Swamp Creek
Fecal Coliform Bacteria
Total Maximum Daily Load

Water Quality Implementation Plan

March 2006
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by

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Acknowledgements

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The work of many Ecology staff made this plan an accurate and useful document as well. Mike Woodall helped the author create watershed maps to support both the technical analysis and visual aids for this report. Discussions with Joe Joy and Karol Erickson, Environmental Assessment Program, strengthened the report's technical analysis. Dave Garland and Anne Dettelbach proved invaluable review and comment on all aspects of the plan from technical analyses to final report. Helen Bresler and Ron McBride ensured that the report was consistent with state policies and Ann Wessel helped connect water cleanup planning to stormwater management activities.

Environmental Protection Agency staff Martha Turvey and Bruce Cleland took a special interest in this plan as well. Martha met with watershed stakeholders and provided early plan review. Bruce Cleland met with the author and watershed stakeholders to help craft a meaningful and achievable water quality monitoring strategy.

Finally, Ecology would like to thank the residents of the Swamp Creek watershed who love their creeks and are working diligently to protect and restore this beautiful watershed. We appreciate all of your interest and support of our work and look forward to our ongoing collaborations and conversations.

Figure 1. Low bacteria levels mean "fun" is also "safe" in Swamp Creek. Urban creeks provide an oasis for children looking for a place to stay cool or just explore and have fun such as in Swamp Creek at Wallace Park in Kenmore.

Executive Summary

The waters of the Swamp Creek Watershed have high bacteria levels and action must be taken to reduce them. This document, the Swamp Creek Total Maximum Daily Load (Swamp Creek Water Quality Improvement Plan), details those actions. The goal of the plan is for Swamp Creek to meet the bacteria criteria of the Washington State Water Quality Standards, Washington Administrative Code (WAC) 173-201A.

This Water Quality Improvement Plan contains the technical information used to develop the total maximum daily load (TMDL), the information required by the U.S. Environmental Protection Agency for the approval of a TMDL, and the implementation plan for the TMDL.

The Water Quality Improvement Plan has identified urban stormwater and nonpoint pollution sources as the primary problem. The most important activities identified for immediate action include illicit discharge detection, pet waste management, public education, investigation of areas with onsite septic systems, and small farm outreach. Water quality monitoring is a required activity for entities that are discharging stormwater in accordance with the Department of Ecology's municipal stormwater permit program. No industrial sources of pollution were identified in the Plan.

The reductions in bacteria levels required to return Swamp Creek to compliance with state standards ranged from 68 to 96 percent. The responsibility for reducing bacteria levels is distributed among pollutions sources by season. Ecology anticipates that if state and local coordination proceed as expected, by December 2012, each of the sampling stations within the Swamp Creek Watershed will be compliance with the state primary contact recreation standards. Compliance with the extraordinary primary contact standards should be achieved by 2017.

Entities that will be working to clean up Swamp Creek include Snohomish County, the cities of Everett, Lynnwood, Brier, Kenmore, Bothell, and Mountlake Terrace, the Washington State Department of Transportation, Snohomish Health District, Snohomish Conservation District, and the Adopt-A-Stream Foundation. The help of watershed residents and businesses will also be needed.

Some of the actions needed are required as part of National Pollutant Discharge Elimination System (NPDES) municipal stormwater permits. The choice of other activities to use to achieve the load allocations established in this TMDL is up to the local entities; however, compliance with the state Water Quality Standards is mandatory. This TMDL does not establish new state regulations and requirements. Where funding is not currently available, Ecology will assist in finding appropriate funding sources.

To gauge the progress of this TMDL, Ecology will convene a meeting of municipal stakeholders no less than annually to share water quality data, trends (where applicable), and to evaluate the status of implementation activities. Stormwater permit requirements will be reevaluated every five years as part of this plans adaptive management process.

Figure 2. Swamp Creek is part of the Lake Washington Watershed. The Swamp Creek Watershed starts in the southern part of Everett and ends in the city of Kenmore. Swamp Creek discharges into the Sammamish River and ultimately into Lake Washington.

Introduction

The Washington State Department of Ecology (Ecology) is concerned about the quality of water in the Swamp Creek watershed. Swamp Creek is polluted with high levels of **fecal coliform bacteria**[1]. This is a problem because the high levels of this bacteria indicate that the water may be unsafe for swimming and other recreational activities.

Swamp Creek became polluted because of the way we do certain activities, not the activities themselves. For example, caring for dogs, cats, horses, and other animals is not a problem; not managing their manure correctly is a problem. Roads and parking lots are necessary part of our modern society, but rainwater that washes off of them (stormwater) is causing our local streams and creeks to be polluted. The solution is to do these things differently so that we can have animals, a modern lifestyle, and clean water.

To make the water in Swamp Creek safer to recreate in, Ecology prepared this report, the *Swamp Creek Fecal Coliform Total Maximum Daily Load Water Quality Improvement Plan* (referred to hereafter as the *Water Quality Improvement Plan*). It details our current understanding of the bacterial pollution problem in Swamp Creek and the actions we should be taking to solve it. However, this report is only a plan. Unless it is put into action, Swamp Creek will not get cleaner.

Section 303(d) of the Federal Clean Water Act (CWA) requires a scientific explanation when local waters are found to be polluted. This scientific explanation is called a Total Maximum Daily Load or "**TMDL**." In Washington State, the Department of Ecology prepares a Water Quality Improvement Plan that contains the TMDL. Ecology then sends the plan to the United States Environmental Protection Agency (U.S.E.P.A) for review and approval. You can learn more about the federal TMDL program at http://www.epa.gov/owow/tmdl/intro.html.

In the Swamp Creek *Water Quality Improvement Plan*, you will learn more about where the bacteria are coming from and how we can get them under control. We all need to work together to reduce bacteria levels. You will learn where Swamp Creek is located and how your everyday activities might be affecting the creek. Finally, the plan will tell you about the activities of your local city or county government, environmental organizations, and what you can do in your own backyard to be part of the solution.

In the following pages, we will discuss the following:

- How does the Water Cleanup Process work and why does Swamp Creek need one?
- Where is the Swamp Creek Watershed and where is the pollution coming from?
- What are the solutions to this problem and what can you do?

[1] Definitions for bold text can be found in Appendix A of this document.

The Water Cleanup Process

Washington State typically follows follows a three-step process for developing Water Quality Improvement Plans (see Figure 3). In some cases, Ecology prepares separate reports for each step of the process. This Swamp Creek Water Quality Improvement Plan takes a different approach and combines all three steps into one document. This new approach was taken to reduce the level of effort by Ecology and local governments to prepare this Plan and to reduce the amount of time needed to put the plan into action. Each of the steps used to prepare this Water Quality Improvement Plan are discussed below.

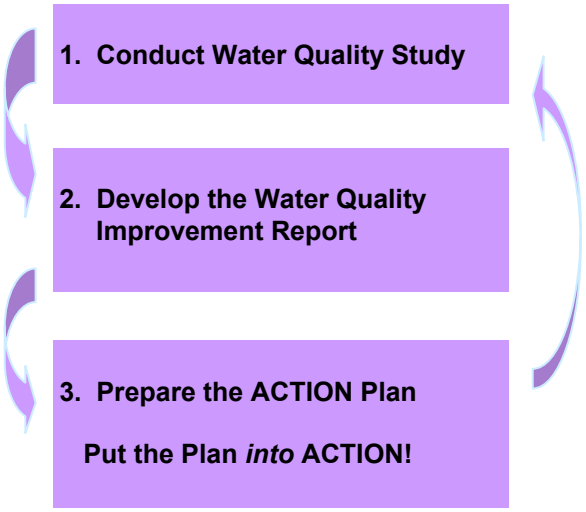


Figure 3. Ecology's Water Cleanup Process

Step 1: Ecology reviews available water quality data and shares this information with local governments. This scientific review shows how dirty the water is now, and how clean it needs to be.

Step 2: Ecology prepares a *draft Water Quality Improvement Plan*. This plan outlines the findings of the Water Quality Study and sets the numeric goals for cleaning up Swamp Creek.

Step 3: Ecology collaborates with local government, businesses, and the public to identify the actions needed to make Swamp Creek a safe place for people and fish. These actions are detailed in the *final Water Quality Improvement Plan*.

As noted earlier, a Water Quality Improvement Plan contains a Total Maximum Daily Load or "TMDL." Simply put, the TMDL is the maximum amount of a pollutant that a waterbody can accept before the risk of injury to human or aquatic life becomes too high. In common usage, the term TMDL is frequently used to describe the entire process for cleaning up an impaired waterbody. For our purposes in this Water Quality Improvement Plan it refers to a discrete amount of pollution, or load, that is divided into three components; the **wasteload allocation**, the **load allocation**, and the **margin of safety**. Some TMDLs establish only load allocations or only wasteload allocations. This TMDL will have all three components. Each of these is discussed in more detail int the subsection on Water Quality later in this document and in Appendix B.

Why is Ecology preparing a Water Quality Improvement Plan for Swamp Creek?

Federal law requires that a Water Quality Improvement Plan be developed when we know that a local stream, river, or lake is polluted. Ecology reviewed water quality monitoring data collected by Snohomish and King Counties as part of our Water Quality Assessment[2] and determined that bacteria levels exceeded allowable levels set in the Washington State Water Quality Standards[3] at three locations (Table 1). The high levels of bacteria create an increased risk of illness for anyone coming in contact with Swamp Creek.

Health Risk from Bacteria

Bacteria levels for Washington waters are set to protect people who work and play in and on the water from waterborne illnesses. Fecal coliform is used as an "indicator bacteria" for the state's freshwaters (e.g., lakes and streams). Fecal coliform in water "indicates" the presence of waste from humans and other warm-blooded animals. Waste from warm-blooded animals is more likely to contain pathogens that will cause illness in humans than waste from cold blooded animals. The fecal coliform criteria are set at levels that have been shown to maintain low rates of serious intestinal illness (gastroenteritis) in people (Table 2). Swamp Creek has an "Extraordinary Primary Contact" designation for primary contact recreation.

The Extraordinary Primary Contact use is intended for waters that either support swimming and other recreational activities, or those that flow into a lake. It should be capable of "providing extraordinary protection against waterborne disease..." Swamp Creek has this designation because it flows into Lake Washington, one of the most valuable recreational lakes in western Washington. To protect Lake Washington, fecal coliform levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) exceeding 100/colonies mL" [WAC 173-201A-200(2)(b), 2003 edition].[4] The "not-more-than-10%" criterion is referred to in this report as the 90th percentile criterion[5].

Swamp Creek bacteria levels must be no higher than the geometric mean criterion or the 90th percentile criterion. These two measures used in combination ensure that bacterial levels in a water body will not cause a greater risk to human health than intended.

[2] To learn more about the Water Quality Assessment or to view maps of your local neighborhood and the waters near it, visit Ecology's Water Quality Assessment website at http://www.ecy.wa.gov/programs/wq/303d/2002/2002-index.html.

[3] Washington State's Water Quality Standards set the bar for quality in all state waters. Visit our Water Quality Standards webpage at http://www.ecy.wa.gov/programs/wq/swqs/index.html to get the latest information how clean Washington waters should be.

[4] The term "colony forming units" refers to the number of bacteria colonies that grow in a Petri dish after 100 milliliters (mL) of stream water is filtered and tested on the dish. To give you an idea of how much water that is, 100 mL is almost half a cup (0.42 cups to be more exact).

[5] For compliance with this TMDL, the 90th percentile levels will be calculated using the log values of sample results as described in Ott 1995. Where this method conflicts with Water Quality Policy 1-11, or other methods of determining the 90th percentile value, Ecology will determine compliance on a case-by-case basis.

Table 1. Portions of Swamp Creek that are currently on the Washington State 303 (d) list. There are three monitoring stations in Swamp Creek where bacterial pollution problems have been documented for many years (see Figure 4 for locations). Learn more about the Water Quality Assessment at **http://apps.ecy.wa.gov/wqawa/viewer.htm**

Waterbody Name (monitoring station)	Township/ Range/ Section	Listing number from the *Water Quality Assessment*	Parameters	Designated Uses (all locations)
Swamp Creek (SCLU)	27N 04E 02	7464	Fecal coliform	Recreation, Water supply, Fish and shellfish, Wildlife habitat, and Stock watering
Swamp Creek (SCLD)	27N 04E 35	21989	Fecal coliform	
Swamp Creek (0470)	26N 04E 12	13130	Fecal coliform	

Table 2. Water Quality Criteria for Bacteria in Washington State. Swamp Creek has an "extraordinary primary contact" designation because it flows into Lake Washington, one of our most valuable recreational waters in Western Washington.

Designated Use	State Bacteria Criteria	
	Geometric Mean Value	90th Percentile Value
Extraordinary Primary Contact: Waters providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.	50 cfu/100 mL	100 cfu/100 mL
Primary Contact: Activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing	100 cfu/100 mL	200 cfu/100 mL
Secondary Contact: Activities where a person's water contact would be limited (e.g., wading or fishing) to the extent that bacterial infections of eyes, ears, respiratory or digestive systems, or urogenital areas would normally be avoided.	200 cfu/100 mL	400 cfu/100 mL

Ecology will evaluate Swamp Creek's ability to meet state standards both annually and seasonally (wet versus dry season).

The criteria for fecal coliform bacteria are based on allowing no more than the pre-determined risk of illness to humans that work or recreate in a water body. The criteria used in the state standards are designed to allow 7 or fewer illnesses out of every 1,000 people engaged in primary contact activities. Once the concentration of fecal colifom in the water exceeds the numeric criterion, the chance of becoming ill increases above acceptable levels. Ecology is preparing this plan because we have reached that point and bacteria levels must now be reduced.

Restoring and maintaining good water quality is smart *and* required by law—Washington's Antidegradation Policy

The State of Washington's goal of restoring waters to good health and keeping them that way is part of the state's Water Quality Antidegradation policy (WAC 173-201A-070). This Water Quality Improvement Plan also addresses that policy

The purpose of the antidegradation policy is to:

- Restore and maintain the highest possible quality in state surface waters;
- Describe situations where water quality may be lowered from its current condition;
- Apply three levels of protection for surface waters of the state:
    - Tier I is used to ensure existing and designated uses are maintained and protected and applies to all waters and all sources of pollution.
    - Tier II is used to ensure that waters of a higher quality than the criteria assigned in this chapter are not degraded unless such lowering of water quality is necessary and in the overriding public interest.
    - Tier III is used to prevent the degradation of waters formally listed as "outstanding resource waters," and applies to all sources of pollution.

Relationship of this TMDL with Use Attainability Analyses

Our Water Quality Standards describe the expected uses of all the waters in Washington State. Uses are activities like swimming, fishing, or boating. Sometimes these uses may be inappropriate. In those cases, Federal law allows for the removal of a use from a waterbody (40 CFR 131.10) based on the preparation and approval of a use attainability analysis (UAA). A UAA is a scientific assessment of factors affecting the attainment of the use and may include physical, chemical, biological, and economic factors. A use can only be removed if it is not existing or attainable.

Ecology does not believe that adequate information exists to show that criteria for extraordinary primary contact cannot be met in Swamp Creek. Therefore, Ecology does not support the development of a UAA for Swamp Creek prior to the development, implementation, and adaptive management of this Water Quality Improvement Plan.

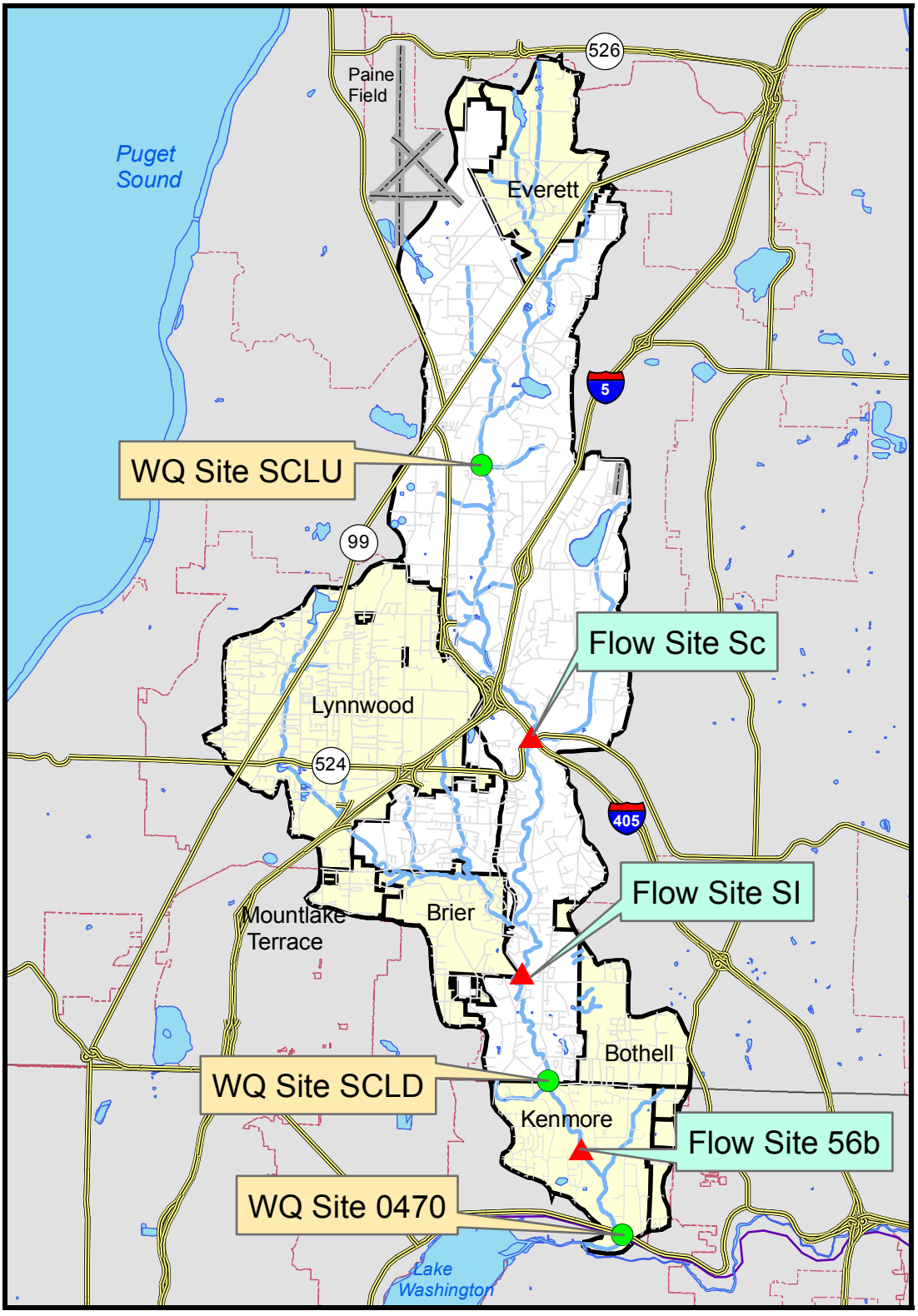


Figure 4. Monitoring locations used for setting TMDL allocations. Circles indicate water quality monitoring stations, triangles indicate flow monitoring points

Description of the Swamp Creek Watershed

The Swamp Creek watershed spans about 12 miles in length from top to bottom. Starting just below State Highway 526 in the city of Everett, the mainstem of the creek winds 14 miles through the watershed before it flows into the Sammamish River at Kenmore. Swamp Creek contributes to the quality of water in the Sammamish River, which empties to upper Lake Washington 0.7 miles below the Swamp Creek confluence.

Physical Features

Swamp Creek is typical of Puget Sound lowland watersheds. In the gently sloping upper basin, Swamp Creek flows through a narrow valley which gradually broadens to a floodplain almost ¾ of a mile wide in the lower basin. The middle basin also contains a narrow valley with steep slopes in excess of 15 percent just south of the I-405 and I-5 crossing. Elevation in the headwaters is approximately 520 feet, while the elevation at the mouth is about 20 feet above sea level. The stream gradient is flat, decreasing from about 50 feet per mile in the upper basin to less than 20 feet per mile near the mouth. Scriber Creek, Little Swamp Creek, and Martha Creek are the largest of the 19 streams tributary to Swamp Creek. Major lakes In the Swamp Creek watershed are Scriber Lake, Martha Lake, and Stickney Lake (SWM 1994, 2000).

Most of Swamp Creek and its tributaries are shallow and unsuitable for full-immersion swimming activities. However, several noteworthy exceptions are Wallace Park in the city of Kenmore, Lake Martha, and Lake Stickney. Lake Scriber in Lynnwood is large and deep enough for swimming but this activity is not encouraged by the city. Although public access to the creek is largely limited to road crossings and a few parks, Swamp Creek is fully accessible to adjacent land owners, their children, and in some cases their neighbors. Limited boating opportunities exist where Swamp Creek meets the Sammamish River.

Land Use

In the late 1990's, Swamp Creek watershed was highly urbanized with about 50% of the land in residential or commercial use, 30% with forest cover, 10% in commercial use, and less than 10% rural property (MRLC 1999, SWM 2002). Commercial and light industrial uses are primarily located within Lynnwood and Everett. Small farms and pastures are most common in the middle of the watershed, especially in Brier and unincorporated Snohomish County. The watershed is located within the US Census Defined Urbanized Area; therefore, it is expected that population growth, and urban development, will be concentrated in this area.

An examination of orthophotos taken in 1995 was performed as part of the Habitat Inventory and Assessment of North, Swamp, and Little Bear Creeks (KCWLR 2001). This land use analysis method is different than the one used for this Water Quality Improvement Plan and suggested that forested cover is only 20%--mostly composed of deciduous trees. Road density was highest in the Scriber Creek subbasin.

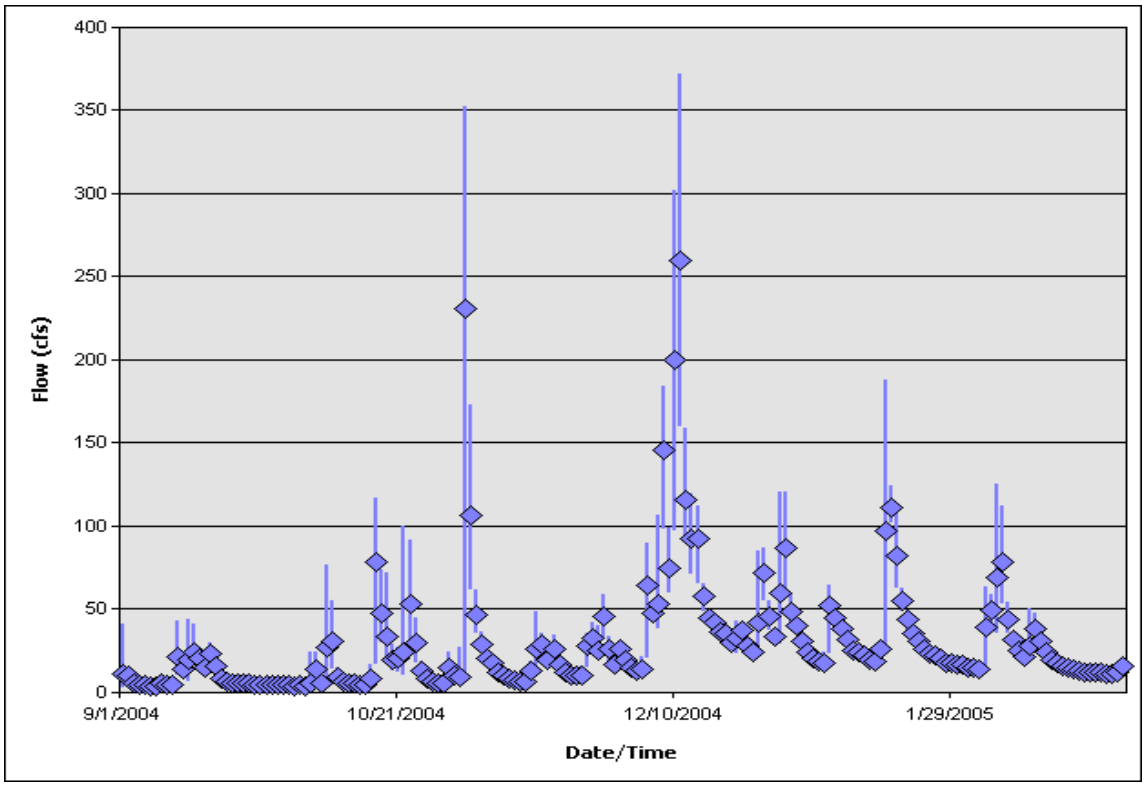


Figure 5. Average Daily flow in Swamp Creek at the Snohomish-King County Line (station SI). Flows are relatively low in the summer—about 6 to 7 cubic feet per second (cfs)[6] and pick up in the winter when the rain comes. Winter base flows range up to about 35 cfs and peak flows sometimes reach as high as 350 cfs!

Water Quantity

The amount of water in Swamp Creek varies depending on the season and whether it has rained recently. Parts of Swamp Creek usually dry up during part of the summer. At monitoring station SCLU (Figure 4) from 1992 through 2004, data was not reported due to lack of flows for one or more summer months. When present, summer flows are very low below Lake Stickney such that fish passage for adult salmonids is not possible (SWM 2002).

Near the Snohomish/King County line, the average daily flow in the three driest months of the year is 6-7 cubic feet per second (cfs)[6]. In the winter, the average flow changes greatly by month reaching nearly 60 cfs. As shown in Figure 5, winter flow in Swamp Creek is generally no higher than 35 cfs; however, rain events cause flows to increase tenfold on numerous occasions with some events reaching over 350 cfs. These changes in stream flow are also called stream hydrology. More discussion of Swamp Creek's hydrology can be found in the Pollution Sources section of this plan.

[6] One cfs (cubic foot per second) is about 40 gallons of water passing you by every second.

Water Quality

Bacterial pollution has been known to be a problem in Swamp Creek for many years. Snohomish County Surface Water Management Division and King County Water and Land Resources Division have been performing water quality monitoring for over a decade so we have a good picture of bacteria levels over time and in recent years. The three most highly monitored sites are shown in Figure 4. Stations SCLU, SCLD, and 0470 characterize the upper, middle, and lower portions of the basin, respectively.

How polluted is Swamp Creek?

Since the year 2000, a consistent pattern of bacterial pollution has been observed in Swamp Creek at each of the three long term stations (Appendix B). All areas exceed state criteria for bacteria at all times of the year (Table 3). During the dry summer months when stream flows are low, bacteria levels rise far beyond both the geometric mean criterion of 50 cfu/100 mL and the 90th percentile criterion 100 cfu/100 mL. During the wetter months of the year, bacteria concentrations improve at each site, but not enough to meet state standards. For these reasons, it is necessary to establish a TMDL for Swamp Creek.

Snohomish County performed two water quality studies in Swamp Creek in the early 1990's. One study was conducted above station SCLU and the other was done as part of a larger one-year urban monitoring program. The purpose of the first study was to examine the quality of water coming from residential, mixed, or small farm land uses. Although it turned out to be difficult to clearly show the effect of each type of land use, none of the five locations monitored met state bacteria standards. Fourteen Swamp Creek sites were tested as part of the urban monitoring study—11 out of the 14 sites exceeded state bacteria thresholds.

Although it is not reflected in Ecology's current Water Quality Assessment, Swamp Creek does not consistently meet state standards for temperature or dissolved oxygen and benthic invertebrate samplings indicate that overall aquatic habitat quality ranges from fair to poor (SWM 2002). Ecology will be reassessing available data for the next Assessment process in 2006, which may result in more 303(d) listings for Swamp Creek.

Table 3. Current Water Quality Statistics in Swamp Creek Watershed. Data from 2000 through 2004 show that all state criteria for bacteria are exceeded for wet and dry seasons. Bacteria levels are much higher in dry weather months.

Monitoring Location	Dry Season			Wet Season			State Standards	
	# of Samples	GMV	90th %tile	# of Samples	GMV	90th %tile	GMV	90th %tile
SCLU (upper Swamp Creek)	16	343	2,688	34	66	636	50	100
KC BB470/ SCLD (county line)	25	176	459	70	86	310	50	100
KC 0470 (mouth)	28	300	1,260	47	131	674	50	100

GMV refers to the geometric mean value criterion and 90th %tile refers to the 90th percentile criterion.

Establishing the Loading Capacity

1) **Wasteload Allocation (WLA)**: This represents the contribution of discrete "point" sources of pollutants (e.g., municipal, industrial, and construction stormwater discharges);

2) **Load allocation (LA)**: This represents "nonpoint" sources of a pollutant, (natural sources, most agricultural activities, and other sources that are not regulated by an Ecology permit); and

3) **Margin of safety (MOS):** This allows for uncertainty in the estimation of, and ability to achieve, the previous two allocations.

Thus, the TMDL equation is as follows:

TMDL = WLA + LA + MOS.

The sum of these three components is also called the **Loading Capacity**.

Figure 6. Doing the Math: How does a TMDL add up? These three parts of a TMDL add up to the maximum amount of a pollutant that a water body can receive before it is considered polluted. See Appendix B of this report for the full technical study on how the Swamp Creek TMDL was established.

Ecology expects that many of the efforts taken to reduce bacteria levels may also improve oxygen levels. Education, groundwater recharge, and riparian improvement projects are encouraged by this Water Quality Improvement Plan to help address these Swamp Creek water quality problems.

What is an acceptable level of bacteria for Swamp Creek?

The purpose of this report is to document the bacteria pollution problem in Swamp Creek and develop solutions. Part of the solution is to establish a **total maximum daily load** or TMDL[7]. A TMDL is the maximum amount of pollutant that a waterbody can receive before it is considered polluted. That maximum amount of pollution is called the "loading capacity." The loading capacity is further broken down into three components, which are described further in Figure 6.

In this report, the loading capacities for Swamp Creek are established at each of the three monitoring stations shown in Figure 4 and expressed as the total number of bacteria that can pass by each station over the course of a day (Table 4). As shown in Table 3, bacteria levels were generally three times higher during the dry weather compared to wet weather (seasonal variation) and wasteload allocations were required during the wet season due to the presence of municipal stormwater. For those reasons,

[7] See Appendix B of this report for the full technical study on how the TMDL for Swamp Creek was prepared.

Table 4. Load and Wasteload Allocations. Load and Wasteload Allocations are a direct percentage of the loading capacity at each TMDL compliance point based upon the Estimated Contribution from each source. At each station, pollution must be reduced by the "Reduction Percentage Needed" to meet the 90th percentile bacteria criterion of 100 cfu/100 mL.

	Dry Season TMDL (May-September)			Wet Season TMDL (October-April)			
						Estimated Contribution	
Pollution Source	Reduction Percentage Needed	Loading Capacity (cfu/day)	Estimated Contribution (Load Allocation)	Reduction Percentage Needed	Loading Capacity (cfu/day)	Load Allocation	Wasteload Allocation
Station SCLU	96.3%	8.95E+09		84%	5.20E+10		
Snohomish County							42%
Everett							17.8%
WSDOT							1.4%
Nonpoint Sources			90%			28.8%	
Margin of Safety			10%			9.8%	
Station SCLD	78.2%	2.26E+10		68%	9.83E+10		
Snohomish County							33.9%
Lynnwood							26%
Everett							4.4%
Brier							3.0%
Bothell							2.3%
WSDOT							2.3%
Mountlake Terrace							1.1%
Nonpoint Sources			90%			24.6%	
Margin of Safety			10%			9.9%	
Station 0470	92.1%	2.84E+10		85%	1.13E+11		
Snohomish County							31.7%
Lynnwood							17%
Kenmore							4.6%
Everett							4.0%
Brier							2.7%
Bothell							1.5%
WSDOT							2.2%
Mountlake Terrace							1.0%
Nonpoint Sources			90%			24.7%	
Margin of Safety			10%			9.9%	

Each pollution source is required to reduce their pollution discharge by the amounts shown in Table 4 to achieve compliance with the 90th percentile bacteria criterion of 100 cfu/100 mL. Load and wasteload allocations are a direct percentage of the loading capacity at each TMDL compliance point based upon the Estimated Contribution from each source. The combined loadings from all entities will result in compliance with the target value 90th percentile target value of 100 cfu/100 mL.

Figure 7. Urban stormwater. If there was such as thing as a pollution smorgasbord, urban stormwater would be the ultimate dining experience. Laden with fertilizer, pesticides, petroleum products, heavy metals from tire wear, storm sewers rapidly convey these pollutants from the road above to local streams in most of western Washington whenever it rains.

What is Polluting Swamp Creek--What should be done?

Many human activities have an effect on the natural environment. When activities are done properly, the impact can be managed and surface waters can remain safe and clean. Ecology has examined the sources of pollution in the Swamp Creek watershed by looking at monitoring data and available literature, interviewing stakeholders, and conducting windshield surveys. This process revealed many of the actions needed to reduce bacteria levels in Swamp Creek. These pollution sources are discussed below.

Urban Stormwater

Stormwater can be a significant source of bacterial and nutrient inputs to local water bodies. In this document, stormwater is defined very broadly and includes 1) rainwater that hits the ground and does not infiltrate at that location and 2) other discharges that are collected in stormwater collection systems (pipes or ditches) and is conveyed to local surface waters. (See http://www.ecy.wa.gov/programs/wq/stormwater for more information.) Sources of stormwater pollution that are not conveyed in a regulated stormwater system are discussed individually elsewhere in this chapter.

Urban stormwater can carry bacteria from pet wastes on the ground, surfacing wastewater from failing OSSs, excess nutrients from lawns and gardens, and pollutants associated with activities such as car washing and sidewalk cleaning.
In urban areas around Puget Sound and elsewhere across the country, bacteria concentrations in stormwater range from approximately 1,000 to over 100,000 organisms/100 mL (Chang 1999, Doran et al. 1981, Pitt 1998, Varner 1995). In a recent study by the Center for Watershed Protection, mean fecal coliform concentrations in urban stormwater were 15,000 cfu/100 mL (Center for Watershed Protection, 1999). That same study showed that nearly every individual stormwater runoff sample exceeded bacterial standards, usually by a factor of 75 to 100.

DNA ribotyping studies of bacteria found in streams and creeks in urban Puget Sound streams consistently show the presence of bacteria from dogs and cats (Table 5). In a watershed containing 100,000 people, it is estimated that dogs alone generate over two and one half tons of feces each day—that is almost 2 million pounds per year. Although current methods do not allow for quantification of sources, the consistent presence of pet waste in regional studies indicates that BMPs to control these particular sources should begin as soon as possible in obvious public locations where animals are taken for exercise and there is a high potential for stormwater contamination where pets may defecate. Unfortunately, our ability to accurately quantify the contribution from any single bacterial source (either domesticated or wild animals) using DNA ribotyping is still a goal.

Municipal Stormwater

Federal regulations address urban stormwater through the Phase I and Phase II Municipal Stormwater Permit programs. Snohomish County and the Washington State Department of Transportation (WSDOT) currently have Phase I permits. Many cities and towns will be covered by the Phase II permit program. The basic provisions of these permit programs will contribute to this TMDL.

The portion of stormwater generated in Swamp Creek that is located in, and conveyed through stormwater systems operated and maintained by Snohomish County, is regulated by Ecology's Phase I General Stormwater Permit for the Island/Snohomish Water Quality Management Area. The county's current permit contains the elements shown below.

1. *Eliminate illicit discharges (such as illegal sanitary sewer connections),*
2. *Analyze, prioritize, and schedule the implementation of stormwater management needs,*
3. *Establish adequate legal authority to control stormwater discharges from its stormwater system,*
4. *Monitor the effectiveness of its stormwater management program,*
5. *Develop watershed-wide coordination mechanisms for shared water bodies,*
6. *Develop a program to control runoff from new development, redevelopment activities, and construction sites discharging to the storm sewer system,*
7. *Ensure appropriate treatment and source control measures are in place to reduce pollutants from existing commercial and residential areas discharging to the storm sewer,*
8. *Ensure appropriate operation and maintenance of stormwater facilities discharging to the storm sewer system, and*
9. *Development of an educational program aimed at residents, businesses, industries, and employees whose job functions may impact stormwater quality.*

The Phase II Municipal Permit will be issued to communities located within urbanized areas as determined by the U.S. Census. At a minimum, the Phase II Municipal Stormwater permit will require permit holders to address the following federal requirements:

1. *Public education and outreach*
2. *Public participation/involvement*
3. *Illicit discharge detection and elimination*
4. *Construction site runoff control*
5. *Post-construction runoff control*
6. *Pollution prevention/good housekeeping*
7. *Implementation of applicable TMDLs*
8. *Program evaluation and reporting*

The terms and conditions of Ecology's Phase I and Phase II Stormwater permits are currently drafted and published for public review from February 15, 2006 through May 19, 2006. For more information on the Phase II and other stormwater permits, visit Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/index.html.

Table 4. Summary of bacteria sources identified in urban streams in Puget Sound. Numbers shown are a percentage of the total isolates evaluated (except bottom row). Values shown do not accurately reflect relative concentrations from each source category. Bottom row indicates the number of bacteria colonies isolated and enumerated to determine the percentages above. Bold numbers show the three most common isolates for each study.

Source	Edgewater Creek (2000)	Glennwood Creek	Swamp Creek (2000)	Woodland Creek (2002)	North Creek Bothell (2004)
Cat/Feline	6.8	14	1.6	1.5	3
Dog/Canine	**7.4**	**21**	**14.3**	**24.3**	**15**
Opossum/Rabbit	2.7	2.5	2.4	1.5	1
Raccoon	**10.8**	2	**7.1**	5.1	5
Beaver/Rodent	2	9	0.8	8.8	**18**
Squirrel	1.4		0.8		
Deer				6.6	<1
Storm Drain		0.5			
Human/Sewage	1.4		2.4	**14.7**	12
Horse				3.7	
Bovine				3.7	
Chicken				0.7	
Avian	**8**	**28**	**13.5**	**11**	**38**
Goose		1.3	4.8	2.2	
Sea gull		0.7	1.6	1.5	
Duck					<1
Multi species				6.6	
Unknown	*60.1*	*21*	*50.8*	*8.1*	*6*
Total percentage	100	100	100	100	100
# of isolates	147	196	126	182	349

Corrective/preventative actions for Municipal Stormwater Systems

Ecology's municipal stormwater permits establish the primary activities needed to control pollution from urban stormwater. These include identification and correction of illicit discharges, control of commercial bacteria discharges to the storm sewer, public education and public involvement. Additional permit activities are required by this Water Quality Improvement Plan. Snohomish County and all of the Phase II cities will take measures to protect their storm sewers from several known sources of bacterial pollution through the adoption and enforcement of local regulations. This TMDL details additional actions that will improve public awareness of the bacterial pollution problem, and public involvement in local stormwater management programs in an advisory role. Water quality monitoring is also required. These actions are discussed in detail in Appendix D.

This Water Quality Improvement Plan also encourages additional action by local governments to control stormwater pollution. Ecology strongly recommends that all municipal stormwater permittees have an aggressive plan to control pet wastes (Figure 8). This includes education and outreach targeting this specific pollution source, assessment of the need for pet waste collection/education stations, installation and maintenance of these stations in public areas and private areas where necessary, and development and enforcement of animal waste control ordinances.

This Water Quality Improvement Plan also recognizes several other activities that may help control bacteria levels in storm sewers. First is the control of nutrients. Fertilizer runoff, food and grease wastes, and waste wash waters all provide nutrients that could support the growth of bacteria in storm sewers; therefore, this plan recognizes the importance of controlling this potential contributing factor to bacteria survival and regrowth in storm sewer systems. Street sweeping is another important practice that reduces the buildup of multiple pollutants in storm sewers and is encouraged by this plan.

Figure 8. Fluffy's pet waste. Studies show that pet wastes are getting into our local streams. Citizens associations and local governments should work together to help pet owners properly dispose of pet waste. Shown is a pet waste management station located in Wallace Park.

Corrective/preventative actions for Private Stormwater Systems

Private stormwater systems are subject to the same pollution sources as publicly owned systems. Within the Swamp Creek watershed there are numerous private storm sewer systems. Business owners and neighborhood associations are encouraged to examine their land use and maintenance strategies to improve local water quality. Educational outreach to private stormwater system owners is recommended to prevent car washing, pet waste, and other discharges. Grant funding sources are encouraged to support these collaborative efforts.

Livestock and Commercial Animal Handling Facilities

Veterinary offices, animal kennels, and other commercial animal handling facilities generate significant amounts of animal wastes as a byproduct of boarding and other services. These businesses must properly manage animal wastes in order for this water cleanup effort to succeed. Animal kennels and horse boarding facilities are not regulated by the Snohomish Health District or the Department of Ecology.

Snohomish County is home to a particularly large number of horses boarded in commercial stables. It is estimated that one horse produces 50 pounds of manure a day…this adds up to over eight tons of manure per year. The additional waste produced from bedding soiled with 8-10 gallons of urine from each horse per day can create a challenge for any small business.

Because wetlands are not suitable for grazing and grass production throughout the year, wetland areas are commonly found close to waste manure piles. Sometimes waste is directly deposited in the wetlands for fill or for convenience since they tend to be found in lower areas of a property. Wetlands frequently drain to local streams and thus become a pathway for bacterial pollution.

Upper Swamp Creek Potential Pollution Sources

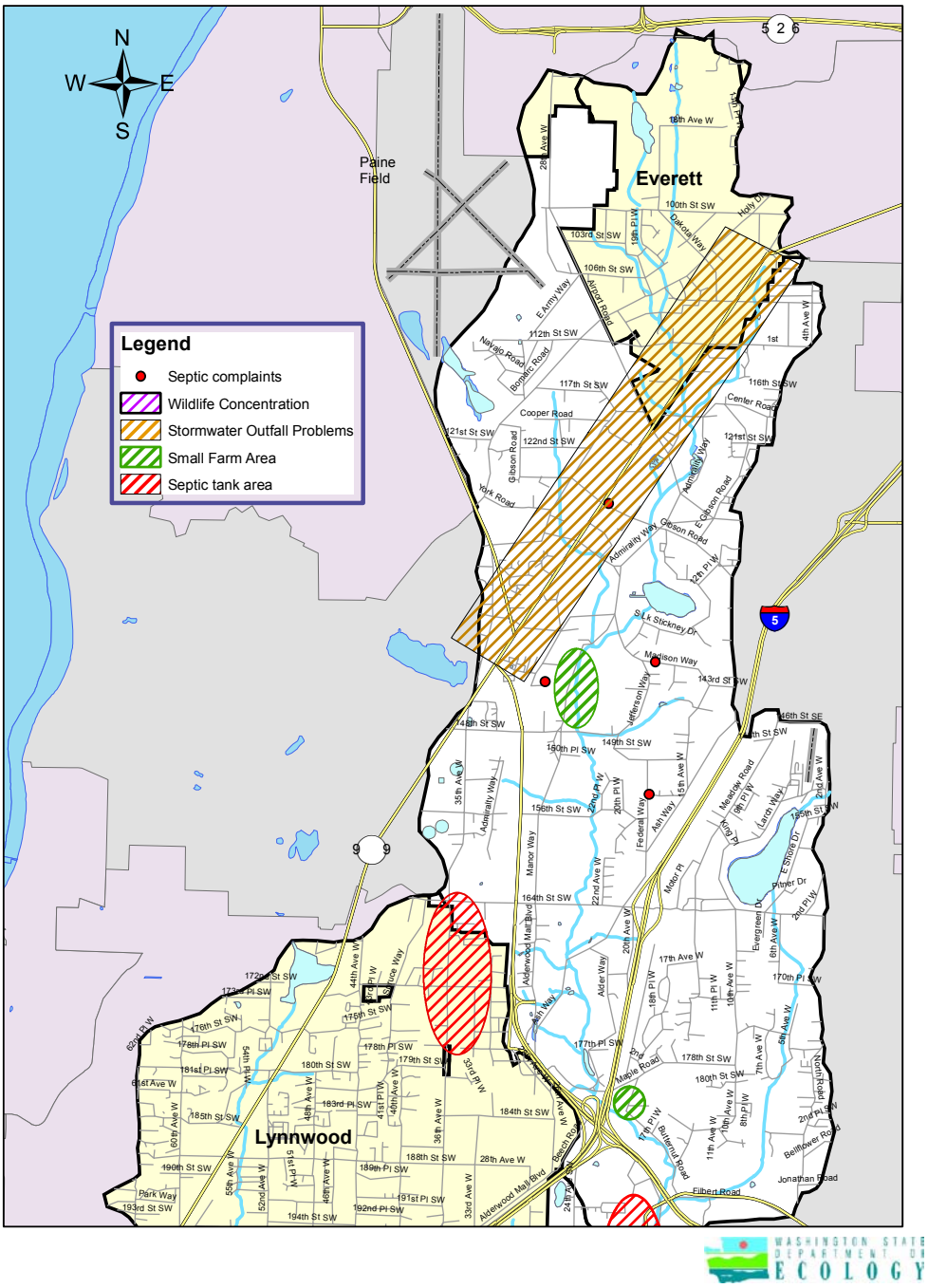


Figure 9a. Potential Pollution Sources, Upper Watershed. Studies have identified a number of areas in the Upper Swamp Creek Watershed that may need help in controlling bacteria being discharged to Swamp Creek. The square area had numerous stormwater outfalls with high bacteria levels.

Lower Swamp Creek Potential Pollution Sources

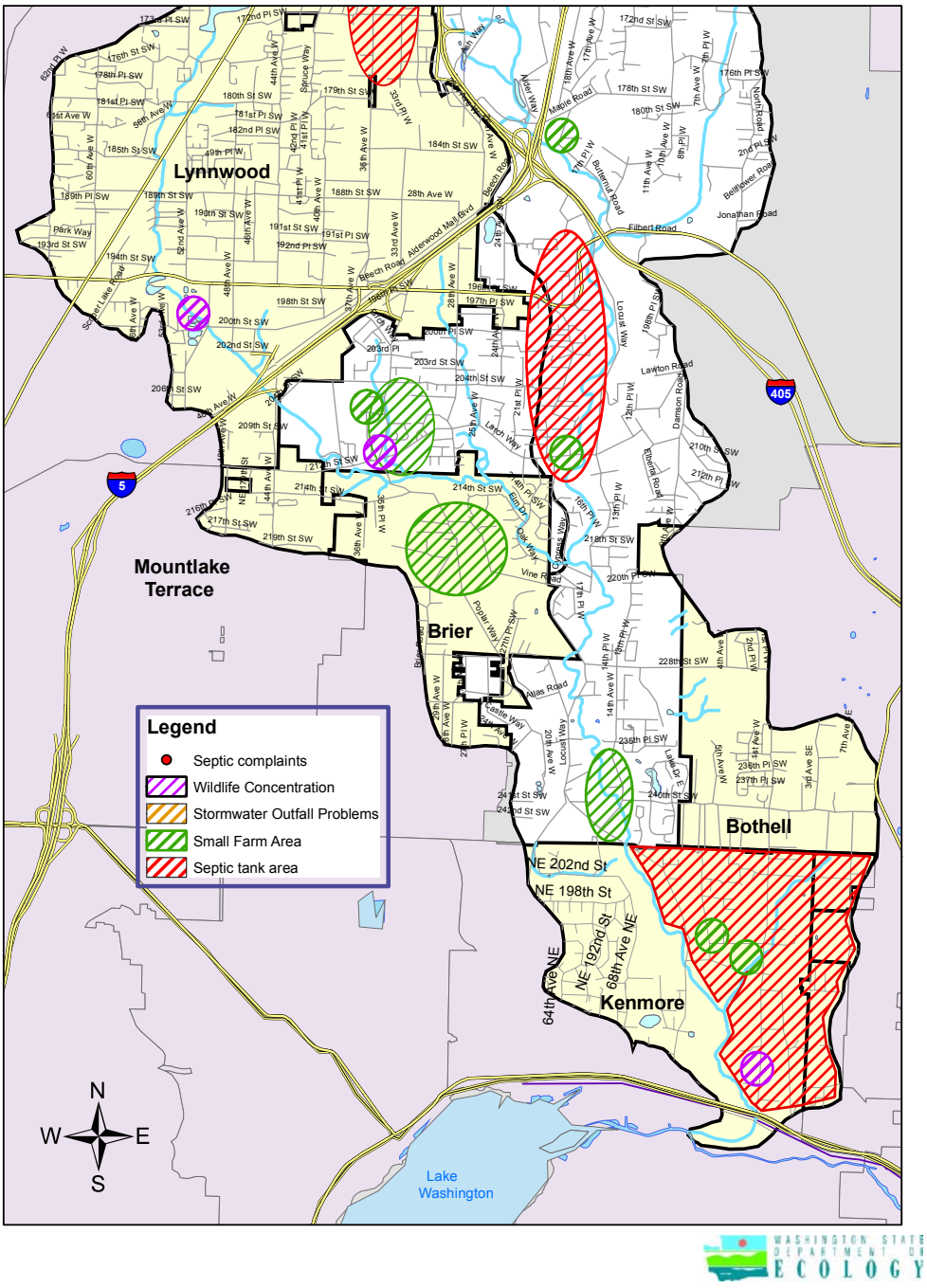


Figure 9b. Potential Pollution Sources, Lower Watershed. Like the upper watershed, small farms and septic tanks are present. Site visits and technical assistant visits should be made to these areas.

Potential Problem Areas

Right now, it is estimated that there are about 14 facilities in the Swamp Creek watershed that handle animal waste as part of their core business practices (SWM, unpublished data). No specific businesses have been identified as problem sources; however, a detailed inspection of the best management practices at these facilities has not been performed. A windshield survey revealed a facility in NW Kenmore along 80 Ave NE that may be a commercial equestrian facility. An internet search revealed no riding or boarding facilities in the Swamp Creek watershed.

Corrective/preventative actions

It is especially important for businesses to recognize the importance of proper manure and pasture management to protect water quality. Animal kennels should manage fecal waste products to prevent their entry into surface or stormwater systems by implementing the BMPs listed below:

- Regularly sweep and clean animal keeping areas to collect and properly dispose of droppings to prevent their entry into surface waters or stormwater systems.
- Do not hose down areas of potential fecal contamination to storm drains or to receiving waters. Always verify that drains used for this purpose go to the sanitary sewer.
- Do not allow any washwaters to be discharged to storm drains or to receiving waters.
- If animals are kept in unpaved and uncovered areas, the ground should have vegetative cover or some other type of ground cover such as mulch.
- If animals are not leashed or in cages, the area where animals are kept should be surrounded by a fence or other means that prevents animals from moving away from the controlled area where BMPs are used.

Livestock manure storage piles should not be located by any water drainage system, including wetlands that connect to local streams. All commercial stables should have a farm plan developed in conjunction with the Snohomish Conservation District and fully implement all elements relating to water quality protection.

Local governments that have been issued a municipal stormwater management permit should inspect any businesses that are discharging stormwater to their storm sewer system. In cases where businesses discharge stormwater directly to Swamp Creek, this TMDL strongly recommends that local government or other entities provide technical assistance or other actions as needed to prevent pollution runoff from these potential sources.

Residential Equestrian Facilities

The majority of land dedicated to caring for horses is associated with homeowners and their personal stables. The range of land types used for residential horse facilities is very diverse. For budgetary and other reasons, residential horse owners frequently have limited area for grazing and exercise. Thus, many times horses live in wooded conditions or are confined to small outdoor paddocks where grass and vegetation is quickly

consumed or destroyed. Manure deposited by animals frequently finds its way into natural drainage corridors and becomes a source of water pollution.

Potential Problem Areas

Compared to more rural watersheds in the County, the number of horses in the Swamp Creek watershed is thought to be low and likely to decrease as the trend towards urbanization continues in the basin. Interviews, windshield surveys, and literature reviews revealed several areas where small farms are located in the watershed in close proximity to Swamp Creek or one of its tributary streams (SWM 1994, 2002). These areas are shown in Figures 9a and 9b.

Corrective/preventative actions

Like commercial facilities, residential horse owners need to carefully manage their pastures and the manure produced by their animals (see Corrective/Preventative actions for commercial animal handling facilities). All small farms in the proximity of a drainage conveyance should contact the Snohomish Conservation District to have a farm plan developed. Small farms should receive regular technical assistance visits from the appropriate conservation district.

Figure 10. Equestrian Facilities. This owner uses gravel, rubber mats, wood pellet bedding, interceptor drains, and frequent use of the dumping fork to prevent water pollution and improve compost quality. Composting manure is covered to prevent rain from carrying waste to surface water.

Domestic Wastewater

Wastewater takes many forms. In this Water Quality Improvement Plan, wastewater from showers, toilets, and sinks is defined as "domestic wastewater." Domestic wastewater can be generated in private residences or commercial businesses and is either treated by onsite septic systems or is conveyed to a wastewater treatment facility through a regional sewage conveyance system.

Regional Conveyance Systems

Centrally collected wastewater in the Swamp Creek Watershed is conveyed through one or more sewer systems operated by the Alderwood Sewer District, city of Everett, Northshore Utility District, Lynnwood Sewer Authority, Mountlake Water and Sewer District, Bothell Sewer District, and Brier Sewer District. The majority of this wastewater is conveyed to the King County wastewater treatment system. The majority of Swamp Creek is serviced by the Alderwood Sewer District.

It is possible that centrally conveyed sewage could enter surface waters under several scenarios. Overflows from pump stations are one possibility. Ecology does not generally allow sewer overflow pipes at pump stations, rather system redundancy and telemetry are employed to help ensure that overflows do not occur if and when mechanical or physical problems occur. Where allowed, overflow points are usually capped and locked and can only be opened in the event of an emergency.

Ecology reviews all overflow incidents when they are reported and is not aware of any open overflow points into the Swamp Creek watershed. When overflows occur they are short-lived and cannot account for the consistent high bacterial counts observed in the mainstem of Swamp Creek. Overflows due to line blockages are another potential source of bacterial pollution; however, like pump station overflows, these events are short-lived and cannot account for consistent high bacterial counts observed in Swamp Creek.

Less is known about the potential of leaky sewer lines to contaminate local surface and ground waters (called exfiltration). There are several scenarios where leaky sewer lines might contribute pollutants to local surface waters. The first is a leaky force main or gravity sewer in close proximity to surface water. For sewer systems that rely on gravity to ensure good flow, the favorable natural grade adjacent to a stream makes it a practical place to locate lines at an economical cost. Leaky joints due to shifting earth, line deterioration, or improper installation could lead to leakage to a local stream in these situations.

The other scenario is the translocation of leaking sewage through the trenches where sewer pipes are laid. Compounding the problem is the possibility of groundwater entering these trenches thus improving the conveyance ability of the man-made trench. Depending on the type of backfill material used, the problem could be further exacerbated. Newer methods of installing sewer lines use periodic dams to help prevent trench conveyance of groundwater or pipe leakage.

The infiltration of groundwater into a sewer system is not necessarily an indicator of sewage exfiltration because the force of groundwater pressure on the outside of the

sewer pipe is generally greater than the force of sewage trying to get out. Depending on the location and size of leakage areas, the solids in sewer pipes could, in some cases, seal themselves before substantial leakage to groundwater could occur.

Corrective/preventative actions
Where sewer lines intersect with or run parallel to surface waters, the need for water quality testing upstream and downstream of the lines should be evaluated based on the history of line integrity, age of the line, type of materials, and any other relevant factors. Other reasonable methods to inspect pipe integrity such as TV inspection and pressure testing should be considered also as they are appropriate. Both surface water and ground water testing may be necessary in some cases. Sewer lines known or suspected not to conform with Ecology's Criteria for Sewage Works Design (Louthain 1998) should be a priority for inspection.

This TMDL recommends that all sewer conveyance purveyors inspect their pump stations for unauthorized emergency overflow points. If they are found to exist, they should be capped or otherwise eliminated.

Figure 11. On site septic systems. If the ground above your septic system is wet, squishy, or smells bad, you should have it inspected and pumped as shown here.

Sewage system operators should make GIS or hard copy maps (as appropriate) available to staff conducting field work so they may perform more detailed inspections of stream segments where sewer lines are located near a creek or where they cross a creek.

Onsite Septic Systems

Onsite septic systems, both community-based and individual systems, are not a problem when designed, sited, and operated properly. A properly functioning OSS uses the soil surrounding the drainfield to remove bacteria and some nutrients from the wastewater. However, soil compaction, clogging of the soil with solids, and hydraulic overload can all cause a failure of the system to adequately treat wastewater. Signs of OSS failure include:

- Odors, surfacing sewage, wet spots, or lush vegetation in the drainfield area,
- Plumbing or septic tank backups,
- Slow draining fixtures, and
- Gurgling sounds in the plumbing system.

If wastewater surfaces as described in the first bullet above, it is possible that this wastewater could go directly to a nearby stream, or it could be carried there when it rains and water travels over the land surface.

Connecting septic systems to stormwater sewers or piping them directly to surface waters is occasionally discovered and is illegal. Another problem observed in some older septic systems is the subsurface movement of wastewater through extremely porous soils. This latter problem can be difficult to detect.

Corrective/preventative actions
Most homeowners in the Swamp Creek Watershed should contact the Snohomish Health District for assistance if they suspect a problem with their septic tank. Kenmore residents should contact the Public Health of Seattle & King County. Homeowners should have their septic systems pumped and inspected on a regular basis. Information on the location and operation of your septic system is available by calling the Snohomish Health District at http://www.snohd.org/envhealth/www/waste.html or by calling 425-339-5250.

Repair costs for failing septic systems can vary greatly and can only be determined on a case by case basis. The Snohomish Housing Authority has a low interest loan program to help moderately-low income residents (family of two less than $46,000 income) to finance septic system repairs. You can contact the Snohomish Housing Authority by calling 425-290-8499 or at http://hasco.org. (See Funding Sources Section for more information).

Altered Hydrology/Loss of Base Flows

Hydrology is the study of the water cycle. Water from rivers, lakes, and oceans evaporates and is returned to the earth as rain and snow. Under natural conditions much of our rainwater infiltrates into the ground or is stored in wetlands. When water is stored these ways, it can feed local creeks during our long dry summer months. The natural environment also provides opportunities to filter out pollutants.

In contrast, stormwater conveyance systems found in Swamp Creek and other urbanized areas provide an efficient mechanism to rapidly transport pollutants to surface waters preventing this filtering and storage. Traditional stormwater conveyance techniques can create two hydrologic problems: increased peak stream flows and decreased base flows. Each of these problems is discussed below.

Peak flows

Changes in stream hydrology (Figure 12) can play a great role in the water quality of urban creeks. Impervious surfaces combined with development practices that quickly shunt stormwater to the nearest creek or stream for disposal can deposit pollutants, create turbid water and stream widening, and contribute to the loss of fish habitat (Center for Watershed Protection, 2002).

In the case of Swamp Creek, altered stream hydrology and excessive peak flows pose serious risks to salmon habitat (SWM 2002) and are likely to be affecting bacterial pollutant levels. A study of nine watersheds in the Puget Sound area showed significant hydrologic changes as urbanization increased—Swamp Creek has not yet reached the level of the most heavily impacted urban areas (Konrad and Booth 2002).

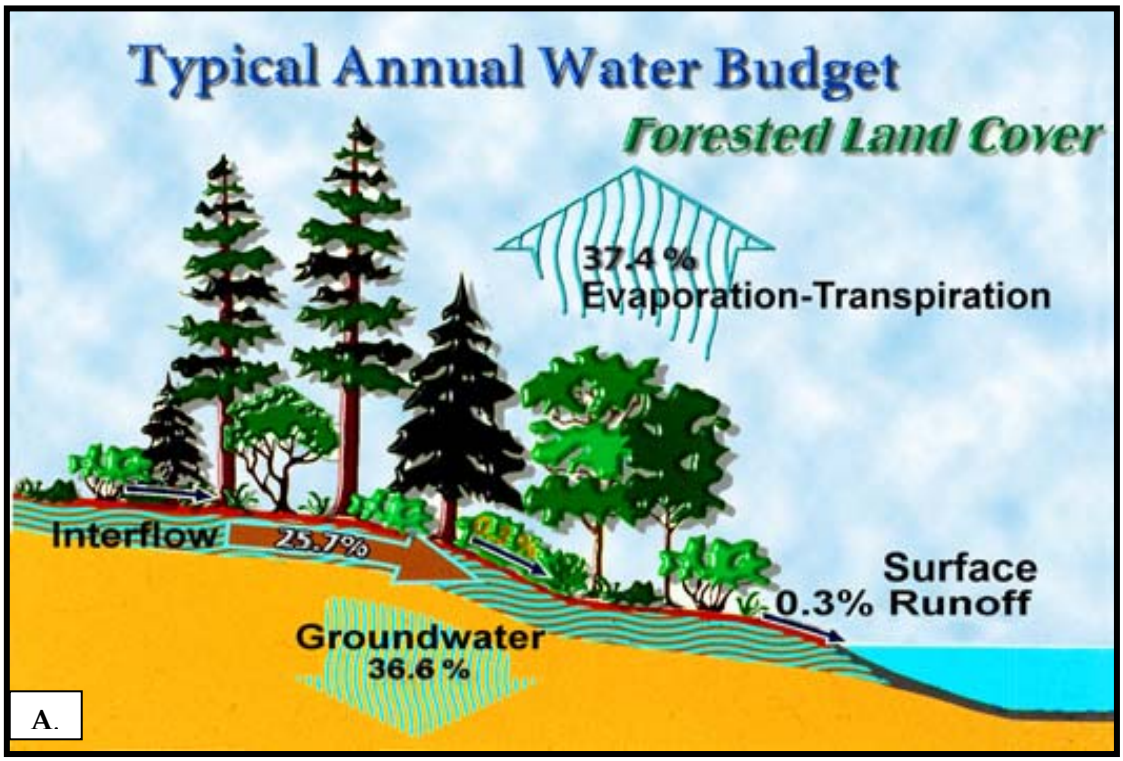
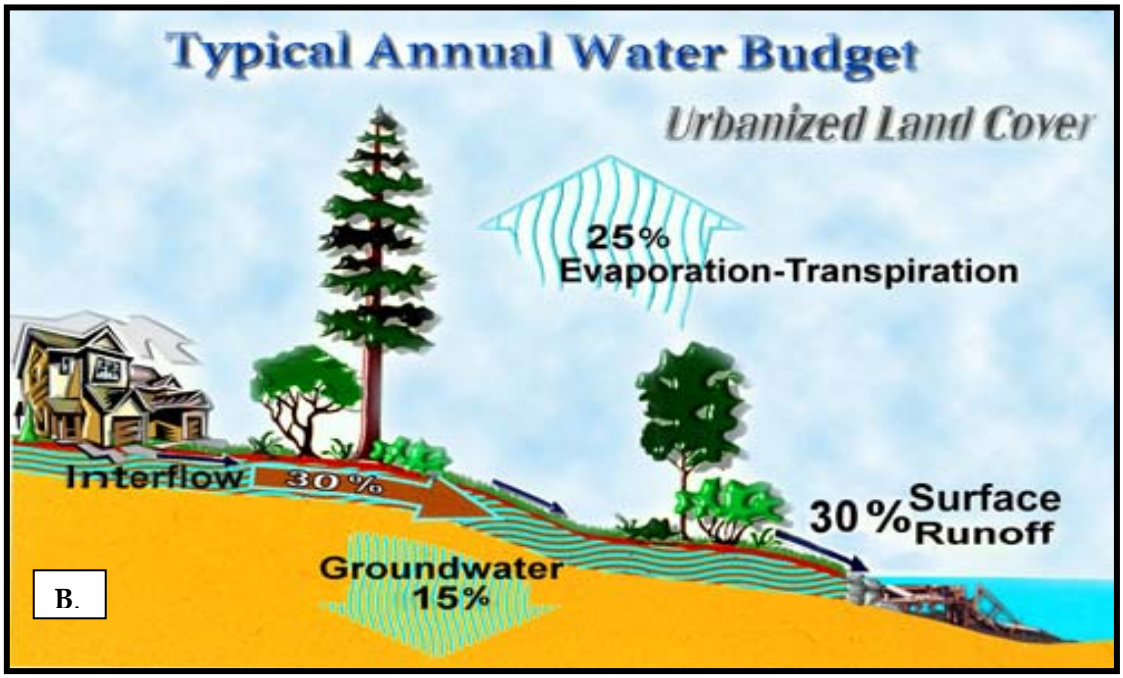


Figure 12. Altered Hydrology. Roads, rooftops, and sidewalks, change the water cycle in significant ways. Where water used to seep into the ground to feed streams in the summer (see A above), much of our water resource now runs quickly to a storm drain and is lost to us (see B below). When there is less water in streams in the summer, pollution levels can rise as a result. This same phenomenon of increased runoff contributes to flooding in the winter.



However, salmon recovery studies performed in the Lake Washington area modeled the intensity and volume of storm flows in Swamp Creek and classified them as extreme (Kerwin 2001). Increased frequency of flood flows from 1964 - 1990 were found to coincide with urbanization over the same period (Kerwin 2001). Depending on which subbasin you are in, future land use changes in Swamp Creek are expected to increase flows from 2 to 30% (SWM 2002). The effective impervious area (amount of hard surfaces connected to a stream or river) in Swamp Creek is estimated to be 26% of the watershed (Kerwin 2001).

Reduced Base Flows

When water levels in a stream decrease and pollutant loadings stay the same, the concentration of pollutants in the water becomes greater. Decreasing summer baseflows increase the challenge that we face as a society to reduce pollutants and return streams to good health.

Current research on the reduction of summer base flows by increasing amounts of impervious cover is inconclusive (Konrad and Booth 2002, CWP 2002). Several studies suggest that summer base flows in Swamp Creek are likely augmented by water imported from other basins (Konrad and Booth 2002, Kerwin 2001), which could be discharged as excess lawn irrigation water, water system leakage, or septic tank discharge. We do not want to depend on these sources of water to maintain healthy stream flows.

Potential Problem Areas

Due to the widespread nature of development across the watershed, no single problem area has been identified for this Water Quality Improvement Plan. Any location that is currently discharging bacteria laden stormwater is part of the problem.

Corrective/preventative actions

Pollution concentrations in stormwater are largely addressed by Ecology's municipal stormwater permits. To help reduce the effect of new stormwater discharges, this Plan recommends that that state and local government work together to advance the use of Low Impact Development (LID) practices in new development and consider LID retrofits as funding and redevelopment opportunities allow. Ecology, the Puget Sound Action Team (PSAT), cities within the watershed, and Snohomish County should collaborate to develop the necessary ordinances, guidance, and training to facilitate the transition of builders from the use of high impact development practices to LID practices where practical. Training should be provided for city governments.

Consistent with a conservative approach to maintaining adequate streamflows fed by interflow and other groundwater sources, this TMDL recommends all land owners should examine stormwater pathways on their properties and assess the feasibility of infiltrating stormwater onsite to maintain sub-watershed groundwater levels and reduce the potential for creating contaminated stormwater.

Because no decrease in Swamp Creek summer baseflows has been identified during the preparation of this plan, this Plan takes a conservative approach to conserving stream flows and recommends infiltration of stormwater wherever feasible. This approach will not only reduce the potential for creating contaminated surface runoff, but also will help

ensure adequate long-term groundwater resources (including interflows) that do not rely on transient recharge sources such as lawn irrigation water and onsite septic tanks.

Loss of Riparian Habitat

Riparian habitat (streamside buffers) plays a valuable role in water quality. Adequately sized and healthy riparian buffers help filter out a variety of pollutants including fecal coliform bacteria and substances that can lead to the depletion of oxygen in streams. In addition, temperature plays an important role in determining how much oxygen water can hold. When wooded stream buffers are removed to create lawns, establish pasture or cropland, or to make room for development, water temperatures increase because more of the stream is exposed to warm air and sunlight. Direct shading from trees is one important component that can affect stream temperatures.

Corrective/preventative actions

As the amount of undisturbed and unpaved land decreases in our urban communities, the role of riparian areas in managing urban water pollutants is only likely to grow. We need to use all available area to soak up and filter stormwater. This TMDL encourages all affected landowners and developers to maximize buffer widths consistent with reasonable land use expectations to help filter out pollutants and provide stream shading during summer months. Certain riparian vegetation, such as small shrubs and thickets, can also aid in excluding animals from water and drainage areas.

Sediment

Although not generally considered a source of bacterial pollution, sediment can affect local waters in a variety of ways 1) covering salmon eggs, and 2) filling streams making them wider and shallower, 3) providing a storage area for bacteria. Excessive sediments can affect dissolved oxygen levels by causing stream widening, which leads to increased contact of water with warmer surface air and sunlight. Warmer water holds less oxygen. The two most common sources are sediment are runoff from construction sites and hydraulic scouring caused by increased amounts of stormwater from impervious surfaces.

Fecal coliform bacteria can survive in sediment by bonding to sediment grains (e.g., clay) or organic matter. The degree to which surface water contamination is affected by contaminated sediments is unknown. This phenomenon has been documented in Puget Sound and is often referred to as "sediment archiving" of bacteria. Agricultural areas are likely locations where sediment archiving of bacteria has already occurred. The prevalence of sediment archiving in urban streams has not been investigated yet as part of this TMDL.

Corrective/preventative actions

This Plan recommends actions to reduce the introduction of nonnative organic sediments and nutrients into Swamp Creek. Nutrient runoff from landscaped areas and nutrients from illicit discharges to storm sewers (car wash waters, restaurant greases and washwaters, etc…) should be controlled to ensure that survival and regrowth of bacteria in streams and storm sewers is minimized. Additional investigation of sediment archiving and regrowth in storm sewers should be considered for grant funding during the early phase of implementation for this plan or through adaptive management of the Plan.

Wildlife

Similar to other nonpoint sources, wildlife contributes to the level of bacteria in surface waters. Contributions from wildlife are typically not considered pollution. In those cases where man-caused alterations of the natural environment have caused concentrations of wildlife that lead to high bacteria levels, wildlife contributions may be considered a source of pollution that should be reduced. Examples of man-caused alterations may include certain agricultural areas (birds congregating on warm farm roofs for example) or recreational areas offering year-round refuge for large numbers of Canadian geese. At this time, no such areas have been identified in the Swamp Creek study area.

Problem Areas

Several areas have been identified as potential problem areas for excessive wildlife concentrations. Figure 8b shows the location of several ponds reported in literature (SWM 1994) or through interviews with local government staff.

Corrective/Preventative Actions

Ecology recommends that the appropriate local government official (county or city surface water management staff) be contacted to coordinate the investigation of these sites. When excessive waterfowl are present, exclusionary vegetation, "Do Not Feed the Waterfowl" signage, or other measures should be considered to reduce bacteria inputs.

Figure 13. Are Wood Ducks contributing to our bacterial pollution problems? Ducks, geese, and other wildlife in their natural settings can contribute background levels of bacteria. However, where human activities are concentrating animal populations, the increased risks to human health should be addressed.

What will be done, Who will do it?

Several plans for improving water quality in Swamp Creek have been prepared over the last 14 years. Government agencies and other groups worked together to develop the Swamp Creek Watershed Management Plan in the early 1990's (SWM 1994). This plan addressed a wide range of watershed needs including water pollution, aquatic habitat, and flooding. Although many of the plan elements were accomplished or initiated, the plan was only partially funded and all identified activities were not completed.

Snohomish County also prepared the Swamp Creek Drainage Needs Report in December 2002 (SWM 2002). The report focused on unincorporated areas of Snohomish County and identified a number of areas where small farms may be affecting water quality. Although these areas where not individually listed in the Recommended Plan section of the report, the need for increased efforts to implement pollution control measures on these farms was identified (section 10.4.7). Areas needing additional investigation are discussed in the Pollution Sources section of this Water Quality Improvement Plan.

Local government and other organizations have worked together to prepare this Water Quality Improvement Plan. There is no single solution to improving water quality in Swamp Creek. Everyone will need to pitch in to solve the problem. If you want to see how you can help, the best place to start in right in your own backyard. If you want to go further, read about what your local government is already doing and how you can help them work for you. If you have a small farm, or a special interest in fish or wildlife, read about the activities sponsored by the Adopt-a-Stream Foundation or local conservation district. The following pages will tell you more about all of these organizations and how they are working to make Swamp Creek a safe place for people and fish.

Federal, Tribal, State, and County Entities

Environmental Protection Agency

The 1997 Memorandum of Agreement between the Environmental Protection Agency, Region 10 and Ecology requires that EPA and Ecology jointly evaluate the implementation of TMDLs in Washington. These evaluations will address whether interim targets are being met, whether implementation measures such as BMPs have been put into effect, and whether NPDES permits are consistent with TMDL wasteload allocations.

EPA provides technical assistance and funding to states and tribes to implement the Clean Water Act (CWA). For example, EPA's CWA Section 319 grants are combined with Ecology's grant and loan funds are made available to stakeholders through Ecology's annual Water Quality Grant and Loan Process. On occasion, the EPA also has other grant monies available (104(b)(3)) to address storm water pollution problems.

Recommended Actions: The EPA should conduct, support, and distribute information on urban pollution sources and source identification techniques, and continue to offer funding support for targeted projects at the local level.

Washington State Department of Ecology

Ecology has been delegated authority by the EPA to implement many aspects of the federal Clean Water Act. This includes the National Pollution Discharge Elimination System (NPDES) permitting and the Total Maximum Daily Load (TMDL) program. The Snohomish River Basin is under the jurisdiction of Ecology's Northwest Regional Office (NWRO). To address the municipal permitting needs of this TMDL, the NWRO has one municipal stormwater engineer and one municipal stormwater specialist who provide technical assistance and auditing activities for the Phase I and Phase II municipal stormwater permits across the region. An additional municipal permitting staff member will be added to NWRO in mid-2006. Ecology's headquarters also has several staff that help identify and distribute education and outreach materials to stormwater permittees.

Ecology's NWRO also has a team of six inspectors that oversee compliance with stormwater permits issued to the Washington State Department of Transportation (WSDOT) and nonpublic entities. When technical assistance is not effective or is inappropriate, the NWRO also has two staff responsible for preparing enforcement actions for this team to ensure compliance with NPDES permits.

Ecology has a Water Cleanup Specialist assigned to the implementation of the Swamp Creek TMDL that will assist stormwater permittees and other environmental agencies and groups. The NWRO recently hired a water quality monitoring specialist who is available to provide assistance in the development of ambient monitoring and source identification monitoring projects. Ecology's Environmental Assessment Program will assist in effectiveness monitoring approximately five years following TMDL approval.

Ecology also helps local governments with funding for water quality facilities and activities through the Centennial Clean Water Fund, 319 Fund and State Revolving Loan Fund. The full range of Ecology funding opportunities is discussed under the section "Funding Opportunities." Ecology's Grant Specialists assist local government in the development of stream restoration and water quality improvement projects. Ecology is providing grant funding for several water quality projects that are expected to improve water quality across Snohomish County (see discussion of Snohomish County activities later in this section) and is evaluating several projects now that will focus specifically on Swamp Creek.

Ecology will be responsible for organizing meetings of the Swamp Creek Municipal Workgroup no less than annually and will lead additional meetings as requested by the Workgroup. Ecology will also provide additional guidance to local governments developing water quality monitoring plans as part of this Plan.

Recommended Actions: Ecology should continue providing the current level of support for implementing this plan and the municipal stormwater permit. Additional resources are needed to help address nonpoint pollution violations through field inspections.

It is essential to the success of this TMDL that Ecology continue to coordinate TMDL activities within the Swamp Creek Watershed and continue to provide grant funding opportunities to assist in funding TMDL activities.

Puget Sound Action Team

The Puget Sound Action Team (Action Team) works to restore and protect the biological health and diversity of Puget Sound by protecting and enhancing Puget Sound's water and sediment quality; its fish and shellfish; and its wetlands and other habitats. The Action Team includes a chair appointed by the Governor, directors from 10 state agencies, and representatives from tribal, federal and local governments. Its staff works with tribal and local governments, community groups, citizens and businesses, and state and federal agencies to develop and carry out two-year work plans that outline measurable actions, as well as expected results to improve the water quality and habitats for fish, marine animals and other aquatic life in Puget Sound.

The Action Team has two local liaisons that work in the Swamp Creek Watershed (one for the King County portion and another for the part that is in Snohomish County. Each liaison works directly with cities, tribes, counties, and others to help facilitate and coordinate a wide range of activities related to improving water quality in Puget Sound.

Three specific Action Team priority program areas have direct relevance to this TMDL: 1) The Public Information and Education (PIE) program, which can provide funding to qualified local governments to educate the public on bacterial pollution problems within the TMDL focus area and 2) Stormwater management and promotion of Low Impact Development practices, and 3) proper maintenance of septic tanks to prevent surface water pollution.

Recommended Actions: This TMDL encourages affected local governments to work with the Action Team to continue spearheading the development of updated models, written guidance, and other tools that will both educate local governments on and help them to implement LID practices within their jurisdictions.

Washington State Department of Transportation

The Washington State Department of Transportation (WSDOT) water quality program provides guidance and technical support to road planning, design, construction, and maintenance to help WSDOT enhance transportation project delivery and achieve compliance with the federal Clean Water Act and state water quality laws. Since 1995, WSDOT has been regulated under the Phase I Municipal Stormwater permit. Pursuant to that NPDES permit, WSDOT also submitted a stormwater management plan (SWMP) to Ecology in 1997.

WSDOT identified six elements in the 1997 SWMP as having the highest priority: (1) construction of structural stormwater BMP facilities; (2) monitoring and research related to stormwater BMPs; (3) erosion and sediment control programs; (4) attaining full funding for operations and maintenance programs; (5) watershed-based mitigation strategies; and (6) water quality-related training. These elements continue to be high priorities for WSDOT.

In recent years, WSDOT has begun monitoring fecal coliform levels in both treated and untreated stormwater runoff from state highways. This new data was used in this TMDL to help estimate the loading of bacterial pollution from state highway storm

sewers more accurately. Ecology is currently revising WSDOT's municipal stormwater permit for reissuance in late 2006.

Required and Recommended Actions: The anticipated TMDL-related actions that WSDOT will be required to undertake as part of its municipal stormwater permit are not included in Appendix D of this document. Ecology is developing those actions as it prepares to reissue the WSDOT permit later in 2006. Readers interested in TMDL-related permited conditions for WSDOT should look in the appendix section of the draft permit, which is expected to be issued in late 2006. Check Ecology's Water Quality Program website for the most up-to-date information. (http://www.ecy.wa.gov/programs/wq/stormwater/municipal/wsdot.html)

This TMDL encourages WSDOT to undertake the following additional actions to reduce bacteria levels in Swamp Creek.

- Evaluate the potential for using bioretention and other techniques in right-of-ways to reduce stormwater volumes in areas addressed by this TMDL. Where research shows this approach is feasible, WSDOT should work with Ecology to develop a plan to implement this strategy in areas affected by this and other bacterial TMDLs.
- Evaluate, and implement where feasible, construction techniques that promote stormwater infiltration, such as the use of permeable pavement surfaces. Both new construction and retrofit applications should be examined.

Snohomish County Government

The activities of several branches of Snohomish County Government can affect the overall water quality in the Swamp Creek watershed. The bulk of water quality related activities are carried out by Snohomish County Pubic Works, which performs a variety of pollution identification and prevention activities. Snohomish County Planning and Development Services is also very important as it oversees building and land development activities and performs enforcement. Because past land use practices so greatly affect water quality, the activities of this department are especially important to pollution prevention.

Snohomish County Public Works--Surface Water Management

Surface Water Management (SWM) is involved in a wide range of water pollution control activities including education, water quality monitoring, riparian restoration, salmon recovery, native plant salvaging, and NPDES permit administration. Education is conducted through the Watershed Keepers, Salmon Watcher, and other programs as well as the activities of a South County Basin Watershed Steward. Surface Water Management also provides funding for and coordinates with the Snohomish Conservation District. Water quality is tracked through ambient monitoring, targeted source identification, and illicit discharge monitoring.

Surface Water Management finalized the Swamp Creek Watershed Management Plan in 1994 and recently completed the Drainage Needs Report, which provides valuable

information on the hydrologic profile of waterbodies within the unincorporated areas of the county's urban growth area (UGA). Current efforts to help address urban pollution sources include the Animal Waste Control Project, the North Creek Stormwater Management Project, and the Onsite Septic Management Program.

The Animal Waste Control Project is researching the problem of pet waste management at the residential and commercial level. The Stormwater Management Project is studying two urban issues: how to maximize Native Growth Protection Areas for removal of pollutants in stormwater and how to perform a low-cost stormwater capture and treatment retrofit in established residential neighborhoods. Finally, the county is working with the Snohomish Health District to map the location of all onsite septic systems, prioritize areas to examine system failure rates, and conduct two pilot studies. These projects address several of the top pollution reduction strategies outlined in this Water Quality Improvement Plan.

Snohomish County SWM currently performs monthly water quality monitoring in Swamp Creek at two locations, 148th SW and near the county line at Lockwood Rd. Snohomish County data can be found on the internet at http://www.data.surfacewater.info.

Solid Waste Management Division
Solid Waste Management has important programs that affect both pet waste and livestock waste management issues. In collaboration with Surface Water Management, Solid Waste Management develops educational material on how to best manage pet wastes.

Snohomish County Planning and Development Services
Snohomish County Planning and Development Services (PDS) develops and administers county regulations for commercial and residential development as well as public projects. The PDS also enforces the Snohomish County Code as it relates to protection of water quality, implements the Critical Areas Ordinance and other development regulations, and works closely with the agricultural community through its agricultural liaison and the Agricultural Advisory Board.
The activities of the PDS greatly affect the generation and treatment of stormwater prompting them to research stormwater BMPs and provide educational outreach to contractors on proper BMP use. Along with other parts of Snohomish County Government, the PDS is promoting Low Impact Development (LID) principles. The county has recently helped sponsor the Sustainable Development Task Force, which is a public/private partnership dedicated to the adoption of strategies that protect the environment by promoting the wise use of building materials, energy efficiency, and the reduction or elimination of stormwater. An experimental LID ordinance was written in 2001 and county staff are now updating that ordinance.

Snohomish County Parks and Recreation Department
The Snohomish County Parks and Recreation Department oversees over 9,000 acres of public land for recreational use and conservation purposes. The Department works with other parts of county government to manage county lands, administers a variety of educational programs, and develops and maintains park facilities

Required and Recommended Actions: The anticipated actions that Snohomish County will be required to undertake as part of its municipal stormwater permit are listed in Appendix D of this document. The following actions are additional recommendations that the city should consider to help reduce bacterial pollution in Swamp Creek.

- Fully implement the findings from the Animal Waste Control Project.
- In parks and recreational lands where pets are allowed, pet waste education and collection stations should be installed where there is the potential for bacterial pollution to waterbodies or stormwater conveyance systems.
- Implement LID aggressively in areas of new development and maximize the reduction of stormwater during redevelopment. Projects that maintain, restore or improve natural hydrologic processes should be given significant consideration in the prioritization of capital improvement and public land acquisition projects.
- The county should continue to work in partnership with the Snohomish Health District in identifying and resolving pollution from on site septic systems.
- Because of the widespread distribution of bacterial pollution sources, it is important for SWM to identify pollution sources through both ambient and targeted water quality monitoring. Source identification efforts are needed in both urban and rural areas.
- Where businesses (dog kennels, commercial equestrian facilities, etc…) or small farms are contributing bacterial pollution outside of the MS4 system, policies, procedures, and resources should be made available to address this problem.
- When technical assistance is inappropriate or ineffective, Code Enforcement is an essential follow up activity to remove known bacterial pollution sources and also a valuable deterrent to potential violators. Due to the temporal nature of many water pollution problems, Code Enforcement staff should work to ensure that referrals from Surface Water Management staff are addressed promptly. The number of annual referrals for enforcement and the actions taken on those referrals should be tracked annually. Water quality ordinances should be reviewed and revised as needed to allow field staff to quickly identify and take action on obvious water quality problems without the need for providing water quality data—direct access of livestock to surface water, improper placement of manure piles, and other poor animal management practices should be addressed quickly. The use of lower courts for prosecution and appeal of water quality violations should be considered.

Cities and Towns

City of Everett

The city of Everett is located at the northern end of the Swamp Creek Watershed. The headwaters of Swamp Creek begin in Everett at the Walter E. Hall golf course, just south of SR 526. With a total population of about 97,500 citizens, it is the largest of the six cities within this TMDL area; however, only five percent of the city contributes to the Swamp Creek watershed. About 50% of the land use in Everett's

portion of Swamp Creek is residential—forested areas, a golf course, and commercial properties cover the remaining land.

Everett's Surface Water Management program was established in 1988 and performs most of the activities aimed at controlling pollution to Swamp Creek. It is part of the city's Public Works Department and currently has a staff of three. Many ongoing programs are in place now to help address pollutants entering local surface waters.

- Citizens can report pollution problems to a 24-hour emergency telephone number or send e-mail to the city's surface water web site. The web site also provides information on how citizens and educators can learn more about water pollution issues as well as how to get involved in local activities.
- Schools receive newsletters, presentations, and curriculum materials.
- The city provides information and education to the business community on how to control stormwater pollution through the use of best management practices.
- The city sponsors volunteer groups aimed at stenciling storm drains (dump no waste drains to stream), installing Grate Mates, and provides charity benefit car wash kits that prevent illicit discharges to the city's drainage system.
- The car wash program has been developed to offer residents a way to perform charity car washes while avoiding impacts to local surface waters—efforts such as these help maintain dissolved oxygen levels downstream.
- Everett has mapped all detention facilities and drainage lines within city limits using GIS and inspects most detention systems in the Swamp Creek portion of its service area annually to help control peak flows, stream scouring, and sediment deposition in the Swamp Creek watershed.
- Public sewer connection incentive. ..$5,000 low interest loan available to help homeowners hookup to sanitary sewer.
- Catch basin cleaning, street sweeping, construction site inspection, stormwater site plan review
- Airs surface water protection messages and videos on local Everett television.
- The city has enforcement authority for water quality related issues.
- Community Housing Improvement Program (CHIP). Financial help with housing repair, including on site septic tank repair, for low and moderate income homes. Example, low income household of 2 persons over 18 years of age making $18,700 or less can get a 3% simple interest loan with interest ceasing after 10 years and no payment required for 25 years. See city website or call Lauren Kitchen at 425-257-8735 for more information.
- Future activity: Everett will develop a program to detect and correct illicit connections to its storm sewer system as required by the municipal stormwater permit to be issued by Ecology in the fall of 2006.

The city of Everett recently relocated its water quality monitoring station in Swamp Creek to a location near Avondale Road and 119th St SW. Monitoring is conducted quarterly.

City of Everett staff view funding as a significant issue in resolving the water quality problems in the Swamp Creek watershed.

Required and Recommended Actions: The anticipated actions that the city of Everett will be required to undertake as part of its municipal stormwater permit are listed in Appendix D of this document. The following actions are additional recommendations that the city should consider to help reduce bacterial pollution in Swamp Creek.

- Improve web-based information on bacterial pollution in Swamp Creek on the city website.
- Evaluate the need for pet waste management stations within the city's portion of the watershed (both pubic and private areas) and install/maintain these stations where they are needed.
- Adopt a pet waste code or ordinance requiring proper pet waste management by pet owners.
- Snohomish County Surface Water Management is currently developing a joint project with the Snohomish Health District to map all on-site septic systems in Snohomish County and to identify areas with the highest potential for creating surface water problems. As this information is developed, the city should consider working with the health district, or independently, to investigate suspected problem areas within their jurisdiction.

City of Kenmore

The city of Kenmore is located along the upper edge of Lake Washington and is separated nearly in half by the Sammamish River. Kenmore's population is about 19,000 and about 30% of the city (1.8 square miles) is located in the Swamp Creek watershed where it drains to the Sammamish River. Kenmore comprises about 8% of the Swamp Creek watershed and most of that area is residential zoned at 6 houses per acre. Housing density is lower along Swamp Creek at 1 house per acre. A small portion of the city is zoned for commercial, business, and public institution uses—primarily along Highway 522 (Bothell Way).

Although the city did not participate in the development of the Swamp Creek Watershed Management Plan in the early 1990's, they are participants in the WRIA 8 Salmon Recovery Forum. The city is currently using a past version of the King County Surface Water Design Manual date 1998 and has not yet adopted the County's new 2005 manual. Kenmore's activities to control surface water pollution include:

- Street sweeping activities-during fall and winter arterials are swept monthly and residential streets are swept every other month.

Kenmore operates the Wallace/Swamp Creek Park located in the northern part of the city. The park is 17 acres in size and provides trails for walking and a large stream area that is used by families in the summer heat to cool off. The park is also a very popular spot for pet exercise—pet waste stations in place.

King County currently monitors the quality of Swamp Creek as it enters and exits the city of Kenmore. The County intends on continuing sampling at this point and their data can be found on the internet at http://dnr.metrokc.gov/wlr/waterres/streams/swamp.htm. The city performs no water quality monitoring at this time.

Required and Recommended Actions: The anticipated actions that the city of Kenmore will be required to undertake as part of its municipal stormwater permit are listed in Appendix D of this document. The following actions are additional recommendations that the city should consider to help reduce bacterial pollution in Swamp Creek.

- Improve web-based information on bacterial pollution in Swamp Creek on the city website.
- Evaluate the need for pet waste management stations within the city's portion of the watershed (both pubic and private areas) and install/maintain these stations where they are needed.
- Adopt a pet waste code or ordinance requiring proper pet waste management by pet owners.
- The Swamp Creek Watershed Management Plan identified an area east of Swamp Creek as a potential area for problem septic tanks. The city should work with local residents and if necessary, Public Health of Seattle and King County, to investigate potential pollution sources such as livestock and on-site septic tank failure. Because of the large number of residential properties pet waste management should be a focus area throughout the watershed as well.

City of Bothell

The City of Bothell is very active in maintaining and improving local water quality and is currently developing its Phase II Municipal Stormwater Program. Bothell has a total population of 31, 000—about 5% of the city is located in the Swamp Creek Watershed (375 acres). Most of that land is residential and is zoned at 5 houses per acre. Bothell comprises about 4% of the Swamp Creek Watershed.

Bothell established a stormwater utility in 1994 and has been working actively to reduce bacterial pollution within its city limits. A project to map City drainage lines is scheduled for completion within the next two years. Some detention facilities are now being entered into the City's database using a Geographic Information System (GIS). Bothell was a committee member for the *Swamp Creek Watershed Management Plan* and is an active member in WRIA 8 Salmon recovery efforts. The City's storm water group investigates approximately 100 drainage/flooding/water quality/spill complaints a year. The city's major pollution reduction programs include:

- The North Creek TMDL Action Grant (discussed below),
- Regular articles on water pollution problems in "Bothell Bylines" newsletter.
- One annual educational lectures at the UW-Bothell campus with additional lectures to Boy Scout troops and schools,
- Periodic habitat improvement projects such as tree plantings with citizens and students (Thrasher's Corner Park, RE-Leaf events),
- Storm drain stenciling programs done in partnership with local businesses, homeowner associations and other volunteers (380 drains so far),
- Charity benefit car wash kits that remove point source pollutants from the drainage system. The car wash program has been developed to offer residents a way to perform charity car washes while avoiding impacts to local surface waters—efforts such as these help improve dissolved oxygen levels throughout the lower sections of both Swamp and North Creeks.

The City is currently focusing most of its pollution reduction actions on reducing bacteria levels in the North Creek Watershed, which comprises most of the city's area. Their North Creek TMDL Implementation Project involves a survey of public perceptions on water pollution problems, development and execution of a broad education and outreach program, pollution identification activities, and water quality monitoring. The information gained from this work will assist Bothell, and other urban communities, in understanding and resolving local bacterial pollution problems.

Bothell does not currently perform monitoring in the Swamp Creek Watershed. All tributaries to North Creek have been characterized and are currently under study. Data from similar land uses in the North Creek Watershed should be helpful in understanding pollution in the Swamp Creek portion of Bothell.

Required and Recommended Actions: The anticipated actions that the city of Bothell will be required to undertake as part of its municipal stormwater permit are listed in Appendix D of this document. The following actions are additional recommendations that the city should consider to help reduce bacterial pollution in Swamp Creek.

- Most of the Bothell area draining to Swamp Creek is zoned for residential use at a density of 4-6 units/acre. The city should evaluate the need for pet waste management stations within the city's portion of the watershed (both pubic and private areas). Pet waste stations should be installed and maintained on public property where needed. The City should also assist homeowner associations in meeting the need for pet waste stations where they are needed on nonpublic property.
- Review and adopt as needed, a pet waste code or ordinance requiring proper pet waste management by pet owners and businesses that handle pet waste as part of their normal business practices.

- Identification of illicit discharges to the storm sewer and surface water drainages should be prioritized. Because most of Bothell is already covered under the North Creek TMDL, this Water Quality Improvement Plan recognizes the need to prioritize TMDL activities needed across the city.

City of Brier

The northeast half of the city of Brier is located in the Scriber Creek subbasin of the Swamp Creek watershed. The city has an overall population of about 6,500 and is primarily a residential community—about half of the city (735 acres) is part of Swamp Creek Watershed and most are single household residential properties. Brier comprises about 5% of the total Swamp Creek Watershed and a larger part of the Scriber Subbasin. About 90% of the city is zoned for single family dwellings at a density of 3 houses per acre.

Brier is the smallest city within the Swamp Creek watershed and it's goal is to preserve the area's semi-rural character. The city maintains three parks for use by residents; Locust Creek Park, Brier Park, and Brierwood Park. Brier Park has a horse riding arena and reflects the importance of equestrian activities to the community. Horse owners must maintain a 30' buffer from streams, provide adequate fencing for animal exclusion, and comply with animal density requirements. All animal owners are required to properly manage their animals' wastes (Title 6, Chapter 6.04 Brier Municipal Code).

Required and Recommended Actions: The anticipated actions that the city of Brier will be required to undertake as part of its municipal stormwater permit are listed in Appendix D of this document. The following actions are additional recommendations that the city should consider to help reduce bacterial pollution in Swamp Creek.

- Most of Brier that drains to Swamp Creek is zoned for residential use, the city should evaluate the need for pet waste management stations within the city's portion of the watershed (both pubic and private areas) and install/maintain these stations where they are needed.
- Compliance by livestock owners with animal waste ordinances should be investigated, documented, and rigorously enforced when education and technical assistance are ineffective. Public settings and events that provide an opportunity for educating citizens should include information on proper animal waste management (signage at parks, display at library, booth at the annual SeaScare event, etc…)
- Identification of illicit discharges to both the storm sewer and surface water drainages should be prioritized in the area covered by this TMDL. Streamwalks should be conducted by the city or a contracted third party.
- Snohomish County Surface Water Management is currently developing a joint project with the Snohomish Health District to map all on-site septic systems in Snohomish County and to identify areas with the highest potential for creating surface water problems. As this information is developed, the city should work with the health district, or independently, to investigate suspected problem areas within their jurisdiction.
- City staff should check for areas of excessive wildlife concentrations.

City of Lynnwood

With a population of about 30,000, Lynnwood is not the largest city in the Swamp Creek Watershed. However, it covers nearly 20 percent of the watershed making it the single largest city area within the watershed. Expansion into the city's projected urban growth area will triple that amount (Lynnwood Comprehensive Plan). Right now, more than half (61%) of Lynnwood is located in the Scriber Creek Subbasin of the watershed.

Lynnwood is primarily a suburban community with extensive commercial development along arterial roadways. Land use within Lynnwood's portion of the Swamp Creek Watershed is about 50% residential, 25% commercial, and 25% with forest or other vegetative cover. About 17% of the existing land is located in road right-of-ways. Much of the population growth for the city is expected to occur within the Swamp Creek Watershed.

Pollution control is addressed by several different parts of Lynnwood city government. The Public Works Department is home to the city's environmental engineer and their Transportation Division. Construction and Stormwater Utility Maintenance, located within the Transportation Division, is responsible for managing stormwater runoff from the 295 miles of road and 118 miles of sidewalks and paved road shoulders in Lynnwood. The stormwater management system also has 100 miles of underground pipe, 7,400 catch basins, and 52 stormwater ponds. The city has taken the following actions to control bacterial pollution in Swamp Creek:

- Promoting storm drain stenciling by schools and clubs to promote environmental awareness.
- Restricted feeding of waterfowl with installation of educational signs at two problem parks adjacent to Scriber Creek.
- Evaluates redevelopment for potential installation of improved stormwater treatment.
- Passed an animal control ordinance that requires citizens to pick up after their pets (LMC 6.02.160).
- Passed the New Tree Ordinance to preserve and protect existing trees and encourage the planting of new ones for both aesthetic and environmental benefit of the community (LMC 17.15).
- Adopted new critical areas regulations using best available science and Washington State Department of Ecology methodologies (LMC 17.10).

Required and Recommended Actions: The anticipated actions that the city of Lynnwood will be required to undertake as part of its municipal stormwater permit are listed in Appendix D of this document. The following actions are additional recommendations that the city should consider to help reduce bacterial pollution in Swamp Creek.

- The city should evaluate the need for pet waste management stations within the city's portion of the watershed (both pubic and private areas) and install/maintain these stations where they are needed. Public settings and events that provide an opportunity for educating citizens on local water pollution problems should include information on proper animal waste management (signage at parks, display at library, booth at the annual community events, etc…).
- Identification of illicit discharges to both the storm sewer and surface water drainages should be prioritized in the area covered by this TMDL. Streamwalks should be conducted by the city or a contracted third party.
- Snohomish County Surface Water Management is currently developing a joint project with the Snohomish Health District to map all on-site septic systems in Snohomish County and to identify areas with the highest potential for creating surface water problems. As this information is developed, the city should work with the health district, or independently, to investigate suspected problem areas within their jurisdiction.
- City staff should check for areas of excessive wildlife concentrations and work with local citizens to reduce bacteria inputs from these areas.
- The City should restrict or prohibit the discharge of pressure washing wastes into the storm sewer system to prevent the entry of bacteria, bacterial nutrients, and other pollutants.

City of Mountlake Terrace

The City of Mountlake Terrace's northeast corner is located in the Scriber Creek subbasin of the Swamp Creek watershed. The city has an overall population of about 21,000 and is primarily a residential community--eight percent of the city (207 acres) is part of Swamp Creek Watershed and is a mix of single household residential, low density multi- household, medium density multi-household, and community business. All properties are connected to the sanitary sewer system.

The city included stormwater activities along with water and sewer service activities in a combined utility ordinance and joint utility maintenance program starting in the mid 1960's. In 2000, the Water/Sewer/Stormwater Utility was segregated into three separate utility funds each with a dedicated funding source. The sewer and stormwater programs provide important services to control water pollution in Swamp Creek as detailed below:

- Street Sweeping is conducted 40 hours each week. All streets are swept monthly with arterials cleaned twice a month.
- All storm basins are checked every other year for sediment. The last round of basin probing in the spring of 2005 showed that approximately 25% of the basins needed to be cleaned since the last city-wide cleaning effort in 2000-2001. Aggressive street sweeping helps reduce the buildup of pollutants in storm basins.
- Surface water management is addressed through the development process with site review and approval based on the 2005 Department of Ecology Stormwater

Management Manual for Western Washington. Site inspections are performed on all commercial and multifamily sites in the city.

- Storm drain stenciling: The City has applied approximately 350 torch down storm drain stencils to stormwater catch basins.
- Grate Mate participant in 2003: Two apartment complexes participated in a Grate Mate storm filter installation project in 2003
- Mountlake Terrace has participated in WRIA 8 salmon recovery efforts at the planning stage as a member of the WRIA 8 Forum
- Education and outreach are provided to citizens through lawn care seminars, articles in the city's quarterly newsletter City Happenings, and during annual "National Night Out" activities.
- Business Community receives education through site inspections and upon the request of business owners.
- The Surface Water Utility has an education program developed to work with schools and community groups to heighten the public's awareness of issues related to surface water quality. These groups may be involved with projects such as storm drain stenciling, stream and wetland adoption and cleanup, tree planting and habitat restoration. School presentations are given to all 3rd graders.
- All new development projects are reviewed under the current DOE Stormwater Manual. Low impact development encouraged as allowed through DOE Manual
- All outfalls are mapped and have been traced out to suspected point source sites
- Mountlake Terrace and Edmonds have partnered to conduct site inspections for Fats, oils, and grease through the sewer utility. Site inspection information is shared with stormwater. Fire District 1 personnel are also sending along reports as they conduct fire inspections at commercial business sites.
- Future Activity: An illicit discharge program is being developed in conjunction with the upcoming NPDES II requirements.
- The city encourages citizens to report pollution problems by calling the Stormwater Program Manager at 425-670-8264 ext 105 and provides 24 hr response through 911. An incident response van is available at all times.

Required and Recommended Actions: The anticipated actions that the city of Mountlake Terrace will be required to undertake as part of its municipal stormwater permit are listed in Appendix D of this document. The following actions are additional recommendations that the city should consider to help reduce bacterial pollution in Swamp Creek.

- Improve web-based information on bacterial pollution in Swamp Creek on the city website.
- Evaluate the need for pet waste management stations within the city's portion of the watershed (both pubic and private areas) and install/maintain these stations where they are needed.

- Review, and adopt as needed, a pet waste code or ordinance requiring proper pet waste management by pet owners and businesses that handle pet waste as part of their normal business practices.

Special Purpose Districts

Snohomish Conservation District

The Snohomish Conservation District (SCD) can play an important role in improving and maintaining good water quality in the Swamp Creek Watershed. The SCD is the county's primary resource for providing technical and financial assistance to owners of livestock throughout the county and within city boundaries. The SCD has engineering, small farm assistance, and water quality monitoring resources.

Currently, the SCD is soliciting grant funding to aid with pollution identification and correction work in the Swamp Creek Watershed. Planned activities include stream walks, door-to-door outreach to all streamside landowners, and engineering and technical assistance with the installation of rain gardens on existing properties.

Recommended Actions: Ecology does not have authority to require specific actions of the SCD. However, this Water Quality Improvement Plan makes the following recommendations for action to reduce bacterial pollution in Swamp Creek.

- Improve web-based information on bacterial pollution in Swamp Creek on the SCD website. Review existing program information (such as backyard conservation) for addition of new information on pet waste management.
- Perform direct outreach and regular follow-up visits to small farm owners, commercial equestrian facilities, and equestrian clubs to promote proper manure and pasture management.
- Work with local governments on coordinated outreach to citizens regarding proper management of pet waste and stormwater—especially on private properties.
- The SCD has reported that there is inadequate base funding to support the level of workshops, technical and financial assistance, direct outreach, follow up visits, and monitoring activities to meet the needs of this and other TMDLs; therefore, this Water Quality Improvement Plan recommends that the SCD explore mechanisms for improving base funding to perform these activities including assessments and partnerships with local governments.
- The SCD is encouraged to participate activities aimed at pollution source identification (water quality monitoring, aerial surveys, etc…). These activities can be valuable in identifying areas of high pollutant concentrations and strategically concentrating outreach and technical assistance where they are needed most. Activities that directly engage SCD, or contract workers, with the public at their place of business or residences are highly encouraged.

Snohomish Health District

The Snohomish Health District (SHD) has a wide variety of responsibilities to protect human health. Among its four major branches is its Environmental Health Division, which oversees permitting and inspection of various activities and facilities including food establishments, on-site septic systems, small and individual drinking water systems, public swimming pools, and solid waste disposal facilities. A major portion of the activities of the Water and Wastewater Section centers around permitting installation and repair of onsite sewage disposal systems.

Improperly functioning on-site septic systems and poorly handled solid waste can affect both dissolved oxygen and bacteria levels in the area of this plan. The SHD has the exclusive authority to enforce county and state codes regarding the treatment of residential wastewater by individual residential on site septic systems. Similarly, they have specialized skills needed to investigate and evaluate on site systems. On site septic systems are considered a very likely and significant contributor to many areas showing high bacteria levels during summer months. Therefore, the SHD is among the most crucial organizations in resolving the bacterial pollution problems within this TMDL area.

The SHD is currently working with Snohomish County Surface Water Management in developing a system for identifying and prioritizing on-site septic systems for inspection.

Recommended Actions: Ecology does not have authority to require specific actions of the SHD. However, this Water Quality Improvement Plan makes the following recommendations.

- Information developed as part of the grant program noted above should be distributed to local governments when it is completed.
- Continuing education regarding on-site septic system maintenance is encouraged. Education strategies should address the effect of home ownership changes, new on site systems as they are built, and maintenance reminders.
- This TMDL highly recommends the establishment of adequate staffing and resources to meet the need for sanitary surveys and other direct investigative strategies to locate and resolve the problem of failing septic systems. If the collaborative project with Snohomish County SWM is shown to be effective, it should be replicated in the Swamp Creek Watershed.

Sewer Districts

In the Swamp Creek watershed, there are no municipally-owned domestic wastewater treatment systems discharging directly into Swamp Creek or its tributaries. However, an extensive network of sewer collection and conveyance systems exists in the basin to serve existing development. The area is served by the Alderwood Sewer District, city of Everett, Northshore Utility District, Lynnwood Sewer Authority, Mountlake Water and Sewer District, Bothell Sewer District, and Brier Sewer District.

Ecology's Phase I and II stormwater permits will require local and county government to determine if the sanitary sewer collection systems within the Swamp Creek Watershed include high flow bypasses. In addition, it is anticipated that local sewer districts will be issued NPDES permits within the next five years. These permits are expected to include provisions to detect and report unauthorized discharges of municipal wastewater. When problems are found, Ecology will engage in compliance activities, which may include consultation or formal enforcement.

Recommended Actions: Ecology does not have authority to require specific actions of sewer districts that are not covered by an NPDES permit. Further, this TMDL has not quantitated discharges from these potential sources and no wasteload allocation has been calculated. However, because of the importance of addressing this potential pollution source, this Water Quality Improvement Plan makes the following recommendations:

- All sewer conveyance purveyors should inspect their pump stations for emergency overflow points that are not specifically authorized by Ecology. If unauthorized points are found to exist, they should be brought to the attention of Ecology's Municipal Permitting Unit, who will provide guidance, or oversight, as needed.
- Where sewer lines intersect with or run parallel to surface waters, the need for water quality testing upstream and downstream of the lines, and/or in groundwater directly should be evaluated based on the history of line integrity, age of the line, type of materials, and any other relevant factors. Other reasonable methods to inspect pipe integrity such as TV inspection and pressure testing should be considered also as they are appropriate.
- When local governments, citizen's groups, or other organizations are conducting stream walks to identify pollution sources, maps or GIS-based information should be made available to assist field workings in assessing streams for signs of periphyton growth or other indicators of leakage in the vicinity of pipe crossings and construction parallel to streams. Where the sewage conveyor also operates a wastewater treatment laboratory, resources should be made available to help field staff test water samples for unusually high levels of bacteria.

Nonprofit and Volunteer Organizations

Adopt-A-Stream Foundation

The Adopt-A-Stream Foundation (AASF) is a non-profit 501(c)(3) organization based in South Everett, WA, next to North Creek, a tributary to the Sammamish River. Its adopted mission is "to teach people how to become stewards of their watershed." http://www.streamkeeper.org/foundation.htm.

AASF carries out its mission by out producing and distributing environmental education materials nationally and internationally, conducting S*treamkeeper Academy*™ events for school and community group audiences throughout the Pacific Northwest, and providing local communities with stream and wetland restoration assistance. In addition, AASF is developing the Northwest Stream Center: a regional environmental

learning facility that has stream and wetland ecology and fish and wildlife habitat as its central themes. AASF's long-term goal is to stimulate everyone to become a *Streamkeeper*™ taking actions necessary to protect and enhance their home watersheds.

The AASF considers clean water an integral part of a healthy spawning and rearing habitat for wild salmon, steelhead, trout, and other wildlife, and a key element to providing natural settings essential for the rest and relaxation for local residents. During the last five years, AASF completed 65-stream and wetland restoration project in the Stillaguamish, Snohomish, and Sammamish watersheds. These projects ranged from stream bank planting to construction of fish ladders to the restoration of a complex three-acre wetland system from a parking lot.

In order to contribute directly to the efforts of this TMDL, AASF plans to perform "environmental audits" of pollution problems in riparian areas throughout the Swamp Creek TMDL area. They hope to develop prescriptions for corrective action and establish partnerships with responsible landowners to carry out prescribed actions. Recently, AASF applied for funding both alone and in conjunction with the SCD to accomplish this work.

Recommended Actions: Ecology recognizes the importance of the activities of the Adopt-A-Stream foundation and makes the following recommendations:

- This TMDL places great value on the proposed audit program. It provides a key component missing from many public education and outreach efforts: direct contact with landowners responsible for water pollution and fish and wildlife habitat degradation. It will also result in partnerships with those individuals that lead to the reduction or elimination of water pollution problems, and the enhancement of fish and wildlife habitat.
- In addition to the audit program, this TMDL encourages funding for other AASF activities that address bacterial pollution in conjunction with efforts to improve dissolved oxygen levels.

Other Watershed Groups and Citizens

Local citizens play a critical role in improving the water quality of Swamp Creek. Through a thoughtful review of one's daily activities, many citizens can have an immediate impact on local water quality by doing certain tasks differently. By preventing car wash water from mixing with stormwater, properly disposing of pet wastes, and avoiding the addition of grass clippings or any other foreign substance into neighboring creeks, the bacteria levels can be reduced. Where feasible, rainwater soaked into lawns and gardens can help feed local streams during the summer or reduce peak flows in the winter. Local citizens can also get involved in stream rehabilitation, communicate their interest in the environment to local elected officials, and educate others on how to improve water quality in Swamp Creek.

Resource constraints prevented state staff from working directly with citizen groups outside the public review process during the development of this plan. Rather, it was envisioned that most local groups will work directly with either their local city or county government, or a regional organization like the Adopt-a-Stream Foundation.

Recommended Actions: This Water Quality Improvement Plan supports the work of watershed groups that seek to improve water quality through community awareness projects, on-the-ground efforts to reduce stormwater runoff/improve stormwater quality and other applicable activities. All government agencies and the Adopt-a-Stream Foundation should work cooperatively with local citizens to improve Swamp Creek.

Local Businesses

Ecology anticipates that education and regulation of local businesses will be performed by local governments. For that reason, Ecology has not conducted outreach outside the public review process during the development of this plan. Most businesses are located in commercial areas with storm sewer coverage and therefore will be addressed through municipal stormwater permits.

Recommended Actions: All local businesses should help to control, and eliminate where possible, pollution originating from their sites. This plan encourages business owners to work in partnership with local government and community groups to promote good stormwater management practices and improve riparian habitat.

How will we fund these water cleanup activities?

There is no single source of funding to get Swamp Creek clean again. In urban areas, local governments will be using money from their wastewater or stormwater management accounts that are funded through the monthly or annual payments of local residents. In some cases, citizens are being encouraged to look into their own budgets as they consider how they will manage pet waste, wash the family car in an environmentally friendly manner, plant trees, or install a rain gardens.

For larger projects, multiple sources of financial assistance are available through Ecology's grant and loan programs, local conservation districts, and other sources. Most of the funding opportunities are competitive and offered on an annual basis. Ecology TMDL staff will work with stakeholders to develop funding applications and prepare appropriate scopes of work that will help implement this TMDL.

Funding is available from a number of the agencies mentioned in this document. The most popular funds used in our area are discussed below. There are many other funding sources, especially for projects that benefit both water quality and salmon.

A good source of information on funding sources is the Catalog of Federal Funding Sources for Watershed Protection Web site. This site provides a searchable database of financial assistance sources (grants, loans, cost-sharing) available to fund a variety of watershed protection projects. To learn more about the federal catalog, use the following link: http://cfpub.epa.gov/fedfund/

An important aspect of gaining funding is to have a clear need identified. It is recommended that you contact the grant specialist for the grant you are considering in order to obtain up-to-date information on current grant priorities, deadlines, and procedures. The following is a partial list of funding opportunities that are popular in western Washington.

Environmental Protection Agency

Environmental Education Grants Program

Education institutions, environmental and educational public agencies, and not-for-profit organizations are eligible for this funding which supports environmental education projects. These grants require non-federal matching funds for at least 25 percent of the total cost of the project. If project requests are $5,000 or less through a Regional Office or $100,000 or less through EPA Headquarters, chances of being funded increase. For more information contact Diane Berger @ (202) 260-8619, berger.diane@epa.gov, or on the Internet @ www.epa.gov/enviroed.

Ecology Funding Opportunities

Centennial/SRF/319 Fund

These three funding sources are managed by Ecology through one combined application program. Centennial and 319 funds are grants and the State Revolving Fund (SRF) is a low interest loan program and each is available to public entities. Grants require a 25 percent match. They may be used to provide education/outreach, technical assistance, for specific water quality projects, or as seed money to establish various kinds of water quality related programs or program components. At the time of this report, grant

funds are generally not available for making capital improvements to private property. However riparian fencing, riparian re-vegetation, and alternative stock watering methods are grant eligible. Eligibility rules can change so one should check at the beginning of each grant cycle. It is recommended that you contact the Ecology Water Cleanup Specialist for your watershed directly to discuss and develop grant proposals.

Low-interest loans are available to public entities for all the above uses, and have also been used as "pass-through" to provide low-interest loans to homeowners for septic system repair or agricultural best management practices (loan money can be used for a wider range of improvements on private property), for instance.
Ecology's grant and loan cycle kicks off in September of each year with public meetings held throughout the state. See Ecology's webpage at http://www.ecy.wa.gov/programs/wq/links/funding.html for more information on Ecology financial assistance opportunities as well as other funding sources.

Coastal Protection Fund

Since July 1998, water quality penalties issued under Chapter 90.48 RCW have been deposited into a sub-account of the Coastal Protection Fund. A portion of this fund is made available to regional Ecology offices to support on-the-ground projects to perform environmental restoration and enhancement. Local governments, tribes, and state agencies must propose projects through Ecology staff. Stakeholders with projects seeking to reduce bacterial pollution are encouraged to contact their Ecology Water Cleanup specialist to investigate fund availability and to determine if their project is a good candidate.

Salmon Recovery Funding Board (SRFB)

The Salmon Recovery Funding Board (SRFB) provides grants to local governments, tribes, nonprofit organizations, and state agencies for salmon habitat restoration, land acquisition and habitat assessments. Funded projects and programs must produce sustainable and measurable benefits for fish and fish habitat. Most projects designed to improve salmon habitat also provide water quality benefits. As of October 2002, the SRFB has provided grants for 517 projects statewide with an accumulated value of $96.4 million.

King County Funding Sources

King County offers a number of grant programs for water quality/salmon habitat related projects. Two of these programs are available to a majority of the Swamp Creek watershed that is served by the King County Wastewater Treatment Division. The programs described below are generally available for projects that occur south of the City of Everett.

WaterWorks

Grants up to $50,000 are available for community projects focused on watershed improvement. Depending on the level of funding needed, one of three application processes apply. There is no deadline for applying for awards less than $500. Application periods vary for larger grants and may change from year to year. See the

King County website at http://dnr.metrokc.gov/wlr/pi/grant-exchange/waterworks.htm for the most up-to-date information.

Splash

The Splash Water Quality Education Fund provides grants up to $15,000 for educational projects related to water quality. The primary activity of the project must be community education. Application process vary depending on the level of funding needed and there is no deadline for applying for awards less than $500. For larger projects, see the King County website at http://dnr.metrokc.gov/wlr/pi/grant-exchange/splash.htm.

The Public Involvement and Education (PIE) Program

The PIE program is administered by the Puget Sound Action Team. PIE dollars help citizens, schools, businesses, non-profits, local and tribal governments to:

- Create solutions to local pollution problems
- Protect, preserve and restore habitat
- Motivate people to be environmental stewards
- Partner with others for lasting results

PIE is not a grant program. Instead, through personal services contracts, the Puget Sound Action Team obtains the services of individuals and organizations to educate and involve residents of Puget Sound as they carry out the 2005 - 2007 Puget Sound Water Quality Work Plan. The Action Team staff provides guidance on fulfilling a state contract as well as technical assistance related to the project.
If you would like to receive notification of PIE funding opportunities, e-mail or phone your contact information to gwilliams@psat.wa.gov, 360-407-7311. To help you decide if PIE is the right program to fund your project, read through the current and past PIE project descriptions .

Snohomish Housing Authority

The Snohomish Housing Authority is an independent agency that helps build stronger communities by providing affordable housing and assisting low-income residents in maintaining their homes through low interest loans. When low-income residents face the challenge of replacing a failing septic tank, SHA assistance may be an option. Borrowers need to be moderately low income; a family of two with income less than $45,000 or a family of four with income less than $56,000. Homeowners making less than $30,000 may be eligible for 0 percent loans. The home must be owner-occupied with a 20 percent equity stake and the housing authority loan must be in 2nd position. The maximum loan is $40,000 for 30 years at 3 percent interest. You can contact the Snohomish Housing Authority by calling 425-290-8499 or at http://hasco.org.

Measuring Progress toward Goals

The progress of this Water Quality Improvement Plan will be measured by 1) assessing the pollution control activities underway or completed and 2) direct measurement of water quality. The goal is for all areas of Swamp Creek to consistently meet the Washington State Water Quality Standards for bacteria. Ecology anticipates that if state and local coordination proceed as expected, by December 2012 each of the sampling stations within the Swamp Creek watershed will meet the state bacteria standards for primary contact recreation. Compliance with the extraordinary primary contact standards are anticipated by 2017. These two measures of progress are discussed in more detail below.

Documenting Pollution Control Activities

In order to gauge the progress of this TMDL, Ecology will convene a meeting of municipal stakeholders no less than annually to share information on the state of water quality in the watershed and status of implementation activities. Water quality data, trends (where applicable), regulatory changes, new and innovative concepts, and funding sources will be discussed to evaluate the overall status of the TMDL. Ecology will solicit input from the workgroup at this time to help direct the adaptive management of this TMDL. Ecology will track implementation no less than annually using the tracking table in Appendix E and through municipal stormwater permit program audits.

Direct Measurement of Water Quality

An essential part of this water cleanup effort is the monitoring of surface waters and identification of potential pollution sources. Monitoring is needed during all phases of the TMDL to identify polluted areas, contributing sources, and to verify that corrective actions have been, and remain effective in protecting local waters. Three types of water quality monitoring are needed to implement the Swamp Creek Water Quality Improvement Plan:

- TMDL Effectiveness Monitoring (required)
- Source Detection Monitoring (recommended)
- Special Purpose Studies (recommended)

Each of these monitoring strategies is discussed below.

TMDL Effectiveness monitoring

TMDL Effectiveness monitoring tells us whether or not bacteria levels in Swamp Creek are decreasing. This can be accomplished in two ways: 1) by directly measuring the reduction of pollutants from individual pollution sources or 2) by indirectly measuring the success of this plan by monitoring water quality in Swamp Creek and its tributaries. This Plan will require NPDES permit holders to conduct effectiveness monitoring using one of these options. Ecology will conduct effectiveness monitoring to determine whether this TMDL is working. This Water Quality Improvement Plan recommends that Ecology use option two above.

Ecology Monitoring: The timing of Ecology's monitoring will depend upon the pollution parameters addressed in the TMDL, the period after which positive results should be identifiable, and the availability of resources. Ecology hopes to accomplish this approximately once every five years. Effectiveness monitoring priorities will be selected by each regional office and verified through the annual scoping process. Ecology will use all available sources of data when effectiveness monitoring is initiated.

In order to be thorough in accomplishing this task, monitoring personnel in Ecology's Environmental Assessment Program (EAP) will follow a review sequence. For this Water Quality Improvement Plan, the EAP will contact the regional office TMDL coordinator to determine the status of the TMDL implementation plan and what ongoing monitoring has been initiated as part of implementation activities. On completion of these steps, an examination of the resulting data will be made and a water quality status determination will be announced for the water body in an advisory memorandum followed by a technical report.

NPDES Monitoring: This TMDL requires municipal stormwater permit holders to monitor and report on permit-related actions to reduce bacteria levels and to perform water quality monitoring. Several water quality monitoring options exist and any one of them will contribute to our future ability to understand pollution levels in Swamp Creek and perform adaptive management as needed.

Source Detection Monitoring

Source detection monitoring is used to pinpoint suspected pollution sources. It allows local government and private groups to focus BMP implementation resources where they are needed most. Source detection monitoring is used when pollution sources are not obvious and additional data is needed to track down the unknown or suspected causes. Events that typically trigger the need for targeted monitoring include:

- When ambient water quality monitoring has identified high bacteria levels on either a consistent or a sporadic basis.
- Where potential sources of fecal coliform bacteria are identified and need to be verified. Examples of potential problem areas include poorly managed animal confinement/recreation areas, failing onsite septic systems, or illicit discharges.

When high bacteria levels are observed, additional sampling can help to track the bacteria source down to a discrete geographic area. Ecology and/or local government will review the data and determine how to proceed to control the source(s). This Water Quality Improvement Plan supports funding for targeted monitoring programs to identify pollutant sources and develop programs to reduce or eliminate those sources.

Special Purpose Studies

In some cases, special purpose monitoring studies may be needed to support the goals of this TMDL. There is a great need to improve the efficiency, accuracy, and the scope of water quality monitoring with respect to bacterial source control. Potential areas for special studies that have been identified at this time are as follows:

- Evaluating the success of individual projects to determine BMP effectiveness.

- New techniques for source tracking such as DNA ribotyping, antibiotic resistance, bacteriodes testing, optical brightener testing, etc….
- Effects of sediment archiving where BMPs have been applied and other obvious sources have been addressed.
- GIS-, or landscape scale analyses that include monitoring for model or process verification or pollution source identification (e.g., identifying areas with a high potential for the presence of failing septic tanks).
- Effect of nutrient inputs on bacteria survival and regrowth.

Figure 14. Water Quality Monitoring. Monitoring surface water helps us find where pollution is coming from and whether or not our implementation efforts have been, and continue to be, effective in protecting local streams.

Reasonable Assurance Strategy

When establishing a TMDL, reductions of a particular pollutant are allocated among the pollutant sources (both point and nonpoint sources) in the water body – for the Swamp Creek Watershed and its bacterial pollution problem, both point and nonpoint sources exist. Water Quality Improvement Plans must show "reasonable assurance" that these sources will be reduced to their allocated amount. Education, outreach, technical and financial assistance, permit administration, and enforcement will all be used to ensure that the goals of this water clean up plan are met.

Ecology believes that the following activities will lead to the successful implementation of this Water Quality Improvement Plan and add to the assurance that bacteria levels will be reduced to meet state standards.

NPDES Permit Programs

Eight NPDES permittees will be directly affected by this TMDL. Ecology's municipal stormwater permit program will address stormwater pollution from unincorporated Snohomish County and from the cities of Everett, Lynnwood, Bothell, Kenmore, Brier, Mountlake Terrace, and the WSDOT. Water cleanup activities from these entities are discussed elsewhere in this document. Although bacterial contributions from industrial sources was not identified as part of this plan, it is possible that the industrial permit program could be affected in the future with changes in the watershed's business community. TMDL-related permit conditions will be adaptively managed every five years at the time of permit reissuance.

Ecology Funding Programs

Ecology has a Centennial Grant program that is widely used to help fund water cleanup activities. Ecology is assisting Snohomish County to fund three projects that will eventually contribute to the reduction of bacterial pollution in Swamp Creek: Animal Waste Control Project, the North Creek Stormwater Management Project, and the Onsite Septic Management Program. These efforts are focused in other TMDL areas but will provide valuable outreach tools, strategies, and other information that should be used in other urban areas in Washington State.

Currently, the Snohomish Conservation District and the Adopt-A-Stream Foundation have applied to Ecology for funds to perform TMDL-related activities within the Swamp Creek watershed. If fencing and riparian restoration projects are identified, stakeholders can also work with the Swamp Creek Water Cleanup Specialist to explore funding through the Coastal Protection Fund.

Other Water Cleanup Activities

In addition to regulatory and grant funding programs in place through the Department of Ecology, there are other water cleanup activities underway, which were detailed earlier in the "What will be done. Who will do it" section of this document. Among the participating entities not regulated by Ecology are Snohomish Health District, Snohomish Conservation District, and the Adopt-a-Stream Foundation.

Adaptive Management

The Swamp Creek Water Quality Improvement Plan will use an adaptive management approach to ensure the progress and overall success of this plan. It calls for evaluating whether BMPs are effective at causing Swamp Creek to attain water quality standards after five years of implementation activities. Following the successful implementation of BMPs and adequate sampling representing all climatological, hydrological, and land use characteristics, a reassessment of compliance with water quality standards can be made.

When water quality criteria for fecal coliform bacteria are met then the objectives of this TMDL are met and no further reductions or additional BMPs are needed.
For the first five years following approval of this plan the emphasis will be on implementation of BMPs through the municipal stormwater permits, grant funded programs, and the development of monitoring programs. As fecal coliform source control measures and activities are successfully completed, the implementation of this plan will be based on the adjustment of source control efforts throughout the watershed as determined by ambient water quality monitoring. If new fecal coliform sources are found that were not previously identified, they will be corrected through appropriate jurisdictions.

Enforcement

The Water Pollution Control Act (chapter 90.48 RCW) provides broad authority to issue permits and regulations, and to prohibit illegal discharges to surface water. It designates Ecology as the state water pollution control agency for all the purposes of the federal Clean Water Act. The act openly declares that it is the policy of the state to maintain the highest possible standards to ensure the purity of all waters of the state and to require the use of all known, available, and reasonable means to prevent and control water pollution. The act defines waters of the state and pollution and authorizes the Department of Ecology to control and prevent pollution, to make and enforce rules, including water quality standards. Under this statute, Ecology is authorized to administer wastewater disposal permits and to require prior approval of plans and methods of operation of sewage or other disposal systems.

Local governments are expected to continue exercising their authority to enforce their ordinances. Ecology will encourage local government to enforce local ordinances pertaining to stormwater discharge or water quality where in effect and applicable. Ecology will also be conducting audits of municipal stormwater permit programs and enforcement is an element of those permits.

Public Involvement

Ecology staff met in person, or contacted by phone, a number of key stakeholders in the Swamp Creek Watershed during the period August 2005 through March 2006. Ecology requested that Snohomish County and the future Phase II permittees convene to form the Swamp Creek Municipal Workgroup to facilitate discussions on the development of the TMDL and provide input. Meetings of the municipal workgroup were held on the following dates:

- December 20, 2006
- February 9, 2006
- March 2, 2006
- March 23, 2006

A public meeting was held on April 18, 2006, at Lynnwood City Hall. Display ads were published in several local papers.

Public meeting flyers were distributed at various schools and other locations in the watershed and email announcements were made to citizens and government officials known to have an interest in water quality issues in Swamp Creek.

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Appendix A: Acronyms and Glossary

303(d) list: Section 303(d) of the federal Clean Water Act requires Washington State periodically to prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality limited estuaries, lakes, and streams that fall short of state surface water quality standards, and are not expected to improve within the next two years.

Best Management Practices (BMPs): Physical, structural, and/or operational practices that, when used singularly or in combination, prevent or reduce pollutant discharges.

Clean Water Act (CWA): Federal Act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the CWA establishes the TMDL program.

Designated Uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each water body or segment, regardless of whether or not the uses are currently attained.

Effective Shade: The fraction of incoming solar shortwave radiation that is blocked from reaching the surface of a stream or other defined area.

Enterococci: A subgroup of the fecal streptococci that includes S. *faecalis*, *S. faecium* , *S. gallinarum* and *S. avium*. The enterococci are differentiated from other streptococci by their ability to grow in 6.5% sodium chloride, at pH 9.6, and at 10 degrees C and 45 degrees C.

Existing Uses: Those uses actually attained in fresh and marine waters on or after November 28, 1975, whether or not they are designated uses. Introduced species that are not native to Washington, and put-and-take fisheries comprised of nonself-replicating introduced native species, do not need to receive full support as an existing use.

Extraordinary primary contact: Waters providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.

Fecal Coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within twenty-four hours at 44.5 plus or minus 0.2 degrees Celsius. FC are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100mL).

Geometric Mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from ten to 10,000 fold over a given period. The calculation is performed by either: 1) taking of the nth root of a product of n factors, or 2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Load Allocation (LA): The portion of a receiving waters' loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources.

Loading Capacity: The greatest amount of a substance that a water body can receive and still meet water quality standards.

Municipal Separate Storm Sewer Systems (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains): (i) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body having jurisdiction over disposal of wastes, storm water, or other wastes and (ii) designed or used for collecting or conveying stormwater; (iii) which is not a combined sewer; and (iv) which is not part of a Publicly Owned Treatment Works (POTW) as defined in the Code of Federal Regulations at 40 CFR 122.2.

Margin of Safety (MOS): Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving water body.

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Nonpoint Source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the National Pollutant Discharge Elimination System Program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

Pathogen: Disease-causing microorganisms such as bacteria, protozoa, viruses.

Phase I Stormwater Permit: The first phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to medium and large municipal separate storm sewer systems (MS4s) and construction sites of five or more acres.

Phase II Stormwater Permit: The second phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to smaller municipal separate storm sewer systems (MS4s) and construction sites over one acre.

Point Source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to the public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish, or other aquatic life.

Primary contact recreation: Activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing.

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, saltwaters, wetlands and all other surface waters and water courses within the jurisdiction of the state of Washington.

Total Maximum Daily Load (TMDL): A distribution of a substance in a waterbody designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: 1) individual wasteload allocations (WLAs) for point sources, 2) the load allocations (LAs) for nonpoint sources, 3) the contribution of natural sources, and 4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Wasteload Allocation (WLA): The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. WLAs constitutes one type of water quality-based effluent limitation.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Appendix B: Water Quality Study

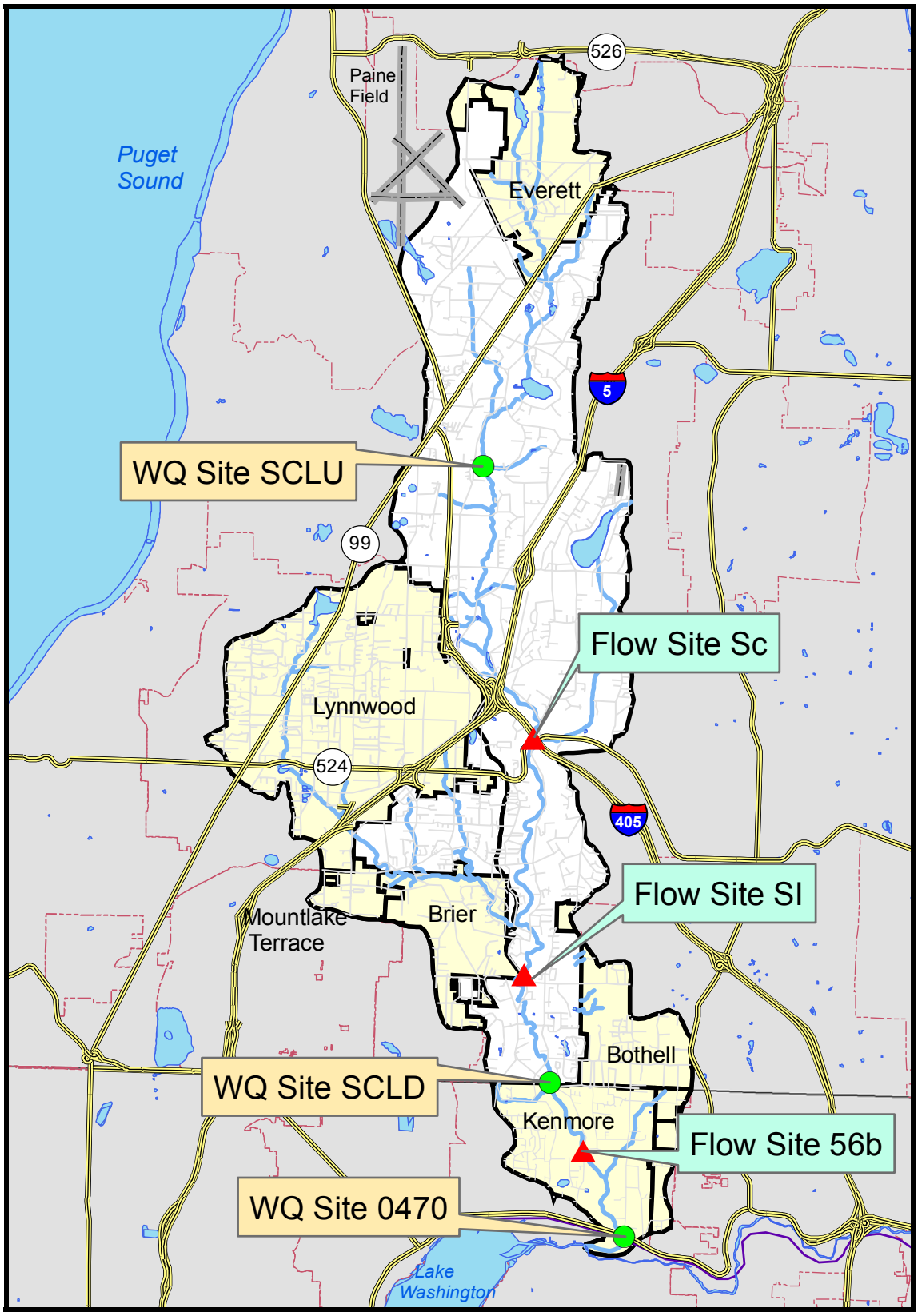


Figure 1. Monitoring locations used for setting TMDL allocations. Circles indicate water quality monitoring stations, triangles indicate flow monitoring points.

Total Maximum Daily Load Analysis

The Washington State Department of Ecology (Ecology) believes that actions must be taken to reduce bacteria levels in Swamp Creek. The high bacteria levels have been measured in multiple locations in the creek. This indicates that the risk of becoming ill is higher than allowed by the state for people that come in contact with the polluted water.

Geometric Mean Value	90th Percentile Value
50 cfu/100 mL	100 cfu/100 mL

Table 1. Washington State Water Quality Standards for Bacteria—Extraordinary Primary Contact.

There are two "yardsticks" that we use to gauge whether or not bacteria levels are too high in Swamp Creek (Table 1). The first is a **geometric mean**, which is similar to an average. The second is the 90th percentile value. The 90th percentile value indicates where the upper 10 percent of sample values starts. We use this second yardstick because bacteria levels go up and down even in a healthy stream. Allowing for some variability makes sense. The key is not to let bacteria levels get too high! The 90th percentile value sets the upper limit for that variability.

In addition to these concerns, Section 303 of the Clean Water Act (CWA) mandates that a Total Maximum Daily Load (TMDL) be developed when we know that a lake, stream, or other waterbody is polluted. In Washington State, Ecology is responsible for preparing that TMDL.

This appendix is part of the Swamp Creek Fecal Coliform Total Maximum Daily Load Water Quality Improvement Plan (*Water Quality Improvement Plan*). Washington State has a three-step Water Cleanup Process (see Figure 2). This appendix represents **Step 1** of the process. More information on Ecology's three-step Water Cleanup Process can be found at the beginning of this report.

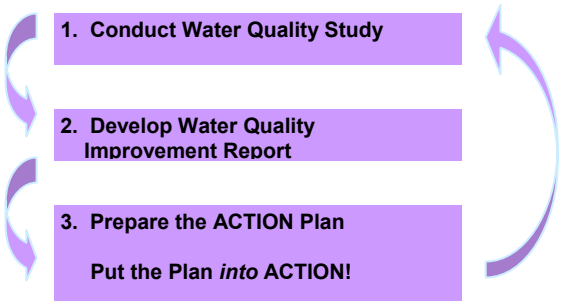


Figure 2. The TMDL Process. When a waterbody is polluted, federal law requires the development of a TMDL plan. Ecology's 3-step process has been combined into one for Swamp Creek creating the "Swamp Creek Water Quality Improvement Plan."

This portion of the Water Quality Improvement Plan describes how Ecology prepared the fecal coliform bacteria TMDLs for the Swamp Creek Watershed. In the following pages, Ecology will discuss the following topics and steps that led to setting the Swamp Creek TMDL:

- Overview of the TMDL Allocation Process
- Existing bacteria levels in Swamp Creek
- Numeric goals for a cleaner Swamp Creek (setting the Loading Capacity)
- Setting the Load Allocations (LAs) and Wasteload Allocations (WLAs)
- Establishing the Margin of Safety (MOS)

Establishing the Loading Capacity

1) **Wasteload Allocation (WLA)**: This represents the contribution of discrete "point" sources of pollutants (e.g., municipal, industrial, and construction stormwater discharges);

2) **Load allocation (LA)**: This represents "nonpoint" sources of a pollutant, (natural sources, most agricultural activities, and other sources that are not regulated by an Ecology permit); and

3) **Margin of safety (MOS):** This allows for uncertainty in the estimation of, and ability to achieve, the previous two allocations.

Thus, the TMDL equation is as follows:

TMDL = WLA + LA + MOS.

The sum of these three components is also called the **Loading Capacity**.

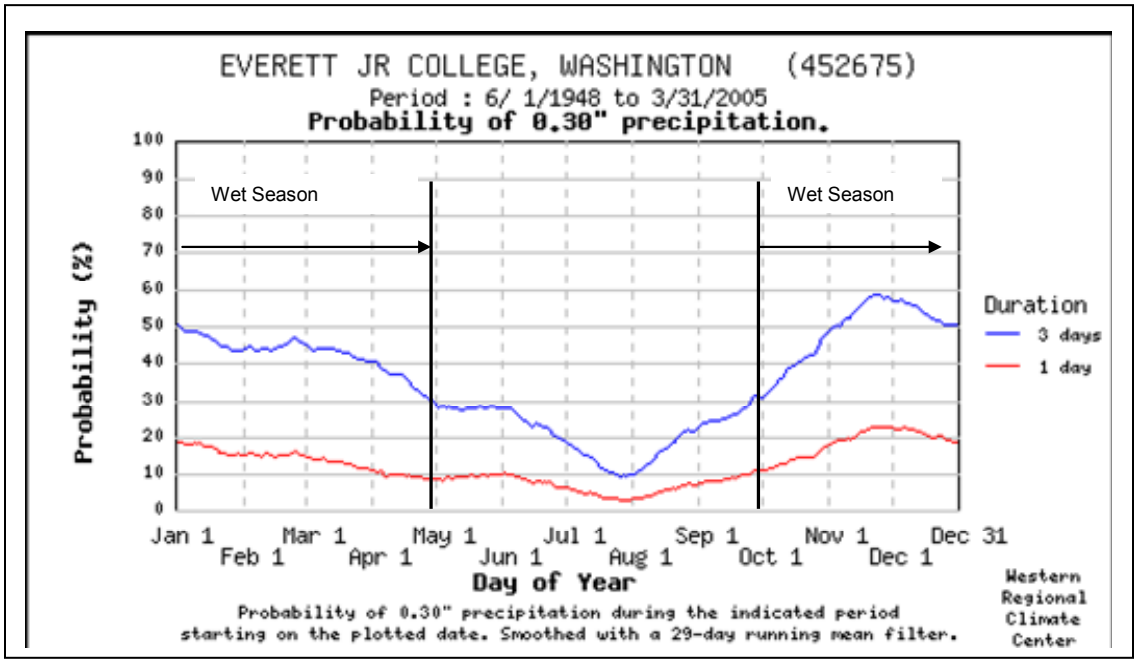


Figure 3. Determining the seasonal period for the Swamp Creek Watershed. Data from the Western Regional Climate Center for the weather station at Everett Jr. College indicates that there is a 30% chance of a 0.3" rainfall event over 3 days during the period October 1 through April 30. This criterion was used to set the seasonal periods for the Swamp Creek TMDL.

Overview of the TMDL Allocation Process

Simply put, the TMDL is the maximum amount of a pollutant that a waterbody can accept before there is a loss of beneficial uses (e.g., swimming, boating). In common usage, the term TMDL is also used to describe the entire process for cleaning up an impaired waterbody. For our purposes in this section it refers to a discrete amount of pollution, or load, that is divided into three components; the **wasteload allocation**, the **load allocation**, and the **margin of safety**.

How do you measure a TMDL? TMDLs are frequently measured in terms of mass such as "lbs/day" or "kg/day." In the case of bacteria, that becomes a little trickier because scientists typically do not measure bacteria by weight. Federal regulations do allow expression of TMDL loads using "other appropriate measures" (40 CFR 122.45(f), 40 CFR 122.30.2(f)). Because fecal coliform bacteria are counted in "colony forming units (cfu) per 100 milliliters (mL)[8]," this TMDL will use that same approach to keep the goal of the TMDL as clear as possible…"to return Swamp Creek to a level at or below the state criteria for allowable bacteria levels." Defining allocations in these terms will also make complicated computations unnecessary and future monitoring data can be used directly to measure the effectiveness of the Swamp Creek Water Quality Improvement Plan.

TMDLs must consider seasonal variation. Weather can play an important role in the quality of our local streams. For that reason, the Clean Water Act Section 303(d)(1)(C) requires that TMDLs "…be established at a level necessary to implement the applicable water quality standards with seasonal variations…." The regulation also states that "TMDLs shall take into account critical conditions for stream flow, loading, and water quality parameters" [40 CFR 130.7(c)(1)].

Ecology determined the seasonal period in Swamp Creek using precipitation data from the Western Regional Climate Center (WRCC 2005). The closest weather station with a long term set of precipitation records was located at Everett Jr. College. This station is close to the Swamp Creek Watershed, not separated by any major land mass or other significant geographic features, and should closely resemble the precipitation in the Swamp Creek area. Rain events of 0.3" or more occur at a higher probability during the months October through April (Figure 3). Therefore, October through April has been defined as the wet season. Conversely, rain events were less likely the rest of the year so dry weather is defined to occur during May through September.

What other factors are considered in setting the TMDL? In addition to understanding seasonal variation, Ecology must examine the existing levels of pollution and discuss where it is coming from. In the next section of this Appendix, Ecology will explain these issues, determine how much bacteria Swamp Creek can accept before it is considered polluted (loading capacity), and where those allowable levels of bacteria will come from.

[8] The term "colony forming units" refers to the number of bacteria colonies that grow in a Petri dish after 100 milliliters (mL) of stream water is filtered and tested on the dish. 100 mL is almost half a cup (0.42 cups to be more exact).

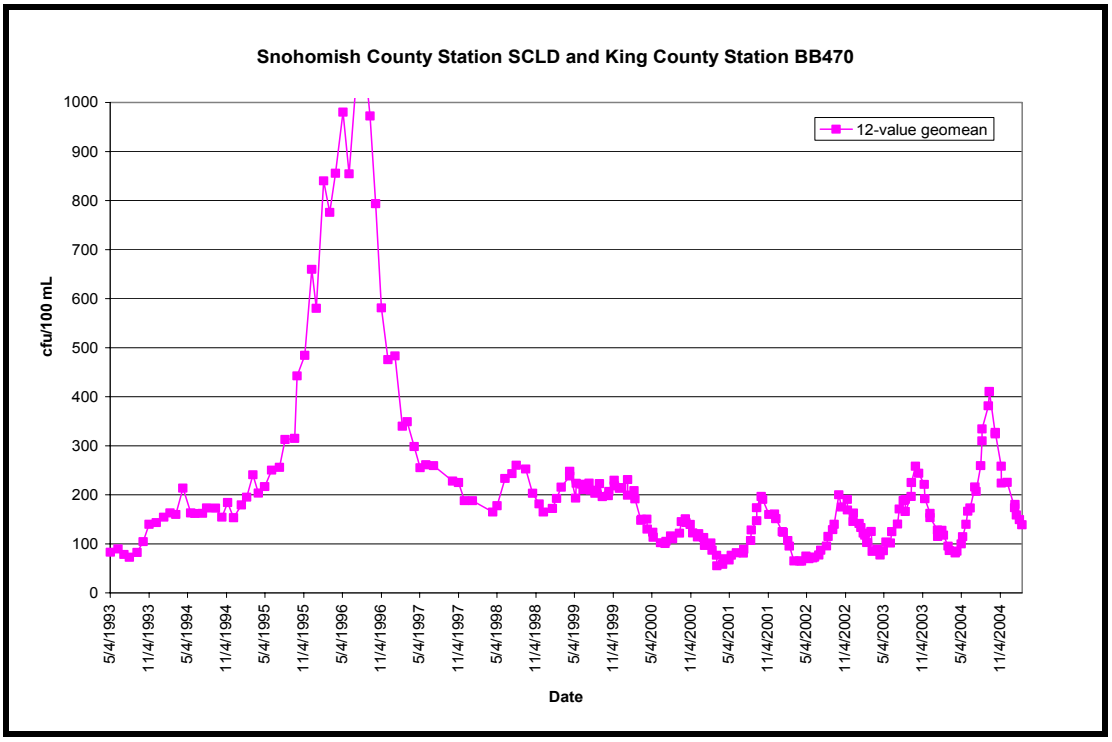
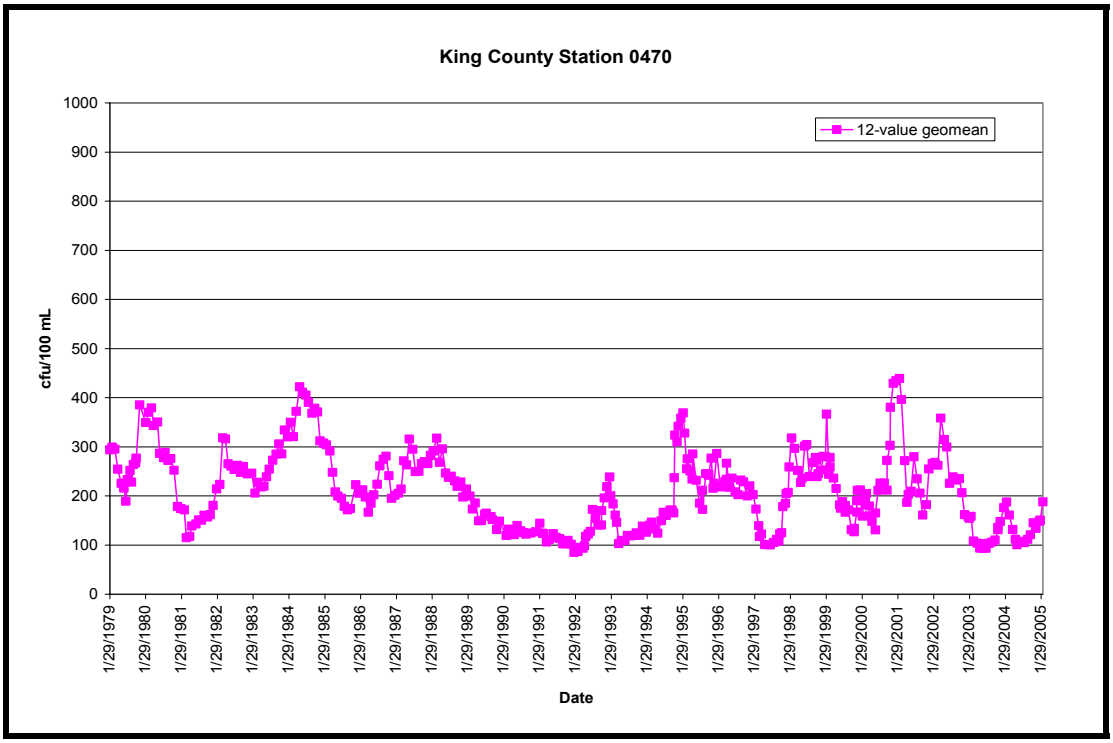


Figure 4. Long term data analysis for station SCLD/BB470. Bacteria levels were much higher during the mid-1990's for monitoring station SCLD/BB470 near the Snohomish/King County line (top figure). Conversely, bacteria levels at Station 0470, which is closer to the mouth of Swamp Creek, have been more stable (lower figure). Data for upper Station SCLU is similar to 0470.



Existing Bacterial Pollution Levels

What data were used? Ecology evaluated water quality and quantity data collected by Snohomish County Surface Water Management Division (SCSWM 2005) and King County Water and Land Resources Division (KCWLRD 2005a) to characterize bacteria levels in the Swamp Creek Watershed. Long term water quality data sets are available for Swamp Creek at the three locations shown in Figure 1, Stations SCLU, SCLD, and 0470. These stations characterize the upper, middle, and lower portions of the basin, respectively. Data were then analyzed to determine the geometric mean value[9] (GMV) and the 90th percentile bacteria concentrations to assess compliance with state standards.

Looking over many years, the pattern of bacteria levels varied among the long term water quality monitoring sites. At station 0470 bacteria levels fluctuated within a consistent range for the entire period of record (Figure 4). Station SCLU data showed similar fluctuations (data not shown). In contrast, a significant change in water quality occurred at SCLD during the mid 1990's. A consistent pattern emerged at station SCLD around 2000. For that reason, Ecology has used data from 2000 through early 2005 to characterize pollution levels at each of the three TMDL compliance points.

Although monitoring data were available from several more stations, the lack of flow monitoring stations to determine loadings in the proximity of those sites and small number of samples taken at each site, made that data unsuitable for this analysis. The use of these three long-term stations spread out along the main stem of Swamp Creek provides the most comprehensive picture of water quality in the basin.

How polluted is Swamp Creek now? Water measured at all three stations exceeded state criteria for bacteria at all times of the year (Table 2); therefore, there is no critical period. During the dry summer months when stream flows are low, bacteria levels rise far beyond both the geometric mean criterion of 50 cfu/100 mL and the 90th percentile criterion 100 cfu/100 mL. During the wetter months of the year, bacteria concentrations improve at each site, but not enough to meet state standards. Because state bacteria standards were consistently exceeded, it is necessary to establish TMDLs for each of the three long-term water quality monitoring stations.

Should the TMDL establish seasonal targets? Ecology determined that seasonal TMDL targets are needed at each station for two reasons. First, there is variation in bacteria levels attributable to seasonal variation. Bacteria concentrations are generally two to three times higher in the summer than the winter for both the geometric mean and 90th percentile values across all stations (Table 2). Although concentrations are higher during dry weather, the total number (loading) of bacteria is higher (increase of 38 to 293%) in the winter (Table 3). Although dilution from groundwater and other inputs increases the creek's loading capacity, concentration-based limits are still being exceeded.

Second, municipal stormwater is a pollution source during the wet season. Federal regulations require wasteload allocations be developed as part of a TMDL when NPDES-regulated stormwater discharges are present (40CFR130.2(h)).

[9] Log normalized values were used to determine both geometric mean and 90th percentile bacteria concentrations.

Table 2. Current bacteria levels and reduction targets. Ecology determined that both the geometric mean value (GMV) and 90th percentile values are too high during both wet and dry seasons. Target Percent Reductions show the amount of improvement needed. The highest levels of reduction are highlighted in bold.

Swamp Creek Sampling Site	Water Quality Standard		Current Conditions				Target Percent Reductions			
			Dry		Wet		Dry		Wet	
	GMV	90th %tile	GMV	90th %tile	GMV	90th %tile	GMV	90th %tile	GMV	90th %tile
Upper Swamp Creek (SCLU)	50	100	343	2,688	66	636	85.4	***96.3***	24.4	***84.3***
Middle Swamp Creek (SCLD/BB470)	50	100	176	459	86	310	71.7	***78.2***	42.2	***67.8***
Lower Swamp Creek Midstream (0470)	50	100	300	1,260	131	674	83.3	***92.1***	61.7	***85.2***

Table 3. Swamp Creek Loading Estimates for Dry and Wet Seasons. Two factors greatly influence the numbers of bacteria that can be in Swamp Creek over time: Flow and concentration. The average seasonal flows change a lot—there is much less water during the dry weather season. Although there is a lot more water in the winter, there are also more bacteria present at that time.

Drainage Area (acres)	Season	Average Seasonal Flow (cfs)	WQ Standard (90th %tile) cfu/100mL	Current Condition (90th %tile) cfu/100mL	Estimated Loading Capacity (cfu/day)	Current Loading (cfu/day)	Current loading increase during the wet season
Loading at SCLU							
3711	dry	3.7	100	2688	8.95E+09	2.41E+11	-----
3711	wet	21.2	100	636	5.20E+10	3.31E+11	38%
Loading at SCLD							
13933	dry	9.2	100	459	2.26E+10	1.04E+11	-----
13933	wet	40.2	100	310	9.83E+10	3.05E+11	293%
Loading at 0470							
15282	dry	11.6	100	1260	2.84E+10	3.58E+11	-----
15282	wet	46.2	100	674	1.13E+11	7.62E+11	213%

How Much Bacteria can Swamp Creek Accept? (Loading Capacity)

As discussed earlier, the Washington State Water Quality Standards (WAC 173-201A) set the allowable levels of bacteria for state waters. In Swamp Creek, those levels are 50 cfu/100 mL GMV and 100 cfu/100 mL for the 90th percentile value. These numbers are based on concentrations of bacteria.

The total allowable number of bacteria in all of Swamp Creek varies depending on how much water is present. When there is more water in the stream, there is more room for bacteria, when there is less water, less bacteria can be added. Bacteria added to Swamp Creek above and beyond the state standards must be removed. This TMDL looks at both the loading (total number of bacteria) and the concentration (number of bacteria per 100 mL) to understand pollution levels.

Determining the maximum amount of bacteria that Swamp Creek can handle. (Setting the Loading Capacity). There are several ways to estimate the number of bacteria in Swamp Creek. For example, numbers of bacteria can be counted over a day, month, or year. Ecology used the following method to estimated the daily bacteria loads in Table 3:

Seasonal Flow[10] (ft^3/second)	x	*Bacteria Concentration Level (cfu/100 mL)*	x	*Conversion Factor (2.447×10^7)*	=	*Number of Bacteria per day*

Knowing the loading of bacteria provides an extra tool for understanding how bacteria are distributed in a watershed. It is also necessary to look at the concentration of bacteria to determine compliance with state standards. Because the waters of Swamp Creek should never exceed state criteria, concentration levels are sometimes used as a surrogate measure for the loading capacity. In the Swamp Creek TMDL, we used both measures to explain the TMDL goals, or targets, for improvement. Looking at either the daily number of bacteria, or the concentrations in a set of representative samples, the percentage reduction needed is the same.

What is the goal of this TMDL? (Setting the TMDL Target) Because there are two different criteria for bacteria in state standards, Ecology needed to quantitate how large the reduction would be under each scenario. As shown in Table 2, the largest reduction needed under dry or wet conditions, at each water quality monitoring station, was the 90th percentile criterion. The largest reduction was chosen as the goal for this TMDL and thus the target values for this TMDL are based upon achieving the instream bacteria concentrations of 100 cfu/100 mL at each of the TMDL compliance points.

[10] Average daily flow information was obtained from directly from King County (KCWLRD 2005b) and from the Snohomish County Surface water website (SWM 2005) at the stations shown earlier in Figure 1.

Definitions:

Nonpoint Source: Pollution that enters a local stream from dispersed land-based or water-based activities. Some good examples are livestock defecating in a stream, a failing septic tank, or the dumping of human waste off of a boat while it is in the water. These activities are very hard to count and add up because they can occur in so many locations.

Point Source: Sources of pollution that discharge at a specific location from pipes (also called outfalls) or conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than one acre of land. Ecology issues permits to anyone with a point source discharge, which greatly helps us understand and control pollution from these sources.

Figure 5. Distributing pollution between types of sources. Septic tanks, leaky sewer lines, pet waste, and wildlife are all possible sources of bacterial pollution. This Water Quality Improvement Report does not detail the individual contribution of these sources. Instead, it describes the contributors in a general way using the terms “Point Source” and “Nonpoint” source.

Setting the Load and Wasteload Allocations

So far, this section of the Swamp Creek Water Quality Improvement Plan has shown the current level of pollution in Swamp Creek (current geometric mean and 90th percentile values), how clean the creek should be (water quality standards), and how much bacterial pollution it can absorb and still meet state standards (the Loading Capacity). It was also determined that there are seasonal variations in stream bacteria levels. The final step in establishing the TMDL is to estimate where the excess pollution is coming from and to develop load and wasteload allocations as needed for the dry and wet weather seasons.

Where is the pollution coming from? In an ideal world, a Water Quality Improvement Plan would pinpoint each and every source of pollution. That would allow us to immediately focus on the most cost-effective solutions to clean up a watershed. In the case of bacterial pollution, we know that the sources are usually failing septic tanks, improper management of animal waste, leaky sewer lines, and wildlife. Unfortunately, urban watersheds are very complex and contain many potential pollutant sources making detailed quantifications of sources difficult. The main body of this Water Quality Improvement Plan discusses our basic knowledge about urban bacteria sources.

Point Sources versus Nonpoint Sources. Although this TMDL does not provide a high level of detail on the sources of bacterial pollution in Swamp Creek, it will broadly distribute pollution into "point" and "nonpoint" source categories (Figure 5). Point sources are locations were pollution can enter local streams by pipes or channels owned or operated by municipal government or businesses. Ecology regulates discharges from these locations (also called outfalls) through its National Pollutant Discharge Elimination (NPDES) permit program.

Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than one acre of land. When a TMDL is in place, Ecology must address TMDL-required wasteload allocations through its permit program (40CFR130.2(h)).

Wet Weather means Stormwater. The hydrology of urban watersheds like Swamp Creek is significantly affected by traditional stormwater management strategies. Due to the sudden increase in water brought on by the efficient movement of water off roads, roof tops, and parking lots and into Swamp Creek, stormwater loads account for much of the hydraulic and pollutant loadings to the creek during much of the wet season. Stormwater is largely managed by storm sewer systems but can also flow off the land directly into surface water carrying pollutants from animals and failing septic systems.

This TMDL assumes that the seasonal variation in Swamp Creek bacteria levels is affected greatly by two factors during the wet weather season: 1) relatively high water tables and saturated soils, and 2) the increased supply of stormwater as a result of impervious surface associated with extensive urban growth. With urbanization comes a high level of stormwater management through the use of municipal separate storm sewer systems (MS4s), which are regulated by Ecology's NPDES program.

Ecology also assumes that the critical condition for pollutant loadings during the wet season in Swamp Creek occurs during precipitation events. There are a number of municipal entities that operate MS4s that will be discussed below. Because bacterial

pollution is known to be present in high amounts in municipal stormwater, each of these entities will be receiving **wasteload allocations**. No industrial facilities under permit by Ecology were identified as being significant contributors of bacteria as part of this TMDL.

Dry Weather Pollution. Although MS4s could be contributing some pollution during dry weather periods, there is little stormwater being generated so the main source of bacteria pollution is likely from "nonpoint" sources. These could include failing septic tanks, improperly managed animal wastes, excessive concentrations of wildlife, and perhaps leaky sewer lines. For these sources of pollution not regulated by a permit, this TMDL will establish **load allocations** specific to the dry season.

Putting it all together. The Swamp Creek Watershed TMDL recommends general load allocations for nonpoint sources and specific wasteload allocations for municipal stormwater permit holders (Snohomish County, Washington State Department of Transportation (WSDOT), cities of Everett, Lynnwood, Kenmore, Brier, Mountlake Terrace, and Bothell). The load allocations represent the cumulative loading from all nonpoint sources and are established for both the dry and wet seasons.

Flow data from stations Sc, Sl, and 56b were used with bacterial concentration data for water quality monitoring stations SCLU, SCLD, and 0470, respectively. This combination of flow and concentration data provided the best loading relationships given the available data.

Wasteload allocations are derived for all relevant point sources with current NPDES permits or those that will be permitted in the near future. Ecology established wasteload allocations by taking into account the water quality monitoring data, land use information, and precipitation data. Wasteload allocations are established for the wet season.

Bacteria loads can vary greatly due to ever-changing flows, the tendency of bacteria to attach to particles, and the natural variability in bacteria numbers. Thus, it is difficult to assign fixed allocations for wasteloads and nonpoint loads. Instead, Ecology recommends water quality based allocations that reflect the expected reduction of bacteria under defined flow conditions. This approach allows compliance with the TMDL to be measured more easily by directly determining compliance with state water quality standards. Taken together, the allocations must not exceed the loading capacity for each water body. Load and wasteload allocations are discussed in detail below.

Dry Weather Load Allocations

Load allocations pertain to nonpoint sources discharging directly to state waters, and not to municipal stormwater conveyance systems such as roadside ditches or urban storm sewers. Information on the relative contributions from the various nonpoint sources contributing to water quality concerns in the Swamp Creek watershed did not allow for development of specific load allocations by source type at this time. Source identification monitoring during implementation of the Water Quality Improvement Plan will help identify the various pollution sources, their relative contribution in the watershed, and the proper corrective actions to control those sources.

Load allocations for the Swamp Creek watershed were developed as target percent reductions at each of the three water quality monitoring stations in Figure 1 and are shown in Table 4. A ten percent margin of safety is established for each TMDL compliance point.

Table 4. Dry Season Load Allocations and TMDL targets. Different levels of reduction are needed at each TMDL compliance point. The load allocations are expressed as percentage load reductions. The total Estimated Loading Capacity (expressed in number of bacteria per day) can be found in Table 4.

Current Conditions		Reduction Percentage Needed	Load Allocation	Margin of Safety	Limiting criteria	Target Value (cfu/100 mL)
Geometric Mean (cfu/100 mL)	90th %tile (cfu/100 mL)					
Station SCLU						
343	2,688	96%	90 %	10%	90th percentile	100
Station SCLD						
176	4,59	78%	90%	10%	90th percentile	100
Station 0470						
300	1,260	92%	90%	10%	90th percentile	100

Wasteload Allocations

Ecology assumed that the critical condition for the wet weather season occurred as a result of precipitation events. Stormwater is assumed to constitute the bulk of the pollution input during the critical period of the wet weather season. Therefore, Ecology used the Simple Method (CWP 2005a) to determine the relative loading from each municipal MS4 within the Swamp Creek watershed. The following process was followed:

1. Determine the land uses above each of the three representative water quality monitoring stations.
2. Estimate the relative bacteria loading from each MS4 using the Simple Method.
3. Assign wasteload allocations to municipal stormwater permittees at each water quality monitoring station based upon their proportional contribution at that station and the bacteria criterion needing the greatest reduction.

Determine Land use above each water quality monitoring station.

Data from the Multi-resolution Land Characterization Consortium (MRLC 1999) was used to characterize land uses in the Swamp Creek watershed. A geographical information system (GIS) program (ARCVIEW 9) was used to determine land use above each water quality monitoring station (Figure 7). Because the MRLC data identified twelve different types of land use, it was necessary to consolidate them to similar categories (for example, deciduous forest and evergreen forest were combined to create a single forest category). Land uses were categorized into forest, agriculture/rural, residential, commercial/urban, and roadway only components (Table 5).

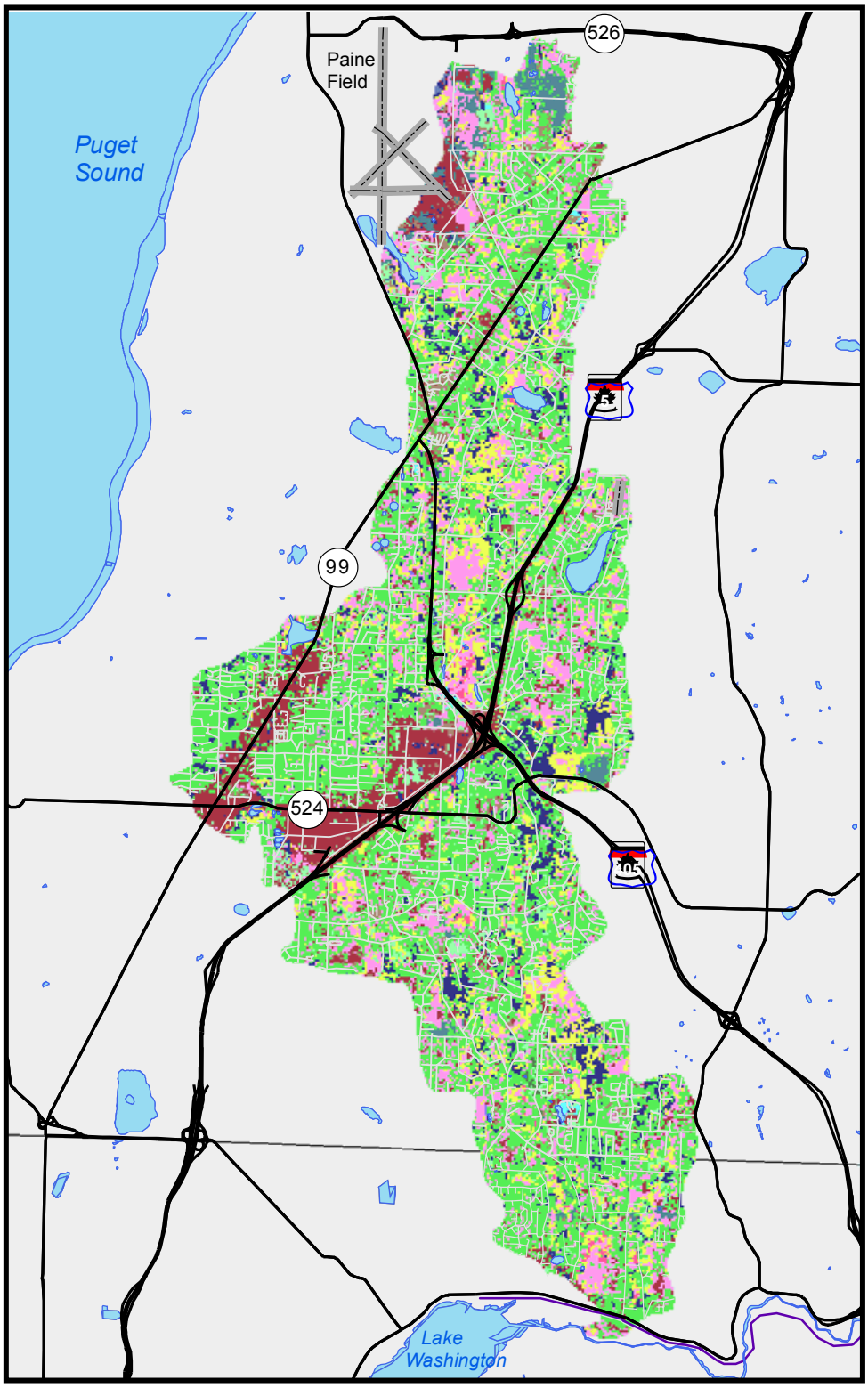


Figure 7. Land Use Analysis. Each color above shows a different land use. Geographical information system (GIS) software allows users to sort by color to determine land use in a given area. 12 land uses are shown. Green areas are not forest but actually low density residential land use. Deciduous forests are shown in pink, evergreen forests in dark blue. Commercial areas are maroon.

Table 5. Land Use Types Identified by the MRLC above Station SCLU. Twelve different land uses were identified in data produced by the Multi-resolution Land Characterization Consortium (MRLC 1999). These land uses were consolidated into 5 categories for use with the Simple Method. *All data expressed in acres.*

Land Use	Snohomish County	City of Everett	Washington State Department of Transportation
Open Water =	27.6	3.1	
Low Density Residential	996.0	472.3	17.3
High Density Residential			
Transitional	3.5	3.8	
Residential =	999.5	476.1	17.3
Commercial/Industrial/Transportation =	240.5	46.4	6.7
Deciduous Forest	494.6	227.5	0.7
Evergreen Forest	190.0	26.2	
Mixed Forest	293.6	82.3	
Woody Wetlands		11.8	
Forest =	978.2	347.8	0.7
Shrubland	164.6	29.5	2.3
Grasslands/Herbaceous	113.5	56.5	9.9
Pasture/Hay		0.2	
Small Grains		0.9	
Urban/Recreational Grasses	80.7	109.2	
Rural/Agricultural =	358.8	196.3	12.2

Table 6. Road Widths used to calculate roadway acreages. Total widths are considered to be estimates that generally characterize the roadway characteristics in an urban setting.

Roadway name	# of Lanes	Road Width	Shoulder Width	Right of Way	Total Width
Interstate 405	8	96	40	60	196
Interstate 5	6	72	40	60	172
Highway 524	4	48			48
Highway 525	4	48			48
Highway 527	4	48			48
Highway 99	4	48			48
Highway 522	4	48	40	60	148

Land uses within the jurisdiction of Snohomish County and each city were then calculated separately (Table 7). WSDOT road areas were calculated separately. Lane widths are assumed to be 12′. Additional right of ways (ROWs) on larger roads (I-5 and I-405) were assumed to be 30′ on outer perimeter of the highway with 10′ shoulders assumed on each side of the north and south bound lanes of I-5 and I-405. No shoulder width or additional ROW considered for roads crossing more urbanized areas (Table 6). The predominant land use in which the road areas fell were subtracted from the county and city land use areas.

Table 7. Swamp Creek TMDL Land Use Estimates. Land use above each water quality monitoring station was estimated using data from the Multi-resolution Land Characterization Consortium. (MRLC 1999). Washington State Department of Transportation road widths were estimated using assumptions in Table 8 and those areas were subtracted from the land areas for each entity. Individual and total land use values expressed in acres.

Land Use (above SCLU)	Snohomish County	Everett	WSDOT	Land Use Total	% of Total Area
Open Water	27.6	3.1		30.7	0.8%
Residential	999.5	476.1	17.3	1475.6	39.4%
Commercial/Industrial	240.5	46.4	6.7	286.9	7.7%
Forest	978.2	347.8	0.7	1326.0	35.4%
Rural/Agricultural	358.8	196.3	12.2	555.1	14.8%
Roads only			36.9	36.9	1.0%

Land Use (above SCLD)	Snohomish County	Bothell	Mountlake Terrace	Brier	Lynnwood	Everett	WSDOT	Land Use Total	% of Total Area
Open Water	85.0				3.3	3.1		91.4	0.6%
Residential	3858.2	350.4	125.4	344.3	1444.5	476.1	75.0	6598.9	46.5%
Commercial/Industrial	574.6		18.9	45.1	851.3	46.4	121.6	1536.3	10.8%
Forest	3043.7		38.9	274.7	490.0	347.8	11.7	4195.2	29.6%
Rural/Agricultural	753.5		12.5	70.9	231.7	196.3	38.3	1264.9	8.9%
Roads only							246.6	246.6	1.7%

Land Use (basin-wide)	Snohomish County	Bothell	Kenmore	Mountlake Terrace	Brier	Lynnwood	Everett	WSDOT	Land Use Total	% of Total Area
Open Water	85.0		0.4			3.3	3.1		91.9	0.6%
Residential	3941.7	375.3	650.0	125.4	344.3	1444.5	476.1	77.5	7357.3	47.4%
Commercial/Industrial	582.6		59.7	18.9	45.1	851.3	46.4	125.6	1604.0	10.3%
Forest	3091.4		396.5	38.9	274.7	490.0	347.8	12.2	4639.4	29.9%
Rural/Agricultural	774.9		48.3	12.5	70.9	231.7	196.3	39.6	1334.6	8.6%
Roads only								254.9	254.9	1.6%

Relative bacterial loading from each municipal entity (MS4s).

After the land use above each monitoring station was calculated, the amount of bacteria discharged from each municipal entity was estimated using the Simple Method (CWP 2005a). The Simple Method considered seasonal precipitation, amount of impervious cover, and average pollutant concentration levels to determine pollutant loading levels. After determining land uses within the watershed, the following steps were following in determining the relative loading of each MS4 as part of this TMDL.

- Estimate bacteria concentrations coming from each land use
- Estimate the wet season precipitation for the Swamp Creek Watershed
- Estimate the level of impervious surfaces associated with each land use type
- Calculate stormwater loads using the Simple Method

Estimating bacteria concentrations coming from each land use. Ecology used several sources of data to characterize the levels of bacteria in stormwater for this TMDL. The WSDOT provided data on stormwater discharges from local highways in its 2004 NPDES Annual Report—much of the data supplied was from watersheds within Ecology's Northwest Region. Ecology used that data for the Road Only land use type. Stormwater discharges to MS4s from forested areas were assumed to meet water quality standards. Other bacteria concentration values were taken from regional and national databases by Joy 2004. The average concentration of bacteria in the stormwater generated from the different land use categories in shown in Table 8.

Table 8. Stormwater runoff characteristics and impervious cover estimates. Forested areas were assumed to meet the 90th percentile standard and have some small amount of runoff due to their generally small size, proximately to MS4s, and the likelihood of roads and trails due to their anticipated high usage in urban areas.

Land use type	Fecal coliform (cfu/100 mL)	Impervious cover (%)
Forest	100	20
Agriculture/Rural	3,000	30
Residential	2,000	40
Commercial/Urban	980	87
Road Only	1,400	60

Estimating the wet season precipitation in the Swamp Creek Watershed.

Ecology obtained precipitation data from the Western Regional Climate Center (WRCC 2005)(Table 9) (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?waever). The average annual precipitation value from the Everett Jr. College site is also very close to the value of 36.44 inches reported at the Snohomish County precipitation gauge at the Alderwood Water District near 164th St (SWM 1994).

Table 9. Monthly Precipitation and Temperatures from the Everett Junior College weather station. The cumulative values of average monthly precipitation during the months October through April were used in the Simple Method model.

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Annual
Average Maximum Temperature (F)	63.7	68.6	72.9	73.3	68.5	59.8	51	45.8	45.2	49.1	52.8	58	59.1
Average Minimum Temperature (F)	45.7	50.8	53.5	53.3	48.6	42.6	37.4	34.4	33.1	34.6	36.7	40.4	42.6
Average Total Precipitation (in.)	2.36	2.16	1.2	1.35	1.98	3.45	4.87	5.06	4.57	3.4	3.57	2.65	36.61
Average Total SnowFall (in.)	0	0	0	0	0	0	0.4	1	2.3	0.6	0.5	0.1	5

Simple Method Formula

L = 1.03 E-3 * R * C * A

Where….

L = Seasonal load in billions of colonies
R = Seasonal runoff in inches
C = Bacteria concentration in #/100 mL
A = Area in acres
1.03 E-3 = unit conversion factor

R = P * Pj * Rv

P = Seasonal rainfall in inches

Pj = Fraction of annual rainfall events that produce runoff (assumed 85%)

Rv = Runoff coefficient

Rv = 0.05 + 0.9Ia

Ia = Percent impervious cover

Estimating the level of impervious surfaces associated with each land use type. Impervious cover percentages were taken from several sources (Table 8). Residential and Commercial/Urban impervious cover percentages were taken from the Center for Watershed Protection (2005), which cited a number of Pacific Northwest studies. Ecology used the impervious coverage figure of 60% for WSDOT roads based on the assumption that their area was a combination of roadway and right-of-way. The remaining values were taken from regional and national values by Joy 2004.

Calculating stormwater loads using the Simple Method. The Simple Method (CWP 2005) was used with the data above to determine the total annual loading from each entity requiring a wasteload allocation. These annual values were then compared to determine the relative loading from each entity.

Estimated annual percentage of total fecal coliform loading ('loading proportion') was then computed for each land use category within each sub-basin, with special attention to the roadway category. As noted earlier, the Washington State Department of Transportation (WSDOT) wasteload allocations (WLAs) were based on the respective road areas in each watershed subarea.

Because all of the land area within Swamp Creek is within the urban growth area and levels of impervious surfaces are either present or planned, loading from each of the remaining municipalities was calculated using individual land use characteristics (Appendix C).

Assign wasteload allocations.

Ecology determined in Table 2 of this Appendix that meeting the 90th percentile criterion would require the greatest percent reduction in existing bacteria levels. Thus, the 90th percentile criterion of 100 cfu/100 mL is the target value for this TMDL at each TMDL compliance point. Based upon the relative loadings from each MS4 (Appendix C) the Estimated Contribution of pollution from each municipal stormwater permittee at each TMDL compliance point was determined. Each municipal stormwater permittee will be required to achieve the reductions in Table 10 to achieve the TMDL target of meeting the 90th percentile value of 100 cfu/100 mL at each TMDL compliance point.

Table 10. Wet Season Load and Wasteload Allocations. Load and Wasteload Allocations (WLAs) are a direct percentage of the loading capacity at each TMDL compliance point based upon the Estimated Contribution from each entity. At each station, pollution must be reduced by the "Reduction Percentage Needed" to achieve compliance with the 90th percentile bacteria criterion of 100 cfu/100 mL.

Pollution Source	Current Conditions		Reduction Percentage Needed	Estimated Contribution		Limiting Criteria	Target Value (cfu/100 mL)
	Geometric Mean (cfu/100 mL)	90th %tile (cfu/100 mL)		Load Allocation	Wasteload Allocation		
Station SCLU	66	636	84%			90th percentile	100
Snohomish County					42%		
Everett					17.8%		
WSDOT					1.4%		
Nonpoint Sources				28.8%			
Margin of Safety				9.8%			
Station SCLD	86	310	68%			90th percentile	100
Snohomish County					33.9%		
Lynnwood					26%		
Everett					4.4%		
Brier					3.0%		
Bothell					2.3%		
WSDOT					2.3%		
Mountlake Terrace					1.1%		
Nonpoint Sources				24.6%			
Margin of Safety				9.9%			
Station 0470	131	674	85%			90th percentile	100
Snohomish County					31.7%		
Lynnwood					17%		
Kenmore					4.6%		
Everett					4.0%		
Brier					2.7%		
Bothell					1.5%		
WSDOT					2.2%		
Mountlake Terrace					1.0%		
Nonpoint Sources				24.7%			
Margin of Safety				9.9%			

Margin of Safety

Uncertainty is accounted for in TMDLs using a margin of safety (MOS) to ensure that load and wasteload allocations remain protective of water quality. The MOS is either explicit in the form of an allocation, or implicit, such as in the use of conservative assumptions in the analysis. This TMDL uses the implicit approach.

This TMDL provides explicit protection by reserving 10% of available bacterial loading for the MOS. Another margin of safety implicit in the *Swamp Creek Water Quality Improvement Plan* is the overlapping nature of sub-basins used in setting wasteload and load allocation targets. The relatively small geographic size of the upper watershed sub-basin will help ensure the success of local source identification and evaluation efforts. As sources are corrected in upper sub-basins, water quality targets in downstream basin areas become more attainable, helping assure successful water cleanup.

Appendix C: Estimated Wet Weather Bacteria Loading

Table 1. Swamp Creek - Estimated Wet Season Bacteria Loading @ SCLU

Wet Weather Precipitation = 27.3 inches

Land Use	Area (acres)			
	Total Area (acres)	Snoh. Co.	WSDOT roads	City of Everett
Forest	1,326	978		348
Agricultural/Rural	555	359		196
Residential	1,476	999		476
Commercial/Industrial	287	241		46
State Roadway	37	0	37	0
TOTALS=	3,680	2,577	37	1,067

Land Use	Constants			
	Ia- impervious %	Rv - runoff coefficient	Pj - fraction of runoff events	FC conc.
Forest	20	18.05	0.85	100
Agricultural/Rural	30	27.05	0.85	3,000
Residential	40	36.05	0.85	2,000
Commercial/Industrial	87	78.35	0.85	980
State Roadway	60	54.05	0.85	1,400

Land Use	Loadings (billions of colonies)					
	Wet Season FC Load	Snoh. Co Wet Season Loading	WSDOT Wet Season loading	Everett Wet Season Loading	Nonpoint Source Loading	Margin of Safety
Forest	5.72E+04				5.72E+04	
Agricultural/Rural	1.08E+06	2.78E+05	0.00E+00	1.52E+05	5.38E+05	1.08E+05
Residential	2.54E+06	1.12E+06	0.00E+00	5.33E+05	6.36E+05	2.54E+05
Commercial/Industrial	5.27E+05	3.97E+05	0.00E+00	7.66E+04		5.27E+04
State Roadway	6.67E+04	0.00E+00	6.01E+04	0.00E+00		6.67E+03
TOTALS=	4.27E+06	1.80E+06	6.01E+04	7.62E+05	1.23E+06	4.21E+05

Proportional Loading =		42.04%	1.41%	17.85%	28.84%	9.87%

Table 2. Swamp Creek - Estimated Wet Season Bacteria Loading @ SCLD

Wet Season Precipitation = 27.3 inches

Land Use	Total Area	Acreage (not counting open water)						
		Snoh. Co.	WSDOT roads	City of Everett	City of Bothell	City of Mountlake Terrace	Briar	City of Lynnwood
Forest	4,195	3,044	0	348	0	39	275	490
Agricultural/Rural	1,265	754		196	0	12	71	232
Residential	6,599	3,858		476	350	125	344	1,444
Commercial/Industrial	1,536	575		46	0	19	45	851
State Roadway	247	0	247	0	0	0	0	0
TOTALS=	13,842	8,230	247	1,067	350	196	735	3,018

Land Use	Constants			
	Ia- impervious %	Rv - runoff coefficient	Pj - fraction of runoff events	FC conc.
Forest	20	18.05	0.85	100
Agricultural/Rural	30	27.05	0.85	3,000
Residential	40	36.05	0.85	2,000
Commercial/Industrial	87	78.35	0.85	980
State Roadway	60	54.05	0.85	1,400

	Loadings (billions of colonies)									
Land Use	Wet Season FC Load	Snoh. Co Wet Season Loading	WSDOT Wet Season loading	Everett Wet Season Loading	City of Bothell Wet Season Loading	City of Mountlake Terrace Wet Season Loading	City of Brier Wet Season Loading	City of Lynnwood Wet Season Loading	Nonpoint Source Loading	Margin of Safety
Forest	1.81E+05								1.81E+05	
Agricultural/Rural	2.45E+06	5.85E+05	0.00E+00	1.52E+05	0.00E+00	9.66E+03	5.50E+04	1.80E+05	1.23E+06	2.45E+05
Residential	1.14E+07	4.32E+06	0.00E+00	5.33E+05	3.92E+05	1.41E+05	3.86E+05	1.62E+06	2.84E+06	1.14E+06
Commercial/Industrial	2.82E+06	9.49E+05	0.00E+00	7.66E+04	0.00E+00	3.12E+04	7.46E+04	1.41E+06		2.82E+05
State Roadway	4.46E+05	0.00E+00	4.01E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		4.46E+04
TOTALS=	1.73E+07	5.86E+06	4.01E+05	7.62E+05	3.92E+05	1.81E+05	5.15E+05	3.20E+06	4.25E+06	1.71E+06
Proportional Loading =		33.90%	2.32%	4.41%	2.27%	1.05%	2.98%	18.55%	24.61%	9.90%

Table 3. Swamp Creek - Estimated Bacterial Pollution Loading @ Station 0470

Wet Weather Precipitation = 27.3 inches

Land Use	Acreage (total acreage 15, 190 (not counting open water)								
	Area (acres)	Snoh. Co.	WSDOT roads	City of Everett	City of Bothell	City of Mountlake Terrace	Briar	City of Lynnwood	City of Kenmore
Forest	4,639	3,091	0	348	0	39	275	490	397
Agricultural/Rural	1,335	775		196	375	12	71	232	48
Residential	7,357	3,942		476	0	125	344	1,444	650
Commercial/Industrial	1,604	583		46	0	19	45	851	60
State Roadway	255	0	255	0	0	0	0	0	0
TOTALS=	15,190	8,391	255	1,067	375	196	735	3,018	1,155

Land Use	Constants			
	Ia- impervious %	Rv - runoff coefficient	Pj - fraction of runoff events	FC conc.
Forest	20	18.05	0.85	100
Agricultural/Rural	30	27.05	0.85	3,000
Residential	40	36.05	0.85	2,000
Commercial/Industrial	87	78.35	0.85	980
State Roadway	60	54.05	0.85	1,400

Land Use	Loadings (billions of colonies)										
	Wet Season FC Load	Snoh. Co Wet Season Loading	WSDOT Wet Season loading	Everett Wet Season Loading	City of Bothell Wet Season Loading	City of Mountlake Terrace Wet Season Loading	City of Brier Wet Season Loading	City of Lynnwood Wet Season Loading	City of Kenmore Wet Season Loading	Nonpoint Source Loading	Margin of Safety
Forest	2.00E+05									2.00E+05	
Agricultural/Rural	2.59E+06	6.01E+05	0.00E+00	1.52E+05	2.91E+05	9.66E+03	5.50E+04	1.80E+05	3.75E+04	1.29E+06	2.59E+05
Residential	1.27E+07	4.42E+06	0.00E+00	5.33E+05	0.00E+00	1.41E+05	3.86E+05	1.62E+06	7.28E+05	3.17E+06	1.27E+06
Commercial/Industrial	2.94E+06	9.62E+05	0.00E+00	7.66E+04	0.00E+00	3.12E+04	7.46E+04	1.41E+06	9.87E+04		2.94E+05
State Roadway	4.61E+05	0.00E+00	4.15E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		4.61E+04
TOTAL =	1.89E+07	5.98E+06	4.15E+05	7.62E+05	2.91E+05	1.81E+05	5.15E+05	3.20E+06	8.64E+05	4.66E+06	1.87E+06
Proportional Loading =		31.7%	2.2%	4.0%	1.5%	1.0%	2.7%	17.0%	4.6%	24.7%	9.9%

Appendix D: Special Requirements for Municipal Stormwater Permittees

Federal law requires applicable TMDLs to be addressed when water quality permits are issued. Where a TMDL has been approved, NPDES permits must contain effluent limits and conditions consistent with the TMDL (40 CFR 122.44(d)(1)(vii)(B), 40 CFR 122.34(e)(1)). Additionally, state law (RCW 90.48) does not permit the introduction of polluting matter into state waters. Although effluent limitations are typically expressed in a numerical form, effluent limitations for stormwater discharges from municipal separate storm sewer systems (MS4s) will be expressed in the form of Best Management Practices (BMPs).

Each municipality affected by this Water Quality Improvement Plan faces variations in the number of potential source areas, types and numbers of land uses, financial constraints, and other issues that will affect the scope of TMDL-related activities within their jurisdiction. Ecology recognizes this and intends there to be flexibility in the development and implementation of BMPs and water quality monitoring programs associated with this Plan. It should also be noted, however, that where surface waters have been identified as polluted, it is assumed that existing resources and programs alone are inadequate to address the problem and additional steps must be taken to resolve existing pollution problems.

To demonstrate progress toward meeting water quality standards, Ecology intends to include the following actions as permit requirements in Phase I and Phase II Municipal Stormwater NPDES permits for jurisdictions whose stormwater discharges are identified as sources of loadings to this TMDL. These requirements will be included in the first permit issued after the completion of this Water Quality Improvement Plan. Subsequent permits may include different requirements, depending on the success of achieving the goals of the Report. Requirements for the Washington State Department of Transportation are not included in this Appendix and will be addressed during the development of their NPDES permit.

1) Pollution Source Control Activities

No later than two years from permit issuance, all municipal stormwater permittees shall adopt and enforce an ordinance or other equivalent mechanism requiring the application of source control BMPs related to bacterial pollutants (equivalent to Volume IV of the 2005 Ecology Stormwater Management Manual for Western Washington) for the following existing land uses and activities that generate bacterial pollution.

Specifically, Volume IV, chapter 2, contains general information for implementing BMPs (section 2.1) and specific BMPs for 1) commercial animal handling areas (pg 2-10), 2) commercial composting facilities (pgs 2-11, 2-12), and 3) illicit connections to storm drains (pg 2-22). Where these activities are not occurring, no action is required. BMPs for commercial composting operations shall also be consistent with WAC 173-350-220, Solid Waste Handling Standards, Composting Facilities.

No later than two years from permit issuance, permittees that have land uses with domestic animals (cattle, horses, pets, etc..) that may discharge wastes to their MS4 shall adopt and enforce an ordinance or other equivalent mechanism that protects the MS4 from these sources. A complaint-based response mechanism shall be sufficient to identify sites that are potentially pollution generating.

Where potential sources related to the land uses and activities above do exist, operational source control BMPs shall be required for all pollutant generating sources. Only in those cases where a facility is demonstrated to be causing a violation of surface water standards or is discharging illegally, shall structural source control BMPs shall be required as related to this TMDL. The provision for structural source control BMPs is not intended to apply to individual municipal stormwater outfalls.

2) Public Involvement

All municipal stormwater permittees shall prepare a Bacterial Pollution Remediation Plan (BPRP) as subsection of their Stormwater Management Program (SWMP). The purpose of the BPRP is to facilitate the public's participation in advising on the development, implementation, and update of TMDL-related portions of the SWMP. The BPRP shall include information on relevant activities being taken to reduce bacterial pollution including ordinances, inspection and enforcement resources and strategies, illicit discharge program elements, and water quality monitoring. Municipal stormwater permittees shall evaluate and document the applicability of the following approaches in the BPRP.

- Receiving water sampling to identify bacterial pollution sources within targeted subbasins.
- Development and implementation of a Pet Waste Ordinance
- Evaluate current water pollution ordinance enforcement capabilities
- Evaluation of critical areas ordinance in relation to TMDL goals
- Implementation of an educational program for K-12 students to increase their awareness of bacterial pollution problems.
- Investigation and implementation of methods that prevent additional stormwater bacterial pollution through stormwater treatment, reducing stormwater volumes from existing areas using low impact development retrofitting, and preventing additional sources of stormwater in association with new development using low impact development strategies.

3) TMDL Activity Documentation and Tracking

All municipal stormwater permittees shall discuss program changes and BPRP activities completed during the previous year in a subsection of their Stormwater Management Program (SWMP) annual report. The purpose of this requirement is to allow for the timely tracking and evaluation of TMDL-related permit requirements by Ecology and the public.

4) Public Outreach and Education

All municipal stormwater permittees shall increase awareness of bacterial pollution problems and the need to protect water quality by properly managing animal wastes. This requirement shall be considered an additional minimum measure to the Phase I permit (S5.C.10.(b)(ii). This requirement shall be integrated into one or more of the minimum measures S5.C.1.(a)i, ii, iii, or iv in Phase II permits to cities.

5) Water Quality Monitoring

All municipal stormwater permittees are responsible for performing, or contracting out, water quality monitoring in accordance with Options 1 or 2 below. This monitoring shall be described in a plan prepared in accordance with Ecology's Guidelines for Preparing Quality Assurance Project Plans (QAPPs) for Environmental Studies (Ecology Publication No. 01-03-003 or most current version) and submitted to approval to Ecology within 120 days of permit issuance. Permittees may rely on another entity to satisfy the monitoring component required by this TMDL. Permittees that are relying on another entity to satisfy this monitoring obligation remain responsible for permit compliance if the other entity fails to perform the required monitoring.

Monitoring shall begin within 180 days of permit issuance. The monitoring start date will be extended day for day if Ecology requires more than 30 days to review the QAPP. Permittees shall choose one of the two options outlined in Figure 2 and discussed below:

Option 1, Direct Measurement of Stormwater: The concentration and loading of bacteria to Swamp Creek from stormwater within the permittee's jurisdiction shall be estimated by sampling representative outfalls within the MS4 system. Specific sampling locations and frequencies of stormwater outfall monitoring will be determined during Ecology's approval of a Quality Assurance Project Plan (QAPP) prepared as a requirement of the NPDES Permit.

Option 2, Indirect Measurement of Pollution Sources: Changes in bacterial levels in Swamp creek as a result of stormwater inputs shall be estimated through receiving water monitoring using flow duration or comparable analyses[11]. Measuring the effect of stormwater discharges in the receiving water (Swamp Creek or its tributaries) as part of a regularly scheduled program is the approach recommended by this plan.

Within Option 2, permittees may either a) measure water quality entering and leaving their jurisdiction or b) measure water quality at the locations specified in Figure 1 as follows[12]:

[11] Although the characterization of stormwater volumes and concentrations are less precise using this technique, the resulting data will also serve larger watershed goals to understand trends in water quality and the success of this TMDL. Characterization of stormwater effects using flow duration analysis is not intended to address other permit requirements for stormwater monitoring.

[12] Higher frequency monitoring at sites SCUP and SRLD during 2007 is recommended to establish baseline information for those sites.

- Snohomish County shall monitor bacteria levels at sites SCLU and SCLD and perform flow monitoring at sites Sc and Sl.
- The City of Everett shall monitor bacteria levels at site SCUP, which is in the vicinity of Avondale Road and 119th St SW.
- The City of Kenmore shall monitor bacteria levels at site 0470 and perform flow monitoring at site 56b.
- The Cities of Lynnwood, Mountlake Terrace, and Brier shall monitor bacteria levels at site SRLD. SRLD shall be located at the stream crossing along Cypress Way, Oak Way, or another site approved by Ecology.

Option 2 monitoring must be performed at a frequency that will produce approximately 60 data points or more at each monitoring station over a five year period. The purpose of establishing data frequency requirements is to ensure that a reasonable amount of data will be collected when storm events are affecting the receiving water when a regularly scheduled ambient monitoring approach is used. Continuous flow monitoring at each monitoring point, or a representative location, must be performed to determine if a sampling event is affected, or dominated, by storm flows.

6) Coordination of Stormwater Management Activities

In association with Phase I permit condition S5.C(3), Snohomish County shall include the discussion of TMDL-related activities as part of the stormwater management coordination activities for physically connected and shared waterbodies.

7) Illicit Discharge Detection and Elimination

The schedule and activities identified for the illicit discharge detection and elimination program in both the Phase I and Phase II permits shall be sufficient to meet TMDL requirements with the following clarifying conditions:

> Phase I Permit—Snohomish County shall give strong consideration to prioritizing Outfall Reconnaissance Inventories (ORIs) in areas where bacterial TMDLs are in place. All ORIs shall include bacteria source screening for sewage/septic sources. The County shall develop threshold values for responding to obvious bacterial pollution problems and initiating investigation/termination activities as defined in permit condition S5C8(b)(vii).
>
> Phase II Permit—Waterbodies addressed by a TMDL for bacteria shall be designated as high priority waterbodies (see permit condition S.5.C.3.(c)(ii)) and shall receive field assessments and screening prior to other receiving waterbodies unless approved in writing from Ecology. The presence of sewage/septic system sources shall be investigated as part of all screenings.

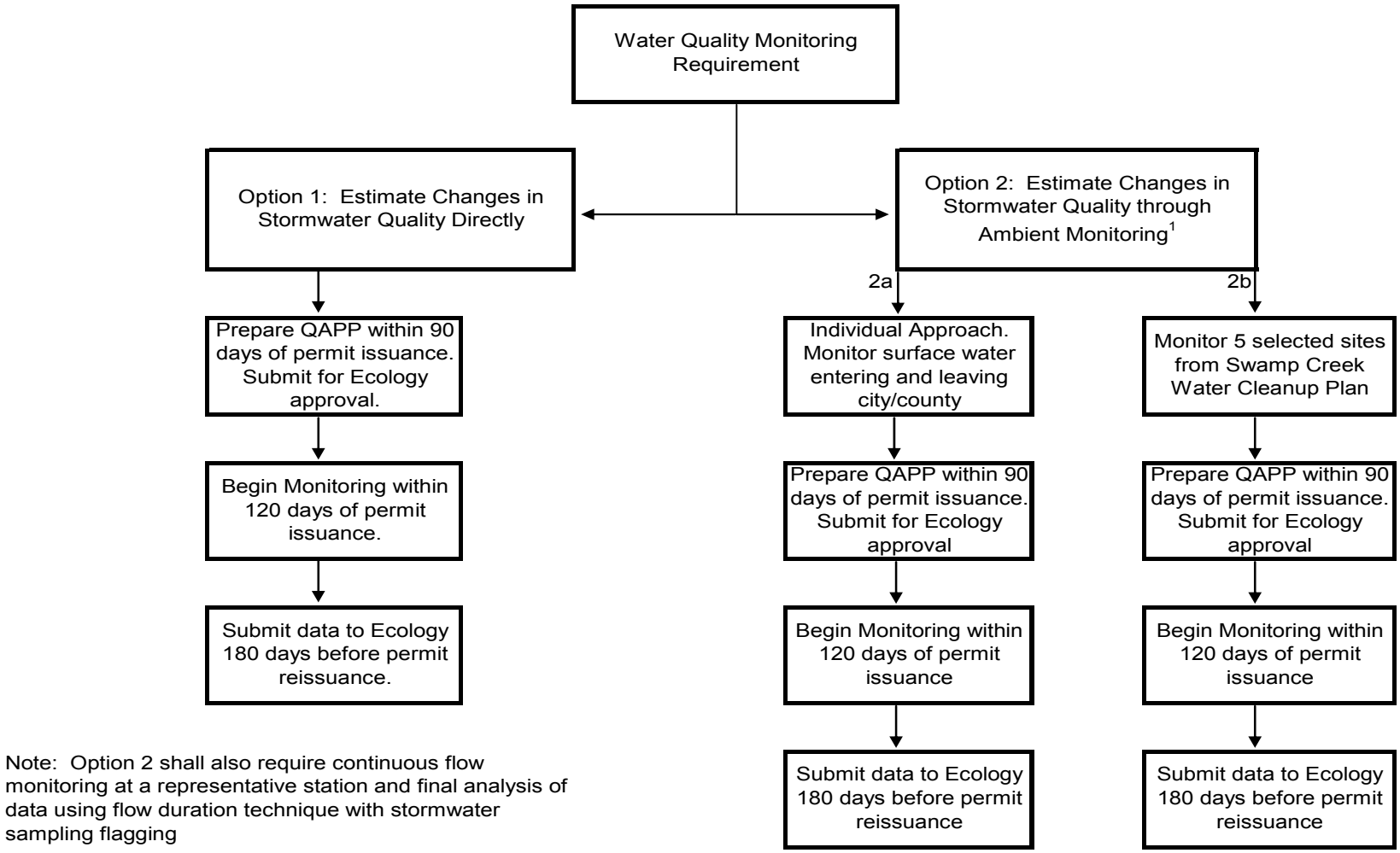


Figure 1. Flowchart of basic NPDES/TMDL stormwater monitoring requirements. Permittees may choose any one of the three monitoring paths provided above.

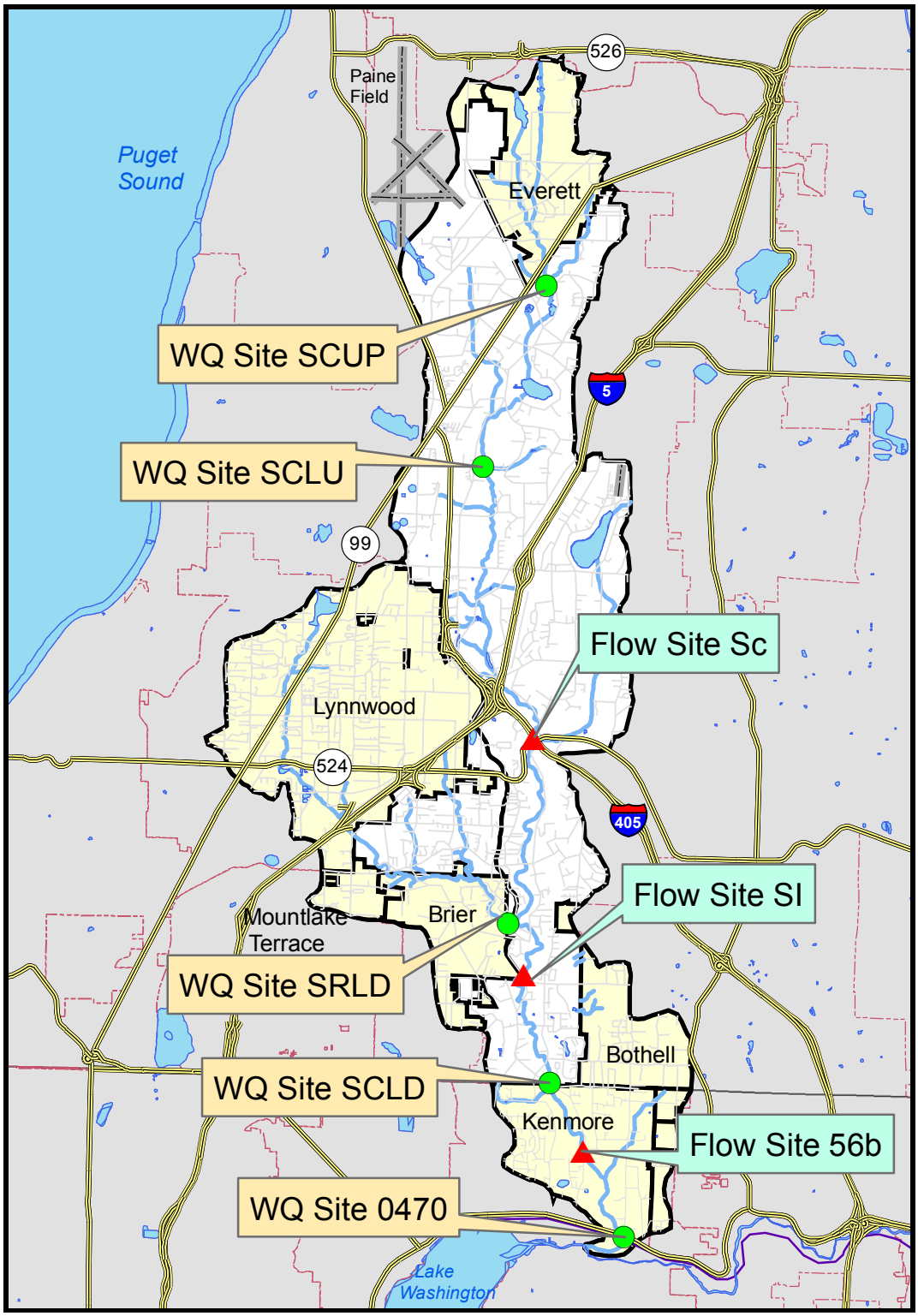


Figure 2. Required monitoring stations under monitoring Option 2(b). Monitoring Option 2b establishes five locations be monitored to determine changes in water quality over time. Approximately 60 samples should be collected at each site over a five year period. Accurate daily flow monitoring is needed at SI or 56b throughout the monitoring period.