Puyallup River Watershed Fecal Coliform Total Maximum Daily Load

Water Quality Improvement Report and Implementation Plan

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Cover photo: White River, a tributary to the Puyallup River, near Buckley, WA

Project Codes

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Puyallup River Watershed Fecal Coliform Total Maximum Daily Load

Water Quality Improvement Report

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Abstract

The Puyallup River Watershed has many listings on the federal Clean Water Act 303(d) list as impaired for fecal coliform bacteria. This total maximum daily load (TMDL) report includes a study of bacteria impairment, indicates how much the bacteria needs to be reduced to meet Washington State water quality standards (load and wasteload allocations), and describes activities to achieve those reductions.

During October 2006 to September 2007, the Washington State Department of Ecology collected bacteria and streamflow data from 55 sites throughout the study area twice per month. These data were analyzed to determine how much the current bacteria levels needed to be reduced to meet the water quality standards.

The Puyallup River Watershed is required to have a geometric mean of less than 100 bacteria colonies per 100 milliliters of water (cfu/100 mL). Not more than 10% of samples used to calculate the geometric mean can exceed 200 cfu/100 mL.

This TMDL expresses load allocations as a percent reduction needed to meet the concentration-based standard. Wasteload allocations are expressed as concentration limits. These percent reductions are targets used to prioritize implementation activities to reduce bacteria. Load allocations are established from nonpoint (diffuse) sources along many of the mainstem and tributaries of the Puyallup and White River systems. Wasteload allocations are established for Phase I and II communities, wastewater treatment plants, industrial permitted facilities.

Compliance with this TMDL will be based on meeting the water quality standard.

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Executive Summary

Introduction

The Puyallup River, White River, and several of their tributaries have fecal coliform (FC) bacteria levels higher than Washington State's allowed levels (standards) for freshwater streams. These typically harmless bacteria tend to exist along with disease-causing bacteria and viruses (i.e., pathogens), so they serve to indicate the potential for pathogens in the water. Meeting the FC standards is important because it helps make our rivers and streams safe places to swim, fish, boat, and do other recreational activities.

The federal Clean Water Act requires that a total maximum daily load (TMDL) be developed for each of the water bodies on the state's 303(d) list of polluted waters. The TMDL identifies pollution problems in the watershed, and then specifies how much pollution needs to be reduced or eliminated to achieve clean water. The Washington State Department of Ecology (Ecology) then works with the local community to develop an implementation plan to assess the effectiveness of the water quality improvement activities. Together, the TMDL and the implementation plan make up the *water quality improvement report* (WQIR).

This WQIR will be submitted to the U.S. Environmental Protection Agency (EPA) for review and approval. This report will also include implementation commitments that will describe and prioritize specific actions planned to improve water quality.

The goal of this Puyallup River watershed FC TMDL is to reduce FC concentrations within the study area (Figure ES-1) to water quality standards by 2022.

Watershed description

The Puyallup River basin, Water Resource Inventory Area (WRIA) 10, drains an area of approximately 1,065 square miles. The watershed contains more than a dozen cities and towns, including Washington State's third largest city, Tacoma. The major rivers of the basin are the Puyallup River and its two largest tributaries: the White (Stuck) and Carbon Rivers. The study area excludes the Clarks Creek and South Prairie Creek watersheds, where bacteria TMDLs have recently been done.

The White River enters the Puyallup River near the cities of Puyallup and Sumner and drains a 494 square-mile basin. Mud Mountain Dam, located at about river mile (RM) 28 on the White River, affects flow in the White River. Water is removed from the White River at about RM 24, stored in Lake Tapps, and then returned to the White River at about RM 4.

The Puyallup River watershed within the TMDL study area serves as receiving water for six municipal wastewater treatment plants (WWTPs): Puyallup, Orting, Enumclaw, Sumner, Buckley, and Rainier School.

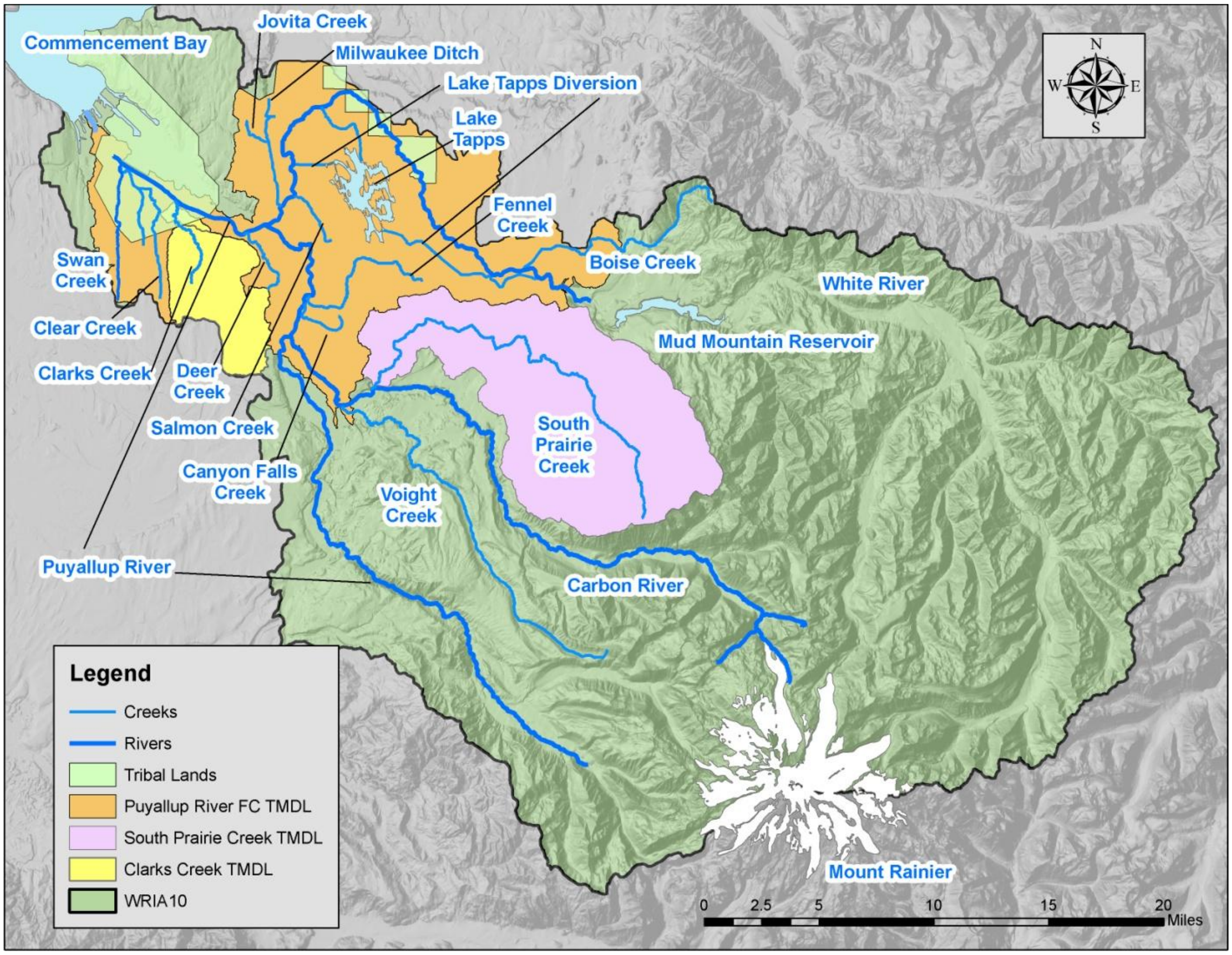

Figure ES-1. Puyallup/White River watershed (WRIA 10) including the Puyallup River watershed FC TMDL study area.

TMDL targets

This TMDL sets targets in terms of the FC concentrations necessary to meet criteria described in the following paragraphs. Percent reductions reflect the estimated level of source control needed to meet water quality standards.

Tables ES-1 and ES-2 contain the target FC reductions for water bodies that violated water quality standards. The water quality standards within the TMDL study area are:

- Geometric mean (similar to an average) of 100 bacteria colonies per 100 milliliters of water (cfu/100 mL).
- No more than 10% of samples should exceed 200 cfu/100 mL. In this report, this is calculated as the 90th percentile of sample results.

Table ES-1. FC reductions and target capacity for the Puyallup River tributaries.

Station ID	Site Description	Observed FC (cfu /100mL)		FC Reduction	FC Target Capacity (cfu /100 mL)	
		Geo-mean	90th %tile		Geo-mean	90th %tile
Dry Season (May – October)						
10-DEE-0.1	Deer Creek near mouth	509	1336	**85%**	76	200
Wet Season (November to April)						
10-DEE-0.1	Deer Creek near mouth	119	219	**16%**	100	184
10-CLK-0.01	Clark Creek at mouth	87	253	**31%**[1]	60[1]	174[1]
Clarks Ck. 1-3	Pooled data for Clarks Ck at 3 sites	132	402	**57%**[2]	57[2]	174[2]
Non-Seasonal						
10-SWN-3.9	Swan Creek at 80th St E	59	437	**54%**	27	200
10-UNO-0.3	Alderton Creek at 80th St E	83	734	**73%**	83	734

[1] Not the official FC target capacity and percent reductions, official targets were set a by a separate TMDL for Clarks Creek.
[2] Official FC target capacity and percent reductions based on 2002-03 data set in separate Clarks Creek Watershed FC TMDL report (James, 2008).
Note: Yellow (light shading) = 0-33% FC reduction; Orange (medium) = 33-67%; Red (dark) = 67-100%.

Table ES-2. FC reductions and target capacity for the White River and its tributaries.

Station ID	Site Description	Observed FC (cfu /100 mL)		FC Reduction	FC Target Capacity (cfu /100 mL)	
		Geo-mean	90th %tile		Geo-mean	90th %tile
Dry Season (July – October)						
10-WHT-0.1	White River at mouth	68	248	**20%**	55	200
10-WHT-1.4	White River at 142nd	58	251	**20%**	47	200
10-BOI-0.1	Boise Creek at mouth	401	2435	**92%**	33	200
10-BOI-1.0	Boise Creek at 252nd	724	1556	**87%**	93	200
10-BOI-2.2	Boise Creek at 276th	105	462	**57%**	45	200
10-BOW-0.3	Bowman Creek at Kersey Way	99	507	**61%**	39	200
10-JOV-0.4	Jovita Creek at West Valley Hwy E	295	586	**66%**	100	199
10-SAL-0.2	Salmon Creek at East Valley Hwy	194	876	**77%**	44	200
Wet Season (November to June)						
10-BOI-0.1	Boise Creek at mouth	70	507	**61%**	27	200
10-BOI-1.0	Boise Creek at 252nd	57	614	**67%**	18	200
10-MIL-2.2	Milwaukee Ditch near Hwy 167	52	351	**43%**	30	200
10-SAL-0.2	Salmon Creek at East Valley Hwy	86	274	**27%**	63	200
10-TAS-0.01	Trib to White R at Auburn Riverside HS	39	476	**58%**	17	200
Non-Seasonal						
10-RSSW-0.01	Rainer School stormwater drainage	32	1475	**86%**	4	200
10-UNW-0.2	Unknown trib to White River at 180th	203	2057	**90%**	20	200

Yellow (light shading) = 0-33% FC reduction; Orange (medium) = 33-67%; Red (dark) = 67-100%.

Conclusions and recommendations

Conclusions

- Fecal coliform concentrations were highest during the dry season (July to October) for both the Puyallup River and the White River.
- Clarks, Deer, Salmon, Jovita, Boise, and Bowman Creeks were higher than (exceeded) water quality standards during the dry season.
- Boise Creek was the largest FC loading source of any tributary in the TMDL study area. It also required the largest FC reduction of any dry season source.
- Wet season FC concentrations were well below water quality standards at all measured stations on the mainstem Puyallup River.
- Boise Creek, Clarks Creek, Deer Creek, upper Swan Creek (SWN-3.9), Alderton Creek (10-UNO-0.3) Salmon Creek, Milwaukee Ditch at creek mile (CM) 2.2, and the unnamed tributary to White River (at both UNW-0.1 and UNW-0.2) exceeded water quality standards during the wet season. Of these sites, Boise and Clarks Creek were the largest FC loading sources.
- Stormwater runoff caused high FC concentrations on the White River and Boise Creek. However, on the mainstem Puyallup River, counts were consistently low during the wet season and consistently elevated during the dry season, regardless of rainfall.
- The dry season storm event on 9/4/07 resulted in the only dry season FC counts above 200 cfu/100 mL at all mainstem sites on the White River from RM 0.1 to 7.5.

Recommendations

- The Boise Creek watershed should be the number one priority cleanup basin for this TMDL. King County and the city of Enumclaw should work together to locate and eliminate sources of fecal pollution, particularly between CM 0.1 and 1.0.
- Clarks Creek continues to violate water quality standards and was the second largest FC loading source to the Puyallup River (of the basins that exceeded water quality standards). Clarks Creek should be the number two priority cleanup basin.
- The highest FC counts occurred during the dry season, (July to October) for both the Puyallup and White Rivers. Dry season sources should be addressed first, particularly for:
  1. Stormwater delivery to the White River mainstem.
  2. Boise and Clarks Creeks.
  3. Salmon, Deer, Jovita, and Bowman Creeks.
- Wet season stormwater delivery of FC loads to the White River should be reduced below RM 23.8.
- Unexplained increases in FC concentrations within the following reaches should be investigated:
  - White River RM 3.3 to 1.4.

- Puyallup River RM 3.0 to 1.4.
- White River RM 23.8 to 18.9.
- Puyallup River RM 12.0 to 10.3 (FC counts increase during the dry season only).

Implementation summary

The implementation section of this report describes how fecal coliform bacteria levels will be reduced to meet water quality standards. Bacteria TMDL reductions in the Puyallup River watershed should be achieved by 2022.

Fecal coliform bacteria primarily enter waterways from one or more of the following sources:

- Livestock with direct access to streams or with poor manure management.
- Failing or improperly constructed septic systems.
- Pet waste.
- Wildlife.
- Improperly treated sewage or other illicit discharges to the MS4 or the creek itself.

Since the scope of the TMDL was very large, there are many sampling points that collected data only at the mouth of tributaries in the Puyallup and White River systems. One of the key action items from each participant is to determine the sources of the pollution to reach the load reductions for nonpoint sources.

After pollution sources are determined, Ecology will use adaptive management to add additional implementation activities to achieve water quality standards. Please refer to the summary of action tables starting on page 102. These tables list all the requirements for entities with reduction requirements. Ecology will perform sampling to determine if interim targets of 50 percent of the needed reduction are achieved by 2017. Ecology will perform effectiveness monitoring when the all needed reductions are achieved by 2022.

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What is a Total Maximum Daily Load (TMDL)

Federal Clean Water Act requirements

The Clean Water Act established a process to identify and clean up polluted waters. The Clean Water Act requires each state to have its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards consist of (1) designated uses for protection, such as cold water biota and drinking water supply, and (2) criteria, usually numeric criteria, to achieve those uses.

Every two years, states are required to prepare a list of water bodies – lakes, rivers, streams, or marine waters – that do not meet water quality standards. This list is called the 303(d) list. To develop the list, Ecology compiles its own water quality data along with data from local, state, and federal governments, tribes, industries, and citizen monitoring groups. This is called a water quality assessment. All data are reviewed to ensure that they were collected using appropriate scientific methods before the data are used to develop the 303(d) list. The 303(d) list is part of the larger water quality assessment.

The water quality assessment tells a more complete story about the condition of Washington's water. The assessment divides water bodies into five categories:

Category 1 – Meets standards for parameter(s) for which it has been tested.

Category 2 – Waters of concern.

Category 3 – Waters with no data available.

Category 4 – Polluted waters that do not require a TMDL because:

- 4a. Has an approved TMDL and it is being implemented.
- 4b. Has a pollution control program in place that should solve the problem.
- 4c. Is impaired by a non-pollutant such as low water flow, dams, and culverts.

Category 5 – Polluted waters that require a TMDL – the 303(d) list.

TMDL process overview

The Clean Water Act requires that a TMDL be developed for each of the water bodies on the 303(d) list. A TMDL study identifies pollution problems in the watershed and then specifies how much pollution needs to be reduced or eliminated to achieve clean water. Ecology then works with the local community to develop an overall approach to control the pollution.

This *water quality improvement report* will be submitted to the U.S. Environmental Protection Agency (EPA) for review and approval. This TMDL is created with both the improvement report and the implementation plan all in one report. This report includes implementation commitments that describe and prioritize specific actions planned to improve water quality.

Elements required in a TMDL

The goal of a TMDL is to ensure that impaired water will attain water quality standards. A TMDL includes a written, quantitative assessment of the water quality problems and of the pollutant sources that cause the problem, if known. The TMDL determines the amount of a given pollutant that can be discharged to the water body and still meet standards (the *loading capacity*), and allocates that load among the various sources.

Identifying the pollutant loading capacity for a water body is an important step in developing a TMDL. EPA defines the loading capacity as "the greatest amount of loading that a water body can receive without violating water quality standards" (EPA, 2001). The loading capacity provides a reference for calculating the amount of pollution reduction needed to bring a water body into compliance with the standards.

The portion of the receiving water's loading capacity assigned to a particular source is a *wasteload* or *load* allocation. If the pollutant comes from a discrete (point) source, such as a municipal or industrial facility's discharge pipe, that facility's share of the loading capacity is called a *wasteload allocation*. If the pollutant comes from a set of diffuse (nonpoint) sources such as general urban, residential, or farm runoff, the cumulative share is called a *load allocation*.

The TMDL must also consider seasonal variations, and include a *margin of safety* that takes into account any lack of knowledge about the causes of the water quality problem or its loading capacity. A *reserve capacity* for future loads from growth pressures is sometimes included as well. By definition, a TMDL is the sum of the allocations, which must not exceed the loading capacity. The sum of the wasteload and load allocations, the margin of safety, and any reserve capacity must be equal to or less than the loading capacity.

Loading Capacity ≥ TMDL = sum of all wasteload allocations + sum of all load allocations + margin of safety + reserve capacity (if any).

Why Ecology is Conducting a TMDL Study in this Watershed

Overview

The Puyallup and White Rivers, as well as Boise, Swan, and Clear Creeks, have been placed on Washington State's 303(d) list (1996, 1998, and 2004) of impaired water bodies for not meeting contact recreation water quality standards. The federal Clean Water Act of 1972 requires Washington State to (1) develop a water quality improvement report or TMDL and (2) implement activities described in the report to bring these water bodies back into compliance with standards.

This report includes the technical analysis and the implementation plan for the water quality improvement report, also called a TMDL. The report establishes the scientific basis for a set of instream fecal coliform (FC) bacteria targets to meet contact recreation water quality standards.

Fecal coliform bacteria are used as indicators of fecal contamination and the presence of other disease-causing (pathogenic) organisms. High FC bacteria numbers in waterways may indicate an increased risk of infection from pathogens associated with fecal waste. The technical analysis identifies reductions in FC concentrations necessary to meet water quality standards in the Puyallup River basin. The study was conducted by the Washington State Department of Ecology (Ecology) Environmental Assessment Program. This document also provides an overview of the actions that may be used to reduce FC in the Puyallup River watershed.

When a TMDL technical study is undertaken, the sampling study design usually includes more water bodies or stream reaches than are on the 303(d) list. A comprehensive sampling design is necessary to identify the spatial and temporal extent of the contamination problem, and to identify sources of point (discrete) and nonpoint (diffuse) source loads.

Target pollutant reductions may be expressed as loads, concentrations, or other appropriate measures [40 CFR 130.2(I)]. Fecal coliform targets are expressed as concentrations in this report. Concentrations are the primary targets for future compliance by comparison to Washington State FC criteria.

Fecal coliform loads (concentrations multiplied by streamflow) are used as a relative measure of pollutant flux between river reaches or from tributary and point source inputs. Loads are also used to compare FC seasonal and hydrologic flux. Concentrations of FC are useful because they can be compared to the water quality standards for all streamflow scenarios.

The FC reduction targets for each site are calculated from data generated during the critical condition for the sites. Although the critical conditions for the sites are identified, the reductions are meant to apply year-around.

Study area

The study area (Figure 1) for this TMDL consists of the White River watershed below RM 23.8 and the Puyallup River watershed from the confluence of the Puyallup and Carbon Rivers. The study area also includes the lower stretch of the Carbon River watershed from the confluence of Voight Creek to its mouth. Tribal land and waters for the Puyallup Tribe of Indians and Muckleshoot Indian Tribe are within the area being studied; however, these waters are not under the TMDL's jurisdiction. The TMDL covers state waters only. This study area is in Water Resource Inventory Area (WRIA) 10.

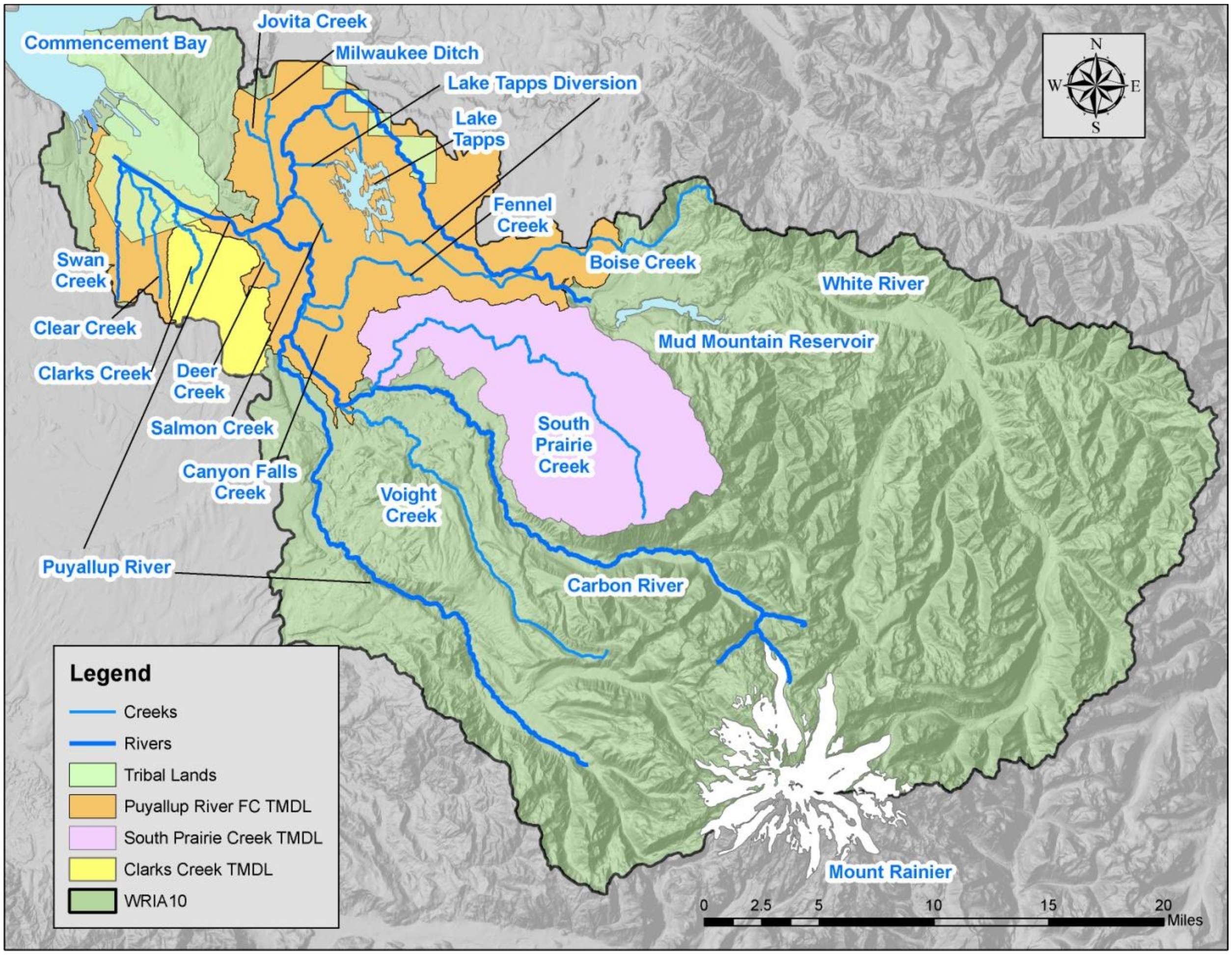

Figure 1. Map of Puyallup River watershed (WRIA 10).

Pollutants addressed by this TMDL

This TMDL addresses FC bacteria pollution within the study area (Figure 1). Apart from this study, several approved and ongoing TMDLs address additional FC listings within the watershed.

Pollutants addressed by previous TMDL studies in WRIA 10

South Prairie Creek Bacteria and Temperature TMDL

Ecology completed a technical study of South Prairie Creek for FC bacteria and temperature in June 2003 and a detailed implementation plan in July 2006.

The TMDL concluded that the following reductions in FC concentration were needed:

- Mainstem of South Prairie Creek:
  - Growing season – 14 to 41% reductions
  - Non-growing season – 23 to 71% reductions
- South Prairie Creek Tributaries :
  - Spiketon Creek at State Route 165:
    - Growing season – 84% reduction
    - Non-growing season – 48% reductions
  - Unnamed tributary/ditch:
    - Growing season – 61 to 71% reductions
    - Non-growing season – 7 to 8% reductions

The project also determined that additional data were needed in two sub-basins of South Prairie Creek, Spiketon Creek, and Inglin Creek. Ecology initiated sampling for this project in December 2008 (Kardouni, 2009).

Related Documents:

- South Prairie Creek Bacteria and Temperature TMDL Study. www.ecy.wa.gov/biblio/0303021.html.
- South Prairie Creek Bacteria and Temperature TMDL (Water Cleanup Plan): Submittal Report. www.ecy.wa.gov/biblio/0310055.html.
- South Prairie Creek Bacteria and Temperature TMDL (Water Cleanup Plan): Detailed Implementation Plan. www.ecy.wa.gov/biblio/0610018.html.
- Quality Assurance Project Plan: Addendum to South Prairie Creek Total Maximum Daily Load Phase II Evaluation. www.ecy.wa.gov/biblio/0103064add1.html.

Clarks Creek Watershed Fecal Coliform Bacteria TMDL

In December 2007, Ecology completed a water quality assessment of Clarks Creek and its tributaries based on data from a water quality study conducted by the city of Puyallup in 2002 and 2003 (James, 2008). The study showed that:

- Fecal coliform bacteria exceeded numeric criteria in much of the watershed in the winter. Meeker Creek and Rody Creek exceeded the criteria in the summer.
- High levels of bacteria are not a natural condition but instead appear to be traceable to rodents, waterfowl, and pet feces in stormwater, and other sources including human sources.

Ecology concluded that bacteria reductions of 18 to 57% were necessary on three segments of Clarks Creek. Meeker Creek required a 94% reduction, and Rody Creek a 95% reduction.

Related Documents:

- Clarks Creek Watershed Fecal Coliform Bacteria TMDL – Water Quality Improvement Report. www.ecy.wa.gov/biblio/0710110.html.
- Clarks Creek Watershed Fecal Coliform Bacteria Total Maximum Daily Load: Water Quality Implementation Plan. http://www.ecy.wa.gov/biblio/0910081.html

White River TMDLs

There is a pH TMDL on the Lower White River. It is currently under development. Ecology completed a TMDL in the upper White River in 2004.

Impaired designated uses and water bodies on Ecology's 303(d) list of impaired waters

The Washington State Water Quality Standards, set forth in Chapter 173-201A of the Washington Administrative Code (WAC), include designated beneficial uses, as well as numeric and narrative water quality criteria for surface waters of the state. The numeric and narrative water quality criteria are set at levels to protect the designated beneficial uses. In other words, the criteria are set to protect the streams for the ways people use them.

All of the streams covered by this TMDL are designated for *Primary Contact Recreation* use. Examples of *Primary Contact* uses are swimming and other activities where the water and skin or body openings (e.g., eyes, ears, mouth, nose, and urogenital) come into direct and extended contact.

This TMDL study addresses the 2008 303(d) listings outlined in Table 1. Table 1 also includes additional water body segments that are not on the 2008 303(d) list, but that exceeded water quality standards and receive allocations in this TMDL. Collectively, Table 1 makes up the water bodies that should be classified as Category 4a in the 2012 water quality assessment cycle, provided that the TMDL has been approved by EPA prior to the 2012 assessment.

Table 1. Water bodies with fecal coliform exceedences addressed by this TMDL

Water body	EIM User Location ID	Approximate River Mile extent of segment	303(d) Listed?	Listing ID
White River	n/a	0.3 to 0.6	2008 303(d) list	16708
Boise Creek	n/a	Mouth to 0.2	2008 303(d) list	16706
Salmon Creek	10-SAL-0.2	0.2 to origin	2008 303(d) list	45601
Deer Creek	10-DEE-0.1	0.1 to origin	2008 303(d) list	45616
Unnamed Creek (Tributary to the Puyallup River)	10-UNO-0.3	0.3 to origin	2008 303(d) list	45688
White River	10-WHT-0.1	0.1 to 1.4	Recommended*	n/a
White River	10-WHT-1.4	1.4 to 3.3	Recommended*	n/a
Boise Creek	10-BOI-0.1 10-BOI-1.0 10-BOI-2.2	0.1 to 3.2	Recommended*	n/a
Swan Creek	10-SWN-3.9	3.9 to origin	Recommended*	n/a
Bowman Creek	10-BOW-0.3	0.3 to origin	Recommended*	n/a
Jovita Creek	10-JOV-0.4	0.4 to origin	Recommended*	n/a
Milwaukee Ditch	10-MIL-2.2	2.2 to origin	Recommended*	n/a
Unnamed Creek (Tributary to the White River at near Muckleshoot Reservation)	10-UNW-0.1 10-UNW-0.2	0.1 to origin	Recommended*	n/a
Unnamed Creek (Drainage to the White River at Rainier School WWTP)	10-RSSW-0.01	Mouth to origin	Recommended*	n/a
Unnamed Creek (Drainage to the White River at Auburn River High School)	10-TAS-0.01	Mouth to origin	Recommended*	n/a

* These waterbodies exceed the fecal coliform criteria and meet Ecology's 303(d) listing policy. These waterbodies are therefore recommended for listing as impaired in the next Washington State Water Quality Assessment.

In 2006, Ecology designed this TMDL study to address the 2004 303(d) listings (Table 2). The 2008 303(d) list was approved by EPA in January 2009. Several changes occurred, between the 2004 and 2008 lists, within the TMDL study area based on data from this TMDL and Ecology's ambient monitoring program, including:

- The White River at R Street (Listing ID 16711) and the Puyallup River at Meridian Street (Listing ID 16712) were removed from the 303(d) list after the 2008 water quality assessment process. This process was based on data collected for Ecology's freshwater ambient monitoring program from 2004 to 2006.
- Salmon Creek, Deer Creek, and the unnamed tributary to the Puyallup River (referred to as Alderton Creek or 10-UNO-0.3 in this report) were added to the 303(d) list based on data collected for this TMDL in 2006.

Based on the 2006-07 TMDL data, several listings should be removed from the 303(d) list and changed from Category 5 to Category 1 in the next water quality assessment cycle, including:

- Puyallup River (Listing ID 7498)
- White River (Listing ID 16709)
- Clear Creek (Listing ID 7501)
- Swan Creek (Listing ID 7514)

Table 2. Study area water bodies on the 2004 303(d) list for fecal coliform.

Water body	Listing ID	Township, Range, Section
Puyallup River	16712 7498	20N 04E 22 20N 04E 18
White River	16711 16708 16709	21N 05E 29 20N 06E 34 20N 04E 49
Clear Creek	7501	20N 03E 11
Swan Creek	7514	20N 03E 11
Boise Creek	16706	20N 06E 34

This watershed has other water quality issues. In particular, the following 303(d) listings for parameters other than fecal coliform occur in the study area, but are not addressed in this TMDL report (Table 3).

Table 3. Additional 2008 303(d) listings not addressed by this report.

Water body	Parameter	Listing ID(s)
Boise Creek	Temperature	7496
	pH	35337
Clarks Creek	pH	7499
Meeker Ditch	Fecal Coliform*	7507
	Dissolved Oxygen	7510; 47578
	pH	7511
White River	pH	7524; 7525; 7526
	Temperature	17513; 17515; 17517; 21301; 21302
Bowman Creek	Dissolved Oxygen	9383
Puyallup River	Mercury	10874; 35421

*Addressed by existing TMDL.

Why are we doing this TMDL now?

In 2005, Ecology conducted a scoping process, involving local stakeholders, to prioritize 303(d) listed waters in the South Puget Sound water resource inventory areas (WRIAs) 10, 11 and 12. The Puyallup River watershed listings for fecal coliform were the highest priorities identified among the local entities and Ecology.

What part of the process are we in?

This WQIR will be submitted to the U.S. Environmental Protection Agency (EPA) for review and approval. This report also includes implementation commitments that describe and prioritize specific actions planned to improve water quality. These commitments are more commonly found in the *water quality implementation plan*; however, this report combines all reports into one.

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Water Quality Standards and Designated Uses

Bacteria

Bacteria criteria are set to protect people who work and play in and on the water from waterborne illnesses. In Washington State, the Department of Ecology (Ecology) water quality standards use fecal coliform (FC) as an "indicator bacteria" for the state's freshwaters (e.g., lakes and streams). Fecal coliform in water "indicates" the presence of waste from humans and/or other warm-blooded animals. Waste from warm-blooded animals is more likely to contain pathogens that will cause illness in humans than waste from cold-blooded animals. The FC criteria are set at levels that are shown to maintain low rates of serious intestinal illness (gastroenteritis) in people.

The Washington State Water Quality Standards, set forth in Chapter 173-201A of the Washington Administrative Code (WAC), include designated beneficial uses, water body classifications, and numeric and narrative water quality criteria for surface waters of the state.

Summary

- Tribal Waters
  - The Puyallup Tribe of Indians water quality standards within the TMDL study area are the same as Washington State's *Primary Contact Recreation* standards for bacteria.
  - The Muckleshoot Indian Tribe does not have specific water quality standards.
  - Washington State waters must meet the tribal water quality standards (or Washington State's standards when no tribal standards exist) before entering tribal land.
- Marine Waters
  - Inner Commencement Bay, where the Puyallup River initially discharges into the bay, must meet the *Secondary Contact Recreation* bacteria criteria for marine waters.
  - Outer Commencement Bay must meet *Primary Contact Recreation* bacteria criteria for marine waters.
  - Since there are no available salinity data for the tidal estuary at the mouth of the Puyallup River, the freshwater bacteria standards apply.
- Freshwaters
  - All rivers and tributaries within the TMDL study area are classified as *Primary Contact Recreation* and must meet the applicable criteria, except for:
    - The Puyallup River from the mouth to river mile (RM) 1, which is classified as *Secondary Contact Recreation*.

Tribal waters

Reservations for both the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe exist within the TMDL study area (Figure 1). The tribes have the option to set their own water quality standards within these reservations. The Puyallup Tribe of Indians had standards approved by EPA in 1994 (EPA, 2009). The Puyallup Tribe standards for bacteria are the same as the Washington State water quality standards described below. The Muckleshoot Tribe has not developed specific water quality standards to date. Washington State surface waters are required to meet the Washington water quality standards before entering the tribal lands within the TMDL study area. Since the Puyallup Tribe and Washington State standards are the same, this will allow for the Puyallup Tribe's water quality standards to be met.

Marine waters

Inner Commencement Bay is classified as *Secondary Contact Recreation* and outer Commencement Bay is *Primary Contact Recreation* (Figure 2). The boundary between the inner and outer bay is a line bearing 225 degrees from the Hylebos Waterway light. Table 4 lists the recreational use bacteria criteria for marine waters. Since there are no available salinity data for the tidal estuary at the mouth of the Puyallup River, the freshwater bacteria standards apply.

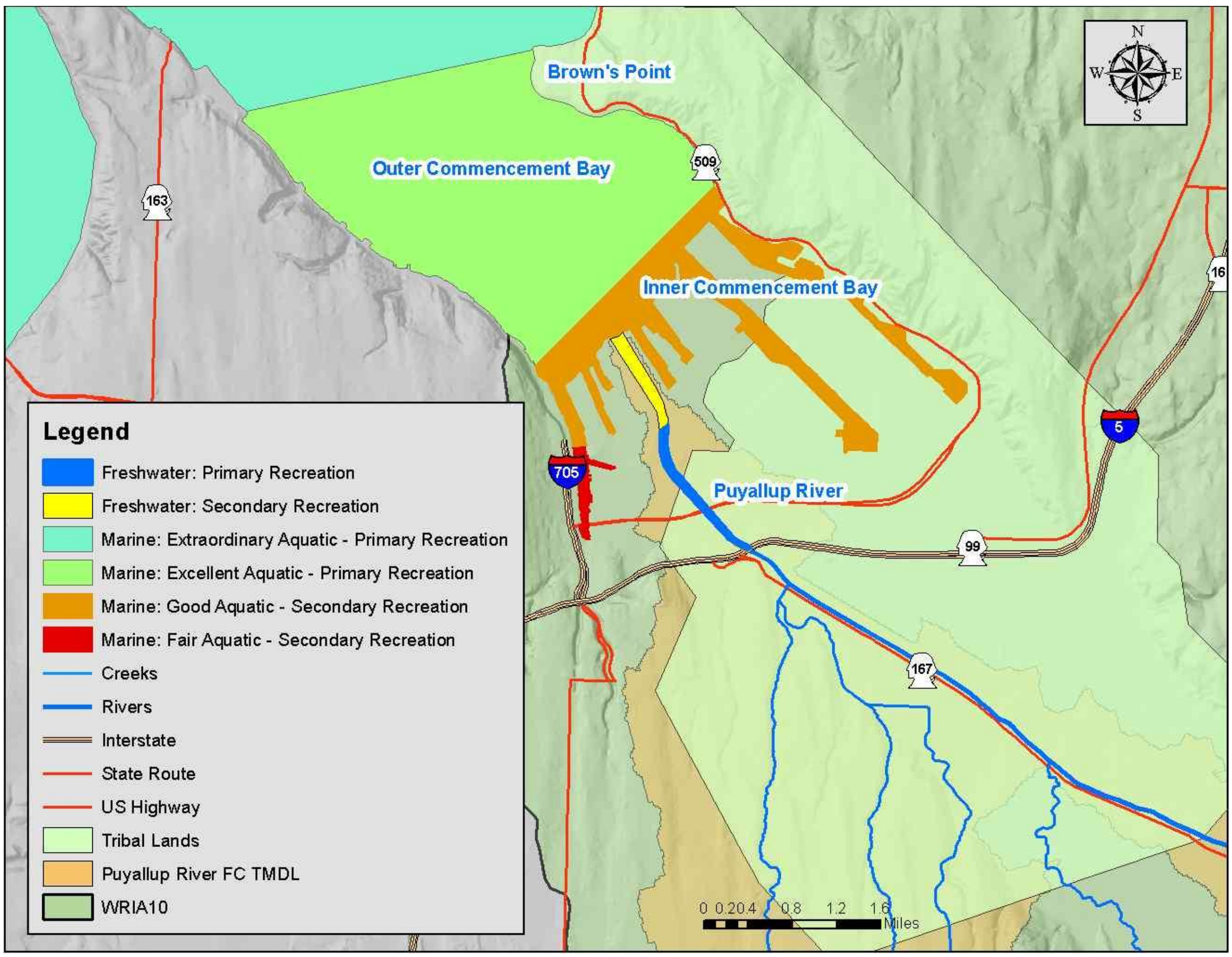

Figure 2. Marine waters classifications for recreational contact uses in WRIA 10.

Table 4. Water contact recreation bacteria criteria for marine water.

Category	Bacteria Indicator
Primary Contact Recreation	Fecal coliform organism levels must not exceed a geometric mean value of 14 colonies/ 100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 43 colonies /100 mL.
Secondary Contact Recreation	Enterococci organism levels must not exceed a geometric mean value of 70 colonies/ 100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 208 colonies/100 mL.

Fresh waters

The Puyallup River is classified as *Secondary Contact Recreation* water (previously Class B) from the mouth to RM 1, *Primary Contact Recreation* water (previously Class A) from RM 1 to RM 31.6 (Kings Creek), and *Extraordinary Primary Contact Recreation* (previously Class AA) from Kings Creek to the headwaters (Figure 3).

The White River is classified as *Primary Contact Recreation* water (Class A) from the mouth to Mud Mountain Dam and *Extraordinary Primary Contact Recreation* (Class AA) from Mud Mountain Dam, to the headwaters. Clear Creek, Swan Creek, and Boise Creek are classified as *Primary Contact Recreation* waters.

All the rivers and tributaries within the TMDL study area are classified as Primary Contact Recreation, except for the Puyallup River from the mouth to RM 1, which is Secondary Contact.

Numeric criteria for specific water quality parameters are intended to protect designated uses. Under the revised water quality standards, while the waterbody classification system has changed, the FC bacteria numeric target for each of the water bodies included in this study has not. Freshwater standards are listed for bacteria in Table 5.

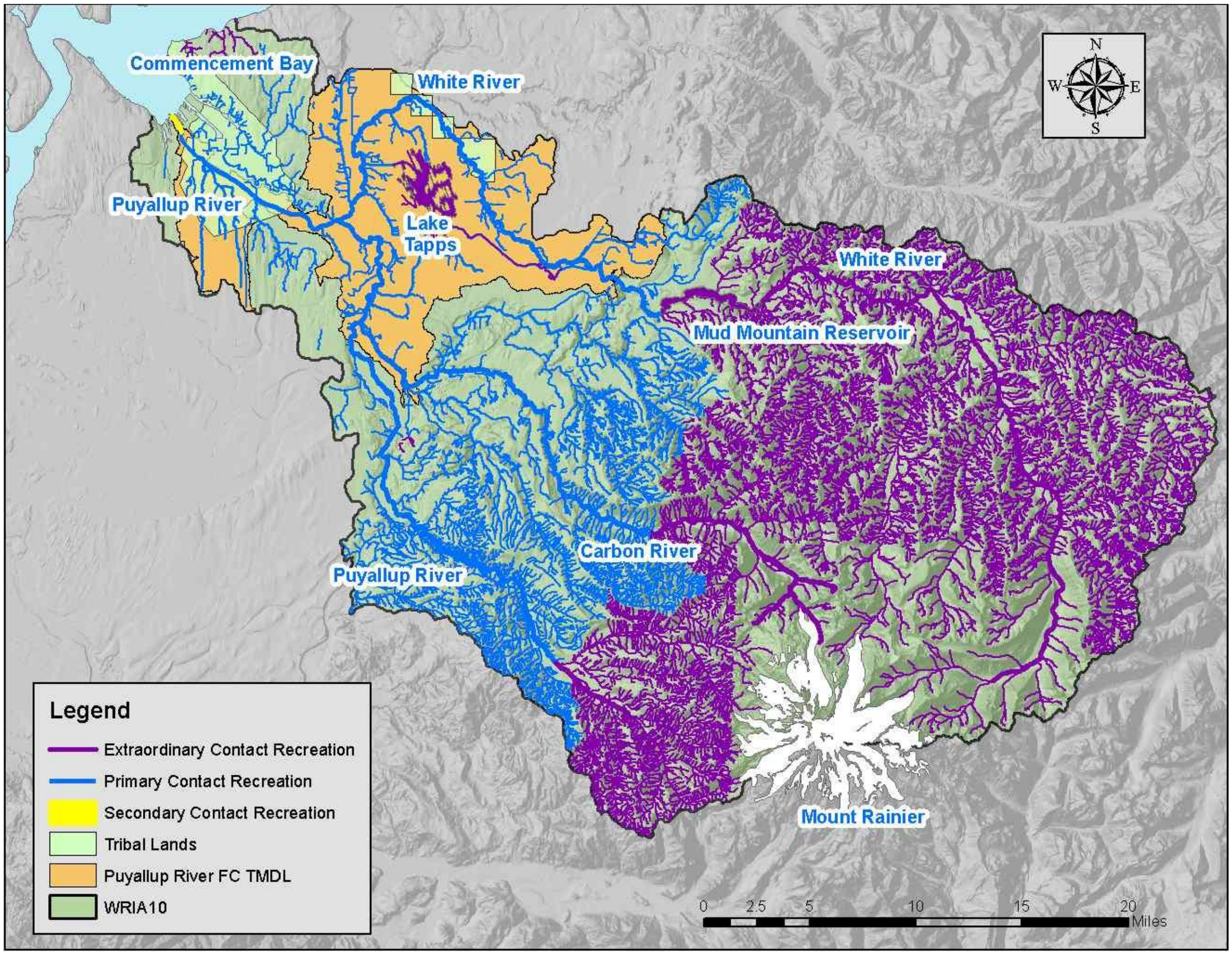

Figure 3. Freshwater classifications for recreational contact uses in WRIA 10.

Table 5. Water contact recreation bacteria criteria in freshwater [WAC 173-201A-200(2)(b)].

Category	Bacteria Indicator
Extraordinary Primary Contact Recreation	Fecal coliform organism levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10% 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.
Primary Contact Recreation	Fecal coliform organism levels must not exceed a geometric mean value of 100 colonies/100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200 colonies/100 mL.
Secondary Contact Recreation	Fecal coliform organism levels must not exceed a geometric mean value of 200 colonies/100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 400 colonies/100 mL.

The freshwater FC criteria have two statistical components, a geometric mean and an upper limit value that 10% of the samples cannot exceed. Concentrations of FC measured in environmental samples follow log-normal distribution. In Washington State FC TMDL studies, the upper limit statistic (i.e., not more than 10% of the samples shall exceed) has been interpreted to be comparable to the 90th percentile value of the log normalized values (Cusimano, 1997; Joy, 2000; Sargeant, 2002). This is useful for estimating FC percent reductions needed, but is not strictly equivalent mathematically, and does not on a regulatory basis substitute for part 2 of the FC water quality standard. Colony forming units (cfu) is assumed to be comparable to colonies for purpose of comparing to water quality standards.

Compliance with the water quality standards is based on meeting both the geometric mean criterion and the 10% of samples (or single sample if less than ten total samples) limit. These two measures used in combination ensure that bacterial pollution in a water body will be maintained at levels that will not cause a greater risk to human health than intended. While some discretion exists for selecting sample averaging periods, compliance will be evaluated for both monthly (if five or more samples exist) and seasonal (summer-versus-winter) data sets.

The FC criteria are based on allowing no more than the pre-determined risk of illness to humans who work or recreate in a water body. The criteria used in the state standards are designed to allow seven or fewer illnesses out of every 1,000 people engaged in primary contact activities. Once the concentration of FC in the water reaches the numeric criterion, human activities that would increase the concentration above the criteria are not allowed. If the criterion is exceeded, the state requires that human activities be conducted in a manner that will bring FC concentrations back into compliance with the standard.

If natural levels of FC (from wildlife) cause criteria to be exceeded, no allowance exists for human sources to measurably increase bacterial pollution. Disease-causing pathogens can originate from a number of sources including wildlife *(Graczyk et al., 1998; Heitman et al., 2002; Kuhn et al., 2002).* While the specific level of illness rates caused by animal-versus-human sources has not been quantitatively determined, warm-blooded animals (particularly those that are managed by humans and thus exposed to human- derived pathogens as well as those of animal origin) are a common source of serious waterborne illness for humans.

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Watershed Description

Study area

The Puyallup River basin, Water Resource Inventory Area 10, drains an area of approximately 1,065 square miles, with over 728 miles of rivers and streams. The watershed contains more than a dozen cities and towns, including the state's third largest city, Tacoma. The major rivers of the basin are the Puyallup River and its two largest tributaries, the White (Stuck) and Carbon Rivers. The study area excludes the Clarks Creek and South Prairie Creek watersheds, where bacteria TMDLs have recently been done.

Large areas of the reservations for both the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe are within the TMDL study area. The Washington State Department of Ecology (Ecology) does not have jurisdiction on the Puyallup and Muckleshoot Reservations.

The Puyallup River originates from the Puyallup glacier of Mount Rainier in the Cascade Range and empties into Puget Sound at Commencement Bay in Tacoma. The lower reach of the Puyallup River is a relatively flat floodplain ranging in elevation from sea level at Commencement Bay to approximately 50 feet at the confluence of the White and Puyallup Rivers. The mouth of the Puyallup River is a salt-wedge estuary, with deeper marine water overlain by a layer of fresh water.

The White River enters the Puyallup River near the city of Puyallup and drains a 494 square-mile basin with a total length of 68 miles. The Mud Mountain Dam, at about river mile (RM) 28 on the White River, affects flow in the White River. Water is removed from the White River at about RM 24 and stored in Lake Tapps, then returned to the White River at about RM 4. Water stored in Lake Tapps was previously used for power generation but that is no longer the case. Therefore, much more water is now kept in the mainstem of the White River.

Climate

The Puyallup River basin has a temperate marine climate with warm, dry summers and cool, wet winters. The mean annual temperature is about 52°F (degrees Fahrenheit). The warmest month is July, with an average temperature of about 64°F. The coolest month is January, with an average temperature of about 39°F. Annual average rainfall in the basin ranges from 40 inches at the city of Puyallup to 70 inches at Electron Dam on the Puyallup River (RM 41). Mountain snowpack has been recorded at up to 150 inches. Eighty percent of the precipitation occurs during October through March. Snow occasionally falls in the lower watershed, but it soon melts.

Land use

The Puyallup River basin was one of the first watersheds in Puget Sound to experience the full impacts of industrial, urban, and agricultural development. The Puyallup River basin has been substantially altered from its historic condition. In particular, the lower river bears little resemblance to its historic past. Extensive urban growth, heavy industry, a large modern marine port, an extended revetment and levee system, and agriculture have combined to significantly alter the natural landscape. The area is experiencing rapid residential growth, generally into areas that were previously agricultural.

Table 6 and Figure 4 depict land use within the TMDL study area based on the zoning of each tax assessed parcel. Residential was the largest zoning category. In general:

- The upper watersheds within the study area were primarily rural residential and agricultural, with very low housing densities. This includes areas of unincorporated King and Pierce Counties and the cities of Buckley, Enumclaw, and Orting.
- Within the lower watersheds, housing densities were typically higher and mixed with more commercial and industrial properties. This includes the cities of Algona, Auburn, Bonney Lake, Edgewood, Fife, Pacific, Puyallup, Tacoma, and Sumner.

Table 6. Zoning of tax-assessed parcels in the Puyallup River watershed FC TMDL study area.

Zoning Type	Acres	Percent
Residential	38048	39%
Undeveloped Land and Water	22352	23%
Agriculture	9281	10%
Other	6216	6%
Commercial Businesses	6064	6%
Commercial Forest	4729	5%
Industry and Transportation	4172	4%
Cascadia Planned Community	3874	4%
Parks, Recreation, and Cultural Facilities	2326	2%
Total	97062	100%

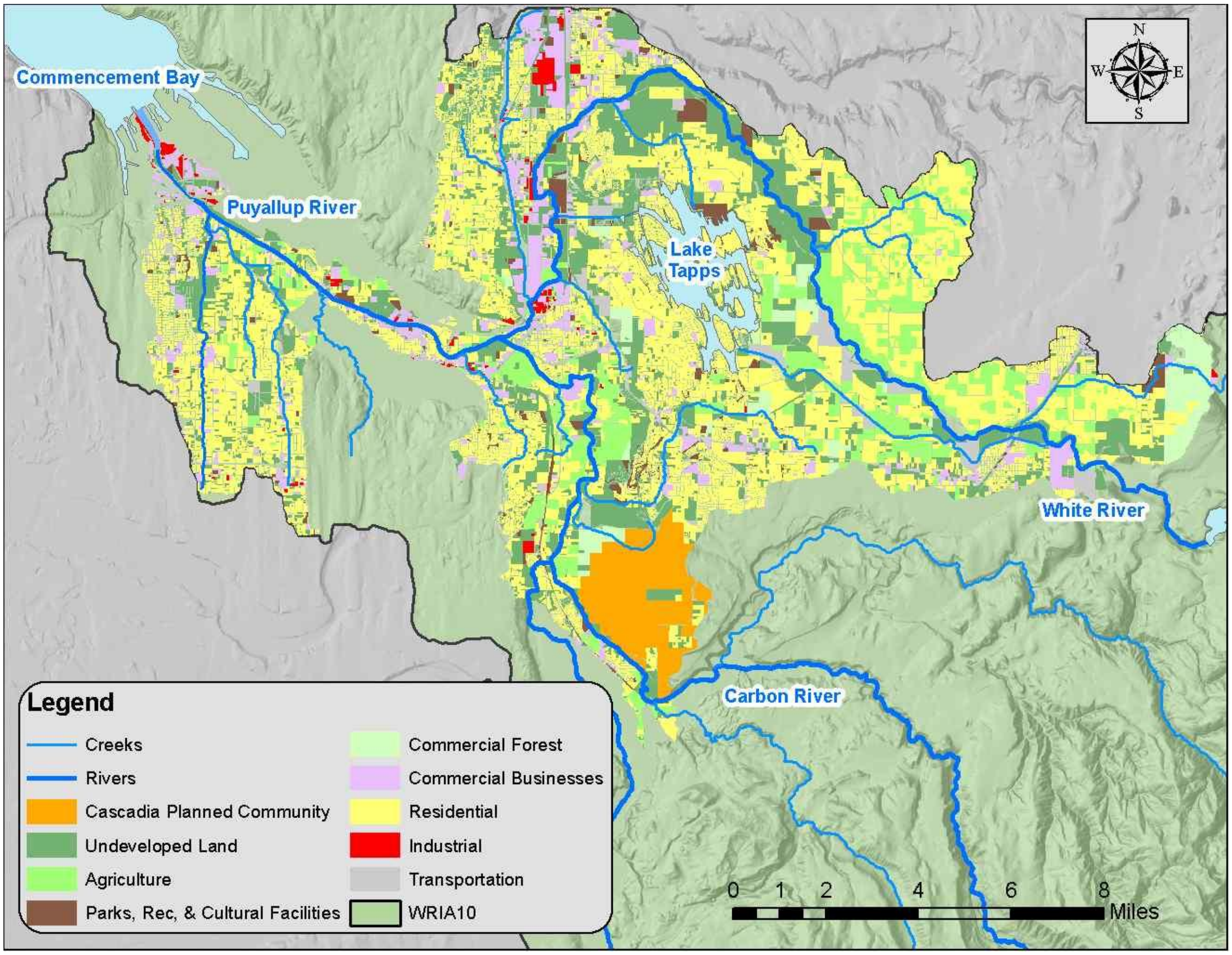

Figure 4 Tribal. Zoning within the Puyallup watershed FC TMDL study area.

Tribal jurisdiction

Large areas of the reservations for both the Puyallup Tribe of Indians and the Muckleshoot Indian Tribe are within the TMDL study area. Ecology does not have jurisdiction on the Puyallup and Muckleshoot land. Surface waters that flow into the tribal boundaries are considered waters of the state upstream of the boundary and tribal waters downstream of the boundary. The opposite applies to waters flowing out of tribal land.

The White River flows through Muckleshoot land between RM 16 and 9. The unnamed tributary to the White River (sites 10-UNW-0.1 and 10-UNW-0.2) flows through Muckleshoot land from below RM 0.2 (site 10-UNW-0.2) to its confluence with the White River.

The Puyallup River flows through the 1873 Survey Area of the Puyallup reservation from approximately RM 7.5 to RM 1.4. The Puyallup Land Claims Settlement Agreement states that the Tribe and EPA have exclusive jurisdiction for administration and implementation of environmental laws on trust lands within the 1873 Survey Area of the Puyallup Reservation. EPA granted the tribe treatment as a state, under Section 518(e) of the Clean Water Act, to carry out the water quality standards program under Section 303 of the Clean Water Act on trust lands within the Reservation, including the Puyallup River. In October 1994, EPA approved the tribe's water quality standards, which apply to the mainstem Puyallup River channel (below the mean high water mark) within reservation boundaries.

Multiple sites monitored during the TMDL were located on tribal land. Ecology monitored these locations to help assess the extent of FC contamination in the watershed. These sites, which are not subject to the TMDL, are:

- 10-UNW-0.1
- 10-PUY-5.7
- 10-PUY-3.0
- 10-PY-WWTP (see *Wasteload Allocations* section)

See Tables 10 and 11 for site descriptions and coordinates.

Potential sources of bacteria

Point sources/ permit holders

Fecal coliform bacteria can be present in a wide variety of municipal and industrial wastewater and stormwater sources. No method is 100% effective at removing FC all of the time, so FC bacteria can enter the receiving waters from these sources. Fecal coliform bacteria and other potential contaminants from industrial and municipal sources are regulated by various National Pollutant Discharge Elimination System (NPDES) and general permits from Ecology (Figure 7).

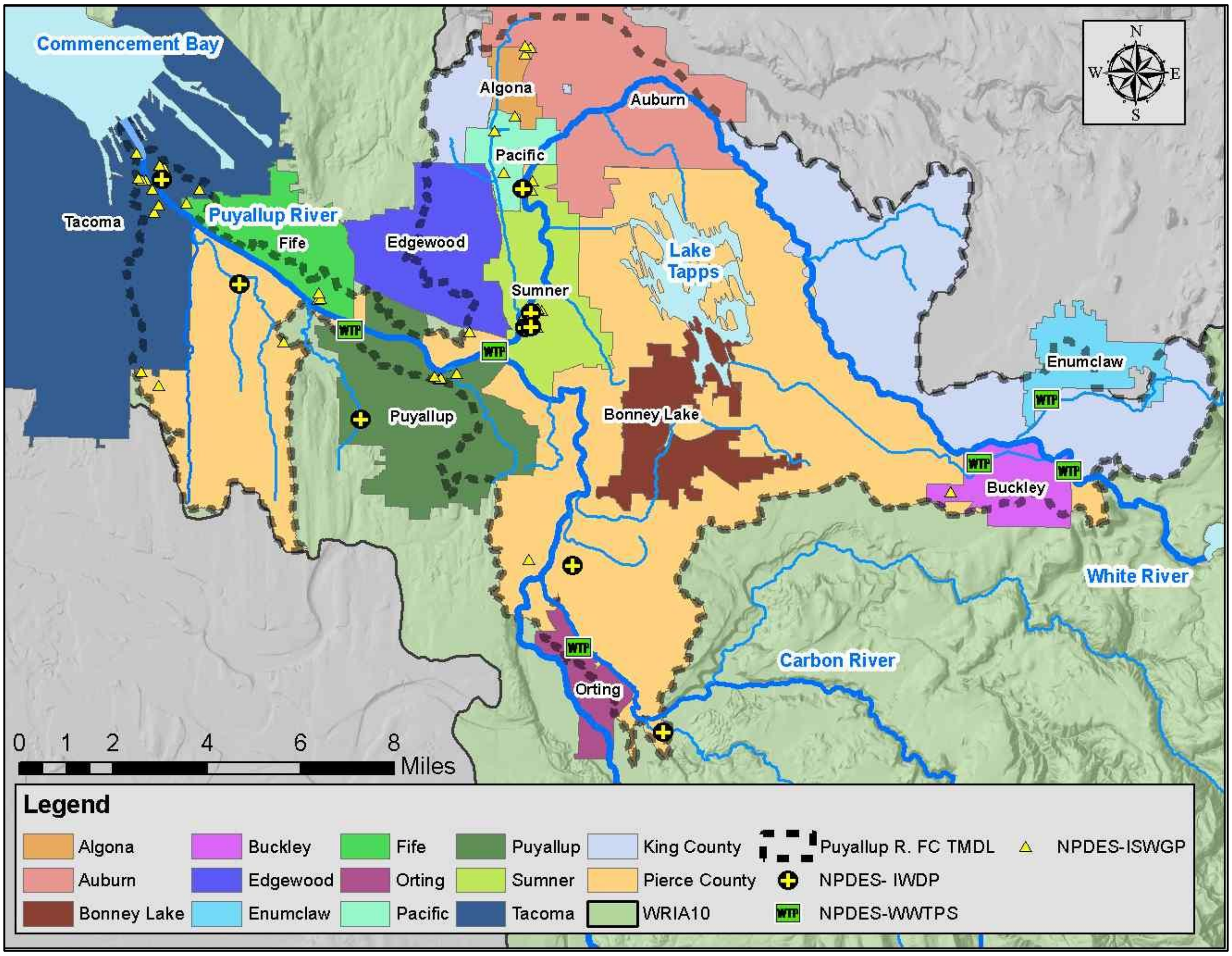

Figure 5. Jurisdictions and facilities within the Puyallup River watershed FC TMDL study area regulated by NPDES or Washington State permits.

NPDES = National Pollutant Discharge Elimination System.
IWDP = Individual Wastewater Discharge Permit.
ISWGP = Industrial Stormwater General Permit.

Wastewater

The Puyallup River watershed within the TMDL study area serves as receiving water for six municipal wastewater treatment plants (WWTPs) (Table 7). This list excludes point sources that may be in the Clarks Creek or South Prairie Creek watersheds, which have been addressed in other TMDLs.

Table 7. WWTPs in the Puyallup watershed FC TMDL study area.

Wastewater Treatment Plant	Treatment	Receiving Water	Sample Frequency	Monthly Geomean Limit	Weekly Geomean Limit
City of Puyallup	UV	Puyallup R.	3/week	<100cfu/100mL[1]	n/a
Town of Orting	UV	Carbon R.	2/week	<200cfu/100mL	<400cfu/100mL
City of Enumclaw	UV	White R.	3/week	<100cfu/100mL	<200cfu/100mL
City of Sumner	UV		3/week	<100cfu/100mL	<200cfu/100mL
City of Buckley	UV		2/week	<100cfu/100mL	<200cfu/100mL
Rainier School	Chlorination		1/week	<200cfu/100mL	<400cfu/100mL

[1] Not more than 10% of the samples used to calculate should exceed 200 cfu/100 mL.
UV= ultra violet.

Industrial facilities that discharge wastewater are also given individual NPDES permits. Table 8 lists NPDES individual wastewater discharge permits (IWDP) within the study area (Figure 7). IWDPs require that the discharge meet surface water quality standards. Effluent limitations may be set based on an individual wasteload allocation or on a wasteload allocation developed during the TMDL process. Due to limited resources, these facilities were not sampled during the TMDL. Discussion of wasteload allocations and FC monitoring at these facilities is provided in the *TMDL Analyses* section of this report.

Table 8. NPDES individual wastewater discharge permits in the Puyallup watershed FC TMDL study area.

Facility	NPDES Permit #	Receiving Water body
Fleischman's Vinegar Co. Inc.	WA0038598D	White River (outfall 2: non-contact cooling water)
Manke Lumber Co. Inc.	WA0040339B	White River
McFarland Cascade Pole and Lumber Co.	WA0037953D	Puyallup River (outfall 2)
Puyallup Hatchery	WA0039748A	Clarks Creek (outfall 1 and 2)
Sonoco Products	WA0000884D	White River
Trout Lodge Trout Springs Canyon Falls Hatchery	WA0039268A	Canyon Falls Creek
Trout Lodge Troutco Clear Creek Hatchery	WA0039021A	Clear Creek
Voights Creek Hatchery	WA0039730A	Voights Creek
Western Wood Preserving	WA0040738C	White River (outfall 1 and 2 via City of Sumner storm sewer)

Stormwater

During precipitation events, rainwater washes the surface of the landscape, pavement, rooftops, and other impervious surfaces. This stormwater runoff can accumulate and transport fecal matter via stormwater drains to receiving waters and potentially degrade water quality (Lubliner, 2005).

The TMDL study did not directly evaluate stormwater contributions from any of the permitted stormwater collection systems in the study area. However, the study did find that stormwater was impacting surface water FC concentrations. General wasteload allocations for stormwater permittees are outlined in the TMDL analyses section of this report.

Ecology recently issued a new general NPDES permit for industrial stormwater, effective from January 2010 to January 2015. The permit requires that any stormwater discharged by a facility not cause or contribute to a violation of water quality standards in the receiving water. Within the TMDL study area, 44 facilities are covered under the general industrial stormwater permit (Appendix D). Some of these facilities are located within the study area, but may discharge stormwater outside of the study area.

The NPDES stormwater regulations establish stormwater permits for municipal entities that own or operate municipal separate storm sewer systems (MS4s). The NPDES Phase I municipal stormwater permit regulates discharges from MS4s owned or operated by Clark, King, Pierce, and Snohomish Counties, and the cities of Seattle and Tacoma. Phase I permittees in the Puyallup watershed TMDL include: Pierce County, King County, city of Tacoma, Metro Parks Tacoma, and Port of Tacoma. The Washington State Department of Transportation (WSDOT) is also a Phase I permittee, although their requirements are distinct from the others and outlined in a separate permit.

Ecology's Phase II Municipal Stormwater Permit for Western Washington covers the following cities within the Puyallup Watershed FC TMDL study area: Algona, Auburn, Bonney Lake, Buckley, Edgewood, Enumclaw, Fife, Orting, Pacific, Puyallup, and Sumner.

WSDOT was issued a separate Municipal Stormwater permit in February 2009. This stormwater permit regulates stormwater discharges from state highways and related facilities contributing to discharges from separate storm sewers owned of operated by WSDOT within the Phase I and II designated boundaries.

WSDOT's permit also covers stormwater discharges to any water body in Washington State for which there is a U.S. Environmental Protection Agency (EPA) approved TMDL with load allocations and associated implementation documents specifying actions for WSDOT stormwater discharges (applicable TMDLs listed in Appendix 3 of the WSDOT permit). Under the new permit, WSDOT is also required to reduce the discharge of pollutants to the maximum extent practicable (MDP) using all known, available, and reasonable methods of prevention, control, and treatment (AKART) to prevent and control pollution of waters of the state. (Ecology, 2009).

During the permit development process, WSDOT agreed to update their Highway Runoff Manual (HRM) to equivalency with Ecology's Stormwater Manuals. This was completed in 2008. They also agreed to implement their HRM statewide. The application of the HRM statewide was formalized with an implementing agreement signed by both agencies directors.

The HRM manual provides project engineers and designers with technically sound stormwater management practices, equivalent to guidance provided in Ecology's stormwater management manuals, to achieve compliance with federal and state water quality regulation. It is based on best available science and results from existing federal and state laws that require stormwater management systems to be properly designed, constructed, maintained, and operated to:

- Prevent pollution of state waters and protect water quality, including compliance with *state water quality standards*.
- Satisfy state requirements for all known available and reasonable methods of prevention, control, and treatment of wastes prior to discharge to waters of the State.
- Satisfy the federal technology-based treatment requirements under 40 CFR Part 125.3.

The guidelines and criteria in the HRM also support WSDOT in its efforts to comply with the requirements of the federal Endangered Species Act (ESA).

Nonpoint sources

Nonpoint sources and practices are dispersed and not readily controlled by discharge permits. Several types of nonpoint sources may be present in the study area, including:

- Range and pastured livestock with direct access to the stream.
- Poor livestock or pet manure management on non-commercial farms.
- Pet manure from residential areas.
- Poorly constructed or maintained on-site septic systems.
- Pulp and wood waste.

Fecal coliform bacteria from nonpoint sources are transported to the creeks by direct and indirect means. Manure that is spread over fields during certain times of the year can enter streams via surface runoff or fluctuating water levels. Often livestock have direct access to water. Manure is deposited in the riparian area of the access points where fluctuating water levels, surface runoff, or constant trampling can bring the manure into the water. Some residences may have wastewater piped directly to waterways or may have malfunctioning on-site septic systems where effluent seeps to nearby waterways. Swales, sub-surface drains, and flooding through pastures and nearby homes can carry FC bacteria from sources to waterways.

Wildlife and background sources

A wide variety of perching birds, upland game birds, raptors, and waterfowl are found within the Puyallup watershed. Birds, elk, deer, beaver, muskrat, and other wildlife in rural areas are potential sources of FC bacteria. Open fields are attractive feeding grounds for some birds whose presence can increase FC counts in water runoff.

Usually these sources are dispersed and do not elevate FC counts over state criteria, but sometimes animals are locally concentrated and can cause elevated counts. Any concentrated bird or wildlife presence in the watershed will be noted during sampling surveys.

Goals and Objectives

Project goals

The goal of the Puyallup River watershed bacteria TMDL is to reduce FC concentrations to meet the criteria in the Washington State water quality standards, protect human and ecological health, and comply with the Federal Clean Water Act.

Study objectives

The study objectives are to:

- Determine FC bacteria concentrations and loads from tributaries, point sources, and drainages in the Puyallup River study area under various seasonal and hydrological conditions, including storms.
- Recommend FC load allocations (for nonpoint sources) and wasteload allocations (for point sources) to protect beneficial uses, including *Primary and Secondary Contact Recreation*.
- Identify the sources and relative contributions of FC loadings to the Puyallup River so clean-up activities can focus on the largest sources.

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Field Data Collection

Ecology completed the Quality Assurance (QA) Project Plan for the *Puyallup River Watershed Fecal Coliform Bacteria Total Maximum Daily Load Study* (Sullivan, 2006) to provide background information and a detailed data collection and analysis plan. The QA Project Plan was reviewed and approved for sampling prior to the first sample collection on October 9-11, 2006. Sampling continued through September 2007. Table 9 lists the 23 sampling dates; approximately bi-monthly, partitioned into either a dry season or wet season group based on streamflows (see below).

Sample dates

Table 9. Sampling dates for the Puyallup River watershed FC TMDL.

Dry Season	Wet Season
Oct. 9-11, 2006	November 14 – 15, 2006
Oct. 23-25, 2006	December 4-5, 2006
July 10-11, 2007	December 18, 2006
July 24-25, 2007	January 8-9, 2007
August 7-8, 2007	January 22-23, 2007
August 21-22, 2007	February 6-7, 2007
Sept. 4-5, 2007	February 20-21, 2007
Sept. 18-19, 2007	March 6-7, 2007
	March 20-21, 2007
	April 3-4, 2007
	April 17-18, 2007
	May 7-8, 2007
	May 21-22, 2007
	June 5-6, 2007
	June 19-20, 2007

Seasonal source assessment

Bacteria source assessment (or screening) was analyzed for either a wet (runoff) or dry (non-runoff) season. The determination of wet and dry seasons, for the study period, was made by observing the monthly average flow for the Puyallup and White Rivers and totals of precipitation within the study area (Figure 6). The dry period was determined to begin in July and continue through October. The wet season extended from November to June when larger amounts of precipitation resulted in more runoff events. Although precipitation amounts dropped off in April, flows remained steady in the White River and increase in the Puyallup River into June due to snowmelt from the higher elevations in the basin.

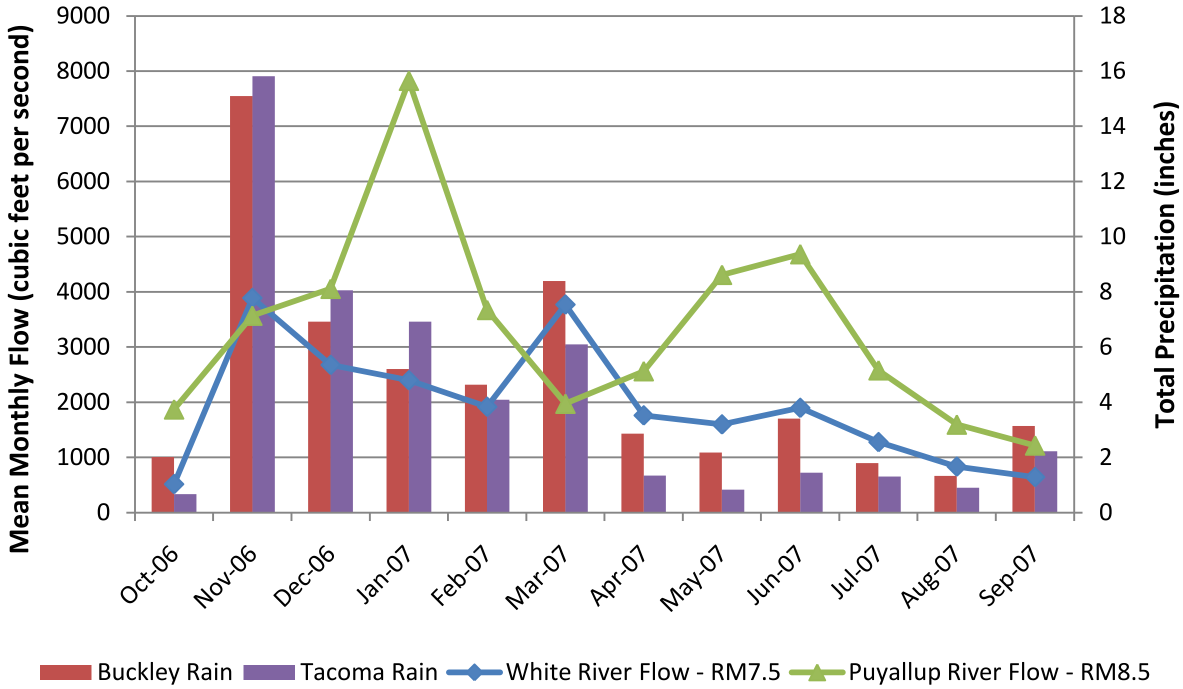

Figure 6. Seasonal flow and precipitation patterns during the 2006-07 TMDL study.

The same seasonal periods were used for tributaries to the White River as for the mainstem White and Puyallup Rivers, based on streamflows and bacteria concentrations. Tributaries to the Puyallup River typically dropped to baseflow earlier in the year, and at several sites a trend in higher bacteria concentrations was observed at this point. For these reasons, the dry season for the Puyallup River tributaries was set as May to October, and the wet season was set as November to April.

Stormwater

The White River mainstem (below 10-WHT-23.8), Boise Creek, Salmon Creek, Milwaukee Ditch, and Jovita Creek exhibited moderate to strong correlations between increases in both precipitation and FC concentrations. Ecology did not conduct any targeted storm sampling events, but rather identified storm events within the routine sampling events. A stormwater analysis concluded that:

- Four storm events were sampled during the wet season and one during the dry season.
- Storm event thresholds were identified as:
  - Wet Season: greater than 0.4 inches of rain in the preceding 24 hours.
  - Dry Season: greater than 0.2 inches of rain in the preceding 12 hours.
- The threshold for Boise Creek was greater than 0.1 inches of rain in the preceding 12 hours for both the wet and dry season.
- The mouth of Boise Creek showed a very strong correlation to the preceding 12 hour rainfall.

The Puyallup River and its tributaries showed little or weak relationships between rainfall and FC counts.

Sample locations

Ecology collected FC bacteria samples and streamflow measurements from 55 sites in the watershed. Figure 7 shows all sampling locations. Table 10 and Table 11 list the corresponding sampling location identification, description, and latitude/longitude of the sampling sites.

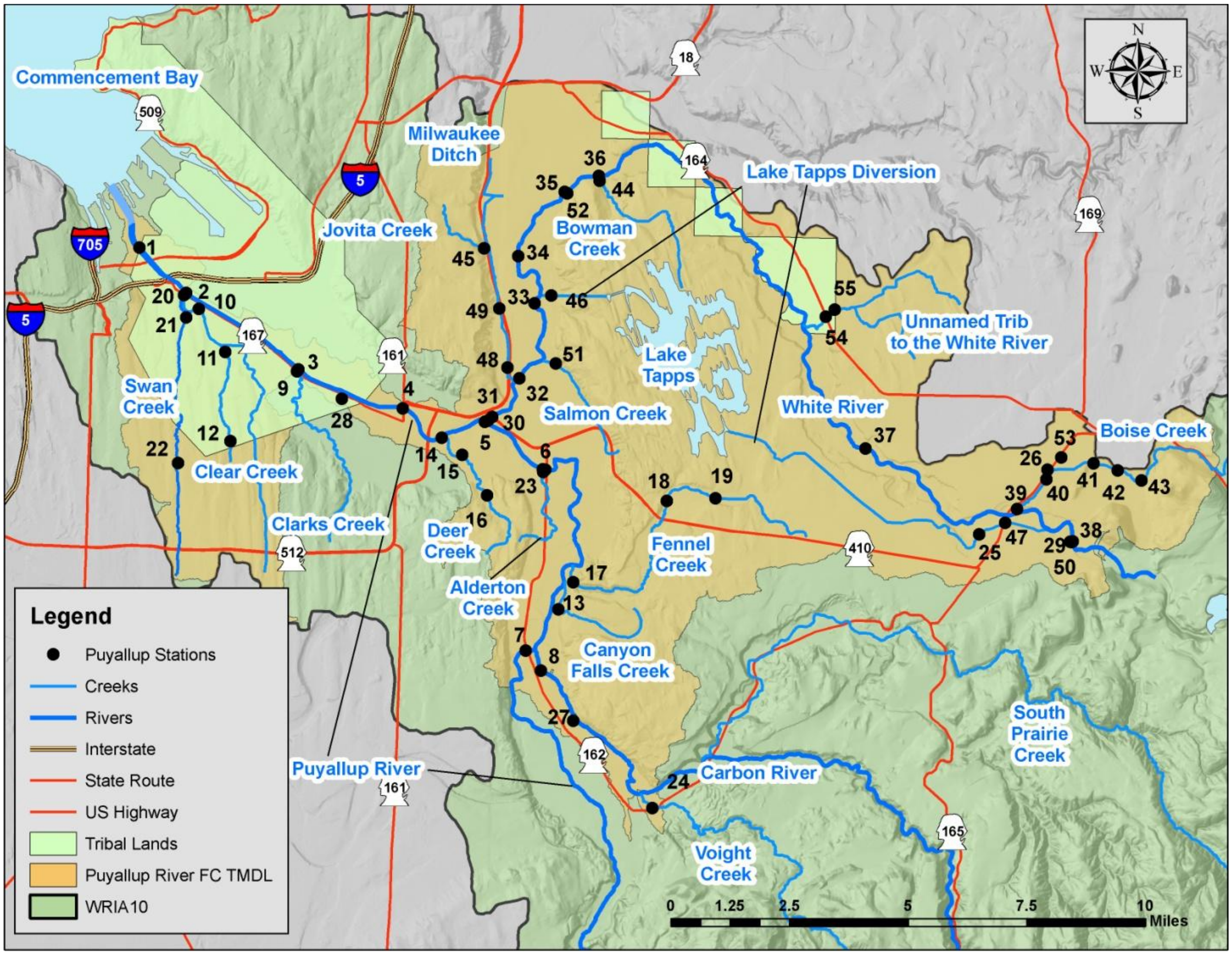

Figure 7. Map of Puyallup River watershed FC TMDL sampling stations.

Table 10. Station IDs, location descriptions, and coordinates for the Puyallup River, tributaries, and WWTPs in the TMDL study area.

No.	Station ID	Description	Latitude °N	Longitude °W
Puyallup River Mainstem				
1	10-PUY-1.4	Puyallup River at Lincoln Avenue Bridge	47.24984	122.41355
2	10-PUY-3.0	Puyallup River upstream of Swan Creek	47.23633	122.39207
3	10-PUY-5.7	Puyallup River upstream of Clarks Creek	47.21385	122.34108
4	10-PUY-8.5	Puyallup River at Meridian St	47.20277	122.29396
5	10-PUY-10.3	Puyallup River upstream of the White River	47.19921	122.25723
6	10-PUY-12.0	Puyallup River at Highway 162 near Sumner	47.18503	122.22973
7	10-PUY-17.7	Puyallup River upstream of the Carbon River	47.12972	122.23668
Puyallup River Tributaries				
8	10-CAR-0.2	Carbon River near mouth	47.12376	122.22972
9	10-CLK-0.01	Clark Creek at mouth	47.21326	122.34173
10	10-CLR-0.4	Clear Creek at mouth	47.23158	122.38623
11	10-CLR-1.7	Clear Creek at Pioneer Way	47.21870	122.37400
12	10-CLR-3.6	Clear Creek at 72nd	47.19153	122.37079
13	10-CNF-0.2	Canyon Falls Creek near mouth	47.14251	122.22253
14	10-DEE-0.1	Deer Creek near mouth	47.19397	122.27627
15	10-DEE-1.0	Deer Creek at end of Inter Avenue	47.18898	122.26669
16	10-DEE-2.0	Deer Creek off Shaw Road near 15th Street	47.17676	122.25559
17	10-FNL-0.4	Fennel Creek near mouth	47.15093	122.21619
18	10-FNL-4.1	Fennel Creek at Sumner-Buckley Hwy	47.17627	122.17509
19	10-FNL-5.8	Fennel Creek upstream of Bonney Lake	47.17739	122.15333
20	10-SWN-0.01	Swan Creek at mouth	47.23567	122.39310
21	10-SWN-0.6	Swan Creek at Pioneer Way	47.22884	122.39178
22	10-SWN-3.9	Swan Creek at 80th	47.18444	122.39387
23	10-UNO-0.3	Alderton Creek at 80th St	47.18436	122.23065
24	10-VOI-0.4	Voight Creek downstream of hatchery	47.08266	122.17869
Wastewater Treatment Plants				
25	10-BK-WWTP	City of Buckley WWTP	47.16807	122.03517
26	10-EC-WWTP	City of Enumclaw WWTP	47.18811	122.00521
27	10-OT-WWTP	Town of Orting WWTP	47.10865	122.21477
28	10-PY-WWTP	City of Puyallup WWTP	47.20524	122.32130
29	10-RS-WWTP	Rainer School WWTP	47.16634	121.99449
30	10-SM-WWTP	City of Sumner WWTP	47.19955	122.25583

Table 11. Station IDs, location descriptions, and coordinates for the White River and tributaries.

No.	Station ID	Description	Latitude °N	Longitude °W
White River Mainstem				
31	10-WHT-0.1	White River at mouth	47.20073	122.25393
32	10-WHT-1.4	White River at 142nd	47.21266	122.24222
33	10-WHT-3.3	White River at 24th St E	47.23560	122.23618
34	10-WHT-4.8	White River at 8th St E	47.24987	122.24383
35	10-WHT-6.2	White River upstream of Auburn Riverside HS	47.26976	122.22379
36	10-WHT-7.5	White River at R Street	47.27482	122.20858
37	10-WHT-18.9	White River downstream of Buckley	47.19357	122.08669
38	10-WHT-23.8	White River upstream of Buckley	47.16644	121.99330
White River Tributaries & Diversions				
39	10-BOI-0.1	Boise Creek at mouth	47.17605	122.01860
40	10-BOI-1.0	Boise Creek at 252nd	47.18525	122.00570
41	10-BOI-1.7	Boise Creek at 268th	47.19034	121.98436
42	10-BOI-2.2	Boise Creek at 276th	47.18828	121.97394
43	10-BOI-3.2	Boise Creek at 284th	47.18545	121.96314
44	10-BOW-0.3	Bowman Creek at Kersey Way	47.27345	122.20822
45	10-JOV-0.4	Jovita Creek at W. Valley Hwy E	47.25205	122.25917
46	10-LTD-0.4	Lake Tapps diversion near White River	47.23815	122.22876
47	10-LTD-23.7	Lake Tapps diversion near Buckley	47.17173	122.02372
48	10-MIL-0.4	Milwaukee Ditch Ck behind warehouse off W.	47.21582	122.24763
49	10-MIL-2.2	Milwaukee Ditch near Hwy 167	47.23376	122.25177
50	10-RSSW-0.01	Stormwater drainage at Rainer School WWTP	47.16619	121.99389
51	10-SAL-0.2	Salmon Creek at East Valley Hwy	47.21749	122.22614
52	10-TAS-0.01	Trib to White River at Auburn Riverside HS	47.26929	122.22250
53	10-UNK-BOI	Unknown trib to Boise Ck at trail & 456th St	47.19184	121.99920
54	10-UNW-0.1	Unknown trib to White River at Hwy 164	47.23345	122.10554
55	10-UNW-0.2	Unknown trib to White River at 180th	47.23562	122.10182

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Study Methods

Field collection methods

The project team followed the field collection study methods described in the QA Project Plan for the *Puyallup River Watershed Fecal Coliform Bacteria TMDL Study* (Sullivan, 2006). Methods followed include:

- Field Sampling and Measurement Protocols for the Watershed Assessments Section (Ecology, 1993).
- Determination of Instantaneous Flow Measurements of Rivers and Streams (Ecology, 2000).
- Methods for the Examination of Water and Wastewater 20th Edition (APHA, 1998).

Analytical methods

Statistical Rollback Method

Although TMDL studies normally express allocations as pollutant loads (pollutant concentration multiplied by streamflow), this approach does not always work well for bacteria TMDL studies. An allocation of FC bacteria pollutant loads in terms of "numbers of bacteria per day" is awkward and challenging to understand. Instead of managing FC pollution in terms of total load, Ecology has used the Statistical Rollback Method (Ott, 1995) to manage the distribution of FC bacteria counts. The approach relates the analysis to the water quality concentration standard better and has proven successful in past FC TMDL assessments (Cusimano, 1997; Joy, 2000; Sargeant, 2002).

The Statistical Roll-Back Method was used to establish FC reduction targets at all sampling sites that had sufficient sampling size (>5 samplings). The roll-back method assumes that the distribution of the data follows a normal or log-normal distribution. FC concentrations from each site are tested for lognormality prior to use of the roll-back method. The cumulative probability plot of the observed FC data gives an estimate of the geometric mean and 90th percentile, which can then be compared to the FC concentration standards. The roll-back procedure is described in detail in Appendix G.

It is important to remember that the FC bacteria TMDL targets are only in place to assist water quality managers in assessing the progress toward compliance with the FC water quality criteria. Compliance is measured as meeting water quality criteria. Any water body with FC TMDL targets is expected to meet both the applicable geometric mean and 'not more than 10% of samples' criteria and also to meet beneficial uses for the category.

Simple loading analysis

Simple load analyses were performed using a spreadsheet to compare measured loading sources relative to each other and, in some cases, evaluate the mass balance of FC bacteria for a reach.

Loads were not used to determine the amount of FC bacteria reduction needed at sites; only the measured concentration data was used to calculate the target percent reductions needed. Loading patterns will help in directing implementation to the highest loading sources. Cleaning up high loading sources will benefit downstream stations where the upstream loads are contributing to exceedances of water quality standards.

Load duration curves

Loading capacities for sites with continuous streamflow data were initially developed using the load duration curve developed by EPA (EPA, 2007). Load duration curves are helpful for identifying and addressing sources that occur within a particular range of flow conditions.

Data analysis revealed that sites within the TMDL study area were more influenced by seasonal sources and stormwater than by streamflow conditions. For this reason, load allocations were not developed based on the load duration curves. The curves are useful for general loading information and illustrating how FC loads from storm events impact the concentration-based statistics. Load duration curves developed for the project are included in Appendix F.

Statistical tests for significant changes between stations

Wilcoxon signed rank test

The Wilcoxon signed rank test is a non-parametric statistical test used to determine whether or not the median difference between paired observations is equal to zero. The Wilcoxon signed rank test was used to determine if a significant change in streamflow or FC concentrations occurred between two stations.

Study Quality Assurance Evaluation

Ecology reviewed all data collected for the TMDL to determine if the data met quality objectives from the QA Project Plan (Sullivan, 2006). Overall, the data met the quality objectives and are of acceptable quality for TMDL analysis.

Some fecal coliform results were qualified due to analysis occurring beyond a 24 hour holding time. All analyses were done within 30 hours of sample collection. An Ecology holding time study has shown that FC samples analyzed by MEL within 30 hours were comparable to samples analyzed within 6-8 hours (Mathieu, 2005). After a data quality review, the qualified results were used in the calculated statistics.

Representativeness and completeness

The goal of the project was to collect and analyze 100% of the samples outlined in the study design of the QA Project Plan. Of the over 1,000 samples collected for the project, only one was not analyzed; this was due to a damaged bottle that leaked in transit. Some samples were not collected due to weather/streamflow conditions, including flooding during the wet season and stagnant or no flow during the dry season.

Seasonal geometric means and 90th percentiles were calculated only for sites with a minimum of five samples collected per averaging period. Annual statistics were calculated for sites that had less than five sites per season, but greater than 5 sites total.

Comparability

Ecology's Freshwater Monitoring Unit (FMU) collects monthly measurements and samples, including fecal coliform, from the Puyallup River at Meridian Street. Monthly FC data is available from the station, known as 10A070, from 1978 to the present (Ecology, 2009c). This site was referred to as 10-PUY-8.5 for this TMDL and was sampled twice a month, although rarely on the same day as the FMU sampling.

Figure 8 compares FC statistics for each data set during the course of the TMDL. The data sets proved to have very similar distributions, demonstrating the comparability of the two data sets within the TMDL study period.

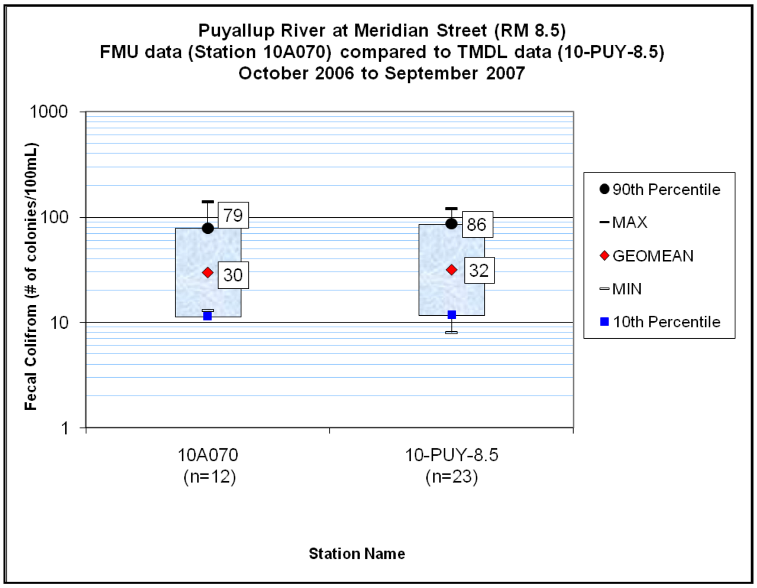

Figure 8. Box plot comparison of FC concentrations for the Puyallup River at RM 8.5 between Ecology's FMU ambient monitoring data and data collected for the TMDL.

Precision

Analytical precision

Duplicate laboratory analysis refers to analyzing duplicate aliquots from a single sample container. Each sample is carried through all of the steps of sample preparation and analysis. The results for laboratory duplicates provide an estimate of analytical precision, including the homogeneity of the sample matrix (MEL, 2008).

Ecology's Manchester Environmental Laboratory (MEL) evaluated analytical precision by duplicating the analysis of about 10% of the samples. MEL compared the relative percent difference (RPD) of each duplicate pair to their acceptance criteria of less than 40% RPD. The RPD is the difference between the two sample values, divided by their mean, and then multiplied by 100. Samples above 40% RPD were qualified as estimates.

Total precision

Field replicate samples are two samples collected from the same location at the same time. Collecting field replicates is a method of looking at the precision of the entire process of sampling and analysis (MEL, 2008).

The QA Project Plan set the measurement quality objective (MQO) for fecal coliform precision as a median relative standard deviation (RSD) of less than or equal to 30%. The new recommended MQOs for bacteria require that the median RSD of the replicate pairs is less than or equal to 20% and that at least 90% of the replicate pairs have a RSD of 50% or less. RSD, or the coefficient of variation, is the standard deviation of two values, divided by their mean. The value is then multiplied by 100 and expressed as percent RSD. Replicate pairs with a mean of 20 cfu/100mL or less are excluded from the analysis (Mathieu, 2006).

Field replicates collected for the project met both the original and new precision criteria, with a median RSD of 16.0% and 90.0% of the replicate pairs less than 49.9% RSD (Table 12). Lab duplicates were not required to meet the precision criteria, but were compared to field precision MQOs for reference. As expected, the field replicate %RSD values were much higher than those for the lab duplicates because the field replicates measure total variability, which includes analytical variability.

Table 12. MQO results for field replicates and laboratory duplicates.

Field Replicates				Laboratory Duplicates	
MQO	%RSD	Criterion	Pass?	MQO	%RSD
50% of replicate pairs <= to	16.0	<30%RSD	Yes	50% of replicate pairs <= to	7.2
50% of replicate pairs <= to*	16.0	<20%RSD	Yes	90% of replicate pairs <= to	25.7
90% of replicate pairs <= to*	49.9	<50%RSD	Yes		

***** New MQO for precision in fecal coliform replicates.

Replicate FC samples were collected in the field in a side-by-side manner. Ecology collected replicates for 19.8% of the samples, which met the project's replicate frequency goal of 20.0%.

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Results and Discussion

Ecology loaded all project data into its online Environmental Information Management (EIM) database. EIM also contains information about the study and sampling stations (including links to an online interactive map).

To access the data:

- Go to: www.ecy.wa.gov/eim/
- Click 'Search for data' link
- Click 'Search by user study ID' link
- Enter 'LSUL0001' into the 'User Study ID' field
- Click 'Results' link to view results online or 'Download' link to download a spreadsheet.

Mainstem of the White River

Table 13 contains geometric mean and 90th percentile statistics for the entire 2006-07 study period, as well as for both the wet and dry season. Figure 11 depicts box plots of FC concentrations for the White River mainstem.

Table 13. FC concentrations for the White River mainstem.

	Annual			Wet Season			Dry Season		
Station ID	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-WHT-0.1	23	35	173	15	25	121	8	68	248
10-WHT-1.4	23	34	219	15	25	186	8	58	251
10-WHT-3.3	23	19	129	15	13	94	8	41	159
10-WHT-4.8	23	22	127	15	14	82	8	49	178
10-WHT-6.2	21	19	145	14	14	115	7	38	188
10-WHT-7.5	22	20	146	15	14	111	7	43	190
10-WHT-18.9	21	16	129	13	11	104	8	30	151
10-WHT-23.8	21	6	32	14	4	17	7	16	55

Highlighted cells indicate an exceedance of water quality criteria.

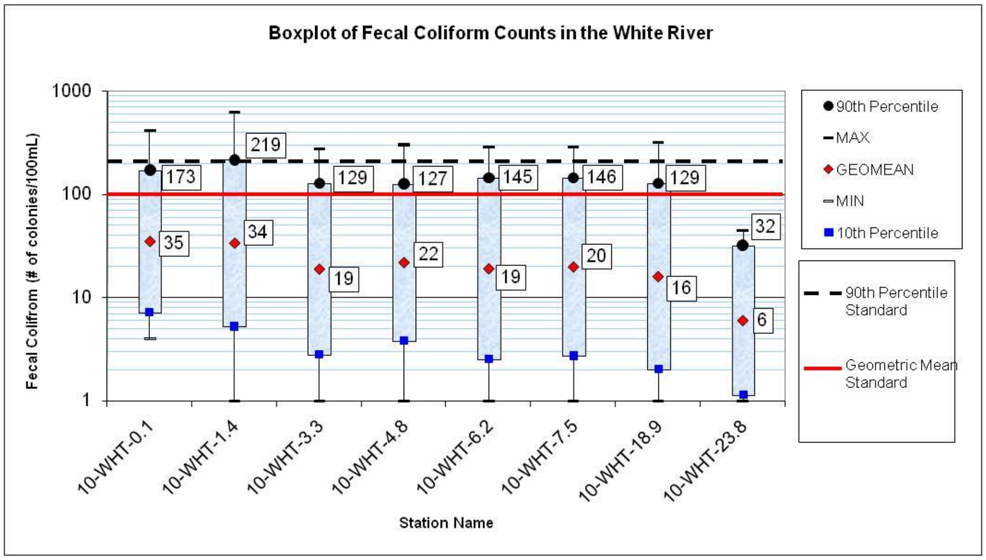

Figure 9. Boxplot depicting distribution of annual FC concentrations on the White River mainstem.

Statistical trend analysis

Wilcoxon signed rank tests for statistical significance were performed between each site and the corresponding downstream site. In summary:

- Annual and wet season FC concentrations significantly increased between RM 23.8 and RM 18.9.
- Concentrations remained relatively constant (no significant increase or decrease) from RM 18.9 to 3.3.
- FC concentrations significantly increased during the dry season from RM 3.3 to 1.4.

Upper White River (RM 23.8 to 18.9)

The upper White River watershed (Figure 12) drains the city of Buckley and portions of Enumclaw, as well as areas of rural King and Pierce Counties. The White River flows into this stretch from the Mud Mountain Reservoir approximately five miles upstream of the Buckley city limits. A portion of the river is diverted about one mile downstream of station 10-WHT-23.8 to Lake Tapps via a canal.

Results and discussion

Table 14 contains geometric mean and 90th percentile statistics for the entire 2006-07 study period, storm events, and for both the wet and dry season. The White River downstream of Buckley (10-WHT-18.9) and the mouth of Boise Creek (10-BOI-0.1) exhibited a relationship between rainfall and FC concentrations. Routine sample events that exceeded storm event criteria were excluded from the wet and dry season statistics below (Table 14) at these two sites. The storm event FC values were analyzed separately to highlight the impact of stormwater on FC concentrations at these sites.

Table 14. FC concentrations for the upper White River watershed.

Station ID	Annual			Storm Events			Wet Season			Dry Season		
	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-WHT-18.9*	**21**	**16**	**129**	**5**	**86**	**266**	**9**	**5**	**21**	**6**	**19**	**86**
10-BK-WWTP	22	7	94				14	9	193	8	8	68
10-EC-WWTP	23	25	207				15	29	396	8	21	112
10-BOI-0.1*	23	128	1129	5	927	3339	11	31	71	7	293	1331
10-LTD-23.7	22	12	92				14	11	108	8	15	67
10-RSSW-0.01	22	24	1007				14	32	1475	8	15	608
10-RS-WWTP	22	24	1544				14	292	7828	8	3	43
10-WHT-23.8	**21**	**6**	**32**				**14**	**4**	**17**	**7**	**16**	**55**

*Storm events excluded in wet and dry season averages.
Highlighted cells indicate an exceedance of water quality criteria.
Mainstem stations are identified by bold text.

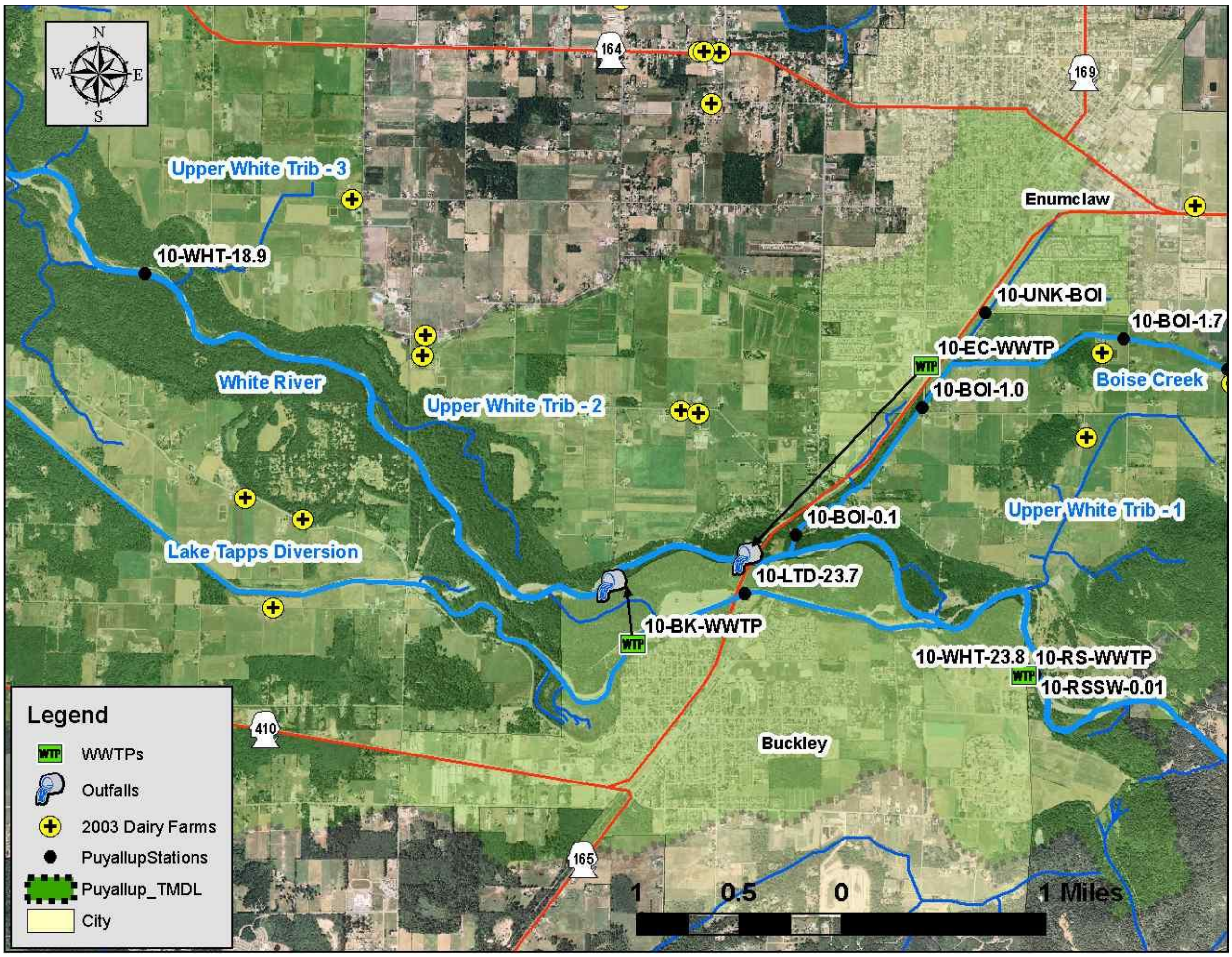

Figure 10. Map of the upper White River watershed.

Several measured point sources and tributaries enter the White River between RM 23.8 and 18.9 that may contribute to the significant increase in FC concentrations in this stretch. These include:

- Rainier School WWTP effluent (RS-WWTP) and stormwater outfall (RSSW-0.01).
- Buckley WWTP effluent (BK-WWTP).
- Boise Creek (BOI-0.1).
- Enumclaw WWTP effluent (EC-WWTP).

Three mapped water bodies within this stretch were not measured during the study. In Figure 12 they are labeled as:

- Upper White Trib -1:
    - Drains rural residential, agricultural (with one commercial dairy), and undeveloped forest south of Enumclaw and the Boise Creek watershed.
    - Discharges to the White River just upstream of the Lake Tapps diversion.
- Upper White Trib -2:
    - Drains a small area of primarily undeveloped forest.
    - Discharges to the White River approximately halfway between the Buckley WWTP outfall and 10-WHT-18.9.
- Upper White Trib -3:
    - Drains rural residential, agricultural (with one commercial dairy), and undeveloped riparian forest west of Enumclaw.
    - Discharges to the White River just upstream of 10-WHT-18.9.

Boise Creek exhibited high bacteria concentrations intermittently in the wet season and consistently in the dry season. The Boise Creek watershed section of this report contains upstream monitoring results and discussion.

Enumclaw WWTP

Ecology measured counts above 200 cfu/100 mL at the Enumclaw WWTP on two occasions:

- 1000 cfu/100 mL on 2/20/07.
- 800 cfu/100 mL on 3/20/07.

On both occasions, there had been greater than 0.75 inches of rain in the preceding 24 hours, and the effluent flows were greater than 3 million gallons per day (mgd). After sampling was completed, the facility received several upgrades and increased its capacity.

Rainier School WWTP

Samples collected from both the Rainier School WWTP effluent and from station RSSW-0.01 displayed intermittent high FC concentrations. RSSW-0.01 was located near its confluence with the White River and consisted of drainage water from the Rainier School grounds combined with effluent from the WWTP.

Ecology measured counts of over 1000 cfu/100 mL on six occasions at RS-WWTP. There were also some discrepancies where the WWTP reported low FC counts on samples collected within one day of when Ecology measured high counts. Subsequently the plant made adjustments to their sampling schedule and chlorination maintenance routine. Split samples were taken between Ecology and the plant in May of 2007 and all sample results came back low.

When RS-WWTP results were greater than 100 cfu/100 mL, there was a strong correlation (r^2=0.95) with elevated results at RSSW-0.01. This observed correlation demonstrates that bacterial contamination measured at the outfall was present in its receiving waters (RSSW-0.01) at the discharge point to the White River.

The Rainier School WWTP was connected to the Buckley WWTP via a gravity-fed sewer line in February 2011. The plant is scheduled to be decommissioned, at which time the permit will be cancelled.

Buckley WWTP

Overall, FC concentrations measured in the effluent at the Buckley WWTP were relatively low. On January 8, 2007, Ecology collected a FC sample that measured *650 cfu/100 mL*. The plant staff also collected and analyzed a sample on this same day, although at a different time, that measured only *30 cfu/100 mL*. The reason for the difference in the results between Ecology and the Buckley WWTP samples is unknown.

The Buckley plant has recently upgraded from chlorine to UV disinfection and has expanded capacity. It handles waste from additional residential areas, as well as from Rainier School.

Loading Patterns

The average FC load from all measured sources was over four times larger during storm events than it was during non-storm events in both the wet and dry season. In summary:

- The combined FC load from RSSW-0.01, BK-WWTP, and EC-WWTP was very small ranging from only 1.3% (during dry season non-storm events) to 3.7% (during wet season non-storm events) of the total load measured.
- The largest portion of the storm load, approximately 60%, originated from Boise Creek. Boise Creek also had very high FC levels during storm events with a geometric mean of *927 cfu/100 mL* and 90th percentile of *3,339 cfu/100 mL.*
- Thirty-eight % of FC storm load came from WHT 23.8; however, concentrations were low at this site with a maximum of only *33 cfu/100 mL* during storm events.

Storm events were the most critical period for FC concentrations at WHT-18.9, considering that:

- During non-storm events, the annual geometric mean was *10 cfu/100 mL* and the 90th percentile was *60 cfu/100 mL*.
- During storm events, the annual geometric mean was *86 cfu/100 mL* and the 90th percentile was *266 cfu/100 mL*.

Boise Creek

The Boise Creek watershed drains *approximately* 15.4 square mile area of *southeast King County*. The upper basin, above CM 3.2, is primarily forestland, while the lower basin drains part of the city of Enumclaw and is a mix of rural residential, agriculture, and commercial. Ecology sampled four mainstem stations during the TMDL at CMs 0.1, 1.0, 2.2, and 3.2 (Figure 13).

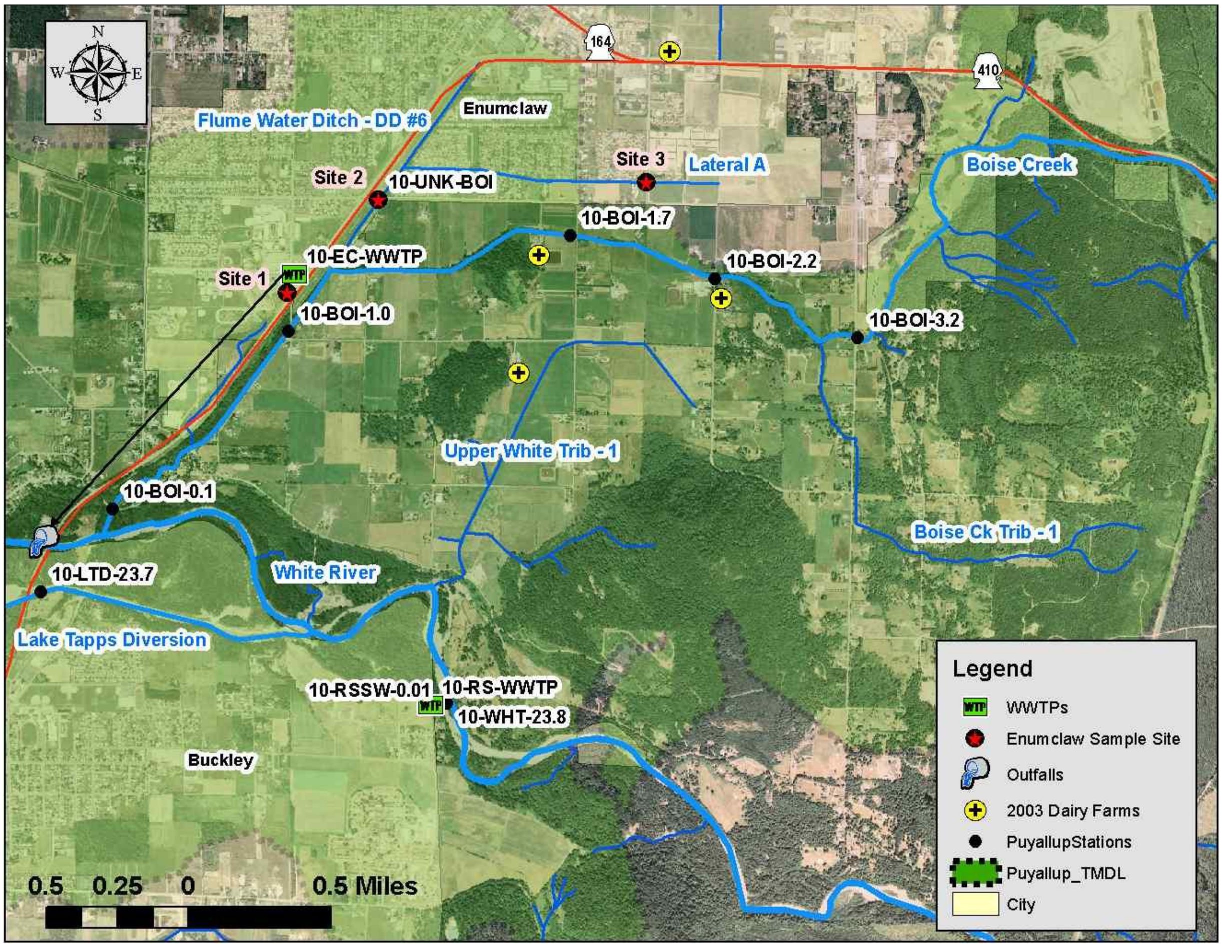

Figure 11. Map of the Boise Creek watershed.

Statistical trend analysis

Wilcoxon signed rank tests for statistical significance (Table 15) were performed between each site and the corresponding downstream site. In summary:

- FC concentrations significantly increased from CM 3.2 to 2.2.
- Dry season and annual FC concentrations significantly increased from CM 2.2 to 1.0.
- Wet season flow increased significantly between both:
  - CM 3.2 and 2.2.
  - CM 2.2 and 0.1

Table 15. Wilcoxon signed rank test results for Boise Creek. Bold italicized numbers indicate a significant change.

Reach	Change in Geomean (cfu/100 mL)	2 -tailed P value	Average Change in Flow (cfs)	2 -tailed P value
Annual				
CM 3.2 - 2.2	***+29***	***0.000***	***+3.69***	***0.000***
CM 2.2 - 1.0	***+76***	***0.007***		
CM 1.0 - 0.1	+6	0.627		
CM 2.2 – 0.1			***+2.52***	***0.042***
Wet Season				
CM 3.2 - 2.2	***+20***	***0.000***	***+5.42***	***0.002***
CM 2.2 - 1.0	+28	0.081		
CM 1.0 - 0.1	+13	0.470		
CM 2.2 – 0.1			***+3.65***	***0.047***
Dry Season				
CM 3.2 - 2.2	***+50***	***0.028***	+0.66	0.093
CM 2.2 - 1.0	***+619***	***0.046***		
CM 1.0 - 0.1	-323	0.753		
CM 2.2 – 0.1			+0	0.575

Results and discussion

Table 16 contains geometric mean and 90th percentile statistics for the entire 2006-07 study period, storm events, and for both the wet and dry season. Routine sample events that exceeded storm event criteria were excluded from the wet and dry season statistics below (Table 14) at these two sites. The storm event FC values were analyzed separately to highlight the impact of stormwater on FC concentrations at these sites.

Table 16. FC concentrations for Boise Creek.

Station ID	Annual			Storm Events			Wet Season (without storms)			Dry Season (without storms)		
	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-BOI-0.1	23	128	1129	5	927	3339	11	31	71	7	293	1331
10-BOI-1.0	20	122	1526	5	696	1870	10	21	76	5	697	1626
10-BOI-2.2	22	46	291	5	173	580	10	16	64	7	84	318
10-BOI-3.2	22	17	148	5	73	493	10	4	21	7	42	103

Highlighted cells indicate an exceedance of water quality criteria.

In order to further segment the source/s of pollution contributing to the significant increase between CM 2.2 and 1.0, additional samples were collected on 7/10/07 and 8/7/07 from Boise Creek at 268th St. (CM 1.7) (Table 17).

Table 17. Comparison of samples collected at Boise Creek at 268th St (10-BOI-1.7) and the routine TMDL stations upstream and downstream.

Date	10-BOI-1.0	10-BOI-1.7	10-BOI-2.2
7/10/2007	1600	140	17
8/7/2007	830	120	92

The increase in FC counts from CM 1.7 to 1.0 indicates that the primary source of pollution is located within this stretch. Included within this stretch are several residences, a commercial dairy, and two stormwater drainage channels from the city of Enumclaw. The city of Enumclaw WWTP staff sampled these stormwater drains during the TMDL study. Table 18 lists the locations sampled, and Table 19 contains the sampling results.

Table 18. Site descriptions and coordinates for city of Enumclaw sites sampled during the TMDL.

Site ID	Description	Latitude °N	Longitude °W
Site 1	Semanski St drainage at NW corner of Semanski St & SR 410.	47.18718	122.00578
Site 2	Flume Water Ditch (Drainage District #6) at Warner Ave/456th St.	47.19191	121.99917
Site 3	Lateral A to Flume Water Ditch at Watson St.	47.19317	121.97908

Table 19. Sample results for city of Enumclaw sampling and three samples collected by Ecology.

Date	Enumclaw WWTP monitoring			Ecology TMDL monitoring
	Site 1	Site 2	Site 3	Site 2 (aka 10-UNK-BOI)
11/14/2006	5	31	116	
12/4/2006	1 U	19	90	
12/18/2006	1	84	127	
1/8/2007	35	87	124	
1/22/2007	3	82	TNTC	
2/6/2007	1 U	41	4	
2/20/2007	TNTC	TNTC	TNTC	
3/6/2007	1 U	54	1	
3/20/2007	TNTC	TNTC	TNTC	
4/3/2007	2	100	3	
4/17/2007	10	95	3	
5/7/2007	17	137	10	
5/21/2007	TNTC	TNTC	73	
6/5/2007	TNTC	TNTC	TNTC	
6/19/2007	21	115	98	
7/10/2007	58	TNTC	168	
7/24/2007	182	197	155	
8/7/2007	13	120	67	
8/21/2007	TNTC	165	40	250
9/4/2007	TNTC	TNTC	122	3700 J
9/18/2007	TNTC	123	TNTC	330

TNTC= Too numerous to count.

Further investigation of sources within this stretch is warranted.

No additional sampling was done between CM 3.2 and 2.2 where a smaller, yet significant, increase in FC counts occurred. There is a small unnamed tributary (Boise Creek Trib–1 in Figure 13) which joins Boise Creek just below CM 3.2 that was not monitored.

Loading Patterns

General loading patterns (Figure 14) observed on Boise Creek:

- In each of the four sets of conditions, loading increased by more than double between RM 2.2 and 0.1.
- During storm events, the load at CM 0.1 was approximately 8 times the load at CM 2.2.
    - The storm flow increase in this stretch was similar to the storm flow increase between CM 3.2 and 2.2; however, the FC load only increased by 2 times in this stretch.
- In the dry season, the load increased by 3 times from CM 2.2 to 1.0:
    - However, there was no significant increase in flow. This suggests a highly concentrated FC source such as failing septic systems or deposition of animal (e.g., livestock or wildlife) feces directly in the stream.

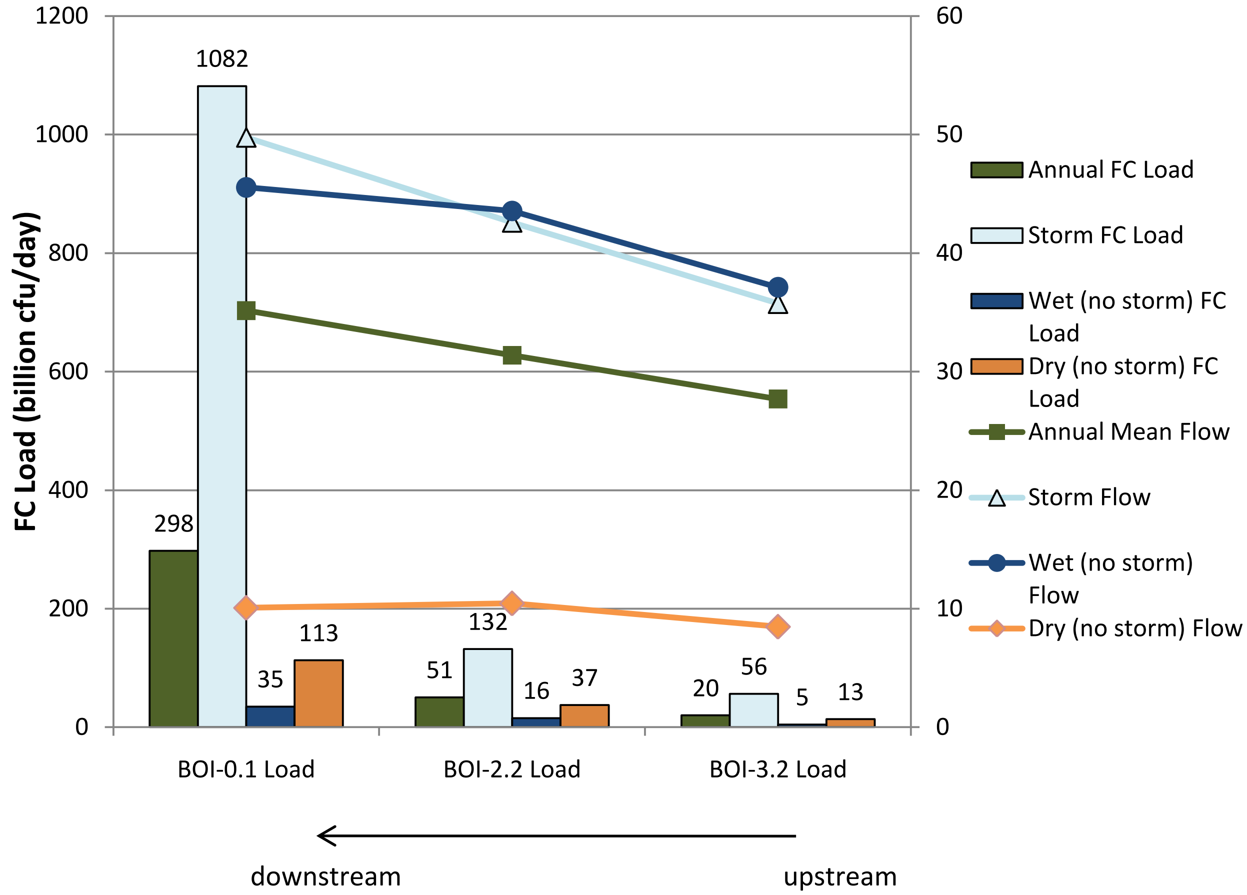

Figure 12. Average FC loads and flows for Boise Creek during various conditions.

Middle White River (RM 18.9 to 3.3)

Results and discussion

Table 20 contains geometric mean and 90th percentile statistics for the entire 2006-07 study period, storm events, and for both the wet and dry season. FC concentrations at the White River mainstem sites and at Bowman Creek increased during storm events. At these sites, routine sample events that exceeded storm event criteria were excluded from the wet and dry season statistics below and analyzed separately to highlight the impact of stormwater on FC concentrations at these sites.

Table 20. FC concentrations for the middle White River watershed.

Station ID	Annual			Storm Events			Wet Season			Dry Season		
	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-WHT-3.3*	**23**	**19**	**129**	**5**	**96**	**284**	**11**	**7**	**34**	**7**	**31**	**84**
10-LTD-0.4	22	6	81				14	5	54	8	8	82
10-WHT-4.8*	**23**	**22**	**127**	**5**	**98**	**318**	**11**	**8**	**28**	**7**	**38**	**97**
10-TAS-0.01	7	39	476									
10-WHT-6.2*	**21**	**19**	**145**	**5**	**112**	**356**	**10**	**7**	**33**	**7**	**27**	**92**
10-BOW-0.3*	22	37	230	5	82	333	10	15	73	7	78	353
10-WHT-7.5*	**22**	**20**	**146**	**6**	**113**	**269**	**11**	**7**	**35**	**6**	**25**	**68**
10-UNW-0.2	7	203	1250									
10-UNW-0.1	14	44	247									
10-WHT-18.9*	**21**	**16**	**129**	**6**	**88**	**240**	**9**	**5**	**21**	**6**	**19**	**86**

*Storm events excluded in wet and dry season averages.
Highlighted cells indicate an exceedance of water quality criteria.
Mainstem stations are identified by bold text.

The sampling location at 10-UNW-0.1 was moved slightly upstream during March 2007 to a location with safer access and a more accurate flow cross-section at 10-UNW-0.2. In late June, flow became stagnant at UNW-0.2 but continued to flow at UNW-0.1, indicating flow input from groundwater or another source. Comparison samples were taken in duplicate on 6/5/07; the results were:

- UNW-0.1: *12* and *16 cfu/100 mL*
- UNW-0.2: *400* and *1100 cfu/100 mL*

The cause of the large decrease in FC counts is unknown, although it may be the result of groundwater dilution. Four of the six samples over 200 cfu/100 mL were collected during the four wet season storm events, indicating that stormwater runoff influences high FC counts at these sites. The highest FC concentration (*1500 cfu/100 mL*) and loading occurred during the large storm event on February 20th.

Bowman Creek (BOW-0.3) had FC counts consistently over 100 cfu/100 mL during most of the dry season. The creek originates approximately three miles upstream of the mouth at Bowman Lake. Potential FC sources include leaking sewer lines or on-site septic systems, wildlife, and urban runoff.

Station 10-TAS-0.01 is a stormwater drainage that joins the White River just downstream of WHT-6.2 at the Auburn Riverside High School. The channel was often stagnant and backed up by water from the White River and was only sampled during the wettest months (November to March). The highest FC count (*860 cfu/100 mL*) occurred during the February 20th storm event.

Water from Lake Tapps returns to the White River between RM 4.8 and 3.3. The diversion was sampled just below the spillway from the hydroelectric power plant approximately one half mile upstream from its confluence with the White River. Counts at this site (LTD-0.4) were generally very low except on 9/4/07 when the FC concentration was *1600 cfu/100 mL*. This elevated result may have been influenced by recreational use of the lake during Labor Day weekend or the 0.4 inches of rain in the preceding 24 hours.

Loading Patterns

Not enough data were available within this stretch to develop accurate FC loading patterns or a loading balance. Loading for several of the tributaries and WHT-7.5 is discussed further in Appendix E.

Lower White River (RM 3.3 to 0.1)

The final 3.3 mile stretch of the White River is a mostly urban drainage area with mixed industrial, commercial, and residential land use. The stretch is receiving waters for Milwaukee Ditch, Salmon, and Jovita Creeks, as well as the city of Sumner WWTP (Figure 15).

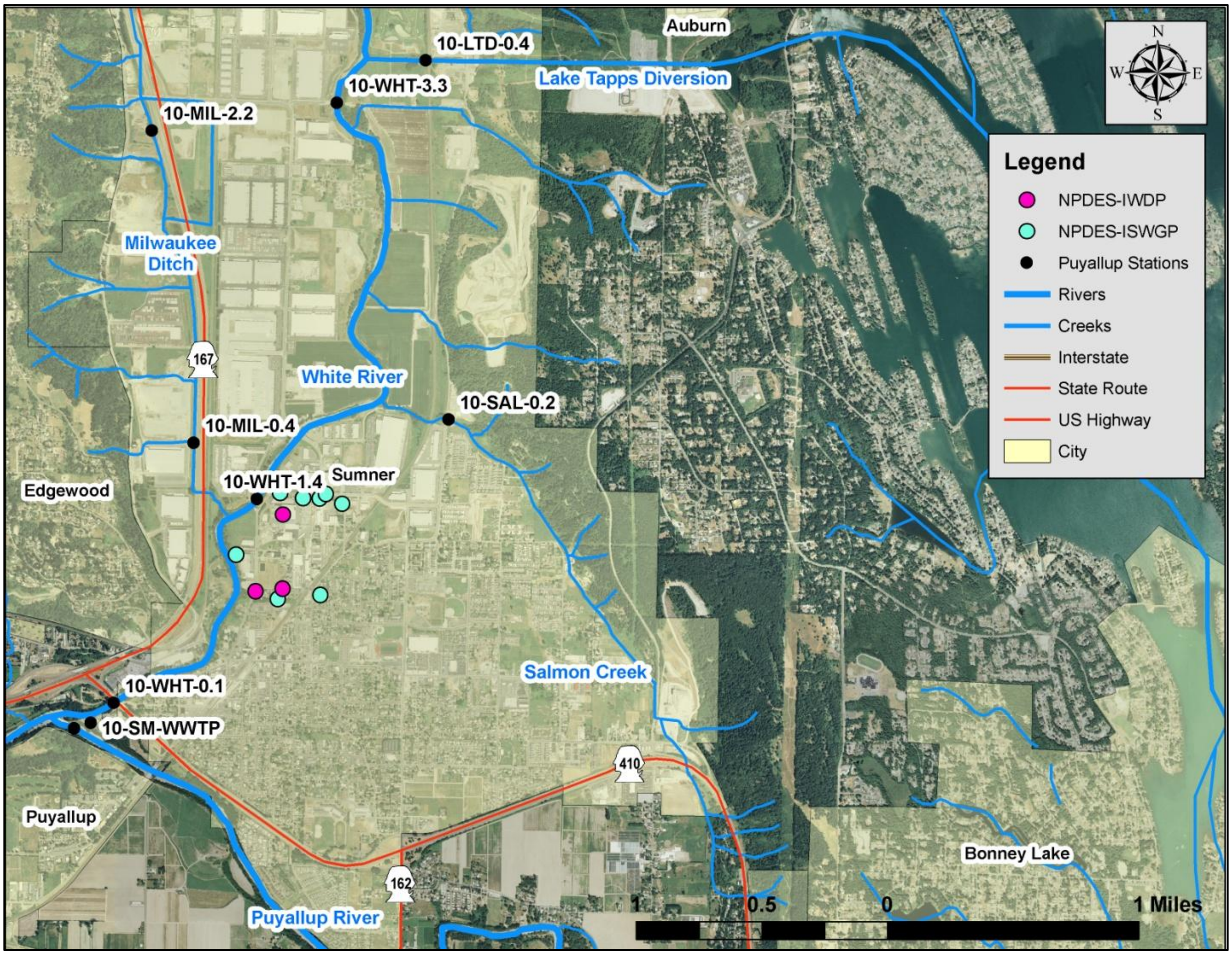

Figure 13. Map of the lower White River.

Results and discussion

Table 21 contains geometric mean and 90th percentile statistics for the entire 2006-07 study period, storm events, and for both the wet and dry season. FC concentrations at the White River mainstem sites, as well as at Jovita and Salmon Creeks, increased during storm events. At these sites, routine sample events that exceeded storm event criteria were excluded from the wet and dry season statistics below and analyzed separately to highlight the impact of stormwater on FC concentrations at these sites.

Table 21. FC concentrations for the lower White River watershed.

Station ID	Annual			Storm Events			Wet Season			Dry Season		
	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-WHT-0.1*	**23**	**35**	**173**	**5**	**119**	**503**	**11**	**16**	**51**	**7**	**54**	**152**
10-SM-WWTP	22	6	30				14	3	9	8	11	53
10-MIL-0.4	6	51	77									
10-MIL-2.2	14	46	316									
10-JOV-0.4*	16	71	553	5	124	570	6	15	76	5	257	465
10-WHT-1.4*	**23**	**34**	**219**	**5**	**131**	**639**	**11**	**15**	**88**	**7**	**45**	**147**
10-SAL-0.2*	23	114	443	5	338	1175	11	57	100	7	156	627
10-WHT-3.3*	**23**	**19**	**129**	**5**	**96**	**284**	**11**	**7**	**34**	**7**	**31**	**84**

*Storm events excluded in wet and dry season averages.
Highlighted cells indicate an exceedance of water quality criteria.
Mainstem stations are identified by bold text.

Salmon Creek exhibited high FC counts during three of the four storm events (all but June 5th) and during the dry season, particularly August and September.

Jovita Creek is approximately 1.5 miles long. It drains Trout Lake and a mix of residential and commercial land before flowing into Milwaukee Ditch at its RM 3.0.

Milwaukee Ditch parallels Highway 167 for most of its length and drains a mix of heavily vegetated hillside and commercial land predominated by large warehouses. Originally, samples were collected at RM 2.2 due to ease of access; however, flow was difficult to measure at this site due to the muddy substrate and water depth. During the dry season of 2007, the site on Milwaukee Ditch at RM 2.2 was moved to RM 0.4 where it was possible to collect samples and measure flows.

On average during the dry season, Jovita Creek contributed 13% of the flow and 83% of the FC load to MIL-0.4. Milwaukee Ditch effectively diluted high FC counts from Jovita Creek during this period with relatively low FC counts at RM 0.4. In contrast, during the wet season, concentrations at MIL-2.2 were greater than 100 cfu/100 mL during each of the four storm events. At JOV-0.4, concentrations were only greater than 100 cfu/100 mL during the February 20th storm event.

In general, Ecology measured very low FC counts at the city of Sumner WWTP. All sample results were below 100 cfu/100 mL and well below water quality standards.

Loading Patterns

Not enough data were available within this stretch to develop accurate FC loading patterns or a loading balance. Loading from the tributaries is discussed in Appendix E.

Mainstem of the Puyallup River

Table 22 contains geometric mean and 90th percentile statistics for the entire 2006-07 study period, as well as for both the wet and dry season. Storm event statistics were not calculated for the Puyallup River or its tributaries due to the weak observed relationship between rainfall and high FC counts. Figure 14 depicts box plots of FC concentrations on the Puyallup River mainstem.

Table 22. FC concentrations for the Puyallup River mainstem.

Station ID	Annual			Wet Season			Dry Season		
	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-PUY-1.4	23	37	115	15	22	49	8	96	155
10-PUY-3.0	22	31	72	14	22	40	8	64	93
10-PUY-5.7	23	30	80	15	20	43	8	61	123
10-PUY-8.5	23	32	86	15	23	49	8	83	129
10-PUY-10.3	23	15	68	15	7	24	8	51	74
10-PUY-12.0	23	15	58	15	10	40	8	32	53
10-PUY-17.7	23	9	35	15	6	19	8	23	36

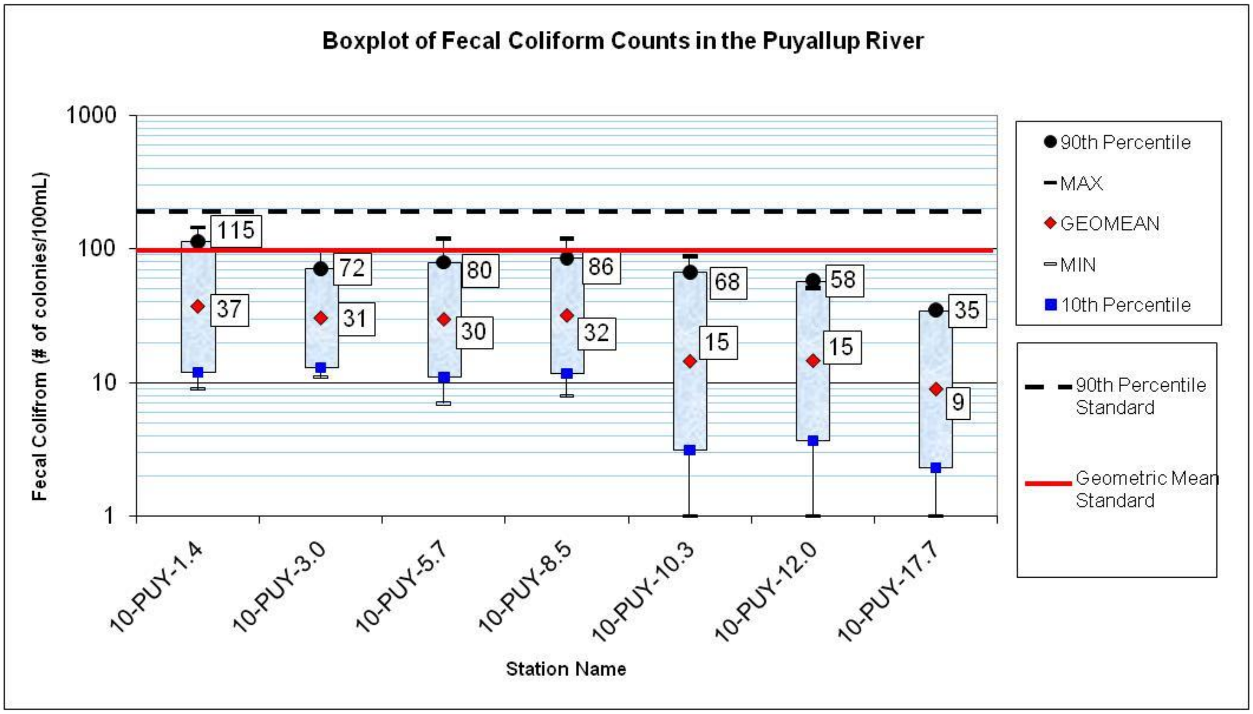

Figure 14. Box plot depicting distribution of annual FC concentrations on the Puyallup River mainstem.

Statistical trend analysis

Wilcoxon signed rank tests for statistical significance (Table 23) were performed between each site and the corresponding downstream site. In summary:

- Annually, FC concentrations significantly increased in three stretches:
  - RM 17.7 to 12.0
  - RM 10.3 to 8.5
  - RM 3.0 to 1.4. This increase was particularly pronounced in the dry season.
- Concentrations remained relatively constant (no significant increase or decrease) from RM 12.0 to 10.3 and from RM 8.5 to 3.0. With the exception of:
  - During the dry season only, FC concentrations increased significantly from RM 12.0 to 10.3.

Table 23. Wilcoxon signed rank test results for the Puyallup River mainstem.

Reach	Annual		Wet Season		Dry Season	
	Change in Geomean (cfu/100 mL)	P(T<=t) two-tail	Change in Geomean (cfu/100 mL)	P(T<=t) two-tail	Change in Geomean (cfu/100 mL)	P(T<=t) two-tail
RM 17.7 – RM 12.0	***+6***	***0.000***	***+4***	***0.006***	***+9***	***0.027***
RM 12.0 – RM 10.3	0	0.493	-3	0.082	***+19***	***0.017***
RM 10.3 – RM 8.5	***+17***	***0.001***	***+16***	***0.001***	***+32***	***0.046****
RM 8.5 – RM 5.7	-2	0.167	-3	0.125	-22	0.672
RM 5.7 – RM 3.0	1	0.626	+2	0.842	+3	0.398
RM 3.0 – RM 1.4	***+6***	***0.015***	0	0.300	***+32***	***0.028***

*excludes October 2006.
Bold italicized numbers indicate a significant change.

Upper Puyallup River (RM 17.7 to 10.3)

The Puyallup River at RM 17.7, just upstream of the confluence with the Carbon River, was the uppermost sampling station for the river and marked a boundary condition for the study (similar to WHT-23.8).

Results and discussion

Table 24 contains geometric mean and 90th percentile statistics for the entire 2006-07 study period, the wet season, and the dry season.

Table 24. FC concentrations for the upper Puyallup River watershed.

Station ID	Annual			Wet Season			Dry Season		
	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-PUY-10.3	**23**	**15**	**68**	**15**	**7**	**24**	**8**	**51**	**74**
10-UNO-0.3	12	83	734						
10-PUY-12.0	**23**	**15**	**58**	**15**	**10**	**40**	**8**	**32**	**53**
10-FNL-0.4	23	14	84	11	6	29	12	29	135
10-CNF-0.2	23	5	23	15	2	10	8	22	54
10-PUY-17.7	**23**	**9**	**35**	**15**	**6**	**19**	**8**	**23**	**36**
10-CAR-0.2	23	16	47	15	13	38	8	25	59

Highlighted cells indicate an exceedance of water quality criteria.
Mainstem stations are identified by bold text.

Samples from PUY-17.7 and CAR-0.2 resulted in relatively low FC concentrations throughout the study period. Large volumes of flow from glacial snowmelt and undeveloped watersheds upstream likely diluted FC sources upstream of the confluence of the two rivers.

The slight, but significant, increase in FC counts from PUY 17.7 and 12.0 is likely due to large FC load and slightly higher FC concentrations from CAR-0.2. The two measured tributaries within this stretch, Fennel and Canyon Falls Creeks, met the water quality standards at their farthest downstream station. Of the two, Fennel Creek had higher FC counts and contributed more FC load.

The significant dry season increase in FC counts between RM 12.0 and 10.3 was unexplained by monitoring results. A small tributary known as Alderton Creek (10-UNO-0.3) sampled within this stretch was dry or stagnant from late May through September, the majority of the dry season.

When flowing, FC counts at 10-UNO-0.3 were intermittently high; however, the flow was minimal and FC loading was relatively small compared to other measured inputs.

Loading Patterns

Not enough data were available within this stretch to develop accurate FC loading patterns or a loading balance. Loading from the tributaries is discussed in Appendix E.

Fennel Creek

Fennel Creek is approximately eight miles long. It flows west from Buckley through Bonney Lake and then south, dropping over Victor Falls before joining the Puyallup River. The creek has one main tributary that drains both Bonney Lake and Sara Jane Lake.

Statistical trend analysis

Wilcoxon signed rank tests for statistical significance (Table 25) was performed between each site and the corresponding downstream site. In summary:

- FC concentrations significantly decreased from CM 4.1 to 0.4.
- Flow increased significantly between both:
  - CM 5.8 and 4.1
  - CM 4.1 and 0.4

Table 25. Wilcoxon signed rank test results for Fennel Creek.

Reach	Change in Geomean (cfu/100 mL)	P(T<=t) two-tail	Average Change in Flow (cfs)	P(T<=t) two-tail
CM 5.8 – 4.1	+3	0.820	***+1.77***	***0.001***
CM 4.1 – 0.4	***-21***	***0.002***	***+11.42***	***0.000***

Bold italicized numbers indicate a significant change.

Results and discussion

Table 26 contains geometric mean and 90th percentile statistics for the entire 2006-07 study period, the wet season, and the dry season.

Table 26. FC concentrations for Fennel Creek.

Station ID	Annual			Wet Season			Dry Season		
	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-FNL-0.4	23	14	84	11	6	29	12	29	135
10-FNL-4.1	22	35	175	10	22	103	12	59	255
10-FNL-5.8	22	32	213	10	13	82	12	67	271

Loading Patterns

Figure 15 depicts the FC loads at each of the three Fennel Creek stations. The large FC loading increase between RM 4.1 and 0.4, driven by an increase in flow, resulted in a significant decrease in FC concentrations. There was surface water and groundwater recharge within this stretch, evident by the significant increase in flow, which effectively diluted high FC counts originating upstream of RM 4.1.

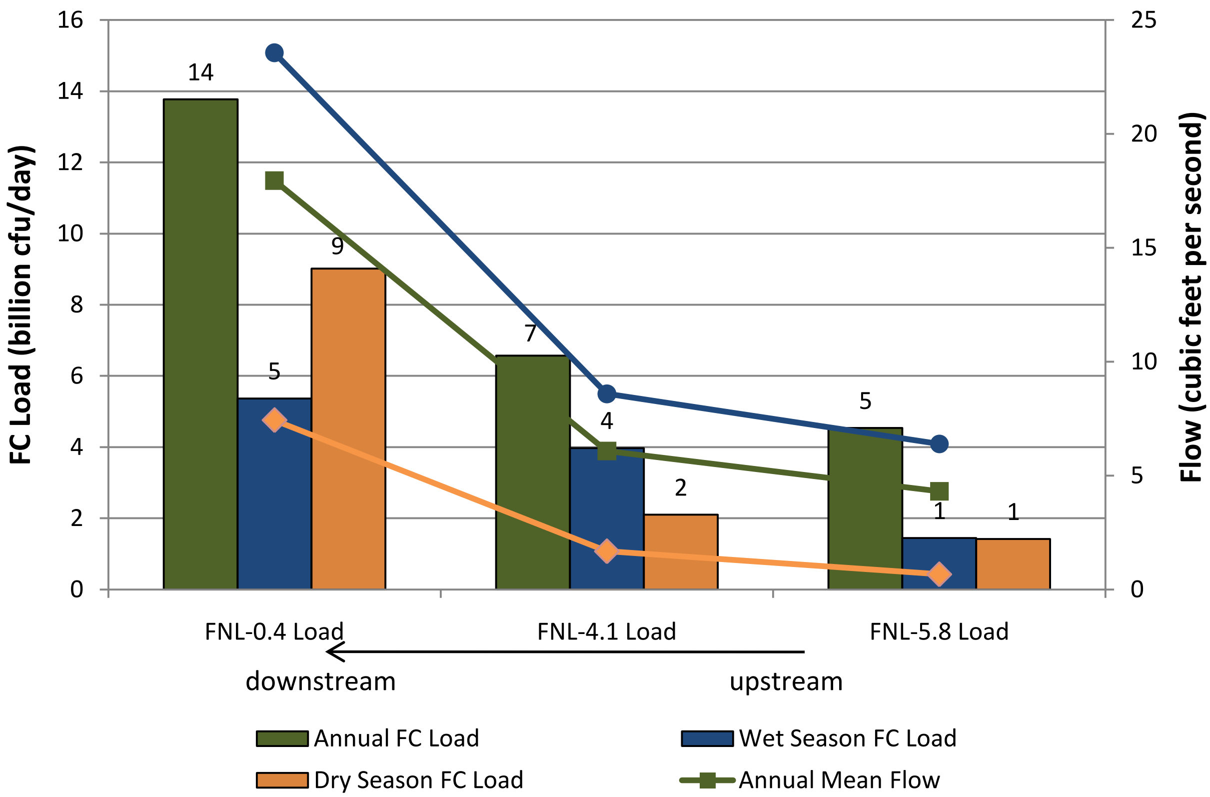

Figure 15. Average FC loads and flows for Fennel Creek during various conditions.

Carbon River

Results and discussion

Table 27 contains geometric mean and 90th percentile statistics for the entire 2006-07 study period, the wet season, and the dry season.

Table 27. FC concentrations for the Carbon River watershed.

Station ID	Annual			Wet Season			Dry Season		
	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-CAR-0.2	23	16	47	15	13	38	8	25	59
10-OT-WWTP	22	11	125	10	19	234	12	8	72
10-VOI-0.4	22	22	109	10	7	24	12	54	102

Highlighted cells indicate an exceedance of water quality criteria.

In general, FC counts were low in the Orting WWTP effluent, with a geometric mean of only *19 cfu/ 100 mL*. Five out of 22 samples had FC counts between 100 and 300 cfu/100 mL.

Voight Creek below the fish hatchery (10-VOI-0.4) had low FC concentrations below water quality criteria. However, the geometric mean during the dry season was approximately 7 times larger than during the wet season.

Loading Patterns

Not enough data were available within this stretch to develop accurate FC loading patterns or a loading balance. Loading from the tributaries is discussed in Appendix E.

Middle Puyallup River (RM 10.3 to 3.0)

Results and discussion

Table 28 contains geometric mean and 90th percentile statistics for the entire 2006-07 study period, the wet season, and the dry season.

Table 28. FC concentrations for the middle Puyallup River watershed.

Station ID	Annual			Wet Season			Dry Season		
	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-PUY-3.0	**22**	**31**	**72**	**14**	**22**	**40**	**8**	**64**	**93**
10-CLK-0.01	23	87	253						
10-PUY-5.7	**23**	**30**	**80**	**15**	**20**	**43**	**8**	**61**	**123**
10-PY-WWTP	22	11	47						
10-PUY-8.5	**23**	**32**	**86**	**15**	**23**	**49**	**8**	**83**	**129**
10-DEE-0.1	23	254	878	11	119	219	12	509	1336
10-WHT-0.1	23	35	173	15	25	121	8	68	248
10-PUY-10.3	**23**	**15**	**68**	**15**	**7**	**24**	**8**	**51**	**74**

Highlighted cells indicate an exceedance of water quality criteria.
Mainstem stations are identified by bold text.

The mouth of the White River (10-WHT-0.1) had higher FC concentrations than the Puyallup River at RM 10.3 upstream of the confluence. The White River was the largest FC loading source to the Puyallup at RM 8.5 and was likely the main factor in the significant increase in FC from Puyallup RM 10.3 to 8.5.

High FC concentrations at the mouth of Deer Creek (10-DEE-0.1) exceeded water quality criteria year-round. Deer Creek also may have contributed to the increase at PUY-8.5, although FC loading from DEE-0.1 was significantly less than from the White River.

Several additional samples were taken upstream to help identify the stream segment where the source of greatest FC contamination originates. The results were:

- 3/21/07: FC count at DEE-0.1 = *200 cfu/100 mL*. An additional sample collected upstream at CM 2.0 off Shaw Road = *57 cfu/100 mL*.
- 4/18/07: FC count at DEE-0.1 = *110 cfu/100 mL*. An additional sample from CM 2.0 = *28 cfu/100 mL*.
- 5/22/07: FC count at DEE-0.1 = *440 cfu/100 mL*. An additional sample collected upstream at CM 0.8 at the west end of Inter Avenue = *85 cfu/100 mL*.

The main source of FC contamination appears to originate between CM 0.8 and 0.1. Further investigation of FC sources within this stretch is warranted.

In general, Ecology measured very low FC counts at the city of Puyallup WWTP. All sample results were below 100 cfu/100 mL, with the exception of one high result of *310 cfu/100 mL* measured on 8/8/07.

FC counts for Clarks Creek generally ranged from *31* to *160 cfu/100 mL* with the exception of two samples above 200 cfu/100 mL:

- 3/7/07: *830 cfu/100 mL*
- 6/6/07: *620 cfu/100 mL*

There was no clear relationship to precipitation, streamflow, or time of year to explain these spikes in FC concentration. The Clarks Creek FC TMDL is currently addressing FC sources within the watershed.

Loading Patterns

Not enough data were available within this stretch to develop accurate FC loading patterns or a loading balance. Loading from the tributaries is discussed in Appendix E.

Lower Puyallup River (RM 3.0 to 1.4)

Results and discussion

Table 29 contains geometric mean and 90th percentile statistics for the entire 2006-07 study period, the wet season, and the dry season.

Table 29. FC concentrations for the lower Puyallup River watershed.

	Annual			Wet Season			Dry Season		
Station ID	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-PUY-1.4	**23**	**37**	**115**	**15**	**22**	**49**	**8**	**96**	**155**
10-SWN-0.01	20	41	123	9	23	78	12	64	117
10-PUY-3.0	**22**	**31**	**72**	**14**	**22**	**40**	**8**	**64**	**93**

Mainstem stations are identified by bold text.

Fecal coliform results met water quality standards at 10-SWN-0.01.

First Creek, formerly known as T-Street Gulch or Lister Gulch was the only larger drainage between Puyallup RM 3.0 and 1.4 that was not sampled during the study. In the summer of 2008, several hundred cubic yards of garbage and debris were removed from the First Creek drainage (City of Tacoma, 2009).

Flow and FC data are not available. However, given the amount of refuse removed, First Creek may have been a source of FC during the study period.

Clear/Swan Creek

The Clear/Swan Creek basin drains approximately 5.8 miles of primarily rural residential land (Pierce County, 2005). Swan Creek is technically a tributary to Clear Creek. However at the beginning of the project, Ecology labeled the mouth of these two creeks as Swan Creek, so 10-SWN-0.01 represents the combined drainage of these two creeks before entering the Puyallup River.

Results and discussion

Table 30 and Table 31 contain geometric mean and 90th percentile statistics for the entire 2006-07 study period, the wet season, and the dry season.

Table 30. FC concentrations for Clear Creek.

	Annual			Wet Season			Dry Season		
Station ID	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-CLR-0.4	23	30	79	11	27	70	12	33	90
10-CLR-1.7	22	22	103	10	22	113	12	22	102
10-CLR-3.6	10	16	138	-	-	-	-	-	-

Table 31. FC concentrations for Swan Creek and the mouth of Clear Creek (10-SWN-0.01).

Station ID	Annual			Wet Season			Dry Season		
	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile	n	Geo-mean	90th %tile
10-SWN-0.01	20	41	123	9	23	78	11	64	117
10-SWN-0.6	22	14	62	11	11	65	12	17	56
10-SWN-3.9	14	59	437	-	-	-	-	-	-

Highlighted cells indicate an exceedance of water quality criteria.

Fecal coliform results were below water quality standards throughout both watersheds, with the exception of Swan Creek at CM 3.9 where intermittently high FC counts were measured.

Loading Patterns

Not enough data were available within this stretch to develop accurate FC loading patterns or a loading balance. Loading from the tributaries is discussed in Appendix E.

Fecal Coliform load sources that violate water quality standards

Additional FC loading patterns and analysis can be found in Appendix E.

Figure 16 shows the average dry season FC loading sources for sites that violated Washington State water quality standards within the TMDL study area. Boise Creek was the largest FC load source, followed by Clarks Creek, Salmon Creek, and Deer Creek. Figure 18 illustrates the relative impact each tributary has on the White or Puyallup River during the dry season. For example, Boise Creek has approximately 10 times the impact of Deer Creek and Deer Creek has about 10 times the impact of Bowman Creek.

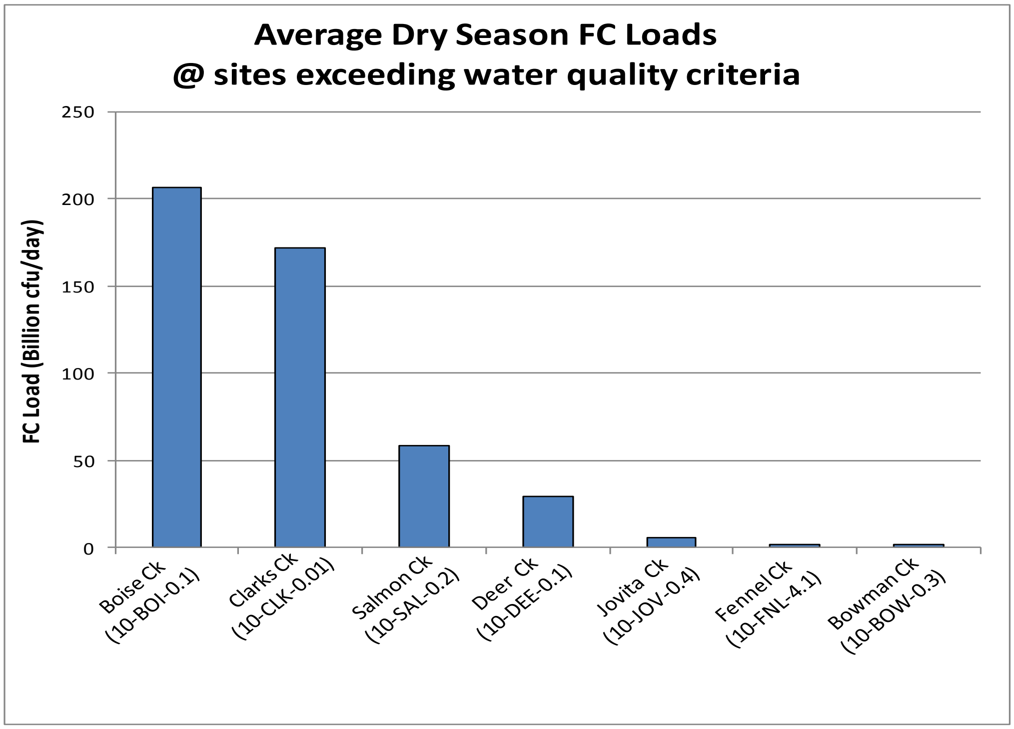

Figure 16. Average dry season FC loads for TMDL sites that exceeded water quality criteria.

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TMDL Analyses

Loading capacity

Definition and determination

EPA regulations define loading capacity as the greatest amount of pollutant loading that a water body can receive without violating water quality standards [40CFR§130.2(f)]. The loading must be expressed as mass-per-time or other appropriate measure. In addition, the critical conditions that cause water quality standard violations must be considered when determining the loading capacity.

Washington State FC bacteria TMDLs use a combination of mass-per-time units and FC concentration targets to define loading capacities. This is necessary since mass-per-time units (loads) do not adequately define periods of FC criteria violations. FC sources are quite variable, and different sources can cause water quality violations at different times (e.g., poor dilution of contaminated sources during low-streamflow conditions or increased source loading during run-off events). Loads are instructive for identifying changes in FC source intensity between sites along a river, or between seasons at a site.

The concentration targets are derived from the Washington State FC criteria and provide a better (than FC loads) measure of the loading capacity during the most critical period. The Puyallup River watershed FC loading capacities are expressed *not* as loads. Instead, they are expressed as the applicable two concentration-based statistics in the state FC criteria (e.g., the geometric mean and the value not to be exceeded by more than 10% of the samples).

As discussed earlier in the *Data Analysis Methods* section, the 90th percentile value of samples is used in TMDL evaluations as an estimate of the latter criterion. Tables 32 and 33 indicate target FC concentration levels and estimates of the reductions necessary to meet water quality criteria.

The percent reduction values in Tables 32 and 33 indicate the relative degree the water body is out of compliance with criteria (i.e., how far it is over its capacity to receive FC source loads and still provide the designated beneficial uses). Sites representing reaches or tributaries that are currently meeting water quality criteria do not have a FC reduction value. Sites that require aggressive reductions in FC sources will have a high FC percentage reduction value, while sites with minor problems will have a low FC percentage reduction value.

Tables 32 and 33 include FC target reductions for sites that did not meet (exceeded) criteria during either the wet or dry season, or both, to provide water quality managers with a sense of when FC sources are creating criteria violations. If no seasonal changes were observed, or there were too few samples to calculate results by season, then data from the entire year were used and target reductions were labeled as non-seasonal. While potential stormwater events were identified for certain sites, numerical stormwater reductions were not separated out from overall reductions, due to the small amount of data available to calculate these statistics. Instead, numerical stormwater load allocations are included as part of the overall reduction needed.

Commencement Bay

Ecology did not collect FC samples between the mouth of the Puyallup River and RM 1.0 to assess whether this stretch is meeting the freshwater standard for *Secondary Contact Recreation*. Likewise, enterococci bacteria samples were not collected within Inner Commencement Bay to determine if it was meeting the marine standard for *Secondary Contact Recreation*. However more stringent standards were met in the freshwater upstream of RM 1.0 and the marine water in Outer Commencement Bay:

- The Puyallup River at RM 1.4 met the freshwater *Primary Contact Recreation* criteria.
- Ecology's long-term marine monitoring program collected FC samples in Outer Commencement Bay near Brown's Point during the TMDL. The preliminary results were below the marine standards for *Primary Contact Recreation* with:
  - A geometric mean of 2 cfu/100 mL.
  - A 90th percentile of 8 cfu/100 mL.

Puyallup River and tributaries

Table 32 contains target FC capacity and percent reductions necessary to meet water quality standards. The FC capacity on the mainstem of the Puyallup River was adequate to handle current FC loads. The *Primary Contact Recreation* criteria were met at all measured stations over the entire 2006-07 study, as well as during the wet and dry seasons individually.

The mainstem stations at RM 1.4 and 8.5 did come close to exceeding the criteria for the dry season averaging period, particularly at PUY-1.4. Targeted FC reductions on the White River and tributaries throughout the TMDL study area should reduce FC concentrations at these stations and leave a greater margin of safety.

The FC capacity was exceeded on five of the Puyallup tributaries:

- Deer Creek (10-DEE-0.1) requires a reduction of 85% in the dry season and 16% in the wet season.
- Alderton Creek (10-UNO-0.3) requires a large reduction of 73% year-round.
- A 54% reduction is needed in the upper watershed of Swan Creek (upstream of 10-SWN-3.9), while the downstream stations are currently below criteria.
- Clarks Creek:
  - The recently completed Clarks Creek FC TMDL (James, 2008) called for a 57% reduction based on combined data from stations located at CM 1.4, 4.0 and 4.9.
  - Based on FC data collected during this TMDL, the mouth of Clarks Creek needs a 31% reduction, which includes a 13% reserve for growth identified in the Clarks Creek TMDL.

No FC reductions were needed on the Carbon River, Clear Creek, Canyon Falls Creek, and Voight Creek. While Fennel Creek did not exceed the water quality standards, the predicted 90th percentile values were above 200 cfu/100 mL at two stations (10-FNL-4.1 and 10-FNL-5.8). Concentrations just below 200 cfu/100 mL were observed at both stations on multiple occasions. The calculated 90th percentile values suggest these sites are near (and possibly above) their loading capacity for FC. Any additional FC loading, or conditions of reduced flow, might be expected to cause a violation of standards.

Table 32. Target FC reductions necessary to meet FC load allocations for Nonpoint sources in the Puyallup River tributaries.

FC load allocations are presented as a target geomean and 90th percentile FC concentrations.

Station ID	Site Description	Observed FC (cfu /100mL)		Nonpoint Source FC Reduction Needed	FC Target Capacity (cfu /100mL)	
		Geo-mean	90th %tile		Geo-mean[1]	90th %tile
Dry Season (May – October)						
10-DEE-0.1	Deer Creek near mouth	509	1336	**85%**	76	200
Wet Season (November to April)						
10-DEE-0.1	Deer Creek near mouth	119	219	**16%**	100	184
10-CLK-0.01	Clark Creek at mouth	87	253	**31%**[2]	60[2]	174[2]
Clarks Ck. 1-3	Pooled data for Clarks Creek at 3 sites	132*	402*	**57%**[3]	57[3]	174[3]
Non-Seasonal						
10-SWN-3.9	Swan Creek at 80th St E	59	437	**54%**	27	200
10-UNO-0.3	Alderton Creek at 80th St E	83	734	**73%**	83	734

[1] This represents the average daily limit and is expressed as a seasonal or non-seasonal (annual) geometric mean.

[2] Not the official FC target capacity and percent reductions, official targets were set a by a separate TMDL for Clarks Creek.

[3] Official FC target capacity and percent reductions based on 2002-03 data set in separate Clarks Creek Watershed FC TMDL report (James, 2008).

Yellow (light shading) = 0-33% FC reduction; Orange (medium) = 33-67%; Red (dark) = 67-100%.

White River and tributaries

Boise Creek was the largest FC loading source measured during the TMDL study that violated water quality standards. If the 92% dry-season rollback reduction was achieved at the mouth of Boise Creek (10-BOI-0.1), the FC load to the White River at R St. (10-WHT-7.5) would be reduced by 12.6%, and the dry season 90th percentile would drop from *190* to *166 cfu/ 100 mL*. Table 33 contains target FC capacity, based on numeric criteria, and percent reductions necessary to meet water quality standards. FC capacity for the White River was adequate for current conditions from RM 3.3 to the upstream study boundary at RM 23.8. However, during the dry season, 90th percentile values at all stations within this stretch (except at RM 23.8) were near the *Primary Contact Recreation* criterion of 200 cfu/100 mL, ranging from 151 to 190 cfu/100 mL.

FC reductions of 20% are needed during the dry season on the lower White River at:

- The mouth (10-WHT-0.1).
- 142nd Street (10-WHT-1.4).

The FC capacity was exceeded at multiple White River tributaries:

- Wet Season FC reductions are necessary on:
  - Boise Creek at the mouth (10-BOI-0.1) and at 252nd Street (10-BOI-1.0).
  - Milwaukee Ditch near State Route 167 (10-MIL-2.2).
  - Salmon Creek at East Valley Highway (10-SAL-0.2).
  - The unnamed tributary to the White River at 180th Street (10-UNW-0.2).
  - The tributary at Auburn River High School (10-TAS-0.01).
- Dry-season reductions are needed at:
  - Boise Creek at the mouth (10-BOI-0.1), at 252nd Street (10-BOI-1.0), and at 276th Street (10-BOI-2.2).
  - Bowman Creek at Kersey Way (10-BOW-0.3).
  - Jovita Creek at West Valley Highway (10-JOV-0.4).
  - Salmon Creek at East Valley Highway (10-SAL-0.2).
- A large year-round reduction of 86% is needed at RSSW-0.01, which should be met when the Rainier School WWTP effluent is connected to the Buckley WWTP.

No FC reductions were necessary on the Lake Tapps diversion at the point where the water is diverted (LTD-23.7) or close to its confluence with the White River (LTD-0.4).

Table 33. Target FC reductions necessary to meet FC load allocations for the Nonpoint Sources to the White River and its tributaries.

FC load allocations are presented as a target geomean and 90th percentile FC concentrations.

Station ID	Site Description	Observed FC (cfu /100mL)		FC Reduction Needed	FC Target Capacity (cfu /100mL)	
		Geo-mean	90th %tile		Geo-mean[1]	90th %tile
Dry Season (July – October)						
10-WHT-0.1	White River at mouth	68	248	**20%**	55	200
10-WHT-1.4	White River at 142nd	58	251	**20%**	47	200
10-BOI-0.1	Boise Creek at mouth	401	2435	**92%**	33	200
10-BOI-1.0	Boise Creek at 252nd	724	1556	**87%**	93	200
10-BOI-2.2	Boise Creek at 276th	105	462	**57%**	45	200
10-BOW-0.3	Bowman Creek at Kersey Way	99	507	**61%**	39	200
10-JOV-0.4	Jovita Creek at West Valley Hwy E	295	586	**66%**	100	199
10-SAL-0.2	Salmon Creek at East Valley Hwy	194	876	**77%**	44	200
Wet Season (November to June)						
10-BOI-0.1	Boise Creek at mouth	70	507	**61%**	27	200
10-BOI-1.0	Boise Creek at 252nd	57	614	**67%**	18	200
10-MIL-2.2	Milwaukee Ditch near Hwy 167	52	351	**43%**	30	200
10-SAL-0.2	Salmon Creek at East Valley Hwy	86	274	**27%**	63	200
10-TAS-0.01	Trib to White R at Auburn Riverside HS	39	476	**58%**	17	200
Non-Seasonal						
10-RSSW-0.01	Rainer School stormwater drainage	32	1475	**86%**	4	200
10-UNW-0.2	Unknown trib to White River at 180th	203	2057	**90%**	20	200

[1] This represents the average daily limit and is expressed as a seasonal or non-seasonal (annual) geometric mean.

Yellow (light shading) = 0-33% FC reduction; Orange (medium) = 33-67%; Red (dark) = 67-100%.

Maps of FC reductions

Figures 19-22 map the stream segments within the TMDL study area where FC reductions are needed to meet water quality standards.

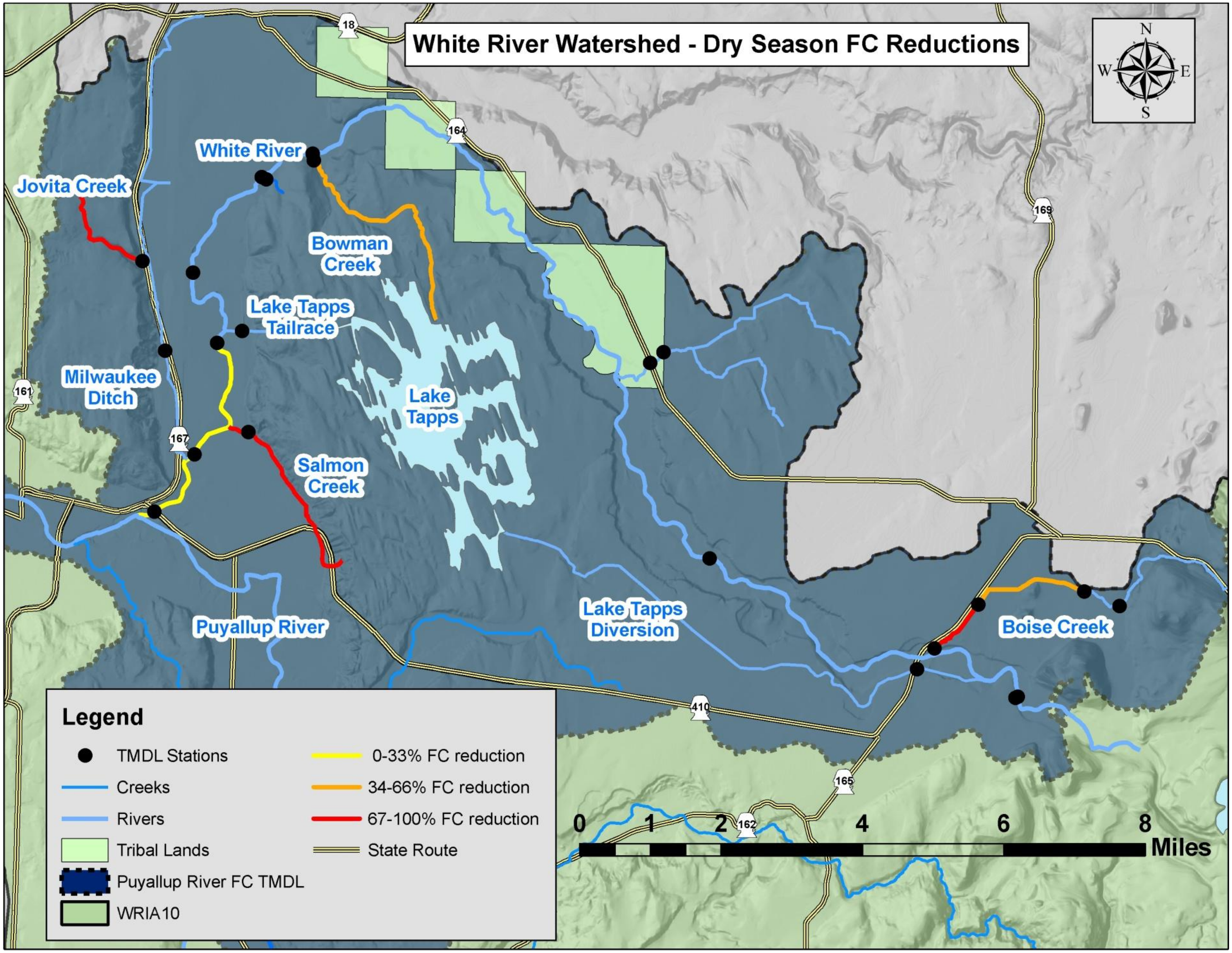

Figure 17. Target dry season FC reductions in the White River watershed. Dry season = July to October.

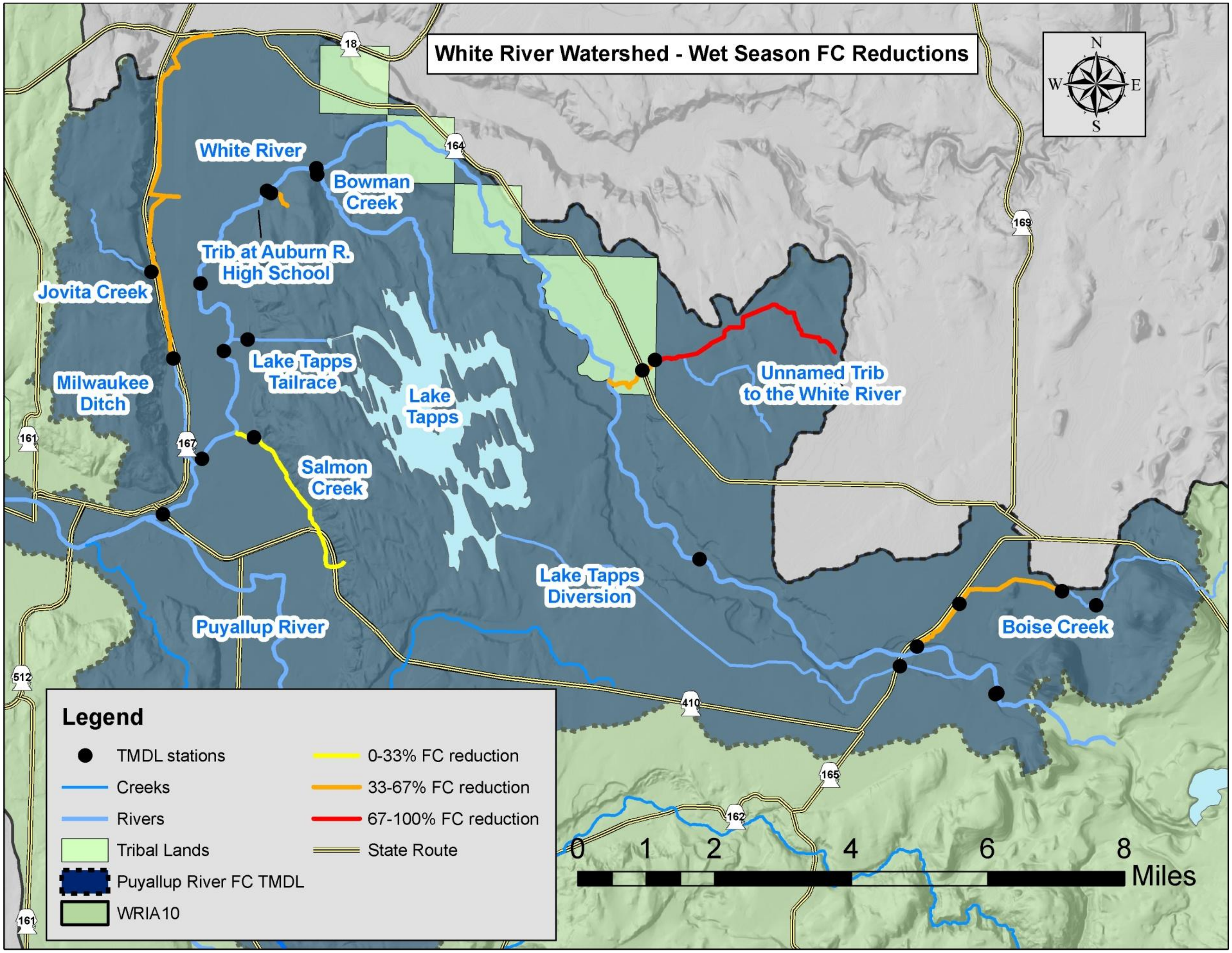

Figure 18. Target wet season FC reductions in the White River watershed. Wet season = November to June.

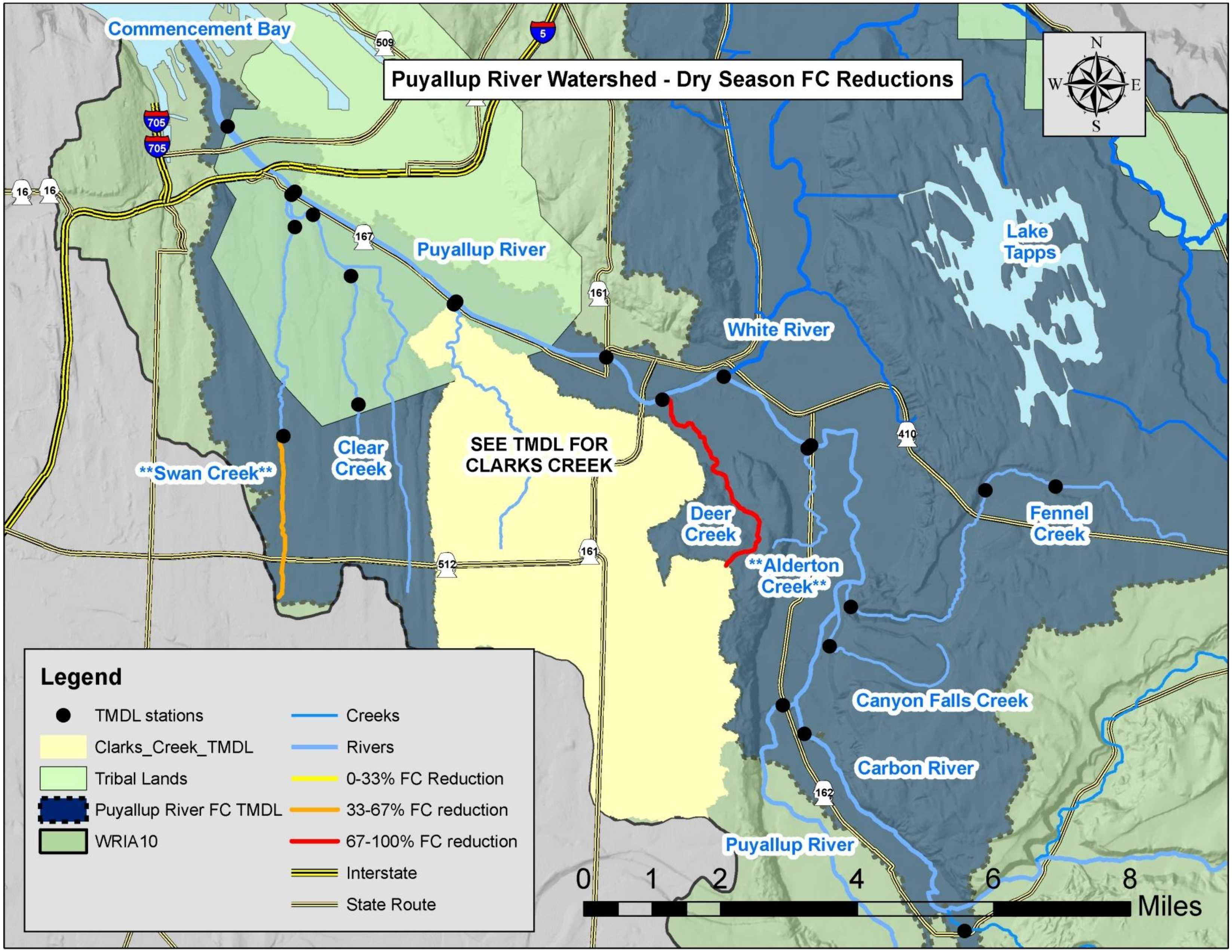

Figure 19. Target dry season FC reductions in the Puyallup River watershed. Dry season = July to October (mainstem); May to October (tributaries).

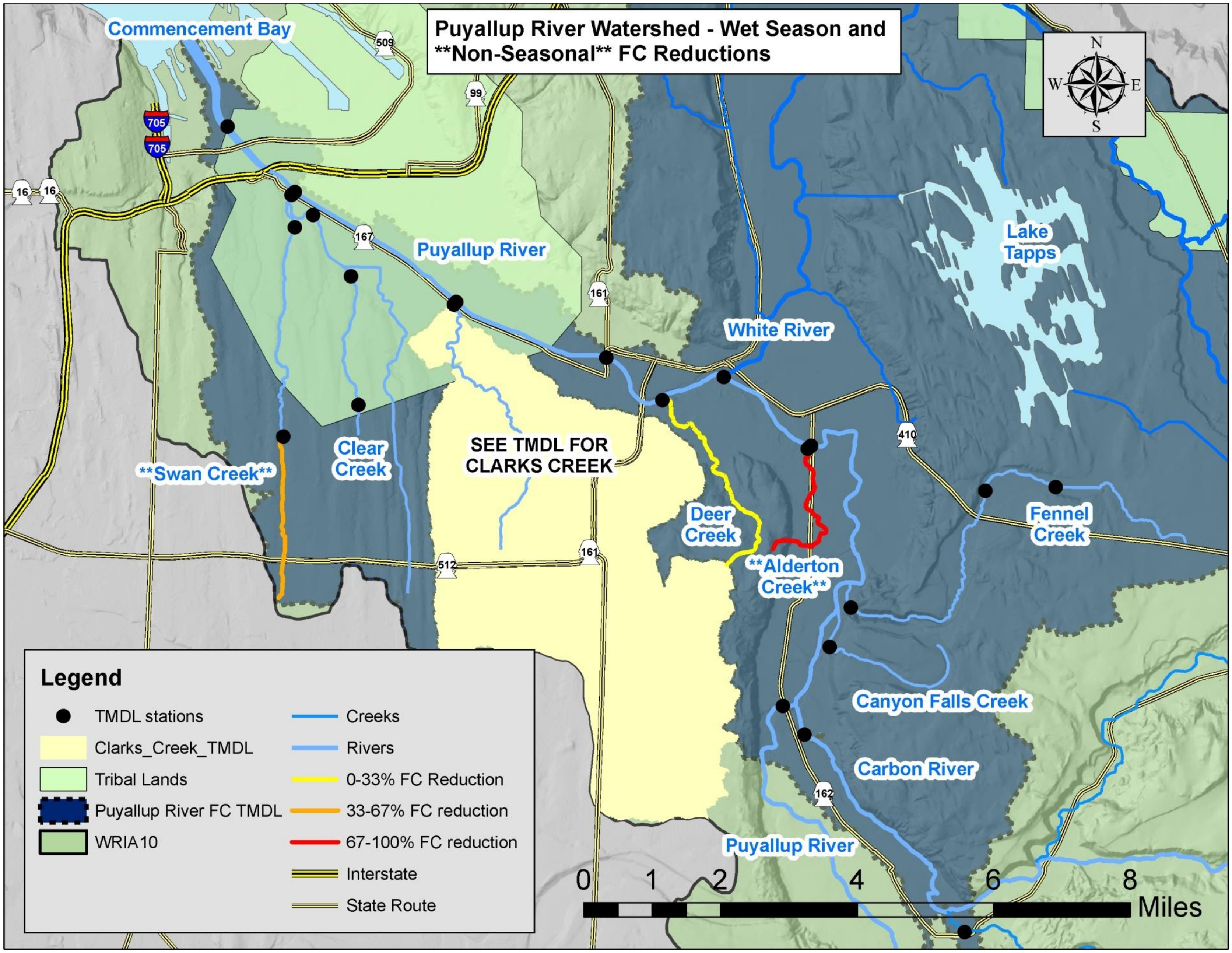

Figure 20. Target wet season FC reductions in the Puyallup River watershed. Wet season = November to June (mainstem); November to April (tributaries).

Load and wasteload allocations

This TMDL study demonstrated that Primary Contact Recreation in the Puyallup River basin is impaired in many areas by FC. In order to meet the water quality standards for primary contact recreation, reductions in FC are needed.

Load allocations

Load allocations represent the reduction needed in non-point sources in the watershed. Potential non-point sources within the watershed include, but are not limited to:

- Livestock with direct access to stream or with poor manure management.
- Failing or improperly constructed septic systems.
- Urban stormwater.
- Pet waste.

The federal Clean Water Act states that FC wasteload and load allocations may be expressed as loads, concentrations, or other appropriate measures [40 CFR 130.2(I)]. This TMDL expresses the load allocations in terms of percent reductions needed to achieve concentration levels that are in accordance with the water quality standards. Washington State uses FC concentrations as the most appropriate measure of meeting load allocations because the FC concentrations can be directly compared to the water quality concentration-based standards.

For non-point sources, load allocations are equivalent to loading capacity values, as described in the previous loading capacity section (Tables 32-33). Load allocations are expressed in terms of target FC concentrations, at the stations downstream of non-point sources. The target reduction values must be met in order for nonpoint sources to meet their load allocations.

Wasteload allocations

Point sources, such as municipal wastewater treatment plants (WWTPs) in the basin, are assigned wasteload allocations based on their NPDES permit limits. Municipal stormwater and stormwater outfalls are assigned wasteload allocations based on their Phase I or Phase II Western Washington Stormwater General Permit requirements. This TMDL expresses the wasteload allocation for the municipal WWTPs as a permit-based concentration limit. These are described below in Tables 34-36.

Municipal Wastewater Treatment Plants

All WWTPs within the study area do not require any modifications to their NPDES permit limits for their FC wasteload allocations. The current NPDES permit FC limits for the WWTPs appear to be adequate, and no seasonal wasteload allocation is needed.

The wasteload allocation is set as either the current surface water quality-based concentration limits or the current technology-based NPDES permit concentration limits for each WWTP (Table 34).

Table 34. Wasteload allocations for WWTPs based on NPDES permit FC concentration limits.

<table>
<tr><th>Wastewater Treatment Plant</th><th>NPDES Permit No.</th><th>Receiving Water</th><th>Sample Frequency</th><th>Monthly Geomean Limit</th><th>Weekly Geomean Limit</th></tr>
<tr><td>Town of Orting</td><td>WA0020303</td><td>Carbon R.</td><td>2/week</td><td><200cfu/100mL</td><td><400cfu/100mL</td></tr>
<tr><td>City of Enumclaw</td><td>WA0020575</td><td rowspan="3">White R.</td><td>3/week</td><td><100cfu/100mL</td><td><200cfu/100mL</td></tr>
<tr><td>City of Sumner</td><td>WA0023353</td><td>3/week</td><td><100cfu/100mL</td><td><200cfu/100mL</td></tr>
<tr><td>City of Buckley</td><td>WA0023361</td><td>2/week</td><td><100cfu/100mL</td><td><200cfu/100mL</td></tr>
</table>

The city of Puyallup WWTP is located within 1873 survey area of the Puyallup Tribe of Indians reservation and discharges to the Puyallup River within this area. The Puyallup Tribe is the beneficial owner of the bed and banks (to the mean high water mark) of the Puyallup River within the 1873 reservation (which the United States holds in trust). This WWTP is therefore not subject to wasteload allocations set by the state of Washington. The WWTP's current NPDES permit is administered by the Puyallup Tribe and EPA. The effluent limitations are set equal to the Puyallup Tribe's water quality standards (equivalent to *Primary Contact Recreation* for FC).

The Rainier School WWTP was connected to the Buckley WWTP via a sanitary sewer line in February 2011. Now that the connection is complete, the Rainier School plant is offline, the NPDES permit will be cancelled, and wasteload allocations for Rainier School are not necessary.

The Orting WWTP is the only facility in the study area with the less stringent technology-based permit limits of *200 cfu/100 mL* (monthly geomean) and *400 cfu/100 mL* (weekly geomean). However, the mouth of the Carbon River (receiving waters for Orting) is well below water quality standards for FC, and the Orting WWTP currently accounts for only about 1% of the load to the Carbon River at the mouth. These technology-based limits were placed in the permit based on a simple mixing analysis under critical conditions that showed water quality standards would not be violated at these limits (Ecology, 2009d).

While Ecology measured some inconsistent high FC counts, self-monitoring results from each of the WWTPs continue to meet their NPDES permit limits.

Measured FC loads from the WWTPs were relatively small compared to other measured inputs. Therefore, Ecology believes more stringent FC permit limits would not greatly affect FC loads in the Puyallup and White Rivers.

Individual Waste Discharge Permit Holders

Within the study area, Sonoco Products is the only industrial facility that discharges treated industrial process water to surface waters. In a 2010 study, the facility found high concentrations of fecal indicator bacteria (fecal coliform and *Escherichia coli*) in their treated effluent, which discharges to the White River (Sonoco, 2011). Although the facility discharges a very small amount of effluent (approximately 0.15 MGD) and a relatively small FC load, the concentrations of FC were above water quality standards. Given that the White River does not currently meet FC standards in the receiving water segment, there is no additional loading capacity, and the Sonoco effluent must meet the surface water quality standards at the point of discharge.

A wasteload allocation for the Sonoco effluent discharge to the White River is set as the current surface water quality-based concentration limits of the receiving waters (Table 35).

Table 35. Wasteload allocation for Sonoco Products' effluent discharge to the White River.

Wastewater Treatment Plant	NPDES Permit No.	Receiving Water	Geomean Limit	Less than 10% of the samples greater than
Sonoco Products	WA0000884D	White River	100cfu/100mL	200cfu/100mL

Several other facilities in the TMDL study area, including four fish hatcheries, three wood-preservation treatment facilities, and one vinegar production facility (Table 8) hold individual wastewater discharge permits.

Each of the hatchery operations diverts water from a nearby creek or river into raceways and rearing ponds, then discharges the water back to the water body from which it was removed. FC is not currently a parameter of concern for this type of water use.

Of the remaining facilities, all but one (Manke Lumber) discharge treated stormwater only under their individual permit. Manke Lumber discharges non-contact process cooling water to the White River, in addition to stormwater, under their permit. FC is not currently a parameter of concern in non-contact cooling water.

Urban Stormwater

Fecal coliform stormwater loads in urban areas are considered capable of occurring at any time. Therefore, stormwater FC wasteload allocations were not specifically reserved for a 'storm' season. The stormwater wasteloads are based on the FC reductions needed to achieve water quality standards in the nearest receiving waters.

Stormwater runoff was a significant FC loading source during both the July – October critical period and the November – June period on the White River mainstem and in the Boise Creek watershed. There was also some evidence that runoff increased FC loads and concentrations on several other tributaries throughout the watershed.

Numeric municipal stormwater wasteload allocations are established *in this TMDL* as the water quality standards (Table 35), rather than as FC loads, for several reasons including:

- The study area encompasses a large geographic area.
- Stormwater is discharged within 14 separate Phase I or II jurisdictions.
- Municipal stormwater is regulated by either a Phase I or Phase II permit within the entire study area.
- Limited stormwater data were available.

Table 36. Numeric stormwater wasteload allocations (cfu/mL).

Permittee	NPDES Permit No.	Receiving Water/s (large rivers only)	Stormwater Wasteload Allocation	
			Geo-mean	Less than 10% of samples greater than
Phase I				
King County	WAR044501A	White River	100	200
Pierce County	WAR044002A	Puyallup, White, & Carbon Rivers	100	200
City of Tacoma	WAR044003A	Puyallup River	100	200
Port of Tacoma	WAR044200A	Puyallup River	100	200
Metro Parks Tacoma*	WAR044202A	Puyallup River	100	200
Phase II				
Algona	WAR045500A	White River	100	200
Auburn	WAR045502A	White River	100	200
Bonney Lake	WAR045002A	Puyallup River	100	200
Buckley	WAR045003A	White River	100	200
Edgewood	WAR045006A	White River	100	200
Enumclaw	WAR045514A	White River	100	200
Fife	WAR045007A	Puyallup River	100	200
Orting	WAR045016A	Puyallup River & Carbon River	100	200
Pacific	WAR045535A	White River	100	200
Puyallup	WAR045017A	Puyallup River	100	200
Sumner	WAR045019A	White River & Puyallup River	100	200
WSDOT Municipal Stormwater General Permit				
WSDOT	WA043000A	Puyallup, White, & Carbon Rivers	100	200

*Secondary permittee – Parks within the study area boundaries include: the Eastside Pool and Portland Ave., Roosevelt, Rogers, Cloverdale, and Swan Creek Parks.

Ecology recognizes the difficulty of characterizing the highly variable frequency and duration of FC loads in stormwater. Numeric effluent limits for municipal stormwater discharges that are consistent with TMDLs are not often feasible or appropriate when expressing wasteload allocations in municipal stormwater permits. At this time, Ecology intends to express the numeric municipal stormwater wasteload allocations, from this TMDL, as best management practices (BMPs) that will be considered for inclusion *in the municipal stormwater permits*. Specific BMPs in the permits should be source control BMPs and BMPs that reduce the volume of discharging stormwater, or other activities to reduce fecal coliform bacteria concentrations. BMPs are considered an appropriate form of effluent limits *in permits* for control of pollutants in municipal stormwater (Wayland and Hanlon, 2002).

While implementing BMPs, jurisdictions should pay particular attention to reducing stormwater FC inputs to the White River mainstem and within the Boise Creek watershed (see Recommendations section).

Margin of safety

The federal Clean Water Act requires that TMDLs be established with a margin of safety (MOS). The MOS accounts for uncertainty in the available data, or the unknown effectiveness of the water quality controls that are put in place. The MOS can be stated explicitly (e.g., a portion of the load capacity is set aside specifically for the MOS). However, implicit expressions of the MOS are also allowed, such as conservative assumptions in the use of data, application of models, and the effectiveness of proposed management practices.

Implicit MOS elements were applied to analyses to provide a large MOS for the Puyallup River FC TMDL evaluation. The recommended FC reductions and allocations are conservatively set to protect human health and the beneficial uses to the fullest extent possible. The following are conservative assumptions that contribute to the MOS.

- The Statistical Rollback Method was applied to FC data from the most critical season. The resultant TMDL target annual FC load reductions are more stringent than would be required under the listed Washington State *Primary Contact* and *Secondary Contact Recreation* FC criteria. Namely, the geometric mean or concentration not to be exceeded in more than 10% of the samples is more stringent than 100/200 or 200/400 cfu/100 mL.

- Since the variability in FC concentrations during low-flow conditions is usually quite high, the TMDL targets and percent reduction estimated by the Statistical Rollback Method are conservative, especially if a 90th percentile is the critical criterion. In these cases, the high coefficient of variation of the log-normalized data can produce a 90th percentile value for the FC counts greater than any of the sample results used to calculate the value. This is especially true at sites with fewer than 20 data.

- Load allocations were set at several sites downstream from suspected nonpoint sources located above the most upstream site in the set, but likely influencing the downstream sites. The reduction or elimination of the FC at the upstream site will likely bring all downstream sites of the set into compliance with water quality standards.

Reasonable assurances

When establishing a TMDL, reductions of a particular pollutant are allocated among the pollutant sources (both point and nonpoint sources) in the water body. For the Puyallup River Watershed Fecal Coliform TMDL, both point and nonpoint sources exist. TMDLs (and related action plans) must show “reasonable assurance” that these sources will be reduced to their allocated amount. Education, outreach, technical and financial assistance, permit administration, and enforcement will all be used to ensure that the goals of this water cleanup plan are met.

Ecology believes that the activities listed under the prospective creek listings (see Summary of Actions) section already support this TMDL and add to the assurance that fecal coliform in the Puyallup River watershed will meet conditions provided by Washington State water quality standards. This assumes that the activities described are continued and maintained.

The goal of the Puyallup River Watershed Water Quality Improvement Plan for fecal coliform is to help the waters of the basin meet the state's water quality standards. There is considerable interest and local involvement toward resolving the water quality problems in the Puyallup River Watershed. Numerous organizations and agencies are already engaged in stream restoration and source correction actions that will help resolve the fecal coliform problem. The following rationale helps provide reasonable assurance that the Puyallup River nonpoint source TMDL goals will be met by 2022.

City of Algona, city of Auburn, city of Bonney Lake, city of Buckley, city of Edgewood, city of Enumclaw, city of Fife, city of Orting, city of Puyallup and city of Sumner

The above-mentioned cities are defined as Phase II communities by the Washington State Department of Ecology, and therefore, are required to comply with the requirements of the Phase II National Pollution Discharge Eliminination System Stormwater (NPDES) Permit. Phase II communities are those that own and operate a storm drain system, discharge to surface waters, are located in urbanized areas, and have a population of more than 1000.

City of Auburn

The city operates the Water, Sewer and Stormwater Utilities under Auburn City Code (ACC) Title 13. Stormwater is regulated under Chapter 13.48, including Water Quality (13.48.210).

The city has the responsibility for land use actions within its jurisdiction and operates under ACC Title 14, Title 16, and Title 18. ACC Title 14 covers project review. ACC Title 16 contains the regulations for Shoreline Management, Chapter 16.08 and Critical Areas, Chapter 16.10. ACC Title 18 contains the zoning code.

In 2007, the city was issued a National Pollutant Discharge Elimination System (NPDES) permit by the Washington State Department of Ecology. This permit requires the city to prepare and implement a stormwater management program to improve the quality of the water discharged from the city's storm drainage system into the Green and White Rivers, and into the ground water below the city. The Storm Drainage Utility coordinates the city's NPDES response as well as works on regional efforts to manage flooding and improve water quality.

City of Buckley

The city of Buckley is included in the group of western Washington communities falling under Phase II NPDES stormwater jurisdiction by Ecology. The city developed and adopted a Comprehensive Stormwater Management Plan and Stormwater Management Program to meet the stormwater provisions recommended by Ecology and the Puget Sound Water Quality Management Plan, which directs municipalities in the Puget Sound Basin to develop and implement a comprehensive stormwater management program.

The city of Buckley adopted provisions under BMC 14.30 and 14.40 to meet the intent of managing stormwater to minimize contact with contaminants, mitigate the impacts of increased runoff due to major buildout and development within the city's drainage areas, provide management of runoff from large and small construction sites, and to preserve wildlife habitat.

These efforts are designed to meet city goals to protect the health, safety, and welfare of the local citizenry and to preserve surface water resources within the city of Buckley.

City of Edgewood

The city's current stormwater program is governed by the requirements of Chapter 13 of the Edgewood Municipal Code (EMC). EMC 13.05 covers site development regulations and requires new development and redevelopment projects within city jurisdiction to meet stormwater management design criteria in the Stormwater Management Manual for Western Washington (Ecology, 2005). EMC 13.25 covers illicit stormwater discharges and states it is unlawful to discharge pollutants into the public storm drainage system directly or indirectly. EMC 13.25 also prohibits any cross-connection between the storm drainage system and any sanitary sewer system and includes enforcement actions and penalties for non-compliance.

The city of Edgewood Community Development has responsibility for evaluating land use proposals and making land use decisions within the city. Proposals are reviewed with respect to the city's Critical Areas Ordinance (EMC 14) which was developed in accordance with the state of Washington's Growth Management Act and EMC 18, outlining development standards and zoning. The Community Development has enforcement authority for improper land use actions. Planning decisions can have a large impact upon future loadings.

The city of Edgewood contracts with Pierce County to perform maintenance activities on the city's stormwater infrastructure. This includes inspections of collection and conveyance structures, cleaning, and repairs. Maintenance actions help to remove pollutants from the stormwater system before they are washed downstream and also to reduce nuisance flooding.

City of Enumclaw

The Public Works Department of the city of Enumclaw is authorized to enforce the following ordinances: Ordinance 2343 that adopts the use of the Ecology stormwater manual, Ordinance 2461 that deals with stormwater management, and Ordinance 2455 that regulates domestic animals, urban livestock and poultry.

Fennel Creek Preservation Group

Formed in March 2004, the FCPG is comprised of Bonney Lake citizens attentive to the impacts upon Fennel Creek from increased pressures created by urban growth.

City of Fife

The City's Public Works Department is responsible for stormwater infrastructure, drainage and flood protection, improving surface water quality, incorporating current development standards, and stormwater management.

The City's current stormwater program is governed by the requirements of Chapter 15.34 City of Fife Municipal Code. New development within city jurisdiction must meet criteria in the specified 2005 Department of Ecology Manual and current City Standards. FMC 15.32.055 Illicit discharges states it is unlawful to discharge pollutants into the public storm drainage system directly or indirectly and prohibits any cross-connection between the storm drainage system and any sanitary sewer system.

The city of Fife Community Development Department has responsibility for decision making regarding land use actions within the city. This is accomplished through evaluating land use proposals for compliance with existing city regulations and through compliance with the Critical Areas Ordinance contained in Chapter 2.58 of the Fife Municipal Code. The Planning Division has enforcement authority for improper land use actions.

Friends of Swan Creek

Friends of Swan Creek Watershed is a diverse group of adults & youth who work together to provide educational and volunteer opportunities in Swan Creek Park & Watershed. Their mission is to educate the public about the Swan Creek Watershed and engage people of all ages in activities that cultivate environmental stewardship and preserve this natural resource in the heart of an urban landscape.

City of Orting

City Engineers and the Orting Stormwater Department are responsible for stormwater infrastructure, drainage and flood protection, improving surface water quality, incorporating current development standards, and stormwater management.

As of March 31, 2011, the city is current with permit requirements. The city adopted Ecology's 2005 Stormwater Manual.

The city's stormwater program contains a permitting process that includes plan review, inspection, and enforcement capability. Plan review is performed by the city's engineers. Notices of Intent (NOIs) are submitted by the applicant to Ecology, and copies of these NOIs are maintained by the city. The city inspects all development and construction sites for compliance with BMPs, Stormwater Pollution Prevention Plans (SWPPPs), and stormwater rules. Additionally, permitted sites are inspected upon completion of construction to ensure that stormwater facilities and BMPs are in place. Any noncompliance discovered during inspections is addressed through enforcement activities as needed.

The city meets requirements for public education and outreach by attending five city events annually and is committed to community stormwater education at the student level through local classrooms. Measuring program effectiveness is assessed by surveys through mailers, city website, and local events.

The city adopted ordinances that include maintenance responsibility, maintenance schedules, and enforcement procedures related to post-construction stormwater facilities as specified in Chapter 4 of Volume V of the Stormwater Management Manual for Western Washington (revised 2005).

Public involvement, volunteer programs, future stormwater development/programs, IDDE are all included in the recordkeeping process. Recordkeeping also includes outfall maintenance and inspections; street cleaning maintenance and costs allocated with street cleaning; catch basin inspections/cleaning and allocated costs; retention pond maintenance.

City of Pacific

The city of Pacific has developed municipal code 20.48 to handle their responsibilities for stormwater.

City of Puyallup

The Stormwater Engineering Division and Collections Division of the city's Public Works Department is responsible for stormwater infrastructure, drainage and flood protection, improving surface water quality, incorporating current development standards, and stormwater management.

The city's current stormwater program is governed by the requirements of Chapter 21.10 of the Puyallup Municipals Code (PMC). New development within city jurisdiction over 1 acre in size must meet the requirements of the 2005 Department of Ecology Stormwater Manual for Western Washington, all other developments still fall under the King County Stormwater Manual.

The city of Puyallup Planning Division has responsibility for decision making regarding land use actions within the city. This is accomplished through evaluating land use proposals for compliance with existing city regulations and through compliance with the Critical Areas Ordinance contained in Chapter 21.06 of the PMC and developed in accordance with the state of Washington's Growth Management Act. The Planning Division has enforcement authority for improper land use actions. Planning decisions will have a large impact upon future loadings.

The Sewer and Stormwater Collections unit maintains and repairs all wastewater and stormwater piping, structures and related facilities. Division employees provide an important public health service with the regular cleaning and video inspection of sanitary sewer lines. The division also investigates and monitors water quality in the watershed and regulates industrial discharges. Their work is equally important in stormwater, reducing nuisance flooding by regular maintenance. They are prepared and offer critical emergency assistance during larger flood events. In addition to routine cleaning of wastewater and stormwater collection systems, significant repair and replacement of sewer and stormwater utilities are accomplished annually.

City of Sumner

The Public Works Department serves as the entity responsible for regulating and managing the development of water quality and stormwater facilities. The city approves design and implementation of stormwater infrastructure based on criteria and thresholds set forth in the adopted 2005 Stormwater Management Manual for Western Washington, Development Specifications and Standard Details Chapter 5, and Sumner Municipal Code Chapter 13. These ordinances are the regulatory mechanisms applied and enforced to maintain compliance with water quality standards and requirements of the Phase II NPDES Permit.

Sumner Municipal Code Chapter 13.48 specifically identifies types of illicit connections and discharges to the municipal separate storm sewer system not permissible without a permit. In the event an illicit discharge or connection is ascertained, the Sumner Public Works Department and Shops Department work collaboratively to identify the source(s), and work with the property owner to reduce concentrations and eliminate pollution generators. Subsequently, if environmental remediation is not acquired and/or abatement of the violation is not attained within an established timeframe, the city may again invoke Municipal Code to provide the process for exercising enforcement actions.

King Conservation District (KCD)

As a separate municipal state corporation created under Chapter 89.08 RCW, the KCD administers programs to conserve the natural resources of King County. KCD efforts focus on individual contact with farm owners and residents within the entire King County. The goals of the district are to promote practices that maximize productive land use, while conserving natural resources and protecting water quality through education, funding assistance, and cooperation.

KCD advises landowners on the implementation of BMPs to protect water quality and fish and wildlife habitat, and designs and installs stream enhancement projects. KCD holds classes, conducts farm tours and provides grants and cost-share funding for water quality-related farm improvements.

King County

The Water and Land Resources Division (WLRD) in King County Department of Natural Resources and Parks has programs in watershed and natural resource stewardship, stormwater compliance, and water quality monitoring. Following are the program descriptions.

The **Stormwater Services Section** provides education and technical assistance to prevent the contamination of stormwater through implementation of King County Code 9.12: Water Quality. Programs include source control inspections and technical assistance to businesses in the basin. The section also responds to drainage and water quality complaints that frequently include poor pet waste management and other bacterial pollution. Additionally, the section identifies and facilitates the removal of any illicit discharges to the storm drainage system, including such bacteria sources as illicit sanitary sewer connections.

The NPDES and State Waste Discharge General Permits cover discharges from municipal separate storm sewers. Phase I of the municipal stormwater program went into effect in 1990 and applies to municipalities with populations of more than 100,000.

Ecology issued the original Phase I permits in July 1995. These permits regulated the discharges from municipal separate storm sewers owned or operated by Clark, King, Pierce and Snohomish Counties, and the cities of Seattle and Tacoma. Municipal separate storm sewer systems owned or operated by the Washington State Department of Transportation (WSDOT) located in those counties and cities were also permitted under the 1995 permits. WSDOT now has a separate municipal stormwater permit.

On January 17, 2007, Ecology re-issued the Phase I municipal stormwater permit with an effective date of February 16, 2007. Ecology modified the permit on June 17, 2009 and September 1, 2010 to implement the outcomes of appeals. October 1, 2010 is the effective date of the latest permit modification. The permit expires on February 15, 2012.

The **Development and Environmental Services (DDES**) reviews development proposals to ensure that they are designed to be consistent with the Surface Water Design Manual. DDES also inspects developments during construction to ensure that stormwater runoff is controlled and that required stormwater facilities are installed according to required standards. Code Enforcement officers within the section investigate complaints of irresponsible or hazardous development in unincorporated King County that are also violations of King County Code, including zoning, housing/building, shorelines and critical areas.

The **Livestock Program** promotes proper livestock management practices and financially assists agricultural landowners with BMP implementation. Some of these BMPs include, but are not limited to, stream and wetland buffer fencing; native roof runoff management; etc. The program implements the County's 1993 Livestock Management Ordinance (KCC 21A.30)(LMO) which requires land owners under King County jurisdiction to implement best management practices to minimize the transport of non-point pollution from livestock to water bodies, and supports the raising and keeping of livestock while minimizing the adverse impacts of livestock on water quality and salmonid fisheries habitat. Proper management of manure will help reduce the potential for bacterial pollution in nearby streams. The LMO recommends implementing Farm Plans for farms with livestock.

Muckleshoot Indian Tribe

The Muckleshoot Indian Tribes' Usual and Accustomed Area (U & A) was determined in the U.S. Supreme County case U.S. v. Washington for fisheries resources that are culturally and economically important to the Tribe. The Muckleshoot Indian Tribe Fisheries Division (MITFD) has an active resource protection staff and may assist in stream restoration and water quality improvement efforts. MITFD staff review permits for all of the jurisdictions in the TMDL area and continue to monitor these permits and restoration projects to evaluate whether the TMDL is implemented and not adversely affected by future land actions.

Pierce County Public Works and Utilities, Surface Water Management Division

In addition to other responsibilities, the Surface Water Management Division of Pierce County's Public Works and Utilities Department is responsible for managing water quality and flooding through basin-specific basin planning efforts, for ensuring compliance with the stormwater quality management requirements of the Clean Water Act, and for gathering existing water quality data performing physical surveys, water quality monitoring, and coordinating public input for initiatives of the Surface Water Management Division.

Under federal regulations CFR Title 40 122.26, Pierce County manages a stormwater system. The unincorporated areas of the county are covered under a Phase I municipal stormwater NPDES permit. The county has oversight of the permit requirements and has developed both a stormwater manual and a best management practices manual for potential dischargers to this system.

Chapter 11.05 of the Pierce County Code, Illicit Stormwater Discharges (Ordinance No. 96-47), makes it unlawful for any person to discharge any pollutants into municipal drainage facilities. The county usually uses education and technical assistance to address nonpoint source pollution entering drainage ditches, but can require immediate cessation of discharges and implementation of best management practices.

There are six streams listed in this TMDL for Pierce County to focus on. The following table organizes those streams by priority based on loading, amount of creek that is within Pierce County's jurisdiction and actions needed:

Priority	***Stream/Creek***
1	Swan Creek
2	Alderton Creek
3	Salmon Creek
4	Deer Creek
5	Bowman Creek
6	Milwaukee Ditch

Pierce Conservation District (PCD)

PCD, under authority of Chapter 89.08 RCW, Conservation Districts, provides education and technical assistance to residents, develops conservation plans for farms, and assists with design and installation of best management practices. When developing conservation plans, PCD uses guidance and specifications from the U.S. Natural Resources Conservation Service. Farmers who receive a Notice of Correction from Ecology are normally referred to PCD for assistance.

In 2002, PCD requested and was granted fee funding from the Pierce County Council, in accordance with Chapter 80.08.400 RCW. This provided a stable source of funding and allowed an increase in services.

Pierce Stream Team

Pierce Stream Team is a coalition of volunteers whose goal is to improve the quality of streams in Pierce County for the benefits of fish, wildlife, and people through public education and action projects. Stream Team offers opportunities for volunteers to participate in water quality monitoring, streamside restoration with native plants, storm drain stenciling, and stream cleanup projects. Stream Team educates the public through educational displays about streams and related issues at a variety of events, including the Puyallup Fair. Stream Team is a program of the Pierce Conservation District and is available to work with partner entities and organizations to collect water quality data, restore riparian areas, and help implement other components of the NPDES permit.

Public Health Seattle-King County

Public Health Seattle-King County (PHSKC) enforces rules adopted by the state Board of Health, including rules necessary to assure safe and reliable public drinking water and protection of public health. PHSKC is responsible for assuring that installed, modified, or repaired on-site sewage systems in King County meet state and local regulations. PHSKC is fee funded and staffing is geared primarily toward processing permit applications. There is little funding available to find and properly correct failing septic systems throughout the county.

The Wastewater Program regulates on-site septic systems in accordance with Chapter 246-272 WAC. PHSKC requires pumpers and installers of on-site septic to be county-certified. Staff of the Wastewater Program issue installation and repair permits and responds to sewage complaints regarding septic systems. They also educate homeowners and provide enforcement. The program considers development and operation of community wastewater treatment systems to replace inadequate and, in some cases, failing septic systems. The Public Health Wastewater Program educates, advises, and permits owners of on-site septic systems.

Puyallup Tribe of Indians

The Puyallup Land Claims Settlement Agreement states that the Tribe and EPA have exclusive jurisdiction for administration and implementation of environmental laws on trust lands within the 1873 Survey Area of the Puyallup Reservation. EPA granted the Tribe treatment as a state under Section 518(e) of the Clean Water Act, to carry out the water quality standards program under Section 303 of the Clean Water Act on trust lands within the Reservation, including the Puyallup River. In October 1994, EPA approved the Tribe's water quality standards, which apply to the Puyallup River within Reservation boundaries.

Washington State Department of Ecology (Ecology)

Washington State Department of Ecology has responsibility under the federal Clean Water Act to establish water quality standards, coordinate water cleanup projects (TMDLs), administer NPDES permits, and enforce water quality regulations under the Water Pollution Control Act (Chapter 90.48 RCW). In addition to this regulatory role, Ecology gives grants and loans to local governments, tribes, conservation districts, and citizen groups for water quality projects. Projects that carry out water cleanup plans for TMDLs are a high priority for funding.

For non-dairy agricultural problems, farmers are typically referred to conservation districts for technical assistance if Ecology confirms that poor farm management practices are polluting surface water. If necessary, Ecology can require specific actions under Ch. 90.48 RCW, such as implementation of an approved farm plan, to correct the problem. Concentrated Animal Feeding Operations (CAFOs) that discharge or propose to discharge to waters of the state are point source polluters that are regulated by the (NPDES) permit program.

Washington State Department of Transportation (WSDOT)

WSDOT stormwater was not sampled during the TMDL study. Therefore, there is not water quality data indicating WSDOT stormwater is a source of fecal coliform. It is reasonable to assume that WSDOT stormwater may be a source or a conveyance of fecal coliform in areas were adjacent land uses are a recognized source of this bacteria. While WSDOT roadways or rights-of-way can be the source of fecal coliform bacteria at a WSDOT outfall (if measured) from adjacent private property via natural drainage, an illicit discharge, or an illegal connection, WSDOT will implement the following which include some pollution-prevention measures that address fecal coliform bacteria concentrations, for state road and highway runoff according to its Municipal Stormwater NPDES Permit and Stormwater Management Program Plan (SWMPP) in all applicable Phase I and II coverage areas:

- Discharge inventory and Illicit Discharge Detection and Elimination (source identification and control).
- Implementation of the Highway Runoff Manual (stormwater BMP design manual equivalent to Ecology's Stormwater Management Manual).
- Baseline fecal coliform stormwater grab sampling of highways (at selected sites statewide per the Permit requirements).
- Stormwater BMP retrofit program.
- Highway maintenance program.

Tacoma Pierce Health Department (TPCHD)

TPCHD regulates on-site septic systems in Pierce County in accordance with Ch. 246-272A WAC and Tacoma Pierce County Board of Health Resolution 2010-4222, and has an on-site operations and maintenance program. High-volume business systems and complex systems, both business and residential, are required to perform yearly inspections. Moderate volume business systems and systems using enhanced treatment technology are required to perform inspections every three years. Other residential systems must be inspected at time of sale. Sanitary surveys or other investigative work is usually complaint or problem driven and usually must be grant-funded. Education and outreach is accomplished through a variety of tasks, including: providing educational DVDs, presentations, and "as-built" information to property owners; giving presentations to community groups and organization; and mailings of educational materials to targeted audiences.

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Study Findings

White River watershed

Dry season (July to October)

- Fecal coliform (FC) levels at the mouth of the White River and the station at river mile (RM) 1.4 did not meet (exceeded) water quality criteria during the dry season.
  - This was due in part to both a significant increase in FC counts from RM 3.3 to 1.4 and a large portion of the FC loading capacity coming from upstream sites.
- Boise Creek was the largest FC loading source of any tributary in the TMDL study area. It also required the largest FC reduction of any dry season source.
  - FC counts were consistently high from July to September 2007, even when there was no recent precipitation.
- Salmon, Jovita, and Bowman Creeks exceeded water quality criteria during the dry season, but contributed smaller FC loads to the system compared to Boise Creek.

Wet season (November to June)

- When storm events were excluded from the statistics, wet-season FC concentrations were well below water quality criteria on the White River mainstem. With storm events included, FC counts were still below standards, but increased dramatically.
- Salmon Creek, Milwaukee Ditch at creek mile 2.2, and the unnamed tributary to White River (at both UNW-0.1 and UNW-0.2) exceeded water quality criteria during the wet season.

Storm events

- Based on five identified storm events, the White River had FC 90th percentile values greater than 200 cfu/100 mL at all sites from RM 0.1 to 18.9.
- The dry-season storm event on September 4, 2007 resulted in the only dry-season FC counts above 200 cfu/100 mL at all mainstem sites on the White River from RM 0.1 to 7.5.
- Boise Creek at the mouth exhibited a strong correlation between 12-hour rainfall of greater than 0.1 inches and high FC counts.
  - During the wet season, the four storm events each had FC counts greater than 200 cfu/100 mL. No other wet-season sample events had FC counts greater than 200.
- The February 20, 2007, storm event, with greater than one inch of rain in the preceding 24 hours, produced high FC counts and loads at all sites except WHT-23.8, LTD-0.4, and BOW-0.3.

Puyallup River watershed

Dry season (July to October for mainstem; May to October for tributaries)

- Fecal coliform levels in the Puyallup River neared, but did not exceed, the FC loading capacity at RM 1.4 and 8.5.
  - FC counts increased significantly at each of these sites when compared to the next station upstream.
  - The increase at RM 8.5 was likely due to the input of the White River upstream. FC reductions in the White River watershed should lower FC counts at this site.
  - The cause of the increase at RM 1.4 is unknown. The only measured input in this stretch, Clear Creek, was below water quality standards.

- Clarks, Deer, and upper Fennel Creeks exceeded water quality standards during the dry season. Of the three sites, Clarks Creek was the largest FC loading source.

Wet season (November to June for mainstem; May to October for tributaries)

- Wet-season FC concentrations were well below water quality standards at all sampling stations on the Puyallup River.

- Clarks, Deer, upper Swan Creeks (SWN-3.9), and Alderton Creek (10-UNO-0.3) exceeded water quality standards. Of the four sites, Clarks Creek was the largest FC loading source.

Storm events

- There was no clear relationship between recent rainfall and high FC concentrations in the Puyallup River or its tributaries.

- On the mainstem Puyallup River, FC counts were consistently low during the wet season and consistently elevated during the dry season, regardless of rainfall.

Recommendations

Cleanup priorities

The Boise Creek watershed is the number one priority cleanup basin for this Puyallup River Basin TMDL. King County and the city of Enumclaw should work together to locate and eliminate sources of fecal pollution (FC), particularly between CM 0.1 and 1.0.

Clarks Creek continues to violate water quality standards and contributes a significant FC load to the Puyallup River. The Clarks Creek watershed is the second largest tributary FC loading source in the study area that exceeds water quality standards. It is the number two priority basin.

The greatest FC water quality standards exceedences in the Puyallup and White River watersheds happened during the dry season, from July to October. Dry-season sources of contamination are of special concern, particularly for:

- Stormwater delivery to the White River mainstem.
- Boise and Clarks Creek.
- Salmon, Deer, Jovita, and Bowman Creeks.

An unnamed tributary to the White River (sites 10-UNW-0.1 and 10-UNW-0.2, at CM 0.1 and 0.2) violated water quality criteria at 10-UNW-0.2, just upstream of the Muckleshoot Indian Tribe reservation. Sources upstream of the reservation must be controlled so that state waters meet water quality standards before entering Muckleshoot land.

Within their jurisdiction, each appropriate government entity needs to reduce wet-season stormwater FC loads to the White River mainstem, Boise Creek, and the unnamed tributary to the White River within the TMDL study area.

Mainstem source identification and elimination

The appropriate jurisdiction or entity should investigate the cause of unexplained significant increases in FC concentrations within the following stream segments (numbered in order of priority). More detailed information about responsible entities and required actions is included in the implementation plan.

1. White River from RM 3.3 to 1.4. Dry-season, storm-event sampling, followed by an illicit discharge detection and elimination (IDDE) program, is needed at:
    a. Any small tributaries, drainages, or stormwater outfalls to the White River along either bank within this stretch (in city of Sumner).
    b. Stormwater outfalls for individual waste discharge NPDES permit holders within this stretch including Sonoco Products, Western Wood Preserving, and Fleischman's Vinegar, Inc.
    c. Stormwater outfalls for general industrial stormwater permit holders that may discharge within this stretch including Exide Technologies, Thermo Fluids Inc, Precision

Aerospace, Pasquier Panel Products Inc, Mcconkey and Co, Golden State Foods Sumner, Shining Ocean, and Pacific Northwest Baking Co.

2. White River from RM 23.8 to 18.9. Storm-event sampling, particularly during the dry season, is needed at the three unmonitored tributaries (Upper White Trib - 1, 2, and 3) identified in Figure 12 (in King County).

3. State water quality criteria must be met at the upstream boundary of MIT tribal waters. There is a need to monitor fecal coliform on the White River at RM 16, Site 10 –WHT18.9, and the unknown tributary to the White near 180th. Per an email received from the Muckleshoot Tribe detailing these tributaries as a source, Ecology will do source ID monitoring.

4. Puyallup River from RM 3.0 to 1.4. Dry-season sampling may be needed at:
    a. First Creek (formerly T Street gulch) on the south bank of the river (in city of Tacoma).
    b. Any other drainages or outfalls with summer baseflow to either river bank of the Puyallup River within this stretch (in city of Tacoma).
    c. This is lower priority work, because the Puyallup River mainstem was near but did not exceed the water quality standards.

5. Puyallup River from RM 12.0 to 10.3. Dry-season sampling needed at:
    a. Any drainage channels or stormwater outfalls within this stretch (aside from Alderton Creek) with summer baseflow along either the south bank (in Pierce County and city of Puyallup) or north bank (in city of Sumner).
    b. This is lower priority work, because the Puyallup River mainstem was near but did not exceed the water quality standards.

Implementation Plan

Introduction

This i*mplementation plan* describes what actions are needed to improve water quality. It expands on the recommendations from the first part of this report. This plan describes the roles and authorities of cleanup partners (that is, those organizations with jurisdiction, authority, or direct responsibility for cleanup) and the programs or other means through which they will address these water quality issues.

Typically, Ecology produces an *implementation plan*, which is submitted with the technical analysis to the U.S. Environmental Protection Agency (EPA) for approval of the TMDL. Then, following EPA approval, Ecology and interested and responsible parties work together to develop a w*ater quality implementation plan*. However, this *implementation plan* serves as both the *implementation strategy* and *implementation plan*.

This plan describes how fecal coliform bacteria levels will be reduced to meet water quality standards. Bacteria TMDL reductions in Puyallup River Watershed are expected to be achieved by 2022.

Fecal coliform bacteria primarily enter waterways from one or more of the following sources:

- Livestock with direct access to stream or with poor manure management.
- Failing or improperly constructed septic systems.
- Pet waste.
- Wildlife.
- Improperly treated sewage or other illicit discharges to the MS4 or the creek itself.

The area covered by this TMDL is large. Therefore, breaking actions by tributary helps prioritize work that needs to be done. There are two major rivers systems, the White and the Puyallup. This section breaks down each river system.

Summary of actions

White River

Boise Creek

Boise Creek was the largest fecal coliform bacteria load measured in the TMDL study. Some of the activities completed or underway include:

- King County Water and Land Resources is currently working on a pilot program to help determine sources of bacteria in county ditches. They are using bacteriological assays to attempt to discriminate between human and pasture animal sources.

- In 2010, the King Conservation District Land and Water Stewardship Workshops were held in Enumclaw. This is the ever-popular series of four nights covering streams/wetlands, mud, manure and pastures. The 2010 series spanned the period from February 11th to March 11th. Total of 25 individual people attended one or more of the workshops.

- King County Stormwater Services inventoried municipal stormwater outfalls in the summer season, and screened any dry-weather discharges for potential bacteria problems. No dry-weather discharges were determined to have a fecal count that was above the standard.

The following table describes additional actions needed to be performed in order to determine and correct sources of fecal coliform bacteria. Action items are ordered by priority with 1 being the highest and 3 being the lowest.

Entity	Action	Priority
King Conservation District	Work with local land owners to identify fecal coliform sources. Provide technical assistance for removal of sources into stormwater conveyances and the creek	1
	Work with King County to help remove fecal sources from stormwater conveyances through landowner-driven, voluntary stewardship approaches.	1
	Target outreach to properties owners along Boise Creek or drainages to include BMPs that reduce fecal coliform that enters into Boise Creek.	1
	Focused stream and wetland buffers implementation (Boise Creek and tribs) at least 2 property owners per year.	2
	Seek additional funding to assist landowners in the city of Enumclaw.	2

Entity	Action	Priority
King County Water and Land Resources Division	King County will implement the requirements of their Municipal NPDES permit IC/IDDE program when notified of water quality violations caused by stormwater discharges from the county's Municipal Separate Storm Sewer System (MS4), or notified of an illicit discharge or illicit connection to the county's MS4. This program includes tracing and investigating sources of fecal coliform pollution and eliminating any illicit connections or discharges. These actions may include, but are not limited to sampling discharges from the county's MS4 outfalls, and investigating suspect drainage from agricultural operations, septic systems, animal waste stockpiles or other potential illicit discharges to the county's MS4 system. If stormwater discharges are found to be causing or contributing to water quality violations in the receiving water then the IC/IDDE source tracing program will be implemented. King County will work with other partners (i.e. conservation district and the local health department) to remove illicit discharges and connections; and encourage and promote implementation of BMPs that control or eliminate sources of fecal coliform pollution. Particularly CM 0.1.	1
King County	Building upon the dry-weather outfall screening that King County has already conducted, and because data from Boise Creek indicate a wet-weather FC problem, the county will screen the municipal stormwater system during wet weather and will implement appropriate IC/IDDE program activities to eliminate and minimize FC sources.	1
King County	King County will inventory Commercial Animal Handling Areas (associated with Standard Industrial Code 074 and 075) and implement their business inspection program for these business types in the Boise Creek basin. The purpose of this work is to verify the implementation of source control BMPs.	1
King County Livestock Management	Implement the county's 1993 Livestock Management Ordinance (LMO) KCC21A.30, which requires land owners under King County's jurisdiction to implement best management practices to supports the raising and keeping of livestock while minimizing the adverse impacts of livestock on water quality. Provide enforcement through the Code Enforcement referrals	1

Entity	Action	Priority
City of Enumclaw	Investigate sources of fecal coliform pollution. During the wet and dry seasons. These sources are not limited to stormwater outfalls. Implement a source identification and elimination program. Focus specifically on the stormwater outfalls mentioned in Table 18 and 19 of this document. Particularly 1.0 (252nd Street). Enumclaw may need to work with other jurisdictions (i.e. conservation districts and the local health department) to remove the source from their conveyance.	1
	Develop a pet waste program or work with other jurisdictions that have pet waste programs to keep pet waste from stormwater conveyances.	2
	Work with local land owners to develop farm plans to implement water quality BMPS and to identify fecal coliform sources or join the King Conservation District so they may provide that service. Provide technical assistance for removal of sources into stormwater conveyances and the creek.	1
Public Health Seattle-King County	Respond to reports of failing septics located in the Boise Creek area and ensure the problems are corrected.	2
Washington State Department of Agriculture	Enforce the Dairy Nutrient Management Act (Ch 90.64 RCW). Respond to dairy complaints	1
	Work with any dairies near Boise Creek to assure they are not impacting fecal coliform in Boise Creek	1
Washington State Department of Ecology	Enforce the Water Pollution Control Act (Ch. 90.48 RCW)	1
	Assist stakeholders with pollution identification where available	1
	Investigate non-dairy agriculture complaints brought to our attention by complaints or other contacts	1
	Conduct TMDL effectiveness monitoring when water quality standard are expected to be achieved.	2
	Enforce the Concentrated Animal Feeding Operation NPDES permit	1

Bowman Creek

Entity	Action	Priority
King County Livestock Management	Implement the county's 1993 Livestock Management Ordinance (LMO) KCC21A.30, which requires land owners under King County's jurisdiction to implement best management practices to supports the raising and keeping of livestock while minimizing the adverse impacts of livestock on water quality. Provide enforcement through the Code Enforcement referrals	2
King Conservation District	Offer technical assistance to land owners with livestock to remove any sources of fecal coliform pollution	2
Pierce County	If sources are found in the Pierce County's jurisdiction, work with other local jurisdictions to remove sources of fecal coliform bacteria	3
City of Auburn	If fecal coliform sources are found after Ecology monitoring in the city of Auburn's jurisdiction, work with other local jurisdictions to remove sources of fecal coliform bacteria	3
Washington State Department of Agriculture	Enforce the Dairy Nutrient Management Act (Ch 90.64 RCW). Respond to dairy complaints	1
	Work with any dairies near Bowman Creek to assure they are not impacting fecal coliform in Bowman Creek	1
Washington State Department of Ecology	Enforce the Water Pollution Control Act (Ch. 90.48 RCW)	1
	Assist stakeholders with pollution identification where available	2
	Investigate non-dairy agriculture complaints brought to our attention by complaints or other contacts	1
	Sample Bowman Creek to determine exact sources of fecal coliform pollution	1
	Enforce the Concentrated Animal Feeding Operation NPDES permit	1
	Conduct TMDL effectiveness monitoring when water quality standard are expected to be achieved.	2

Jovita Creek

Entity	Action	Priority
City of Edgewood	Investigate sources of fecal coliform pollution. Particularly at Jovita Creek near West Valley Highway. These sources are not limited to stormwater outfalls. If a stormwater outfall is found to be a conveyance of fecal coliform pollution then implement a source identification and elimination program. Edgewood will need to work with other jurisdictions (i.e. conservation districts and the local health department) to remove the source from their conveyance.	1
King County Stormwater Services	Investigate sources of fecal coliform pollution. These may include, but are not limited to stormwater outfalls drainages from cross-connected sanitary sewers, pastures, pet waste or other discharges to the conveyance system. If a stormwater outfall is found to be conveying fecal coliform pollution, implement a source identification and elimination program. .	2
Washington State Department of Ecology	Enforce the Water Pollution Control Act (Ch. 90.48 RCW)	1
	Assist stakeholders with pollution identification where available	2
	Investigate non-dairy agriculture complaints brought to our attention by complaints or other contacts	1
	Enforce the Concentrated Animal Feeding Operation NPDES permit	1
	Conduct TMDL effectiveness monitoring when water quality standards are expected to be achieved.	2

Milwaukee Ditch

Entity	Action	Priority
City of Algona	If stormwater sources are found in the city's jurisdiction during sampling performed by Ecology, actions will need to be determined to remove those sources during adaptive management.	2
City of Pacific	If stormwater sources are found in the city's jurisdiction during sampling performed by Ecology, actions will need to be determined to remove those sources during adaptive management.	2

Entity	Action	Priority
City of Edgewood	If stormwater sources are found in the city's jurisdiction during sampling performed by Ecology, actions will need to be determined to remove those sources during adaptive management.	2
King County Stormwater Services	If stormwater sources are found in King County's jurisdiction during sampling performed by Ecology, actions will need to be determined to remove those sources during adaptive management.	2
Pierce County	If stormwater sources are found in Pierce County's jurisdiction during sampling performed by Ecology, actions will need to be determined to remove those sources during adaptive management.	2
Washington State Department of Ecology	Sample creek to determine exact sources of fecal coliform pollution	1
	Enforce the Water Pollution Control Act (Ch. 90.48 RCW)	1
	Assist stakeholders with pollution identification where available	2
	Investigate non-dairy agriculture complaints brought to our attention by complaints or other contacts	1
	Enforce the Concentrated Animal Feeding Operation NPDES permit	1
	Conduct TMDL effectiveness monitoring when water quality standard are expected to be achieved.	2
Washington State Department of Transportation	WSDOT municipal stormwater permit regulates stormwater discharges from state highways and related facilities owned or operated by WSDOT within the Phase I and II designated boundaries. WSDOT's permit also covers stormwater discharges to any water body in Washington State for which there is an EPA approved TMDL with load allocations and associated discharges (applicable TMDLs listed in Appendix 3 of WSDOT permit). Because municipal stormwater is regulated by either a Phase I or II permit within the entire TMDL study area. WSDOT is required to implement the following actions within the entire TMDL study area. WSDOT will implement the following, which include some pollution-prevention measures that address fecal coliform bacteria concentrations, for state road and highway runoff according to its Municipal Stormwater NPDES Permit and Stormwater Management Program Plan (SWMPP) and in all applicable Phase I and II coverage areas:	2

Entity	Action	Priority
Washington State Department of Transportation (cont;d)	• discharge inventory/IDDE (source identification and control), • implementation of the Highway Runoff Manual (stormwater BMP design manual equivalent to Ecology's Stormwater Management Manual), • baseline fecal coliform stormwater grab sampling of highways (at selected sites statewide per the Permit requirements) • stormwater BMP retrofit program, and • highway maintenance program.	

Salmon Creek

The city of Sumner has started monitoring on Salmon Creek. After inspecting the outfalls of salmon creek, an illicit discharge was examined and tested positive for fecal counts. Sumner identified an area of (3-4) homes that suggests failing septic system, based on the discoloration of water initiating at a certain section of pipeline. The Health Department was notified and they are investigating these sites. The city of Sumner will continue to sample and test Salmon Creek to identify areas where fecal counts are high enough to suggest a possible source. They been send updates as things develop and as significant information presents itself.

Entity	Action	Priority
City of Sumner	Investigate sources of fecal coliform pollution in Salmon Creek. These sources are not limited to stormwater outfalls. If a stormwater outfall is found to be a conveyance of fecal coliform pollution then implement a source identification and elimination program. Sumner will need to work with other jurisdictions (i.e. conservation districts and the local health department) to remove the source from their conveyance.	1
Pierce Stream Team	Assist in any volunteer monitoring that is needed to determine fecal coliform sources	2
Pierce County	Perform IDDE on the portion of Salmon Creek that is within the jurisdiction boundary near the headwaters	2
Tacoma Pierce County Health Department	Continue working on failing septic issues along Salmon Creek	1
Washington State Department of Ecology	Enforce the Water Pollution Control Act (Ch. 90.48 RCW)	1
	Assist stakeholders with pollution identification where available	2
	Enforce the Concentrated Animal Feeding Operation NPDES permit	1
	Investigate non-dairy agriculture complaints brought to our attention by complaints or other contacts	1
	Perform inspections of stormwater sites and other permitted facilities	1
	Conduct TMDL effectiveness monitoring when water quality standard are expected to be achieved.	2

Tributary to the White River at Auburn Riverside High School

Entity	Action	Priority
City of Auburn	The city shall conduct a sampling program to quantify possible fecal coliform bacteria contamination to the White River resulting from the Mill Pond municipal outfall. The sampling shall examine wet weather flows beginning in the fall of 2011, A sampling plan and results shall be submitted to Ecology	1
	If fecal coliform concentrations are found to exceed the wasteload allocation then the city shall conduct a source identification and reduction program. The program will investigate sources of fecal coliform bacteria in the Mill Pond outfall drainage area and use approved BMPs, as needed, to reduce fecal coliform concentrations to meet the waste load allocation.	2
Washington State Department of Ecology	Sample this creek to determine exact sources of fecal coliform pollution	2
	Enforce the Water Pollution Control Act (Ch. 90.48 RCW)	1
	Assist stakeholders with pollution identification where available	2
	Investigate non-dairy agriculture complaints brought to our attention by complaints or other contacts	1
	Enforce the Concentrated Animal Feeding Operation NPDES permit	1
	Perform inspections of stormwater sites and other permitted facilities	1
	Conduct TMDL effectiveness monitoring when water quality standard are expected to be achieved.	2

Tributary at RM 16, Site 10 WHT 18.9 of the White River, and Unknown tributary to White at 180th

A tributary entering a side channel near RM 16, the Site 10 WHT at RM 18.9, and the unknown tributary of the White River at 180^{th} was not monitored as part of this TMDL. However, per an email received by the Muckleshoot Indian Tribe dated April 18, 2011, stating they have data that shows this as a fecal coliform source. State water quality criteria must be met at the upstream boundary of MIT waters. Ecology will perform source ID work.

Washington State Department of Ecology	Sample tributary to determine exact sources of fecal coliform pollution	1
	Enforce the Water Pollution Control Act (Ch. 90.48 RCW)	1
	Enforce the Concentrated Animal Feeding Operation NPDES permit	1
	Investigate non-dairy agriculture complaints brought to our attention by complaints or other contacts	1
King County Livestock Management	Implement the county's 1993 Livestock Management Ordinance (LMO) KCC21A.30, which requires land owners under King County's jurisdiction to implement best management practices to supports the raising and keeping of livestock while minimizing the adverse impacts of livestock on water quality. Provide enforcement through the Code Enforcement referrals	1
Washington State Department of Agriculture	Enforce the Dairy Nutrient Management Act (Ch 90.64 RCW). Respond to dairy complaints	1
	Work with any dairies near RM 16 to assure they are not impacting fecal coliform	1

Puyallup River

Alderton Creek

Entity	Action	Priority
Pierce County	Investigate sources of fecal coliform pollution in Alderton Creek. These may include, but are not limited to stormwater outfalls. If a stormwater outfall is found to be a conveyance of fecal coliform pollution then implement a source identification and elimination program. Pierce County will need to work with other jurisdictions (i.e. conservation districts and the local health department) to remove the source from their conveyance.	1
Pierce Stream Team	Assist in any volunteer monitoring that is needed to determine fecal coliform sources	3
Pierce Conservation District	Offer technical assistance to land owners with livestock to remove any sources of fecal coliform pollution	2
Tacoma Pierce County Health Department (Environmental Health)	Investigate referrals from citizens/local governments where there is evidence of suspected on-site sewage failures.	2
Washington State Department of Ecology	Enforce the Water Pollution Control Act (Ch. 90.48 RCW)	1
	Assist stakeholders with pollution identification where available	2
	Enforce the Concentrated Animal Feeding Operation NPDES permit	1
	Investigate non-dairy agriculture complaints brought to our attention by complaints or other contacts	1
	Conduct TMDL effectiveness monitoring when water quality standard are expected to be achieved.	2

Clarks Creek

Clarks Creek Fecal Coliform TMDL is currently underway. There are many actions planned and water quality standards are expected to be met by 2015. This will meet the target set in this TMDL. See *Clarks Creek TMDL Water Quality Implementation Plan* - Ecology publication number 09-10-081.

Deer Creek

The city of Puyallup is working with Washington Department of Fish and Wildlife (WDFW) on controlling the water levels on the beaver dam located immediately behind the East Main Safeway.

The city of Puyallup tested the landfill adjacent to Deer Creek for fecal coliform to assure that it was not a potential source. Testing confirmed that it is not a source.

The city of Puyallup has appraised land near Shaw Road on Deer Creek as a potential regional detention pond and for Shaw Road widening. This property is large enough, to restore riparian habitat along Deer Creek (currently open reed canary grass pasture), provide peak flow detention storage and possibly a soccer field or two for public recreation. If the property is purchased, grant applications will be made for design/construction. This project should have at least a nominal positive effect on fecal coliform in Deer Creek.

Entity	Action	Priority
City of Puyallup	Investigate sources of fecal coliform pollution entering Deer Creek. Particularly during the dry season (May through October). These may include, but are not limited to stormwater outfalls. If a stormwater outfall is found to be a conveyance of fecal coliform pollution, implement a source identification and elimination program. Puyallup will need to work with other jurisdictions (i.e. conservation districts and the local health department) to remove the source from their conveyance.	1
	Puyallup will work on illicit discharge detection and elimination as part of the NPDES Phase II permit compliance. Map cross connections and areas of septic influence.	1
Pierce Conservation District	Offer technical assistance to land owners with livestock to remove any sources of fecal coliform pollution from the creek.	3
Pierce Stream Team	Assist in volunteer monitoring that is needed to determine fecal coliform sources	2
Pierce County	Investigate sources of fecal coliform pollution in upper Deer Creek. These may include, but are not limited to stormwater outfalls. If a stormwater outfall is found to be a conveyance of fecal coliform pollution then implement a source identification and elimination program. Pierce County will need to work with other jurisdictions (i.e. conservation districts and the local health department) to remove the source from their conveyance.	2
Tacoma Pierce Health Department (Environmental Health)	Investigate referrals from citizens/local governments where there is evidence of suspected on-site sewage failures.	2
Washington State Department of Ecology	Enforce the Water Pollution Control Act (Ch. 90.48 RCW)	1
	Assist stakeholders with pollution identification where available	2
	Investigate non-dairy agriculture complaints brought to our attention by complaints or other contacts	1
	Enforce the Concentrated Animal Feeding Operation NPDES permit	1
	Perform inspections of stormwater sites and other permitted facilities	1
	Conduct TMDL effectiveness monitoring when water quality standard are expected to be achieved.	2

Fennel Creek

Fennel Creek is located at the lowest elevation in the local geological area and is fed by numerous seeps, springs and unnamed tributaries. Therefore, anything that washes from adjacent uplands parcels would carry contaminants into the watershed and become a potential problem.

Bonney Lake currently has a "Septic System Abatement Plan." It is a plan on how sewer lines will be brought to homes that are older and have potentially failing septics. This program is implemented as funding allows.

Entity	Action	Priority
City of Bonney Lake	Investigate sources of fecal coliform pollution. These sources are not limited to stormwater outfalls. If a stormwater outfall is found to be a conveyance of fecal coliform pollution, implement a source identification and elimination program. Bonney Lake will need to work with other jurisdictions (i.e. conservation districts and the local health department) to remove the source from their conveyance.	2
	Continue to implement the septic system abatement plan as funding allows.	3
Fennel Creek Preservation Group	Continue to engage in education & stewardship activities in the Fennel Creek Watershed.	3
Pierce Conservation District	Offer technical assistance to land owners with livestock to remove any sources of fecal coliform pollution	2
Tacoma Pierce Health Department (Environmental Health)	Investigate referrals from citizens/local governments where there is evidence of suspected on-site sewage failures.	2
Washington State Department of Ecology	Enforce the Water Pollution Control Act (Ch. 90.48 RCW)	1
	Investigate non-dairy agriculture complaints brought to our attention by complaints or other contacts	1
	Enforce the Concentrated Animal Feeding Operation NPDES permit	1
	Conduct TMDL effectiveness monitoring when water quality standard are expected to be achieved.	2

First Creek

Washington State Department of Ecology	Sample creek in the dry season to determine sources of fecal coliform	1

Swan Creek

Tacoma Metro Parks has begun their master plan planning process for Swan Creek Park, with the draft plan slated for completion by summer. Although the area this involves is not directly where samples were taken for this TMDL, it will help to improve the overall health of Swan Creek.

Entity	Action	Priority
Friends of Swan Creek Watershed	Engage in stewardship activities in the Swan Creek area particularly Swan Creek Park	2
Pierce County	Investigate sources of fecal coliform pollution. These may include, but are not limited to stormwater outfalls. If a stormwater outfall is found to be a conveyance of fecal coliform pollution, implement a source identification and elimination program. Pierce County will need to work with other jurisdictions (i.e. conservation districts and the local health department) to remove the source from their conveyance.	1
Pierce Stream Team	Assist in any volunteer monitoring that is needed to determine fecal coliform sources	2
Tacoma Pierce Health Department (Environmental Health)	Investigate referrals from citizens/local governments where there is evidence of suspected on-site sewage failures.	2
Washington State Department of Ecology	Enforce the Water Pollution Control Act (Ch. 90.48 RCW)	1
	Assist stakeholders with pollution identification where available	2
	Enforce the Concentrated Animal Feeding Operation NPDES permit	1
	Investigate non-dairy agriculture complaints brought to our attention by complaints or other contacts	1
	Conduct TMDL effectiveness monitoring when water quality standard are expected to be achieved.	2

Dry season sampling may also be needed on any drainages or outfalls with summer baseflow to the Puyallup River from:

- RM 3.0 to 1.4. This includes city of Tacoma on both the north and south bank.
- RM 12.0 to 10.3. This includes city of Sumner to the north bank and city of Puyallup and Pierce County to the south bank.
- This is lower priority work, because the Puyallup River mainstem was near but did not exceed the water quality standards.

In addition to the specific actions on specific waterways, the following permit holders should perform dry season stormwater event sampling for one year to determine if fecal coliform bacteria inputs exist in their discharge in or near the White River. Permit holders should develop a sampling plan for each permitted facility for Ecology to review.

Permit Holder	Number	Type
Sonoco Products**	WA0000884	Individual
Western Wood Preserving	WA0040738	Individual
Fleishman's Vinegar	WA0038598	Individual
Exide Technologies	WAR010598	General Industrial Stormwater
Thermo Fluids Inc	WAR004376	General Industrial Stormwater
Precision Aerospace	WAR010778	General Industrial Stormwater
Pasquier Panel Products Inc	WAR010604	General Industrial Stormwater
Mcconkey and Co	WAR002526	General Industrial Stormwater
Golden State Foods Sumner	WAR002512	General Industrial Stormwater
Shining Ocean	WAR009732	General Industrial Stormwater
Pacific Northwest Baking	WAR011009	General Industrial Stormwater

****** Sonoco completed a fecal coliform test per permit requirement S14. The report did not find the cause of high fecal coliform counts. Further investigation is required to eliminate fecal coliform from the discharge.

What is the schedule for achieving water quality standards?

TMDL reductions should be achieved by 2022. These targets will be described in terms of concentrations and/or loads, as well as in terms of implemented cleanup actions. Partners will work together to monitor progress toward these goals, evaluate successes, obstacles, and changing needs, and make adjustments to the cleanup strategy as needed.

It is ultimately Ecology's responsibility to assure that cleanup is being actively pursued and water standards are achieved.

Adaptive management

While Ecology is authorized under Chapter 90.48 RCW to impose strict requirements or issue enforcement actions to achieve compliance with state water quality standards, it is the goal of all participants in the Puyallup River TMDL process to achieve clean water through voluntary control actions.

TMDL reductions for fecal coliform should be achieved by 2022. This plan contains interim targets. These targets are described in terms of concentrations and/or loads, as well as in terms of clean up actions. Interim targets of a 50 percent reduction should be achieved by 2017. Partners will work together to monitor progress toward these goals, evaluate successes, obstacles and changing needs, and make adjustments to the cleanup strategy as needed. Adaptive management will help to adjust implementation efforts in order to make them the most effective. Adaptive management meetings will be held to discuss progress and redirect unsuccessful implementation.

Ecology will consider and issue notices of noncompliance, in accordance with the Regulatory Reform Act, in situations where the cause or contribution to the cause of noncompliance with load allocations can be established.

Monitoring progress

Ecology will perform interim monitoring when enough actions have been achieved to suspect a 50 percent reduction in fecal coliform bacteria. Implementation will be tracked at annual adaptive management meeting beginning in 2012.

Effectiveness monitoring plan

Effectiveness monitoring is performed to determine if the interim targets and overall water quality standards goal have been met after the measures described in the water quality implementation plan have been installed and are functioning properly.

Before effectiveness monitoring is performed, a quality assurance project plan (QAPP) will be prepared. The QAPP should follow Ecology guidelines (Lombard and Kirchmer, 2004), paying particular attention to consistency in sampling and analytical methods. Monitoring objectives should clearly be established to ensure that sampling results will meet those objectives. Monitoring personnel will consult with the original TMDL modeler to determine critical parts of the implementation plan and to verify critical locations. Separate QAPPs should be developed for the implementation and effectiveness monitoring efforts as they should have different monitoring objectives.

Effectiveness monitoring will be performed to determine the effectiveness of this implementation plan. Effectiveness monitoring will compare the results from BMP implementation against attainment of water quality standards. Information from the ten-year report cards will be compiled and evaluated. Water quality monitoring in Salmon Creek and tributaries will be performed such that comparisons with the initial 303(d) listing information can be made. If the results from the effectiveness monitoring show that water quality standards are now being met, this information should be provided to Ecology through the Water Quality Assessment process.

Potential funding sources

Multiple sources of financial assistance for water cleanup activities are available through Ecology's grant and loan programs, local conservation districts, and other sources. Table 37 shows some of the potential sources of water cleanup funding.

Table 37. Possible Funding Sources to Support TMDL Implementation

Sponsoring Entity	Funding Source	Uses to be Made of Funds
Department of Ecology, WQP	Centennial Clean Water Fund, Section 319, and State Revolving Fund http://www.ecy.wa.gov/programs/wq/funding/	Facilities and water pollution control-related activities; implementation, design, acquisition, construction, and improvement of water pollution control. Priorities include: implementing water cleanup plans; keeping pollution out of streams and aquifers; modernizing aging wastewater treatment facilities; reclaiming and reusing waste water.
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.
County 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).
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	Grant Exchange, including six grant programs http://dnr.metrokc.gov/grants/	Restoration, water quality improvement, education projects.
Office of Interagency Committee, Salmon Recovery Board	Salmon Recovery Funding Board http://www.iac.wa.gov/srfb/grants.asp	Provides grants for habitat restoration, land acquisition and habitat assessment.
Natural Resources Conservation Service	Emergency Watershed Protection http://www.nrcs.usda.gov/programs/ewp/index.html	NRCS purchases land vulnerable to flooding to ease flooding impacts.
Natural Resources Conservation Service	Wetland Reserve Program http://www.wa.nrcs.usda.gov/programs/wrp/wrp.html	Landowners may receive incentives to enhance wetlands in exchange for retiring marginal agricultural land.

Ecology will work with stakeholders to identify funding sources and prepare appropriate scopes of work that will help implement this TMDL.

Summary of public involvement methods

A website was set up at the beginning of this project to inform both stakeholders and the public how the subcommittee meetings were progressing. A display ad was placed in the News Tribune on Monday, May 23, 2011, the Puyallup Herald and the Enumclaw Courier on Wednesday, May 25, 2011.

Next steps

After approval of the TMDL by EPA, Ecology will work with stakeholders to implement actions that are recommended and work toward meeting water quality standards by 2022.

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Appendices

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Appendix A. Glossary, Acronyms, and Abbreviations

Glossary

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

Baseflow: The component of total streamflow that originates from direct groundwater discharges to a stream.

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

Boxplot: A graphical representation of data that shows the distribution including the mean, quantiles, and minimum and maximum values. Typically the "box" represents the middle 50% of the data. In order to plot the 90th percentile value, fecal coliform box plots show the middle 80% of the data.

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

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

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

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

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

Fecal coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2 degrees Celsius. Fecal coliform bacteria are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100mL).

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

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

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

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

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): (1) 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 (2) designed or used for collecting or conveying stormwater; (3) which is not a combined sewer; and (4) which is not part of a Publicly Owned Treatment Works (POTW) as defined in the Code of Federal Regulations at 40 CFR 122.2.

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

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

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

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

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

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

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or is likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) 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.

Reach: Stream segment.

Riparian: Transitional zone between aquatic and upland areas. The riparian area has vegetation or other physical features reflecting permanent influence on surface water or subsurface water.

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

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, salt waters, wetlands and all other surface waters and watercourses within the jurisdiction of Washington State.

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

Wasteload allocation: The portion of a receiving water's loading capacity allocated to existing or - point sources of pollution. Wasteload allocations constitute one type of water quality-based effluent limitation.

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

90th percentile: A statistical number obtained from a distribution of a data set, above which 10% of the data exists and below which 90% of the data exists.

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

BMP	Best management practices
cfs	Cubic feet per second
CM	Creek mile
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FC	Fecal coliform bacteria
Geomean	Geometric mean
GIS	Geographic Information System software
IWDP	Individual Wastewater Discharge Permit
ISWGP	Industrial Stormwater General Permit
Max	Maximum
Min	Minimum
MQO	Measurement quality objective
NPDES	National Pollutant Discharge Elimination System
RM	River mile
RPD	Relative percent difference
RSD	Relative standard deviation
TMDL	Total Maximum Daily Load (water cleanup plan)
Trib	Tributary
USGS	United States Geological Survey
WAC	Washington Administrative Code
WRIA	Water Resources Inventory Area
WSDOT	Washington State Department of Transportation
WWTP	Wastewater treatment plant

Appendix B. Record of public participation

Introduction

A presentation of technical findings was given on September 30, 2009 to the members of the technical advisory committee at the Bonney Lake Library. The watershed is very large so it was decided to break all meetings in to smaller subcommittees by tributary. There was a website developed to tell people about the meetings; http://www.ecy.wa.gov/programs/wq/tmdl/puyallup/bacteria.html.

Summary of comments and responses

See Response to Comments.

Outreach and announcements

A 30-day public comment period for this report was held from May 18, 2011 through June 20, 2011.

A Display ad was placed in the following publications:

- The Tacoma News Tribune
- The Puyallup Herald
- The Enumclaw Courier

DEPARTMENT OF
ECOLOGY
State of Washington

Comments requested on the Draft Puyallup Watershed Water Quality Improvement and Implementation Plan for fecal coliform

There are too many fecal coliform bacteria in the Puyallup River Watershed. Fecal coliform is a type of bacteria found in the intestinal tract of warm blooded animals. In 2006, the Department of Ecology (Ecology) collected water quality data in response to impairment listings on the 303(d) list. The results showed that waters in the Puyallup River Watershed have higher than normal amounts of fecal coliform bacteria. Ecology analyzed the data and made recommendations to reduce fecal coliform pollution in the Puyallup and White Rivers and the following tributaries (Deer, Clarks, Swan, Alderton, Boise, Bowman, Jovita, Salmon, and Milwaukee).

Ecology has worked with many different local governments, citizens groups and permit holders to come up actions needed to reduce fecal coliform inputs in the Puyallup River Watershed. The draft plan has identified implementation activities for various partners, many are already underway.

Public comment period
May 18 – June 20, 2011

The Plan is available for review online at:
http:www.ecy.wa.gov/biblio/1110040.html

In person (will be available after May 25) at:

Puyallup Library
324 S Meridian
Puyallup, WA 98371

Enumclaw Library
1700 First Street
Enumclaw, WA 98022

Please send comments by June 20, 2011 to Cindy James, Department of Ecology, PO Box 47775, Olympia WA 98504-7775, or email at Cindy.James@ecy.wa.gov

Your comments are encouraged during the public comment period through June 20, 2011.

For more information, please call Cindy James at 360-407-6556, or e-mail Cindy.James@ecy.wa.gov.

Appendix C. Response to public comments

Ecology received comments from King County, Pierce County, Muckleshoot Indian Tribe, city of Puyallup and a private citizen. Below are the comments received and the responses to them.

Comments from Peter Laney, citizen

Comment 1:
I went through the draft this morning and have one comment. If you could put the main roads/highways in the maps a person like me in Pierce County would be able to zero in quickly on the issue "am I part of the problem or not" or "am I close to one of the named problem areas".

Response 1:
Comment noted. We have added major highways to the maps to help further identify problem areas.

Comments from Dan Wrye, Pierce County Surface Water Management

Comment 1:
We note that the Puyallup River Watershed Fecal Coliform TMDL does not include the South Prairie Creek or the Clark Creek basins. We understand that the reason for this is because those streams already have been modeled for other TMDLs. Pierce County thinks this is unfortunate, for the reasons we state above (see letter) concerning the benefits of a whole watershed perspective.

Between the two omissions, clearly Clarks Creek stands out. We note that the TMDL assigns Clarks Creek as the second largest FC loading source in the Puyallup River Watershed (by far and away), yet it is not included in the rank order list of streams for Pierce County to focus on (page 84). Addressing Clarks Creek, which is also currently undergoing a dissolved oxygen TMDL, will be an overall priority for Pierce County, meaning the six streams in the Puyallup River Watershed Fecal Coliform TMDL (Swan Creek, Alderton Creek, Deer Creek, Salmon Creek, Milwaukee Creek, and Bowman Creek) will be prioritized in relationship to and in consideration of Clarks Creek significant FC loading source and for its dissolved oxygen concerns in the watershed.

Response 1:
We have referenced the other TMDLs (Clarks and South Prairie) in this TMDL; however, they are at different levels of completed implementation so the reference was the best way to include them.

To specifically address Clarks Creek, the Clarks Creek Fecal Coliform TMDL's requirements for Pierce County are limited to the tributaries. Since the majority of Clarks Creek lies under the city of Puyallup's jurisdiction, the majority of the action items are in Puyallup. We appreciate the priority focus on the tributary work for fecal coliform, but feel at least the one and two priority of this TMDL are a higher priority.

The Clarks Creek DO TMDL is still under development, and does not address fecal coliform. Priority actions in this TMDL will be important, but have not been developed yet.

Comment 2:
Page 74, under Urban Stormwater. We concur and support Ecology's intention to express municipal stormwater wasteload allocations as best management practices (BMPs). We request this statement be modified to include "to the maximum extent possible".

Response 2:
Comment noted. Ecology believes the existing statement in the TMDL is appropriate. The determination of "maximum extent practicable" is made when the BMPs are included in the permit, and there is opportunity for comment on that determination with the draft permit.

Comment 3:
Pierce County is prepared to implement the BMPs recommended in the TMDL beginning in 2012. Pierce County does not see a need for Ecology to include them in our next municipal permit and requests Ecology not to do so. If Ecology decides to so do, Pierce County requests the opportunity to review and comment on the BMPs and permit language and requests Ecology to so do in the context of other permit changes to minimize increased cost of compliance or potentially contradicting permit obligations.

Response 3:
Ecology is required to evaluate any EPA-approved TMDLs for inclusion of BMPs necessary to achieve waste load allocations in the next version of the permit. Pierce County will have the opportunity to review and comment on the draft permit prior to issuance.

Comment 4:
Also on Page 74, the draft implementation document states that municipal stormwater wasteload allocations (WLAs) are established as water quality standards. This second statement on WLAs on the same page as (1) above, contradicts the establishment of WLAs as BMPs. Again Pierce County supports BMPs as municipal stormwater WLAs. We do not support water quality standards as WLAs. Under either circumstance, we request this statement to be modified to include "to the maximum extent practicable".

Response 4:
Commented noted. Ecology recognizes these statements might be confusing, but they do not directly contradict each other. One statement says the WLAs <u>in the TMDL</u> are set as the water quality criteria, while the other statement says that these numeric WLAs should be implemented as BMPs <u>in the NPDES permits</u>. This section has been rearranged to improve clarity.

Comment 5:
Pages xv, 60, 61, 75 and 101 all confirm the importance of implementing Clarks Creek as a Fecal Coliform load to the watershed and supports Pierce County in-watershed prioritizing in consideration of the six streams in this TMDL with Clarks Creek for work planning of available resources over the next several years.

Response 5:
See response to first comment from Pierce County.

Comment 6:
Pierce County supports the implementation recommendations contained on pages 91-104; Pierce County has already begun implementation. As indicated above (1) we support implementation of these BMPs to the maximum extent practicable and (4) in consideration of Clarks Creek.

Response 6:
Thank you for the information. We will keep it for our implementation adaptive management meeting in 2013.

Comment 7:
Pierce County notes the absence of the city of Tacoma in the implementation plan. The City has parts of the Swan Creek and First Creek basins within its jurisdiction. Is there a reason it is not listed within the implementation plan?

Response 7:
The portion of Swan and First Creeks that need reductions in fecal coliform are above the jurisdiction of the city of Tacoma. After several meetings with them, it was clear that the reductions needed are upstream, in the Pierce County portions of the watershed.

Comments from Mark Palmer, City of Puyallup

Comment 1:
On page 80, the City organization is described incorrectly. It should read "The Stormwater Engineering Division and Collections Division of the city's Public Works Department."

Response 1:
Commented noted, change made.

Comment 2:
The second paragraph under City of Puyallup on page 80 indicates that new development must meet the specified King County manual. This requirement was changed in 2010 to meet NPDES permit requirements. This should now read "New development within city jurisdiction over 1 acre in size must meet the requirements of the 2005 Department of Ecology Stormwater Manual for Western Washington, all other developments still fall under the King County Stormwater Manual."

Response 2:
Commented noted, change made.

Comment 3:
On page 102, the first paragraph describes the 12th Avenue Southeast Regional Stormwater Detention Project. Please be advised that the City Council recently remanded the purchase of this property back to staff, and a full analysis and staff report, but other alternative solutions may

be staff's recommendation upon completion of the staff report. At a minimum please revise the last sentence of the paragraph to read "If the property is purchased…".

Response 3:
Comment noted, change made.

Comments from Dan Repp, city of Auburn

Comment 1:
Page 77, apparently a search and replace was done on the words "Mill Creek" it produced an error in the description of City of Auburn receiving waters. The report now states that the City discharges to Milwaukee Ditch which is incorrect. The City of Auburn drainage area starts in the Boundary Blvd area and flows north from there not south.

Response 1:
Milwaukee Ditch is a drainage ditch that parallels Hwy 167 and flows south into the White River. During the project planning process, Milwaukee Ditch was mistakenly identified as Mill Creek. Mill Creek is a tributary that flows north to the Green River and drains the areas immediately north of Milwaukee ditch. In the report, the name Mill Creek has been replaced with Milwaukee Ditch to correct this error.

Based on the Washington State DNR watercourse GIS layer, the city of Auburn was identified as a potential contributor to the Milwaukee Ditch drainage. Comments from multiple jurisdictions prompted Ecology to further investigate the sub-basin drainage area boundaries for both Milwaukee Ditch and Mill Creek. Based on several descriptions from other studies and other watercourse maps, it appears that the city of Auburn drainage area likely does not contribute to Milwaukee Ditch. The city of Auburn has been removed from the list of action items and the reference to the city discharging to Milwaukee Ditch has been corrected.

Comment 2:
Page 95 – Bowman Creek Action Items

The city of Auburn disagrees with adding the City to the Bowman Creek action item list. The City's concern is that it will be responsible for a 1st priority action item even though it's currently unknown that fecal contamination is occurring within City jurisdiction. The City requests that Ecology, rather than speculating on sources of contamination, complete its proposed sampling effort and then defines pollutant sources before assigning clean up actions.

The city of Auburn believes that some of the Bowman Creek action item priorities will not be effective at reducing fecal bacteria pollution in the Creek. King County Livestock Management, King Conservation District, Pierce County actions should have higher priorities than shown. The rural to semi-rural nature of the Bowman Creek watershed means that livestock and hobby farms are the most likely sources of fecal bacteria and King County Livestock Management and King Conservation District are the agencies best suited for reducing livestock pollution. The action item priority for King County Livestock Management and King Conservation District should be increased from 2 to 1.

Additionally, the headwaters of Bowman Creek originate in unincorporated Pierce County and it makes sense to remove pollutant sources higher in the watershed first since pollutants move downstream. Therefore the action item for Pierce County should increase from 3 to 1.

Response 2:
Information collected during sampling was limited. Therefore, we need more information on Bowman Creek to answer the question on the sources of pollution. The number one priority is for Ecology to perform source identification on the creek to help the multi-jurisdictional representatives prioritize their work. There is a very small portion of Bowman Creek in Pierce County, and much more of it in King County. You are correct in stating it has a rural setting; therefore the number two priority is for the King Conservation District and King County Livestock management to work together on the majority of the stream making sure livestock best management practices are followed. We agree that the city should not be a number one priority, and have changed it to a three. If we still do not reach our fecal coliform reductions after our investigations, then we will look to Pierce County to work on the uppermost area where the headwaters begin and Auburn to deal with any issues that may be part of their stormwater drainage.

Comment 3:
Page 96 Summary of Actions for Milwaukee Ditch

Auburn is incorrectly listed as a contributor to this drainage system.

Response 3:
Comment noted, see response above.

Comments from Kenneth Stone, Washington State Department of Transportation

Comment 1:
Page xi, third paragraph: page 13, Table 4; page 14, Table 5; page 33, fourth paragraph, and page 63, third paragraph.

Suggest replacing references to "not more than 10% of samples…" with 90th percentile of sample results" for consistency with page Xiv and to eliminate confusion as to which criterion is being used in the TMDL.

Response 1:
Comment noted. Ecology recognizes that the use of both the "not more than 10% of the samples" and the 90th percentile may be confusing; however, the use of both is necessary in the context of the TMDL. The "not more than 10% of samples" must be used to determine if a water body is in compliance with fecal coliform criteria in Washington State's water quality standards. The 90th percentile values are necessary to calculate the percent reduction in fecal coliform needed to meet both parts of the water quality standard. The percent reduction (based on the 90th percentile) represents the general amount of cleanup needed to meet water quality criteria, but ultimately compliance is measured by comparing the geometric mean and "not more than 10% of the samples" directly to the criteria.

Comment 2:
Page xiv, first paragraph: "This TMDL sets targets in terms of FC concentrations necessary to meet both parts of the applicable water quality standards.

Suggest the following revisions for clarification: "This TMDL sets targets in terms of FC concentrations necessary to meet the criteria described below."

Response 2:
Comment noted, change made.

Comment 3:
Page 2, last paragraph and equation: "By definition a TMDL is the sum of the allocations, which must not exceed the loading capacity. The sum of the wasteload and load allocations, the margin of safety, and any reserve capacity must equal to or less than the loading capacity. TMDL = Loading Capacity = sum of all wasteload allocations +sum of all load allocations +margin of safety."

Suggest changing the equation to "Loading Capacity greater than or equal to TMDL = sum of all wasteload allocations + sum of all load allocations + margin of safety + reserve capacity (if any)," to be consistent with the sentences explaining the equation.

Response 3:
Comment noted, equation revised to "Loading Capacity ≥ TMDL = sum of all wasteload allocations +sum of all load allocations +margin of safety + reserve capacity (if any)."

Comment 4:
Page 23 first paragraph: "The TMDL study did not directly evaluate stormwater contributions from any of the permitted stormwater collection systems in the study area. However, the study did find that stormwater was impacting surface water concentrations."

Please explain how it was determined that stormwater was impacting surface water FC concentrations, or refer to the section that explains this (Field Data Collection, Stormwater Section , p. 28). If the study does not have data to support this finding, the sentence with "the study did find…" should be rewritten to clarify that while there is no specific documentation that stormwater was impacting surface water FC concentrations, it is presumed to have an effect based on …..(Provide assumptions)…..

Response 4:
Comment noted. The stormwater section on p.28 describes how storm events were identified within the dataset. The results and discussion section of the report provides a comparison of storm event vs. non-storm event statistics, highlighting where water quality criteria were exceeded during storm events. The page 23 language is intended as an introduction to potential sources. For brevity the authors did not provide an in-text reference, as doing so consistently throughout the document is redundant and not consistent with Plain Talk guidelines. In general, documentation of assertions made in any report should be located in the Results and Discussion.

Comment 5:
Page 23, fifth paragraph: "The WSDOT Municipal Stormwater Permit was issued a separate permit in February 2009. Under the new general permit, WSDOT is also required to reduce the discharge of pollutants to the maximum extent practicable (MEP) using all known, available, and reasonable methods of prevention, control, and treatment (AKART) to prevent and control pollution of waters of the state."

Suggest revising this paragraph to be more consistent with the permit coverage language, S1.B.1 and 2 "WSDOT was issued a separate Municipal Stormwater permit in February 2009. This stormwater permit regulates stormwater discharges from state highways and related facilities contributing to discharges from separate storm sewers owned of operated by WSDOT within the Phase I and II designated boundaries. WSDOT's permit also covers stormwater discharges to any water body in Washington State for which there is a U.S. Environmental Protection Agency (EPA) approved TMDL with load allocations and associated implementation documents specifying actions for WSDOT stormwater discharges (applicable TMDLs listed in Appendix 3 of the WSDOT permit). Under the new permit, WSDOT is also required to reduce the discharge of pollutants to the maximum extent practicable (MDP) using all known, available, and reasonable methods of prevention, control, and treatment (AKART) to prevent and control pollution of waters of the state."

Response 5:
Comment noted and change made. Please note that the language that WSDOT requested Ecology to change was actually language that WSDOT suggested adding during the advisory group review and was submitted to Ecology on 2/2/2011. As a courtesy and to increase the efficiency of the review process, in the future Ecology requests that WSDOT submit one set of consistent comments from all reviewers.

Comment 6:
Page 28 first bullet point "Four storm events occurred during the wet season and one during the dry season."

Suggest the following revisions for clarification: "Four storm events were sampled during the wet season and one storm event was sampled during the dry season."

Response 6:
Comment noted and change made.

Comment 7:
Page 74-75, second to last and last paragraphs: "Ecology recognizes the difficulty of characterizing the highly variable frequency and duration of FC loads in stormwater. Numeric effluent limits for municipal stormwater discharges that are consistent with TMDLs are not often feasible or appropriate when expressing wasteload allocations in municipal stormwater permits. At this time, Ecology intends to express the municipal stormwater wasteload allocation in the TMDL as best management practices (BMPs) that will be considered for inclusion in the municipal stormwater permits. BMPs are considered an appropriate form of effluent limits in permits for control of pollutants in municipal stormwater.

Municipal stormwater wasteload allocations are established in this TMDL as the water quality standards (Table 35), rather than as FC loads…"

PLEASE NOTE: Due to the length of this comment, key points have been italicized. Suggest making these sections consistent. The second to last paragraph states "Ecology intends to express the municipal stormwater wasteload allocations in this TMDL as best management practices…"while the last paragraph states "municipal stormwater wasteload allocations are established in this TMDL as the water quality standards…" *These statements directly contradict each other and are therefore confusing.*

We acknowledge that WSDOT may be the source of bacteria in some locations (e.g., dog walking areas within our right of way, large bird colonies under bridges or in ponds), and it is reasonable to assume that WSDOT stormwater may convey fecal coliform in areas where adjacent land uses are recognized sources of this bacteria. However, *since WSDOT stormwater was not sampled during the TMDL study or identified as a bacteria source within the TMDL area, we think we should not be assigned a numeric WLA.*

We feel assigning WSDOT a WLA equal to water quality stands is inappropriate for two reasons, 1) NPDES Municipal Stormwater MS4 permits, "require controls to reduce the discharge of pollutants to the maximum extent practicable." This is the only standard MS4 permitees are held to, and 2) cumulatively, if all permitted dischargers are in compliance with Las, (plus the margin of safety) then water quality should be met. As being required currently, with all stormwater permitees assigned a WLA equal to water quality standards, the resulting water quality standard is likely overly conservative.

Additionally, as we have agreed in the past, a permitted discharger identified in a TMDL is required to comply with their assigned items (identified in the implementation plan), and in doing so, is presumed to be in compliance with assigned WLA's and the TMDL. Through implementation of WSDOT's NPDES Municipal Stormwater permit and Stormwater Management Program Plan (SWMPP), we will be working to identify and correct illicit discharges and illegal connections to our stormwater conveyance system and identify and correct potential sources within our right-of-way. We feel these actions will help minimize WSDOT's contribution of fecal coliform, if/where present, and help achieve the TMDL goals.

Based on this reasoning, WSDOT recommends that the sections above be changed to be consistent with the second to last paragraph (where Ecology will "express the municipal stormwater wasteload allocation in this TMDL as best management practices (BMPs) that will be considered for inclusion in the municipal stormwater permits") we suggest the following revisions: "express the municipal stormwater wasteload allocations in this TMDL as <u>source control BMPs and/or BMPs that reduce the volume of discharging stormwater, or other activities to remediate and/or reduce fecal coliform bacteria concentrations.</u>" This revision is suggested because Ecology does not have any approved BMPs in the Stormwater Management Manual intended to specifically reduce fecal coliform bacteria.

Response 7:
Comments noted.

Regarding confusion on pages 74-75: *Ecology recognizes these statements might be confusing, but they do not directly contradict each other. One statement says the WLAs* ***in the TMDL*** *are set as the water quality criteria, while the other statement says that these numeric WLAs should be implemented as BMPs* ***in the NPDES permits****. This section has been rearranged to improve clarity.*

Ecology is ***required*** *(see 40 C.F.R. § 130.2(h) & (i)) to express WLAs in numeric form. Therefore, Ecology chose the water quality criteria as the numeric WLA to satisfy this* ***requirement****; however, Ecology also explicitly stated, immediately following these numeric WLAs, that the WLAs will be implemented as BMPs in the municipal stormwater permits.*

In doing so, Ecology directly followed guidance from the EPA 2002 'Wayland Memo': Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs. *This memo states that: "Water quality based effluent limitations for NPDES-regulated storm water discharges that implement WLAs in TMDLs* ***may*** *be expressed in the form of best management practices (BMPs) under specified circumstances. See 33 U.S.C. §1342(p)(3)(B)(iii); 40 C.F.R. §122.44(k)(2)&(3). If BMPs alone adequately implement the WLAs, then additional controls are not necessary."*

Regarding WSDOT's assertion that they should not be assigned a numeric WLA: Again, Ecology is ***required*** *to assign all MS4s a numeric WLA. While the study did not show WSDOT specifically as a source of impairment, it did show that multiple water bodies were impaired during storm events. Note that equal stormwater WLAs were assigned to all point source discharges within the study area, given that specific sources are not identified.*

Regarding the comment "cumulatively, if all permitted dischargers are in compliance with Las, (plus the margin of safety) then water quality should be met. As being required currently, with all stormwater permitees assigned a WLA equal to water quality standards, the resulting water quality standard is likely overly conservative." Ecology does not understand this comment and thus cannot fully address it. Permitted discharges do not receive 'load allocations,' only 'wasteload allocations'. If all non-point sources are meeting their load allocations exactly and all point sources are meeting their wasteload allocations exactly, then the water body should be exactly the margin of safety below the TMDL (water quality criteria).

Regarding revision in final paragraph of comments. Changes made to accommodate requested revision.

Comment 8:
Page 85, under the third heading – Washington Department of Transportation (WSDOT): "WSDOT will implement the following…"

Suggest additional working to this section due to the introductory statements made on page 76 to describe "Reasonable assurances," which states, "When establishing a TMDL, reductions of a particular pollutant are allocated among the pollutant sources (both point and nonpoint sources) in the water body. For the Puyallup River Watershed Fecal Coliform TMDL, both point and nonpoint sources exist." Because WSDOT has not specifically been identified as a source during the TMDL study, we would like the underlined information added: "WSDOT stormwater was not sampled during the TMDL study. Therefore, there is not water quality data indicating WSDOT stormwater is a source of fecal coliform. It is reasonable to assume that WSDOT stormwater may be a source or a conveyance of fecal coliform in areas were adjacent land uses are a recognized source of this bacteria. While WSDOT roadways or rights-of-way can be the source of fecal coliform bacteria at a WSDOT outfall (if measured) from adjacent private property via natural drainage, an illicit discharge, or an illegal connection."

Response 8:
Comment noted, change made.

Comment 9:
Page 106, first paragraph: "Monitoring will be required midway through the implementation progress to see if interim goals have been reached."

Suggest following revision to clarify responsibilities: "Ecology will perform monitoring midway through TMDL implementation to determine if interim goals have been reached."

Response 9:
Comment noted, change made.

Comment 10:
For clarity of WSDOT's responsibilities, we suggest removing WSDOT from the Milwaukee Ditch table of action items and crating a separate section noting that because this TMDL area is completely with Phase I and II permit areas, WSDOT is required to implement these actions throughout the entire TMDL area. Suggested wording: "WSDOT municipal stormwater permit regulates stormwater discharges from state highways and related facilities owned or operated by WSDOT within the Phase I and II designated boundaries. WSDOT's permit also covers stormwater discharges to any water body in Washington State for which there is an EPA approved TMDL with load allocations and associated discharges (applicable TMDLs listed in Appendix 3 of WSDOT permit). Because municipal stormwater is regulated by either a Phase I or II permit within the entire TMDL study area. WSDOT is required to implement the following actions within the entire TMDL study area.

WSDOT will implement the following…"

Response 10:
Text will be added. The TMDL is organized by tributaries and the WSDOT action will stay in the table.

Comment 11:
WSDOT has not performed a QA/QC check on the water quality or flow data presented in this report, nor have we re-computed the math behind derived values, and reserve the right to make corrections if errors are found at a later date.

Response 11:
Comment noted. In any scientific study, the principal investigator should be the one to conduct a QA/QC check, as project-specific knowledge is necessary for the data quality evaluation. Ecology welcomes reviewers to help identify potential errors; however, the report review process is the appropriate time to raise any questions about the adequacy of the QA/QC data and analysis in the report. To date, WSDOT has had the opportunity to raise questions or concerns about data quality in three separate review stages of this report: advisory group review of technical report, advisory group review of full report with implementation strategy, and public comment period. Ecology feels this was a more than adequate amount of opportunity and reserves the right to respond to comments outside the review period only to the extent that we deem appropriate.

Comments from Nancy Rapin, Muckleshoot Indian Tribe

Comment 1:
The TMDL study found a significant increase in fecal coliform concentrations in the White River mainstem from river mile 23.8 to river mile 18.9. Since Site 10-WHT-18.9 is the closest monitoring location to the upstream boundary of the MIT Tribal waters, it is a point of compliance for this TMDL. As the TMDL document acknowledges, state water quality criteria must be met at the upstream boundary of MIT tribal waters. **This highlights the need to continue monitoring fecal coliform concentrations at Site 10-WHT-18.9 in the adaptive management and effectiveness monitoring plans for the TMDL.**

Response 1:
Commented noted, we will add information to the section titled "Mainstem source identification and elimination" to emphasize the need for monitoring in this area.

Comments from David Batts, King County

Comment 1:
Various suggested formatting and word changes.

Response 1:
Changes noted; some changes were incorporated and some were not. Of those not included it was because they did not change the meaning of the document and others were not in "plain talk" format.

Comment 2:
On page 43, the mainstem and tributary dry and wet periods differ (the wet to dry transition cutoff); but mainstem and tributary hydro-periods are the same here. Since I don't see the Puyallup mainstem in the table title deletions fix this.

Response 2:
Comment noted. The captions for Tables ES-1 and 2 were edited to "FC reductions and target capacity for the Puyallup River tributaries."

Comment 3:
Since implementation will be in full swing in 2012, 10 years is 2022.

Response 3:
Commented noted, date changed.

Comment 4:
I seem to recall that EAP used to figure on TMDL status monitoring on a 5-year cycle basis until success has been achieved. Assuming implementation is in full swing in 2012, this targets the first follow-up monitoring in 2017 and every five years until the state water quality standards are met.

Response 4:
Due to staffing limitations and the large number of TMDLs every five years is not possible. Ecology will monitor the effectiveness of this TMDL when enough implementation has been done to suspect that we have achieved water quality standards.

Comment 5:
They may have interpreted it this way, but without re-opening WAC 173-201a, 90th percentile is not equivalent on a regulatory basis to 'no more than 10%'. It is also not mathematically equivalent. The added language following should be retained to make this clear.

Response 5:
Comment noted. The 90th percentile is comparable to the "not more than 10%" criteria if the data follows a lognormal distribution. Paragraph has been edited for clarity.

Comment 6:
Compliance is a regulatory term, and not appropriate in the context of behavior with regard to the TMDL. The TMDL is successful when the waterbodies are all in compliance with the state water quality standards.

Response 6:
Comment noted. The sentence was edited to clarify its intended meaning.

Comment 7:
I believe there's ongoing debate about this. All we know for sure is that meeting the criteria puts the waterbody in compliance with state water quality standards. The link between the indicator FC and pathogenic potential is suggestive but not robust.

Response 7:
Comment noted. Concerns about whether or not the current water quality criteria are protective of human health should be raised as part of the triennial review process for the water quality standards.

Comment 8:
The Phase I Municipal Stormwater Permit defines the water year hydro-periods as:
Dry: May 1 – Sept 30 and Wet: Oct 1 – April 30.

Response 8:
Comment noted. Flow and weather conditions that result in high fecal coliform concentrations vary from year to year. For the TMDL study year, the specified months represent the wet and dry season for that particular year. In future studies, the wet and dry seasons may be slightly different based on conditions specific to that year. The TMDL separates the data into seasons (for the study year) to represent reductions to sources that may be specific to each season and to avoid the masking of criteria exceedences that might result from using an annual dataset or a rigid set of dates for the wet and dry season.

Comment 9:
Understood – but is there any evidence that snowmelt mobilizes significant amounts of bacteria? Are there any studies comparing snowmelt runoff to precipitation runoff?

Does this mean that dry and wet seasons will now be re-defined for future monitoring if the hydrologic condition is different then?

Response 9:
Comment noted. See response to previous comment.

Comment 10:
Can this be expanded upon? It is not clear how bacteria is factored in, since in some cases high loading may be from direct input (e.g. livestock wading streams), and in other cases runoff driven. (Dispensing with any discussion of seasonal wildlife loads for now.)

Response 10:
Comment noted. Bacteria concentrations were factored in where there was a clear relationship between a decrease in flow and increase in bacteria. When this happens, the increase in bacteria likely represents a dry season source or problem (for example decreased dilution of sources).

Comment 11:
Could just delete the assumption statement here and move it to Appendix G, with the added considerations in this review comment.

(I don't have time to research this, but I am pretty sure Ott's method can be used with other data distribution. I think the method used to calculate 90th percentile as presented may well be based on the assumption of log normality, but I think Ott's SR method itself can be used e.g. with data following a normal distribution, using a more conventional percentile estimator.)

Ott's SR method also assumes CV is constant, which it is not. As sampling GMV goes down, CV will decrease. This provides some margin of safety, which should be mentioned here.

Response 11:
Comments noted. Some revisions were made to this section for clarity. In regards to the CV decreasing with the geometric mean, this is addressed in the 'Margin of Safety' section of this report.

Comment 12:
There should also be a data verification and validation section; and QA/QC should include addressing holding times for samples and calibration for field instruments.

Response 12:
Comment noted. Data verification and validation was conducted as described in the QAPP and did not merit special consideration in the report. Sentence added to discuss holding times. Flow meters were the only field instrument used in the study. The meters are factory calibrated on a routine basis and zero calibrated in the field when appropriate. Meters that failed the zero calibration are not used to collect data. There are no calibration results to report.

Comment 13:
While recognizing the cost of monitoring at multiple sites, these per-site minimums are very low and not reassuring with regard to representativeness, especially for smaller streams which tend to be flashier and are not aggregators of FC to the degree the rivers are.

It's unfortunate that Ecology's Data Credibility Policy does not address the need for adequate sample size. Recommend that for future monitoring in these watersheds, Ecology should use the collected data to determine needed sample size through statistical power analysis.

In addition, the National Monitoring Program convention was that for representativeness, sampling should be spread over at least two years.

Response 13:
Commented noted. Note that five is the minimum requirement, but at most sites Ecology used ten or more samples in the wet season calculation and eight or more samples in the dry season calculation.

In regards to collecting two years of data: In many cases Ecology would like to be able to collect multiple years of data for each TMDL; however this is simply not feasible under current constraints. Ecology's ambient monitoring program collects multiple year datasets in watersheds across the site to assess trends and temporal variation on a multiple year scale.

Comment 14:
I think it's a stretch to extrapolate comparability for future monitoring from a single year of data.

Response 14:
Comment noted. The word 'future' was deleted.

Comment 15:
Is 90th percentile calculated here the same way as it is for statistical rollback? If not, you can get different values. Would be a good idea in an Analysis Methods or in an Appendix – how percentile was calculated for box plots.

Response 15:
Comment noted. Percentiles for box plots were calculated in the same manner as for statistical rollback.

Comment 16:
If the t-test was done on log-transformed data, this should be stated, and t-test assumptions must be met for the transformed data.

Whatever transformations and assumption-testing were done should be stated under Study Methods – Analytical Methods.

Response 16:
Comment noted. For convenience the T-test was originally used in analysis. T-tests were done on log-transformed datasets that met the normality assumptions of the test. As a courtesy, the datasets were re-tested using the Wilcoxon signed rank test, a non-parametric test, and the results presented in the final report.

Comment 17:
Seasonal or annual analysis? Both? Same question for all following analyses.

Response 17:
Comment noted. Tables and language revised to clarify.

Comment 18:
Better than what?

Response 18:
Comment noted. Revised for clarity.

Comment 19:
Some substantial portion of the drainage to these watersheds non-point runoff, so we have a combination of WLA and LA.

Response 19:
Comment noted. A load allocation is already assigned in Tables 32 and 33 for non-point runoff in these watersheds.

Comment 20:
According to page 43 Dry Season is May to October and Wet Season is November - April

Response 20:
Comment noted. Revised for clarity.

Comment 21:
All references to King County should be deleted, as Bowman Creek drainage lies entirely within the city of Auburn. Need to delete any actions attributable to King County (as stricken out)

Response 21:
Comment noted. Agree and all references to King County Water and Land Resources for Bowman Creek are deleted.

Comment 22:
Prior to this draft, the only nexus identified between King County and this TMDL was Boise Creek. The King Conservation District may be involved only to the extent that it has outreach in the municipalities.

Response 22:
Comment noted. Bowman Creek has agricultural areas. After Ecology conducts source identification sampling, it may be determined that there are agricultural inputs. King Conservation District has jurisdiction in Auburn. We will ask for their help with technical assistance for agricultural water quality problems.

Comment 23:
Mill Creek drainage is located in the city of Pacific with no drainage in King County

Response 23:
It was determined by our technical staff that the stream identified in earlier drafts was actually Milwaukee Ditch not Mill Creek. There is some area that is the responsibility of King County.

Comment 24:
Need to make a distinction between MS4 stormwater, which is regulated by the Phase I and II Municipal Stormwater Permits, and non-point source stormwater driven runoff, which is not regulated by these permits unless it enters a MS4. Direct non-point discharges to waterbodies do not fall under these permits.

Response 24:
Comment noted. This boilerplate term is for general stormwater and was not intended to include information about Phase I and II permits.

Comment 25:
I think a more appropriate term here, given the following description is ‘net’ rather than conservative.

Response 25:
Comment noted. Revised for clarity.

Comment 26:
Same comment as above. If you are going to retain the word conservative what does it mean exactly? Conservative in which direction? Is it an overestimate or underestimate?

Response 26:
Comment noted. Revised for clarity

Comment 28:
I could be wrong, but I don't think the 90th percentile method is specified in Ott's statistical rollback method.

Response 28:
Comment noted. See response (5) to earlier comment on 90th percentile.

Comment 29:
Is this a copyright date or what? To the best of my knowledge, Ecology uses PCs (not Macs). The recent PC versions of Excel were in Office 2003 followed by Office 2007; the most recent version is Office 2010. Version is important because calculation errors may be present and not discovered until well after publication.

Response 29:
Comment noted. The 2006 date was in the boilerplate reference and the authors do not know if it is a copyright date or not; regardless the version used for calculation (Microsoft Office Professional Plus 2007) is identified in the references section. No changes were made.

Comment 30:
Should cite where this equation comes from. Should be NSSP (2007). See http://www.fda.gov/Food/FoodSafety/Product-SpecificInformation/Seafood/FederalStatePrograms/NationalShellfishSanitationProgram/UCM056682 for the remainder of the citation.

Response 30:
Comment noted, reference added.

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Appendix D. Industrial general stormwater permit holders within the Puyallup River Watershed FC TMDL study area.

Name	City	Latitude °N	Longitude °W	Permit #
Commencement Bay Corrugated	Orting	47.135560	122.238060	SO3001162D
Walt And Vern's Inc	Buckley	47.159170	122.048060	SO3000026D
Specialty Wood Mfg	Tacoma	47.186670	122.407500	SO3003073C
Master Precaster	Puyallup	47.190560	122.280830	SO3005634A
Woodruffs Products	Puyallup	47.190830	122.280000	SO3008708A
Girard Wood Products	Puyallup	47.191390	122.282780	SO3000118D
Shope Enterprises Inc	Puyallup	47.192500	122.272780	SO3003099C
Merchants Metals	Tacoma	47.190830	122.415560	SO3011354A
Grand Forks Auto Wrecking	Puyallup	47.200830	122.351390	SO3011392A
Bellingham-Sumas Stages Inc	Puyallup	47.205280	122.267500	SO3004638A
Exide Technologies	Sumner	47.206940	122.240280	SO3010598A
Thermo Fluids Inc	Sumner	47.207220	122.236670	SO3004376B
Precision Aerospace	Sumner	47.209440	122.243890	SO3010778A
Pasquier Panel Products Inc	Sumner	47.212500	122.235000	SO3010604A
Mcconkey And Co	Sumner	47.212780	122.236940	SO3002526C
Golden State Foods Sumner	Sumner	47.212780	122.238330	SO3002512C
Shining Ocean	Sumner	47.213060	122.236390	SO3009732A
Pacific Northwest Baking Co	Sumner	47.213060	122.240280	SO3011009A
Murreys Disposal	Fife	47.214440	122.336390	SO3005639A
Premier Building Systems	Fife	47.214720	122.335000	SO3001689D
Cascade Plastics Co Inc	Fife	47.216390	122.336110	SO3003162C
Raceway Technology	Tacoma	47.240000	122.411670	SO3001690D
Precision Machine Works Inc	Tacoma	47.242220	122.409440	SO3001688D
Veneer Chip Transport	Tacoma	47.243060	122.396940	SO3001194D
Metro Freight Systems Inc	Sumner	47.249440	122.240560	SO3000968D
Tacoma Rail	Tacoma	47.247500	122.391110	SO3001318D
Tacoma Central No. 1	Tacoma	47.247220	122.412500	SO3000711D
JB Hunt Distribution Facility	Sumner	47.252500	122.240280	SO3010579A
Tacoma Metals Inc	Tacoma	47.250000	122.415560	SO3000682D
Feed Commodities	Tacoma	47.250000	122.417220	SO3011487A
Kml Corporation	Tacoma	47.250560	122.418890	SO3000134D
Tripak #2	Tacoma	47.251110	122.406940	SO3011376A
United Parcel Service Pacific	Pacific	47.254720	122.253330	SO3004127B
APM Terminals Pacific Ltd	Tacoma	47.252780	122.407220	SO3000307D
Morgan Trucking Inc	Tacoma	47.252780	122.408890	SO3005622A
Horizon Lines Cargo Freight Stn	Tacoma	47.253330	122.408610	SO3010457A
Fred Tebb And Sons Inc	Tacoma	47.253610	122.407500	SO3001641D
Recovery 1	Tacoma	47.254440	122.409720	SO3001386D
Simpson Timber Co	Tacoma	47.258060	122.420280	SO3001429D
Precision Iron Works Inc	Pacific	47.267500	122.258060	SO3001525D
Pacific Metal Fabrication	Pacific	47.272220	122.249170	SO3004473B
SCS Refrigerated Svcs LLC	Algona	47.291390	122.245000	SO3002032D
Tim's Cascade	Algona	47.293610	122.242500	SO3004482B
Fletchers Fine Foods Inc	Algona	47.293890	122.245000	SO3002034D

Appendix E. Additional fecal coliform loading analysis.

Simple loading analysis

Simple load analyses were performed using a spreadsheet to compare measured loading sources relative to each other and, in some cases, evaluate the mass balance of FC bacteria for a reach. Loads were not used to determine the amount of FC reduction needed at sites; only the measured concentration data were used to calculate the target percent reductions needed. A simple mass-balance was performed to show general patterns of loading within the study area. The patterns will help in directing implementation to the highest loading sources. Cleaning up high loading sources will benefit downstream stations where the upstream loads are contributing to exceedances.

Loads were calculated by multiplying the FC concentration by the streamflow at each site. The calculation used FC bacteria units in colony forming units (cfu)/100 mL multiplied by the flow in cubic feet per second (cfs). The product (#/100 mL * cfs) was then multiplied by the constant, 24,465,067 ($2.45 * 10^7$), to calculate the actual load of number of FC bacteria per day. Finally the number of cfu per day was divided by 1 billion and reported as billion cfu per day. This was done to avoid the use of scientific notation for these very large numbers and to make loads easier to compare.

The loading analysis did not account for loss from settling or die-off nor gain from resuspension or regrowth. Therefore, the residual term of the mass balance (i.e., the unexplained gain or loss in a reach) includes these unmeasured losses and gains, unidentified sources, plus any error in measuring the known loads.

While not accounting for all fate and transport mechanisms may not be an actual representation of what is occurring in the stream, most reaches were short enough to make a general assumption that most or some of the upstream load was transported to the next downstream station. Travel times of loads were generally on the order of hours and not days between stations.

The lack of steady-state flow for some sample dates increased the error of the reach-load analysis. Generally, the flow was steady during the dry season and less so in the wet season. Some sample surveys were not used in the reach-load analysis because of an extreme discrepancy in the flow balance.

Individual stream segment (reach) loads were averaged over each season and then compared to other reach loads to develop an overall loading pattern. Averaging the loads lessened the impact of any one individual survey load, which helped smooth out the inherent variability of the loads.

Again, the goal of the simple mass-balance was to show the general pattern of loading within the watershed to help in direct cleanup implementation efforts.

Upper White River loading patterns

Figure 23 depicts the average FC loads for the four inputs measured by Ecology upstream of station WHT-18.9. Flow data were not available for WHT-18.9 so a loading balance was not developed, and the FC load from unmeasured sources in this stretch was not estimated.

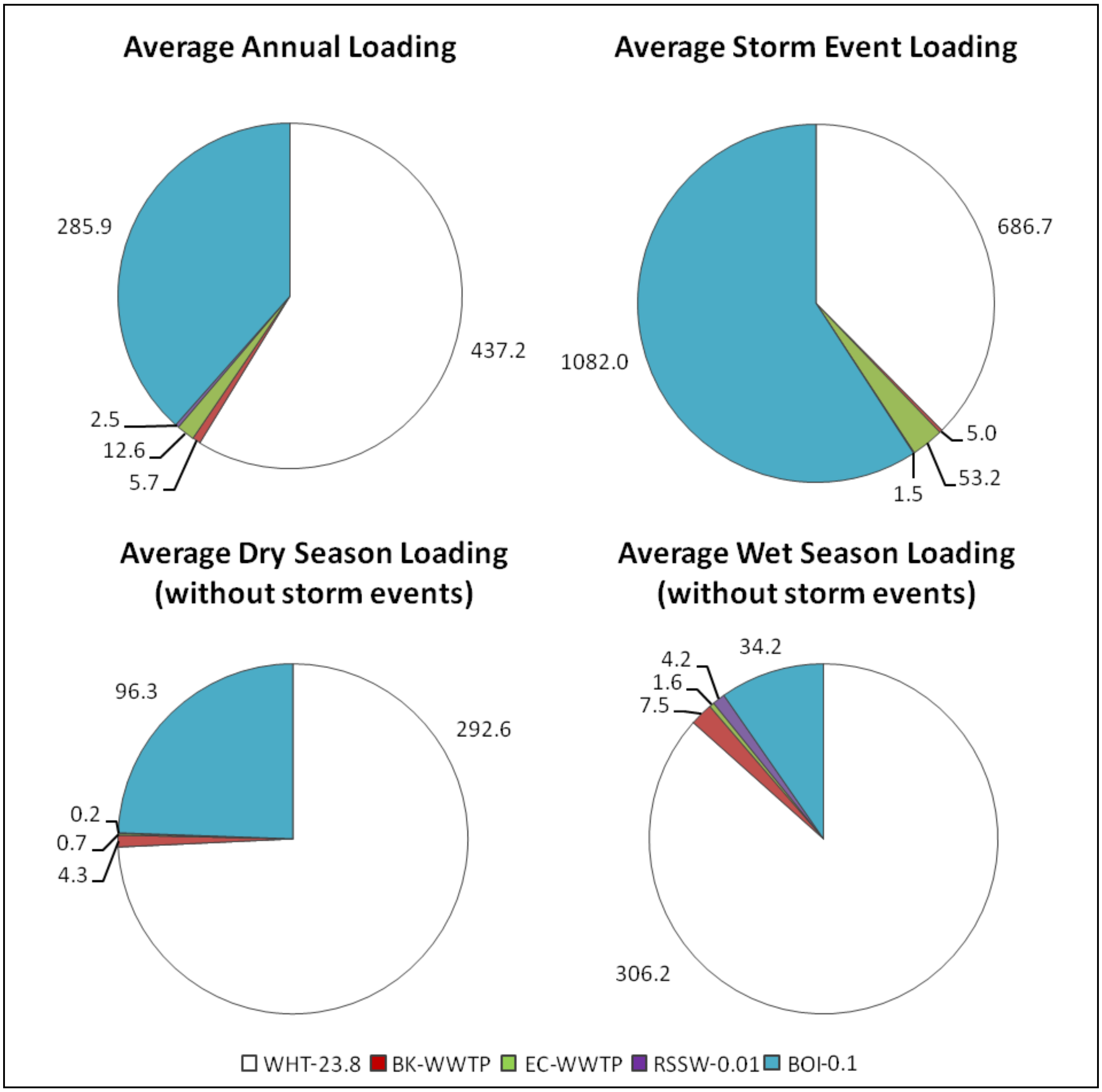

Figure 21. Average FC load (billion cfu/day) for the entire 2006-07 study, storm events only, the dry season (July to October) excluding storm events, and the wet season (November to June) excluding storm events.

The average FC load from all measured sources was over four times larger during storm events than it was during both the wet and dry season, excluding storm events. The combined loads from RSSW-0.01, BK-WWTP, and EC-WWTP were very small, accounting for only 1.3% (during dry-season, non-storm events) to 3.7% (during wet-season, non-storm events) of the total load measured.

Storm events were the most critical period for FC concentrations at WHT-18.9, considering that:

- During non-storm events, the annual geometric mean was *10 cfu/100 mL* and the 90th percentile was *60 cfu/100 mL*.
- During storm events, the annual geometric mean was *86 cfu/100 mL* and the 90th percentile was *266 cfu/100 mL*.

The largest portion of the storm load, approximately 60%, originated from Boise Creek. Most of the remainder came from WHT 23.8. However, concentrations were low at this site with a maximum of only *33 cfu/100 mL* during storm events. Boise Creek on the other hand, had very high FC levels during storm events with a geometric mean of *927 cfu/100 mL* and 90th percentile of *3,339 cfu/100 mL*.

At BOI-0.1, the average FC load for both the wet and dry season was less than 10% of the storm load average. However, the average load in the dry season was nearly three times greater than in the wet season. This is the reverse of a typical loading pattern and indicates that there may be a source present in the watershed exclusive to the dry season.

Carbon River loading patterns

Figure 24 depicts the FC loading balance for the mouth of the Carbon River. The majority of FC loading to the Carbon River (approximately 70%) came from unmeasured sources upstream of the mouth. Voight Creek accounted for almost 30% of the FC load, while the OT-WWTP made up about 1% of the load.

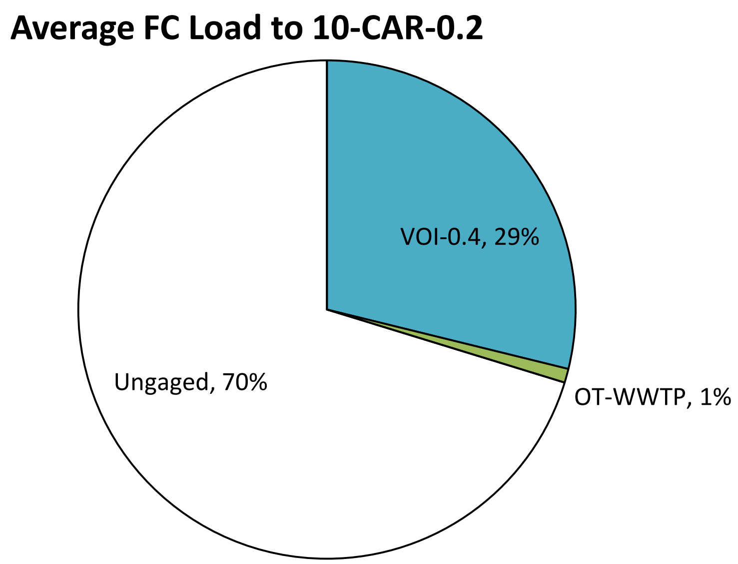

Figure 22. Average annual FC load balance for the Carbon River at its mouth.

Clear/Swan Creek loading patterns

Figure 25 depicts FC loading data for Clear Creek. The largest increase in loading occurred between the East Fork of Clear Creek at 72nd St. (10-CLR-3.6) and the mainstem of Clear Creek downstream of the Trout Lodge fish hatchery (10-CLR-1.7). CLR-3.6 was dry or stagnant from May through October, so no FC load was calculated. Concentrations actually decreased slightly in this stretch, so the loading increase was mainly due to an increase in the volume of flow.

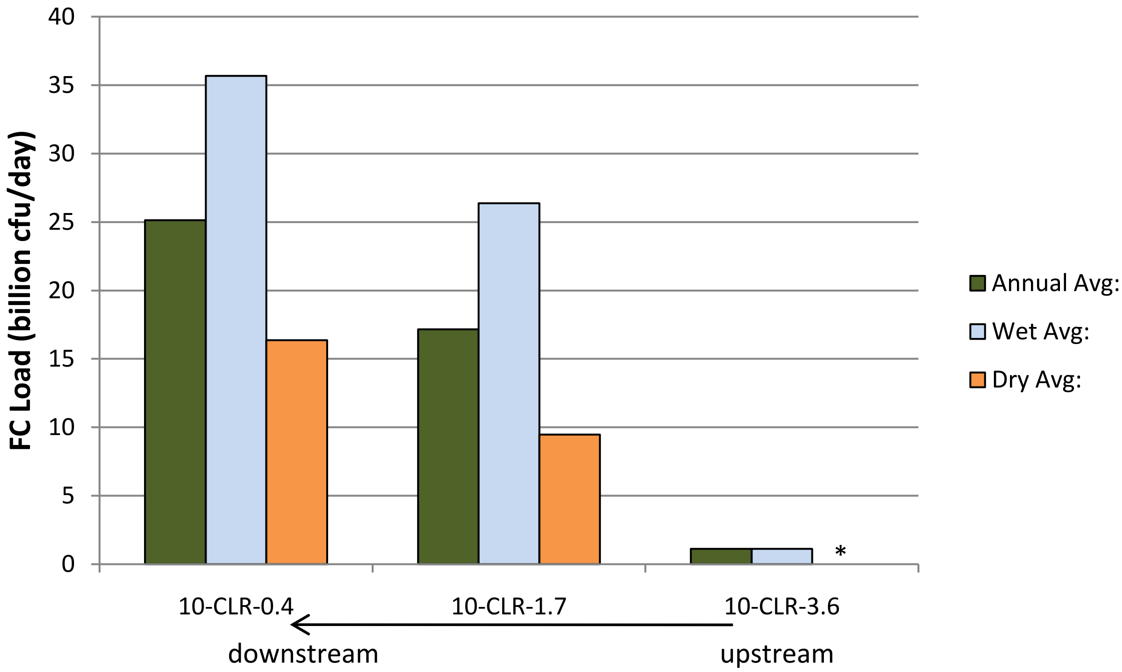

Figure 23. FC loads for Clear Creek during various conditions.

Increases in FC load also occurred between stations CLR-1.7 and CLR-0.4; however, there was not a statistically significant change in FC concentrations. Again, most of the loading was due to an increase in flow. The tributaries of Squally and Canyon Creeks join Clear Creek within this stretch.

Only a wet season loading pattern was developed for Swan Creek (Figure 26), due to the lack of flow at SWN-3.9 during the dry season. The FC load approximately doubled from CM 3.9 to 0.6, while the concentrations decreased significantly. Groundwater and surface-water recharge between these two stations effectively diluted high FC concentrations from upstream.

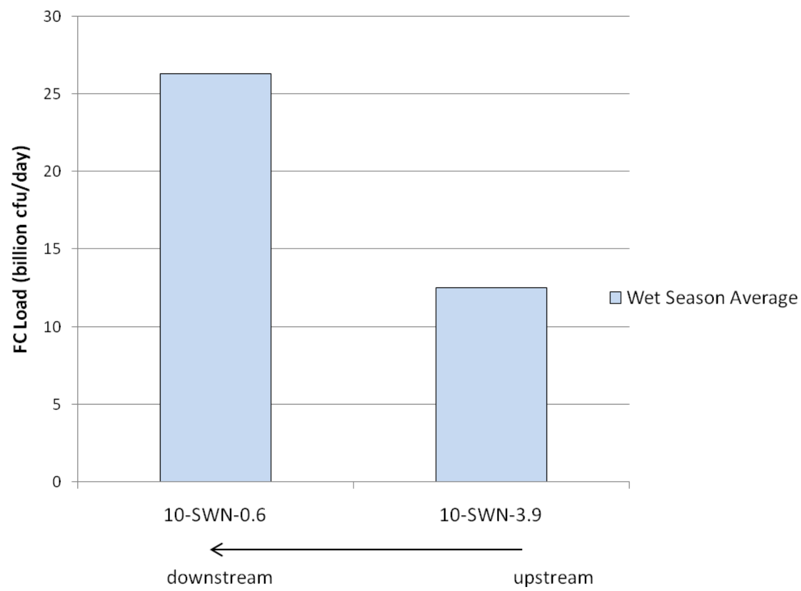

Figure 24. FC loads for Swan Creek during the wet season.

Overall loading patterns

Figures 27 and 28 compare the annual and seasonal FC loading for measured sources within the White River (Figure 27) and the Puyallup River (Figure 28) portions of the study area.

The White River sites include an annual average, a storm-event average, and wet-and dry-season averages, with storm events excluded. The majority of the measured FC load came from four sites: WHT-23.8, BOI-0.1, LTD-0.4, and SAL-0.2. Of these four, Boise and Salmon Creeks exceeded water quality standards.

The Puyallup River sites include an annual, a wet-season, and a dry-season average. FC loads for Voight Creek and the Orting WWTP are included in the load for CAR-0.2. The largest FC load sources were PUY-17.7, CAR-0.2, and CLK-0.01. The next largest FC loads were from DEE-0.1, FNL-0.4, and CLR-0.4. Of these six sites, only the mouths of Clarks Creek and Deer Creek exceeded water quality criteria.

The pie chart in Figure 29 depicts the overall loading balance at PUY-8.5. The FC load measured at WHT-7.5 (which includes all upstream sources) accounted for almost 60% of the total load. Approximately 20% of the load was unmeasured or otherwise unaccounted for and was labeled as the ungauged load. The data set excludes the storm event on February 20-21, 2007 due to large FC loading spikes in specific areas and a large discrepancy in the load balance.

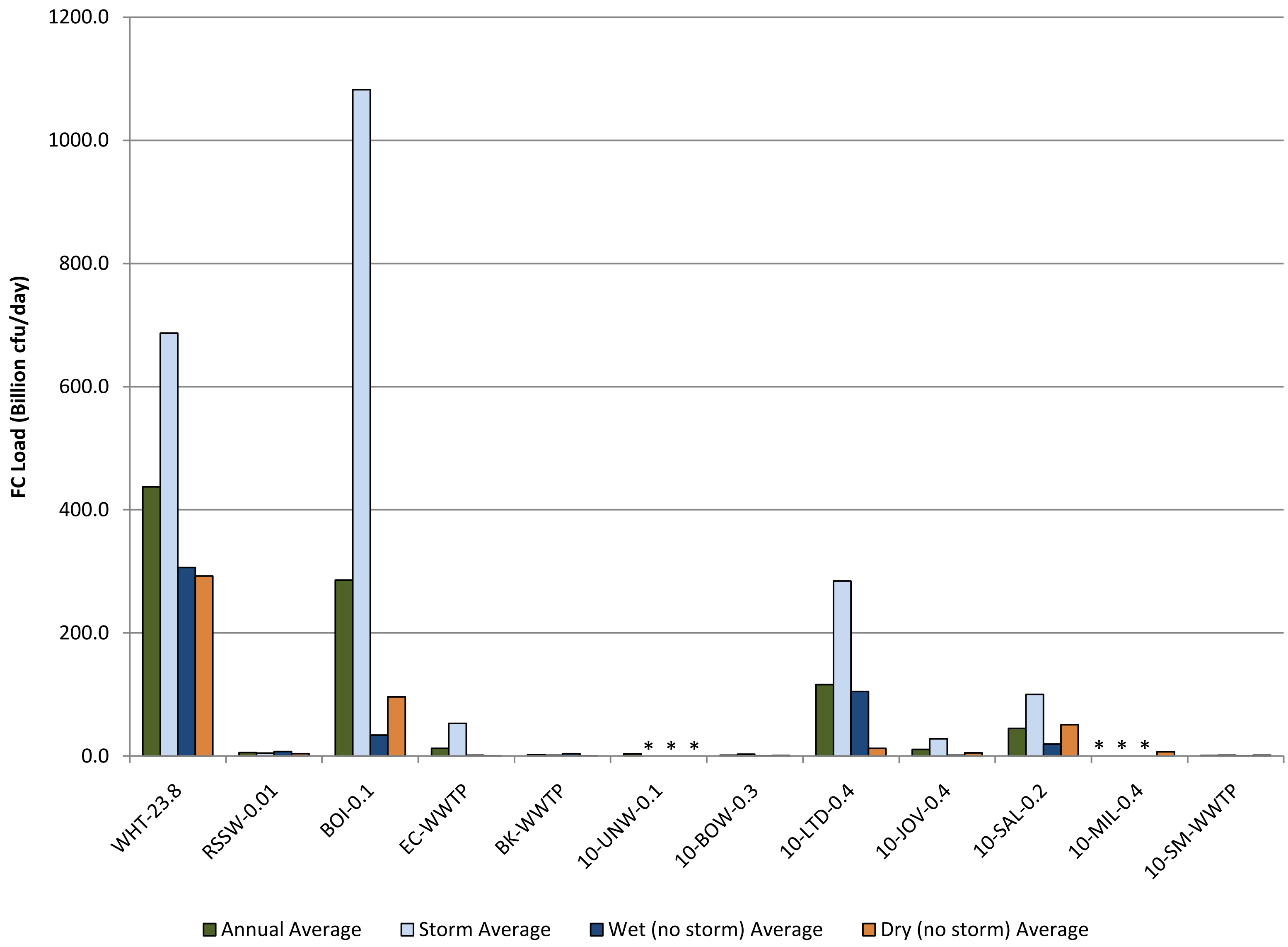

Figure 25. Average FC loads for tributaries/inputs to the White River under various conditions.

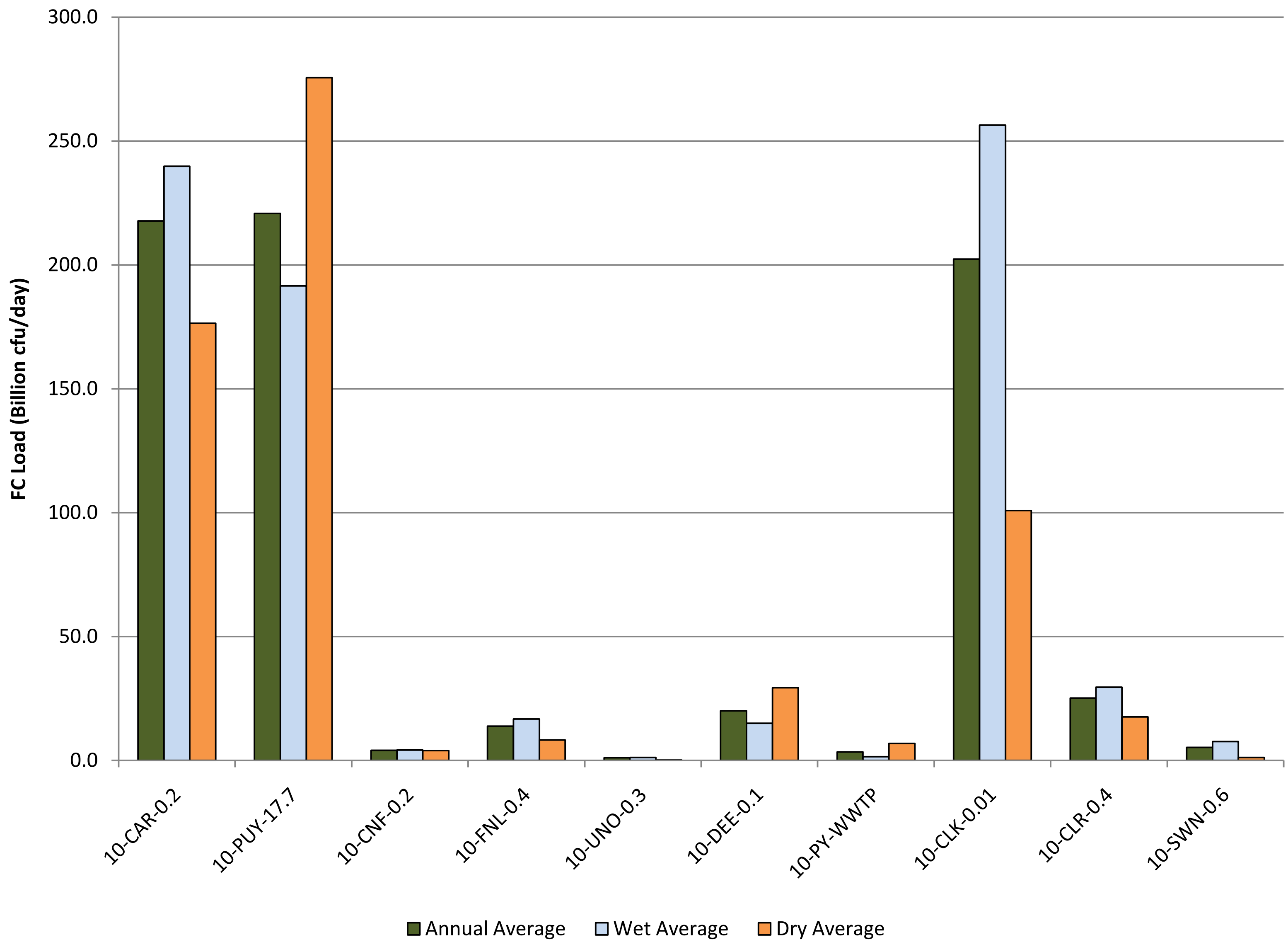

Figure 26. Average FC loads for tributaries/inputs to the Puyallup River under various conditions.

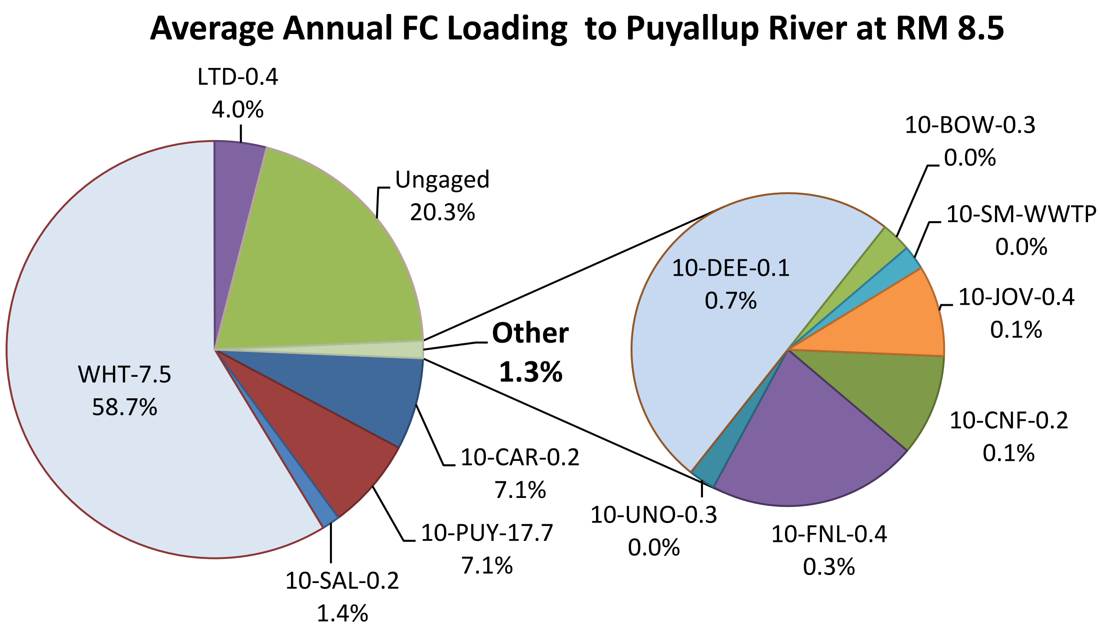

Figure 27. Percent contribution of upstream sites to the average annual FC loading to the Puyallup River at RM 8.5. The data set excludes the storm event on February 20-21, 2007.

Figure 30 shows dry-season FC loading to the White River at RM 7.5. The largest portion of the FC load, about 60%, was from ungauged sources. WHT-23.8 and BOI-0.1 accounted for the majority of the remaining load.

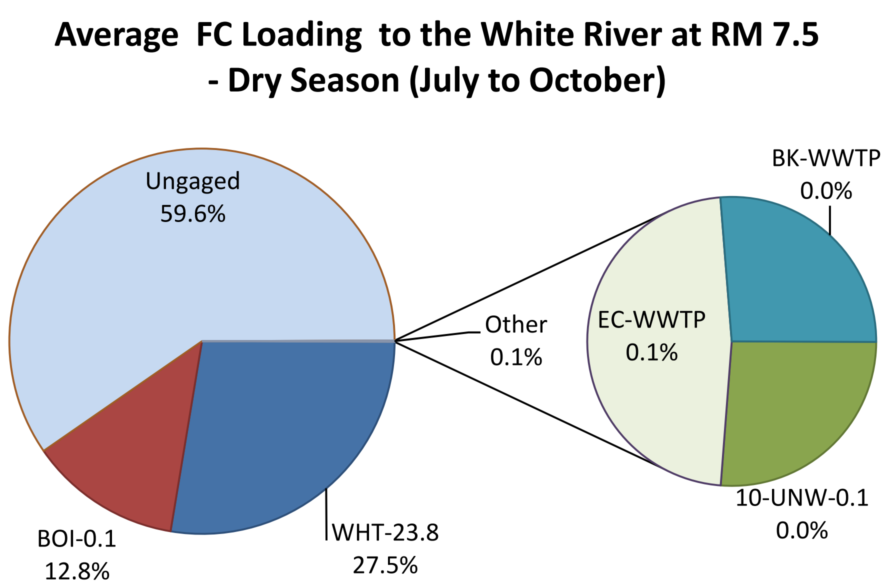

Figure 28. Percent contribution of upstream sites to the average dry season FC loading to the White River at RM 7.5.

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Appendix F. Load duration curves.

Load duration curves

Fecal coliform loading capacities for sites with continuous streamflow data were developed using the load duration curve developed by EPA (EPA, 2007).

The basis of the load duration curve is a flow duration curve which plots flow values against the cumulative frequency that a given flow value is met or exceeded. Lower baseflows are exceeded a majority of the time and thus have a higher cumulative frequency, whereas flows during large storm/flooding events are exceeded a small percentage of the time and have a low cumulative frequency. Flow duration curves were developed using daily average discharge data from USGS- operated continuous stream gages within the study area.

The flow duration curve is generally divided into flow duration intervals. For example, flows that occur 0 to 10% of the time are categorized as 'High Flows', and flows that occur 10 to 40% of the time are 'Moist Conditions'.

A load duration curve is then developed by (1) calculating the FC loading capacity based on the water quality standards for each flow value and (2) plotting these loading capacity values in place of the flow values.

A load duration target is developed by multiplying the streamflow value at the midpoint of each flow zone with the numeric water quality target (geometric mean or 90th percentile value) and a conversion factor. The target concentration is constant across all flow conditions, but is expressed as different load values based on each range of flow conditions.

Figures 31 to 35 contain the load duration curves developed for several TMDL stations. The curves include observations about stormwater FC loads and seasonal data trends.

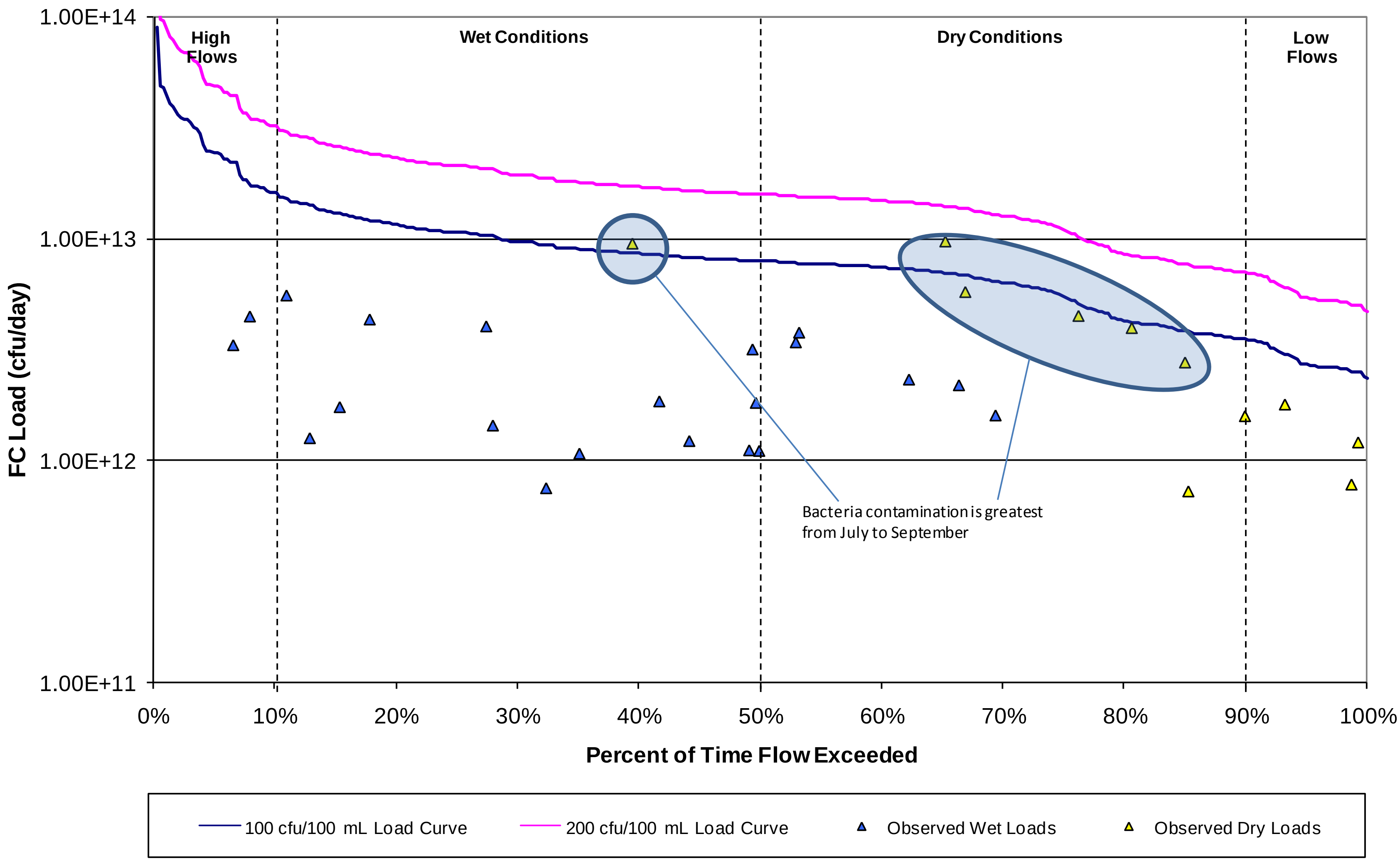

Figure 29. Load Duration Curve for the Puyallup River at Meridian St. (10-PUY-8.5).

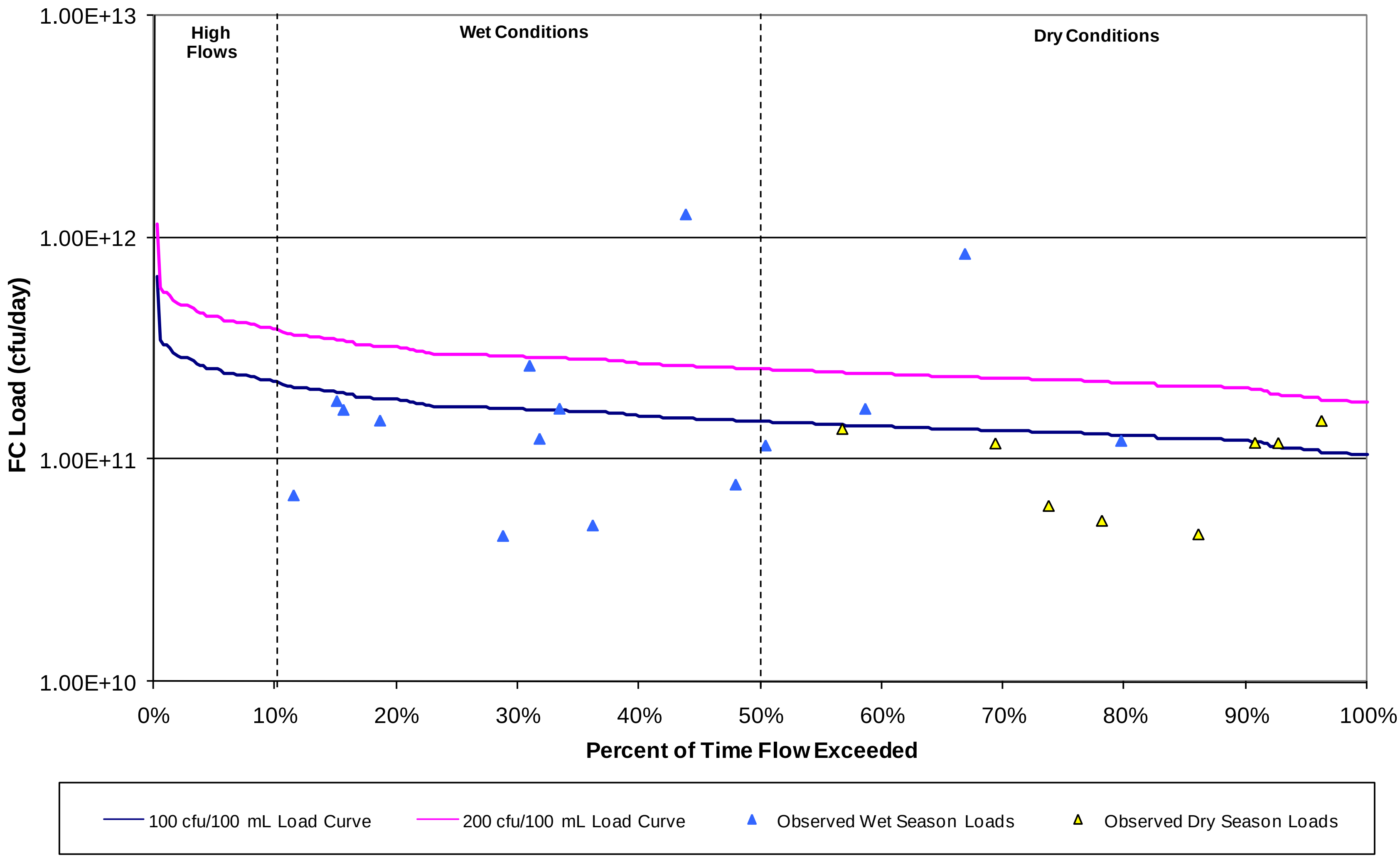

Figure 30. Load Duration Curve for Clarks Creek at the mouth (10-CLK-0.01).

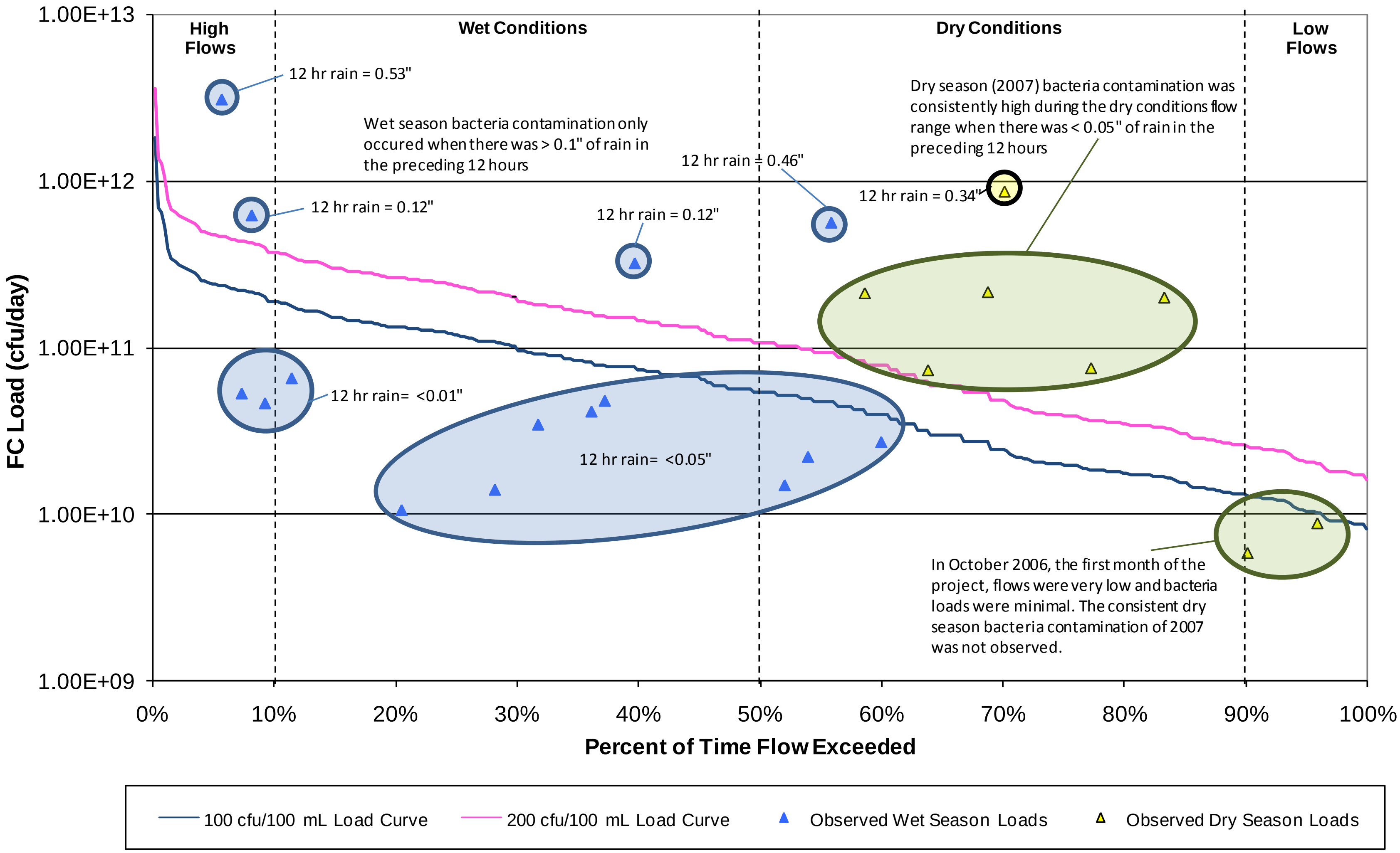

Figure 31. Load Duration Curve for Boise Creek near the mouth at SE Mud Mountain Rd. (10-BOI-0.1).

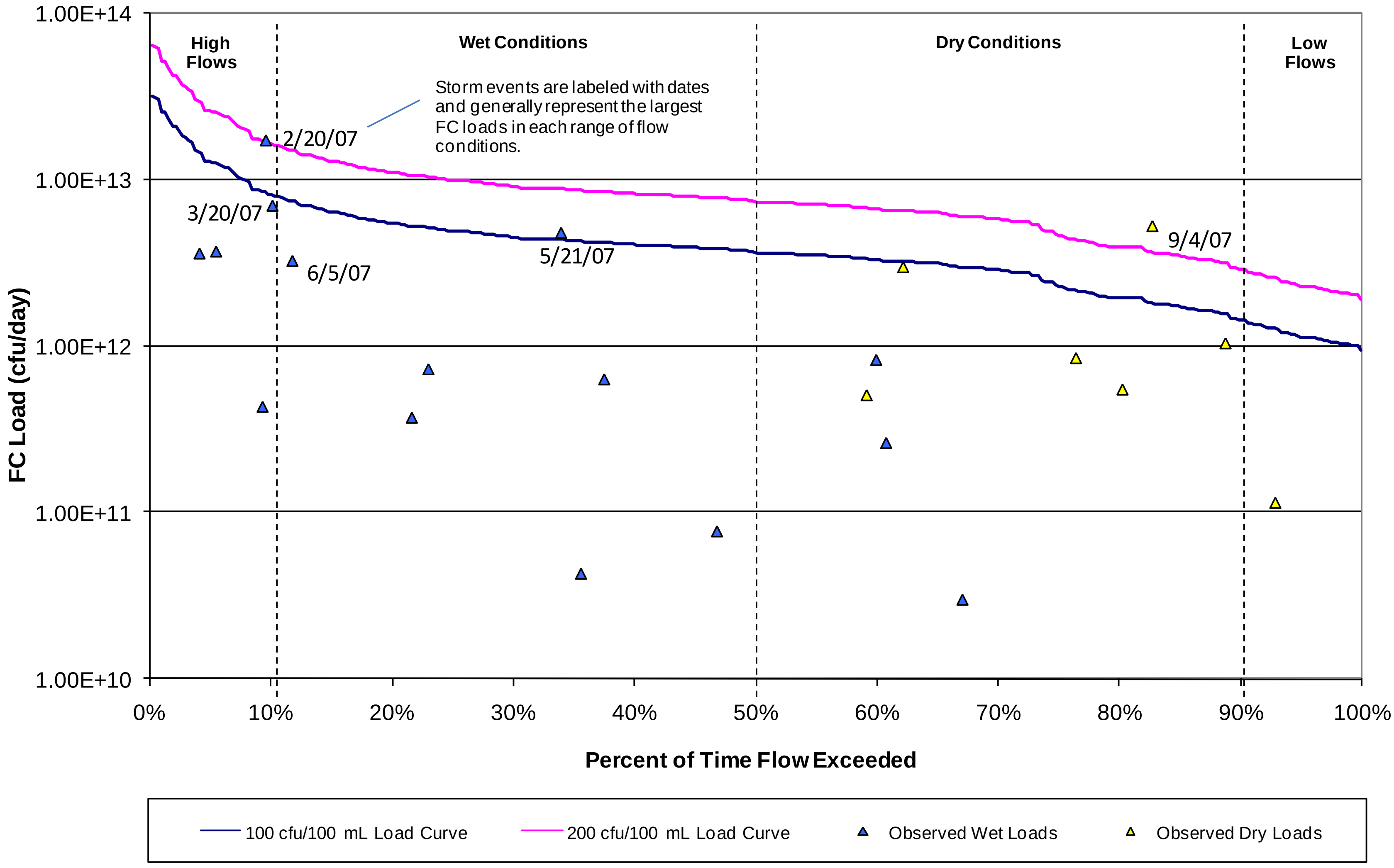

Figure 32. Load Duration Curve for the White River at R St. (10-WHT-7.5).

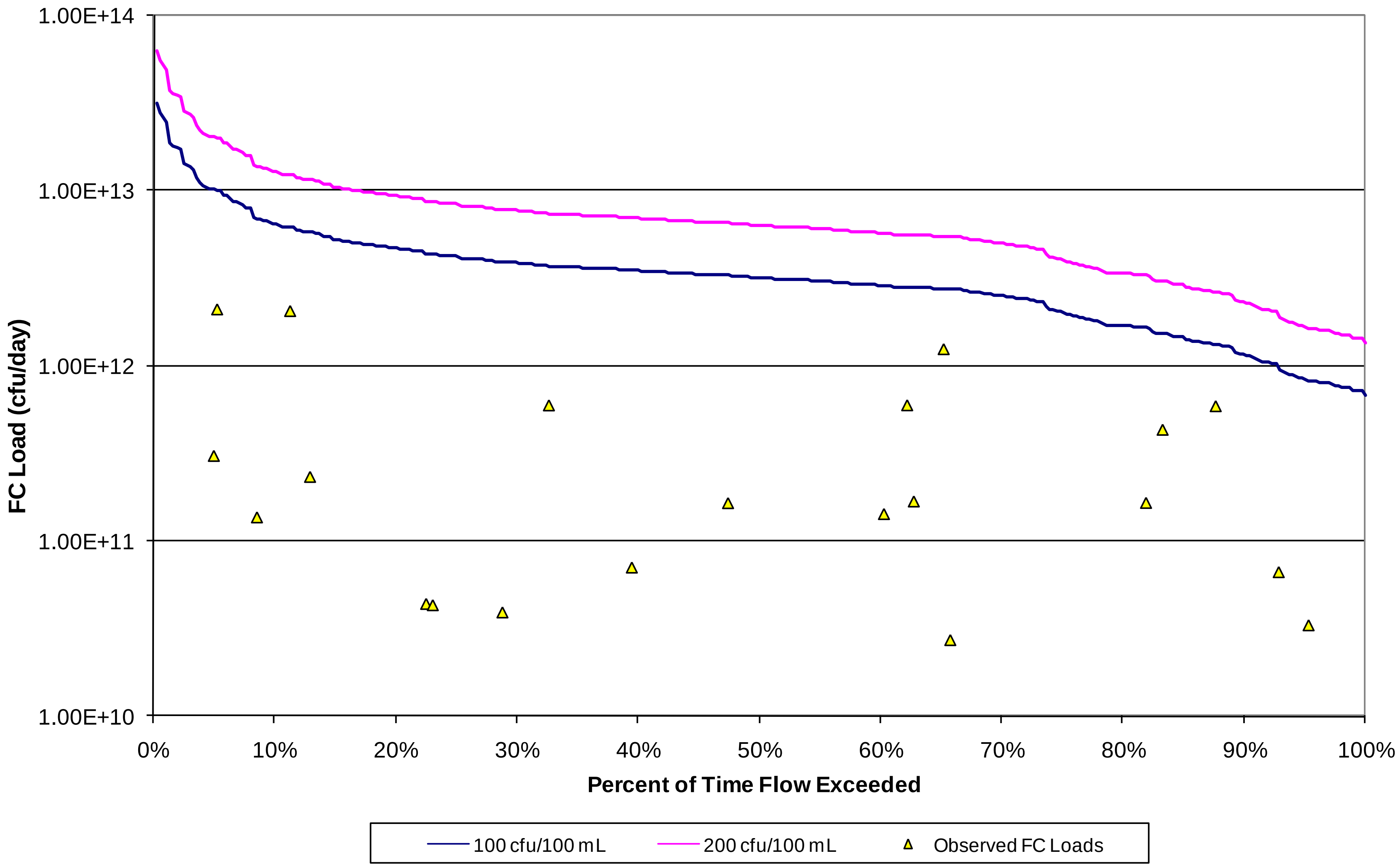

Figure 33. Load Duration Curve for the White River upstream of the Lake Tapps Diversion (10-WHT-23.8)

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Appendix G. Statistical rollback method.

The rollback procedure is as follows:

- A check was made to make sure the FC bacteria data collected in 2006-07 fit a log-normal distribution at each sampling location. WQHYDRO® (Aroner, 2003) was used to test the FC data for log-normal distribution fit.
- An Excel® (Microsoft, 2006) spreadsheet was used to calculate the geometric mean of the data.
- The 90th percentile of the data was estimated by using the following statistical equation. (The 90th percentile value of samples was used in this TMDL evaluation as an estimate for the "no more than 10% samples exceeding …." criterion in the FC bacteria standard (WAC 173-201A).)

From NSSP (2007): 90th percentile = $10^{(\mu_{\log} + 1.2817 * \sigma_{\log})}$

where: $\mu_{\log}$ = mean of the log transformed data

$\sigma_{\log}$ = standard deviation of the log transformed data

- The target percent reduction required was set as the highest of the following two resulting values:

$$\text{Target percent reduction} = \left[\frac{observed\ 90th\ percentile - 200\ cfu/100mL}{observed\ 90th\ percentile}\right] x100$$

$$\text{Target percent reduction} = \left[\frac{observed\ geometric\ mean - 100\ cfu/100mL}{observed\ geometric\ mean}\right] x100$$