	3	8	3	7	3
D Number Plecoptera taxa	11	5	10	5	11	5	11	5
D Number Trichoptera taxa	11	5	11	5	9	3	9	3
D Number of long-lived taxa	6	5	6	5	5	5	5	5
D Number of intolerant taxa	6	5	6	5	5	5	7	5
I % Tolerant taxa	19.51	5	20.8	3	13.44	5	9.96	5
D % Predator	30.39	5	31.95	5	17.95	3	19.02	3
D Number of clinger taxa	34	5	32	5	33	5	35	5
I % Dominance (3 taxa)	46.54	5	51.44	3	34.93	5	37.68	5
TOTAL SCORE		48		44		44		44
BIOLOGICAL CONDITION CATEGORY	high		high		high		high	

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	5314		4774		15101		13301	
D EPT taxa richness	28		26		28		27	
D Predator richness	19		16		13		19	
D Scraper richness	8		7		9		6	
D Shredder richness	8		11		11		8	
D %Intolerant taxa	1.49		1.41		0.91		0.94	
I Hilsenhoff Biotic Index	5.12		5.14		5.47			
I % <i>Baetis tricaudatus</i>	18.38		20.13		12.1		7.62	
I %Collector	40.19		45.83		50.37		58.02	
I %Parasite	2.8		2.67		3.8		12.35	
I %Oligochaeta	2.12		4.92		8.4		11.08	
I Number tolerant taxa	5		4		4		5	
I %Simuliidae	1.22		0.5		1.02		0.31	
I %Chironomidae	21.85		18.83		41.37		35.37	

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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M= Moderate biological integrity.

H= High biological integrity.



BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Woodard Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Woodard Creek		Woodard Creek		Woodard Creek		Woodard Creek		Woodard Creek		Woodard Creek		Woodard Creek	
Station	Libby Rd		Libby Rd		Libby Rd		Libby Rd		Libby Rd		Libby Rd		Libby Rd	
Client	Public Health		Public Health		Public Health		Public Health		Public Health		Public Health		Public Health	
Date	8/29/03		8/12/04		9/9/05		9/8/06		9/11/07		8/27/08		7/29/09	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	53	5	48	5	60	5	38	3	47	5	54	5	51	5
D Number Ephemeroptera taxa	7	3	7	3	10	5	4	1	7	3	8	3	4	1
D Number Plecoptera taxa	10	5	8	5	9	5	9	5	9	5	7	3	7	3
D Number Trichoptera taxa	9	3	11	5	10	5	8	3	10	5	10	5	9	3
D Number of long-lived taxa	5	5	6	5	5	5	4	3	4	3	4	3	4	3
D Number of intolerant taxa	2	1	1	1	2	1	2	1	1	1	3	3	2	1
I % Tolerant taxa	5.16	5	6.78	5	6.98	5	9.59	5	7.93	5	10.66	5	3.96	5
D % Predator	29.03	5	23.13	5	20.92	5	22.28	5	32.13	5	34.06	5	23.78	5
D Number of clinger taxa	>20	5	>20	5	>20	5	>20	5	>20	5	33	5	30	5
I % Dominance (3 taxa)	53.73	3	49.27	5	42.45	5	39.12	5	50.28	3	47.09	5	46.42	5
TOTAL SCORE		40		44		46		36		40		42		36
BIOLOGICAL CONDITION CATEGORY		high		high		high		moderate		high		high		moderate

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	3214		1484		2926		463		1735		2290		3342	
D EPT taxa richness	26		26		29		21		26		25		20	
D Predator richness	15		10		16		12		12		14		13	
D Scraper richness	15		15		15		9		10		13		10	
D Shredder richness	8		9		8		5		9		5		7	
D %Intolerant taxa	0.77		0.65		1.31		0.52		0.21		0.31		0.24	
I Hilsenhoff Biotic Index	3.5		3.78		3.79		3.86		3.46		5.15		5.51	
I % <i>Baetis tricaudatus</i>											5.02		2.15	
I %Collector	53.73		62.98		54.57		59.07		52.27		45.9		64.99	
I %Parasite	0.14		0.89		0.98		0.78		0.76		2.3		0.57	
I %Oligochaeta	10.86		7.1		18.28		10.62		3.31		3.87		9.12	
I Number tolerant taxa	4		4		7		3		4		8		6	
I %Simuliidae	7.31		10.48		7.98		10.62		8.83		4.7		8.59	
I %Chironomidae	13.48		12.66		13.01		13.73		11.45		17.51		21.05	

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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D= Metric value generally decreases with declining biological integrity.

L= Low biological integrity.
M= Moderate biological integrity.
H= High biological integrity.



BIBI scores between 0-24.
BIBI scores between 25-39.
BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Woodard Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Public Health and Social Services Department

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Woodard Creek		Woodard Creek	
Station	Libby Rd		Libby Rd	
Client	Public Health		Public Health	
Date	7/26/10		8/3/11	
METRIC	Value	Score	Value	Score
D Total number of taxa	52	5	56	5
D Number Ephemeroptera taxa	5	3	6	3
D Number Plecoptera taxa	9	5	9	5
D Number Trichoptera taxa	11	5	10	5
D Number of long-lived taxa	5	5	4	3
D Number of intolerant taxa	3	3	2	1
I % Tolerant taxa	4.9	5	10.1	5
D % Predator	18.39	3	25.1	5
D Number of clinger taxa	34	5	36	5
I % Dominance (3 taxa)	50.28	3	35.12	5
TOTAL SCORE		42		42
BIOLOGICAL CONDITION CATEGORY		high		high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	4393		2426	
D EPT taxa richness	25		25	
D Predator richness	15		17	
D Scraper richness	11		5	
D Shredder richness	9		5	
D %Intolerant taxa	0.17		0.33	
I Hilsenhoff Biotic Index	5.51			
I % <i>Baetis tricaudatus</i>	2.57		5.84	
I %Collector	67.97		58.54	
I %Parasite	0.48		0.61	
I %Oligochaeta	3.9		4.47	
I Number tolerant taxa	7		7	
I %Simuliidae	25.37		7.38	
I %Chironomidae	23.34		23.51	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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D= Metric value generally decreases with declining biological integrity.

L= Low biological integrity.

M= Moderate biological integrity.

H= High biological integrity.



BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Woodland Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Station Client Date	Woodland Creek Draham Road Stream Team 8/13/05		Woodland Creek Draham Road Stream Team 8/13/06		Woodland Creek Draham Road Stream Team 8/28/07		Woodland Creek Draham Road Stream Team 8/23/08		Woodland Creek Draham Road Stream Team 8/15/09		Woodland Creek Draham Road Stream Team 7/13/10		Woodland Creek Draham Road Stream Team 7/12/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	46	5	45	5	43	5	59	5	46	5	53	5	59	5
D Number Ephemeroptera taxa	4	1	1	1	4	1	6	3	4	1	6	3	6	3
D Number Plecoptera taxa	8	5	8	3	10	5	12	5	8	5	7	3	8	5
D Number Trichoptera taxa	8	3	9	3	7	3	8	3	8	3	10	5	10	5
D Number of long-lived taxa	3	3	4	3	3	3	5	5	2	1	4	3	3	3
D Number of intolerant taxa	1	1	2	1	2	1	1	1	0	1	0	1	1	1
I % Tolerant taxa	12.92	5	7.24	5	8.99	5	12.88	5	33.4	3	17.65	5	17.5	5
D % Predator	18.19	3	7.34	1	21.14	5	10.38	3	9.29	1	14.2	3	8.8	1
D Number of clinger taxa	>20	5	>20	5	>20	5	37	5	29	5	31	5	35	5
I % Dominance (3 taxa)	42.94	5	74.67	3	44.5	5	46.49	5	51.83	3	38.34	5	39.81	5
TOTAL SCORE		36		30		38		40		28		38		38
BIOLOGICAL CONDITION CATEGORY		moderate		moderate		moderate		high		moderate		moderate		moderate

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	4587		2626		6005		13398		5689		3101		9096	
D EPT taxa richness	20		18		21		26		20		23		24	
D Predator richness	13		12		13		16		11		14		20	
D Scraper richness	9		7		7		10		8		13		5	
D Shredder richness	6		9		6		7		8		8		4	
D %Intolerant taxa	0.08		0.44		0.59		0.11		0		0		0.14	
I Hilsenhoff Biotic Index	3.91		5.2		4.04		5.74		5.99		6.09			
I % <i>Baetis tricaudatus</i>							10.36		28.69		12.69		12.57	
I %Collector	63.2		84.45		57.65		64.06		60.54		63.64		76.6	
I %Parasite	2.03		1.94		1.58		0.72		3.91		5.55		6.07	
I %Oligochaeta	1.88		1.06		0.65		2.98		3.24		13.79		11.25	
I Number tolerant taxa	6		6		4		7		7		9		10	
I %Simuliidae	7.1		60.64		25.96		23.04		6.82		2.38		7.49	
I %Chironomidae	18.71		9.21		12.04		18.22		13.25		19.5		33.61	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.

D= Metric value generally decreases with declining biological integrity.

L= Low biological integrity.

M= Moderate biological integrity.

H= High biological integrity.



BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Woodland Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body	Woodland Creek		Woodland Creek		Woodland Creek		Woodland Creek		Woodland Creek		Woodland Creek		Woodland Creek	
Station	Pleasant Glade Rd		Pleasant Glade Rd		Pleasant Glade Rd		Pleasant Glade Rd		Pleasant Glade Rd		Pleasant Glade Rd.		Pleasant Glade Road	
Client	Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team		Stream Team	
Date	8/13/05		8/12/06		7/26/07		7/22/08		7/15/09		7/27/10		7/21/11	
D METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	37	3	44	5	44	5	57	5	50	5	50	5	51	5
D Number Ephemeroptera taxa	4	1	5	3	4	1	5	3	6	3	6	3	4	1
D Number Plecoptera taxa	4	1	8	3	8	5	10	5	10	5	9	5	9	5
D Number Trichoptera taxa	6	3	8	3	7	3	9	3	9	3	7	3	10	5
D Number of long-lived taxa	3	3	4	3	4	3	4	3	3	3	4	3	4	3
I Number of intolerant taxa	0	1	1	1	1	1	2	1	2	1	1	1	0	1
D % Tolerant taxa	5.64	5	8.98	5	6.71	5	5.29	5	8.97	5	7.73	5	3.33	5
D % Predator	13.98	3	8.99	1	12.43	3	13.42	3	9.5	1	7.62	1	6.96	1
I Number of clinger taxa	19	3	>20	5	27	5	32	5	32	5	31	5	31	5
% Dominance (3 taxa)	53.15	3	67.21	3	64.89	3	64.4	3	65.86	3	72.04	3	70.39	3
TOTAL SCORE		26		32		34		36		34		34		34
BIOLOGICAL CONDITION CATEGORY		moderate		moderate		moderate		moderate		moderate		moderate		moderate

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

D Total abundance (m2)	532		1402		2647		3696		3957		2513		4208	
D EPT taxa richness	14		21		19		24		25		22		23	
D Predator richness	6		12		13		15		14		13		16	
D Scraper richness	8		9		8		7		9		9		2	
D Shredder richness	5		7		6		9		7		7		6	
%Intolerant taxa	0		0.09		0.05		0.06		0.11		0.05		0	
I Hilsenhoff Biotic Index	4.27		4.45		4.58		5.74		5.88		6.12			
I % <i>Baetis tricaudatus</i>							3.89		6.08		4.79		2.84	
I %Collector	64.9		75.33		73.88		72.21		76.31		84.15		85.43	
I %Parasite	1.35		1.11		0.36		0.58		1.09		0.81		0.49	
I %Oligochaeta	4.73		3.07		4.34		3.85		2.47		11.36		19.77	
I Number tolerant taxa	2		3		5		9		6		6		7	
I %Simuliidae	35.36		43.55		48.46		50.32		54.42		54.7		45.45	
%Chironomidae	11.04		4.7		6.92		7.03		8.7		6.57		8.57	

L, M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.

BIBI scores between 25-39.

BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

Yelm Creek

Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

Thurston County Resource Stewardship Department-Stream Team

Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.

Subsampling: 500 organism minimum per replicate or entire sample. Level 3 PNW standard taxonomic effort.

Abundances adjusted to a full sample and square meter basis. Analysis by Aquatic Biology Associates, Inc., Corvallis, OR.

Water Body Station Client Date	Yelm Creek Sheasley's Stream Team 7/20/09		Yelm Creek Peterson's Stream Team 7/30/09		Yelm Creek Sheaseley's Stream Team 7/7/10		Yelm Creek Peterson's Stream Team 7/19/10		Yelm Creek Peterson's Stream Team 7/19/11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	43	5	73	5	44	5	76	5	71	5
D Number Ephemeroptera taxa	4	1	6	3	3	1	9	5	8	3
D Number Plecoptera taxa	6	3	11	5	5	3	13	5	15	5
D Number Trichoptera taxa	7	3	16	5	8	3	13	5	13	5
D Number of long-lived taxa	2	1	7	5	3	3	8	5	6	5
D Number of intolerant taxa	3	3	5	5	3	3	6	5	6	5
I % Tolerant taxa	13.5	5	12.73	5	15.17	5	20.99	3	21.15	3
D % Predator	3.93	1	27.94	5	8.4	1	20.26	5	15.3	3
D Number of clinger taxa	23	5	45	5	22	5	49	5	48	5
I % Dominance (3 taxa)	42.16	5	41.88	5	56.39	3	43.66	5	49.68	5
TOTAL SCORE		32		48		32		48		44
BIOLOGICAL CONDITION CATEGORY		moderate		high		moderate		high		high

Maximum score of 50.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	6424		2834		8769		3275		6697	
D EPT taxa richness	17		33		16		35		36	
D Predator richness	10		21		10		19		21	
D Scraper richness	7		14		9		17		9	
D Shredder richness	6		15		7		13		13	
D %Intolerant taxa	0.34		1.48		0.21		2		1.41	
I Hiilsenhoff Biotic Index	5.99		5.25		5.98		5.66			
I % <i>Baetis tricaudatus</i>	0.02		9.04		0.05		17		19.37	
I %Collector	42.11		34.31		32.65		50.93		63.83	
I %Parasite	12.78		2.15		6.44		1.03		1.72	
I %Oligochaeta	3.24		10.79		1.2		15.95		23.95	
I Number tolerant taxa	9		5		9		8		5	
I %Simuliidae	0.67		0		0.33		4.44		3	
I %Chironomidae	16.62		10.3		30.13		14.95		9.72	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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BIBI scores between 0-24.
BIBI scores between 25-39.
BIBI scores >40.

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

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