# Thurston County
# Water Resources Monitoring Report
# 2005-2006 Water Year
# 2006-2007 Water Year

**Report Includes:**

*Water Quality of Streams and Lakes*

*December 2008*


Prepared by:

Thurston County Public Health and Social Services Department, Environmental Health Division and Thurston County Water and Waste Management Department, Storm and Surface Water Program

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
Washington State Department of Ecology

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# Introduction

This report contains water quality data collected by Thurston County Environmental Health Division during the 2005/06 and 2006/07 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 stormwater utilities and Thurston County Storm and Surface Water Utility funds. The report also contains a chapter of student volunteer-collected water quality data. This is the twelfth annual water resources report.

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 shown on the map on page three and are as follows:

| Puget Sound: | Chehalis Drainage to Pacific: |
|---|---|
| Nisqually River | Skookumchuck River |
| Budd Inlet/Deschutes River | Chehalis River |
| Henderson Inlet | Black River |
| Eld Inlet | |
| Totten Inlet | |

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 10. 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

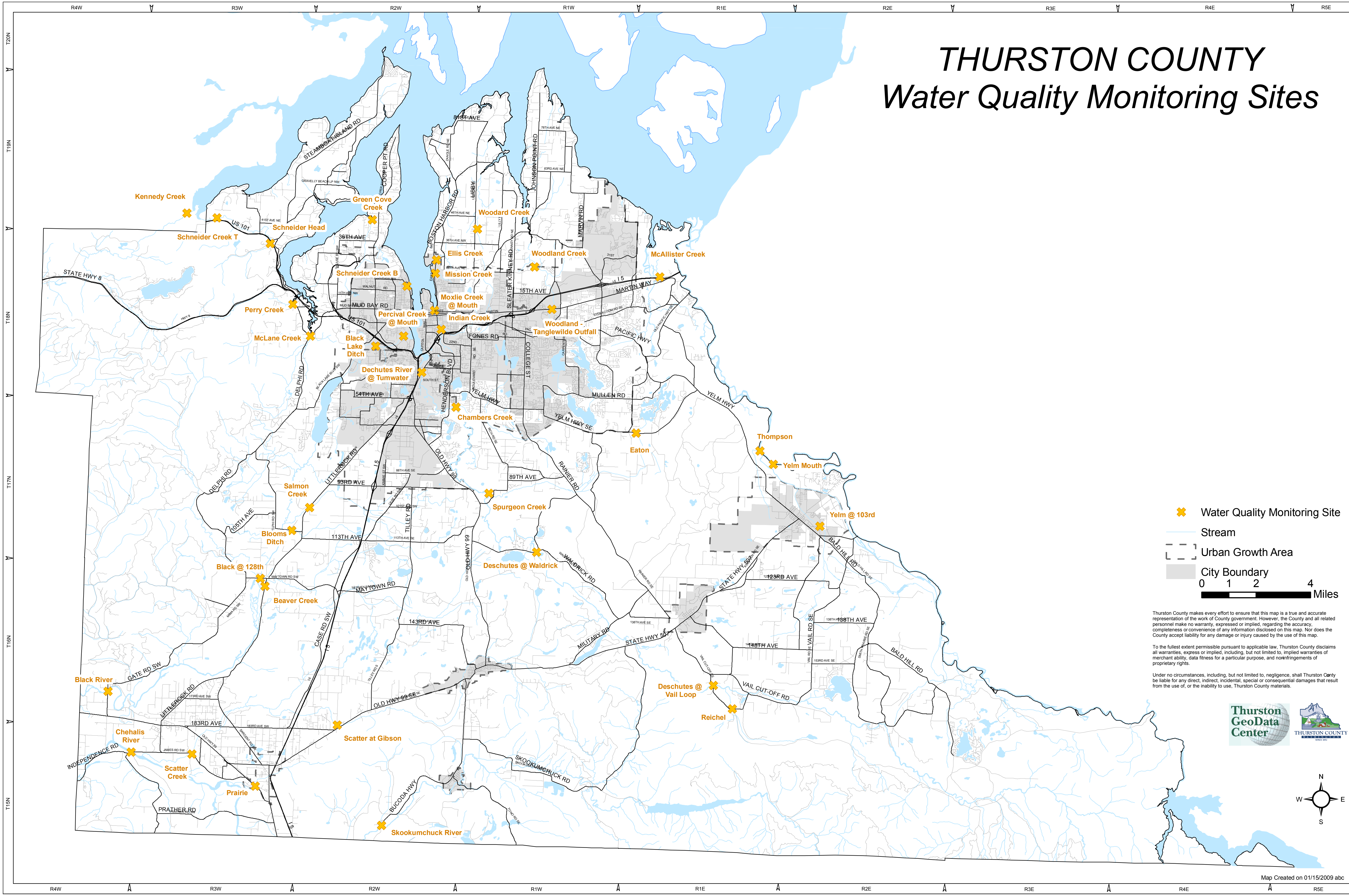
In water year 2005/06, water quality information was collected on twenty one streams. In water year 2006/07, water quality information was collected on twenty-six streams. Sampling sites for streams are generally located close to the mouths of the streams before they discharge into the larger river or 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 three sites: Deschutes River throughout water year 2005/06 and on October 2006 and May and June 2007; Tanglewilde and Moxlie Creek.

Field parameters were measured using a YSI multi-parameter field instrument. Stream discharges, measured during water quality monitoring events, were measured using a Swoffer flow meter and by wading the stream.


THURSTON COUNTY
Water Quality Monitoring Sites
Kennedy Creek
Schneider Creek T
Schneider Head
Green Cove Creek
Woodard Creek
Ellis Creek
Woodland Creek
McAllister Creek
Schneider Creek B
Mission Creek
Perry Creek
Moxlie Creek @ Mouth
Percival Creek @ Mouth
Indian Creek
Woodland - Tanglewilde Outfall
McLane Creek
Black Lake Ditch
Dechutes River @ Tumwater
Chambers Creek
Eaton
Thompson
Yelm Mouth
Salmon Creek
Spurgeon Creek
Yelm @ 103rd
Blooms Ditch
Deschutes @ Waldrick
Black @ 128th
Beaver Creek
Black River
Deschutes @ Vail Loop
Reichel
Chehalis River
Scatter Creek
Scatter at Gibson
Prairie
Skookumchuck River
STEAMBOAT ISLAND RD
COOPER PT RD
US 101
STATE HWY 8
36TH AVE
MUD BAY RD
15TH AVE
MARTIN WAY
I 5
PACIFIC HWY
FONES RD
COLLEGE ST
MULLEN RD
YELM HWY
YELM HWY SE
54TH AVE
DELPHI RD
LITTLEROCK RD
93RD AVE
89TH AVE
RAINIER RD
OLD HWY 99
105TH AVE
113TH AVE
TILLEY RD
WALDRICK RD
MAYTOWN RD
123RD AVE
143RD AVE
138TH AVE
148TH AVE
CASE RD SW
MILITARY RD
STATE HWY 507
VAIL RD SE
BALD HILL RD
VAIL CUT-OFF RD
GATE RD SW
183RD AVE
OLD HWY 99 SE
INDEPENDENCE RD
SKOOKUMCHUCK RD
BUCODA HWY
PRATHER RD
HENDERSON BLVD
JOHNSON POINT RD
MARVIN RD
SLEATER KINNEY RD
BOSTON HARBOR RD
81ST AVE
R4W
R3W
R2W
R1W
R1E
R2E
R3E
R4E
R5E
T20N
T19N
T18N
T17N
T16N
T15N
Water Quality Monitoring Site
Stream
Urban Growth Area
City Boundary
0 1 2 4 Miles
Thurston County makes every effort to ensure that this map is a true and accurate representation of the work of County government. However, the County and all related personnel make no warranty, expressed or implied, regarding the accuracy, completeness or convenience of any information disclosed on this map. Nor does the County accept liability for any damage or injury caused by the use of this map.
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Thurston GeoData Center
THURSTON COUNTY
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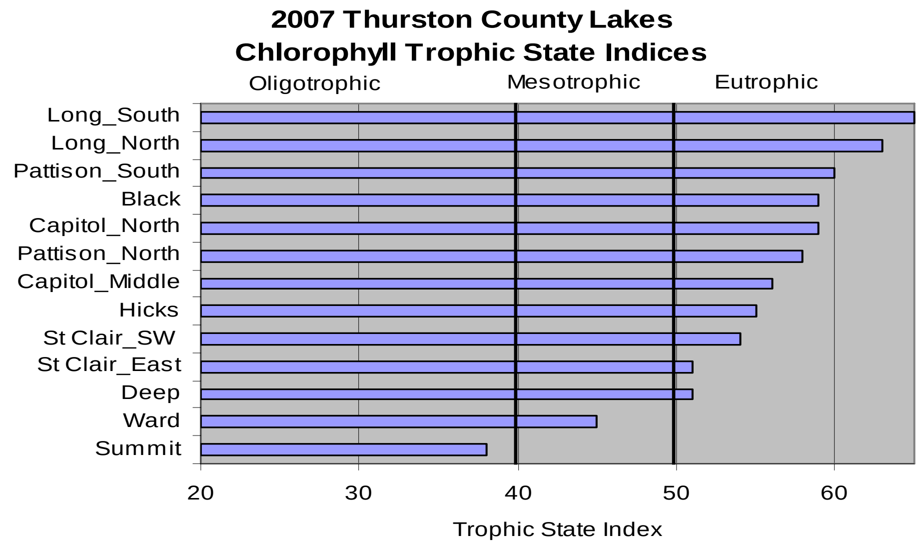
Map Created on 01/15/2009 abc

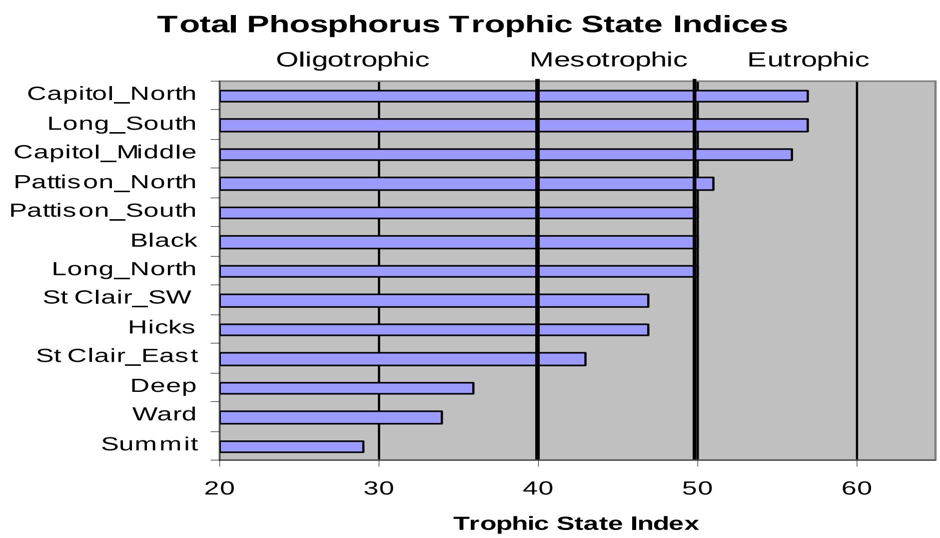
Lakes

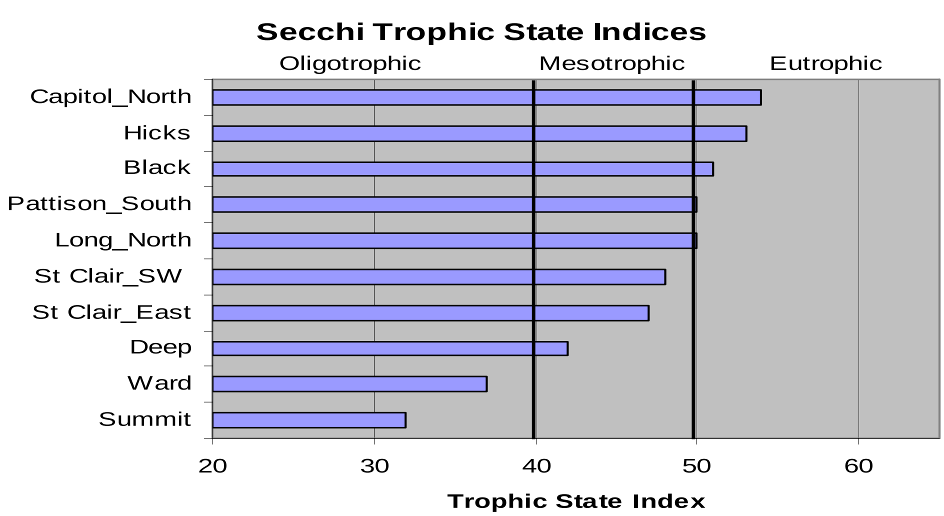
In 2006, water quality information was collected at fifteen sites on ten lakes. In 2007, sixteen sites on nine lakes were sampled and monitored. For lake monitoring, field parameters were measured at one or two meter increments from the surface to the bottom of the lake using the YSI multiparameter field 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. Three lakes had two sampling sites on them and Capitol Lake had three sites, because these lakes have separate basins.

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 page show the 2007 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.


2007 Thurston County Lakes
Chlorophyll Trophic State Indices
Oligotrophic
Mesotrophic
Eutrophic
Long_South
Long_North
Pattison_South
Black
Capitol_North
Pattison_North
Capitol_Middle
Hicks
St Clair_SW
St Clair_East
Deep
Ward
Summit
20
30
40
50
60
Trophic State Index


Total Phosphorus Trophic State Indices
Oligotrophic
Mesotrophic
Eutrophic
Capitol_North
Long_South
Capitol_Middle
Pattison_North
Pattison_South
Black
Long_North
St Clair_SW
Hicks
St Clair_East
Deep
Ward
Summit
20
30
40
50
60
Trophic State Index


Secchi Trophic State Indices
Oligotrophic
Mesotrophic
Eutrophic
Capitol_North
Hicks
Black
Pattison_South
Long_North
St Clair_SW
St Clair_East
Deep
Ward
Summit
20
30
40
50
60
Trophic State Index

## Surface Water Quantity Monitoring

Thurston County's Department of Water and Waste Management, Storm and SurfaceWater Utility performs stream flow and stream temperature, lake level, ground water level and precipitation monitoring. There are currently eleven active stream gaging stations, fifteen rainfall gaging stations, ground water level recorders in four areas, and sixteen lake level gages. The data are used for a variety of purposes including to calibrate and 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. The data also serves as an early warning of possible flooding, especially the ground water level data.

### Continuous Stream Flow and Stream Temperature Data

Stream flow data is collected using a combination of Geokon LC-1 measurement and control module utilizing a vibrating wire pressure transducer and Waterlogger DH-21 pressure transducers. Stream temperatures and ambient air temperatures are also recorded concurrently. Stage measurements are recorded either 60 minute or 15 minute intervals. The stage is then converted to a flow value (cubic feet per second) by the use of a rating curve. Historical 15-minute data is available for most of the stream flow collection sites listed below. Stream flow and temperature data are available on the Thurston County website at http://www.co.thurston.wa.us/monitoring/StreamFlow_temp/Streamflow_Home.htm

Continuous stream flow data for the following creeks and rivers are available:

| | |
|---|---|
| Deschutes River at Rainier (USGS data) | Start date: 1990-1997, 1997 - 2003 |
| Black Lk Ditch @ Jones Quarry Bridge | Start date: 2003 – present (Discontinued 2006) |
| Black Lake Ditch at Black Lake outlet | Start date: Aug 2006 - present |
| Chambers Creek at Rich Road | Start date: 8/28/89 - present |
| Green Cove Creek at 36th Avenue NW | Start date: 6/20/89 - present |
| McLane Creek at Delphi Road | Start date: 9/21/94 - present |
| Percival Ck @ Black Lk Ditch Confluence | Start Date: 2003 - present |
| Percival Creek at Mottman Road | Start date: 2/26/88 - 3/7/96 (Discontinued 2008) |
| Percival Creek at South Puget Sound Comm. Col. | Start date: Nov 2008 - present |
| Woodland Creek at Pleasant Glade Road | Start date: 2/26/88 - 2/5/96, 2003 - present |
| Woodard Creek at 36th Avenue NE | Start date: 3/1/88 – present |
| Scatter Creek at James Rd | Start Date: April 2008 |
| Black River at Littlerock (128th Ave SW) | Start Date: June 2008 |

The streamflow monitoring program is currently under significant reorganization and upgrades in 2008. Most of the sites have been upgraded with new equipment and the data quality has been reviewed for quality and will be posted in early 2009. In addition, cooperation with the United States Geological Survey – Hydrologic Data Division will bring additional river and streamflow data to the program in the upcoming year. Data from newer stations may not be available because rating curves have not been reliably developed yet.

## Precipitation

Thurston County's Storm and Surface Water Utility measures precipitation at fifteen locations throughout Thurston County. Data is collected using a Campbell Scientific precipitation, temperature, and barometric pressure recording equipment . Rainfall is recorded with a tipping bucket that registers every 1/100 of an inch of rainfall. Precipitation data is collected from field recordings every month or by radio telemetry and is downloaded to a database and processed for posting on the County's Monitoring Website. The data can be downloaded at http://www.co.thurston.wa.us/monitoring/Precipitation/Precipitation_Home.htm. The water year begins October 1 and ends September 30. Rainfall statistics for the water year and period of record are available.

In addition to County-maintained precipitation stations, the National Oceanic and Atmospheric Administration (NOAA) measures precipitation at the Olympia Airport. That information is also available at the above website.

Rainfall data is available for the following areas.

| | |
|---|---|
| Upper Deschutes River | Start Date: October 1990 to present |
| Eaton Creek/Lake St. Clair | Start Date: March 1992 to 2000, 2002 to present |
| Green Cove Creek Basin | Start Date: October 1990 to 2000, 2002 to present |
| Nisqually/McAllister Basin | Start Date: 2002 to present |
| Olympia Airport | Start Date: 1955 to present |
| Percival Creek Basin | Start Date: October 1989 to 2000, 2001 to present |
| Summit Lake | Start Date: November 1993 to 2000, 2003 to present |
| Tenino | Start Date: October 1994 to 2001, 2003 to present |
| Woodard Creek Basin | Start Date: October 1988 to present |
| Woodland Creek Basin | Start Date: October 1988 to present |
| Grand Mound | Start Date: June 2007 to present |
| Skookumchuck | Start Date: December 2008 |
| Boston Harbor | Start Date: April 2006 to present |
| Sunrise Beach | Start Date: October 2002 to present |
| Yelm | Start Date: November 2007 to present |

## Lake Levels

Thurston County Department of Water and Waste Management, Surface and Storm Water Utility has volunteer lake level gage readers for sixteen lake sites. Graphs of each lake's water surface elevation over time can be seen by going to http://www.co.thurston.wa.us/monitoring/index.htm. The following is a listing of the lakes monitored:

Black Lake
East and West Chambers Lake
Deep Lake
Offutt Lake
Pattison Lake
Scott Lake

Hewitt Lake
Hicks Lake
Lake Lawrence
Long Lake
McIntosh Lake
Smith Lake
Summit Lake
St. Clair
Ward Lake

**Ground Water Level Monitoring**

Continuous ground water elevations are monitored in the following areas of the County:

Salmon Creek Basin (Thirteen Sites)
Hidden Forest Subdivision (Three sites)
Yelm (Nine sites)
Tanglewilde Subdivision (Ten Sites)
Evergreen Terrace (Six sites)

The groundwater data can be downloaded from the Thurston County Monitoring website at: http://www.co.thurston.wa.us/monitoring/Groundwater/Groundwater_home.htm. Data from some of these locations may not be posted on the website. To check for availability and to request data, contact the Department of Water and Waste Management.

# 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 July 1, 2003. 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**

**Water Contact Recreation Criteria**

| **Parameter** | Extraordinary Primary Contact Recreation (includes lakes) | Primary Contact Recreation | Secondary Contact Recreation |
|---|---|---|---|
| **Freshwater Fecal Coliform** (colonies/100 L) **Part I** – geometric mean ≤ X | 50 | 100 | 200 |
| **Freshwater Fecal Coliform** (colonies/100 L) **Part II -** 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.

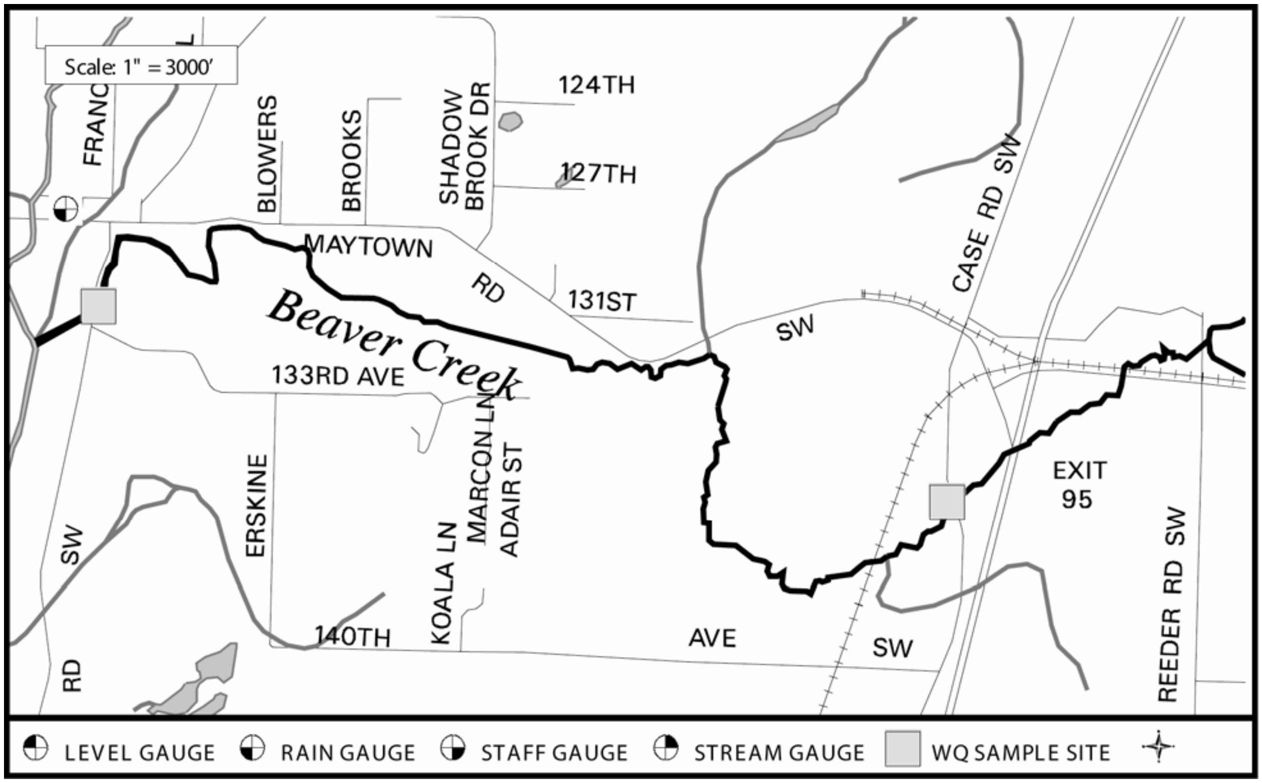
# Black Watershed

**WRIA 23**

**Chapter Includes:**

**Beaver Creek**
**Black River**
**Deep Lake**
**Salmon Creek**

# Beaver Creek #667




**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, and agriculture and rural residential

**FISHERIES RESOURCES:** (From <u>A Catalog of Washington Steams and Salmon Utilization</u>, 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:**

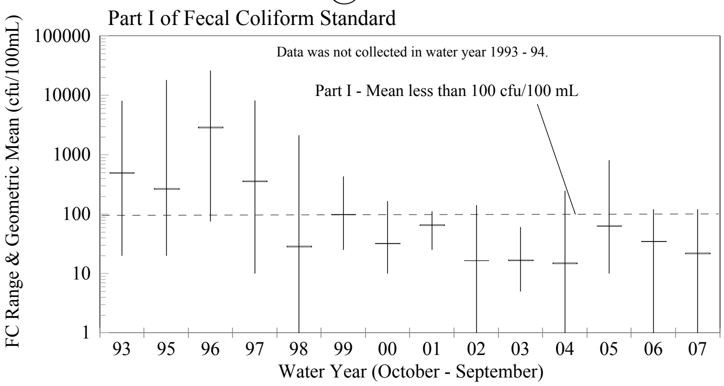
Good – Water quality has improved. Both parts of the fecal coliform standard were met at the Littlerock Rd. site for both water years 2005/06 and 2006-07.

**OTHER DATA:**

Thurston County Department of Water and Waste Management, (360) 357-2491 or www.co.thurston.wa.us/monitoring

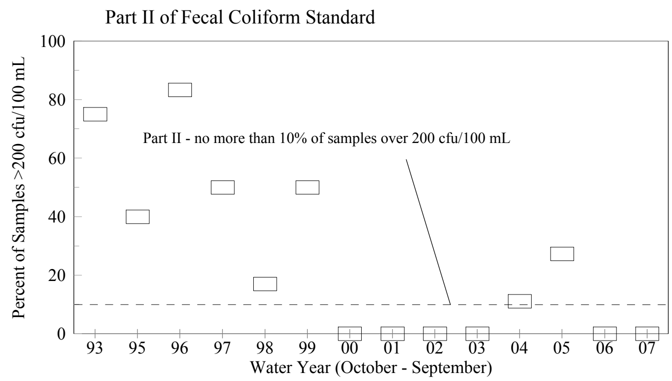
Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

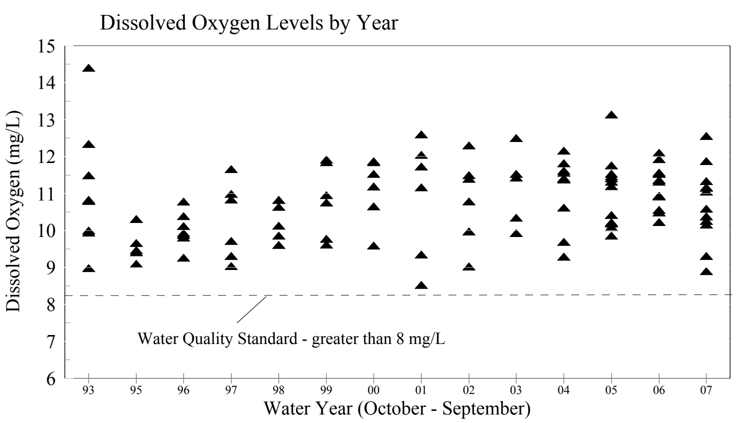
## Beaver Creek @ Littlerock Rd.




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

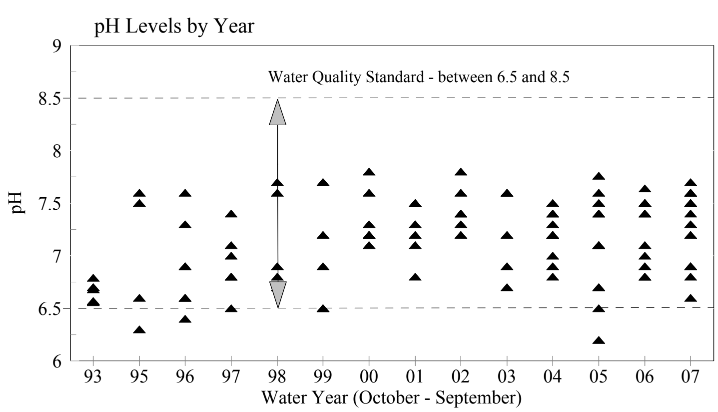
The creek has met Part I since 1997/98 at the Littlerock Road site. Part II of the standard has been met since 2005/06.




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 three violations measured in the period of record since 1993.



Beaver Creek was monitored at Littlerock Road Bridge (formerly 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 Case Road as an upstream site used for comparison. Monitoring at the Case Road site 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. However 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 is now meeting standards.

## Major Issues:

- Livestock access practices may have been contributing to pollution.
- Development pressures are 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: 2005/06 and 2006/07 | | | | Cumulative Data: 1992-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | EC | Highest 7-DAD Max of 17.5EC | 05/06<br>06/07 | | 5.40 – 16.80<br>5.09 – 17.39 | | | 2.90 - 18.25 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 10.23 – 12.1<br>8.9 – 12.6 | 0 of 11<br>0 of 12 | | 8.53 - 14.4 |
| Conductivity | Fmhos/cm | | 05/06<br>06/07 | 91<br>88 | 66 – 119<br>54 - 114 | | 87 | 43 - 160 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.4*<br>7.4* | 6.8 - 7.6<br>6.6 – 7.7 | 0 of 12<br>0 of 12 | | 6.2 - 7.8 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 2.02<br>2.13 | 1.1 – 3.3<br>0.3 – 4.3 | 0 of 12<br>0 of 12 | 2.76 | 0.7 - 10.0 |
| Fecal Coliform | colonies/ 100 ml | GMV: ≤100 and ≤ 10% not to exceed 200 | 05/06<br>06/07 | 33**<br>20** | 0 - 120<br>0 - 110 | **% exceeding 200**<br>0%<br>0% | 83** | 0 – 26000 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.036<br>0.042 | 0.024 - 0.057<br>0.022 – 0.061 | | 0.063 | 0.022 - 0.425 |
| Nitrate + Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.821<br>0.661 | 0.571– 1.11<br>0.422 – 0.929 | | 0.903 | 0.327 – 2.61 |

* Median
** Geometric mean value (GMV)

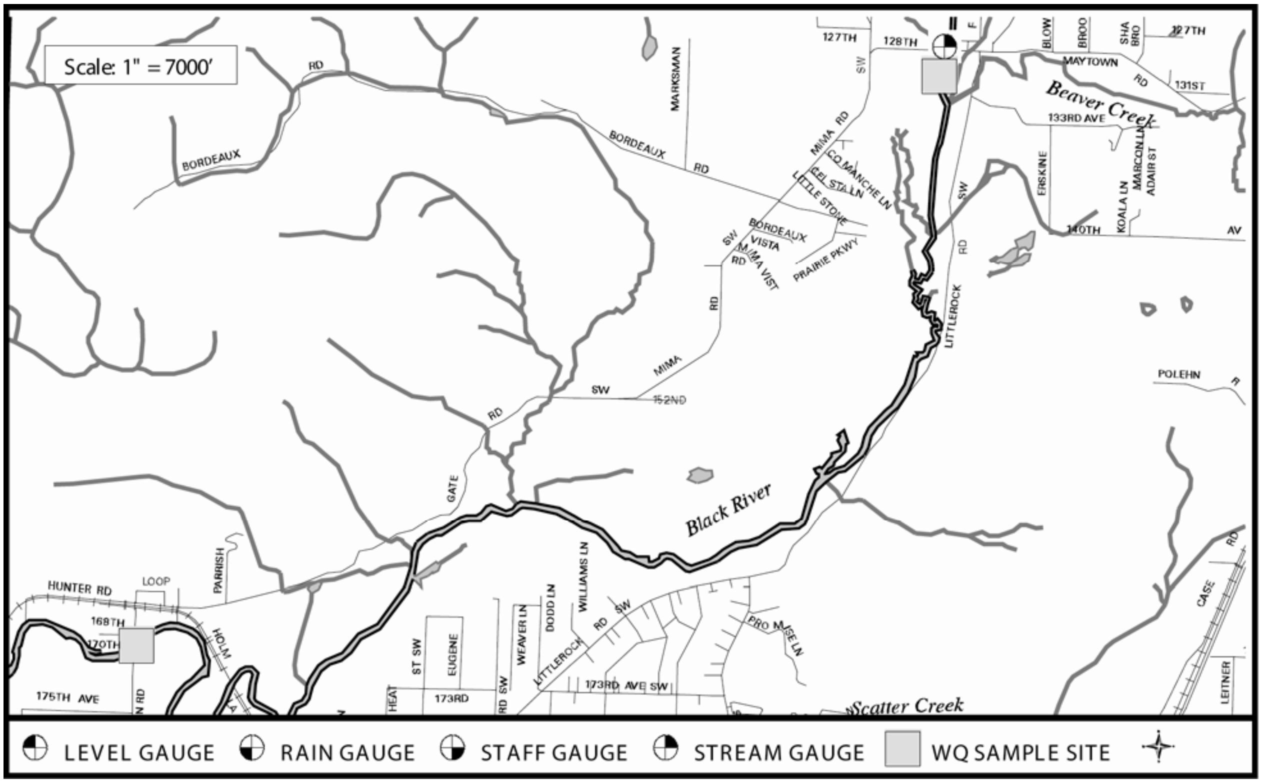
## Beaver Creek @ Littlerock Road

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/11/2005 | 1:30:00 PM | 11.51 | 7.5 | 11.32 | 119 | 65 | 1.1 | 7.1 | 0.033 | 1.050 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/8/2005 | 1:00:00 PM | 7.35 | 6.8 | 10.94 | 81 | 70 | 3.0 | 69.8 | 0.057 | 0.828 | |
| 12/7/2005 | 12:30:00 PM | 5.40 | 7.1 | 11.93 | 70 | 0 | 1.4 | 50.7 | 0.030 | 0.789 | |
| 1/4/2006 | 2:10:00 PM | 6.24 | 6.8 | 11.53 | 66 | 25 | 2.5 | | 0.042 | 0.812 | Very high water, full width of stream bed, too high to do flow. |
| 2/7/2006 | 1:00:00 PM | 5.50 | 6.9 | 12.10 | 66 | 5 | 1.8 | | 0.029 | 0.703 | too high and fast to wade & measure flow |
| 3/13/2006 | 12:00:00 PM | 5.46 | 7.0 | 10.49 | 73 | 10 | 2.1 | 82.8 | 0.024 | 0.681 | |
| 4/26/2006 | 3:00:00 PM | 12.56 | 7.5 | 11.57 | 97 | 50 | 2.2 | 27.3 | 0.034 | 0.884 | |
| 5/16/2006 | 1:30:00 PM | 16.70 | 7.4 | 10.23 | 106 | 55 | 3.3 | 14.8 | 0.035 | 1.110 | |
| 6/14/2006 | 1:00:00 PM | 15.77 | 7.4 | 10.56 | 103 | 90 | 2.3 | 15.5 | 0.029 | 0.833 | |
| 7/11/2006 | 9:15:00 AM | 15.24 | 7.5 | | 110 | 80 | 1.7 | 8.0 | 0.051 | 0.752 | no DO measurement |
| 8/9/2006 | 12:10:00 PM | 16.80 | 7.6 | 10.92 | 110 | 120 | 1.4 | 2.8 | 0.038 | 0.571 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/11/2006 | 1:20:00 PM | 12.73 | 7.5 | 11.37 | 90 | 70 | 1.4 | 2.9 | 0.036 | 0.834 | |

## Thurston County Water Resources Monitoring Report 2006 - 2007

*Beaver Creek @ Littlerock Road*

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 12:45:00 PM | 11.86 | 7.4 | 10.59 | 111 | 15 | 0.6 | 3.2 | 0.031 | 0.594 | |
| 11/13/2006 | 3:15:00 PM | 8.29 | 6.6 | 10.38 | 59 | 40 | 4.3 | | 0.059 | 0.603 | too fast/deep to wade |
| 12/12/2006 | 2:15:00 PM | 7.14 | 6.8 | 11.16 | 71 | 40 | 4.0 | | 0.048 | 0.477 | too fast too deep |
| 1/22/2007 | 3:00:00 PM | 5.09 | 6.9 | 11.05 | 75 | 0 | 1.1 | 102.0 | 0.022 | 0.702 | F.C. result was <5. |
| 2/21/2007 | 11:50:00 AM | 6.28 | 6.9 | 9.31 | 54 | 65 | 3.8 | | 0.051 | 0.422 | too fast to wade |
| 3/21/2007 | 12:50:00 PM | 7.93 | 7.3 | 12.56 | 73 | 5 | 0.3 | | 0.036 | 0.457 | Too fast and deep to wade |
| 4/24/2007 | 12:45:00 PM | 11.93 | 7.2 | 11.34 | 85 | 35 | 2.2 | 49.1 | 0.035 | 0.586 | |
| 5/15/2007 | 2:45:00 PM | 14.72 | 7.6 | 11.88 | 93 | 85 | 2.9 | 24.2 | 0.034 | 0.698 | |
| 6/11/2007 | 2:15:00 PM | 14.32 | 7.6 | 10.26 | 102 | 15 | 1.6 | 12.0 | 0.040 | 0.772 | |
| 7/17/2007 | 10:45:00 AM | 17.39 | 7.5 | 8.90 | 106 | 0 | 2.1 | 7.0 | 0.061 | 0.836 | F.C. result was <5. |
| 8/20/2007 | 2:45:00 PM | 15.82 | 7.5 | 10.16 | 113 | 110 | 1.0 | 5.5 | 0.043 | 0.859 | |
| 9/18/2007 | 12:00:00 PM | 12.84 | 7.7 | 11.17 | 114 | 70 | 1.7 | 3.7 | 0.038 | 0.929 | |




**PART OF BLACK RIVER WATERSHED**

**LENGTH OF RIVER:** 25 miles

**BASIN SIZE:** 136 square miles

**STREAM ORDER:** 4

**PRIMARY LAND USES:**

Mostly forest on the west and agriculture on the east, with some residential concentrations, including the towns of Littlerock and Rochester.

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

Coho, Chum, Chinook

**GENERAL TOPOGRAPHY:**
To the west of the river lies the Black Hills, while the eastern side of the watershed is prairie. The river has a very low gradient and an extensive wetland along most of its length.

**GENERAL WATER QUALITY:**

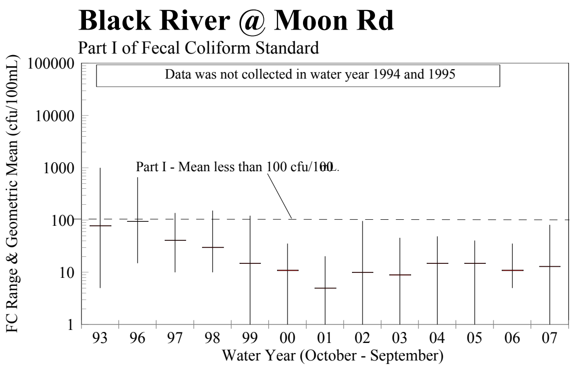
Good - Summer high temperatures occur, which are a natural condition. Both parts of the fecal coliform standard were met.

**OTHER DATA:**

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

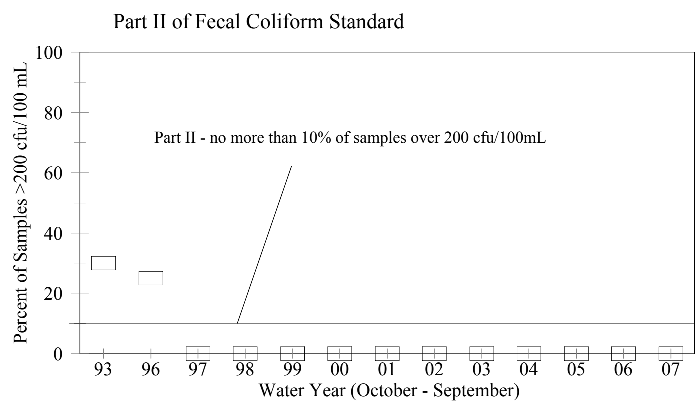
Thurston County Environmental Health Division (360) 754-4111 (water quality data for 1991-1993). www.co.thurston.wa.us/health/ehswat/swater.htm

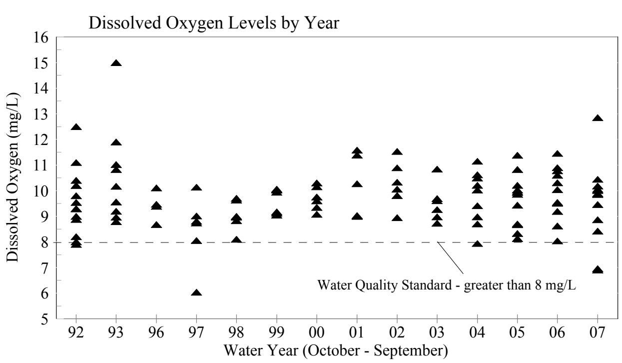
Thurston County Department of Water and Waste Management, Storm Water Utility
(360) 357-2491 (flow data from 1992).
www.co.thurston.wa.us/monitoring




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

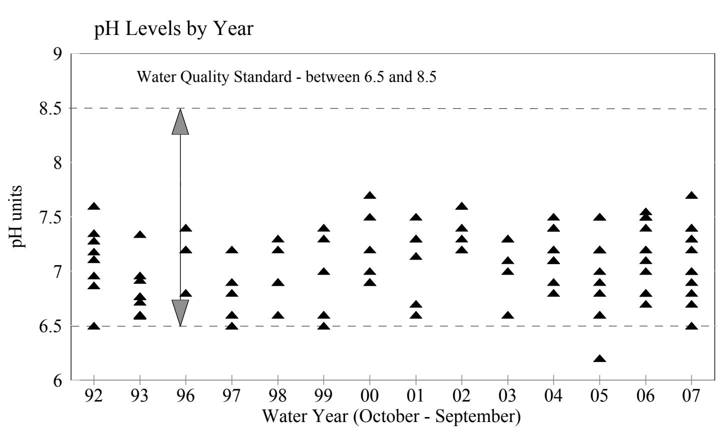
There have been no recorded violations of part I or part II of the fecal coliform standard since 1997. Part II of the standard was violated in 1993 and 1996. No data was collected in 1994 and 1995.




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 occasions when the dissolved oxygen standard is violated. No violations occurred between 1999 and 2003, one measurement was slightly below the standard in 2004. Two violations occurred in 2006/07.

The standard requires the pH to be within the range of 6.5 and 8.5. There were no violations recorded between 1992 and 2003. However, there was one violation in water year 2004/05.



The Black River is monitored at the Moon Road Bridge as part of the ambient monitoring program. There is data for the period from 1991 through 1993 at other upstream sites that can be made available upon request or by visiting www.co.thurston.wa.us/health/ehswat/swater.htm.

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: 2005/06 and 2006/07 | | | | Cumulative Data: 1992-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 05/06<br>06/07 | | 5.52 – 19.2<br>5.02 – 18.91 | | | 4.22 - 22.80 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 8.04 – 11.5<br>6.91 – 12.9 | 0 of 11<br>2 of 12 | | 6.04 - 15.00 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 88<br>87 | 54- 117<br>49 - 115 | | 80 | 41 – 136 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.2*<br>7.1* | 6.7 – 7.6<br>6.5 – 7.7 | 0 of 12<br>0 of 12 | 7.1* | 6.2 - 7.7 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 1.62<br>1.73 | 0.6 – 3.8<br>0 – 6.8 | 0 of 12<br>0 of 12 | 2.48 | 0.07 – 14 |
| Fecal Coliform | colonies/ 100 ml | GMV: ≤100 and ≤ 10% not to exceed 200 | 05/06<br>06/07 | 11**<br>12** | 5 - 35<br>0 – 80 | **% exceeding 200**<br>0%<br>0% | 20** | 0 – 1100 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.03<br>0.03 | 0.024 - 0.049<br>0.022 - 0.047 | | 0.04 | 0.014 - 0.071 |
| Nitrate + Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.724<br>0.623 | 0.568- 0.836<br>0.358 – 0.798 | | 0.666 | 0.303 - 1.51 |

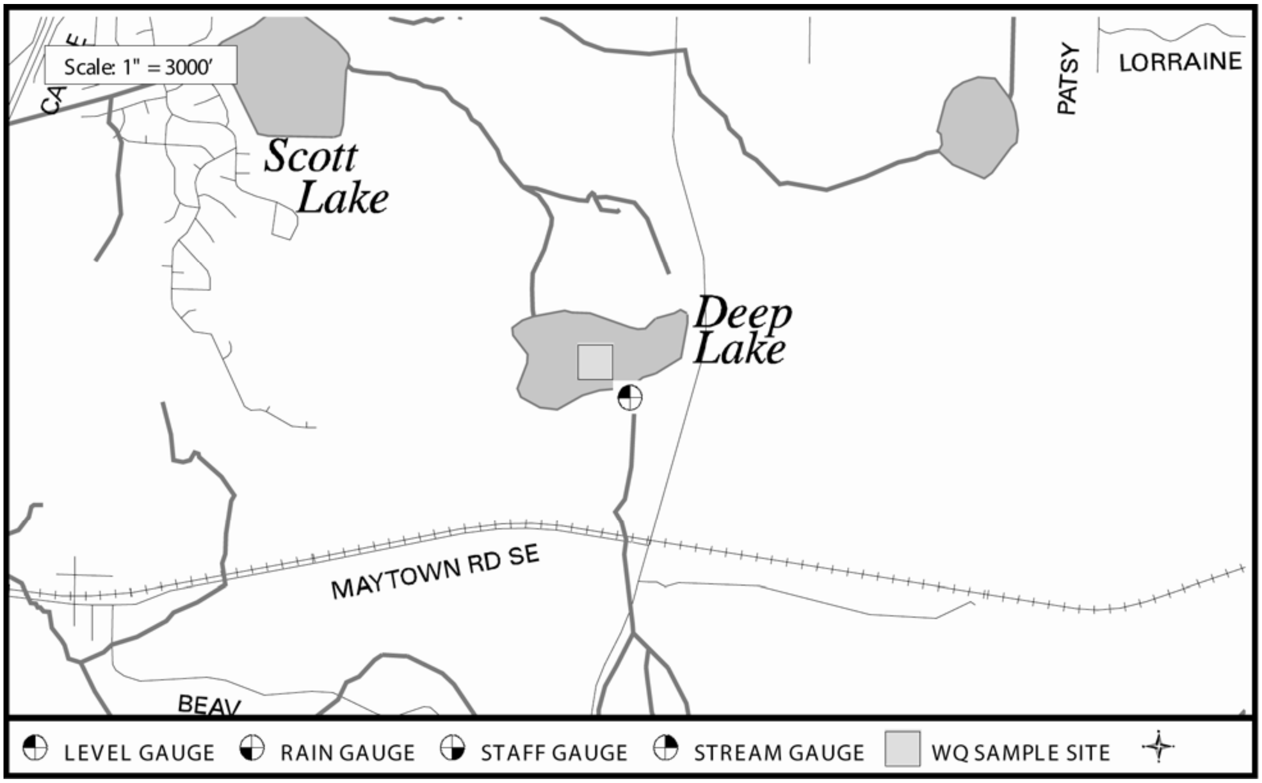
* Median
** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/11/2005 | 12:30:00 PM | 12.26 | 7.2 | 9.19 | 113 | 20 | 0.6 | | 0.033 | 0.836 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/8/2005 | 12:30:00 PM | 7.82 | 6.8 | 8.04 | 62 | 35 | 3.8 | | 0.049 | 0.568 | |
| 12/7/2005 | 12:05:00 PM | 5.52 | 7.1 | 10.78 | 76 | 5 | 1.3 | | 0.032 | 0.729 | |
| 1/4/2006 | 12:45:00 PM | 6.96 | 6.7 | 8.62 | 54 | 5 | 2.9 | | 0.031 | 0.610 | |
| 2/7/2006 | 12:20:00 PM | 6.62 | 6.8 | 10.04 | 57 | 15 | 2.0 | | 0.027 | 0.653 | |
| 3/13/2006 | 12:30:00 PM | 5.95 | 7.0 | 9.51 | 72 | 10 | 2.5 | | 0.024 | 0.768 | |
| 4/26/2006 | 2:40:00 PM | 12.96 | 7.5 | 10.90 | 89 | 5 | 1.6 | | 0.028 | 0.773 | |
| 5/16/2006 | 2:15:00 PM | 16.80 | 7.5 | 11.45 | 97 | 5 | 1.2 | | 0.025 | 0.790 | |
| 6/14/2006 | 12:30:00 PM | 15.45 | 7.2 | 9.54 | 100 | 5 | 1.3 | | 0.039 | 0.789 | |
| 7/11/2006 | 9:45:00 AM | 17.08 | 7.4 | | 110 | 15 | 0.7 | | 0.031 | 0.797 | no DO measurement |
| 8/9/2006 | 11:35:00 AM | 19.20 | 7.6 | 10.60 | 111 | 25 | 0.8 | | 0.024 | 0.613 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/11/2006 | 12:45:00 PM | 17.60 | 7.5 | 10.31 | 117 | 10 | 0.7 | | 0.029 | 0.764 | |

## Thurston County Water Resources Monitoring Report 2006 - 2007

*Black River @ Moon Rd Br*

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 12:20:00 PM | 13.70 | 7.3 | 9.88 | 114 | 15 | 0.3 | | 0.029 | 0.786 | |
| 11/13/2006 | 3:00:00 PM | 8.59 | 6.5 | 6.91 | 53 | 80 | 5.8 | | 0.047 | 0.358 | |
| 12/12/2006 | 1:45:00 PM | 7.43 | 6.8 | 9.85 | 70 | 10 | 2.2 | | 0.030 | 0.456 | |
| 1/22/2007 | 2:30:00 PM | 5.02 | 6.7 | 9.46 | 74 | 10 | 1.1 | | 0.022 | 0.738 | |
| 2/21/2007 | 12:10:00 PM | 7.14 | 6.9 | 8.42 | 49 | 10 | 6.8 | | 0.038 | 0.472 | |
| 3/21/2007 | 12:30:00 PM | 8.96 | 7.0 | 10.01 | 71 | 10 | 0.0 | | 0.034 | 0.455 | |
| 4/24/2007 | 12:20:00 PM | 11.52 | 7.0 | 10.18 | 82 | 0 | 1.1 | | 0.026 | 0.601 | F.C. result was <5. |
| 5/15/2007 | 2:15:00 PM | 14.93 | 7.3 | 12.85 | 92 | 5 | 1.5 | | 0.029 | 0.687 | |
| 6/11/2007 | 12:15:00 PM | 14.56 | 7.4 | 10.05 | 100 | 10 | 0.6 | | 0.028 | 0.754 | |
| 7/17/2007 | 10:00:00 AM | 18.91 | 7.2 | 6.96 | 108 | 20 | 0.7 | | 0.029 | 0.644 | |
| 8/20/2007 | 2:25:00 PM | 17.12 | 7.4 | 8.86 | 110 | 25 | 0.2 | | 0.023 | 0.723 | |
| 9/18/2007 | 11:40:00 AM | 15.12 | 7.7 | 10.44 | 115 | 20 | 0.5 | | 0.024 | 0.798 | |




**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 - Visibility is usually good, and phosphorus levels are below the state water quality action level.

**OTHER AVAILABLE DATA:**
Water quality data - Thurston County Environmental Health Division, (360) 754-4111, www.co.thurston.wa.us/health/ehswat/swater.htm

**GENERAL DISCUSSION:**

Deep Lake was sampled monthly, May through October, since 1994. Profile graphs of temperature, pH, dissolved oxygen, and conductivity data for 2007 can be found at the end of this narrative. In 2007, Deep Lake was thermally stratified from May through September. This means that the lake developed a warm surface layer and a cooler bottom layer, as the solar radiation warmed the water. The lake's shallow depth (average depth of 12 feet or 3.7 meters) and good water clarity results in a dense population of rooted aquatic plants along the lake bottom, which usually keeps the lake well oxygenated at all depths. At a depth of about two to four meters the water was supersaturated with oxygen.

The 2007 average water clarity, as measured with a secchi disk, was 3.4 meters (11 feet). The range of measurements was from 2.6 meters (8.4 feet) in May to 3.7 meters (12.3 feet) in July. A graph of average summer secchi disk measurements from 1975 and 1994 through 2007 is included at the end of this narrative. A graph of water clarity trends is also shown at the end of this chapter comparing the annual average to the long-term average for the lake.

Total phosphorus concentrations at the surface averaged 0.009 milligrams per liter (mg/L) in 2007. This is well within the state water quality standard of 0.020 mg/L for Puget Sound lowland lakes. The chlorophyll *a* concentration averaged 8 µg/L. The highest concentration measured in 2007 was 17 µg/L in May, which corresponded with the lowest water clarity measurement.

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.

For 2007, the Deep Lake TSI's for chlorophyll *a*, total phosphorus, and secchi disk visibility are 51, 36, and 42, respectively. The trophic state indices for the years of record are graphed and included on the page following the monthly profile graphs. In 2007 the secchi disk and chlorophyll indices were within the mesotrophic range, indicating moderate productivity, and the total phosphorus index was within the oligotrophic range, indicating low productivity. In most years in the record, Deep Lake TSIs have been near the upper end of the oligotrophic range and low end of the mesotrophic range indicating low to moderate productivity with some annual variability probably resulting from weather influences.

## 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.

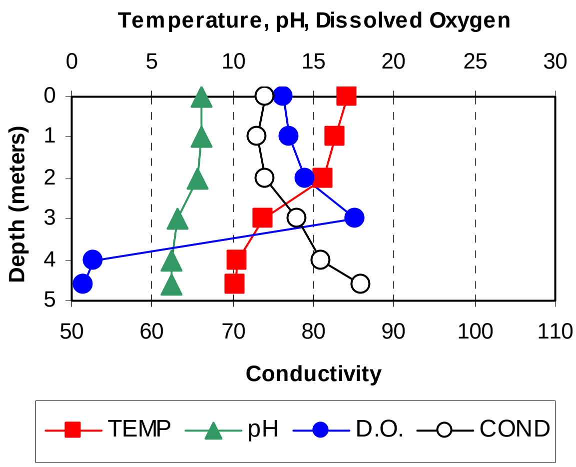
- An invasive, non-native aquatic plant, Eurasian water milfoil, was discovered in the lake in 2003. Washington State Parks and Recreation is taking steps to control its spread in the lake.

## Funding Sources:

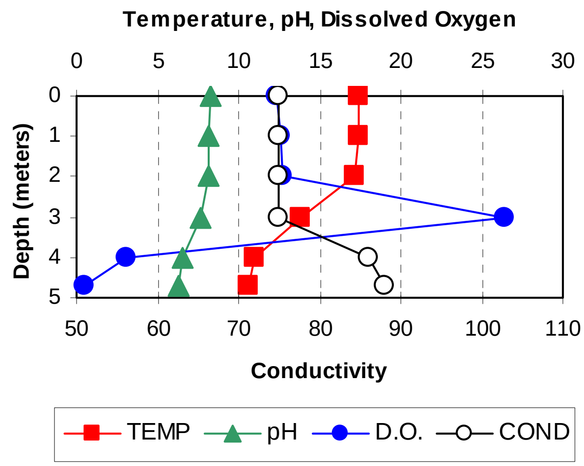
Thurston County funding will continue to support sampling in 2008.

# DEEP LAKE

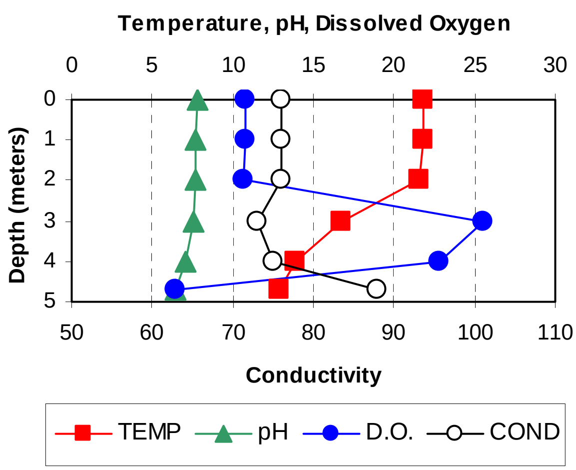
## May 23, 2007



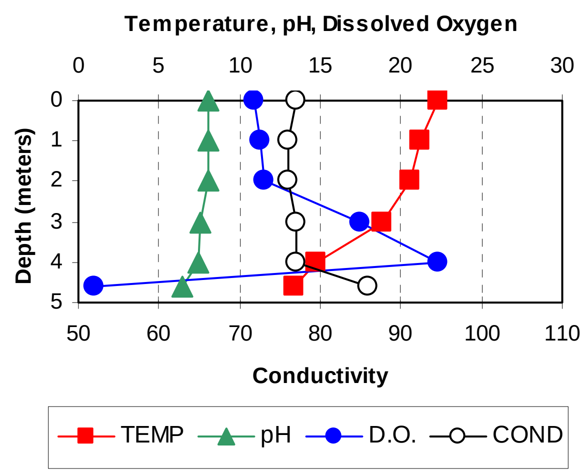

## June 18, 2007



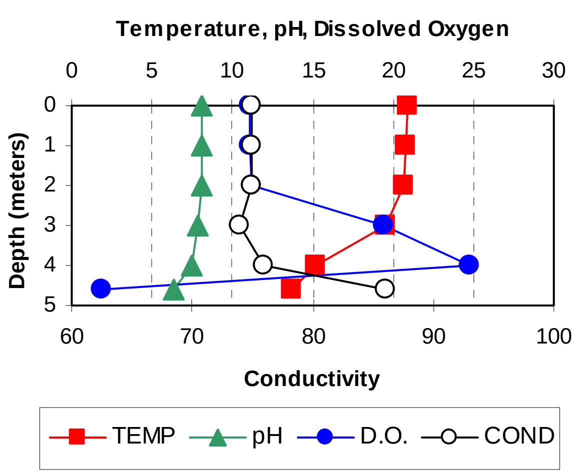

## July 23, 2007



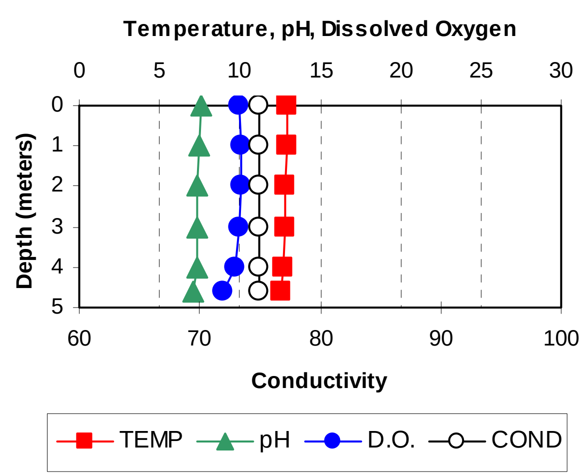

## August 14, 2007

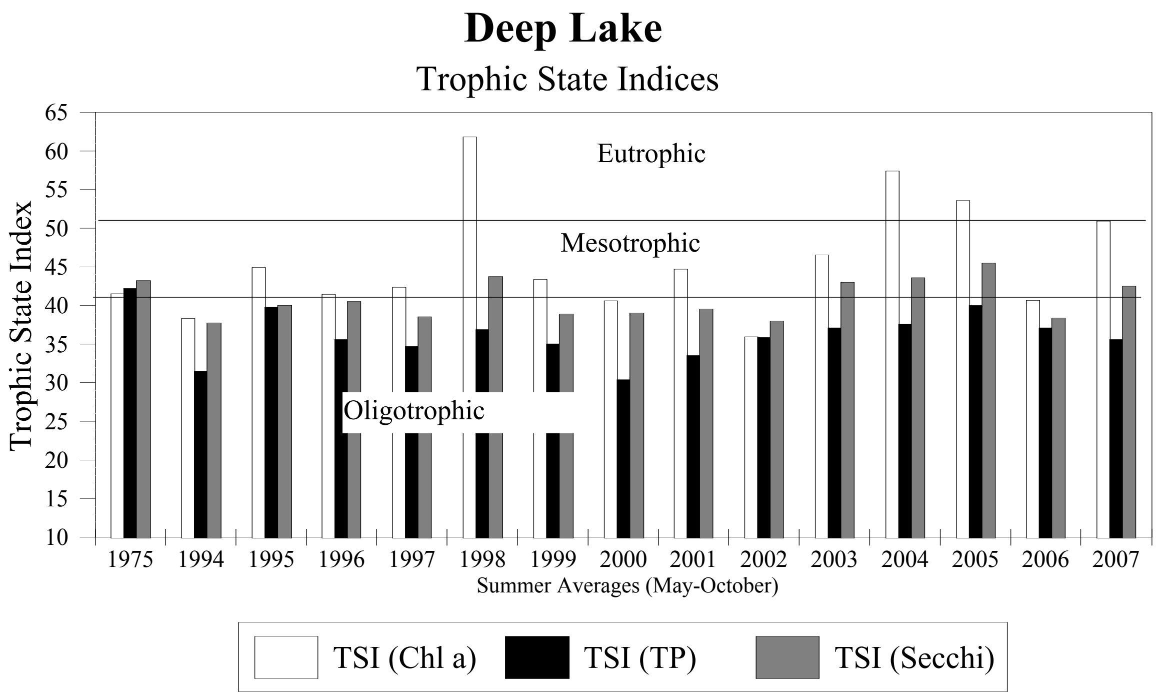


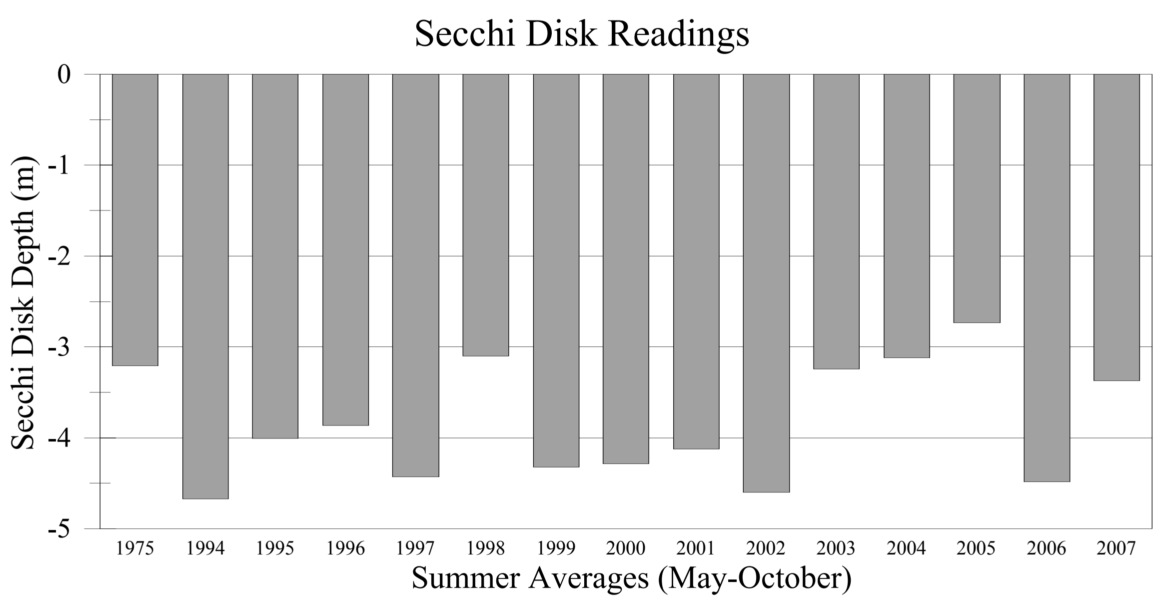

## September 12, 2007

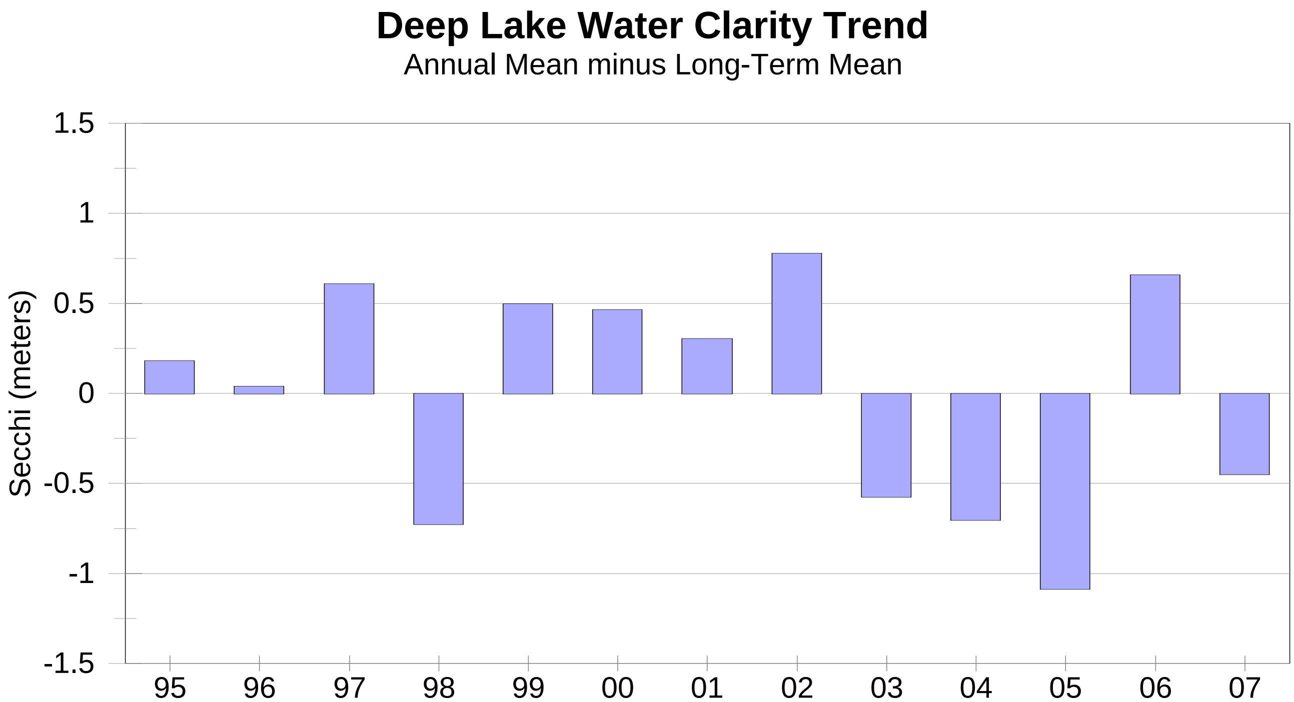



## October 17, 2007




Deep Lake
Trophic State Indices
Trophic State Index
Eutrophic
Mesotrophic
Oligotrophic
65
60
55
50
45
40
35
30
25
20
15
10
1975
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)
TSI (Chl a)
TSI (TP)
TSI (Secchi)


Secchi Disk Readings
Secchi Disk Depth (m)
0
-1
-2
-3
-4
-5
1975
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)


Deep Lake Water Clarity Trend
Annual Mean minus Long-Term Mean
Secchi (meters)
1.5
1
0.5
0
-0.5
-1
-1.5
95
96
97
98
99
00
01
02
03
04
05
06
07

## 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 Color | Lake Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/23/2007 | 12:30:00 PM | 4.6 | 4.0 | 0.010 | 0.033 | 0.377 | 0.955 | 2.57 | 17 | 3.1 | #6 yellow-green | Chl a & algae composite @ 1, 2, & 3M. |
| 06/18/2007 | 1:30:00 PM | 4.7 | 4.0 | 0.007 | 0.050 | 0.333 | 0.985 | 3.06 | 10 | 1.8 | #6 yellow-green | Chl a & algae composite @ 1, 2, & 3M. |
| 07/23/2007 | 2:00:00 PM | 4.7 | 4.0 | 0.007 | 0.200 | 0.324 | 6.640 | 3.74 | 5.3 | 1 | #6 yellow-green | Chl a & algae composite @ 1, 2, & 3M. |
| 08/14/2007 | 1:45:00 PM | 4.6 | 4.0 | 0.008 | 0.028 | 0.262 | 0.612 | 3.55 | 4.8 | 0.4 | #6 yellow-green | Chl a & algae composite @ 1, 2, & 3M. |
| 09/12/2007 | 1:00:00 PM | 4.6 | 4.0 | 0.007 | 0.015 | 0.270 | 0.371 | 3.58 | 4.8 | 3 | #6 yellow-green | Chl a & algae composite @ 1, 2, & 3M. |
| 10/17/2007 | 12:00:00 PM | 4.6 | 4.0 | 0.014 | 0.012 | 0.354 | 0.347 | 3.69 | 5.9 | 6.8 | #6 yellow-green | Chl a & algae composite @ 1, 2, & 3M. |

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

| Averages: | | |
|---|---|---|
| | **Sur TP** | *0.009* |
| | **Secchi** | *3.37* |
| | **Chl a** | *8.0* |

# *Algae data:* Deep Lake

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| 05/23/2007 | | | |
| | BG | Anabaena species | ☐ |
| | DF | Ceratium species | ☐ |
| | EU | Phacus species | ☐ |
| | YL | Dinobryon species | ☑ |
| 06/18/2007 | | | |
| | CP | Cryptomonas species | ☐ |
| | DT | Cymbella species | ☐ |
| | GR | Botryococcus braunii | ☐ |
| | YL | Dinobryon species | ☑ |
| 07/23/2007 | | | |
| | CP | Chroomonas species | ☐ |
| | DT | Cocconeis pediculus | ☐ |
| | DT | Tabellaria species | ☐ |
| | GR | Elakatothrix species | ☐ |
| | GR | Oocystis species | ☐ |
| | YL | Dinobryon species | ☑ |
| 08/14/2007 | | | |
| | BG | Anabaena species | ☐ |
| | BG | Chroococcus species | ☐ |
| | CP | Chroomonas species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DT | Asterionella species | ☐ |
| | GR | Scenedesmus species | ☐ |
| | YL | Dinobryon species | ☐ |
| 09/12/2007 | | | |
| | BG | Anabaena species | ☐ |
| | CP | Chroomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Gomphonema lanceolatum | ☐ |
| | GR | Oocystis borgei | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | YL | Dinobryon species | ☑ |

*10/17/2007*

| Type | Description | Dominant in Sample |
|---|---|---|
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Melosira species | ☐ |
| DT | Tabellaria species | ☐ |
| GR | Elakatothrix species | ☐ |
| GR | Scenedesmus species | ☐ |
| YL | Dinobryon species | ☐ |

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

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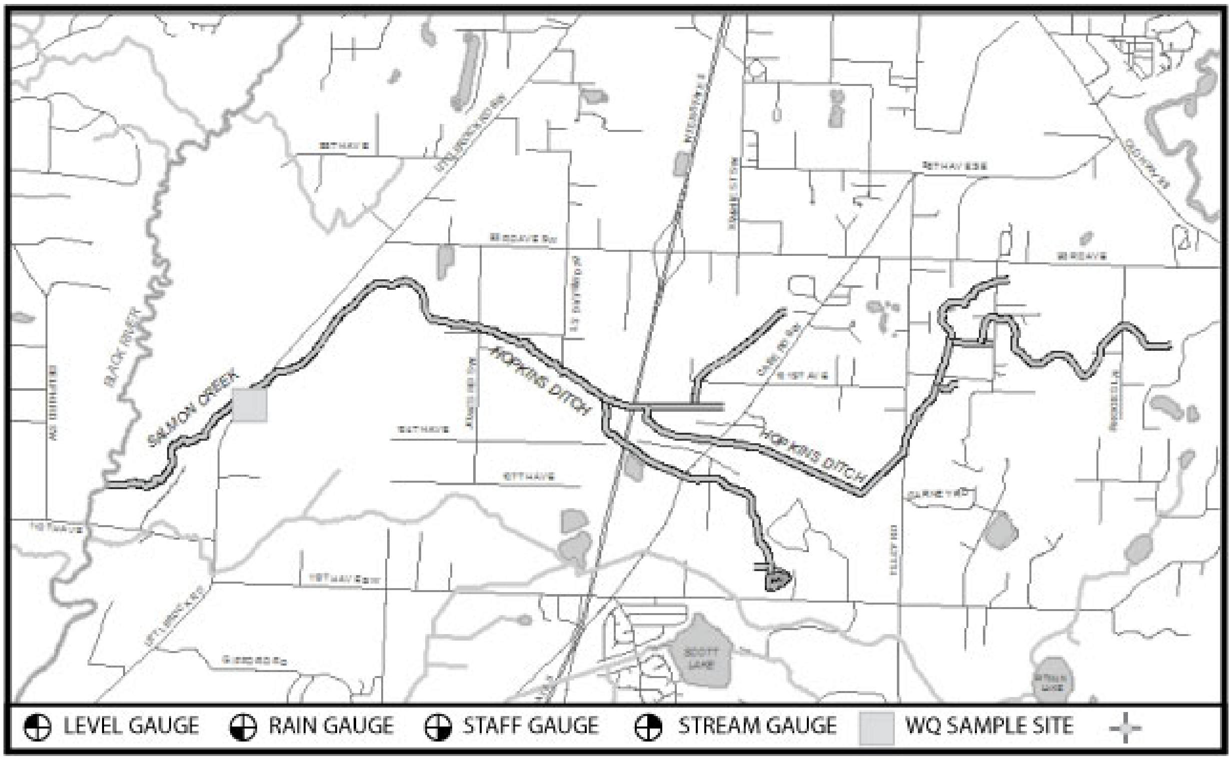
# Salmon Creek #685




**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 <u>A Catalog of Washington Steams and Salmon Utilization</u>, 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:**

Good. Met fecal coliform standard. Dissolved oxygen is low in dry months.

**OTHER DATA:**

Thurston County Environmental Health Division (360) 754-4111 (water quality data for 1991-1993). www.co.thurston.wa.us/health/ehswat/swater.htm

Thurston County Department of Water and Waste Management, Storm Water Utility (360) 357-2491 Salmon Creek and groundwater monitoring. Salmon Creek Drainage Basin Plan www.co.thurston.wa.us/monitoring

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 water quality standard for fecal coliform has two parts: part I - the geometric mean shall not exceed 100 colony forming units per 100 milliliters of sample *and*, part II - no more than 10 percent of the samples shall exceed 200 colonies/100 mL of sample. Both parts of the fecal coliform standard were met in 2005/06, with a geometric mean of 19 colonies per 100 ml, and no samples were greater than 200. In 2006/07 both parts were met; however, one sample was greater than 200 (8 percent). During 2005/06, the dissolved oxygen fell below the standard four times and during 2006/07 it fell below the standard six times. There were 2 violations of the turbidity standard during each water year.

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.

## Funding Sources:

- Thurston County

# Water Quality Summary

Conventional Parameters

**Salmon Creek**

| Parameter | Units | WQ Standard WAC 173-201A | Water Year Data: 2005/06 and 2006/07 | | | | 2004-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | Water Year | Mean | Range | # samples violating standard | Mean | Range |
| Temperature | $^{o}$ C | Highest 7-DAD Max of 17.5 $^{o}$ C | 05-06<br>06-07 | | 4.57 – 16.24<br>5.13 – 17.12 | | | 1.99 – 16.47 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05-06<br>06-07 | | 6.79 – 10.8<br>5.53 – 10.3 | 4 of 12<br>6 of 12 | | 5.32 – 11.2 |
| Conductivity | µmhos/m | | 05-06<br>06-07 | 97<br>92 | 67 – 130<br>64 - 125 | | 98 | 78 - 136 |
| pH | | 6.5 - 8.5 | 05-06<br>06-07 | 7.0*<br>6.9* | 6.5 – 7.2<br>6.7 – 7.5 | 0 of 12<br>0 of 12 | 6.8* | 6.4 – 7.2 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05-06<br>06-07 | 4.24<br>3.69 | 0.6 – 18.2<br>0 – 9.8 | 2 of 12<br>2 of 12 | 2.57 | 0.7 – 6.1 |
| Fecal Coliform | Colonies/ 100ml | GMV: ≤100 and ≤ 10% not to exceed 200 | 05-06<br>06-07 | 19**<br>17** | 0 – 200<br>0 - 515 | % exceeding 200<br>0%<br>8% | 18** | 0 - 170 |
| Total Phosphorus | mg/L | | 05-06<br>06-07 | 0.043<br>0.037 | 0.018 – 0.083<br>0.014 – 0.092 | | 0.045 | 0.015 – 0.073 |
| Nitrate + Nitrite-nitrogen | mg/L | | 05-06<br>06-07 | 0.232<br>0.207 | 0.017 – 0.696<br>0.035 – 0.714 | | 0.172 | 0.033 – 0.588 |

* Median
** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/11/2005 | 2:15:00 PM | 11.34 | 6.8 | 6.79 | 130 | 10 | 2.9 | 0.59 | 0.057 | 0.044 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/8/2005 | 1:40:00 PM | 6.60 | 6.5 | 8.54 | 79 | 10 | 1.9 | 13.92 | 0.035 | 0.095 | |
| 12/7/2005 | 1:15:00 PM | 4.85 | 6.7 | 9.55 | 83 | 0 | 0.6 | 10.80 | 0.019 | 0.255 | F.C. result was <5. |
| 1/4/2006 | 2:25:00 PM | 6.04 | 6.6 | 9.80 | 67 | 10 | 1.7 | 42.60 | 0.023 | 0.667 | |
| 2/7/2006 | 1:15:00 PM | 5.21 | 6.8 | 10.81 | 69 | 20 | 0.8 | | 0.030 | 0.655 | Too high to wade. |
| 3/13/2006 | 11:30:00 AM | 4.57 | 6.9 | 9.31 | 82 | 15 | 1.4 | 24.90 | 0.018 | 0.696 | |
| 4/24/2006 | 3:00:00 PM | 11.97 | 7.2 | 9.39 | 94 | 0 | 1.4 | 10.10 | 0.028 | 0.050 | F.C. result was <5. |
| 5/16/2006 | 12:50:00 PM | 14.67 | 7.1 | 7.68 | 101 | 75 | 1.7 | 4.87 | 0.028 | 0.017 | |
| 6/14/2006 | 2:15:00 PM | 14.78 | 7.1 | 7.51 | 108 | 45 | 3.0 | 4.02 | 0.047 | 0.019 | |
| 7/11/2006 | 8:45:00 AM | 14.26 | 7.1 | | 121 | 200 | 7.5 | 0.81 | 0.077 | 0.029 | no DO measurement |
| 8/9/2006 | 12:45:00 PM | 16.24 | 7.1 | 7.10 | 124 | 75 | 9.8 | 0.11 | 0.075 | 0.099 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/11/2006 | 2:00:00 PM | 13.91 | 7.2 | 6.93 | 109 | 70 | 18.2 | 0.11 | 0.083 | 0.163 | |

# Thurston County Water Resources Monitoring Report 2006- 2007

*Salmon Creek @ Littlerock Rd.*

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 1:20:00 PM | 12.21 | 7.2 | 7.42 | 116 | 515 | 4.6 | 0.32 | 0.043 | 0.045 | |
| 11/15/2006 | 12:15:00 PM | 7.60 | 6.8 | 7.52 | 68 | 0 | 1.5 | 43.00 | 0.029 | 0.180 | F.C. result was <5. |
| 12/12/2006 | 2:30:00 PM | 7.30 | 6.7 | 9.19 | 77 | 0 | 1.1 | 32.90 | 0.016 | 0.368 | F.C. result was <5. |
| 1/22/2007 | 3:30:00 PM | 5.13 | 6.7 | 9.65 | 80 | 0 | 1.0 | 32.08 | 0.014 | 0.714 | F.C. result was <5. |
| 2/21/2007 | 3:00:00 PM | 7.05 | 6.7 | 8.72 | 64 | 85 | 9.8 | 58.39 | 0.034 | 0.456 | |
| 3/21/2007 | 1:15:00 PM | 7.66 | 6.8 | 10.27 | 79 | 10 | 0.0 | 36.70 | 0.027 | 0.376 | |
| 4/24/2007 | 1:30:00 PM | 10.99 | 6.8 | 8.99 | 87 | 20 | 0.6 | 19.25 | 0.022 | 0.129 | |
| 5/15/2007 | 3:45:00 PM | 13.17 | 7.0 | 9.97 | 92 | 15 | 2.1 | 9.27 | 0.025 | 0.035 | |
| 6/11/2007 | 2:45:00 PM | 13.71 | 7.0 | 7.82 | 90 | 45 | 2.5 | 2.99 | 0.041 | 0.038 | |
| 7/17/2007 | 11:15:00 AM | 17.12 | 7.0 | 5.53 | 125 | 25 | 8.2 | 1.87 | 0.092 | 0.038 | |
| 8/20/2007 | 3:15:00 PM | 15.71 | 7.0 | 7.22 | 110 | 65 | 5.8 | 1.63 | 0.051 | 0.036 | |
| 9/18/2007 | 12:30:00 PM | 12.86 | 7.2 | 6.51 | 120 | 40 | 7.1 | 0.74 | 0.052 | 0.066 | |

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# Budd/Deschutes Watershed

**WRIA 13**

**Chapter Includes:**

**Barnes Lake**
**Black Lake**
**Black Lake Ditch**
**Capitol Lake**
**Chambers Creek**
**Deschutes River**
**Ellis Creek**
**Indian Creek**
**Mission Creek**
**Moxlie Creek**
**Percival Creek**
**Schneider Creek**
**Spurgeon Creek**
**Ward Lake**

# Barnes Lake


**PART OF** Budd Inlet **WATERSHED**

**LENGTH OF LAKE:** 0.33 miles

**MAXIMUM DEPTH:** 10 feet

**GENERAL DESCRIPTION:**

Barnes Lake is located within the City of Tumwater. The approximate altitude of the lake is 156 feet. It is a very small, private lake with no surface inlet or outlet.

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

Poor – Water clarity is poor, nutrient levels are high, the dissolved oxygen level is very low.

**MAJOR ISSUES:**

- Low dissolved oxygen is an impediment to sustaining a fishery in this lake.
- Dense aquatic plant growth along the shoreline impairs recreational uses of the lake by lake residents.

**FUNDING FOR 2006 MONITORING:**

Barnes Lake – Lake Management District managed by the City of Tumwater.

## WATER QUALITY MONITORING METHODS:

Water quality monitoring of Barnes Lake was conducted once per month from May through October 2006 as part of the Barnes Lake – Lake Management District. There was one sampling site located in the open water in the approximate center of the lake. The lake was accessed by row boat off Lake Terrace Drive.

Field measurements were made for the following parameters:

- Temperature
- pH
- Dissolved Oxygen
- Conductivity

These parameters were measured at one meter increments from the surface to the bottom of the lake using the Yellow Springs Instrument multi-parameter field instrument. Water clarity was also measured. Clarity was measured using a secchi disk, which is a standard black and white quadrant disk lowered into the water until it is not visible.

Water samples were collected and analyzed for the following:

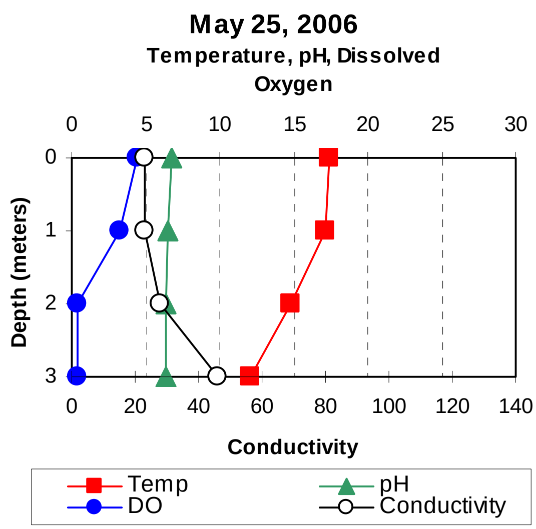
- Total Phosphorus
- Total Nitrogen
- Chlorophyll *a*
- Algae species (present and dominant)

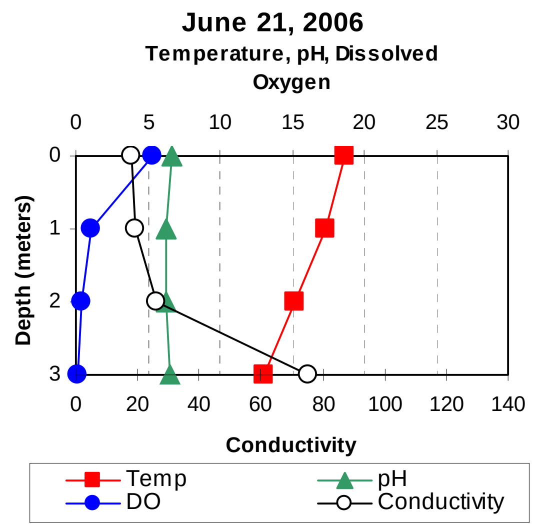
The nutrients (total phosphorus and total nitrogen) were sampled near the surface and near the bottom. The bottom samples were collected using a Kemmerer sampler. Chlorophyll *a* and algae samples were taken as composite samples from the warm surface layer or the photic zone (the surface area where sunlight can penetrate).

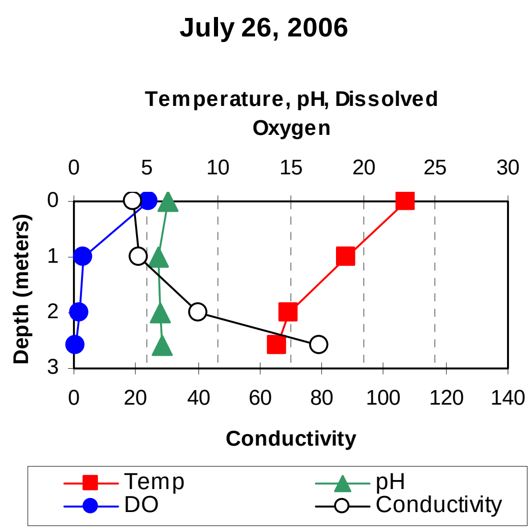
## MONITORING RESULTS:

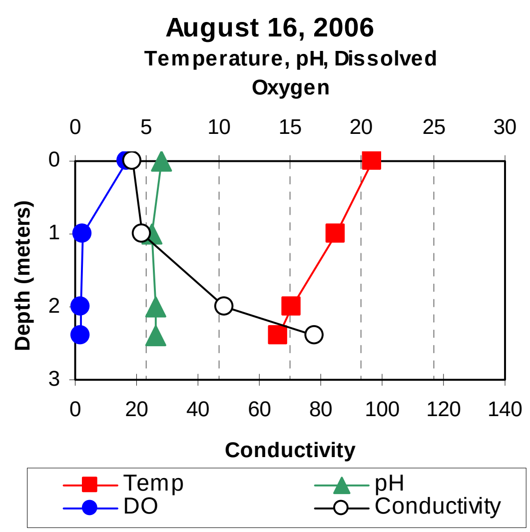
Profile graphs of temperature, pH, dissolved oxygen, and conductivity data are shown on the following page. Even though Barnes Lake is very shallow, it does thermally stratify during the mid-summer months. In July and August, the surface temperature was six to eight degrees Celsius warmer than it was at the bottom, 8.5 feet down. Barnes Lake has an orange to dark brown water color. The dark-colored water absorbs solar radiation, and the poor water clarity prevents light from penetrating very far into the water column. These conditions allow the lake to stratify into a distinct warm surface layer and a cold bottom layer despite its shallow depth.

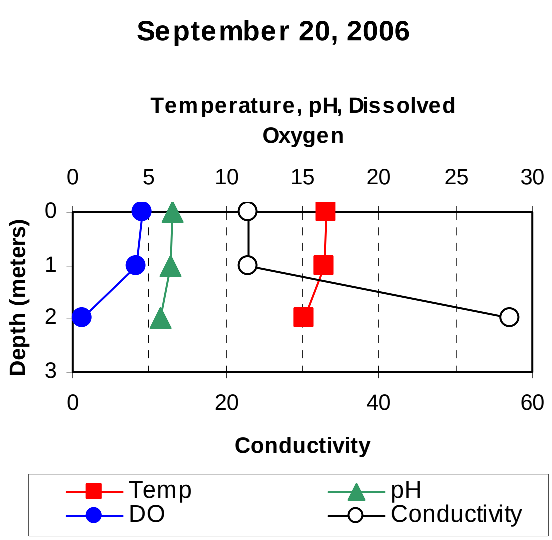
The pH and conductivity in Barnes Lake are lower than most lakes in Thurston County. The dissolved oxygen concentrations in the lake are very low, and are generally below levels that can sustain fish. Profile graphs of the field measurements are shown on the following page.

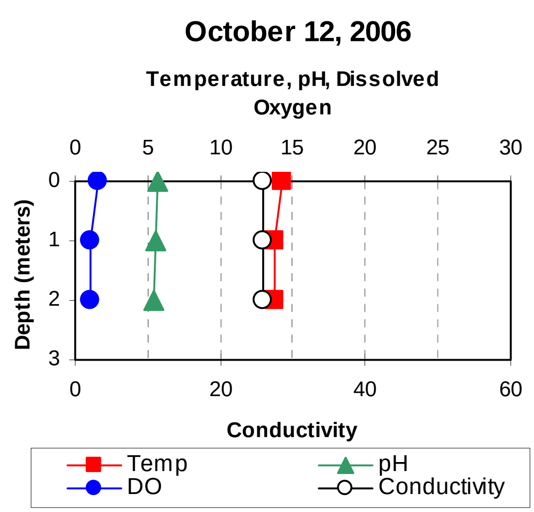

May 25, 2006
Temperature, pH, Dissolved Oxygen
Depth (meters)
Conductivity
Temp
DO
pH
Conductivity


June 21, 2006
Temperature, pH, Dissolved Oxygen
Depth (meters)
Conductivity
Temp
DO
pH
Conductivity

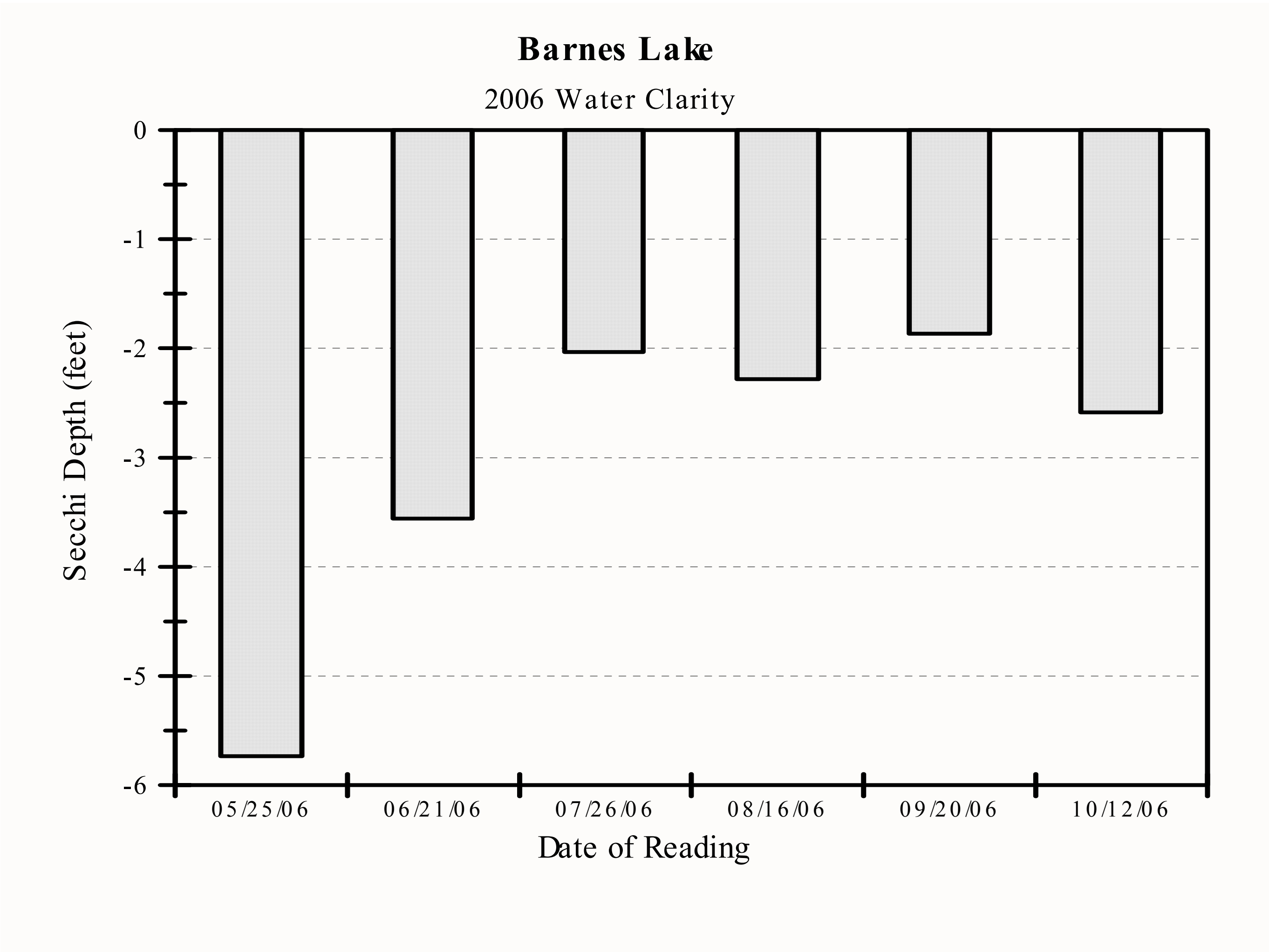

July 26, 2006
Temperature, pH, Dissolved Oxygen
Depth (meters)
Conductivity
Temp
DO
pH
Conductivity


August 16, 2006
Temperature, pH, Dissolved Oxygen
Depth (meters)
Conductivity
Temp
DO
pH
Conductivity

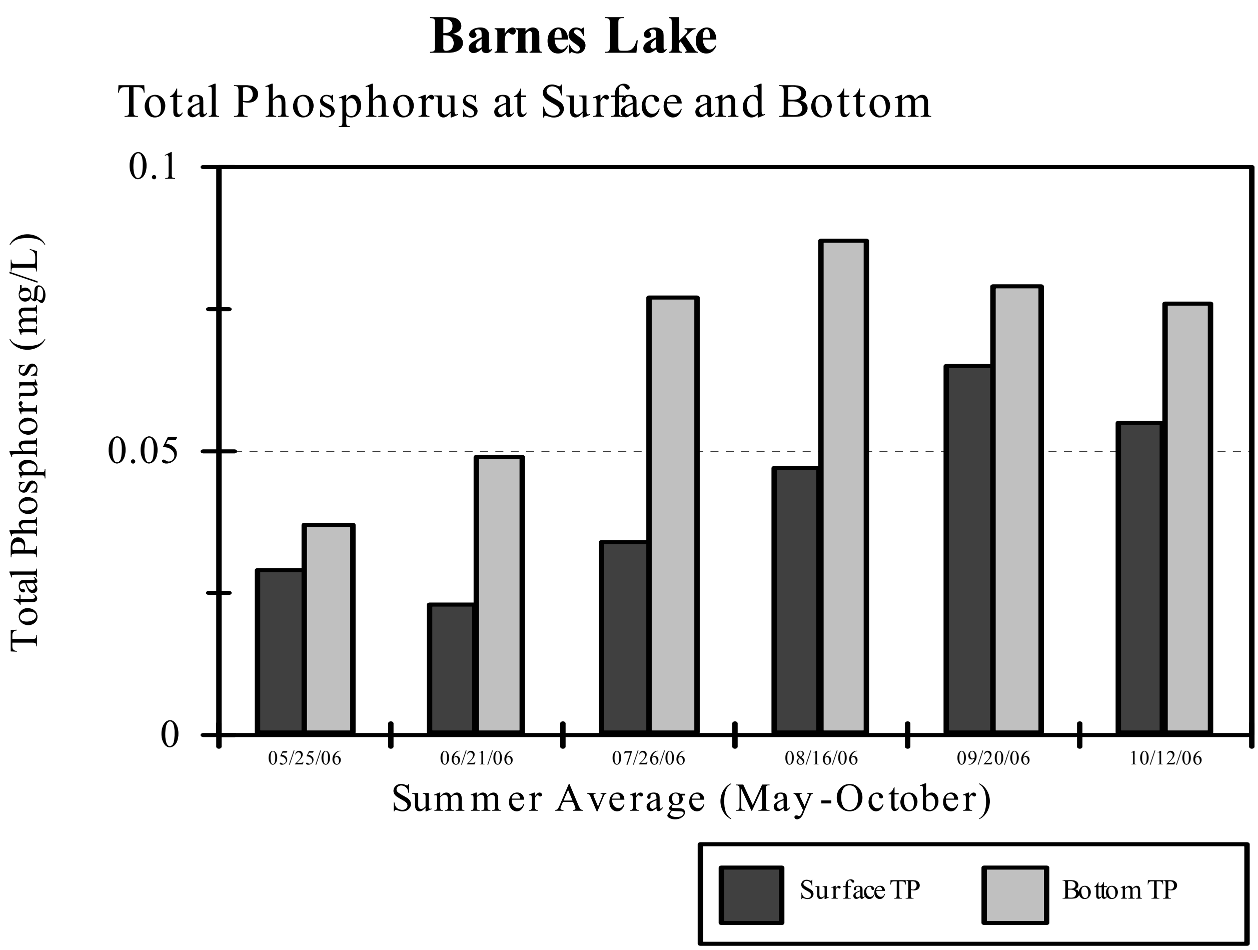

September 20, 2006
Temperature, pH, Dissolved Oxygen
Depth (meters)
Conductivity
Temp
DO
pH
Conductivity


October 12, 2006
Temperature, pH, Dissolved Oxygen
Depth (meters)
Conductivity
Temp
DO
pH
Conductivity

The water clarity in Barnes Lake is low. As a frame of reference, the accepted standard for a public swimming beach is a visibility of 4 feet. In May the reading was 5.7 feet, and it was the only month when the clarity was greater than 4 feet. The season average water clarity was 3 feet. Below is a graph of the monthly water clarity measurements.



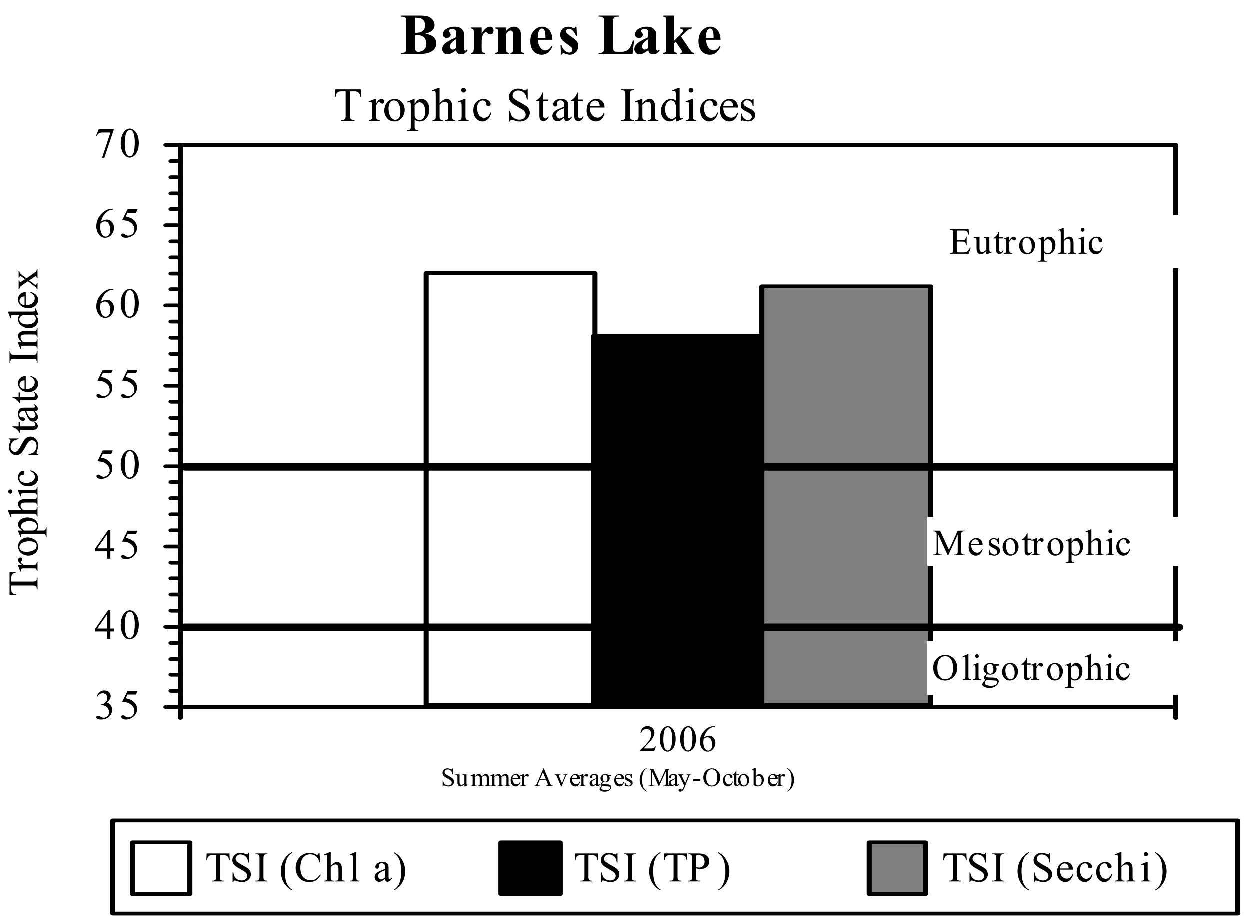
The amount of nutrients, phosphorus and nitrogen, in the lake water is a major factor in the amount of algae growth in the lake. Total phosphorus concentrations in surface samples averaged 0.042 milligrams per liter (mg/L). This is well over the state water quality standard of 0.020 mg/L for Puget Sound lowland lakes. The chlorophyll *a* concentration averaged 24.7 µg/L. Chlorophyll is an indication of the amount of algae growth in the water column. The May sample had a low chlorophyll concentration. The other months showed fairly high algae production, especially July, August, and September. A graph of the total phosphorus concentrations at the lake surface and near the bottom is shown below. Phosphorus concentrations are usually higher at the bottom as it is released from the lake sediments.




**TROPHIC STATE:**

The *Carlson trophic state indices (TSI)* are used to express the degree of productivity, or plant and algae growth, in a lake. The average summer total phosphorus and chlorophyll *a* concentrations and secchi disk measurements are used to calculate the *Carlson trophic state indices*. 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.

In Barnes Lake, the TSI's for chlorophyll *a*, total phosphorus, and secchi disk visibility were 62, 58, and 61, respectively. These are all in the eutrophic range, indicating high productivity in this lake. These levels are much higher than most lakes in Thurston County. Below is a graph of the three trophic state indices.



## Barnes Lake @ Mid-lake

**Site ID#** *BUDBNL010*

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/25/2006 | 11:15:00 AM | 3 | 2.5 | 0.029 | 0.037 | 0.485 | 1.440 | 1.75 | 3.2 | 1.8 | #8 orange | Chl a & algae composites @ .5+1.5M |
| 06/21/2006 | 11:30:00 AM | 3.1 | 2.5 | 0.023 | 0.049 | 0.437 | 0.534 | 1.09 | 15 | 4.9 | #8 yellow-orange | Chl a & algae composites @.5+1.5m |
| 07/26/2006 | 10:30:00 AM | 2.6 | 2.0 | 0.034 | 0.077 | 0.617 | 0.806 | 0.63 | 49 | 10 | #10 brown | Chl a & algae composite @ 0.5 & 1 M. |
| 08/16/2006 | 11:15:00 AM | 2.4 | 2.0 | 0.047 | 0.087 | 0.682 | 0.946 | 0.70 | 25 | 8.9 | #10 brown | Chl a & algae composite @ 0.5 & 1 M. |
| 09/20/2006 | 12:00:00 PM | 2.2 | 1.5 | 0.065 | 0.079 | 0.730 | 0.889 | 0.57 | 45 | 6.7 | #10 brown | Chl a & algae composite @ .5 & 1M. Cloudy. |
| 10/12/2006 | 10:00:00 AM | 2.1 | 1.5 | 0.055 | 0.076 | 0.616 | 0.822 | 0.79 | 11 | 7.6 | #10 brown | Chl a & algae composite @ 0.5 & 1M. |

*Summary for 'Site Description' = Barnes Lake @ Mid-lake (6 detail records)*

| | | |
|---|---|---|
| **Averages** | **Sur TP** | *0.042* |
| | **Secchi** | *0.92* |
| | **Chl a** | *24.7* |

# *Algae data:* Barnes Lake

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| *05/25/2006* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Coelosphaerium species | ☐ |
| | DF | Ceratium species | ☐ |
| | EU | Euglena species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Ankyra judayi | ☐ |
| | GR | Oocystis species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Mallomonas species | ☐ |
| *06/21/2006* | | | |
| | CP | Chroomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | YL | Synura species | ☑ |
| *07/26/2006* | | | |
| | BG | Aphanocapsa species | ☐ |
| | BG | Oscillatoriaceae species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | CP | Rhodomonas (Pyrenomonas)s | ☐ |
| | DF | Ceratium species | ☐ |
| | EU | Euglena species | ☐ |
| | EU | Phacus species | ☐ |
| | GR | Botryococcus species | ☐ |
| | GR | Closterium species | ☐ |
| | GR | Palmellaceae species | ☐ |
| | YL | Chrysopyte-sp | ☐ |

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| 08/16/2006 | | | |
| | BG | Aphanocapsa species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | CP | Rhodomonas (Pyrenomonas)s | ☐ |
| | DF | Ceratium species | ☐ |
| | EU | Phacus species | ☐ |
| | GR | Closterium species | ☐ |
| | YL | Chrysopyte-sp | ☐ |
| | YL | Dinobryon species | ☐ |
| 09/20/2006 | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanocapsa species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | CP | Rhodomonas (Pyrenomonas)s | ☐ |
| | DF | Ceratium species | ☐ |
| | EU | Euglena species | ☐ |
| | EU | Phacus species | ☐ |
| | GR | Botryococcus species | ☐ |
| | GR | Closterium species | ☐ |
| | YL | Chrysopyte-sp | ☐ |
| 10/12/2006 | | | |
| | BG | Aphanocapsa species | ☑ |
| | CP | Cryptomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | EU | Euglena species | ☐ |
| | EU | Phacus species | ☐ |
| | YL | Chrysopyte-sp | ☑ |

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

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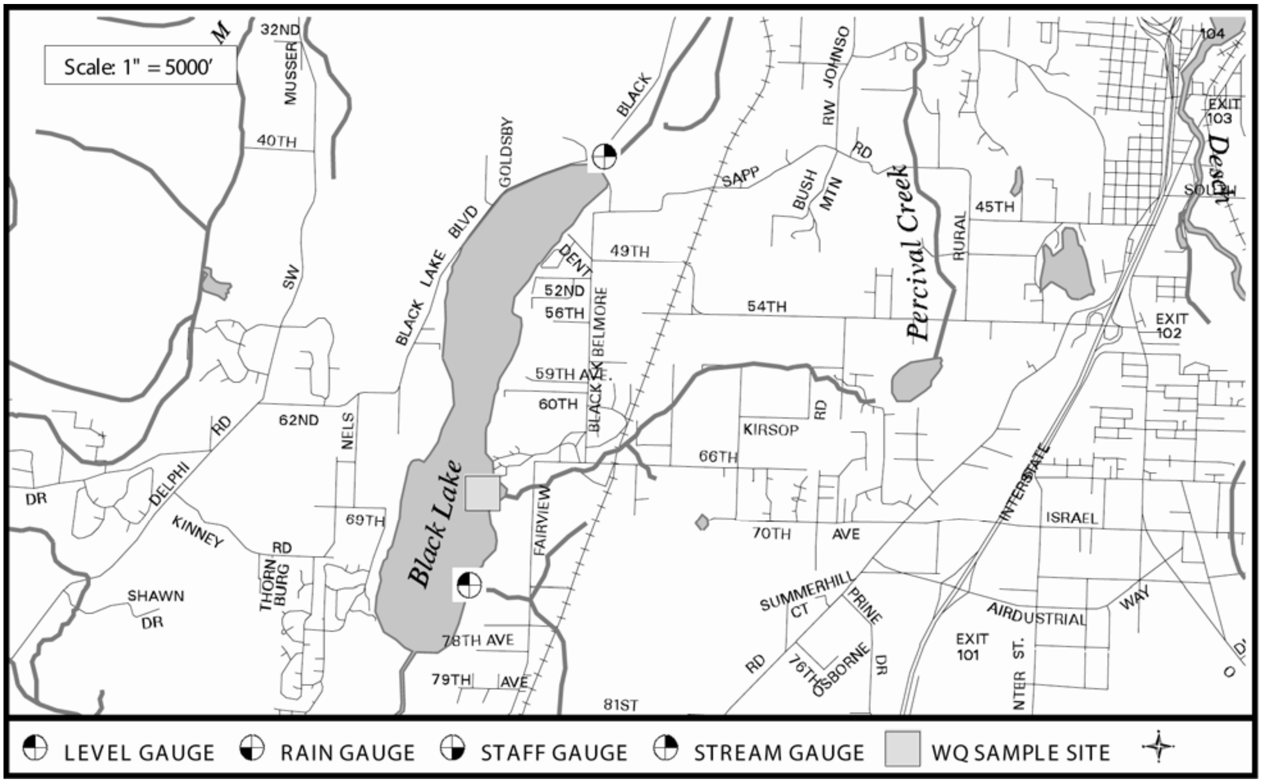



**PART OF BUDD INLET WATERSHED**

**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. County staff have observed water flowing north into the lake from this large Black River wetland system.

**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 interferes with recreational uses.

**OTHER AVAILABLE DATA:**
Water quality data since 1992 -Thurston County Environmental Health Division, www.co.thurston.wa.us/health/ehswat/swater.htm. (360) 754-4111.

Thurston County Storm and Surface Water Utility, (360) 357-2491, (rainfall, lake level, and stream flow data).

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

**GENERAL DISCUSSION:**

Temperature, pH, dissolved oxygen, and conductivity measurements are displayed in monthly profile graphs at the end of this chapter. In 2007 the lake thermally stratified from June through September. This means that the lake developed a warm surface layer as solar radiation warmed the upper water, but the bottom water stayed cool. Because of its dark color, Black Lake water gets very warm. The surface water reached a high of 23.4 degrees Celsius in September, but the bottom layer of water (hypolimnion) remained much colder, at 16.8 degrees. The lower layer of colder water, generally below 5 meters, was very low in oxygen throughout the summer. This condition results in a slow release of phosphorus from the sediments into the water near the bottom. This can be seen in the higher concentrations of phosphorus in the bottom samples (see data on the data report page). The release of nutrients from the sediments stimulates algae productivity in the lake, especially in late summer when the lower and upper waters mix. In September 2007 a blue-green algae bloom occurred as can be seen with the high chlorophyll concentrations and very low water clarity.

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.

In 2007, the TSI's for total phosphorus, chlorophyll *a*, and secchi disk were 50, 59, and 51, respectively. All three TSIs were at or within the eutrophic category or highly productive category. The trophic state indices graph, on the page following the profile graphs, show that in most years the lake has been at the upper limit of the mesotrophic range with some year-to-year variations that push well into the eutrophic range.

The average water clarity for the 2007 season was 1.9 meters (6.2 feet). It ranged from 1 meter in September to 2.5 meters in July (3.3 to 8.3 feet). The graph at the end of this chapter shows the annual average for the period of record. The water clarity trend graph, which normalizes the annual averages using the long-term mean shows no obvious trend in water clarity over the period of record.

Algae types common to Black Lake include diatoms, green and blue-green algae. However, during the peak chlorophyll production, the blue-green algae *Aphanizomenon or Anabaena* are usually the dominant algae responsible for the “algae blooms”. Dominance of the algae population by blue-green algae is generally considered a sign of nutrient-rich conditions and poor water quality. At times in the past, algal growth has impaired recreational uses of the lake 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, there was a spectacular blue-green algae bloom that covered much of the western shore of the lake. At the point of algae die-off, 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.

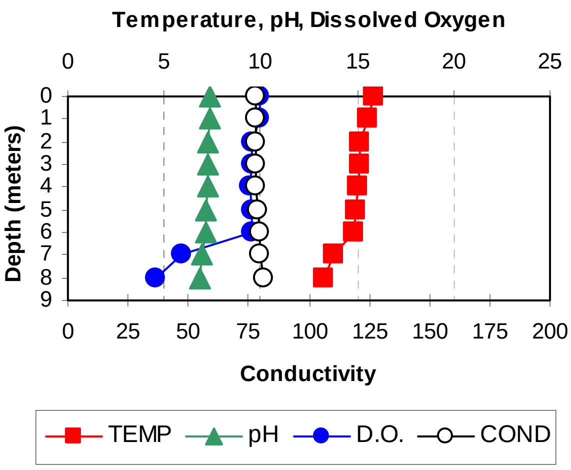
## Major Issues:

- Major blue-green algae blooms that occur during late summer and fall interfere with the recreational uses of the lake.
- Occasional beaver activity in the lake outlet ditch to the north causes lake levels to rise resulting in flooding of yards and docks. Thurston County Roads and Transportation Department is responsible for maintaining the ditch.
- Swimmer’s itch is reported to be a regular summer problem in this lake, so preventative measures should always be taken by bathers.

## Funding Sources:

Sampling was funded by Thurston County, and will continue to be supported in 2008.

### May 21 2007

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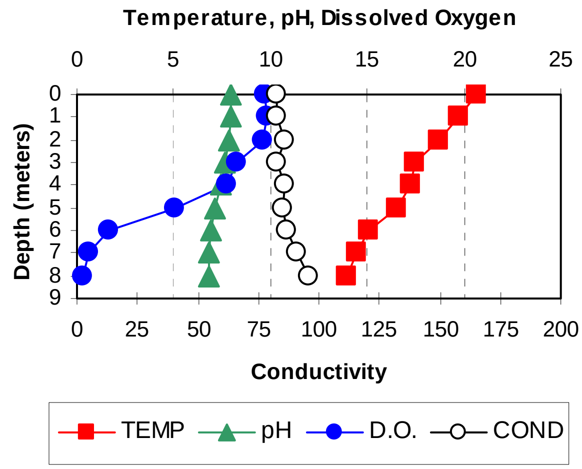


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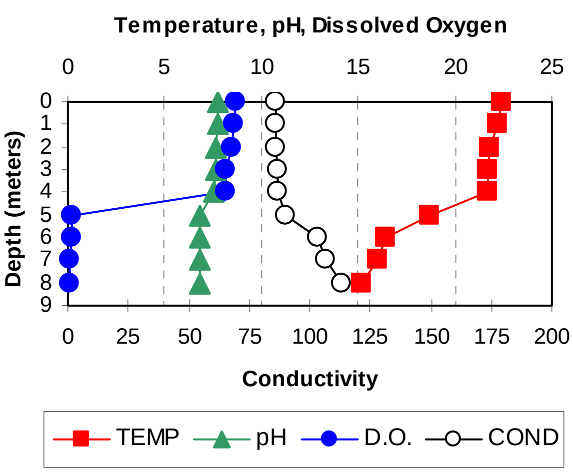


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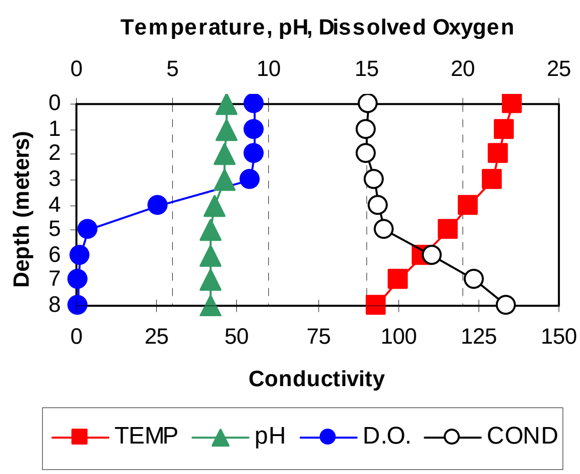


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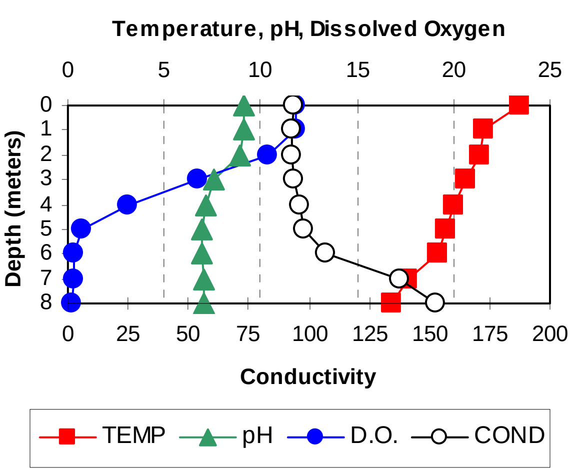


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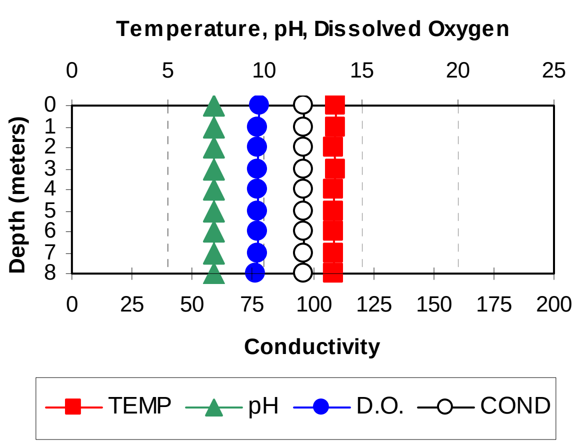
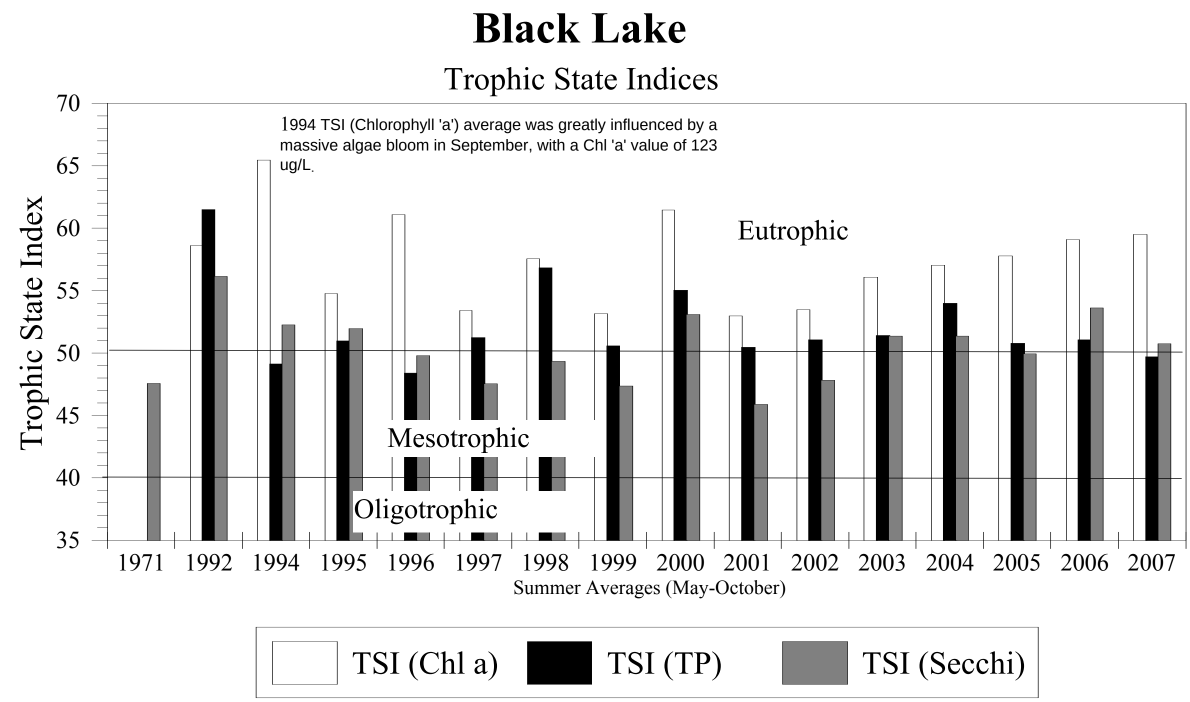
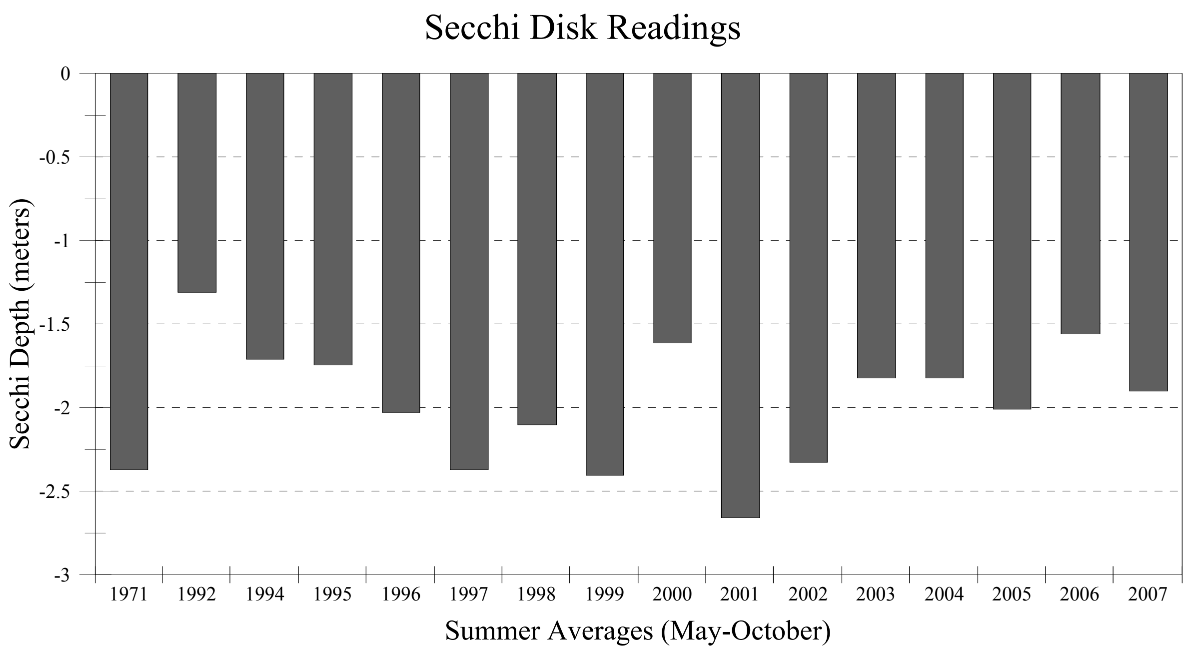
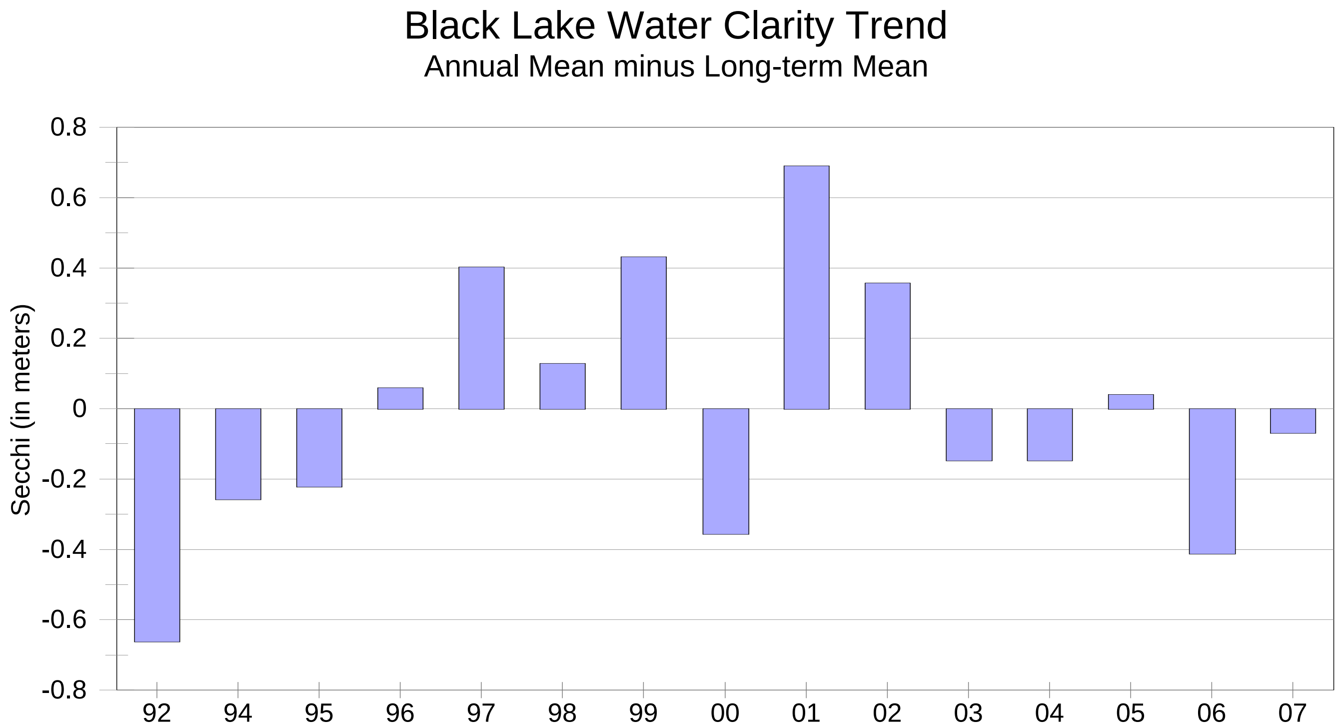



Black Lake
Trophic State Indices
1994 TSI (Chlorophyll 'a') average was greatly influenced by a massive algae bloom in September, with a Chl 'a' value of 123 ug/L.
Eutrophic
Mesotrophic
Oligotrophic
Trophic State Index
70
65
60
55
50
45
40
35
1971
1992
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)
TSI (Chl a)
TSI (TP)
TSI (Secchi)


Secchi Disk Readings
Secchi Depth (meters)
0
-0.5
-1
-1.5
-2
-2.5
-3
1971
1992
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)




0 = Long Term Mean

## 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 Color | Lake Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/21/2007 | 11:45:00 AM | 8.1 | 7.5 | 0.012 | 0.018 | 0.557 | 0.567 | 2.16 | 5.3 | 1.4 | #7 yellow-orange | Chl a & algae composite @ 1, 2, & 3M. |
| 06/20/2007 | 12:15:00 PM | 8.7 | 8.0 | 0.017 | 0.042 | 0.342 | 0.354 | 2.15 | 9.6 | 3.1 | #6 yellow-green | Chl a & algae composite @ 1, 2.5, & 4M. |
| 07/23/2007 | 3:00:00 PM | 8.3 | 7.5 | 0.014 | 0.200 | 0.300 | 0.557 | 2.53 | 7.5 | 3.4 | #7 yellow | Chl a & algae composite @ 1, 2, & 3M. |
| 08/15/2007 | 1:00:00 PM | 8 | 7.0 | 0.016 | 0.127 | 0.267 | 0.387 | 2.29 | 6.9 | 2 | #7 yellow | Chl a & algae composite @ 1, 2, & 3M. |
| 09/11/2007 | 12:45:00 PM | 8.3 | 7.5 | 0.035 | 0.521 | 0.708 | 0.788 | 1.00 | 48 | 4.8 | #3 pea-green | Chl a & algae composite @ 1 & 2M. |
| 10/16/2007 | 2:15:00 PM | 8.3 | 7.5 | 0.047 | 0.049 | 0.705 | 0.561 | 1.27 | 37 | 7.8 | #3 pea-green | Chl a & algae composite @ 1, 2, & 3M. |

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

**Averages:**

| | |
|---|---|
| **Sur TP** | *0.024* |
| **Secchi** | *1.90* |
| **Chl a** | *19.1* |

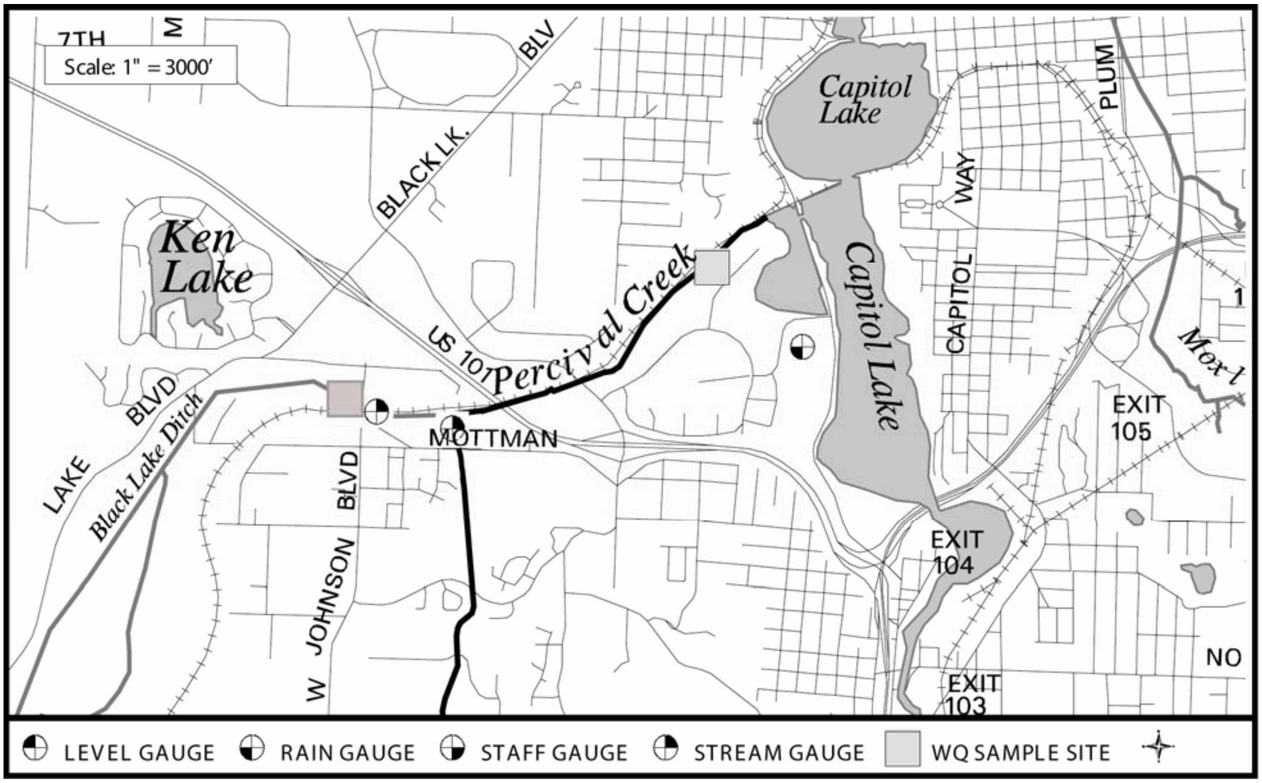
# *Algae data:* Black Lake @ South Basin

| | Type | Description | Dominant in Sample |
|---|---|---|---|
| *05/21/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Fragilaria species | ☐ |
| | GR | Ankyra judayi | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | YL | Dinobryon species | ☐ |
| *06/20/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Cyclotella species | ☐ |
| | DT | Fragilaria species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Stephanodiscus species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Dictyosphaerium pulchellum | ☐ |
| | GR | Oocystis species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | GR | Staurastrum species | ☐ |

| | Type | Description | Dominant in Sample |
|---|---|---|---|
| *07/23/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | BG | Aphanocapsa species | ☐ |
| | CP | Chroomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Fragilaria species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Synedra species | ☐ |
| | GR | Cosmarium species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | GR | Staurastrum species | ☐ |
| | YL | Dinobryon species | ☐ |
| *08/15/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | BG | Coelosphaerium species | ☐ |
| | BG | Gomphosphaeria species | ☐ |
| | CP | Chroomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Fragilaria species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Synedra species | ☐ |
| | EU | Euglena species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Arthrodesmus species | ☐ |
| | GR | Elakatothrix species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Synura species | ☐ |

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| *09/11/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | BG | Microcystis species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Fragilaria species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Rhizosolenia eriensis | ☐ |
| | DT | Stephanodiscus species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Botryococcus species | ☐ |
| | GR | Elakatothrix species | ☐ |
| | YL | Mallomonas species | ☐ |
| *10/16/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | BG | Aphanocapsa species | ☐ |
| | BG | Gomphosphaeria species | ☐ |
| | CP | Chroomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Stephanodiscus species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Botryococcus species | ☐ |
| | GR | Pediastrum species | ☐ |

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




**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 temperature and dissolved oxygen standards during summer months. Exceeded turbidity standard twice in 2006/07.

**OTHER DATA:**

Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

Thurston County Department of Water and Waste Management, (360) 357-2491 or www.co.thurston.wa.us/monitoring

The water quality standard for fecal coliform has two parts: Part I - the geometric mean shall not exceed 100 colonies/100mL *and* Part II - no more than 10% of the samples shall exceed 200 colonies/100mL. For both water years, both parts of the fecal coliform standard were met. The standard for pH requires the pH to be within the range of 6.5 to 8.5. There were no pH violations for either water year. The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. Dissolved oxygen measurement in July and August 2007 were below the minimum allowable concentration. The water temperatures in the stream were higher than the 17.5 degree Celsius water quality standard in July and August of both years, as well as June and September 2007. Because the ditch originates from Black Lake, these high temperature and low dissolved oxygen measurements reflect conditions typical of a lake environment.

## 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: 2005/06 and 2006/07 | | | | Cumulative Data: 2004 - 2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | Water Year | Mean | Range | # samples violating standard | Mean | Range |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 2005/06<br>2006/07 | | 6.29 – 20.33<br>4.91 – 21.47 | | | 5.18 – 19.83 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 2005/06<br>2006/07 | | 8.75 – 11.35<br>6.3 – 11.1 | 0 of 12<br>2 of 11 | 8.8 | 7.57 – 10.5 |
| Conductivity | µmhos/cm | | 2005/06<br>2006/07 | 94<br>92 | 73 - 136<br>74 - 153 | | 95 | 76 – 117 |
| pH | | 6.5 - 8.5 | 2005/06<br>2006/07 | 7.2<br>7.1 | 6.9 – 7.4<br>6.8 – 7.6 | 0 of 12<br>0 of 12 | 7 | 6.9 – 7.2 |
| Turbidity | NTU | not to exceed 5 NTU over background | 2005/06<br>2006/07 | 2.74<br>3.61 | 1.1 – 7.4<br>0.6 – 11.8 | 0 of 12<br>2 of 12 | 1.83 | 1 – 3 |
| Fecal Coliform | colonies/ 100 mL | GMV ≤100 and ≤ 10% not to exceed 200 | 2005/06<br>2006/07 | 25<br>24 | 0 – 140<br>0 - 155 | **% exceeding 200**<br>0 %<br>0 % | 36 | 5 - 280 |
| Total Phosphorus | mg/L | | 2005/06<br>2006/07 | 0.0308<br>0.0333 | 0.017 – 0.052<br>0.023 – 0.050 | | 0.032 | 0.027 – 0.039 |
| Nitrate+Nitrite-nitrogen | mg/L | | 2005/06<br>2006/07 | 0.198<br>0.180 | 0.038 – 0.416<br>0.040 – 0.347 | | 0.165 | 0.043 – 0.256 |

* Median

** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2005 | 2:30:00 PM | 14.66 | 7.4 | 9.19 | 105 | 25 | 7.4 | 12 | 0.052 | 0.052 | Salmon spawning in stream. Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/07/2005 | 2:00:00 PM | 10.68 | 7.0 | 8.83 | 95 | 115 | 3.7 | 78 | 0.039 | 0.320 | |
| 12/05/2005 | 12:30:00 PM | 6.29 | 7.0 | 10.67 | 98 | 15 | 1.7 | 36 | 0.031 | 0.232 | |
| 01/05/2006 | 1:00:00 PM | 6.82 | 6.9 | 11.17 | 82 | 20 | 4.0 | 106 | 0.033 | 0.350 | |
| 02/06/2006 | 2:20:00 PM | 6.96 | 7.0 | 11.35 | 73 | 35 | 2.6 | | 0.023 | 0.416 | |
| 03/14/2006 | 10:30:00 AM | 7.47 | 7.2 | 10.00 | 79 | 0 | 2.0 | 58 | 0.026 | 0.404 | |
| 04/24/2006 | 12:40:00 PM | 12.42 | 7.2 | 11.06 | 83 | 5 | 3.0 | 33 | 0.023 | 0.228 | |
| 05/15/2006 | 1:45:00 PM | 16.48 | 7.2 | 9.64 | 88 | 5 | 2.0 | 21 | 0.021 | 0.078 | |
| 06/13/2006 | 1:30:00 PM | 19.47 | 7.1 | 9.08 | 90 | 100 | 2.7 | 22 | 0.017 | 0.038 | |
| 07/10/2006 | 2:45:00 PM | 20.33 | 7.3 | | 101 | 30 | 1.3 | 6 | 0.034 | 0.074 | no DO measurement |
| 08/08/2006 | 2:30:00 PM | 20.02 | 7.3 | 9.90 | 103 | 105 | 1.1 | 5 | 0.029 | 0.123 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 09/12/2006 | 3:15:00 PM | 16.50 | 7.3 | 8.75 | 136 | 140 | 1.4 | 1 | 0.042 | 0.063 | |

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/09/2006 | 3:20:00 PM | 12.24 | 7.4 | 9.69 | 153 | 155 | 0.8 | 0 | 0.037 | 0.054 | |
| 11/14/2006 | 12:00:00 PM | 9.34 | 6.8 | 9.20 | 85 | 25 | 7.7 | | 0.044 | 0.137 | too fast and deep to take flow measurement |
| 12/11/2006 | 12:30:00 PM | 6.85 | 6.9 | 10.34 | 88 | 25 | 11.8 | | 0.050 | 0.173 | too fast to wade |
| 02/22/2007 | 10:30:00 AM | 7.04 | 7.0 | 11.12 | 74 | 10 | 1.0 | | 0.031 | 0.328 | Too fast too deep to wade |
| 03/20/2007 | 3:30:00 PM | 10.49 | 7.3 | | 77 | 10 | 0.6 | | 0.028 | 0.292 | DO not working, too fast and deep to wade. |
| 04/26/2007 | 4:30:00 PM | 13.78 | 7.1 | 10.22 | 81 | 0 | 1.2 | 34 | 0.027 | 0.245 | F.C. Result is <5. |
| 05/17/2007 | 2:00:00 PM | 16.66 | 7.1 | 9.80 | 85 | 45 | 1.3 | 24 | 0.023 | 0.211 | |
| 06/12/2007 | 1:15:00 PM | 17.94 | 7.2 | 10.79 | 89 | 80 | 2.7 | 16 | 0.025 | 0.058 | |
| 07/17/2007 | 1:00:00 PM | 21.47 | 7.1 | 6.30 | 89 | 10 | 2.8 | 10 | 0.036 | 0.126 | |
| 08/21/2007 | 9:15:00 AM | 19.63 | 7.1 | 7.62 | 97 | 85 | 0.9 | 8 | 0.023 | 0.040 | Beaver dam upstream ~60' |
| 09/17/2007 | 3:00:00 PM | 17.81 | 7.6 | 8.84 | 101 | 125 | 10.1 | 6 | 0.048 | 0.151 | Beaver dam upstream, lots of algae in water, looks like anabaena, also at lake outlet. |

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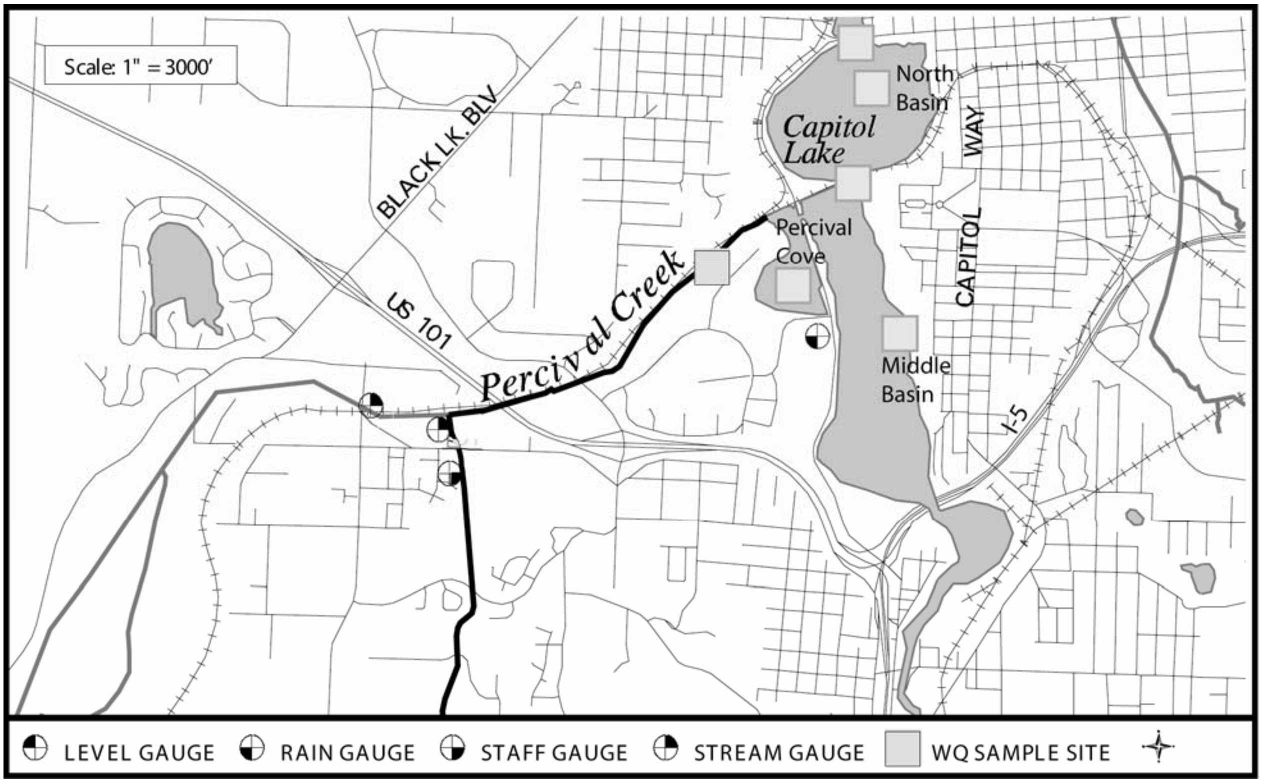



**PART OF** Budd Inlet **WATERSHED**

**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**:

Boating and fishing. Shoreline trails are used by walkers, joggers, and bird watchers.

**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.

There is a public boat launch at Tumwater Historical Park on the south side of the Interstate 5 bridge. At this time the lake is closed to motorized boats in order to help reduce the spread of Eurasian water milfoil, which was discovered in the lake in 2001.

## 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 I-5 overpass and the railroad trestle near Marathon Park.

## GENERAL WATER QUALITY:

(Excellent, Good, Fair, Poor)
Fair to 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. Control is on-going for an infestation of the noxious aquatic plant, Eurasian water milfoil.

## OTHER AVAILABLE DATA:

Thurston County Environmental Health Division, (360) 754-4111, (historical water quality data).

## 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 but the water passes through the lake and discharges through the tide gate into Budd Inlet. During high winter flows in the Deschutes River the water exchange in the lake can be as fast as 0.2 days. 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 sediment transported into it by the Deschutes River and Percival Creek and other smaller sources. The wide shallow basins lead to 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 some of the uses of the lake. 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.

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, inadvertent sewage discharges, and other nonpoint pollution sources.

To reduce the water quality impact 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 programs inception several illicit connections have been found and eliminated. As part of this new program, a major storm sewer system which discharges into Capitol Lake near 7th Avenue and Water Street was investigated for possible sewer connections and damaged pipes in late 2004 and 2005. Two damaged pipes were found and repaired. The system will continue to be monitored and potential pollution sources investigated. The City of Tumwater currently has plans to build regional stormwater facilities to address discharges into both Percival Creek and the Deschutes River.

### *2007 Ambient Monitoring Program*

In 2007 the sampling locations for ambient monitoring program were changed to eliminate the need to launch and navigate a boat on the lake to access the sampling sites. In addition the contract between General Administration and Thurston County was renewed, but was not completed in time for sampling in July. As a results, the May and June samples were collected at the same three sites as in past years. After the contract was completed the sampling sites were reduced from three to two, and the locations changed from mid-basin sites to a location near the lake outlet at the tidegate and at the bridge crossing between the middle and north basins. Percival Cove is no longer sampled. There were two sampling events in September.

Sample parameters included temperature, pH, dissolved oxygen, specific conductivity, water clarity, total phosphorus, total nitrogen, chlorophyll a, fecal coliform, and identification of algae present. Nutrients, chlorophyll and algae samples were collected at a depth of one-meter. Nutrient samples also included nitrate and ammonia in order to further document the affect the lake has on nutrient utilization and Budd Inlet. This may be helpful in assessing one aspect of the estuary option

### *Field Parameters*

Capitol Lake does not thermally stratify as do most Thurston County lakes, due to its shallow depth and riverine influence. The water quality sampling sites were relocated in August 2007 to sites at the lake outlet next to the tide gate and at the constriction between the middle and the north basins. These locations have scour holes at them making it deeper than the most other areas of the lake. As a result, there is more stratification seen at these two sites than was seen in the mid-basin locations. The temperature at the bottom tended to be two to three degrees cooler and the dissolved oxygen was 2 to 8 mg/L lower at the bottom. There was high conductivity water at the bottom at both north basin sites which indicates salt water. The tide gate at the lake outlet is designed to prevent marine water from flowing into the lake. However, during high tides greater than 14 feet, salt water flows over the fish ladder and into the lake, where it settles in the deepest part of the lake. In September the salt water influence was detected at the Railroad bridge site.

Capitol Lake typically has had high dissolved oxygen levels during late summer that were associated with peak algae or aquatic plant growth. In 2007, the highest dissolved oxygen levels occurred in August and September, 13.7 and 13.5 mg/L respectively, during the period of high algae growth.

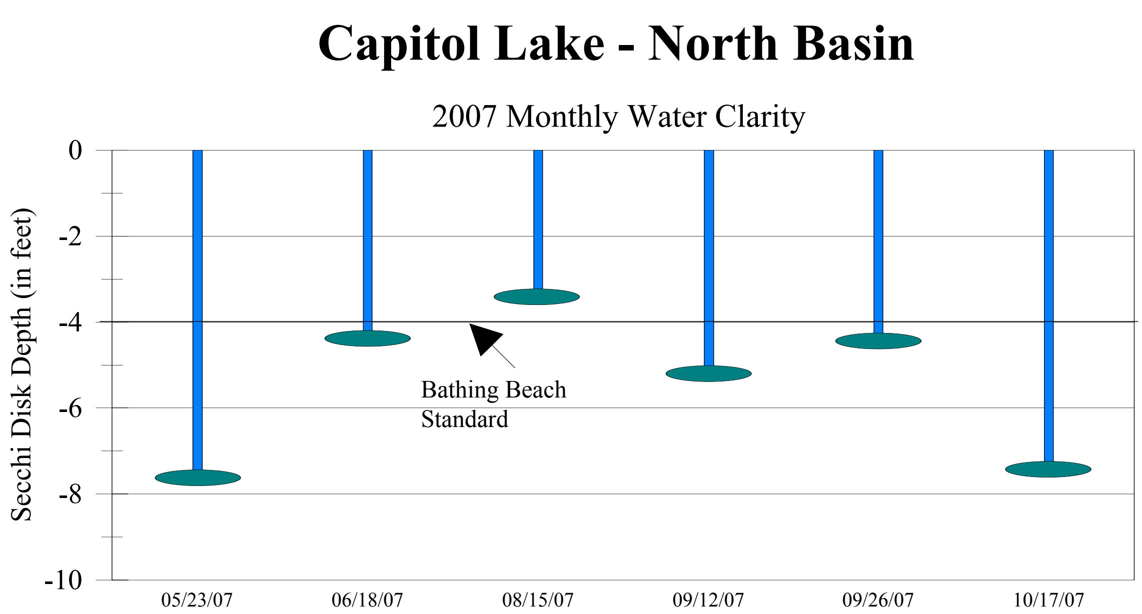
### *Trophic State Indices*

The Carlson trophic state indices (TSI), are used to express the degree of productivity (algae, aquatic plants, etc.) 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. 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. Since these measurements are not a true representation of water clarity, the secchi disk TSIs are not used.

The north basin's 2007 TSIs for chlorophyll *a* and total phosphorus are 59 and 57, respectively. The middle basin had TSI values of 56 and 56 for chlorophyll *a* and total phosphorus, respectively. Because there were only two samples collected in Percival Cove in 2007, the TSI's were not calculated and graphed for that basin. The TSIs show that the lake basins are in a eutrophic, or highly productive, condition. Graphs of the yearly TSIs for each basin since 1999 are included at the end of this chapter.

***Water Clarity***

The graph below shows the 2007 monthly water clarity measurements in the north basin. The May and June measurement were made at mid-basin. The other measurements were made from the dock at Marathon Park. The standard that is generally applied to bathing beaches is water clarity of at least four feet. The clarity fell below four feet in August. The poorest water clarity measurement this season was in August at 0.98 meters (or 3.2 feet). The highest water clarity measurement was in May, 2.3 meters (or 7.5 feet). The season average clarity in the north basin was meters 1.5 (5 feet). A graph of the summer average water clarity for the past nine years can be found at the end of the chapter.



***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 violations. The results from this year's bacteria sampling are shown in the table below. The state water quality standard for primary contact recreation is a geometric mean of 50 fecal coliform organisms per 100 ml with not more than ten 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 organisms per 100 ml.

All sample results were below the beach closure threshold of 200 and below both parts of the state water quality standard. Fecal coliform bacteria results from the past eight years are included in a table in the data section at the end of this report.

**Capitol Lake Fecal Coliform Bacteria Sampling Results**

| Date | North Basin | Middle Basin | Percival Cove |
|---|---|---|---|
| 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 | -- |

## Major Issues:

- A 10-year plan (for 2003 to 2013) for adaptively managing Capitol Lake was developed by the Washington Department of General Administration and a multi-agency steering committee. The goal of the plan is to achieve measurable improvements in flood control, water quality, salmon enhancement, 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 General Administration and the other participating agencies.

- A study to examine the feasibility of returning the lake to a naturally functioning estuary is being conducted.

- The Washington State Department of Ecolgy 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 technical report is scheduled to be completed in 2008.

- 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
  - Control of excessive aquatic plant and algae growth
  - Invasion of noxious weeds such as purple loosestrife and Eurasian water milfoil
  - Flooding and lake shoreline erosion
  - Chinook salmon hatching and rearing operation
  - Stormwater discharges

- In 2001 Eurasian water milfoil, an exotic 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. Hand pulling and other alternative means of control are being used to help control the plant's spread.

## Funding Sources:

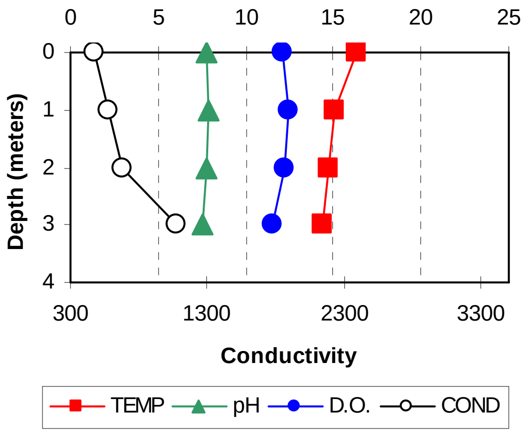
Funds for water quality monitoring in 2007 were provided by the State of Washington Department of General Administration.

**Capitol Lake Fecal Coliform Bacteria Sample Results**

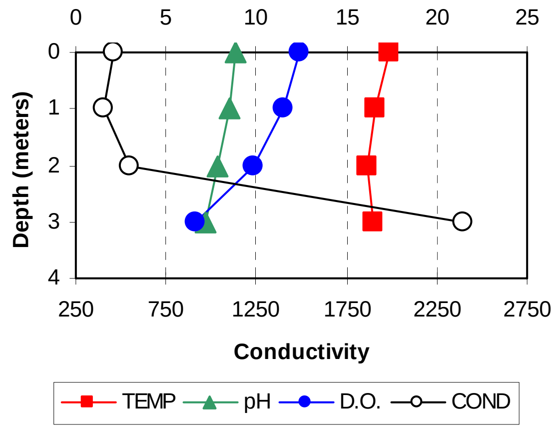
| Date | North Basin | Middle Basin | Percival Cove |
|---|---|---|---|
| 6/21/00 | 5 | 5 | 10 |
| 7/19/00 | 5 | 3 | 10 |
| 8/23/00 | <5 | 5 | <5 |
| 9/21/00 | 25 | 20 | 5 |
| 10/25/00 | 40 | 35 | 5 |
| 5/16/01 | 35 | 45 | 10 |
| 6/20/01 | <5 | <5 | 5 |
| 7/17/01 | 5 | <5 | <5 |
| 8/15/01 | <5 | <5 | <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 | -- |
| Mean (GMV) | 2.9 | 4.5 | 3.8 |

# CAPITOL LAKE – NORTH BASIN

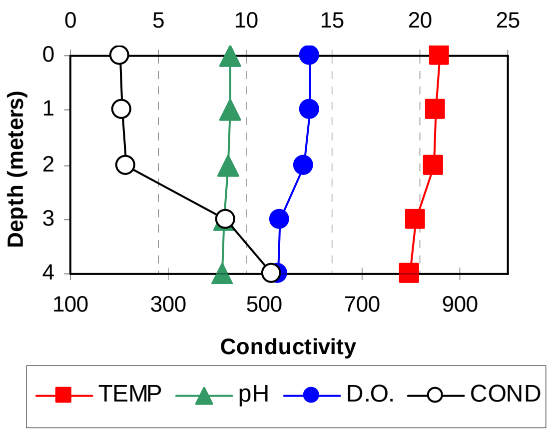
**May 23, 2007**
**Temperature, pH, Dissolved Oxygen**




**June 18, 2007**
**Temperature, pH, Dissolved Oxygen**

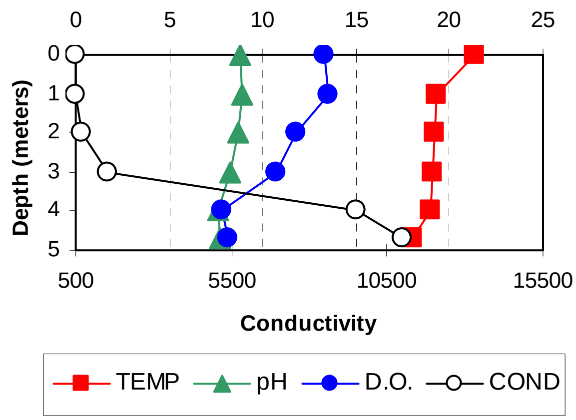



**August 15, 2007**
**Temperature, pH, Dissolved Oxygen**

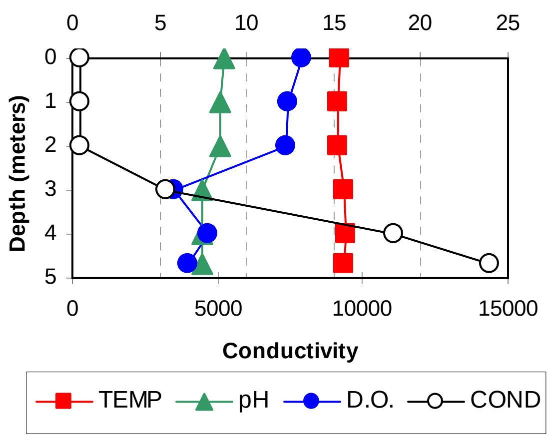



**September 12, 2007**

**Temperature, pH, Dissolved Oxygen**

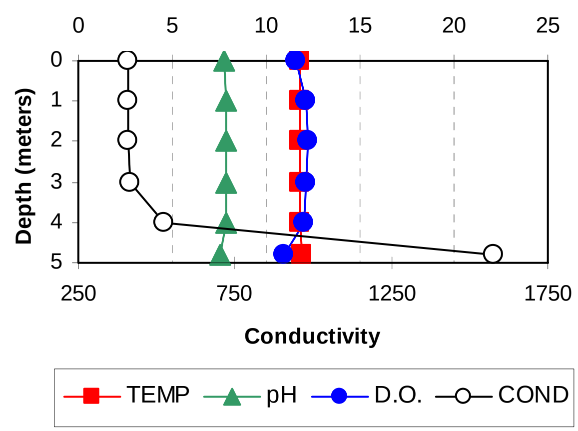



**September 26, 2007**
**Temperature, pH, Dissolved Oxygen**

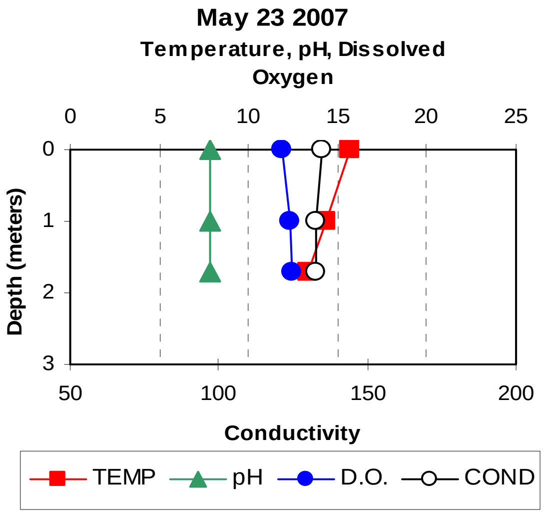


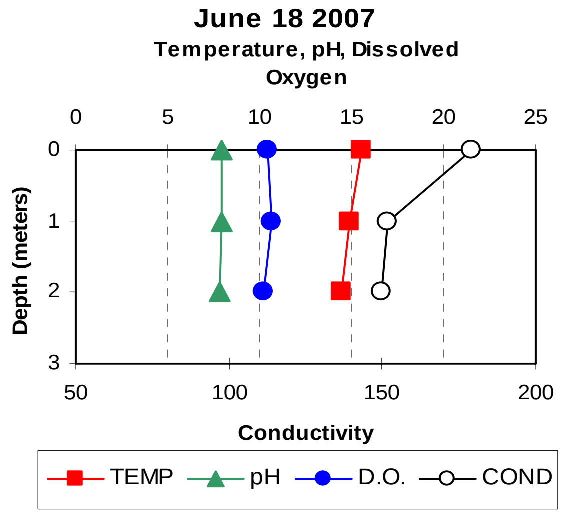

**October 17, 2007**

**Temperature, pH, Dissolved Oxygen**

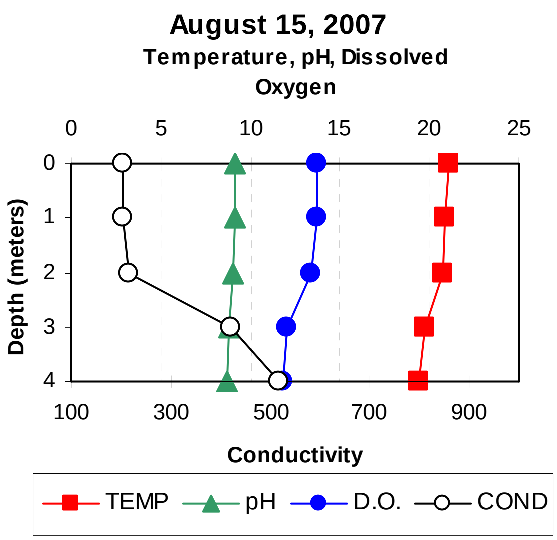


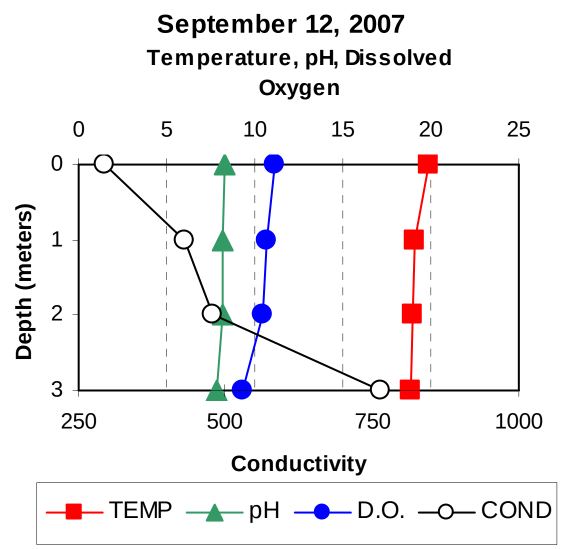
## CAPITOL LAKE – MIDDLE BASIN

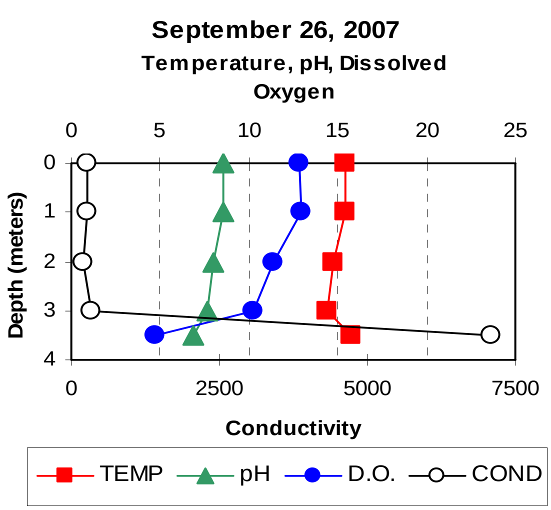


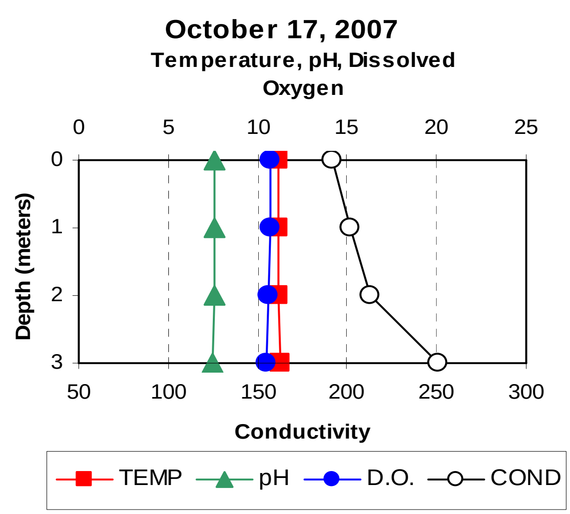




## CAPITOL LAKE - RAILROAD BRIDGE



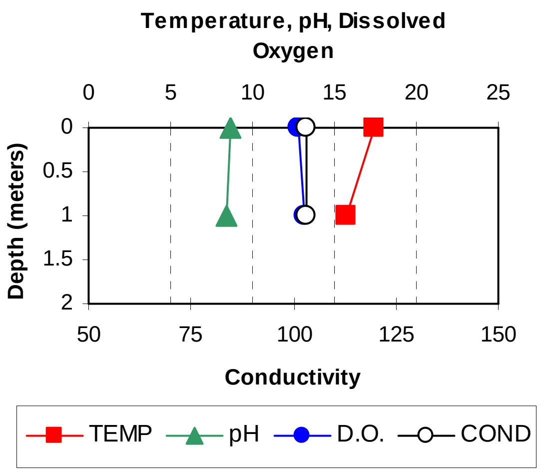



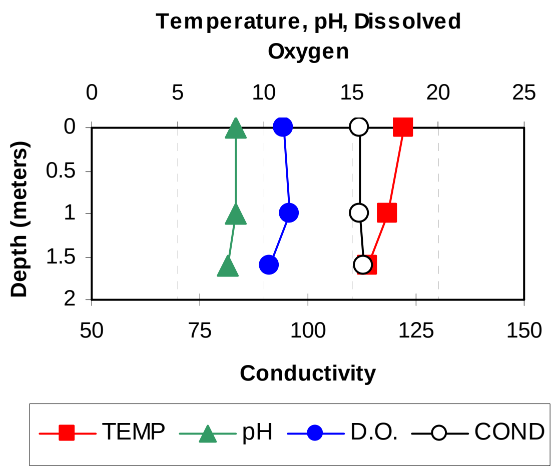



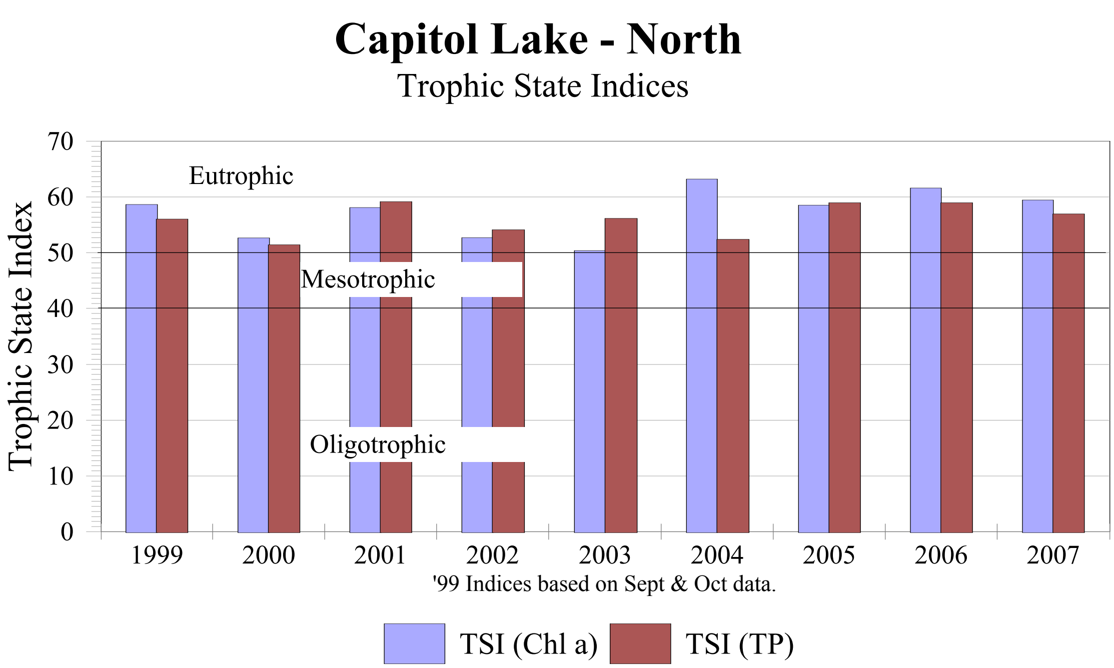
# CAPITOL LAKE – PERCIVAL COVE

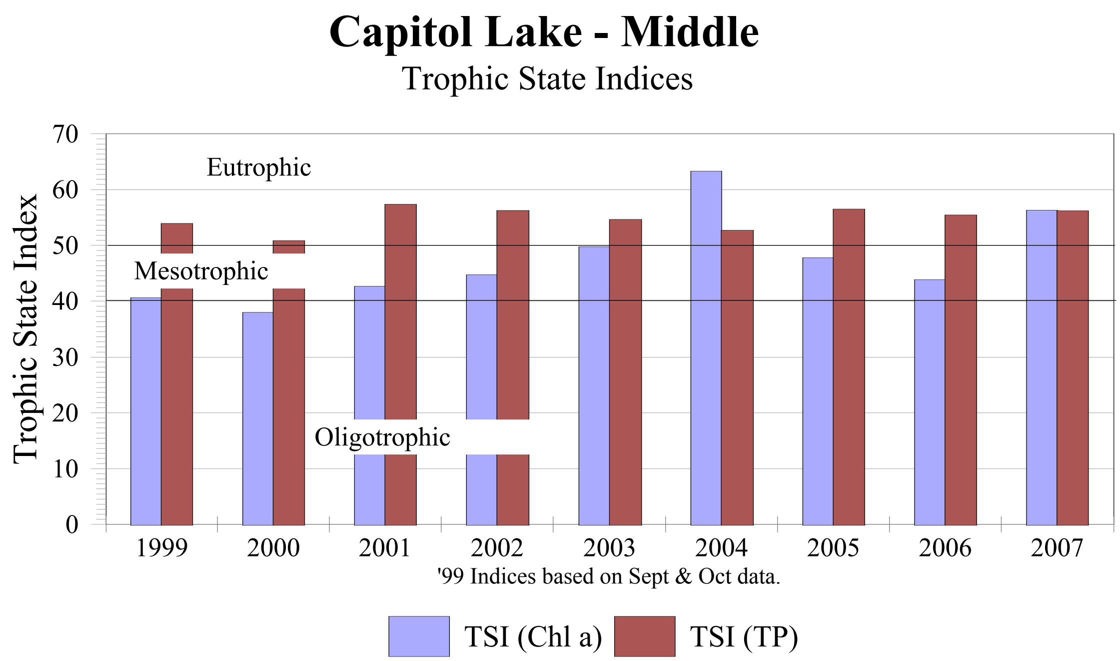
**May 23, 2007**

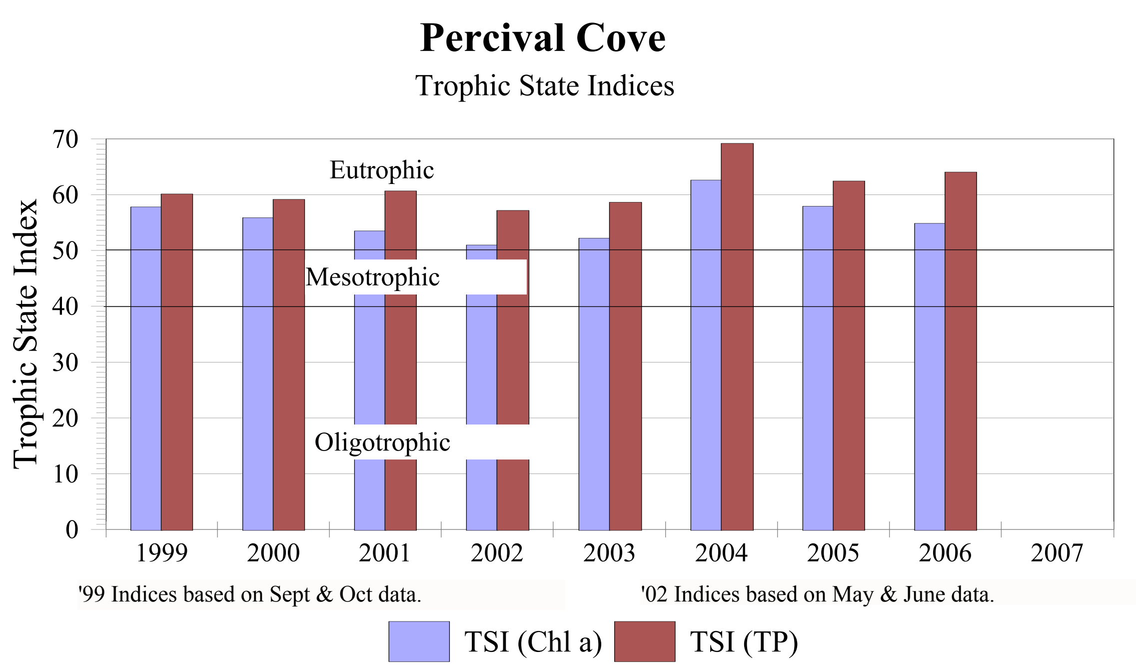


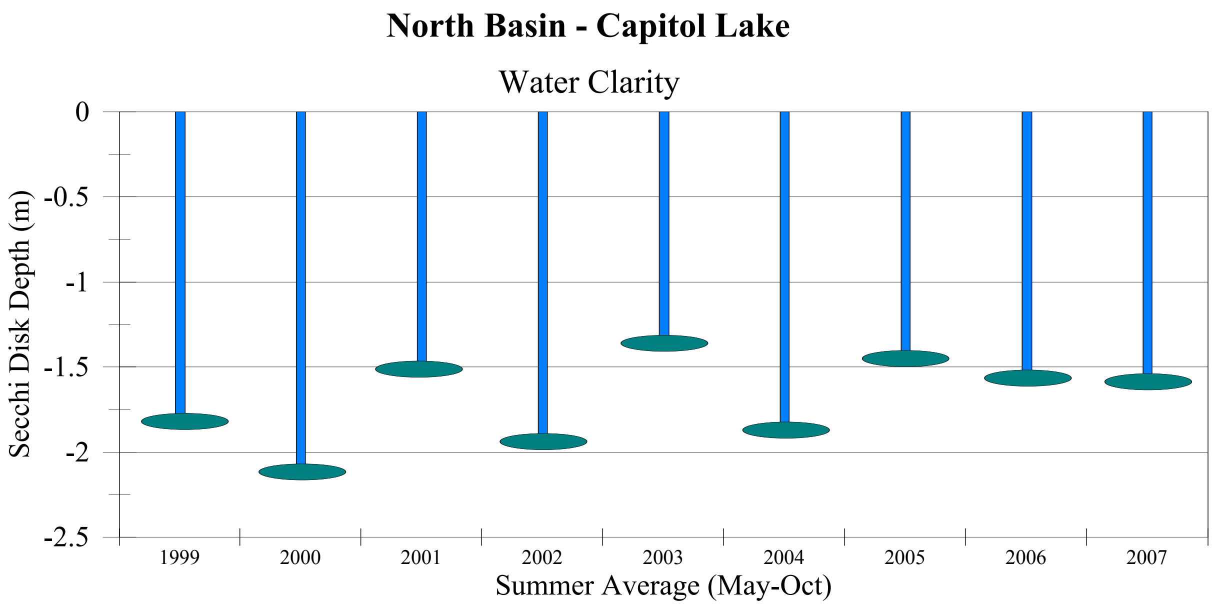

**June 18, 2007**




Capitol Lake - Middle
Trophic State Indices
Trophic State Index
70
60
50
40
30
20
10
0
Eutrophic
Mesotrophic
Oligotrophic
1999
2000
2001
2002
2003
2004
2005
2006
2007
'99 Indices based on Sept & Oct data.
TSI (Chl a)
TSI (TP)


Percival Cove
Trophic State Indices
Trophic State Index
70
60
50
40
30
20
10
0
Eutrophic
Mesotrophic
Oligotrophic
1999
2000
2001
2002
2003
2004
2005
2006
2007
'99 Indices based on Sept & Oct data.
'02 Indices based on May & June data.
TSI (Chl a)
TSI (TP)




NOTE: Water clarity was measured between May and October. The number of measurements represented by the average for each year varied from two to six measurements.

## Capitol Lake @ Mid- North Basin

***Site ID#*** *BUDCAL005*

| *Date* | *Time* | *Bottom Depth m* | *Sur TP mg/L* | *Sur TN mg/L* | *NO3+NO2 mg/L* | *NH4 mg/L* | *Secchi m* | *Chl a ug/L* | *Phae a ug/L* | *Water Color* | *Lake Notes* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/23/2007 | 2:15:00 PM | 3.2 | 0.021 | 0.878 | 0.576 | 0.005 | 2.27 | 5.9 | 2.5 | #6 yellow-green | Chl a & algae composite @ 1 & 2M. Ammonia was <.010. FC- 0. FC was <5. |
| 06/18/2007 | 3:00:00 PM | 3.1 | 0.045 | 0.869 | 0.456 | 0.069 | 1.29 | 16 | 9.8 | #6 murky yellow-gr | Chl a & algae composite @ 1 & 2M. FC was <5. |

*Summary for 'Site Description' = Capitol Lake @ Mid- North Basin (2 detail records)*

| **Averages:** | | |
|---|---|---|
| | **Sur TP** | *0.033* |
| | **Secchi** | *1.78* |
| | **Chl a** | *11.0* |

## Capitol Lake @ Tide Gate

***Site ID#*** *BUDCAL000*

| *Date* | *Time* | *Bottom Depth m* | *Sur TP mg/L* | *Sur TN mg/L* | *NO3+NO2 mg/L* | *NH4 mg/L* | *Secchi m* | *Chl a ug/L* | *Phae a ug/L* | *Water Color* | *Lake Notes* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 08/15/2007 | 4:30:00 PM | 4.2 | 0.045 | 0.520 | 0.209 | 0.005 | 0.98 | 19 | 5.1 | | All samples collected at 1M. No bacteria samples collected. NH4 was <detection of 0.010. |
| 09/12/2007 | 3:45:00 PM | 4.7 | 0.041 | 0.684 | 0.282 | 0.005 | 1.53 | 26 | 6.9 | | All samples collected at 1M. FC was <5. NH4 was < detection limit of 0.010. |
| 09/26/2007 | 11:00:00 AM | 4.7 | 0.041 | 0.642 | 0.35 | 0.018 | 1.30 | 24 | 6.2 | | All samples collected at 1M. FC was 5. |
| 10/17/2007 | 3:00:00 PM | 4.8 | 0.040 | 0.802 | 0.534 | 0.005 | 2.21 | 23 | 7.2 | | All samples collected at 1M. FC was 15. NH4 was <detection limit of <0.010. |

*Summary for 'Site Description' = Capitol Lake @ Tide Gate (4 detail records)*

| **Averages:** | | |
|---|---|---|
| | **Sur TP** | *0.042* |
| | **Secchi** | *1.51* |
| | **Chl a** | *23.0* |

## Capitol Lake @ Mid- Middle Basin

**Site ID#** BUDCAL015

| Date | Time | Bottom Depth m | Sur TP mg/L | Sur TN mg/L | NO3+NO2 mg/L | NH4 mg/L | Secchi m | Chl a ug/L | Phae a ug/L | Water Color | Lake Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/23/2007 | 2:40:00 PM | 1.7 | 0.017 | 0.990 | | | 1.94 | 0.5 | 2.5 | #6 yellow-green | Chl a & algae composite @ 1M. FC- 0. FC was <5. |
| 06/18/2007 | 3:30:00 AM | 2.3 | 0.024 | 0.991 | | | 2.38 | 2.7 | 3.7 | #6 yellow-green | Chl a & algae composite @ 1M. FC was 20. |

*Summary for 'Site Description' = Capitol Lake @ Mid- Middle Basin (2 detail records)*

**Averages:**

| | |
|---|---|
| Sur TP | 0.021 |
| Secchi | 2.16 |
| Chl a | 1.6 |

## Capitol Lake @ Railroad Bridge



**Site ID#** BUDCAL010

| Date | Time | Bottom Depth m | Sur TP mg/L | Sur TN mg/L | NO3+NO2 mg/L | NH4 mg/L | Secchi m | Chl a ug/L | Phae a ug/L | Water Color | Lake Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 08/15/2007 | 4:00:00 PM | 3.4 | 0.049 | 0.525 | 0.142 | 0.005 | | 21 | 3.8 | #3 pea-green | All samples collected at 1M. No bacteria samples collected. NH4 was < detection limit of 0.010. |
| 09/12/2007 | 3:15:00 PM | 3 | 0.046 | 0.692 | 0.377 | 0.019 | | 12 | 6.4 | yellow-green | All samples collected at 1M. FC was <5. |
| 09/26/2007 | 10:30:00 AM | 3.5 | 0.054 | 0.735 | 0.32 | 0.016 | | 42 | 6.9 | lt green | All samples collected at 1M. FC was <5. |
| 10/17/2007 | 2:30:00 PM | 3 | 0.031 | 0.871 | 0.662 | 0.03 | | 4.8 | 4.2 | yellow green | All samples collected at 1M. FC was 50. |

*Summary for 'Site Description' = Capitol Lake @ Railroad Bridge (4 detail records)*

**Averages:**

| | |
|---|---|
| Sur TP | 0.045 |
| Secchi | |
| Chl a | 20.0 |

## Capitol Lake in Percival Cove

**Site ID#** *BUDCAL040*

| Date | Time | Bottom Depth m | Sur TP mg/L | Sur TN mg/L | NO3+NO2 mg/L | NH4 mg/L | Secchi m | Chl a ug/L | Phae a ug/L | Water Color | Lake Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/23/2007 | 3:15:00 PM | 1.4 | 0.056 | 0.557 | | | 1.00 | 27 | 8.3 | #7 murky yellow | Chl a & algae composite @ 1M. FC- 15. |
| 06/18/2007 | 4:15:00 PM | 1.6 | 0.067 | 0.507 | | | 1.12 | 33 | 8.4 | #7 yellow murky | Chl a & algae composite @ 1M. FC was 10. |

*Summary for 'Site Description' = Capitol Lake in Percival Cove (2 detail records)*

**Averages:**

| | |
|---|---|
| **Sur TP** | *0.062* |
| **Secchi** | *1.06* |
| **Chl a** | *30.0* |

# *Algae data:* Capitol Lake @ Mid- North Basin

| | Type | Description | Dominant in Sample |
|---|---|---|---|
| *05/23/2007* | | | |
| | BG | Oscillatoria species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DT | Diatoms species | ☐ |
| | GR | Pandorina morum | ☐ |
| | GR | Schroederia setigera | ☐ |
| *06/18/2007* | | | |
| | BG | Jaaginema species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Rhizosolenia eriensis | ☐ |
| | DT | Synedra species | ☐ |
| | DT | Tabellaria species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | GR | Pandorina morum | ☐ |
| | GR | Spondylosium species | ☐ |

***Key:***

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

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| *08/15/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | CP | Chroomonas species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DT | Cyclotella species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Navicula species | ☐ |
| | DT | Rhizosolenia eriensis | ☐ |
| | DT | Stephanodiscus species | ☐ |
| | GR | Actinastrum species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | GR | Golenkiniopsis species | ☐ |
| | GR | Pandorina morum | ☐ |
| | GR | Scenedesmus species | ☐ |
| | GR | Staurastrum species | ☐ |
| *09/12/2007* | | | |
| | CP | Chroomonas species | ☐ |
| | DF | Peridinium wisonsinense | ☐ |
| | DT | Diatoms species | ☐ |
| | DT | Rhizosolenia eriensis | ☐ |
| | DT | Synedra species | ☐ |
| | GR | Actinastrum species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | GR | Golenkiniopsis species | ☐ |
| | GR | Scenedesmus species | ☐ |
| | GR | Spondylosium species | ☐ |

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| 09/26/2007 | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Cyclotella species | ☑ |
| | DT | Rhizosolenia eriensis | ☐ |
| | DT | Synedra species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | GR | Golenkiniopsis species | ☐ |
| | GR | Scenedesmus species | ☐ |
| | GR | Ulothrix species | ☐ |
| 10/17/2007 | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DF | Peridinium wisonsinense | ☐ |
| | DT | Cyclotella species | ☑ |
| | DT | Diatoma species | ☐ |
| | DT | Diatoms species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Tabellaria species | ☐ |

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

# ***Algae data:*** Capitol Lake @ Mid- Middle Basin

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| *05/23/2007* | | | |
| | BG | Oscillatoria species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Cyclotella species | ☐ |
| | DT | Diatoms species | ☐ |
| | DT | Rhizosolenia eriensis | ☐ |
| | GR | Closterium species | ☐ |
| | GR | Cosmarium species | ☐ |
| | GR | Gonium species | ☐ |
| | GR | Pandorina morum | ☐ |
| | GR | Scenedesmus species | ☐ |
| | GR | Schroederia setigera | ☐ |
| | YL | Dinobryon species | ☐ |
| *06/18/2007* | | | |
| | BG | Oscillatoria species | ☐ |
| | CP | Chroomonas species | ☐ |
| | DT | Navicula species | ☐ |
| | GR | Pandorina morum | ☐ |

***Key:***

| | |
|---|---|
| *BG = Blue green* | *EU = Euglenophyte* |
| *CP = Cryptophyte* | *GR = Green* |
| *DF = Dinoflagellate* | *YL = Yellow* |
| *DT = Diatom* | |

| | Type | Description | Dominant in Sample |
|---|---|---|---|
| *08/15/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | CP | Chroomonas species | ☐ |
| | DF | Peridinium wisonsinense | ☐ |
| | DT | Cocconeis pediculus | ☐ |
| | DT | Cyclotella species | ☐ |
| | DT | Fragilaria species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Navicula species | ☐ |
| | DT | Rhizosolenia eriensis | ☐ |
| | DT | Stephanodiscus species | ☐ |
| | DT | Synedra species | ☐ |
| | GR | Actinastrum species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | GR | Coelastrum species | ☐ |
| | GR | Golenkiniopsis species | ☐ |
| | GR | Pandorina morum | ☐ |
| | GR | Scenedesmus species | ☐ |
| | YL | Dinobryon species | ☐ |
| *09/12/2007* | | | |
| | CP | Chroomonas species | ☐ |
| | DF | Peridinium wisonsinense | ☐ |
| | DT | Diatoms species | ☐ |
| | DT | Rhizosolenia eriensis | ☐ |
| | DT | Synedra species | ☐ |
| | GR | Actinastrum species | ☐ |
| | GR | Golenkiniopsis species | ☐ |
| | GR | Scenedesmus species | ☐ |
| | GR | Spondylosium species | ☐ |

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| *09/26/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Attheya zachariasi | ☐ |
| | DT | Cyclotella species | ☑ |
| | DT | Diatoms species | ☐ |
| | DT | Rhizosolenia eriensis | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | GR | Golenkiniopsis species | ☐ |
| | GR | Pandorina morum | ☐ |
| | GR | Scenedesmus species | ☐ |
| *10/17/2007* | | | |
| | CP | Cryptomonas species | ☐ |
| | DT | Cyclotella species | ☐ |
| | DT | Diatoms species | ☐ |
| | DT | Melosira species | ☐ |
| | EU | Trachelomonas species | ☐ |

***Key:***

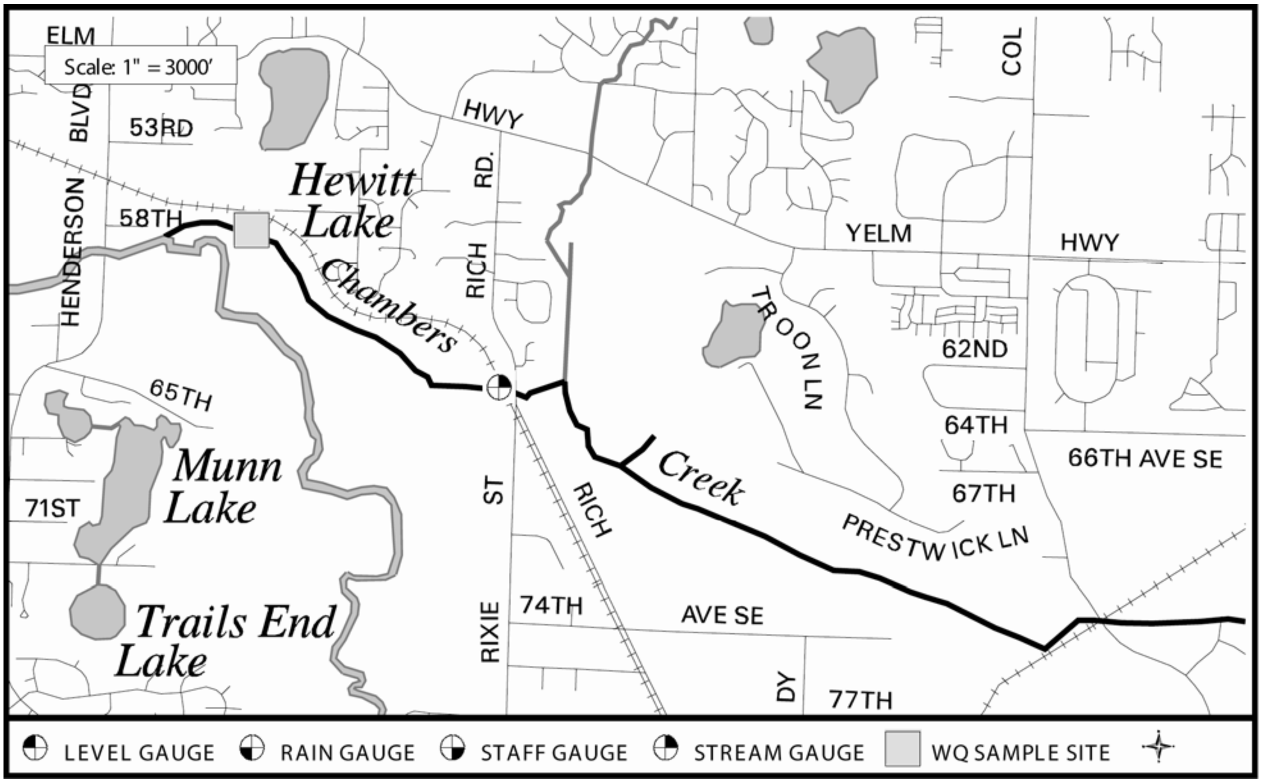
*BG = Blue green*
*CP = Cryptophyte*
*DF = Dinoflagellate*
*DT = Diatom*
*EU = Euglenophyte*
*GR = Green*
*YL = Yellow*

## *Algae data:* Capitol Lake in Percival Cove

| | *Type* | *Description* | *Dominant in Sample* |
|---|---|---|---|
| *05/23/2007* | | | |
| | CP | Cryptomonas species | ☐ |
| | DT | Diatoms species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Gonium species | ☐ |
| | GR | Pandorina morum | ☐ |
| | GR | Scenedesmus species | ☐ |
| | GR | Schroederia setigera | ☐ |
| | GR | Volvox tertius | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Mallomonas species | ☐ |
| *06/18/2007* | | | |
| | CP | Chroomonas species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DT | Fragilaria species | ☐ |
| | DT | Melosira species | ☐ |

***Key:***

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




**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

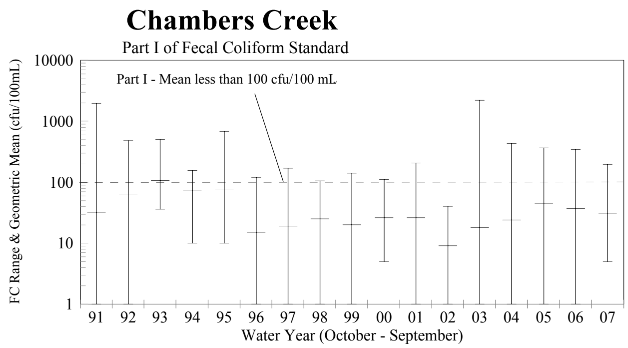
**GENERAL TOPOGRAPHY:** Elevations vary from about 200 feet around the lakes and 190 feet in the creek bed. Elevation drops to 130 feet towards the mouth where the creek enters the Deschutes River. Moderately sloped with frequent rolling terraces and occasional small glacial depressions, (kettles). These 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)

Fair to Good – The creek passed both parts of the fecal coliform standard in both water years 2005/06 and 2006/07. The nitrate concentration is elevated above background conditions.

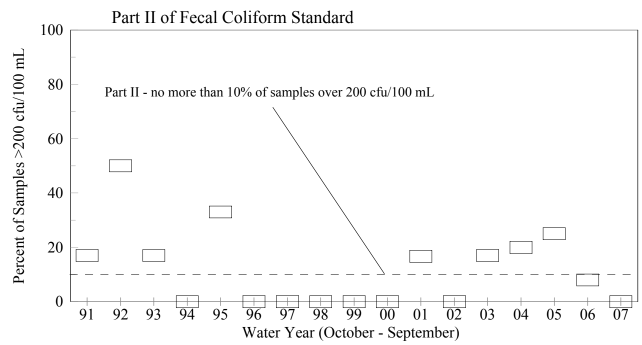
**OTHER WATER RESOURCE DATA:**
Thurston County Dept. of Water and Waste Management, (360) 357-2491 or www.co.thurston.wa.us/monitoring

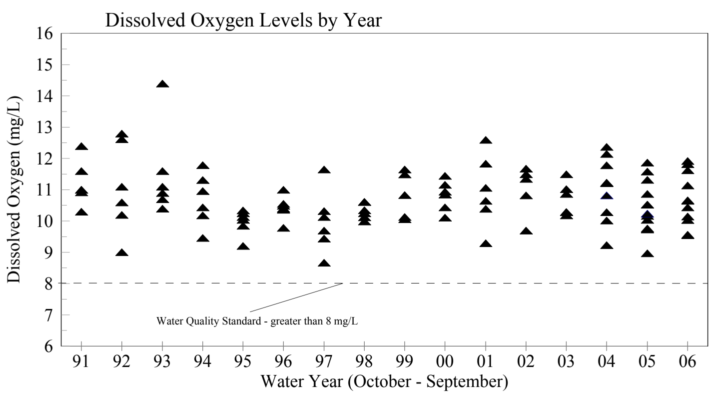
Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm




The water quality standard for fecal coliform bacteria has two parts: part I - the geometric mean shall not exceed 100 cfu/100mL *and*; part II - no more than ten percent of the samples shall exceed 200 cfu/100mL.

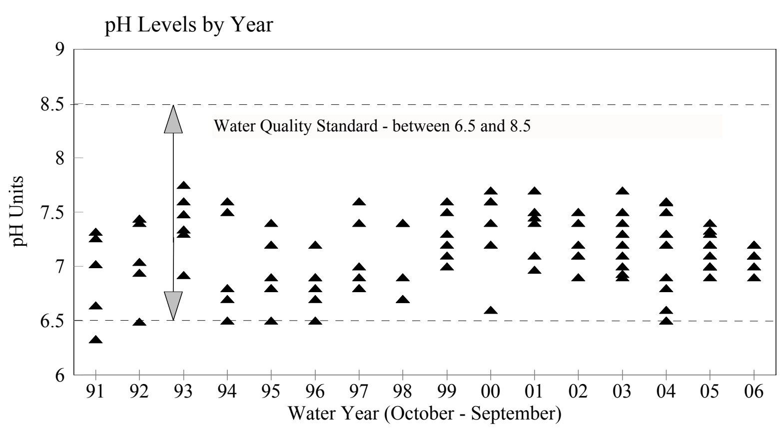
Part I of the fecal coliform bacteria standard has been violated only in 1993. Part II of the standard has been violated numerous years. The creek met the standard for both 2005/06 and 2006/07.




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 was a pH violation in 1992, when the measurement was below 6.5. Since then there have been several instances where the measurement was just at 6.5, which is still within the acceptable range.



Nitrate concentrations continue to be higher than is usual for most surface water streams. In water year 2005/06 the average was 1.8 mg/L and the highest result was July 2006 at 2.8 mg/L. In water year 2006/07 the average was 1.6 mg/L and the highest result was October 2006 at 2.62 mg/L. The source of the nitrates is most likely from contamination of the shallow groundwater that provides the base flow for the creek. An examination of the nitrate pattern shows that nitrates are higher during periods of low flow and low rainfall when dilution with rain water is minimal.

## Major Issues:

- High nitrate concentrations at the mouth.
- Development in the basin, which is expected to occur at a rapid rate since most of the basin is within the urban growth boundary, may impact stream quality.
- Chambers/Ward/Hewitt Comprehensive Drainage Basin Plan was completed July 1995, which included recommendations to address flooding and water quality issues.

## Funding Sources:

- Local stormwater utility rate

# Water Quality Summary

Conventional Parameters

**Chambers Creek**

| **Parameter** | **Units** | **WQ Standard** WAC 173-201A | **Water Year Data: 2005/06 and 2006/07** | | | | **Cumulative Data:** 1996 - 2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 05/06<br>06/07 | | 5.64 – 14.07<br>6.57 – 14.43 | 0 of 12<br>0 of 11 | | 4.9 – 14.61 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 9.55 – 11.9<br>8.57 – 12.5 | 0 of 12<br>0 of 11 | | 8.67 – 14.4 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 130<br>128 | 75 – 165<br>91 - 166 | | 112 | 53 – 156 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.2*<br>7.1* | 6.9 – 7.4<br>6.9 – 7.2 | 0 of 12<br>0 of 11 | 7.2* | 6.3 – 8.1 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 1.6<br>1.5 | 0.5 – 2.4<br>0.1 – 4.3 | 0 of 12<br>0 of 11 | 2.71 | 0.2 – 95.5 |
| Fecal Coliform | colonies/ 100 ml | GMV: ≤100 and ≤ 10% not to exceed 200 | 05/06<br>06/07 | 37**<br>31** | 0 – 343<br>5 - 195 | **% exceeding 200**<br>8%<br>0% | 31** | 0 – 2200 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.021<br>0.021 | 0.015 – 0.026<br>0.016 – 0.029 | | 0.025 | 0.002 – 0.17 |
| Nitrate + Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 1.823<br>1.609 | 1.18 – 2.8<br>0.882 – 2.62 | | 1.609 | 0.556 – 3.66 |

* Median

** Geometric mean value (GMV)

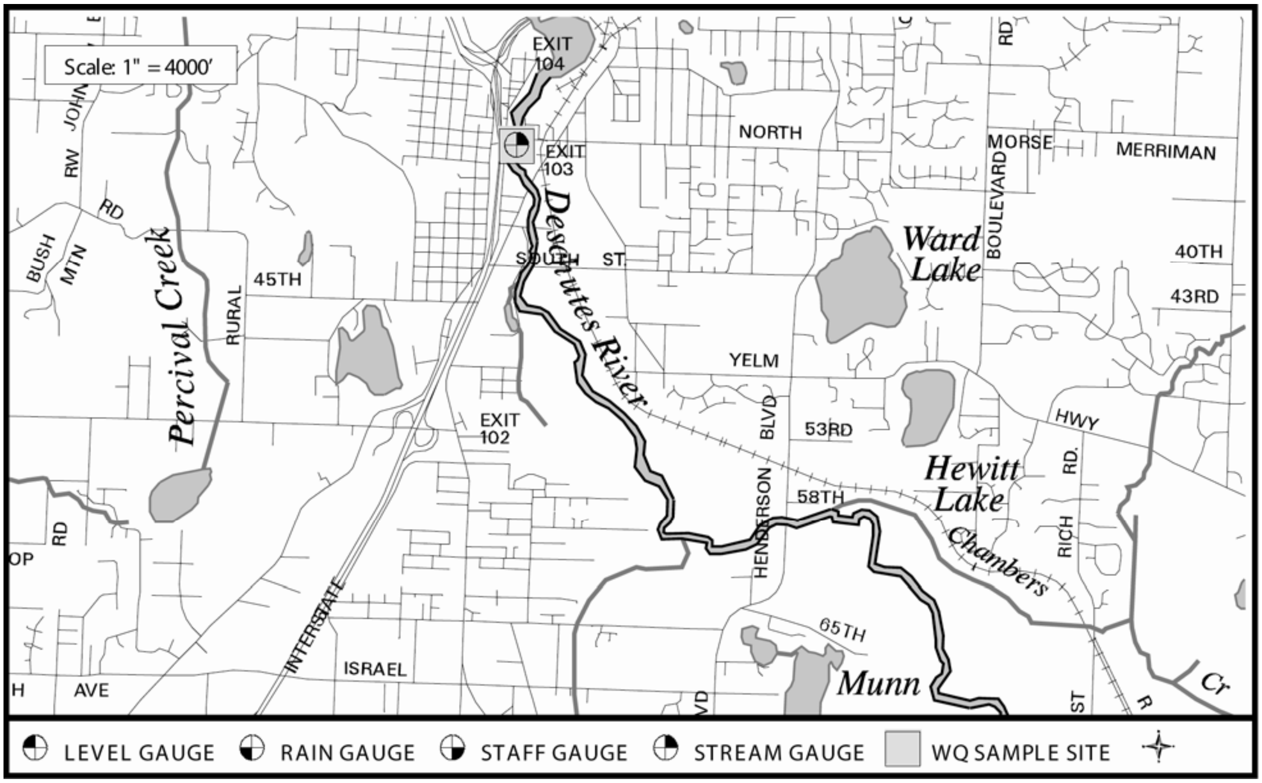
## Chambers Creek off Henderson Blvd

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2005 | 1:30:00 PM | 11.22 | 7.4 | 10.44 | 152 | 65 | 0.5 | 0.73 | 0.017 | 1.690 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/7/2005 | 2:30:00 PM | 9.31 | 7.0 | 9.56 | 136 | 343 | 1.6 | 2.46 | 0.025 | 1.670 | |
| 12/5/2005 | 3:15:00 PM | 6.54 | 7.3 | 11.82 | 144 | 25 | 0.8 | 1.48 | 0.015 | 2.070 | |
| 1/5/2006 | 11:15:00 AM | 7.20 | 6.9 | 11.63 | 81 | 0 | 2.1 | 8.90 | 0.026 | 1.230 | F.C. result was <5. |
| 2/7/2006 | 10:20:00 AM | 5.64 | 7.0 | 11.92 | 75 | 25 | | 39.80 | 0.018 | 1.180 | Turbidity didn't calibrate |
| 3/13/2006 | 10:10:00 AM | 5.74 | 7.0 | 10.15 | 98 | 5 | 1.9 | 21.50 | 0.020 | 1.310 | |
| 4/24/2006 | 1:45:00 PM | 12.31 | 7.2 | 10.65 | 119 | 10 | 1.9 | 9.30 | 0.024 | 1.310 | |
| 5/16/2006 | 11:15:00 AM | 13.12 | 7.2 | 9.55 | 134 | 105 | 1.6 | 5.24 | 0.026 | 1.800 | |
| 6/12/2006 | 1:45:00 PM | 13.46 | 7.1 | 10.03 | 132 | 100 | 2.1 | 5.22 | 0.020 | 1.700 | |
| 7/10/2006 | 3:30:00 PM | 14.07 | 7.2 | | 157 | 100 | 0.9 | 3.02 | 0.022 | 2.800 | no DO measurement |
| 8/9/2006 | 2:00:00 PM | 13.95 | 7.3 | 11.14 | 161 | 60 | 1.5 | 2.21 | 0.018 | 2.500 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/12/2006 | 2:30:00 PM | 13.25 | 7.3 | 10.66 | 165 | 105 | 2.4 | 1.43 | 0.024 | 2.610 | |

# Thurston County Water Resources Monitoring Report 2006 - 2007

## Chambers Creek off Henderson Blvd

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2006 | 10:10:00 AM | 9.10 | 7.2 | 10.74 | 166 | 50 | 0.9 | 1.56 | 0.016 | 2.620 | |
| 11/15/2006 | 10:30:00 AM | 8.73 | 6.9 | 9.43 | 103 | 25 | 2.0 | 7.72 | 0.025 | 1.210 | |
| 1/24/2007 | 2:00:00 PM | 6.57 | 7.1 | 11.00 | 100 | 5 | 1.6 | 26.67 | 0.016 | 1.450 | |
| 2/22/2007 | 11:00:00 AM | 7.46 | 7.0 | 11.41 | 91 | 25 | 0.1 | 28.37 | 0.025 | 0.882 | |
| 3/21/2007 | 2:30:00 PM | 8.90 | 7.1 | 12.51 | 97 | 5 | 2.6 | 25.11 | 0.026 | 0.945 | |
| 4/25/2007 | 11:30:00 AM | 10.79 | 7.1 | 11.02 | 112 | 40 | 1.5 | 15.49 | 0.017 | 1.240 | |
| 5/16/2007 | 3:00:00 PM | 13.54 | 7.2 | 11.36 | 122 | 30 | 1.7 | 10.22 | 0.020 | 1.400 | |
| 6/12/2007 | 11:40:00 AM | 11.71 | 7.2 | 10.36 | 138 | 45 | 1.1 | 5.92 | 0.017 | 2.030 | |
| 7/17/2007 | 1:45:00 PM | 14.43 | 7.1 | 8.57 | 155 | 30 | 4.3 | 5.28 | 0.029 | 1.700 | Slight sewage odor & white/brown scum foam in pools. |
| 8/21/2007 | 3:15:00 PM | 14.32 | 7.2 | 9.43 | 160 | 195 | 0.5 | 3.33 | 0.019 | 2.120 | |
| 9/19/2007 | 12:30:00 PM | 12.48 | 7.1 | 10.32 | 166 | 65 | 0.3 | 3.24 | 0.017 | 2.340 | |




**PART OF BUDD INLET WATERSHED**

**LENGTH OF CREEK:** 57 miles

**BASIN SIZE**: 103,850 Acres

**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)

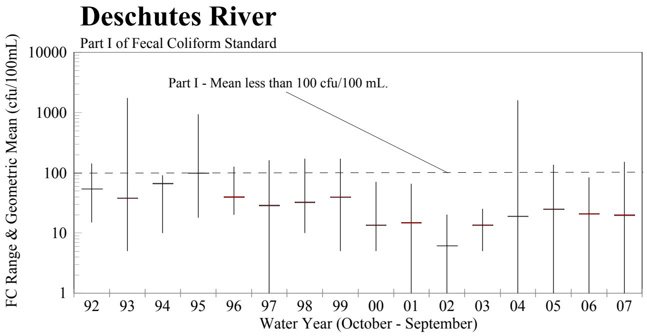
Coho, Chinook, and probably Chum.

**GENERAL TOPOGRAPHY:**

Upper watershed is at 3,800 feet 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.

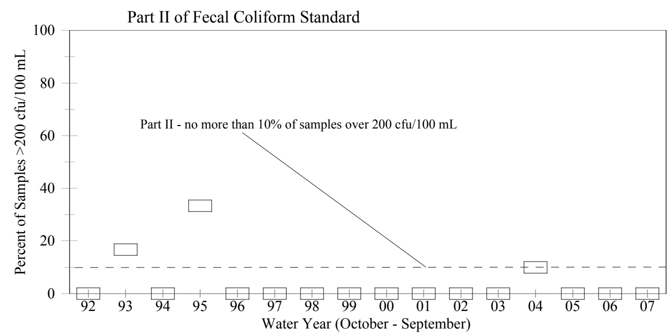
**GENERAL WATER QUALITY:** (Excellent, Good, Fair, Poor)

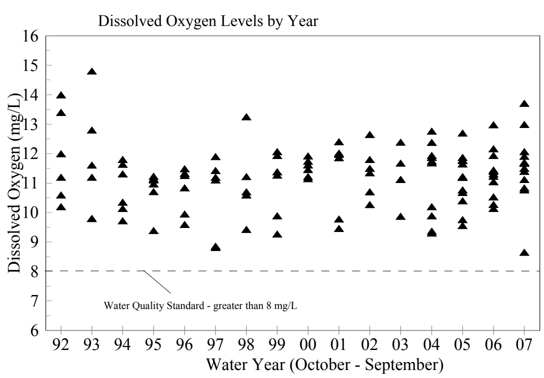
Good - Both parts of the fecal coliform standard were met for water years 2005/06 and 2006/07. There were two turbidity violations in 2006/07. In past studies, there have been temperature and bacteria violations documented upstream, as well as in-stream flow and habitat deficiencies.




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

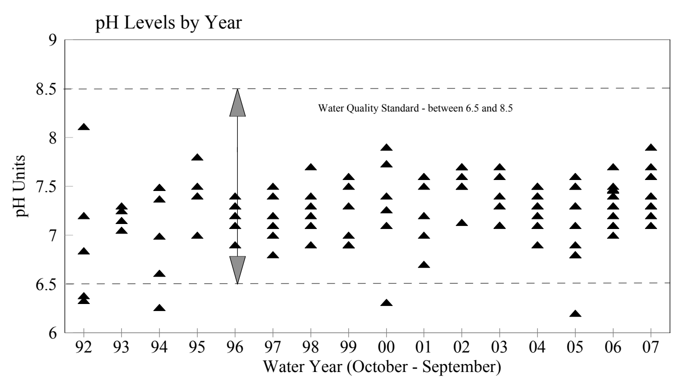
Both Part I and part II of the water quality standard were met in water years 2005/06 and 2006/07 at the Tumwater Falls Park sampling site on the river.




The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. All dissolved oxygen measurements taken in water years 2005/06 and 2006/07 were greater than 8 mg/L.

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 occasional pH measurements below 6.5.



**OTHER WATER RESOURCE DATA:**

Thurston County Dept. of Water and Waste Management, (360) 357-2491 or www.co.thurston.wa.us/monitoring

Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

Water quality data: Washington Department of Ecology, Environmental Assessment Program (360) 407-6000.

US Geological Survey, Tacoma, (253) 593-6510.

The Deschutes River is being monitored near its mouth just above the Tumwater Falls at Tumwater Falls Park as part of the county long-term ambient monitoring program. Historical water quality data collected by Thurston County is reported in two documents, *Budd Inlet/Deschutes River Watershed Characterization Part II Water Quality Study*, March 1993 and *Addendum* (to the March 1993 report), October 1995.

Various segments of the Deschutes River are listed on 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. The TMDL project was a four year process to identify pollution sources and develop a plan to correct them.

# Water Quality Summary

Conventional Parameters

**Deschutes River**

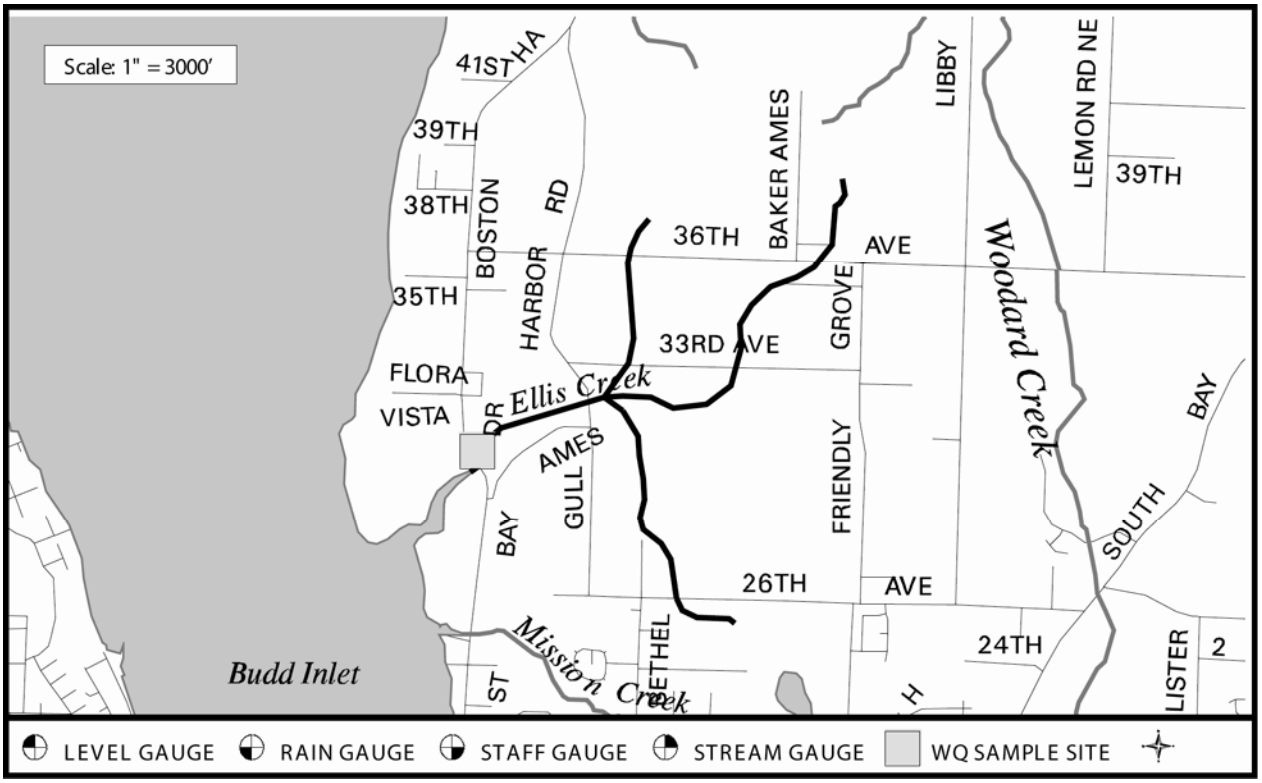
| **Parameter** | **Units** | **WQ Standard** WAC 173-201A | **Water Year Data: 2005/06 & 2006/07** | | | | **Cumulative Data:** 1991-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# of samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 05/06<br>06/07 | | 6.26 – 16.12<br>6.85 – 16.29 | | | 4.72 – 19.16 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 10.1 – 12.98<br>8.65 – 13.7 | 0 of 11<br>0 of 12 | | 8.81 - 14.80 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 120<br>113 | 83 - 159<br>45 - 156 | | 101 | 43 – 151 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.4*<br>7.4* | 7 – 7.7<br>7.1 – 7.9 | 0 of 12<br>0 of 12 | 7.3* | 6.2 - 8.1 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 4.11<br>5.59 | 1.3 – 11.5<br>0.9 - 18 | 0 of 12<br>2 of 12 | 8.57 | 0.5 - 125 |
| Fecal Coliform | colonies/ 100 ml | GMV: ≤100 and ≤10% of samples not to exceed 200 | 05/06<br>06/07 | 21**<br>20** | 0-83<br>0-150 | **% exceeding 200**<br>0%<br>0% | 26** | 0 – 1745 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.030<br>0.044 | 0.021-0.052<br>0.013-0.192 | | 0.037 | 0.013 - 0.324 |
| Nitrate+Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.893<br>0.811 | 0.723 – 1.07<br>0.378 - 1.18 | | 0.640 | 0.244 - 0.952 |
| Ammonia | mg/L | | 05/06<br>06/07 | 0.023<br>0.011 | 0.016 – 0.038<br><0.010 – 0.022 | | 0.024 | <0.010 - 0.182 |

*Median

**Geometric Mean Value

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | NH4 | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/11/2005 | 10:00:00 AM | 11.11 | 7.4 | 10.28 | 147 | 55 | 1.4 | 79.0 | 0.030 | 0.827 | 0.02 | SRP 0.016. Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/8/2005 | 2:15:00 PM | 8.01 | 7.1 | 11.40 | 84 | 20 | 5.4 | 566.0 | 0.033 | 0.723 | | |
| 12/7/2005 | 1:45:00 PM | 6.26 | 7.1 | 11.94 | 116 | 5 | 2.0 | 250.0 | 0.025 | 0.902 | | |
| 1/5/2006 | 12:25:00 PM | 7.49 | 7.2 | 12.98 | 83 | 20 | 10.3 | 989.0 | 0.036 | 0.823 | | |
| 2/7/2006 | 1:40:00 PM | 6.74 | 7.0 | 12.17 | 83 | 60 | 11.5 | 1120.0 | 0.052 | 0.938 | | |
| 3/13/2006 | 3:30:00 PM | 7.60 | 7.4 | 10.53 | 101 | 5 | 4.5 | 486.0 | 0.027 | 0.949 | | |
| 4/25/2006 | 12:40:00 PM | 11.78 | 7.5 | 11.31 | 112 | 0 | 3.2 | 300.0 | 0.023 | 0.782 | | |
| 5/17/2006 | 10:00:00 AM | 15.20 | 7.3 | 10.14 | 131 | 25 | 3.6 | 170.0 | 0.021 | 0.909 | | |
| 6/13/2006 | 2:15:00 PM | 15.23 | 7.3 | 11.05 | 129 | 45 | 2.3 | 190.0 | 0.022 | 0.888 | | |
| 7/11/2006 | 2:40:00 PM | 16.12 | 7.7 | | 145 | 30 | 1.9 | 125.0 | 0.030 | 0.984 | 0.02 | SRP=0.017 no DO measurement |
| 8/9/2006 | 1:35:00 PM | 15.99 | 7.5 | 11.44 | 150 | 83 | 1.9 | 90.0 | 0.025 | 0.926 | 0.02 | Samples not stored at proper temperature for 3-5 days, SRP and NO3 + NO2 may be high. Total N=1.11, SRP=.005 |
| 9/11/2006 | 2:30:00 PM | 14.52 | 7.5 | 11.23 | 159 | 55 | 1.3 | 45.0 | 0.031 | 1.070 | 0.04 | Sampled under bridge in Tumwater Falls Park. Total-N=1.26 and SRP=.017 |

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | NH4 | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 2:10:00 PM | 12.46 | 7.4 | 11.91 | 156 | 10 | 0.9 | 81.0 | 0.036 | 1.180 | 0.02 | total-N=1.4 SRP=.02 |
| 11/15/2006 | 10:15:00 AM | 8.41 | 7.2 | 11.40 | 73 | 135 | 18.0 | 1120.0 | 0.053 | 0.598 | | |
| 12/12/2006 | 10:00:00 AM | 7.45 | 7.1 | 11.70 | 45 | 150 | 10.0 | 2200.0 | 0.192 | 0.378 | | |
| 1/24/2007 | 1:30:00 AM | 6.90 | 7.3 | 10.77 | 105 | 30 | 4.8 | 518.0 | 0.029 | 0.982 | | |
| 2/22/2007 | 10:40:00 AM | 6.85 | 7.3 | 12.07 | 78 | 25 | 14.2 | 920.0 | 0.050 | 0.681 | | |
| 3/21/2007 | 2:00:00 PM | 7.88 | 7.4 | 12.99 | 84 | 10 | 5.2 | 730.0 | 0.032 | 0.582 | | |
| 4/24/2007 | 2:00:00 PM | 11.86 | 7.4 | 11.50 | 116 | 0 | 1.1 | 333.0 | 0.013 | 0.759 | | F.C. result was <5. |
| 5/16/2007 | 3:30:00 PM | 14.48 | 7.9 | 13.71 | 128 | 0 | 4.8 | 237.0 | 0.014 | 0.774 | 0.005 | F.C. result was <5. SRP= 0.005, NH4= <0.010 |
| 6/11/2007 | 3:30:00 PM | 14.36 | 7.6 | 10.83 | 138 | 15 | 1.4 | 179.0 | 0.015 | 0.961 | 0.005 | SRP= 0.009, NH4= <0.010 |
| 7/17/2007 | 12:20:00 PM | 16.29 | 7.3 | 8.65 | 141 | 38 | 3.9 | 135.0 | 0.039 | 0.917 | | |
| 8/22/2007 | 1:45:00 PM | 15.83 | 7.7 | 11.67 | 146 | 55 | 1.3 | 107.0 | 0.024 | 0.904 | | |
| 9/18/2007 | 1:30:00 PM | 13.56 | 7.6 | 11.12 | 150 | 50 | 1.5 | 81.0 | 0.029 | 1.020 | | |




**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.

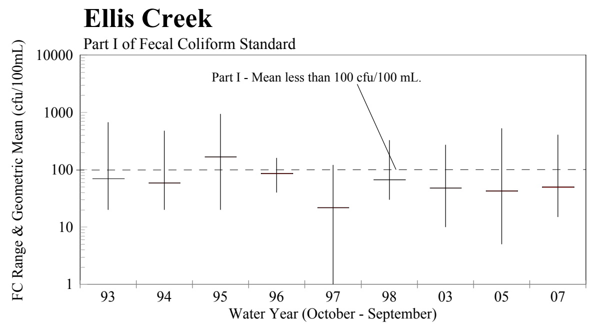
**GENERAL WATER QUALITY:** (Excellent, Good, Fair, Poor)

Good- Part II of the fecal coliform water quality standards was violated.

**OTHER DATA:**

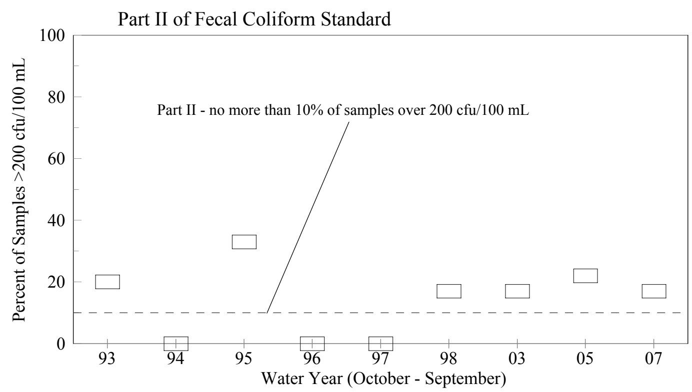
City of Olympia, Stream Team, (360) 570-5841

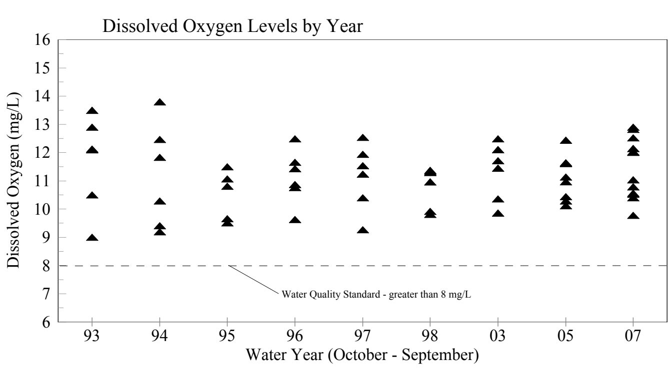
Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm




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

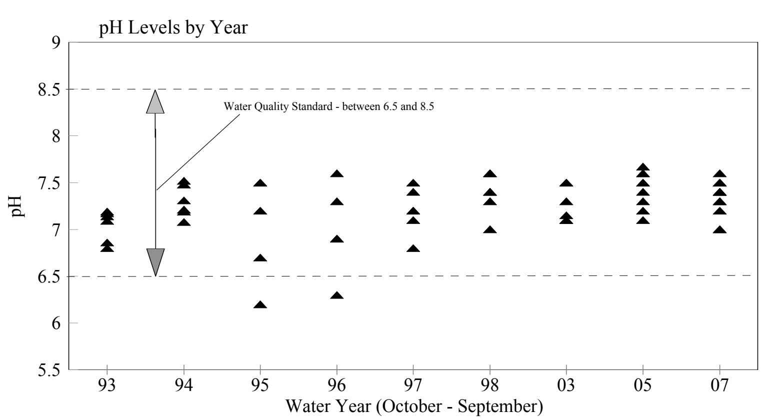
Ellis Creek has met Part I of the water quality standard in most years sampled. However, it has failed Part II of the standard in several years. In 2006/07 it met Part I and failed Part II.




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 has been no violation of the pH standard.



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. The creek is now monitored every other year. Part II of the fecal coliform bacteria standard was violated this water year. Other water quality conditions were within the standards. Visual observations made by field staff indicate that the bottom substrate of the stream channel has changed over time from predominantly gravel to sand.

## Major Issues:

- Because of it 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 fine sand.

## Funding Sources:

- Local Stormwater Utility Rates

# Water Quality Summary

Conventional Parameters

## Ellis Creek

| Parameter | Units | WQ Standard WAC 173-201A | Water Year Data: 2006/07 | | | Cumulative Data: 1992-2005 | |
|---|---|---|---|---|---|---|---|
| | | | Mean | Range | # samples violating standard | Mean | Range |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | | 7.17 – 14.09 | | | 4.51 - 15.20 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | | 9.78 – 12.9 | 0 of 12 | | 9.2 - 13.8 |
| Conductivity | µmhos/cm | | 120 | 64 - 157 | | 104 | 47 - 154 |
| pH | | 6.5 - 8.5 | 7.4* | 7.0 – 7.6 | 0 of 12 | 7.2* | 6.2 - 7.7 |
| Turbidity | NTU | not to exceed 5 NTU over background | 4.26 | 0.5 – 26.3 | 1 of 12 | 5.61 | 1 – 37 |
| Fecal Coliform | colonies / 100 ml | GMV: ≤100 and ≤ 10% not to exceed 200 | 50** | 15 - 405 | **% exceeding 200**<br>17% | 58** | 0 - 935 |
| Total Phosphorus | mg/L | | 0.044 | 0.027 – 0.074 | | 0.047 | 0.025 – 0.109 |
| Nitrate Nitrite-nitrogen | mg/L | | 0.784 | 0.544 – 1.02 | | 0.836 | 0.458 - 1.14 |
| Ammonia | mg/L | | | | | 0.015 | <0.010 - 0.041 |

* Median

** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2006 | 11:30:00 AM | 8.83 | 7.3 | 12.90 | 151 | 30 | 0.6 | 0.31 | 0.046 | 1.020 | |
| 11/14/2006 | 3:40:00 PM | 8.21 | 7.0 | 12.01 | 81 | 30 | 6.3 | 7.60 | 0.046 | 0.622 | |
| 12/8/2006 | 3:00:00 PM | 7.17 | 7.4 | 12.52 | 100 | 15 | 1.9 | 2.82 | 0.028 | 0.631 | |
| 1/23/2007 | 12:30:00 PM | 7.21 | 7.4 | 11.04 | 93 | 55 | 2.4 | 4.03 | 0.027 | 0.668 | Swoffer not calibrating, less than 400 spin count, spinner stops too fast |
| 2/20/2007 | 3:30:00 PM | 7.41 | 7.0 | 10.56 | 64 | 210 | 26.3 | 17.59 | 0.074 | 0.639 | |
| 3/19/2007 | 3:15:00 PM | 9.76 | 7.3 | 12.82 | 90 | 405 | 3.5 | 4.53 | 0.038 | 0.544 | |
| 4/25/2007 | 10:00:00 AM | 9.53 | 7.5 | 12.03 | 114 | 15 | 2.0 | 3.22 | 0.038 | 0.657 | |
| 5/16/2007 | 11:30:00 AM | 10.44 | 7.5 | 12.15 | 135 | 20 | 1.4 | 1.82 | 0.038 | 0.894 | |
| 6/13/2007 | 10:00:00 AM | 11.36 | 7.5 | 10.40 | 149 | 95 | 2.3 | 0.80 | 0.043 | 0.997 | |
| 7/23/2007 | 11:30:00 AM | 14.09 | 7.4 | 9.78 | 154 | 55 | 2.2 | 0.83 | 0.056 | 0.839 | |
| 8/22/2007 | 11:45:00 AM | 13.56 | 7.6 | 10.53 | 157 | 90 | 1.7 | 0.46 | 0.049 | 0.966 | |
| 9/19/2007 | 12:00:00 PM | 12.00 | 7.2 | 10.79 | 155 | 20 | 0.5 | 0.38 | 0.050 | 0.935 | |

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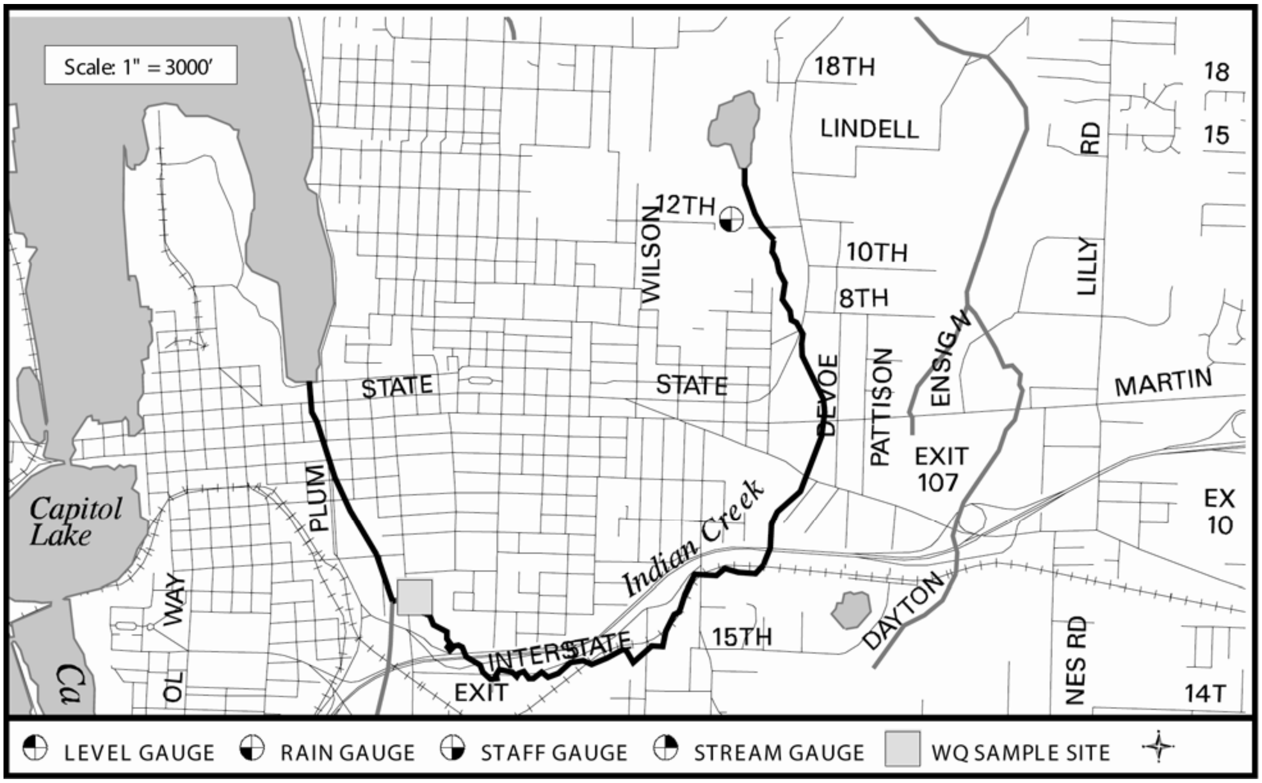



**PART OF BUDD INLET WATERSHED**

**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)

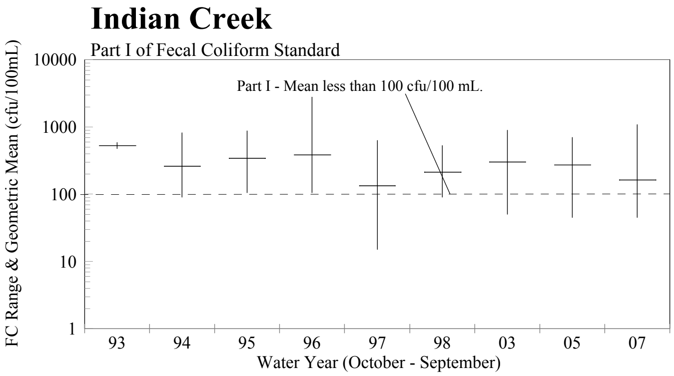
None from catalog but Washington Department of Fish and Wildlife plants Coho in Indian Creek near the Boulevard Street bridge. NED (Northwest Environmental Data Base) indicates resident fish are found in the entire length of Indian Creek. Species include coastal cutthroat, cottids, and three-spined stickleback.

**GENERAL TOPOGRAPHY:**

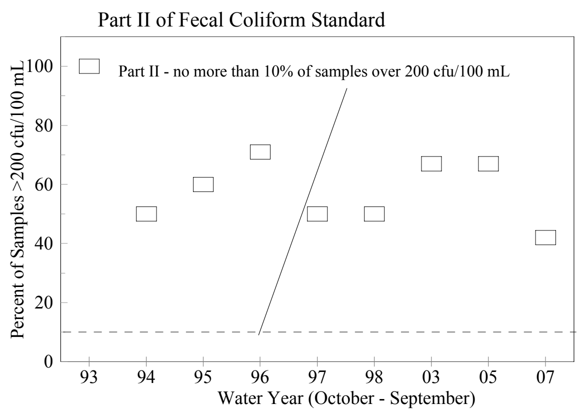
Originates in Bigelow Lake, a sphagnum bog lake. Low to medium channel gradients. Located in areas of rolling terraces and numerous small depressions. Upper portion of creek flows in a wide flood plain with extensive streamside wetlands. Downstream reaches of the stream are confined by steeper upper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

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

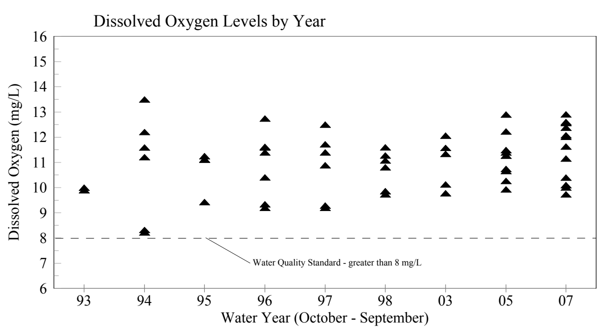
Poor - Fecal coliform concentrations are consistently high and fail both parts of the standard. Elevated metals and organics detected in creek sediments in past studies.



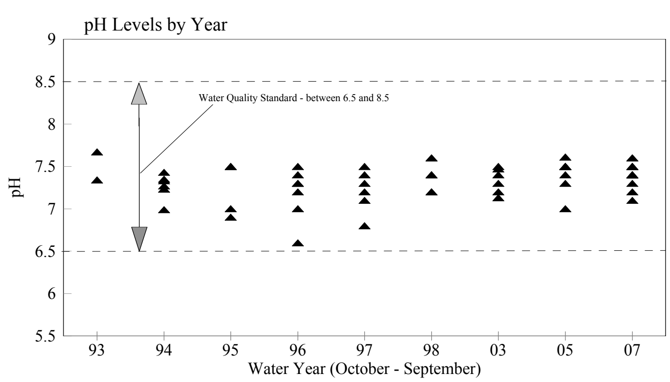

The water quality standard for fecal coliform bacteria has two parts: Part I - the geometric mean shall not exceed 100 colony forming units per 100 milliliters of sample *and*, Part II - no more than ten percent of the samples shall exceed 200 cfu/100 mL.




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




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 has been no violation of the pH standard.

**OTHER DATA:**

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

Thurston County Environmental Health
Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

From 1993-1998, Indian Creek was monitored each water year as part of the long-term ambient monitoring program. The monitoring frequency is now every other year. In water year 2006/07, both parts of the fecal coliform state standard were violated, and there was a turbidity violation in March.

## Major Issues:

- Fecal coliform bacteria contamination continues to a problem in this urban stream.
- Storm water runoff from local roadways 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: 2006/07 | | | Cumulative Data: 1993 – 2005 | |
|---|---|---|---|---|---|---|---|
| | | | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | | 7.0 – 14.88 | | | 4.43 - 15.00 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | | 9.73 – 12.9 | 0 of 12 | | 8.22 - 13.50 |
| Conductivity | µmhos/cm | | 149 | 118 - 195 | | 142 | 64 - 187 |
| pH | | 6.5 - 8.5 | 7.4* | 7.1 - 7.6 | 0 of 12 | 7.4* | 6.6 - 7.7 |
| Turbidity | NTU | not to exceed 5 NTU over background | 5.78 | 2.1 – 15.5 | 1 of 12 | 7.64 | 1.1 – 42.6 |
| Fecal Coliform | colonies / 100 ml | GMV: ≤100 and ≤ 10% not to exceed 200 | 164** | 45 - 1085 | **% exceeding 200**<br>42% | 270** | 15 - 3700 |
| Total Phosphorus | mg/L | | 0.052 | 0.038 - 0.072 | | 0.054 | 0.024 - 0.152 |
| Nitrate+Nitrite-nitrogen | mg/L | | 0.920 | 0.297 - 1.22 | | 0.953 | 0.586 - 1.84 |
| Ammonia | mg/L | | | | | 0.034 | <0.010 - 0.189 |

* Median

** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2006 | 10:15:00 AM | 9.68 | 7.2 | 12.60 | 177 | 130 | 2.1 | 0.89 | 0.041 | 1.110 | |
| 11/15/2006 | 9:35:00 AM | 8.32 | 7.1 | 12.02 | 119 | 45 | 5.0 | 6.12 | 0.061 | 0.297 | |
| 12/8/2006 | 2:00:00 PM | 7.20 | 7.4 | 12.91 | 141 | 65 | 2.3 | 2.86 | 0.041 | 0.855 | |
| 1/23/2007 | 11:30:00 AM | 7.39 | 7.4 | 10.40 | 127 | 45 | 3.4 | 4.44 | 0.038 | 1.050 | Swoffer not calibrating, less than 400 spin count spinner stops too fast. |
| 2/22/2007 | 11:30:00 AM | 7.00 | 7.3 | 12.57 | 118 | 85 | 3.5 | 6.77 | 0.047 | 0.684 | |
| 3/19/2007 | 3:45:00 PM | 10.72 | 7.4 | 12.38 | 124 | 750 | 15.5 | 5.75 | 0.072 | 0.818 | |
| 4/25/2007 | 10:50:00 AM | 10.45 | 7.5 | 11.63 | 143 | 45 | 5.2 | 3.13 | 0.046 | 0.951 | |
| 5/16/2007 | 4:00:00 PM | 12.40 | 7.6 | 12.08 | 151 | 225 | 6.8 | 2.07 | 0.060 | 1.060 | |
| 6/13/2007 | 11:15:00 AM | 12.32 | 7.5 | 10.01 | 162 | 280 | 5.6 | 2.03 | 0.048 | 1.220 | |
| 7/23/2007 | 12:00:00 PM | 14.88 | 7.4 | 9.73 | 153 | 160 | 5.5 | 2.12 | 0.060 | 1.050 | |
| 8/22/2007 | 11:00:00 AM | 14.19 | 7.5 | 10.10 | 173 | 635 | 3.8 | 1.44 | 0.048 | 1.070 | |
| 9/17/2007 | 2:45:00 PM | 13.93 | 7.6 | 11.16 | 195 | 1085 | 10.6 | 2.35 | 0.062 | 0.874 | |

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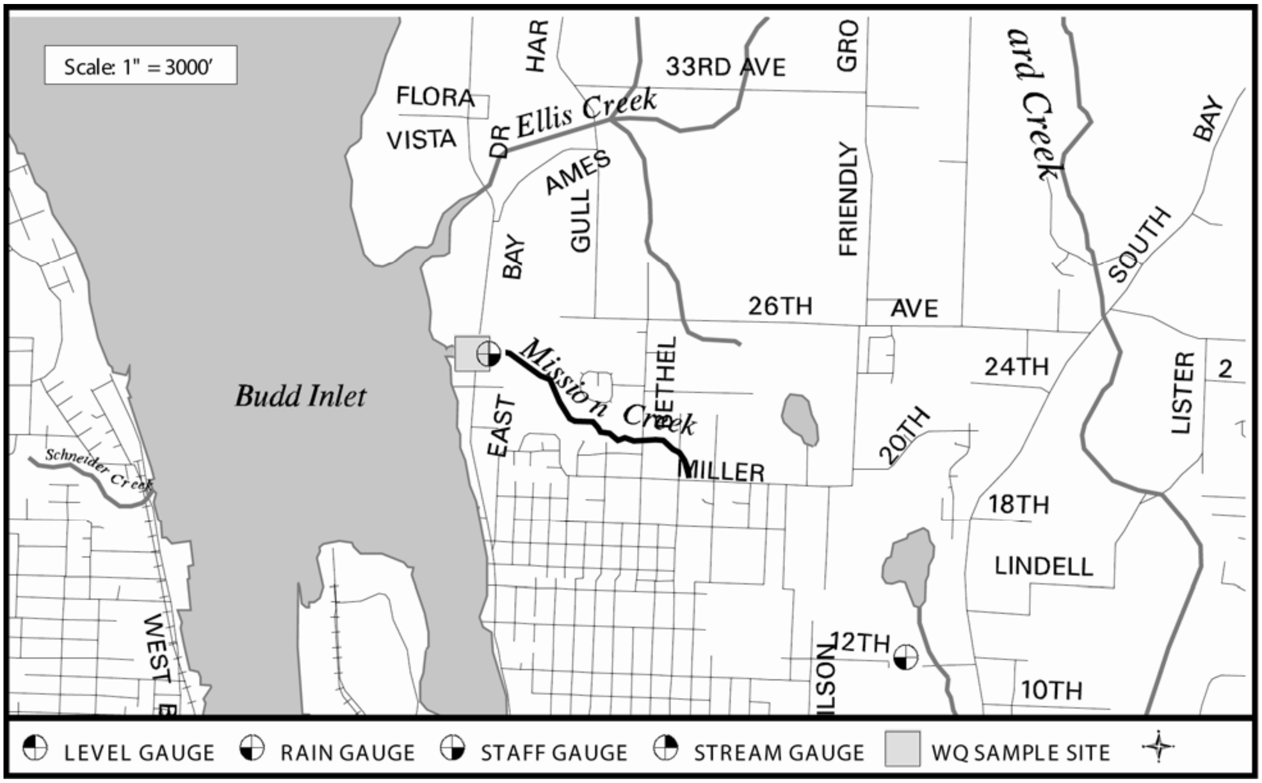
# Mission Creek #0025




**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 <u>A Catalog of Washington Steams and Salmon Utilization</u>, 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.

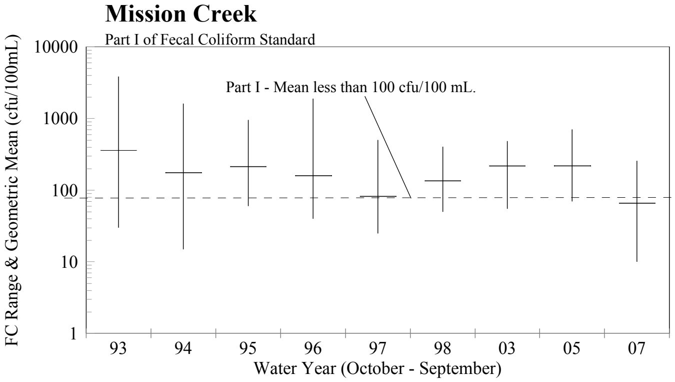
**GENERAL WATER QUALITY:** (Excellent, Good, Fair, Poor)

Fair - Failed part II of the fecal coliform standard. Nutrients, particularly nitrate, are elevated.

**OTHER DATA:**

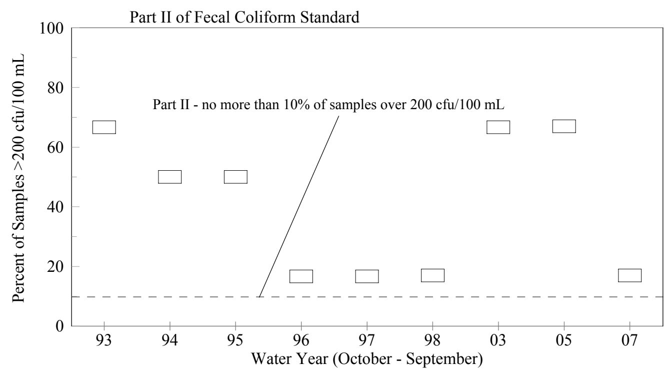
Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

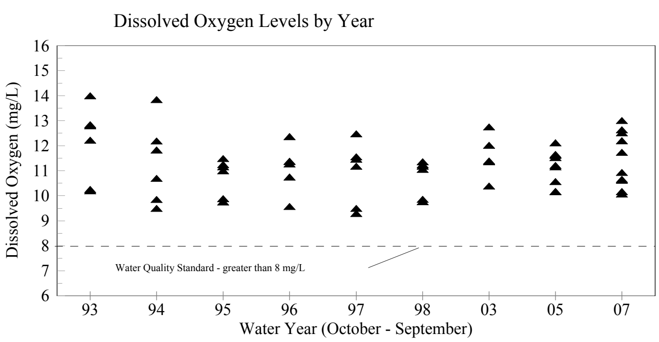
City of Olympia, Stream Team, (360) 570-5841




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

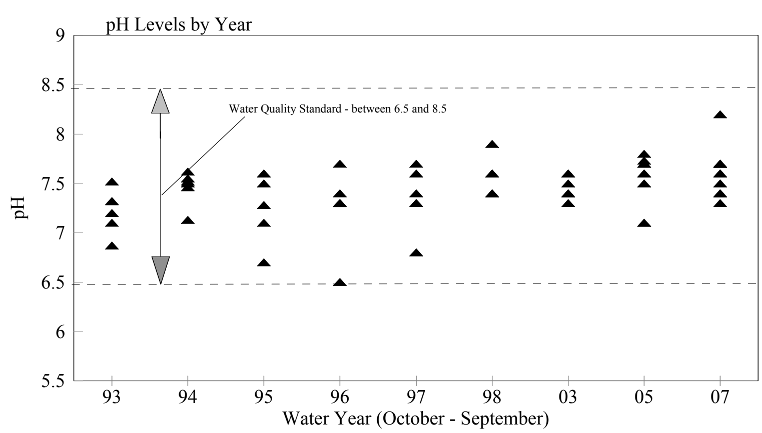
Mission Creek has failed both parts of the standard every year since 1993 with two exceptions, this water year being one. In 2006/07, Mission met part I but failed part II. The geometric mean was 66 and two of twelve samples were greater than 200.




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 has been no violation of the pH standard.



Between 1992 and 1998, monitoring of Mission Creek was conducted during each water year as part of the ambient monitoring program. The creek is now monitored every other year. Only part II of the state fecal coliform water quality standards was violated during water year 2006/2007 and the geometric mean is lower than it has been in the past. Nutrients are elevated in this creek, particularly nitrates.

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. An area-wide 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.

## 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<br>WAC 173-201A | Water Year Data: 2006/07 Mean | Water Year Data: 2006/07 Range | Water Year Data: 2006/07 # samples violating standard | Cumulative Data: 1992-2003 Mean | Cumulative Data: 1992-2003 Range |
|---|---|---|---|---|---|---|---|
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | | 7.32 – 14.2 | 0 of 12 | | 4.5 – 15.41 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | | 10.1 – 13.0 | 0 of 11 | | 9.29 – 14 |
| Conductivity | µmhos/cm | | 124 | 82 - 143 | | 115 | 53 – 145 |
| pH | | 6.5 - 8.5 | 7.6* | 7.3 – 8.2 | 0 of 12 | 7.5* | 6.5 - 7.9 |
| Turbidity | NTU | not to exceed 5 NTU over background | 3.05 | 0.5 – 8.0 | 0 of 12 | 13.22 | 1.4 - 456 |
| Fecal Coliform | colonies / 100 ml | GMV: ≤100 and ≤ 10% not to exceed 200 | 66** | 10 - 255 | **% exceeding 200**<br>17% | 183** | 15 - 3844 |
| Total Phosphorus | mg/L | | 0.08 | 0.04 – 0.133 | | 0.1 | 0.015 - 1.12 |
| Nitrate Nitrite-nitrogen | mg/L | | 1.162 | 0.71 – 1.45 | | 1.26 | 0.532 - 3.01 |

* Median

** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2006 | 10:45:00 AM | 9.17 | 7.4 | 13.01 | 143 | 120 | 1.7 | 0.27 | 0.108 | 1.270 | |
| 11/14/2006 | 3:15:00 PM | 8.67 | 7.3 | 11.74 | 107 | 10 | 1.7 | 1.11 | 0.055 | 0.710 | |
| 12/8/2006 | 2:30:00 PM | 7.32 | 7.6 | 12.52 | 122 | 25 | 0.8 | 0.82 | 0.051 | 1.100 | |
| 1/23/2007 | 12:00:00 PM | 7.67 | 7.6 | 10.93 | 114 | 10 | 0.5 | 1.46 | 0.040 | 1.260 | Swoffer not calibrating, less than 400 spin count, spinner stops too fast |
| 2/20/2007 | 3:00:00 PM | 7.61 | 7.4 | 10.07 | 82 | 70 | 7.2 | 4.14 | 0.055 | 0.795 | |
| 3/19/2007 | 3:00:00 AM | 10.00 | 7.6 | 12.64 | 106 | 180 | 8.0 | 1.81 | 0.073 | 1.080 | |
| 4/25/2007 | 10:30:00 AM | 9.70 | 7.7 | 12.20 | 124 | 45 | 2.0 | 1.17 | 0.060 | 1.300 | |
| 5/16/2007 | 10:15:00 AM | 10.42 | 8.2 | | 133 | 35 | 2.4 | 0.78 | 0.073 | 1.390 | DO not working on YSI#1. |
| 6/13/2007 | 10:30:00 AM | 11.63 | 7.7 | 10.62 | 136 | 125 | 1.8 | 0.41 | 0.081 | 1.450 | |
| 7/23/2007 | 11:00:00 AM | 14.20 | 7.5 | 10.17 | 136 | 255 | 2.5 | 0.63 | 0.105 | 0.995 | |
| 8/22/2007 | 11:15:00 AM | 13.70 | 7.7 | 10.66 | 142 | 230 | 4.0 | 0.37 | 0.123 | 1.320 | |
| 9/19/2007 | 11:15:00 AM | 11.85 | 7.7 | | 142 | 115 | 4.0 | 0.33 | 0.133 | 1.270 | DO not working on YSI#1 |

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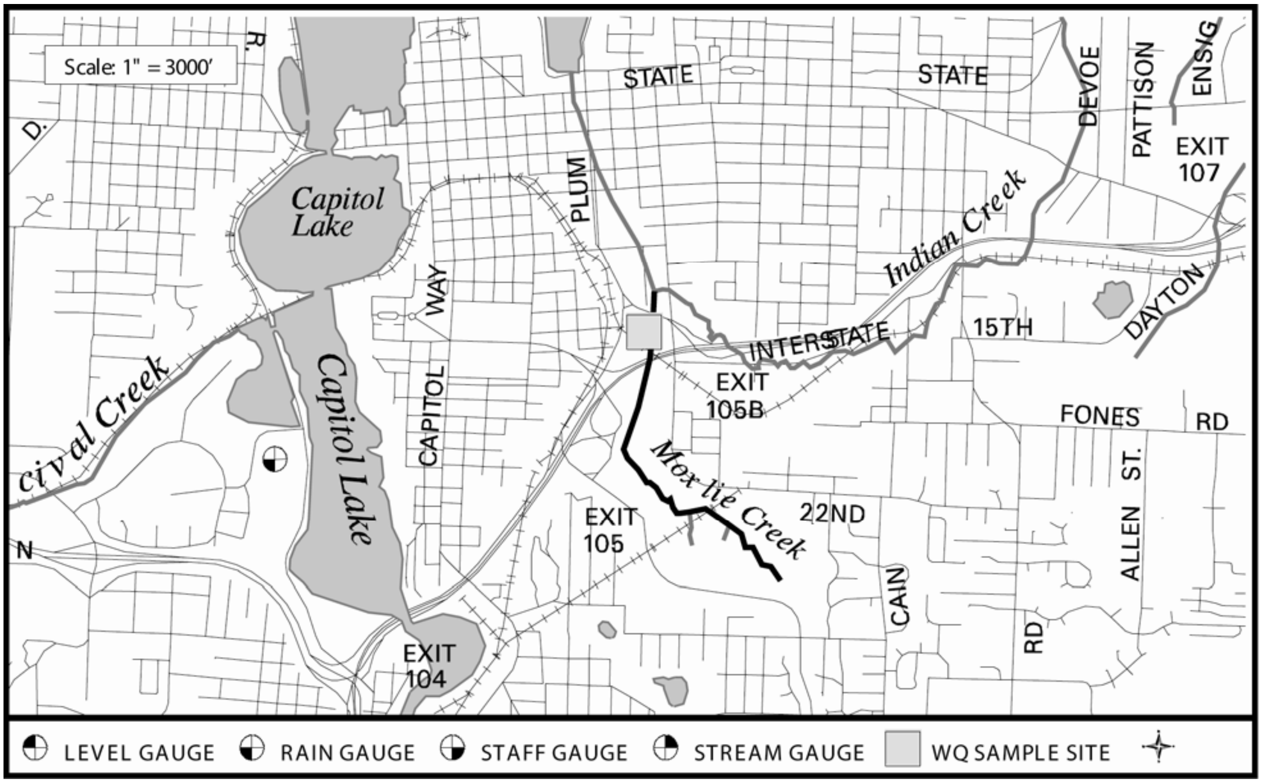



**PART OF BUDD INLET WATERSHED**

**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 percent. Adjacent upland terrace in 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.

**OTHER DATA:**

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

Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

Moxlie Creek is part of the ambient monitoring program, and is monitored every other water year. No sampling was done during 2005/06. The sampling site is at the outfall pipe at Marine Drive where the creek discharges into Budd Inlet. This site can only be monitored during a low tide, otherwise the outfall is submerged. In the past, Moxlie Creek was sampled at Plum Street just before the creek entered the 72 inch pipe under the city. However, sampling at that location missed approximately three-quarters of a mile of the lower creek that is particularly vulnerable to sewer cross-connections and storm water run-off.

The creek failed both parts of the fecal coliform bacteria standard in water years 2002/03, 2004/05 and 2006/07. 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.

## Major Issues:

- Stormwater discharges to the creek threaten the integrity of the natural creek channel in the upper watershed and degrades 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 is an on-going problem.

## Funding Sources:

- Local Stormwater Utility Rate

# Water Quality Summary

Conventional Parameters

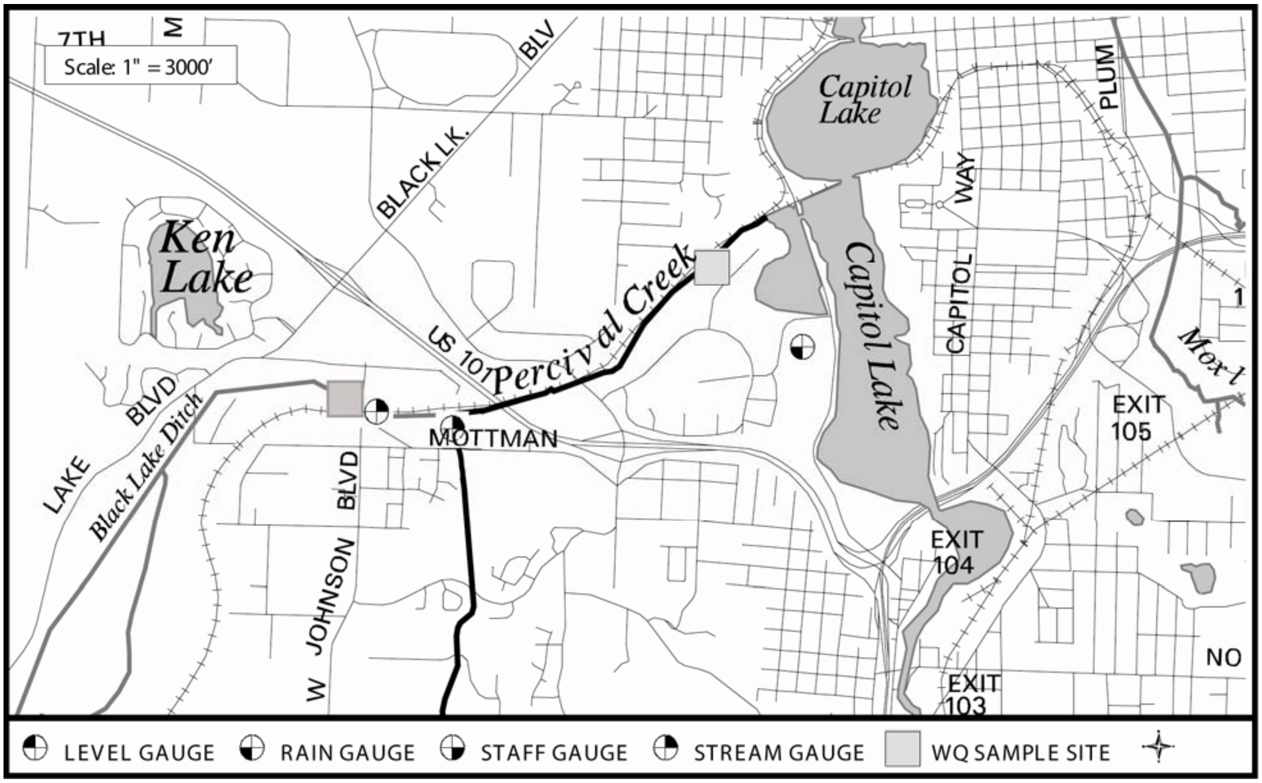
## Moxlie Creek

| Parameter | Units | WQ Standard WAC 173-201A | Water Year Data: 2006/07 | | | Cumulative Data: 1998 - 2005 | |
|---|---|---|---|---|---|---|---|
| | | | Mean | Range | # samples violating standard | Mean | Range |
| Temperature | º C | Highest 7-DAD Max of 17.5 º 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 | 393** | 100 - 1800 | **% exceeding 200** 75% | 584** | 20 - 7400 |
| Total Phosphorus | mg/L | | 0.077 | 0.064 – 0.093 | | 0.106 | 0.068 – 0.2 |
| Nitrate + Nitrite-nitrogen | mg/L | | 0.730 | 0.538 – 0.856 | | 0.655 | 0.44 – 0.761 |
| Ammonia | mg/L | | 0.036 | 0.022 – 0.052 | | 0.048 | 0.015 – 0.15 |

** Geometric mean value (GMV)

Shaded area – field parameters are no longer taken at this site

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | NH4 | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2006 | 2:20:00 PM | | | | | 580 | | | 0.080 | 0.749 | 0.03 | |
| 11/15/2006 | 9:30:00 AM | | | | | 310 | | | 0.069 | 0.538 | 0.02 | |
| 12/8/2006 | 2:30:00 PM | | | | | 500 | | | 0.064 | 0.681 | 0.05 | Pipe flowing full due to high tide, sheen on top |
| 1/23/2007 | 2:30:00 PM | | | | | 450 | | | 0.064 | 0.856 | 0.05 | |
| 2/22/2007 | 12:50:00 PM | | | | | 205 | | | 0.071 | 0.755 | 0.03 | |
| 3/19/2007 | 2:40:00 PM | | | | | 1800 | | | 0.086 | 0.594 | 0.03 | |
| 4/26/2007 | 10:15:00 AM | | | | | 150 | | | 0.068 | 0.798 | 0.02 | |
| 5/16/2007 | 10:00:00 AM | | | | | 100 | | | 0.091 | 0.792 | 0.03 | Smells bad! |
| 6/13/2007 | 10:50:00 AM | | | | | 180 | | | 0.079 | 0.782 | 0.03 | |
| 7/23/2007 | 10:30:00 AM | | | | | 1080 | | | 0.087 | 0.765 | 0.05 | |
| 8/22/2007 | 8:15:00 AM | | | | | 590 | | | 0.093 | 0.719 | 0.04 | |
| 9/19/2007 | 8:30:00 AM | | | | | 500 | | | 0.076 | 0.727 | 0.04 | |




**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)

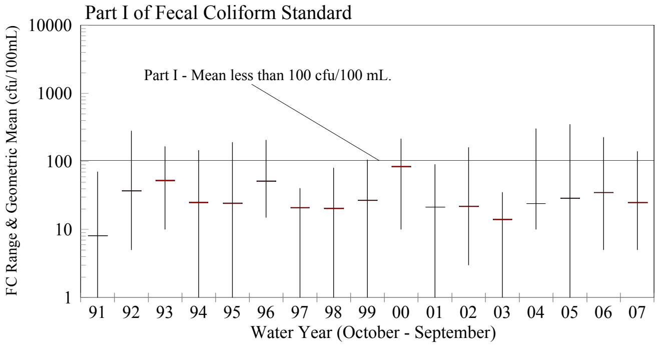
Chinook, Coho, (probably Chum)

**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. 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)

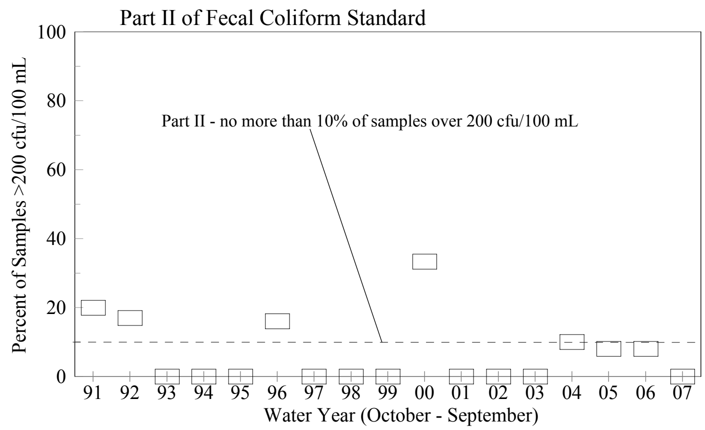
Good - Met both parts of the fecal coliform standard. Turbidity exceeded background one time in December 2006.

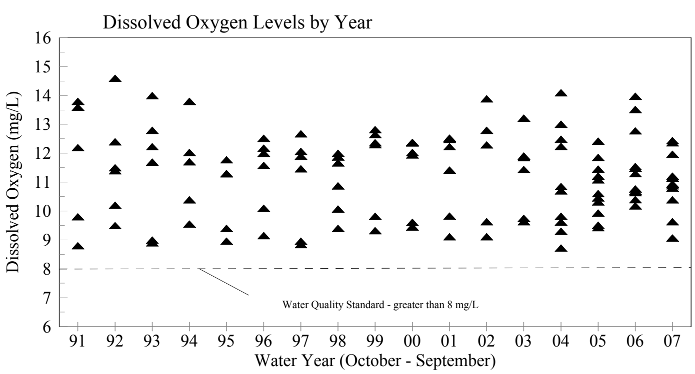
## Percival Creek Mouth




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

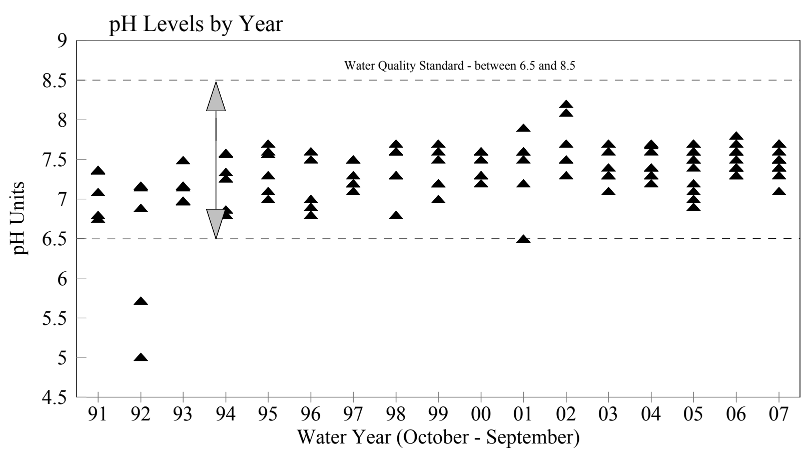
There have been no violations of part I of the fecal coliform standard. Part II of the standard was violated in 1991, 1992, 1996 and 2000. However, the standard has been met in recent years.




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

The standard for pH requires the pH to be within the range of 6.5 to 8.5. There were two instances in 1992 where the pH was outside the standard range. No violations have occurred since 1992.



**OTHER DATA:**

Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

Thurston County Department of Water and Waste Management, (360) 357-2491 or www.co.thurston.wa.us/monitoring

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

## 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 were 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 people often establish camps within the riparian corridor.

## Funding Sources:

- Local stormwater utility rates

# Water Quality Summary

## Conventional Parameters

## Percival Creek at the Foot Bridge

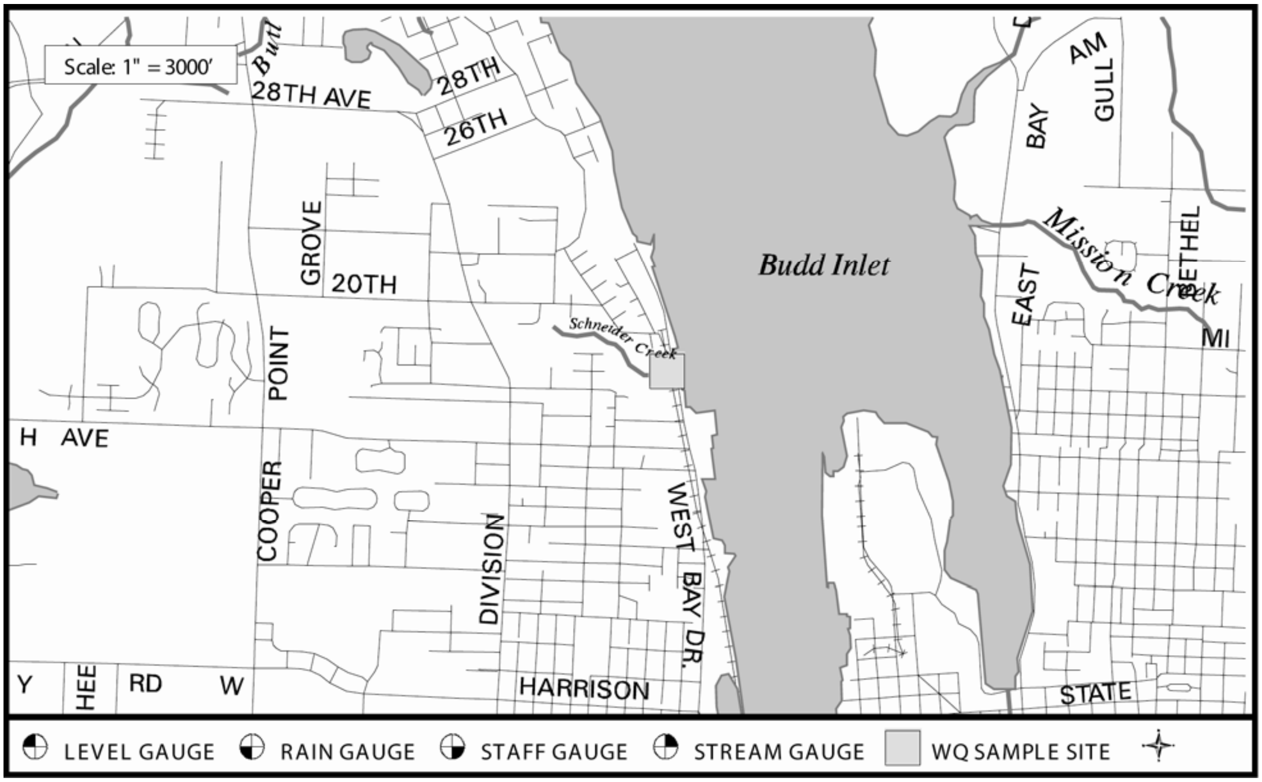
| Parameter | Units | WQ Standard WAC 173-201A | Water Year Data: 2005/06 & 2006/07 | | | | Cumulative Data: 1991-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | Water Year | Mean | Range | # samples violating standard | Mean | Range |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 05/06<br>06/07 | | 6.15 – 17.27<br>5.41 – 19.32 | | | 3.50 – 19.41 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 10.2 - 14<br>9.07 – 12.4 | 0 of 11<br>0 of 11 | | 8.72 - 14.60 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 106<br>103 | 80 - 151<br>81 - 154 | | 93 | 56 – 148 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.5*<br>7.5* | 7.3 – 7.8<br>7.1 – 7.7 | 0 of 12<br>0 of 12 | 7.3** | 5.0 – 8.2 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 3.2<br>4.2 | 1.1 – 6.3<br>0.9 – 12.6 | 0 of 11<br>1 of 12 | 3.5 | 0.6 - 28.5 |
| Fecal Coliform | colonies/ 100 ml | GMV ≤100 and ≤ 10% not to exceed 200 | 05/06<br>06/07 | 35**<br>25** | 5 - 225<br>5 - 140 | **% exceeding 200**<br>8%<br>0% | 30** | 0 - 6875 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.033<br>0.039 | 0.024 – 0.056<br>0.026 – 0.092 | | 0.035 | 0.013 - 0.121 |
| Nitrate Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.307<br>0.275 | 0.127 – 0.472<br>0.161 – 0.42 | | 0.317 | 0.141 - 0.737 |

* Median
** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2005 | 3:00:00 PM | 13.69 | 7.6 | 10.64 | 118 | 25 | 6.3 | 14.18 | 0.056 | 0.158 | Salmon spawning. Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/7/2005 | 3:00:00 PM | 10.38 | 7.4 | 10.77 | 99 | 225 | 4.3 | 84.29 | 0.042 | 0.368 | |
| 12/5/2005 | 2:30:00 PM | 6.48 | 7.6 | 13.52 | 104 | 5 | 3.2 | 43.77 | 0.031 | 0.308 | |
| 1/5/2006 | 9:30:00 AM | 6.91 | 7.3 | 13.98 | 88 | 20 | 4.5 | 111.20 | 0.032 | 0.419 | |
| 2/7/2006 | 11:45:00 AM | 6.15 | 7.4 | 12.78 | 80 | 15 | | | 0.025 | 0.428 | Too fast to wade. Turbidity didn't calibrate |
| 3/14/2006 | 9:30:00 AM | 7.25 | 7.4 | 10.68 | 87 | 20 | 2.6 | 71.70 | 0.028 | 0.472 | |
| 4/24/2006 | 1:15:00 PM | 12.42 | 7.5 | 11.54 | 94 | 10 | 2.8 | 44.35 | 0.024 | 0.272 | |
| 5/16/2006 | 9:30:00 AM | 15.09 | 7.3 | 10.40 | 100 | 15 | 3.1 | 29.29 | 0.029 | 0.209 | |
| 6/12/2006 | 3:15:00 PM | 17.24 | 7.6 | 10.18 | 103 | 45 | 4.1 | 24.43 | 0.027 | 0.127 | |
| 7/10/2006 | 2:15:00 PM | 17.23 | 7.8 | | 122 | 105 | 1.6 | 10.63 | 0.035 | 0.276 | no DO measurement |
| 8/8/2006 | 3:00:00 PM | 17.27 | 7.7 | 11.48 | 130 | 95 | 1.7 | 7.79 | 0.030 | 0.285 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/12/2006 | 12:30:00 PM | 13.64 | 7.4 | 11.30 | 151 | 160 | 1.1 | 4.69 | 0.035 | 0.364 | |

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 2:40:00 PM | 11.90 | 7.5 | 10.39 | 154 | 140 | 7.4 | | 0.092 | 0.370 | no flow due to salmon spawning |
| 11/14/2006 | 1:15:00 PM | 9.26 | 7.1 | 11.97 | 87 | 20 | 7.1 | 150.00 | 0.042 | 0.192 | |
| 12/11/2006 | 12:45:00 PM | 7.31 | 7.4 | 12.37 | 93 | 40 | 12.6 | 77.24 | 0.043 | 0.236 | |
| 1/23/2007 | 1:30:00 AM | 5.41 | 7.4 | 10.94 | 87 | 5 | 3.8 | 85.20 | 0.028 | 0.420 | |
| 2/22/2007 | 10:00:00 AM | 7.06 | 7.3 | 12.44 | 81 | 10 | 1.7 | 105.41 | 0.033 | 0.367 | |
| 3/20/2007 | 3:50:00 PM | 10.43 | 7.5 | | 86 | 5 | 0.9 | 77.93 | 0.029 | 0.296 | DO not working |
| 4/26/2007 | 10:30:00 AM | 12.45 | 7.5 | 11.14 | 93 | 5 | 1.9 | 45.61 | 0.026 | 0.299 | |
| 5/17/2007 | 1:15:00 PM | 15.19 | 7.7 | 10.80 | 100 | 10 | 2.2 | 28.23 | 0.031 | 0.298 | |
| 6/13/2007 | 1:45:00 PM | 17.21 | 7.7 | 10.88 | 107 | 115 | 2.4 | 20.87 | 0.028 | 0.202 | |
| 7/17/2007 | 3:20:00 PM | 19.32 | 7.7 | 9.07 | 108 | 15 | 3.9 | 18.28 | 0.045 | 0.200 | |
| 8/22/2007 | 10:15:00 AM | 17.66 | 7.7 | 9.63 | 115 | 85 | 1.2 | 14.03 | 0.029 | 0.161 | |
| 9/17/2007 | 2:00:00 PM | 15.74 | 7.6 | 11.21 | 124 | 130 | 5.6 | 11.21 | 0.036 | 0.254 | |

# 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 is in a deep-cut ravine. The creek discharges to Budd Inlet via a culvert under West Bay Drive.

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

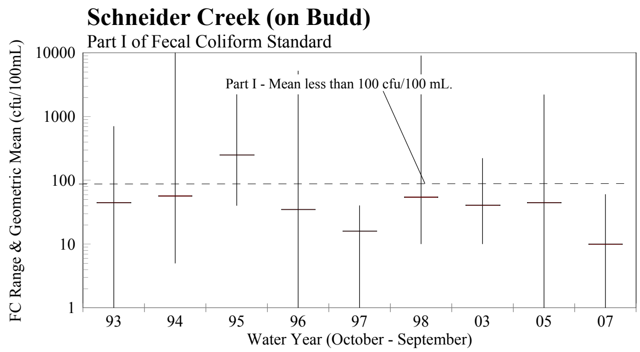
Good – Met both parts of the fecal coliform water quality standard this year. Stream channel is severely impacted by peak stormwater flows.

**OTHER DATA:**

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

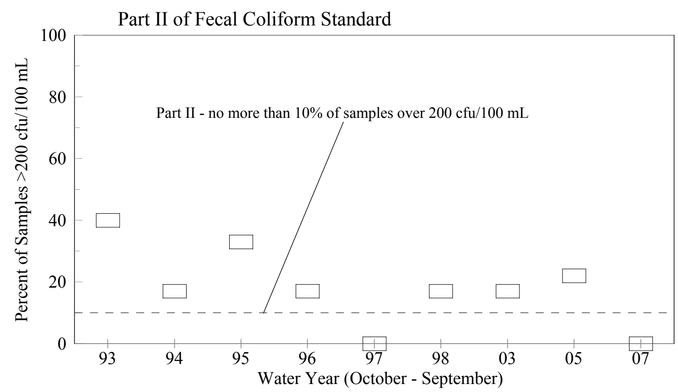
Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

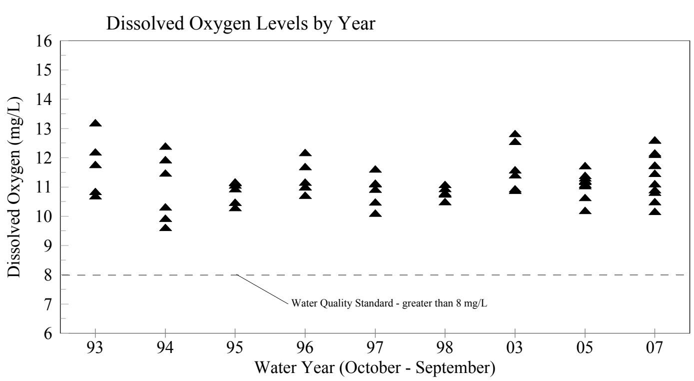
## Schneider Creek #0009
## (Budd Inlet Watershed)




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

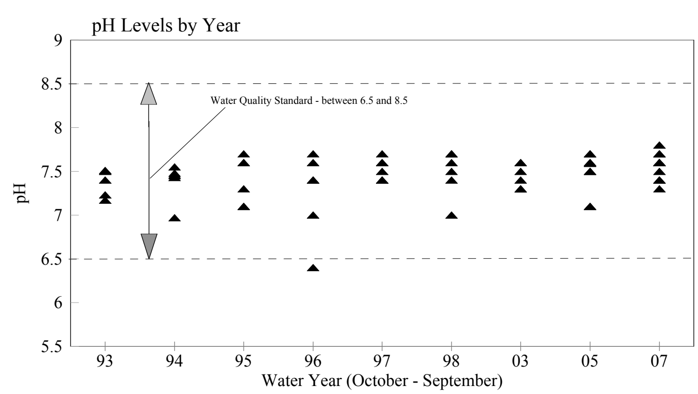
In the 2004/05 water year, Schneider Creek met Part I of the standard but violated Part II. In 2006/07 the creek met both parts.




The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. The creek met the dissolved oxygen standard.

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



From 1993 - 1998, the creek was monitored each water year as part of the long-term ambient monitoring program. The creek is now monitored every other year. Both parts of the fecal coliform water quality standard were met in water year 2006/2007. At around 1.5 milligrams per liter, the nitrate concentration in this creek is above typical surface water levels. It likely reflects the nitrate concentrations in the shallow ground water which provides base flow to the creek. During the winter months the creek is highly impacted by peak storm water flows that scour 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.

## Funding Sources:

- Local Stormwater Utility

# Water Quality Summary

Conventional Parameters

**Schneider Creek (in Budd Inlet Watershed)**

| **Parameter** | **Units** | **WQ Standard** WAC 173-201A | **Water Year Data: 2006/07** | | | | **Cumulative Data: 1993-2005** | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 06/07 | | 8.56 – 11.72 | | | 6.29 – 12.07 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 06/07 | | 10.2 – 12.6 | 0 of 12 | | 9.62 – 13.2 |
| Conductivity | µmhos/cm | | 06/07 | 147 | 109 - 163 | | 131 | 58 - 170 |
| pH | | 6.5 - 8.5 | 06/07 | 7.6* | 7.3 – 7.8 | 0 of 9 | 7.5* | 6.4 - 7.7 |
| Turbidity | NTU | not to exceed 5 NTU over background | 06/07 | 1.46 | 0 – 9.1 | 0 of 12 | 5.36 | 0 – 146 |
| Fecal Coliform | colonies / 100 ml | GMV: ≤100 and ≤ 10% not to exceed 200 | 06/07 | 10** | 0 - 60 | **% exceeding 200**<br>0% | 48** | 0 – 181,500 |
| Total Phosphorus | mg/L | | 06/07 | 0.025 | 0.02 - 0.033 | | 0.03 | 0.010 - 0.21 |
| Nitrate+Nitrite nitrogen | mg/L | | 06/07 | 1.55 | 1.28 – 1.75 | | 1.450 | 0.597 – 2.28 |

* Median

** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2006 | 12:00:00 PM | 10.09 | 7.4 | 12.61 | 163 | 5 | 0.3 | 1.58 | 0.032 | 1.440 | |
| 11/15/2006 | 9:45:00 AM | 9.84 | 7.3 | 11.47 | 125 | 15 | 1.1 | 2.28 | 0.023 | 1.440 | |
| 12/8/2006 | 3:30:00 PM | 8.75 | 7.6 | 11.75 | 143 | 0 | 0.3 | 1.53 | 0.020 | 1.280 | F.C. result was <5. |
| 1/23/2007 | 12:45:00 PM | 9.14 | 7.6 | 10.91 | 142 | 0 | 0.4 | 2.32 | 0.021 | 1.710 | F.C. result was <5. Swoffer not calibrating, less than 400 spin count, spinner stops too fast |
| 2/20/2007 | 3:40:00 PM | 8.56 | 7.4 | 10.50 | 109 | 35 | 4.2 | 6.23 | 0.025 | 1.440 | |
| 3/19/2007 | 4:10:00 PM | 10.08 | 7.5 | 12.12 | 132 | 60 | 9.1 | 3.96 | 0.033 | 1.530 | |
| 4/24/2007 | 2:50:00 PM | 10.74 | 7.8 | 12.17 | 153 | 0 | 0.1 | 3.41 | 0.020 | 1.740 | F.C. result was <5. |
| 5/16/2007 | 4:20:00 PM | 10.96 | 7.7 | 12.61 | 157 | 10 | 0.3 | 3.81 | 0.023 | 1.700 | |
| 6/13/2007 | 9:30:00 AM | 10.70 | 7.6 | 10.17 | 161 | 20 | 0.1 | 3.40 | 0.024 | 1.750 | |
| 7/17/2007 | 4:00:00 PM | 11.72 | 7.6 | 10.82 | 159 | 5 | 0.6 | 2.86 | 0.028 | 1.510 | |
| 8/21/2007 | 1:20:00 PM | 11.56 | 7.6 | 11.12 | 162 | 40 | 0.0 | 2.23 | 0.026 | 1.610 | |
| 9/17/2007 | 1:25:00 PM | 11.45 | 7.7 | 11.74 | 161 | 50 | 1.0 | 2.17 | 0.030 | 1.460 | |

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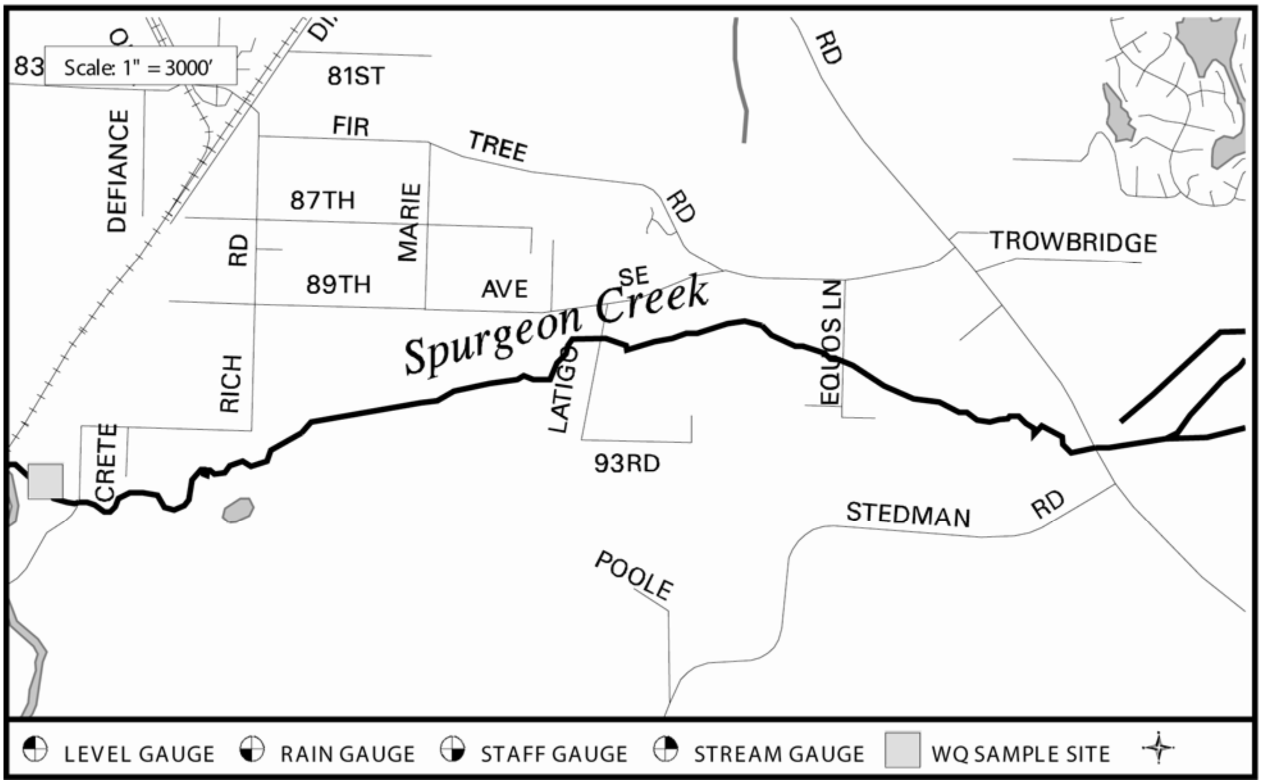
# Spurgeon Creek #0037




**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 - All water quality standards met except part II of the fecal coliform standard in water year 2006/07.

**OTHER DATA:**

Thurston County Environmental Health Division, Surface Water Section, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

The water quality standard for fecal coliform bacteria has two parts: part I - the geometric mean shall not exceed 100 colony forming units (cfu) /100 mL *and*, part II - no more than ten percent of the samples shall exceed 200 cfu/100mL. The geometric mean for the 2005/06 water year was 23 cfu/100ml with no samples greater that 200. The creek met both parts of the standard for water year 2005/06. However, in 2006/07, the geometric mean was 46 with two samples out of eleven (18%) greater that 200. The creek met part I of the standard but failed part II for 2006/07.

The water quality standard for dissolved oxygen is a lowest one-day minimum of 8 mg/L. All measurements recorded in 2005/06 and 2006/07 were above the minimum allowable level. There were no recorded violations of dissolved oxygen in the historic data record from 1990 through 1998.

The Class A standards for pH requires the pH to be within the range of 6.5 to 8.5. There were no violations during water year 2005/06 and 2006/07, and only one violation in the period of record.

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.

## 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 is 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: 2005/06 and 2006/07 | | | | Cumulative Data: 1990-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 05/06<br>06/07 | | 4.49 – 17.49<br>5.91 – 16.71 | 0 of 12<br>0 of 11 | | 6.00 – 18.67 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 10.5 – 12.5<br>9.15 – 13.3 | 0 of 12<br>0 of 11 | | 8.80 - 14.10 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 105<br>102 | 78 – 122<br>76 - 121 | | 98 | 57 - 131 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.4* | 7.1 – 7.8<br>7.0 – 7.7 | 0 of 12<br>0 of 11 | 7.3* | 6.4 - 7.9 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 2.48<br>1.87 | 1.3 – 4.4<br>0 – 3.3 | 0 of 12<br>0 of 11 | 3.16 | 1.0 - 43.0 |
| Fecal Coliform | colonies / 100 ml | GMV ≤100 and ≤ 10% not to exceed 200 | 05/06<br>06/07 | 23**<br>46** | 0 – 125<br>5 - 4300 | **% exceeding 200**<br>0%<br>18% | 49** | 0 - 640 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.034<br>0.052 | 0.021 – 0.054<br>0.023 – 0.26 | | 0.031 | 0.007 - 0.073 |
| Nitrate+Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.229<br>0.180 | 0.013 – 0.6<br>0.018 – 0.465 | | 0.326 | <0.010 - 0.704 |

* Median

** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2005 | 1:00:00 PM | 11.25 | 7.6 | 11.30 | 122 | 25 | 1.4 | 4.12 | 0.034 | 0.023 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/8/2005 | 9:00:00 AM | 5.99 | 7.4 | 11.70 | 93 | 0 | 1.6 | 10.60 | 0.041 | 0.160 | |
| 12/7/2005 | 9:00:00 PM | 4.49 | 7.4 | 12.13 | 107 | 10 | 1.3 | 9.69 | 0.025 | 0.406 | Flooded at Boe's. Sampled on downstream side of Rich Rd. |
| 1/5/2006 | 10:30:00 AM | 6.80 | 7.2 | 12.50 | 81 | 20 | 3.5 | | 0.029 | 0.600 | Too high to do flow. |
| 2/7/2006 | 11:15:00 AM | 5.22 | 7.1 | 11.64 | 78 | 15 | | | 0.021 | 0.568 | Turbidity didn't calibrate |
| 3/13/2006 | 11:00:00 AM | 5.43 | 7.2 | 10.48 | 98 | 5 | 2.9 | 22.40 | 0.030 | 0.483 | |
| 4/24/2006 | 2:15:00 PM | 13.32 | 7.6 | 11.48 | 112 | 40 | 2.5 | 13.12 | 0.031 | 0.216 | |
| 5/16/2006 | 12:00:00 PM | 15.78 | 7.5 | 10.56 | 115 | 55 | 3.6 | 9.16 | 0.038 | 0.133 | |
| 6/12/2006 | 2:20:00 PM | 15.29 | 7.6 | 10.62 | 112 | 30 | 4.4 | 8.85 | 0.032 | 0.079 | |
| 7/11/2006 | 11:25:00 AM | 15.64 | 7.8 | | 110 | 125 | 1.5 | 1.72 | 0.054 | 0.049 | no DO measurement |
| 8/9/2006 | 3:00:00 PM | 17.49 | 7.7 | 10.46 | 116 | 95 | 2.6 | 4.33 | 0.038 | 0.021 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/12/2006 | 1:45:00 PM | 14.49 | 7.6 | 10.61 | 117 | 40 | 2.0 | 3.89 | 0.037 | 0.013 | |

Spurgeon Creek off Rich Road

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2006 | 9:25:00 AM | 8.68 | 7.3 | 11.53 | 121 | 45 | 1.0 | 3.94 | 0.023 | 0.018 | |
| 11/15/2006 | 11:30:00 AM | 7.99 | 7.0 | 10.04 | 80 | 28 | 1.5 | | 0.026 | 0.208 | flooded out of bank |
| 1/24/2007 | 2:45:00 AM | 5.91 | 7.2 | 11.10 | 93 | 5 | 3.0 | 28.30 | 0.028 | 0.465 | |
| 2/21/2007 | 3:45:00 PM | 6.95 | 7.1 | 10.32 | 76 | 45 | 1.6 | | 0.038 | 0.307 | Area flooded, could not get a flow |
| 3/21/2007 | 3:10:00 PM | 8.11 | 7.4 | 13.28 | 91 | 5 | 0.0 | 27.70 | 0.036 | 0.327 | |
| 4/25/2007 | 12:30:00 PM | 10.82 | 7.5 | 11.78 | 104 | 25 | 2.6 | 18.84 | 0.035 | 0.261 | |
| 5/16/2007 | 2:20:00 PM | 13.56 | 7.7 | 11.77 | 105 | 30 | 3.3 | 13.42 | 0.031 | 0.194 | |
| 6/12/2007 | 10:00:00 AM | 11.27 | 7.5 | 11.74 | 109 | 4300 | 2.0 | 9.16 | 0.260 | 0.133 | |
| 7/17/2007 | 2:15:00 PM | 16.71 | 7.5 | 9.15 | 111 | 10 | 2.2 | 8.88 | 0.041 | 0.026 | |
| 8/21/2007 | 2:45:00 PM | 15.69 | 7.5 | 9.84 | 116 | 255 | 2.6 | 8.27 | 0.033 | 0.021 | |
| 9/19/2007 | 1:30:00 PM | 13.05 | 7.6 | 10.86 | 117 | 85 | 0.8 | 4.88 | 0.023 | 0.025 | |

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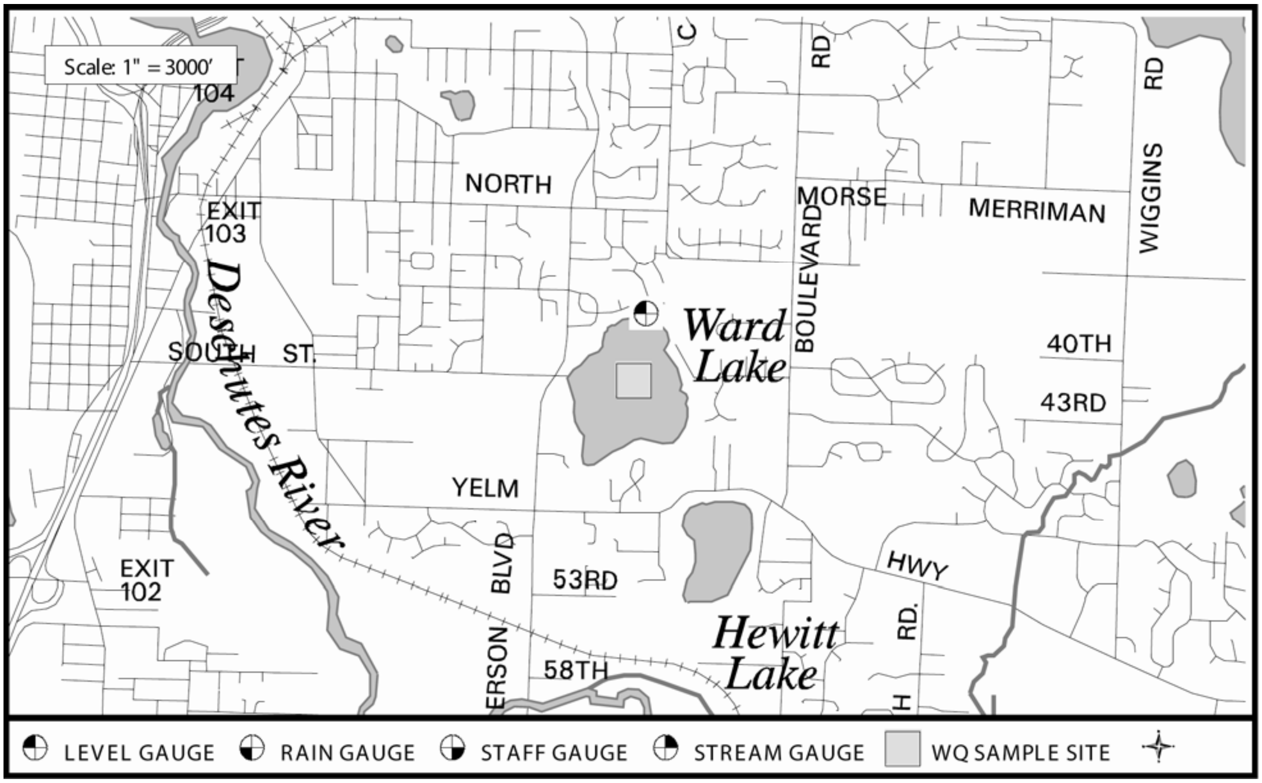



**PART OF DESCHUTES RIVER WATERSHED**

**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)

Excellent to Good - the lake has low levels of nutrients. Uses are not generally impeded by aquatic weeds or algal growth. The lake is on the WDOE 303(d) list of impaired waterbodies for PCB contamination in fish.

**OTHER AVAILABLE DATA:**
Water Quality data since 1992 - Thurston County Environmental Health Division, www.co.thurston.wa.us/health/ehswat/swater.htm. (360) 754-4111

Thurston County Storm and Surface Water Utility, (360) 357-2491, (rainfall and lake level data).

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. Nutrient levels are low. The lake supports only a light growth of aquatic plants, limited in large part by the depth of the lake. Algae blooms are not common but occasionally moderate densities of algae are observed, especially during the winter.

The lake stratifies into two distinct layers of water during the summer months, May through October. In 2007, the warmer surface water layer (called the epilimnion) extended from the surface to a depth of about 6 meters. The warmest water temperature at the surface reached 23.2 degrees Celsius in August. Water temperature at the bottom remained at about 6 degrees Celsius. The lower colder layer of water was anoxic (contains very low or no levels of dissolved oxygen) during the period of thermal stratification. Bacterial decomposition of aquatic plants, algae and other organic material uses and depletes the dissolved oxygen in the water near the bottom. This anoxic condition results in solubilizing phosphorus in the sediments as release into the water, as can be seen by the high total phosphorus concentrations in the bottom samples (See the data report at the end of this narrative.). These additional nutrients in the water column can stimulate algae growth after the lake mixes in late fall or early winter.

In 2007, the water clarity (measured by secchi disk readings) ranged from 3.1 meters (10.4 feet) in July to 6.4 meters (20.9 feet) in June. The average for the season was 5 meters (16.4 feet). The secchi disk readings graph on the page following the field measurement profiles shows the average annual secchi disk measurements for 1992 and 1995 through 2007. The water clarity trend graph, included at the end of the narrative, does not indicate an obvious upward or downward trend in the thirteen year period of record.

The average total phosphorus concentration in the upper water of the lake was 0.008 milligrams per liter (mg/l) in 2007. This lake has very low phosphorus concentration which is one indicator of good water quality. The average 2007 chlorophyll *a* concentration was 4.2 micrograms per liter (µg/l), which is also very low. 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. This year July was the month with the highest chlorophyll level at 14 micrograms per liter.

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. Eutrophic lakes are generally considered to have poor water quality.

The 2007 TSIs for total phosphorus, chlorophyll *a*, and secchi disk transparency measurements were 34, 45, and 37 respectively. These TSI's show that Ward Lake is primarily in the oligotrophic (or low productivity) category. The trophic state indices graph on the page following the field measurements profiles show the TSIs since 1995. Since 2003 the chlorophyll index has been in mesotrophic range, which may indicate that a shift in productivity is occurring. Residents reported late winter / early spring algae blooms in 2005 and 2007, which may also be an indication of a shift in water quality conditions.

At the end of this chapter is a report of the algae species present in the lake samples. Lakes with higher nutrient levels and poorer water quality tend to be dominanted by blue-green algae. Blue-green species were present in all but one monthly sample. Green algae are more common in oligotrophic lakes, and there were several species of these algae present also. The composition of the algae species in Ward Lake will be examined over time to watch for any shift from green algae dominance to blue-green algae dominance. Such a shift may indicate that the lake is becoming more nutrient-rich and changing from a low productivity state to a higher productivity state.

## 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. Currently, a planned urban village is under construction on the west side of the lake on a site that had formerly been a landscape plant nursery. Spills and storm-related sewage spills have occurred into Ward Lake in the past.

- Conflict between lake users at the Department of Fish and Wildlife public access have been a controversial issue.

- 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.

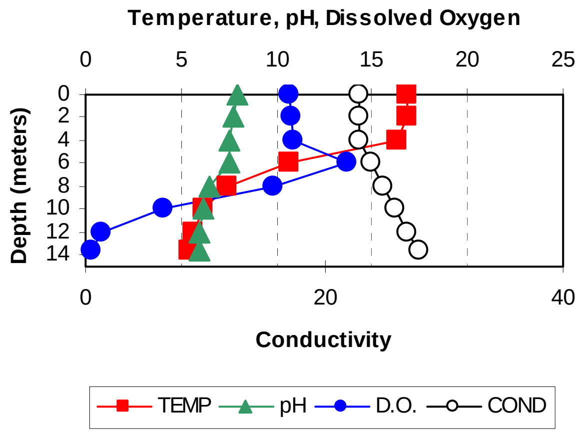
- Late winter / early spring algae blooms occurred in 2005 and again in 2007 raising concerns from residents about the water quality and possible impacts from development activities within the watershed.

## Funding Sources:

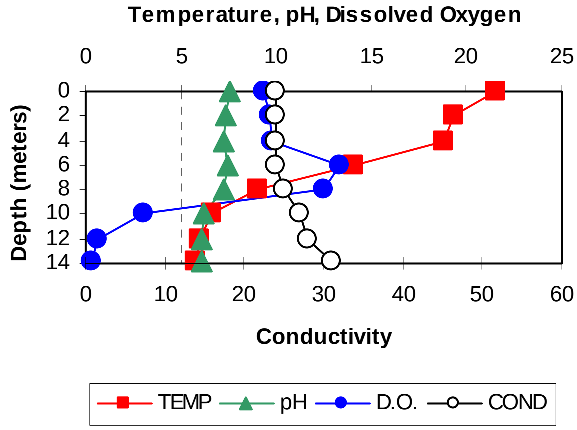
County funds will continue to support monitoring in 2008.

# WARD LAKE

## May 21, 2007




## June 20 2007

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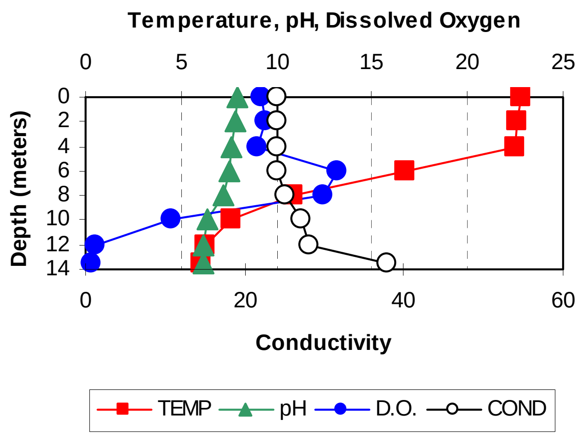


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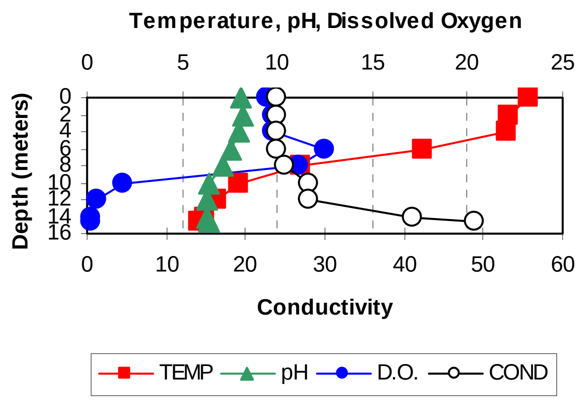
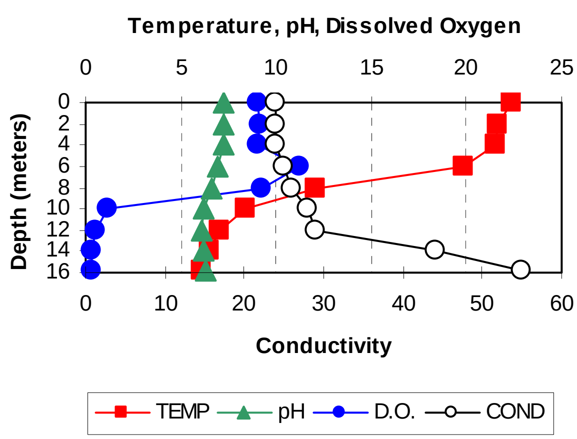



## September 10, 2007

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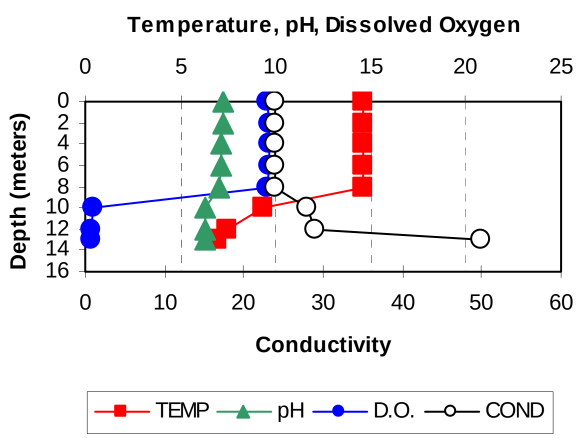
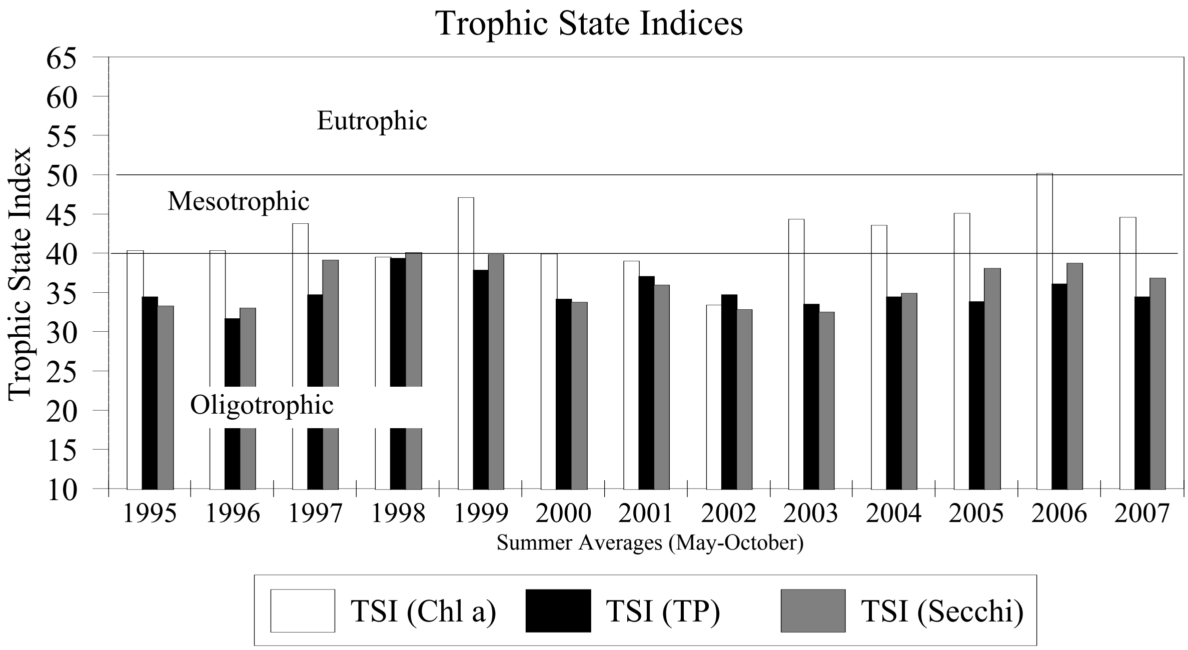
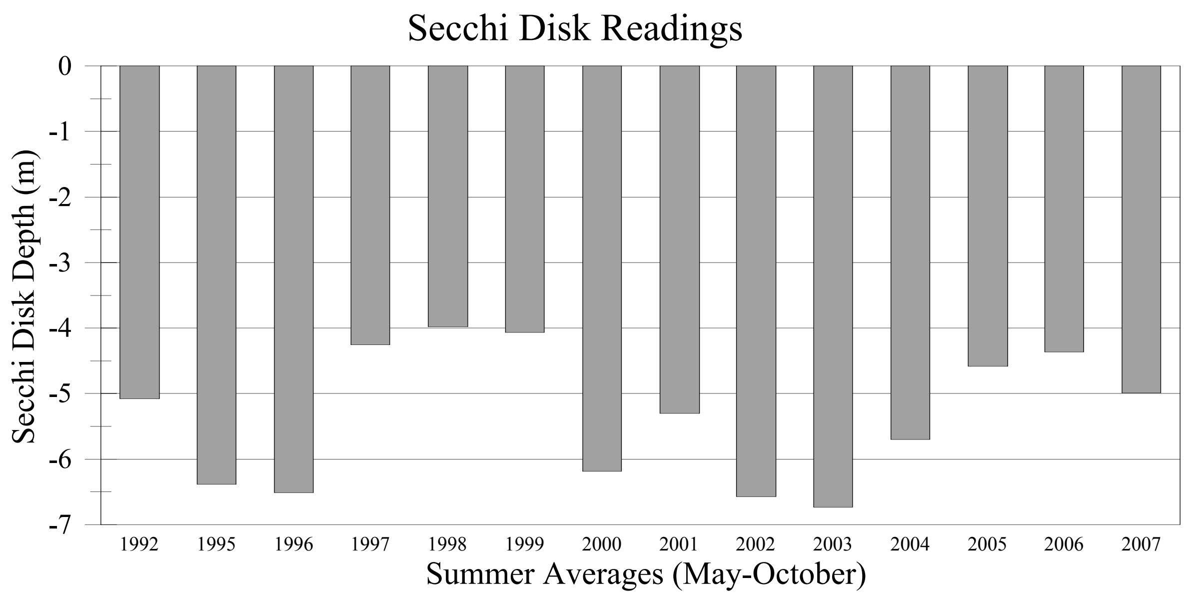
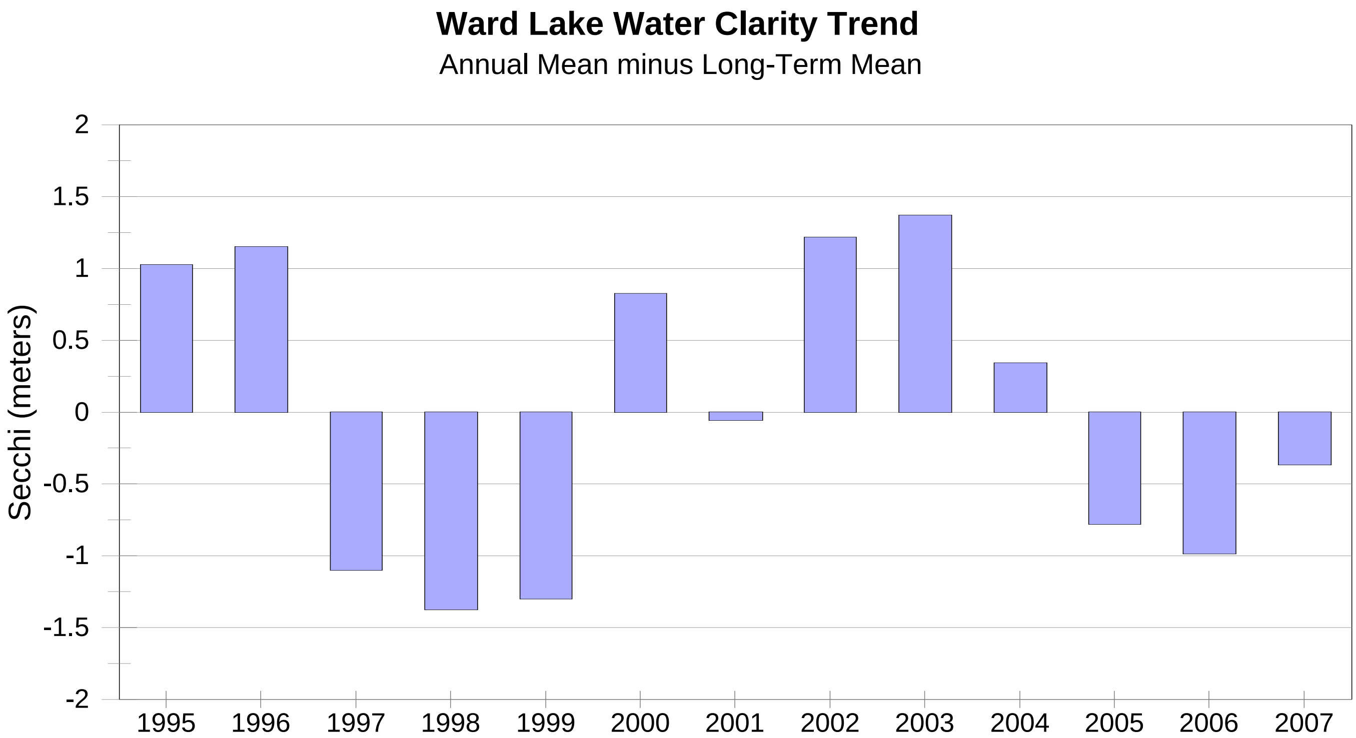


# Ward Lake


Trophic State Indices
Trophic State Index
65
60
55
50
45
40
35
30
25
20
15
10
Eutrophic
Mesotrophic
Oligotrophic
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)
TSI (Chl a)
TSI (TP)
TSI (Secchi)


Secchi Disk Readings
Secchi Disk Depth (m)
0
-1
-2
-3
-4
-5
-6
-7
1992
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)


Ward Lake Water Clarity Trend
Annual Mean minus Long-Term Mean
Secchi (meters)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007

## 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 Color | Lake Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/21/2007 | 3:15:00 PM | 13.6 | 12.5 | 0.010 | 0.048 | 0.335 | 0.476 | 4.64 | 2.4 | 0.4 | #2 lt green | Chl a & algae composite @ 2, 4, & 6M. |
| 06/20/2007 | 3:00:00 PM | 13.8 | | 0.008 | 0.043 | 0.252 | 0.374 | 6.38 | 1.1 | 1.2 | #2 lt green | Chl a & algae composite @ 1, 2.5, & 4M. |
| 07/23/2007 | 4:00:00 PM | 13.5 | 12.5 | 0.014 | 0.033 | 0.297 | 0.290 | 3.17 | 13 | 1.8 | #4 green | Chl a & algae composite @ 2, 4, & 6M. |
| 08/14/2007 | 2:45:00 PM | 14.7 | 14.0 | 0.005 | 0.157 | 0.256 | 0.542 | 4.26 | 3.7 | 0.4 | #2 lt green | Chl a & algae composite @ 2, 4, & 6M. |
| 09/10/2007 | 3:00:00 PM | 15.9 | 15.0 | 0.005 | 0.367 | 0.254 | 0.933 | 6.23 | 1.6 | 1.4 | #2 lt green | Chl a & algae composite @ 2, 4, & 6M. |
| 10/16/2007 | 11:50:00 AM | 13 | 12.0 | 0.007 | 0.059 | 0.289 | 0.427 | 5.24 | 3.2 | 1.8 | #2 lt green | Chl a & algae composite @ 2, 4, & 6M. |

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

| Averages: | | |
|---|---|---|
| | **Sur TP** | *0.008* |
| | **Secchi** | *4.99* |
| | **Chl a** | *4.2* |

# *Algae data:* Ward Lake

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| *05/21/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | GR | Botryococcus species | ☐ |
| | GR | Elakatothrix species | ☐ |
| | GR | Oocystis species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| *06/20/2007* | | | |
| | CP | Cryptomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | GR | Botryococcus species | ☐ |
| | GR | Oocystis species | ☐ |
| *07/23/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | BG | Aphanocapsa species | ☐ |
| | BG | Merismopedia species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | GR | Elakatothrix species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Synura species | ☐ |
| *08/14/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | BG | Aphanocapsa species | ☐ |
| | BG | Aphanothece species | ☐ |
| | BG | Chroococcus species | ☐ |
| | BG | Merismopedia species | ☐ |
| | DF | Ceratium species | ☐ |
| | GR | Oocystis species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | YL | Synura species | ☐ |

| Type | Description | Dominant in Sample |
|---|---|---|
| *09/10/2007* | | |
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Chroococcus species | ☐ |
| GR | Ankistrodesmus species | ☐ |
| GR | Botryococcus species | ☐ |
| YL | Dinobryon species | ☐ |
| *10/16/2007* | | |
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Aphanocapsa species | ☐ |
| BG | Aphanothece species | ☐ |
| BG | Chroococcus species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| EU | Trachelomonas species | ☐ |
| GR | Ankyra judayi | ☐ |
| GR | Botryococcus braunii | ☐ |
| GR | Oocystis species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| YL | Dinobryon species | ☐ |

***Key:***

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

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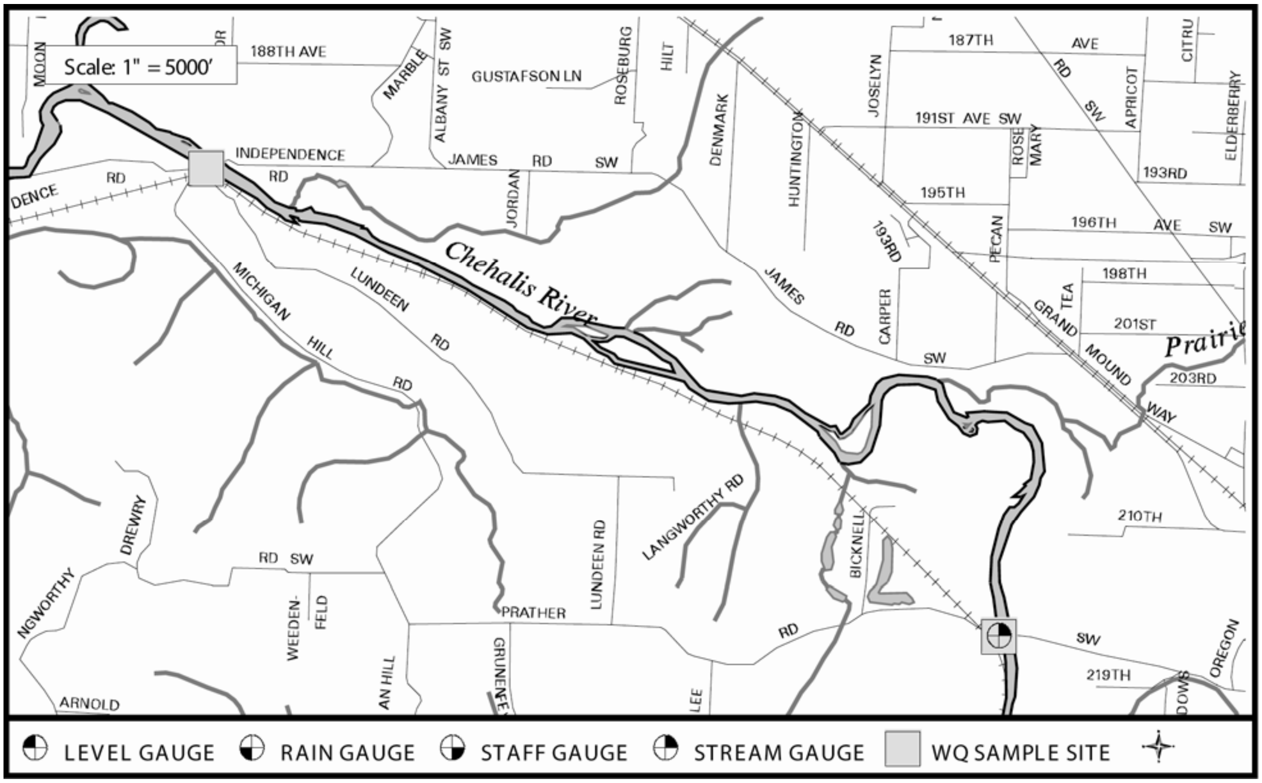
# Chehalis Watershed

**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:**

Good – Summer high temperatures occur, which are a natural condition. Turbidity violations occurred in both 2005/06 & 2006/07 water years.

**OTHER DATA:**

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

Thurston County Environmental Health Division (360) 754-4111 (water quality data for 1991-1993) or www.co.thurston.wa.us/health/ehswat/swater.htm

Thurston County Department of Water and Waste Management,
(360) 357-2491 (flow data from 1992) or www.co.thurston.wa.us/monitoring

## 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 water quality data for the Chehalis at Prather Road for 1996-1998, on the web site at www.co.thurston.wa.us/ehswat/swater.htm.

Temperatures recorded in July and August have been high. This is an indication that there are likely violations of the temperature standard during the summer months. Fecal coliform standards were met for Part I and Part II of the standard for the past three water years. The Washington Department of Ecology conducted a total maximum daily load study to address the water quality problems in the Chehalis River in the 1990's.

## 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: 2005/06 and 2006/07 | | | | Cumulative Data: 1996-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | Water Year | Mean | Range | # samples violating standard | Mean | Range |
| Temperature | ° C | Highest 7-DAD Max of 17.5 ° C | 05/06<br>06/07 | | 5.68 – 19.82<br>5.31 – 20.12 | | | 3.94 - 20.88 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 10.3 – 12.1<br>8.18 – 13.4 | 0 of 11<br>0 of 12 | | 8.04 - 13.3 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 98<br>94 | 70 - 128<br>59 - 121 | | 90 | 42 – 136 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.4*<br>7.2* | 6.9 - 7.7<br>6.9 – 7.8 | 0 of 12<br>0 of 12 | 7.2* | 6.4 – 7.7 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 6.18<br>17.8 | 0.8 – 21<br>0.1 - 65 | 2 of 12<br>4 of 12 | 10.47 | 0.2 - 228 |
| Fecal Coliform | colonies/ 100 mL | GMV: ≤ 100 and ≤ 10% not to exceed 200 | 05/06<br>06/07 | 20**<br>24** | 0 - 100<br>0 - 185 | **% exceeding 200**<br>0%<br>0% | 31** | 0 - 1600 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.042<br>0.071 | 0.017 – 0.071<br>0.028 - 0.164 | | 0.056 | 0.022 - 0.58 |
| Nitrate + Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.782<br>0.630 | 0.544 – 0.956<br>0.332 - 0.918 | | 0.713 | 0.455 – 1.06 |

* Median
** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/11/2005 | 12:15:00 PM | 12.86 | 7.4 | 10.40 | 113 | 20 | 1.7 | 380 | 0.055 | 0.679 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/8/2005 | 12:00:00 PM | 8.12 | 7.2 | 11.03 | 87 | 45 | 8.4 | 4920 | 0.048 | 0.896 | |
| 12/7/2005 | 11:45:00 AM | 5.68 | 7.3 | 12.10 | 83 | 100 | 3.7 | 2550 | 0.034 | 0.890 | |
| 1/4/2006 | 12:30:00 PM | 6.94 | 6.9 | 11.86 | 72 | 70 | 21.0 | 9520 | 0.059 | 0.956 | |
| 2/7/2006 | 12:00:00 PM | 6.66 | 6.9 | 11.96 | 70 | 55 | 20.0 | 8760 | 0.071 | 0.950 | |
| 3/13/2006 | 1:15:00 PM | 6.76 | 7.2 | 10.30 | 78 | 10 | 8.8 | 3940 | 0.039 | 0.914 | |
| 4/26/2006 | 2:20:00 PM | 12.49 | 7.6 | 11.50 | 97 | 10 | 2.6 | 1590 | 0.022 | 0.554 | |
| 5/16/2006 | 2:30:00 PM | 18.02 | 7.5 | 11.50 | 128 | 0 | 2.6 | 726 | 0.017 | 0.575 | |
| 6/14/2006 | 11:30:00 AM | 16.95 | 7.4 | 10.43 | 96 | 20 | 2.6 | 864 | 0.037 | 0.544 | |
| 7/11/2006 | 10:00:00 AM | 18.31 | 7.6 | | 112 | 45 | 0.8 | 331 | 0.031 | 0.756 | no DO measurement |
| 8/9/2006 | 11:10:00 AM | 19.82 | 7.6 | 11.85 | 124 | 10 | 0.9 | 197 | 0.037 | 0.832 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/11/2006 | 11:55:00 AM | 16.80 | 7.7 | 11.46 | 115 | 8 | 1.1 | 205 | 0.060 | 0.832 | |

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 11:20:00 AM | 13.58 | 7.4 | 10.71 | 121 | 25 | 1.3 | 215 | 0.059 | 0.918 | |
| 11/13/2006 | 2:35:00 PM | 8.51 | 6.9 | 11.49 | 64 | 100 | 65.0 | 15100 | 0.133 | 0.726 | |
| 12/12/2006 | 1:30:00 PM | 7.68 | 7.0 | 11.46 | 66 | 185 | 47.2 | 7780 | 0.164 | 0.451 | |
| 1/22/2007 | 2:10:00 PM | 5.31 | 7.1 | 11.23 | 85 | 30 | 7.6 | 3100 | 0.036 | 0.777 | |
| 2/21/2007 | 12:30:00 PM | 6.69 | 6.9 | 9.75 | 59 | 60 | 62.4 | 13000 | 0.142 | 0.698 | Brown, high and fast |
| 3/21/2007 | 12:00:00 PM | 8.63 | 7.2 | 12.47 | 78 | 30 | 22.0 | 3860 | 0.047 | 0.522 | |
| 4/24/2007 | 12:00:00 PM | 11.23 | 7.1 | 11.17 | 84 | 15 | 2.9 | 1770 | 0.033 | 0.332 | |
| 5/15/2007 | 1:45:00 PM | 15.53 | 7.7 | 13.39 | 111 | 0 | 2.4 | 845 | 0.030 | 0.393 | F.C. result was <5. |
| 6/11/2007 | 12:00:00 PM | 15.96 | 7.7 | 11.57 | 99 | 20 | 1.2 | 924 | 0.028 | 0.391 | |
| 7/17/2007 | 9:30:00 AM | 20.12 | 7.3 | 8.18 | 119 | 5 | 0.5 | 191 | 0.063 | 0.755 | |
| 8/20/2007 | 1:45:00 PM | 18.29 | 7.8 | 11.33 | 120 | 40 | 0.1 | 221 | 0.059 | 0.806 | |
| 9/18/2007 | 11:15:00 AM | 15.16 | 7.7 | 11.40 | 117 | 15 | 1.0 | 228 | 0.062 | 0.792 | |

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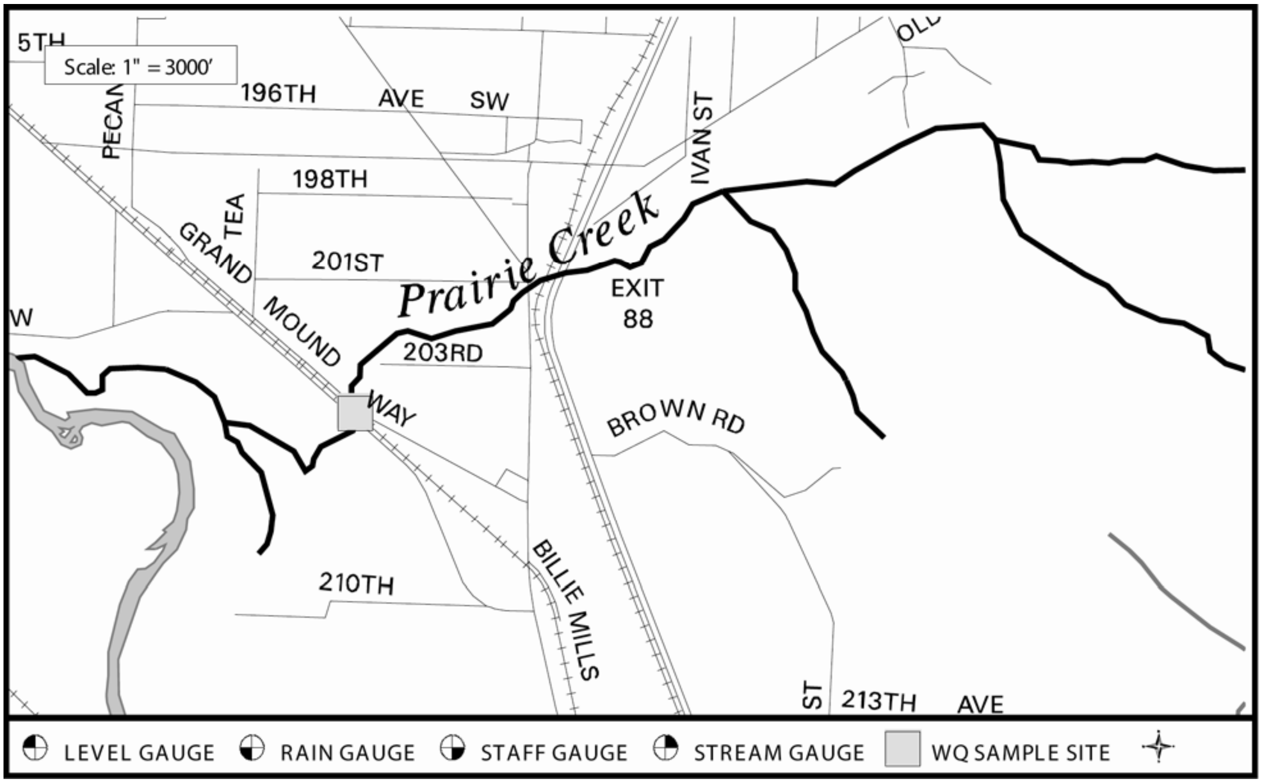
# Prairie Creek #0729




**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. Exceeded Part II of the Fecal Coliform standard in 2005/06. One turbidity reading slightly exceeded 5 NTU over background in February 2007. Nitrate values are often elevated in this creek.

**OTHER DATA:**
Thurston County Environmental Health Division, (360) 754-4111, www.co.thurston.wa.us/health/ehswat/swater.htm

## Prairie Creek #0729

### 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 2003-2005 than in past years. The lower nitrate levels were most likely the result of less groundwater pollution due to drought conditions. In 2005/06 the mean nitrate level increased. However, in 2006/07 the mean was down to the 2003/04 level. Water quality monitoring will continue.

## Funding Sources:

- Thurston County

# Water Quality Summary

Conventional Parameters

**Prairie Creek**

| **Parameter** | **Units** | **WQ Standard** WAC 173-201A | **Water Year Data: 2005/06 and 2006/07** | | | | **Cumulative Data: 1996-2005** | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 05/06<br>06/07 | | 4.43 – 11.54<br>4.28 – 11.48 | | | 2.24 – 13.2 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 9.93 – 11.9<br>9.32 – 13.6 | 0 of 6<br>0 of 6 | | 8.33 – 14.3 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 50<br>45 | 45 – 55<br>42 – 46 | | 49 | 38 – 78 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 6.8*<br>6.7* | 6.6 - 7.6<br>6.5 - 7.2 | 0 of 6<br>0 of 6 | 6.9* | 5.8 – 7.9 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 5.92<br>6.22 | 4.3 – 9.2<br>2.6 – 11.70 | 0 of 6<br>1 of 6 | 6.28 | 2.4 - 28 |
| Fecal Coliform | colonies / 100 ml | GMV: ≤100 and ≤ 10% not to exceed 200 | 05/06<br>06/07 | 19**<br>36** | 0 - 345<br>10 – 140 | **% exceeding 200**<br>17%<br>0% | 28** | 0 - 460 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.297<br>0.034 | 0.022 - 0.041<br>0.017 - 0.051 | | 0.043 | 0.001 - 0.161 |
| Nitrate + Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 1.068<br>0.649 | 0.005 - 1.76<br>0.005 – 1.09 | | 0.860 | 0.049 - 2.07 |

* Median
** Geometric mean value (GMV)

# Thurston County Water Resources Monitoring Report 2005- 2006

## Prairie Creek @ Old Hwy 9

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/8/2005 | 10:45:00 AM | 6.77 | 6.7 | 9.93 | 55 | 45 | 5.8 | 12.11 | 0.041 | 0.901 | |
| 12/7/2005 | 10:30:00 AM | 4.43 | 6.8 | 11.72 | 45 | 10 | 4.3 | 6.26 | 0.027 | 0.902 | |
| 1/4/2006 | 11:30:00 AM | 5.72 | 6.6 | 11.29 | 50 | 20 | 5.7 | 21.00 | 0.027 | 1.760 | |
| 2/7/2006 | 11:15:00 AM | 4.59 | 6.7 | 11.89 | 50 | 10 | 5.8 | 18.80 | 0.022 | 1.710 | |
| 3/13/2006 | 2:15:00 PM | 6.11 | 7.0 | 10.65 | 49 | 0 | 9.2 | 10.10 | 0.030 | 1.130 | F.C. was <5. |
| 4/24/2006 | 1:30:00 PM | 11.54 | 7.6 | 11.80 | 53 | 345 | 4.7 | | 0.031 | 0.005 | NO2+NO3 was less than the detection limit of 0.010. No flow taken, too slow to measure in pooled area & too shallow to measure in riffle. |

# Thurston County Water Resources Monitoring Report 2006- 2007

## Prairie Creek @ Old Hwy 9

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/13/2006 | 1:30:00 PM | 8.05 | 6.5 | 9.37 | 46 | 85 | 8.1 | 48.71 | 0.051 | 0.983 | |
| 12/12/2006 | 11:45:00 AM | 6.47 | 6.5 | 11.10 | 45 | 140 | 6.4 | 14.10 | 0.032 | 0.494 | |
| 1/22/2007 | 12:30:00 PM | 4.28 | 6.6 | 11.16 | 46 | 10 | 4.6 | 9.05 | 0.017 | 1.090 | |
| 2/21/2007 | 1:10:00 PM | 6.58 | 6.8 | 9.32 | 42 | 10 | 11.7 | 48.64 | 0.039 | 1.020 | |
| 3/21/2007 | 10:40:00 AM | 6.99 | 7.1 | 13.64 | 43 | 30 | 3.9 | 6.24 | 0.035 | 0.304 | |
| 4/24/2007 | 11:15:00 AM | 11.48 | 7.2 | 11.79 | 45 | 45 | 2.6 | 1.83 | 0.028 | 0.005 | Nox result is <0.010 |

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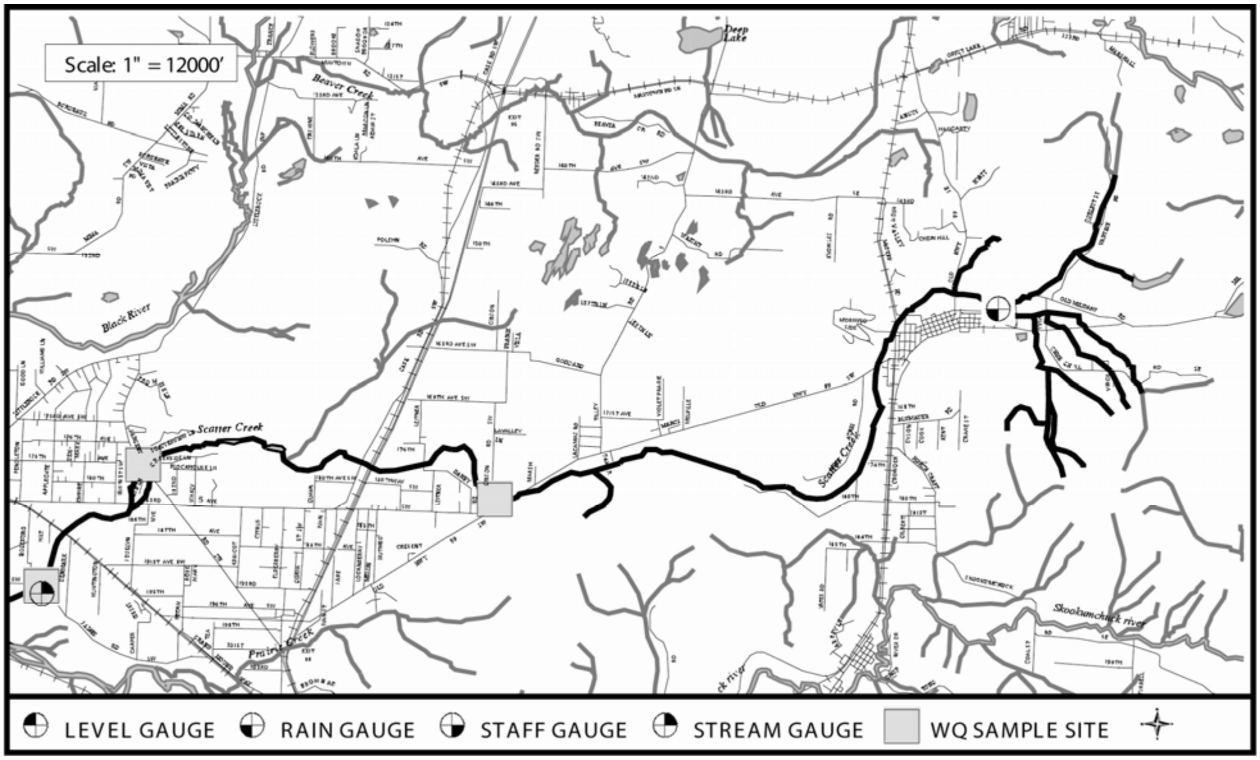
# Scatter Creek #0716




**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)

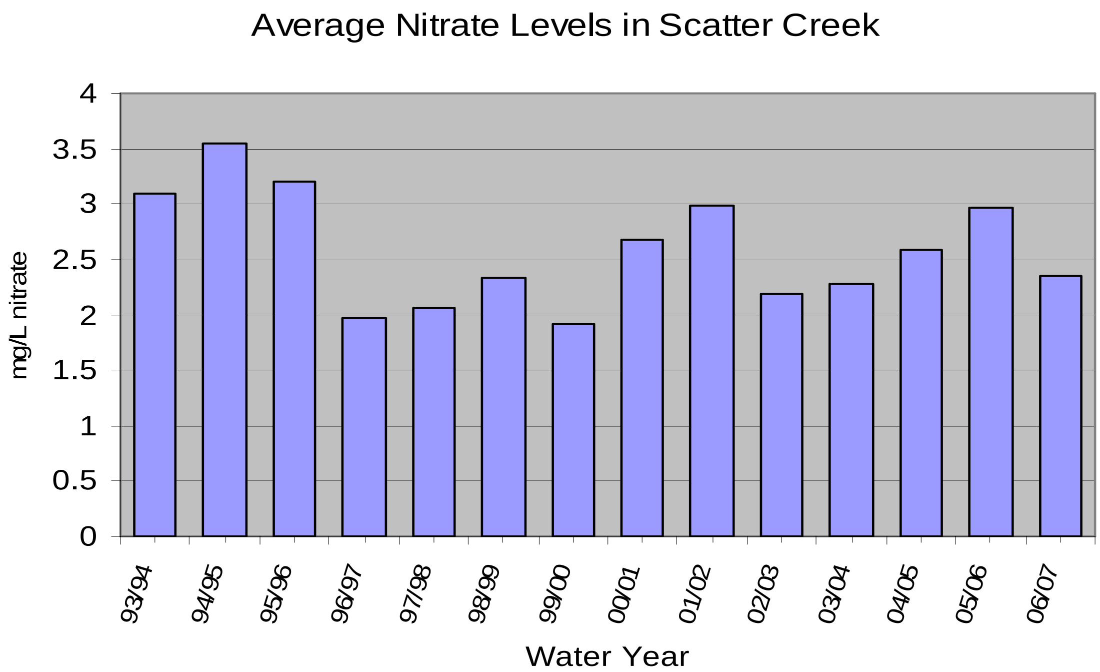
Good – Met all water quality standards except turbidity exceeded the criteria one time in 2006. The creek has elevated nitrates in the lower reaches.

**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) 754-4111 (Surface and groundwater quality data).
www.co.thurston.wa.us/health/ehswat/swater.htm

Thurston County Department of Water and Waste Management, Storm Water Utility
(360) 357-2491 or
www.co.thurston.wa.us/monitoring




The Health Department began monitoring Scatter Creek in September 1993. The station farthest downstream is at James Road near Scatter Creek's confluence with the Chehalis River. The upper-most site is at the Gibson Road crossing on Violet Prairie. Monitoring at the Gibson Road site was discontinued after December 2004.

The raw data from the James Road station for water year 2005/06 and 2006/07 is included at the end of this section. The above graph shows the average annual nitrate levels at the James Road site since sampling began in 1993. The high nitrate levels are a reflection of the groundwater quality in the area.

## 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

## Funding Sources:

- Thurston County

# Water Quality Summary
Conventional Parameters
**Scatter Creek at James Road**

| Parameter | Units | WQ Standard WAC 173-201A | Water Year Data: 2005/06 and 2006/07 | | | | Cumulative Data: 1993-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | Water Year | Mean | Range | # samples violating standard | Mean | Range |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 05-06<br>06-07 | | 5.57 – 18.94<br>6.8 – 18.94 | 0 of 12<br>0 of 12 | | 4.21 - 17.4 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05-06<br>06-07 | | 10.6 – 12.5<br>10.2 – 13.6 | 0 of 12<br>0 of 12 | | 9.04 - 13.5 |
| Conductivity | µmhos/cm | | 05-06<br>06-07 | 159<br>146 | 86 - 203<br>85 - 209 | | 131 | 61 – 198 |
| pH | | 6.5 - 8.5 | 05-06<br>06-07 | 7.7*<br>7.6* | 7.0 – 8.2<br>6.9 – 8.2 | 0 of 12<br>0 of 12 | 7.6* | 6.6 - 8.3 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05-06<br>06-07 | 2.5<br>1.5 | 0.6 – 12.2<br>0 – 6 | 1 of 12<br>0 of 12 | 1.97 | 0 - 9.0 |
| Fecal Coliform | colonies/ 100 ml | GMV: ≤100 and ≤ 10% not to exceed 200 | 05-06<br>06-07 | 32**<br>47** | 5 - 470<br>0 – 140 | **% exceeding 200**<br>8%<br>0% | 30** | 0 – 350 |
| Total Phosphorus | mg/L | | 05-06<br>06-07 | 0.061<br>0.056 | 0.024 - 0.106<br>0.031 - 0.096 | | 0.086 | 0.023 - 0.590 |
| Nitrate + Nitrite-nitrogen | mg/L | | 05-06<br>06-07 | 2.97<br>2.36 | 1.49 – 3.61<br>1.11– 3.77 | | 2.57 | 0.726 - 7.57 |

* Median
** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/11/2005 | 11:40:00 AM | 10.92 | 7.8 | 11.64 | 195 | 20 | 0.6 | 9.22 | 0.102 | 3.610 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/8/2005 | 11:15:00 AM | 7.07 | 7.7 | 12.45 | 148 | 25 | 1.5 | 8.67 | 0.106 | 2.690 | |
| 12/7/2005 | 11:15:00 AM | 5.57 | 7.7 | 12.38 | 169 | 5 | 2.0 | 10.88 | 0.105 | 3.600 | |
| 1/4/2006 | 12:00:00 PM | 6.27 | 7.0 | 11.81 | 86 | 20 | 2.3 | | 0.039 | 1.490 | Too high to do flow. |
| 2/7/2006 | 11:45:00 AM | 6.27 | 7.0 | 12.21 | 102 | 10 | 12.2 | | 0.024 | 2.890 | Too high to do flow. |
| 3/13/2006 | 1:45:00 PM | 7.68 | 7.6 | 11.66 | 110 | 15 | 2.9 | 104.30 | 0.035 | 2.610 | |
| 4/26/2006 | 1:45:00 PM | 12.69 | 8.2 | 12.43 | 142 | 20 | 1.7 | 30.70 | 0.063 | 2.730 | |
| 5/16/2006 | 2:45:00 PM | 18.94 | 8.1 | 10.95 | 176 | 10 | 1.5 | 20.24 | 0.050 | 2.840 | |
| 6/14/2006 | 10:40:00 AM | 14.37 | 7.6 | 11.23 | 189 | 75 | 1.5 | 16.04 | 0.033 | 3.080 | |
| 7/11/2006 | 10:10:00 AM | 14.11 | 7.8 | | 196 | 100 | 1.0 | 16.90 | 0.041 | 3.300 | no DO measurement |
| 8/9/2006 | 10:35:00 AM | 15.68 | 7.6 | 11.44 | 195 | 125 | 1.2 | 17.49 | 0.050 | 3.360 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/11/2006 | 11:20:00 AM | 12.43 | 7.6 | 10.55 | 203 | 470 | 1.2 | 18.67 | 0.086 | 3.430 | |

Scatter Creek @ James Rd

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 10:45:00 AM | 11.07 | 7.3 | 10.60 | 209 | 80 | 0.5 | 15.23 | 0.082 | 3.590 | Staff gage = 0.28 |
| 11/13/2006 | 2:00:00 PM | 8.10 | 6.9 | 10.56 | 85 | 125 | 3.6 | 80.80 | 0.080 | 1.110 | |
| 12/12/2006 | 12:30:00 PM | 8.05 | 7.4 | 11.57 | 113 | 20 | 0.9 | 57.10 | 0.053 | 1.580 | |
| 1/22/2007 | 1:40:00 PM | 6.80 | 7.3 | 11.48 | 113 | 100 | 0.8 | 134.39 | 0.031 | 2.460 | |
| 2/21/2007 | 1:00:00 PM | 7.27 | 7.2 | 10.53 | 92 | 105 | 6.0 | | 0.072 | 1.470 | Too deep to wade. |
| 3/21/2007 | 11:30:00 AM | 7.77 | 7.4 | 13.14 | 113 | 20 | 0.0 | | 0.047 | 2.080 | Too fast and deep to wade |
| 4/26/2007 | 12:15:00 PM | 11.27 | 7.9 | 12.31 | 126 | 0 | 1.2 | 49.09 | 0.033 | 2.080 | F.C. result was <5. |
| 5/15/2007 | 1:15:00 PM | 15.45 | 8.2 | 13.55 | 129 | 23 | 1.3 | 28.36 | 0.033 | 1.760 | |
| 6/11/2007 | 11:40:00 AM | 13.61 | 7.9 | 10.20 | 171 | 85 | 1.3 | 13.48 | 0.045 | 2.130 | |
| 7/16/2007 | 2:20:00 PM | 17.80 | 7.9 | 10.42 | 189 | 100 | 0.8 | 15.63 | 0.037 | 2.830 | |
| 8/20/2007 | 1:15:00 PM | 14.58 | 7.7 | 10.16 | 201 | 75 | 0.6 | 16.30 | 0.057 | 3.400 | |
| 9/18/2007 | 10:50:00 AM | 11.75 | 7.7 | 10.97 | 208 | 140 | 1.4 | 18.21 | 0.096 | 3.770 | |

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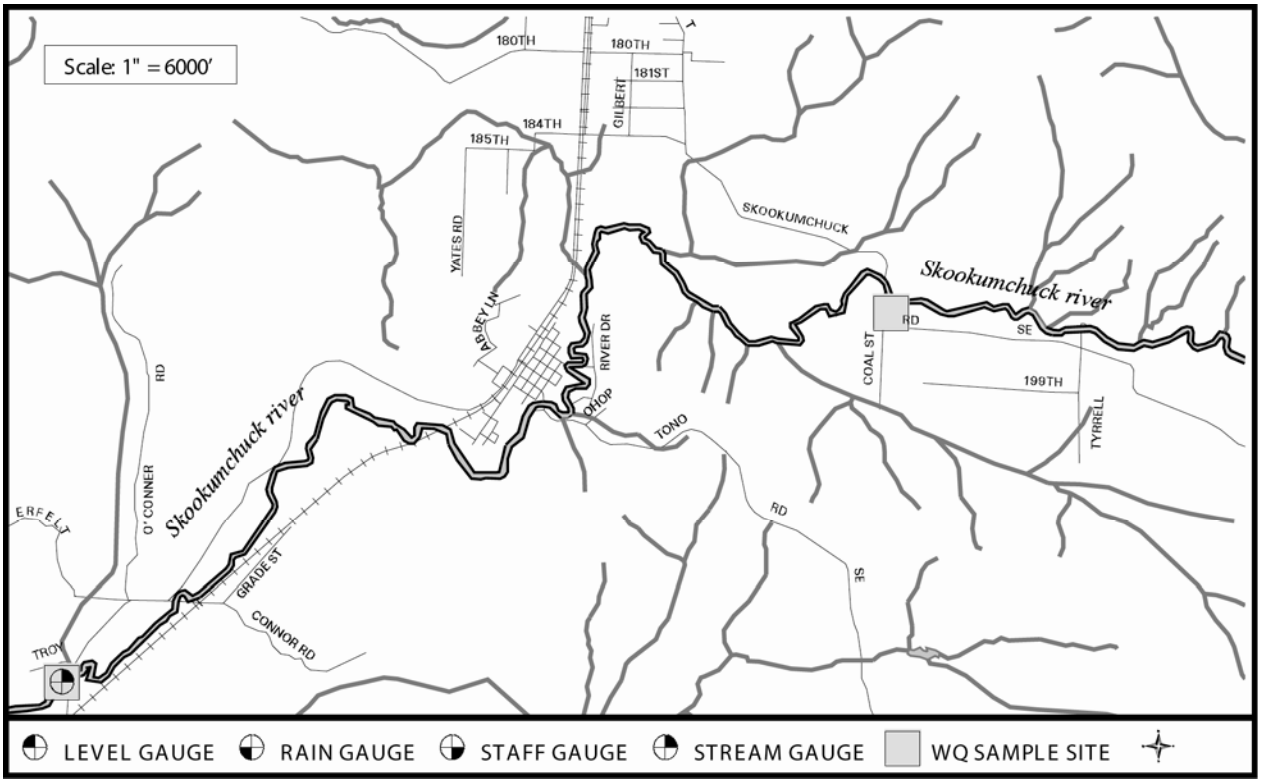
# Skookumchuck River #0761




**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 <u>A Catalog of Washington Streams and Salmon Utilization</u>, WDOF)**

Chinook, Coho, Chum, Steelhead

**GENERAL TOPOGRAPHY:**

Moderately to steep sloped forested headwaters; 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**.** Met all water quality standards except turbidity for water year 2005/06 and 2006/07 Turbidity standard was violated once in 2005/06 and four of twelve times in 2006/07.

**OTHER DATA:**

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

Thurston County Environmental Health Division, (360) 754-4111.
www.co.thurston.wa.us/health/ehswat/swater.htm

The Thurston County Health Department monitored the river during the period from 1982-1985 in response to concerns about high bacteria levels found 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 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 further reduced to one location at the Highway 507 bridge. This site is now sampled monthly. Flows reported are from the USGS gage located just downstream of the sampling site. The river met the water quality standards during water year 2005/06 with the exception of one turbidity violation in February 2006. In 2006/07, all water quality standards were met except for four turbidity violations all occurring during the wet season.

Monitoring will continue as funding is available.

## Major Issues:

- Non-point source pollution
- Habitat loss from erosion and sedimentation
- Native riparian vegetation is lacking is some areas

## Funding Sources:

- Thurston County

# Water Quality Summary

Conventional Parameters

**Skookumchuck River at USGS gauge**

| **Parameter** | **Units** | **WQ Standard** WAC 173-201A | **Water Year Data: 2005/06** and **2006/07** | | | | **Cumulative Data:** 1993-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 05/06<br>06/07 | | 5.93 – 17.1<br>5.54 – 17.22 | 0 of 12<br>0 of 12 | | 3.97- 17.03 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 10.0 – 12.1<br>9.71 – 13.6 | 0 of 12<br>0 of 12 | | 9.14 – 14.4 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 64<br>60 | 52 - 75<br>59 – 73 | | 59 | 42 – 77 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.4*<br>7.4* | 7.0 – 7.9<br>6.6 – 7.9 | 0 of 12<br>0 of 12 | 7.3* | 6.4 – 8.1 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 5.45<br>15.5 | 2.2 - 15<br>1.6 - 99 | 1 of 12<br>4 of 12 | 8.0 | 1.1 - 62 |
| Fecal Coliform | colonies / 100 ml | GMV: ≤ 100 and ≤ 10% not to exceed 200 | 05/06<br>06/07 | 22**<br>32** | 5 - 235<br>5 - 290 | **% exceeding 200**<br>8%<br>8% | 28** | 0 - 800 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.029<br>0.043 | 0.015 – 0.053<br>0.012 – 0.183 | | 0.04 | 0.01 - 0.220 |
| Nitrate + Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.520<br>0.410 | 0.175 – 0.893<br>0.186 – 0.864 | | 0.518 | 0.078 - 1.25 |

* Median
** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/11/2005 | 11:00:00 AM | 12.53 | 7.5 | 10.40 | 75 | 35 | 2.8 | 116 | 0.023 | 0.175 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/8/2005 | 10:15:00 AM | 8.06 | 7.3 | 11.26 | 66 | 35 | 7.4 | 321 | 0.047 | 0.836 | |
| 12/7/2005 | 10:00:00 AM | 5.93 | 7.3 | 11.87 | 68 | 15 | 3.3 | 279 | 0.029 | 0.744 | |
| 1/4/2006 | 10:45:00 AM | 6.64 | 7.0 | 12.13 | 58 | 15 | 11.4 | 1020 | 0.042 | 0.893 | |
| 2/7/2006 | 10:20:00 AM | 6.34 | 7.2 | 11.95 | 52 | 5 | 15.0 | 918 | 0.053 | 0.799 | |
| 3/13/2006 | 2:45:00 PM | 6.10 | 7.2 | 10.35 | 60 | 10 | 9.9 | 391 | 0.035 | 0.854 | |
| 4/26/2006 | 12:30:00 PM | 9.80 | 7.4 | 11.81 | 61 | 5 | 2.2 | 237 | 0.015 | 0.366 | |
| 5/16/2006 | 3:20:00 PM | 17.10 | 7.8 | 10.86 | 64 | 5 | 2.4 | 151 | 0.017 | 0.334 | |
| 6/14/2006 | 9:40:00 AM | 14.24 | 7.3 | 10.65 | 68 | 15 | 3.0 | 144 | 0.023 | 0.328 | |
| 7/11/2006 | 10:45:00 AM | 13.68 | 7.9 | | 65 | 65 | 2.5 | 100 | 0.018 | 0.371 | no DO measurement |
| 8/9/2006 | 9:40:00 AM | 16.29 | 7.4 | 10.04 | 66 | 55 | 2.5 | 75 | 0.018 | 0.288 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/11/2006 | 10:30:00 AM | 13.08 | 7.5 | 10.61 | 66 | 235 | 3.0 | 120 | 0.027 | 0.246 | |

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 10:00:00 AM | 11.85 | 6.6 | 10.62 | 69 | 15 | 2.6 | 97 | 0.024 | 0.260 | |
| 11/13/2006 | 1:00:00 PM | 9.76 | 6.8 | 10.83 | 47 | 110 | 99.0 | 2420 | 0.183 | 0.669 | river is flooded, very muddy |
| 12/12/2006 | 11:15:00 AM | 7.02 | 7.1 | 11.65 | 52 | 290 | 27.3 | 755 | 0.075 | 0.593 | |
| 1/22/2007 | 12:00:00 PM | 5.54 | 7.4 | 11.11 | 56 | 10 | 12.5 | 513 | 0.036 | 0.623 | |
| 2/21/2007 | 2:20:00 PM | 6.31 | 7.0 | 9.71 | 53 | 45 | 23.8 | 930 | 0.069 | 0.864 | |
| 3/21/2007 | 10:15:00 AM | 5.94 | 7.3 | 13.62 | 52 | 30 | 8.0 | 610 | 0.037 | 0.461 | |
| 4/24/2007 | 10:20:00 AM | 11.77 | 7.5 | 11.04 | 62 | 5 | 1.8 | 175 | 0.015 | 0.251 | |
| 5/15/2007 | 12:00:00 PM | 14.04 | 7.7 | 11.69 | 65 | 10 | 2.1 | 132 | 0.012 | 0.186 | |
| 6/11/2007 | 11:00:00 AM | 15.50 | 7.4 | 10.66 | 65 | 10 | 1.9 | 143 | 0.013 | 0.282 | |
| 7/16/2007 | 1:30:00 PM | 17.22 | 7.6 | 10.76 | 66 | 40 | 1.8 | 36 | 0.020 | 0.270 | |
| 8/20/2007 | 12:30:00 PM | 14.63 | 7.5 | 10.35 | 67 | 70 | 1.6 | 43 | 0.014 | 0.250 | |
| 9/18/2007 | 10:50:00 AM | 12.29 | 7.9 | 10.47 | 67 | 80 | 3.4 | 108 | 0.017 | 0.208 | 6+ horses next to river/in river ~100 yds from bridge. |

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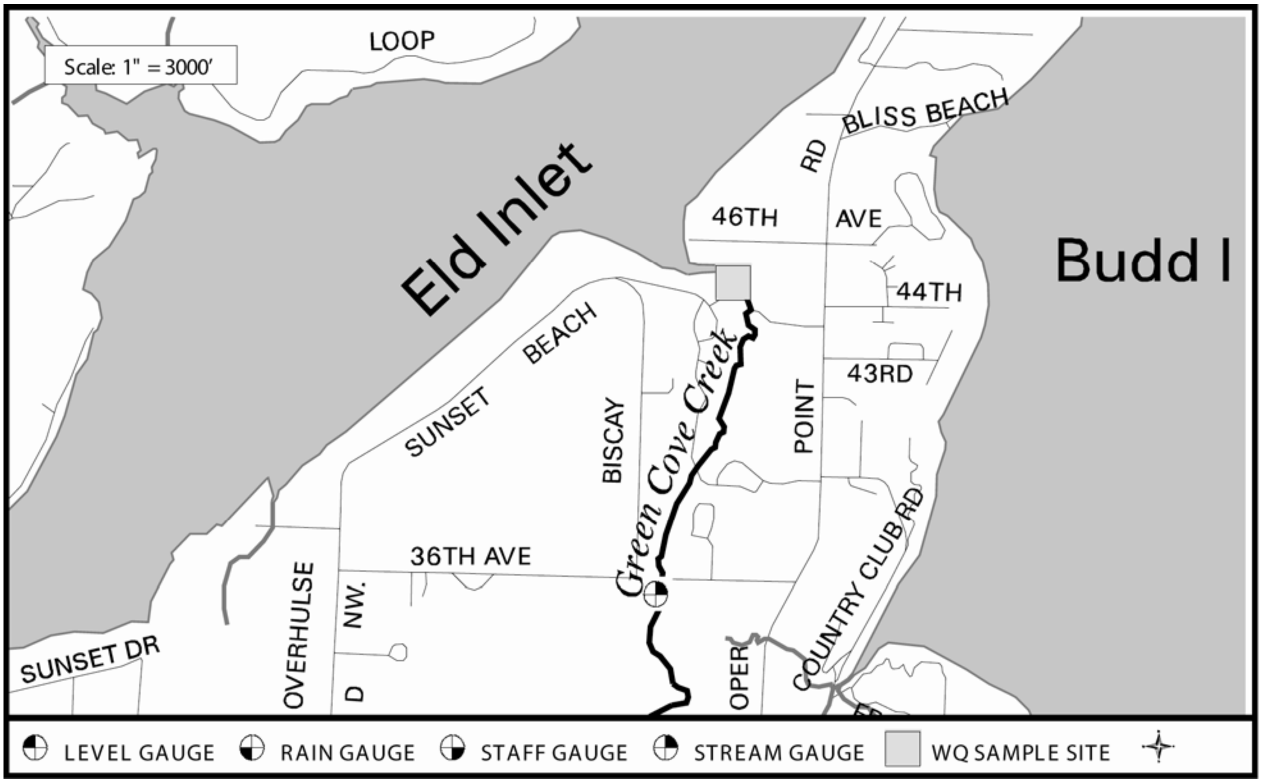
# Eld Inlet Watershed

**WRIA 13**

**Chapter Includes:**

**Green Cove Creek**
**McLane Creek**
**Perry Creek**

# Green Cove Creek #0133




**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)

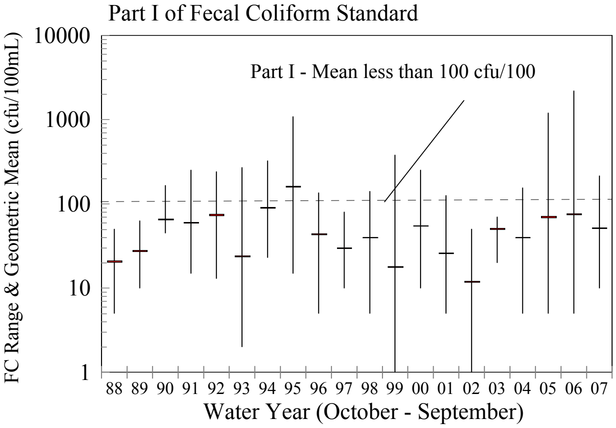
Good - Part II of the fecal coliform standard was violated in 2005/06 water year. All other standards were met.

**OTHER DATA:**

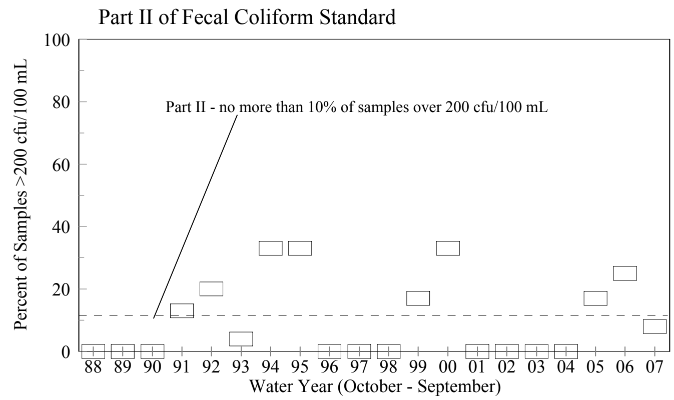
Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/heatlh/ehswat/swater.htm

Thurston County Water and Waste Management Department, (360) 357-2491 or www.co.thurston.wa.us/monitoring

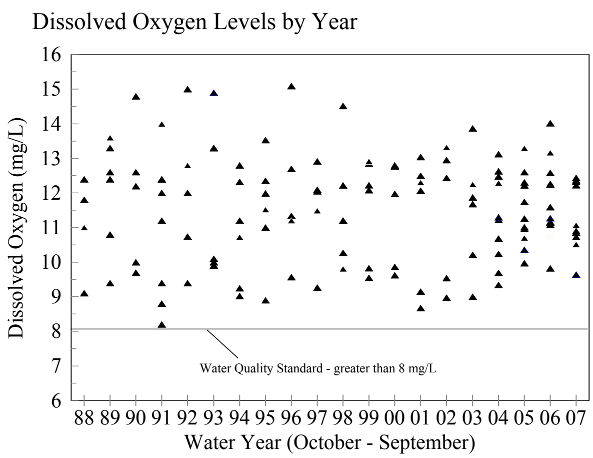
# Green Cove Creek




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

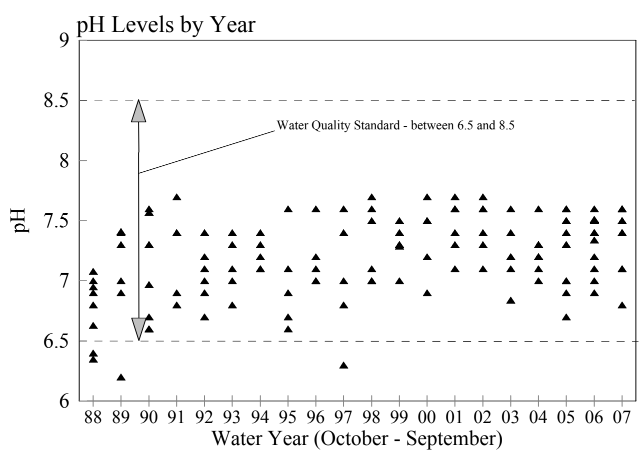



Green Cove Creek usually meets Part I of the bacteria standard, but occasionally fails Part II. In water year 2005/06 the creek met only Part I and failed Part II with 25% of the samples greater than 200 colonies per 100 ml. In 2006/07 it met both parts.




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 since 1988.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. The pH measurements have been within the acceptable range since 1998. Only four measurements in the entire data record were outside the pH standard range.



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.

## Major Issues:

- Urban development
- Stormwater runoff

## Funding Sources:

- Local Storm and Surface Water Utility

# Water Quality Summary
## Conventional Parameters
## Green Cove Creek

| Parameter | Units | WQ Standard WAC 173-201A | Water Year Data: 2005/06 & 2006/07 | | | | Cumulative Data: 1988-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | Water Year | Mean | Range | # samples violating standard | Mean | Range |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 05/06<br>06/07 | | 4.42 – 14.09<br>5.13 – 15.62 | 0 of 12<br>0 of 12 | | 0.40 – 17.40 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 9.82 – 14.0<br>9.64 – 12.4 | 0 of 12<br>0 of 12 | | 8.2 – 15.1 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 104<br>103 | 49 - 163<br>52 - 162 | | 94 | 25 – 239 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.4*<br>7.4* | 6.9 – 7.6<br>6.8 - 7.6 | 0 of 12<br>0 of 12 | 7.2* | 6.2 - 7.7 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 5.3<br>2.1 | 0.5 - 43<br>0 – 9.5 | 1 of 12<br>1 of 12 | 3.4 | 0.5 - 60.0 |
| Fecal Coliform | colonies/ 100 mL | GMV: ≤100 and ≤ 10% not to exceed 200 | 05/06<br>06/07 | 76**<br>52** | 5 - 2181<br>10 - 215 | **% exceeding 200**<br>25%<br>8% | 39** | 0 - 1200 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.039<br>0.039 | 0.021 – 0.063<br>0.018 - 0.067 | | 0.040 | 0.011 - 0.170 |
| Nitrate + Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.819<br>0.700 | 0.321 – 1.56<br>0.182 – 1.45 | | 0.562 | 0.169 - 1.38 |

* Median
** Geometric mean value (GMV)

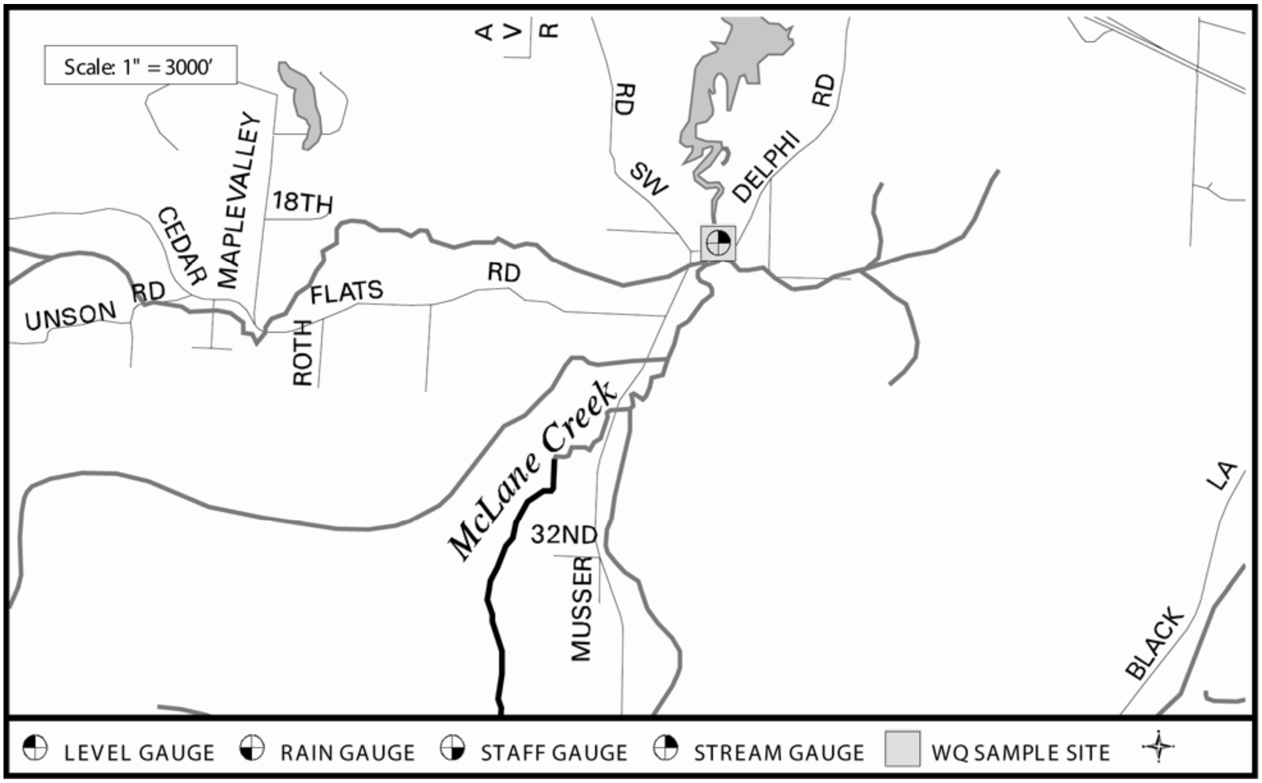
| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2005 | 11:30:00 AM | 11.23 | 7.5 | 11.15 | 140 | 98 | 1.3 | 0.43 | 0.063 | 0.914 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/7/2005 | 12:40:00 PM | 7.64 | 7.1 | 11.59 | 67 | 65 | 3.0 | 8.16 | 0.042 | 0.324 | |
| 12/5/2005 | 11:15:00 AM | 4.42 | 7.2 | 14.02 | 73 | 2181 | 1.3 | 3.12 | 0.034 | 0.321 | |
| 1/3/2006 | 12:15:00 PM | 6.23 | 6.9 | 13.16 | 49 | 80 | 43.0 | 21.10 | 0.031 | 0.572 | |
| 2/6/2006 | 11:20:00 AM | 5.38 | 7.0 | 12.58 | 49 | 15 | 5.0 | 22.10 | 0.021 | 0.400 | |
| 3/14/2006 | 3:30:00 PM | 6.90 | 7.4 | 9.82 | 71 | 5 | 2.7 | 4.93 | 0.024 | 0.470 | |
| 4/24/2006 | 11:30:00 AM | 9.84 | 7.4 | 12.25 | 96 | 10 | 2.7 | 2.26 | 0.024 | 0.549 | Lots of algae growth; brown and small amount of green attached. |
| 5/15/2006 | 1:15:00 PM | 12.54 | 7.6 | 11.08 | 120 | 315 | 0.9 | 1.24 | 0.036 | 0.925 | |
| 6/13/2006 | 12:20:00 PM | 13.67 | 7.4 | 11.16 | 115 | 295 | 1.4 | 1.01 | 0.042 | 0.749 | |
| 7/10/2006 | 12:45:00 PM | 14.09 | 7.5 | 11.27 | 150 | 45 | 0.8 | 0.37 | 0.050 | 1.490 | |
| 8/8/2006 | 12:30:00 PM | 13.94 | 7.5 | 12.29 | 160 | 80 | 0.5 | 0.28 | 0.049 | 1.550 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/12/2006 | 12:00:00 PM | 12.83 | 7.3 | 10.74 | 163 | 80 | 0.6 | 0.27 | 0.051 | 1.560 | |

## Thurston County Water Resources Monitoring Report 2006 - 2007

*Green Cove Creek @ Mouth*

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 10:30:00 AM | 10.23 | 7.4 | 10.85 | 162 | 10 | 0.8 | 0.23 | 0.046 | 1.450 | |
| 11/14/2006 | 11:30:00 AM | 7.03 | 6.8 | 12.37 | 58 | 45 | 2.7 | 13.97 | 0.031 | 0.216 | |
| 12/11/2006 | 11:20:00 AM | 6.75 | 7.1 | 12.44 | 57 | 80 | 4.8 | 12.50 | 0.026 | 0.182 | |
| 1/24/2007 | 1:00:00 PM | 5.13 | 7.4 | 11.07 | 71 | 15 | 1.1 | 4.77 | 0.018 | 0.447 | |
| 2/20/2007 | 12:30:00 PM | 6.86 | 7.1 | 10.73 | 52 | 155 | 9.5 | 25.20 | 0.043 | 0.339 | |
| 3/20/2007 | 12:30:00 PM | 8.48 | 7.4 | | 70 | 10 | 0.0 | 6.47 | 0.028 | 0.279 | DO not working |
| 4/26/2007 | 4:00:00 PM | 11.18 | 7.6 | 12.23 | 94 | 10 | 0.6 | 3.14 | 0.031 | 0.464 | |
| 5/17/2007 | 11:40:00 AM | 10.62 | 7.6 | 12.32 | 114 | 150 | 0.8 | 1.26 | 0.036 | 0.783 | |
| 6/12/2007 | 5:00:00 PM | 12.84 | 7.6 | 10.90 | 130 | 95 | 0.8 | 0.66 | 0.042 | 0.992 | |
| 7/23/2007 | 1:45:00 PM | 15.62 | 7.5 | 9.64 | 130 | 215 | 0.7 | 0.72 | 0.053 | 0.742 | |
| 8/21/2007 | 12:15:00 PM | 14.33 | 7.5 | 10.52 | 155 | 130 | 0.4 | 0.24 | 0.050 | 1.280 | |
| 9/17/2007 | 11:45:00 AM | 13.35 | 7.5 | 11.27 | 143 | 75 | 3.4 | 0.58 | 0.067 | 1.220 | |

# McLane Creek #0138




**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.

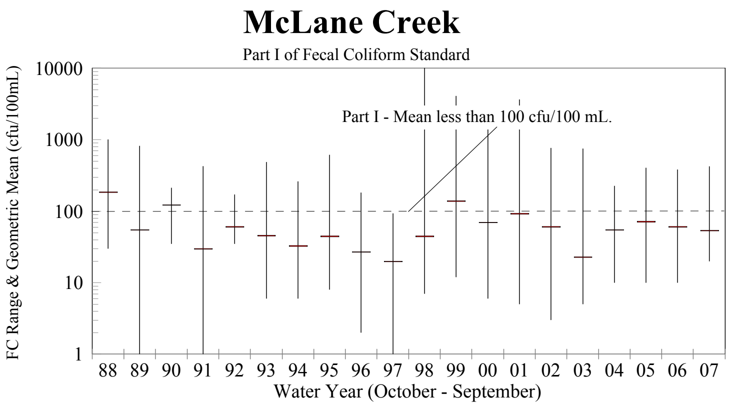
**GENERAL WATER QUALITY**:(Excellent, Good, Fair, Poor)

Good – The creek often fails Part II of the fecal coliform standard.

**OTHER DATA:**

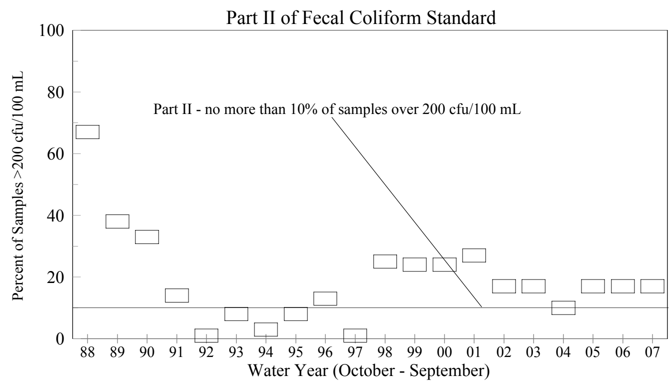
Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

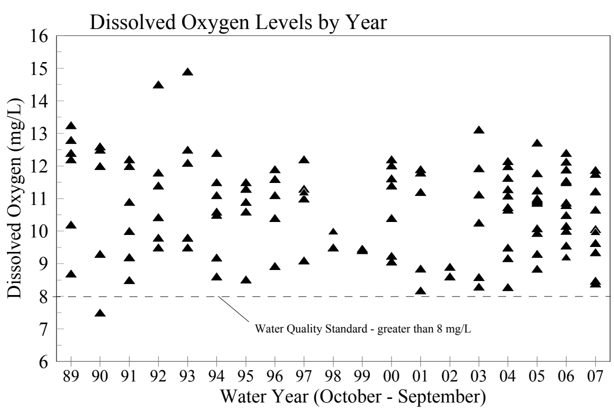
Thurston County Department of Water and Waste Management, (360) 357-2491 (flow data) or www.co.thurston.wa.us/monitoring




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

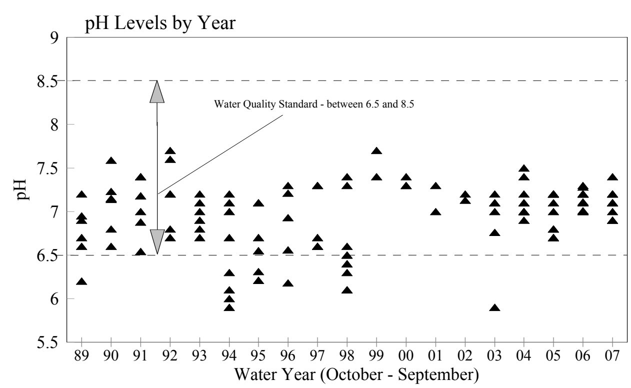
The creek met part I of the standard in both water years 2005/06 & 2006/07. However, it failed part II with 17% of the samples greater than 200 colonies per 100 mL for both water years. The creek has frequently failed part II of the bacteria standard in recent water years.




The water quality standard for dissolved oxygen is a lowest one-day minimum of 8.0 mg/L. No violations of the standard have been recorded since 1990.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. No pH violations were recorded in water years 2005/06 or 2006/07. However, there have been numerous measurements outside the pH standard, especially between 1994 and 1998.



McLane Creek has been monitored by Thurston County since 1983 when the first comprehensive water quality study work was done. This creek supports a significant fisheries resource. 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. Part II of the standard continues to be violated. 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.

## Major Issues:

- Agricultural nonpoint sources.
- Logging practices.

## 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: 2005/06 & 2006/07** | | | | **Cumulative Data:** 1988-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 05/06<br>06/07 | | 5.8 – 15.05<br>5.72 – 15.36 | 0 of 12<br>0 of 12 | | 2.3 – 18.17 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 9.21 – 12.4<br>8.39 – 11.9 | 0 of 12<br>0 of 12 | | 7.5 - 14.9 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 69<br>68 | 48 - 91<br>44 - 92 | | 67 | 27 – 403 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.2*<br>7.1* | 7.0 – 7.3<br>6.9 - 7.4 | 0 of 10<br>0 of 12 | 7.0* | 5.9 - 7.7 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 4.6<br>5.3 | 1.7 – 14.2<br>0 - 18 | 1 of 11<br>2 of 12 | 5.6 | 0.5 – 135 |
| Fecal Coliform | colonies/ 100 mL | GMV: ≤100 and ≤ 10% not to exceed 200 | 05/06<br>06/07 | 61**<br>54** | 10 - 380<br>20 – 420 | **% exceeding 200**<br>17%<br>17% | 57** | 0 – 17000 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.028<br>0.034 | 0.012 - 0.066<br>0.018 - 0.096 | | 0.030 | <0.002 - 0.140 |
| Nitrate+Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.363<br>0.261 | 0.14 - 0.931<br>0.116 - 0.451 | | 0.355 | 0.104 – 0.830 |

* Median

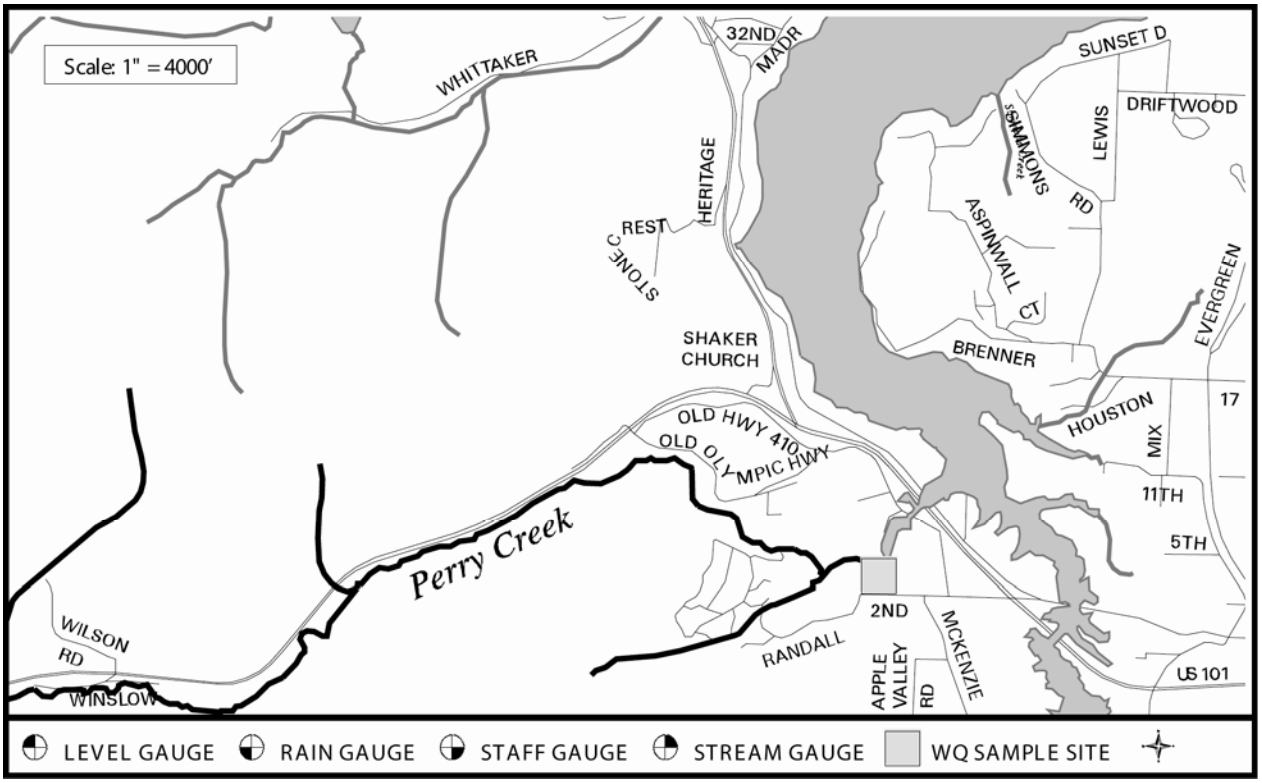
** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2005 | 11:00:00 AM | 11.04 | 7.2 | 10.01 | 91 | 95 | | 3.36 | 0.035 | 0.140 | No turbidity measurement |
| 11/7/2005 | 12:30:00 PM | 8.90 | 7.2 | 10.49 | 57 | 20 | 3.8 | | 0.023 | 0.931 | Fish spawning, no flows taken. |
| 12/5/2005 | 11:00:00 AM | 5.80 | 7.0 | 11.89 | 65 | 60 | 2.6 | | 0.066 | 0.623 | |
| 1/3/2006 | 11:45:00 AM | 7.54 | 7.1 | 12.40 | 50 | 10 | 3.0 | 117.20 | 0.020 | 0.589 | |
| 2/6/2006 | 11:00:00 AM | 6.82 | 7.2 | 12.13 | 48 | 15 | 4.6 | | 0.015 | 0.425 | Too deep to do flow measurement. |
| 3/15/2006 | 10:30:00 AM | 6.46 | 7.0 | 9.56 | 56 | 40 | 3.3 | 48.30 | 0.012 | 0.440 | |
| 4/24/2006 | 11:00:00 AM | 9.33 | 7.1 | 11.55 | 65 | 35 | 1.9 | 22.10 | 0.016 | 0.267 | |
| 5/15/2006 | 12:45:00 PM | 12.79 | 7.3 | 10.80 | 71 | 30 | 1.8 | 9.41 | 0.020 | 0.224 | |
| 6/13/2006 | 11:40:00 AM | 13.67 | 7.2 | 11.50 | 74 | 135 | 1.7 | 7.85 | 0.013 | 0.184 | |
| 7/10/2006 | 12:15:00 PM | 15.05 | 7.2 | 10.16 | 85 | 260 | 3.1 | 3.39 | 0.035 | 0.205 | |
| 8/8/2006 | 12:00:00 PM | 14.52 | 7.3 | 10.88 | 78 | 380 | 10.3 | 2.42 | 0.032 | 0.177 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high. Monitoring done ~50' downstream from usual site due to dam made by kids, large amounts of attached brown algae on stream bottom. |
| 9/12/2006 | 11:20:00 AM | 12.46 | 7.0 | 9.21 | 89 | 190 | 14.2 | 1.84 | 0.049 | 0.146 | |

McLane Creek @ Delphi Bridge

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 10:00:00 AM | 10.55 | 7.0 | 9.35 | 92 | 210 | 7.5 | 2.52 | 0.032 | 0.116 | |
| 11/14/2006 | 11:00:00 AM | 8.63 | 6.9 | 11.22 | 47 | 25 | 5.4 | | 0.026 | 0.430 | high flow, some fish |
| 12/11/2006 | 11:00:00 AM | 8.13 | 6.9 | 9.64 | 54 | 20 | 6.6 | | 0.096 | 0.383 | lots of fish |
| 1/24/2007 | 11:30:00 AM | 5.72 | 7.1 | 10.66 | 57 | 30 | 1.1 | 40.83 | 0.018 | 0.413 | |
| 2/20/2007 | 12:00:00 PM | 7.10 | 7.2 | 10.06 | 44 | 30 | 11.3 | | 0.033 | 0.451 | Too fast too deep to wade |
| 3/20/2007 | 12:00:00 PM | 8.32 | 7.2 | | 52 | 50 | 0.0 | 64.49 | 0.020 | 0.252 | DO not working |
| 4/26/2007 | 3:30:00 PM | 10.86 | 7.2 | 11.76 | 60 | 20 | 0.9 | 24.69 | 0.019 | 0.183 | |
| 5/17/2007 | 11:00:00 AM | 10.61 | 7.2 | 11.88 | 69 | 55 | 1.9 | 12.96 | 0.023 | 0.209 | |
| 6/12/2007 | 4:00:00 PM | 13.69 | 7.4 | 11.22 | 76 | 130 | 1.9 | 7.70 | 0.024 | 0.193 | |
| 7/18/2007 | 12:45:00 PM | 15.36 | 7.1 | 8.39 | 87 | 75 | 3.6 | 5.29 | 0.037 | 0.178 | |
| 8/21/2007 | 11:15:00 AM | 14.66 | 7.1 | 8.48 | 90 | 23 | 5.9 | 3.46 | 0.034 | 0.164 | |
| 9/17/2007 | 11:30:00 AM | 13.56 | 7.1 | 9.98 | 92 | 420 | 18.0 | 3.36 | 0.047 | 0.157 | |

# Perry Creek #0001




**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)

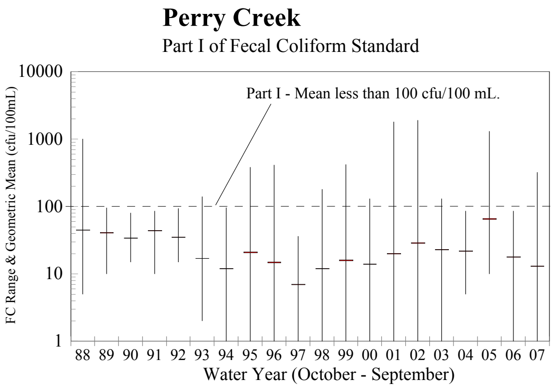
Good - Met all water quality standards except one turbidity violation in February 2007

**OTHER DATA:**

Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

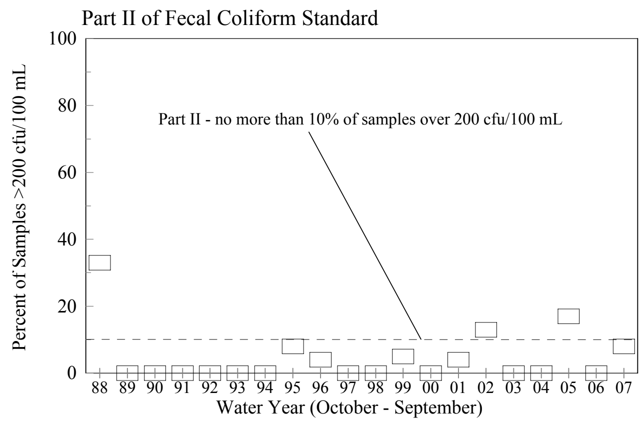
Washington Department of Ecology, Environmental Assessment Program, National Monitoring Program Project, (360) 407-6447

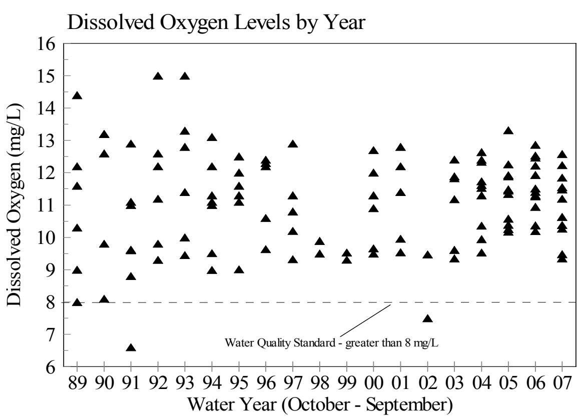
## Perry Creek #0001




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

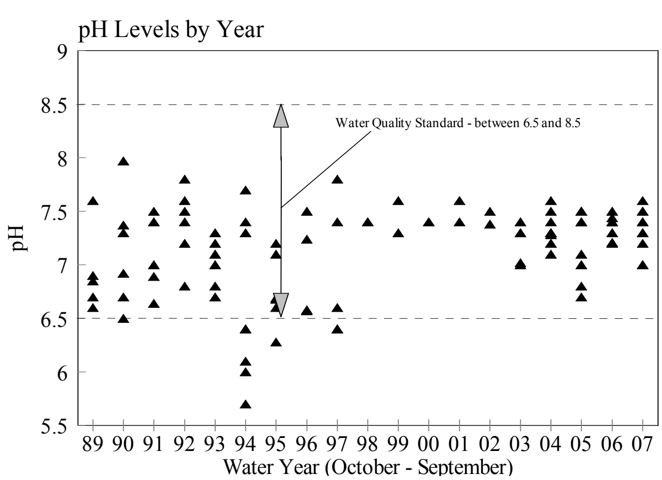
There have been no violations of part I. Part II of the standard was violated in 1988, 2002 and 2005.




The water quality standard for dissolved oxygen is a lowest one-day minimum of 8.0 mg/L. Throughout the period of record there have only been a few measurements below the minimum. There were no violations in 2005/06 or 2006/07.

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.



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. Thurston County intends to continue long-term ambient monitoring in the basin.

## Major Issues:

- Agricultural nonpoint pollution
- Segments of stream have on-site septic systems in close proximity

## Funding Sources:

- Local Storm and Surface Water Utility

# Water Quality Summary

Conventional Parameters

**Perry Creek**

| Parameter | Units | WQ Standard<br>WAC 173-201A | Water Year Data: 2005/06 & 2006/07 | | | | Cumulative Data: 1988-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 17.5 º C | 05/06<br>06/07 | | 5.83 – 13.9<br>5.38 – 14.56 | 0 of 12<br>0 of 12 | | 1.7 - 16.80 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 8.0 | 05/06<br>06/07 | | 10.2 – 12.9<br>9.35 – 12.6 | 0 of 12<br>0 of 12 | | 6.6 - 15.0 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 76<br>73 | 52 - 99<br>52 - 101 | | 71 | 34 - 243 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.4*<br>7.4* | 7.2 – 7.5<br>7 – 7.6 | 0 of 12<br>0 of 12 | 7.3* | 5.7 - 8.0 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 1.58<br>2.93 | 0.2 – 4.3<br>0.0 – 9.3 | 0 of 12<br>1 of 12 | 4.18 | 0 - 160 |
| Fecal Coliform | colonies/ 100 mL | GMV: ≤100 and ≤ 10% not to exceed 200 | 05/06<br>06/07 | 18**<br>13** | 0 - 85<br>0 - 320 | **% exceeding 200**<br>0%<br>8% | 18** | 0 - 1900 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.019<br>0.030 | 0.007 - 0.049<br>0.013 - 0.106 | | 0.025 | 0.001 - 0.193 |
| Nitrate+Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.406<br>0.345 | 0.231 - 0.732<br>0.167 - 0.489 | | 0.358 | 0.125 - 0.599 |

* Median

** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2005 | 10:45:00 AM | 10.68 | 7.4 | 10.94 | 95 | 45 | 0.6 | 1.41 | 0.026 | 0.321 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/7/2005 | 12:00:00 PM | 8.54 | 7.4 | 11.30 | 62 | 15 | 4.3 | | 0.024 | 0.732 | Water high, tons of fish spawning. Did not measure flow. |
| 12/5/2005 | 10:30:00 AM | 5.83 | 7.2 | 12.47 | 69 | 15 | 1.6 | | 0.049 | 0.490 | Did not measure flow, still hundreds of live salmon spawning, lots of dead ones. |
| 1/3/2006 | 11:15:00 AM | 7.46 | 7.3 | 12.86 | 56 | 10 | 3.9 | 75.90 | 0.017 | 0.437 | Lots of birds. |
| 2/6/2006 | 10:30:00 AM | 6.64 | 7.3 | 12.53 | 52 | 10 | 2.9 | 70.00 | 0.012 | 0.286 | |
| 3/15/2006 | 11:00:00 AM | 6.31 | 7.2 | 10.19 | 59 | 0 | 2.5 | 29.20 | 0.011 | 0.326 | F.C. result was <5. |
| 4/24/2006 | 10:30:00 AM | 8.50 | 7.4 | 12.22 | 66 | 85 | 1.0 | 12.47 | 0.007 | 0.231 | |
| 5/15/2006 | 12:00:00 PM | 11.19 | 7.5 | 11.41 | 78 | 5 | 0.7 | 3.93 | 0.010 | 0.324 | |
| 6/13/2006 | 11:00:00 AM | 13.15 | 7.5 | 11.51 | 83 | 60 | 0.5 | 2.59 | 0.010 | 0.292 | |
| 7/10/2006 | 11:45:00 AM | 13.75 | 7.4 | 11.27 | 93 | 58 | 0.2 | 1.33 | 0.018 | 0.507 | |
| 8/8/2006 | 11:30:00 AM | 13.90 | 7.4 | 11.93 | 99 | 15 | 0.3 | 0.82 | 0.019 | 0.426 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/12/2006 | 11:00:00 AM | 11.52 | 7.2 | 10.37 | 99 | 30 | 0.5 | 0.41 | 0.023 | 0.505 | |

## Thurston County Water Resources Monitoring Report 2006 - 2007

*Perry Creek off Perry Creek Rd*

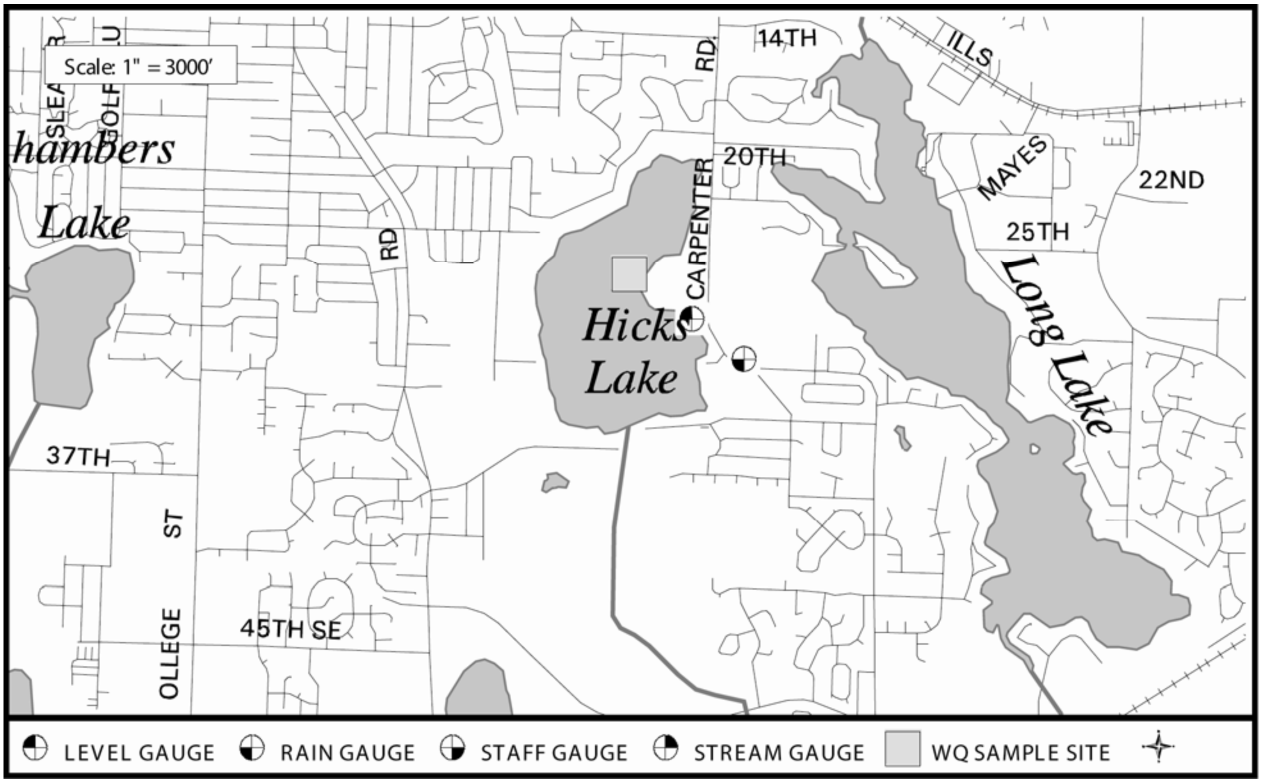
| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 9:15:00 AM | 9.93 | 7.2 | 10.38 | 64 | 10 | 0.8 | 0.66 | 0.018 | 0.465 | |
| 11/14/2006 | 10:40:00 AM | 8.61 | 7.0 | 11.48 | 53 | 30 | 7.4 | | 0.040 | 0.380 | fish spawning, did not disturb |
| 12/11/2006 | 10:15:00 AM | 8.08 | 7.0 | 9.48 | 66 | 320 | 8.3 | | 0.106 | 0.327 | lots of fish, dead and alive |
| 1/24/2007 | 10:45:00 AM | 5.38 | 7.3 | 11.55 | 64 | 10 | 0.7 | 17.45 | 0.013 | 0.343 | |
| 2/20/2007 | 11:25:00 AM | 6.84 | 7.3 | 10.63 | 52 | 35 | 9.3 | 133.17 | 0.030 | 0.398 | |
| 3/20/2007 | 11:40:00 AM | 7.77 | 7.5 | | 60 | 20 | 6.0 | 28.03 | 0.021 | 0.194 | DO not working Unusually murky and cloudy, still smells like fish |
| 4/26/2007 | 3:00:00 PM | 10.21 | 7.5 | 12.23 | 68 | 0 | 0.5 | 9.54 | 0.014 | 0.167 | F.C. result was <5. |
| 5/17/2007 | 10:45:00 AM | 9.82 | 7.5 | 12.58 | 77 | 0 | 0.1 | 5.04 | 0.016 | 0.261 | F.C. result was <5. |
| 6/12/2007 | 3:45:00 PM | 12.68 | 7.6 | 11.85 | 84 | 10 | 0.0 | 2.69 | 0.017 | 0.307 | |
| 7/18/2007 | 12:15:00 PM | 14.56 | 7.4 | 9.35 | 93 | 10 | 0.9 | 1.63 | 0.026 | 0.467 | |
| 8/21/2007 | 10:30:00 AM | 12.65 | 7.4 | 10.27 | 99 | 5 | 0.4 | 0.68 | | | EH lab analyzed sample for Nox; result was <1.0. |
| 9/17/2007 | 11:00:00 AM | 12.76 | 7.4 | 11.19 | 101 | 40 | 0.7 | 0.58 | 0.023 | 0.489 | |

# Henderson Inlet 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 recreational uses.

**OTHER AVAILABLE DATA:**

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

Thurston County Department of Water and Waste Management, Storm Water Utility, (360) 357-2491 (lake stage and precipitation data).

Water quality data since 1970's - Thurston County Environmental Health Division, www.co.thurston.wa.us/health/ehswat/swater.htm, (360) 754-4111).

**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 used 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.

Temperature, pH, dissolved oxygen, and conductivity measurements are displayed in monthly profile graphs at the end of this chapter. The lake was thermally stratified from May through September in 2007. 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 July, but the bottom layer of water (hypolimnion) remained much colder, at 9.5 degrees. The lower layer of colder water, generally below 4 to 5 meters, was very low in oxygen throughout the summer. This condition results in a slow release of phosphorus from the sediments into the water near the bottom. This can be seen in the higher concentrations of phosphorus in the bottom samples (see data on the data report page). 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. No major algae bloom occurred in 2007.

A secchi disk reading graph located at the end of this narrative shows the average summer secchi disk depths since 1995. In 2007, the average water clarity or secchi disk depth was 1.6 meters (or 5.2 feet) with a range from 1.3 meters in August to 1.9 meters in June (or 4.1 feet to 6.1 feet). Overall the water clarity in 2007 was poor. The last graph at the end of this chapter shows the trend of water clarity by subtracting the annual average clarity from the overall average for the period of record. The graph shows that the water clarity in 2006 and 2007 was below the long-term average for the lake.

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 2007 TSI's for total phosphorus, chlorophyll *a*, and secchi disk are 47, 55, and 53, respectively. This information is shown on the trophic state indices graph found at the end of this narrative. In 2007, two of the three indices were within the eutrophic, or highly productivity range. The graph shows that from 2002 through 2005 the TSI's were within the meostrophic range and water quality conditions were fairly good. In 2006 and 2007 the productivity was higher and water clarity lower than it has been for several years. This may be reflecting the influence 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.

## Major Issues:

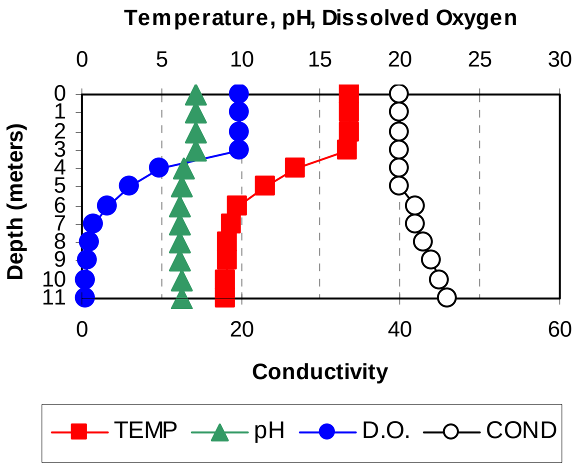
- Low water levels occur during summer months, especially during periods of drought such as in 2001. High lake levels can also occur during higher than normal winter rainfall conditions. Extreme high lake levels cause flooding of some lakeshore structures. The outlet channel is on private property, is 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:

Funding for sampling in 2008 will continue.

## May 21, 2007

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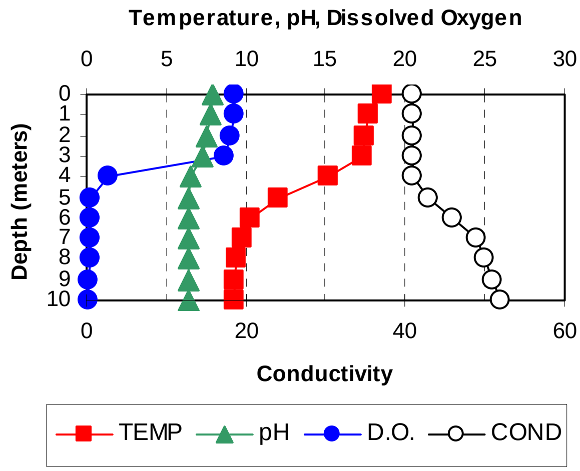


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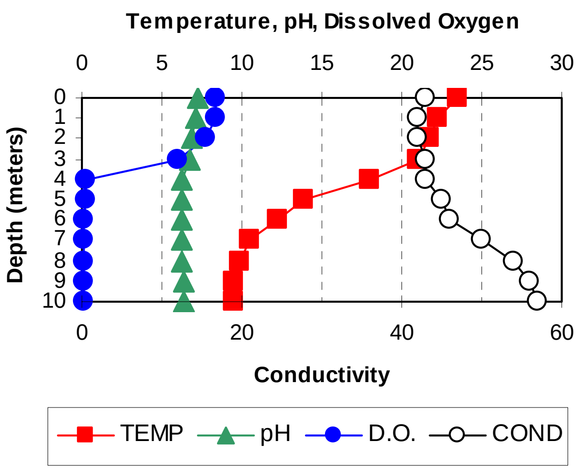


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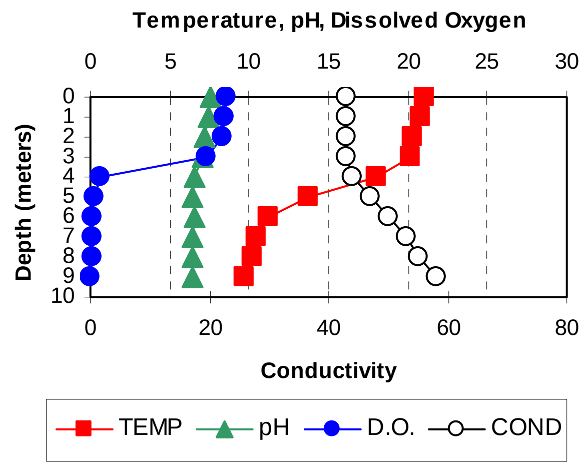
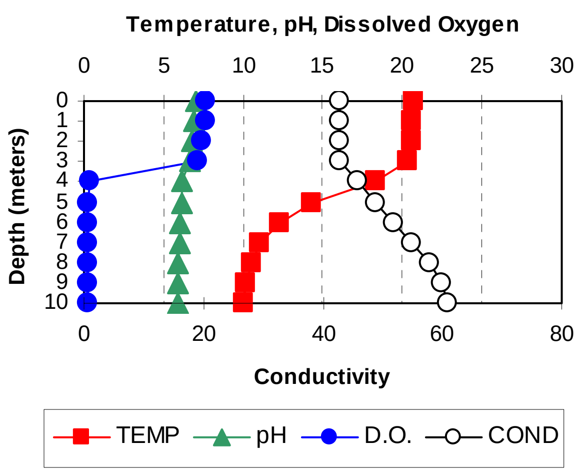
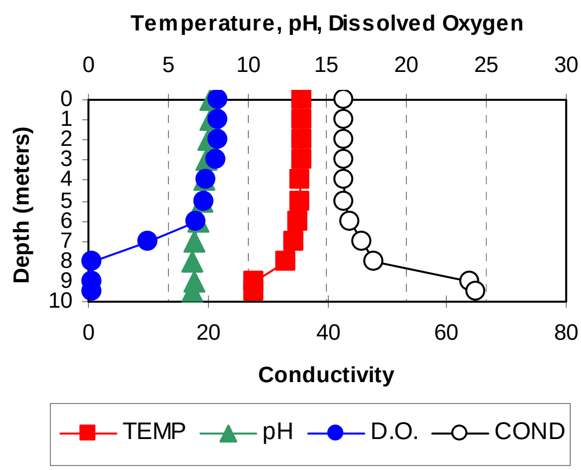
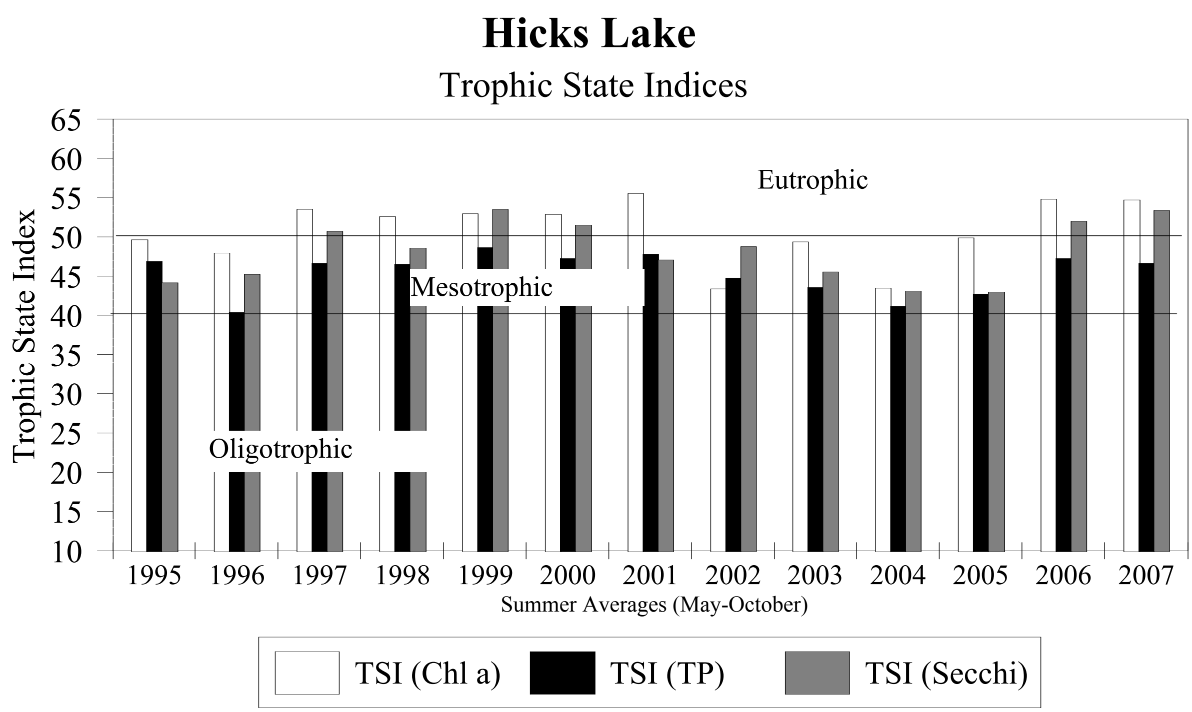


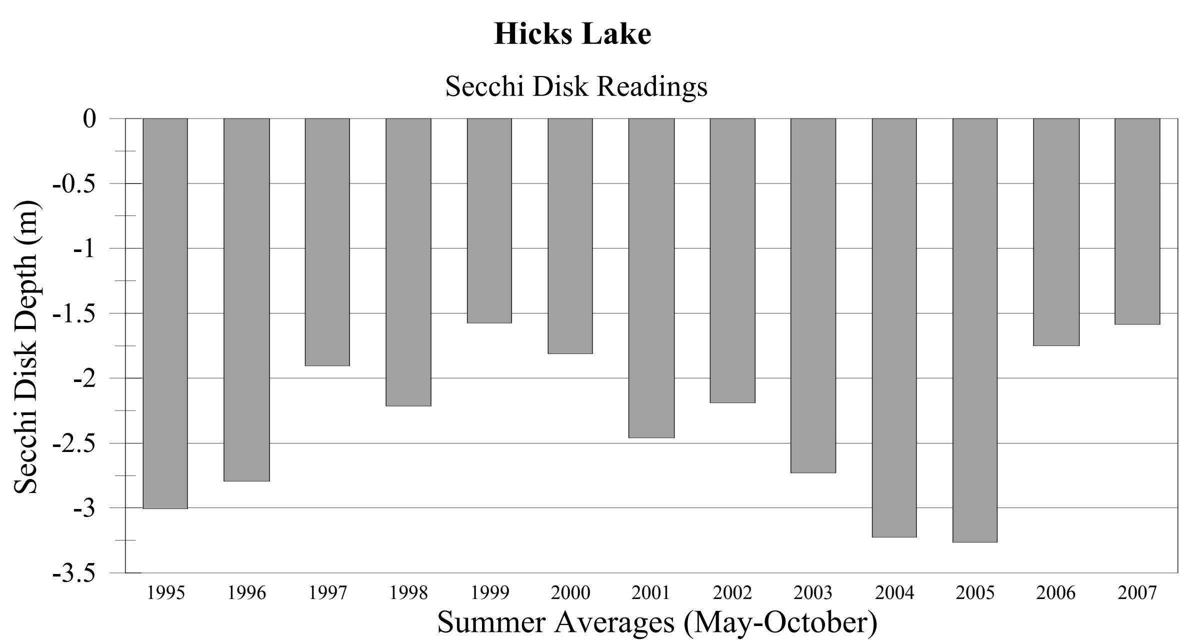

## September 10, 2007

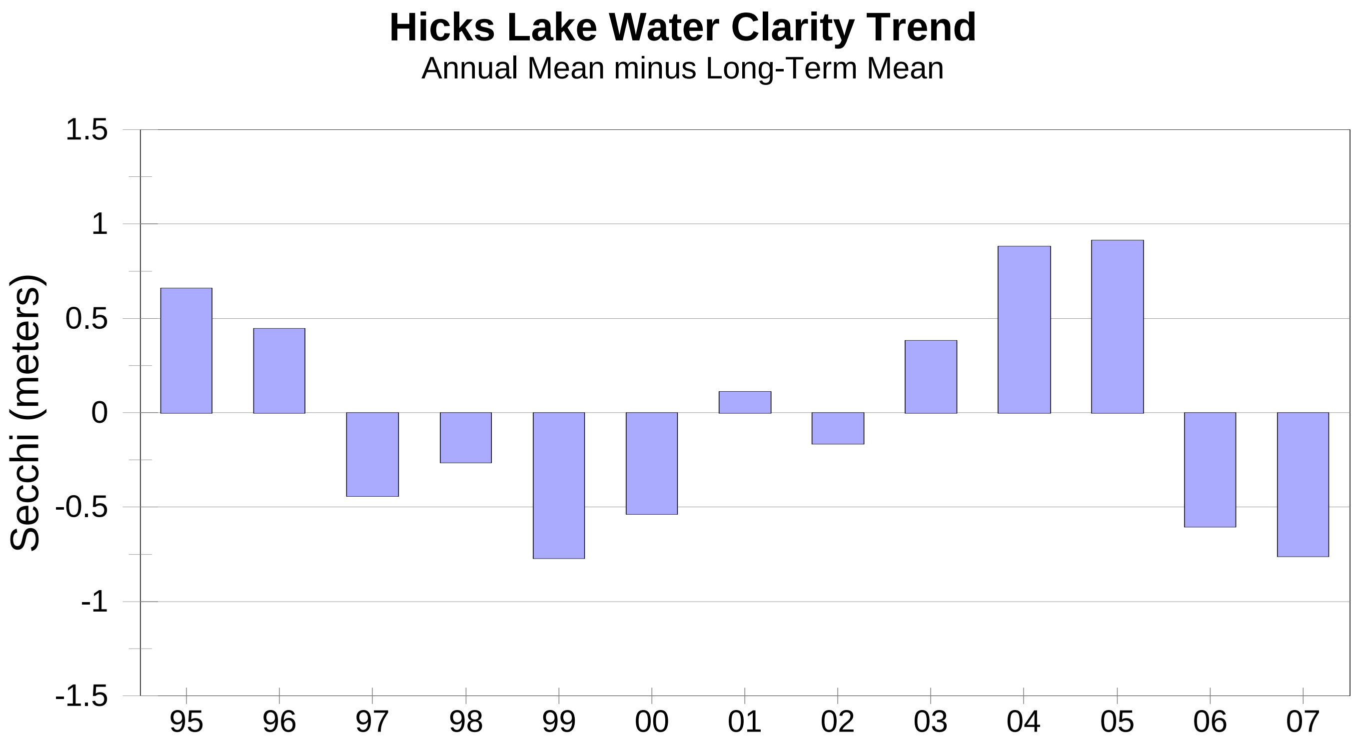



## October 16, 2007




Hicks Lake
Trophic State Indices
Trophic State Index
65
60
55
50
45
40
35
30
25
20
15
10
Eutrophic
Mesotrophic
Oligotrophic
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)
TSI (Chl a)
TSI (TP)
TSI (Secchi)


Hicks Lake
Secchi Disk Readings
Secchi Disk Depth (m)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)


Hicks Lake Water Clarity Trend
Annual Mean minus Long-Term Mean
Secchi (meters)
1.5
1
0.5
0
-0.5
-1
-1.5
95
96
97
98
99
00
01
02
03
04
05
06
07

## Hicks Lake

**Site ID#** *HENHIL000*

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/21/2007 | 4:15:00 PM | 11 | 10.0 | 0.026 | 0.034 | 0.526 | 0.501 | 1.77 | 7.5 | 4.5 | #8 dk orange | Chl a & algae composite @ 1, 2, & 3M. |
| 06/19/2007 | 1:30:00 PM | 10.1 | 9.0 | 0.017 | 0.066 | 0.433 | 0.429 | 1.87 | 9.6 | 2.7 | #7 yellow-orange | Chl a & algae composite @ 1, 2, & 3M. |
| 07/25/2007 | 2:40:00 PM | 10.3 | 9.5 | 0.017 | 0.093 | 0.573 | 0.671 | 1.62 | 19 | 4 | #7 yellow-orange | Chl a & algae composite @ 1 & 2M. |
| 08/13/2007 | 12:15:00 PM | 9 | 8.0 | 0.019 | 0.083 | 0.540 | 0.654 | 1.26 | 13 | 4.4 | #7 yellow | Chl a & algae composite @ 1, 2, 3M. |
| 09/10/2007 | 11:45:00 AM | 10.2 | 9.0 | 0.017 | 0.136 | 0.556 | 0.967 | 1.61 | 12 | 4.7 | #9 dk orange | Chl a & algae composite @ 1, 2, & 3M. |
| 10/16/2007 | 11:00:00 AM | 9.5 | 9.0 | 0.018 | 0.102 | 0.532 | 0.984 | 1.37 | 9.1 | 4.8 | #9 dk orange | Chl a & algae composite @ 1, 2, & 3M. |

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

| Averages: | | |
|---|---|---|
| | **Sur TP** | *0.019* |
| | **Secchi** | *1.58* |
| | **Chl a** | *11.7* |

# *Algae data:* Hicks Lake

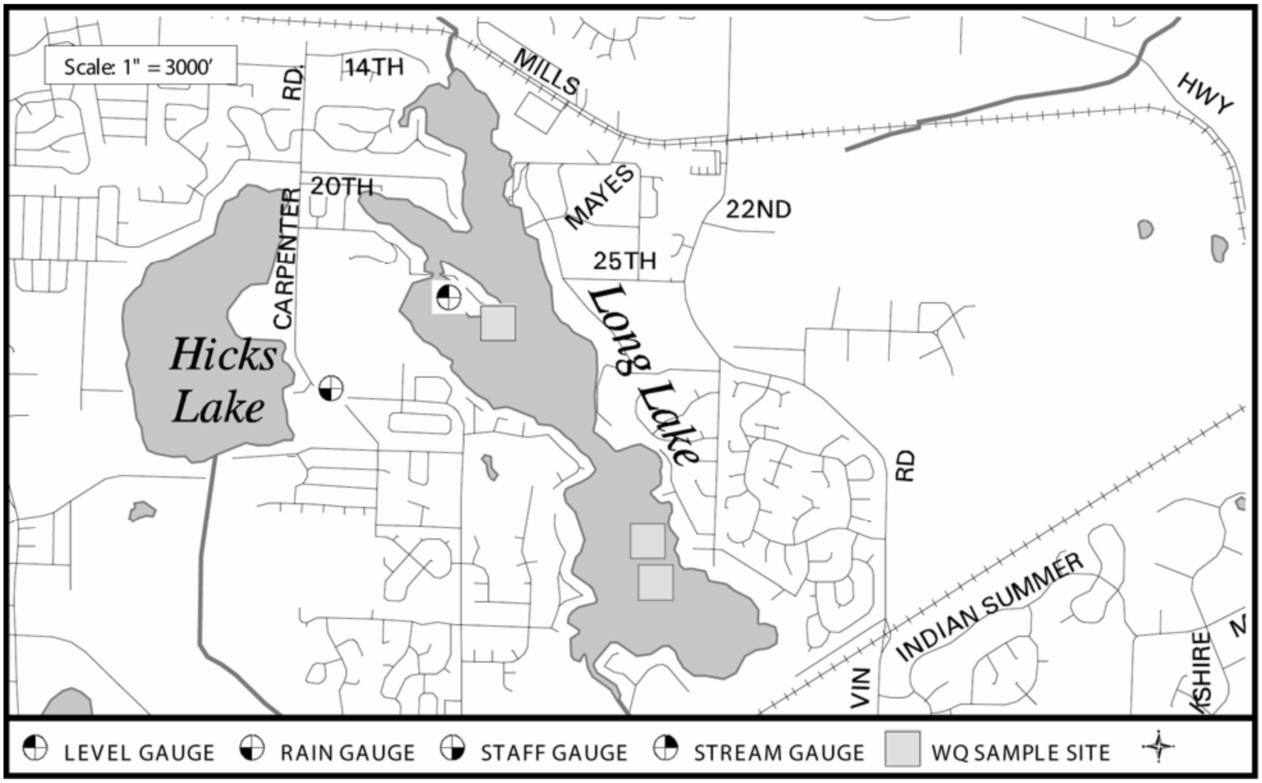
| | Type | Description | Dominant in Sample |
|---|---|---|---|
| *05/21/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | CP | Chroomonas species | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Synedra species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | GR | Dictyosphaerium pulchellum | ☐ |
| | GR | Elakatothrix species | ☐ |
| *06/19/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | CP | Chroomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Cymbella species | ☐ |
| | DT | Tabellaria species | ☐ |
| | GR | Actinastrum species | ☐ |
| | GR | Botryococcus species | ☐ |
| | GR | Dictyosphaerium pulchellum | ☐ |
| | YL | Synura species | ☐ |
| *07/25/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☑ |
| | BG | Microcystis species | ☐ |
| | CP | Chroomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | GR | Spondylosium species | ☐ |
| | GR | Staurastrum species | ☐ |
| | YL | Dinobryon species | ☐ |

| Type | Description | Dominant in Sample |
|---|---|---|
| ***08/13/2007*** | | |
| BG | Anabaena spiroides | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Aphanocapsa species | ☐ |
| CP | Cryptomonas species | ☐ |
| DT | Cyclotella species | ☐ |
| DT | Rhizosolenia eriensis | ☐ |
| EU | Trachelomonas species | ☐ |
| GR | Botryococcus species | ☐ |
| GR | Spondylosium species | ☐ |
| GR | Staurastrum species | ☐ |
| ***09/10/2007*** | | |
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Aphanothece species | ☐ |
| DT | Rhizosolenia eriensis | ☐ |
| DT | Synedra species | ☐ |
| GR | Ankistrodesmus species | ☐ |
| GR | Elakatothrix species | ☐ |
| GR | Scenedesmus species | ☐ |
| YL | Dinobryon species | ☐ |
| ***10/16/2007*** | | |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Aphanocapsa species | ☐ |
| BG | Aphanothece species | ☐ |
| CP | Cryptomonas species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Cyclotella species | ☐ |
| DT | Rhizosolenia eriensis | ☐ |
| EU | Trachelomonas species | ☐ |
| GR | Botryococcus species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| GR | Staurastrum species | ☐ |
| YL | Dinobryon species | ☐ |

| *Type* | *Description* | *Dominant in Sample* |
|---|---|---|

**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.

**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 lake was treated with an aquatic herbicide in 1991 to eradicate the exotic aquatic plant, Eurasian water milfoil. Since the herbicide treatment, the milfoil infestation has been controlled through hand-pulling and bottom barriers.

**OTHER AVAILABLE DATA:**

Water Quality data - Thurston County Environmental Health Division, www.co.thurston.wa.us/health/ehswat/swater.htm (360) 754-4111.

Thurston County Dept. of Water and Waste Management, Lakes Program, (360) 357-2491 (Lake management activities since 1983).

Washington Department of Ecology, Environmental Assessment Program, (360) 407-6000 (Water Quality Data).

**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 groundwater. Water quality monitoring sites are located in the deepest area of each main basin.

***Field Parameters***
The monthly temperature, dissolved oxygen, pH, and conductivity profile graphs are included 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 2007 the north basin was thermally stratified from May through September. The south basin was weakly stratified May through August. In both basins, the dissolved oxygen concentrations at the bottom were below 2 mg/L from May through September. Under those anoxic conditions phosphorus is released from the sediments into the water column in a form easily used by algae.

***Secchi Disk Water Clarity***
The water clarity for 2007 is shown on the graph entitled “2007 Secchi Disk Readings”. The water clarity in the north basin ranged from 1.4 meters (4.6 feet) in October to 2.3 meters (7.6 feet) in August. The season average was 2.0 meters (6.6 feet). The water clarity in the south basin ranged from 1.07 meters (3.5 feet) in October to 1.42 meters (4.7 feet) in August. The season average in the south basin was 1.3 meters (4.1 feet). The season averages from previous years are compared in graphs located after the field measurement profile graphs.

To examine trends in water clarity, the annual average (mean) secchi disk reading is normalized by subtracting the mean secchi reading for the entire record from the annual mean. A ‘positive’ bar on the graph indicates that the average for the year is 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 included in the report and are titled “Water Clarity Trend” graphs. When the graphs include the effective period of the alum treatment in the 1980’s, the water clarity appears to be declining over time. However, when the graphs are adjusted to include only the data after the effective period of the alum treatment, beginning in 1990, a trend in water clarity is less apparent.

***Total Phosphorus Levels***

The average 2007 surface total phosphorus concentration in the north basin was 0.024 milligrams per liter (mg/l). In the south basin the average surface TP was 0.038 mg/l. 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 the north basin the total phosphorus concentrations were above the water quality standard in May and again in September and October after the lake had begun to mixe, bringing nutrient-rich waters up from the bottom. In the south basin, the concentrations were at or over the 0.020 mg/L standard throughout the sampling period, but highest in September and October. In the north basin, the water clarity was poorest and algae production, as measured by chlorophyll *a* concentration, was highest in September and October. In the south basin, the chlorophyll concentrations were highest in October, but were generally high throughout the summer season. Graphs at the end of this chapter show the annual average phosphorus concentrations in both basins since 1981.

***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 north basin 2007 TSIs for total phosphorus, chlorophyll *a*, and secchi disk are 50, 63, and 50, respectively. These TSIs indicate moderate to highly productive conditions. The south basin TSIs for total phosphorus, chlorophyll *a*, and secchi disk are 57, 65, and 57, respectively. The south basin TSIs indicate eutrophic, or highly productive, conditions. (See Trophic State Indices trend graphs.)

## 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.

  - Pursue a multifaceted strategy to reduce native nuisance aquatic plants to improve recreational and aesthetic conditions, while maintaining fish and wildlife habitat.

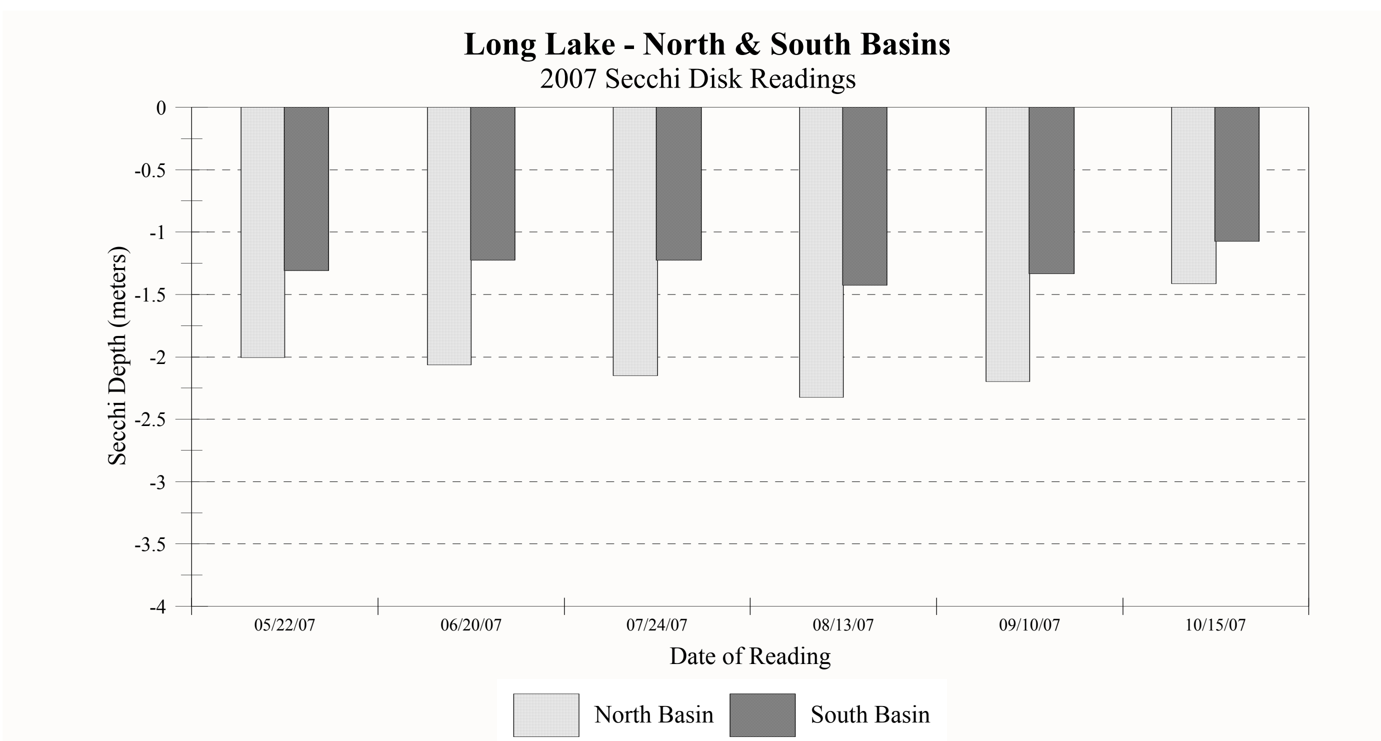
  - Investigate the feasibility for adding aluminum sulfate to reduce internal cycling of phosphorus to improve water clarity and reduce the frequency and intensity of blue-green algae blooms.

- In 2002, zooplankton sampling and alkalinity analysis were discontinued from the monitoring program. In 2003 and 2004 the water quality sampling frequency was changed by the steering committee from six monthly sampling events to three (July, August, and September). Since 2005 six monthly samples were again collected to support a partial lake alum treatment feasibility assessment.

- In Spring of 2008, the south basin was treated with alum to reduce the available phosphorus concentration in the water column to reduce algae production.

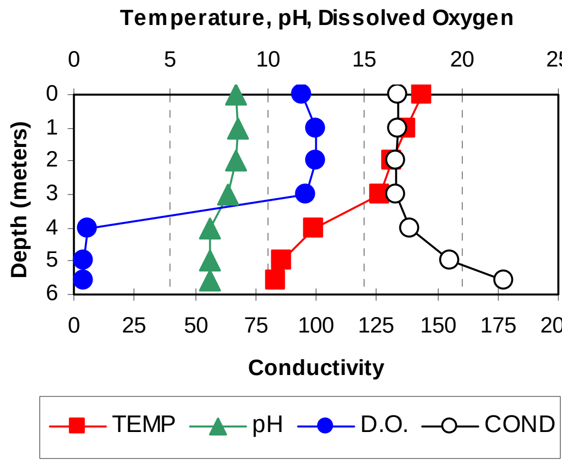
## Funding Sources:

The Long Lake - Lake Management District (LMD) funds the water quality monitoring of the lake to aid them in making lake management decisions. 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. A current LMD runs through 2010.

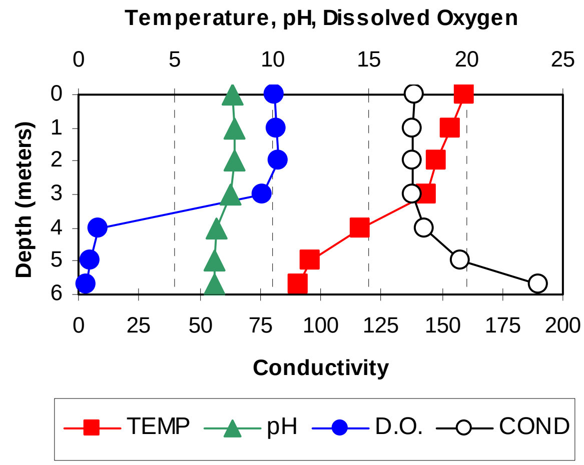


# LONG LAKE NORTH (LO3)

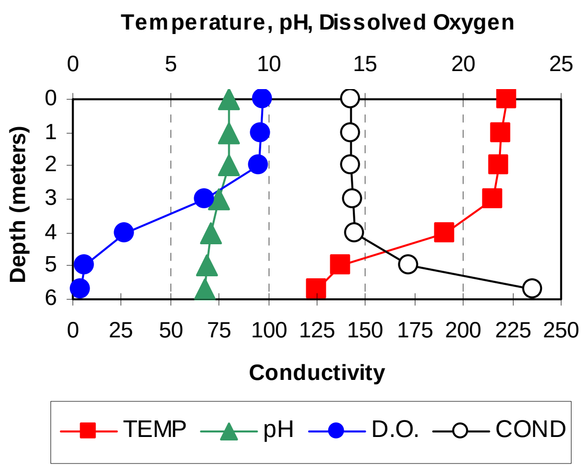
## May 22, 2007



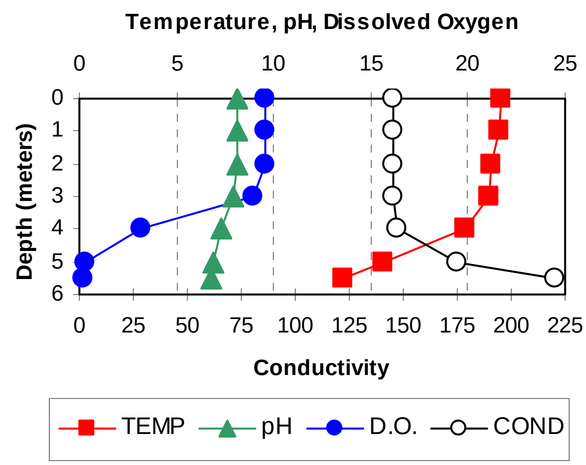

## June 20, 2007



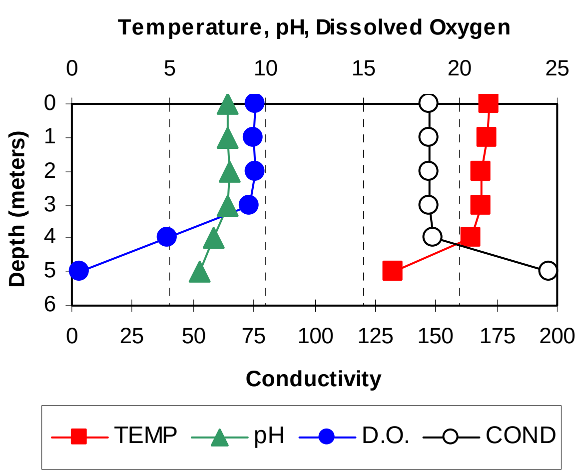

## July 24, 2007



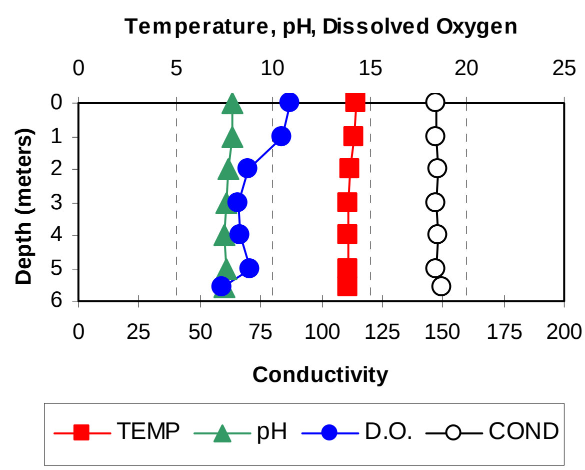

## August 13, 2007




## September 10, 2007

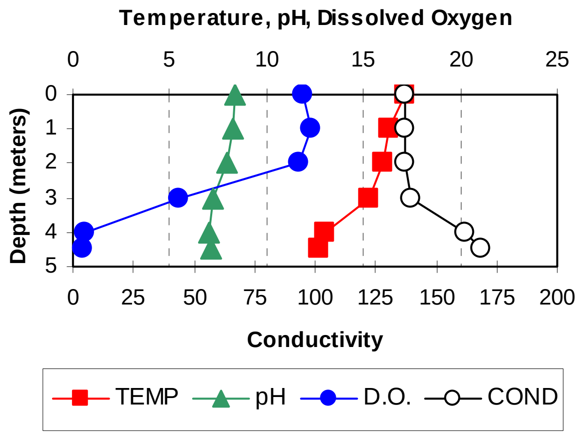



## October 15, 2007

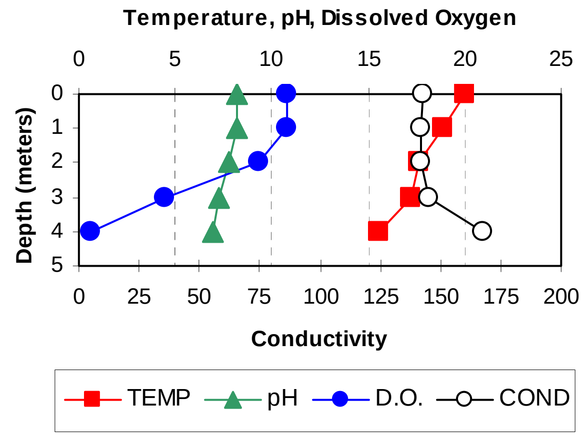


# LONG LAKE SOUTH (LO4)

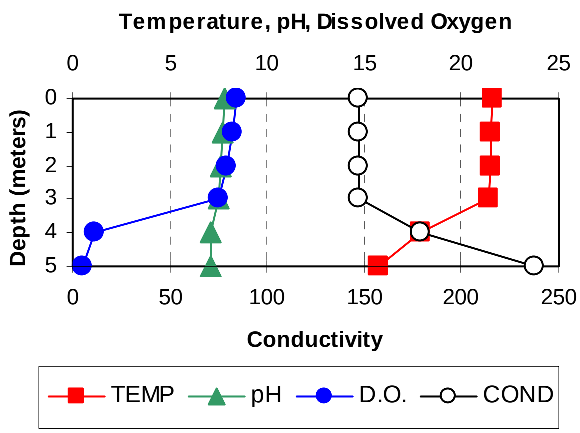
### May 22, 2007



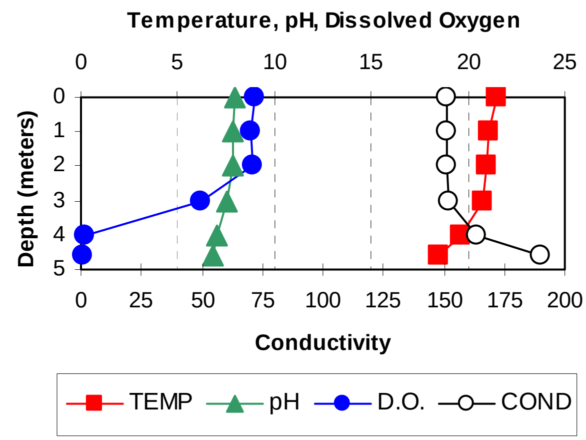

### June 20, 2007



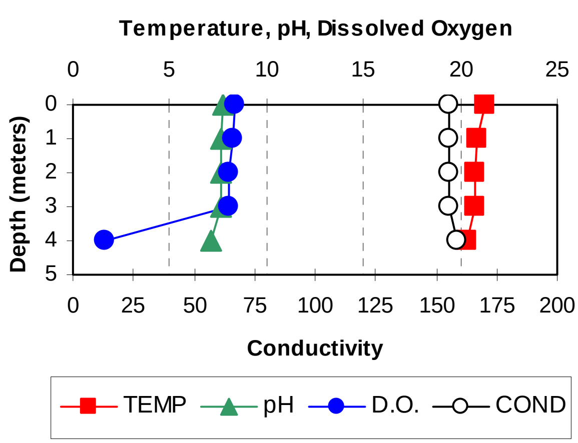

### July 24, 2007



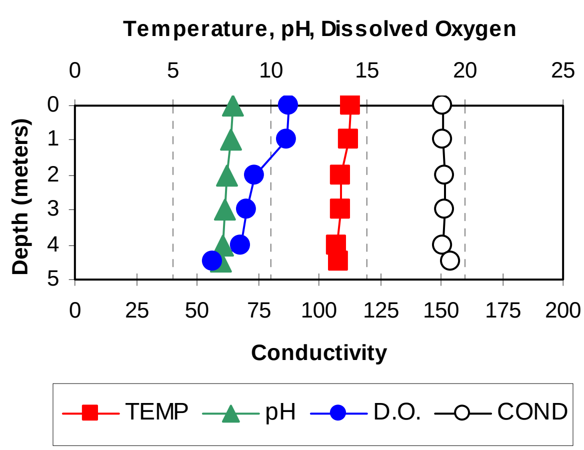

### August 13, 2007



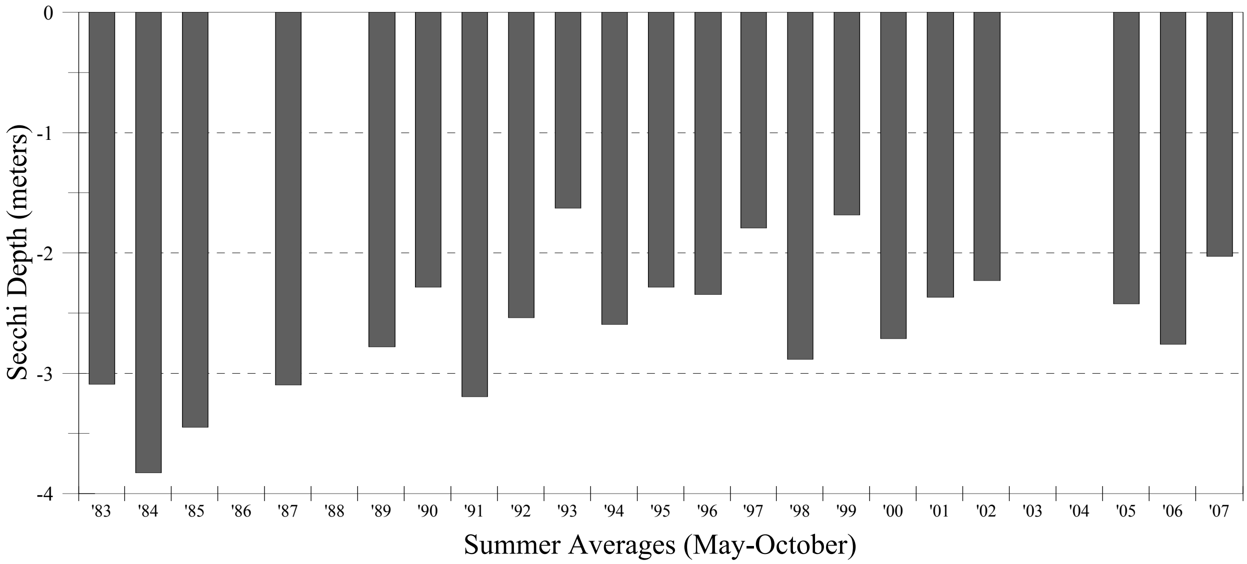

### September 10, 2007



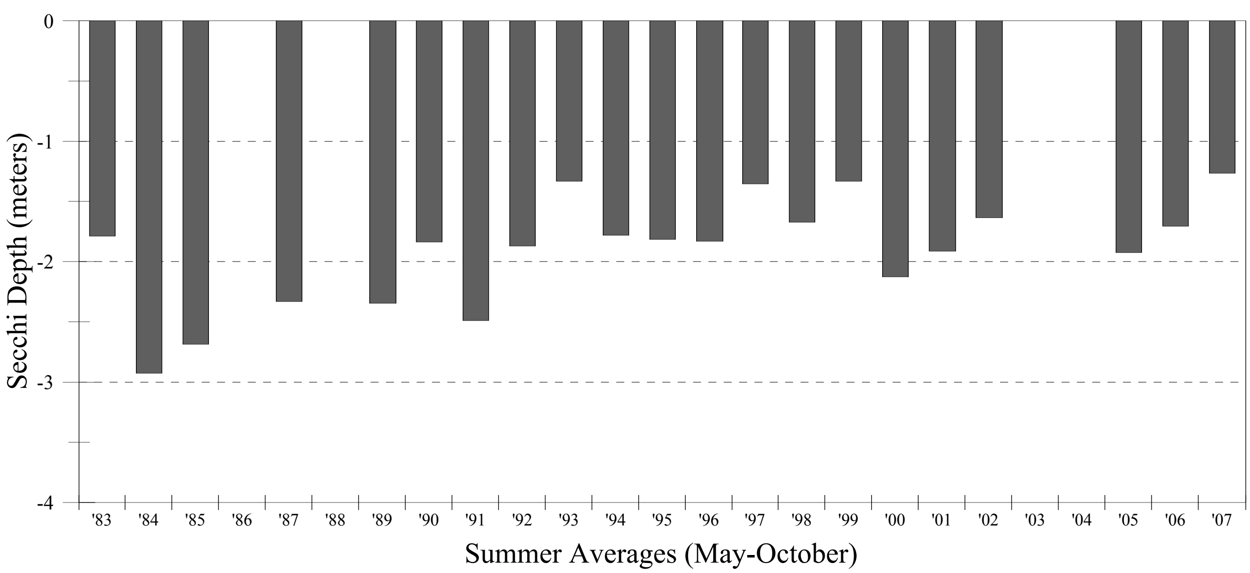

### October 15, 2007

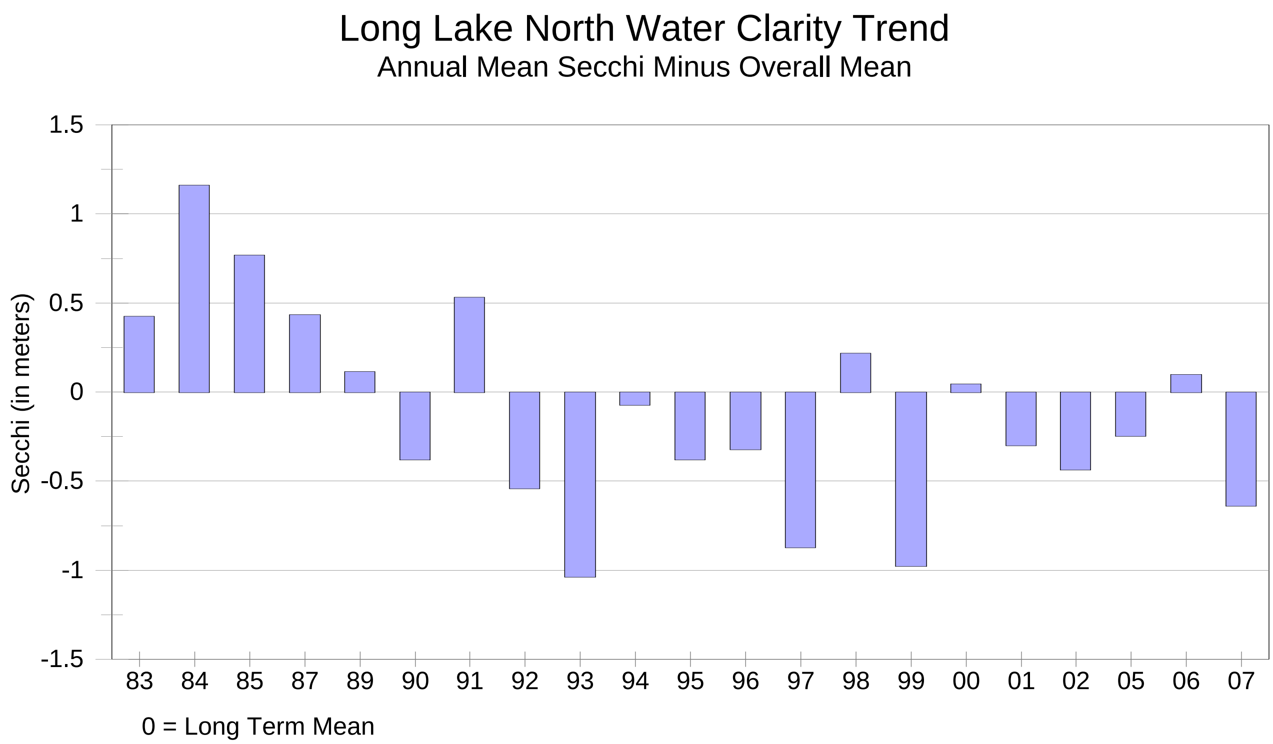


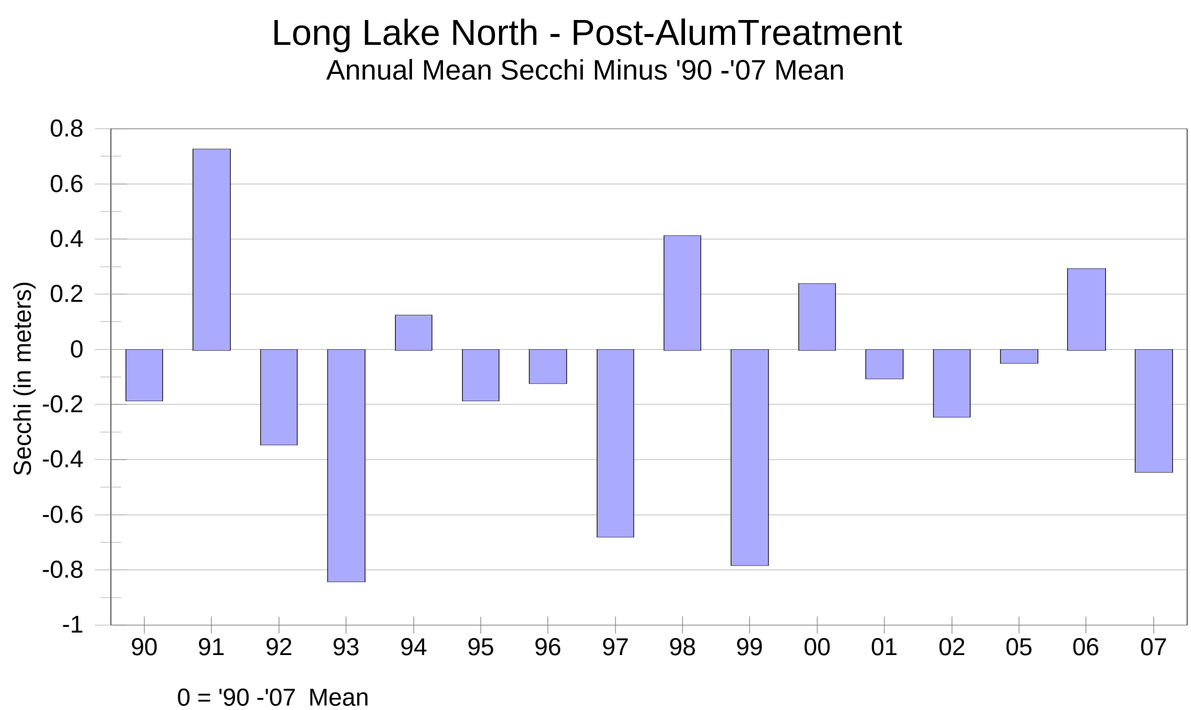
## Long Lake - North Basin
Secchi Disk Readings

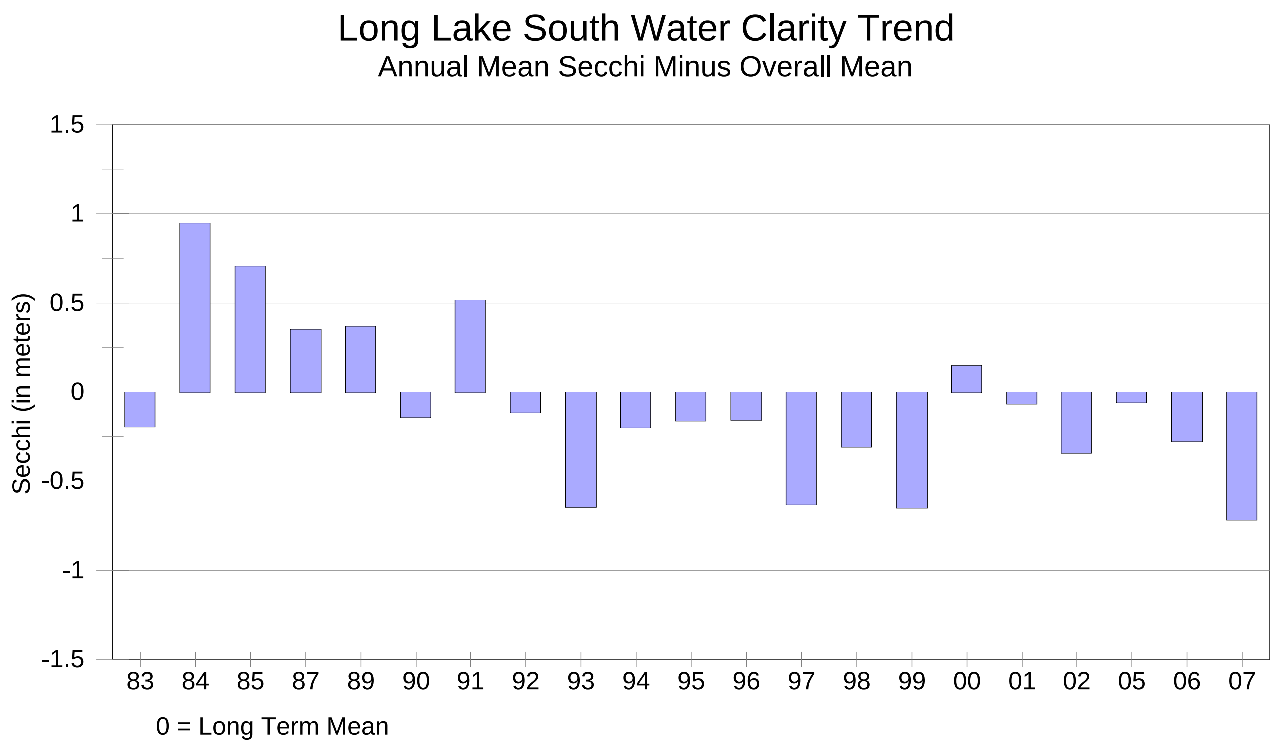


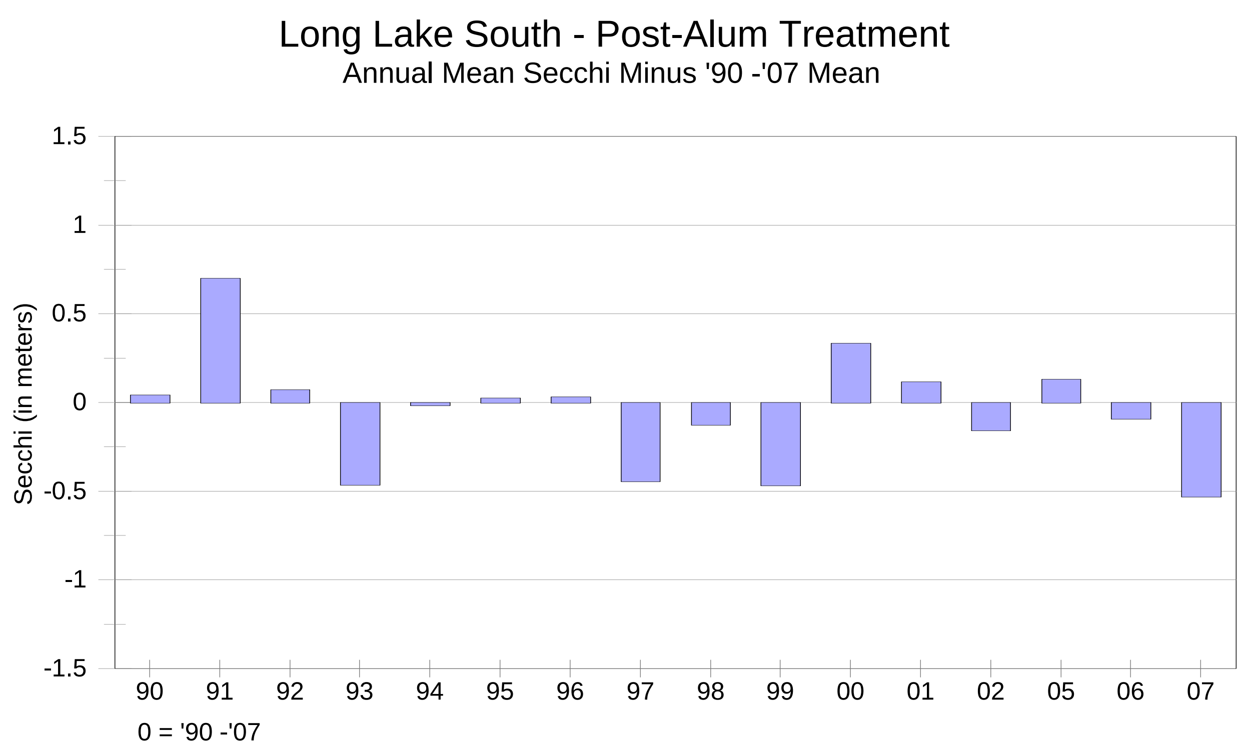

## Long Lake - South Basin
Secchi Disk Readings

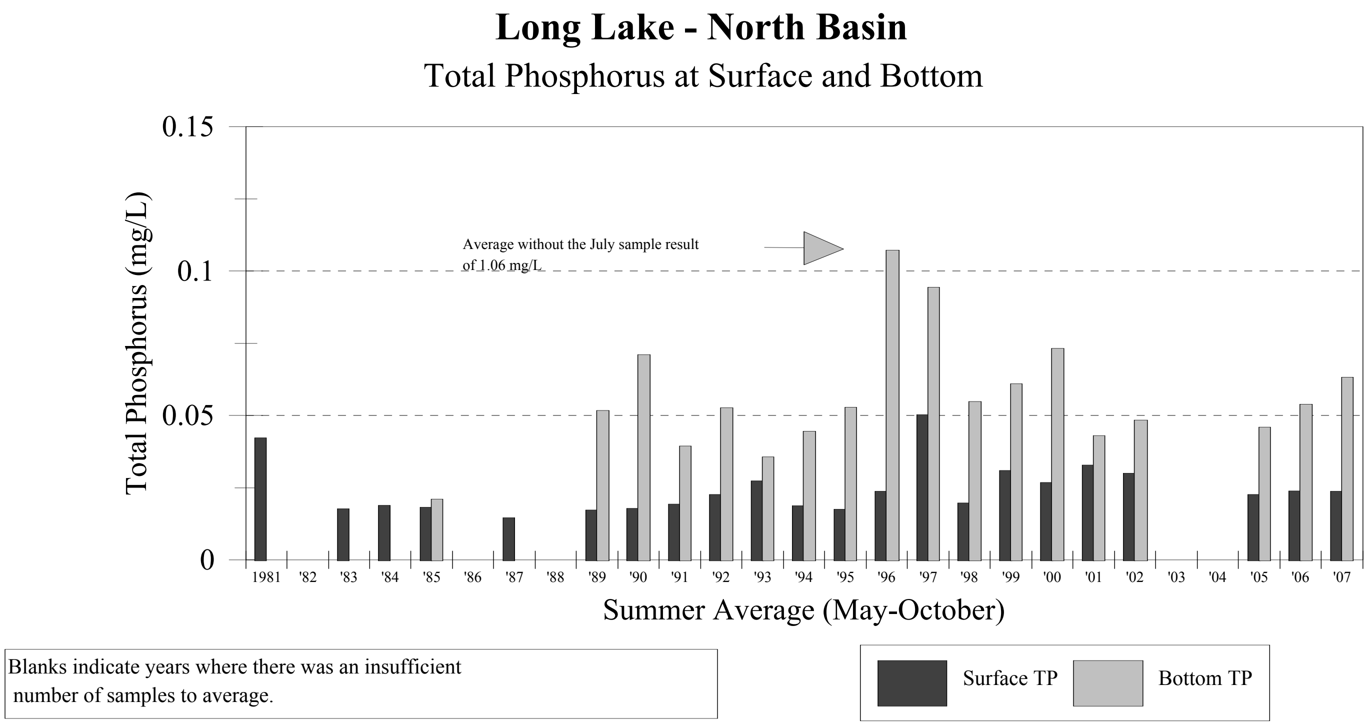



Long Lake North Water Clarity Trend
Annual Mean Secchi Minus Overall Mean
Secchi (in meters)
1.5
1
0.5
0
-0.5
-1
-1.5
83 84 85 87 89 90 91 92 93 94 95 96 97 98 99 00 01 02 05 06 07
0 = Long Term Mean

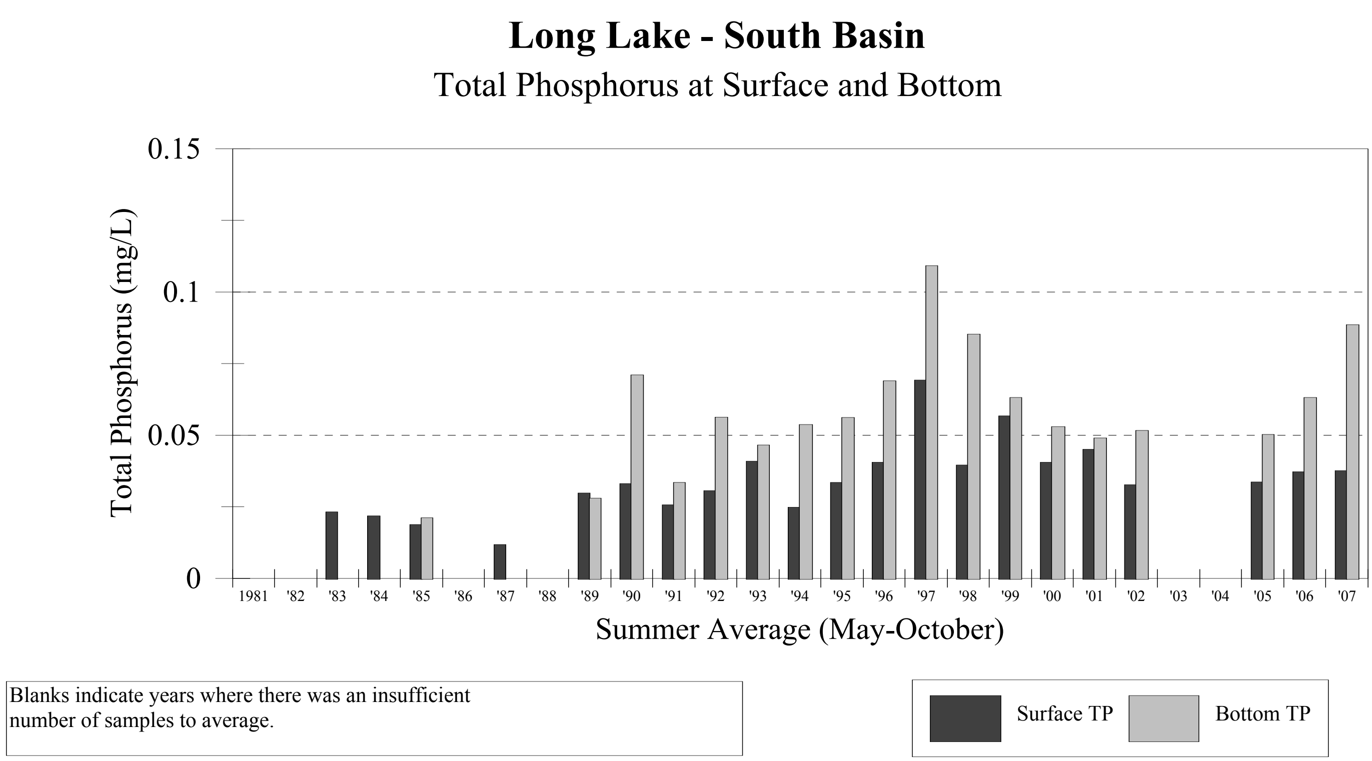

Long Lake North - Post-AlumTreatment
Annual Mean Secchi Minus '90 -'07 Mean
Secchi (in meters)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
90 91 92 93 94 95 96 97 98 99 00 01 02 05 06 07
0 = '90 -'07 Mean


Long Lake South Water Clarity Trend
Annual Mean Secchi Minus Overall Mean
Secchi (in meters)
1.5
1
0.5
0
-0.5
-1
-1.5
83
84
85
87
89
90
91
92
93
94
95
96
97
98
99
00
01
02
05
06
07
0 = Long Term Mean

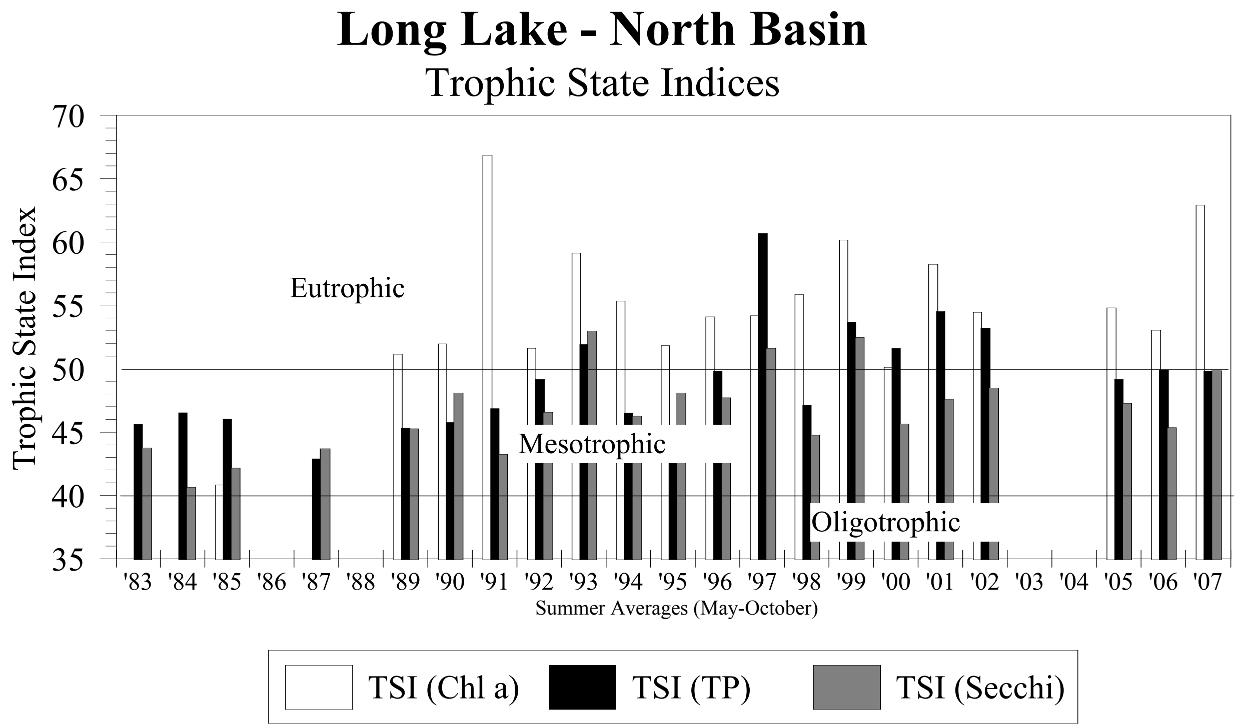

Long Lake South - Post-Alum Treatment
Annual Mean Secchi Minus '90 -'07 Mean
Secchi (in meters)
1.5
1
0.5
0
-0.5
-1
-1.5
90
91
92
93
94
95
96
97
98
99
00
01
02
05
06
07
0 = '90 -'07

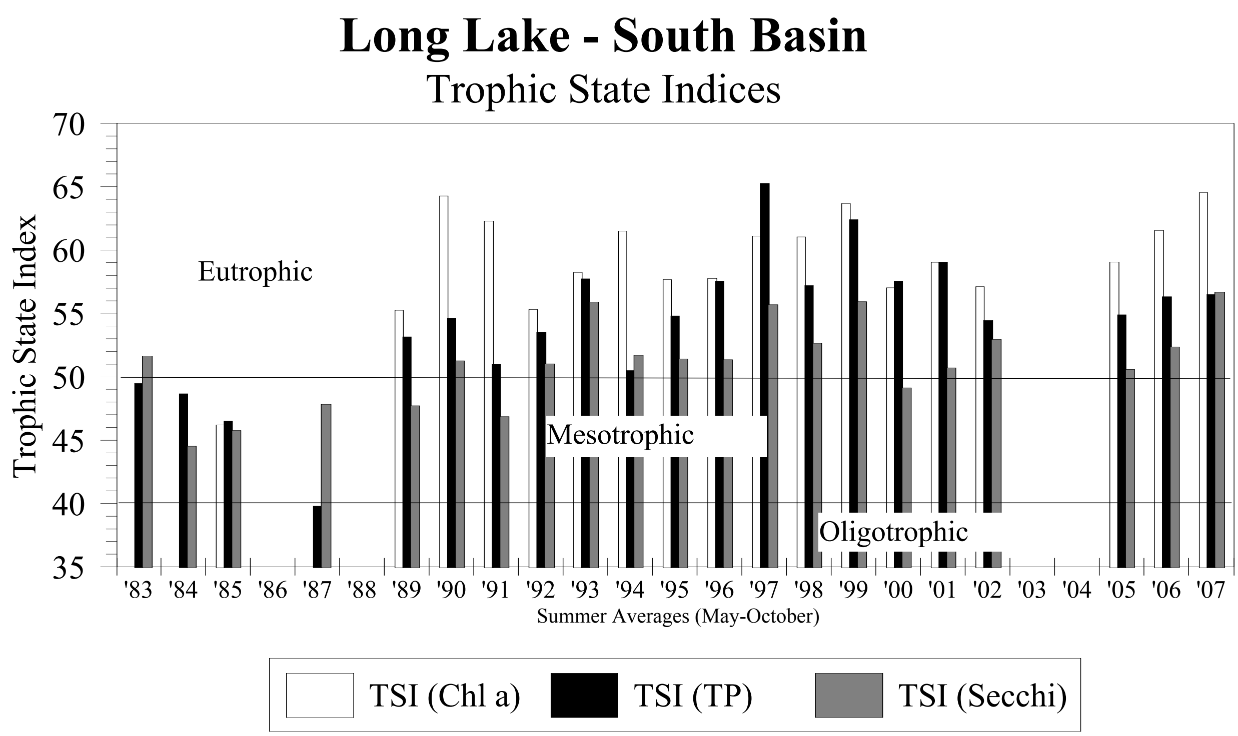


Long Lake - North Basin
Total Phosphorus at Surface and Bottom
Average without the July sample result of 1.06 mg/L
Total Phosphorus (mg/L)
0.15
0.1
0.05
0
1981
'82
'83
'84
'85
'86
'87
'88
'89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
'02
'03
'04
'05
'06
'07
Summer Average (May-October)
Blanks indicate years where there was an insufficient number of samples to average.
Surface TP
Bottom TP

Long Lake - South Basin
Total Phosphorus at Surface and Bottom
Total Phosphorus (mg/L)
0.15
0.1
0.05
0
1981
'82
'83
'84
'85
'86
'87
'88
'89
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
'01
'02
'03
'04
'05
'06
'07
Summer Average (May-October)
Blanks indicate years where there was an insufficient number of samples to average.
Surface TP
Bottom TP


Long Lake - North Basin
Trophic State Indices
Trophic State Index
70
65
60
55
50
45
40
35
Eutrophic
Mesotrophic
Oligotrophic
'83 '84 '85 '86 '87 '88 '89 '90 '91 '92 '93 '94 '95 '96 '97 '98 '99 '00 '01 '02 '03 '04 '05 '06 '07
Summer Averages (May-October)
TSI (Chl a)
TSI (TP)
TSI (Secchi)


Long Lake - South Basin
Trophic State Indices
Trophic State Index
70
65
60
55
50
45
40
35
Eutrophic
Mesotrophic
Oligotrophic
'83 '84 '85 '86 '87 '88 '89 '90 '91 '92 '93 '94 '95 '96 '97 '98 '99 '00 '01 '02 '03 '04 '05 '06 '07
Summer Averages (May-October)
TSI (Chl a)
TSI (TP)
TSI (Secchi)

## 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 Color | Lake Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/22/2007 | 3:30:00 PM | 5.6 | 5.0 | 0.023 | 0.049 | 0.574 | 0.855 | 2.00 | 17 | 3.6 | #7 yellow | Chl a & algae composite @ 1, 2, &3M. |
| 06/20/2007 | 11:15:00 AM | 5.7 | 5.0 | 0.016 | 0.040 | 0.385 | 0.549 | 2.06 | 9.1 | 2.5 | #3 pea-green w/ bl-gn chunk | Chl a & algae composite @ 1, 2, & 3M. |
| 07/24/2007 | 11:15:00 AM | 5.7 | 5.0 | 0.019 | 0.144 | 0.451 | 0.648 | 2.15 | 11 | 4.1 | #7 yellow | Chl a & algae composite @ 1, 2, & 3M. Lg clumps of bl-grn algae throughout water column. |
| 08/13/2007 | 11:40:00 AM | 5.5 | 5.0 | 0.014 | 0.038 | 0.402 | 0.415 | 2.32 | 11 | 1.5 | #6 yellow-green | Chl a & algae composite @ 1, 2, & 3M. |
| 09/10/2007 | 11:00:00 AM | 5.4 | 4.8 | 0.021 | 0.065 | 0.510 | 0.613 | 2.19 | 63 | 5.8 | #6 yellow-green | Chl a & algae composite @ 1, 2, & 3M. |
| 10/15/2007 | 3:30:00 PM | 5.6 | 5.0 | 0.049 | 0.044 | 0.802 | 0.624 | 1.41 | 51 | 8.7 | #8 yellow-orange | Chl a & algae composite @ 1 & 2M. |

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

| **Averages:** | | |
|---|---|---|
| | **Sur TP** | *0.024* |
| | **Secchi** | *2.02* |
| | **Chl a** | *27.0* |

## 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 Color | Lake Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/22/2007 | 3:10:00 PM | 4.5 | 4.0 | 0.032 | 0.053 | 0.735 | 1.020 | 1.30 | 30 | 2.6 | #7 yellow-orange | Chl a & algae composite @ 1 & 2M. |
| 06/20/2007 | 11:00:00 AM | 4.5 | 4.0 | 0.033 | 0.083 | 0.602 | 0.746 | 1.22 | 27 | 5.3 | #3 pea-green | Chl a & algae composite @ 1 & 2M. |
| 07/24/2007 | 10:45:00 AM | 5 | 4.0 | 0.025 | 0.175 | 0.510 | 1.120 | 1.22 | 18 | 5 | #7 yellow | Chl a & algae composite @ 1, 2, & 3M. |
| 08/13/2007 | 11:00:00 AM | 4.6 | 4.0 | 0.034 | 0.116 | 0.502 | 0.613 | 1.42 | 39 | 5.5 | #7 yellow | Chl a & algae composite @ 1, 2, & 3M. |
| 09/10/2007 | 10:30:00 AM | 4.4 | 3.8 | 0.044 | 0.063 | 0.684 | 0.699 | 1.33 | 25 | 4.8 | #3 pea-green | Chl a & algae composite @ 1 & 2M. |
| 10/15/2007 | 3:00:00 PM | 4.5 | 4.0 | 0.058 | 0.042 | 0.895 | 0.644 | 1.07 | 52 | 12 | #3 pea-green | Chl a & algae composite @ 1 & 2M. |

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

| Averages: | | |
|---|---|---|
| | **Sur TP** | *0.038* |
| | **Secchi** | *1.26* |
| | **Chl a** | *31.8* |

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

| | *Type* | *Description* | *Dominant in Sample* |
|---|---|---|---|
| *05/22/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☑ |
| | CP | Chroomonas species | ☐ |
| | DT | Cyclotella species | ☐ |
| | DT | Fragilaria species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Tabellaria species | ☐ |
| | GR | Botryococcus species | ☐ |
| | GR | Closterium species | ☐ |
| | GR | Cosmarium species | ☐ |
| | GR | Elakatothrix species | ☐ |
| | GR | Oocystis species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | GR | Staurastrum species | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Synura species | ☐ |
| *06/20/2007* | | | |
| | BG | Anabaena species | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Cyclotella species | ☐ |
| | DT | Fragilaria species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Tabellaria species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | GR | Staurastrum species | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Synura species | ☐ |

| Type | Description | Dominant in Sample |
|---|---|---|

*07/24/2007*

| | | |
|---|---|---|
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Aphanothece species | ☐ |
| BG | Chroococcus species | ☐ |
| BG | Lyngbya species | ☐ |
| BG | Oscillatoria species | ☐ |
| CP | Chroomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Cyclotella species | ☐ |
| DT | Fragilaria species | ☐ |
| DT | Melosira species | ☐ |
| DT | Tabellaria species | ☐ |
| EU | Euglena species | ☐ |
| GR | Oocystis species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| GR | Staurastrum species | ☐ |
| YL | Dinobryon species | ☐ |

*08/13/2007*

| | | |
|---|---|---|
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Aphanocapsa species | ☐ |
| BG | Aphanothece species | ☐ |
| BG | Gomphosphaeria species | ☐ |
| BG | Lyngbya species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Fragilaria species | ☐ |
| DT | Melosira species | ☐ |
| DT | Tabellaria species | ☐ |
| GR | Oocystis species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| YL | Dinobryon species | ☐ |
| YL | Synura species | ☐ |

| Type | Description | Dominant in Sample |
|---|---|---|
| *09/10/2007* | | |
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Aphanothece species | ☐ |
| BG | Chroococcus species | ☐ |
| BG | Lyngbya species | ☐ |
| BG | Microcystis species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Cyclotella species | ☐ |
| DT | Fragilaria species | ☐ |
| DT | Melosira species | ☐ |
| DT | Rhizosolenia eriensis | ☐ |
| DT | Tabellaria species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| YL | Dinobryon species | ☐ |
| *10/15/2007* | | |
| BG | Aphanocapsa species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DF | Oodinium species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Fragilaria species | ☐ |
| DT | Melosira species | ☐ |
| DT | Stephanodiscus species | ☐ |
| EU | Trachelomonas species | ☐ |
| GR | Elakatothrix species | ☐ |
| YL | Dinobryon species | ☐ |
| YL | Synura species | ☐ |

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

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

| Type | Description | Dominant in Sample |
|---|---|---|
| *05/22/2007* | | |
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☑ |
| CP | Chroomonas species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Fragilaria species | ☐ |
| DT | Melosira species | ☐ |
| EU | Trachelomonas species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| YL | Dinobryon species | ☐ |
| *06/20/2007* | | |
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Coelosphaerium species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Cyclotella species | ☐ |
| DT | Fragilaria species | ☐ |
| DT | Melosira species | ☐ |
| DT | Tabellaria species | ☐ |
| EU | Phacus species | ☐ |
| GR | Cosmarium species | ☐ |
| GR | Elakatothrix species | ☐ |
| GR | Oocystis species | ☐ |
| GR | Pediastrum species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| GR | Staurastrum species | ☐ |
| YL | Dinobryon species | ☐ |

| | *Type* | *Description* | *Dominant in Sample* |
|---|---|---|---|
| *07/24/2007* | | | |
| | BG | Anabaena species | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Tabellaria species | ☑ |
| | EU | Euglena species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| *08/13/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Microcystis species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Fragilaria species | ☐ |
| | DT | Melosira species | ☐ |
| | DT | Rhizosolenia eriensis | ☐ |
| | DT | Tabellaria species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Eudorina species | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Dinobryon species | ☐ |

| Type | Description | Dominant in Sample |
|---|---|---|
| *09/10/2007* | | |
| BG | Anabaena species | ☐ |
| BG | Aphanothece species | ☐ |
| BG | Lyngbya species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Cyclotella species | ☐ |
| DT | Fragilaria species | ☐ |
| DT | Melosira species | ☐ |
| DT | Tabellaria species | ☐ |
| EU | Trachelomonas species | ☐ |
| GR | Ankistrodesmus species | ☐ |
| GR | Elakatothrix species | ☐ |
| GR | Staurastrum species | ☐ |
| YL | Dinobryon species | ☐ |
| *10/15/2007* | | |
| BG | Anabaena species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Oodinium species | ☐ |
| DT | Fragilaria species | ☐ |
| DT | Melosira species | ☐ |
| DT | Stephanodiscus species | ☐ |
| EU | Trachelomonas species | ☐ |
| YL | Dinobryon species | ☐ |

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

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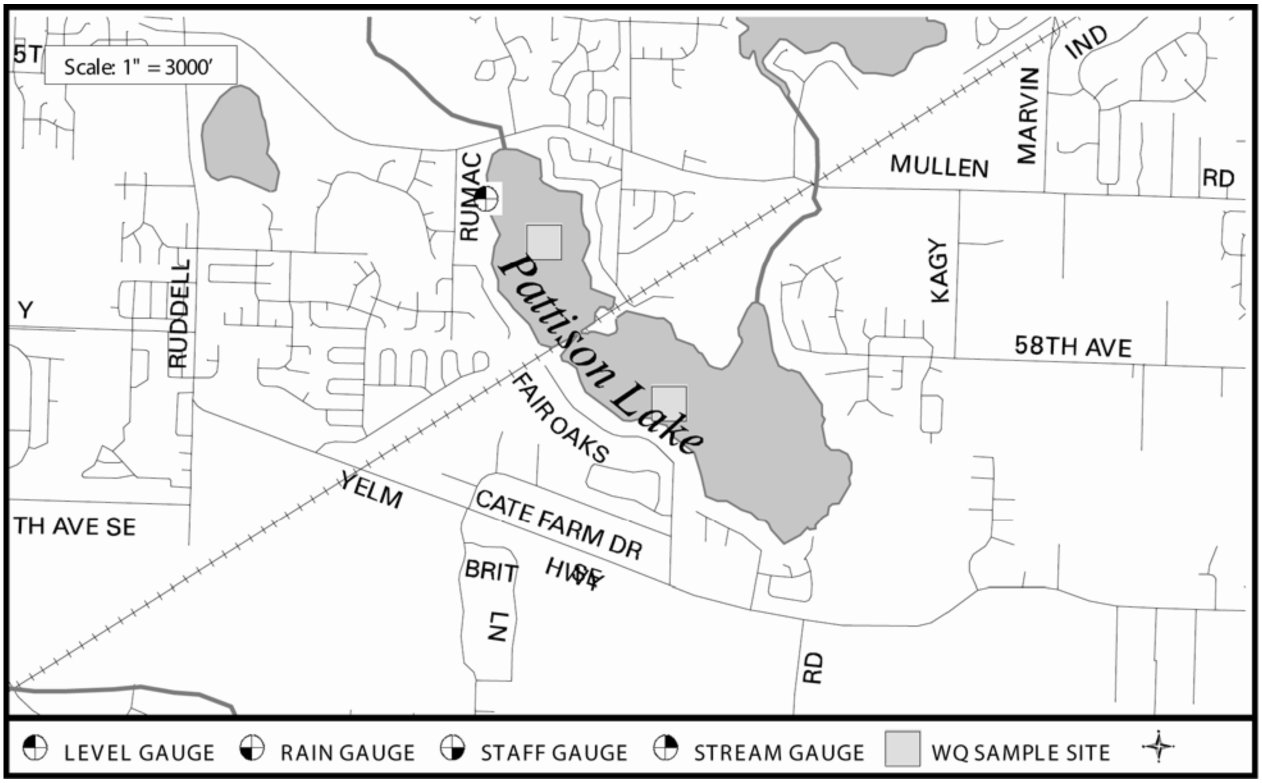



**PART OF HENDERSON INLET WATERSHED**

**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)

Good to Fair - Algae blooms, filamentous algae growth, and aquatic plant growth have, at times, impaired 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 Department of Water and Waste Management, (360) 357-2491 (lake stage and precipitation data).

Water Quality Data - Thurston County Environmental Health Division, www.co.thurston.wa.us/health/ehswat/swater.htm (360) 754-4111.

**GENERAL DISCUSSION:**

The lake is separated into two distinct basins by fill from the railroad tracks. Water quality is 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 has been no major lake management activities since that time. However, water quality monitoring during the summer months has been conducted by the County.

The temperature, pH, dissolved oxygen, and conductivity measurements are displayed on profile graphs found after the narrative at the end of this chapter. In both basins, the lake was weakly temperature stratified from May through September. Stratified means that the lake develops a warm surface layer as solar radiation warmed the upper water, but a layer of water at the bottom stays cool. Because Pattison Lake is fairly shallow, and the south basin more shallow than the north, the warm upper water and the cooler lower water are not very distinct layers and sometimes mix during the summer. During May through September, the dissolved oxygen levels near the bottom were close to zero.

The 2007 average secchi disk transparency in the north basin, was 1.4 meters (or 4.7 feet), with a range from 1 meters in May to 2.1 meters in September (3.3 to 6.9 feet). In the south basin, the 2007 average secchi disk transparency was 2 meters (or 6.6 feet) with a range from 0.9 meters in October to 2.5 meters in July, August, and September (or 3 to 8.3 feet). The average water clarity measured in each basin over the past twelve years is shown on graphs at the end of this chapter. The water clarity in the North Basin in 2006 and 2007 was the lowest it had been since 1999.

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. Graphs of the tropic state indices for each basin for the years monitored are included at the end of this chapter.

The 2007 North Pattison Lake TSIs for total phosphorus, chlorophyll *a*, and secchi disk are 51, 58, and 55, respectively. Most years the trophic state of the north basin is mesotrophic, or moderately productive. However, in 2007 all three indices were in the eutrophic, or highly productive, range, which reflects high algae growth and low water clarity.

The 2007 South Pattison Lake TSIs for total phosphorus, chlorophyll *a*, and secchi disk are 50, 60, and 50, respectively. Typically, the south basin has higher phosphorus levels and more algae growth than the north basin. However, in 2007 the south basin had slightly better water quality, as shown by two of the three indices falling at the upper range of the mesotrophic range, or moderately productive.

## Major Issues:

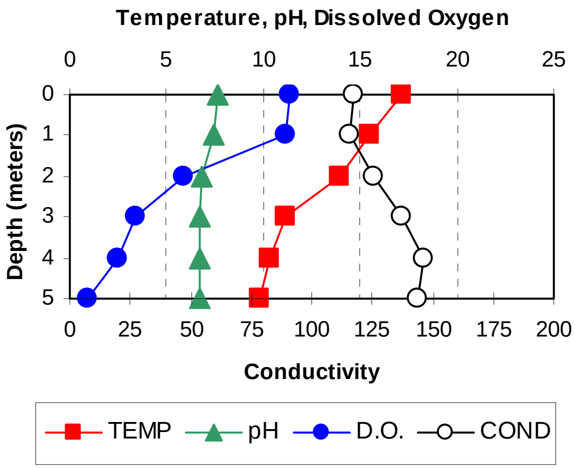
- Blockages in the outlet channel in past years have caused the lake level to rise, flooding docks and yards.
- Abundant nutrients often create algae blooms, which reduce water clarity. Nutrients also stimulate filamentous algae growth, especially in the south basin, which form floating mats on the surface that impair recreational uses.

## Funding Sources:

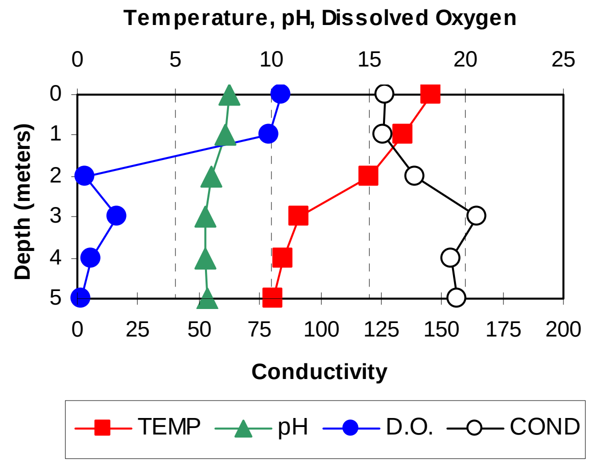
Thurston County funding will support continued sampling in 2008.

# NORTH PATTISON

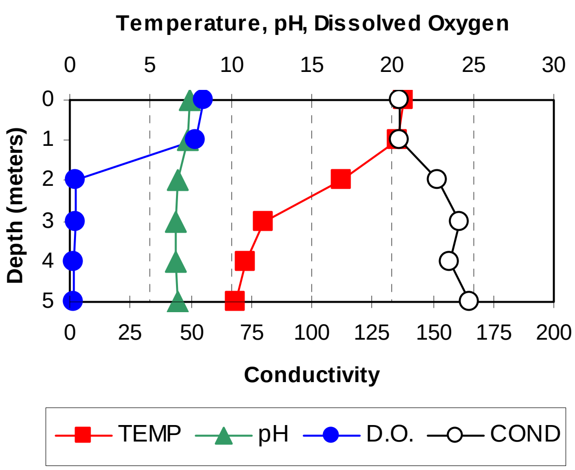
## May 22 2007



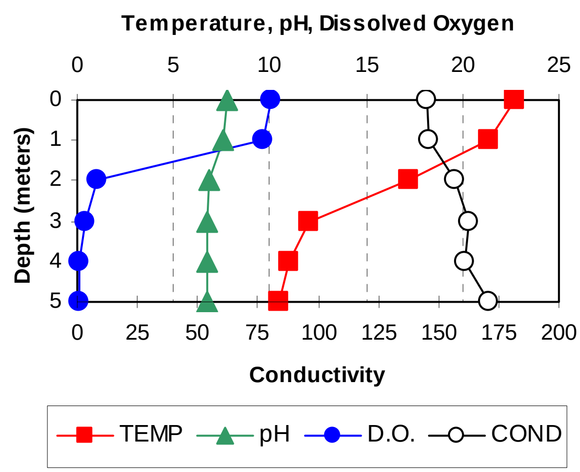

## June 19 2007



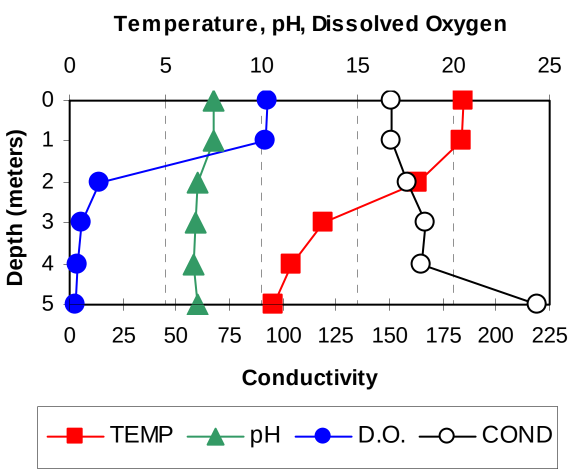

## July 24, 2007




## August 15, 2007




## September 10, 2007

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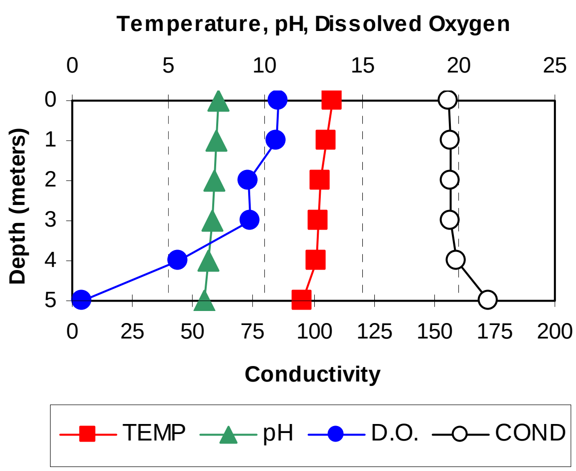
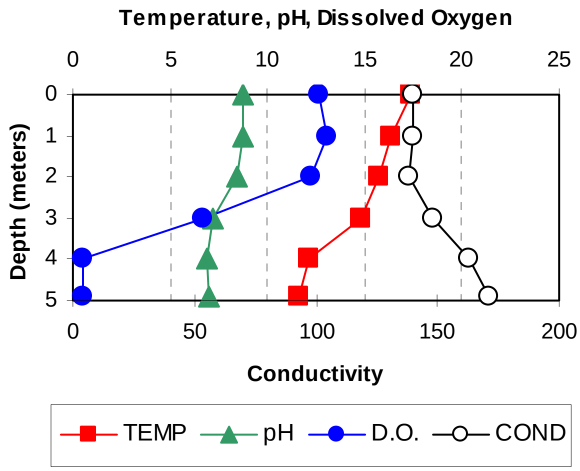
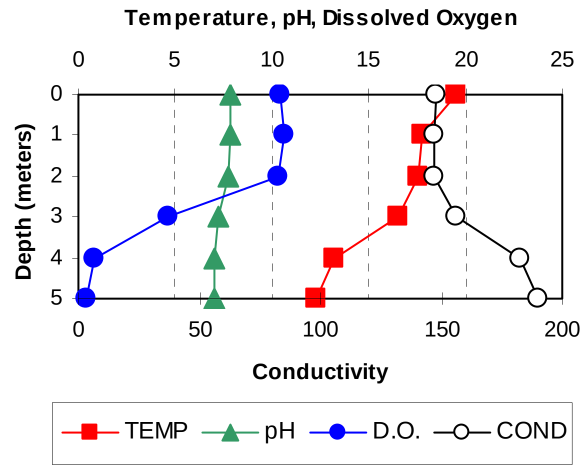


# SOUTH PATTISON

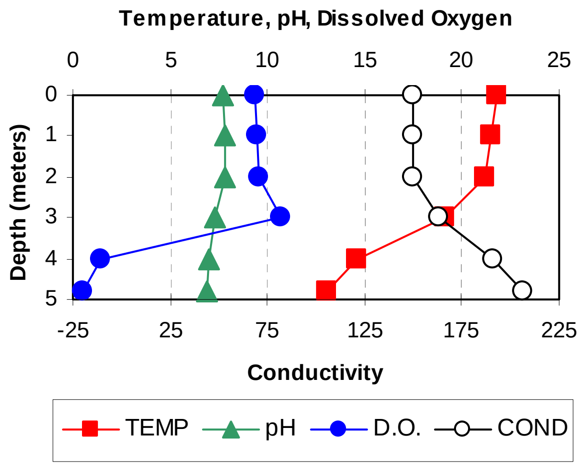
## May 22 2007



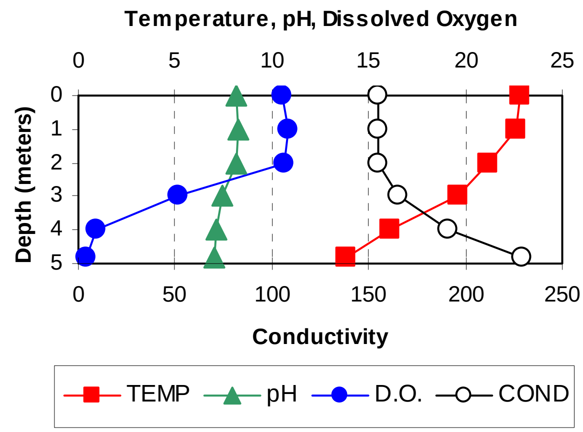

## June 19 2007



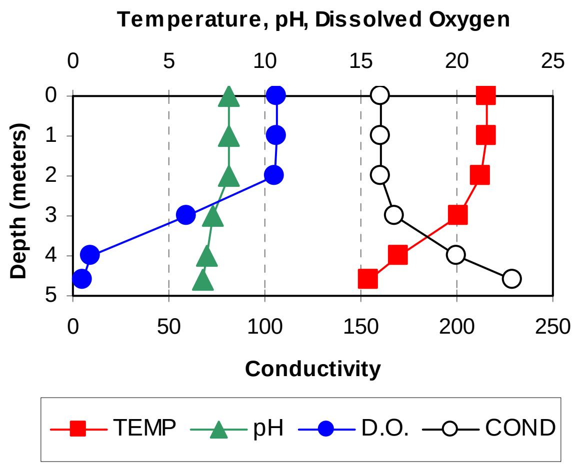

## July 24, 2007



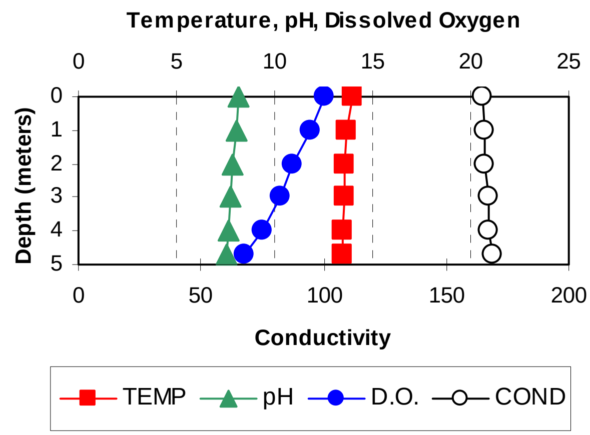

## August 15, 2007

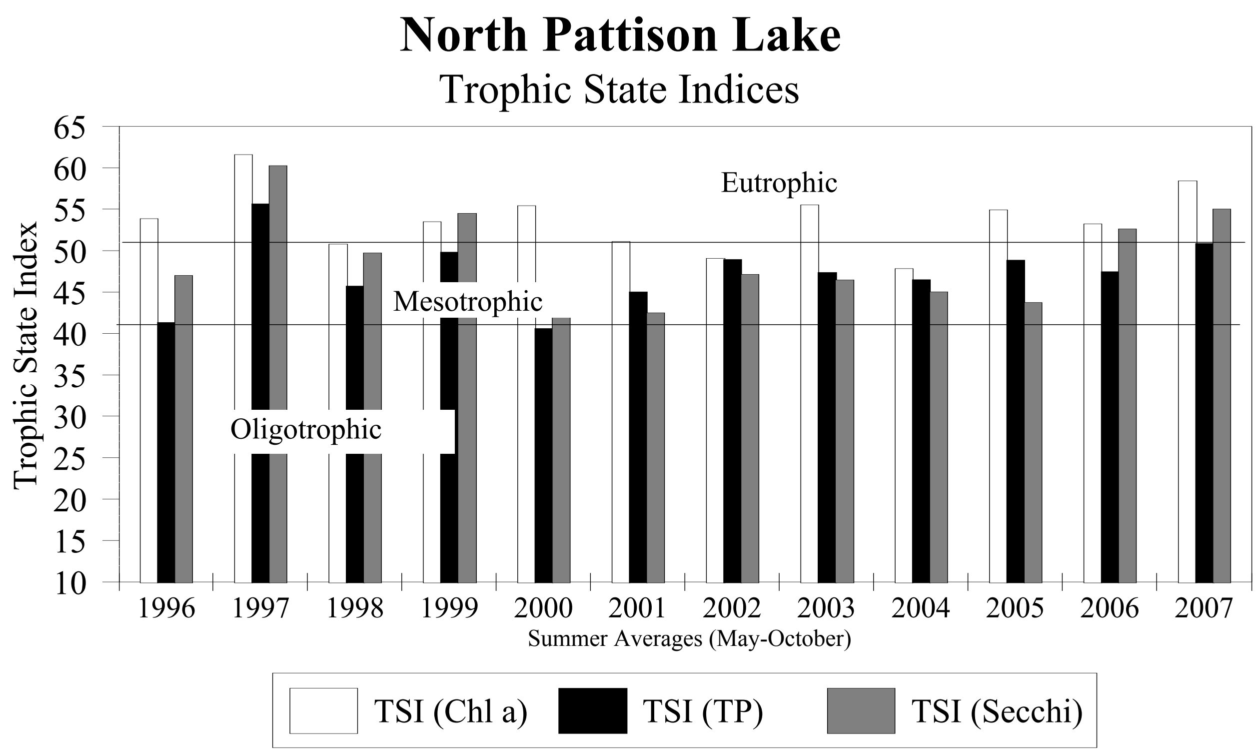


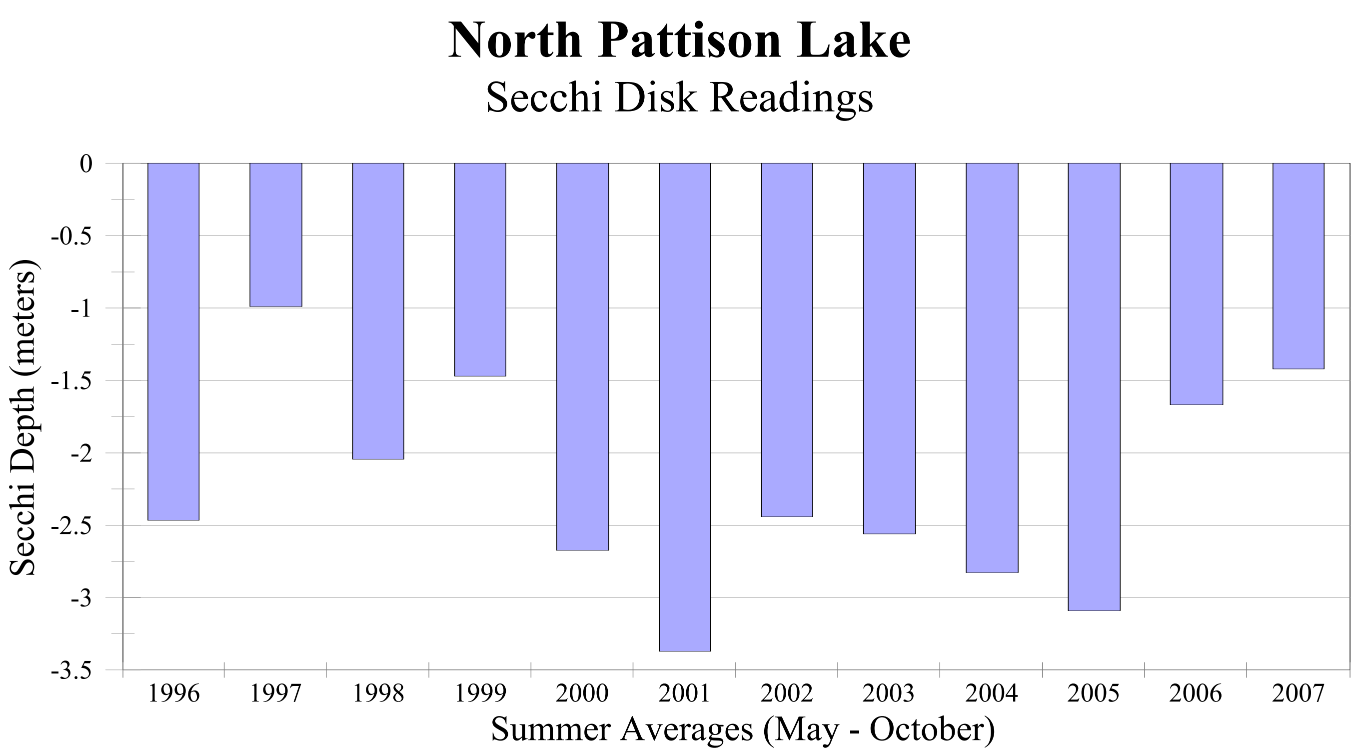

## September 10, 2007

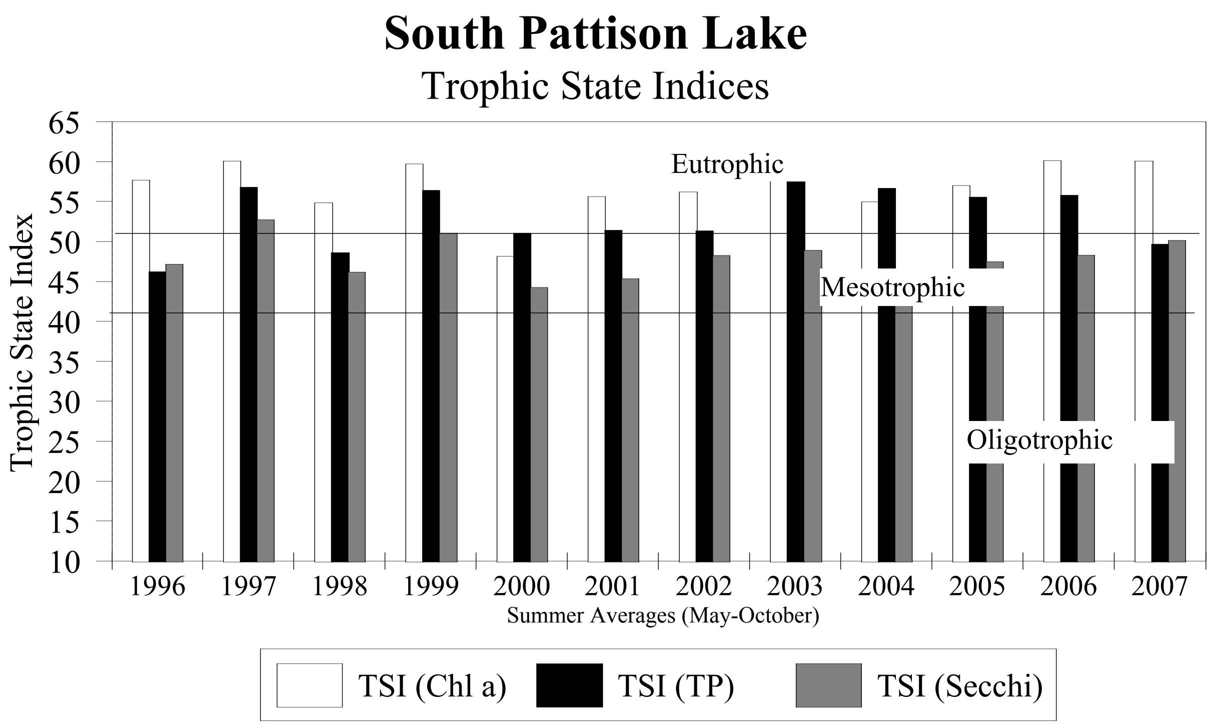


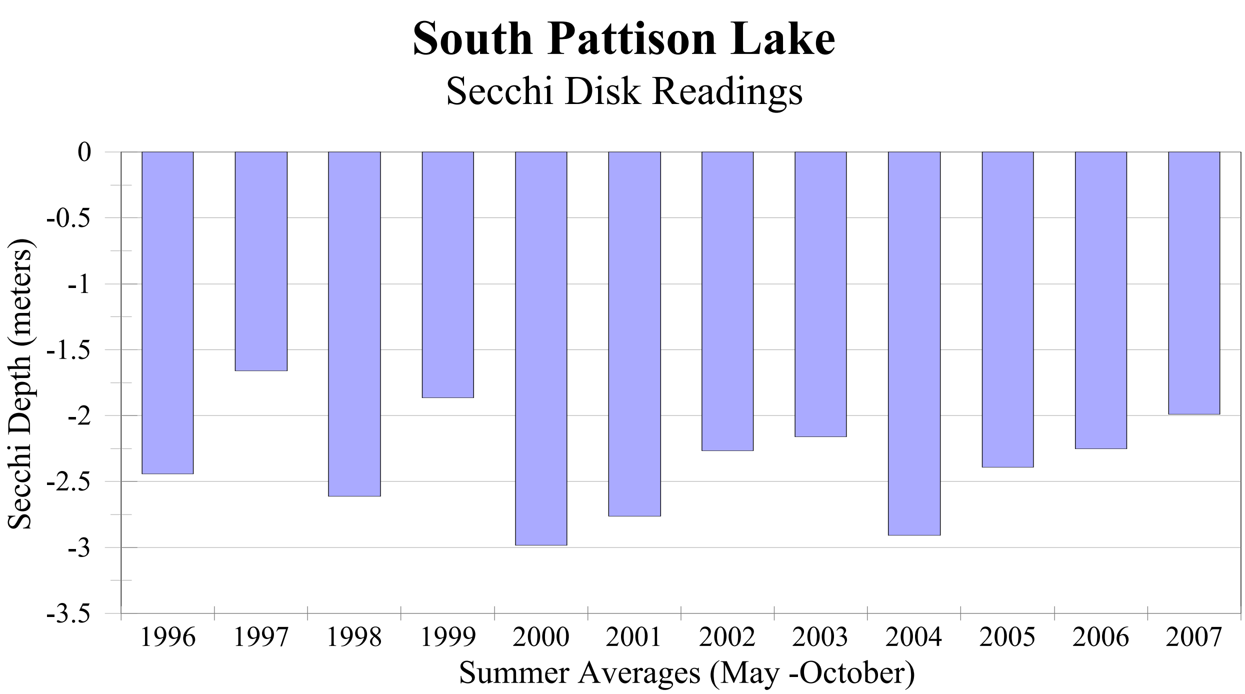

## October 15, 2007




North Pattison Lake
Trophic State Indices
Trophic State Index
65
60
55
50
45
40
35
30
25
20
15
10
Eutrophic
Mesotrophic
Oligotrophic
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)
TSI (Chl a)
TSI (TP)
TSI (Secchi)


North Pattison Lake
Secchi Disk Readings
Secchi Depth (meters)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May - October)


South Pattison Lake
Trophic State Indices
Trophic State Index
65
60
55
50
45
40
35
30
25
20
15
10
Eutrophic
Mesotrophic
Oligotrophic
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)
TSI (Chl a)
TSI (TP)
TSI (Secchi)


South Pattison Lake
Secchi Disk Readings
Secchi Depth (meters)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May -October)

## North Pattison Lake

**Site ID#** *HENNPL010*

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/22/2007 | 2:00:00 PM | 5.3 | 4.5 | 0.016 | 0.019 | 1.400 | 1.880 | 1.00 | 15 | 7.5 | #9 dk orange | Chl a & algae composite @ 1M. |
| 06/19/2007 | 12:15:00 PM | 5.3 | 4.5 | 0.029 | 0.019 | 1.330 | 1.990 | 1.13 | 19 | 4.9 | #9 orange | Chl a & algae composite @ .5 & 1M. |
| 07/24/2007 | 12:00:00 PM | 5.3 | 4.5 | 0.028 | 0.022 | 1.160 | 1.910 | 1.26 | 9.6 | 2.3 | #8 dk orange | Chl a & algae sample @ 1M. |
| 08/15/2007 | 2:20:00 PM | 5.2 | 4.5 | 0.014 | 0.022 | 0.950 | 1.790 | 1.75 | 12 | 1.2 | #9 orange | Chl a & algae composite @ 0.5 & 1M. |
| 09/10/2007 | 1:20:00 PM | 5.1 | 4.5 | 0.020 | 0.092 | 0.915 | 1.600 | 2.09 | 21 | 2.8 | #8 yellow-orange | Chl a & algae composite @ 0.5 & 1M. |
| 10/15/2007 | 1:30:00 PM | 5.2 | 4.5 | 0.046 | 0.032 | 1.400 | 1.280 | 1.26 | 26 | 6.7 | #8 yellow-orange | |

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

| Averages: | | |
|---|---|---|
| | **Sur TP** | *0.026* |
| | **Secchi** | *1.42* |
| | **Chl a** | *17.1* |

## South Pattison Lake

**Site ID#** *HENSPL010*

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/22/2007 | 2:00:00 PM | 4.9 | 4.0 | 0.025 | 0.030 | 1.310 | 1.260 | 1.05 | 27 | 7.2 | #7 yellow | Chl a & algae composite @ 1 & 2M. |
| 06/19/2007 | 12:45:00 PM | 5 | 4.0 | 0.025 | 0.053 | 0.929 | 0.947 | 2.37 | 12 | 4.2 | #7 yellow | Chl a & algae composite @ 1 & 2M. |
| 07/24/2007 | 12:30:00 PM | 4.8 | 4.0 | 0.018 | 0.129 | 0.967 | 0.960 | 2.53 | 5.3 | 2.5 | #7 yellow-orange | Chl a & algae composite @ 1, 2, & 3M. |
| 08/15/2007 | 2:45:00 PM | 4.8 | 4.0 | 0.016 | 0.085 | 0.625 | 0.812 | 2.51 | 5.9 | 2.7 | #6 greenish-yellow | Chl a & algae composite @ 1 & 2M. |
| 09/10/2007 | 1:45:00 PM | 4.6 | 4.0 | 0.017 | 0.027 | 0.602 | 0.582 | 2.51 | 8.5 | 3.4 | #6 yellow-green | Chl a & algae composite @ 1 & 2M. |
| 10/15/2007 | 2:15:00 PM | 4.7 | 4.0 | 0.040 | 0.036 | 1.070 | 0.764 | 0.93 | 63 | 8 | #3 pea-green | Chl a & algae composite @ 1 & 2M. Major algae scum at boat launch. |

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

**Averages:**

| | |
|---|---|
| **Sur TP** | *0.024* |
| **Secchi** | *1.98* |
| **Chl a** | *20.3* |

# *Algae data:* North Pattison Lake

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| *05/22/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☑ |
| | CP | Chroomonas species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DT | Asterionella species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Mallomonas species | ☐ |
| *06/19/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | CP | Chroomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | GR | Oocystis species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | YL | Synura species | ☑ |
| *07/24/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | DF | Ceratium species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Ankyra judayi | ☐ |
| | YL | Dinobryon species | ☐ |
| *08/15/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | CP | Chroomonas species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | GR | Staurastrum species | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Synura species | ☐ |

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| 09/10/2007 | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | BG | Chroococcus species | ☐ |
| | DF | Ceratium species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | GR | Botryococcus species | ☐ |
| | GR | Elakatothrix species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | GR | Staurastrum species | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Synura species | ☐ |
| 10/15/2007 | | | |
| | BG | Aphanizomenon flos-aquae | ☑ |
| | CP | Cryptomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Elakatothrix species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | GR | Staurastrum species | ☐ |
| | YL | Dinobryon species | ☐ |

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

# *Algae data:* South Pattison Lake

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| *05/22/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☑ |
| | CP | Chroomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Fragilaria species | ☐ |
| | GR | Elakatothrix species | ☐ |
| | GR | Staurastrum species | ☐ |
| *06/19/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | BG | Coelosphaerium species | ☐ |
| | CP | Chroomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | GR | Ankyra judayi | ☐ |
| | GR | Oocystis species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | GR | Staurastrum species | ☐ |
| | GR | Tetraspora species | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Synura species | ☐ |

| Type | Description | Dominant in Sample |
|---|---|---|

*07/24/2007*

| Type | Description | Dominant in Sample |
|---|---|---|
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Aphanothece species | ☐ |
| BG | Chroococcus species | ☐ |
| BG | Coelosphaerium species | ☐ |
| CP | Chroomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Fragilaria species | ☐ |
| EU | Trachelomonas species | ☐ |
| GR | Botryococcus species | ☐ |
| GR | Oocystis species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| GR | Staurastrum species | ☐ |
| YL | Dinobryon species | ☐ |

*08/15/2007*

| Type | Description | Dominant in Sample |
|---|---|---|
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Aphanocapsa species | ☐ |
| BG | Aphanothece species | ☐ |
| BG | Microcystis species | ☐ |
| CP | Chroomonas species | ☐ |
| CP | Cryptomonas species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Fragilaria species | ☐ |
| DT | Synedra species | ☐ |
| EU | Trachelomonas species | ☐ |
| GR | Ankyra judayi | ☐ |
| GR | Botryococcus species | ☐ |
| GR | Elakatothrix species | ☐ |
| GR | Eudorina species | ☐ |
| GR | Eutetramorus globosus | ☐ |
| GR | Oocystis species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| GR | Staurastrum species | ☐ |

| Type | Description | Dominant in Sample |
|---|---|---|
| *09/10/2007* | | |
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Aphanocapsa species | ☐ |
| BG | Aphanothece species | ☐ |
| BG | Chroococcus species | ☐ |
| BG | Eucapsis alpina | ☐ |
| CP | Cryptomonas species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Fragilaria species | ☐ |
| DT | Melosira species | ☐ |
| DT | Synedra species | ☐ |
| GR | Ankistrodesmus species | ☐ |
| GR | Radiococcus nimbatus | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| GR | Staurastrum species | ☐ |
| YL | Dinobryon species | ☐ |
| *10/15/2007* | | |
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☑ |
| BG | Coelosphaerium species | ☐ |
| BG | Microcystis species | ☐ |
| CP | Chroomonas species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Melosira species | ☐ |
| EU | Trachelomonas species | ☐ |
| GR | Botryococcus species | ☐ |
| GR | Botryococcus species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| GR | Staurastrum species | ☐ |
| GR | Staurastrum species | ☐ |
| YL | Dinobryon species | ☐ |

| *Type* | *Description* | *Dominant in Sample* |
|---|---|---|

***Key:***

| | |
|---|---|
| *BG = Blue green* | *EU = Euglenophyte* |
| *CP = Cryptophyte* | *GR = Green* |
| *DF = Dinoflagellate* | *YL = Yellow* |
| *DT = Diatom* | |

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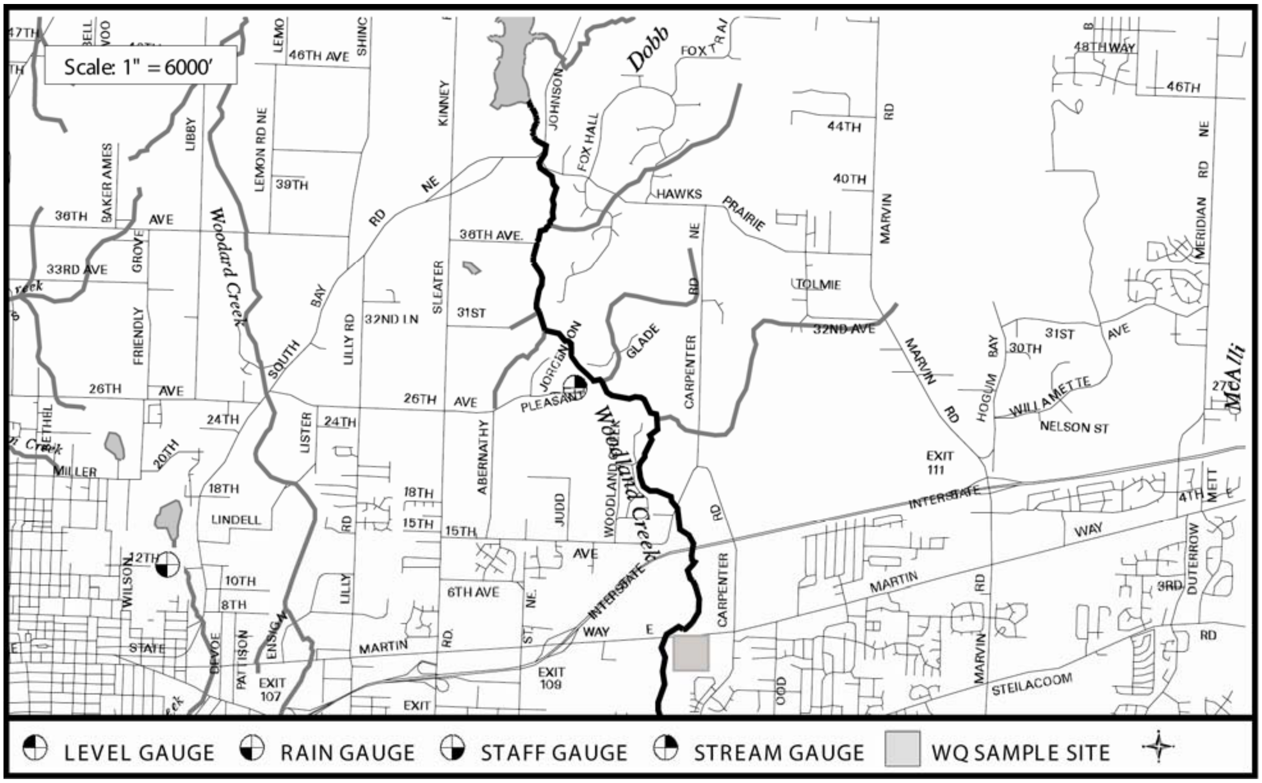


**PART OF HENDERSON WATERSHED**

**PRIMARY LAND USES:**
Urban residential
Commercial

**GENERAL TOPOGRAPHY:**
The Tanglewilde outfall is a stormwater outfall that discharges into Woodland Creek. The stormwater system collects runoff from the Tanglewilde neighborhood and portions of Martin Way and Carpenter Road. It also carries shallow ground water that infiltrates into the storm water system during wet periods of the year.

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

Fair - Failed part II of the fecal coliform standard for both water years 2005/06 and 2006/07. Has very high nitrate levels.

**OTHER DATA:**

Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

Washington Department of Ecology, Water quality data from Henderson TMDL study, (360) 407-6000.

Thurston County Department of Water and Waste Management, (360)357-2491 or www.co.thurston.wa.us/monitoring

The Tanglewilde stormwater outfall was added to the ambient monitoring network in 2005. This stormwater discharges into Woodland Creek, which is a tributary to Henderson Inlet. Woodland Creek is listed on the1998 303d Section of the Clean Water Act for fecal coliform, temperature and dissolved oxygen standards violations in the upper reaches of the creek. A Total Maximum Daily Load (TMDL) study was begun in the winter of 2002/03 by Washington Department of Ecology. The TMDL report identifies the Tanglewilde stormwater outfall as a major source of bacteria and nitrogen pollution to Woodland Creek.

During the 2005-06 water year, ten samples were collected at this site and in water year 2006/07, eight samples were collected. (This outfall is often dry in summer months.)The water quality standard for fecal coliform has two parts: part I - the geometric mean shall not exceed 50 colony forming units per 100 milliliters of sample, *and* part II - no more than 10 percent of the samples shall exceed 100 colonies/100 mL of sample. For both water years, the outfall met part I of the fecal coliform standard but did not meet part II. In 2005/06, 30 percent of the samples were greater than 100 and in 2006/07, 25 percent were greater than 100. Nitrate results are consistently very high in this discharge. The average is 8.68 mg/l for 2005/06 and 6.25 mg/l for 2006/07. While there is no water quality standard for nitrates in surface water, the typical background concentration is less than 1 mg/l in surface water. The drinking water limit is 10 mg/l. This stormwater has infiltration of shallow ground water, and the high nitrate values likely reflect local contamination of the shallow ground water.

## Major Issues:

- This stormwater outfall is contributing to water quality problems in Woodland Creek.
- On-site septic systems and other urban activities are contributing to the contamination of the shallow ground water in the area, which is infiltrating into the stormwater system.

## Funding Sources:

- Local Storm and Surface Water Utility

# Water Quality Summary
## Conventional Parameters
## Tanglewilde Stormwater Outfall

| Parameter | Units | **WQ Standard**<br>WAC 173-201A | Water Year Data: 2005/06 and 2006/07 | | | | Water Year Data 2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD<br>Max of 16 º C | 05-06<br>06-07 | | 10.22 – 13.02<br>9.7 – 18.91 | 0 of 7<br>1 of 8 | | 7.87 – 14.39 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 9.5 | 05-06<br>06-07 | | 10.9 – 12.96<br>9.07 – 12.26 | 1 of 7<br>0 of 7 | | 10.1 – 12.5 |
| Conductivity | µmhos/cm | | 05-06<br>06-07 | 195<br>160 | 168 – 229<br>71 - 216 | | 164 | 67 - 225 |
| pH | | 6.5 - 8.5 | 05-06<br>06-07 | 7.4*<br>7.3* | 6.8 – 7.7<br>7.0 – 7.6 | 0 of 7<br>0 of 8 | 7.4 | 7.0 – 7.8 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05-06<br>06-07 | 1.54<br>4.88 | 0 – 6.9<br>0 – 18.5 | 1 of 7<br>2 of 8 | 4.9 | 0 - 14 |
| Fecal Coliform | colonies / 100 ml | GMV: ≤50 and ≤ 10% not to exceed 100 | 05-06<br>06-07 | 10**<br>5** | 0 -195<br>0 - 310 | **% exceeding 100**<br>30%<br>25% | 127 | 5 - 7300 |
| Total Phosphorus | mg/L | | 05-06<br>06-07 | 0.140<br>0.116 | 0.096 – 0.208<br>0.1 – 0.132 | | 0.154 | 0.102 – 0.195 |
| Nitrate+Nitrite-nitrogen | mg/L | | 05-06<br>06-07 | 8.68<br>6.25 | 6.54 – 12.4<br>2.42 – 8.78 | | 6.777 | 2.32 – 9.15 |
| Ammonia | mg/L | | 05-06<br>06-07 | 0.027<br>0.016 | <0.010 – 0.208<br><0.010 – 0.071 | | 0.023 | <0.010 – 0.04 |

* Median
** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/7/2005 | 10:00:00 AM | 10.68 | 7.5 | 12.96 | 173 | 100 | 2.3 | 0.40 | 0.116 | 6.540 | NH4 result <0.010 |
| 12/5/2005 | 2:00:00 PM | 10.22 | 7.7 | 12.19 | 229 | 0 | 0.0 | 0.09 | 0.163 | 12.400 | NH4 result <0.010, FC is <5. |
| 1/3/2006 | 3:45:00 PM | 10.98 | 7.1 | 11.79 | 168 | 165 | 6.9 | 0.64 | 0.129 | 7.500 | NH4 result <0.010 |
| 2/6/2006 | 1:55:00 PM | 11.59 | 6.8 | 11.48 | 168 | 10 | 0.6 | 2.12 | 0.096 | 7.630 | NH4 result <0.010 |
| 3/14/2006 | 1:45:00 PM | 10.90 | 7.5 | 10.92 | 198 | 0 | 0.5 | 0.22 | 0.129 | 9.370 | NH4 result <0.010, FC is <5. |
| 4/25/2006 | 10:00:00 AM | 11.79 | 7.7 | 11.43 | 214 | 0 | 0.1 | 0.07 | 0.126 | 8.540 | Flow is estimate, SW3 not calibrating properly, FC is <5. |
| 5/15/2006 | 2:20:00 PM | 13.02 | 7.2 | 10.94 | 216 | 0 | 0.4 | | 0.132 | 9.120 | NH4 result <0.010, FC is <5. Low flow, no YSI or flow measurements |
| 6/12/2006 | 12:00:00 PM | | | | | 195 | | | 0.125 | 8.440 | NH4 result <0.010, Low flow, no YSI or flow measurements |
| 7/11/2006 | 12:40:00 PM | | | | | 5 | | | 0.208 | 8.690 | Low flow, no YSI or flow measurements. |
| 8/7/2006 | 4:00:00 PM | | | | | 40 | | | 0.181 | 8.624 | Low flow, no YSI or flow measurements. Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high. |

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/14/2006 | 2:30:00 PM | 13.44 | 7.0 | 10.87 | 190 | 10 | 0.5 | 0.85 | 0.127 | 7.790 | NH4 result was <0.010 |
| 12/11/2006 | 2:45:00 PM | 10.54 | 7.2 | 11.75 | 71 | 310 | 17.0 | 0.72 | 0.105 | 2.420 | |
| 1/23/2007 | 3:00:00 AM | 11.26 | 7.1 | 12.26 | 183 | 0 | 0.0 | 0.59 | 0.111 | 7.300 | F.C. is <5. |
| 2/20/2007 | 1:40:00 PM | 9.70 | 7.6 | 10.93 | 139 | 115 | 2.9 | 0.32 | 0.100 | 4.930 | NH4 result is <0.010 |
| 3/20/2007 | 2:00:00 PM | 11.30 | 7.5 | | 190 | 10 | 0.0 | 0.50 | 0.113 | 7.540 | DO not working. NH4 result <0.010 |
| 4/25/2007 | 1:00:00 PM | 11.91 | 7.5 | 11.43 | 205 | 0 | 0.0 | 0.14 | 0.115 | 8.500 | F.C. result was <5. NH4 result <0.010 |
| 5/16/2007 | 1:10:00 PM | 12.96 | 7.4 | 11.74 | 216 | 0 | 0.1 | 0.03 | 0.132 | 8.780 | F.C. result was <5. Flow is very shallow |
| 7/18/2007 | 2:50:00 PM | 18.91 | 7.2 | 9.07 | 84 | 0 | 18.5 | 0.03 | 0.128 | 2.740 | Marginal flow, F.C. result is <5. |

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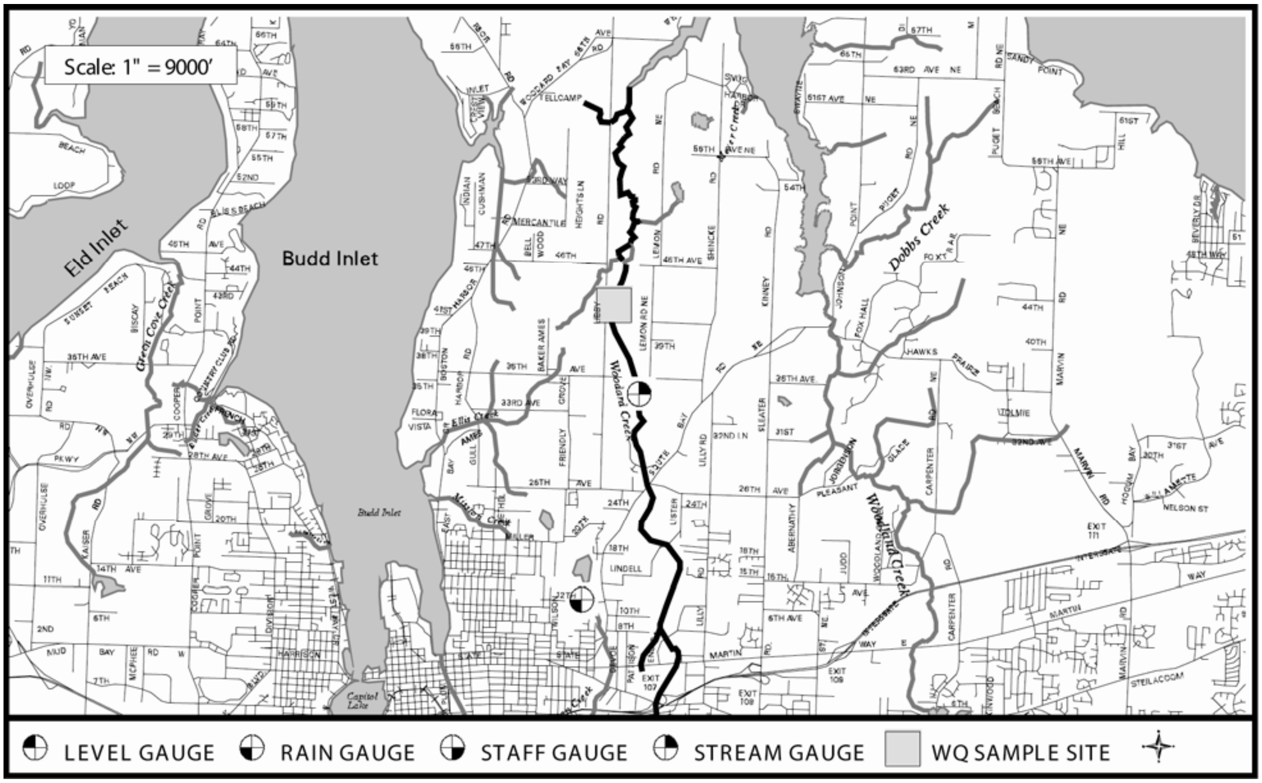



**PART OF HENDERSON WATERSHED**

**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.

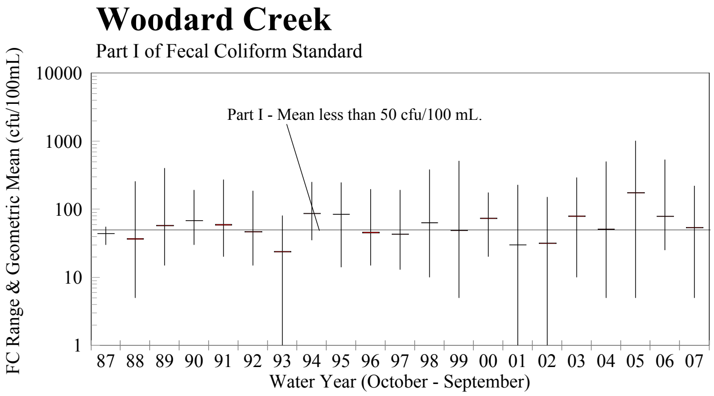
**GENERAL WATER QUALITY:** (Excellent, Good, Fair, Poor)

Fair - Failed both parts of the fecal coliform water quality standard in both water years 2005/06 & 2006/07. Listed on 303d list for past violations of fecal coliform, dissolved oxygen and pH standards. The pH standard was met during the last two water years. The dissolved oxygen standard was violated only one time during the 2006/07 water year.

**OTHER DATA:**

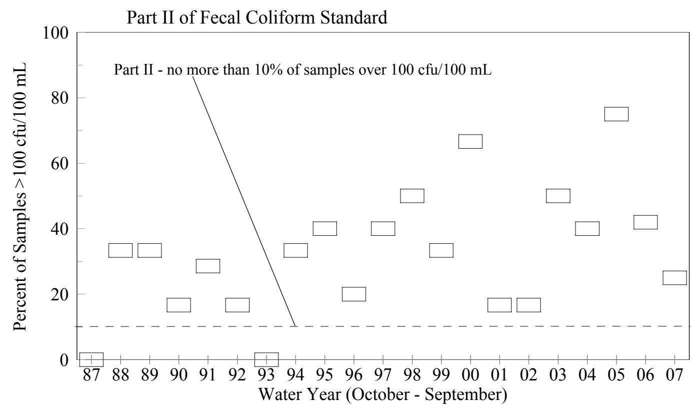
Thurston County Environmental Health Division, (360)754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

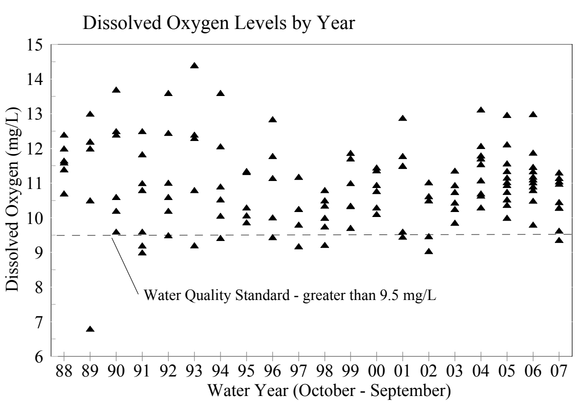
Thurston County Department of Water and Waste Management, (360) 357-2491 (flow data) or www.co.thurston.wa.us/monitoring




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.

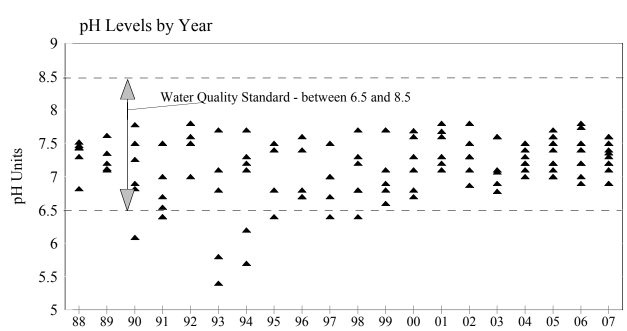
In 2005/06 and 2006/07, the creek failed both parts of the standard. Woodard Creek has a history of failing the bacteria standard and is included on a list of impaired water bodies that is prepared every two years by the Washington Department of Ecology.




The water qality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. There is a history of dissolved oxygen measurements that are at or below the minimum during summer low-flow periods. There was one measurement below the standard during water year 2006/07.

The standard for pH requires the pH to be within the range of 6.5 to 8.5. There were no measurements outside the standard since 1998.



Woodard Creek has been monitored by Thurston County since 1983. Considerable work has been done to improve water quality, including: stormwater sampling, basin planning, intensive stream sampling, and constructed stormwater treatment facilities. The primary impact at the head of the creek is urban stormwater. Numerous animal-keeping farm sites are located along the mid-stretch of the stream. 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 conducted a Total Maximum Daily Load (TMDL) study in the Henderson Inlet watershed, including Woodard Creek, beginning in the winter of 2002/03. A water clean-up plan to address water quality problems is identified in the technical report. The Thurston County Board of Health created the Henderson Watershed Protection Area in 2005. The Septic System Operation & Maintenance program went into effect in this area in 2007 and includes septic system education, inspections and operation and maintenance certification.

## Major Issues:

- Agricultural practices
- Urban stormwater

## Funding Sources:

- Local Storm and Surface Water Utility
- Thurston County Henderson Watershed Protection Area Operation and Maintenance Program

# Water Quality Summary

Conventional Parameters

**Woodard Creek**



| **Parameter** | **Units** | **WQ Standard** WAC 173-201A | **Water Year Data: 2005/06 & 2006/07** | | | | **Cumulative Data:** 1987-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | ° C | Highest 7-DAD Max of 16 ° C | 05-06<br>06-07 | | 5.43 – 14.45<br>7.39 – 14.34 | 0 of 12<br>0 of 12 | | 2.00 - 16.21 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 9.5 | 05-06<br>06-07 | | 9.8 – 13.0<br>9.36 – 11.3 | 0 of 11<br>1 of 10 | | 6.80 - 14.40 |
| Conductivity | μmhos/cm | | 05-06<br>06-07 | 132<br>130 | 94 - 160<br>82 - 161 | | 126 | 52 - 265 |
| pH | | 6.5 - 8.5 | 05-06<br>06-07 | 7.4*<br>7.4* | 6.9 – 7.8<br>6.9 – 7.6 | 0 of 12<br>0 of 12 | 7.2* | 5.4 - 7.8 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05-06<br>06-07 | 2.9<br>3.6 | 0.4 - 5<br>1.3 – 8.1 | 0 of 12<br>0 of 12 | 3.36 | 1.3 - 19.0 |
| Fecal Coliform | colonies/ 100 ml | GMV: ≤50 and ≤ 10% not to exceed 100 | 05-06<br>06-07 | 79**<br>54** | 25 - 530<br>5 – 220 | **% exceeding 100**<br>42%<br>25% | 57** | 0 - 1000 |
| Total Phosphorus | mg/L | | 05-06<br>06-07 | 0.036<br>0.040 | 0.026 - 0.051<br>0.022 - 0.062 | | 0.037 | 0.011 - 0.112 |
| Nitrate+Nitrite-nitrogen | mg/L | | 05-06<br>06-07 | 0.865<br>0.714 | 0.422 – 1.29<br>0.253 – 1.12 | | 0.729 | 0.353 - 1.56 |

* Median

** Geometric mean value (GMV)

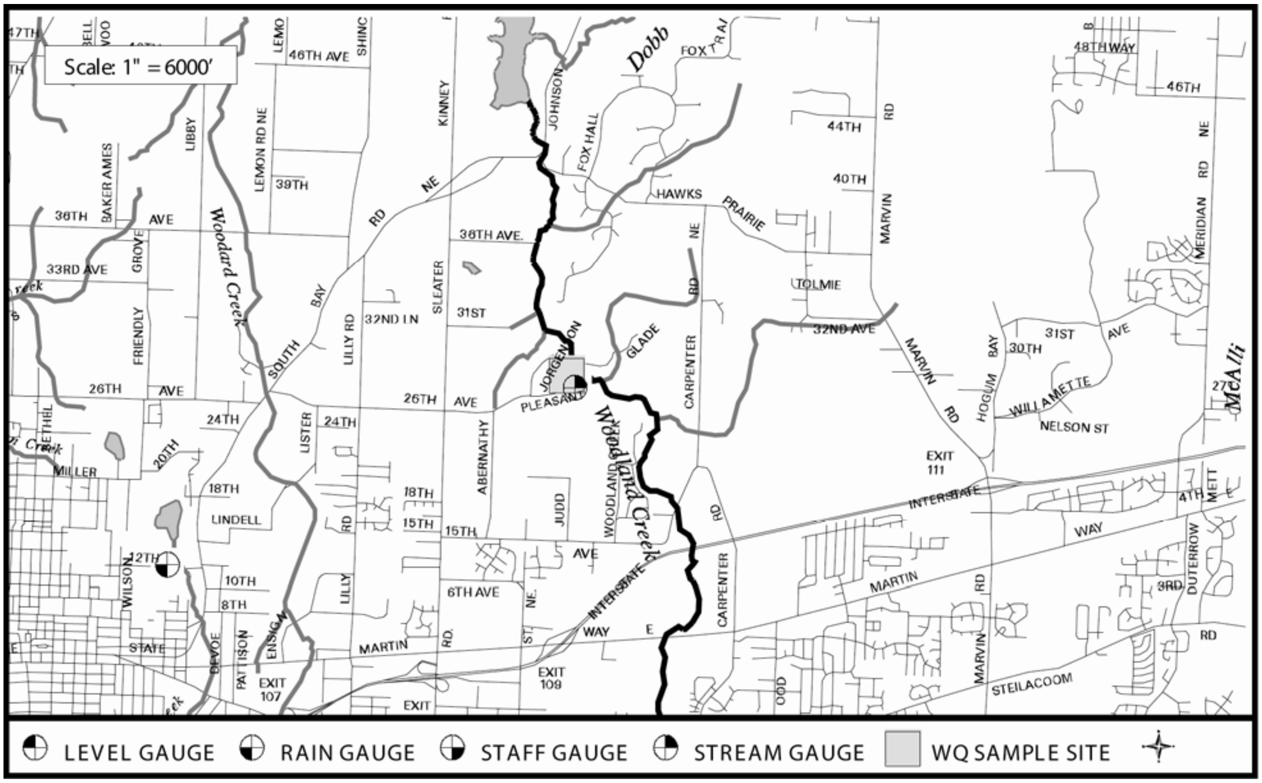
| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/12/2005 | 10:45:00 AM | 10.29 | 7.5 | 11.02 | 157 | 530 | 0.4 | 2.19 | 0.030 | 0.727 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/7/2005 | 9:30:00 AM | 7.56 | 6.9 | 11.47 | 95 | 125 | 2.7 | 12.99 | 0.051 | 0.422 | |
| 12/5/2005 | 1:00:00 PM | 5.43 | 7.2 | 12.99 | 124 | 25 | 1.1 | 5.64 | 0.030 | 0.586 | |
| 1/3/2006 | 3:00:00 PM | 6.55 | 7.5 | 11.88 | 95 | 75 | 2.8 | 12.30 | 0.040 | 0.738 | |
| 2/6/2006 | 1:00:00 PM | 6.46 | 7.0 | 11.19 | 94 | 48 | 2.3 | 28.10 | 0.026 | 0.841 | |
| 3/14/2006 | 2:45:00 PM | 8.14 | 7.2 | 9.80 | 123 | 45 | 3.8 | 15.10 | 0.030 | 0.940 | |
| 4/25/2006 | 11:20:00 AM | 10.25 | 7.4 | 11.11 | 137 | 45 | 3.7 | 9.26 | 0.038 | 0.763 | |
| 5/15/2006 | 3:00:00 PM | 13.14 | 7.4 | 10.49 | 143 | 40 | 5.0 | 7.69 | 0.047 | 0.834 | |
| 6/12/2006 | 12:45:00 PM | 12.83 | 7.4 | 10.90 | 145 | 25 | 3.6 | 5.89 | 0.031 | 0.863 | |
| 7/11/2006 | 1:50:00 PM | 12.94 | 7.8 | | 156 | 110 | 3.2 | 3.79 | 0.046 | 1.290 | no DO measurement |
| 8/7/2006 | 3:00:00 PM | 14.45 | 7.4 | 11.34 | 160 | 128 | 4.0 | 3.02 | 0.030 | 1.240 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/13/2006 | 9:00:00 AM | 11.85 | 7.7 | 10.80 | 159 | 295 | 1.9 | 2.16 | 0.034 | 1.140 | |

## Thurston County Water Resources Monitoring Report 2006- 2007

*Woodard Creek @ Mouth 4116 Libby Rd. NE*

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 11:00:00 AM | 9.68 | 7.5 | 11.15 | 161 | 75 | 1.4 | 4.40 | 0.026 | 1.120 | |
| 11/14/2006 | 1:30:00 PM | 7.39 | 6.9 | 10.45 | 90 | 30 | 2.3 | 14.67 | 0.031 | 0.253 | |
| 12/11/2006 | 1:45:00 PM | 7.85 | 7.1 | 10.98 | 111 | 185 | 5.2 | 15.00 | 0.037 | 0.454 | |
| 1/23/2007 | 4:15:00 AM | 7.76 | 7.2 | 11.27 | 125 | 20 | 1.3 | 16.26 | 0.022 | 0.893 | |
| 2/20/2007 | 2:30:00 PM | 7.49 | 6.9 | 9.36 | 82 | 220 | 8.1 | 38.17 | 0.051 | 0.544 | |
| 3/20/2007 | 3:00:00 PM | 9.62 | 7.2 | | 117 | 30 | 2.5 | 19.73 | 0.041 | 0.548 | DO not working |
| 4/25/2007 | 3:15:00 PM | 10.82 | 7.4 | 11.05 | 133 | 5 | 4.0 | 11.44 | 0.041 | 0.772 | |
| 5/16/2007 | 12:00:00 PM | 11.51 | 7.4 | 11.31 | 139 | 70 | 3.1 | 9.82 | 0.040 | 0.726 | |
| 6/13/2007 | 12:45:00 PM | 12.39 | 7.5 | 10.29 | 148 | 58 | 3.6 | 7.24 | 0.045 | 0.813 | |
| 7/18/2007 | 4:00:00 PM | 14.34 | 7.3 | 9.63 | 151 | 35 | 6.3 | 6.19 | 0.062 | 0.722 | |
| 8/22/2007 | 12:15:00 PM | 13.83 | 7.6 | 10.29 | 153 | 118 | 3.2 | 4.28 | 0.042 | 0.853 | |
| 9/19/2007 | 10:30:00 AM | 11.82 | 7.6 | | 154 | 90 | 2.8 | 3.51 | 0.037 | 0.867 | DO not working |

# Woodland Creek #0006




**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 - Failed both parts of the fecal coliform standard. Listed on the 303d list for violations of fecal coliform, dissolved oxygen, and temperature, in the upper reach.

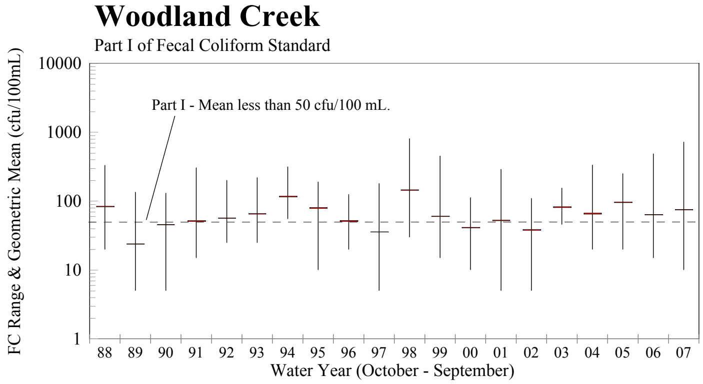
**OTHER DATA:**

Thurston County Environmental Health Division, (360) 754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

Washington Department of Ecology, Water quality data from Henderson TMDL study, (360) 407-6000.

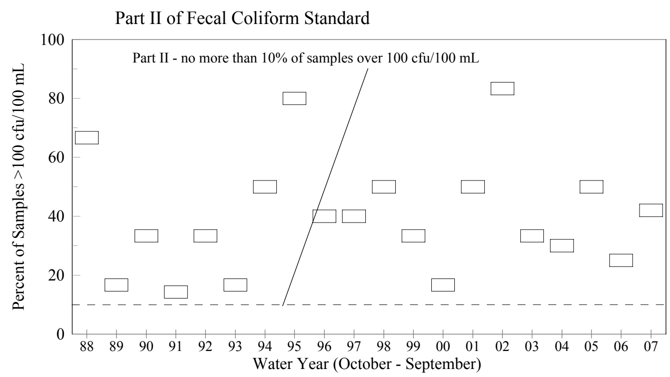
Thurston County Department of Water and Waste Management, (360)357-2491 or www.co.thurston.wa.us/monitoring

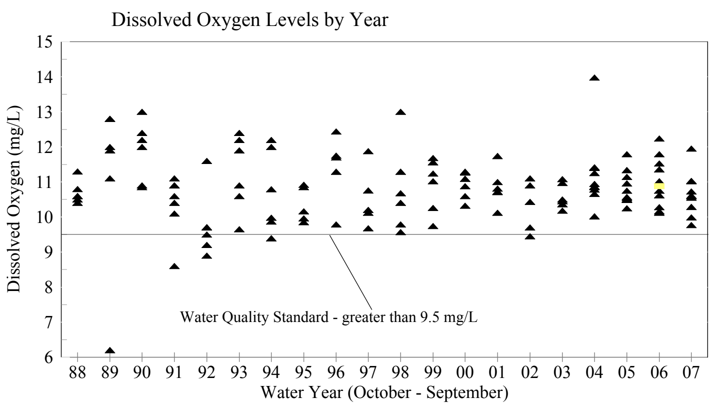
## Woodland Creek #0006




The water quality standard for fecal coliform has two parts: part I - the geometric mean shall not exceed 50 colony forming units per 100 milliliters of sample *and*, part II - no more than 10 percent of the samples shall exceed 100 colonies/100 mL of sample.

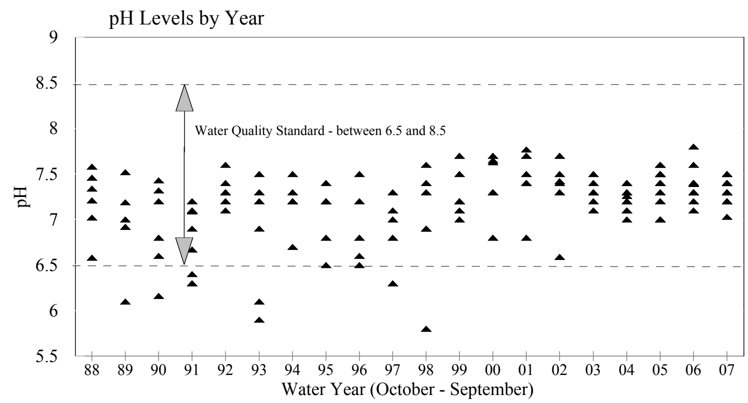
The water quality failed both parts of the bacteria standard in water years 2005/06 and 2006/2007. Throughout the period of record this creek has consistently failed part II and failed part I the majority of years.




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 2005/06 and 2006/07. Dissolved oxygen has occasionally been below the standard in past years, usually 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 1998.



Woodland Creek has been monitored by Thurston County since 1983. There have been numerous intensive study efforts during that time, including DNA ribotyping of E. coli in 2000. A considerable amount of remedial work has been done. Stormwater is clearly the biggest impact to the creek. Shellfish harvesting downgrades occurred in Henderson Inlet in October 2000, June 2001, and June 2005 due to bacterial pollution. Washington Department of Health data shows an increasing trend in fecal coliform pollution in the Inlet. In December 2001, Thurston County created the Henderson Shellfish Protection District. In 2002, 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. The Thurston County Board of Health created the Henderson Watershed Protection Area in 2005. The Septic System Operation & Maintenance program went into effect in this area in 2007 and includes septic system education, inspections and operation and maintenance certification.

Both parts of the fecal coliform standard were violated in 2005/06 and 2006/07. Nitrate results are consistently above the levels typical of Thurston County streams. Since the base flow of the creek is from springs, the high nitrate values reflect groundwater quality conditions. The source of the high nitrates is likely the urban land uses in the watershed.

Woodland Creek is listed on the 303d Section of the Clean Water Act for fecal coliform, temperature and dissolved oxygen standards violations in the upper reaches of the creek. A Total Maximum Daily Load (TMDL) study was begun in the winter of 2002-2003 by Washington Department of Ecology. A water clean-up plan to address water quality problems is identified in the technical report.

## Major Issues:

- Urban stormwater discharges are contributing to water quality problems.
- Nonpoint pollution from failing on-site septic systems and livestock in the watershed is occurring.
- Shellfish harvest downgrades in Henderson Inlet occurred in 2000, 2001, and 2005 due to bacteria pollution from Woodland Creek and other tributaries.

## Funding Sources:

- Local Storm and Surface Water Utilities

# Water Quality Summary
Conventional Parameters
**Woodland Creek**

| Parameter | Units | WQ Standard WAC 173-201A | Water Year Data: 2005/06 & 2006/07 | | | | Cumulative Data: 1983-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | Water Year | Mean | Range | # samples violating standard | Mean | Range |
| Temperature | º C | Highest 7-DAD Max of 16 º C | 05/06<br>06/07 | | 7.5 – 13.21<br>7.89 – 12.51 | 0 of 12<br>0 of 12 | | 5.50 – 13.81 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 9.5 | 05/06<br>06/07 | | 10.1 – 12.2<br>9.77 - 12 | 0 of 12<br>0 of 10 | | 6.20 - 14.00 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 150<br>148 | 115 - 171<br>115 - 173 | | 141 | 12 – 190 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.4*<br>7.4* | 7.1 – 7.8<br>7.0 – 7.5 | 0 of 12<br>0 of 12 | 7.2* | 5.9 - 7.8 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 4.1<br>4.4 | 1.4 – 12.5<br>1.5 – 15.4 | 1 of 12<br>1 of 12 | 3.27 | 0.6 - 18 |
| Fecal Coliform | colonies/ 100 ml | GMV: ≤50 and ≤ 10% not to exceed 100 | | | | **% exceeding 100** | 61** | 5 - 805 |
| | | | 05/06<br>06/07 | 64**<br>76** | 15 - 485<br>10 - 720 | 25%<br>42% | | |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.056<br>0.054 | 0.039 - 0.067<br>0.037 - 0.07 | | 0.06 | 0.03 - 0.11 |
| Nitrate+Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 1.52<br>1.32 | 1.26 – 1.88<br>0.846 – 1.74 | | 1.4 | 0.766 - 3.42 |

* Median
** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/12/2005 | 9:45:00 AM | 10.23 | 7.4 | 10.75 | 171 | 68 | 1.4 | 9.95 | 0.066 | 1.600 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/7/2005 | 9:00:00 AM | 8.59 | 7.3 | 12.24 | 136 | 35 | 3.8 | 16.00 | 0.061 | 1.280 | |
| 12/5/2005 | 1:20:00 PM | 8.08 | 7.4 | 11.79 | 157 | 70 | 2.5 | 12.00 | 0.063 | 1.570 | |
| 1/3/2006 | 3:15:00 PM | 7.54 | 7.2 | 11.36 | 115 | 40 | 6.8 | 38.90 | 0.058 | 1.300 | |
| 2/6/2006 | 12:45:00 PM | 7.50 | 7.1 | 11.53 | 116 | 15 | 12.5 | 93.50 | 0.053 | 1.260 | |
| 3/14/2006 | 2:15:00 PM | 9.19 | 7.3 | 10.12 | 141 | 20 | 4.1 | 42.70 | 0.039 | 1.420 | |
| 4/25/2006 | 11:50:00 AM | 11.54 | 7.4 | 11.02 | 153 | 45 | 2.8 | 27.93 | 0.047 | 1.360 | |
| 5/15/2006 | 2:30:00 PM | 13.21 | 7.4 | 10.28 | 161 | 45 | 3.6 | 21.62 | 0.052 | 1.630 | |
| 6/12/2006 | 12:15:00 PM | 12.84 | 7.3 | 10.62 | 156 | 485 | 5.9 | 23.57 | 0.055 | 1.360 | |
| 7/11/2006 | 1:15:00 PM | 11.99 | 7.6 | 10.16 | 159 | 190 | 2.8 | 15.70 | 0.058 | 1.880 | |
| 8/7/2006 | 3:30:00 PM | 13.00 | 7.4 | 10.89 | 171 | 70 | 2.0 | 13.66 | 0.054 | 1.760 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/13/2006 | 9:45:00 AM | 11.25 | 7.8 | 10.88 | 168 | 140 | 1.5 | 10.96 | 0.067 | 1.760 | |

## Woodland Creek @ Mouth

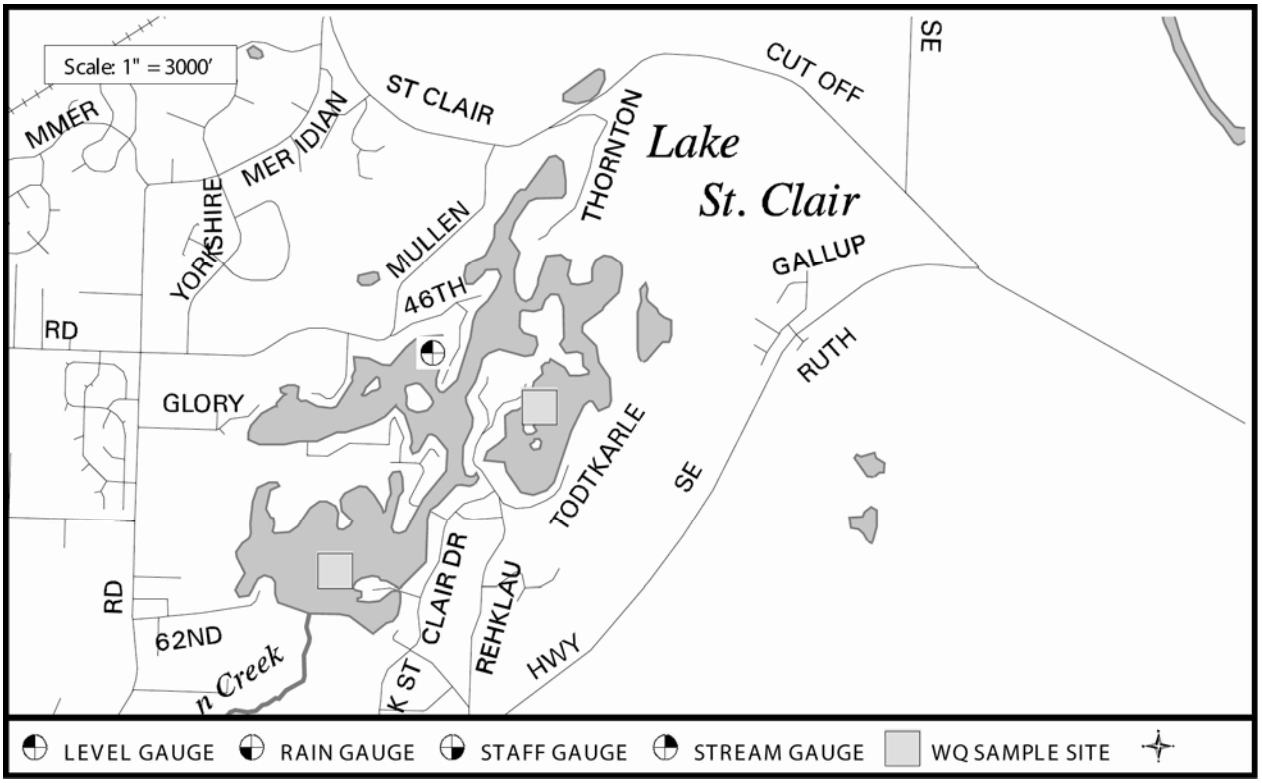
| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 11:30:00 AM | 10.44 | 7.4 | 10.59 | 173 | 120 | 1.6 | 10.70 | 0.063 | 1.740 | |
| 11/14/2006 | 2:00:00 PM | 9.04 | 7.0 | 10.73 | 126 | 10 | 3.7 | 25.49 | 0.048 | 1.240 | |
| 12/11/2006 | 2:30:00 PM | 8.63 | 7.3 | 11.02 | 132 | 720 | 6.0 | 37.85 | 0.046 | 0.846 | |
| 1/23/2007 | 3:45:00 AM | 7.89 | 7.3 | 11.95 | 141 | 15 | 2.8 | 56.86 | 0.037 | 1.290 | |
| 2/20/2007 | 1:45:00 PM | 8.44 | 7.2 | 9.99 | 115 | 100 | 15.4 | 81.79 | 0.066 | 0.993 | |
| 3/20/2007 | 2:15:00 PM | 10.55 | 7.3 | | 134 | 55 | 5.5 | 71.22 | 0.049 | 0.972 | DO not working |
| 4/25/2007 | 2:30:00 PM | 12.37 | 7.4 | 10.55 | 147 | 25 | 4.1 | 43.74 | 0.050 | 1.100 | |
| 5/16/2007 | 12:20:00 PM | 12.51 | 7.4 | 11.03 | 151 | 80 | 2.4 | 30.64 | 0.057 | 1.250 | |
| 6/13/2007 | 12:15:00 PM | 12.18 | 7.4 | 10.29 | 163 | 195 | 1.9 | 20.27 | 0.056 | 1.600 | |
| 7/18/2007 | 3:15:00 PM | 12.51 | 7.2 | 9.77 | 160 | 50 | 3.9 | 20.39 | 0.070 | 1.450 | |
| 8/22/2007 | 12:30:00 PM | 12.09 | 7.5 | 10.61 | 169 | 95 | 3.4 | 15.95 | 0.055 | 1.690 | |
| 9/19/2007 | 10:00:00 AM | 11.07 | 7.5 | | 169 | 210 | 1.5 | 14.57 | 0.053 | 1.640 | DO not working |

# Nisqually Watershed

**WRIA 13**

**Chapter Includes:**

**Lake St. Clair**
**McAllister Creek**




**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)

Good - This lake is considered mesotrophic, or moderately productive. Algae growth and water clarity are somewhat limited by the natural dark brown “tea-color” of the water.

**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) 754-4111.

City of Olympia, Public Works Department, (360) 753-8314, (lake level data)

**GENERAL DISCUSSION:**

Due to the very irregular shape of the lake with somewhat isolated basins, steep slopes, and depths of over 100 feet the water quality conditions vary between basins. Eaton Creek is the only surface water input, which discharges to the lake in the largest and deepest, southwest basin. Groundwater seeps out of the lake to the north to McAllister Springs, a City of Olympia water supply. 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.

Sampling is done at two locations, the large southwest basin and the eastern basin. Both the southwest and the east basins were strongly thermally stratified throughout the entire sampling period. This means that the lake developed a warm surface layer and a cooler bottom layer, as the solar radiation warmed the upper water. The surface water temperature in the east basin reached nearly 23 degrees Celsius in July. Typically, the warm surface water layer (or epilimnion) is only approximately two meters deep before the water temperature begins to cool. The water temperature from approximately 8 meters to the bottom in both basins was about 5 degrees Celsius from May through October.

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 had an anoxic zone at the bottom 8 meters of the lake in May increasing to 24 meters by October. The east basin had a much smaller anoxic zone of about 2 to 3 meters at the bottom throughout the sampling season. The east basin is similar to the large southwest basin in that there is a notable drop in dissolved oxygen at a depth between 4 and 6 meters followed by a slight increase, and then a decrease to anoxic conditions to the bottom. This “oxygen sag” may be due to the decomposition of algae cells, which settle to the bottom of the warm surface layer where the density difference in the two water layers prevents them from sinking further into the colder lower water. This is an annual phenomenon in Lake St. Clair which is not observed in any other Thurston County lakes. (See the temperature, dissolved oxygen, pH, and conductivity profile graphs on the following pages)

The 2007 season average secchi disk measurement in the “big” southwest basin was 2.3 meters (7.4 feet). Water clarity in the east basin is usually better than in the big basin. In the east basin, the average secchi disk measurement for 2007 was 2.5 meters (8.1 feet). The secchi disk reading graphs for the thirteen years of record are included on the pages following the field measurement profiles. The graph show no particular trend in water clarity in either basin, and the clarity remains relatively stable from year to year. The east basin is consistently clearer than the big southwest basin by about one-half to one meter.

In the big basin, the average total phosphorus concentration at the surface was 0.020 milligrams per liter in 2007. The state water quality action level for Puget Sound lowland lakes is 0.020 milligrams per liter. The most productive algae growth period in Lake St. Clair is spring. In the big basin, the chlorophyll *a* concentration in June 2007 was 24 micrograms per liter. It dropped to 5.3 in July and remained at 8 or less for through the October sampling. In the east basin, the chlorophyll level was 22 micrograms per liter in May then dropped to less than 6 through September.

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 2007 TSIs for the southwest (big) basin of Lake St. Clair for total phosphorus, chlorophyll *a*, and secchi disk are 47, 54, and 48, respectively. The east basin 2007 TSIs for total phosphorus, chlorophyll, and secchi disk transparency are 43, 51, and 47, respectively. These TSIs indicate that both basins are in a moderately productive, or mesotrophic, condition. The east basin TSIs are slightly lower than in the southwest basin, indicating better water quality. Graphs of TSIs for the past thirteen years for both basins are included on the pages following the field measurement profiles.

## Major Issues:

- Lake St. Clair is a major source of water to McAllister Springs, a City of Olympia water supply.

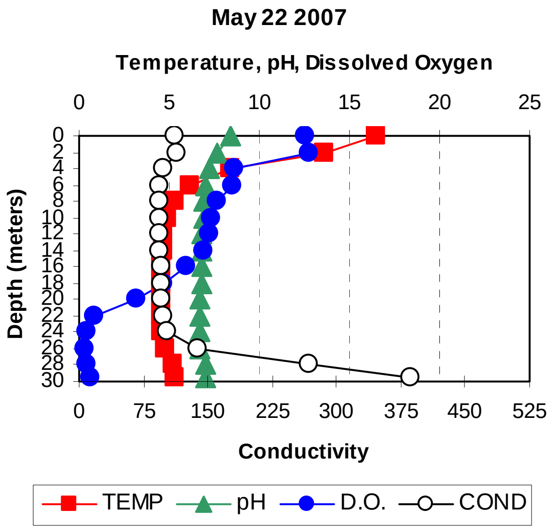
- The City of Olympia is developing a well field for the municipal water supply near the lake, the pumping of which may influence the lake level. The lake level is being monitored by the City. If the water withdrawal at the well field significantly affects the lake level, mitigation may be necessary.

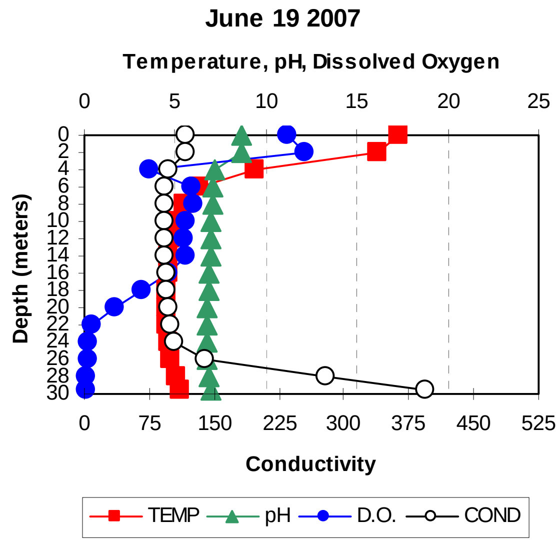
- High lake levels in past wet years caused shoreline residents to voice concerns about erosion and property damage caused by boat and jet ski wakes in the big southwest basin.

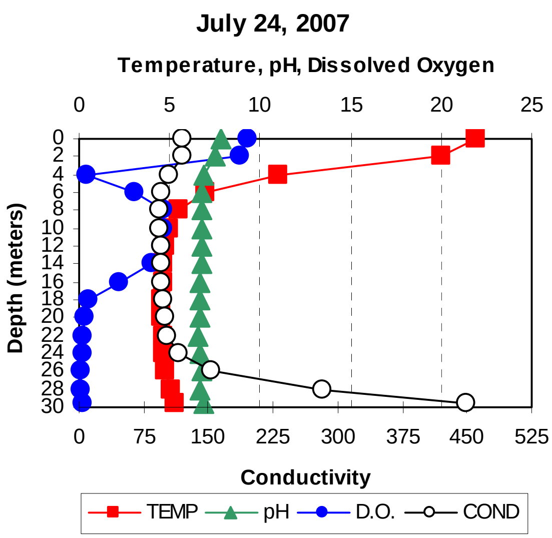
## Funding Sources:

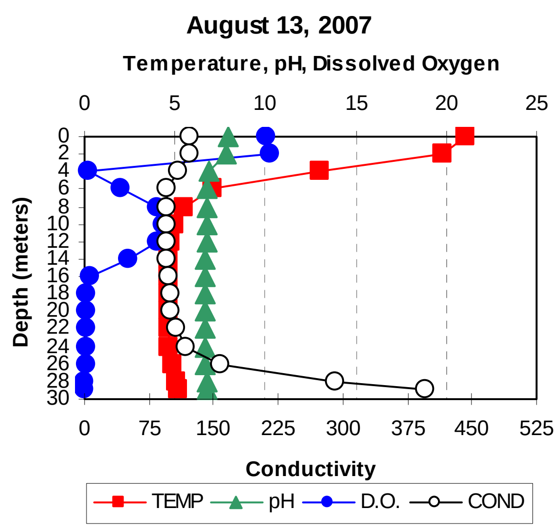
Monitoring was funded by Thurston County and will be continued in 2008.

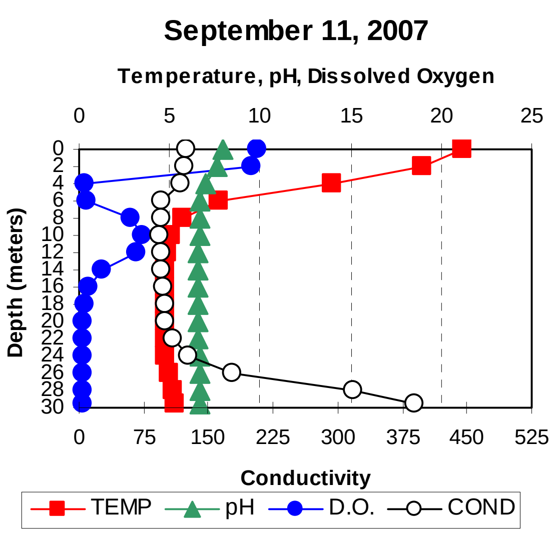
# LAKE ST. CLAIR – BIG BASIN

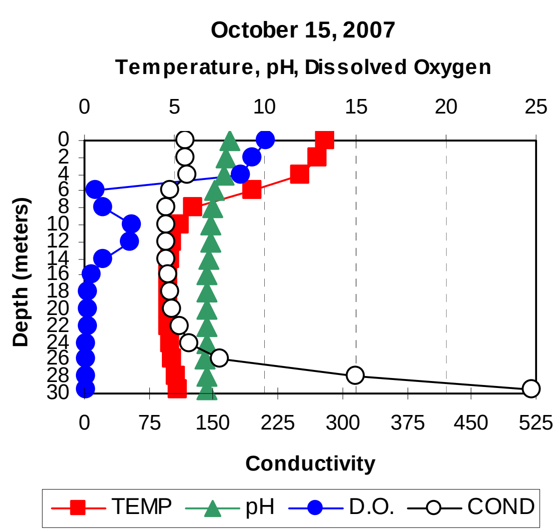


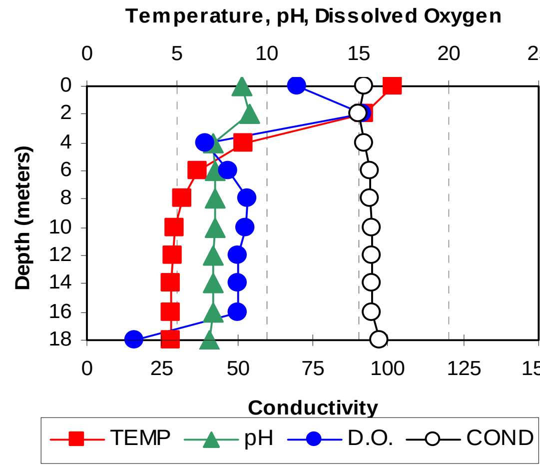



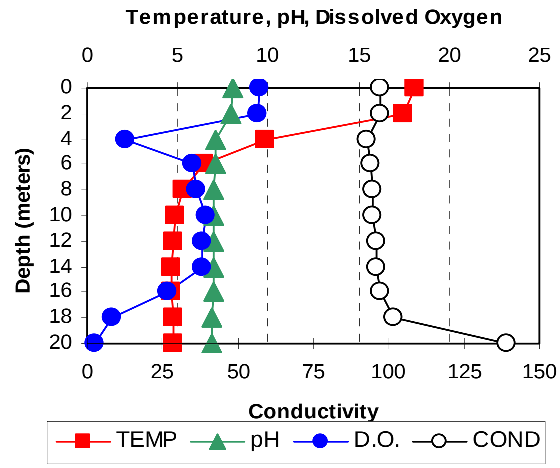



# LAKE ST. CLAIR – EAST BASIN

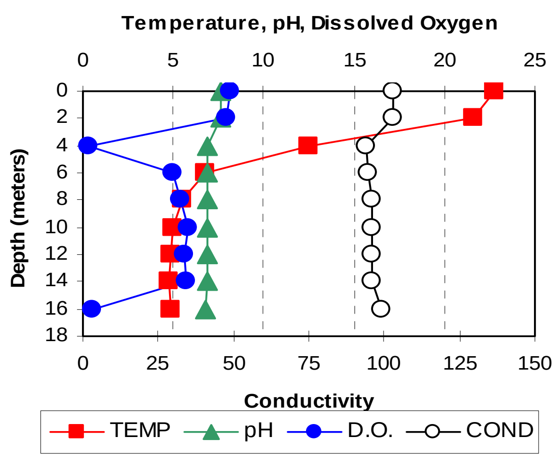
**May 22 2007**



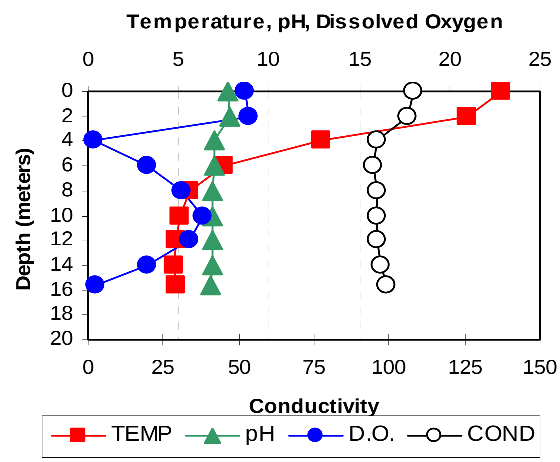

**June 19 2007**



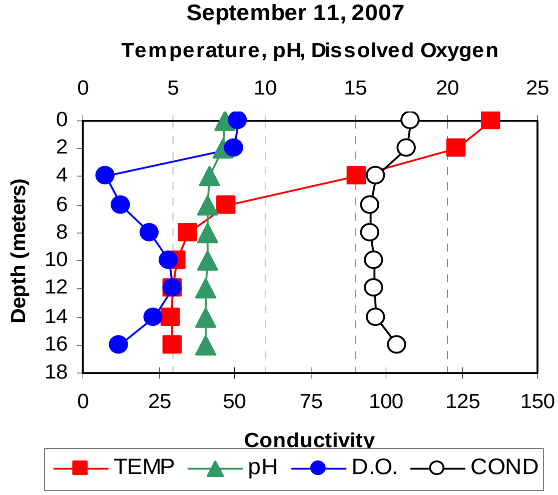

**July 24, 2007**



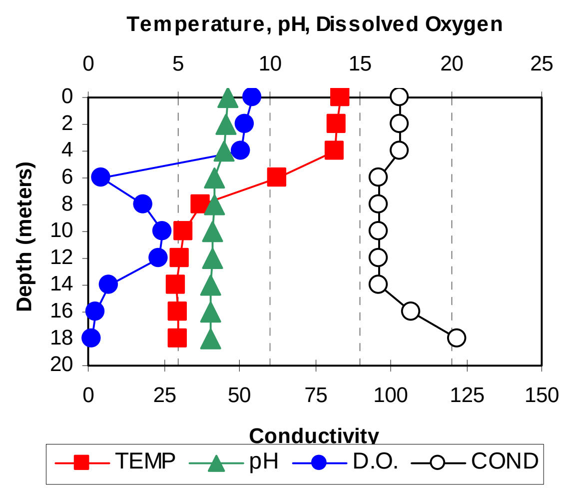

**August 13, 2007**

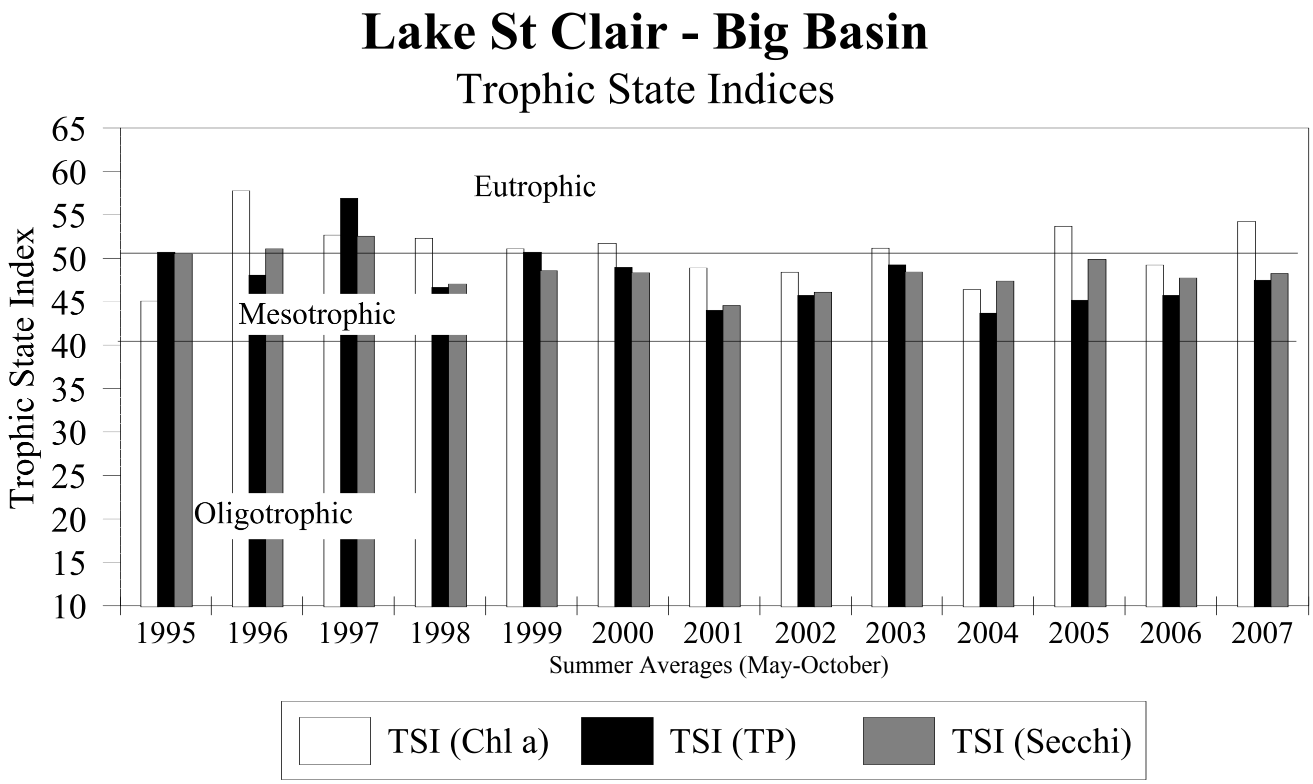


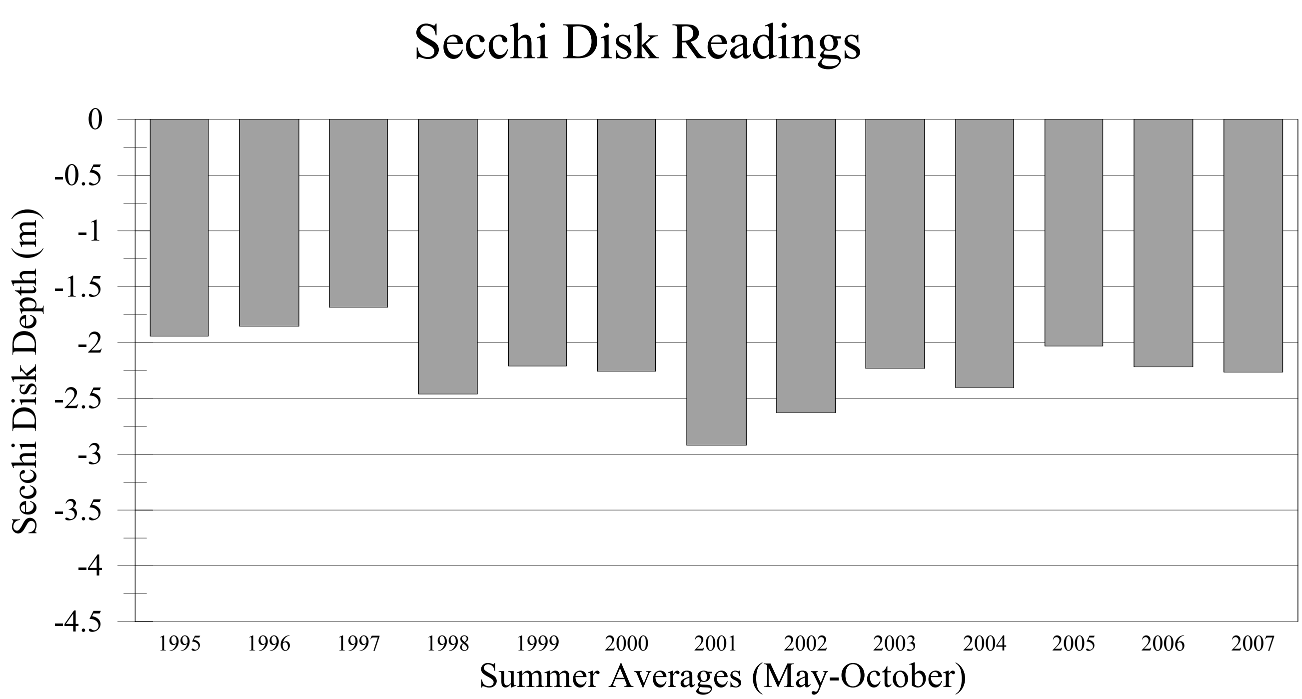

**September 11, 2007**

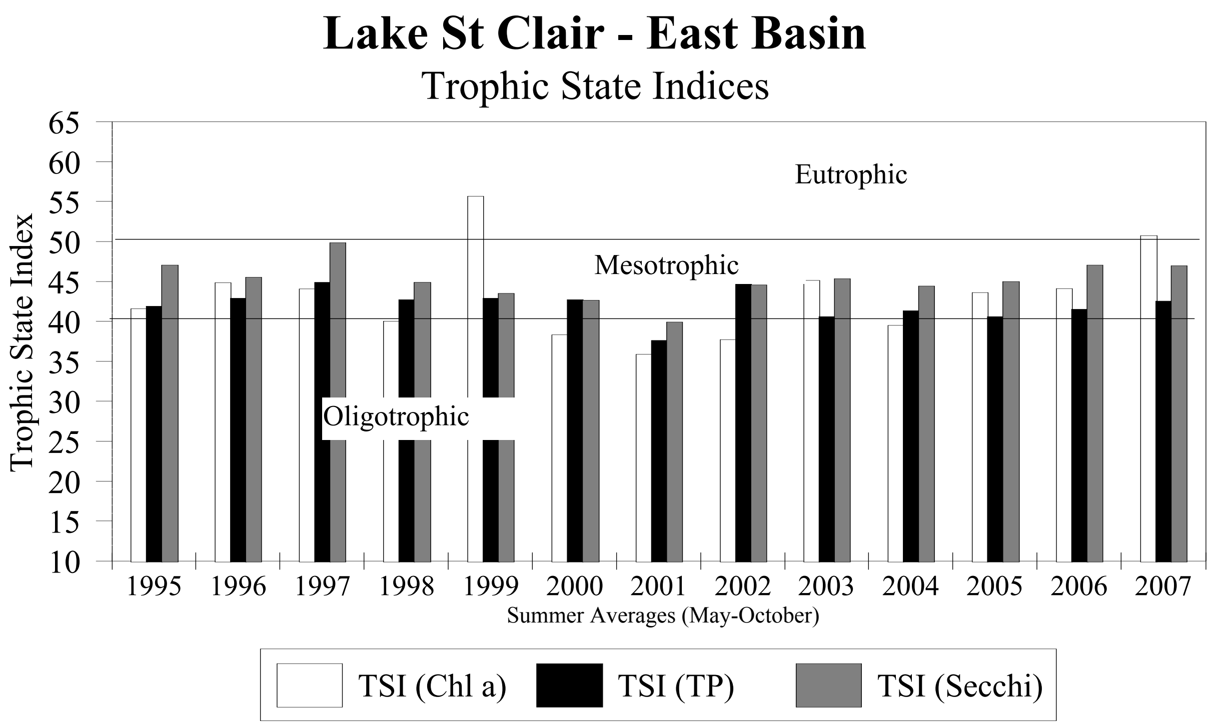


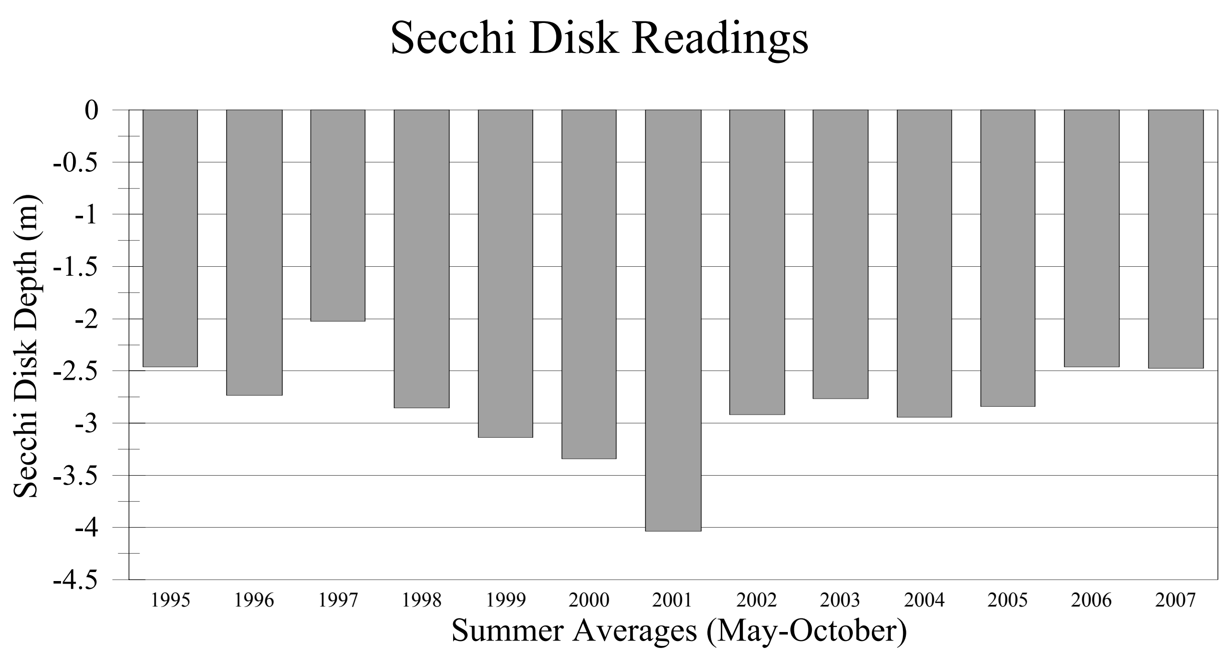

**October 15, 2007**




Lake St Clair - Big Basin
Trophic State Indices
Trophic State Index
65
60
55
50
45
40
35
30
25
20
15
10
Eutrophic
Mesotrophic
Oligotrophic
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)
TSI (Chl a)
TSI (TP)
TSI (Secchi)


Secchi Disk Readings
Secchi Disk Depth (m)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)


Lake St Clair - East Basin
Trophic State Indices
Trophic State Index
65
60
55
50
45
40
35
30
25
20
15
10
Eutrophic
Mesotrophic
Oligotrophic
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)
TSI (Chl a)
TSI (TP)
TSI (Secchi)


Secchi Disk Readings
Secchi Disk Depth (m)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Summer Averages (May-October)

## 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 Color | Lake Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/22/2007 | 12:00:00 PM | 29.5 | 28.0 | 0.027 | 0.736 | 0.793 | 4.300 | 1.44 | 18 | 2.8 | #9 dk orange | Chl a & algae composite @ 1, 2, & 3M. Gage- 68.30. |
| 06/19/2007 | 10:00:00 AM | 29.5 | 28.0 | 0.017 | 0.989 | 0.398 | 1.580 | 2.16 | 24 | 0.6 | #7 orange | Chl a & algae composite @ 1, 2, & 3M. Staff gage - 68.00 |
| 07/24/2007 | 2:00:00 PM | 29.6 | 28.0 | 0.017 | 0.958 | 0.462 | 5.650 | 2.42 | 5.3 | 1 | #7 yellow-orange | Chl a & algae composite @ 1 & 2M. Staff gage - 67.86. |
| 08/13/2007 | 1:30:00 PM | 29 | 28.0 | 0.013 | 0.810 | 0.476 | 4.180 | 2.47 | 5.3 | 2.1 | #7 yellow-orange | Chl a & algae composite @ 1 & 2M. Staff gage - 67.58. |
| 09/11/2007 | 2:40:00 PM | 29.5 | 28.0 | 0.012 | 0.958 | 0.414 | 3.390 | 2.93 | 6.4 | 1.4 | #7 yellow | Chl a & algae composite @ 1 & 2M. Staff gage - 67.48. |
| 10/15/2007 | 11:00:00 AM | 29.6 | 28.0 | 0.035 | 0.904 | 0.468 | 4.930 | 2.13 | 8 | 6.9 | #8 orange | Chl a & algae composite @ 1, 2, & 3M. Staff gage - 67.78. |

*Summary for 'Site Description' = St. Clair Lake @ SW Basin (6 detail records)*

| Averages: | | |
|---|---|---|
| | **Sur TP** | *0.020* |
| | **Secchi** | *2.26* |
| | **Chl a** | *11.2* |

## 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 Color | Lake Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/22/2007 | 12:45:00 PM | 18 | 17.0 | 0.020 | 0.031 | 0.666 | 0.861 | 1.72 | 22 | 2.2 | #9 dk orange | Chl a & algae composite @ 1, 2, & 3M. |
| 06/19/2007 | 10:45:00 AM | 20 | 18.0 | 0.016 | 0.067 | 0.482 | 0.535 | 2.58 | 2.1 | 3.8 | #7 orange | Chl a & algae composite @ 1, 2, & 3M. |
| 07/24/2007 | 2:45:00 PM | 16 | 15.0 | 0.014 | 0.038 | 0.405 | 0.566 | 2.53 | 5.3 | 2.1 | #7 yellow-orange | Chl a & algae composite @ 1& 2M. |
| 08/13/2007 | 2:30:00 PM | 15.6 | 15.0 | 0.013 | 0.040 | 0.386 | 0.552 | 2.56 | 4.3 | 1.3 | #9 dk orange | Chl a & algae composite @ 1 & 2M. |
| 09/11/2007 | 3:00:00 PM | 16.8 | 16.0 | 0.009 | 0.049 | 0.384 | 0.543 | 2.87 | 2.1 | 2.2 | #7 yellow | Chl a & algae composite @ 1 & 2M. |
| 10/15/2007 | 11:50:00 AM | 18.2 | 17.0 | 0.014 | 0.187 | 0.473 | 0.717 | 2.55 | 11 | 2.6 | #8 orange | Chl a & algae composite @ 1, 2, & 3M. |

*Summary for 'Site Description' = St. Clair Lake @ East Basin (6 detail records)*

| Averages: | | |
|---|---|---|
| | **Sur TP** | *0.014* |
| | **Secchi** | *2.47* |
| | **Chl a** | *7.8* |

# *Algae data:* St. Clair Lake @ SW Basin

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| *05/22/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☐ |
| | CP | Chroomonas species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Asterionella species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| *06/19/2007* | | | |
| | BG | Aphanizomenon flos-aquae | ☑ |
| | CP | Chroomonas species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| *07/24/2007* | | | |
| | BG | Anabaena species | ☐ |
| | BG | Aphanizomenon flos-aquae | ☑ |
| | CP | Chroomonas species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DT | Cyclotella species | ☐ |
| | DT | Fragilaria species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | GR | Botryococcus species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | YL | Dinobryon species | ☐ |

| Type | Description | Dominant in Sample |
|---|---|---|
| *08/13/2007* | | |
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Chroococcus species | ☐ |
| CP | Chroomonas species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Cyclotella species | ☐ |
| GR | Ankyra judayi | ☐ |
| GR | Botryococcus species | ☐ |
| GR | Eutetramorus globosus | ☐ |
| GR | Oocystis species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| YL | Dinobryon species | ☐ |
| *09/11/2007* | | |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Chroococcus species | ☐ |
| CP | Chroomonas species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Cyclotella species | ☐ |
| GR | Radiococcus nimbatus | ☐ |
| YL | Dinobryon species | ☐ |

| Type | Description | Dominant in Sample |
|---|---|---|
| *10/15/2007* | | |
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Chroococcus species | ☐ |
| CP | Chroomonas species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Fragilaria species | ☐ |
| EU | Euglena species | ☐ |
| EU | Trachelomonas species | ☐ |
| GR | Ankyra judayi | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| YL | Dinobryon species | ☐ |
| YL | Synura species | ☐ |

***Key:***

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

# ***Algae data:*** St. Clair Lake @ East Basin

*05/22/2007*

| Type | Description | Dominant in Sample |
|---|---|---|
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☑ |
| CP | Chroomonas species | ☐ |
| CP | Cryptomonas species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Cyclotella species | ☐ |

*06/19/2007*

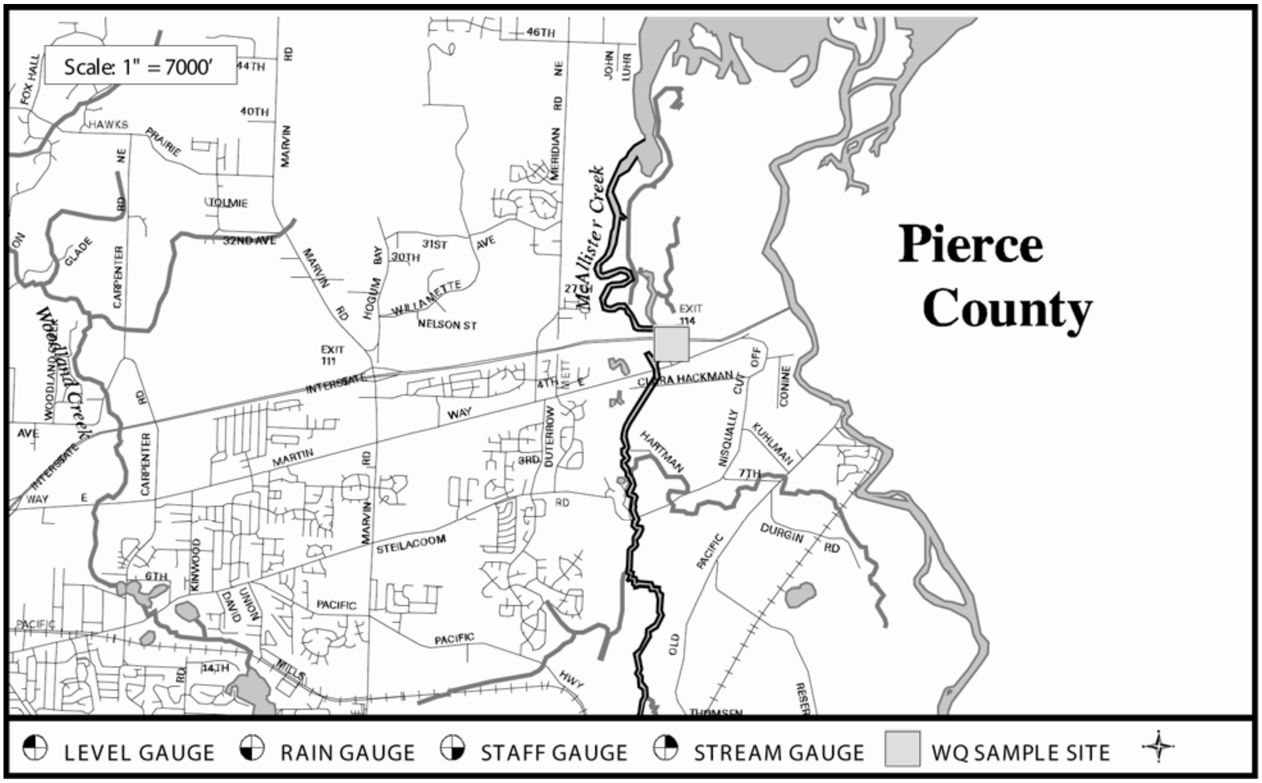
| Type | Description | Dominant in Sample |
|---|---|---|
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Chroococcus species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Cyclotella species | ☐ |
| GR | Oocystis species | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| GR | Staurastrum species | ☐ |

*07/24/2007*

| Type | Description | Dominant in Sample |
|---|---|---|
| BG | Anabaena species | ☐ |
| BG | Aphanizomenon flos-aquae | ☐ |
| BG | Chroococcus species | ☐ |
| CP | Cryptomonas species | ☐ |
| DF | Ceratium species | ☐ |
| DT | Cyclotella species | ☐ |
| DT | Fragilaria species | ☐ |
| GR | Ankistrodesmus species | ☐ |
| GR | Ankyra judayi | ☐ |
| GR | Sphaerocystis schroeteri | ☐ |
| GR | Staurastrum species | ☐ |
| YL | Dinobryon species | ☐ |

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| *08/13/2007* | | | |
| | BG | Chroococcus species | ☐ |
| | CP | Chroomonas species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DF | Ceratium species | ☐ |
| | DT | Cyclotella species | ☐ |
| | DT | Fragilaria species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Ankyra judayi | ☐ |
| | GR | Cosmarium species | ☐ |
| | GR | Dictyosphaerium pulchellum | ☐ |
| | GR | Elakatothrix species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | GR | Staurastrum species | ☐ |
| | YL | Dinobryon species | ☐ |
| | YL | Mallomonas species | ☐ |
| | YL | Synura species | ☐ |
| *09/11/2007* | | | |
| | CP | Chroomonas species | ☐ |
| | DT | Fragilaria species | ☐ |
| | EU | Trachelomonas species | ☐ |
| | GR | Oocystis species | ☐ |
| | GR | Radiococcus nimbatus | ☐ |
| *10/15/2007* | | | |
| | CP | Cryptomonas species | ☐ |
| | DT | Fragilaria species | ☐ |
| | EU | Euglena species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | YL | Synura species | ☐ |

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




**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 standard was violated 10 of 11 times 2005/06 and 6 of 9 times 2006/07. The turbidity standard was violated 4 of 11 times 2006/07.

**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)754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

McAllister Creek is sampled as part of the long-term ambient monitoring program. McAllister Creek is part of the Nisqually Reach Shellfish Protection District formed in 2001 after a downgrade of commercial shellfish growing areas. The creek was also sampled as part of a total maximum daily load study conducted by the Washington Department of Ecology. Using the technical study as a guide, development of a water clean-up plan is currently underway.

The creek is tidally influenced throughout most its length and has a very low gradient, both of which influence the water quality. The water quality standard for fecal coliform bacteria has two parts: the geometric mean shall not exceed 50 mg/100mL *and* no more than 10% of the samples shall exceed 100 colonies/100 mL. In 2005/06 the geometric mean was 94 colonies / 100 mL with 50% of the samples exceeding 100. In 2006/07 the geometric mean was 60 with 33% of the samples greater than 100. For dissolved oxygen, the water quality standard is a lowest one-day minimum of 9.5 mg/L. In 2005/06 this standard was exceeded ten of the twelve times it was measured. In 2006/07 the standard was not met six of the nine times.

## Major Issues:

- Improvement and protection of McAllister Creek water quality is critical to maintain the commercial shellfish harvest businesses in Nisqually Reach near the mouth of the creek.
- Non-point pollution problems from agriculture and on-site sewage disposal systems 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 results 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: 2005/06** and **2006/07** | | | | **Cumulative Data:** 1992-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 16 º C | 05-06<br>06-07 | | 7.46 – 15.7<br>8.78 – 13.85 | 0 of 12<br>0 of 12 | | 6.50 – 16.37 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 9.5 | 05-06<br>06-07 | | 6.56 – 13.1<br>6.02 – 10.2 | 10 of 11<br>6 of 9 | | 3.42 - 10.90 |
| Conductivity | µmhos/cm | | 05-06<br>06-07 | 3697<br>3498 | 11 – 19700<br>278 - 26130 | | 4162 | 187 - 33960 |
| pH | | 6.5 - 8.5 | 05-06<br>06-07 | 7.1*<br>7.2* | 6.9 – 7.4<br>6.8 – 7.5 | 0 of 12<br>0 of 12 | | 6.6 - 7.8 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05-06<br>06-07 | 4.08<br>10.53 | 1.9 – 7.5<br>1.2 - 38 | 0 of 9<br>4 of 11 | 4.1 | 1.3 - 22 |
| Fecal Coliform | colonies/ 100 ml | GMV: ≤50 and ≤ 10% not to exceed 100 | 05-06<br>06-07 | 94**<br>60** | 20 – 375<br>10 - 260 | **% exceeding 100**<br>50%<br>33% | 75** | 5 - 7500 |
| Total Phosphorus | mg/L | | 05-06<br>06-07 | 0.163<br>0.172 | 0.123 – 0.226<br>0.115 – 0.229 | | 0.153 | 0.112 - 0.197 |
| Nitrate+Nitrite-nitrogen | mg/L | | 05-06<br>06-07 | 1.24<br>1.18 | 1.00 – 1.59<br>0.704 – 1.53 | | 1.15 | 0.517 - 1.93 |

* Median

** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/11/2005 | 9:25:00 AM | 10.89 | 7.2 | 6.56 | 583 | 115 | | | 0.172 | 1.130 | Salinity 0.28. No turbidity measurment recorded. |
| 11/8/2005 | 8:00:00 AM | 8.02 | 7.1 | 8.51 | 454 | 65 | 3.7 | | 0.226 | 1.180 | Salinity = 0.22 |
| 12/5/2005 | 2:15:00 AM | 7.46 | 7.0 | 9.43 | 12871 | 20 | 7.5 | | 0.162 | 1.110 | Salinity = 7.36 |
| 1/3/2006 | 2:00:00 PM | 7.69 | 6.9 | 8.54 | 19700 | 20 | 6.0 | | 0.123 | 1.000 | Salinity = 11.7 |
| 2/6/2006 | 2:45:00 PM | 8.11 | 6.9 | 8.90 | 2100 | 30 | 4.0 | | 0.138 | 1.520 | Salinity = 1.1 |
| 3/14/2006 | 1:25:00 PM | 9.63 | 7.1 | 8.60 | 675 | 65 | 5.1 | | 0.189 | 1.590 | Salinity = .33 |
| 4/24/2006 | 9:45:00 AM | 11.98 | 7.1 | 8.75 | 2297 | 175 | | | 0.143 | 1.290 | Salinity = 1.2. No turbidity measurement. |
| 5/16/2006 | 10:30:00 AM | 14.48 | 7.0 | 8.84 | 3240 | 70 | 4.0 | | 0.143 | 1.300 | Salinity = 1.7 |
| 6/12/2006 | 11:30:00 AM | 14.51 | 7.1 | 9.10 | 1021 | 210 | | | 0.155 | 1.250 | salinity = .5. No turbidity measurement. |
| 7/11/2006 | 12:20:00 PM | 14.64 | 7.4 | | 11 | 355 | 2.1 | | 0.152 | 1.270 | salinity = .54 no DO measurement |
| 8/8/2006 | 1:00:00 PM | 15.70 | 7.4 | 13.13 | 820 | 375 | 2.4 | | 0.166 | 1.060 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/13/2006 | 8:45:00 AM | 12.93 | 7.1 | 7.12 | 593 | 195 | 1.9 | | 0.184 | 1.140 | Salinity=0.29 |

| *Date* | *Time* | *Temp C* | *pH* | *DO mg/L* | *Cond @25c umhos/cm* | *FC cfu/100mL* | *Turb NTU* | *Flow cfs* | *TP mg/L* | *NOx mg/L* | *COMMENTS* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/9/2006 | 12:15:00 PM | 11.64 | 6.9 | 8.02 | 4163 | 260 | 4.3 | | 0.161 | 1.200 | Salinity =2.2 |
| 11/15/2006 | 8:45:00 AM | 9.02 | 6.8 | 6.59 | 364 | 20 | 4.0 | | 0.229 | 1.200 | Salinity = 0.18 |
| 12/8/2006 | 1:15:00 PM | 8.78 | 7.2 | 9.00 | 26130 | 10 | 38.0 | | 0.142 | 0.735 | Very turbid, outgoing flow. Salinity = 15.9, Sampled I-5 outfall to McAllister 1:25 (no rain, just trickling) Fc = <5 |
| 2/20/2007 | 1:00:00 PM | 8.93 | 7.1 | 9.67 | 1818 | 125 | 30.8 | | 0.197 | 1.180 | Salinity = 0.93 |
| 3/20/2007 | 1:00:00 PM | 10.21 | 7.2 | | 1354 | 30 | 9.4 | | 0.182 | 1.340 | DO not working Salinity = 0.7 |
| 4/25/2007 | 2:00:00 PM | 11.45 | 7.2 | 9.91 | 278 | 40 | 1.2 | | 0.135 | 1.350 | |
| 5/16/2007 | 8:00:00 AM | 13.85 | 7.4 | | | 55 | 12.5 | | 0.115 | 0.704 | Salinity=1.87, DO not working. No conductivity recorded, too much fluctuation. |
| 6/13/2007 | 11:45:00 AM | 13.50 | 7.3 | 8.38 | 758 | 90 | 1.6 | | 0.148 | 1.340 | Salinity = 0.37 |
| 7/18/2007 | 2:30:00 PM | 13.67 | 7.0 | 6.02 | 799 | 60 | 3.0 | | 0.206 | 1.020 | |
| 8/22/2007 | 7:50:00 AM | 12.79 | 7.3 | 6.78 | 694 | 110 | 2.9 | | 0.195 | 1.250 | Salinity = 0.34 |
| 9/19/2007 | 9:00:00 AM | 11.75 | 7.5 | | 575 | 120 | | | 0.183 | 1.300 | DO not working, No turbidity reading recorded. Water low but coming back in. |

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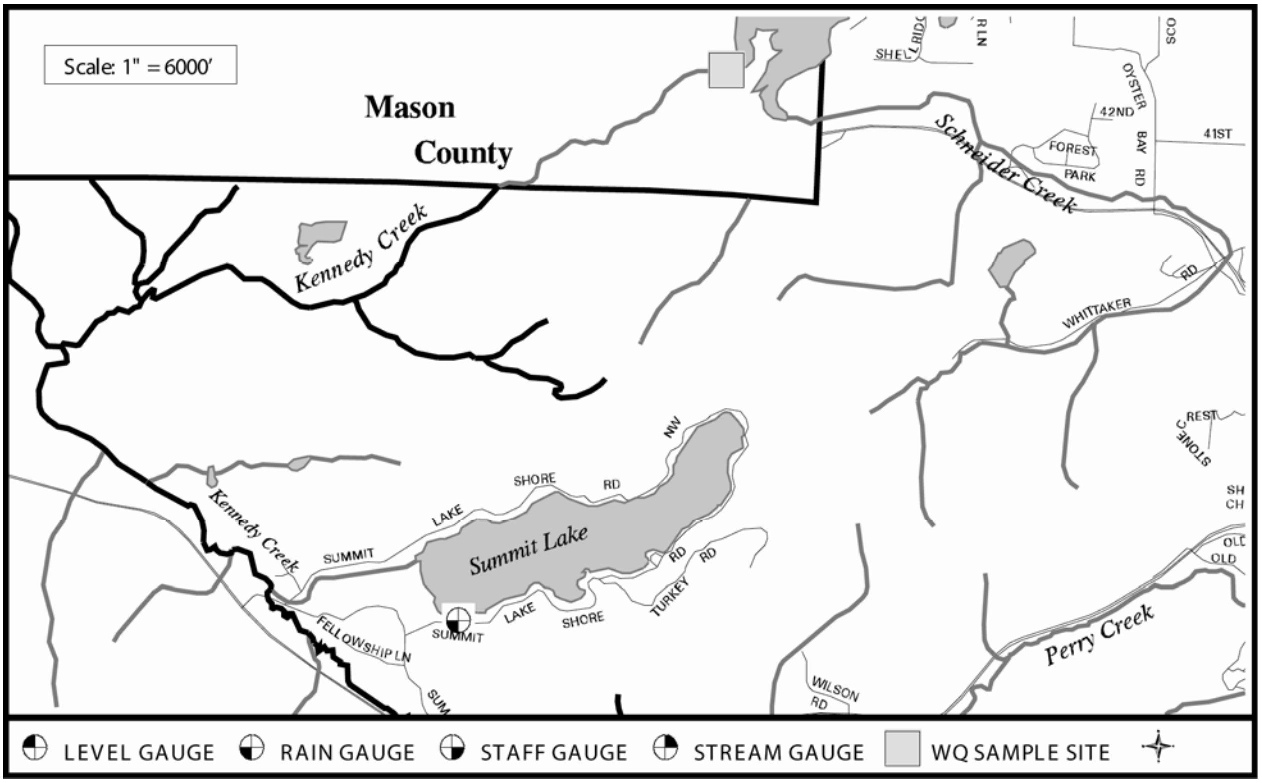
# Totten / Little Skookum Inlet Watershed

**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.

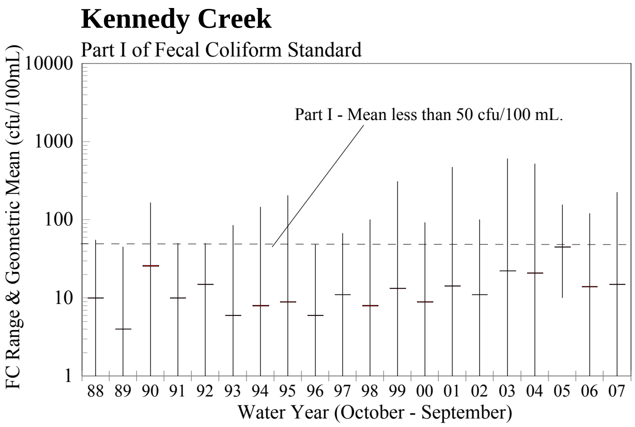
**GENERAL WATER QUALITY:** (Excellent, Good, Fair, Poor)

Good – Passed both parts of the bacteria standard. Had one dissolved oxygen violation during summer low flow period in 2007. The turbidity standard was violated in November 2005 and 2006 and February 2007.

**OTHER DATA:**
Thurston County Environmental Health Division, (360) 754-4111 or
www.co.thurston.wa.us/health/ehswat/swater.htm

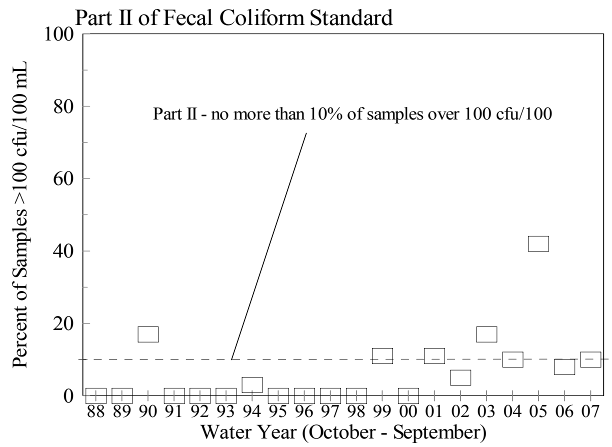
Thurston County Department of Water and Waste Management, Storm Water Utility, Stream flow (360) 357-2491 or
www.co.thurston.wa.us/monitoring

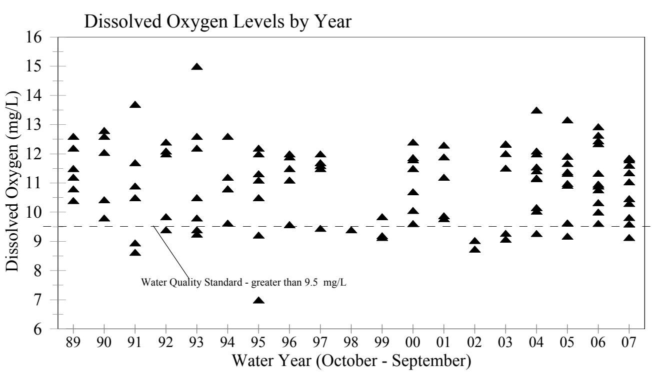
Washington Department of Ecology, Environmental Assessment Program, National Monitoring Program Project, Intensive wet season data between 1992 and 2002,
(360) 407-6000.




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

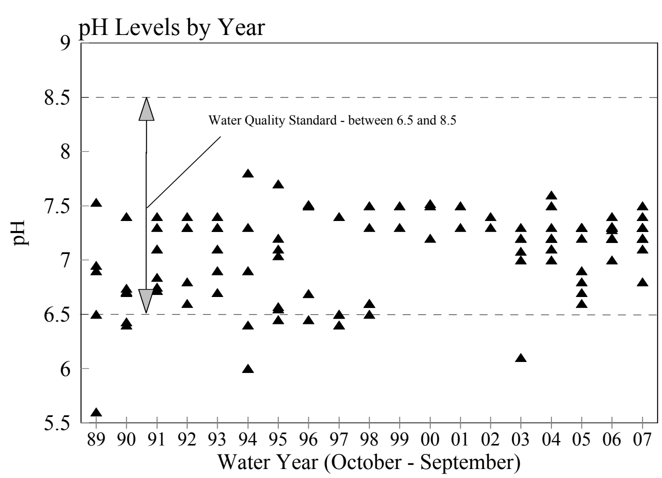
In the past, the water quality of this stream has been excellent. However in 2004/05, the fecal coliform geometric mean was the highest on record at 45 colonies/100mL, with Part II of the standard violated because 42% of the samples were greater than 100. However, in 2005/06 & 2006/07 the geometric means were low and both parts of the standard were met.




The water quality standard for dissolved oxygen is a lowest one-day minimum of 9.5 mg/L. The DO frequently falls below the standard during the summer low-flow period. In July 2007 there was a violation.

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 occasional measurements below the standard. There were no violations in 2005/2006 or 2006/2007.



## Major Issues:

- Fecal coliform bacteria levels during the dry season appear to be increasing. Investigation for potential sources was conducted in 2006 and 2007.

- Kennedy Creek was part of a Washington Department of Ecology Total Maximum Daily Load Study. A water quality clean-up plan was prepared in November 2007, which included 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:

- Local stormwater utility rate

# Water Quality Summary

Conventional Parameters

**Kennedy Creek**

| **Parameter** | **Units** | **WQ Standard** WAC 173-201A | **Water Year Data: 2005/06 & 2006/07** | | | | **Cumulative Data: 1988-2005** | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 16 º C | 05/06<br>06/07 | | 6.19 – 14.56<br>5.62 – 14.72 | 0 of 12<br>0 of 12 | | 1.09 - 17.53 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 9.5 | 05/06<br>06/07 | | 9.62 – 12.9<br>9.14 – 11.9 | 0 of 12<br>1 of 12 | | 7 – 13.7 |
| Conductivity | µmhos/cm | | 05/06<br>06/07 | 76<br>75 | 53 - 99<br>45 - 101 | | 69 | 37 – 202 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.3*<br>7.3* | 7.0 - 7.4<br>6.8 - 7.5 | 0 of 12<br>0 of 12 | 7.1* | 5.6 - 7.8 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 3.28<br>5.98 | 0.3 – 10.5<br>0 - 40 | 1 of 12<br>2 of 12 | 4.39 | 0 – 120 |
| Fecal Coliform | colonies/ 100 mL | GMV: ≤50 and ≤ 10% not to exceed 100 | 05/06<br>06/07 | 14**<br>15** | 0 – 120<br>0 - 225 | **% exceeding 100**<br>8%<br>10% | 11** | 0 – 605 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.024<br>0.029 | 0.012 - 0.044<br>0.012 - 0.091 | | 0.027 | 0.006 - 0.23 |
| Nitrate+Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.643<br>0.465 | 0.335 – 1.57<br>0.333 - 0.739 | | 0.592 | 0.185 - 1.52 |

* Median

** Geometric mean value (GMV)

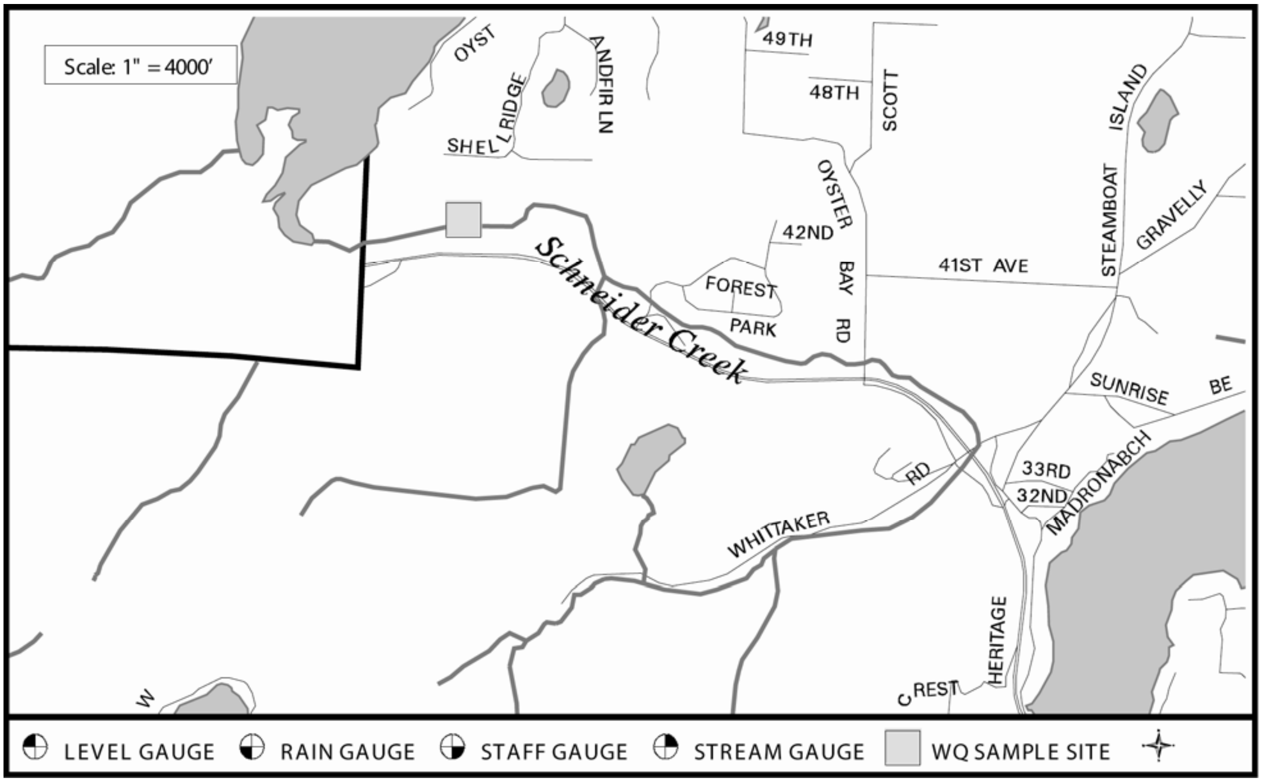
| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2005 | 10:15:00 AM | 11.35 | 7.3 | 10.33 | 97 | 40 | 0.6 | 8.65 | 0.024 | 0.385 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/7/2005 | 11:30:00 AM | 8.71 | 7.2 | 10.91 | 63 | 20 | 10.5 | | 0.044 | 1.570 | Fish spawning, did not measure flow. |
| 12/5/2005 | 10:00:00 AM | 6.19 | 7.2 | 12.64 | 67 | 15 | 1.7 | 69.43 | 0.038 | 0.824 | |
| 1/3/2006 | 11:00:00 AM | 7.23 | 7.2 | 12.93 | 55 | 10 | 8.2 | | 0.028 | 0.884 | Too high for flow |
| 2/6/2006 | 10:15:00 AM | 6.50 | 7.3 | 12.45 | 53 | 5 | 7.4 | | 0.020 | 0.625 | Too fast to wade. |
| 3/14/2006 | 11:15:00 AM | 6.66 | 7.4 | 10.01 | 60 | 0 | 2.9 | 83.60 | 0.012 | 0.734 | F.C. result was <5. |
| 4/24/2006 | 10:00:00 AM | 8.85 | 7.2 | 12.35 | 65 | 0 | 2.2 | 55.45 | 0.014 | 0.456 | F.C. result was <5. |
| 5/15/2006 | 11:50:00 AM | 11.75 | 7.3 | 10.90 | 82 | 5 | 1.2 | 14.58 | 0.016 | 0.557 | |
| 6/13/2006 | 9:45:00 AM | 13.09 | 7.2 | 10.97 | 84 | 40 | 0.7 | 13.22 | 0.017 | 0.475 | |
| 7/10/2006 | 11:10:00 AM | 14.56 | 7.3 | 10.77 | 92 | 120 | 0.3 | 9.42 | 0.021 | 0.524 | |
| 8/8/2006 | 11:00:00 AM | 14.52 | 7.3 | 11.34 | 98 | 40 | 1.1 | 4.56 | 0.022 | 0.335 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/12/2006 | 10:15:00 AM | 13.02 | 7.0 | 9.62 | 99 | 50 | 2.5 | 4.61 | 0.028 | 0.349 | |

## Thurston County Water Resources Monitoring Report 2006 - 2007

*Kennedy Creek Mouth*

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2006 | 11:20:00 AM | 9.57 | 7.2 | 10.30 | 101 | 65 | 1.3 | 4.01 | 0.021 | 0.343 | |
| 11/14/2006 | 10:00:00 AM | 8.61 | 6.8 | 11.04 | 53 | 10 | 17.6 | | 0.054 | 0.724 | fish spawning, no flow measurement, too deep & fast |
| 12/11/2006 | 10:30:00 AM | 7.98 | 7.2 | 11.61 | 59 | 35 | 6.2 | | 0.053 | 0.488 | fish still spawning, no flow measurement. |
| 1/24/2007 | 9:45:00 AM | 5.62 | 7.3 | 11.35 | 62 | 5 | 1.7 | 73.60 | 0.014 | 0.568 | |
| 2/20/2007 | 11:00:00 AM | 7.09 | 7.1 | 9.82 | 45 | 20 | 40.4 | | 0.091 | 0.739 | Too high and fast to wade |
| 3/20/2007 | 11:15:00 AM | 7.88 | 7.3 | | 56 | 10 | 1.7 | 139.28 | 0.018 | 0.432 | DO not working |
| 4/26/2007 | 2:30:00 PM | 10.33 | 7.5 | 11.85 | 65 | 10 | 0.7 | 52.29 | 0.012 | 0.366 | |
| 5/17/2007 | 9:40:00 AM | 10.42 | 7.3 | 11.80 | 79 | 0 | 0.5 | 19.07 | 0.014 | 0.430 | F.C. result was <5. |
| 6/12/2007 | 2:15:00 PM | 13.53 | 7.4 | 11.85 | 86 | 20 | 0.0 | 12.20 | 0.012 | 0.405 | |
| 7/18/2007 | 11:00:00 AM | 14.72 | 7.3 | 9.14 | 94 | 0 | 0.7 | 9.02 | 0.020 | 0.404 | F.C. result is <5. |
| 8/21/2007 | 10:20:00 AM | 14.32 | 7.3 | 9.60 | 97 | 100 | 0.0 | 6.05 | 0.017 | 0.343 | |
| 9/17/2007 | 10:00:00 AM | 13.29 | 7.2 | 10.47 | 100 | 225 | 0.9 | 5.60 | 0.018 | 0.333 | |

# 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:**

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

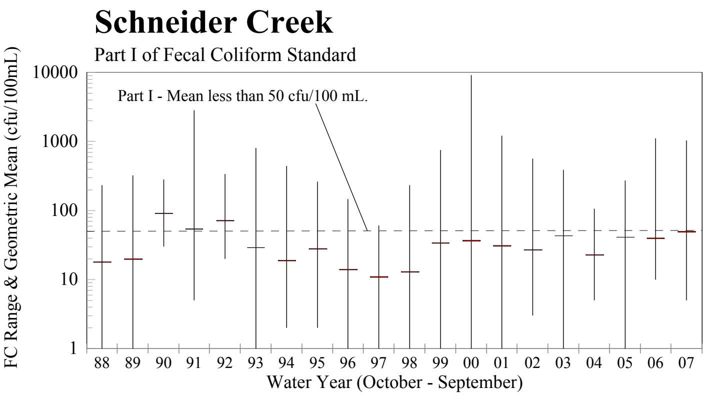
**GENERAL WATER QUALITY:** (Excellent, Good, Fair, Poor)

Fair - Failed Part II of the fecal coliform standard in both water years 2005/06 & 2006/07. Dissolved oxygen and occasional temperature violations in summer months.

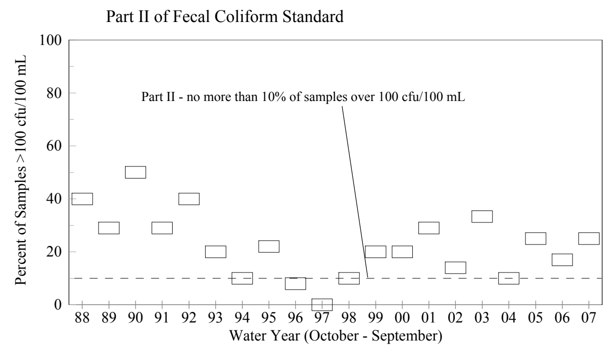
**OTHER DATA:**

Thurston County Environmental Health Division, (360)754-4111 or www.co.thurston.wa.us/health/ehswat/swater.htm

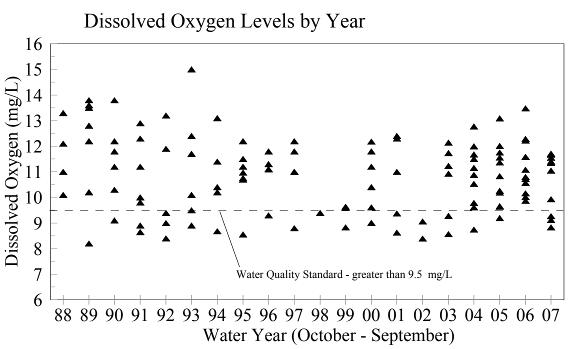
Washington Department of Ecology, Environmental Assessment Program, National Monitoring Program Project, Intensive wet season data between 1992 and 2002, (360) 407-6000.



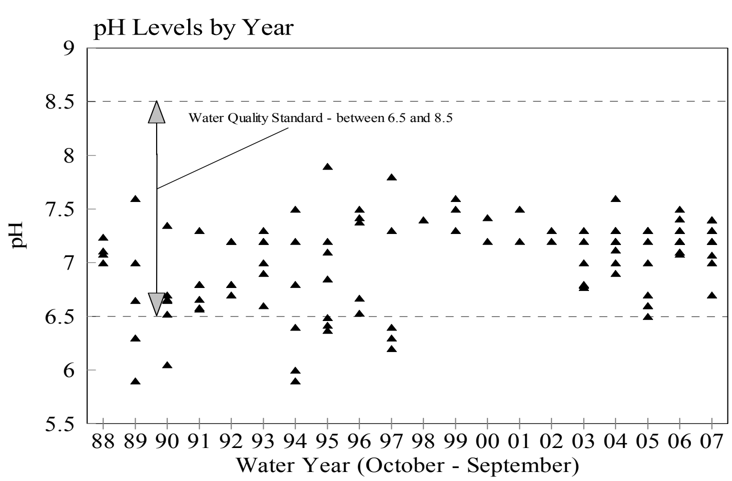

The water quality standard for fecal coliform has two parts: Part I - the geometric mean shall not exceed 50 colonies/100mL *and* Part II, no more than10% of the samples shall exceed 100 colonies/100 mL.




Part I of the standard has been met since 1993 but Part II of the standard is violated in most years 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 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 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. 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. The data is summarized on the table entitled *Schneider Creek Head*. This site failed Part I of the fecal coliform standard and had dissolved oxygen concentrations below the standard for three of the nine site visits. Nutrients, especially nitrates, are lower at this site. 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 also have the potential to affect water quality.

## Funding Sources:

- Local Storm and Surface Water Utility

# Water Quality Summary

Conventional Parameters

**Schneider Creek (in Totten/Little Skookum Inlet Watershed)**

| Parameter | Units | WQ Standard WAC 173-201A | Water Year Data: 2005/06 & 2006/07 | | | | Cumulative Data: 1987-2005 | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | EC | Highest 7-DAD Max of 16EC | 05/06<br>06/07 | | 4.44 – 14.79<br>5.48 – 14.97 | 0 of 12<br>0 of 12 | | 1.5 – 18.15 |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 9.5 | 05/06<br>06/07 | | 9.87 – 13.5<br>8.83 – 11.71 | 0 of 12<br>3 0f 10 | | 8.2 – 15 |
| Conductivity | Fmhos/cm | | 05/06<br>06/07 | 85<br>81 | 55 - 115<br>51 - 109 | | 75 | 37 – 169 |
| pH | | 6.5 - 8.5 | 05/06<br>06/07 | 7.2*<br>7.3* | 7.1 – 7.5<br>6.7 – 7.4 | 0 of 12<br>0 of 12 | 7.1* | 5.9 – 7.9 |
| Turbidity | NTU | not to exceed 5 NTU over background | 05/06<br>06/07 | 3.38<br>5.73 | 0.8 – 11.5<br>0.3 – 28.4 | 1 of 12<br>2 of 12 | 6.18 | 0.4 - 100 |
| Fecal Coliform | colonies/ 100 mL | GMV: ≤50 and ≤ 10% not to exceed 100 | 05/06<br>06/07 | 40**<br>50** | 10 - 1100<br>5 - 1025 | **% exceeding 100**<br>17%<br>25% | 27** | 0 – 9100 |
| Total Phosphorus | mg/L | | 05/06<br>06/07 | 0.034<br>0.036 | 0.022 – 0.044<br>0.019 – 0.091 | | 0.032 | <0.005 - 0.134 |
| Nitrate+Nitrite-nitrogen | mg/L | | 05/06<br>06/07 | 0.246<br>0.169 | 0.037 – 0.781<br>0.027 – 0.277 | | 0.210 | 0.015 - 0.67 |

* 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: 2006/2007** | | | | **Cumulative Data: none** | |
|---|---|---|---|---|---|---|---|---|
| | | | **Water Year** | **Mean** | **Range** | **# samples violating standard** | **Mean** | **Range** |
| Temperature | º C | Highest 7-DAD Max of 16 º C | 06/07 | | 4.5 – 15.82 | 0 of 10 | | |
| Dissolved Oxygen | mg/L | Lowest one-day minimum of 9.5 | 06/07 | | 8.25 – 10.9 | 4 of 9 | | |
| Conductivity | µmhos/cm | | 06/07 | 99 | 54 - 163 | | | |
| pH | | 6.5 - 8.5 | 06/07 | 7.2* | 6.8 – 7.2 | 0 of 10 | | |
| Turbidity | NTU | not to exceed 5 NTU over background | 06/07 | 4.94 | 0.2 - 13 | | | |
| Fecal Coliform | colonies / 100 ml | GMV: ≤50 and ≤ 10% not to exceed 100 | 06/07 | 32** | 0 - 605 | **% exceeding 100**<br>30% | | |
| Total Phosphorus | mg/L | | 06/07 | 0.022 | 0.013 – 0.036 | | | |
| Nitrate+Nitrite-nitrogen | mg/L | | 06/07 | 0.051 | 0.02 – 0.142 | | | |

* Median

** Geometric mean value (GMV)

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2005 | 10:00:00 AM | 11.19 | 7.3 | 10.01 | 115 | 35 | 0.8 | 0.88 | 0.038 | 0.037 | Turb standard recall of lot used to cal YSI on this date. Results could be up to 8% lower than the true turb value. |
| 11/7/2005 | 11:00:00 AM | 8.27 | 7.1 | 11.08 | 63 | 30 | 11.5 | 40.17 | 0.044 | 0.781 | |
| 12/5/2005 | 9:30:00 AM | 4.44 | 7.1 | 13.48 | 71 | 15 | 1.9 | 15.53 | 0.026 | 0.299 | |
| 1/3/2006 | 10:00:00 AM | 6.66 | 7.2 | 12.28 | 55 | 60 | 6.2 | 74.80 | 0.030 | 0.370 | |
| 2/6/2006 | 9:40:00 AM | 5.97 | 7.2 | 12.22 | 55 | 20 | 7.5 | 62.00 | 0.022 | 0.248 | |
| 3/14/2006 | 11:15:00 AM | 6.74 | 7.2 | 10.16 | 65 | 10 | 5.8 | 20.80 | 0.025 | 0.237 | |
| 4/24/2006 | 9:45:00 AM | 9.08 | 7.2 | 11.58 | 78 | 10 | 1.9 | 9.26 | 0.028 | 0.169 | |
| 5/15/2006 | 11:30:00 AM | 11.32 | 7.5 | 10.72 | 94 | 25 | 0.9 | 2.91 | 0.023 | 0.214 | |
| 6/13/2006 | 10:20:00 AM | 13.34 | 7.2 | 10.80 | 102 | 1100 | 1.2 | 2.38 | 0.026 | 0.197 | |
| 7/10/2006 | 10:30:00 AM | 14.79 | 7.3 | 10.57 | 105 | 25 | 0.8 | 1.01 | 0.033 | 0.177 | |
| 8/8/2006 | 10:40:00 AM | 14.75 | 7.4 | 11.58 | 106 | 165 | 0.9 | 0.69 | 0.033 | 0.133 | Samples not stored at proper temperature for 3-5 days, NO2+NO3 may be high |
| 9/12/2006 | 9:50:00 AM | 12.48 | 7.1 | 9.87 | 109 | 45 | 1.1 | 0.56 | 0.037 | 0.093 | |

| Date | Time | Temp C | pH | DO mg/L | Cond @25c umhos/cm | FC cfu/100mL | Turb NTU | Flow cfs | TP mg/L | NOx mg/L | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/10/2006 | 11:00:00 AM | 8.90 | 7.3 | | 75 | 45 | 1.0 | 0.58 | 0.028 | 0.027 | No D.O. reading. |
| 11/14/2006 | 9:30:00 AM | 7.93 | 6.7 | 11.05 | 51 | 35 | 20.0 | 75.00 | 0.044 | 0.273 | |
| 12/11/2006 | 9:30:00 AM | 7.56 | 7.0 | 11.40 | 65 | 30 | 9.4 | | 0.052 | 0.205 | fish still spawning, did not do flow |
| 1/24/2007 | 9:15:00 AM | 5.48 | 7.3 | 11.35 | 70 | 33 | 2.0 | 14.49 | 0.019 | 0.277 | |
| 2/20/2007 | 10:30:00 AM | 7.08 | 7.1 | 9.12 | 54 | 25 | 28.4 | 107.01 | 0.091 | 0.263 | |
| 3/20/2007 | 10:15:00 AM | 8.53 | 7.2 | | 66 | 10 | 2.6 | | 0.028 | 0.141 | DO not working. Swoffer meter not working |
| 4/26/2007 | 2:00:00 AM | 10.57 | 7.4 | 11.55 | 80 | 5 | 1.3 | 8.32 | 0.025 | 0.115 | |
| 5/17/2007 | 9:15:00 AM | 9.95 | 7.3 | 11.71 | 90 | 155 | 0.8 | 3.59 | 0.025 | 0.170 | |
| 6/12/2007 | 1:40:00 PM | 12.48 | 7.4 | 11.67 | 101 | 40 | 0.3 | 1.71 | 0.026 | 0.164 | |
| 7/18/2007 | 10:30:00 AM | 14.97 | 7.4 | 8.83 | 106 | 60 | 1.5 | 1.36 | 0.036 | 0.152 | |
| 8/21/2007 | 10:00:00 AM | 14.54 | 7.2 | 9.27 | 109 | 180 | 0.5 | 1.18 | 0.031 | 0.121 | |
| 9/17/2007 | 9:30:00 AM | 13.43 | 7.2 | 9.93 | 105 | 1025 | 1.0 | 0.78 | 0.029 | 0.121 | |

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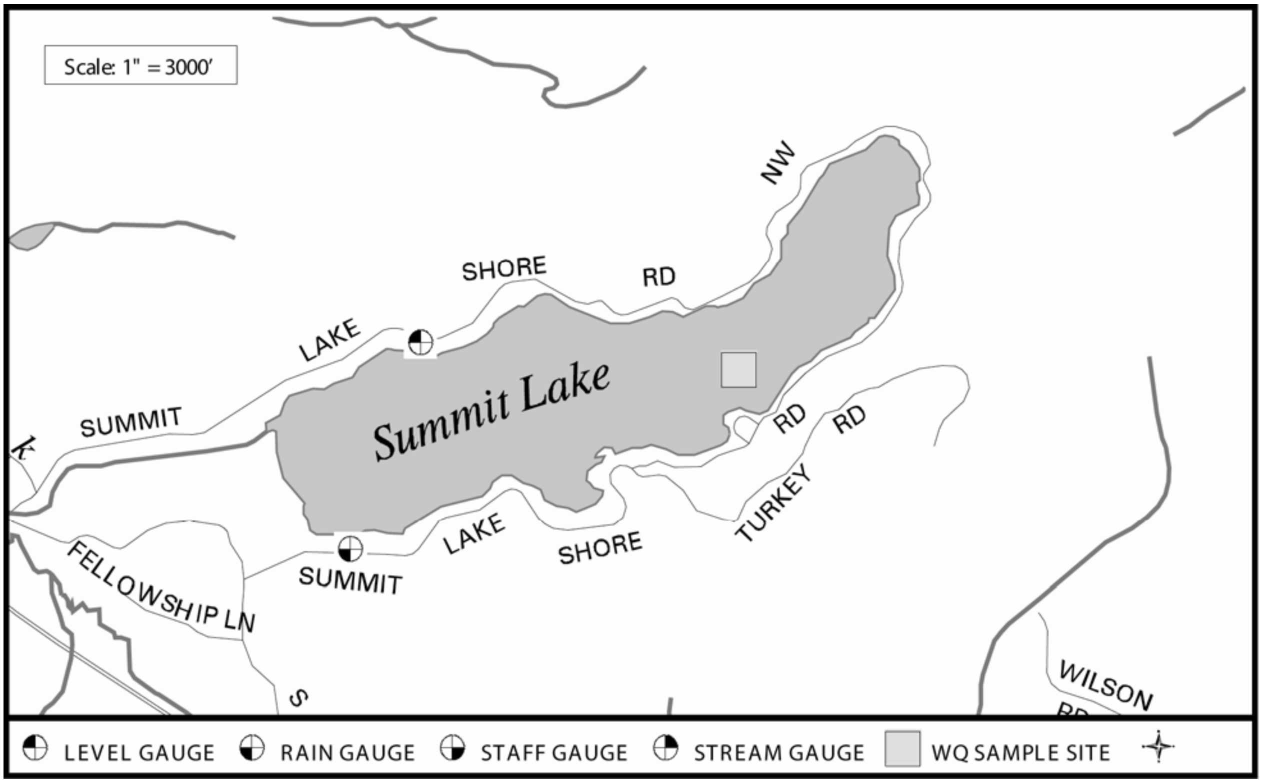



**PART OF TOTTEN INLET WATERSHED**

**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 500 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 high visibility. The high water quality is important because the lake is the drinking water source for most of the lake residents. Uses are not impeded by aquatic weeds or algal growth.

**OTHER DATA:**

Thurston County Dept. of Water and Waste Management, Storm and Surface Water Utility, (360) 357-2491, (Precipitation, lake level, and stream flow 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) 754-4111

**GENERAL DISCUSSION:**

Summit Lake is one of the deepest lakes in Thurston County, with a maximum depth of 30 meters (100 feet). The lake clearly stratifies into two distinct layers of water in the summer, as can be seen in the profile graphs which follow. In 2007 the lake was already stratified in May and remained so through October. The warm upper layer extends from the surface to between 6 and 14 meters deep. The colder bottom water had developed anoxic conditions (lack of dissolved oxygen in the water) by August. When the lake is thermally stratified and there is no replenishment of the dissolved oxygen from the atmosphere to the bottom waters, bacterial decomposition of material such as aquatic plants, algae, and other organic matter depletes the available oxygen at the bottom. During the anoxic period, phosphorus is released from the sediments into the water near the bottom. This slight increase in bottom phosphorus concentrations can be seen in the data report at the end of this narrative.

The water clarity in 2007 averaged 6.9 meters (22.6 feet) and ranged from 5.5 meters (18 feet) in May to 10.1 meters (33 feet) in July. As can be seen from the secchi disk readings graph at the end of this narrative, Summit Lake consistently has average secchi disk readings between 5.75 and 8 meters. The graph entitled ‘Summit Lake Water Clarity Trend’ charts the difference between each year’s average secchi reading and the overall average Summit Lake secchi reading from the period of record. Graphing the secchi disk visibility in this way helps to visually see true trends in water quality versus normal annual fluctuations. For Summit Lake, it appears there is no upward or downward trend in water clarity over the past 17 years of record, just plus or minus one meter variation around the mean.

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.

Summit Lake is an oligotrophic, or low productivity, lake. The Summit Lake TSI’s for total phosphorus, chlorophyll *a*, and secchi disk for 2007 are 29, 38, and 32, respectively. The trophic state indices graph which follows this narrative shows that all three parameters, total phosphorus, chlorophyll *a* concentrations, and water clarity, indicate that the lake is low in nutrients and algae growth with high 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. Blue-green algae species, which are common in more nutrient rich environments, are often present in this lake but are rarely dominant. To date, only relatively minor and localized blue-green algae blooms occur. Algae species present in the lake are included in a table at the end of this chapter. Rooted aquatic plants in this lake are minimal and do not interfere with recreational uses.

## 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.

- 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.

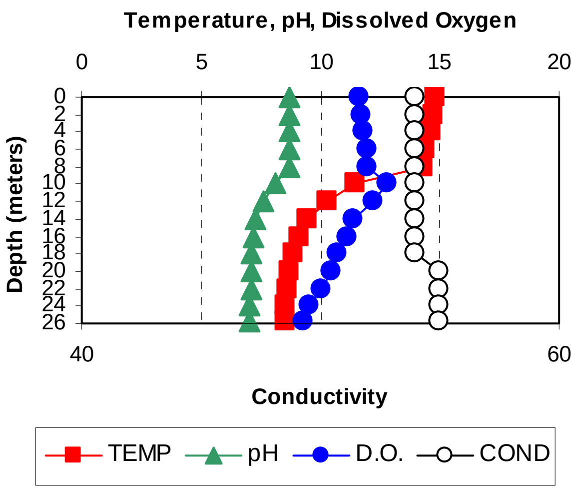
- The high density residential activities along the shoreline and forestry activities in the upper watershed are a concern for water quality.

## Funding Sources:

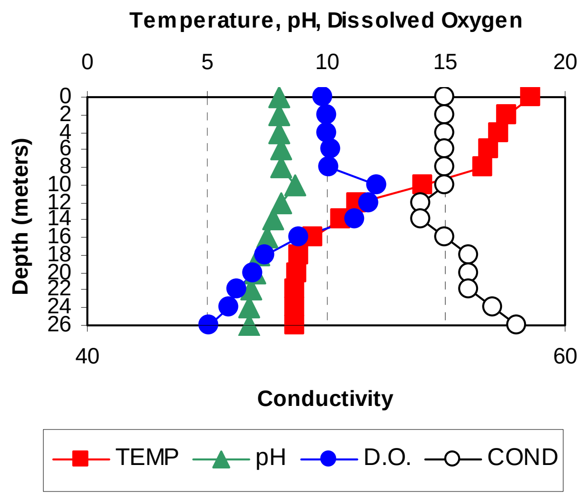
Thurston County funds will continue to support monitoring in 2008.

## SUMMIT LAKE

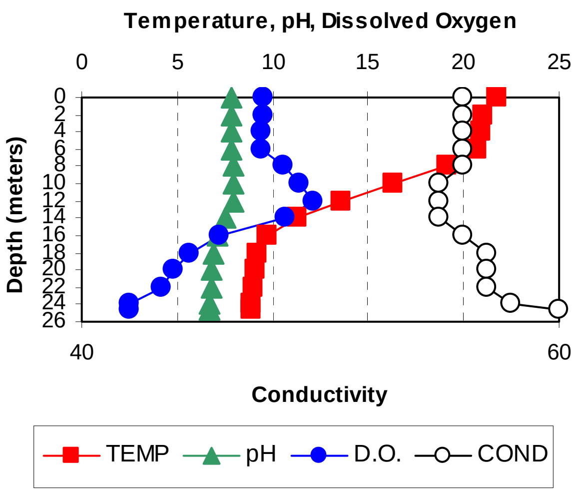
### May 21, 2007



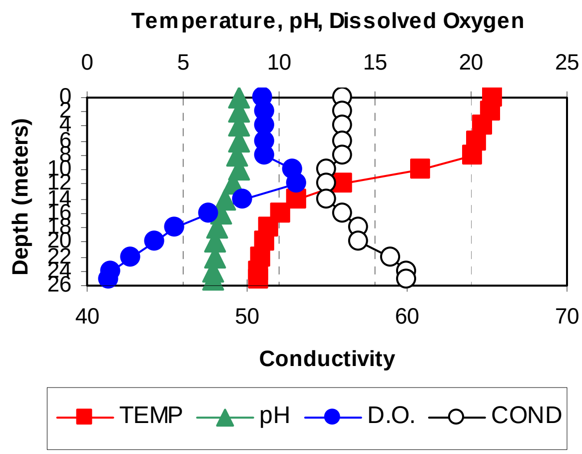

### June 20, 2007



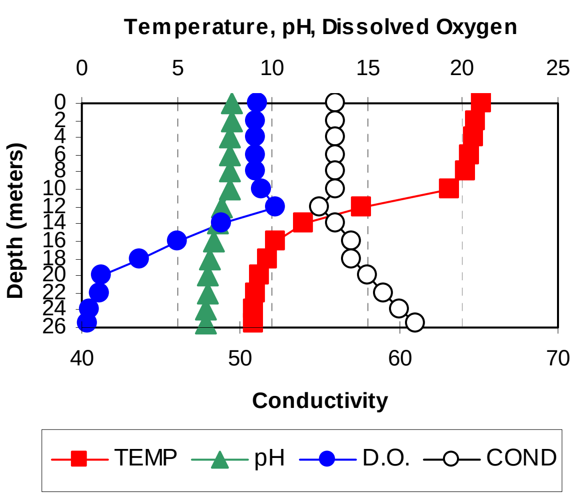

### July 25, 2007



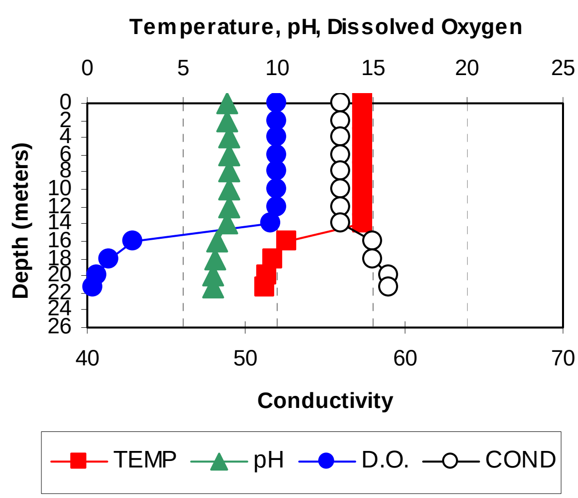

### August 15, 2007

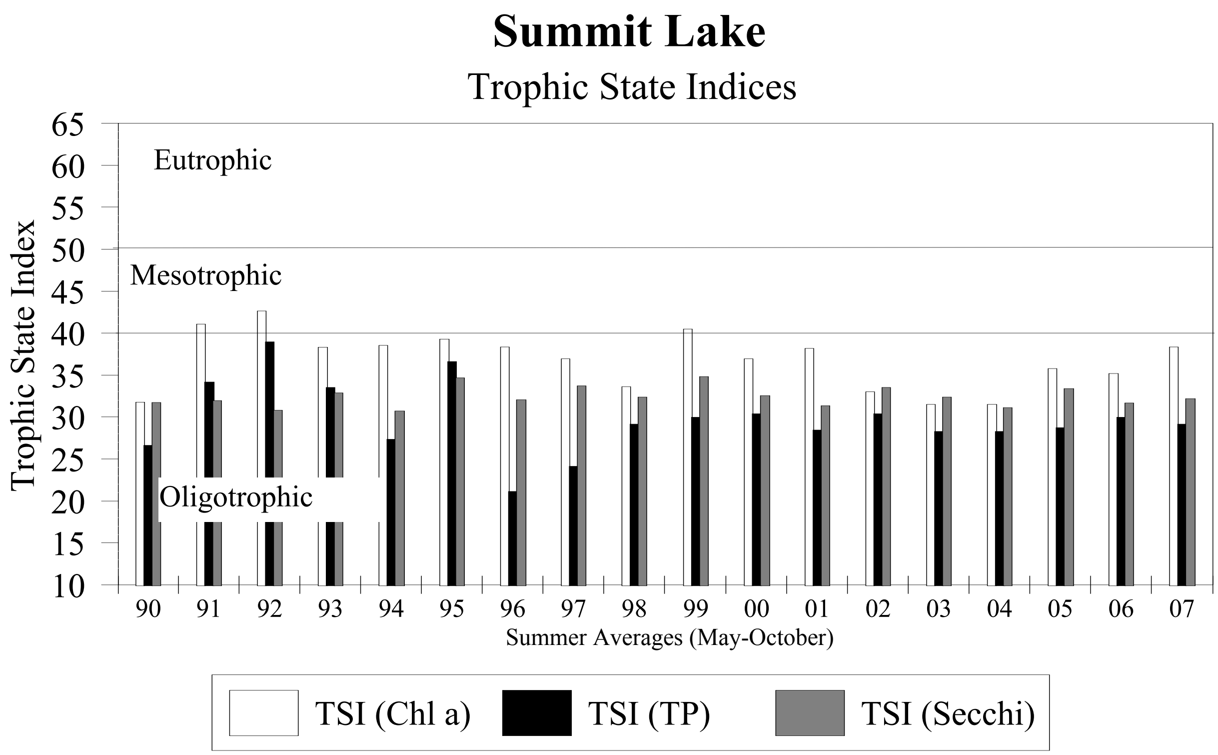


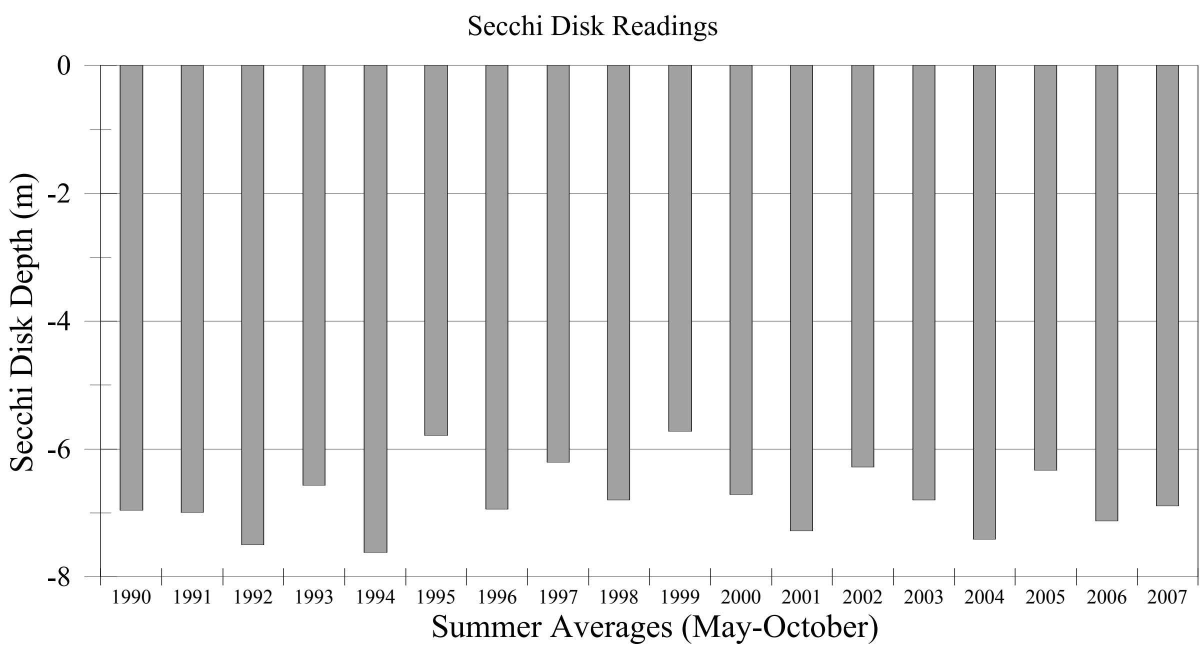

### September 11, 2007

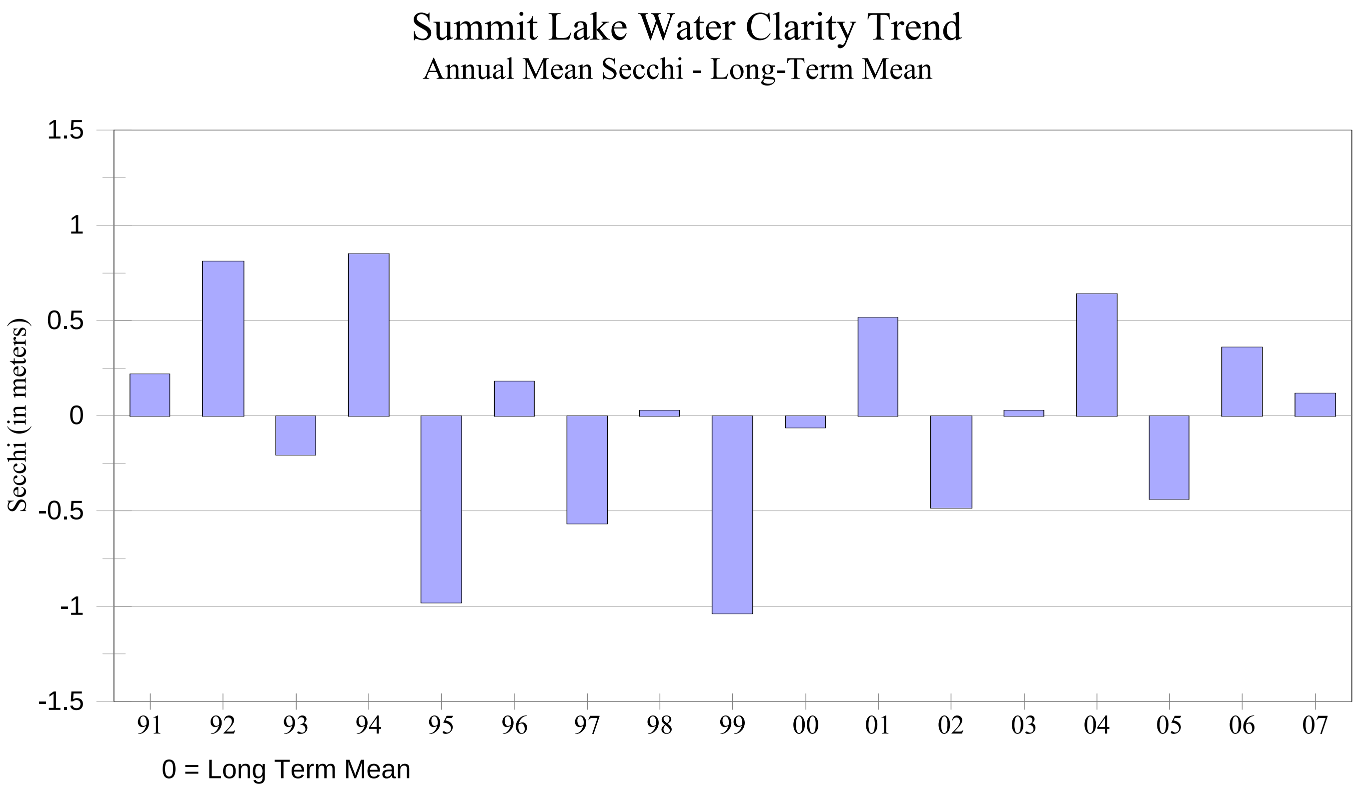



### October 16, 2007




Summit Lake
Trophic State Indices
Trophic State Index
Eutrophic
Mesotrophic
Oligotrophic
65
60
55
50
45
40
35
30
25
20
15
10
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07
Summer Averages (May-October)
TSI (Chl a)
TSI (TP)
TSI (Secchi)


Secchi Disk Readings
Secchi Disk Depth (m)
0
-2
-4
-6
-8
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Summer Averages (May-October)


Summit Lake Water Clarity Trend
Annual Mean Secchi - Long-Term Mean
Secchi (in meters)
1.5
1
0.5
0
-0.5
-1
-1.5
91
92
93
94
95
96
97
98
99
00
01
02
03
04
05
06
07
0 = Long Term Mean

## 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 Color | Lake Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05/21/2007 | 2:00:00 PM | 25.7 | 24.0 | 0.006 | 0.005 | 0.275 | 0.328 | 5.54 | 6.4 | 0.05 | #2 lt green | Chl a & algae composite @ 2, 4, & 6M. Phaeo a was <0.1 |
| 06/20/2007 | 1:45:00 PM | 26 | 25.0 | 0.004 | 0.006 | 0.109 | 0.250 | 6.51 | 1.6 | 0.3 | #2 lt green | Chl a & algae composite @ 2, 6, & 10M. |
| 07/25/2007 | 1:00:00 PM | 24.7 | 24.0 | 0.007 | 0.017 | 0.134 | 0.309 | 10.08 | 0.8 | 0.9 | #2 lt green | Chl a & algae composite @ 2, 6, & 10M. |
| 08/15/2007 | 11:30:00 AM | 25.3 | 24.0 | 0.005 | 0.027 | 0.140 | 0.254 | 5.90 | 0.5 | 1.7 | #2 lt green | Chl a & algae composite @ 2, 5, & 8M. |
| 09/11/2007 | 11:30:00 AM | 25.6 | 24.0 | 0.006 | 0.023 | 0.149 | 0.234 | 7.30 | 1.9 | 0.7 | #2 lt green | Chl a & algae composite @ 2, 6, & 10M. |
| 10/16/2007 | 1:15:00 PM | 21.3 | 20.0 | 0.006 | 0.017 | 0.205 | 0.218 | 5.93 | 2.1 | 2 | #2 lt green | Chl a & algae composite @ 2, 4, & 6M. |

*Summary for 'Site Description' = Summit Lake, Main (North) Basin (6 detail records)*

| Averages: | | |
|---|---|---|
| | Sur TP | 0.006 |
| | Secchi | 6.88 |
| | Chl a | 2.2 |

# *Algae data:* Summit Lake, Main (North) Basin

| Date | Type | Description | Dominant in Sample |
|---|---|---|---|
| *05/21/2007* | | | |
| | CP | Chroomonas species | ☐ |
| | CP | Cryptomonas species | ☐ |
| | DT | Asterionella species | ☐ |
| | DT | Cyclotella species | ☐ |
| | DT | Fragilaria species | ☐ |
| | DT | Melosira species | ☐ |
| | GR | Elakatothrix species | ☐ |
| | GR | Oocystis species | ☐ |
| | YL | Dinobryon species | ☐ |
| *06/20/2007* | | | |
| | DT | Cyclotella species | ☑ |
| | DT | Melosira species | ☐ |
| | GR | Botryococcus species | ☐ |
| *07/25/2007* | | | |
| | BG | Aphanocapsa species | ☐ |
| | BG | Chroococcus species | ☐ |
| | DT | Cocconeis pediculus | ☐ |
| | DT | Stephanodiscus species | ☐ |
| | GR | Ankistrodesmus species | ☐ |
| | GR | Cosmarium species | ☐ |
| | GR | Elakatothrix species | ☐ |
| | GR | Sphaerocystis schroeteri | ☐ |
| | GR | Spondylosium species | ☐ |
| | YL | Dinobryon species | ☐ |

| Type | Description | Dominant in Sample |
|---|---|---|
| ***08/15/2007*** | | |
| DT | Cyclotella species | ☐ |
| GR | Ankistrodesmus species | ☐ |
| GR | Cosmarium species | ☐ |
| GR | Elakatothrix species | ☐ |
| GR | Eutetramorus globosus | ☐ |
| GR | Oocystis species | ☐ |
| GR | Tetraedron species | ☐ |
| YL | Dinobryon species | ☐ |
| ***09/11/2007*** | | |
| BG | Anabaena species | ☐ |
| BG | Chroococcus species | ☐ |
| BG | Gomphosphaeria species | ☐ |
| DT | Melosira species | ☐ |
| GR | Botryococcus species | ☐ |
| GR | Cosmarium species | ☐ |
| GR | Elakatothrix species | ☐ |
| GR | Scenedesmus species | ☐ |
| GR | Tetradesmus smithii | ☐ |
| YL | Dinobryon species | ☐ |
| ***10/16/2007*** | | |
| BG | Aphanothece species | ☐ |
| BG | Chroococcus species | ☐ |
| CP | Cryptomonas species | ☐ |
| DT | Asterionella species | ☐ |
| DT | Melosira species | ☐ |
| GR | Botryococcus species | ☐ |
| GR | Cosmarium species | ☐ |
| GR | Elakatothrix species | ☐ |
| GR | Oocystis species | ☐ |
| YL | Dinobryon species | ☑ |

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

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# Volunteer Monitoring

**Chapter Includes:**

**Project "GREEN" Monitoring**

# 2006-2007 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, 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 Anne Mills, Program Coordinator, Thurston Conservation District, at (360) 754-3588, ext. 108 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 2006-2007 water years follows.

| Site | School | DO | FC | pH | BOD | Water Temp. | Turbidity | Total Solids |
|---|---|---|---|---|---|---|---|---|
| *THTC=Too High to Count | 10/19/2006 | | | | | | | |
| Eaton Creek-86th Ave SE (Hall's) | Lydia Hawk | 9.2 | 18 | 7.5 | 0 | 10 | 10 | 1 |
| Eaton Creek-Evergreen Valley Rd. | Southworth (Murphy) | 8.4 | 86 | 7.5 | 1.3 | 10 | 3.3 | 1 |
| Horn Creek | McKenna (Dahlberg) | 7.8 | 86 | 7.5 | 0 | 10 | 0 | <1 |
| Kalama Creek | Mill Pond (Knight) | 8.3 | 29 | 7 | 1.1 | 10 | 0 | 1.5 |
| Lacamas Creek-288th St. S | McKenna (Pederson) | 6 | n.a | 7.5 | 1 | 11 | 5 | N.A. |
| Lacamas Creek-S.R.507 | McKenna (Roth) | 8.9 | 82 | 7 | 0.2 | | 3.3 | N.A. |
| McAllister Creek-Nis. Refuge | RRHS (Geyen) | 7.6 | 112 | 7.5 | 1.3 | 12 | 32 | 386.5 |
| McAllister Creek-Steilacoom Rd. | RRHS (Gradoville) | 6.2 | 40 | 7 | 1.5 | 8 | 5 | 1.5 |
| Muck Creek-8th Ave. E | Clarkmoor Elem. | 10 | 31 | 7.5 | 2 | N.A. | 1.25 | <1 |
| Nisqually - Frank's Landing | Wa He Lut | 12 | N/A. | 7 | 4 | 14 | 7 | 48.5 |
| **Nisqually Date:10/19/06** | | **mg/L** | **Col/100mL** | **units** | **mg/L** | **Celsius** | **JTUs** | **mg/L** |
| Nisqually- McKenna | Mill Pond (Carlsen) | 12 | 70 | 6.5 | 2.5 | 12 | 25 | 11.5 |
| Nisqually -Tank Crossing | YHS - (Wood) | 9.5 | 66 | 7.5 | 1.5 | 13 | 15 | n.a. |
| Nisqually-Centralia Boat Launch | Yelm HS (Wallis) | 10.25 | 17 | 7.5 | error | 14 | 1.6 | 10 |
| Nisqually-Centralia Powerhouse | Southworth (Tatro) | 7.4 | 12 | 7 | 0.4 | 15 | 20 | 10 |
| Nisqually-Nis. Pines | Yelm HS (Wallis) | 10 | 35 | 7.5 | 1.1 | 13 | 21 | 6.5 |
| Nisqually-Tahoma Woods | Columbia Crest | 12 | 0 | error | N.A. | N.A. | THTC* | 13757 |
| Ohop Creek-Kjelstad Rd. | Eatonville Elem. | 8.6 | 40 | 7 | 0.6 | 10 | 15 | 4.5 |
| Red Salmon Creek-McBride's | Meadows Elem. | 9.8 | 20 | 7.5 | 0.97 | 10 | 0 | <1 |
| Tanawax Creek- | Weyerehauser Elem. | 8.6 | 24 | 7 | 0.6 | 10 | 11.6 | 149.5 |
| Toboton Creek-Piessner Rd. | Lackamas Elem. | 10.3 | 46 | 8.3 | 1.3 | 10 | 15 | N.A. |
| Total Phosphates-Nisqually-McKenna- | 0 | | | | | | | |
| Yelm Creek-Bald Hills Rd. | Praire Elem. | 3.2 | n.a. | 7 | 0.2 | 11 | 43 | 34 |
| Yelm Creek-Ft. Stevens | Ft. Stevens (Wertz) | 8.5 | 4 | 7 | 0 | 15 | 5.8 | <1 |
| Yelm Creek-Ft. Stevens | Ft. Stevens (Rich) | 9 | 4 | 7 | 0 | 15 | 6.6 | <1 |

| Nisqually Data | 03/01/2007 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | D.O. | FC | pH | BOD | Temp. | Turbidity | Total Solids | Comments |
| Site | School | mg/l | Col/100ml | | mg/l | Celsius | JTU | mg/l | |
| Nisqually@Tahoma Woods | Col.Cr.El.(Johnstone/Myers | 13 | n.a. | 7 | n.a. | 3 | 7.5 | | |
| Ohop Creek@Kjelstad Rd. | Eatonville Elem(Bewley) | 10 | 44 | 7 | 10 | 0 | 15 | | |
| Tanawax Creek@Cutoff Rd. | Weyerhaeuser(Bewley) | 12 | 32 | 7 | 0 | 9 | 15 | | |
| Muck Creek@8th Ave. East | Clarkmoor(Endicott) | 6.3 | 22 | 7 | 4.8 | 10** | 0 | | |
| Toboton Creek@Peisner Rd. | Lackamas Elem (McGinnis) | 34 | | 7 | 9 | 2 | 5 | | high iron content, |
| Horn Creek | Mill Pond (Dhalberg) | 7.9 | n.a. | 6.5 | 9.7 | 10 | 1 | | |
| Lacamas Creek @ S.R. 507 | McKenna (Roth) | | | | | | | | |
| Yelm Creek@ Ft. Steven's | Fort Stevens (Rich) | 16.33 | n.a. | 7.5 | -3.17 | 12 | 5 | | |
| Yelm Creek@ Ft. Steven's | Fort Stevens (Wertz) | 20 | n.a. | 7 | 0.5 | 12 | 6.6 | | |
| Yelm Creek@Mouth | Mill Pond (Cie) | 11 | 22 | 7.5 | n.a. | 8 | 0 | | |
| Kalama Creek | Mill Pond(Knight) | | | | | | | | |
| Nisqually@Centralia Park | Yelm H.S. (Wallis) | 9.15 | 17 | 7 | 2.33 | 3 | 1.6 | | |
| Nisqually@McKenna | Mill Pond (Carlsen) | 13.3 | 5 | 6 | n/a | 1 | 15 | | |
| Nisqually@Nisqually Pines | Yelm H.S. (Wood) | 10 | 3 | 6 | -3 | 3 | 10 | | |
| Nisqually@Powerhouse | Southworth Elem.(Tatro) | 10 | 16 | 7 | n.a. | 2.5 | n.a. | | |
| Nisqually@ Tank Crossing | Y.H.S. (Wood) | 14.3 | 10 | 7.5 | 3.9 | 4 | 6.7 | | |
| Muck Creek@Roy | McKenna Elementary(Roth) | | | | | | | | |
| Eaton Creek | Southworth (Murphy) | n.a. | 276 | 7 | n.a. | 5 | 1 | | |
| Eaton Creek @ Hall's | Lydia Hawk (Poole) | 9.6 | 2 | 7 | n.a. | 8 | 1.6 | | |
| Nisqually@Handicap Access | Meadows (Munnecke) | 10 | | 7 | 1 | 4 | 6.7 | | |
| Nisqually@Frank's Landing | Wa He Lut School(Montrose | 12.6 | 9 | 7 | 2.6 | 6 | 5 | | |
| McAllister@Old Hatchery | River Ridge (Gradoville) | 7.3 | 88 | 7 | 1.2 | 8.5 | 16 | | |
| Red Salmon@McBride's | Meadows (Johnson) | 11 | 22 | 7.5 | n/a | 10 | 11.6 | | |
| Wash Creek | Meadows (Kuhnau/Stewart) | 11 | n.a. | 7.5 | n.a. | 6 | 5 | | |
| McAllister@Refuge | River Ridge(Geyen) | 8.1 | 13 | 7.2 | 1.3 | 0 | 15 | | |
| *T.M.C=Too Many to Count | | | | | | | | | |
| n.a. = not available | | | | | | | | | |
| ** = estimate | | | | | | | | | |

# South Sound
# GREEN
# 2006-2007
# Water Quality Data

| Parameter | DO (mg/l) | | DO sat (%) | | FC (# /100ml) | | pH | | BOD (mg/l) | | Water Temp. (°C) | | Turbidity (JTU) | | Total Solids** (mg/l) | | Weather/Notes | | School | Teacher 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** | **School** | **Teacher** |
| Deschutes @ Military Rd | 10 | 10.6 | 94 | 81 | *NAF* | 16 | 7.5 | 6.8 | 0 | 0.4 | 12 | 4.5 | 0 | 2 | 0.9 | 2.8 | overcast,showers; 14°C | 5°C | CSE | Nichols |
| Deschutes River @ Rich Rd (Petit) | 7.7 | 12.2 | 70 | 95 | *NAF* | 12 | 7.0 | 7.0 | | 2 | 12 | 5 | 0 | 13.3 | 1 | 8.7 | overcast, drizzle; 14°C | 11:15, cloudy; 5°C | Black Hills HS | St. Clair |
| Deschutes River @ The Plant Center (The Barn) | 9.6 | 11.4 | 87 | 82 | 37 | 20 | 7.3 | 7.0 | 1.16 | 3.15 | 10.5 | 2 | 0 | 0 | 8 | 7.2 | overcast; light rain; 11°C | 2°C | St Martins University | Hartman |
| Deschutes River @ Pioneer Park | 8.8 | 11 | 88 | 105 | 266 | 635 | 7.0 | 7.0 | 0 | *NAF* | 13 | *NAF* | 1.7 | 15 | 0.4 | 5.7 | crisp, clear; 45°F | 40°F | Komachin MS | Reimer |
| Deschutes River @ Tumwater Falls | 10.06 | 10.56 | 109 | 111 | 312 | 12 (TC^10) | 7.0 | 7.0 | 0.86 | 0.56 | 20 | 17 | 3.3 | 10 | 1.1 | 4.3 | overcast, windy; 61°F | 3:00 PM; cloudy; 45°F | Olympia HS | Kirk |
| Deschutes River @ Historical Park | 9.33 | 13.67 | 90 | 140 | 520 | 24 | 7.5 | 7.5 | 0.83 | 2 | 9 | 7 | 5 | 18.33 | 2 | 27 | cold, cloudy; 14°C | 9:00; cloudy; 4°C | McKenny Elem | Brewer |
| | | | | | | | | | | | | | | | | | | | | |
| **Black River/Percival Creek Watershed** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **School** | **Teacher** |
| Black Lake Ditch @ R. W. Johnson Rd. | 8.27 | 10.067 | *NAF* | 83 | *NAF* | *NAF* | 7.0 | 7.0 | 3.3 | *NAF* | *NAF* | 7 | 13.3 | 5 | 2 | 1.8 | sunny and cool | | YMCA Service Corp | Ziegler |
| Percival Creek @ Chapparal | 10.1 | | 80 | | *NAF* | | 7.0 | | 7.8 | | 12 | | 0 | | 8.3 | | cloudy,rainy; 3°C | | Bush MS | Adams |
| Percival Creek @ Sapp Rd | 9.5 | 10.3 | 86 | 82 | 0 | *NAF* | 7.0 | 7.0 | 0 | 2.3 | 11.5 | 6 | 5 | 5 | 2.4 | 2.3 | 10/20: clear, damp | 9:45; partly cloudy; 8°C | Tumwater MS | Harris |
| Percival Creek @ Alderbrook (duck pond) | 7.9 | 11.5 | 75 | 90 | 1 | TC^10 | 7.0 | 7.0 | 0.7 | 1.5 | 13 | 6 | 5 | 10 | 2.6 | 4.8 | overcast with rain | 8:30; partly cloudy; 4°C | Tumwater MS | Harris |
| Percival Creek@ Alderbrook (woods) | | *NAF* | | *NAF* | | TC^<5 | | 7.0 | | 2.53 | | 6.5 | | 0.5 | | *NAF* | | 9:10; cloudy, snow; 4°C | THS | Buechner |
| Capitol Lake @ 5th and Water | 10 | 11 | | 110 | *NAF* | | 8.0 | 7.5 | *NAF* | *0* | 12 | 5 | 5 | 10 | 5.1 | | drizzling/light rain; 13°C | | Pioneer Elem | Cereghino |
| Capitol Lake @ Marathon Park | 10.53 | 10.77 | 95 | 84 | *NAF* | *NAF* | 7.5 | 7.2 | 2.63 | NAF | 11 | 5 | 1.66 | 11.66 | 1.6 | 3.4 | rainy;14°C | 3/2-10:30; cloudy, lt. rain | Pioneer Elem | Varano |
| Ken Lake | 9.2 | 10.2 | 100 | *NAF* | 117 | 4 | 7.0 | 7.0 | 1.3 | 1.5 | 21 | *NAF* | 5 | 0 | 0.8 | *NAF* | 10/24: drizzle/ rain; 45°F | 3/2; overcast | Avanti HS | Sogn |
| Fish Pond Creek @ Kennydell Park | 8.8 | 9.7 | 78 | 80 | 33 | 6 | 6.0 | 6.5 | 8.6 | 2.5 | 10 | 7 | 1.66 | 0 | *NAF* | 0 | 10/18: rainy; 14°C | 9:30; cloudy,snow; 3°C | Bush MS | Cutler |
| Ashley Creek @ the pond | NAF | 9.2 | NAF | 72 | NAF | 2 (TC^30) | NAF | 6.5 | NAF | 1.2 | NAF | 6.5 | NAF | 0 | NAF | 0.2 | | 8:18; snowing; 3°C | Bush MS | Cutler |
| Ashley Creek @ the culvert | NAF | 9 | NAF | 72 | NAF | 0 (TC^ 30) | NAF | 6.5 | NAF | *NAF* | NAF | 6.5 | NAF | 0 | NAF | 1.8 | | 8:18; snow; 3°C | Bush MS | Cutler |
| Black River @ DFW boat Launch | 6.3 | | 55 | | *NAF* | | 7.0 | | *NAF* | | 9 | | 0 | | *NAF* | | 10/23 | | BHHS | St. Clair |
| | | | | | | | | | | | | | | | | | | | | |
| **Henderson/Nisqually** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **School** | **Teacher** |
| Pattison Lake Ditch | 3.6 | | 55 | | 0 | | 8.5 | | 1.7 | | 13 | | 3.3 | | NAF | | 13°C | | Timberline HS | Marshall |
| Woodland Creek @ Community Center | | 9.3 | | 73 | | 42 | | 7.2 | | 2.5 | | 5 | | <5 | | 4 | 28th, air 34°F | | Mount View Elem | Stevens |
| Woodland Creek @ Draham Rd | 7.1 | 9.3 | 64 | 74 | 34 | 28 | 7.0 | 7.1 | 0.6 | 2 | 11 | 6 | <5 | <5 | 2.9 | 4.3 | overcast; 59°F | 40°F, 10:00 a.m. | Mountain View Elem | Stevens |
| Woodland @ Mark St Bridge | 8.5 | 10.3 | 78 | 89 | 39 | 6 | 7.5 | 7.0 | 0.5 | 0.3 | 12 | 9 | 0 | 5 | 1 | NAF | overcast; 64°F | cold, 1:30 p.m. | Lydia Hawk Elem | Poole |
| Woodland Creek @ Pleasant Glade | 8.2 | 11.5 | 75 | NAF | NAF | 330 | 7.4 | 6.5 | NAF | 0 | 12 | NAF | 8.3 | 18 | 1.6 | NAF | overcast, foggy, cool; 50°F | 40°F | Komachin MS | Glock |
| Woodland Creek @ Hollywood | 10 | 11.7 | 83 | 89 | NAF | NAF | 7.5 | 7.5 | 1 | 2.1 | 8 | 4 | 5 | 11.7 | 2 | NAF | partly cloudy; 57°F | air 42°F 5°C, overcast | South Bay Elem | Lang |
| Beachcrest | 11.3 | 10.5 | 102 | 93 | NAF | 66 | 8.0 | 7.5 | 1.3 | 0.5 | 11 | 10 | 7.5 | 6.7 | NAF | NAF | clear; 14.5°C | cloudy,cold, 10 a.m. | Olympic View Elem | Crain |
| Tolmie Creek @ State Park | 9.6 | | 85 | | 0 | | 9.3 | | 1 | | 10 | | 0.83 | | NAF | | overcast,light drizzle | | Timberline HS | Marshall |
| | | | | | | | | | | | | | | | | | | | | |
| **Budd Inlet Watershed** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **School** | **Teacher** |
| Garfield Creek @ Nature Trail | 8.5 | 15.8 | 75 | 120% | 132 | TC^40 | 7.0 | 7.0 | 0.7 | NAF | 11 | 8 | 5 | 5 | 8.8 | NAF | partly cloudy, warm; 12-15°C | samples contaminated | Garfield Elem | Stine/Reynolds |
| Mission Creek @ Ethridge and Central (Park) | 8.8 | 8.8 | 82 | 82 | 26 | 26 | NAF | 7.0 | 1.6 | 1.6 | 12 | 12 | 0 | 0 | NAF | NAF | | 13°C air, partly cloudy; 2 p.m. | Roosevelt Elem | Ferguson |
| Misson Creek @ East Bay Drive | 9.3 | 9.8 | 85 | 77 | 38 | 40 | 7.0 | 7.0 | 1.5 | 1.5 | 11.5 | 5.1 | 0 | 0 | NAF | NAF | | a.m. | Roosevelt Elem | Ferguson |
| Moxlie Creek @ stormwater pipe | 10 | 9.83 | 88 | 84 | 8 ◊ | NAF | 6.5 | 7.0 | 1.7 | E | 9.5 | 9 | 6.6 | 2.5 | 2.7 | 1 | overcast, some rain | overcast, air 9°C | Centennial Elem | Samson |
| Moxlie Creek @ spring | 10.6 | 6.83 | 97 | 73 | 416 ◊ | NAF | 6.5 | 7.0 | 3.4 | E | 9.5 | 9 | 6.6 | 5 | 20 | 1.2 | overcast, light rain | overcast, air 9°C | Centennial Elem | Samson |
| Indian Creek @ Fredrick St | 9.7 | 10.8 | 105 | NAF | 416 | 616 | 7.5 | 7.0 | 7.73 | 1.55 | 20 | NAF | 7.5 | 5 | 6.2 | 3.8 | Oct. 18: cloudy; 53°F | cloudy 2/28 | Avanti HS | Sogn |
| Indian Creek @ Quince St | 9.35 | 10 | 100 | NAF | 492 | 392 | 7.3 | 7.0 | 4.65 | 0 | 20 | NAF | 35+ | 0 | 10.6 | 6.1 | Oct. 18: cloudy; 53°F | cloudy 2/28 | Avanti HS | Sogn |
| Schneider Creek@ Yantis/West Olympia | 14.1 | 14.5 | 127 | 122 | 125 | NAF | 5.5 | 7.0 | 4.35 | 0.4 | 11 | 8 | 0 | 0 | 1 | 8.8 | | cloudy, approx. 40°F | Garfield Elem | Nied |
| | | | | | | | | | | | | | | | | | | | | |
| **Eld Inlet Watershed** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **School** | **Teacher** |
| Beatty Creek @ the bridge | 8.7 | 10.3 | 76 | 85 | 8 | NAF | 7.5 | 7.0 | 0 | 0.05 | 9 | 5.5 | 2.5 | 8.3 | 0.2 | 0.8 | overcast; 15°C | overcast, 1:30 p.m., 7°C | McLane Elem | Schilter |
| McLane Creek @ The Nature Trail | 10 | 9.6 | 86 | 76 | NAF | NAF | 7.0 | 7.0 | 1.6 | E | 9 | 5.5 | 0 | 2.5 | 1.4 | 2 | overcast; 14°C | 1:30 p.m. overcast, 6°C | McLane Elem | Bergholz |
| Library Creek @ TESC | 7.6 | 10.2 | 64 | 90 | 312 | 49 | 7.5 | 7.5 | 0 | 2.74 | 12.5 | 3 | 3.3 | 0 | NAF | 4.2 | overcast, rainy; 13.5 °C | a.m. | Capital HS | Hook |
| Snyder Creek @ TESC | 10 | 11 | 92 | 95 | 253 | 23 | 7.3 | 7.3 | 1 | 0.7 | 12 | 9 | 5 | 5 | 4.2 | 5.6 | overcast; 13°C | ground; 8:45; 3°C | Capital HS | Baker |
| Green Cove Creek@ Cedrona | | 7.5 | | 56 | | NAF | | 6.5 | | E | | 4 | | 1.66 | | 1.8 | | mostly cloudy, 8°C, 1:15 p.m. | Marshall MS | Trafton |
| Green Cove Creek@ Fire Station | | 11.2 | | 86 | | NAF | | 6.8 | | NAF | | 4.5 | | 3.4 | | NAF | | overcast, cold, dry; 10:30 a.m. | Marshall MS | Cook |
| Green Cove Creek @ 36th | 9 | | NAF | | 95 | | 7.3 | | NAF | | NAF | | 0 | | 14.8 | | cloudy; 10.5°C | | Marshall MS | Cook |
| Cooper Crest Creek @ the bridge | 8.8 | 10.8 | 78 | 83 | 13 | NAF | 7.5 | 7.0 | | 0.5 | 11 | 5.5 | <5 | 11.6 | NAF | 5.3 | drizzle;14°C | 6°C air | Marshall MS | Trafton |
| | | | | | | | | | | | | | | | | | | | | |
| **Totten Inlet Watershed** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **Oct** | **Mar** | **School** | **Teacher** |
| Schneider Creek @ Bridges | 9.5 | | 86 | | 53 | | 7.0 | | 2.3 | | 12 | | 3.3 | | NAF | | partly cloudy, light wind; 10°C | | Griffin MS | Temple |
| Schneider Creek@ Reroute | | 11.4 | | 86 | | 10 | | 6.5 | | NAF | | 4 | | 5 | | 1.5 | | | Griffin MS | Temple |
| Kennedy Creek @ The Salmon Trail | 9 | 11 | 81 | 85 | 115+ | NAF | 7.0 | 6.8 | 0.3 | 0.5 | 11 | 5 | 0 | | NAF | 3.7 | overcast; 13°C | overcast; 13°C | Capital HS | Baker |
| | | | | | | | | | | | | | | | | | | | | |
| **KEY** | | | | | | | | | | | | | | | | | | | | |
| **NAF = Not analyzed for** | | | | | | | | | | | | | | | | | | | | |
| **◊ = Possible switch of spring & storm pipe results ??** | | | | | | | | | | | | | | | | | | | | |
| **IR = insufficient replicates** | | | | | | | | | | | | | | | | | | | | |
| **TC^= Thurston County Env. Health Lab** | | | | | | | | | | | | | | | | | | | | |
| **E = Error** | | | | | | | | | | | | | | | | | | | | |
| ****= LOTT Lab Results** | | | | | | | | | | | | | | | | | | | | |

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# 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 included sample results for 2006 and 2007. In 2006 and 2007, twenty-three samples were collected. 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 2006 and 2007 are as follows:

**Black Lake Ditch** @ R. W. Johnson Road
**Deschutes River** @ Pioneer Park
**Ellis Creek** @ Priest Point Park - east side of East Bay Drive
**Fox Creek** @ Pleasant Glade NE
**Green Cove Creek** @ $36^{th}$ Ave NW
**Indian Creek** @ Wheeler Ave SE
**Little McAllister Creek** @ Meadows
**McLane Creek** @ DNR Nature Trail
**Mission Creek** @ Bethel Street NE
**Moxlie Creek** @ Watershed Park
**Palm Creek** @ Pleasant Glade NE
**Percival Creek** @ SPSCC Artist's Bridge
**Schneider Creek** @ West Bay Drive

**Woodland Creek** @ Draham Rd.
**Woodland Creek** @ Pleasant Glade Rd.

Eight streams were sampled by Thurston County Environmental Health staff in 2006 and 2007. The samples were collected at the ambient monitoring locations. They are as follows:

**Chambers Creek** off end of $58^{th}$ 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

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## 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**

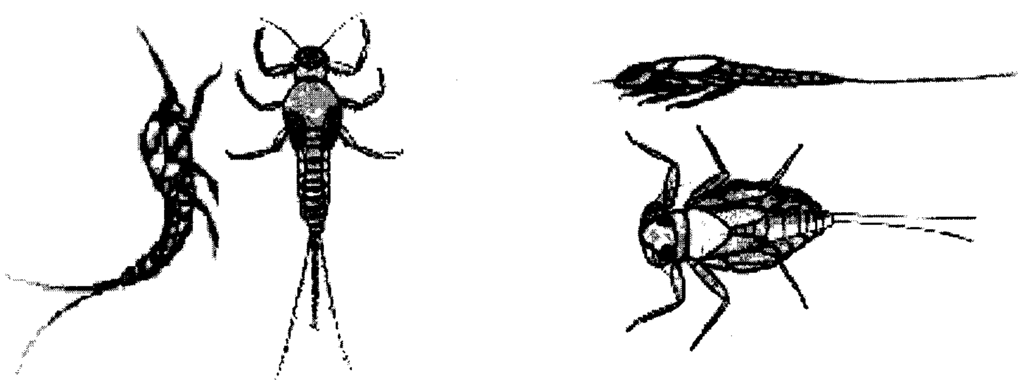
The total number of different types of organisms (taxa richness) declines as degradation increases. About half to two-thirds the number of taxa found at an excellent site are found in a moderate site. The primary change from an excellent site is that there will be many fewer taxa of stoneflies. Mayflies 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*)

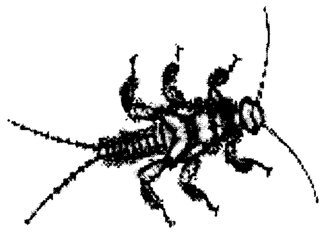
Mayflies are insects that spend most of their lives in streams, emerging briefly as adults ("ephemerally") to mate and lay eggs. Gills are often visible along the abdomen. If an animal has three tails it's a mayfly;

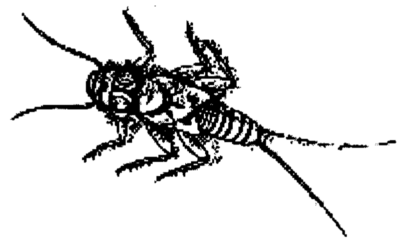


but some mayflies have two tails. Mayfly nymphs are strong swimmers and move like dolphins. As immature nymphs many mayflies feed on algae; as adults they do not eat. Mayfly diversity declines as streams are degraded; mayflies are particularly sensitive to mine waste.

**Stonefly nymphs** (*Order Plecoptera)*

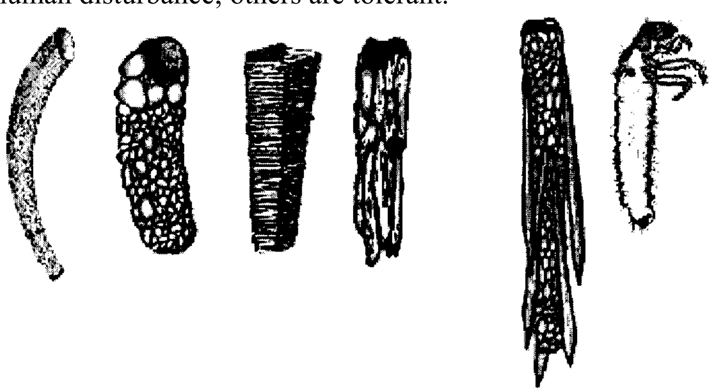
Stonefly nymphs are typically found on or near stones in the stream. They are rather primitive and may have been among the first insects to develop flight. Adult males and females emerge from the water to mate and locate each other by drumming with their abdomens. Stoneflies move like turtles and many 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** *(OrderTrichoptera)*

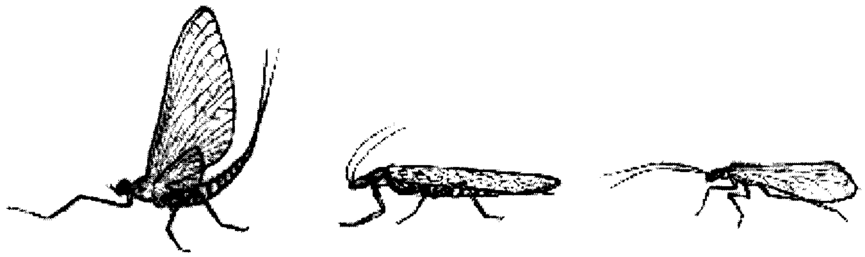
Caddisflies use silk (like butterflies) to build cases from gravel, twigs, needles, or sand. Different species build distinct cases, but they often lose them when removed from a stream. Caddisflies are insects that emerge to mate as winged adults. Caddisfly larvae make a living in a variety of ways: 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.



free-living

**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.

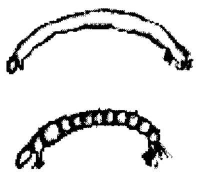


**Riffle beetles** *(Order Coleoptera)*

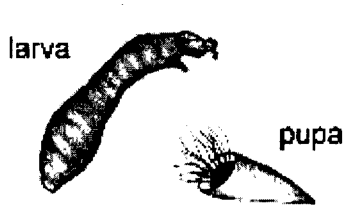
Riffle beetle larvae are specially adapted to cling to smooth rocks in fast-flowing water (riffles). After emergence, adults fly for a short time but return to the water to feed in the same habitat as the larvae. Both the larvae and adults are rather small, dark-colored, and tend to drift to the bottom of a sample so they may be hard to see. Riffle beetles collect and gather a variety of different foods.


**Fly larvae** *(Order Diptera)*

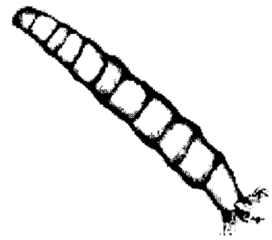
There are many species of true flies, but you are likely to recognize three main groups or families. Midge larvae (or chironomids) are very small, often C-shaped, and have a spastic squirming movement. They are often attached to debris by their tiny legs. Black fly larvae (or simuliids) are dumb-bell 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.



chironomids



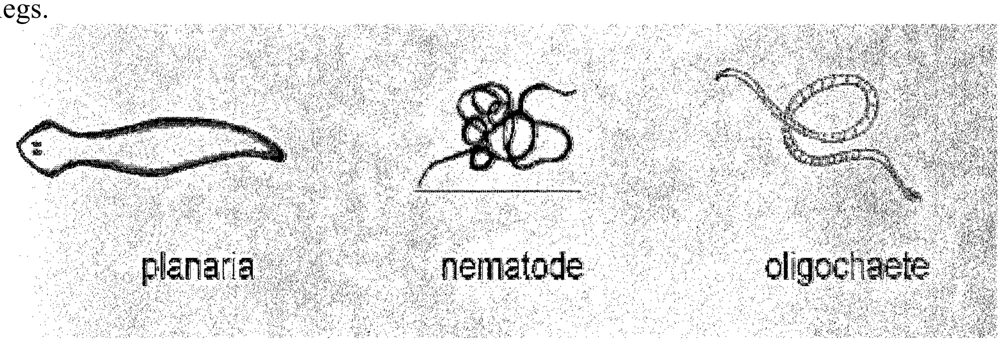

simuliids



tipulid

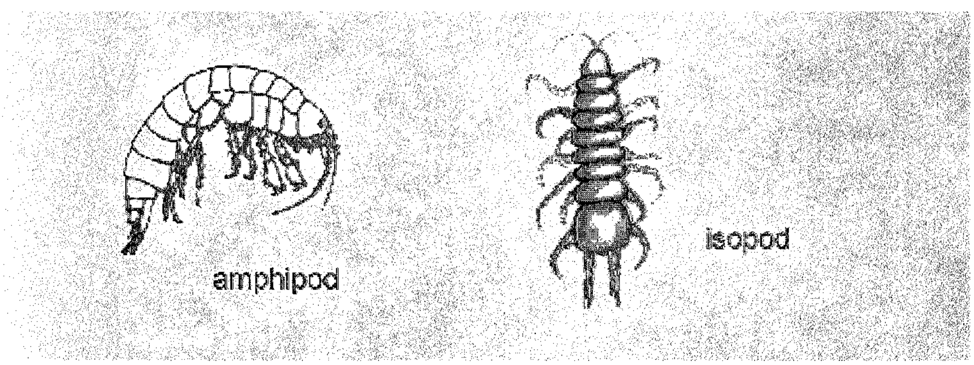
**Aquatic worms**

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.

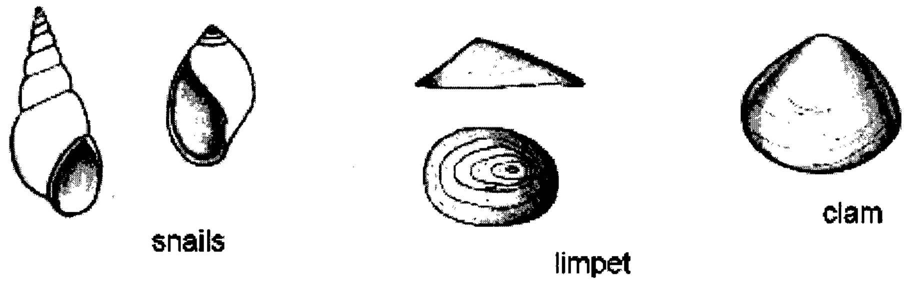



**Crustaceans**

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.

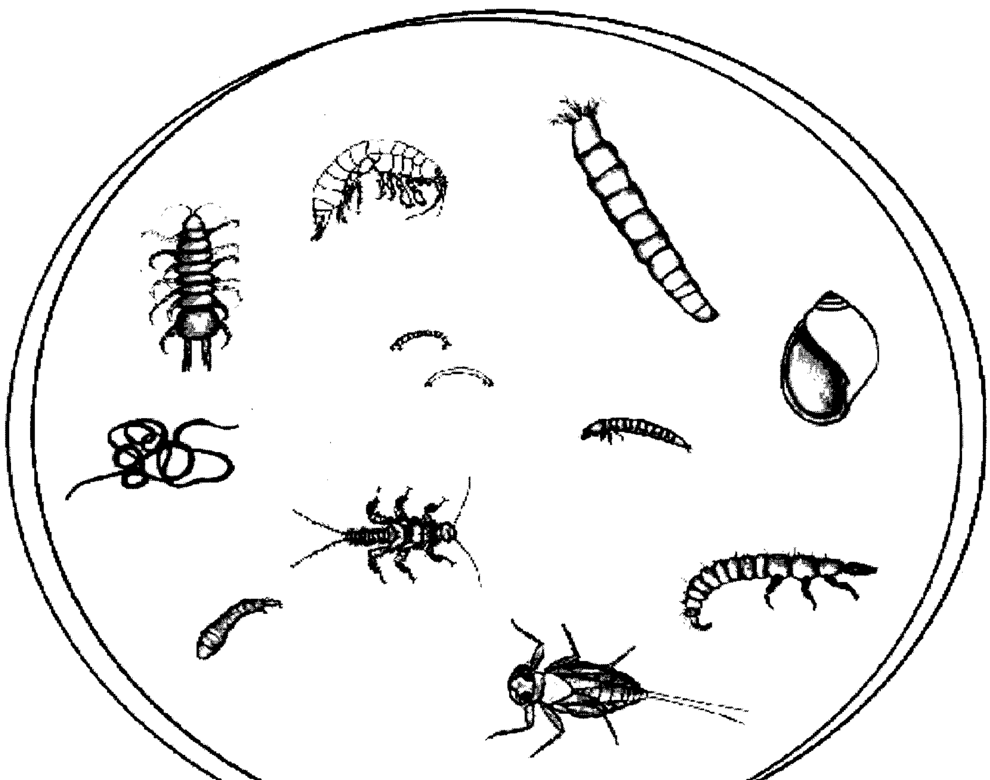


**Molluscs** *(Classes Gastropoda & Pelecypoda)*




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 dangering 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. <u>Using both hands</u>, **vigorously** stir the remaining substrate with the weed fork. Stir to a depth of 10 cm (4 inches) for <u>**60 seconds**</u> 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. <u>Keeping the opening of the net above water,</u> 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. <u>**Make sure that any water you use to rinse rocks, equipment, or your hands comes from the screened rinsing jug**</u>. 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). <u>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.</u>

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*)

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Black Lake Ditch

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Black Lake Ditch** | | **Black Lake Ditch** | | **Black Lake Ditch** | | **Black Lake Ditch** | |
| | **Station** | **RW Johnson Roa** | | **RW Johnson Road** | | **RW Johnson Road** | | **RW Johnson Road** | |
| | **Client** | **Stream Team** | | **Stream Team** | | **Stream Team** | | **Stream Team** | |
| | **Date** | **8/22/04** | | **8/10/05** | | **6/21/06** | | **6/21/07** | |
| | **METRIC** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** |
| **D** | **Total number of taxa** | 34 | 3 | 34 | 3 | 37 | 3 | 35 | 3 |
| **D** | **Number Ephemeroptera taxa** | 3 | 1 | 4 | 1 | 3 | 1 | 3 | 1 |
| **D** | **Number Plecoptera taxa** | 4 | 3 | 2 | 1 | 3 | 1 | 5 | 3 |
| **D** | **Number Trichoptera taxa** | 6 | 3 | 5 | 3 | 6 | 3 | 6 | 3 |
| **D** | **Number of long-lived taxa** | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 1 |
| **D** | **Number of intolerant taxa** | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| **I** | **% Tolerant taxa** | 29.04 | 3 | 21.32 | 3 | 14.54 | 5 | 9.62 | 5 |
| **D** | **% Predator** | 1.49 | 1 | 26.96 | 5 | 1.28 | 1 | 2.83 | 1 |
| **D** | **Number of clinger taxa** | 20 | 3 | 21 | 5 | 20 | 3 | 21 | 5 |
| **I** | **% Dominance (3 taxa)** | 54.73 | 3 | 57.46 | 3 | 87.2 | 1 | 83.63 | 1 |
| | | 9 square feet total area sampled starting 2002 | | | | | | | |
| | **TOTAL SCORE** | | **22** | | **26** | | **20** | | **24** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50.
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | 8/22/04 | | 8/10/05 | | 6/21/06 | | 6/21/07 | |
|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 3160 | | 1252 | | 12726 | | 8667 | |
| **D** | **EPT taxa richness** | 13 | | 11 | | 12 | | 14 | |
| **D** | **Predator richness** | 9 | | 9 | | 10 | | 9 | |
| **D** | **Scraper richness** | 8 | | 8 | | 7 | | 7 | |
| **D** | **Shredder richness** | 3 | | 3 | | 3 | | 5 | |
| **D** | **%Intolerant taxa** | 0 | | 0 | | 0 | | 0.03 | |

| | | 8/22/04 | | 8/10/05 | | 6/21/06 | | 6/21/07 | |
|---|---|---|---|---|---|---|---|---|---|
| **I** | **Hilsenhoff Biotic Index** | 4.95 | | 5.2 | | 5.35 | | 5.29 | |
| **I** | **%Collector** | 75.98 | | 83.47 | | 91.54 | | 86.45 | |
| **I** | **%Parasite** | 1.04 | | 0.29 | | 0 | | 0.25 | |
| **I** | **%Oligochaeta** | 4.31 | | 7.93 | | 0.45 | | 0.86 | |
| **I** | **Number tolerant taxa** | 8 | | 10 | | 8 | | 6 | |
| **I** | **%Simuliidae** | 40.98 | | 43.69 | | 63.12 | | 59.18 | |
| **I** | **%Chironomidae** | 1.55 | | 1.53 | | 3.69 | | 3.29 | |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integ
D= Metric value generally decreases with declining biological integrity.

L= Low biological integrity. BIBI scores between 0-24.
M= Moderate biological integrity. BIBI scores between 25-39.
H= High biological integrity. BIBI scores >40.

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

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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.

## Chambers Creek

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Chambers Creek** | | **Chambers Creek** | | **Chambers Creek** | | **Chambers Creek** | |
| | **Station** | | | | | | | | |
| | **Client** | **Public Health** | | **Public Health** | | **Public Health** | | **Public Health** | |
| | **Date** | **9/23/04** | | **9/15/05** | | **9/7/06** | | **9/20/07** | |
| | **METRIC** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** |
| **D** | **Total number of taxa** | 57 | 5 | 59 | 5 | 39 | 3 | 54 | 5 |
| **D** | **Number Ephemeroptera taxa** | 7 | 3 | 9 | 5 | 6 | 3 | 8 | 3 |
| **D** | **Number Plecoptera taxa** | 10 | 5 | 7 | 3 | 7 | 3 | 10 | 5 |
| **D** | **Number Trichoptera taxa** | 11 | 5 | 11 | 5 | 11 | 5 | 10 | 5 |
| **D** | **Number of long-lived taxa** | 9 | 5 | 6 | 5 | 4 | 3 | 5 | 5 |
| **D** | **Number of intolerant taxa** | 1 | 1 | 2 | 1 | 0 | 1 | 0 | 1 |
| **I** | **% Tolerant taxa** | 12.83 | 5 | 17.53 | 5 | 16.57 | 5 | 20.48 | 3 |
| **D** | **% Predator** | 35.6 | 5 | 14.4 | 3 | 17.15 | 3 | 23.02 | 5 |
| **D** | **Number of clinger taxa** | >20 | 5 | >20 | 5 | >20 | 5 | >20 | 5 |
| **I** | **% Dominance (3 taxa)** | 42.78 | 5 | 39.05 | 5 | 43.15 | 5 | 30.76 | 5 |
| | **TOTAL SCORE** | | **44** | | **42** | | **36** | | **42** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | 9/23/04 | 9/15/05 | 9/7/06 | 9/20/07 |
|---|---|---|---|---|---|
| | **Total abundance (m2)** | 1855 | 2561 | 419 | 1580 |
| **D** | **EPT taxa richness** | 28 | 27 | 24 | 28 |
| **D** | **Predator richness** | 15 | 15 | 12 | 17 |
| **D** | **Scraper richness** | 15 | 15 | 10 | 12 |
| **D** | **Shredder richness** | 10 | 9 | 6 | 8 |
| **D** | **%Intolerant taxa** | 3.16 | 4.14 | 0 | 0 |
| **I** | **Hilsenhoff Biotic Index** | 3.07 | 4.27 | 4 | 3.57 |
| **I** | **%Collector** | 38.24 | 65.16 | 67.43 | 43.2 |
| **I** | **%Parasite** | 1.1 | 1.41 | 1.15 | 2.65 |
| **I** | **%Oligochaeta** | 4.97 | 20.89 | 9.14 | 2.58 |
| **I** | **Number tolerant taxa** | 8 | 7 | 3 | 6 |
| **I** | **%Simuliidae** | 9.81 | 6.01 | 20.29 | 4.62 |
| **I** | **%Chironomidae** | 4.26 | 9.76 | 8 | 3.56 |

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. | BIBI scores between 0-24. |
| M= Moderate biological integrity. | BIBI scores between 25-39. |
| H= High biological integrity. | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

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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.

## Deschutes River @ Pioneer Park

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Deschutes River** | | **Deschutes River** | | | | | | | |
| | **Station** | **Pioneer Park** | | **Pioneer Park** | | | | | | | |
| | **Client** | **Stream Team** | | **Stream Team** | | | | | | | |
| | **Date** | **8/19/06** | | **8/18/07** | | | | | | | |
| | **METRIC** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** |
| D | **Total number of taxa** | 69 | 5 | 56 | 5 | | | | | | |
| D | **Number Ephemeroptera taxa** | 11 | 5 | 11 | 5 | | | | | | |
| D | **Number Plecoptera taxa** | 9 | 5 | 5 | 3 | | | | | | |
| D | **Number Trichoptera taxa** | 11 | 5 | 8 | 3 | | | | | | |
| D | **Number of long-lived taxa** | 5 | 5 | 2 | 1 | | | | | | |
| D | **Number of intolerant taxa** | 1 | 1 | 1 | 1 | | | | | | |
| I | **% Tolerant taxa** | 11.62 | 5 | 24.16 | 3 | | | | | | |
| D | **% Predator** | 5.52 | 1 | 1.51 | 1 | | | | | | |
| D | **Number of clinger taxa** | >20 | 5 | >20 | 5 | | | | | | |
| I | **% Dominance (3 taxa)** | 27.43 | 5 | 45.09 | 5 | | | | | | |
| | **TOTAL SCORE** | | **42** | | **32** | | **0** | | **0** | | **0** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | Metric | 8/19/06 Value | | 8/18/07 Value | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 5037 | | 14446 | | | | | | | |
| D | **EPT taxa richness** | 31 | | 24 | | | | | | | |
| D | **Predator richness** | 18 | | 8 | | | | | | | |
| D | **Scraper richness** | 18 | | 13 | | | | | | | |
| D | **Shredder richness** | 5 | | 4 | | | | | | | |
| D | **%Intolerant taxa** | 0.1 | | 0.07 | | | | | | | |
| I | **Hilsenhoff Biotic Index** | 4.59 | | 4.63 | | | | | | | |
| I | **%Collector** | 55.69 | | 71.78 | | | | | | | |
| I | **%Parasite** | 3.75 | | 2.62 | | | | | | | |
| I | **%Oligochaeta** | 0.33 | | 0.17 | | | | | | | |
| I | **Number tolerant taxa** | 13 | | 10 | | | | | | | |
| I | **%Simuliidae** | 13.17 | | 5.43 | | | | | | | |
| I | **%Chironomidae** | 37.95 | | 40.79 | | | | | | | |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integı
D= Metric value generally decreases with declining biological integrity.

| | | |
|---|---|---|
| L= Low biological integrity. | | BIBI scores between 0-24. |
| M= Moderate biological integrity. | | BIBI scores between 25-39. |
| H= High biological integrity. | | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Ellis Creek @ Priest Point Park

| | | | |
|---|---|---|---|
| **Water Body** | **Ellis Creek** | **Ellis Creek** | **Ellis Creek** |
| **Station** | **Priest Point Park** | **Priest Point Park** | **Priest Point Park** |
| **Client** | **Stream Team** | **Stream Team** | **Stream Team** |
| **Date** | **8/10/05** | **8/2/06** | **7/14/07** |

| | **METRIC** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **D** | **Total number of taxa** | 52 | 5 | 57 | 5 | 52 | 5 | | | | |
| **D** | **Number Ephemeroptera taxa** | 5 | 3 | 6 | 3 | 4 | 1 | | | | |
| **D** | **Number Plecoptera taxa** | 9 | 5 | 9 | 5 | 12 | 5 | | | | |
| **D** | **Number Trichoptera taxa** | 10 | 5 | 10 | 5 | 10 | 5 | | | | |
| **D** | **Number of long-lived taxa** | 4 | 3 | 7 | 5 | 6 | 5 | | | | |
| **D** | **Number of intolerant taxa** | 3 | 3 | 4 | 5 | 4 | 5 | | | | |
| **I** | **% Tolerant taxa** | 3.77 | 5 | 5.67 | 5 | 10.88 | 5 | | | | |
| **D** | **% Predator** | 32.76 | 5 | 30.16 | 5 | 37.65 | 5 | | | | |
| **D** | **Number of clinger taxa** | >20 | 5 | >20 | 5 | 33 | 5 | | | | |
| **I** | **% Dominance (3 taxa)** | 40.44 | 5 | 36.09 | 5 | 46.53 | 5 | | | | |
| | **TOTAL SCORE** | | **44** | | **48** | | **46** | | **0** | | **0** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 983 | | 1476 | | 1431 | | | | | |
| **D** | **EPT taxa richness** | 24 | | 25 | | 26 | | | | | |
| **D** | **Predator richness** | 18 | | 20 | | 18 | | | | | |
| **D** | **Scraper richness** | 9 | | 12 | | 7 | | | | | |
| **D** | **Shredder richness** | 5 | | 7 | | 8 | | | | | |
| **D** | **%Intolerant taxa** | 0.48 | | 0.48 | | 1.09 | | | | | |
| | | | | | | | | | | | |
| **I** | **Hilsenhoff Biotic Index** | 3.69 | | 3.74 | | 3.05 | | | | | |
| **I** | **%Collector** | 49.7 | | 47.27 | | 29.53 | | | | | |
| **I** | **%Parasite** | 1.71 | | 0.49 | | 0.75 | | | | | |
| **I** | **%Oligochaeta** | 0.49 | | 0.65 | | 0.25 | | | | | |
| **I** | **Number tolerant taxa** | 4 | | 4 | | 2 | | | | | |
| **I** | **%Simuliidae** | 2.56 | | 9.57 | | 5.36 | | | | | |
| **I** | **%Chironomidae** | 17.54 | | 18.49 | | 16.57 | | | | | |

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. | | BIBI scores between 0-24. |
| M= Moderate biological integrity. | | BIBI scores between 25-39. |
| H= High biological integrity. | | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Fox Creek @ Pleasant Glade NE

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Fox Creek** | | **Fox Creek** | | **Fox Creek** | | **Fox Creek** | | |
| | **Station** | **Pleasant Glade NE** | | **Pleasant Glade NI** | | **Pleasant Glade NI** | | **Pleasant Glade NE** | | |
| | **Client** | **Stream Team** | | **Stream Team** | | **Stream Team** | | **Stream Team** | | |
| | **Date** | **8/10/04** | | **8/16/05** | | **8/2/06** | | **8/15/07** | | |
| | **METRIC** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** |
| D | **Total number of taxa** | 39 | 3 | 31 | 3 | 38 | 3 | 33 | 3 | | |
| D | **Number Ephemeroptera taxa** | 3 | 1 | 2 | 1 | 3 | 1 | 2 | 1 | | |
| D | **Number Plecoptera taxa** | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | | |
| D | **Number Trichoptera taxa** | 2 | 1 | 0 | 1 | 3 | 1 | 1 | 1 | | |
| D | **Number of long-lived taxa** | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | | |
| D | **Number of intolerant taxa** | 0 | 1 | 1 | 1 | 3 | 3 | 0 | 1 | | |
| I | **% Tolerant taxa** | 11.87 | 5 | 8.09 | 5 | 8.53 | 5 | 18.08 | 5 | | |
| D | **% Predator** | 3.22 | 1 | 2.93 | 1 | 5.5 | 1 | 8.82 | 1 | | |
| D | **Number of clinger taxa** | 16 | 3 | 13 | 3 | 15 | 3 | 12 | 3 | | |
| I | **% Dominance (3 taxa)** | 71.32 | 3 | 75.75 | 1 | 58.49 | 3 | 62.38 | 3 | | |
| | **TOTAL SCORE** | | **20** | | **18** | | **22** | | **20** | | **0** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.

Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | Metric | 8/10/04 | | 8/16/05 | | 8/2/06 | | 8/15/07 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 7221 | | 12419 | | 8299 | | 3634 | | | |
| D | **EPT taxa richness** | 7 | | 4 | | 8 | | 4 | | | |
| D | **Predator richness** | 7 | | 5 | | 9 | | 12 | | | |
| D | **Scraper richness** | 7 | | 5 | | 4 | | 2 | | | |
| D | **Shredder richness** | 5 | | 4 | | 6 | | 1 | | | |
| D | **%Intolerant taxa** | 0 | | 0.03 | | 0.6 | | 0 | | | |
| I | **Hilsenhoff Biotic Index** | 6.69 | | 6.58 | | 6.18 | | 6.61 | | | |
| I | **%Collector** | 81.47 | | 82.72 | | 73.55 | | 76.19 | | | |
| I | **%Parasite** | 0.54 | | 0.9 | | 0.82 | | 0.22 | | | |
| I | **%Oligochaeta** | 0.51 | | 2.65 | | 10.92 | | 0.38 | | | |
| I | **Number tolerant taxa** | 13 | | 13 | | 9 | | 10 | | | |
| I | **%Simuliidae** | 24.28 | | 31.02 | | 17.8 | | 43.56 | | | |
| I | **%Chironomidae** | 63.87 | | 54.38 | | 52.84 | | 41.61 | | | |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integı

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L= Low biological integrity. BIBI scores between 0-24.

M= Moderate biological integrity. BIBI scores between 25-39.

H= High biological integrity. BIBI scores >40.

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

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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.

## Green Cove Creek

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Green Cove Creek** | | **Green Cove Creek** | | **Green Cove Creek** | | **Green Cove Creek** | |
| | **Station** | **36th Avenue NW** | | **Mouth Site** | | **@ 36th Avenue NE** | | **Mouth Site** | |
| | **Client** | **Stream Team** | | **Public Health** | | **Stream Team** | | **Public Health** | |
| | **Date** | **7/22/06** | | **8/23/06** | | **8/11/07** | | **9/12/07** | |
| | **METRIC** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** |
| D | **Total number of taxa** | 50 | 5 | 32 | 3 | 53 | 5 | 58 | 5 |
| D | **Number Ephemeroptera taxa** | 3 | 1 | 3 | 1 | 5 | 3 | 5 | 3 |
| D | **Number Plecoptera taxa** | 7 | 3 | 5 | 3 | 9 | 5 | 8 | 5 |
| D | **Number Trichoptera taxa** | 9 | 3 | 6 | 3 | 10 | 5 | 9 | 3 |
| D | **Number of long-lived taxa** | 2 | 1 | 5 | 5 | 2 | 1 | 7 | 5 |
| D | **Number of intolerant taxa** | 2 | 1 | 1 | 1 | 3 | 3 | 3 | 3 |
| I | **% Tolerant taxa** | 1.74 | 5 | 10.06 | 5 | 7.77 | 5 | 29.67 | 3 |
| D | **% Predator** | 18.47 | 3 | 17.88 | 3 | 19.36 | 3 | 17.13 | 3 |
| D | **Number of clinger taxa** | >20 | 5 | 18 | 3 | 30 | 5 | >20 | 5 |
| I | **% Dominance (3 taxa)** | 57.85 | 3 | 56.24 | 3 | 48.51 | 5 | 47.21 | 5 |
| | **TOTAL SCORE** | | **30** | | **30** | | **40** | | **40** |

**BIOLOGICAL CONDITION CATEGORY**
Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | 7/22/06 | | 8/23/06 | | 8/11/07 | | 9/12/07 | |
|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 7003 | | 643 | | 9640 | | 1651 | |
| D | **EPT taxa richness** | 19 | | 14 | | 24 | | 22 | |
| D | **Predator richness** | 15 | | 12 | | 17 | | 16 | |
| D | **Scraper richness** | 6 | | 5 | | 10 | | 11 | |
| D | **Shredder richness** | 7 | | 4 | | 7 | | 7 | |
| D | **%Intolerant taxa** | 0.08 | | 0.37 | | 1.66 | | 1.38 | |
| I | **Hilsenhoff Biotic Index** | 4.03 | | 4.06 | | 3.66 | | 3.71 | |
| I | **%Collector** | 46.7 | | 51.21 | | 42.77 | | 29.76 | |
| I | **%Parasite** | 1.13 | | 0 | | 2.61 | | 1.38 | |
| I | **%Oligochaeta** | 0.56 | | 3.91 | | 0.1 | | 0.15 | |
| I | **Number tolerant taxa** | 6 | | 4 | | 5 | | 5 | |
| I | **%Simuliidae** | 0.58 | | 4.84 | | 0.05 | | 0.73 | |
| I | **%Chironomidae** | 40.57 | | 25.88 | | 29.15 | | 9.06 | |

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. BIBI scores between 0-24.
M= Moderate biological integrity. BIBI scores between 25-39.
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# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

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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.

## Indian Creek @ Wheeler Avenue SE

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **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** | |
| | **Client** | **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** | |
| | **METRIC** | **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 |
| **D** | **Number Ephemeroptera taxa** | 4 | 1 | 3 | 1 | 3 | 1 | 4 | 1 | 3 | 1 |
| **D** | **Number Plecoptera taxa** | 6 | 3 | 5 | 3 | 6 | 3 | 5 | 3 | 5 | 3 |
| **D** | **Number Trichoptera taxa** | 8 | 3 | 6 | 3 | 5 | 3 | 5 | 3 | 6 | 3 |
| **D** | **Number of long-lived taxa** | 4 | 3 | 2 | 1 | 4 | 3 | 5 | 5 | 4 | 3 |
| **D** | **Number of intolerant taxa** | 2 | 1 | 1 | 1 | 3 | 3 | 1 | 1 | 2 | 1 |
| **I** | **% Tolerant taxa** | 10.22 | 5 | 7.66 | 5 | 3.08 | 5 | 3.67 | 5 | 6.83 | 5 |
| **D** | **% Predator** | 23.53 | 5 | 24.52 | 5 | 24.38 | 5 | 21.51 | 5 | 24.42 | 5 |
| **D** | **Number of clinger taxa** | >20 | 5 | 20 | 3 | 21 | 5 | 22 | 5 | 24 | 5 |
| **I** | **% Dominance (3 taxa)** | 36.07 | 5 | 42.88 | 5 | 55.33 | 3 | 52.29 | 3 | 37.94 | 5 |
| | **TOTAL SCORE** | | **36** | | **30** | | **34** | | **34** | | **34** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | 8/14/03 | 8/10/04 | 8/17/05 | 8/5/06 | 7/6/07 |
|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 1921 | 547 | 1045 | 1435 | 789 |
| **D** | **EPT taxa richness** | 18 | 14 | 14 | 14 | 14 |
| **D** | **Predator richness** | 12 | 10 | 9 | 11 | 9 |
| **D** | **Scraper richness** | 6 | 7 | 7 | 8 | 10 |
| **D** | **Shredder richness** | 6 | 5 | 7 | 5 | 8 |
| **D** | **%Intolerant taxa** | 8.48 | 0.22 | 4.57 | 0.33 | 0.45 |
| **I** | **Hilsenhoff Biotic Index** | 3.86 | 3.58 | 3.67 | 3.49 | 3.75 |
| **I** | **%Collector** | 49.96 | 55.36 | 59.41 | 60.07 | 55.98 |
| **I** | **%Parasite** | 1.06 | 0.22 | 0.68 | 0.42 | 0.45 |
| **I** | **%Oligochaeta** | 5.98 | 11.16 | 21.08 | 3.34 | 5.31 |
| **I** | **Number tolerant taxa** | 2 | 3 | 3 | 4 | 5 |
| **I** | **%Simuliidae** | 14.45 | 5.47 | 4.35 | 2 | 8.5 |
| **I** | **%Chironomidae** | 9.41 | 3.06 | 6.99 | 10.93 | 13.35 |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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M= Moderate biological integrity. BIBI scores between 25-39.
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# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

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Surber sampler, 500 micron mesh, 3 point composite per replicate= 3 ft2 per replicate after 2002, 1 ft2 before 2002, erosional habitat.
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## Kennedy Creek

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Kennedy Creek** | | **Kennedy Creek** | | **Kennedy Creek** | | **Kennedy Creek** | | **Kennedy Creek** | |
| | **Station** | | | | | | | | | | |
| | **Client** | **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** | |
| | **METRIC** | **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 |
| **D** | **Number Ephemeroptera taxa** | 9 | 5 | 8 | 3 | 9 | 5 | 5 | 3 | 8 | 3 |
| **D** | **Number Plecoptera taxa** | 10 | 5 | 9 | 5 | 10 | 5 | 6 | 3 | 8 | 5 |
| **D** | **Number Trichoptera taxa** | 6 | 3 | 5 | 3 | 9 | 3 | 4 | 1 | 6 | 3 |
| **D** | **Number of long-lived taxa** | 6 | 5 | 6 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| **D** | **Number of intolerant taxa** | 3 | 3 | 3 | 3 | 1 | 1 | 0 | 1 | 3 | 3 |
| **I** | **% Tolerant taxa** | 18.13 | 5 | 11.42 | 5 | 16.85 | 5 | 21.84 | 3 | 10.34 | 5 |
| **D** | **% Predator** | 14.27 | 3 | 12.78 | 3 | 8.04 | 1 | 22.88 | 5 | 14.29 | 3 |
| **D** | **Number of clinger taxa** | >20 | 5 | >20 | 5 | >20 | 5 | 21 | 5 | >20 | 5 |
| **I** | **% Dominance (3 taxa)** | 52.64 | 3 | 51.84 | 3 | 40.04 | 5 | 45.12 | 5 | 49.52 | 5 |
| | | 9 square feet total area sampled starting 2002 | | | | | | | | | |
| | **TOTAL SCORE** | | **42** | | **40** | | **40** | | **34** | | **42** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | 9/3/03 | 8/31/04 | 9/2/05 | 8/29/06 | 8/30/07 |
|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 1818 | 3550 | 3345 | 920 | 4234 |
| **D** | **EPT taxa richness** | 25 | 22 | 28 | 15 | 22 |
| **D** | **Predator richness** | 14 | 13 | 16 | 8 | 11 |
| **D** | **Scraper richness** | 17 | 13 | 17 | 8 | 15 |
| **D** | **Shredder richness** | 4 | 4 | 6 | 3 | 5 |
| **D** | **%Intolerant taxa** | 1.37 | 0.24 | 0.43 | 0 | 0.29 |
| | | | | | | |
| **I** | **Hilsenhoff Biotic Index** | 2.78 | 3 | 3.85 | 3.37 | 3.17 |
| **I** | **%Collector** | 25.5 | 40.28 | 53.03 | 39.91 | 35.74 |
| **I** | **%Parasite** | 0.07 | 0.34 | 0.14 | 0.26 | 2.04 |
| **I** | **%Oligochaeta** | 1.56 | 0.61 | 2.9 | 2.73 | 1.36 |
| **I** | **Number tolerant taxa** | 5 | 5 | 9 | 4 | 4 |
| **I** | **%Simuliidae** | 1.97 | 7.52 | 12.31 | 7.15 | 3.45 |
| **I** | **%Chironomidae** | 7.42 | 21.17 | 16.71 | 2.21 | 16.68 |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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| | | |
|---|---|---|
| L= Low biological integrity. | | BIBI scores between 0-24. |
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| H= High biological integrity. | | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

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## Little McAllister Creek @ Meadows

| | | | |
|---|---|---|---|
| **Water Body** | **Little McAllister** | **Little McAllister** | **Little McAllister** |
| **Station** | **Meadows** | **Meadows** | **Meadows** |
| **Client** | **Stream Team** | **Stream Team** | **Stream Team** |
| **Date** | **8/11/05** | **2006 ?Aug** | **8/4/07** |

| | METRIC | Value | Score | Value | Score | Value | Score | Value | Score | Value | Score |
|---|---|---|---|---|---|---|---|---|---|---|---|
| D | Total number of taxa | 44 | 5 | 48 | 5 | 44 | 5 | | | | |
| D | Number Ephemeroptera taxa | 1 | 1 | 2 | 1 | 2 | 1 | | | | |
| D | Number Plecoptera taxa | 6 | 3 | 3 | 1 | 4 | 3 | | | | |
| D | Number Trichoptera taxa | 3 | 1 | 5 | 3 | 8 | 3 | | | | |
| D | Number of long-lived taxa | 3 | 3 | 3 | 3 | 2 | 1 | | | | |
| D | Number of intolerant taxa | 1 | 1 | 0 | 1 | 1 | 1 | | | | |
| I | % Tolerant taxa | 35.28 | 3 | 6.82 | 5 | 9.1 | 5 | | | | |
| D | % Predator | 11.34 | 3 | 10.76 | 3 | 44.91 | 5 | | | | |
| D | Number of clinger taxa | 21 | 5 | 21 | 5 | 26 | 5 | | | | |
| I | % Dominance (3 taxa) | 44.51 | 5 | 63.95 | 3 | 37.59 | 5 | | | | |
| | **TOTAL SCORE** | | **30** | | **30** | | **34** | | **0** | | **0** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total abundance (m2) | 960 | | 1893 | | 882 | | | | | |
| D | EPT taxa richness | 10 | | 10 | | 14 | | | | | |
| D | Predator richness | 12 | | 14 | | 14 | | | | | |
| D | Scraper richness | 4 | | 5 | | 7 | | | | | |
| D | Shredder richness | 5 | | 5 | | 5 | | | | | |
| D | %Intolerant taxa | 0.62 | | 0 | | 0.14 | | | | | |
| I | Hilsenhoff Biotic Index | 5.03 | | 5.89 | | 4.09 | | | | | |
| I | %Collector | 44.49 | | 74.66 | | 36.66 | | | | | |
| I | %Parasite | 9.1 | | 1.03 | | 2.44 | | | | | |
| I | %Oligochaeta | 8.35 | | 0.8 | | 2.58 | | | | | |
| I | Number tolerant taxa | 9 | | 9 | | 9 | | | | | |
| I | %Simuliidae | 0.75 | | 53.75 | | 10.72 | | | | | |
| I | %Chironomidae | 15.59 | | 25.09 | | 21.57 | | | | | |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integ
D= Metric value generally decreases with declining biological integrity.

| | |
|---|---|
| L= Low biological integrity. | BIBI scores between 0-24. |
| M= Moderate biological integrity. | BIBI scores between 25-39. |
| H= High biological integrity. | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## McLane Creek

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **McLane Creek** | | **McLane Creek** | | **McLane Creek** | | **McLane Creek** | | | |
| | **Station** | **DNR Trail** | | **Mouth at Delphi Rd** | | **DNR Trail** | | **Mouth at Delphi Rd** | | | |
| | **Client** | **Stream Team** | | **Public Health** | | **Stream Team** | | **Public Health** | | | |
| | **Date** | **2006** | **August** | **9/6/06** | | **7/28/07** | | **9/14/07** | | | |
| | **METRIC** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** |
| **D** | **Total number of taxa** | 55 | 5 | 47 | 5 | 62 | 5 | 58 | 5 | | |
| **D** | **Number Ephemeroptera taxa** | 8 | 3 | 6 | 3 | 10 | 5 | 9 | 5 | | |
| **D** | **Number Plecoptera taxa** | 10 | 5 | 9 | 5 | 11 | 5 | 7 | 3 | | |
| **D** | **Number Trichoptera taxa** | 12 | 5 | 3 | 1 | 12 | 5 | 6 | 3 | | |
| **D** | **Number of long-lived taxa** | 4 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | | |
| **D** | **Number of intolerant taxa** | 6 | 5 | 0 | 1 | 7 | 5 | 2 | 1 | | |
| **I** | **% Tolerant taxa** | 14.58 | 5 | 9.91 | 5 | 24.66 | 3 | 10.53 | 5 | | |
| **D** | **% Predator** | 31.66 | 5 | 24.88 | 5 | 16.95 | 3 | 18.48 | 3 | | |
| **D** | **Number of clinger taxa** | >20 | 5 | >20 | 5 | >20 | 5 | >20 | 5 | | |
| **I** | **% Dominance (3 taxa)** | 60.63 | 3 | 35.61 | 5 | 49.6 | 5 | 50.94 | 3 | | |
| | **TOTAL SCORE** | | **44** | | **38** | | **44** | | **36** | | **0** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 3006 | | 736 | | 2558 | | 3493 | | | |
| **D** | **EPT taxa richness** | 30 | | 18 | | 33 | | 22 | | | |
| **D** | **Predator richness** | 14 | | 11 | | 17 | | 15 | | | |
| **D** | **Scraper richness** | 12 | | 10 | | 16 | | 15 | | | |
| **D** | **Shredder richness** | 10 | | 6 | | 6 | | 5 | | | |
| **D** | **%Intolerant taxa** | 0.81 | | 0 | | 1.26 | | 0.14 | | | |
| **I** | **Hilsenhoff Biotic Index** | 3.11 | | 3.42 | | 4.05 | | 2.84 | | | |
| **I** | **%Collector** | 25.29 | | 38.69 | | 53.57 | | 31.24 | | | |
| **I** | **%Parasite** | 0.89 | | 0.65 | | 0.84 | | 1.2 | | | |
| **I** | **%Oligochaeta** | 0.34 | | 7.48 | | 0.23 | | 1.68 | | | |
| **I** | **Number tolerant taxa** | 5 | | 8 | | 5 | | 11 | | | |
| **I** | **%Simuliidae** | 1.7 | | 0.81 | | 15.86 | | 0.99 | | | |
| **I** | **%Chironomidae** | 11.88 | | 14.63 | | 22.79 | | 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. | | BIBI scores between 0-24. |
| M= Moderate biological integrity. | | BIBI scores between 25-39. |
| H= High biological integrity. | | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Mission Creek

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **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** | |
| | **Client** | **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** | |
| | **METRIC** | **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 |
| **D** | **Number Ephemeroptera taxa** | 6 | 3 | 4 | 1 | 4 | 1 | 3 | 1 | 6 | 3 |
| **D** | **Number Plecoptera taxa** | 10 | 5 | 14 | 5 | 6 | 3 | 10 | 5 | 9 | 5 |
| **D** | **Number Trichoptera taxa** | 11 | 5 | 11 | 5 | 9 | 3 | 10 | 5 | 9 | 3 |
| **D** | **Number of long-lived taxa** | 4 | 3 | 7 | 5 | 3 | 3 | 6 | 5 | 7 | 5 |
| **D** | **Number of intolerant taxa** | 6 | 5 | 8 | 5 | 2 | 1 | 4 | 5 | 3 | 3 |
| **I** | **% Tolerant taxa** | 5.41 | 5 | 3.6 | 5 | 2.87 | 5 | 4.24 | 5 | 4.34 | 5 |
| **D** | **% Predator** | 12.55 | 3 | 32.06 | 5 | 15.9 | 3 | 24.79 | 5 | 16.42 | 3 |
| **D** | **Number of clinger taxa** | >20 | 5 | >20 | 5 | 23 | 5 | >20 | 5 | >20 | 5 |
| **I** | **% Dominance (3 taxa)** | 56.75 | 3 | 61.65 | 3 | 55.89 | 3 | 44.19 | 5 | 63.35 | 3 |
| | **TOTAL SCORE** | | **42** | | **44** | | **32** | | **46** | | **40** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | 8/4/03 | 8/5/04 | 8/20/05 | 7/15/06 | 8/18/07 |
|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 5332 | 2794 | 1167 | 1527 | 5572 |
| **D** | **EPT taxa richness** | 27 | 29 | 19 | 23 | 24 |
| **D** | **Predator richness** | 22 | 24 | 13 | 23 | 19 |
| **D** | **Scraper richness** | 10 | 7 | 5 | 7 | 9 |
| **D** | **Shredder richness** | 9 | 11 | 6 | 10 | 9 |
| **D** | **%Intolerant taxa** | 1.41 | 0.78 | 0.51 | 0.63 | 0.69 |
| **I** | **Hilsenhoff Biotic Index** | 5.19 | 4.23 | 4.95 | 4.09 | 4.7 |
| **I** | **%Collector** | 66.75 | 54.94 | 65.32 | 42.96 | 61.99 |
| **I** | **%Parasite** | 0.92 | 0.26 | 0.62 | 1.1 | 0.43 |
| **I** | **%Oligochaeta** | 5.22 | 1.84 | 11.79 | 1.65 | 0.86 |
| **I** | **Number tolerant taxa** | 5 | 2 | 2 | 3 | 2 |
| **I** | **%Simuliidae** | 0.6 | 1.2 | 1.33 | 3.45 | 1.33 |
| **I** | **%Chironomidae** | 57.27 | 41.95 | 53.95 | 40.13 | 47.12 |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integı
D= Metric value generally decreases with declining biological integrity.

| | |
|---|---|
| L= Low biological integrity. | BIBI scores between 0-24. |
| M= Moderate biological integrity. | BIBI scores between 25-39. |
| H= High biological integrity. | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Moxlie Creek @ Watershed Park

| | | | | | |
|---|---|---|---|---|---|
| **Water Body** | **Moxlie Creek** | **Moxlie Creek** | **Moxlie Creek** | **Moxlie Creek** | **Moxlie Creek** |
| **Station** | **Watershed Park** | **Watershed Park** | **Watershed Park** | **Watershed Park** | **Watershed Park** |
| **Client** | **Stream Team** | **Stream Team** | **Stream Team** | **Stream Team** | **Stream Team** |
| **Date** | **8/4/03** | **8/5/04** | **8/17/05** | **8/2/06** | **8/25/07** |

| | **METRIC** | **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 |
| **D** | **Number Ephemeroptera taxa** | 1 | 1 | 0 | 1 | 2 | 1 | 2 | 1 | 2 | 1 |
| **D** | **Number Plecoptera taxa** | 5 | 3 | 2 | 1 | 4 | 3 | 2 | 1 | 2 | 1 |
| **D** | **Number Trichoptera taxa** | 0 | 1 | 1 | 1 | 2 | 1 | 5 | 3 | 3 | 1 |
| **D** | **Number of long-lived taxa** | 1 | 1 | 2 | 1 | 3 | 3 | 5 | 5 | 3 | 3 |
| **D** | **Number of intolerant taxa** | 1 | 1 | 1 | 1 | 3 | 3 | 1 | 1 | 1 | 1 |
| **I** | **% Tolerant taxa** | 18.92 | 5 | 29.56 | 3 | 10.99 | 5 | 6.63 | 5 | 10.16 | 5 |
| **D** | **% Predator** | 20.26 | 5 | 6.94 | 1 | 16.17 | 3 | 15.28 | 3 | 27.1 | 5 |
| **D** | **Number of clinger taxa** | 11 | 3 | 9 | 1 | 16 | 3 | 15 | 3 | 14 | 3 |
| **I** | **% Dominance (3 taxa)** | 27.03 | 5 | 78.7 | 1 | 54.69 | 3 | 76.09 | 1 | 37.71 | 5 |
| | **TOTAL SCORE** | | **28** | | **14** | | **28** | | **26** | | **28** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 89 | | 275 | | 370 | | 416 | | 283 | |
| **D** | **EPT taxa richness** | 6 | | 3 | | 8 | | 9 | | 7 | |
| **D** | **Predator richness** | 5 | | 6 | | 7 | | 8 | | 9 | |
| **D** | **Scraper richness** | 1 | | 1 | | 5 | | 5 | | 6 | |
| **D** | **Shredder richness** | 7 | | 3 | | 6 | | 5 | | 5 | |
| **D** | **%Intolerant taxa** | 1.35 | | 0.43 | | 0.96 | | 0.29 | | 0.42 | |
| **I** | **Hilsenhoff Biotic Index** | 5.08 | | 6.56 | | 5.3 | | 5.23 | | 5.04 | |
| **I** | **%Collector** | 41.89 | | 39.97 | | 57.89 | | 71.77 | | 37.27 | |
| **I** | **%Parasite** | 2.7 | | 0.43 | | 1.29 | | 0.86 | | 1.27 | |
| **I** | **%Oligochaeta** | 8.11 | | 1.74 | | 7.44 | | 3.17 | | 6.78 | |
| **I** | **Number tolerant taxa** | 3 | | 4 | | 7 | | 2 | | 6 | |
| **I** | **%Simuliidae** | 9.46 | | 1.74 | | 37.86 | | 63.98 | | 11.86 | |
| **I** | **%Chironomidae** | 31.08 | | 81.3 | | 26.21 | | 6.63 | | 33.47 | |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integı
D= Metric value generally decreases with declining biological integrity.

| | | |
|---|---|---|
| L= Low biological integrity. | | BIBI scores between 0-24. |
| M= Moderate biological integrity. | | BIBI scores between 25-39. |
| H= High biological integrity. | | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Palm Creek @ Pleasant Glade NE

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Palm Creek** | | **Palm Creek** | | **Palm Creek** | | **Palm Creek** | | | |
| | **Station** | **Pleasant Glade NE** | | **Pleasant Glade NE** | | **Pleasant Glade NE** | | **Pleasant Glade NE** | | | |
| | **Client** | **Stream Team** | | **Stream Team** | | **Stream Team** | | **Stream Team** | | | |
| | **Date** | **8/27/04** | | **8/22/05** | | **8/14/06** | | **7/31/07** | | | |
| | **METRIC** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** |
| **D** | **Total number of taxa** | 57 | 5 | 61 | 5 | 56 | 5 | 54 | 5 | | |
| **D** | **Number Ephemeroptera taxa** | 6 | 3 | 6 | 3 | 4 | 1 | 6 | 3 | | |
| **D** | **Number Plecoptera taxa** | 8 | 5 | 9 | 5 | 11 | 5 | 9 | 5 | | |
| **D** | **Number Trichoptera taxa** | 11 | 5 | 11 | 5 | 9 | 3 | 10 | 5 | | |
| **D** | **Number of long-lived taxa** | 6 | 5 | 5 | 5 | 5 | 5 | 4 | 3 | | |
| **D** | **Number of intolerant taxa** | 2 | 1 | 4 | 5 | 3 | 3 | 5 | 5 | | |
| **I** | **% Tolerant taxa** | 3.58 | 5 | 1.07 | 5 | 3.17 | 5 | 2.04 | 5 | | |
| **D** | **% Predator** | 27.31 | 5 | 26.93 | 5 | 26.58 | 5 | 45.93 | 5 | | |
| **D** | **Number of clinger taxa** | >20 | 5 | >20 | 5 | >20 | 5 | >20 | 5 | | |
| **I** | **% Dominance (3 taxa)** | 36.95 | 5 | 39.05 | 5 | 32.56 | 5 | 36.56 | 5 | | |
| | **TOTAL SCORE** | | **44** | | **48** | | **42** | | **46** | | **0** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50.                    Each metric scored: 1=low,   3=moderate,   5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 968 | | 1849 | | 1136 | | 1175 | | | |
| **D** | **EPT taxa richness** | 25 | | 26 | | 24 | | 25 | | | |
| **D** | **Predator richness** | 16 | | 20 | | 17 | | 15 | | | |
| **D** | **Scraper richness** | 11 | | 8 | | 6 | | 7 | | | |
| **D** | **Shredder richness** | 11 | | 11 | | 12 | | 11 | | | |
| **D** | **%Intolerant taxa** | 0.37 | | 5.33 | | 0.64 | | 1.83 | | | |
| **I** | **Hilsenhoff Biotic Index** | 3.5 | | 4.03 | | 4.07 | | 3.23 | | | |
| **I** | **%Collector** | 39.4 | | 49.64 | | 56.16 | | 33.92 | | | |
| **I** | **%Parasite** | 9.39 | | 7.13 | | 4.96 | | 2.44 | | | |
| **I** | **%Oligochaeta** | 2.72 | | 1.81 | | 1.26 | | 0.71 | | | |
| **I** | **Number tolerant taxa** | 7 | | 2 | | 6 | | 4 | | | |
| **I** | **%Simuliidae** | 1.24 | | 1.34 | | 3.58 | | 2.55 | | | |
| **I** | **%Chironomidae** | 18.79 | | 34.13 | | 32.46 | | 19.04 | | | |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integı
D= Metric value generally decreases with declining biological integrity.

| | |
|---|---|
| L= Low biological integrity. | BIBI scores between 0-24. |
| M= Moderate biological integrity. | BIBI scores between 25-39. |
| H= High biological integrity. | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Percival Creek

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Percival Creek** | | **Percival Creek** | | **Percival Creek** | | **Percival Creek** | | | |
| | **Station** | **SPSCC** | | **Mouth @ ft bridge** | | **SPSCC** | | **Mouth @ ft bridge** | | | |
| | **Client** | **Stream Team** | | **Public Health** | | **Stream Team** | | **Public Health** | | | |
| | **Date** | **8/5/06** | | **8/31/06** | | **8/4/07** | | **9/19/07** | | | |
| | **METRIC** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | | |
| **D** | **Total number of taxa** | 40 | 3 | 23 | 3 | 39 | 3 | 37 | 3 | | |
| **D** | **Number Ephemeroptera taxa** | 5 | 3 | 3 | 1 | 4 | 1 | 4 | 1 | | |
| **D** | **Number Plecoptera taxa** | 9 | 3 | 7 | 3 | 7 | 3 | 10 | 5 | | |
| **D** | **Number Trichoptera taxa** | 7 | 3 | 4 | 1 | 7 | 3 | 7 | 3 | | |
| **D** | **Number of long-lived taxa** | 5 | 5 | 3 | 1 | 5 | 5 | 3 | 3 | | |
| **D** | **Number of intolerant taxa** | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | | |
| **I** | **% Tolerant taxa** | 18.42 | 5 | 8.35 | 5 | 9.45 | 5 | 22.67 | 3 | | |
| **D** | **% Predator** | 15.66 | 3 | 10.19 | 3 | 21.21 | 5 | 3.94 | 1 | | |
| **D** | **Number of clinger taxa** | >20 | 5 | 18 | 3 | 27 | 5 | 28 | 5 | | |
| **I** | **% Dominance (3 taxa)** | 53.81 | 3 | 69.6 | 3 | 60.97 | 3 | 69.24 | 3 | | |
| | **TOTAL SCORE** | | **34** | | **24** | | **34** | | **28** | | |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 1255 | | 516 | | 988 | | 1596 | | | |
| **D** | **EPT taxa richness** | 21 | | 14 | | 18 | | 21 | | | |
| **D** | **Predator richness** | 11 | | 9 | | 11 | | 10 | | | |
| **D** | **Scraper richness** | 8 | | 6 | | 8 | | 9 | | | |
| **D** | **Shredder richness** | 8 | | 3 | | 9 | | 6 | | | |
| **D** | **%Intolerant taxa** | 0.1 | | 0 | | 0.12 | | 0.08 | | | |
| **I** | **Hilsenhoff Biotic Index** | 3.46 | | 2.81 | | 3.53 | | 1.96 | | | |
| **I** | **%Collector** | 49.91 | | 55.44 | | 59.86 | | 23.44 | | | |
| **I** | **%Parasite** | 0.86 | | 0 | | 1.33 | | 0.23 | | | |
| **I** | **%Oligochaeta** | 5.73 | | 6.26 | | 4.36 | | 0.38 | | | |
| **I** | **Number tolerant taxa** | 4 | | 4 | | 5 | | 6 | | | |
| **I** | **%Simuliidae** | 1.81 | | 2.09 | | 1.21 | | 1.65 | | | |
| **I** | **%Chironomidae** | 3.44 | | 0.93 | | 3.03 | | 1.13 | | | |

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. | | BIBI scores between 0-24. |
| M= Moderate biological integrity. | | BIBI scores between 25-39. |
| H= High biological integrity. | | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Perry Creek

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Perry Creek** | | **Perry Creek** | | **Perry Creek** | | **Perry Creek** | | **Perry Creek** | |
| | **Station** | | | | | | | | | | |
| | **Client** | **Public Health** | | **Public Health** | | **Public Health** | | **Public Health** | | **Public Health** | |
| | **Date** | **9/4/03** | | **9/8/04** | | **8/26/05** | | **8/30/06** | | **8/8/07** | |
| | **METRIC** | **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 |
| **D** | **Number Ephemeroptera taxa** | 9 | 5 | 8 | 3 | 10 | 5 | 7 | 3 | 9 | 5 |
| **D** | **Number Plecoptera taxa** | 11 | 5 | 11 | 5 | 9 | 5 | 6 | 3 | 12 | 5 |
| **D** | **Number Trichoptera taxa** | 8 | 3 | 9 | 3 | 8 | 3 | 7 | 3 | 9 | 3 |
| **D** | **Number of long-lived taxa** | 4 | 3 | 6 | 5 | 4 | 3 | 4 | 3 | 7 | 5 |
| **D** | **Number of intolerant taxa** | 3 | 3 | 6 | 5 | 4 | 5 | 2 | 1 | 5 | 5 |
| **I** | **% Tolerant taxa** | 7.95 | 5 | 16.1 | 5 | 9.33 | 5 | 10.68 | 5 | 11.84 | 5 |
| **D** | **% Predator** | 21.69 | 5 | 32.97 | 5 | 8.17 | 1 | 36.92 | 5 | 18.09 | 3 |
| **D** | **Number of clinger taxa** | >20 | 5 | >20 | 5 | >20 | 5 | >20 | 5 | >20 | 5 |
| **I** | **% Dominance (3 taxa)** | 45.65 | 5 | 45.31 | 5 | 59.37 | 3 | 38.17 | 5 | 38.84 | 5 |
| | | 9 square feet total area sampled starting 2002 | | | | | | | | | |
| | **TOTAL SCORE** | | **44** | | **46** | | **40** | | **38** | | **46** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.

Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high

Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 3689 | | 3644 | | 3947 | | 941 | | 6468 | |
| **D** | **EPT taxa richness** | 28 | | 28 | | 27 | | 20 | | 30 | |
| **D** | **Predator richness** | 15 | | 14 | | 17 | | 11 | | 17 | |
| **D** | **Scraper richness** | 16 | | 18 | | 17 | | 15 | | 18 | |
| **D** | **Shredder richness** | 7 | | 9 | | 6 | | 4 | | 8 | |
| **D** | **%Intolerant taxa** | 1.78 | | 0.98 | | 0.73 | | 0.89 | | 0.87 | |
| **I** | **Hilsenhoff Biotic Index** | 2.55 | | 3.04 | | 4.46 | | 3.31 | | 3.45 | |
| **I** | **%Collector** | 27.26 | | 37.84 | | 60.21 | | 31.91 | | 39.37 | |
| **I** | **%Parasite** | 0.21 | | 0.34 | | 0.24 | | 0.76 | | 1.96 | |
| **I** | **%Oligochaeta** | 7.32 | | 4.83 | | 11.31 | | 7.63 | | 3.81 | |
| **I** | **Number tolerant taxa** | 9 | | 7 | | 10 | | 8 | | 8 | |
| **I** | **%Simuliidae** | 1.1 | | 1.79 | | 0.15 | | 1.78 | | 0.09 | |
| **I** | **%Chironomidae** | 6.84 | | 14.08 | | 36.72 | | 14.89 | | 23.35 | |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integr

D= Metric value generally decreases with declining biological integrity.

| | | |
|---|---|---|
| L= Low biological integrity. | | BIBI scores between 0-24. |
| M= Moderate biological integrity. | | BIBI scores between 25-39. |
| H= High biological integrity. | | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Schneider Creek (Budd Inlet)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Schneider Creek** | | | | **Schneider Creek** | | | | | |
| | **Station** | **West Bay Drive** | | | | **West Bay Drive** | | | | | |
| | **Client** | **Stream Team** | | | | **Stream Team** | | | | | |
| | **Date** | **8/14/06** | | | | **7/6/07** | | | | | |
| | **METRIC** | **Value** | **Score** | | | **Value** | **Score** | | | | |
| **D** | **Total number of taxa** | 37 | 3 | | | 32 | 3 | | | | |
| **D** | **Number Ephemeroptera taxa** | 2 | 1 | | | 3 | 1 | | | | |
| **D** | **Number Plecoptera taxa** | 6 | 3 | | | 8 | 5 | | | | |
| **D** | **Number Trichoptera taxa** | 3 | 1 | | | 2 | 3 | | | | |
| **D** | **Number of long-lived taxa** | 1 | 1 | | | 2 | 3 | | | | |
| **D** | **Number of intolerant taxa** | 2 | 1 | | | 2 | 3 | | | | |
| **I** | **% Tolerant taxa** | 10.23 | 5 | | | 18.77 | 5 | | | | |
| **D** | **% Predator** | 11.92 | 3 | | | 13.7 | 3 | | | | |
| **D** | **Number of clinger taxa** | 17 | 3 | | | 19 | 3 | | | | |
| **I** | **% Dominance (3 taxa)** | 42.97 | 5 | | | 50.25 | 3 | | | | |
| | **TOTAL SCORE** | | **26** | | | | **32** | | | | |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 1217 | | | | 472 | | | | | |
| **D** | **EPT taxa richness** | 11 | | | | 13 | | | | | |
| **D** | **Predator richness** | 11 | | | | 8 | | | | | |
| **D** | **Scraper richness** | 5 | | | | 6 | | | | | |
| **D** | **Shredder richness** | 3 | | | | 5 | | | | | |
| **D** | **%Intolerant taxa** | 0.99 | | | | 0.76 | | | | | |
| **I** | **Hilsenhoff Biotic Index** | 4.99 | | | | 3.86 | | | | | |
| **I** | **%Collector** | 56.65 | | | | 44.92 | | | | | |
| **I** | **%Parasite** | 1.08 | | | | 0.76 | | | | | |
| **I** | **%Oligochaeta** | 4.13 | | | | 1.02 | | | | | |
| **I** | **Number tolerant taxa** | 1 | | | | 3 | | | | | |
| **I** | **%Simuliidae** | 17.7 | | | | 3.05 | | | | | |
| **I** | **%Chironomidae** | 46.51 | | | | 41.37 | | | | | |

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. | | BIBI scores between 0-24. |
| M= Moderate biological integrity. | | BIBI scores between 25-39. |
| H= High biological integrity. | | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Schneider Creek (Totten Inlet Watershed)

| | | | | | |
|---|---|---|---|---|---|
| | **Water Body** | **Schneider Creek** | | **Schneider Creek** | |
| | **Station** | **at Pneumonia Gulch Ln** | | **at Pneumonia Gulch Ln** | |
| | **Client** | **Public Health** | | **Public Health** | |
| | **Date** | **8/24/06** | | **9/10/07** | |
| | **METRIC** | **Value** | **Score** | **Value** | **Score** |
| D | **Total number of taxa** | 41 | 5 | 55 | 5 |
| D | **Number Ephemeroptera taxa** | 7 | 3 | 7 | 3 |
| D | **Number Plecoptera taxa** | 7 | 3 | 10 | 5 |
| D | **Number Trichoptera taxa** | 6 | 3 | 8 | 3 |
| D | **Number of long-lived taxa** | 4 | 3 | 7 | 5 |
| D | **Number of intolerant taxa** | 2 | 1 | 5 | 5 |
| I | **% Tolerant taxa** | 22.16 | 3 | 32.52 | 3 |
| D | **% Predator** | 26.3 | 5 | 17.76 | 3 |
| D | **Number of clinger taxa** | >20 | 5 | >20 | 5 |
| I | **% Dominance (3 taxa)** | 49.21 | 5 | 40.48 | 5 |
| | **TOTAL SCORE** | | **36** | | **42** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50.
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | Metric | 8/24/06 | 9/10/07 |
|---|---|---|---|
| | **Total abundance (m2)** | 1301 | 4950 |
| D | **EPT taxa richness** | 20 | 25 |
| D | **Predator richness** | 12 | 16 |
| D | **Scraper richness** | 12 | 16 |
| D | **Shredder richness** | 4 | 4 |
| D | **%Intolerant taxa** | 0.18 | 0.91 |
| I | **Hilsenhoff Biotic Index** | 2.87 | 3.14 |
| I | **%Collector** | 13.59 | 25.44 |
| I | **%Parasite** | 0.18 | 0.82 |
| I | **%Oligochaeta** | 4.42 | 2.32 |
| I | **Number tolerant taxa** | 6 | 4 |
| I | **%Simuliidae** | 0.64 | 0.87 |
| I | **%Chironomidae** | 1.84 | 1.93 |

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. | | BIBI scores between 0-24. |
| M= Moderate biological integrity. | | BIBI scores between 25-39. |
| H= High biological integrity. | | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Woodard Creek

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Woodard Creek** | | **Woodard Creek** | | **Woodard Creek** | | **Woodard Creek** | | **Woodard Creek** | |
| | **Station** | | | | | | | | | | |
| | **Client** | **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** | |
| | **METRIC** | **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 |
| **D** | **Number Ephemeroptera taxa** | 7 | 3 | 7 | 3 | 10 | 5 | 4 | 1 | 7 | 3 |
| **D** | **Number Plecoptera taxa** | 10 | 5 | 8 | 5 | 9 | 5 | 9 | 5 | 9 | 5 |
| **D** | **Number Trichoptera taxa** | 9 | 3 | 11 | 5 | 10 | 5 | 8 | 3 | 10 | 5 |
| **D** | **Number of long-lived taxa** | 5 | 5 | 6 | 5 | 5 | 5 | 4 | 3 | 4 | 3 |
| **D** | **Number of intolerant taxa** | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 |
| **I** | **% Tolerant taxa** | 5.16 | 5 | 6.78 | 5 | 6.98 | 5 | 9.59 | 5 | 7.93 | 5 |
| **D** | **% Predator** | 29.03 | 5 | 23.13 | 5 | 20.92 | 5 | 22.28 | 5 | 32.13 | 5 |
| **D** | **Number of clinger taxa** | >20 | 5 | >20 | 5 | >20 | 5 | >20 | 5 | >20 | 5 |
| **I** | **% Dominance (3 taxa)** | 53.73 | 3 | 49.27 | 5 | 42.45 | 5 | 39.12 | 5 | 50.28 | 3 |
| | | 9 square feet total area sampled starting 2002 | | | | | | | | | |
| | **TOTAL SCORE** | | **40** | | **44** | | **46** | | **36** | | **40** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | 8/29/03 | | 8/12/04 | | 9/9/05 | | 9/8/06 | | 9/11/07 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 3214 | | 1484 | | 2926 | | 463 | | 1735 | |
| **D** | **EPT taxa richness** | 26 | | 26 | | 29 | | 21 | | 26 | |
| **D** | **Predator richness** | 15 | | 10 | | 16 | | 12 | | 12 | |
| **D** | **Scraper richness** | 15 | | 15 | | 15 | | 9 | | 10 | |
| **D** | **Shredder richness** | 8 | | 9 | | 8 | | 5 | | 9 | |
| **D** | **%Intolerant taxa** | 0.77 | | 0.65 | | 1.31 | | 0.52 | | 0.21 | |
| **I** | **Hilsenhoff Biotic Index** | 3.5 | | 3.78 | | 3.79 | | 3.86 | | 3.46 | |
| **I** | **%Collector** | 53.73 | | 62.98 | | 54.57 | | 59.07 | | 52.27 | |
| **I** | **%Parasite** | 0.14 | | 0.89 | | 0.98 | | 0.78 | | 0.76 | |
| **I** | **%Oligochaeta** | 10.86 | | 7.1 | | 18.28 | | 10.62 | | 3.31 | |
| **I** | **Number tolerant taxa** | 4 | | 4 | | 7 | | 3 | | 4 | |
| **I** | **%Simuliidae** | 7.31 | | 10.48 | | 7.98 | | 10.62 | | 8.83 | |
| **I** | **%Chironomidae** | 13.48 | | 12.66 | | 13.01 | | 13.73 | | 11.45 | |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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| | | |
|---|---|---|
| L= Low biological integrity. | | BIBI scores between 0-24. |
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# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Woodland Creek @ Pleasant Glade Road

| | | | | |
|---|---|---|---|---|
| **Water Body** | **Woodland Creek** | **Woodland Creek** | **Woodland Creek** | |
| **Station** | **Pleasant Glade Rd.** | **Pleasant Glade Rd.** | **Pleasant Glade Rd.** | |
| **Client** | **Stream Team** | **Stream Team** | **Stream Team** | |
| **Date** | **8/13/05** | **8/12/06** | **7/26/07** | |

| | **METRIC** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **D** | **Total number of taxa** | 37 | 3 | 44 | 5 | 44 | 5 | | | | |
| **D** | **Number Ephemeroptera taxa** | 4 | 1 | 5 | 3 | 4 | 1 | | | | |
| **D** | **Number Plecoptera taxa** | 4 | 1 | 8 | 3 | 8 | 5 | | | | |
| **D** | **Number Trichoptera taxa** | 6 | 3 | 8 | 3 | 7 | 3 | | | | |
| **D** | **Number of long-lived taxa** | 3 | 3 | 4 | 3 | 4 | 3 | | | | |
| **D** | **Number of intolerant taxa** | 0 | 1 | 1 | 1 | 1 | 1 | | | | |
| **I** | **% Tolerant taxa** | 5.64 | 5 | 8.98 | 5 | 6.71 | 5 | | | | |
| **D** | **% Predator** | 13.98 | 3 | 8.99 | 1 | 12.43 | 3 | | | | |
| **D** | **Number of clinger taxa** | 19 | 3 | >20 | 5 | 27 | 5 | | | | |
| **I** | **% Dominance (3 taxa)** | 53.15 | 3 | 67.21 | 3 | 64.89 | 3 | | | | |
| | **TOTAL SCORE** | | **26** | | **32** | | **34** | | **0** | | **0** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 532 | | 1402 | | 2647 | | | | | |
| **D** | **EPT taxa richness** | 14 | | 21 | | 19 | | | | | |
| **D** | **Predator richness** | 6 | | 12 | | 13 | | | | | |
| **D** | **Scraper richness** | 8 | | 9 | | 8 | | | | | |
| **D** | **Shredder richness** | 5 | | 7 | | 6 | | | | | |
| **D** | **%Intolerant taxa** | 0 | | 0.09 | | 0.05 | | | | | |
| **I** | **Hilsenhoff Biotic Index** | 4.27 | | 4.45 | | 4.58 | | | | | |
| **I** | **%Collector** | 64.9 | | 75.33 | | 73.88 | | | | | |
| **I** | **%Parasite** | 1.35 | | 1.11 | | 0.36 | | | | | |
| **I** | **%Oligochaeta** | 4.73 | | 3.07 | | 4.34 | | | | | |
| **I** | **Number tolerant taxa** | 2 | | 3 | | 5 | | | | | |
| **I** | **%Simuliidae** | 35.36 | | 43.55 | | 48.46 | | | | | |
| **I** | **%Chironomidae** | 11.04 | | 4.7 | | 6.92 | | | | | |

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

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| | | |
|---|---|---|
| L= Low biological integrity. | | BIBI scores between 0-24. |
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| H= High biological integrity. | | BIBI scores >40. |

# Benthic Invertebrate Index of Biological Integrity-BIBI (modified Karr 1998)

**WA: Thurston County Public Health and Social Services Department and Water & Waste Management-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.

## Woodland Creek @ Draham Road

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Water Body** | **Woodland Creek** | | **Woodland Creek** | | **Woodland Creek** | | | | | |
| | **Station** | **Draham Road** | | **Draham Road** | | **Draham Road** | | | | | |
| | **Client** | **Stream Team** | | **Stream Team** | | **Stream Team** | | | | | |
| | **Date** | **8/13/05** | | **8/13/06** | | **8/28/07** | | | | | |
| | **METRIC** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** | **Value** | **Score** |
| D | **Total number of taxa** | 46 | 5 | 45 | 5 | 43 | 5 | | | | |
| D | **Number Ephemeroptera taxa** | 4 | 1 | 1 | 1 | 4 | 1 | | | | |
| D | **Number Plecoptera taxa** | 8 | 5 | 8 | 3 | 10 | 5 | | | | |
| D | **Number Trichoptera taxa** | 8 | 3 | 9 | 3 | 7 | 3 | | | | |
| D | **Number of long-lived taxa** | 3 | 3 | 4 | 3 | 3 | 3 | | | | |
| D | **Number of intolerant taxa** | 1 | 1 | 2 | 1 | 2 | 1 | | | | |
| I | **% Tolerant taxa** | 12.92 | 5 | 7.24 | 5 | 8.99 | 5 | | | | |
| D | **% Predator** | 18.19 | 3 | 7.34 | 1 | 21.14 | 5 | | | | |
| D | **Number of clinger taxa** | >20 | 5 | >20 | 5 | >20 | 5 | | | | |
| I | **% Dominance (3 taxa)** | 42.94 | 5 | 74.67 | 3 | 44.5 | 5 | | | | |
| | **TOTAL SCORE** | | **36** | | **30** | | **38** | | **0** | | **0** |

**BIOLOGICAL CONDITION CATEGORY**

Categories based on comparison with relatively unimpacted Puget Lowland and Willamette Valley streams.
Maximum score of 50. Each metric scored: 1=low, 3=moderate, 5=high
Note that this BIBI based on average/summation of 3 replicates, not on each individual replicate.

**OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total abundance (m2)** | 4587 | | 2626 | | 6005 | | | | | |
| D | **EPT taxa richness** | 20 | | 18 | | 21 | | | | | |
| D | **Predator richness** | 13 | | 12 | | 13 | | | | | |
| D | **Scraper richness** | 9 | | 7 | | 7 | | | | | |
| D | **Shredder richness** | 6 | | 9 | | 6 | | | | | |
| D | **%Intolerant taxa** | 0.08 | | 0.44 | | 0.59 | | | | | |
| I | **Hilsenhoff Biotic Index** | 3.91 | | 5.2 | | 4.04 | | | | | |
| I | **%Collector** | 63.2 | | 84.45 | | 57.65 | | | | | |
| I | **%Parasite** | 2.03 | | 1.94 | | 1.58 | | | | | |
| I | **%Oligochaeta** | 1.88 | | 1.06 | | 0.65 | | | | | |
| I | **Number tolerant taxa** | 6 | | 6 | | 4 | | | | | |
| I | **%Simuliidae** | 7.1 | | 60.64 | | 25.96 | | | | | |
| I | **%Chironomidae** | 18.71 | | 9.21 | | 12.04 | | | | | |

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. | | BIBI scores between 0-24. |
| M= Moderate biological integrity. | | BIBI scores between 25-39. |
| H= High biological integrity. | | BIBI scores >40. |

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