SKYKOMISH RIVER, PHOTO BY SKY MILLER

# Streams and Rivers by Watershed

*Stillaguamish Watershed*

*Snohomish Watershed*

*Lake Washington & Puget Sound Tributaries*

Snohomish County contains parts of three major watersheds:

- Stillaguamish
- Snohomish
- Lake Washington and Puget Sound Tributaries

The following sections summarize and discuss available water quality information for individual watersheds. The sections include information on where state water quality standards are being met, where violations occur, and an analysis of changes since the last publication of the State of the Waters Report in 1996. Each section concludes with a summarization of concerns for the watershed, a list of primary contaminants, and the probable sources of the contaminants.

## Stillaguamish Watershed

- Stillaguamish North and South Forks
- Stillaguamish Mainstem
- Pilchuck Creek
- Church Creek
- Portage Creek
- Glade Bekken

The Stillaguamish watershed, located in northern Snohomish and southeastern Skagit Counties, drains an area of approximately 650 square miles. It is the fifth largest watershed draining into Puget Sound. The North and South Forks are the two main branches of the Stillaguamish in the upper watershed. The North and South Forks flow west from the Cascade foothills and join near the city of Arlington. The headwaters of the North and South Forks are Class AA and the lower reaches are Class A waters. The North Fork changes to Class A status below the confluence of Squire Creek, and the South Fork becomes Class A below the confluence of Canyon Creek. The North and South forks are characterized by low density residential land use and small, non-commercial farms, with tree harvesting occurring in the upper reaches and along some tributaries.

From Arlington, the Stillaguamish River divides and rejoins as it meanders across the broad floodplain until the majority of the water passes through Hat Slough into Port Susan. During high flows, a small portion of the river passes through the historical channel near Stanwood with outlets leading into both Port Susan and Skagit Bay. Major tributaries of the lower Stillaguamish are Church and Pilchuck Creeks, which flow from the north, and Portage Creek, which flows from the south.

The Stillaguamish floodplain, west of Arlington, is characterized by traditional agriculture with increasing pressures for higher density rural development. Commercial agriculture, mainly dairy farms and croplands, occurs along the mainstem Stillaguamish and Portage Creek. Small, non-commercial farms with horses or cattle are common along the tributaries. The lower mainstem and tributaries are designated as Class A waters.

The Tulalip Tribes began monitoring in the lower watershed in 1988. Snohomish County continued monitoring at many of the Tulalip sites from 1994 through the present. The Stillaguamish Tribe began work in the upper watershed in 1993 and has since expanded monitoring efforts to the lower river and some of the estuarine areas. The Department of Ecology has monitored at a number of sites and currently collects data at four sites. The tribes and County collaborate with other agencies in the watershed, including the Washington Department of Health, and the U.S. Forest Service.

In 1998 the Department of Ecology evaluated the water quality of the mainstem and major tributaries in the Stillaguamish watershed. Ecology found that over 80 percent of the river miles of the Stillaguamish that they assessed were not safe for swimming and 60 percent of these river miles were not suitable for salmon spawning.

Bacteria and nutrients are major problems in the Stillaguamish watershed. These pollutants are probably contributed by numerous commercial and small non-commercial farms as well as by septic system failures. Erosion and sedimentation, which are significant problems in this watershed, are caused primarily by upstream sources such as tree harvesting and also from bank erosion from livestock. Residential and commercial development in the Stillaguamish watershed is less extensive than in the rest of the County. This is reflected in the lower number of local flooding problems and lower concentrations of typical urban runoff pollutants such as toxic metals.

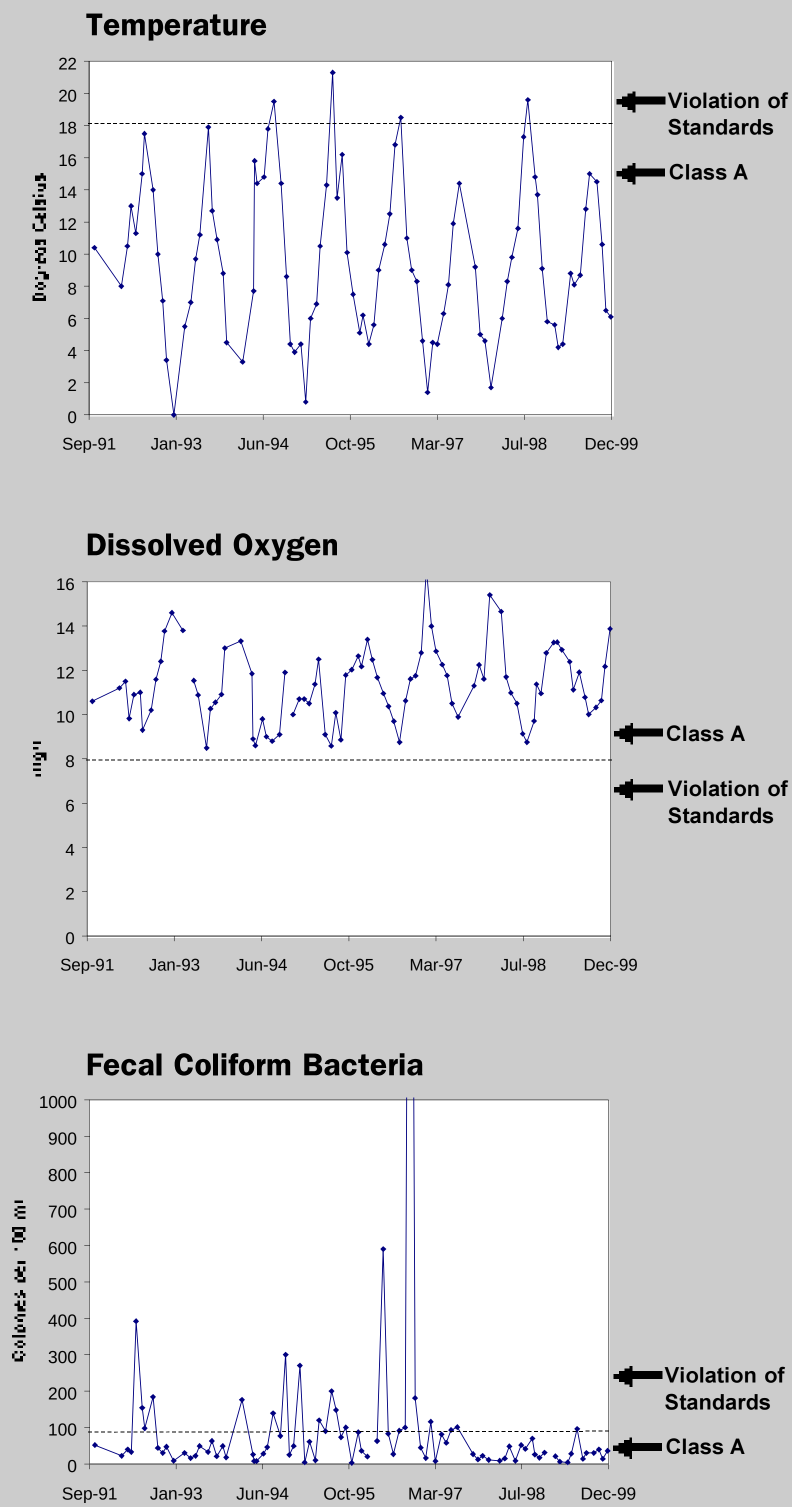
Solutions to water quality problems in the Stillaguamish include livestock management programs that would reduce sediment, bacteria, and nutrients. Repairing failing septic systems could further reduce bacteria and nutrient levels. Revegetation of sensitive areas would reduce erosion as well as lower stream temperatures and increase dissolved oxygen. Continued work in federal and private forestlands to stabilize old logging roads will prevent erosion and landslides.

# Stillaguamish North and South Forks

The North and South Forks of the Stillaguamish drain a large forested area where the primary land uses are timber harvesting, rural residential development, non-commercial farming and some commercial development in the City of Arlington. The confluence of the North and South Forks of the Stillaguamish is in Arlington. Commercial agriculture is found along the lower floodplains of both forks from Oso to Arlington on the North Fork (18 river miles) and from Jim Creek to Arlington on the South Fork (3 river miles). The Stillaguamish Tribe, the Tulalip Tribes, DOE, and SWM have coordinated monitoring to provide coverage of the North and South Forks and some of the major tributaries since 1990 (Hopkins 1993, Nelson et al. 1995, and Thornburgh 1995).

SWM found the best water quality in the Stillaguamish watershed in the North and South Forks, except for high sediment levels. The Tulalip Tribes concluded that the North Fork delivered over nine times the load of suspended sediment load on average as did the South Fork. The Tribes estimated that 1400 tons per day of suspended sediment was produced in the North Fork and 130 tons per day in the South Fork. Tulalip identified the major sources of fine

## North and South Fork Confluence at Arlington




***Source: SWM & Tulalip Data***

*North and South Forks*

**CONCERNS**

- **designated uses are impaired**

**PROBLEMS**

**North and South Forks**

- **sediment, temperature, bacteria**

**Jim Creek**

- **bacteria**

**PROBABLE SOURCES**

***Sediment***

- **erosion, tree harvesting**

***Bacteria***

- **septic systems, farm animals, pets**

sediments on the North Fork as Deer Creek, Boulder River, the Hazel Slide on the North Fork above Oso, and the agricultural reach between Oso and Arlington. The Stillaguamish Tribe also measured high sediment levels in Montague Creek. Sources of sediment in the South Fork are above Redbridge, the Goldbasin Slide, and Mallardy and Boardman Creeks. The Stillaguamish and Tulalip Tribes found low levels of suspended sediment in Jim and Canyon Creeks.

The Tulalip Tribes found that high sediment levels were correlated with areas where the natural geology was susceptible to erosion and slope failures and further aggravated by erosion from poor forest practices, construction activity, and agricultural practices. The Tribes found the highest sediment in tributaries where forest practices and fragile soils coincided, such as in Deer and Boulder Creeks on the North Fork. High concentrations and loading also occurred along mainstem sites downstream of landslides, such as Hazel on the North Fork and Goldbasin on the South Fork. Sediment in the Stillaguamish watershed can impact salmon by filling gravel spaces and pools, which can smother eggs or juvenile fish in the gravel and destroy spawning habitat. Sustained high turbidities reduce fish growth and cause gill tissue damage.

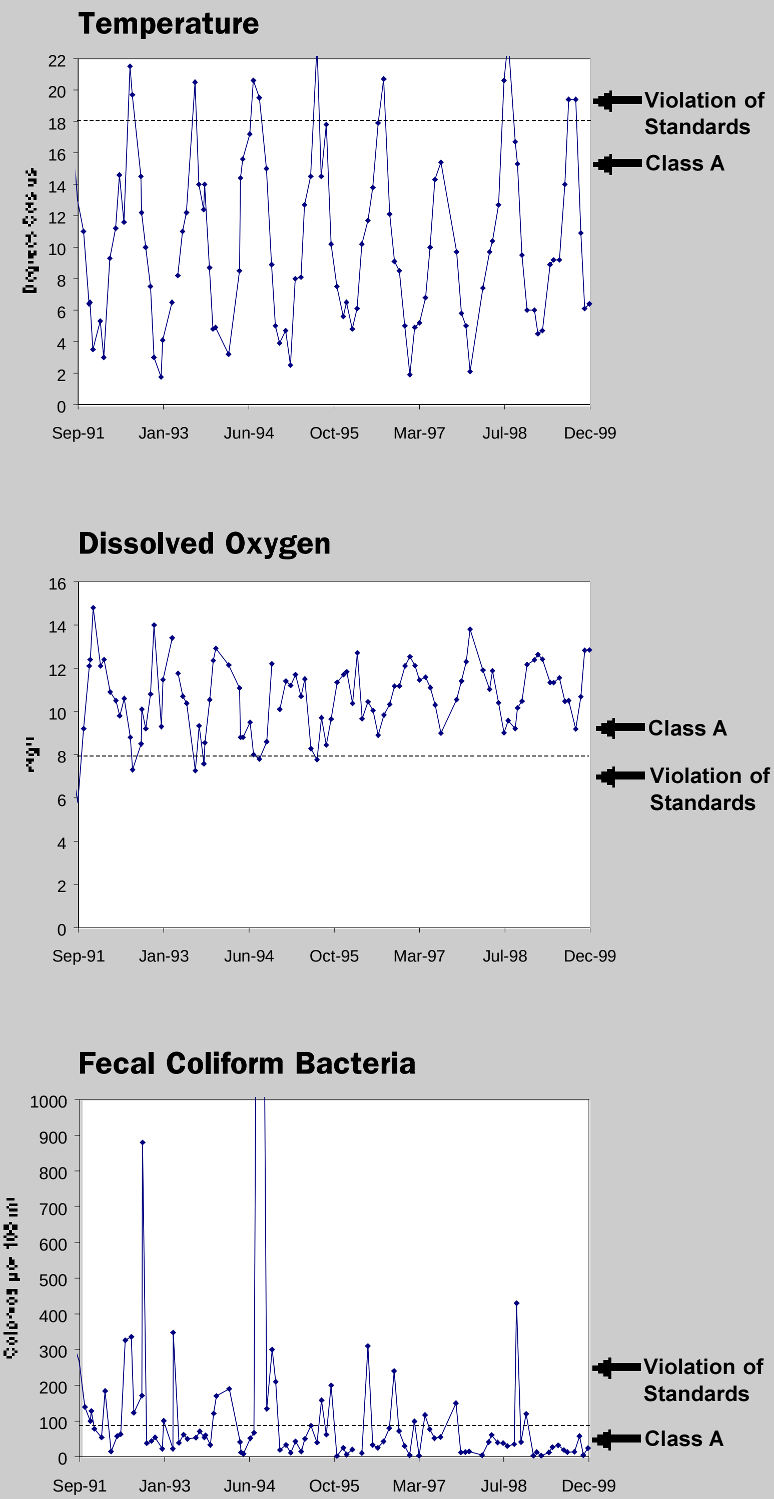
Mean bacteria levels at all sites on the mainstem and tributaries met Class A standards, but some samples from Jim Creek were greater than 200 colonies per 100 ml. DOE found improving trends in bacteria at both the South Fork at Arlington and the North Fork at Cicero (Joy and Glenn 2000). Bacteria levels at both these sites meet standards. Tulalip found greater concentrations and loads of fecal coliform bacteria in the lower North Fork than in the South Fork. Violations of the temperature standard were measured in the North Fork at Highway 9 (20°C), South Fork at Arlington (19°C), Deer Creek (18.9°C), Boardman Creek (19.1°C), Jordan Creek (24.5°C), and Slurry Creek (21°C). Some violations of the oxygen standard were measured in conjunction with high stream temperatures.

Swimming, boating, fish rearing, spawning and migration are impaired uses on the North and South Forks of the Stillaguamish because of problems with sediment, oxygen, and temperature. Bacteria levels in the North and South Forks violate standards, indicating inputs from septic systems, pets, or farm animals. The Tulalip Tribes found a trend of increasing levels of nonpoint source pollution from bacteria, nitrates, and sediment moving downstream in both the North and South Forks. Increases in agriculture and rural residential densities as well as the cumulative impacts from tributary loadings may be responsible. Deer Creek is threatened by impacts from sediments and tree harvesting. Bacteria levels in Jim Creek violate standards, indicating inputs from septic systems, pets, or farm animals.

# *Map of Stillaguamish Watershed with Water Quality Sampling Sites*

(See Table of Contents to view map in PDF format)

**Stillaguamish Lower Mainstem**




***Source: SWM & Tulalip Data***

# Stillaguamish Lower Mainstem

The Tulalip and Stillaguamish Tribes and SWM have monitored the lower Stillaguamish River mainstem continuously since 1988 (Paulsen et al. 1991, Thornburgh 1995). DOE has monitored a site at Silvana since 1977. The Silvana station is located downstream of Arlington and upstream of the mouths of Pilchuck and Portage Creeks. DOE found a significant decrease in bacteria and ammonia at the Silvana site since 1977 (Joy and Glenn 2000). SWM data show an overall decrease in bacteria and an increase in dissolved oxygen at all sites in the lower watershed since 1994. However, SWM monitoring data also indicate that temperature, bacteria, nutrient, and sediment concentrations increase going downstream from the upper mainstem at Arlington to the lower mainstem at Marine Drive. Bacteria levels usually meet standards in the mainstem and Pilchuck Creek, but the other tributaries often violate standards. Sources of pollutants in the lower watershed are livestock on the banks of the river, runoff from manure, and failing septic systems coming from the tributaries and as well as from direct runoff into the mainstem.

Temperatures above 20°C, the lethal range for adult salmon were recorded at Arlington, Silvana, and Marine Drive. Temperatures during the warmest part of the summer were approximately 2°C higher in the lower mainstem at Marine Drive than in the upper mainstem at Arlington. SWM placed a temperature logger in the mainstem at the Interstate 5 bridge during the summer of 1996 that recorded temperatures in the range of 13-20°C for 68 percent of the time and over 20°C for 16 percent of the time. Temperatures over 22°C were recorded on twelve days during that summer. Summer dissolved oxygen levels during the warmest part of the summer violated the standard of 8.0 mg/l only 3% of the time in the lower river during SWM sampling from 1994 through 1999, although no violations have been recorded since 1995. Dissolved oxygen levels are 0.5 to 1.0 mg/l lower in the lower mainstem than at Arlington during the summer.

The highest sediment levels were found in the lower mainstem. Tulalip found that turbidity was relatively low during the dry season (8-12 NTU) and was three times higher during the wet season (26-50 NTU). DOE found a mean turbidity of 39 NTU for the years from 1989 to 1990 at Silvana. SWM found mean concentrations of total suspended solids from 1994 through 1999 of 38 mg/l at Arlington and 59 mg/l downstream at Marine Drive. These sediment levels were the highest measured at all County sites. During storms, Tulalip measured peak levels of turbidity (700 NTU) and fecal coliform bacteria (1600 col/100 ml) in the mainstem. SWM found low long-term mean bacteria concentrations of 40 col/100 ml at Arlington and 34 col/100 ml in the lower mainstem. However, 17% of the samples violated standards and a maximum of 3200 col/100 ml was measured.

Along the mainstem Stillaguamish there is a high concentration of commercial farms. The Snohomish Conservation District farm inventory found that more than 30 percent of the commercial farms had serious and moderate water quality problems (Steinbarger 1995). In addition, many of these farms are adjacent to the river. Some of the water quality problems in the lower mainstem result from pollutant loading from tributaries. However, the farm inventory indicates that at least some of the water quality problems originate from runoff directly into the lower mainstem.

The Tulalip Tribes conducted tests for toxic contaminants in sediments at four sites in the lower mainstem (Halpin 1992). A sample from one site contained low levels of 4-methylphenol, a compound associated with woodwaste and treating facilities. No standards have been established for freshwater sediments, but one sample contained detectable levels of cadmium and chromium. SWM found low long-term mean conductivity levels (58 umhos/cm) but detected an increase from 1994 through 1999. Conductivity is an indicator of contaminants in streams from urban or agricultural activities. This increase may be an indication of increased population and resulting road runoff.

The Department of Ecology lists swimming, boating, fish rearing, spawning, and migration as impaired uses on the mainstem Stillaguamish River. Cleanup plans are under development for bacteria, dissolved oxygen, temperature, lead, copper, ammonia, arsenic, and nickel. The sources of pollution include agriculture, pasture land, runoff from animal manure, removal of riparian vegetation, streambank modification, and discharges from sewage treatment plants. In addition, the high levels of sediment in the Stillaguamish are a concern. Salmon may have reduced growth and tissue damage after prolonged exposure to water with high turbidity.

*Stillaguamish Mainstem*

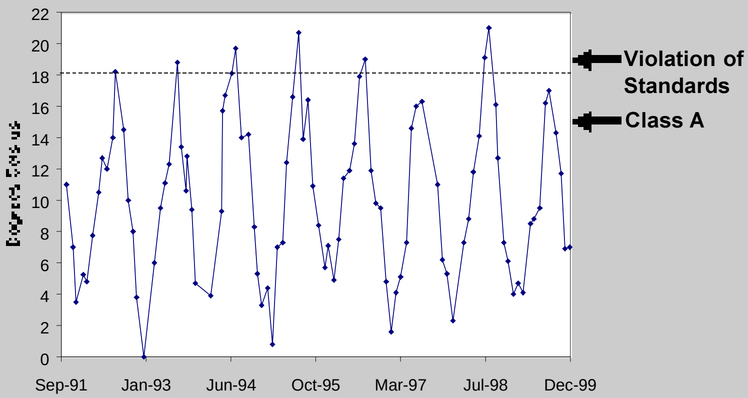
**CONCERNS**
- **does not support designated uses**

**PROBLEMS**
- **sediment, bacteria, temperature, dissolved oxygen**

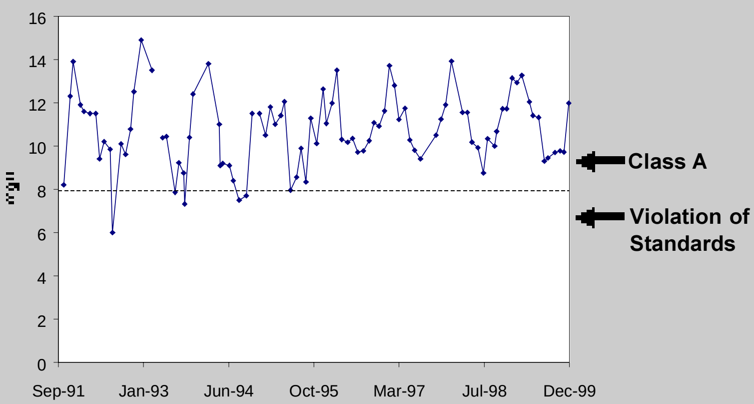
**PROBABLE SOURCES**
- **fertilizers, manure, animal access to creeks, septic systems**

## Pilchuck Creek

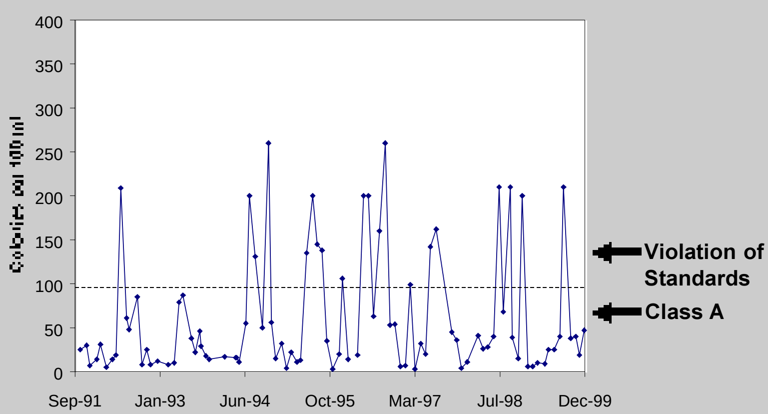
### Temperature




### Dissolved Oxygen




### Fecal Coliform Bacteria




***Source: SWM & Tulalip Data***

# Pilchuck Creek

Pilchuck Creek is the largest tributary to the lower Stillaguamish River. Pilchuck Creek drains approximately 75 square miles, flowing into the Stillaguamish from the north, northwest of the City of Arlington. The upper watershed is primarily forested. Rural residential development, non-commercial farms, and several equestrian centers characterize the lower watershed. The Tulalip Tribes and SWM have monitored a site near the mouth of the creek continuously since 1991.

SWM found Pilchuck Creek to have the best water quality of all the tributaries to the lower Stillaguamish River. Bacteria levels consistently met state standards with a long-term mean of 34 col/100 ml. Suspended sediment levels were the lowest of all the Stillaguamish tributaries with means less than 5 mg/l. However, dissolved oxygen levels violated standards 5 percent of the time during SWM's monthly sampling from 1994-1999. SWM placed a temperature logger near the mouth of Pilchuck Creek during the summer of 1996 that recorded temperatures in the range of 13-20°C for 77 percent of the time and over 20°C for 10 percent of the time. Temperatures over 22°C were recorded on ten days during that summer. Bio-

# *Map of Pilchuck Creek Watershed with Water Quality Sampling Sites*

(See Table of Contents to view map in PDF format)

*Pilchuck Creek*

**CONCERNS**
- **threatened by development**

**PROBLEMS**
- **dissolved oxygen, temperature**

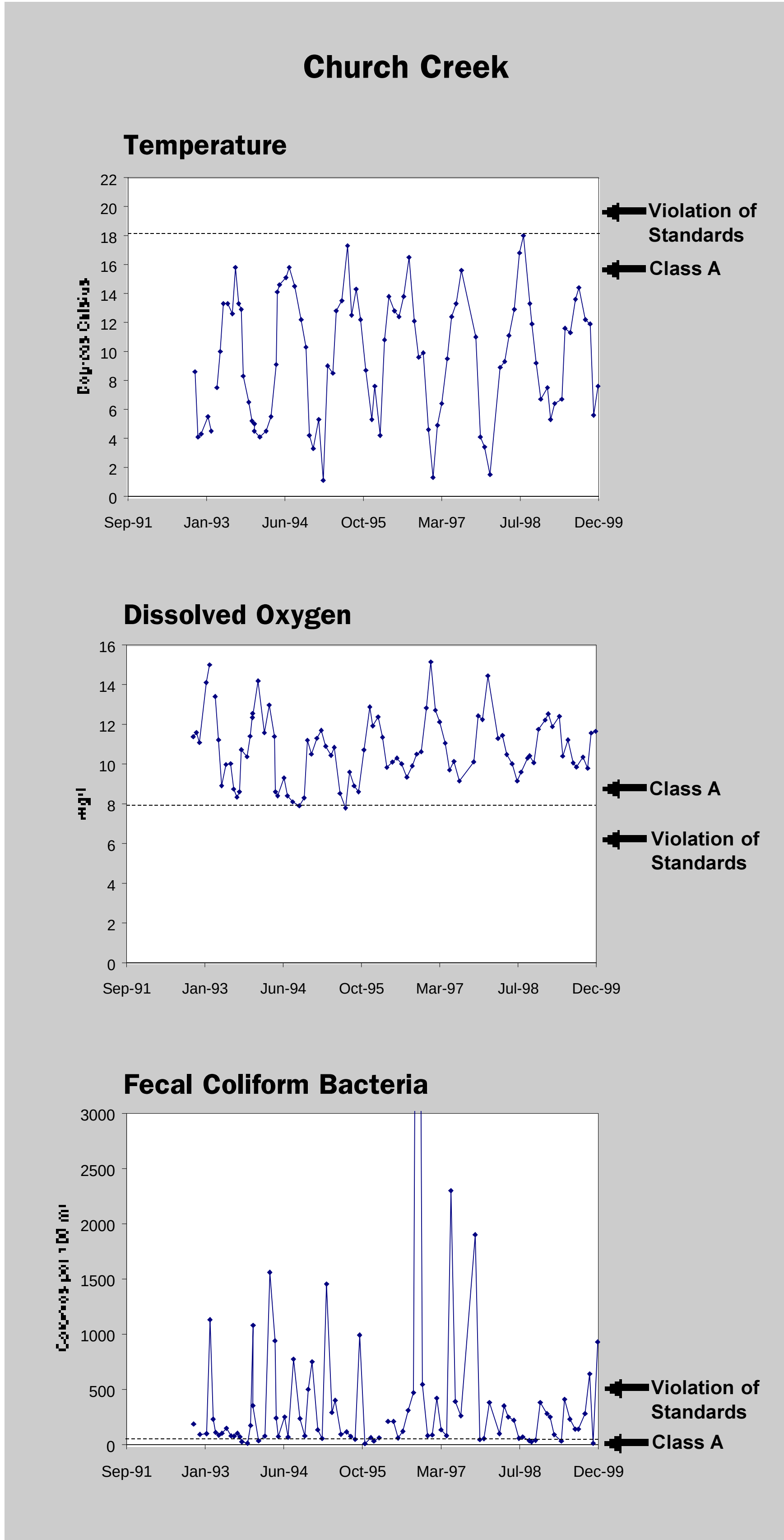
**PROBABLE SOURCES**
- **land clearing**

logical sampling conducted by SWM in 1997 and 1999 found the creek in fair condition.

The Snohomish Conservation District identified 195 commercial and non-commercial farms in the Pilchuck watershed and ranked more than 50% of these farms as causing high or moderate negative impacts on water quality (Steinbarger 1995). The low levels of sediment, bacteria, and nutrients suggest that riparian buffers and the higher flows in Pilchuck Creek are moderating the impacts of pollution from farms. A low mean conductivity (51 umhos/cm) also shows that the creek receives minimal impacts from farm and road runoff. However, the large number of farms with water quality problems indicates that implementing best management practices is critical to maintaining good water quality in this watershed. The Department of Ecology lists Pilchuck Creek as impaired by levels of dissolved oxygen and temperature.

SWM STREAM PLANTING PROJECT ON PILCHUCK CREEK,
PHOTO BY SCOTT MOORE

# Church Creek




**Source: SWM & Tulalip Data**

Church Creek is a major tributary that enters the Stillaguamish from the north and lies to the west of Pilchuck Creek. Church Creek drains approximately 11 square miles of agricultural, forested, and rural residential lands. The Tulalip Tribes and SWM have conducted water quality monitoring in the watershed since 1989 (Paulsen et al. 1991 and Thornburgh 1995).

Temperatures met state standards in Church Creek on all sampling occasions. A temperature logger placed in the upper creek during the summer of 1996 recorded only three days when the temperature reached 18°C. Oxygen violated the standards 3 percent of the time during monthly sampling from 1994 through 1999. Sediment levels are usually low with a mean turbidity of 7 NTU; however SWM has recorded turbidities over 50 NTU during the wet season. Biological sampling conducted by SWM in 1997 and 1999 found the creek in fair condition.

The primary water quality problem in Church Creek is the high bacteria concentration. Mean long-term bacteria concentrations were 170 colonies per 100 ml with 60 percent of the samples from 1994-1999 in violation of standards. During storms, the Tulalip Tribes mea-

*Church Creek*

**CONCERNS**
- **bacteria & nutrient loading into the Stillaguamish**

**PROBLEMS**
- **bacteria, nitrate**

**PROBABLE SOURCES**
- **manure, septic systems**

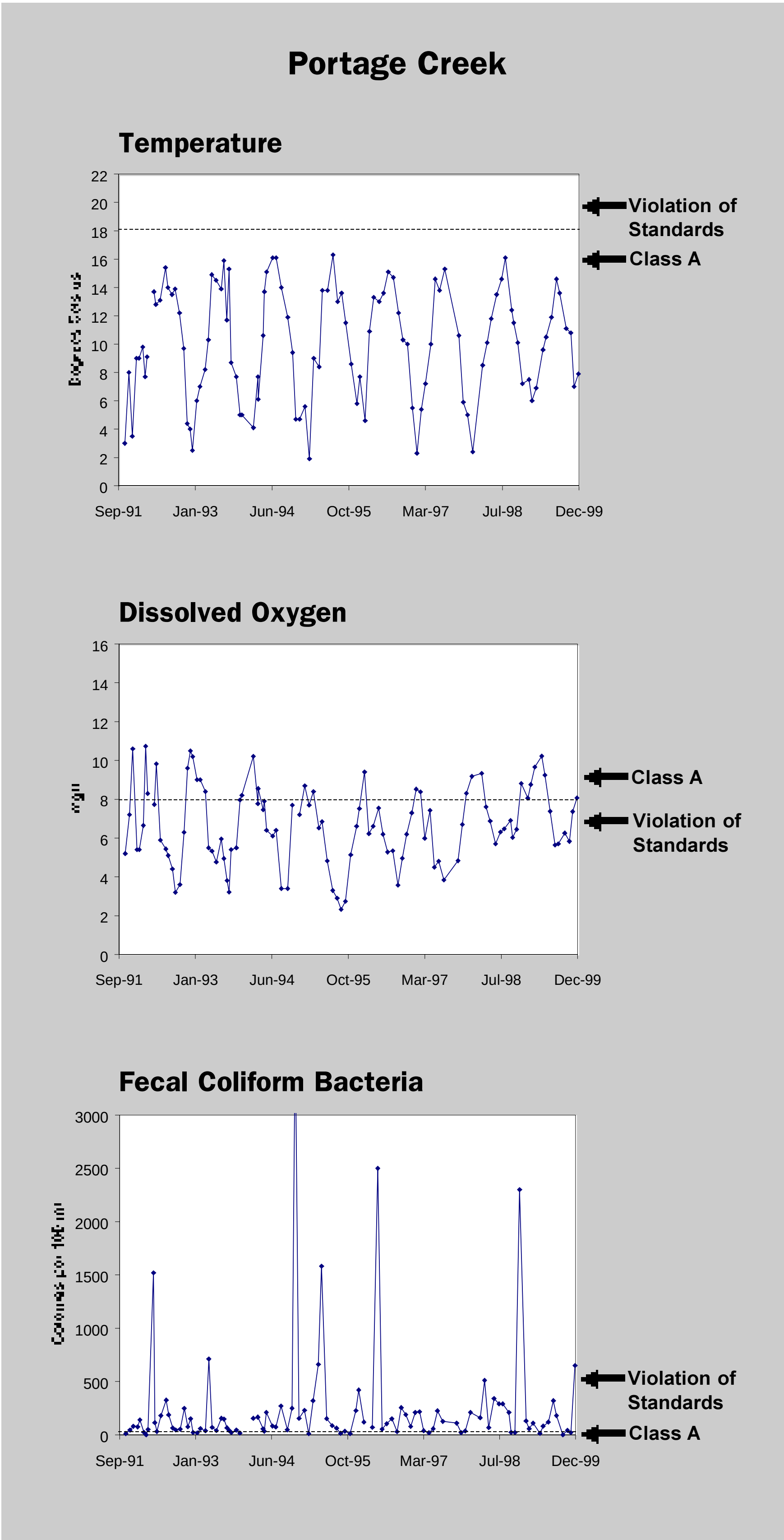
sured bacteria levels of 16,000 col/100 ml and turbidity over 600 NTU.

The Snohomish Conservation District found 92 farms in the Church Creek watershed; over 30% of these farms were causing moderate and serious water quality problems (Steinbarger 1995). A 1990 survey of on-site septic systems in the Church Creek watershed by the Tulalip Tribes showed that 25% of the septic tanks were more than 20 years old and over 30% of the tanks had never been pumped (Nelson et al. 1991). A synoptic survey conducted by the Tribes indicated that the highest bacteria and nitrate-nitrite levels in the watershed corresponded to the areas of agricultural land use. Failing septic systems and poor farming practices likely contribute to the high bacteria and nutrient levels in Church Creek. The Department of Ecology lists lower Church Creek as impaired by levels of fecal coliform bacteria.

TEACHER WORKSHOP ON CHURCH CREEK, PHOTO BY SUZI WONG SWINT

# *Map of Church Creek Watershed with Water Quality Sampling Sites*

(See Table of Contents to view map in PDF format)




***Source: SWM & Tulalip Data***

# Portage Creek

Portage Creek is a tributary that flows into the lower Stillaguamish River from the south, draining the City of Arlington and the area west of the city. Portage Creek, and its major tributary Fish Creek, drain approximately 18 square miles with a variety of residential, commercial, and agricultural development. The upper watershed contains most of the residential and commercial development. The lower watershed is characterized by commercial cropland and pastures with few buffer strips of natural vegetation between the farmland and the stream. The Tulalip and Stillaguamish Tribes and SWM have monitored sites in Portage Creek since 1990 (Paulsen et al. 1991, Thornburgh 1995).

The most significant water quality problem in Portage Creek is the low level of dissolved oxygen, especially in the lower creek. From 1994 through 1999, 77 percent of the monthly samples violated oxygen standards with an average of 5.7 mg/l over the dry season. Usually in streams like Portage Creek with little shade and low oxygen, temperatures are high. However, groundwater inputs keep temperatures low. Temperature loggers placed in the creek during the summer of 1996 recorded temperatures below 16$^{o}$C in the upper creek

# Map of Portage Creek Watershed with Water Quality Sampling Sites

(See Table of Contents to view map in PDF format)

### *Portage Creek*

**CONCERNS**
- **bacteria & nutrient loading into the Stillaguamish**

**PROBLEMS**
- **dissolved oxygen, sediment, bacteria, nutrients**

**PROBABLE SOURCES**
- **fertilizers, manure, animal access, septic systems**

and 17$^{o}$C or lower in the floodplain.

SWM found that Portage Creek had the highest suspended sediment levels of all the tributaries to the lower Stillaguamish, with a maximum of 150 mg/l in the lower creek. Nitrate, which can come from fertilizers and manure, had a long-term mean over 1.0 mg/l. A long-term mean conductivity of 154 umhos/cm in Portage Creek is one of the highest in the County. Runoff of manure and fertilizers from agricultural areas in the lower watershed is the likely source of high bacteria, nitrates, and conductivity and low dissolved oxygen.

The Portage Creek Geographical Information System Pilot Project (1990) found violations of Class A standards for mean concentrations of fecal coliform bacteria, turbidity, and dissolved oxygen. Sediments sampled from a site in the creek near Arlington did not contain detectable levels of metals, but sediments from a site adjacent to Interstate 5 contained arsenic, chromium, copper and nickel in detectable levels.

The Snohomish Conservation District surveyed 79 farms in the Portage Creek watershed, and over 40% of these farms were causing serious or moderate water quality problems (Steinbarger 1995). In addition, a large number of these farms are adjacent to waterbodies. Establishing riparian vegetation and preventing animal access to the creek may help to increase dissolved oxygen and decrease nutrient and bacteria levels. The Department of Ecology lists Portage Creek as impaired by levels of dissolved oxygen, fecal coliform bacteria, and turbidity and has begun to develop a Water Cleanup Plan.

Fish Creek is a major tributary to lower Portage Creek, draining an area of rural residential and agricultural development. The Snohomish Conservation District surveyed 100 farms in the Fish Creek watershed, and over 40% of these farms had moderate or serious water quality problems (Steinbarger 1995). SWM found dissolved oxygen violations 6 percent of the time and no temperature violations. Sediment levels were very low with a mean turbidity of 4 NTU. These characteristics may be attributed to a more intact riparian zone along Fish Creek than along Portage Creek. However, bacteria and nitrate concentrations were higher than in Portage Creek, which may indicate problems with animal waste management and septic system maintenance. Biological sampling conducted by SWM in 1997 and 1999 found the creek in fair condition. The Department of Ecology lists Fish Creek as impaired by levels of fecal coliform bacteria.

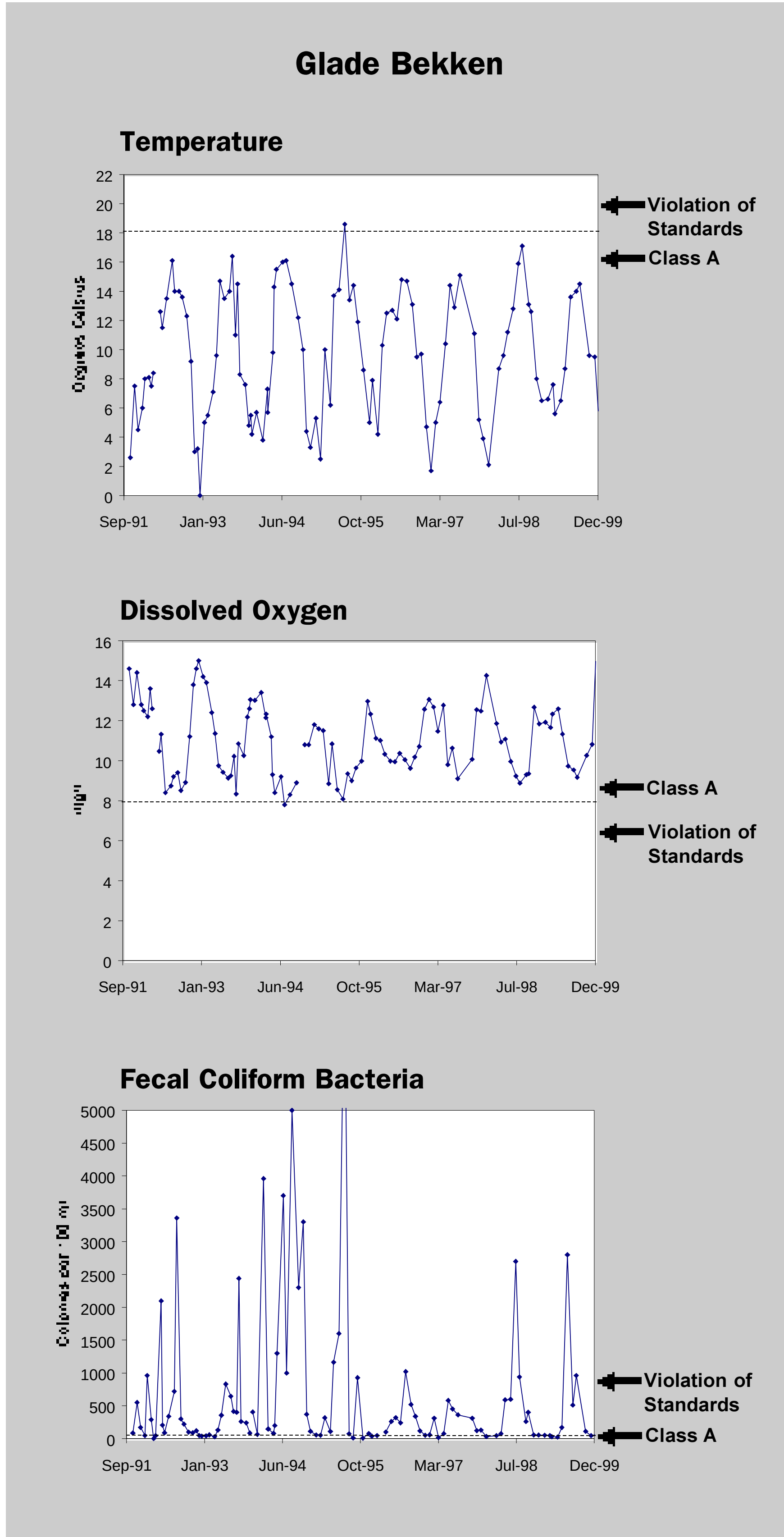
Valley Creek, a tributary to Fish Creek, is a watershed with small, non-commercial hobby farms and direct access for animals to the creek. Dissolved oxygen and fecal coliform bacteria in Valley Creek did not meet Class A standards during the dry seasons of 1989-1991 (Paulsen et al. 1991). During storms, fecal coliform bacteria levels in Valley Creek were greater than 2200 col/100 ml and turbidity was greater than 100 NTU.

# Glade Bekken

Glade Bekken, formerly Tributary 30 to the Stillaguamish, was named by watershed residents in 1998. The stream naming was part of a watershed restoration, outreach, and monitoring program conducted by SWM with a Centennial grant from the Department of Ecology. Glade Bekken drains approximately 3 square miles, flowing into the mainstem Stillaquamish from the south and to the west of Portage Creek. A number of non-commercial farms are located in the upper watershed with several commercial operations in the lowlands. Several miles of the stream provide fish habitat, and the Tulalip Tribes have identified the stream as important for salmon production. The Tulalip Tribes and SWM have monitored a site in Glade Bekken since 1991 (Thornburgh 1995).

Temperatures in Glade Bekken are low due to a largely intact riparian area and groundwater inputs. The only temperature violations were found near the mouth, just downstream of a reach of channelized stream that flowed through open pasture. In 1998, SWM restored the natural meanders and planted native trees and shrubs along that reach.

The primary water quality problems in Glade Bekken are




**_Source: SWM & Tulalip Data_**

### Glade Bekken

**CONCERNS**
- **bacteria & nutrient loading into the Stillaguamish**

**PROBLEMS**
- **bacteria, nitrate, sediment**

**PROBABLE SOURCES**
- **fertilizers, manure, animal access, septic systems**

the high levels of bacteria, nitrate, and sediment. The long-term mean fecal coliform level from 1994 through 1999 is 211 col/100 ml with 62 percent of the samples in violation. The nitrate long-term mean was 1.3 mg/l, and the long-term mean suspended sediment concentration was 22 mg/l. Annual mean bacteria levels have decreased from 1994 through 1999. This decrease may be a response to the numerous best management practices implemented on small farms in the watershed. However, sediment levels show only a slight decrease and nitrate concentrations have not changed. Biological sampling conducted by SWM from 1997 through 1999 found most of the creek in fair condition with several reaches in good condition.

The Snohomish Conservation District completed a farm inventory of areas around Hat Slough, Valley Creek, and Glade Bekken (Steinbarger 1995). They found that almost all the farms in these areas were non-commercial and that over 30% of these farms had serious or moderate water quality problems. A SWM reconnaissance survey located a number of areas with animal access to Glade Bekken. The high bacteria, nitrate, and sediment levels indicate the importance of implementing best management practices on the non-commercial farms in the Glade Bekken watershed.

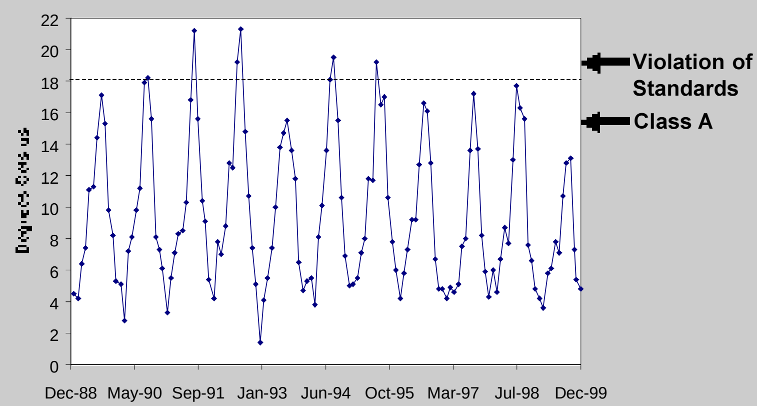
STUDENTS PLANTING ALONG A RESTORED SECTION OF GLADE BEKKEN, PHOTO BY SCOTT MOORE

# *Map of Glade Bekken Watershed with Water Quality Sampling Sites*

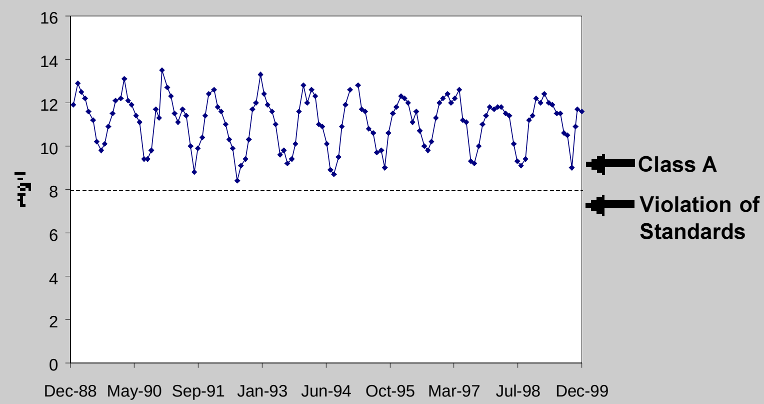
(See Table of Contents to view map in PDF format)

## Snohomish River Mainstem at Snohomish

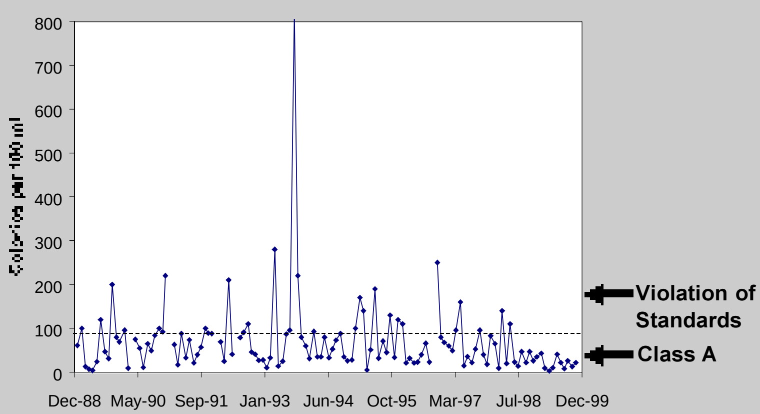
### Temperature




### Dissolved Oxygen




### Fecal Coliform Bacteria




***Source: Dept. of Ecology Data***

# Snohomish Watershed

- Snohomish River Mainstem and Ebey Slough
- Quilceda and Allen Creeks
- Pilchuck River
- French Creek
- Marshland Tributaries
- Skykomish River
- Woods Creek
- Snoqualmie River

The Snohomish River watershed, located on the western slope of the Cascade Mountains, has a total area of about 1900 square miles in Snohomish and King counties. The watershed includes three major rivers: the Skykomish, the Snoqualmie, and the Snohomish. Over 1,730 tributary rivers and streams have been identified in the basin, totaling over 2,700 miles in length (Williams et al. 1975). The watershed contains land zoned for forestry, residential and commercial development, and agriculture. Agricultural land in the watershed is located mainly along the lower mainstem of the Snohomish and Snoqualmie and their tributaries. However, small non-commercial farms are scattered throughout the residential areas. This watershed is experiencing rapid residential and commercial development. Human population in the basin is projected to increase by 53% from 206,000 in 1995 to 315,000 in 2020 (Pentec 1998). Consequently, stream problems include localized flooding, low baseflow, erosion, and sedimentation. High water temperatures, low dissolved oxygen, bacteria, and nutrients are also significant problems. Toxic contaminants, such as metals, have been found in runoff from roads and commercial areas.

Solutions to water quality problems in the Snohomish watershed include livestock management programs that would reduce sediment, bacteria, and nutrients. Repairing failing septic systems and proper disposal of pet wastes can further reduce bacteria and nutrient levels. Revegetation of riparian areas reduces erosion as well as lowers stream temperatures and increases dissolved oxygen. Assessing and rehabilitating detention ponds and increasing storm sewer maintenance can reduce problems resulting from increased storm runoff. Public outreach programs are essential because of rapid residential growth and the potential impacts related to that growth.

## Snohomish River Mainstem and Ebey Slough

The Snohomish River is formed by the confluence of the Skykomish and Snoqualmie Rivers near Monroe. The river flows for 21 miles in a northwesterly direction and enters Possession Sound. Ebey Slough, part of the deltaic mouth of the Snohomish River, enters Puget Sound immediately west of the mouth of Quilceda Creek. The Snohomish River estuary has been highly altered for commercial, industrial, and port facilities. The Snohomish River and Ebey Slough are designated as Class A and encompass a variety of land uses, including commercial agriculture, rural housing, small non-commercial farms, and urban and industrial areas.

The Tulalip Tribes monitored two sites on the upper Snohomish River mainstem at the town of Snohomish and upstream of the town from 1987-1990 (Thornburgh et al. 1991). The Department of Ecology has monitored the river at the town of Snohomish continuously since 1978.

DOE measured a peak temperature of 21.2$^{o}$C and found that up to 50% of the July and August temperature levels over the last ten years have exceeded the water quality standard. DOE found no violations of the oxygen standard during the last ten

*Snohomish Mainstem and Ebey Slough*

**CONCERNS**

- **do not support designated uses**

**PROBLEMS**

- **bacteria, sediment, temperature, dissolved oxygen, metals, organics**

**PROBABLE SOURCES**

- **urban runoff, industrial and commercial runoff, manure, fertilizers**

years. Tulalip found that mean turbidity during base flow conditions met standards (11 NTU), but bacteria levels violated standards during both base flow and storm conditions. Tulalip measured peak levels of bacteria (600 col/100 ml) and turbidity (34 NTU) during storms. DOE found that 14 percent of the samples violated fecal coliform standards.

In a summer survey of Ebey Slough, DOE (Cusimano 1995) found dissolved oxygen levels as low as 6.6 mg/l and relatively high chlorophyll a concentrations (7.4 ug/l). Fecal coliform bacteria concentrations met the state standards for all sampling sites in the lower river and sloughs. Ebey Slough does not adequately support its designated uses of fish rearing, spawning, migration, and harvesting. Low dissolved oxygen is the main problem resulting from industrial point sources, municipal point sources, combined sewer overflows, urban runoff, and storm sewers. Copper loading to the estuary may need to be controlled because it was identified as a pollutant of concern for wastewater treatment plants discharging to the lower river and sloughs (Cusimano 1995).

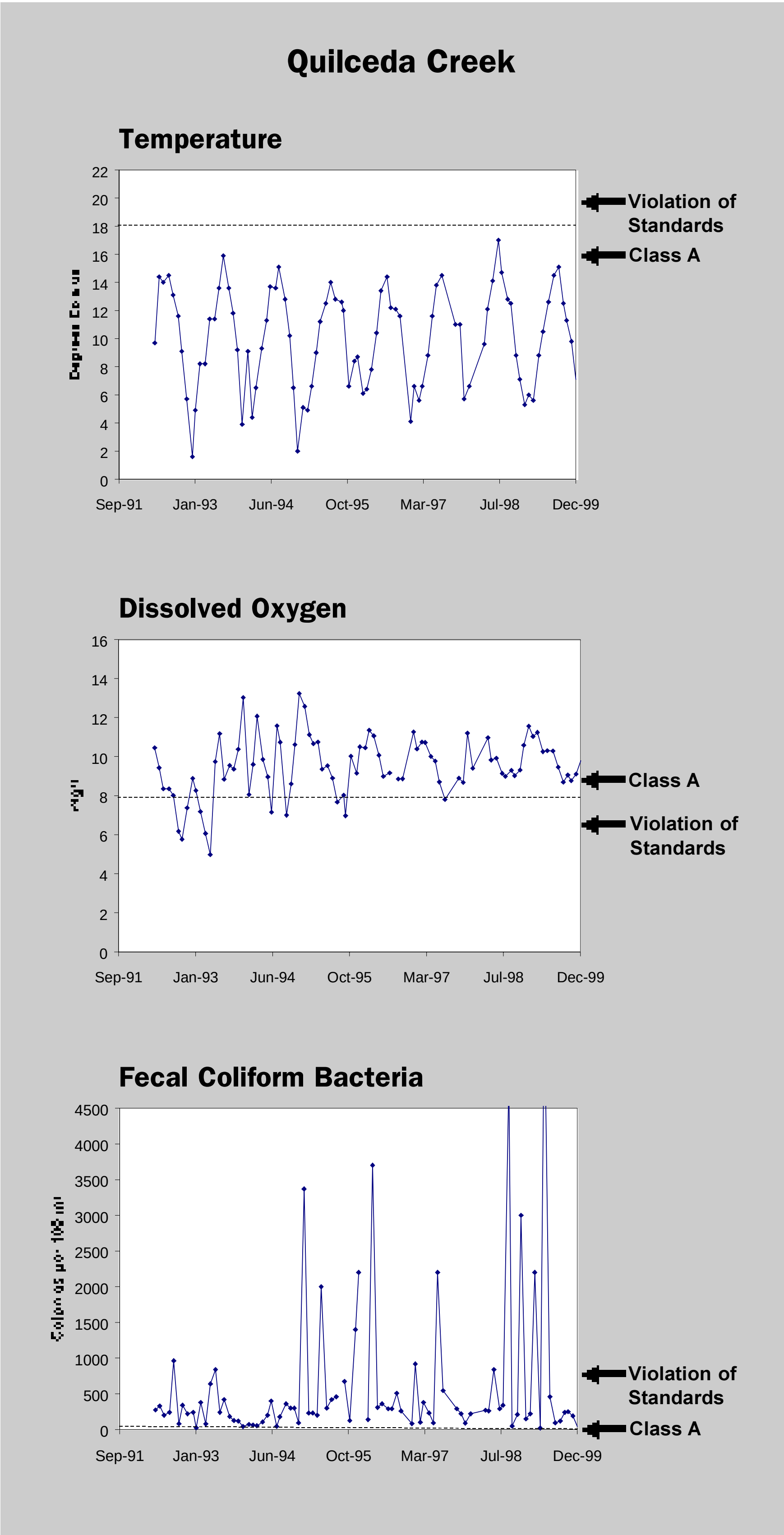
The Department of Ecology determined that the Snohomish River mainstem does not adequately support its designated uses of primary and secondary recreation or fish spawning, rearing, harvesting, or migration. The primary concerns in the Snohomish River are temperature, dissolved oxygen, and bacteria. Other pollutants identified by DOE were organics, copper, cadmium, arsenic, and mercury. The sources of pollution are industrial point sources, combined sewer overflows, agriculture, pasture land, animal holding, manure lagoons, land development, urban runoff and storm sewers, channelization, flow regulation, removal of riparian vegetation, streambank modification, and draining and filling of wetlands. Most pollution occurs in the more industrial and agricultural portions of the lower river.

The Department of Ecology is currently developing a Water Cleanup Plan for the mainstem Snohomish river. Solutions to water quality problems in the Snohomish River and Ebey Slough include livestock management programs that would reduce sediment, bacteria, and nutrients. Revegetation of riparian areas reduces erosion as well as lowers stream temperatures and increases dissolved oxygen. Assessing and rehabilitating detention ponds and increasing storm sewer maintenance can reduce problems resulting from increased storm runoff.

STEAMBOAT SLOUGH, PHOTO BY DARRELL SMITH

# *Map of Lower Snohomish River and Ebey Slough*

(See Table of Contents to view map in PDF format)




***Source: SWM Data***

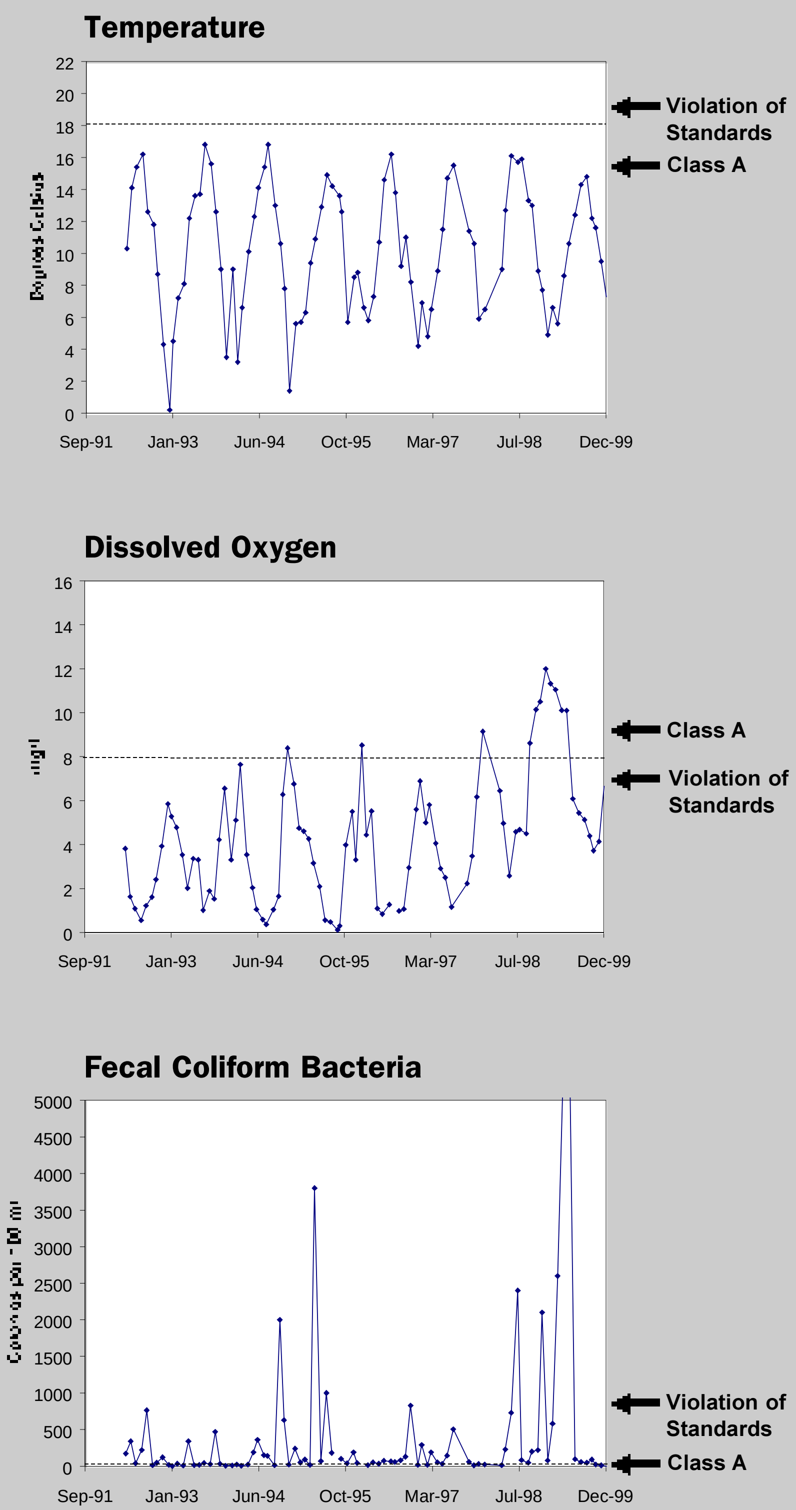
# Quilceda and Allen Creeks

The Quilceda Creek and Allen Creek watershed drains about 49 square miles between Arlington and Everett. Both creeks flow through the City of Marysville south into Ebey Slough, which enters Puget Sound immediately west of the mouth of Quilceda Creek. DOE designated both creeks as Class A waters. Rapid population growth and intensive residential and commercial development are occurring throughout the watershed. Agricultural land use occurs primarily in the upper watershed, while residential, commercial and industrial land uses are common in the lower areas.

The Tulalip Tribes found widespread bacteria violations and high nitrate levels during monitoring of eight sites on Quilceda and Allen Creeks from 1987-90 (Thornburgh et al. 1991). Mean values for fecal coliform bacteria ranged from 60-600 col/100 ml in Allen Creek and from 60-400 col/100 ml in Quilceda Creek. SWM sampling from 1992 through 1999 found that 80 percent of the samples from lower Quilceda Creek and 40 percent from Allen Creek violated bacteria standards. SWM found no temperature violations during this period, but dissolved oxygen violated standards 13 percent of the time in Quilceda Creek and 87 percent of the time in Allen Creek. However, lower Allen Creek shows a trend for increasing dissolved oxygen concentrations since 1997. This increase may have resulted from a reduction of beaver activity in the lower creek, which creates low flows and stagnant water. SWM found the highest concentrations countywide of total phosphorus in these creeks with long-term means of 0.1 mg/l. Turbidities usually met standards except during storms. During a storm in Quilceda Creek in 1990, the Tulalip Tribes measured bacteria levels of 5500 col/100 ml, turbidities of 40 NTU, and nitrate-nitrite levels over 2.0 ml/l (Halpin et al. 1991).

SWM sampling in the watershed from 1992-1995 (Thornburgh 1996) showed that most of the bacteria and nutrient loading was contributed from three sub-basins where farming and septic systems predominated. These sub-basins are the east fork of Quilceda Creek and the north and south forks of Allen Creek. Development along the south fork of Allen Creek and Munson Creek, a tributary to Allen Creek, contributed significant sediment loads to the watershed. Sediment samples from both creeks showed detectable levels of arsenic, cadmium, chromium, copper, lead, manganese, and zinc (Halpin et al. 1991).

**Allen Creek**




**Source: SWM Data**

*Quilceda and Allen Creeks*

**CONCERNS**
- **do not support designated uses**

**PROBLEMS**
- **bacteria, dissolved oxygen, nutrients, and metals**

**PROBABLE SOURCES**
- **urban and commercial runoff, septic systems, manure, fertilizers, animal access to the creeks**

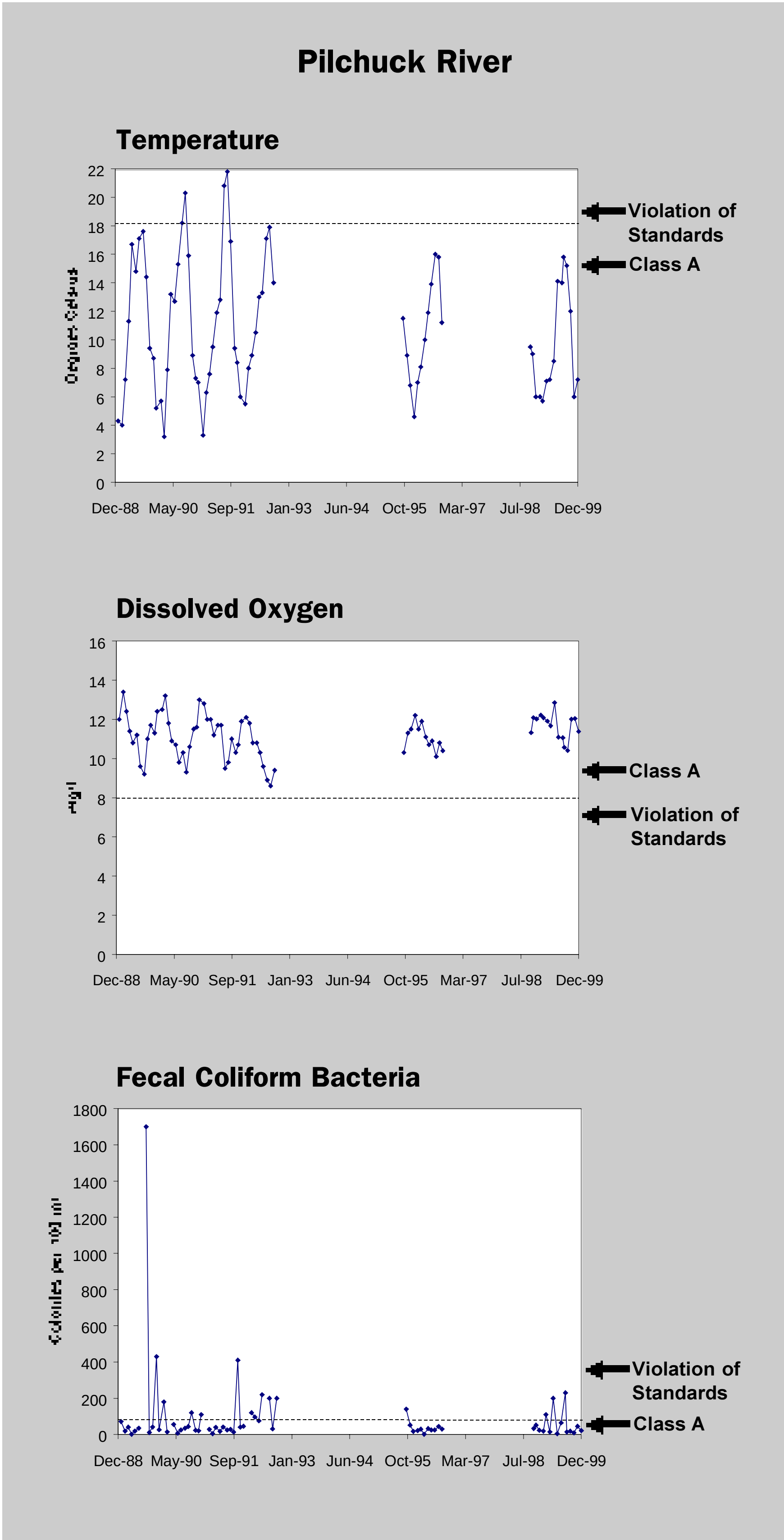
DOE found high concentrations of total organic carbon (4-5 mg/l), which indicate loading of organic material to these streams (Cusimano 1995). Organic material likely to cause these elevated measurements includes manure and human waste from failing septic systems. Mean conductivities of 150 umhos/cm measured by SWM from 1992 through 1999 indicate impacts to the creek from farm and road runoff. Biological sampling conducted by SWM in 1997 and 1999 found the upper Middle Fork of Quilceda Creek in good condition. Munson Creek, a tributary to Allen Creek, was rated in poor biological condition with high levels of human disturbance as indicated by few predator and intolerant species.

A synoptic survey by the Tulalip Tribes (Halpin et al. 1991) identified direct animal access, failing septic systems and over 350 pipes or ditches which discharge waste or runoff as contributing to water quality degradation in Quilceda and Allen Creeks. Impaired uses in Quilceda and Allen Creeks are swimming, wading, fish spawning, rearing, migration, and harvesting. The causes of impairment in Quilceda and Allen Creeks are dissolved oxygen, nutrients, and bacteria. The Department of Ecology is currently developing Water Cleanup Plans to reduce these pollutants in the creeks.

SWM KAYAK TOUR OF LOWER QUILCEDA CREEK FOR WATERSHED RESIDENTS, PHOTO BY RICK HUEY

# *Map of Quilceda/Allen Watershed with SWM Water Quality Sampling Sites*

(See Table of Contents to view map in PDF format)




***Source: Dept. of Ecology Data***

# Pilchuck River

The largest tributary to the Snohomish River is the Pilchuck River, which joins the river near the City of Snohomish. The lower 26.8 river miles of the Pilchuck from the Snohomish waterworks dam to the mouth are Class A, and the upper river is Class AA. The watershed includes Lake Stevens and Little Pilchuck, Catherine, Dubuque, and Panther Creeks. Most of the land uses in the watershed are rural residential and small scale, non-commercial farms. Population is growing in the drainage, especially in the cities of Lake Stevens and Snohomish, with increasing residential development.

The Tulalip Tribes monitored the river at the City of Snohomish from 1987 to 1990 (Thornburgh et al. 1991). DOE monitored the same site from 1978 to 1992 and in 1996 and 1999. SWM began sampling the river in Snohomish in 1998. Results of the monitoring show that the lower Pilchuck River meets Class A standards for dissolved oxygen, turbidity and pH. Temperatures from July through September violated standards, with a maximum of 21.7°C measured by DOE. SWM placed temperature loggers in the mainstem in the summer of 1999 and found increasing temperatures moving downstream in the river. Temperatures were less than 13°C 72 percent of the time up-

# *Map of Pilchuck River Watershed with SWM Water Quality Sampling Sites*

(See Table of Contents to view map in PDF format)

*Pilchuck River*

**CONCERNS**
- **threatened**

**PROBLEMS**
- **bacteria, temperature**

**PROBABLE SOURCES**
- **runoff from residential development and small farms**

stream of Granite Falls, 31 percent of the time just downstream of Granite Falls and only 24 percent of the time at Machias. The highest temperature measured in 1999 was 20ºC at Machias. DOE found that fecal coliform bacteria levels also violated standards from July through September, but usually met the standards during the remainder of the year.

DOE found the general water quality of the Pilchuck River to be good. However, they found some loading of organic material with concentrations of 2-3 mg/l of total organic carbon during a summer survey (Cusimano 1995). Biological sampling conducted by SWM in 1997 and 1999 found the river in poor condition, although the low ranking may result from the large cobble habitat in the mainstem, which provides poor invertebrate habitat, rather than from human disturbance. A low mean conductivity of 61 umhos/cm indicates minimal impacts to the river from farm and road runoff.

Impaired uses in the Pilchuck River are swimming and fish spawning, rearing, migrations, and harvesting. Bacteria concentrations and summer temperatures cause the impaired designations. The Department of Ecology considers the Pilchuck River to be threatened because of potential impacts from further development and is developing a Water Cleanup Plan for the river. Implementing best management practices on farms and repairing failing septic systems will reduce bacteria levels in the river. Maintaining and replanting riparian buffers as the watershed develops will lower summer temperatures.

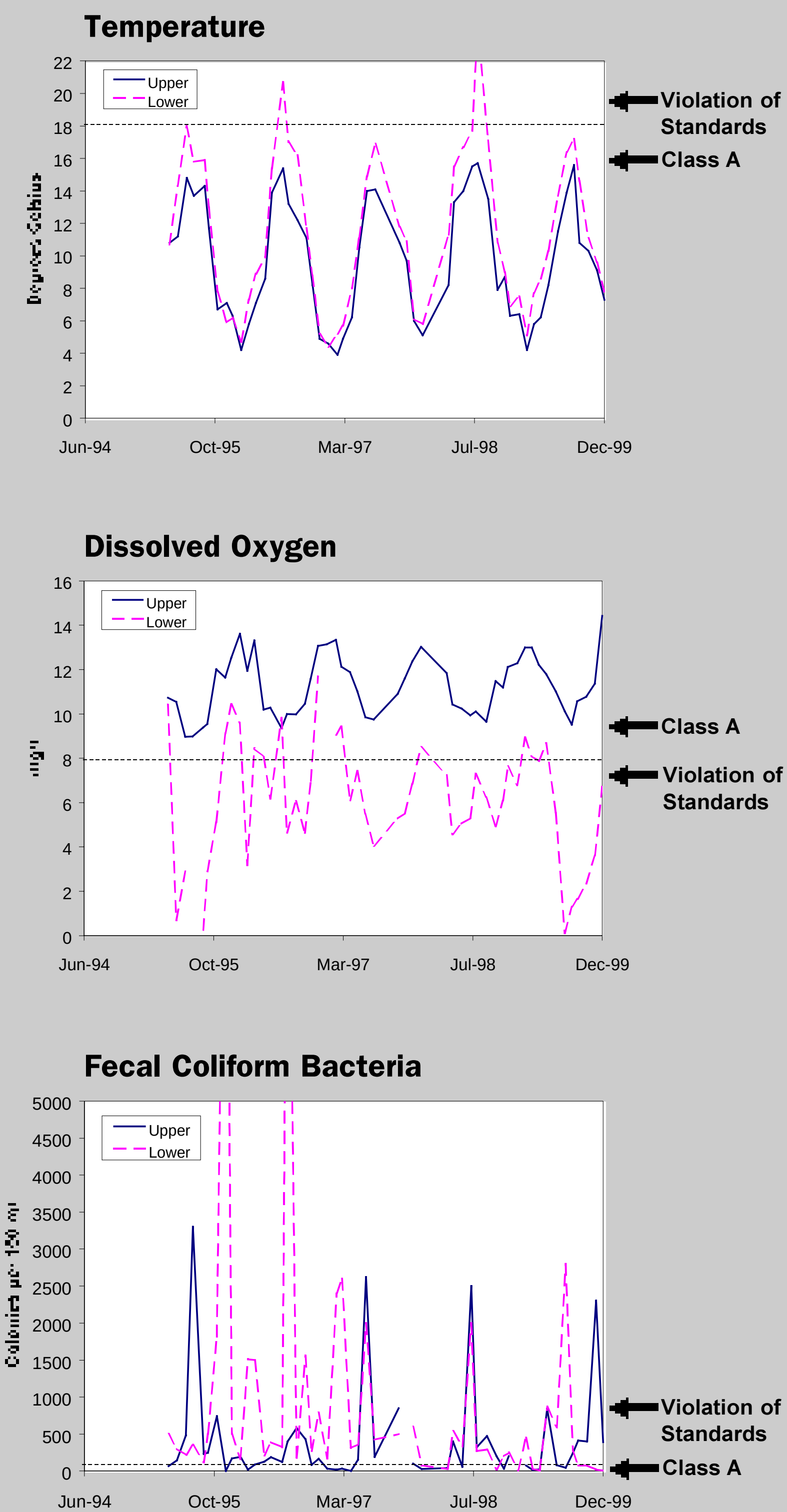
SWM began monitoring of Little Pilchuck, Catherine, and Dubuque Creeks in 1998. With just over one year of data from these creeks, results are preliminary. During that time, the creeks all met dissolved oxygen and turbidity standards. Bacteria standards were violated 73 percent of the time in Catherine Creek, 33 percent of the time in Little Pilchuck Creek, and 20 percent of the time in Dubuque Creek. Temperature loggers in the summer of 1999 recorded violations only in Catherine Creek, where temperatures exceeded 20ºC for 23 percent of the time. Conductivities were low, from 60-90 umhos/cm, with the highest measurements in Catherine Creek. Biological sampling in 1999 found fair conditions in Little Pilchuck and Dubuque Creeks and poor conditions in Catherine Creek. Little Pilchuck and Dubuque Creeks drain watersheds with low density residential land use and few impacts to water quality. Catherine Creek drains Lake Stevens and the surrounding urban area. Outflow from the lake contributes to higher stream temperatures. The Lake Stevens watershed contributes runoff from pet waste and roads, resulting in higher bacteria concentrations and conducitivities and poorer habitat for aquatic life.

# French Creek

The French Creek watershed covers approximately 27 square miles in south-central Snohomish County, north of the City of Monroe and southeast of the City of Snohomish. This fast developing watershed has two distinct characters. In the lower watershed, French Creek flows through agricultural pasture lands over the flat terrain of the Snohomish River floodplain. These lower 5.5 miles of French Creek have been straightened and dramatically altered by agricultural practices. In French Creek's lower most reaches, the creek gradient becomes nearly flat. Land uses in the floodplain area consist of commercial agriculture (crops and dairies). The upper watershed is a mix of forested areas, residential development, hobby farms and pastures, and several commercial equestrian centers.

SWM has sampled both upper and lower French since 1993. Samples from the upper creek yielded favorable oxygen and temperature levels with very few violations of the oxygen standard. Sediment levels in the upper creek were low when compared with the other sampling sites in the County. Bacteria levels were often high, with 59 percent of the samples in violation and a long-term mean of 112 col/100 ml. A mean conductivity of 66 umhos/cm indicates

## Upper & Lower French Creek




**Source: SWM Data**

*French Creek*

**CONCERNS**
- **does not support designated uses**

**PROBLEMS**
- **dissolved oxygen, bacteria, nutrients, temperature**

**PROBABLE SOURCES**
- **septic systems, manure, fertilizers**

minimal runoff from roads and agricultural areas. Biological sampling in 1999 ranked the upper creek in fair condition.

However, several tributaries to upper French Creek sampled in 1994 and 1995 showed water quality problems (Thornburgh 1996). Stables Creek has horse pastures with direct access to the creek and no vegetation buffering the creek. Water quality problems in Stables Creek include high sediment levels and high summer temperatures. Spada Creek, with residential development and little riparian buffer in the upper reaches, had a high summer temperature of 23°C and oxygen levels of 7.0 mg/l or lower. Cripple and Trench Creeks, which drain a residential area served by septic systems, contribute high loads of bacteria and nitrate to French Creek.

Water quality in the lower part of French Creek is poor. Sampling conducted by the Tulalip Tribes from 1987-1990 on lower French Creek showed violations of Class A standards for dissolved oxygen, temperature, and bacteria (Thornburgh et al. 1991). During storms, bacteria levels reached 9000 col/100 ml, the peak turbidity was 65 NTU and nitrate-nitrite was 2.4 mg/l. SWM sampling found that 72 percent of the samples violated dissolved oxygen standards and 80 percent violated bacteria standards with a long-term mean of 300 col/100 ml. However, mean bacteria concentrations measured in 1998 and 1999 were significantly lower than those from previous years. During the summer of 1995, loggers recorded temperatures as high as 27°C in the lower mainstem and, during a five day period in July, temperatures exceeded 20°C from 6-24 hours per day (Thornburgh 1997).

SWM found that conducitivities and metals were also higher in the lower French Creek mainstem than at all other sites in the watershed. A mean conductivity in the lower creek of 181 umhos/cm is three times that measured in the upper creek and one of the highest in the County. Sources of contaminants within the agricultural area that contribute to high conductivity are fertilizers, cleared land, and leaching from metal roofs and machinery. The residential areas in Fryelands in the City of Monroe or Lord's Hill, which drain into lower French Creek, are also sources of high conductivity from road runoff.

In a summer survey, DOE found high concentrations of total organic carbon (8-10 mg/l), biological oxygen demand, and low dissolved oxygen (<5 mg/l). Turbidity and nutrient levels were also high. French Creek provides an influx of oxygen depleting substances and water with low oxygen content into the Snohomish River. This influx of polluted water is thought to lower dissolved oxygen concentrations in the Snohomish River under critical summer low flow conditions (Cusimano 1995).

Impaired uses in French Creek are swimming and wading and fish spawning, rearing, migration and harvesting. High levels of bacteria and nutrients and low levels of dissolved oxygen pollute French Creek. Agricultural practices and maintenance of a channelized drainage system with no stream buffers are the primary reasons for the poor water quality in French Creek. DOE is developing a Water Cleanup Plan for the creek. Implementing best management practices on farms would reduce bacteria and nutrient levels in French Creek. A riparian buffer, especially along the lower channelized reaches of the creek, would lower temperatures and increase oxygen levels.

# *Map of French Creek Watershed with SWM Water Quality Sampling Sites*

(See Table of Contents to view map in PDF format)

# Marshland Tributaries

The Marshland tributaries consist of small Class A creeks that originate northeast of Everett and flow northward through residential areas down the ridge that forms the southern boundary of the Snohomish River floodplain. These streams enter the Marshland Ditch, an irrigation and drainage channel that flows through commercial agricultural lands to a pump station, where it is pumped into the Snohomish River. The North Creek and Bear Creek watersheds bound the area on the south.

The Tulalip Tribes has monitored three sites in the Marshland Tributaries along Lowell-Larimer Road on Wood, Thomas, and McCall Creeks (Thornburgh et al. 1991). Snohomish County also sampled along Lowell-Larimer Road at Wood Creek, Hilton Lake Drainage, and an unnamed creek. Both studies found that dissolved oxygen, pH, and temperature met Class A standards. Several water samples violated copper and lead standards, but the primary problems were sediment, bacteria, and nutrients.

Excessive sediment is a major problem in these streams that drain the hillside above the Marshland agricultural area. Farmers in the lowlands must construct sediment traps and remove sediment from drainage ditches. Sediment comes from highly erodible soil in steep ravines, a problem exacerbated over the years by runoff from residential construction on the hills above Marshland. The Tulalip Tribes measured high turbidities in Wood Creek (mean = 37, maximum = 1000 NTU). Snohomish County measured high total suspended sediments in all the creeks with the highest sediment loads occurring in the winter.

The streams draining Marshland carry high levels of fecal coliform bacteria. Fecal coliform counts violated the Class A standard in both studies at all sites. In the Hilton Lake drainage, bacteria levels in six of the nine samples taken in 1991 were greater than 1000 col/100 ml, with a geometric mean of 700 col/100 ml. A ditch draining down the hillside to Lowell-Larimer Road, which contained raw sewage during a SWM survey in the summer of 1992, was referred to the Snohomish Health District for investigation. The water in many of the drainage ditches along the hillside also contained measurable levels of detergents, indicating failing septic systems.

Snohomish County measured mean nitrate levels in the Marshland Tributaries that were three times higher than those in North and Swamp Creeks during 1990 and 1991. Mean nitrate-nitrite levels in this area ranged from 1.6-3.5 mg/l and mean total phosphorus levels ranged from 0.05-0.20 mg/l. The Tulalip Tribes also measured high nitrate and phosphate levels at all Marshland sites (Thornburgh et al. 1991).

At a site in the main drainage near the pump station, DOE found dissolved oxygen concentrations less than 2.5 mg/l (Cusimano 1995). DOE estimated that the loading of oxygen depleting substances and low dissolved oxygen water to the Snohomish River from Marshland lowered dissolved oxygen concentrations in the river under critical summer low flow conditions.

The presence of raw sewage and detergents in drainage ditches indicates failing septic systems. High levels of bacteria and nutrients in the streams can come from failing septic systems, pet waste, manure, and

*Marshland Tributaries*

**CONCERNS**

- **erosion and sedimentation in steep, hillside streams**
- **agriculture in lower watershed**

**PROBLEMS**

- **bacteria, sediment, dissolved oxygen, nutrients**

**PROBABLE SOURCES**

- **urban runoff, erosion, septic systems, manure, fertilizers**

## *Map of Marshland Watershed*

(See Table of Contents to view map in PDF format)

fertilizers. DOE has listed Wood Creek as impaired by low levels of dissolved oxygen and is developing a Water Cleanup Plan.

High turbidity is a problem in these streams that drain the hillside. Sediment loading comes from runoff from developed properties channeled into steep ravines with erosive soils. Snohomish County recently completed a project in the Hilton Lake Drainage to stabilize a channel in a steep ravine and dissipate storm runoff into the ravine to halt erosion. The County is working with the Marshland Flood Control District to identify and mitigate erosion problems.

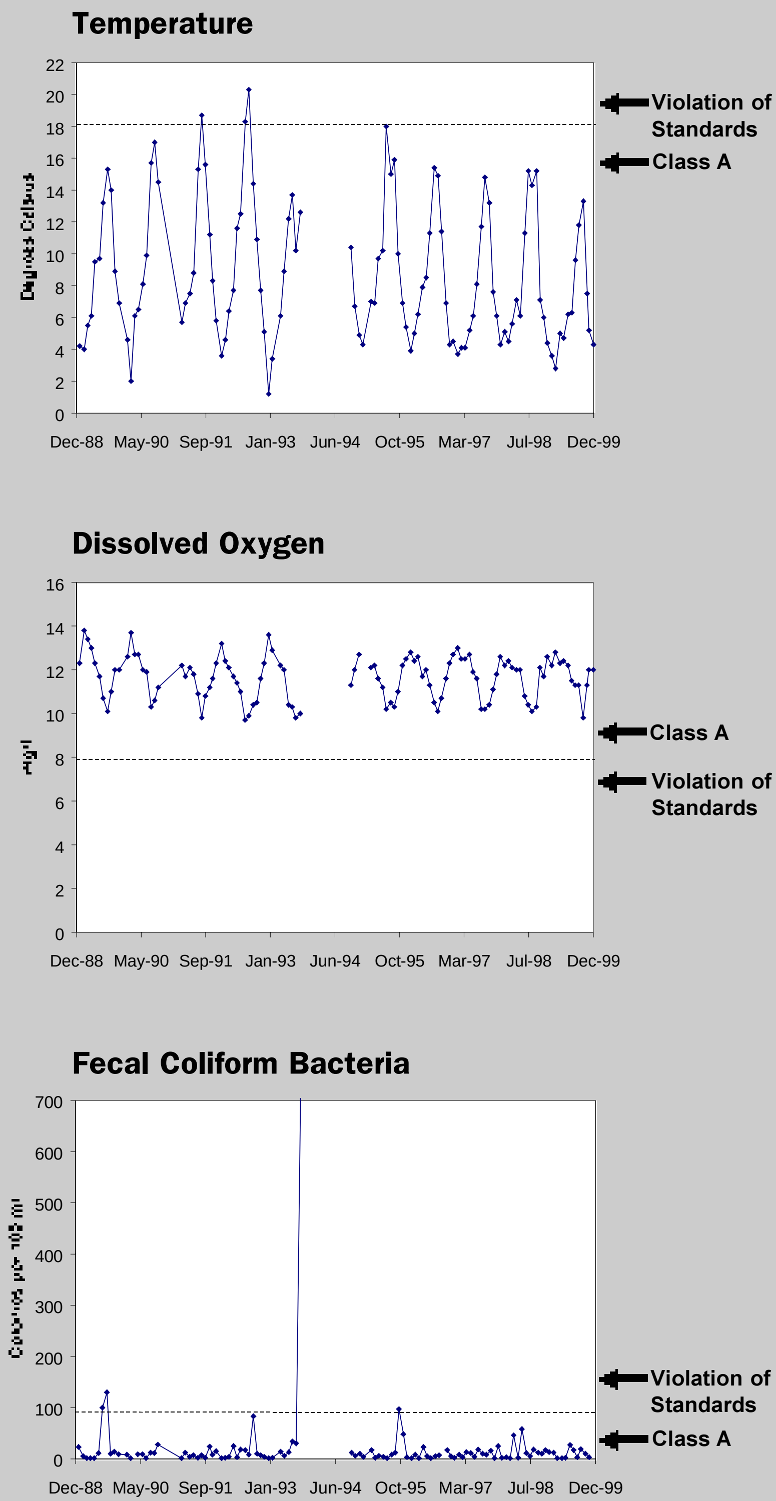
ENERGY DISSIPATOR AND STABILIZED CHANNEL IN HILTON LAKES DRAINAGE, PHOTO BY JOHN ENGEL

# Skykomish River

The Skykomish River drains approximately 700 square miles. The North and South Forks of the Skykomish begin in the Cascades and join upstream of the town of Gold Bar. The Skykomish watershed is predominantly rural with low-density development. The North and South Forks are Class AA; below their confluence the mainstem of the Skykomish is Class A.

The Tulalip Tribes monitored the Skykomish River at Monroe (river mile 25.7) and at Sultan (river mile 34.7) from 1987 to 1990 (Thornburgh et al. 1991). DOE has monitored at Monroe and at Gold Bar (river mile 43.7) since 1978. During these years of monitoring, the Skykomish River met Class A standards for dissolved oxygen, turbidity and fecal coliform bacteria. Summer temperatures at Monroe usually meet standards, with only three measurements between 18 and 20$^{o}$C during the last ten years. At Gold Bar, temperatures were slightly lower and never exceeded 18.0$^{o}$C. The long-term mean bacteria concentration at Monroe was 7 col/100 ml, which is within allowable levels. However, in a summer survey, DOE measured several samples downstream of Sultan that exceeded the Class A standard (Cusimano 1995).

## Skykomish River at Monroe




***Source: Dept. of Ecology Data***

*Skykomish River*

**CONCERNS**
- **fully supports designated uses, but runoff from agricultural areas may degrade lower river**

**PROBLEMS**
- **bacteria, temperature**

**PROBABLE SOURCES**
- **manure**

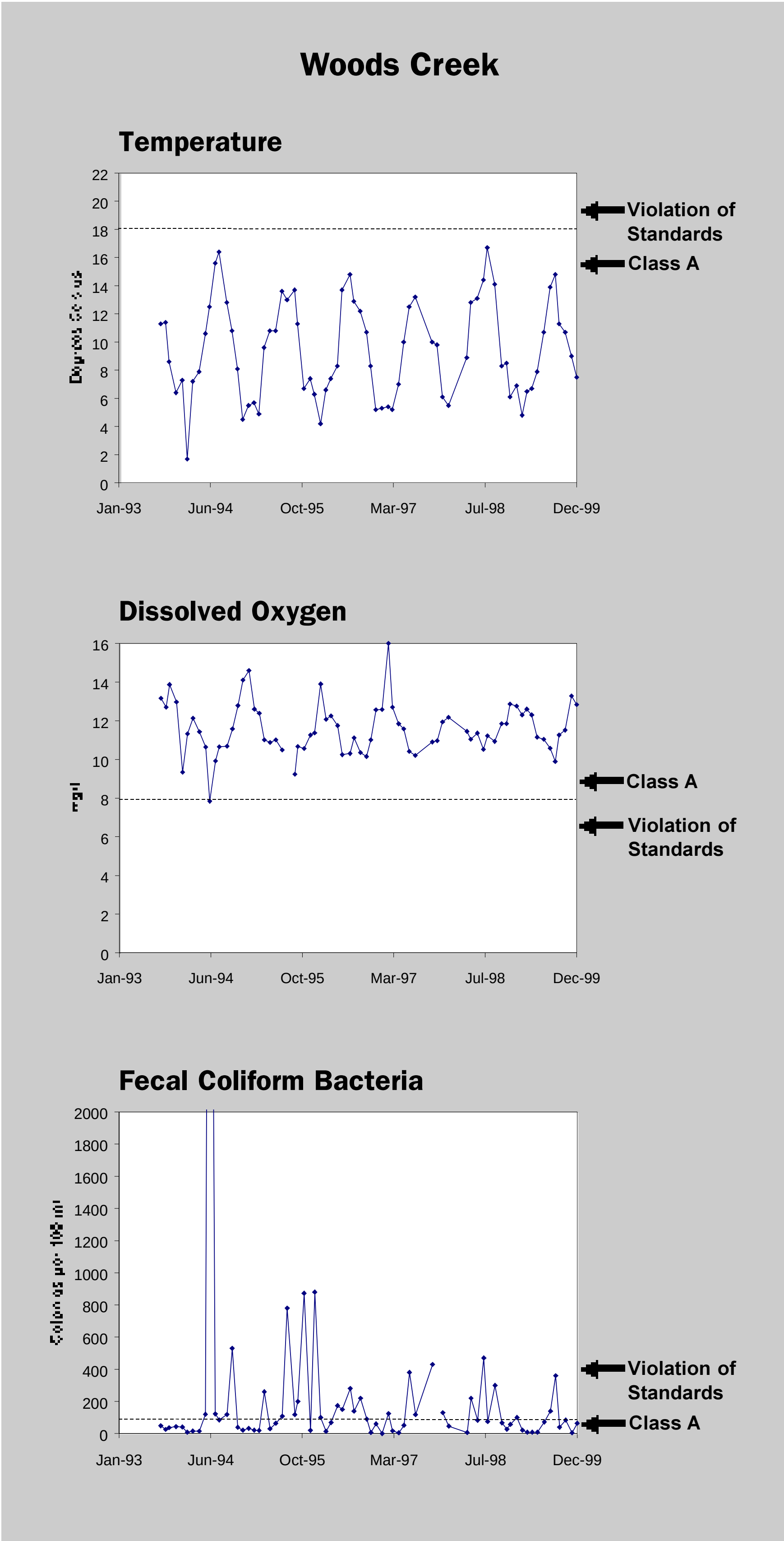
Nitrate-nitrite mean levels were less than 0.2 mg/l, and total phosphorus means were less than 0.03 mg/l. Mean turbidities ranged from 1-5 NTU. The Tribes measured a peak of 90 NTU at Monroe. A mean conductivity of 33 umhos/cm is the lowest measured in the County and indicates minimal problems from road or agricultural runoff.

The Department of Ecology has listed the lower Skykomish River as impaired by levels of bacteria, temperature, dissolved oxygen, copper, lead, and silver. Because of bacteria and summer temperatures, impaired uses in the lower Skykomish are swimming, boating, and fish spawning. Bacteria from agricultural sources are a potential problem in the lower river. Implementing best management practices on farms would decrease bacteria levels.

CONFLUENCE OF THE NORTH AND SOUTH FORKS OF THE SKYKOMISH RIVER, PHOTO BY SKY MILLER

# *Map of Skykomish River Watershed SWM Water Quality Sampling Sites*

(See Table of Contents to view map in PDF format)




***Source: SWM Data***

# Woods Creek

Woods Creek, a major Class A tributary of the lower Skykomish River, drains a watershed of approximately 60 square miles north from Monroe to Lake Roesiger. Woods Creek joins the Skykomish River near Monroe. The lower reaches of Woods Creek support small, non-commercial farms and several large equestrian centers. Tree harvesting and low-density residential development occurs along the upper reaches of Woods Creek.

The Tulalip Tribes monitored sites on Woods Creek from 1987-1990 (Thornburgh et al. 1991), and SWM has monitored the mainstem and west fork since 1993. Water quality in the upper watershed meets state standards for dissolved oxygen, temperature, and turbidity. Bacteria violated standards 39 percent of the time with a long-term mean of 61 col/100 ml. Nitrate concentrations approached 1.0 mg/l, which indicates contamination from human sources. A mean conductivity of 59 umhos/cm indicates little contamination from road or agricultural runoff. Biological sampling conducted by SWM in 1997 and 1999 ranked the stream in fair condition.

However, the Tulalip site near the mouth of Woods Creek has consistently violated bacte-

# *Map of Woods Creek Watershed with SWM Water Quality Sampling Sites*

(See Table of Contents to view map in PDF format)

*Woods Creek*

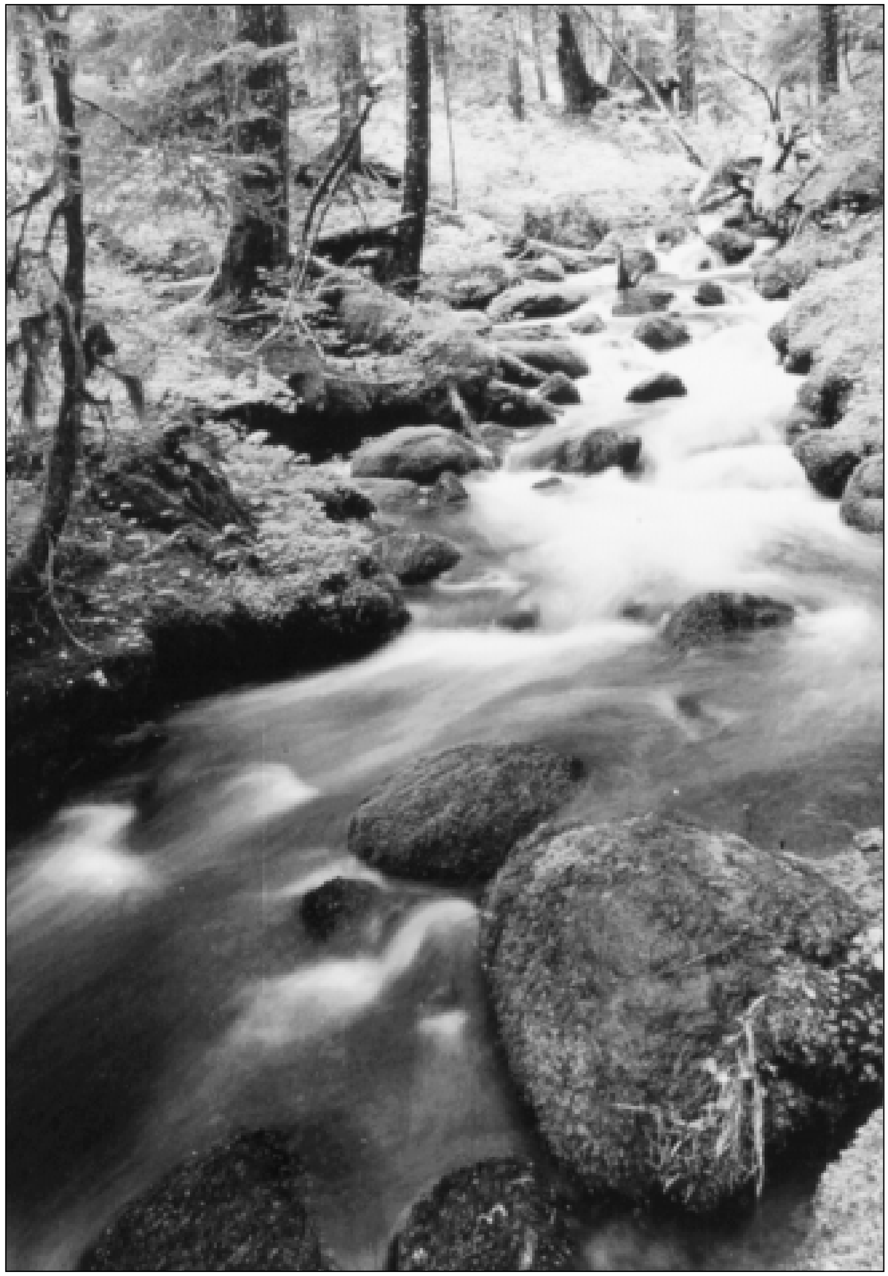
**CONCERNS**
- **does not support designated uses**

**PROBLEMS**
- **bacteria, sediment**

**PROBABLE SOURCES**
- **animal access to streams, manure, tree harvesting**

ria standards with a mean of 400 col/100 ml. During storms, the peak bacteria count at the lower site has been measured at 13,000 col/100 ml with a turbidity of 40 NTU. DOE found high nutrients, total organic carbon, and chlorophyll a concentrations in Woods Creek in the summer, indicating that the creek is impacted by development (Cusimano 1995).

The Department of Ecology has listed Woods Creek as impaired by levels of bacteria and is developing a Water Cleanup Plan. Because of pollution from bacteria and sediment, impaired uses of Woods Creek are swimming, wading, and fish spawning. Water quality problems result from livestock on the banks of the river, runoff from manure sprayed on agricultural lands, failing septic systems, fertilizer enriched groundwater, direct discharge of manure, tree harvesting, forest management, road construction, channeli-zation, removal of riparian vegetation, and streambank modification.



WOODS CREEK, PHOTO BY DARRELL SMITH

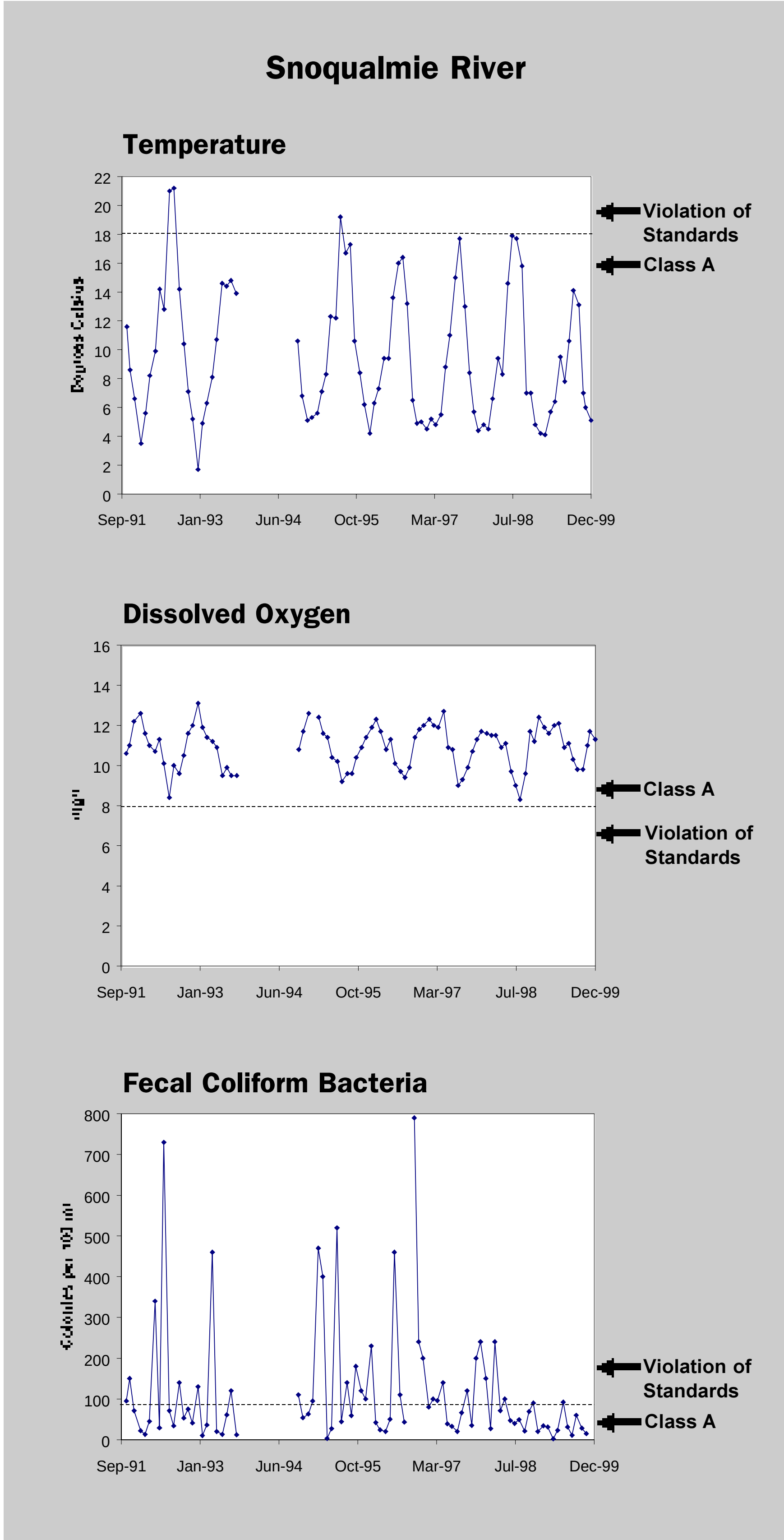
# Snoqualmie River

The Snoqualmie River drains approximately 700 square miles in North King and South Snohomish Counties. Rural development and agriculture are concentrated in the lower valley, where the river is Class A. About six miles of the lower river are in Snohomish County before it joins the Skykomish to form the Snohomish River.

The Tulalip Tribes monitored one site on the lower Snoqualmie River in Snohomish County from 1987-1990 (Thornburgh et al. 1991). During this study, bacteria levels violated Class A standards. The mean turbidity (10 NTU) met standards, but a peak turbidity of 33 NTU violated standards.

The Department of Ecology conducted a low flow assessment of the Snoqualmie in the summer of 1989 (Joy et al. 1991) and has monitored a site near Monroe since 1991. Dissolved oxygen meets standards, but temperatures have exceeded 21°C. Fecal coliform concentrations have violated standards 32 percent of the time with a long-term mean of 63 col/100 ml. The mean conductivity of 44 umhos/cm is one of the lowest measured in County streams.

The Department of Ecology has listed the Snoqualmie River as impaired by high temperatures and has approved a Water




***Source: Dept. of Ecology Data***

*Snoqualmie River*

**C O N C E R N S**

- **does not support designated uses**

**P R O B L E M S**

- **bacteria, temperature, nutrients**

**P R O B A B L E S O U R C E S**

- **septic systems, manure, animal access to the river, fertilizers**

Cleanup Plan. Because of indications of problems from bacteria, temperature, and nutrients, the lower Snoqualmie does not adequately support designated uses. The impaired uses are primary and secondary contact recreation, and fish spawning, rearing, migration, and harvesting.

Agriculture on the lower river results in problems of high temperature, nutrients and bacteria. The sources of these pollutants are livestock on the banks of the river, runoff from manure sprayed on agricultural lands, failing septic systems, fertilizer enriched groundwater, and direct discharge of manure. Temperatures violate standards due to lack of riparian cover and slow moving water in the channelized lower reaches of the river. Solutions to water quality problems on the lower river include implementing farm best management practices, repairing failing septic systems, and planting streamside vegetation.

# *Map of Lower Snoqualmie River Watershed*

(See Table of Contents to view map in PDF format)

## Lake Washington and Puget Sound Tributaries

- Swamp Creek
- North Creek
- Little Bear and Bear Creeks
- Puget Sound Tributaries

Several streams originate in southern Snohomish County and flow into Lake Washington through the Sammamish River. Snohomish County streams that are part of the Lake Washington watershed are Swamp, North, Little Bear, and Bear Creeks. The southern part of the County also includes many small streams that flow directly into Puget Sound. The Puget Sound Tributaries include Big Gulch Creek, Upper and Lower Chennault Creeks, Picnic Point Creek, Norma Creek, and Lund's Gulch.

This area of the County contains only land that is zoned for commercial and residential development. This area is the most developed area in the County, and much of the development occurred before the requirement for stormwater detention. Consequently, extensive problems of erosion and sedimentation result from high stormflows. High temperature and low dissolved oxygen are problems resulting from low summer flows. Concentrations of toxic metals and fecal coliform bacteria in the streams often exceed state water quality standards. Petroleum and detergents have also been found in these streams. All of these pollutants are found in runoff from extensive impervious surfaces associated with urbanization.

Solutions to water quality problems in the Lake Washington and Puget Sound Tributaries include assessing and rehabilitating detention ponds and increasing storm sewer maintenance. Pollutants can be eliminated by identifying and removing illicit discharges of sewage to storm sewers. Bacteria can further be reduced by proper disposal of pet wastes. Revegetation of sensitive areas and riparian corridors reduces erosion as well as lowers stream temperatures and increases dissolved oxygen.

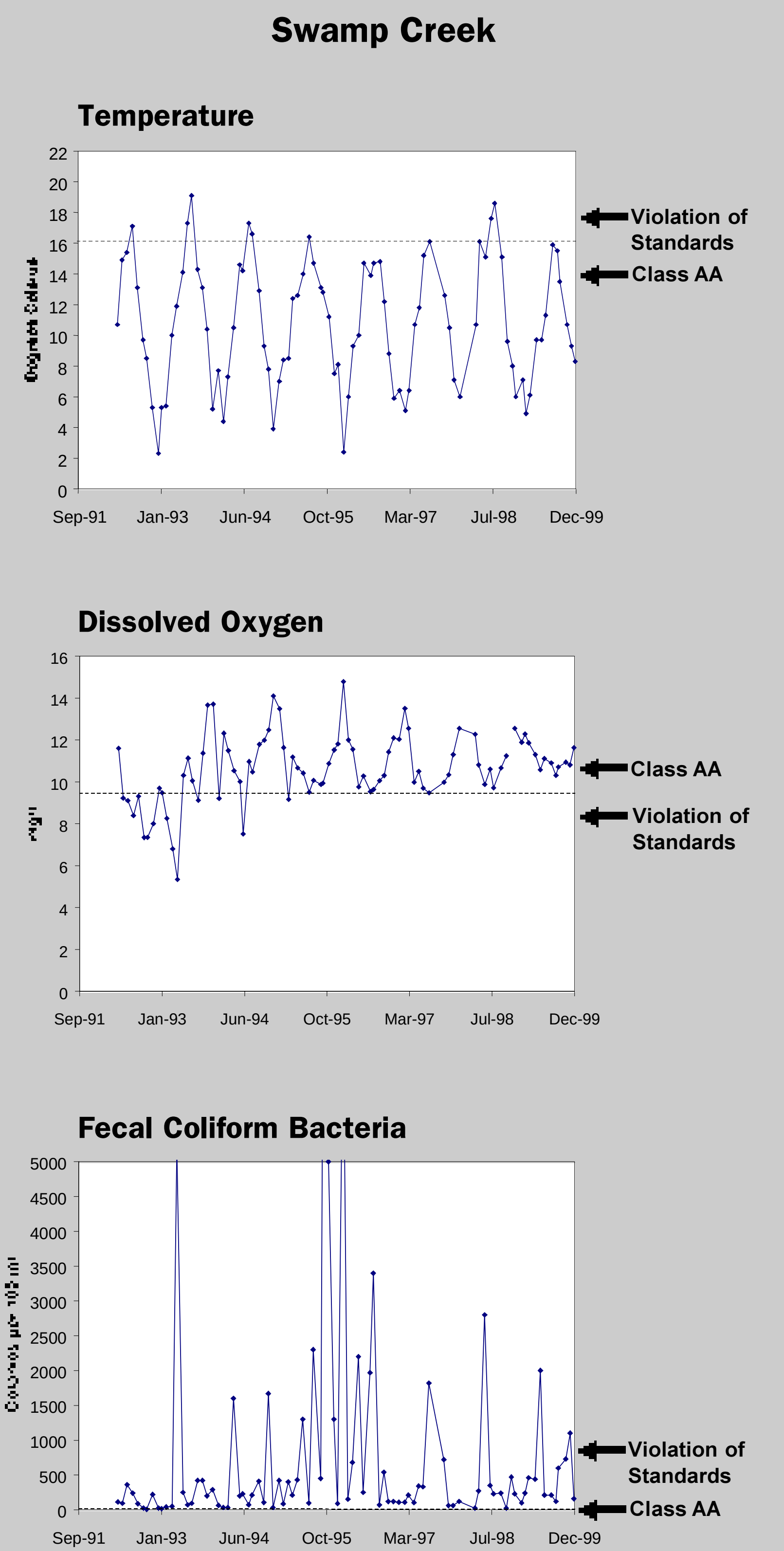
SWAMP CREEK, PHOTO BY CRAIG YOUNG

# Swamp Creek

Swamp Creek is located in south Snohomish County between the North Creek watershed to the east and the Puget Sound Tributaries to the west. Swamp Creek is designated Class AA and flows south from Everett into the Sammamish River. The watershed is highly urbanized and drains portions of Lynnwood, Everett, Brier, Bothell, Mountlake Terrace, and unincorporated Snohomish County. During the winter, the headwaters of Swamp Creek begin inside the Everett City limits. In the summer, the main channel begins south of Everett and contains dry sections within unincorporated Snohomish County. Scriber Creek, the largest tributary to Swamp Creek, drains most of the City of Lynnwood and portions of Mountlake Terrace and Brier.

Swamp Creek has been monitored at a site near the mouth by METRO from 1985-1989 and throughout the watershed by Snohomish County SWM from 1990-present. SWM established two long-term monitoring sites in 1992, one in the upper watershed and one at the King County line. The County conducted an extensive sampling program during 1992 and 1993 (Thornburgh 1996).

Water quality in Swamp Creek is generally poor. Temperature violates standards,




***Source: SWM Data***

*Swamp Creek*

**CONCERNS**
- **does not support designated uses**

**PROBLEMS**
- **bacteria, copper, lead, zinc, dissolved oxygen**

**PROBABLE SOURCES**
- **commercial, industrial, and urban runoff; septic systems; pet wastes**

with temperatures over 19$^{o}$C measured in the lower creek. A temperature logger in the lower creek near the County line in 1997 recorded temperatures over 16$^{o}$C 34 percent of the time and over 18$^{o}$C 4 percent of the time. Levels of dissolved oxygen violated standards 18 percent of the time, although the site at the County line has met standards since 1995. Except for three tributaries, fecal coliform bacteria levels violated Class AA standards throughout the watershed. The mean bacteria in the lower mainstem from 1992 through 1999 was 245 col/100 ml. Turbidity levels in the watershed usually met the state standards.

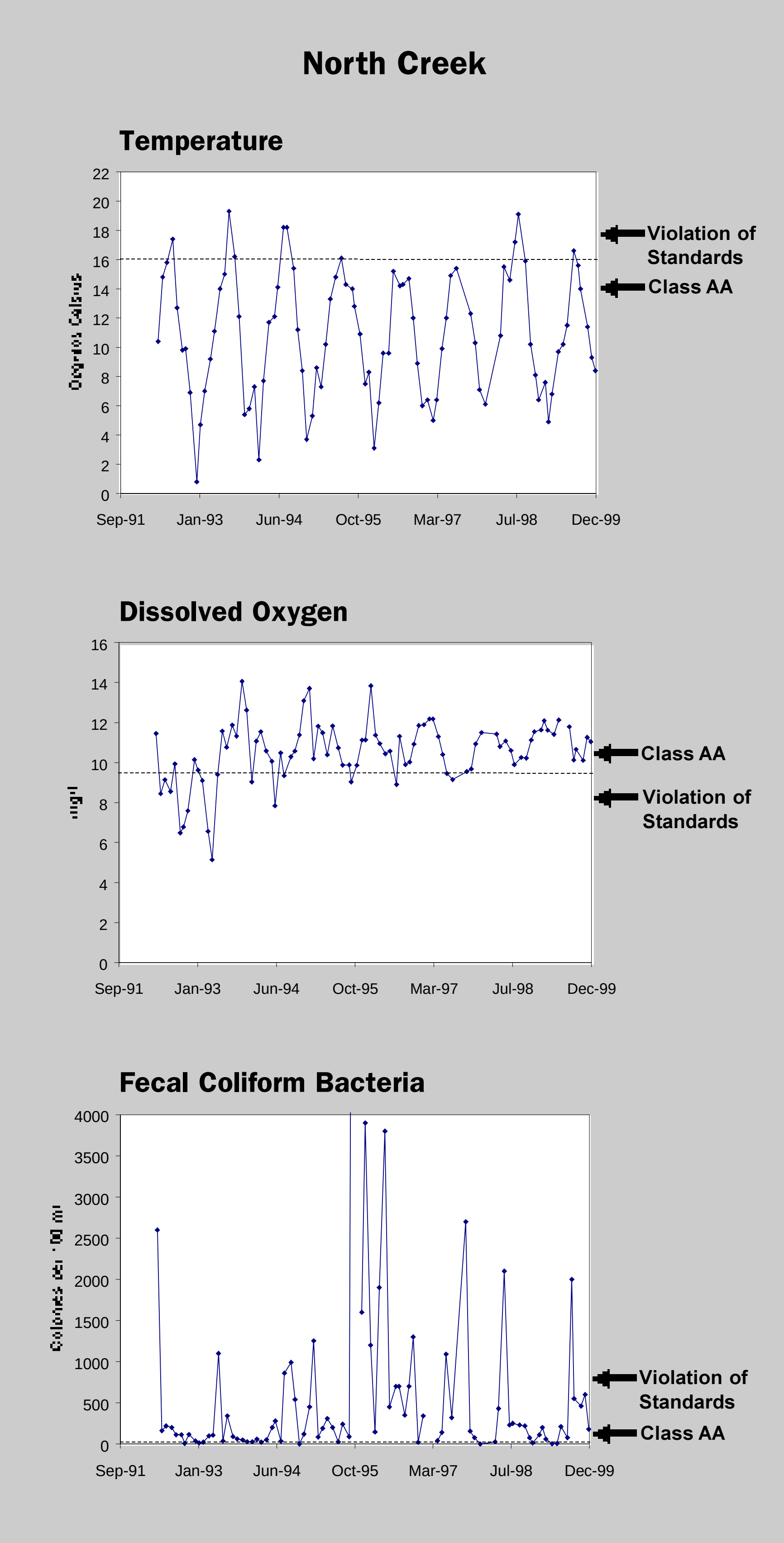
Concentrations of metals are some of the highest in the County, with violations of the standards for copper, lead, and zinc. Sediments at a site near the mouth contained copper, lead, nickel, and zinc. Chromium concentrations in the sediments (40.6 mg/kg) were the highest of all the tributaries to Lake Washington sampled by METRO. A mean conductivity of 142 umhos/cm measured from 1992 through 1999 indicates impacts to the creek from road runoff.

Biological sampling conducted by SWM in 1997 and 1999 found the lower mainstem in poor condition with few long-lived and clinger invertebrate species. Clingers are sensitive to fine sediments and disappear when sediment fills the spaces between rocks and gravel on a streambed. Loss of long-lived species indicates an on-going problem such as low summer flows or periodic flooding and scouring. Lack of stoneflys is a sign of increased pollution from human disturbance and low numbers of mayflys indicate that heavy metals concentrations are an ongoing problem.

DOE has determined that Swamp Creek does not support the designated uses of primary and secondary contact recreation and is developing a Water Cleanup Plan for dissolved oxygen and bacteria. Kramer, Chin, and Mayo, Inc. (1992) identified the major types of nonpoint pollution sources in the Swamp Creek watershed as residential, commercial, and industrial development; failing septic systems; and agricultural activities. Other nonpoint sources include highway runoff, spills of hazardous substances, gravel mining, chemical and waste disposal, and illegal storm drain connections. In addition, filling of wetlands has contributed to summer low flow conditions and flashy storm flows in both winter and summer. Solutions to water quality problems in this watershed include proper disposal of pet wastes, maintaining streamside vegetation to filter road runoff, public outreach to residents on landscaping to reduce pollution, and proper use of fertilizers and toxic materials.

# Map of Swamp Creek Watershed with SWM Water Quality Sampling Sites

(See Table of Contents to view map in PDF format)




***Source: SWM Data***

# North Creek

The North Creek watershed flows south from Everett into the Sammamish River. It is bounded on the west by the Swamp Creek watershed and on the east by the Little Bear Creek watershed. North Creek is designated Class AA. North Creek is highly urbanized and drains portions of the cities of Bothell and Mill Creek. During the winter the headwaters of North Creek begin inside the Everett City limits. In the summer, the main channel contains dry sections as far south as McCollum Park.

Water quality in North Creek has been monitored by METRO (1990) at a site near the mouth and by Snohomish County throughout the watershed. SWM established two long-term monitoring sites in 1992, one in the upper watershed and one at the King County line. The County conducted an extensive sampling program during 1992 and 1993 (Thornburgh 1996). Levels of fecal coliform bacteria consistently violate Class AA standards. The long-term mean for samples at the mouth was 309 col/100 ml and in the lower mainstem was 148 col/100 ml. A temperature logger near the King County line in 1997 recorded temperatures over 16°C 26 percent of the time and over

# *Map of North Creek Watershed with SWM Water Quality Sampling Sites*

(See Table of Contents to view map in PDF format)

*North Creek*

**CONCERNS**

- **does not support designated uses**

**PROBLEMS**

- **bacteria, copper, lead, zinc, dissolved oxygen**

**PROBABLE SOURCES**

- **urban, commercial and industrial runoff; septic systems; manure, pet wastes**

18°C 4 percent of the time. Levels of dissolved oxygen violated standards 19 percent of the time,

Concentrations of mercury, lead, copper, and zinc in water samples at many sites were in violation of state standards. Water samples did not contain detectable levels of silver and cadmium. A sediment sample from the mouth of the creek contained chromium, copper, lead, nickel, and zinc (METRO 1990). A mean conductivity of 136 umhos/cm measured from 1992 through 1999 indicates impacts to the creek from road runoff.

Biological sampling conducted by SWM in 1997 and 1999 found the lower mainstem in very poor condition with few long-lived and clinger invertebrate species. Clingers are sensitive to fine sediments and disappear when sediment fills the spaces between rocks and gravel on a stream bed. Loss of long-lived species indicates an ongoing problem such as low summer flows or periodic flooding and scouring. Lack of stoneflys is a sign of increased pollution from human disturbance and low numbers of mayflys indicate that heavy metals concentrations are an ongoing problem.

DOE has determined that North Creek does not support the designated uses of primary and secondary contact recreation but has not yet begun a Water Cleanup Plan to address problems with dissolved oxygen and bacteria. Kramer, Chin, and Mayo, Inc. (1991) identified the major types of nonpoint pollution sources in the North Creek watershed as residential, commercial, and industrial development, agricultural activities, and failing septic systems. Other sources of nonpoint pollution include highway runoff, spills of hazardous substances, peat mining, chemical storage and waste disposal, and illegal storm drain connections. Filling of wetlands has contributed to summer low flow conditions, which exacerbate other pollution problems by increasing the concentration of pollutants in streams. Solutions to water quality problems in this watershed include proper disposal of pet wastes, maintaining streamside vegetation to filter road runoff, public outreach to residents on landscaping to reduce pollution, and proper use of fertilizers and toxic materials.

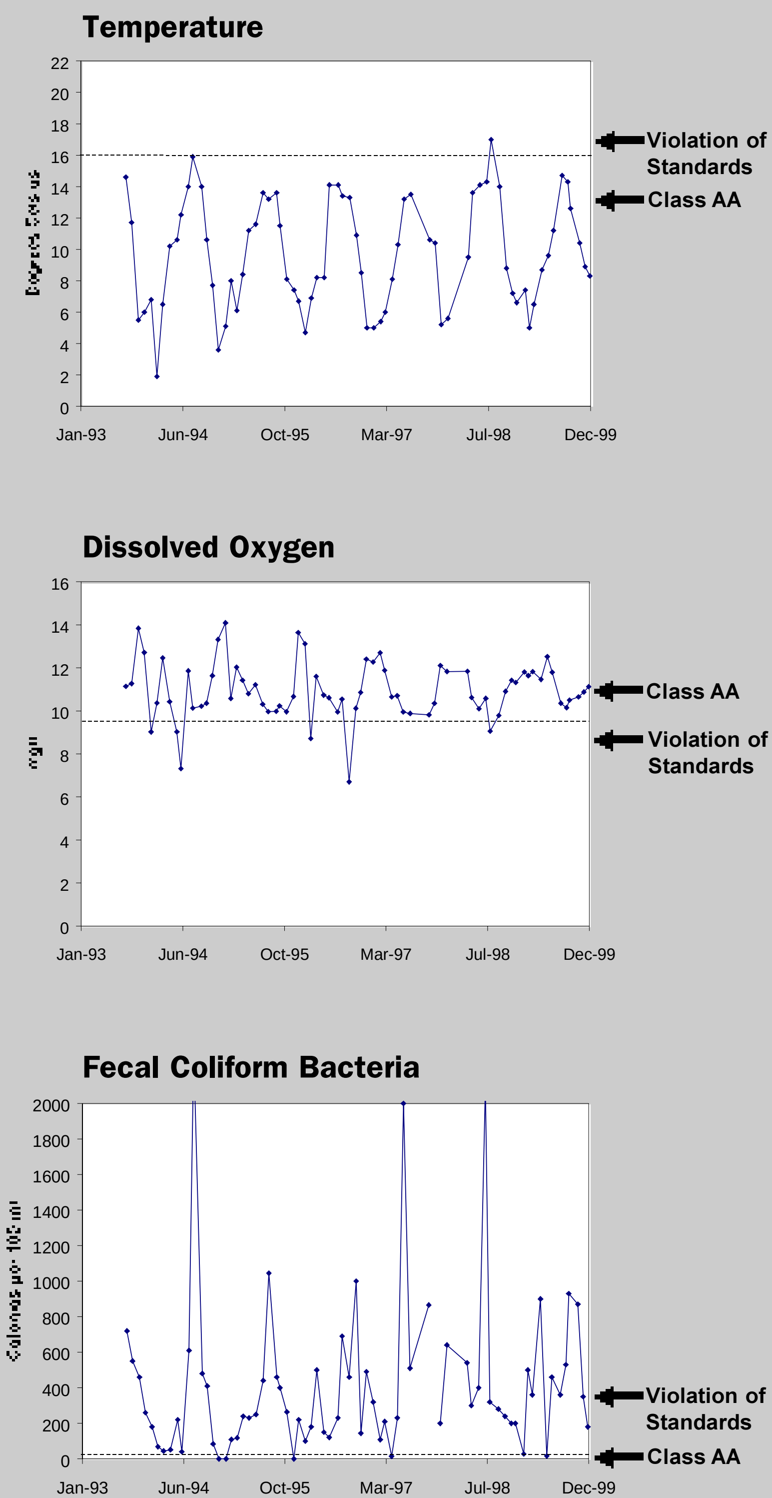
# Little Bear and Bear Creeks

The headwaters of Little Bear Creek are located in a peat bog west of Clearview. The stream is designated Class AA and flows in a southerly direction for 7.7 miles, joining the Sammamish River west of Woodinville. The Little Bear Creek watershed is rapidly urbanizing, with residential development and non-commercial farming in the upper watershed and commercial and industrial development in the lower watershed.

Bear Creek, which is also a Class AA stream, drains an area to the south and west of Little Bear Creek. The Bear drainage lies mainly in King County; however, the headwaters of Upper Bear Creek and Cottage Lake Creek, a tributary, are located in Snohomish County.

Little Bear Creek has been monitored by METRO (1989, 1990, and 1991) at one site in King County near the mouth and at two sites in the upper watershed by SWM since 1993. Mean fecal coliform levels (120-300 col/100 ml) violated Class AA standards at the mouth and in the upper watershed (183 col/100 ml). Nitrate levels in the watershed were some of the highest in the County with means exceeding 1 mg/l. Dissolved oxygen violated standards 8 percent of the time, but tem-

## Little Bear Creek




**Source: SWM Data**

*Little Bear, Bear Creeks*

**CONCERNS**

- **do not support designated uses**

**PROBLEMS**

**Little Bear Creek**

- **bacteria, nitrate, lead**

**Bear & Cottage Lake Creeks**

- **bacteria and copper**

**PROBABLE SOURCES**

- **urban, commercial, and industrial runoff; septic systems, manure, pet wastes**

perature sampling shows only one monthly measurement greater than 16°C. Sediment samples near the mouth of the creek contained chromium, copper, lead, nickel, and zinc. Biological sampling conducted by SWM found fair conditions in the lower mainstem in 1997 and 1999. A mean conductivity of 108 umhos/cm measured from 1992 through 1999 places the creek in the mid range of sites sampled by the County. The conductivity levels indicate that riparian buffers may be reducing impacts to the creek from road runoff.

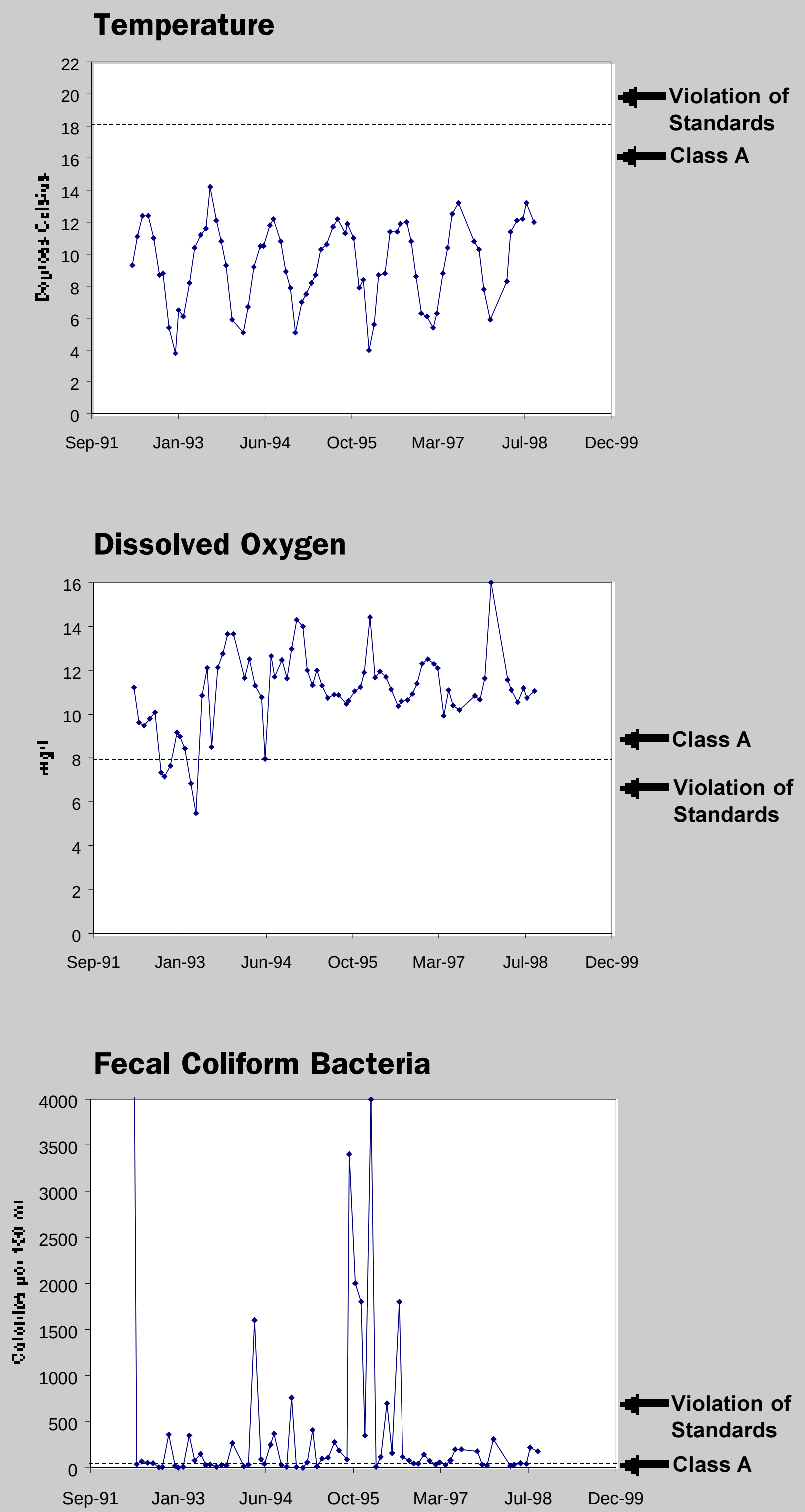
METRO (1989, 1990, and 1991) has monitored water quality in the lower reaches of the Bear watershed. At two sites on Cottage Lake and Bear Creeks, closest to Snohomish County, mean fecal coliform bacteria levels ranged from 100-200 col/100 ml, violating Class AA standards. Dissolved oxygen, temperature, and turbidity met Class AA standards. Sediments from a sample near the mouth contained cadmium, chromium, copper, lead, nickel, and zinc. Metal concentrations in the sediments were fairly low compared with other streams sampled by METRO draining into Lake Washington. High flow sampling in Bear Creek showed concentrations of suspended solids, turbidity, fecal coliform bacteria, ammonia, nitrate-nitrite, and total phosphorus that were at least twice those of the previous base flow sample (Metro 1991). Concentrations of copper in the water during high flow were in violation of state standards.

DOE determined that Little Bear and Bear Creeks do not adequately support the designated uses of primary and secondary contact recreation and fish spawning, rearing, migration, and harvesting but has not yet begun cleanup plans to address contamination by fecal coliform and metals. Major pollutants are copper, nitrate, and bacteria that can come from land development, urban runoff, storm sewers, pasture land, runoff from animal manure, failing septic systems, and removal of riparian vegetation. Solutions to water quality problems in these watersheds include fencing to prevent animal access to creeks, repairing failing septic systems, maintaining streamside vegetation to filter road runoff, public outreach to residents on landscaping to reduce pollution, proper use of fertilizers and toxic materials, and pet waste management.

# *Map of Little Bear/Bear Watershed with SWM Water Quality Sampling Sites*

(See Table of Contents to view map in PDF format)

**Norma Creek**




***Source: SWM Data***

# Puget Sound Tributaries

The Puget Sound tributaries consist of a number of Class A streams that drain westward into Puget Sound between Mukilteo and Edmonds. These tributaries include Big Gulch Creek, Upper and Lower Chenault Creeks, Lund's Gulch, Norma Creek, and Picnic Point Creek. The area is bounded by the mouth of the Snohomish River and the southern boundary of Snohomish County. Development in these watersheds is primarily residential with roads and light industrial and commercial use.

Snohomish County sampled a single site at the mouth of Lund's Gulch monthly from 1990-1991 (Thornburgh and Leif 1992). Concentrations of fecal coliform bacteria and turbidity violated Class A standards. Concentrations of copper, mercury, and lead in the water also violated state standards.

SWM sampled two sites on Norma Creek monthly from 1992 through 1998. Norma Creek flows from Lake Serene, through a residential area and a wooded ravine into the Sound. Sediment and metals are the primary water quality problems in Norma Creek. Mean total suspended sediment was 45 mg/l with a maximum of 1500 mg/l measured in the lower creek. Flashy

# *Map of Puget Sound Tributaries with SWM Water Quality Sampling Sites*

(See Table of Contents to view map in PDF format)

*Puget Sound Tributaries*

**CONCERNS**

- **residential and commercial runoff into Puget Sound**

**PROBLEMS**

- **bacteria, sediment, copper, lead, zinc**

**PROBABLE SOURCES**

- **residential and commercial runoff, pet wastes**

storm flows in both winter and summer caused by filling of wetlands contribute to high sediment loads in the creek. Multiple violations of copper, lead and zinc standards were measured at both the upper and lower sites. Some of the highest metals concentrations in the County were measured at the upper site, which receives road runoff from a large area with low flows to dilute concentrations. A mean conductivity of 222 umhos/cm measured from 1992 through 1998 is the highest measured in the County and indicates severe impacts to the creek from road runoff. Bacteria levels violated standards at both sites but were highest at the upper site (280 colonies/ 100 ml).

Biological sampling conducted by SWM in 1997 and 1999 found the lower mainstem of Norma Creek in very poor condition with few long-lived and clinger invertebrate species. Clingers are sensitive to fine sediments and disappear when sediment fills the spaces between rocks and gravel on a stream bed. Loss of long-lived species indicates an ongoing problem such as low summer flows or periodic flooding and scouring. Lack of stoneflys is a sign of increased pollution from human disturbance and low numbers of mayflys indicate that heavy metals concentrations are an ongoing problem.

DOE has determined that Norma Creek is impaired by levels of dissolved oxygen and fecal coliform bacteria. Sanitary sewers serve the entire watershed, so the bacteria sources are primarily from pets. Metals are commonly found in runoff from roads, and residential and commercial areas. Solutions to water quality problems in this watershed include proper disposal of pet wastes, maintaining streamside vegetation to filter road runoff, public outreach to residents on landscaping to reduce pollution, and proper use of fertilizers and toxic materials.

SWM STREAM REHABILITATION PROJECT IN LUND'S GULCH, PHOTO BY JOHN ENGEL