WASHINGTON STATE DEPARTMENT OF ECOLOGY

Little Bear Creek Fecal Coliform Bacteria Total Maximum Daily Load (Water Cleanup Plan)

Submittal Report

May 2005

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Submittal Report

by

Anne Dettelbach

and

Dave Garland

Washington State Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, Washington 98008-5452

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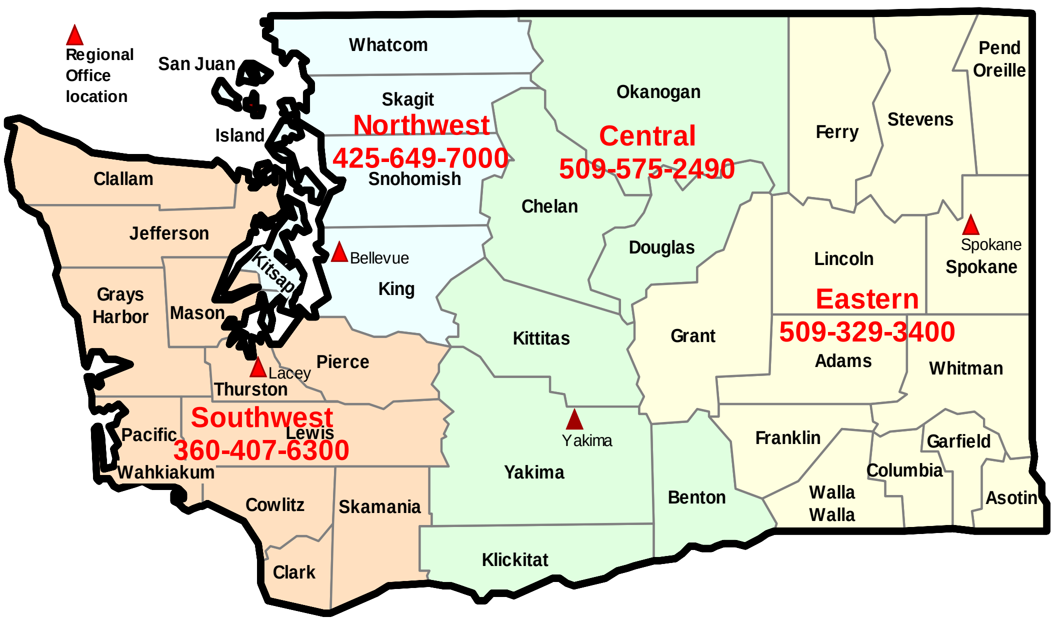

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Glossary of Terms

303(d) list: Required of each state under the Clean Water Act, this is a list of water bodies that do not meet state water quality standards. Now called the Water Quality Assessment.

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) establishes the TMDL program.

Concentration: The amount or mass of a substance or material in a given volume or mass of sample. Concentrations of fecal coliform bacteria are usually measured in colony forming units per 100 milliliters of water (cfu/100mL).

Fecal Coliform (FC): Fecal coliform is bacteria present in the intestinal tracts and feces of warm-blooded animals. FC is used as an indicator organism to indicate the possible presence of disease-carrying (pathogenic) organisms.

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

Loading Capacity: The greatest amount of contaminant loading 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 storm water; (iii) which is not a combined sewer; and (iv) which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2.

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

National Pollutant Discharge Elimination System (NPDES): The national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act.

Nonpoint Source: Pollution that enters any water 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.

90^{th} percentile: An estimated portion of a sample population based on a statistical determination of distribution characteristics. The 90^{th} percentile value is a statistically derived estimate of the division between 90 percent of samples, which should be less than the value, and 10 percent of samples, which are expected to exceed the value.

Pathogen: Disease causing agents, especially microorganisms such as bacteria, protozoa, and viruses.

Phase I Stormwater Permit: The first phase of stormwater regulation required under the federal Clean Water Act covering medium and large municipal separate storm sewer systems 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 covering 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 from either municipal wastewater treatment plants, municipal stormwater facilities, or industrial waste treatment facilities.

Pollution: Contamination, or other alteration of the physical, chemical, or biological properties of any waters of the state; or discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state that is likely to create a nuisance or render such waters harmful, detrimental, or injurious to the public health, safety, and welfare; 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.

Statistical Rollback Method: A calculation of the percent change required for either of two summary statistics for a dataset to meet a target value; in the case of fecal coliform data, the higher (relative to the water quality standard) of the geometric mean or the 90th percentile value is chosen to be "rolled back."

Stormwater: The water that runs off roads, pavement, and roofs during rainfall or snow melt. Storm water can also come from hard or saturated grass surfaces like lawns, pastures, playfields, and from gravel roads and parking lots.

Total Maximum Daily Load (TMDL): The amount of a particular pollutant that a stream, lake, estuary, or other water body can handle without violating state water quality standards. TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard.

Wasteload Allocation (WLA): The portion of a receiving water's loading capacity allocated to one of its existing or future point sources of pollution. WLAs constitute a 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.

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Michael Popiwny and Rachael Dillman (King County) and Mark Henley (Ecology) played an important role in helping us understand how the Brightwater facility fits into this special watershed. John Drabek and Ralph Svrjcek proved invaluable in helping us connect water cleanup planning to stormwater management activities.

Finally, we want to thank the residents of Little Bear Creek watershed who love their creeks and are working diligently to protect and restore this beautiful watershed. Special thanks are due to Joyce Hoikka and Martin Boulanger who shared their little piece of paradise along the creek with us and especially to Greg Stephens, whose personally guided tour of the watershed made it come alive for us. We appreciate all of your interest and support of our work and look forward to our ongoing collaborations and conversations.

Executive Summary

The Little Bear Creek stream network, located in Snohomish and King Counties of Washington State, provides important resources for fish, primary contact recreation (e.g., swimming and wading), and aesthetic enjoyment. Water quality monitoring indicates that portions of this creek system are impaired with too much bacteria as measured by fecal coliform bacteria counts in the water. These bacteria live in the intestinal tracts of warm-blooded animals and are indicators of pathogenic, disease-causing bacteria, viruses, and other pathogens.

In 1998, three stream segments along Little Bear Creek were listed as exceeding state water quality standards for fecal coliform bacteria. Water quality monitoring conducted by Snohomish and King Counties and the city of Woodinville since 1999 verifies that these segments are still impaired with excess bacteria. These data also indicate that four additional stream segments in the watershed (including segments along Trout Stream, Great Dane Creek, Cutthroat Creek) are impaired by bacteria and that one previously listed stream segment may also not meet state water quality standards for dissolved oxygen (or, DO).

Under Section 303(d) of the Clean Water Act, a water cleanup plan (or, Total Maximum Daily Load) must be prepared to correct state water quality standard violations such as the presence of excess fecal coliform bacteria in Little Bear Creek and its tributaries. This water cleanup plan, the *Little Bear Creek Water Cleanup Plan for Fecal Coliform Bacteria (*or, *Little Bear Creek Water Cleanup Plan),* primarily addresses fecal coliform bacteria contamination in the listed streams in the Little Bear Creek watershed. It also calls for activities that will likely address remaining fecal coliform in other streams and that may help resolve the dissolved oxygen impairment. The water cleanup plan considers seasonal variation in bacteria loading at seven monitoring points in the Little Bear Creek system and establishes pollutant loading targets and percent fecal coliform density reductions at three representative points in the Little Bear Creeks mainstem.

Likely sources of bacteria contamination in the Little Bear Creek watershed include agriculture (small farms), businesses that handle pet wastes (e.g., dog kennels, breeders), leaking or failing on-site septic systems, wildlife, and possibly sanitary sewer line leaks. Likely pollutant transport mechanisms include urban stormwater and stormwater runoff from roads and highways. The water cleanup plan assigns specific allowable pollutant loads to Snohomish County, the Washington State Department of Transportation (WSDOT), and the city of Woodinville through their applicable stormwater permits, and to diffuse, nonpoint sources, generally. These values are derived from an analysis of flow estimates, water quality monitoring data, land use data, and literature-derived bacteria loading estimates for various land uses.

Implementation of the *Little Bear Creek Water Cleanup Plan* relies on support for continuation of existing water quality sampling programs to assist source identification and water quality trend monitoring, expansion of existing monitoring programs, special sampling surveys to help identify and correct local bacteria sources, and government as well as individual and community actions to correct known poor management practices that contribute bacteria to Little Bear Creek and its tributaries.

This water cleanup plan recommends the following activities and projects to reduce fecal coliform bacteria in the creek system.

- Acquire and protect riparian areas to enhance water quality and habitat using stream buffers. Restore native riparian vegetation for its water quality and habitat benefits.
- Monitor water quality to help identify and eliminate bacteria sources such as on-site system failures, and animal access to streams.
- Implement activities and/or educational projects that promote best management practices (BMPs) in agricultural areas such as fencing, management of roof runoff, and manure and pet waste management to minimize bacterial pollution to streams.
- Implement activities and/or educational projects that promote BMPs for waste management in dog kennels, veterinary offices, and similar pet waste management facilities.
- Continue to implement and promote projects or ongoing programs that address urban bacteria source control and stormwater treatment. These include low impact development to help limit bacteria-transporting sediment loads and promote runoff infiltration, street and parking lot sweeping to remove wildlife-attracting litter, and dumpster area maintenance.
- Conduct and expand pollution source identification actions throughout the watershed, as resources allow.

Introduction

The Washington Department of Ecology (Ecology) is concerned about protecting and restoring the water quality of the Little Bear Creek system in western Washington. This stream system, located in a rapidly developing area that straddles South Snohomish and King Counties, provides important resources for fish, primary contact recreation (e.g., swimming and wading), and aesthetic enjoyment. Water quality monitoring indicates that portions of the Little Bear Creek system are impaired with too much bacteria as measured by fecal coliform bacteria counts in the water. With input from local agencies and community members, Ecology developed the *Little Bear Creek Water Cleanup Plan* to address and correct these bacterial problems in the Little Bear Creek system.

Section 303(d) of the 1972 Clean Water Act (CWA), requires the United States Environmental Protection Agency (EPA), or a designated authority, to identify the polluted water bodies of the United States and to develop plans to clean them up. In Washington State, Ecology has this responsibility. Water bodies (rivers, streams, lakes, and marine areas) that do not meet federal or EPA-approved state water quality standards are initially put on the "303(d) list" of impaired waters. (In Washington State, these waters are listed in Category 5 of the Washington State Water Quality Assessment.) After being put on the 303(d) list, a plan must be prepared that will guide efforts to return local waters to good health. These plans are called total maximum daily loads (TMDLs). In Washington State, they are also called water cleanup plans.

Under a 1997 agreement with the EPA, Ecology must follow a two-step process to complete a TMDL. First, Ecology prepares a TMDL Submittal Report for approval by the EPA. The Submittal Report includes a technical study that defines the amount of pollution a water body can receive without exceeding water quality standards and assigns load allocations or values for pollution sources, allowing for a margin of safety. The submittal report also lays out a summary implementation strategy (SIS), an outline of the activities required to implement the TMDL. After EPA approves the SIS, Ecology must prepare a detailed implementation plan (DIP) describing specific activities that individual parties must perform to achieve the TMDL targets. The DIP identifies timeframes for meeting interim targets and water quality standards and includes a detailed monitoring plan to measure implementation activities and achievement of interim targets and water quality standards (EPA, 1997a).

Water cleanup plans must document several required processes: 1) determination of the numerical TMDL values; 2) determination of what actions are needed to improve the quality of the polluted waters; 3) inclusion of the public in the decision making process; 4) a monitoring program to measure performance; and 5) the periodic readjustment of needed corrective actions if progress is not occurring or not occurring rapidly enough (i.e., adaptive management).

Figure 1 shows the Little Bear Creek watershed and the water quality sampling stations used to support this analysis.

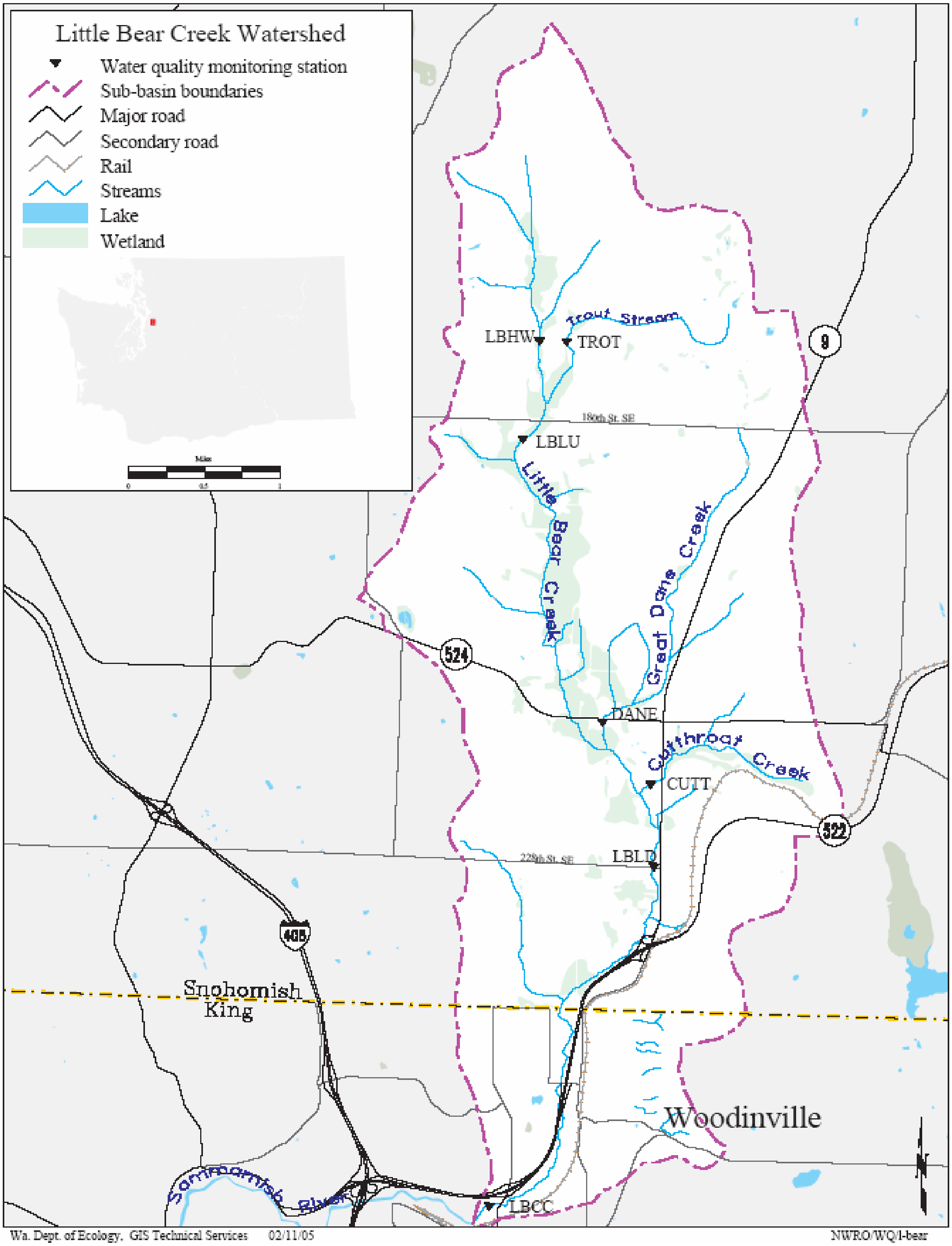

Figure 1: Little Bear Creek Watershed (with sampling locations)

Background

Little Bear Creek originates in Snohomish County, Washington, and flows southward for approximately 7.7 miles, where it empties into the Sammamish River near Woodinville, in King County. The drainage basin is fifteen square miles and covers approximately 9,600 acres. Approximately 80 percent of the Little Bear Creek watershed is located within Snohomish County; the rest (1,920 acres) is situated within the city limits of Woodinville in King County. In 2001, it was estimated that roughly 40 percent of the basin was forested and that 37 percent was covered with impervious surface such as pavement (Kerwin, 2001). Considerable development pressures continue, however, and are likely to result in diminishing forest cover and increasing impervious surfaces. The creek's overall gradient is very gradual, with an average slope of 0.8 percent (Woodinville, 2004).

The creek's upper mainstem is characterized by predominantly young deciduous riparian forest and contains numerous riparian wetlands (Woodinville, 2004). Land uses in the upper watershed include several small farms (many of which have horses and other livestock) and dog kennels. The middle portion contains some farms but is primarily residential in nature, with several new developments in place. The lower portion of the creek, especially the lower 2.2 miles, runs through the commercial portion of downtown Woodinville and is heavily urbanized and/or industrialized. Parts of the lower creek have been modified to straighten and control the channel (Woodinville, 2004). In 2004, King County received approval to site the Brightwater Wastewater Treatment Facility within the Little Bear Creek watershed. Construction of the 114-acre facility is slated to begin in 2005.

Figure 2. Little Bear Creek near the King-Snohomish County line.

Little Bear Creek and its tributaries support runs of Chinook, sockeye, kokanee, and coho salmon, and coastal cutthroat trout (Kerwin 2001), as well as other resident fish species such as coast range sculpins and western brook lampreys. It is considered a "satellite production sub area" for Chinook salmon, meaning salmon are present most years but are less abundant than in other areas. It is the least developed of the three main north tributaries to the Sammamish River and has the least degraded habitat (WRIA 8 Steering Committee, 2002).

Water Quality Standards

The *State of Washington Water Quality Standards for Surface Waters* is published pursuant to Chapter 90.48 of the Revised Code of Washington (RCW) (Ecology, 1997). Ecology has the authority to adopt rules, regulations, and standards as necessary to protect the environment. Under the federal Clean Water Act, the EPA regional administrator must approve the water quality standards adopted by the state (Section 303(c) (3)). State water quality standards designate certain characteristic uses (e.g., swimming, boating, fishing, aquatic life, habitat, etc.) for protection and specify the criteria (e.g., toxic chemicals, bacterial pollutants, dissolved gas, temperature) necessary to protect those uses (Washington Administrative Code (WAC), Chapter 173-201A).

1997 Water Quality Standards Language

The most recent full version of Washington's water quality standards was adopted in November 1997. According to the 1997 state water quality standards, Little Bear Creek is designated as Extraordinary (Class AA). The water quality criteria for fecal coliform for the protection of Class AA characteristic uses are:

> *"Fecal coliform organism levels shall both not exceed a geometric mean value of 50 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 ml."*
>
> [WAC 173-201A-030(1) (c) (i) (A)]

The characteristic uses designated for protection in Little Bear Creek watershed streams are:

> *"Characteristic uses shall include, but not be limited to, the following:*
>
> *(i) Water supply (domestic, industrial, agricultural).*
>
> *(ii) Stock watering.*
>
> *(iii) Fish and shellfish: Salmonid migration, rearing, spawning, and harvesting. Other fish migration, rearing, spawning, and harvesting. Clam and mussel rearing, spawning, and harvesting, and crayfish rearing, spawning, and harvesting.*
>
> *(iv) Wildlife habitat.*
>
> *(v) Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment).*
>
> *(vi) Commerce and navigation."* [WAC 173-201A-030(1) & (2)]

Ecology believes that primary contact recreation is the beneficial use most sensitive to the impairment of excess fecal coliform bacteria. Fecal coliform bacteria are used as an indicator of fecal waste from humans and warm-blooded animals that may contain pathogens that could impact human health. The public has an increased health risk from contact with waters that are impaired by excessive bacteria concentrations. Some forms of aquatic life may also be more sensitive to unknown contaminants that may be associated with bacteria sources such as on-site sewer leaks. Bacteria water cleanup is expected to protect several beneficial uses, including primary contact recreation and aquatic life.

The water quality standards limit the averaging periods used in the calculation of the geometric mean for comparison with the fecal coliform criteria.

> *"In determining compliance with the fecal coliform criteria in WAC 173-201A-030, averaging of data collected beyond a thirty-day period… shall not be permitted when such averaging would skew the data set so as to mask noncompliance periods."*

[WAC 173-201A-060(3)]

2003 Water Quality Standards Language

In July 2003 Ecology submitted updated water quality standards to EPA for approval. The 2003 water quality standards package was partially approved by EPA on January 12, 2005. In its approval letter, EPA notes that it considers proposed descriptive changes to recreational uses to be non-substantive formatting or editorial changes. EPA also observes that the recreational use categories (and associated beneficial uses and criteria designed to protect the uses) established by Ecology in the 2003 water quality standards match those contained in the 1997 water quality standards.

Under the new (partially approved) water quality standards, Little Bear Creek is to be protected for the designated use of extraordinary primary contact recreation. Extraordinary primary contact is defined at WAC 173-201A-020 as "waters providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas." The bacteria indicator for extraordinary primary contact recreation is:

> "*Fecal coliform organism 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) obtained for calculating the geometric mean value exceeding 100 colonies/100 mL."*

[WAC 173-20A-200(2)(b)]

Water Quality and Resource Impairments

One stream segment in the Little Bear Creek watershed was included on the Washington State 1996 Section 303(d) list of impaired water bodies because of high fecal coliform recorded in stream samples. Two additional stream segments were listed on the 1998 list. A total of seven stream segments, including segments on Little Bear tributaries Trout Stream, Great Dane Creek, and Cutthroat Creek are proposed for Category 5 [Section 303(d)] listing on the new draft Washington State Water Quality Assessment (Ecology, 2004). See Table 1, below, for the list of existing and proposed impaired stream segments within the Little Bear Creek system. Each of these segments demonstrated fecal coliform criteria impairments in at least nine percent (and up to 86 percent) of water quality samples upon which 2002/2004 303(d) listing decisions were based.

Table 1. Existing and proposed Section 303(d) bacteria-listed stream segments in Little Bear Creek watershed

Stream Name	Segment Location (Township-Range-Section)	1996 List ID	1998 List ID	Proposed 2002-04 List ID #
Little Bear Creek (LBCC)	026N-05E-09	WA-08-1085	UT96KR	13132
Little Bear Creek (LBLU)	027N-05E-15		UT96KR	7443
Little Bear Creek (LBLD)	027N-05E-27		UT96KR	7444
Little Bear Creek (LBHW)	027N-05E-10			21984
Trout Stream (TROT)	027N-08E-10			21991
Great Dane Creek (DANE)	027N-05E-22			21983
Cutthroat Creek (CUTT)	027N-05E-26			21982

Excessive amounts of fecal coliform bacteria in the Little Bear Creek system indicate an increased risk of pathogen-induced illness to humans (EPA, 2001). Infections due to pathogen-contaminated recreational waters include gastrointestinal, respiratory, eye, ear, nose, throat, and skin diseases (EPA, 1986).

Little Bear Creek near its mouth (just above the confluence with the Sammamish River—proposed 2002-04 List ID #13132) is also proposed for Category 5 listing for having violated the dissolved oxygen water quality criterion.[1] Low dissolved oxygen can affect the characteristic usage of a stream by salmonids for spawning and rearing. Fecal coliform bacteria are associated with fecal matter, which is known to contain nutrients that support plant and animal growth. Algae and other organisms that utilize these nutrients can deplete

[1] Little Bear Creek has been monitored for several additional parameters, including temperature, ammonia, zinc, pH, lead, and mercury. As of the most recent listing cycle, however, no additional impairments have been identified.

oxygen in water bodies under certain environmental conditions. While the direct relationship between fecal coliform levels and their accompanying nutrient input to the Little Bear Creek system is not currently known, it is anticipated that actions to reduce fecal coliform bacteria concentrations in the creek will help improve dissolved oxygen levels.[2]

Current Water Quality

Recent water quality samples collected by Snohomish and King Counties, the city of Woodinville, and Washington State Department of Ecology from Little Bear Creek and its tributaries (Trout Stream, Cutthroat Creek, and Great Dane Creek) confirm that the monitored stream segments used in this analysis violate water quality standards at some time during the year.

To better show spatial and temporal differences and to define seasonal allocation targets, the fecal coliform data at each existing stream sampling site are divided into wet season (October through March) and dry season (April through September). Wet and dry season periods were established by grouping the highest and lowest six contiguous months average precipitation over several years. Table 2 shows summary fecal coliform results for both wet and dry seasons at Little Bear Creek-Headwaters (LBHW), Trout Stream (TROT), Little Bear Creek-Upstream (LBLU), Great Dane Creek at Maltby Road (DANE), Cutthroat Creek at Highway 9 (CUTT), Little Bear Creek-Midstream (LBLD), and Little Bear Creek—Downstream (LBCC). Sampling periods vary from five to twelve years.

Of the seven sampling sites in Table 2, only the Trout Stream site, met the geometric mean fecal coliform standard during the wet and dry seasons. This site did, however, exceed the 90th percentile standard during both wet and dry seasons. All other sites exceeded both the geometric mean and 90th percentile criteria during both wet and dry seasons. Exceedances were generally more pronounced during the dry season, with 90th percentile values ranging from 215 to 5,043 cfu/100 mL (versus the standard of 100 cfu/100 mL).

[2] At this time, Little Bear Creek is not being proposed for delisting for dissolved oxygen. If ongoing or new water quality monitoring data indicate that the dissolved oxygen impairment has been resolved, Ecology will explore delisting the creek for this parameter.

Table 2. Current water quality standards and summary fecal coliform results for Little Bear Creek and tributaries Trout Stream, Great Dane Creek, and Cutthroat Creek (cfu/100 mL). Bold values indicate water quality standard exceedances.

Station	Water Quality Standard		Current Water Quality	
			Wet Season	Dry Season
Little Bear Creek headwaters LBHW	Geometric Mean	50	**537**	**873**
	90th Percentile	100	**4,494**	**5,043**
Trout Stream TROT	Geometric Mean	50	36	32
	90th Percentile	100	**950**	**215**
Little Bear Creek upstream LBLU	Geometric Mean	50	**248**	**449**
	90th Percentile	100	**1,128**	**2,907**
Great Dane Creek DANE	Geometric Mean	50	**53**	**86**
	90th Percentile	100	**237**	**583**
Cutthroat Creek CUTT	Geometric Mean	50	**85**	**152**
	90th Percentile	100	**414**	**1,196**
Little Bear Creek midstream LBLD	Geometric Mean	50	**223**	**364**
	90th Percentile	100	**836**	**1,966**
Little Bear Creek downstream LBCC	Geometric Mean	50	**124**	**290**
	90th Percentile	100	**876**	**1,807**

Streamflows

Streamflows can have significant affects on stream water quality conditions and are important to consider when developing plans to correct known water quality problems. In some areas of the Little Bear Creek watershed, groundwater withdrawals may contribute to reduced streamflows (especially during dry seasons) and can exacerbate and elevate contaminant concentrations in the stream. Stormwater runoff from impervious surfaces such as roads and parking lots can increase streamflow during storms and may reduce late summer streamflows because of reduced groundwater recharge.

Snohomish County maintains two streamflow gauging stations in Little Bear Creek (at LBLU and LBLD) and also collects streamflow data while monitoring on two Little Bear Creek tributaries (at DANE and CUTT). King County also maintains a streamflow gauging station on Little Bear Creek at Highway 202 (LBCC).[3]

Figure 3 compares average monthly streamflows and fecal coliform levels[4] in Little Bear Creek at station LBLD, near the center of the watershed. Figure 3 shows that the highest bacteria levels generally occur during low flows in dry season months. July and August were the months with highest average fecal coliform levels. High fecal coliform levels in the summer (dry months) may indicate the presence of chronic sources of bacteria. Dry summer low streamflow conditions cause these bacteria to be found in greater concentrations.

[3] The U.S. Geological Survey conducted miscellaneous low streamflow measurements in Little Bear Creek near Woodinville in 1945. The monthly mean Little Bear Creek discharges at Woodinville in July, August, and September 1945 were 5.08, 4.80, 8.22 cubic feet per second (cfs), respectively (USGS, 1955).

[4] Average monthly fecal coliform values were calculated from water quality data collected from 1993-2004.

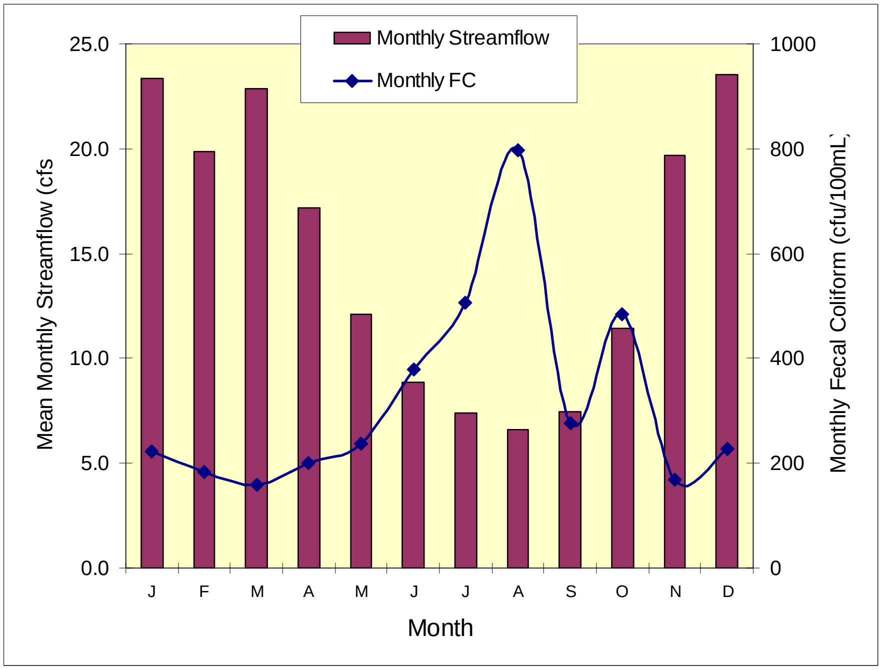

Figure 3. Comparison of average monthly streamflow and average fecal coliform (FC) concentration at Little Bear Creek station LBLD (April 2000-July 2003).

Sources of Fecal Coliform Contamination

Potential fecal coliform bacteria contaminant sources in the Little Bear Creek watershed include urban stormwater (e.g., construction and commercial/residential stormwater runoff), stormwater runoff from roads and highways, on-site septic systems, agriculture (commercial and small farms), dog kennels, possible sanitary sewer line leaks or illicit connections to stormwater conveyances, and wildlife. Table 3 summarizes sources of bacterial pollution to streams in the Little Bear Creek watershed and their estimated significance.

Table 3. Potential sources of bacteria pollution in the Little Bear Creek Watershed.

Source	Explanation
On-Site Septic Systems	Failing or improperly designed/installed on-site septic tanks and/or drainfields that allow discharge of untreated effluent to groundwater or surface water.
Small Farms/ Agriculture	Runoff and drainage from small farms, fields, intensive animal use areas, and pastures. Improper manure application and/or storage practices.
Businesses that produce Pet Waste	Runoff and drainage from dog runs and animal play, grooming, or handling areas. Improper waste management and/or storage practices.
Residential Pet Waste	Runoff and drainage from dog runs and animal play areas. Improper waste management and/or storage practices.
Sewer Leaks	Potential leakage and/or overflows from municipal sanitary sewer lines.
Commercial/ Industrial Facilities	Contaminated stormwater runoff or drainfield drainage from commercial facilities, including solid waste recycling and transfer facilities.
Wildlife	Contamination from wildlife in the watershed such as deer, elk, coyote, cougar, bear, beaver, and birds.
Road and Highway Runoff	Contaminated runoff from unsecured loads, wildlife and litter on streets, roads, highways, roadside ditches, and roadway shoulder areas.

On-Site/Septic Systems

On-site (septic) systems can contribute significant amounts of fecal coliform and other bacteria to streams due to system failures and surface or subsurface malfunctions (EPA, 2001). Failing on-site systems may contribute significant bacteria loads directly to a water body, or via groundwater seepage, especially in shoreline areas or in areas of coarse-textured soils. Poorly installed, faulty, or improperly located on-site systems (septic tanks, drainfields) are other potential sources of human pathogens to surface and ground waters.

Major portions of the upper Little Bear Creek watershed are serviced by on-site systems and, hence, may be vulnerable to septic leakage. At this time, however, on-site treatment systems have not been identified as a major contributor to water quality problems in the watershed (King County, 2004).

Small Farms/Agriculture

The Little Bear Creek watershed has a long history of agriculture. Although agricultural land uses of the watershed have dwindled in recent years, numerous small farms and stables are still scattered throughout the watershed. Stock may include horses, cows, pigs, chicken, ducks, turkey, other fowl, sheep, goats, alpaca, llama, and other exotics. Animal keeping practices on small farms and activities associated with animal keeping operations can contribute to water quality degradation. Problems in the watershed may include overgrazing of pastures, inadequate manure storage and disposal, improper roof runoff management, and direct animal access to streams and wetlands. These activities can cause greater transport of sediment, nutrients, and bacteria to wetlands and streams.

Businesses that generate pet waste

At least fourteen dog kennels/pet boarding facilities are established in the Little Bear Creek watershed. In addition, there are groomers, breeders, veterinary offices, and at least one pet shelter located within the watershed. All of these facilities (if located in Snohomish County) are to be licensed under Title 6 of Snohomish County’s Business Licenses and Regulations Code.

Snohomish Health District Sanitary Code Chapter 3.1 states that certain pet wastes (e.g., dog and cat wastes) shall be “stored or disposed of in a manner, such as burial or bagging and placement into containers, which does not create a public nuisance or pollute surface waters of the state.” Noted acceptable manners of animal waste disposal include: (1) placement in the garbage/disposal at a local solid waste handling facility of bags of wastes weighing no more than ten pounds each; or (2) disposal in the sanitary sewer if the system is served by a sewer treatment facility that has approved acceptance of such wastes. Generally, disposal to an on-site system is not acceptable.

Although the Snohomish Health District or the county animal control agency has the authority to inspect kennels, boarding facilities, shelters, grooming parlors, or pet shops to ensure compliance with applicable regulations, little is currently known about what practices these facilities employ to manage their animal wastes. Poor pet waste management may contribute significant amounts of fecal coliform to the Little Bear Creek stream system.

Household Pet Wastes

Pet wastes generated at individual homes and in public areas such as parks and playgrounds may likewise contribute fecal coliform to the Little Bear Creek system.[5] As with the above, recommended manners of pet waste disposal include: (1) placement in the garbage/disposal at a local solid waste handling facility of bags of wastes weighing no more than ten pounds each; (2) or disposal in the sanitary sewer if the system is served by a sewer treatment facility that has approved acceptance of such wastes. Generally, disposal to an on-site system is not acceptable.

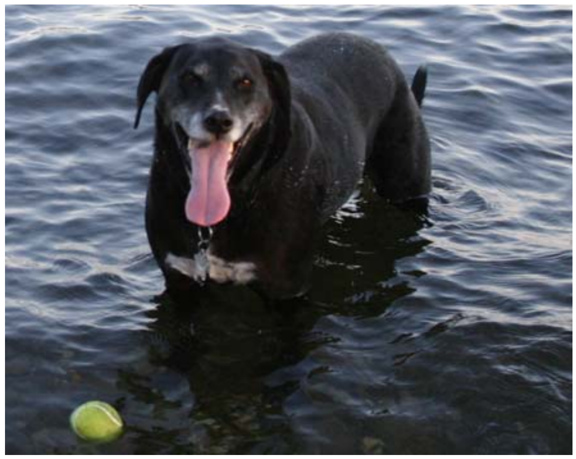

Figure 4. Dogs, cats, and other pets can contribute fecal coliform bacteria to creeks.

Sewer Leaks

Portions of the Little Bear Creek watershed are serviced by sanitary sewer systems operated by three sewer districts: Alderwood Water and Wastewater District; Cross Valley Sewer District; and Woodinville Water District. These areas are generally confined to the industrial areas in King County.

Sanitary sewer line breakages or illicit cross-connections to stormwater sewers can be significant sources of fecal coliform contamination (with concentrations in the tens of thousands of colony forming units per 100 mL). Such sewer system breakdowns or illegal cross-connections are generally corrected as soon as they are detected and do not appear to be a significant source of fecal coliform contamination in the Little Bear Creek watershed at this time. However, as development continues and as larger portions of the watershed move to sewer service (associated, in part, with the Brightwater project), the potential for such leakages or cross-connects will also increase.

Commercial and Industrial Sources, including Waste Handling Facilities

Ecology regulates stormwater discharges from approximately 30 commercial and industrial businesses located in the Little Bear Creek watershed. Ecology has issued industrial stormwater permits to these facilities because they have the potential to pollute local waters. Facilities covered under industrial stormwater permits must conform to specific requirements

[5] Snohomish County estimates that there are approximately 2,300 dogs in Little Bear Creek watershed (found within 1,500 households).

laid out in their permit(s), including the preparation of a stormwater pollution prevention plan (SWPPP), implementation of BMPs, and monitoring and reporting of stormwater water quality.

The Industrial Stormwater General Permit specifies that a permittee's discharge must not cause or contribute to an excursion of the state's water quality standards. Quarterly water quality monitoring and storm event sampling is mandatory for all permitted facilities. Fecal coliform testing, however, is only required if there is a potential source from the industrial activity discharging to a 303(d)-listed water or subject to a TMDL determination. Bacterial pollution is a potential pollutant when the facility handles fecal matter on site, or if the facility activities attract wildlife.

Ecology has identified one facility in the Little Bear Creek watershed with the potential to contribute bacterial pollution through its stormwater discharges. This facility accepts compostable and recyclable materials, and processes them for transportation to recycling facilities. In 2003 this facility was issued a water pollution control citation by Snohomish County for allowing runoff of polluting materials (soaps, detergents, and/or ammonia and process wastewater) to the county's drainage that drains to Little Bear Creek. Since becoming aware of the problem, the facility has identified two failing draining fields and one broken septage pipe. In response the facility is modifying its operations and is connecting industrial and domestic portions of the facility to the Alderwood Water and Wastewater District sanitary sewer system. The facility has also initiated a process with the Snohomish Health District to apply for a solid waste handling permit.

Ecology will require this facility to perform additional water quality monitoring for fecal coliform bacteria to determine if actions taken on site are sufficient to comply with the permit and water quality standards. Additional operational and structural BMPs and/or treatment systems will be required if monitoring indicates that current controls are insufficient to bring the site back into compliance with the applicable state water quality standards for bacteria. The wide array of regulatory mechanisms is expected to be sufficient to control the discharge of bacteria from this site.

Wildlife

Wildlife contributes bacteria to surface waters. Bear, coyote, deer, cougar, beaver, red squirrel, ducks, geese, heron, and other wildlife are observed in the Little Bear Creek watershed. These and other warm-blooded animals contribute fecal coliform bacteria loading directly and indirectly to streams. Loading from wildlife is considered natural background except where land use practices inordinately attract the wildlife. Some practices such as unkempt dumpster areas or littered parking lots can attract birds and other wildlife, and cause excess bacteria loading.

Road and Highway Runoff

Four state roads (SR 524, 522, 202, and Highway 9) run parallel to or intersect major portions of Little Bear Creek. In many locations where roads pass along or over the stream system, the road discharges untreated road runoff directly to the water. Pollution from road runoff is generally considered part of combined stormwater sources, but is worth noting separately here because Snohomish County and the Washington State Department of Transportation

(WSDOT) will be given separate bacteria wasteload allocations in this water cleanup plan to be addressed under their stormwater management programs. (Road and highway runoff will also be factored into the city of Woodinville's wasteload allocation and addressed in its NPDES Phase II Stormwater Management Program.) National literature sources indicate that highway runoff can be a significant source of bacteria to streams. The exact sources of bacteria from road runoff are unknown but may be generally due to wildlife, roadside litter, and unsecured loads. For the purposes of this report, average state road right-of-way was considered to be 65 percent impervious; average county road right-of-way was considered to be 80 percent impervious. Specific best management practices (BMPs) may be appropriate to address roadway stormwater runoff.

Figure 5. Stormwater runoff flowing off roadway during a 2005 January winter storm.

Storm Water

Storm water is the portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, channels or pipes into constructed infiltration facilities or defined surface water channels (EPA, 2001). Stormwater flows are erratic and may not exhibit distinct seasonal trends.

Ecology does not consider stormwater a pollutant source in itself, but an efficient conveyor of pollutants from drainage surfaces. Land uses and activities in urban areas, coupled with an increase in impervious surfaces and accumulation of contaminants (often associated with development), typically results in polluted stormwater. Contaminants collect on impervious areas of the basin, including rooftops, driveways, sidewalks, parking lots, and roads; and heavy rainfall and runoff wash them off into storm drains, or directly into streams. Consequently, pollutants reach stream systems quickly and in high concentrations during typical storms.

Major pollutants in urban stormwater runoff include sediment, nutrients, road salts, heavy metals, petroleum hydrocarbons, pathogenic bacteria, viruses, and toxic chemicals (EPA, 1997b). In the Little Bear Creek watershed, storm water also carries bacteria from sources such as pet waste, rural livestock, on-site system failures, and urban wildlife to the streams. The specific water quality impact of storm water may be hard to quantify, depending on the sampling protocol used.

Storm water within the Little Bear Creek watershed that is generated in unincorporated Snohomish County and that travels through the county's municipal separate storm sewer system (MS4) or via the state road system and that discharges to a surface water, is classified as a point source pollution and is regulated by Ecology's National Pollutant Discharge Elimination System (NPDES) Municipal Phase I Stormwater Management Program. Snohomish County and the WSDOT have NPDES permit coverage for their municipal stormwater discharges under a Phase I stormwater permit (Ecology, 1995).

Storm water that is generated within the watershed and reaches the creek system through an MS4 managed by the city of Woodinville will be regulated as a point source under Ecology's NPDES Municipal Phase II Stormwater Management Program (currently under development).

Total Maximum Daily Load Analysis

Section 303 of the CWA mandates that TMDLs be developed for the parameters(s) causing beneficial use impairment, for all 303(d) listed water bodies. A TMDL is the sum of the **wasteload allocation (WLA)** for discrete point sources of pollutants (such as wastewater treatment plant discharges) and the **load allocation (LA)** for nonpoint sources of pollution, including natural background levels. In addition, a TMDL considers **seasonal variation** and identifies a **margin of safety (MOS)** to allow for uncertainty in the wasteload determination and proposed treatments. A five percent reserve for future growth is also provided. The TMDL equation is: TMDL = WLA + LA + MOS

The TMDL defines the amount of pollutant allowed without exceeding water quality standards and impairing beneficial uses (EPA, 2001). This is called the **loading capacity**. The sum of wasteload allocations plus load allocation, with a margin of safety must not exceed the loading capacity of a water body else the water quality standard(s) will be exceeded.

Bacteria TMDLs often express overall loading capacity and wasteloads in mass loading terms such as colony forming units (cfu) per day (cfu/day) or cfu/year. For nonpoint sources, federal regulations allow expression of TMDL loads using "other appropriate measures" (40 CFR 122.45(f)). These alternative expressions for load are especially appropriate for nonpoint pollution because it is often non-continuous, highly variable, and usually comes from diffuse sources. Loads and load allocations for fecal indicators from nonpoint sources are more usefully represented as concentration or percent reduction in concentration (EPA, 2001). Defining allocations in these terms makes monitoring data more useful for verifying the effectiveness of meeting the TMDL goals.

This TMDL analysis relied primarily on monthly water quality data collected by the Snohomish County Surface Water Management Program.[6] Bacteria sampling data at seven stream stations (coinciding with the seven stream segments listed as impaired for bacteria) in the Little Bear Creek watershed were compiled and compared with standard normal distributions using normal probability plots and correlation coefficients (Gilbert, 1987). Since logged values of the sampling data from three mainstem stations were found to have a high degree of normality (with linear correlation coefficient 'R^2' values ranging from 0.956 to 0.966), the log-normal Little Bear Creek data were used in the statistical analysis.

Statistical Rollback Method

The TMDL analysis in this water cleanup plan applied the Statistical Rollback Method to the log-normalized wet (October–March) and dry (April–September) season stream sampling data (Ott,1995). Ecology uses the Statistical Rollback Method to establish the necessary reduction for both the geometric mean value[7] (GMV) and 90th percentile bacteria concentration components of stream water quality in relation to the fecal coliform water quality standard. An assumption used in the Rollback Method is that the statistical distribution of sample

[6] Monitoring undertaken by Snohomish County following procedures laid out in Snohomish County's Ambient Water Quality Monitoring Program Quality Assurance Project Plan (QAPP), approved by Ecology in 1992.
[7] The geometric mean is approximately the median value in a lognormal distribution.

results at any station remains similar before and after pollution source correction efforts are applied. Since source correction often results in statistical changes in sample populations, this assumption constitutes one of several factors in the margin of safety for this TMDL.

To apply the Statistical Rollback Method, the following approach is used. In the first step, statistics characterizing current water quality are calculated for each sampling station and compared with both parts of the fecal coliform water quality criterion. In Step 2, fecal coliform GMV and 90th percentile[8] targets are set according to the corresponding water quality criterion at each station and the reduction needed for each target value to be reached is then calculated. Wet and dry season target values are calculated separately to account for seasonal variability. In Step 3, the reduction factor (e.g., percent reduction) that allows both target values to be met is selected and applied to the existing GMV and 90th percentile. In most cases, a reduction of the 90th percentile is needed, and application of this reduction factor to the study GMV yields a target GMV that is usually lower (i.e., more restrictive) than the water quality criterion. In the final step, available streamflow data and calculated wet season GMVs are used to estimate wet season loading capacities on Little Bear Creek. Following this process, load and wasteload allocations are assigned to appropriate sources.

Appendix A describes this calculation method in greater detail.

Step 1: Characterize current water quality at specific stations and compare with relevant water quality criteria

Current bacteria concentrations at seven primary sampling stations in the Little Bear Creek watershed exceed water quality standards during some part of the year. In this step, Ecology calculated GMVs and 90th percentile values at each of these stations. Four water quality monitoring stations on the mainstem (LBHW, LBLU, LBLD, and LBCC) characterize upstream drainages; three tributary stations (TROT, CUTT, and DANE) characterize the three major Little Bear tributaries (Trout Stream, Cutthroat Creek, and Dane Creek).

Table 2, on page 9, compares current bacteria water quality at these stations to water quality standards. Overall, water quality at tributary stations is better than in the mainstem of Little Bear Creek. The highest bacteria levels were registered in the upper watershed at LBHW.

Step 2: Set target statistics for stream monitoring stations

In this step, Ecology established target statistics for each of the sampling stations described in Step 1. Because at all stations, the 90th percentile is the more restrictive part of the water quality criterion, rolling the 90th percentile back to 100 cfu/100 mL caused the GMVs to be "rolled back" to a level more restrictive than the standard. The resulting value is called the "target GMV." Taking this approach helps ensure that both parts of the water quality criterion are met. Table 4 summarizes the period of record and number of samples along with fecal coliform statistics at the seven sampling points within the watershed.

[8] The 90th percentile is used as an equivalent expression to the "no more than ten percent" criterion found in the second part of the water quality standards for fecal coliform.

Table 4. Fecal coliform statistical summaries for water quality monitoring sites used for the Little Bear Creek Loading Analysis.

Site	Period of record	Season	No. of samples	GMV	90th percentile	Target GMV
Little Bear Creek Headwaters (LBHW)	2000 - 2004	Wet	19	537	4,494	12
		Dry	20	873	5,043	17
Little Bear Creek Upstream (LBLU)	1993 – 2004	Wet	65	248	1,128	22
		Dry	65	449	2,907	15
Little Bear Creek Midstream (LBLD)	1993 – 2004	Wet	63	223	836	27
		Dry	64	364	1,966	18
Little Bear Creek Downstream (LBCC)	2000 – 2004	Wet	26	124	876	14
		Dry	29	290	1,807	16
Trout Stream (TROT)	2000 – 2004	Wet	18	36	950	4
		Dry	23	32	215	15
Great Dane Creek (DANE)	2000 – 2004	Wet	20	53	237	22
		Dry	23	86	583	15
Cutthroat Creek (CUTT)	2000 – 2004	Wet	19	85	414	20
		Dry	24	152	1,196	13

Step 3: Calculate critical percent reductions needed to meet water quality standards at monitoring stations

All seven sampling sites in Little Bear Creek watershed require different percent reductions to meet the water quality standard. Table 5 translates the target GMVs for mainstem stations into percent reductions in fecal coliform density needed.

Table 5. Target GMVs (cfu/100mL) and target FC density reductions (%) needed to meet fecal coliform standards in mainstem Little Bear Creek.

Little Bear Creek Sampling Site	Geometric Means				Percent Target Reductions (%)	
	Current Water Quality		Water Quality Targets			
	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
Little Bear Creek – Headwaters (LBHW)	537	873	12	17	97.8%	98.0%
Little Bear Creek—Upstream (LBLU)	248	449	22	15	91.1%	96.6%
Little Bear Creek—Midstream (LBLD)	223	364	27	18	88.0%	94.9%
Little Bear Creek—Downstream (LBCC)	124	290	14	16	88.6%	94.5%

Tributary water quality was generally better than in the mainstem. Tributary target reductions are still large, however, because of periodically high values in the stream samples exceeding ten percent of the total number of samples. Target water quality statistics and target reductions for Trout Stream, Great Dane, and Cutthroat Creeks are shown in Table 6.

Table 6. Target GMVs (cfu/100mL) and target FC density reductions (%) needed to meet bacteria standards in Little Bear Creek tributaries Trout, Great Dane, and Cutthroat creeks.

Little B Bear Creek Tributary & Station	**Geometric Means**				**Percent Target Reductions (%)**	
	Current Water Quality		**Water Quality Targets**			
	Wet Season	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**
Trout Stream (TROT)	36	32	4	15	89.5%	53.5%
Great Dane Creek (DANE)	53	86	22	15	59.5%	82.8%
Cutthroat Creek (CUTT)	85	152	20	13	75.9%	91.6%

Step 4: Determine Target Loading Capacities at Representative Stations

Using average monthly seasonal streamflows and the target GMVs established in Step 2, Ecology estimated target wet and dry season loading capacities at representative points in the watershed. This TMDL, involving diffuse sources and a high percentage of impervious surfaces, addresses loading capacity in terms of concentration and estimates mass loading based on mean monthly seasonal stream discharge. The loading capacity at each monitoring station for each season is the concentration needed to meet both parts of the applicable fecal coliform bacteria criterion:

- Fecal coliform organism levels shall not exceed a geometric mean value of 50 colonies/100 mL
- ...shall not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.

Three water quality monitoring stations (LBLU, LBLD, and LBCC), corresponding to those with streamflow data, were selected to best characterize the upstream drainages. Station LBLU characterizes the upper watershed drainages, including the headwaters of Little Bear Creek as well as Trout Stream; Station LBLD characterizes the middle and upper parts of the watershed, including the upper watershed plus the mid-basin drainages of Cutthroat and Great Dane Creeks. Finally, Station LBCC, the point closest to the mouth of Little Bear Creek, characterizes the entire watershed (including more industrialized areas near the future Brightwater Facility). These estimated loading capacities are captured in Table 7.

Table 7. Estimated loading capacities at primary mainstem stream segments in Little Bear Creek watershed.

Water Body Segment	Drainage area (acres)	Season	Estimated Mean monthly flow (cfs)	Target geomean (cfu/100 mL)	Estimated season loading capacity (cfu/day)
Little Bear Creek Upstream (LBLU)	2,260	Wet	6.6	22	3.56×10^{9}
		Dry	3.1	15	1.14×10^{9}
Little Bear Creek Midstream (LBLD)	6,865	Wet	20.1	27	$1.33 \text{ X } 10^{10}$
		Dry	9.9	18	$4.38 \text{ X } 10^{9}$
Little Bear Creek Downstream (LBCC)	9,260	Wet	32.2	14	$1.10 \text{ X } 10^{10}$
		Dry	15.2	16	$5.95 \text{ X } 10^{9}$

Wasteload and Load Allocations

Once the rollback targets and percentages were derived, Ecology established load and wasteload and load allocations, taking into account the water quality monitoring data (and associated earlier analyses) coupled with land use and coverage information and precipitation data. The nature of bacteria loading is typically too dynamic 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.

The Little Bear Creek watershed TMDL recommends general load allocations for nonpoint sources and specific wasteload allocations for municipal stormwater permit holders (Snohomish County, WSDOT, and city of Woodinville). The load allocations are derived for the cumulative loading from all nonpoint sources, and wasteload allocations are derived for all relevant point sources with NPDES or state waste discharge permits. Taken together, the allocations must not exceed the loading capacity for each water body.

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 Little Bear Creek watershed did not allow for development of specific load allocations by source type at this time. Source identification monitoring during early implementation of the Water Cleanup Plan in 2005-06 will help determine relative contribution of the various pollution sources in the watershed.

The most significant nonpoint sources of bacterial contamination are probably inadequate agricultural and livestock practices, pet wastes, failing on-site systems and runoff from homes, and commercial businesses. Load allocations for the Little Bear Creek watershed were developed as target percent reductions within each listed stream segment and are shown in Table 8.

Table 8. Load allocation targets (cfu/100mL) and load reductions needed to meet fecal coliform standards in Little Bear Creek at representative points.

Stream Station	Water Quality Targets (geometric mean)		Target Reductions (percent - %)	
	Wet Season	Dry Season	Wet Season	Dry Season
LBLU	22	15	91.1%	96.7%
LBLD	27	18	88.0%	94.9%
LBCC	14	16	88.7%	94.5%

Land Use Data

The modeling approach for establishing wasteload allocation estimates uses land use data and impervious cover within each sub-basin as well as literature-derived runoff characteristics (Schueler, 1987). Ecology sorted areas within the sub-basin by land use into forest, agriculture, residential, commercial/urban, and roadway categories. Table 9 shows drainage areas and percentage land use areas for individual sub-basins. Table 10 shows estimates of runoff concentrations and impervious cover for each land-use category.

Table 9. Percentage estimates for land use above representative points in the Little Bear Creek Watershed.

Sub-basin	Drainage Area (acres)	Forest	Agriculture	Residential	Commercial / Urban	Roadway
Upper Little Bear Creek (including LBHW, LBLU, and TROT)	2,260	41.6%	25.2%	31.0%	0.0%	2.2%
Middle Little Bear Creek (including above plus LBLD, DANE, and CUTT)	6,865	51.1%	22.8%	19.4%	3.8%	2.9%
Little Bear Creek System (@LBCC)	9,260	44.6%	21.1%	18.0%	11.4%	3.5%

Table 10. Stormwater runoff characteristics and impervious cover estimates for various land use categories.[9]

Land use type	Fecal coliform (cfu/100 mL)	Total phosphorus (mg/L)	Impervious cover (%)
Forest	100	0.10	20
Agriculture	3,000	0.35	30
Residential	2,000	0.26	40
Commercial/Urban	980	0.21	87
Roadway	890	0.26	65/80[10]

Once established, the relative proportions of bacteria loading from the NPDES stormwater permit jurisdictions were applied to the loading capacities to establish proposed wasteload allocations. The following section of the report apportions the estimated point source fecal coliform loading capacities among relevant NPDES permit holders at each stream station.

[9] Land use characteristic values are derived from Embry (2001), Schueler (1987), Novotny and Olem (1994), National Stormwater Quality Database (2004), and Riverton Stormwater Quality Management Plan (1997).

[10] Schueler's model estimates impervious cover associated with roadways at 80 percent. However, WSDOT has provided information suggesting that state road have only 65 percent impervious cover. Therefore, all calculations in this TMDL concerning state roads (*e.g.*, Highway 9 and State Routes 202, 522, and 524) will use a 65 percent impervious cover estimate.

Wasteload Allocations

Wasteload allocations are assigned to point sources of pollution. In many cases, these are industrial facilities that are permitted to discharge to a receiving water. As part of 1987 amendments to the Clean Water Act, Congress added Section 402(p) to the Act requiring permit coverage for stormwater discharges associated with industrial activity and discharges from large and medium MS4s, i.e., systems serving populations over 250,000 or systems serving populations between 100,000 and 250,000, respectively. These municipal discharges are referred to as Phase I MS4 discharges. Snohomish County and WSDOT are Phase I jurisdictions with responsibility in Little Bear Creek watershed.

EPA was also directed to study and issue regulations that designate additional stormwater discharges (other than those covered under Phase I) to be regulated in order to protect water quality. In December 1999, EPA issued regulations expanding the NPDES stormwater program to include discharges from smaller MS4s (including all systems within "urbanized areas" and other systems serving populations from 10,000 to 100,000). This expansion of the NPDES stormwater regulatory program is referred to as Phase II. The city of Woodinville is a Phase II stormwater community by virtue of being an urbanized area having a population of over 10,000.

EPA requires that all regulated stormwater discharges be addressed by the WLA component of TMDLs. EPA recommends expressing stormwater WLAs in the TMDL as aggregate allocations for identifiable categories. These categories should be defined as narrowly as available information allows (*e.g.*, for municipalities, separate WLAs for each municipality) (Wayland and Hanlon, 2002). EPA also acknowledges the difficulty of characterizing the highly variable frequency and duration in bacteria loads in storm water. Numeric limits for municipal stormwater discharges are not often feasible or appropriate when determining stormwater discharge effluent limits in NPDES permits that are consistent with TMDL-established WLAs. Accordingly, EPA guidance recommends that NPDES-regulated municipal (and small construction) stormwater discharge effluent limits be expressed as best management practices (BMPs) or similar requirements, rather than as numeric effluent limits (Wayland and Hanlon, 2002). BMPs identified in the NPDES stormwater permits will help achieve bacteria loading reductions listed in Tables 11-13.

Ecology estimated the relative proportion of stormwater fecal coliform loads for the three NPDES jurisdictions using the "Simple Method Model" (Schueler, 1987). The model requires sub-basin drainage areas and impervious cover, stormwater runoff pollutant concentrations, and annual precipitation. Ecology divided the major Little Bear sub-basin areas into respective jurisdictions of the relevant stormwater permit holders and categorized land uses in each sub-area as residential, commercial/industrial, agricultural, forest, and roadway. Finally, Ecology estimated the portion of fecal coliform stormwater load transported by each permit holder's MS4. The analysis focused on the wet season, as this is when stormwater runoff is most significant. Typical stormwater runoff pollutant concentrations for each land use category (taken from the literature and identified in Table 10, above) were also factored into the analysis (Joy, 2004).

Snohomish County, the city of Woodinville, and WSDOT have each been assigned WLAs through this water cleanup plan. Tables 11-13 show the wasteload allocations (allowable loading during storm flows) assigned to each permitted stormwater source at each representative station. Available loading capacity takes into account the five percent growth factor (reserve for future growth) provided at each station.

Table 11. Fecal coliform (FC) wasteload allocations (WLAs) for Snohomish County at LBLU.

Station: **LBLU**
Wet Season Total Loading Capacity = 3.56×10^{9} cfu/day
Wet Season Available Loading Capacity = 3.39×10^{9} cfu/day
Estimated Current Wet Season Loading = 4.02×10^{10} cfu/day

Assigned Source	Wasteload Allocation (cfu/day)	% of Total Wet Season Loading Capacity	Estimated % Loading Reduction Needed to achieve target
Snohomish County	1.08×10^{8}	3.2	8.4
TOTAL =	**1.08×10^{8}**	**3.2**	

Table 12. Fecal coliform (FC) wasteload allocations (WLAs) for Snohomish County and Washington State Department of Transportation (WSDOT) at LBLD.

Station: **LBLD**
Wet Season Total Loading Capacity = 1.33×10^{10} cfu/day
Wet Season Available Loading Capacity = 1.26×10^{10} cfu/day
Estimated Current Wet Season Loading = 1.10×10^{11} cfu/day

Assigned Source	Wasteload Allocation (cfu/day)	% of Total Wet Season Loading Capacity	Estimated % Loading Reduction Needed to achieve target
Snohomish County	4.93×10^{8}	3.9	11.5
WSDOT	1.01×10^{8}	0.8	11.5
TOTAL =	**5.94×10^{8}**	**4.7**	

Table 13. Fecal coliform (FC) wasteload allocations (WLAs) for city of Woodinville, Snohomish County, and Washington State Department of Transportation (WSDOT) at LBCC.

Station: **LBCC**
Wet Season Total Loading Capacity = 1.10×10^{10} cfu/day
Wet Season Available Loading Capacity = 1.05×10^{10} cfu/day
Estimated Current Wet Season Loading = 9.75×10^{10} cfu/day

Assigned Source	Wasteload Allocation (cfu/day)	% of Total Wet Season Loading Capacity	Estimated % Loading Reduction Needed to achieve target
Snohomish County	3.56×10^{8}	3.4	10.7
WSDOT	1.36×10^{8}	1.3	10.7
City of Woodinville	1.49×10^{9}	14.2	10.7
TOTAL =	**$1. 98 \times 10^{9}$**	**18.9**	

Only municipal stormwater discharges are included in the wasteload allocation portion of the Little Bear Creek TMDL analysis. Industrial stormwater permittees are expected to comply with applicable water quality standards and are not expected to be a significant source of bacterial pollution in the Little Bear Creek watershed. For this reason, this TMDL does not provide a specific wasteload allocation for any industrial stormwater permittees. If, over the course of implementation, additional characterization/monitoring identified any additional significant fecal coliform sources, the TMDL will be updated or modified.

Seasonal Variation

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 determination of "TMDLs shall take into account critical conditions for stream flow, loading, and water quality parameters" [40 CFR 130.7(c)(1)]. As discussed above, fecal coliform bacteria concentrations and loads in the Little Bear Creek stream system show seasonal variations. Generally, higher fecal coliform loads tend to coincide with summer conditions (see Figure 3); however, results vary by station and elevated concentrations occur throughout the year and over a range of discharges. As a result, water quality data have been broken out into wet/winter season (October – March) and dry/summer (April-September) season values in the preceding TMDL analysis.

Margin of Safety

Uncertainty is accounted for in TMDLs using a margin of safety to ensure that load and wasteload allocations remain protective of water quality. The margins of safety are explicit in the form of an allocation, or implicit, such as in the use of conservative assumptions in the analysis.

The conservative assumption used in calculating the water quality target statistics in the TMDL provides a safety factor for the *Little Bear Creek Water Cleanup Plan*. The Statistical Rollback Method assumes equivalent variances of the pre-management data set and the post-management data. The frequency of high sample values should decrease as pollution controls take effect, which should reduce the variance and 90th percentile of the post-management condition (Ott, 1995). Another margin of safety implicit in the *Little Bear Creek Water Cleanup Plan* is the fine division of the Little Bear Creek watershed into small sub-basins and the overlapping nature of sub-basins used in setting wasteload and load allocation targets. The relatively small geographic size of upper watershed sub-basins will help ensure the success of local source identification and evaluation efforts. As sources are corrected in upper sub-basins, water quality targets at lower basin stations become more attainable, helping assure successful water cleanup.

Summary Implementation Strategy (SIS)

This section of the *Little Bear Creek Water Cleanup Plan*, the Summary Implementation Strategy (SIS), inventories numerous existing or planned activities in the Little Bear Creek watershed that can help remedy the bacterial impairment in basin streams. This SIS also recommends focused specific additional monitoring activities to aid illicit discharge identification and correction actions in known problem areas. Ecology anticipates that if these water quality programs and projects (as refined during the implementation planning process and through preparation of the detailed implementation plan (DIP)) proceed as expected, concurrent with additional source identification and correction work in focus areas, all water bodies within the Little Bear Creek watershed will meet their applicable water quality standard(s) for bacteria by December 2010.

Water cleanup plans help ensure that impaired water bodies are cleaned up and can attain water quality standards. Ecology facilitates this process by encouraging and (in some cases) funding local governments, agencies, districts, businesses, and communities to participate in actions that will help identify and correct pollution sources and protect stream quality. In the case of impairment with excess bacteria, source control and treatment of bacterial contamination such as pet waste management, agricultural waste management, on-site system maintenance, and litter prevention are important solutions to the problem.

Several agencies and groups in the Little Bear Creek watershed actively conduct educational and stream restoration projects that help remediate the problem of excess bacteria in these creeks. For example, Snohomish County Surface Water Management runs a Watershed Stewardship program and employs a South County Watershed Steward who focuses outreach efforts on building awareness of water quality issues and promoting water quality improvement projects. The Snohomish County Conservation District recently held four “Horses for Clean Water” classes to educate small farm owners about basic farm management issues and practices (e.g., manure management, offstream watering) to increase landowners’ awareness of water quality issues including bacteria source control. Along with local governments, several citizen groups, such as Adopt-a-Stream Foundation and the Little Bear Creek Protective Association, actively plan and develop stream restoration and other watershed activities that will help reduce fecal coliform contamination in the Little Bear Creek watershed.

In consultation with the parties listed below and others, Ecology will develop a DIP for the Little Bear Creek watershed in the year following TMDL approval by EPA. The DIP, a required element of water cleanup plans in Washington State, will provide additional detail on how implementation will occur as well a specific framework for implementing the bacteria load reductions. The DIP will also document ongoing and planned actions designed to bring Little Bear Creek and its tributaries into compliance with state water quality standards.

Implementation Plan Development and Activities

The following government agencies, citizen groups, and tribes have regulatory authority, influence, information, resources or other involvement in activities to protect and restore the health of the Little Bear Creek stream system.

State and Federal Government Resources

Washington State Department of Ecology

Ecology has been delegated authority under the federal Clean Water Act by the EPA to establish water quality standards and administer the NPDES wastewater-permitting program. In addition, Ecology is authorized by the Washington State legislature to enforce water quality regulations under Chapter 90.48 RCW. Ecology responds to complaints, conducts inspections, and issues NPDES permits as part of its responsibilities under state and federal laws and regulations. In cooperation with conservation districts, Ecology supports implementation of farm plans and BMPs for small farms and may use formal enforcement, including fines, if voluntary compliance is unsuccessful.

In 2006, Ecology will be re-issuing the NPDES Phase I Municipal stormwater permit to Snohomish County and WSDOT and will be issuing the NPDES Phase II Municipal stormwater permit to the city of Woodinville. Ecology expects these permits will incorporate appropriate actions described in this SIS and/or the DIP (e.g., public education, and programs to detect illicit connections to the MS4), and will include stormwater monitoring components that will contribute to the follow-up monitoring needed for this TMDL.

Ecology's role in water cleanup implementation is through coordination of water cleanup plans, administration of the Water Pollution Control Act (RCW 90.48), and support of other programs such as Watershed Planning and the state's nonpoint plan. Ecology will implement many nonpoint source control activities through administration of state statutes and regulations, and through local jurisdictions, resource agencies, and landowners. Ecology will also coordinate with and, when possible, facilitate joint projects and efforts with local watershed planning groups initiated by the watershed planning process under the Watershed Planning Act (RCW 90.82) and the Washington State Salmon Recovery effort.

Ecology provides financial assistance to local governments, tribes, universities, watershed groups, and conservation districts for stream restoration and water quality improvement projects through its Centennial Clean Water Grant Program. Ecology gives high priority to TMDL-related grant project proposals in funding decisions for state Centennial Clean Water Funds.

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 accordance with its permit and SWMP, WSDOT also prepares stormwater pollution prevention plans for major road projects, prepares annual NPDES compliance reports, and conducts water quality monitoring. WSDOT is planning a widening of Highway 9 through portions of the Little Bear Creek watershed near the Brightwater site. Construction is scheduled to begin in late spring or early summer 2005.

Muckleshoot Indian Tribe

The Muckleshoot Indian Tribe is a sovereign nation with land use authority within their reservation. The Muckleshoot Indian Tribe's ancestors had usual and accustomed fishing places primarily at locations on the upper Puyallup, Carbon, Stuck, White, Green, Cedar, and Black Rivers, the tributaries to these rivers, and Lake Washington. The Little Bear Creek watershed is part of the Cedar-Sammamish system, and is therefore within the Muckleshoot Indian Tribe's Usual and Accustomed Areas. Today, the Muckleshoot Indian Tribe has an active resource protection staff and may assist in stream restoration and water quality improvement efforts.

Local Government Resources

Snohomish County

Snohomish County works extensively in the Little Bear Creek watershed to protect and restore water quality. Snohomish County adopted a Water Pollution Control Ordinance (Chapter 7.53 SCC) in March 1998 to protect the quality of Snohomish County's surface and ground waters by providing technical assistance, requiring BMPs, and establishing an enforcement process. The Water Pollution Ordinance also prohibits the discharge of animal wastes to Snohomish County streams. In 2000, Snohomish County adopted The Reduced Drainage Discharge Housing Demonstration Program (Ordinance 00-004) to promote design and development techniques such as low impact development (LID) that significantly reduce drainage discharge. An Amended Ordinance was then adopted in 2003 to repeal and re-enact the program. The county recently permitted a LID housing project, Maltby Joint Ventures, in the Little Bear Creek watershed (in the Cutthroat Creek drainage). This innovative project incorporates LID techniques (including pervious pavement, bio-detention systems, and drainage swales) to increase stormwater infiltration and provides for open space acquisition (20+ acres) in adjoining areas. The county will continue to encourage and support implementation of LID projects under its demonstration program and through public education activities associated with its stormwater program.

The county's surface water management program (SWM) has monitored water quality at numerous locations in Little Bear Creek since the 1990s and maintains two long-term monitoring stations in the Watershed (LBLU and LBLD) to evaluate nonpoint source pollution at these sites. The county's monitoring data can be accessed on the Internet at www.data.surfacewater.info. Snohomish County plans to continue to monitor water quality at these two locations as funds are available and will coordinate ambient water quality monitoring with local governments to minimize duplication of effort.

Snohomish County SWM staff also regularly investigates water quality problems and complaints in the Little Bear Creek watershed, determine whether violations of the Water Pollution Control Ordinance have occurred, and provide technical assistance to resolve the problem. As part of its Stormwater Management Program, the SWM also implements an extensive illicit discharge elimination and dry weather outfall monitoring program aimed at identifying and correcting illegal discharges to the county's MS4. The county has used optical brightener testing to determine where failing septic systems within the Little Bear Creek watershed are contributing to the fecal coliform contamination problem.[11] These stormwater management activities will also continue, pending ongoing program support. SWM has applied for and hopes to be awarded a 2006 Centennial Clean Water Grant to identify and correct failing on-site systems and provide education to owners of on-site systems. Snohomish County will work with the Snohomish Health District to accomplish this.

SWM runs a strong public outreach program, consisting of educational programs for students, teachers, and the general public. The county employs a South Snohomish County Watershed Steward who works in partnership with citizens and agencies to protect and enhance water quality and aquatic habitats. The watershed steward provides stream cleanup, restoration, and planting assistance, develops acquisition and preservation strategies for wetlands and riparian corridors, and investigates landowner water resource problems originating off-site. The county will continue to offer educational and volunteer opportunities such as landowner workshops and native plants salvage efforts as funding allows.

Snohomish County also has regulatory authority over land uses in the watershed where farming activities are likely to occur. The county will work collaboratively with livestock owners, the Snohomish Conservation District (SCD), citizen groups, property owners, and resource agencies to implement farm plans and reduce agricultural pollution.

Under a current Centennial Clean Water Grant, SWM is conducting research to determine the barriers to proper pet waste disposal and is designing and implementing programs to properly dispose of pet waste. SWM will prepare educational information and distribute materials to other local jurisdictions. The grant also calls for providing technical assistance to up to 100 businesses that handle animal wastes. Information and results from the review will be made available across Snohomish County, including in the Little Bear Creek watershed. Snohomish County may decide to follow up on and expand these activities and outreach to businesses that handle pet wastes. Key partners will likely include the SHD and County Auditor's Office.

[11] Optical brighteners are chemicals used as brightening agents in laundry detergent and do not break down easily in septic systems. Their presence in surface waters indicates a human waste stream.

King County

King County has also been actively monitoring the water quality in the Little Bear Creek Watershed. Its monitoring data are available at: http://dnr.metrokc.gov/wlr/waterres/streams/littlebear_intro.htm. In May 2001, in conjunction with the University of Washington, DNRP's Water and Land Resources Division completed the *Habitat Inventory and Assessment of Three Sammamish River Tributaries: North, Swamp, and Little Bear Creeks*. King County also facilitates and participates in the WRIA 8 Salmon Recovery Steering Committee.

King County recently was awarded approval to site a regional wastewater treatment facility, Brightwater, near the center of the Little Bear Creek watershed. Site plans call for developing extensive natural stormwater management treatment features (e.g., sand filtration, incorporation of LID techniques into site design, use of green roofs for certain buildings). The site plan also calls for the creation, re-vegetation, and/or enhancement of 43 acres of wetlands. This activity will upgrade vital stormwater management systems and improve salmon habitat in the Little Bear Creek watershed. Overall, an estimated 60 acres of pervious surface will be created at the Brightwater site on these former auto wrecking and other commercial lots. (Michael Popiwny, King County, personal communication.) In addition to the planned environmental enhancements at the Brightwater site, King County has also earmarked at least $88 million (or ten percent of originally estimated project costs) to mitigate system-wide impacts of Brightwater construction and operation. Mitigation projects are expected to be selected in spring 2005. Several restoration and riparian corridor protection projects in the Little Bear Creek watershed will be eligible for funding under this effort.

Snohomish Conservation District

The Snohomish Conservation District (SCD) is a non-regulatory public agency that provides many services to commercial dairies, small farms, and rural residents. These services include education, technical assistance, farm planning, and financial assistance, when available. SCD has a model farm program that recognizes outstanding efforts by landowners in water quality improvements. Model farm tours are often held to highlight these improvements for other small farm owners. In 2004, the SCD co-sponsored an educational series called 'Horses for Clean Water' in Little Bear Creek, with assistance from an Ecology Centennial Clean Water Grant. The classes focused on environmentally beneficial farm practices such as reducing mud, managing manure, improving pasture management, and providing for wildlife. With available Centennial funds, SCD will develop model farms in the south county area for landowners to tour. Proper BMP implementation can also emphasize the benefits of improved livestock health and chore efficiency.

SCD has helped farmers throughout the Little Bear Creek watershed with free site visits and technical assistance. Additionally, SCD prepares farm plans that guide landowners in assessing their resources and provides them with information they can use to protect and enhance those resources. The farm plan must meet or exceed standards and specifications established by the Natural Resources Conservation Service (NRCS). Landowners can request a free farm plan, or they can be referred to SCD to develop a farm plan if a documented water quality problem exists. SCD currently has several cost-share programs available to landowners. Projects eligible for funding may include fencing, planting, manure management, roof runoff management, off-stream watering, and riparian corridor management. Little Bear Creek farm operators are eligible for free site visits and farm plans and cost-share programs when funding is available.

Ecology, Snohomish County, and the SCD need to work together to review the success of agricultural water quality improvement approaches to date and to identify and, as funding allows, implement the specific additional approaches to reduce agricultural pollution which have proven to be effective. One important step may be for all commercial and small livestock farms in the Little Bear Creek watershed to develop and implement farm plans. Ecology will work with Snohomish County and SCD to help educate farms on the need for a farm plan. It is expected that within five years, as more small farms develop and implement farm plans or BMPs, fecal coliform levels will be measurably reduced in the more rural areas of the watershed.

Snohomish Health District

The Environmental Health Division of the Snohomish Health District (SHD) issues Solid Waste Permits for solid waste disposal sites and handling facilities in Snohomish County, provides regulatory oversight for the On-Site Sewer System Program, investigates (and may take enforcement action related to) sewage discharge complaints, and conducts some water quality monitoring for bacteria in the county. The SHD is responsible for investigating complaints of failed on-site septic systems and requiring corrective measures such as on-site system maintenance, renovation, or hook-up to sewer systems where available. Unreported failing septic systems have the potential to create a localized health threat as well as contribute to bacterial pollution in local surface waters.

In addition to certifying on-site system installers and licensing on-site system pumpers, the SHD educates homeowners on the proper operation and maintenance of on-site systems. Ongoing implementation of such programs will help reduce future failures and prepare homeowners to recognize existing problems that may be contributing to bacterial pollution problems in the Little Bear Creek watershed.

Housing Authority of Snohomish County

The Housing Authority of Snohomish County (HASCO) provides a variety of services to low-income households in Snohomish County outside the Everett city limits. HASCO runs a Housing Rehabilitation Loan Program which provides home improvement loans to qualified low-income households.[12] These low-interest, long-term loans may be used for projects addressing health and safety issues, including to repair or replace leaking or failing on-site systems.

City of Woodinville

The city of Woodinville considers Little Bear Creek to be one of the city’s primary ecological resources and works in numerous ways to protect the Little Bear Creek corridor. The city recently won council approval to establish a Little Bear Creek Linear Park that will stretch from the mouth of Little Bear Creek (at the Sammamish River) northward to the county line. The linear park is expected to provide extended buffers along the stream corridor as well as

[12] A household of four living outside the city limits of Everett but within Snohomish County can qualify if annual household earnings are less than $57,500.

non-motorized transportation and recreation benefits to the citizens of Woodinville. The park is also expected to remove hydrologic barriers and restore streamside habitat, provide road maintenance and drainage improvements, and offer public education opportunities. It is anticipated that this effort will shape the long-term environmental resources of Woodinville (Woodinville, 2004). The city has also undertaken numerous bank stabilization/habitat improvement projects (often in coordination with the Adopt-A-Stream-Foundation or other organizations) and collects water quality data at three points in the watershed. These sampling activities are coordinated with Snohomish County.

The city will seek coverage under the NPDES Municipal Phase II Stormwater Permit, and is working to establish a robust stormwater management program. Through its stormwater management program, the city of Woodinville will begin to take the corrective actions it has been assigned in the table below.

Other Resources

Adopt-A-Stream Foundation

The Adopt-A-Stream Foundation (AASF) is a non-profit 501(c)(3) environmental education and habitat restoration organization that offers citizens tools to help them play a vital role in protecting and enhancing the watersheds in which they live http://www.streamkeeper.org/foundation.htm. The AASF considers clean water an integral part of providing a healthy spawning and rearing habitat for wild salmon, steelhead, trout, and other wildlife, and a key element to providing clean drinking water and places for rest and relaxation. The long term goal of AASF is to ensure the protection and care of every stream, including Little Bear Creek, by encouraging schools, community groups, sports clubs, civic organizations and individuals to adopt their streams and to become Streamkeepers.

The AASF is collaborating with the city of Woodinville to replace a triple culvert on Little Bear Creek at 134th Avenue NE to improve fish passage. Replacement of the culvert with a bridge and extensive re-vegetation of the site are key project activities. The AASF also recently completed an inventory of three watersheds, including Little Bear Creek watershed, to locate pollution sources and identify man-made barriers to salmon migration. AASF's report identified culvert blockages, located direct discharge outfalls, and proposed that nonpoint source pollution in Little Bear Creek is commonly associated with degraded riparian conditions (including the planting of lawns down to the edge of the creek). Culvert replacement activities recommended by AASF in the Little Bear Creek watershed will include re-vegetation efforts that can reduce stormwater impacts and fecal coliform transport to streams.

Local Businesses

All local businesses should act to help control and eliminate, where possible, pollution originating from their sites. Property owners adjacent to the creek system should consider taking steps to improve streamside habitat and evaluate ways to improve stormwater management and infiltration on site. Businesses, such as Alpine Rockeries, that have already implemented such measures can be a model for others, including new neighbors such as Costco and Brightwater. Development and redevelopment efforts can also take steps to minimize the transport of fecal coliform to the Little Bear Creek system, as did the Maltby Joint Venture low-impact-development housing development. Ecology, Snohomish County, and the city of Woodinville will work with businesses as resources allow to encourage good stewardship and environmental management practices.

Local Citizens

Local citizens play a vital role in improving the water quality of Little Bear Creek and its tributaries. Through a thoughtful review of one's own activities, citizens can have an immediate impact on local water quality. Properly disposing of pet wastes, encouraging rainwater to soak into gardens and lawns, and taking other steps to slow the movement of stormwater and contaminants into creeks are all actions that can reduce bacteria inputs and can improve water quality. Local citizens can also get involved in stream rehabilitation, communicate their interest in the environment to elected officials, and educate others on how to improve water quality in the Little Bear Creek watershed.

High Priority Water Cleanup Activities

Table 14 shows a summary of implementation actions and parties likely to play a critical role in correcting sources of fecal coliform bacteria in the Little Bear Creek watershed. Ecology will be discussing these and related activities with the key parties and will be refining this list of implementation actions during the implementation planning process. Agreements or commitments to implement specific actions will be documented in the DIP.

Table 14. Summary of actions and responsible parties to correct sources of bacteria in Little Bear Creek Watershed.

Cleanup Action	Key Parties	Possible Mechanism	Possible Timeframe
Watershed stewardship education	City of Woodinville, Snohomish County, Ecology	NPDES Phase I and II Stormwater Permitted Program	2005-2010
Wetland and riparian areas acquisition and/or restoration	King County (via Brightwater Mitigation or Salmon Recovery Funds), Snohomish County, City of Woodinville	Brightwater Mitigation Funds; state and local salmon recovery funds	2005-2010
Bacteria source detection monitoring	Snohomish County, King County, city of Woodinville, Ecology	NPDES Phase I and II Stormwater Permitted Program (illicit source detection and elimination)	2005-2008
Stormwater source control Best Management Practices (BMPs), including LID	Property owners, Snohomish County, city of Woodinville, WSDOT, Ecology	Snohomish County Reduced Drainage Discharge Housing Demonstration Program	2005-2010
Stormwater treatment BMPs	City of Woodinville, Snohomish County, WSDOT	NPDES Phase I and II Stormwater Permitted Program	2005-2010
On-site septic system inspection, repair, and maintenance	On-site owners, Ecology, city of Woodinville, WSDOH, Snohomish Health District, Housing Authority of Snohomish County	Housing Rehabilitation Loan Program	2005-2010
Pet Waste Business Owner Education and Pet Waste BMP Brochure/Guide	Snohomish County	NPDES Phase I Stormwater Permitted Program	2005-2008
Stormwater treatment of road and highway runoff	City of Woodinville, Snohomish County, WSDOT, Ecology	NPDES Phase I and II Stormwater Permitted Program	2005-2010

Cleanup Action	Key Parties	Possible Mechanism	Possible Timeframe
Small Farms-Agriculture inspection and assistance	Snohomish County, Snohomish Conservation District, Ecology	Horses for Clean Water	2005-2010
Investigation and repair of sewer leaks	Woodinville Water District Cross Valley Sewer District Alderwood Water and Wastewater District		2005-2007
Fecal coliform storm event monitoring and/or implementation of BMPs to reduce fecal coliform discharge to stormwater	Bacteria-generating commercial or industrial facilities, including Waste Management NW	State-issued administrative orders, notices, penalties, or Industrial Stormwater NPDES General Permit; county solid waste handling permit	2005-2007
Long-term ambient water quality monitoring	Snohomish County, City of Woodinville	NPDES Phase I Stormwater Permitted Program	2005-2010
BMP and water cleanup effectiveness monitoring	Snohomish County, WSDOT, City of Woodinville	NPDES Phase I and II Stormwater Permitted Program	2007-2010

Summary of Public Involvement

The *Little Bear Creek Water Cleanup Plan for Fecal Coliform Bacteria* public comment period was open from February 25 through March 31 (35 days), and included two public informational meetings that were held at the Woodinville City Hall on March 3 from 3:00-5:30pm and at the Fernwood Elementary School on March 10, from 7:00 -9:00 p.m. The public comment period allows time to solicit public input and feedback on the proposed final draft TMDL assessment and its associated SIS. Public notice for the commencement of the public comment period and public meeting consisted of a mailed Focus Sheet and display advertisements in the Woodinville Weekly. News releases were also sent to King County Journal (2-25-05 Seattle Daily Journal of Commerce (3-1-2005), and Brightwater Bulletin (2-28-05). In addition, the Seattle Times (3-2-2005) and Everett Herald (3-7-2005) published articles related to the water quality impairments and draft water cleanup plan for Little Bear Creek. KING 5-TV also aired a news segment highlighting the issues on March 10, 2005. Appendix B includes copies and affidavits for the above newspaper legal and display ads.

Ecology published a "Focus Sheet" summary on the Little Bear Creek Water Cleanup Plan on February 18, 2005, mailed it to approximately 3,000 watershed residents, distributed it to the above-listed agencies and groups and interested persons, and made it available at the public meetings noted above. Ecology responded to all written comments received during the public comment period. All comment responses are collectively provided in the responsiveness summary, included as Appendix C of this report.

Reasonable Assurance

The goal of the *Little Bear Creek Water Cleanup Plan for Fecal Coliform Bacteria* is for the waters of the watershed to meet the state's fecal coliform water quality standards. There is considerable interest and local involvement toward resolving the bacteria and other water quality problems in the Little Bear Creek watershed. Numerous organizations and agencies are already engaged in stream restoration and source correction actions that will help resolve the bacteria problem and secure riparian protections to mitigate further pollution sources.

The following rationale help provide reasonable assurance that the Little Bear Creek Watershed TMDL goals will be met by 2010.

- Snohomish County, the city of Woodinville, and WSDOT will be subject to the requirements of NPDES stormwater permits (Phase I or II) which are anticipated to require implementation of actions called for in applicable TMDLs. Ecology will work closely with these jurisdictions to set reasonable, achievable, and effective strategies for meeting the loading reduction targets set forth in this water cleanup plan.

- The city of Woodinville and Snohomish and King Counties have ongoing monitoring programs which will assist in identification of pollution sources and enable the ongoing evaluation of Little Bear Creek watershed water quality. Although reduced in number in recent years, these regular monitoring activities are being augmented by Snohomish County's illicit discharge elimination and dry weather outfall monitoring program. Ecology will also periodically conduct special sampling surveys to help further define pollution sources and promote source correction. Ecology has priority grant rating for water cleanup-related projects applying for Centennial Clean Water Grant monies.

- SCD will continue providing and tracking technical assistance and BMP implementation for landowners in the Little Bear Creek watershed for small farms and agricultural activities.

- SHD regulates on-site sewage systems in accordance with Ch. 246-272 WAC and the Snohomish Health District Sanitary Code (Chapter 8).

Whenever applicable BMPs are not being implemented and Ecology has reason to believe that individual sites or facilities are causing pollution in violation of RCW 90.48.080, Ecology may pursue orders, directives, permits, or enforcement actions to gain compliance with the state's water quality standards. Ecology will enforce water quality regulations under Chapter 90.48 RCW.

Potential Funding Sources

Table 15 describes several possible funding sources that may be available to implement activities necessary to correct fecal coliform problems in the Little Bear Creek watershed. Ecology will work with stakeholders to prepare appropriate scopes of work, to assist with applying for grant opportunities as they arise, and to help in other ways to implement the *Little Bear Creek Water Cleanup Plan*.

Table 15. Possible Funding Sources to Support Little Bear Creek TMDL Implementation

Sponsoring Entity	Funding Source	Uses to be Made of Funds
Department of Ecology Water Quality Program	Clean Water Fund, Section 319, and State Revolving Fund http://www.ecy.wa.gov/programs/wq/funding/	• Implementation, design, acquisition, construction, and improvement of water pollution control • Facilities and water pollution control related activities; • Priorities include: implementing water cleanup plans, keeping pollution out of streams and aquifers, modernizing aging wastewater treatment facilities, reclaiming and reusing waste water

Sponsoring Entity	Funding Source	Uses to be Made of Funds
Department of Ecology, SEA Program	Coastal Zone Protection Fund	Discretionary monies made available to regional Ecology offices to support on-the-ground projects to perform environmental restoration and enhancement.
Puget Sound Action Team	Public Involvement and Education grants http://www.psat.wa.gov/Programs/Pie_Ed/round_14/02_intro_funding.htm	Project priorities include: reduce harmful impacts from stormwater, prevent contamination from public/private sewer systems and other nonpoint sources
Snohomish Conservation District	federal Conservation Reserve Enhancement Program http://www.snohomishcd.org/crep.htm	Conservation easements; cost-share for implementing agricultural/riparian best management practices (BMPs).
Housing Authority of Snohomish County	Housing Rehabilitation Loan Program http://hasco.org/	Low-interest loans for low-income households in Snohomish County (outside of Everett city limits) to address health and safety issues
Natural Resources Conservation Service	Environmental Quality Incentive Program http://www.nrcs.usda.gov/programs/eqip/	Voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals; includes cost-share funds for farm BMPs
King County	Brightwater Mitigation monies	Mitigate for effects of Brightwater Treatment System (at least $88 M available system-wide)
King County	King County Grant Exchange, including six grant programs http://dnr.metrokc.gov/grants/	Restoration, water quality improvement, education projects

Monitoring Strategy

EPA (1991) guidance calls for a monitoring plan for TMDLs where implementation will be phased in over time. The monitoring is conducted to provide assurance that pollution control measures achieve the expected load reductions.

As evidenced by the TMDL analysis undertaken for this report, Snohomish County, city of Woodinville, and King County actively monitor water quality at several points in the Little Bear Creek watershed (at LBLU, LBLD, and LBCC). This monitoring occurs both as part of regular long-term stream monitoring networks, through Snohomish County's illicit discharge elimination and dry weather outfall monitoring efforts, and for other project-specific purposes (e.g., Brightwater). The continuation of these activities is critically important to help understand how water quality is changing in the Little Bear Creek watershed, to locate fecal coliform contamination sources, and to target BMPs, on-site system investigation, and other activities to correct fecal coliform problems. Additionally, illicit discharge identification is recommended at various points in the Little Bear Creek watershed (e.g., upstream of the Little Bear Creek headwaters (LBHW), along Great Dane (DANE) and Cutthroat (CUTT) Creeks, above Trout Stream (TROT), and at other tributaries that may contribute fecal coliform loading (e.g., Rowlands and Howell Creeks). To a great extent, it is anticipated that much of this monitoring can be incorporated into monitoring efforts planned under the various jurisdiction NPDES stormwater permits.

Ecology may supplement the county and city monitoring efforts by conducting targeted water quality monitoring where ambient monitoring shows that adequate progress toward fecal coliform targets is not occurring. Ecology will coordinate compliance water quality monitoring to identify the specific source(s) of fecal coliform pollution, and will refer identified sources to the appropriate agency with technical assistance resources or enforcement authority. Sampling over time will be adjusted to locate the source by narrowing the geographic area where contamination is occurring and, thereby, focus in on the specific source of fecal coliform pollution. This strategy allows implementation of appropriate BMPs in the specific areas of concern, thus maximizing the available resources.

Adaptive Management

Implementation of the *Little Bear Creek Water Cleanup Plan* will be adaptively managed to enable Little Bear Creek and its tributaries to meet Washington State's water quality standards by 2010. Opportunities for adaptive management of the *Little Bear Creek Water Cleanup Plan* implementation include adjusting BMPs, modifying stream sampling frequency and/or locations, conducting special inspections in identified source areas, helping develop and fund water quality projects that address fecal coliform pollution, local educational initiatives, and other means of conforming management measures to current information on the impairment. If water quality standards are met without attaining the wasteload load allocation reductions specified in Tables 11-13, then the objectives of this water cleanup plan are met and no further reductions are needed. If new fecal coliform sources are found that were not previously identified, these will also be corrected by the appropriate jurisdictions.

Ongoing ambient monitoring conducted by the city of Woodinville and Snohomish and King counties will enable implementing entities to modify implementation efforts as necessary to bring all tributaries within the watershed back into compliance with state water quality standards. Ecology will continue to offer grant funding for water quality studies, stream restoration projects, BMP effectiveness evaluations, and for development and implementation of monitoring programs through its annual Centennial Clean Water Fund.

Conclusions

The following conclusions derive from the *Little Bear Creek Water Cleanup Plan*.

- Water quality monitoring conducted by Snohomish and King Counties and the city of Woodinville since 1999 verifies that the 1998 listed stream segments are still impaired with fecal coliform bacteria during most of the year, and identifies additional stream segments that are impaired.

- Potential bacteria pollution sources include failing on-site systems, agriculture (commercial and small farms), businesses that generate pet waste, residential pet waste, commercial/industrial activities, and wildlife. Stormwater and road runoff often convey contamination accumulated from wildlife, litter, and other sources.

- Streams in the Little Bear Creek watershed will meet water quality standards with reductions in fecal coliform bacteria during both wet and dry seasons. Progress toward attaining water quality standards will be tracked by comparing current water quality results with targets listed elsewhere in this report.

- The SIS for the *Little Bear Creek Water Cleanup Plan* involves support of existing pollution control programs being conducted by Snohomish County, Woodinville, WSDOT, Ecology, and others. In addition, the SIS recommends initiation of new projects and approaches (including wetlands acquisition and the development of commercial pet waste management materials) that are deemed necessary for water quality improvement throughout the creek system.

- Based on current and planned implementation measures by Snohomish County, city of Woodinville, Ecology, and WSDOT, all the streams in Little Bear Creek watershed are scheduled to meet water quality standards for fecal coliform by the year 2010.

- Progress toward meeting water quality targets and attaining water quality standards will be tracked and adaptively managed using the proposed monitoring strategy consisting of continuation (and possible expansion) of Woodinville, Snohomish, and King County monitoring programs with assistance from Ecology. The success of this approach relies on provision of ongoing funding support for these monitoring efforts.

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Appendix A

Equations for Statistical Analyses and TMDL Worksheet*s*

Equations for Statistical Analyses

Statistical Theory of Rollback

The statistical rollback method proposed by Ott (1995) describes a way to use a numeric distribution of a water quality parameter to estimate the distribution after pollution source controls have been applied. The method relies on basic dispersion and dilution assumptions and their effect on the distribution of a chemical or a bacterial population at a monitoring site downstream from a source. Rollback then provides a statistical estimate of the new population after application of a chosen reduction factor to the existing source. In the case of the TMDL, compliance with the most restrictive of the dual fecal coliform criteria will determine the reduction factor needed.

As with many water quality parameters, sample values of fecal coliform (FC) collected over time at an individual site typically follow a lognormal distribution. Over the course of a year's sampling period, most of the counts are typically low, but a few are much higher. When monthly FC data are plotted on a logarithmic-probability graph (the open diamonds in the Nooksack River example in Figure A-1), they form a nearly straight line.

The 50^{th} percentile, an estimate of the geometric mean, and the 90^{th} -percentile, a representation of the level above which 10 percent of the samples lie, can be located along a line plotted from an equation estimating the original monthly FC data distribution. In the graphical example, these numbers are 75 cfu/100 mL and 383 cfu/100 mL, respectively. Using the statistical rollback method, the 90^{th} -percentile value is then reduced to 200 cfu/100 mL (Class A 90^{th} -percentile criterion), since 75 cfu/100 mL meets the Class A geometric mean criterion. The new distribution plots parallel to the original and the estimate of the geometric mean for this new distribution, located at the 50^{th} percentile = 39 cfu/100 mL. The resulting geometric mean target represents a sample distribution that would likely have less than 10 percent of its samples over 200 cfu/100 mL. A 48 percent FC reduction is required from combined sources to meet this target distribution from the calculation: (383 - 200) / 383 = 0.477 * 100 ~ 48%.

The following list summarizes the major theorems and corollaries for the Statistical Theory of Rollback (STR) from *Environmental Statistics and Data Analysis* by Ott (1995).

1. If Q = the concentration of a source contaminant, and D = the dilution-diffusion factor, and X = the concentration of the contaminant at the monitoring site, then X = Q*D.
2. Successive random dilution and diffusion of a contaminant Q in the environment often result in a lognormal distribution of the contaminant X at a distant monitoring site.
3. The coefficient of variation (CV) of Q remains the same before and after applying a "rollback", *i.e*., the CV in the post-control state equates to the CV in the pre-control state. The rollback factor = r, a reduction factor expressed as a decimal (a 70% reduction equates to a rollback factor of 0.3). The random variable Q represents a pre-control source output state and rQ represents the post-control state.

4. If D remains consistent in the pre-control and post-control states (long-term hydrological and climatic conditions remain unchanged), then CV(Q)*CV(D)=CV(X), and CV(X) will be the same before and after the rollback is applied.
5. If X is multiplied by the rollback factor r, then the variance in the post-control state will be multiplied by r^2, and the post-control standard deviation will be multiplied by r.
6. If X is multiplied by the rollback factor r the quantiles of the concentration distribution will be scaled geometrically.
7. If any random variable is multiplied by a factor r, then its expected value and standard deviation also will be multiplied by r, and its CV will be unchanged. (Ott uses "expected value" for the mean.)

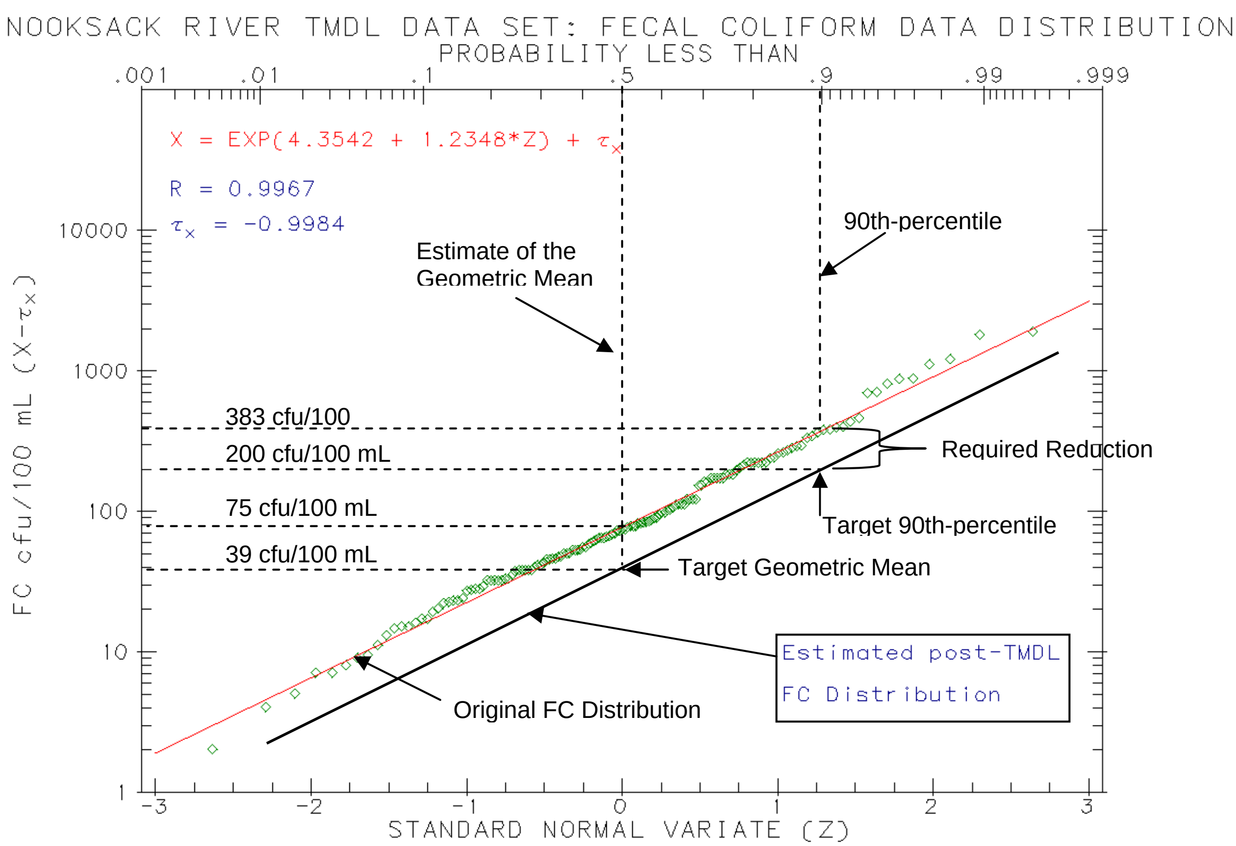


Figure A-1**.** Graphical demonstration of the statistical rollback method (Ott, 1995) used to lculate the fecal coliform TMDL target on the lower Nooksack River.

Statistical Rollback Applied to Little Bear Creek Fecal Coliform Data

Statistical Rollback was conducted for Little Bear Creek fecal coliform data using Snohomish County Surface Water Management membrane filtration sample results collected between 1993 and November 2004 at seven stations for both wet (Oct-March) and dry (April-Sept) seasons. Wet and dry seasons were determined using receding mean monthly streamflow data and are consistent with Snohomish Surface Water Management convention.

Non-detect lab results reported as 1 cfu/100 mL were doubled to 2 cfu/100mL. Non-detects constituted less than 1 percent of the total number of sample values and were less than 20 percent at any one station – (highest percent of non-detects were at TROT wet season = 16.7 percent non-detects).

Statistical Method for Deriving Percentile Values

The 90^{th}-percentile values for the Little Bear Creek sampling data were determined by a method used to protect shellfish areas. The set of fecal coliform counts collected at a site were subjected to a statistically based formula used by the Federal Food and Drug Administration to evaluate growing areas for shellfish sanitation. The National Shellfish Sanitation Program Model Ordinance (USFDA, 2000) states:

The estimated 90^{th} percentile shall be calculated by:

(a) Calculating the arithmetic mean and standard deviation of the sample result logarithms (base 10).

(b) Multiplying the standard deviation in (a) by 1.28.

(c) Adding the product from (b) to the arithmetic mean.

(d) Taking the antilog (base 10) of the results to get the estimated 90th percentile.

(e) The most probable number (MPN) values that signify the upper or lower range of sensitivity of the MPN tests in the 90^{th} percentile calculation shall be increased or decreased by one significant number.

The 90^{th}-percentile derived using this formula assumes a lognormal distribution of the fecal coliform data. The variability in the data is expressed by the standard deviation, and with some datasets, the calculated 90^{th}-percentile may be greater than any of the measured data.

The 90^{th} percentile statistics at each station in Little Bear Creek watershed were typically further out from the water quality standard criteria than the geometric mean values (GMVs). However, the standard deviations of the sample populations at each station were high enough to require the greatest percent reduction be applied to the GMVs in order to meet both parts of the WQ standard. Calculated target reductions to the Little Bear wet and dry season GMVs ranged from 53.5 to 98.1 percent.

In accordance with the application of Statistical Rollback to the Little Bear Creek fecal coliform data, the load allocations for the Little Bear TMDL consist of the rollback targets and percentage reductions calculated at each of the seven primary sampling stations in the Little Bear watershed.

Simple Method to Calculate Urban Bacteria Loads from Storm water

Fecal coliform loading from storm water in Little Bear Creek watershed was estimated using the Simple Method (Schueler, 1987). Land use areas above each of three mainstem sampling stations used for setting wasteload allocations (WLAs) were categorized into forest, agricultural, residential, commercial/urban, and roadway. Runoff attributes were ascribed to each land use area according to typical impervious surface and fecal coliform loading characteristics, and to sub-basin areas according to precipitation and fraction of precipitation events causing runoff (Schueler, 1987). One modification on Schueler (1987) is that *state* roadway was assumed to be 65 percent impervious, all other roadway is assumed 80 percent impervious.

The Simple Method utilizes the following equation for estimating stormwater loads:

$$L = 1.03\,E\text{-}3 * R * C * A$$

L = Annual load in billions of colonies
R = Annual 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 = Annual rainfall in inches

Pj = Fraction of annual rainfall events that produce runoff (assumed 85%, although not necessarily true for western Washington storm intensities)

Rv = Runoff coefficient

$Rv = 0.05 + 0.9Ia$

Ia = Percent impervious cover

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, since county and WSDOT WLAs were based on their respective road areas. Since Snohomish County and WSDOT will be given separate WLAs according their respective roadway areas, county and state roadways were tallied separately.

Loading capacities were estimated for the three mainstem Little Bear stations for which streamflow data are available (LBLU, LBLD, and LBCC). Estimated wet season loading capacities were derived using mean monthly wet season flows and target geometric mean values (GMVs) at each of the three primary Little Bear Creek mainstem stations. Wasteload allocations were then determined at the three primary mainstem stations by applying the wet season loading proportions established by the Rollback Method to the wet season loading capacities estimated from the Simple Method. Wasteload allocations are cumulative at each station; that is, they take into account all sources above the station.

The stormwater Wasteload Allocation for the city of Woodinville was estimated using the cumulative sum of the Woodinville land use categories located within Little Bear Creek watershed which drains to Little Bear Creek. The total of 978 acres within Woodinville drains to Little Bear Creek above sampling station LBCC.

Concentration estimates and imperviousness for various land uses

Land use type	FC (cfu/100mL)	TP (mg/L)	BOD_5 (mg/L)	Impervious Cover (%)
State Roadway	890	0.26	10	65
Other Roadway	890	0.26	10	80
Residential	2000	0.26	13	40
Commercial/Urban	980	0.21	15	87
Forest	100	0.10	5	20
Agriculture	3000	0.35	15	30

Sub-basin precipitation was determined from data presented in a King County modeling study for the Little Bear Creek watershed (Aqua Terra, 2003).

Stormwater loading from roadways was estimated using the following width estimates for road right-of-way in the Little Bear Creek watershed. Fecal coliform loading estimates using Schueler's 'Simple Method' (1987) were then applied to the resulting roadway drainage areas to estimate the relative portion of loading from each roadway jurisdiction.

Road right-of-way estimates for various road types:

Roadway type	Estimated ROW Width
State Hwy 522	100 feet
Other State Roadway	60 feet
County Roadway	40 feet
Other Roadway	40 feet

The following is a tabulation of fecal coliform data used in the Little Bear Creek Fecal Coliform water cleanup plan.

Fecal Coliform Data for Little Bear Creek Basin							
Snohomish Surface Water Management Data - cfu/100mL membrane filtration							
	Sampling Station						
Date	LBHW	LBLU	LBLD	LBCC	TROT	DANE	CUTT
9/8/1993		610	720				
10/6/1993		2100	550				
11/9/1993		160	460				
12/8/1993		430	260				
1/10/1994		320	180				
2/8/1994		490	68				
3/8/1994		57	44				
4/11/1994		80	51				
5/17/1994		510	220				
6/6/1994		300	40				
7/12/1994		879	610				
8/3/1994		300	2300				
9/15/1994		670	480				
10/10/1994		30	410				
11/8/1994		118	84				
12/6/1994		70					
1/11/1995		200					
2/6/1995		330	109				
3/7/1995		220	118				
4/5/1995		640	240				
5/4/1995		680	230				
6/7/1995		460	250				
7/13/1995		520	440				
8/10/1995		1009	1045				
9/18/1995		430	460				
10/4/1995		800	400				
11/7/1995		240	264				
12/12/1995		200					
1/4/1996		250	220				
2/6/1996		300	100				
3/6/1996		236	180				
4/2/1996		100	500				
5/8/1996		212	150				
6/3/1996		2	120				
7/16/1996		740	230				
8/6/1996		660	690				
9/10/1996		510	460				
10/14/1996		670	1000				
11/6/1996		315	144				

Fecal Coliform Data for Little Bear Creek Basin							
Snohomish Surface Water Management Data - cfu/100mL membrane filtration							
	Sampling Station						
12/4/1996		676	490				
1/6/1997			320				
2/10/1997		23	108				
3/4/1997		79	210				
4/7/1997		9	14				
5/5/1997		80	230				
6/4/1997		540	2000				
7/7/1997		829	510				
10/8/1997		310	865				
12/3/1997		35	200				
1/5/1998		250	640				
4/15/1998		54	540				
5/6/1998		220	300				
6/11/1998		5800	400				
7/15/1998		2400	2100				
8/5/1998		2000	320				
9/16/1998		290	280				
10/19/1998		390	240				
11/19/1998		430	200				
12/9/1998		680	200				
1/20/1999		99	27				
2/9/1999		450	500				
3/3/1999		72	360				
4/12/1999		200	900				
5/13/1999		260	16				
6/7/1999		210	460				
7/19/1999		520	360				
8/16/1999		250	530				
8/30/1999		860	930				
10/14/1999		740	870				
11/9/1999		91	350				
12/2/1999		150	180				
1/10/2000		380	380				
2/9/2000		230	200				
3/16/2000		200	200				
4/13/2000	1900	180	2600		5	6	9
5/2/2000	81	210	990	410	5	55	25
6/7/2000	730	400	290	160	44	19	20
7/12/2000	8600	38	200	51	22	24	90
8/10/2000	340	270	430	27	55	240	260
9/13/2000	2200	78	33	32	37	8	42

Fecal Coliform Data for Little Bear Creek Basin							
Snohomish Surface Water Management Data - cfu/100mL membrane filtration							
	Sampling Station						
10/11/2000	1400	2400	360	520	500	27	210
11/13/2000	380	2000	54	420	51	54	51
12/6/2000	29	5500	160	20	92	19	300
1/9/2001	99	59	120	170	9	20	54
2/7/2001	360	300	330	51	7	10	20
3/7/2001	670	3900	5	46	2	32	27
4/4/2001	9300	4900	22	55	23	31	200
5/2/2001	6200	18000	87	27	120		200
6/6/2001	290	8000	120		37	9	540
7/18/2001	220	1800	910	500	200	260	510
8/13/2001	650	280	320	4500	27	160	50
9/6/2001	6500	330	470	160	28	90	140
10/8/2001	6500	81	550	1500	1100	42	590
11/6/2001	99	240	54		6	38	26
12/3/2001	300	130	72	210	880	36	72
1/8/2002	640	410	72	54	79	820	
2/7/2002	5200	3100	360	58		45	63
3/12/2002	91	91	2400	100		54	36
4/11/2002				600			
5/2/2002	230	550	210	130	120	13	81
6/6/2002	2100	2500	13000	540	250	580	32000
7/2/2002	640	820	540	280	1000	230	450
8/8/2002	490	330	420	200		350	200
9/12/2002	200	190		300	10	310	72
10/10/2002	2000	350	540	20	3500	430	130
11/12/2002		1000	1000	32	370	91	910
12/4/2002	860	250	130	1100	5	320	34
1/9/2003	630	39	550	700	330	14	37
2/13/2003	4700	220	620	26	1	51	330
3/6/2003	1000	92	330	32	3	18	94
4/3/2003	4900	270	550	1700	14	90	36
5/8/2003		8000	380	670	13	27	40
6/5/2003	880	240	300	340	4	81	530
7/10/2003	490	1000	250	7100	12	270	310
8/7/2003	220	400	330	120	10	310	290
9/11/2003	820	490	110	3500	350	620	220

Fecal Coliform Data for Little Bear Creek Basin							
Snohomish Surface Water Management Data - cfu/100mL membrane filtration							
	Sampling Station						
10/2/2003	2700	330	190	33	3	190	350
11/6/2003		86	200	2900			
12/4/2003		54	1200	66			
1/8/2004		250	730	1200			
2/5/2004		130	72	25			
3/4/2004		350	180	27			
4/8/2004		440	80	80			
5/5/2004		4500	2200	500			
6/10/2004		590	390	490			
7/8/2004		300	980	140			
8/4/2004		730	24000	310			
8/16/2004		485	550	320	6	540	260

Appendix B

Public Notice Materials

News Release

FOR IMMEDIATE RELEASE – Feb. 23, 2005
03-039

Ecology Department outlines plan to clean Little Bear Creek pollution

BELLEVUE – Many small but important steps make up a plan to curb bacterial pollution in Little Bear Creek in Snohomish County.

The state Department of Ecology (Ecology) is seeking public comment on a proposed water cleanup plan aimed at reducing high levels of fecal coliform bacteria in the creek basin. Fecal coliform bacteria are often associated with other disease-causing bacteria (pathogens) and viruses in water.

The 15-square-mile Little Bear Creek basin extends from its headwaters in South Snohomish County near Silver Firs to Woodinville, where the creek empties into the Sammamish River, which flows to Lake Washington.

Seven stretches of streams in the basin do not meet state standards for swimming and wading. The pollution comes from thousands of sources, including failing septic systems, livestock and pet wastes, and other daily activities that either release bacteria or promote its growth.

"We all have a share in causing the pollution, and each of us can help prevent it," said Anne Dettelbach of Ecology's water-quality program. "Government action alone won't clean these streams."

Ecology urges citizens to maintain and repair their septic tanks, clean up pet waste, keep stock and other animals out of streams and get involved through local organizations and governments.

The proposed cleanup plan would incorporate new and existing state and local initiatives to prevent fecal-coliform pollution, including:

- Education and technical assistance for septic system owners to prevent failures.
- Pet-waste programs for local parks and trails, and education for pet owners.
- Acquisition and/or restoration of wetlands and streamside areas by local governments.

- Improving stormwater management.
- Detecting and repairing sewer leaks.
- Monitoring streams to track progress.

Ecology will host two public meetings to provide information and answer questions about the *Little Bear Creek Water Cleanup Plan*:

- March 3, 3-5:30 p.m., Woodinville City Hall, 17301 133rd Ave. N.E., Woodinville.
- March 10, 7-9 p.m., Fernwood School, 3933 Jewell Road, Bothell.

The cleanup action plan is available on the Internet at http://www.ecy.wa.gov/programs/wq/tmdl/watershed/tmdl_info-nwro.html, at public libraries in Mill Creek and Woodinville, and at Ecology's regional office at 3190 160th Ave. S.E., in Bellevue.

Ecology is accepting public comments through March 31. Send comments to Anne Dettelbach, Department of Ecology, 3190 160th Ave. S.E., Bellevue, Wash., 98008-5452, or by e-mail to adet461@ecy.wa.gov.

# # #

Media contacts: Larry Altose, public information, 425-649-7009; pager, 206-663-1785

For more information:
http://www.ecy.wa.gov/programs/wq/tmdl/watershed/tmdl_info-nwro.html

Broadcast version

Many small, but important steps form the crux of a state Department of Ecology plan to clean up Little Bear Creek in southern Snohomish and northern King counties.

The stream does not meet state standards for fecal bacteria.

Ecology's plan targets thousands of small pollution sources by pulling together dozens of state and local water clean-up initiatives.

They include efforts to control pet waste, help home-owners care for their septic systems, and improve stormwater management.

The Department of Ecology seeks your comments

WASHINGTON STATE DEPARTMENT OF ECOLOGY

DRAFT -- Little Bear Creek
Water Cleanup Plan for Bacteria

Public Meetings	• March 3, 3-5:30 p.m. Woodinville City Hall 17301 – 133rd Ave. NE • March 10, 7-9 p.m. Fernwood School 3933 Jewell Road, Bothell

The state Department of Ecology has drafted a Water Cleanup Plan to address the problem of high fecal coliform bacteria levels in Little Bear Creek and its tributary streams.

The draft plan recommends water cleanup actions to help reduce bacteria levels and health risks in these streams. Our goal is to improve overall water quality to meet state standards.

We are seeking your comments about how well the draft document seems to address bacteria cleanup. Ecology needs your ideas and suggestions to develop an effective water cleanup plan and we welcome you to share your thoughts with us. Thank you for your efforts to improve the quality of our water.

To obtain a copy of the Cleanup Plan, call 425-649-7093; or go to:

- www.ecy.wa.gov/programs/wq/tmdl/watershed/tmdl_info-nwro.html
- The Mill Creek and Woodinville Public Libraries,
- The Ecology Department office (at the address below)

Please send comments by **March 31, 2005** to Anne Dettelbach, Dept. of Ecology, 3190 160th Ave SE, Bellevue WA 98008-5452; or by email to: adet461@ecy.wa.gov

If you have special accommodation needs, please call (425) 649-7041 or (425) 649-4259 (TDD)

Focus on Little Bear Creek

from Ecology's Water Quality Program

Too Much Bacteria Causes Concern

High levels of fecal coliform bacteria have been identified at various locations in the Little Bear Creek Watershed (Snohomish and King Counties). Fecal coliform bacteria may indicate the presence of other disease-causing bacteria (pathogens) in water. These bacteria are easily carried by stormwater runoff or transported in other ways into streams, lakes, or estuaries where they can infect humans through contaminated fish and shellfish, skin contact, or ingestion of water.

Concentrations and distributions of fecal coliform bacteria in Little Bear Creek are being evaluated and will be addressed in a *Little Bear Creek Water Cleanup Plan for Fecal Coliform Bacteria* being prepared by the Department of Ecology (Ecology).

Water Cleanup Plans (TMDLs)

A Water Cleanup Plan, also known as a Total Maximum Daily Load (or TMDL), describes the quantity of a specific pollutant in an area and offers solutions to correct related water quality problems. A Water Cleanup Plan includes the following elements:

- A scientific evaluation of water quality conditions associated with a pollutant of concern.
- A technical analysis of the sources of a pollutant of concern.
- An action plan to control pollutant sources and help protect water quality.

Water Cleanup Plan for Little Bear Creek

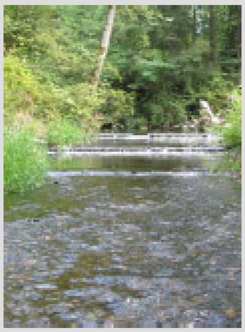
Snohomish and King counties, the City of Woodinville, and other groups and individuals have already done much to restore and clean up Little Bear Creek, but more work is needed. Ecology is compiling information on current activities and additional actions that are needed to identify and correct important remaining fecal coliform bacteria sources in the watershed. This information will form key parts of the *Little Bear Creek Water Cleanup Plan.*

Potential Sources of Fecal Coliform Bacteria

Human sources of these bacteria may vary depending on whether a watershed has sewers or not. **In non-sewered areas, failing septic systems are often significant human sources of fecal coliform bacteria and other pollutants.**

Humans also create problems with illegal sanitary connections, and the illegal disposal or mismanagement of manure and other domestic animal wastes (cattle, horses, poultry, and other domestic animals – especially dogs and cats). *Non-human* sources include pigeons; gulls; ducks, geese, and other waterfowl; rats; raccoons; squirrels; beaver; muskrats; deer; and other warm-blooded wild mammals.

WASHINGTON STATE DEPARTMENT OF ECOLOGY



The Department of Ecology will host two public meetings for the *Little Bear Creek Water Cleanup Plan*:

March 3, 3-5:30 p.m.
Woodinville City Hall
17301-133rd Ave NE

March 10, 7-9 p.m.
Fernwood School
3933 Jewell Road
Bothell

The plan will establish maximum amounts of fecal coliform bacteria that Little Bear Creek and targeted tributaries can receive and still meet state water quality standards.

Fecal coliform bacteria is a common water quality problem in the state. These bacteria affect at least 30% of the state's polluted waters.

February 2005 05-10-024
Original printed on recycled paper

What can you do?

To "fix" fecal coliform contamination, each of us must look at what we do on our property to prevent sewage or manure from reaching public waters. To be a good steward of your watershed:

- Make sure your on-site septic system is in good working order: test and pump it regularly.
- Manage livestock so they can water away from a stream or lake. Need help figuring out an alternative? Please call the Snohomish Conservation District at: **425-335-5634**.
- Protect the natural vegetation alongside streams and lakes, and you may need to plant more. Vegetation filters pollutants from run-off. Your conservation district can help.
- Bag pet waste and put it in the garbage…not in the septic system.
- Safeguard manure piles from rain and surface run-off. Snohomish County, the City of Woodinville, and the Snohomish Conservation District can all help.
- Call the Spill Hotline if you see a spill or illegal dumping: **1-800-258-5990**.

Also--Comment on the Little Bear Creek Water Cleanup Plan

The Washington Department of Ecology is seeking your written comments on the *Little Bear Creek Water Cleanup Plan* **through March 31, 2005**. You can review a copy of the plan starting February 28 at local libraries in Mill Creek 425-337-4822 and Woodinville 425-788-0733 and at Ecology's website:

http://www.ecy.wa.gov/programs/wq/tmdl/watershed/tmdl_info-nwro.html

To receive a copy, or for more information or comments, please contact Anne Dettelbach, Little Bear Creek TMDL Leader, by phone at 425-649-7093, by email adet461@ecy.wa.gov, or at:

WASHINGTON STATE DEPT. OF ECOLOGY
NORTHWEST REGIONAL OFFICE
3190 - 160TH AVE SE
BELLEVUE, WA 98008-5452

If you need this information in an alternate format, please contact the Water Quality Program at 425-649-7041. If you are a person with a speech or hearing impairment, call 711, or 800-833-6388 for TTY

Appendix C
Responses to Comments

Responses to Comments on the Draft Little Bear Creek Cleanup Plan

Comments received on the Draft Little Bear Creek Basin Water Cleanup Plan (TMDL) are summarized below. Many of the comments resulted in revisions to the plan and report. The list below summarizes Ecology's responses to significant comments on the draft plan.

1. **Comment**: Little Bear Creek has always had high fecal coliform counts - even before anyone started monitoring this problem. The sources from the past are most likely the same sources today - only there are more of them: failing septic systems and domestic animals. We are aware of many failed or (presently) failing septic systems and acknowledge that some of the owners of these failing systems do not have the funds to repair or replace. The native soils in which these aged systems were installed never perked well.

   Response: Ecology agrees that failing on-site septic systems and domestic animals have probably been significant sources of bacteria in Little Bear Creek throughout the history of the watershed and that poor soils and limited funds are obstacles to getting good on-site system performance. The Housing Authority of Snohomish County can provide low-interest, long-term loans to qualified low-income households. These loans can be applied to a variety of projects, including to repair or replace leaking or failing on-site septic systems. As well, Ecology may provide loans to local governments to establish local loan funds that can be used to assist private citizens and small commercial enterprises by providing loans for water quality improvement projects, such as rehabilitating on-site septic systems. Local governments may apply for these loans during the annual Water Quality Financial Assistance application period, which now occurs September through October of each year. Ecology will explore this option during the Little Bear Creek implementation planning process.

2. **Comment**: The majority of the watershed is rural and/or suburban and lies within the jurisdiction of Snohomish County. The portion inside the city of Woodinville is characterized as urban/industrial. Fecal coliform contaminants are more likely to be generated in those areas where failing human septic systems are adjacent to the creek, or where farm animals have access to the stream corridor.

   Response: Existing water quality data for Little Bear Creek indicate severe pollution problems originate in the upper part of the Little Bear watershed, but that sources also exist in downstream reaches. Pet waste, stormwater, and leaking sewer lines are typical urban sources which also can convey significant pollution to streams.

   Comment: Should plant nurseries be included as a potential source of fecal coliform bacteria?

3.

   Response: Unless the nurseries are producing compost onsite using manure or other waste materials, Ecology does not expect these businesses to generate significant amounts of fecal coliform bacteria. For this reason, we do not believe it is appropriate to include nurseries as a potential major source of fecal coliform bacteria. If, however, we identify nurseries that do generate fecal coliform bacteria, we will revise the TMDL accordingly and work with those entities to correct the problems.

4. **Comment**: Dog waste is the primary culprit in Little Bear Creek fecal coliform impairment.

   Response: Studies in other watersheds across the United States have noted that dog and other pet wastes can compose a majority of fecal coliform loading to a stream system. At this point, however, Ecology does not know with certainty that dog waste is the single largest contributor of bacteria to Little Bear Creek. Leaking on-site septic systems, other pet wastes, farm animals, or other wastes from warm-blooded animals may also contribute significantly. We look forward to working with the conservation districts, health districts, surface water management program staff from all relevant jurisdictions, and residents of Little Bear Creek watershed to detect and correct all sources of bacteria that contribute to the observed water quality impairment.

5. **Comment**: Canada Geese and ducks are more of a bacteria problem than dogs.

   Response: As stated above, Ecology does not know what the most significant fecal coliform bacteria sources are in Little Bear Creek. We look forward to increasing our understanding of the sources and to working with all interested parties to craft activities and solutions to reduce these sources of bacteria loading.

6. **Comment**: An Ecology discussion paper by Hicks in 2002 on setting standards for the bacteriological quality of Washington's Surface Waters (Publication #00-10-072) states that *Klebsiella* make up a significant or dominant portion of any sample analyzed as fecal coliform. Leaf litter is a source of *Klebsiella* and should be included under wildlife as a contributor to bacteria pollution.

   Response: The Hicks (2002) paper states that *Klebsiella* bacterium can be found in ten to forty percent of human and animal populations. However, this statement does not relate to the proportion of *Klebsiella* in comparison to other bacteria either in the animal digestive system or in the ambient water environment. As is also noted in the 2002 paper, bacterial testing for *E. coli* tests does not detect *Klebsiella*. Ecology has sampled both *E. coli* and fecal coliform in many waters around the state and has determined that almost all of the bacterium detected in our fecal coliform testing turns out to be *E. coli*. Only a very small (two to five percent is typical) fraction of the identified bacteria are not *E. coli*. *Klebsiella* is one of many bacteria that can make up this small fraction, but it is not the only one. Except in very unique situations, such as in a stream that receives a large discharge of wastewater from a pulp and paper mill (which can grow *Klebsiella* in their wastewater), we would not expect *Klebsiella* to be found in more heavily impacted watersheds (such as Little Bear Creek) at high concentrations.

   Ecology is open to being educated on how leaf litter can cause elevated fecal coliform bacteria counts, but is not yet aware of that research. Where watersheds are free of human activity and have minimal animal activity, fecal counts are very low and within water quality standards. If the commenter is referring to the 'archiving' of fecal coliform bacteria in leaves and other organic sediments, elimination of the primary source of that contamination will eventually lead to reduction in the secondary sources.

7. **Comment**: A statement in the TMDL says that WSDOT discharges untreated runoff to streams in some cases. Direct discharges generally only occur from bridges over the stream.

   Response: Ecology agrees that direct discharges do occur from bridges over the stream but believes that other direct discharges from roadways are also possible. Additional monitoring and site investigation during storm events may bear this out.

8. **Comment**: The Department of Ecology should consider installing an additional water quality monitoring site at NE 205th Street (the northern city boundary) to help Woodinville determine 'ambient' fecal coliform contaminant levels as the creek flows into the city.

   Response: In addition to the seven long-term sampling sites which were used to establish the TMDL targets, the draft Little Bear monitoring strategy envisions continued sampling at other sites throughout the basin. The county line site (at NE 205th Street) is one such candidate sampling site. In fact, Ecology has already collected several samples in Little Bear Creek at the restoration project site south of NE 205th Street.

   Possible additional sampling sites include:

LBLB	-	Little Bear Creek at Little Bear Creek Road
LBCL	-	Little Bear Creek at county line/NE 205th
LBOR	-	Little Bear Creek at 195th Street
LBCR	-	Little Bear Creek at Check Ride, Inc.
LBTC	-	Little Bear Creek at 134th Ave. NE restoration site
LBMO	-	Little Bear Creek at mouth below Sam. River Trail

   These sampling locations and several other tributary sampling sites may be altered pending sample results, access permission, and other sampling issues. The long-term monitoring network will be verified in the detailed implementation plan. Ecology will coordinate its sampling with Little Bear Creek monitoring programs currently being conducted by Woodinville, Snohomish and King Counties and explore with those parties and others opportunities and resources available to expand or refine their monitoring programs.

9. **Comment**: Ecology states that industrial stormwater permittees are expected to comply with applicable water quality standards and are not expected to be a significant source of bacterial pollution. Industrial permittees are not issued wasteload allocations for this reason. Snohomish County encourages Ecology to identify industrial permittees that have a potential to contribute fecal coliform bacteria and to require monitoring.

   Response: Industrial stormwater permit holders discharging to 303(d)-listed (i.e., impaired) waterbody segments are listed in Appendix 4 of the state-issued Industrial Stormwater General Permit (January 14, 2005) and, in accordance with permit Condition S.4.G., are directed to conduct quarterly monitoring of authorized discharges of stormwater to surface water. Facilities that discharge to waterbody segments listed for fecal coliform are notified by Ecology in writing that they are required to monitor for fecal coliform on a quarterly basis unless the facilities certifies in writing that there are no known sources of fecal contamination from their industrial activities.

10. **Comment**: Ecology should conduct genetic source testing for fecal coliform bacteria at several sampling locations in the watershed to determine predominant pollutant sources with more precision (livestock, horses, dogs and cats, wildlife or failing septic systems).

    Response: Ecology may use or help fund genetic or Microbial Source Tracking (MST) methods in Little Bear Creek watershed in the future if other, less expensive source identification methods fail to address the bacteria problem in Little Bear Creek. MST is not usually used initially in Ecology TMDL studies because it is expensive, results do not quantify sources of bacteria, and often sources can be identified and corrected using intensive upstream-downstream water quality monitoring (Ecology, 2003).

11. **Comment**: To prevent further habitat degradation and protect Little Bear Creek, the city of Woodinville has acquired seventeen acres adjacent to the corridor near NE 195th Street, and an additional seven acres along the creek near NE 134th Street. The city has also conducted several habitat improvement projects in the Little Bear Creek corridor. Most properties in the corridor are privately owned. Woodinville is committed to working with property owners to eliminate potential sources of fecal coliform contamination, through education, habitat restoration partnerships and when redevelopment proposals are submitted for city review.

    Response: Ecology recognizes the significant actions the city of Woodinville has already taken to protect Little Bear Creek and supports Woodinville’s ongoing initiatives eliminate fecal coliform contamination through direct stream corridor protection and restoration actions and watershed education. We are interested in partnering with the city and hope to explore providing additional means of support.

12. **Comment**: The Department of Ecology process now underway intends to address one Total Maximum Daily Load (TMDL) limit for a specific water quality issue in this corridor. However, city of Woodinville studies show that there are several habitat

deficiencies throughout the Little Bear Creek corridor. In addition to the fecal coliform contaminant in the subject action, Woodinville is taking steps to ,address other deficiency factors including: (1) habitat access, (2) habitat elements, (3) channel conditions and dynamics, (4) streamflow/hydrology characteristics, and (5) other general watershed conditions.

Response: Ecology is very interested in all of these aspects of watershed health in addition to water quality and will support stream restoration projects that accomplish more than water quality improvement. This water cleanup plan, however, has been prepared to address known water quality impairments, in accordance with the Clean Water Act.

13. **Comment**: The city of Woodinville has adopted several ordinances which describe specific improvements for Little Bear Creek, including:

- Critical areas ordinance to apply 'best available science' to property re-developments in the city portion of the watershed;
- Little Bear Creek Lineal Park Master Plan listing 16 specific corridor improvement actions, such as:
  - i. Extended buffers along the corridor
  - ii. Restoration of native plants
  - iii. Habitat restoration
  - iv. Removal of hydrologic barriers
  - v. Public ownership of adjacent properties
  - vi. Public education
  - vii. Road maintenance and drainage improvements
  - viii. Appropriate land use designations

Response: Ecology acknowledges Woodinville's significant efforts to protect Little Bear Creek and adjacent riparian corridor. References in the *Little Bear Creek Water Cleanup Plan*'s Summary Implementation Strategy have been expanded in accordance with these comments.

14. **Comment**: The Department of Ecology should consider working with Woodinville and WSDOT to develop appropriate surface water management controls from SR 522, to control the transport of contaminants into Little Bear Creek.

Response: Ecology is currently discussing best management practices for roadway stormwater with WSDOT. We welcome Woodinville's participation in discussions of how to better protect Little Bear Creek from pollutants in roadway runoff.

15. **Comment**: The importance of Low Impact Development (LID) will become ever more apparent under growth pressures. Little Bear Creek Protective Association (LBCPA) will continue to facilitate efforts to bring more businesses, developers and homeowners into communication with Ecology, the Sustainable Development Task Force of Snohomish County, the Blue Ribbon Task Force for Reduced Drainage Discharge, and the coming city of Maltby for coordinated approaches to watershed-wide LID programs.

Response: Ecology agrees that Low Impact Development (LID) is an important and creative approach to help address problems associated with stormwater, water quality, and long-term stream health. We appreciate having examples of successful LID projects such as the Maltby Joint Venture development in the Little Bear Creek watershed to evaluate the success of this approach and to help educate others on these methods. Ecology also looks forward to coordinating our LID efforts with those of the Sustainable Development Task Force of Snohomish County, the Blue Ribbon Task Force for Reduced Drainage Discharge, and the coming city of Maltby.

16. **Comment**: Snohomish County (PDS) allows homeowners to build too close to the creek with "upgraded" on-site sewage systems that ultimately are doomed to fail. Until Snohomish County curtails the approval of building homes close to the creek and removal of all the native trees and vegetation all the way to creek, this will continue. My suggestion would be that Snohomish County would take a strong stand and forbid any disturbance within 100' (minimum) of the creek - that would mean no cutting of trees, no clearing, restoration of native plants and trees, and leave it alone!

    Response: Ecology will share this comment and your concern with Snohomish Health District and other County personnel. Land use/development decisions regarding buffers are made by local jurisdictions, in accordance with state and local laws and, as such, are generally outside Ecology's jurisdiction. Ecology is also interested in helping fund stream restoration projects that include planting riparian buffers and will discuss this approach with Snohomish County and others during the implementation planning process.

17. **Comment**: Little Bear Creek should be one of the Lake Washington Urban Streams subject to the use of stormwater management study built on the Snohomish County Drainage Needs Report. The county can be a leader in comprehensive watershed management of our urban streams with formal interlocal agreements with other jurisdictions, including the north King County.

    Response: Ecology will share this comment with Snohomish County Surface Water Management staff and will work with them through the implementation planning process to consider how this fits into Little Bear Creek's water quality and other environmental goals.

18. **Comment**: The Department of Ecology should consider acknowledging the different characteristic land uses in the watershed including that urban contaminant sources are most likely in Woodinville and Grace areas; rural and suburban sources in SE Snohomish County. Woodinville believes that the city provides the best means of implementing protection measures for Little Bear Creek throughout its entire reach of urban, industrial land use zones.

    Response: Ecology agrees that Woodinville is in the best position to most effectively implement water quality protection measures for Little Bear Creek within the city limits and will continue to work with city staff to develop implementation actions that are sensible and effective. Different land uses and associated contaminant loadings were considered in the TMDL through the use of the Simple Method model and land use characteristics listed in Appendix A.

19. **Comment**: Fecal coliform can be detected in highway runoff, but the detections are all over the board. Highways do not generate fecal coliform; they are a conveyance mechanism so all we can do is treat the runoff using BMPs.

Response: Ecology has also experienced erratic fecal coliform sample results, especially in stormwater. The Little Bear Creek TMDL acknowledges how roadway stormwater is more a conveyance of pollutants than an original source. Ecology is interested in documenting and supporting highway runoff BMPs that are most effective at removing bacteria pollutants.

20. **Comment**: Most property owners do not recognize, nor want to be told, that the waters that run in the creek do not belong to them - they belong to every citizen in the state of Washington and it is their responsibility to protect them. Protect the natural buffers and wetlands and the problem is solved. Imagine the dollar cost savings!

Response: Significant streams such as Little Bear Creek are considered 'waters of the state' under state law and as such belong to the people of the state of Washington. As the commenter points out, streamside property owners have unique opportunity for responsible stream stewardship or water and habitat degradation.

Ecology is interested in providing streamside owners with information and resources that will help make positive differences for water quality and habitat. For this reason, Ecology has included "watershed stewardship education" as a High Priority Water Cleanup Activity in this TMDL report. Ecology also agrees with the commenter that natural vegetated streamside buffers and wetlands are an important part of the solution for improving stream environments and water quality in particular. For this reason, "wetland and/or riparian areas acquisition and/or restoration" is included as a High Priority Water Cleanup Activity in this report.

21. **Comment**: What effect might several consecutive years of drought do to implementation efforts? Should added effort be given to riparian and wetland acquisition for groundwater recharge and supply protection?

Response: The current drought situation may actually assist in helping identify and correct sources of pollution since sources are harder to detect in larger flow volumes. Ecology acknowledges the importance of riparian and wetland acquisition for groundwater recharge, late summer streamflows, and for augmenting water-supply sources. Riparian and wetland acquisition could be supported in implementing this TMDL, however these issues were not directly explored for the Little Bear Creek watershed through this effort.

22. **Comment**: According to the Navy studies, fecal coliform does not survive when exposed to sunlight. WSDOT uses a number of BMPs which expose fecal coliform to sunlight and are the only ones we are aware of that might have an impact. Most of the highway in this watershed receives these BMP approaches. What would be helpful from Ecology is a list of Ecology approved BMPs explicitly for treatment of low

levels of fecal coliform in a linear environment that we can add to those approved in our Highway Runoff Manual.

Response: Ecology is searching for BMPs that are effective for bacteria pollution in stormwater and will continue to share these with WSDOT and others. Currently, infiltration or biofiltration appear to be the most effective BMP approaches for reducing stormwater bacteria loads. According to EPA, ultraviolet radiation is one of the most important factors that might influence the inactivation of pathogens in the environment along with temperature and moisture conditions (EPA, 2001). Ultraviolet radiation from sunlight, however, is typically only partly effective at reducing bacteria concentrations in moving water.

23. **Comment**: *The Stormwater Management Manual for Western Washington* (Ecology Publications 99-11 through 99-15) does not provide any best management practices that are designed for reduction of fecal coliform bacteria, nor does the 2004 Highway Runoff Manual. If Ecology will be establishing reductions in the fecal coliform WLA for WSDOT, it will first need to establish a means of meeting those goals.

Response: Although the referenced manuals do not include BMPs that are specifically designed to reduce bacterial loads, some BMPs are more capable of doing so than others. Most of the treatment systems we have seen in the journal literature appear to take advantage of the tendency of bacteria to adsorb to certain types of sediment particles. Treatment systems that reduce sediment and allow water to percolate through soil or media may therefore be the most effective.

We also suggest that the Stormwater Management Manuals are not the only reference tools available to WSDOT and others for exploring treatment systems to reduce fecal coliform bacteria. Agricultural engineers have evaluated the bacteria removal efficiencies of various BMP systems, e.g. riparian buffers, lagoons, wetlands, and settling ponds. The local Natural Resource Conservation Service office or county conservation district may be able to help you evaluate your treatment systems. Ecology staff looks forward to working with WSDOT staff in evaluating these processes and identifying sensible, effective approaches during the implementation planning phase.

24. **Comment**: Why is Little Bear Creek protected for the designated use of ‘extraordinary primary contact recreation’?

Response: The “Extraordinary Primary Contact” use is intended for waters capable of “providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.” The use titled "extraordinary primary contact" was created in the 2003 revisions to the surface water quality standards for waters that had been previously assigned a Class AA water body designation. In moving to a new, use-based system for designating the state’s waters, the class-based system was eliminated and new names for uses were developed to come as close as possible to matching the terminology of the class-based system. The use now assigned to Little Bear Creek represents the level of use protection that has historically existed for the water body.

Most of the state's waters have been assigned their uses through the general classification system. Under that system, waters that exist in special areas such as national parks, national forests, and wildernesses are assumed to be capable of providing extraordinary protection for their uses. As well, waters that drain to extraordinary quality fresh or marine waters or to downstream lakes are assigned the uses and criteria of those downstream waters to ensure that the downstream waters are able to meet their criteria for use protection. In many cases, it is the need to protect the downstream uses and criteria that determines why upstream waters have been designated using stringent criteria.

To protect a stream for recreational uses in general, and primary contact in particular, Ecology must look at the full range of the way those uses might occur. For example, while a shallow stream may not support adult swimming, the fact that it is shallow makes it attractive to young children for water play. It is not the act of swimming that causes illness, but the routes and extent of their exposure. And, since children are more sensitive to waterborne illness, a higher degree of protection is warranted for smaller streams such as Little Bear Creek.

25. **Comment**: The Simple Method estimates stormwater runoff pollutant load for urban areas. We believe this does not provide a representative characterization for much of the basin, which is rural. The Simple Method provides a general planning estimate of likely storm water pollutant export from development sites less then one square mile (640 acres) in size. More sophisticated methods, such as time-step or continuous simulation modeling (e.g., HSPF), may be needed to analyze large and complex watersheds. The Little Bear Creek basin is approximately 15 miles^2 in size, which would suggest a more complex model is required.

Response: Ecology recognizes that the Simple Method model does not provide as accurate of a stormwater loading characterization as one would expect from a continuous simulation model like HSPF. Nonetheless, USEPA requires us to undertake stormwater loading quantification for wasteload allocations (WLAs) even as the agency recognizes that ‘these allocations might be fairly rudimentary because of data limitations and variability in the system’ (Wayland and Hanlon, 2002).

We believe that the Simple Method model quantifies stormwater loads at a ‘screening level’ scale commensurate with the data currently available in the basin. The model is recommended by the USEPA as providing a ‘quick and reasonable estimate of pollutant loadings’ (USEPA, 1992). The model is a set of simple annual or seasonal pollutant loading equations that uses a basic unit loading approach for modeling urban or rural environments; many pollutant wash-off models of varying spatial scales are similarly constructed. Since the numeric results are not incorporated into the NPDES permit, the model ‘loads’ suggest the relative magnitude from various land use types – not necessarily a highly accurate accounting of loads.

Ecology is interested to explore with WSDOT the use of other models such as HSPF, but observes that other parties (e.g., WSDOT) would need to help collect the additional real-time data needed to support these more sophisticated models.

26. **Comment**: The fecal coliform estimates for stormwater loads are based on a dated report (1987), which is based on even older data. A more recent, comprehensive data set has been compiled from NPDES Phase 1 municipalities around the country on behalf of EPA by Robert Pitt *et. al*. The database indicates that the relative concentrations of fecal coliform in runoff from each land use are much different than the older data would suggest.

***Response*:** Ecology did consult EPA's national database (especially the data layers having to do with the Pacific Northwest), as well as several regional sources of information, to develop the land use characteristics table. A footnote has been added to the table and the references section has been updated accordingly.

27. **Comment**: WSDOT is concerned with the process of assigning a wasteload allocation (WLA) based solely on NPDES permits for stormwater systems, particularly when there are no data to identify specific fecal coliform sources. In rural jurisdictions with few or no permit holders other than WSDOT, a WLA does not appear justified.

Response: The TMDL evaluation attempts to use the best available data to address the potential sources of pollutants. The *Little Bear Creek Water Cleanup Plan* assigned estimated load allocations to both point and nonpoint sources, as required by law. Storm water that is regulated through an NPDES Phase I or II permit as a point sources must be assigned a wasteload allocation. Stormwater discharges not currently subject to NPDES Phase I or II requirements are not required to obtain NPDES permits and, for regulatory purposes, are treated as nonpoint sources. These sources are assigned load allocations (Wayland and Hanlon, 2002).

At each representative point of the Little Bear Creek watershed evaluated, nonpoint source load allocations were greater than point source wasteload allocations. The TMDL evaluation suggests that nonpoint sources will require more implementation work and greater pollutant reductions than the point sources to reduce pollutant loads in the basin. This would be expected in a rural basin.

28. **Comment**: According to Figure 3, instream fecal coliform concentrations are highest in the summer when stormwater discharges are rare. Stormwater discharges are most common between November and April when instream fecal coliform concentrations are lowest. Accordingly, it seems premature to set wasteload allocations on stormwater system operators before even investigating other more likely, more important sources.

Response: While Figure 3 illustrates high monthly fecal coliform averages during summer months, very high, but transient stormwater-related fecal coliform concentrations also occur during winter months. Stormwater-related bacteria concentrations in winter are less able to affect the monthly average concentration because of their relatively short duration and larger average wet season stream discharges. These wet season stormwater-related bacteria loads are no less important than summer loading, though they may be 'masked' by higher stream discharge.

All potential bacteria sources are being investigated under the Little Bear Creek Fecal Coliform TMDL. Extra attention is given to stormwater system operators during development of the TMDL because of the EPA requirement to assign numeric wasteload allocations to NPDES permittees.

29. **Comment**: The Plan contains much useful information and the note on Little Bear Creek flows in summer of 1945 is very interesting. But, was 1945 an *average, above average or below average* rainfall year with what yearly total in inches of rain?

Response: According to NOAA climatological summaries, 1945 was slightly above average for precipitation measured at SeaTac. It rained 41.2 inches at SeaTac in 1945; the 50-year annual rainfall average is 38.6 inches.

30. **Comment**: What is the King County model from Aqua Terra using for Little Bear rainfall in the TMDL calculations? And how does that model compare to recent averages in the last five or ten years? And compared to this last year? Are we able to infer any streamflow rate changes (i.e., 1945 vs. 2004) that might affect the calculations of an average year?

Response: Aqua Terra calculated an average annual precipitation of 46 inches in Little Bear Creek watershed. To develop this estimate, Aqua Terra considered precipitation data from six different stations around the region. Some of the stations have been collecting precipitation data for over fifty years. One precipitation station was located in the Little Bear Creek watershed. Due to this station's short period of record, however, it could not be relied on (alone) to provide an annual precipitation estimate.

To support TMDL calculations, Ecology refined Aqua Terra's calculations to establish precipitation rates on a finer scale. Ecology did not undertake any specific analyses as a part of this TMDL to allow us to infer streamflow rate changes as they relate to precipitation.

31. **Comment**: Extended duration of reduced flow/or dry season may increase bacteria densities and make target decreases harder to achieve. Could a few lines addressing the increasing importance of groundwater be added? Maybe the five percent safety factor could be safer at ten percent?

Response: Ecology agrees with the commenter that low streamflows (resulting either from dry weather or changes in hydrology) will magnify bacteria counts in the streams, especially where bacteria sources are constant, such as with failing domestic on-site sewage systems.

While Ecology is interested in ground water and groundwater recharge, this TMDL focused primarily on reducing the total input of bacteria to the stream system, not enhancing streamflows. Still, Ecology recognizes that all the values and functions of the stream system are benefited by preserving and enhancing streamflows, especially with clean or at least partially treated water. For these reasons, stormwater infiltration and LID are recommended among the implementation actions in this TMDL, and limitations on groundwater withdrawals may be advocated if the groundwater component of Little Bear streamflows proves to be critical.

The five percent factor noted by the commenter is a reserve for future growth, not a safety factor. This factor is fairly standard for TMDL calculations; at this point Ecology has no basis or rationale for increasing it to ten percent.

32. **Comment**: What is the problem with putting pet waste in a domestic on-site sewage system?

Response: In Snohomish County, the Snohomish Health District Sanitary Code Chapter 3.1 (Solid Waste Handling Regulations) states that "Pet waste shall not be disposed of in a domestic on-site sewage system." King County, the Board of Health Solid Waste Regulations Title 10008.040 states that dog droppings "shall not be put into a septic system." The statement in this water cleanup plan that "generally, disposal to an on-site system is not acceptable" refers to these requirements.

33. **Comment**: Little Bear Creek is known to support at least 9 important species of fish, including several salmonid species of regional significance. Resident species documented in Little Bear Creek include coast range sculpins *(Cottus aleuticus)*, western brook lampreys *(Lampretra richardsoni)*, and cutthroat trout *(Oncorhynchus clarki)*. Anadromous species documented in Little Bear Creek include chinook salmon *(0. tshawytscha)*, coho salmon *(0. kisutch)*, and sockeye salmon *(0. nerka)*. Some species such as pink (0. *gorbuscha)* and chum *(0. keta)* salmon have rarely been observed in Little Bear Creek. However, due to their scarcity, they are not part of an established population; rather, they are strays from another watershed. Undocumented species such as steelhead trout *(0. mykiss)* could potentially utilize Little Bear Creek (David Evans, 2002).

Response: The section of the *Little Bear Creek Water Cleanup Plan* describing fisheries resources of Little Bear Creek has been expanded according to this comment.

References for Response to Comments

David Evans, 2002. *Little Bear Creek Corridor Habitat Assessment*, David Evans and Associates, Inc., July 2002.

Ecology, 2002. *Setting Standards for the Bacteriological Quality of Washington's Surface Water*, Publication No. 00-10-072, December 2002

Ecology, 2003. *Focus on Bacterial Source Tracking,* Ecology publication #03-10-059, July 2003, 2 pp.

Environmental Protection Agency, 2001. *Protocol for Developing Pathogen TMDLs, U. S. Environmental Protection Agency*, EPA 841-R-00-002, Washington, D. C., 90 pp. and appendices.

Wayland, R.H. and J.A. Hanlon, 2002. *Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on those WLAs*, U.S. EPA, Office of Water, Memo to Water Directors EPA Regions 1 – 10, Washington, D.C., November 22, 2002, 6 pp.