Walla Walla River Basin Fecal Coliform Bacteria Total Maximum Daily Load Study

December 2005

Publication No. 05-03-041
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Ecology's Project Code for this study is 02-067-02.

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Walla Walla River Basin Fecal Coliform Bacteria Total Maximum Daily Load Study

by
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December 2005

Waterbody Numbers: See Table 2

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Abstract

The Walla Walla and Touchet rivers have been listed under Section 303(d) of the federal Clean Water Act for non-attainment of Washington State water quality criteria for recreational contact fecal coliform bacteria. The listings are based on sampling conducted by the Washington State Department of Ecology (Ecology) since 1991.

The U.S. Environmental Protection Agency requires states to set priorities for cleaning up 303(d)-listed waters and to establish a Total Maximum Daily Load (TMDL) for each. A TMDL is an analysis of how much of a pollutant load a waterbody can assimilate without violating water quality standards.

This TMDL report describes (1) the technical data evaluation for fecal coliform bacteria in the Walla Walla River basin, and (2) the basis for allocating fecal coliform loads to nonpoint (diffuse) and point (discrete) sources. Ecology conducted the study for 13 months, June 2002 through June 2003.

Reaches of the following waterbodies were given fecal coliform load reduction targets: the Walla Walla and Touchet rivers; the west branch of the Little Walla Walla River; and Dry, Pine, Mud, Mill, Garrison, Yellowhawk, Russell, and Cottonwood creeks.

The wastewater treatment plants for the cities of Dayton, College Place, and Walla Walla, as well as potential Phase 2 municipal stormwater permittees, were given fecal coliform wasteload allocations.

Acknowledgements

The authors of this report would like to thank the following people for their contribution to this study:

- Dave Parker, U.S. Army Corps of Engineers
- Glen Mendel, Washington Department of Fish and Wildlife
- Frank Nicholson, City of Walla Walla Public Works
- Willy Breshears, OMI, Inc., Walla Walla
- Bryan Smith, City of Dayton
- Bob Jamison, City of College Place
- Members of the Walla Walla Technical Advisory Group
- Staff with the U.S. Environmental Protection Agency, Region 10:
  - Helen Rueda
  - Laurie Mann
  - Larry Gadbois
- Staff with the Department of Ecology, Environmental Assessment Program:
  - Dean Momohara, Nancy Jensen and Pam Covey, Manchester Environmental Laboratory
  - Jim Ross, Freshwater Monitoring Unit
  - Steve Golding, Toxics Studies Unit
  - Sarah Coffler, Kim Gridley, Lawrence Sullivan, Mike LeMoine, Karol Erickson, Jim Carroll, and Joan LeTourneau, Watershed Ecology Section
  - Chuck Springer and Jim Shedd, Stream Hydrology Unit
- Staff with the Department of Ecology, Water Resources and Water Quality programs:
  - Victoria Leuba and Bill Neve, Water Resources Program
  - Marcie Mangold, Elaine Snouwaert, and Dave Knight, Water Quality Program, Eastern Regional Office
  - Donovan Gray and Karin Baldwin, Water Quality Program, Eastern Regional Office
  - Jerry Anderson and Patrick McGuire, Water Quality Program, Eastern Regional Office

Executive Summary

Introduction

The Walla Walla and Touchet rivers have been placed on Washington State's list of water-quality-impaired waters for not meeting *Contact Recreation* water quality standards. Fecal coliform bacteria concentrations observed in the past at a few water quality monitoring sites did not meet state criteria protecting recreational contact uses. The geographic and seasonal extent of the fecal coliform contamination could not be determined from these data for most of the basin.

From June 2002 through June 2003, the Washington State Department of Ecology (Ecology) collected additional fecal coliform and other water quality samples from sites along the Walla Walla River, Touchet River, Mill Creek, and from several other tributaries in the basin.

The information provided by the historical and the 2002-03 fecal coliform samples is used for the Total Maximum Daily Load (TMDL) study required by the federal Clean Water Act. This TMDL technical report is used to propose fecal coliform reductions to sources, stream reaches, and tributaries, where appropriate. The recommended reductions will help Ecology and local agencies make better decisions on where resources for water quality improvements are most needed in the Walla Walla River basin.

Walla Walla River Basin

The Walla Walla River is located in the southeast corner of Washington State (Figure E1). The river extends 61 river miles (RM) from the headwaters of its north fork in Oregon to its confluence with the Columbia River in Washington. The drainage basin covers approximately 1,760 square miles, two-thirds of which are in Washington along with the last 40 miles of the mainstem. Water in the Walla Walla basin is heavily managed for irrigation and flood control. Major tributaries in Washington include the Touchet River, Mill Creek, Dry Creek, and Pine Creek.

Forest-based uses are present in the upper watersheds, but agriculture is the dominant land use in most of the basin. The cities of Waitsburg, Dayton, College Place, and Walla Walla are urban population centers. The latter three cities have wastewater treatment plants (WWTPs) that discharge to surface water and are regulated by National Pollutant Discharge Elimination System (NPDES) permits. The area in and around College Place and Walla Walla qualify to apply for municipal stormwater permits.

Primary Contact and *Secondary Contact* recreation are protected beneficial uses in the basin. Most of basin must meet fecal coliform criteria to protect *Primary Contact* uses such as swimming; however, the lower 6.4 miles of Mill Creek and the lower 27.2 miles of the Walla Walla River need only meet the less restrictive fecal coliform criteria for *Secondary Contact* recreation such as boating and fishing.

Fecal Coliform Bacteria Assessments

This 2002-03 fecal coliform assessment was conducted under an approved Quality Assurance (QA) Project Plan (Swanson and Joy, 2002). Fecal coliform samples were collected at 58 sites in the basin.

- *Core Sites* – 25 sites were sampled 16 times over the 13 months. These core sites were set at known or suspected areas of fecal coliform contamination based on the water-quality-impaired list, at the mouths of major tributaries, near cities or where changes in land use occur, and at convenient intervals in larger river systems.

- *Expanded Sites* – 33 sites, including the three municipal WWTPs, were sampled six or fewer times during expanded surveys. These sites were used to monitor minor tributaries, provide QA data generated under WWTP self-monitoring, and better define water quality between larger monitored reaches.

Sites were distributed in the basin as indicated in Table E1.

Table E1. The distribution of core and expanded water quality sites in the Walla Walla River basin, June 2002 through June 2003.

Subwatershed or Source	Core	Expanded	Total
Touchet River	10	9	19
Mill Creek	6	10	16
Yellowhawk/Garrison creeks	2	3	5
Walla Walla River	7	3	10
Minor tributaries to the Walla Walla River	-	4	4
Municipal WWTPs (2 sites at College Place)	-	4	4
Total	25	33	58

Analyses were conducted on the data from each site to check compliance with the following Washington State fecal coliform criteria:

- *Primary Contact Recreation* use – the geometric mean of the samples cannot exceed 100 coliform forming units (cfu) per 100 milliliters (mL); and not more than 10% of the samples can exceed 200 cfu/100 mL.

- *Secondary Contact Recreation* use – the geometric mean of the samples cannot exceed 200 cfu/100 mL; and not more than 10% of the samples can exceed 400 cfu/100 mL.

The number of sites with fecal coliform bacteria problems was greater than indicated on the original water-quality-impaired list. Concurrent sampling of *Escherichia coli* (E. coli) confirmed that most fecal coliform detected was from warm-blooded animal sources. Most sites with fecal coliform bacteria problems had more than 10% of the samples not meeting (exceeding) the applicable criterion. The results for the sub-watersheds are summarized in Figures E2 –E4, and described below.

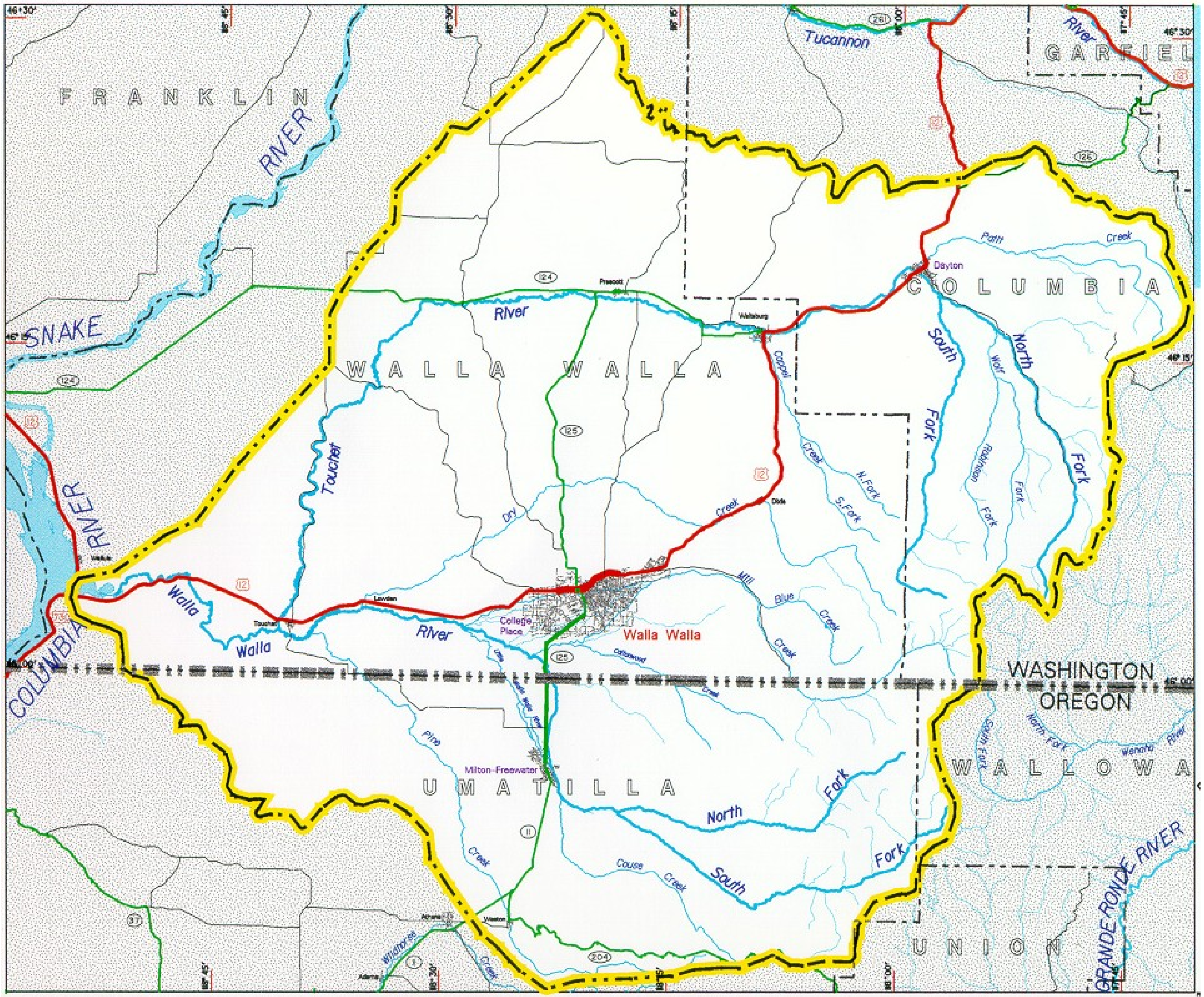

Figure E1. The Walla Walla River basin (U.S. Army Corps of Engineers, 1997).

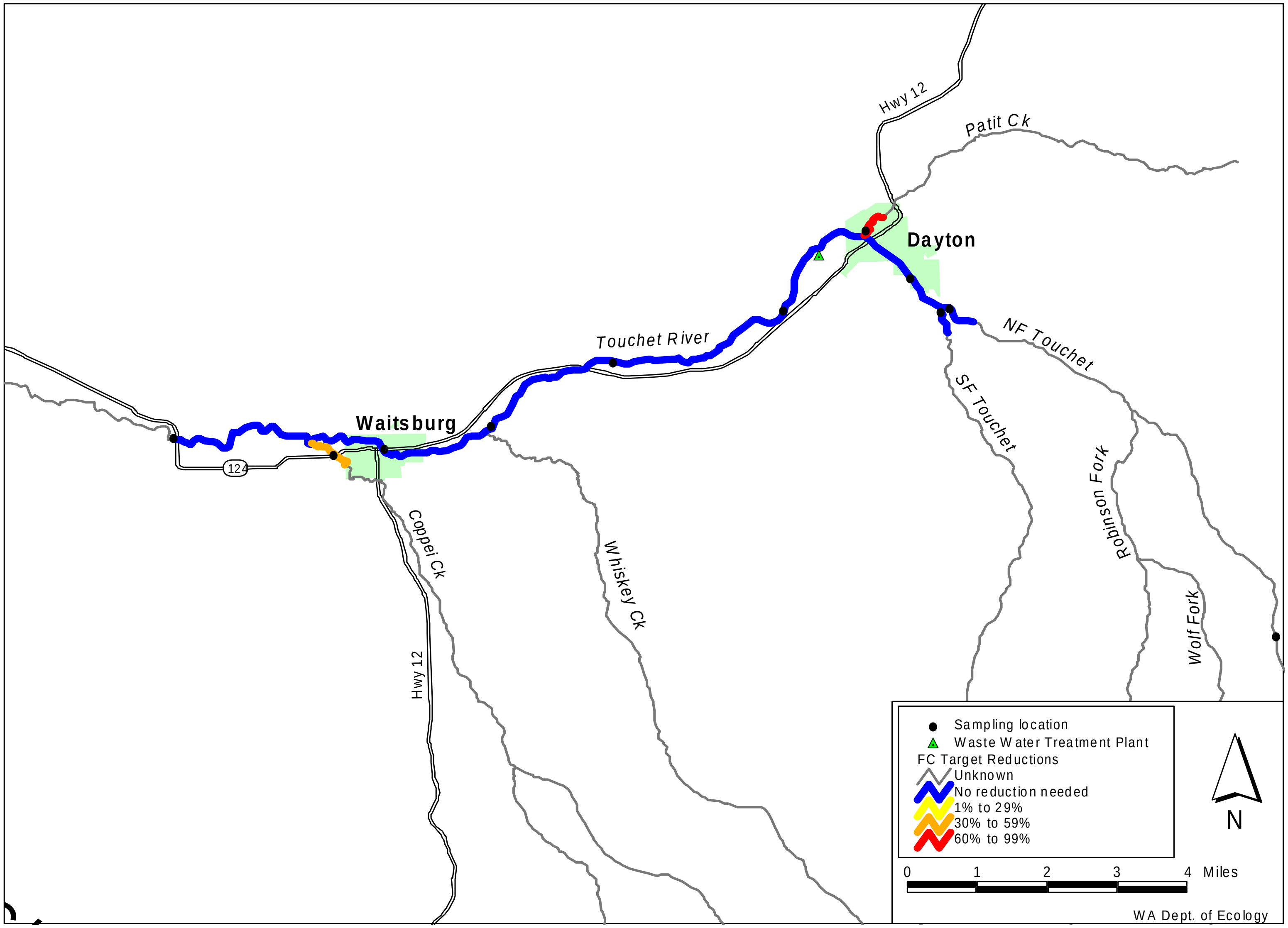

Figure E2. Recommended fecal coliform reduction targets for the upper Touchet River.

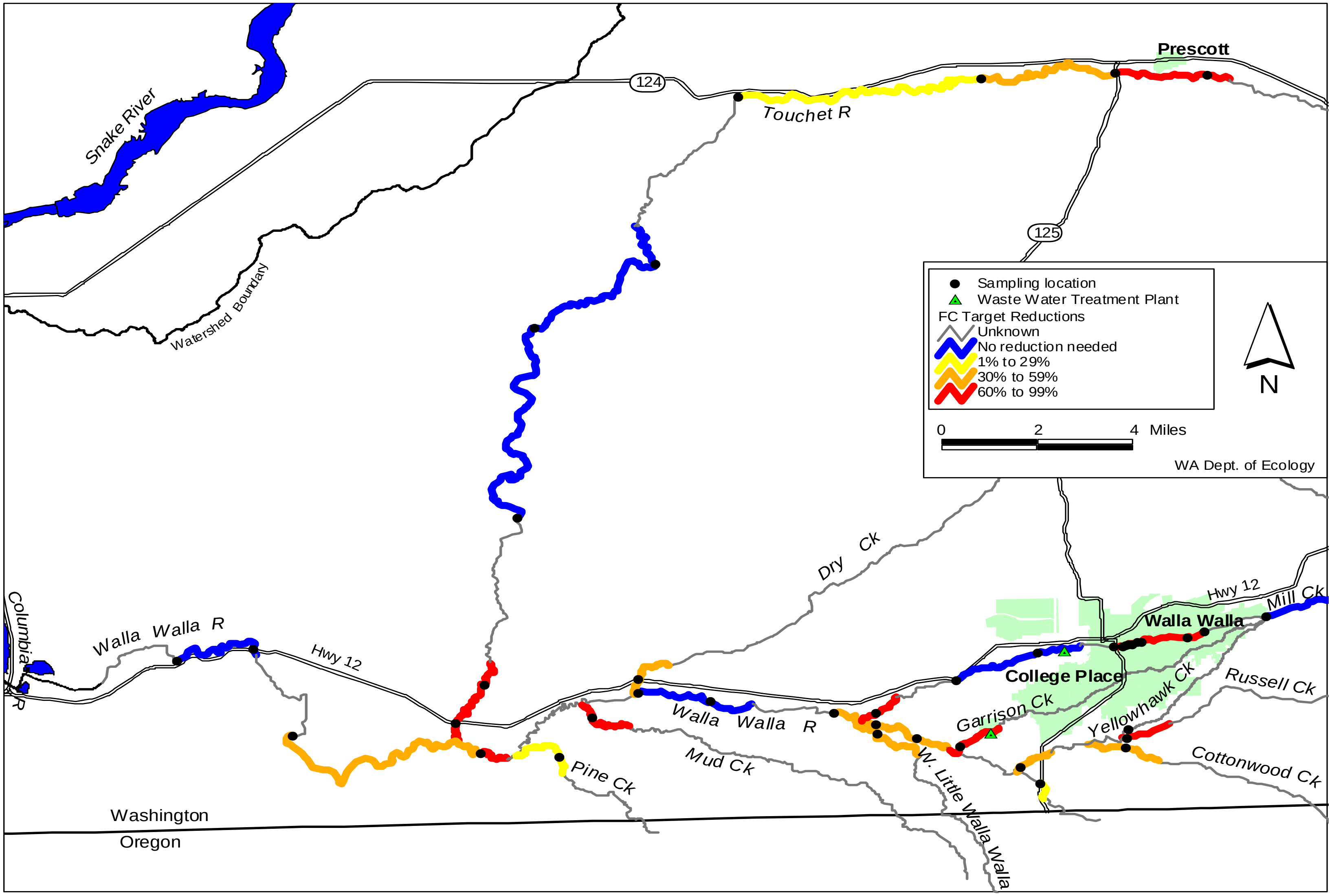

Figure E3. Recommended fecal coliform reduction targets for the lower Touchet River, and the lower Walla Walla River and tributaries.

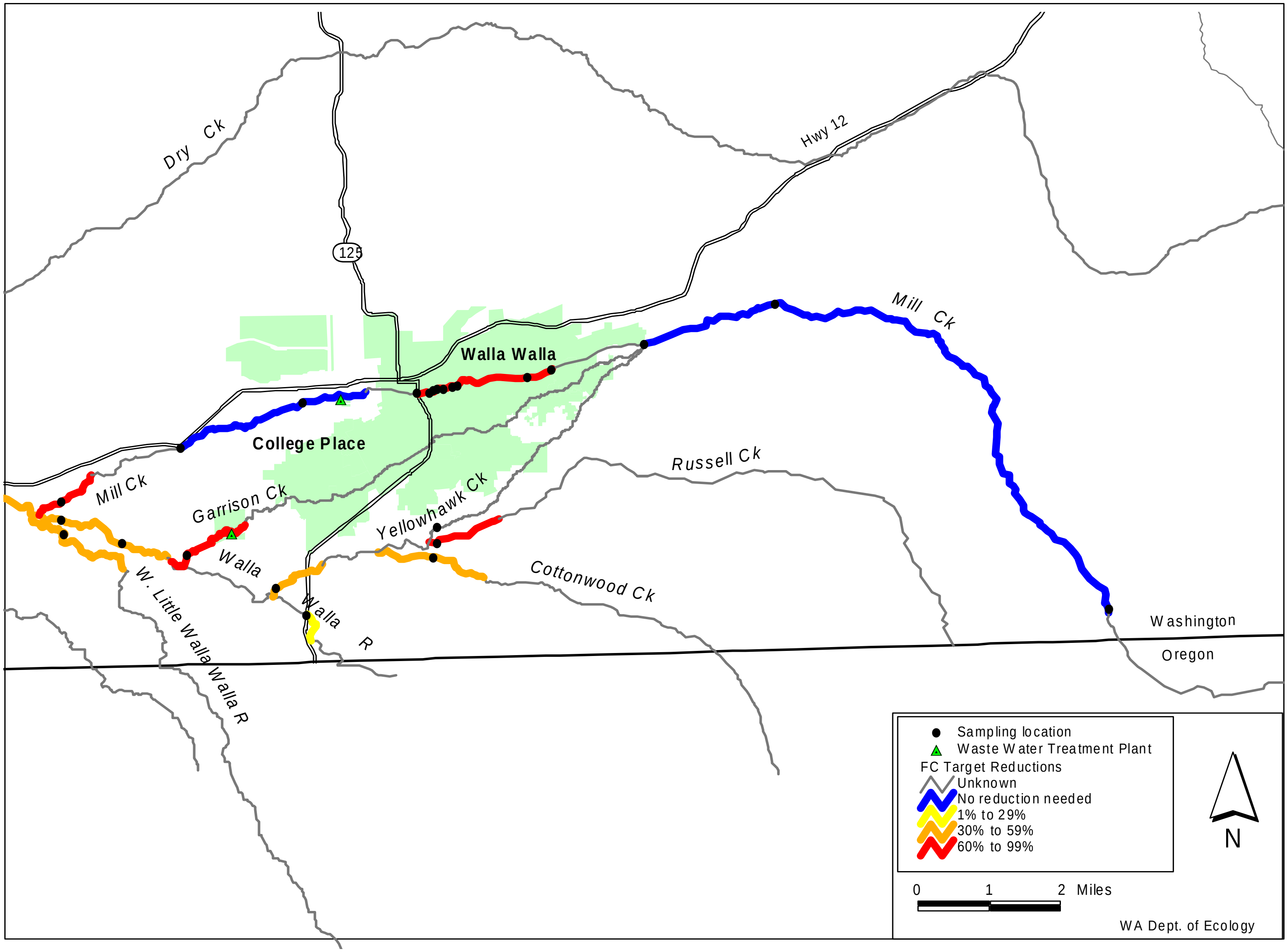

Figure E4. Recommended fecal coliform reduction targets for Mill, Yellowhawk, and Garrison creeks.

Mill Creek

- Mill Creek is classified for *Primary Contact* recreational uses from 13th Street in the city of Walla Walla upstream for 15.2 miles to the Walla Walla waterworks dam. The 6.4 miles downstream of 13th Street is limited to *Secondary Contact* recreational uses.
- Based on fecal coliform sample results, Mill Creek met *Primary Contact* criteria at all sites from the Walla Walla waterworks dam for 11 miles downstream to the diversion structure east of the city of Walla Walla (Figure E4).
- Sites located in the 4.1 miles downstream of the diversion structure to 13th Street did not meet *Primary Contact* criteria, especially when flow volumes were extremely low in the channel from June through November. Nonpoint (diffuse) and stormwater sources of fecal coliform will need to be reduced by 76% to 94%, even though public access to Mill Creek is severely restricted in the city. A significant source of fecal material may be generated by large flocks of birds nesting upstream of the city and in the downtown area under bridges. Biological source tracking methods may be helpful to confirm that anthropogenic (human-caused) sources are not also involved.
- Sites located 1.6 and 3.6 miles downstream of 13th Street met *Secondary Contact* criteria. The site located near the mouth of Mill Creek did not meet *Secondary Contact* criteria and requires a 62% reduction of fecal coliform.
- The City of Walla Walla WWTP discharges directly to Mill Creek from December 1 through April 30. If the effluent fecal coliform concentrations meet the NPDES permit limits, recreational contact criteria in Mill Creek below the outfall will be met.
- The City of Walla Walla, the Washington State Department of Transportation, Walla Walla County, and City of College Place are expected to reduce fecal coliform loads from stormwater by 60% to 80% by evaluating their systems and following best management practices.

Yellowhawk and Garrison Creeks

- Yellowhawk and Garrison creeks receive water diverted from Mill Creek east of the city of Walla Walla at the diversion structure and are classified for *Primary Contact* recreational uses.
- Water delivered to both creeks from Mill Creek at the diversion headworks meets *Primary Contact* criteria (Figure E4).
- Two tributaries to Yellowhawk, Russell, and Cottonwood creeks do not meet *Primary Contact* criteria and require fecal coliform reductions of 68% and 36%, respectively (Figure E4).
- Yellowhawk Creek above the confluences of Russell and Cottonwood was only sampled once, but the fecal coliform result suggested sources of contamination upstream.
- Samples collected at Yellowhawk Creek near the confluence with the Walla Walla River did not meet *Primary Contact* criteria. Fecal coliform will need to be reduced by 42%. The

entire creek should be investigated for nonpoint sources of fecal coliform contamination that occur throughout the years as well as for stormwater sources of fecal coliform.

- The City of Walla Walla, the Washington State Department of Transportation, Walla Walla County, and the City of College Place are expected to reduce fecal coliform loads from stormwater by 42% in Yellowhawk Creek and 81% in Garrison Creek by evaluating their systems and following best management practices.
- Garrison Creek receives effluent from the College Place WWTP, stormwater, and nonpoint sources of fecal coliform contamination. Previous monitoring work demonstrated that fecal coliform concentrations did not meet *Primary Contact* criteria above the WWTP outfall.
- Fecal coliform concentrations near the confluence of Garrison Creek with the Walla Walla River require an 81% reduction (Figure E4).
- The College Place WWTP effluent was not meeting NPDES permit fecal coliform limits. A new facility and more restrictive permit limits, based on effluent land application, will meet wasteload allocation targets.

Touchet River

- The Touchet River is classified for *Primary Contact Recreation* uses. Based on the fecal coliform sampling and historical data, these uses were met for the upper 14 miles from Dayton to Highway 124 below Waitsburg (Figure E2). Patit Creek and Coppei Creek that discharge to this stretch of the Touchet River did not meet *Primary Contact Recreation* criteria and will require fecal coliform reductions from nonpoint sources of 80% and 40%, respectively.
- During June through September, recreational contact criteria were not met for 12 miles from Hart Road near Prescott to Lamar Road (Figure E3). The primary cause of the fecal coliform contamination appeared to be a major nonpoint source (or group of sources) upstream of Hart Road that may have affected this whole stretch of river. Other minor nonpoint sources may have contributed as well. Fecal coliform reductions of 86% at Hart Road to 16% at Lamar Road are needed. Load analyses suggested that if the nonpoint source above Hart Road is reduced, then the 12 miles downstream might meet recreational criteria throughout the year.
- The seven miles of the Touchet River above the Hofer Diversion Dam appeared to meet the recreational contact criteria.
- The lower two miles of the Touchet River near the community of Touchet did not meet recreational contact criteria, especially during June through September.
- Nonpoint sources will need to be reduced by 80% upstream of Cummins Road and at the mouth of the Touchet River to meet *Primary Contact* criteria.
- The Dayton WWTP may have had disinfection problems, or there may have been analytical problems with the fecal coliform samples. If the effluent fecal coliform concentrations meet the NPDES permit limits, then recreational contact criteria in the Touchet River below the outfall will be met. Additional sampling is suggested to confirm that disinfection and analytical methods are adequate.

Walla Walla River and Minor Tributaries

- The Walla Walla River enters Washington from Oregon and must meet *Primary Contact Recreation* criteria for the first 12.8 miles downstream to the confluence with Dry Creek. For the last 27.2 miles below Dry Creek, the river must meet *Secondary Contact Recreation* criteria.
- A 6% fecal coliform reduction is needed in the Walla Walla River near the state line or in Oregon to meet *Primary Contact* criteria (Figure E4).
- A 33% to 35% fecal coliform reduction is needed in the reaches where Yellowhawk Creek, Garrison Creek, the west branch Little Walla Walla River, Mill Creek, and other tributaries join the Walla Walla River (Figure E4). Meeting the applicable recreational contact criteria in the tributaries will assist in cleaning up the Walla Walla River.
- The Washington State Department of Transportation and Walla Walla County are expected to reduce fecal coliform loads in stormwater to the Walla Walla River by 6% to 33% by evaluating their systems and following best management practices.
- The west branch Little Walla Walla River requires a 46% fecal coliform reduction to meet *Primary Contact Recreation* criteria.
- No fecal coliform reductions are required in the two-mile reach upstream of Dry Creek (Figure E3).
- Dry Creek, Mud Creek, and Pine Creek join the Walla Walla River, and require fecal coliform reductions of 45%, 60%, and 21%, respectively (Figure E3).
- The Walla Walla River above the confluence with the Touchet River did not meet *Secondary Contact Recreation* criteria and requires a 60% fecal coliform reduction. The river requires a 32% fecal coliform reduction 4.1 miles below the confluence to meet *Secondary Contact* criteria.
- No fecal coliform reduction appeared to be necessary in the Walla Walla River at two sites 6.3 miles farther downstream (Figure E3).

Recommended Actions

This report provides an overview of the fecal coliform bacteria problems in the Walla Walla basin; geographic and source-type priorities are described. More detailed monitoring and field investigations or systems evaluations are needed to characterize some fecal coliform sources (e.g., the source of contamination along the middle reaches of the Touchet River). Also, further stormwater and sanitary systems, including on-site systems, evaluations are needed to ensure that (1) practices are in place to minimize fecal coliform loads in the urbanized areas of the basin, or (2) WWTP disinfection systems are reliable.

Most of the recommended fecal coliform reduction targets are applied toward reducing nonpoint sources; these are called *load allocations*. An implementation strategy will be developed by Ecology in cooperation with the local community to reduce or eliminate these nonpoint sources.

The current or proposed NPDES permits for the four WWTPs were evaluated and considered adequate if fecal coliform limits were properly enforced, and analytical or operational questions resolved. The WWTPs were given specific fecal coliform wasteload allocations to meet instream targets. The College Place WWTP improvements will be especially important for meeting fecal coliform targets in Garrison Creek.

The communities of Walla Walla and College Place, urbanized areas of Walla Walla County, and the Washington State Department of Transportation are responsible for reducing the impact of stormwater runoff to Mill Creek, Garrison Creek, Yellowhawk Creek, the Touchet River, and the Walla Walla River. Any future municipal stormwater permits will require specific plans and evaluations of stormwater best management practices to meet instream fecal coliform targets.

The recommended fecal coliform reduction targets will be assessed by Ecology after a period of five to ten years to see if implementation measures have been successful. The assessment will determine if the fecal coliform criteria are met, if the reductions will be sustained over the long-term, or if the targets need adjustment because of additional increased understanding of sources and their effect on recreational uses.

Introduction

The Walla Walla and Touchet rivers have been placed on Washington State's 303(d) list (1996, 1998, and 2004) of impaired waterbodies for not meeting contact recreation water quality standards. The federal Clean Water Act of 1972 requires the state to develop a cleanup plan and to implement activities in the plan to bring these waterbodies back into compliance with standards.

This report is the technical document for the cleanup plan, also called a Total Maximum Daily Load (TMDL). The report forms the scientific basis for a set of instream fecal coliform (FC) bacteria targets to meet contact recreation water quality standards. It also allocates FC loads to sources in Washington State's Walla Walla River basin that will not exceed load capacities of the waterbodies. The study was conducted by the Department of Ecology (Ecology) Environmental Assessment Program, Water Quality Studies Unit.

When a TMDL technical study is undertaken, the sampling study design usually includes more waterbodies 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. The Walla Walla River basin sampling study design included a large number of sites along the Walla Walla River, and in the Touchet River and Mill Creek watersheds (Swanson and Joy, 2002).

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

Fecal coliform loads (the product of the concentration multiplied by the 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 appropriate 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. The effectiveness of best management practices and other measures to reduce or remove FC loads requires monitoring throughout the year. Key compliance sites have been identified in the report.

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Background

Basin Description

The Walla Walla River is located in the southeast corner of Washington State (Figure 1). The river extends 61 river miles (RM) from the headwaters of its north fork in Oregon to its confluence with the Columbia River in Washington. The drainage basin covers approximately 1,760 square miles and flows through four counties: Umatilla and Wallowa counties in Oregon, and Columbia and Walla Walla counties in Washington. Two-thirds of the Walla Walla drainage basin and the last 40 miles of the mainstem lie within Washington. Major tributaries include the Touchet River, Mill Creek, Dry Creek, and Pine Creek.

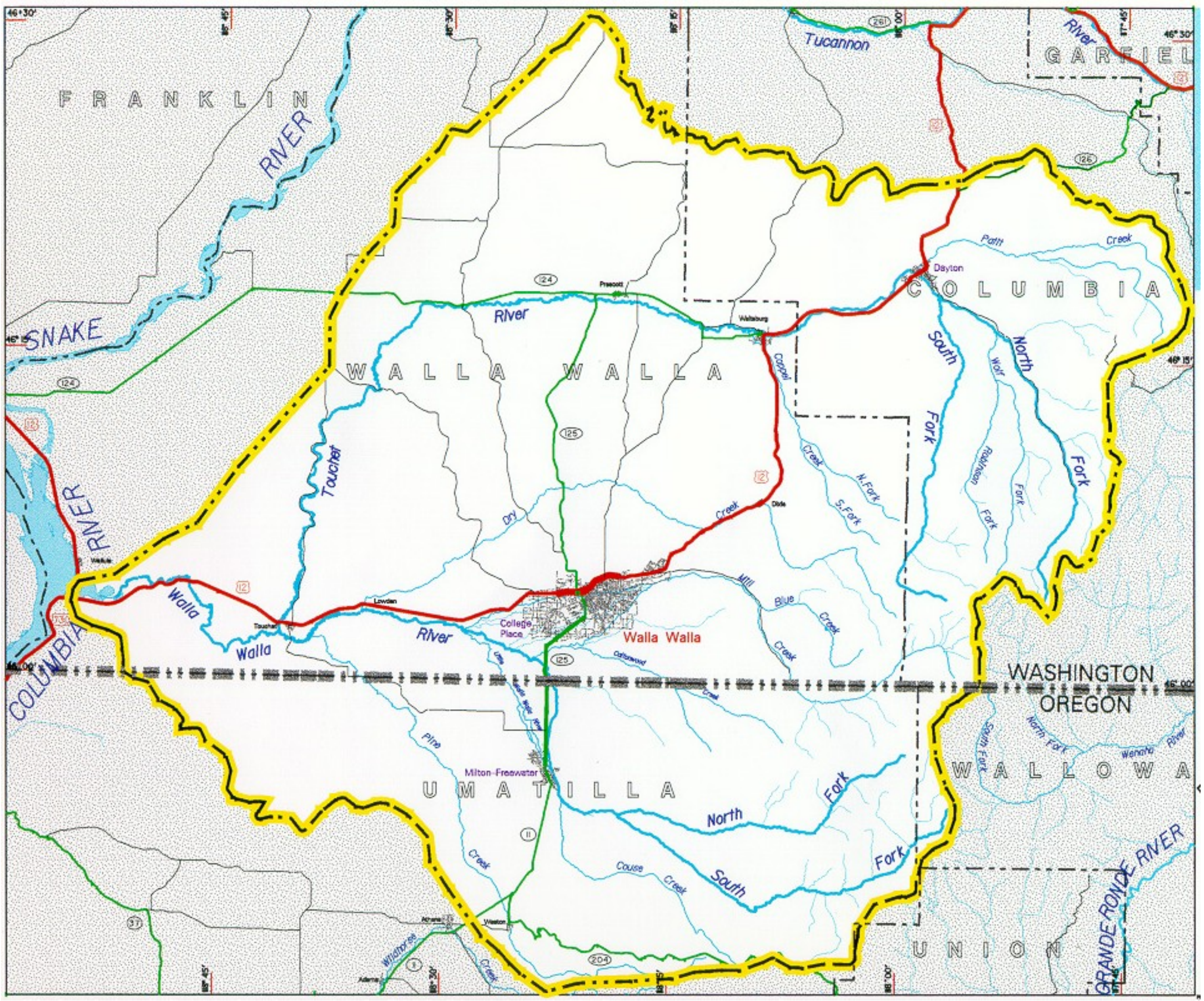

Figure 1. The Walla Walla River basin (U.S. Army Corps of Engineers, 1997).

The headwaters of the Touchet River – Robinson Creek, Wolf Creek, North Fork Touchet, and South Fork Touchet – originate deep in the Blue Mountains at an elevation of 6,074 feet. They are mainly located in forested areas of the Blue Mountain Ecoregion with some small farms in the valleys. As the forks converge just above the city of Dayton to form the mainstem Touchet River, the river enters the Columbia Basin Ecoregion.

The Touchet River flows through the cities of Dayton, Waitsburg, and Prescott reaching its confluence with the Walla Walla River (RM 19.8) by the community of Touchet at an elevation of 425 feet (Figure 1). Land use in the Touchet basin from Dayton to the confluence of the Walla Walla River is predominantly agricultural, with both irrigated and non-irrigated crops.

Dry Creek is located in a 239-square-mile basin with elevations from 460 feet at the confluence with the Walla Walla River near Lowden (RM 27.2) to 4,600 feet in the Blue Mountains (Figure 1). Dry Creek's watershed is mainly used for dryland wheat agriculture, with only sparse forests in the headwaters.

The headwaters of Mill Creek flow from the Blue Mountains in Oregon at elevations of 5,000 feet. At RM 25.2, the City of Walla Walla waterworks dam diverts water for municipal uses. Mill Creek continues through forest, agricultural, and light residential areas where it is joined by its largest tributary, Blue Creek, at RM 16.8. Flood control and irrigation operation structures begin at RM 11.5. A diversion dam is located at RM 11.5 where seasonal high streamflows are diverted to Bennington Lake and eventually released to Russell Creek.

Mill Creek is armored with energy dissipater weirs and a concrete channel from RM 11.5 through the city of Walla Walla to RM 4.5 for flood control. Portions of the creek that are not entirely concrete have revetments to stabilize the banks and a rubble bottom. In the areas with energy dissipaters, the channel can get as wide as 520 feet. Below the city of Walla Walla, Mill Creek flows through agricultural areas to the confluence with the Walla Walla River (RM 33.6).

A diversion structure at RM 10.5 is used to direct most of the streamflow from Mill Creek to senior water rights holders on Yellowhawk and Garrison creeks from May through October. Garrison Creek winds through dense residential areas in the cities of Walla Walla and College Place before reaching agricultural areas and joining the Walla Walla River (RM 36.2). Yellowhawk Creek flows through fewer residential areas. It is joined by Russell and Cottonwood creeks from hills to the east before joining the Walla Walla River (RM 38.2).

Although most of the city of Walla Walla's drinking water comes from the 36-square-mile managed and protected portion of upper Mill Creek, additional supplies are taken from groundwater in a deep basalt aquifer. A relatively dynamic, shallower gravel aquifer is used by residents in the Walla Walla basin as well, mainly for irrigation. Recent studies (1995) identified nitrate and coliform bacteria contamination of the gravel aquifer near the city of Walla Walla (Pacific Groundwater Group, 1995).

Springs supply baseflows to surface waters year-round. Storm events during the winter sometimes cause severe flooding from heavy rainfall and rapid snowmelt. Snowmelt and runoff in the spring increase river discharge volumes.

Rivers and streams in the basin experience greatly reduced flows in the summer from a combination of reduced supply and diversion for irrigation. For example, the Walla Walla River has often gone dry at the Oregon-Washington border, and Mill Creek usually has little to no flow between points of irrigation withdrawals and returns. Conditions have improved recently in the mainstem Walla Walla River as a result of farmers diverting less water in response to bull trout Endangered Species Act listings. Flows near the state line now range from 4 - 15 cubic feet per second (cfs) in the summer.

The Walla Walla River basin is predominantly rural with few urban areas. The major towns are Walla Walla and College Place, with a combined population of less than 40,000. Smaller towns of Dayton, Waitsburg, and Milton-Freewater (Oregon) support surrounding agriculture. Spring and summer wheat, alfalfa seed and hay, and peas are the largest percentage of the irrigated crops. Other crops include grapes, apples, asparagus, barley, and onions.

Headwaters are mostly forest and rangeland managed by the U.S. Forest Service. Some Confederated Tribes of the Umatilla Indian Reservation (CTUIR) lands are located in or near the upper Walla Walla watershed.

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Applicable Water Quality Criteria

Beneficial Uses Definitions

The 2003 revisions to the State of Washington water quality standards are still under review by the U.S. Environmental Protection Agency (USEPA). Most of the revisions have not been accepted so that Ecology is largely operating under the 1997 version of Chapter 173-201A WAC standards (Ecology, 2005a). Part of the revised version has, however, been accepted by USEPA. The adopted portions of the revised standards include the following language for recreational uses in this document:

- *Extraordinary Primary Contact* and *Secondary Contact* uses (formerly Class AA)
- *Primary Contact* and *Secondary Contact* uses (formerly Class A)
- *Secondary Contact* uses only (formerly Class B)

Examples of *Primary Contact* uses are swimming, snorkeling, and activities where the water and skin or body openings (e.g., eyes, ears, mouth, nose, and urogenital) come into direct and extended contact. *Secondary Contact* uses would be boating, fishing, and activities where only brief incidental water contact would be expected.

The language only pertains to recreational uses and those uses that are defined by general narrative criteria and as numeric water contact bacteria criteria. The general criteria are covered by the narrative standard for toxics and aesthetics pollution WAC 173-260.

(a) Toxic, radioactive, or deleterious material concentrations must be below those which have the potential, either singularly or cumulatively, to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health (see WAC 173-201A-240, toxic substances, and 173-201A-250, radioactive substances).

(b) Aesthetic values must not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste (see WAC 173-201A-230 for guidance on establishing lake nutrient standards to protect aesthetics).

The two-level fecal coliform (FC) bacteria numeric criteria for recreational water contact are the same as they were under the 1997 standards (i.e., a geometric mean (GM) criterion, with not more than 10% of the samples to exceed another criterion). The FC criteria are as follows:

• *Extraordinary Primary Contact*	50 cfu/100 mL GM	not more than 10% >100 cfu/100 mL
• *Primary Contact*	100 cfu/100 mL GM	not more than 10% >200 cfu/100 mL
• *Secondary Contact*	200 cfu/100 mL GM	not more than 10% >400 cfu/100 mL

Table 1 shows that rivers and streams in the Walla Walla basin are a mix of Class AA (*Extraordinary Contact*), A (*Primary*), and B (*Secondary*) as defined by the 1997 Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A WAC). All segments and tributaries to Class AA waters are Class AA as well. All other tributaries in the Walla Walla River basin (in Washington) not listed in Table 1 are considered Class A waters.

Table 1. Water quality classifications for the Walla Walla River, North Fork Touchet River, and Mill Creek.

Waterbody	Location	Special Conditions	Class*
Walla Walla River	Mouth to Dry Creek (RM 27.2)	NA	B Secondary Contact Recreation Uses
	Lowden (Dry Creek at RM 27.2) to Oregon border (RM 40)	Temperature shall not exceed 20.0ºC due to human activities. When natural conditions exceed 20.0ºC, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3ºC.	A Primary and Secondary Contact Recreation Uses
NF Touchet River	At Dayton water intake structure (RM 3.0) to headwaters	NA	AA Extraordinary Primary, Primary, and Secondary Contact Recreation Uses
Mill Creek	Mouth to 13th St. Bridge (RM 6.4)	Dissolved oxygen concentration shall exceed 5.0 mg/L	B Secondary Contact Recreation Uses
	13th St. Bridge to Walla Walla Waterworks Dam (RM 11.5)	NA	A Primary and Secondary Contact Recreation Uses
	City of Walla Walla Waterworks Dam (RM 21.6) to headwaters	No waste discharge will be permitted	AA Extraordinary Primary, Primary, and Secondary Contact Recreation Uses

* Ecology Water Quality Standards are under USEPA review. As of October 2004, the *Contact Recreation* classification system has been approved by the USEPA that substitutes the terms *Extraordinary Primary Contact*, *Primary Contact*, and *Secondary Contact* for Class AA, A, and B, respectively. No changes in bacterial indicators or the criteria concentrations were made with the classification changes.

There are a few informal swimming areas on Mill Creek and the Walla Walla and Touchet rivers. *Primary Contact* on the Touchet River is mostly limited to the reaches between Dayton and Waitsburg during the summer. Swimming occurs in Mill Creek upstream of the city of Walla Walla at the U.S. Army Corps of Engineers Mill Creek Recreation Area and at Five-Mile Bridge. Swimming on the Walla Walla River is known to occur between Dry Creek and Mill Creek but may be more widespread (Mendel, 2002).

Secondary Contact (e.g., fishing, boating, waterfowl hunting, and wading) may occur throughout the basin, but the extent is not well known. Steelhead salmon are the only anadromous species presently available to sport anglers. Although recreational fishing occurs year-around, the peak season occurs in the spring, when fecal coliform levels are usually highest.

Currently, monitoring data used for the 1998 303(d) list indicate that some beneficial uses in the watershed are not being met. Recreational uses are not fully protected because bacteria indicator results are elevated. This TMDL study will address these beneficial uses by evaluating bacterial indicators as well as several associated biological and chemical parameters.

Washington and Oregon Recreational Use Numeric Criteria

Coliform bacteria have been used as indicators of fecal contamination since the 1880s (Geldrich, 1966). Coliforms are a group of bacteria with certain shapes that produce gas from sugars and respond to other tests in specific ways. Different sub-sets of the coliform group are used as indicators for specific regulatory purposes. Figure 2 illustrates how the sub-sets within the coliform group are related.

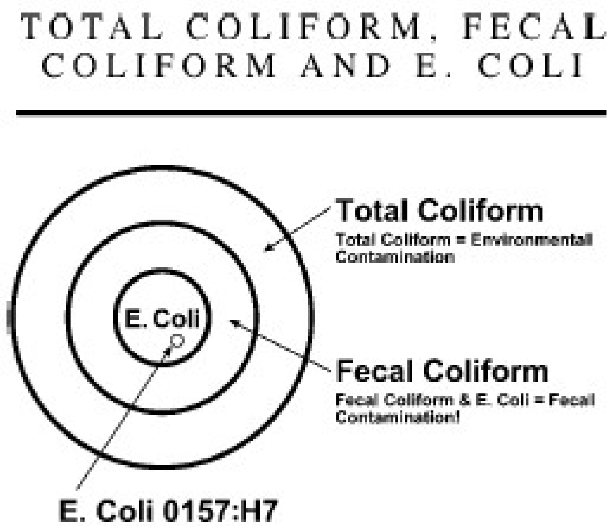

Figure 2. A diagram depicting the relationship between total coliform, fecal coliform, *Escherichia coli* (E. coli), and a specific type of E. coli (Washington State Department of Health, 2005).

Total coliforms are used as indicators of general environmental contamination, and as a regulatory indicator for reclaimed wastewater disposal. For example, the seven-day median concentration of total coliforms cannot exceed 2.2 per 100 milliliters in Class A reclaimed water for use on crops (Washington State Department of Health, 1997).

Fecal coliform (FC) bacteria are used as indicators of the presence of other pathogenic enteric organisms. When FC are found in large numbers, it means that fecal wastes are entering waterways and creating a greater potential for infection from pathogens when people come in contact with these waters. State water quality standards do not distinguish between human and other sources of FC since disease organisms that affect humans are carried in fecal wastes from other warm-blooded animals as well.

Bacteria from the genera *Escherichia*, *Citrobacter*, *Klebsiella*, *Enterobacter*, and *Serratia* (among others) are detected in the FC analysis (APHA et al., 1998). All are present in the feces of warm-blooded animals, but some species may be from other sources as well. Usually, *Escherichia coli* (E. coli) are the dominant species detected in the FC test. A high percentage of

E. coli in samples would likely be from warm-blooded animal sources. A high percentage of thermo-tolerant *Klebsiella* would likely be from pulp waste or rotting vegetation.

E. coli are exclusively produced in the gut of warm-blooded animals, so USEPA recommends using it to better ensure that waters do not contain unhealthy levels of pathogens. E. coli did not replace FC in the Washington State water quality standards, but E. coli samples were collected in this TMDL study as an additional indicator of contamination sources.

E. coli results also allow a comparison to Oregon's E. coli-based standards. Oregon bacteria standards are as follows (OAR 340-041-009):

Coliform bacteria shall not exceed a 30-day log mean of 126 E. coli organisms per 100 ml, based on a minimum of five (5) samples. No single sample shall exceed 406 E. coli organisms per 100 ml.

As stated earlier, Washington State uses a two-level, FC criteria based on a geometric mean statistic and a criterion that cannot be exceeded by more than 10% of the samples used to calculate the geometric mean. Unlike Oregon, Washington State standards do not explicitly state a minimum number of samples or time period on which to calculate the geometric mean and 10% statistics. The standards do affect one aspect of FC statistical calculations: averaging data collected beyond a 30-day period or beyond a specific discharge event under investigation shall not be permitted when the additional data will skew the statistics to mask noncompliance periods (Chapter 173-201A-060(3) WAC).

The Department of Ecology Water Quality Program policy for including data for the 303(d) list assessment states that fewer than five samples can be used for listing a waterbody if 10% exceed the criterion, but that the geometric mean of less than five samples cannot be used (Ecology, 2002). When at least one sample exceeds the criterion, the waterbody segment will be placed in Category 2, *Waters of Concern*.

In basin-wide TMDL studies, the geographic and temporal coverages are too great to afford the costs of bacteria sampling at a frequency more than once or twice a month. In order to protect beneficial uses and in keeping with the Clean Water Act, the TMDL data are interpreted in a conservative manner. A statistical approach is used where mean and the 90^{th} percentile concentration of the log-normalized FC results are considered equivalent to the concentration of the geometric mean and upper 10% of the samples as stated in the water quality standards. This procedure is further explained in the *Technical Analysis /Data Analysis Methods* section in this report.

Water Quality and Resource Impairments

Water Quality Issues

303(d) Listings

The basin-wide fecal coliform (FC) bacteria evaluation was conducted concurrently with evaluations of other parameters on the 303(d) list. The Walla Walla River at river mile (RM) 15.3 and the Touchet River (RM 0.5) were on the 1996 and 1998 303(d) lists for FC based on previous monitoring work (Table 2 and Figure 3). Mill Creek had FC listings in 1996 but not in 1998. Mill Creek pH and temperature water quality criteria were not being met upstream of the city of Walla Walla at RM 10 in both assessments. Temperature and pesticides are also on the 303(d) list, although not necessarily in the same areas (e.g., the Touchet River is listed for high temperatures at RM 0.5 and near the city of Dayton).

The pH listings will be covered in another section of the conventional parameter TMDL (Pelletier, Joy, and Swanson, in preparation). Temperature and organochlorine pesticides and PCBs are evaluated in two other reports (Stohr, in preparation; Johnson et al., 2004).

Table 2. Walla Walla River basin waterbodies on the 1996 and 1998 303(d) lists.

Waterbody	Old WBID	New WBID	Parameter	1996 List	1998 List
Walla Walla River	WA-32-1010	QE90PI	*Fecal Coliform*	*Yes*	*Yes*
			pH	Yes	Yes
			Temperature	Yes	Yes
			PCB and Pesticides	Yes	Yes
Mill Creek	WA-32-1060	SS77BG	*Fecal Coliform*	*Yes*	*No*
			pH	Yes	Yes
			Temperature	Yes	Yes
Touchet River	WA-32-1020	LV94PX	*Fecal Coliform*	*Yes*	*Yes*
			pH	Yes	No
			Temperature	Yes	Yes

Italicized type indicates parameters addressed in the FC bacteria TMDL evaluation.

WBID is the waterbody identification number; old WBIDs were used in the 1996 303(d) list, and new WBIDs are used in the 2004 list.

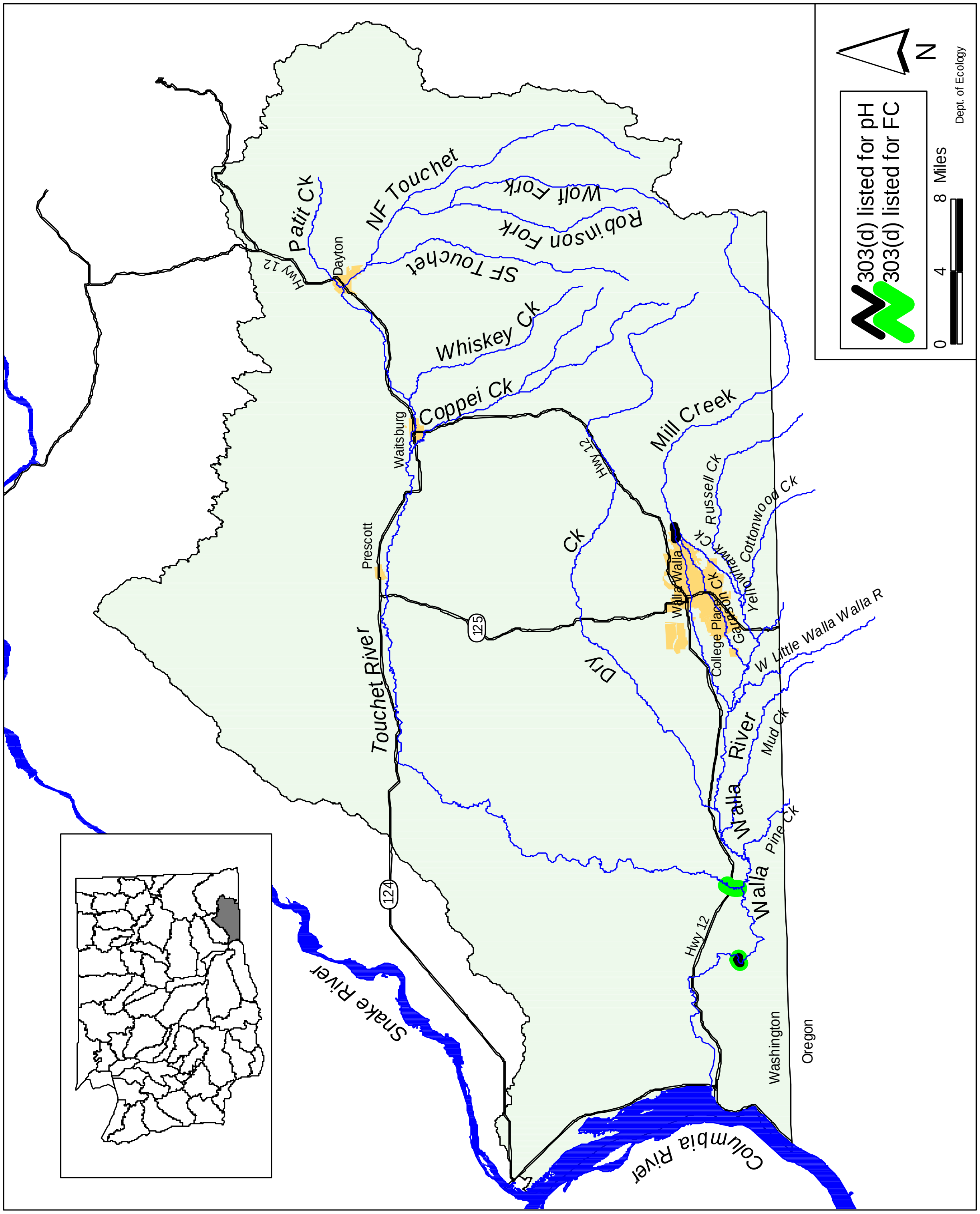

Figure 3. 1998 303(d)-listed segments in the Walla Walla watershed.

Possible Pollution Sources

Most of what was known about past FC sources in the Walla Walla basin for the FC listings in Table 2 was based on a few monitoring sites and intensive surveys. For example, in the three main sub-watersheds:

- The Walla Walla River from RM 15 to the Oregon border (RM 40) had only two historical water quality monitoring sites, and no intensive water quality surveys.
- The lower 10.5 miles of Mill Creek was the subject of an ammonia and chlorine TMDL study in the 1980s. Two monthly water quality sites were monitored into the 1990s. Lower Garrison Creek was the subject of a use-based water quality study in 2000.
- The Touchet River near Dayton and Waitsburg were the subject of wastewater treatment plant (WWTP) studies in the 1980s. Ecology monitored the Touchet River at monthly intervals at RM 0.5 and less often at three sites upstream of RM 40.

In general, the low-flow issues of most streams in the Walla Walla basin profoundly affect water quality, including FC contamination and contact recreation uses. Recent efforts have been made to address water resources in the basin (HDR/EES et al., 2005; Walla Walla 2514 Planning, 2004). Water allocation is a major issue that needs resolving if water quality, irrigation and municipal water uses, Endangered Species Act, and other issues are to be balanced. Many water rights in the Walla Walla basin have very early priority dates (dates of origin), dating back to the mid-to-late 1800s. Water rights issues are not in the scope of this TMDL, but some FC contamination problems in the basins are affected by water volume.

Mill Creek Watershed

Potential sources of FC bacteria pollution to Mill Creek include residential land uses, on-site septic systems, agriculture, wildlife, stormwater, and municipal wastewater. Mill Creek was on the 1996 303(d) list when FC results exceeded water quality criteria above the city of Walla Walla. The listing was removed from the 1998 list because FC results improved at the monitoring site.

The Walla Walla WWTP discharges into Mill Creek from December 1 through April 30 of each year, subject to National Pollutant Discharge Elimination System (NPDES) permit conditions (Appendix A). The Walla Walla WWTP discharges at RM 5.4, downstream from the center of the city. Effluent discharged directly into Mill Creek from December through April is not expected to cause a FC problem when NPDES permit conditions are met.

As mentioned earlier, a diversion dam on Mill Creek directs nearly all streamflows above the city from May through October to Garrison and Yellowhawk creeks for irrigation purposes. The City of Walla Walla WWTP effluent to Mill Creek is diverted for irrigation use from April 15 through December 15. Irrigation flows are then returned to the creek downstream of the diversion at various points.

The major suspected causes of FC pollution in Mill, Yellowhawk, and Garrison creeks are nonpoint sources such as agriculture, poorly performing on-site septic systems, and urban-residential runoff and subsurface contamination. The reaches of Mill Creek with energy dissipater weirs above the city of Walla Walla also create nesting areas for a great number of waterfowl. In the low-flow period, the wildlife may contribute significant bacterial loads.

During the June 2002 – June 2003 TMDL surveys, the College Place WWTP discharged from May through October through wetlands prior to discharge into Garrison Creek. The effluent was discharged from November through April directly to Garrison Creek. Some data suggest that both upstream nonpoint sources and the wetlands are sources of FC contamination to Garrison Creek (White et al., 1998)

Touchet River

The FC counts in the Touchet River basin are most likely from nonpoint sources. Much of the land adjacent to the Touchet River is used for agricultural purposes; some properties have direct access to the river by livestock. Other sources of FC may include wildlife and poorly maintained septic systems. The FC sources on tributaries like Coppei Creek are also probably nonpoint in character.

During these 2002-03 TMDL surveys, municipal wastewater discharges from Dayton, Waitsburg, and Touchet had FC bacteria NPDES permit limits to protect water quality (Appendix A). The Waitsburg and Touchet facilities did not discharge to surface water.

Walla Walla River

The Walla Walla River flows from Oregon to Washington with existing FC loads. Nonpoint sources such as livestock access to riparian areas are potential sources of FC criteria violations along the Walla Walla River. Other sources of FC are present as well (e.g., wildlife and poorly maintained septic systems). The FC loads from Mill Creek, the Touchet River, and other tributaries may also contribute to the criteria violations noted in the lower Walla Walla River. Irrigation diversions and returns may also contribute by providing transport mechanisms for nutrients and FC bacteria.

Stormwater

Fecal coliform loads in stormwater are generated from a variety of sources. Data collected nationwide over the past 40 years have suggested that these sources vary in intensity and are often generally associated with certain land uses. In the past few years, stormwater-generated pollutants have come under scrutiny by federal and state regulating authorities. Certain jurisdictions are now responsible for the quality and quantity of stormwater discharged by their systems under the federal Clean Water Act.

In 2002 the USEPA directed that all TMDLs in jurisdictions with NPDES permits for stormwater systems include the pollutant loads from those systems as wasteload allocations (Wayland and Hanlon, 2002). Ecology adopted the policy after sampling was completed for the Walla Walla

Basin TMDL. Currently, Ecology has the Eastern Washington preliminary draft for Phase II municipal stormwater permits open for public review (Ecology, 2005c).

Walla Walla County, the City of Walla Walla, and the City of College Place may be required to obtain stormwater permits as Phase II municipal separate stormwater sewer systems (Figure 4). The Washington State Department of Transportation will have statewide responsibility for highway stormwater runoff (e.g., Highway 125 and Highway 12) under the Phase II permit process. Under the permits, the jurisdictions will be required to evaluate their stormwater systems, use best management practices, and reduce FC loads.

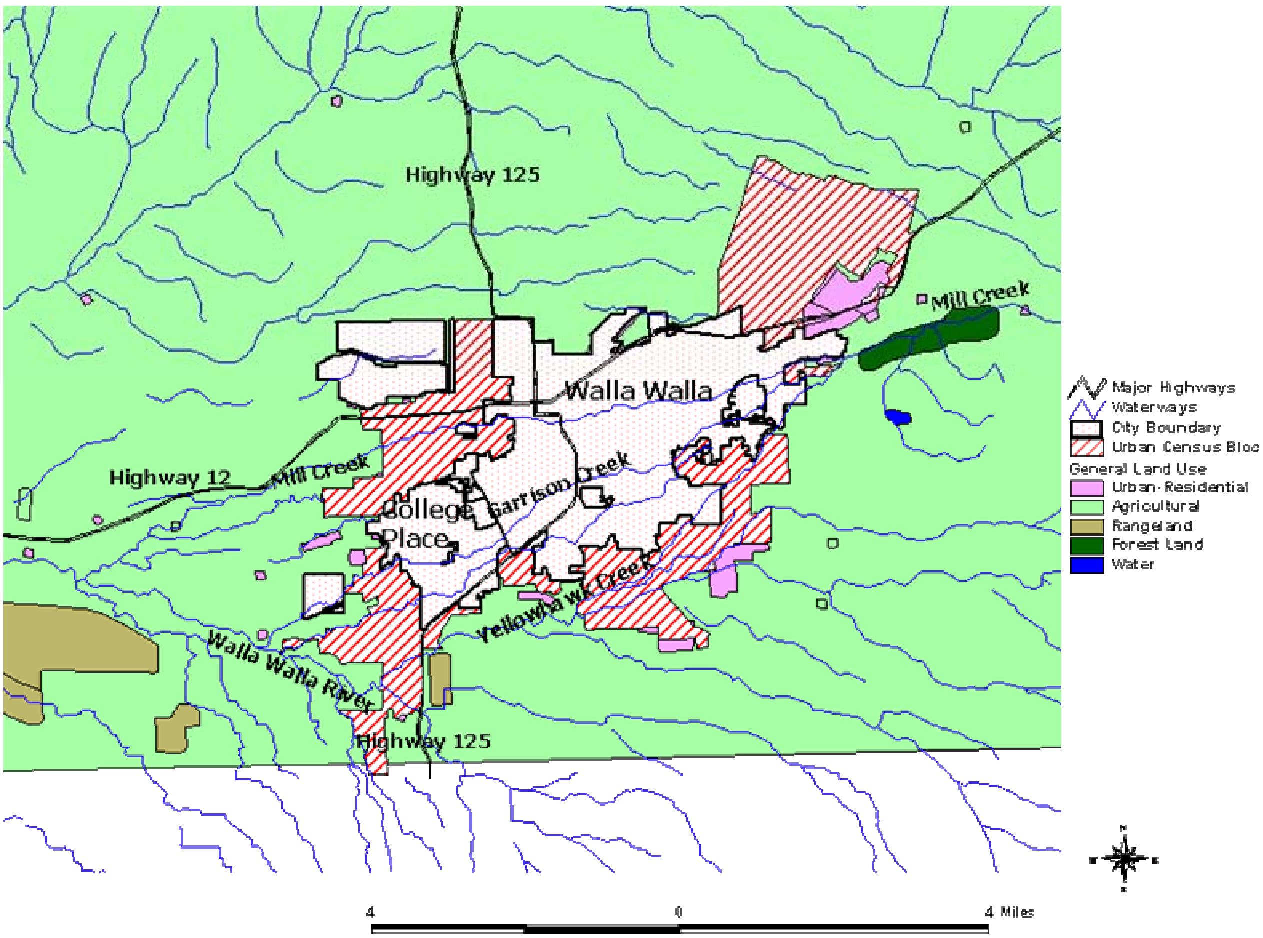

Figure 4. General land use and jurisdictional boundaries in the Walla Walla urban area considered for NPDES stormwater permit responsibilities.

Data were not collected during this TMDL study to specifically characterize the stormwater from these potential NPDES permit sources. Stormwater data from the permit jurisdictions were not available to be evaluated. In this report, stormwater was generally assessed using available data, and interim wasteload allocations are set to FC reduction targets in receiving waters that have likely permitted stormwater sources.

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Technical Analysis

Data Collection Activities

Ecology developed a Quality Assurance (QA) Project Plan for the *Fecal Coliform Bacteria and pH Total Maximum Daily Load Study* in 2002 (Swanson and Joy, 2002). The project plan was approved. It provides background information and a detailed description of monitoring and sample processing activities. A brief description of the June 2002 – June 2003 TMDL survey scope is presented here.

The goal of the fecal coliform (FC) bacteria Total Maximum Daily Load (TMDL) evaluation was stated in the QA Project Plan after reviewing available data and recognizing that the FC problems may be more wide-spread than the 303(d) listings suggested. The FC monitoring goal was to:

Determine the geographic and seasonal extent of bacterial contamination to the Walla Walla River and the Touchet River, and where appropriate propose reductions to sources, reaches, or tributaries in the form of TMDL load and wasteload allocations.

The QA Project Plan included several other parameters to assist in evaluating FC and recreational contact uses. For example, FC and E. coli analyses were conducted on several samples because Ecology was redeveloping its water quality standard in 2002, and the use of both indicators were being discussed. Also, sources of FC and E. coli often are associated with other wastes or processes, so total suspended solids and chloride were included as ancillary parameters. A network of flow monitoring stations was also cooperatively developed with other agencies and other Ecology projects so that loads could be calculated.

Fecal coliform and streamflow data were collected from water quality monitoring sites distributed throughout the basin within Washington (Figure 5 and Appendix A). Fecal coliform samples were collected at 58 sites in the basin.

- *Core Sites* – 25 sites were sampled 16 times over the 13 months. These core sites were set at known or suspected areas of FC contamination based on the water-quality-impaired list, at the mouths of major tributaries, bracketing cities or where changes in land use occur, and at convenient intervals in larger river systems.
- *Expanded Sites* – 33 sites, including the three municipal WWTPs, were sampled six or fewer times during expanded surveys. These sites were used to monitor minor tributaries, provide QA data generated under WWTP self-monitoring, and better define water quality between larger monitored reaches.

Sites were distributed in the basin as shown in Table 3.

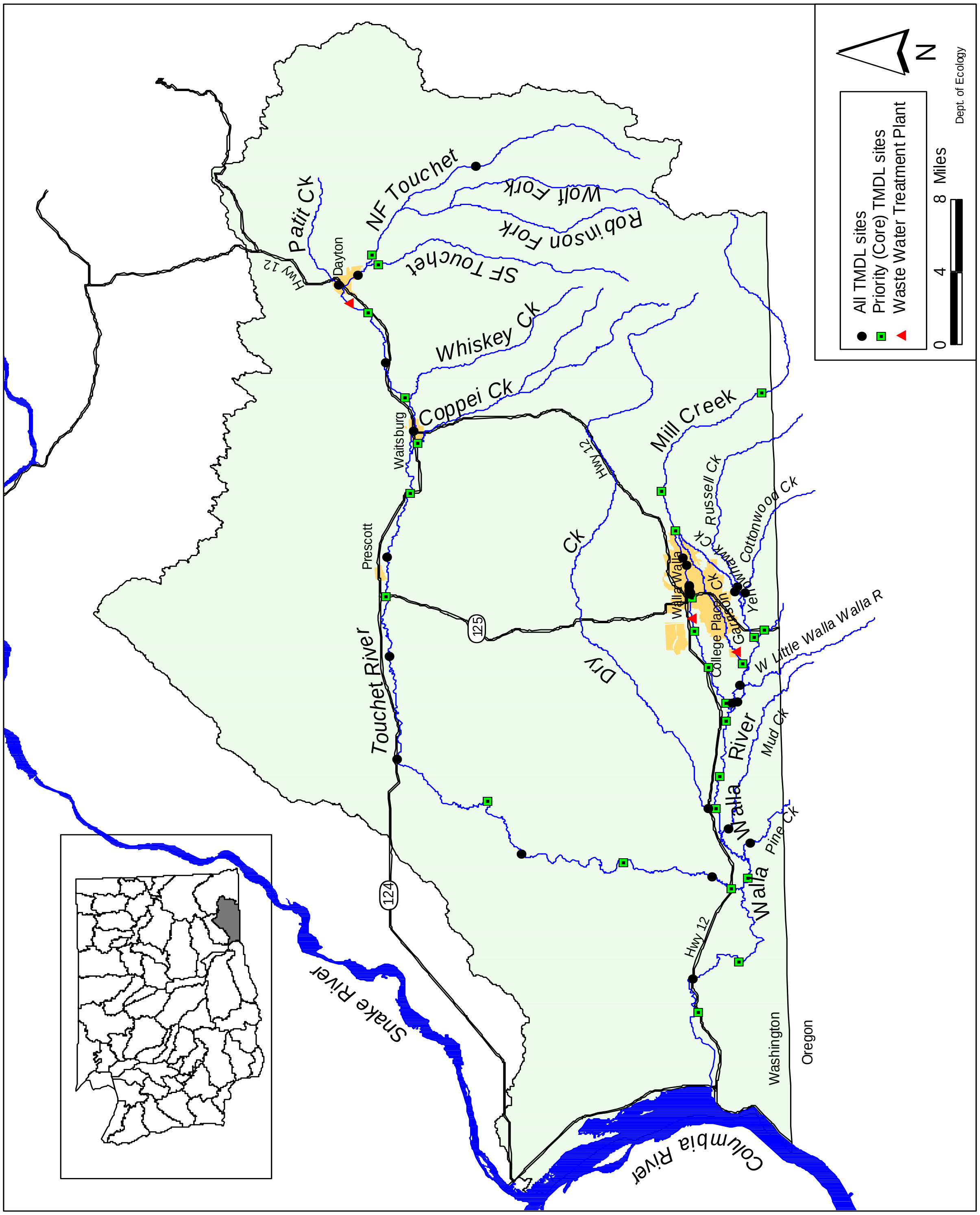


Figure 5. Water quality monitoring sites in the Walla Walla basin, June 2002 – June 2003.

Table 3. Distribution of core and expanded water quality sites in the Walla Walla River basin, June 2002 through June 2003.

Subwatershed or Source	Core	Expanded	Total
Touchet River	10	9	19
Mill Creek	6	10	16
Yellowhawk/Garrison creeks	2	3	5
Walla Walla River	7	3	10
Minor tributaries to the Walla Walla River	-	4	4
Municipal WWTPs (2 sites at College Place)	-	4	4
Total	25	33	58

The paucity of historical FC data in much of the basin, and the finite resources available to cover a large geographic and hydrologically complex basin, limited the scope of this FC study to general problem assessment. The study was designed to provide Ecology and local water quality managers with a broad overview of the FC problems in the basin so that better monitoring and resource allocation decisions can be made. Other than WWTP evaluations, this study was not designed to assess or identify individual sources of FC contamination, especially nonpoint sources.

Swanson (2005) previously published the 2002-03 Ecology TMDL survey-generated data summary. The data summary also includes the quality assurance evaluations for all Ecology TMDL-generated data. Fecal coliform data collected by the Ecology Freshwater Monitoring Unit was also used (Ecology, 2005a). Streamflow data collected by the following were also used:

- Washington Department of Fish and Wildlife (Mendel et al., 2004)
- USGS, http://waterdata.usgs.gov/wa/nwis
- U.S. Army Corp of Engineers
- Ecology Walla Walla Watermaster (Neve, 2004)
- Stream Hydrology Unit, https://fortress.wa.gov/ecy/wrx/wrx/flows/regions/state.asp?region=4

Data Analysis Methods

The Statistical Rollback Method (Ott, 1997) was used to determine if FC distribution statistics for individual sites meet the water quality criteria in the Walla Walla River basin. The method has been successfully applied by Ecology in other FC bacteria TMDL evaluations (Cusimano and Giglio, 1995; Pelletier and Seiders, 2000; Joy, 2000; and Coots, 2002).

The method is applied as follows:

The geometric mean (approximately the median in a lognormal distribution) and 90th percentile statistics are calculated and compared to the FC criteria. If one or both do not meet the criteria, the whole distribution is "rolled-back" to match the most restrictive of the two criteria. The 90th percentile criterion usually is the most restrictive.

The rolled-back geometric mean or 90th percentile FC value then becomes the "target" FC value for the site. (The term target is used to distinguish these estimated numbers from the actual water quality criteria.) The amount a distribution of FC counts is "rolled-back" to the target value is stated as the estimated percent of FC reduction required to meet the FC water quality criteria and contact recreation water quality standards. A detailed graphical example and interpretation is shown in Appendix B.

The rollback was applied to the most representative distribution after taking several analytical steps. At sites with historical data, both step trends and monotonic trend analyses were performed on FC counts and streamflows to determine the most recent and stable dataset (i.e., to ensure that high water and drought years are represented equally). Trend analyses, tests for seasonality, and statistical tests for lognormal distributions were performed using WQHYDRO, a statistical software package for environmental data analysis (Aroner, 2001). The geometric mean and 90th percentile statistics for various subsets of data were then calculated and compared to determine a critical season at each site, and to calculate the target TMDL values.

It is important to remember that the FC 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 waterbody with FC TMDL targets is expected to meet both the applicable geometric mean and 'not more than 10% of the samples' criteria and also to meet beneficial uses for the category.

A Beales ratio estimator formula (Dolan et al., 1981) was used to calculate the annual FC loads at sites with adequate pollutant and streamflow data (Appendix B). The Beales formula provides a better annual or seasonal estimate of pollutant loads compared to the average instantaneous load obtained from a few sampling events. The average instantaneous load was calculated when continuous discharge data were absent or could not be estimated from nearby gaging data.

Historical Data Assessment

In past years, Ecology's Environmental Assessment (EA) Program has monitored for fecal coliform (FC) bacteria at nine sites in the basin. These sites have been sampled at monthly or bimonthly intervals, but not usually for many consecutive years (Table 4). The two Ecology stations in the basin with the longest continuous monitoring records have been the Walla Walla River near Touchet (32A070) and the Touchet River at Touchet (32B070).

Table 4. Ecology ambient (status and trends) water quality monitoring sites in the Walla Walla basin.

ID	Station Name	River Mile	Monitoring Years Since 1989
32A070	Walla Walla River near Touchet	15.3	1989-present
32A100	Walla Walla River at E. Detour Rd. Br.	32.8	1999
32B070	Touchet River at Touchet	0.5	1989-1992; 1996-97
32B080	Touchet River at Sims Road	9.0	1999
32B100	Touchet River at Bolles	40.4	1999
32B130	Touchet River at Dayton	53.3	1991-92
32B140	Touchet River above Dayton	53.7	1996-97
32C110	Mill Creek at Tausick Way	10	1992-93

Wastewater treatment plants (WWTPs) in the cities of Walla Walla, Dayton, Waitsburg, and College Place also have been the subjects of EA Program inspections in the past (Hoyle-Dodson, 1997; Chase and Cunningham, 1981; and Heffner, 1988). Receiving water surveys for Mill Creek (Singleton and Joy, 1982; and Joy, 1987), and Garrison Creek (White et al., 1998) and the Touchet River (Joy, 1986) have provided two or three days of FC data under critical season conditions.

The U.S. Geological Survey (USGS) has established streamflow gages in the basin at a few sites (Table 5). Mill Creek, the Touchet River, and the Walla Walla River below the confluence with the Touchet River have been gaged the longest. Only USGS gages on Mill Creek and on the Walla Walla River are currently active. Recent efforts by Ecology and the Washington Department of Fish and Wildlife have increased streamflow monitoring activity in the basin.

Historical FC and streamflow data were analyzed to determine seasonal FC load and concentration characteristics, water quality standard criteria violation frequency, and long-term trends. These analyses focused on data collected during the past 10 to 12 years. These data were then compared to data collected from June 2002 through June 2003 for this TMDL study.

Table 5. Locations and records of seven USGS streamflow gaging stations in the Walla Walla River basin.

ID	Station Name	River Mile	Drainage Area mi^2	Period of Record
14013000	Mill Creek near Walla Walla	21.2	59.6	1913 -17; 1938 -76; 1979 – present
14015000	Mill Creek at Walla Walla	10.5	95.7	1941 – present
14016000	Dry Creek near Walla Walla	22.0	48.4	1949 - 1966
14016500	East Fork Touchet River near Dayton	3.0	102	1941-51; 1956 - 1965
14017000	Touchet River at Bolles	40.4	361	1924-29; 1951 - 1988
14017500	Touchet River near Touchet	6.9	721	1941 – 54
14018500	Walla Walla River near Touchet	18.2	1657	1951 – present

Walla Walla River

Long-term monitoring at the Walla Walla River near Touchet shows seasonal trends in FC concentrations. Monthly statistics for samples collected at station 32A070 from October 1989 to September 2004 are graphically depicted in Figure 6 along with mean monthly streamflow data from the USGS gaging station 14018500 (Walla Walla near Touchet). The 400 cfu/100 mL criterion for *Secondary Contact Recreation* was violated in May and June based on the 90th percentile values for those months. (In TMDL studies, a 90th percentile statistic is used as a conservative representation of the 10% sample criterion). None of the months have a geometric mean (GM) value greater than 200 cfu/100 mL criterion.

There was variability on an annual basis as well. Calculated 90th percentiles and GM statistics for samples collected at 32A070 are graphically depicted by year with mean annual streamflow (Figure 7). Over this period of record, the 90th percentile criteria were not met in water years 1990, 1993, 1997, 1998, and 2001.

The data collected at 32A070 suggest a statistically significant decreasing trend in FC concentrations over the past 14 years when all data are considered, but not a significant decrease in FC load (Figure 8). Unfortunately, the decreasing FC concentration trend is not statistically significant for the May and June critical period of elevated FC concentration (Appendix C).

Analyses also showed a statistically significant increase in instantaneous river streamflows from 1990 – 2004 (i.e., the flow volumes at the time the samples were taken). The flow increase may help to explain the absence of a falling trend in FC loads at the site. It may also suggest that FC sources are still present, but their impact is less obvious because of dilution.

The FC concentrations and FC loads during the June 2002 – June 2003 TMDL surveys at Cummins Road Bridge (RM 15.6) and Ecology's long-term monitoring station 32A070 were lower than most monthly results collected at the latter station since October 1989 (Figure 9). (These two sites are less than 0.3 miles apart, and no significant tributaries, diversions, or potential sources of FC are located between them.) Low FC counts appeared to influence the lower loads more than low monthly average flows influenced loads during several months in 2002 and 2003 (Figure 10). The cause of the lower counts is not known.

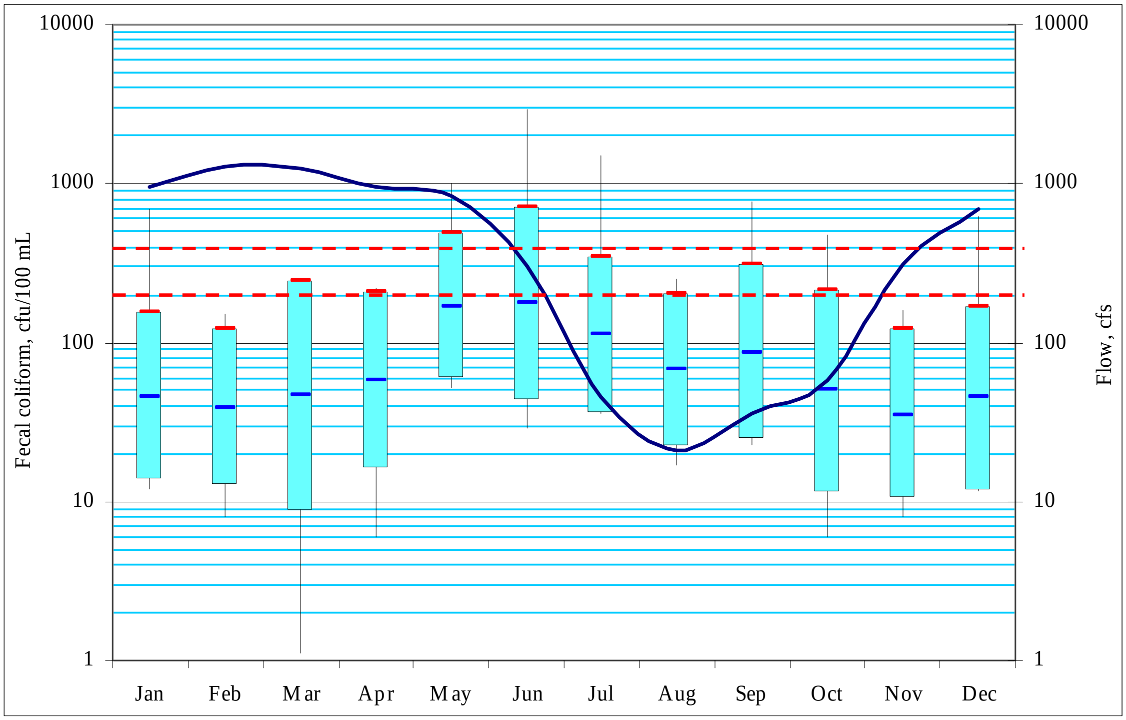


Figure 6. Fecal coliform box-plots (monthly minimum, 10th percentile, geometric mean, 90th percentile, and maximum) for monthly samples collected at Ecology site 32A070, the Walla Walla River near Touchet, in water years 1990–2004. Mean monthly streamflows from USGS station 14018500 are also shown (solid line).

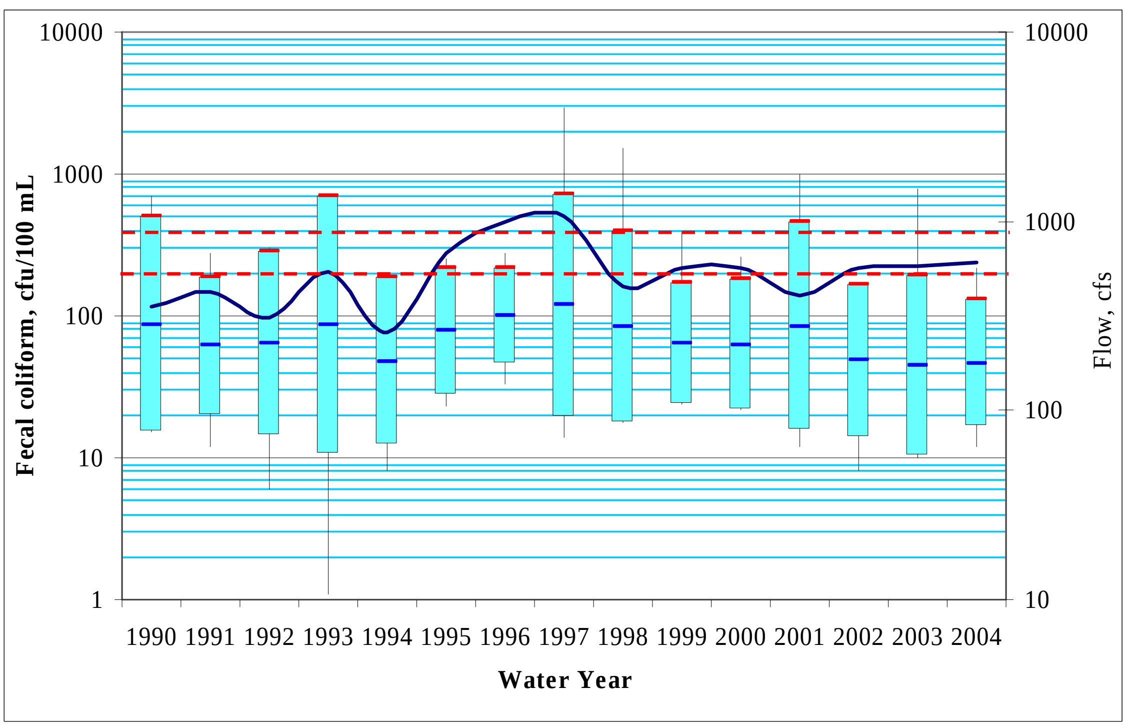
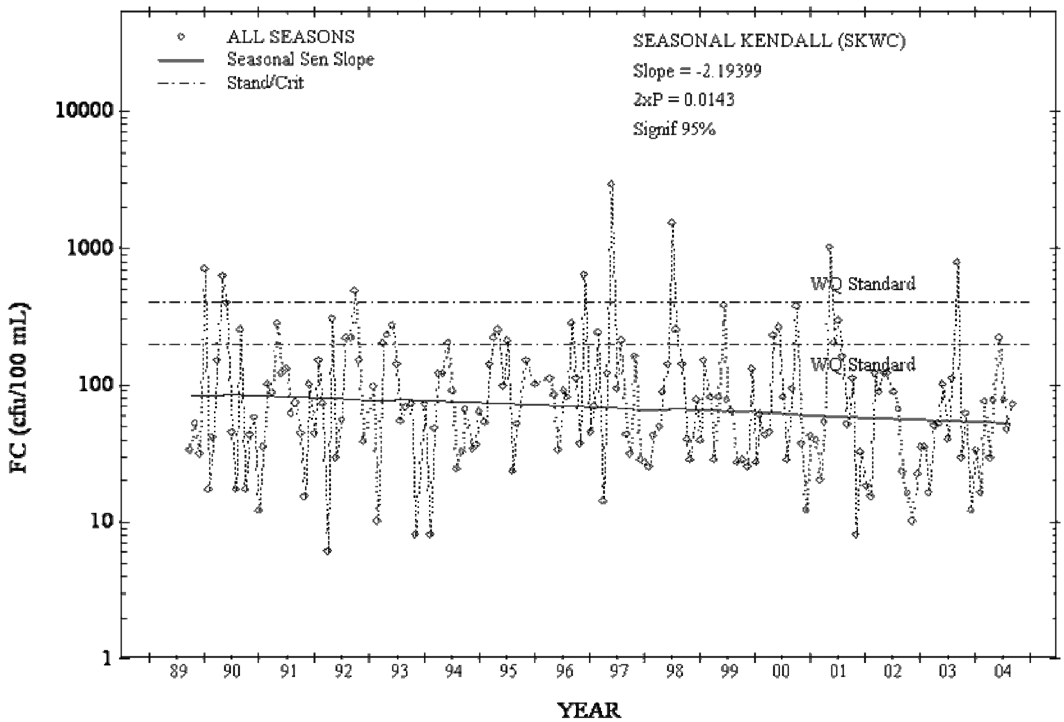


Figure 7. Fecal coliform box-plots (annual minimum, 10th percentile, geometric mean, 90th percentile, and maximum) for monthly samples collected at Ecology site 32A070, the Walla Walla River near Touchet, in water years 1990–2004. Mean annual streamflows from USGS station 14018500 are also shown (solid line).



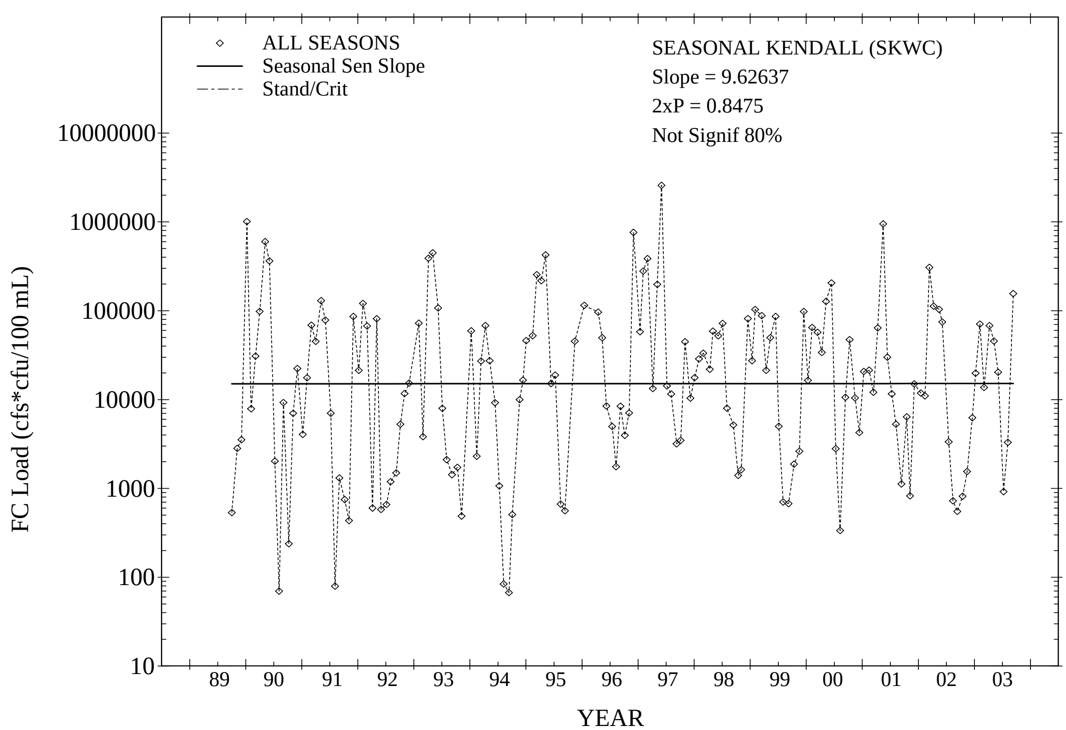


Figure 8. Fecal coliform concentration and load trend analyses for data collected by Ecology from the Walla Walla River near Touchet (site 32A070) in water years 1990–2004.

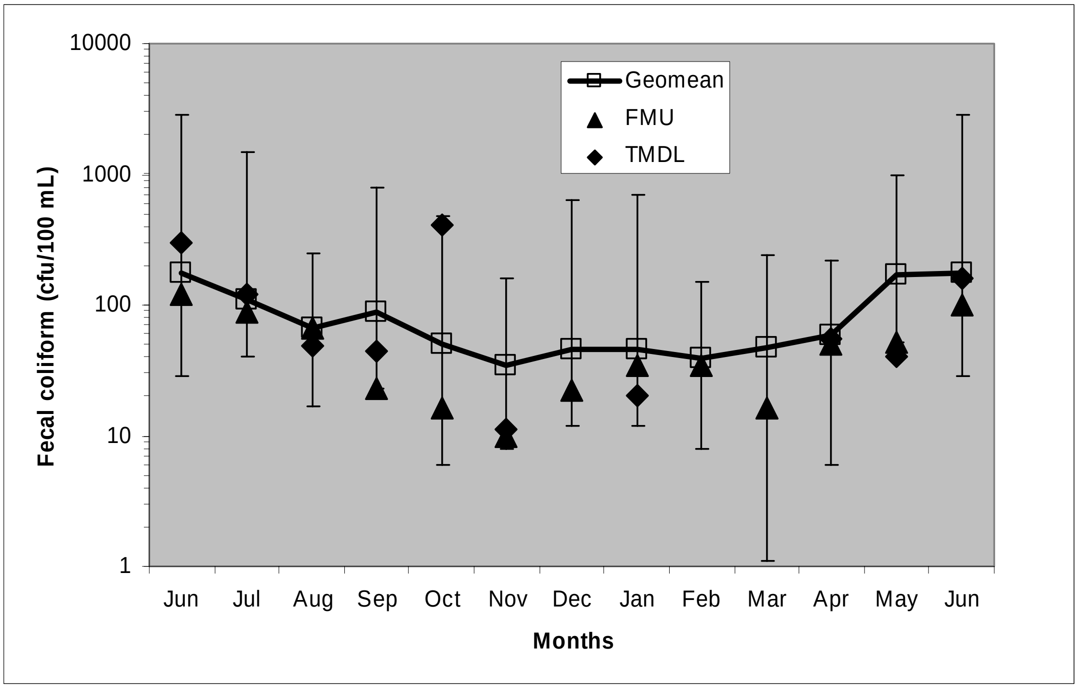


Figure 9. Fecal coliform sample results collected in June 2002 – June 2003 during Ecology TMDL surveys at Cummins Road (river mile 15.6) and collected by the Ecology Freshwater Monitoring Unit (FMU) at site 32A070 (river mile 15.3). Results are compared to the monthly geometric mean, minimum, and maximum fecal coliform concentrations observed at site 32A070 since October 1989.

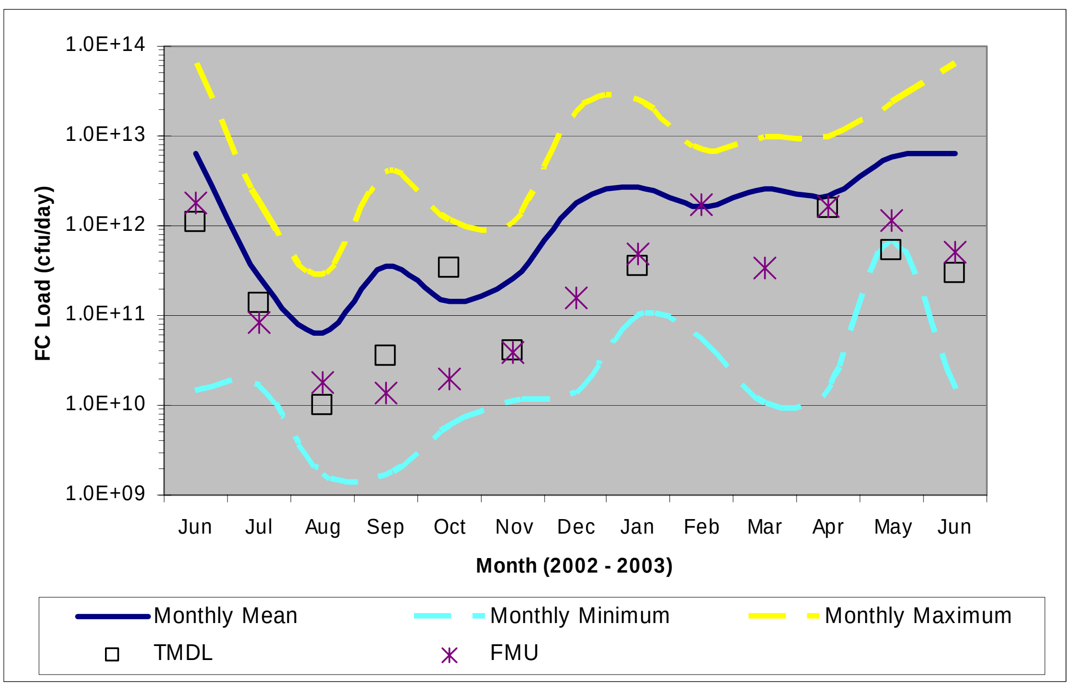


Figure 10. Instantaneous fecal coliform loads in June 2002 – June 2003 estimated from data collected by the Ecology TMDL survey crews at Cummins Road (river mile 15.6) and the Ecology Freshwater Monitoring Unit (FMU) at site 32A070 (river mile 15.3). The loads are compared to the monthly mean, minimum, and maximum fecal coliform loads observed at site 32A070 since October 1989.

Touchet River

Ecology monitored water quality in the Touchet River at Highway 12 (site 32B070) on a monthly basis in water years 1990, 1992, and 1997 (Ecology, 2005a). From June 2002 through June 2003, the TMDL field crews also monitored this site (Swanson, 2005). The monthly statistics for FC indicate there is a seasonal FC concentration pattern (Figure 11). The critical months of elevated FC concentrations are June through September. Figure 11 also shows that instream flows drop during this period due, in part, to irrigation diversions located six miles upstream. Analyses did not detect a significant annual trend in the Touchet River FC concentrations (Appendix C).

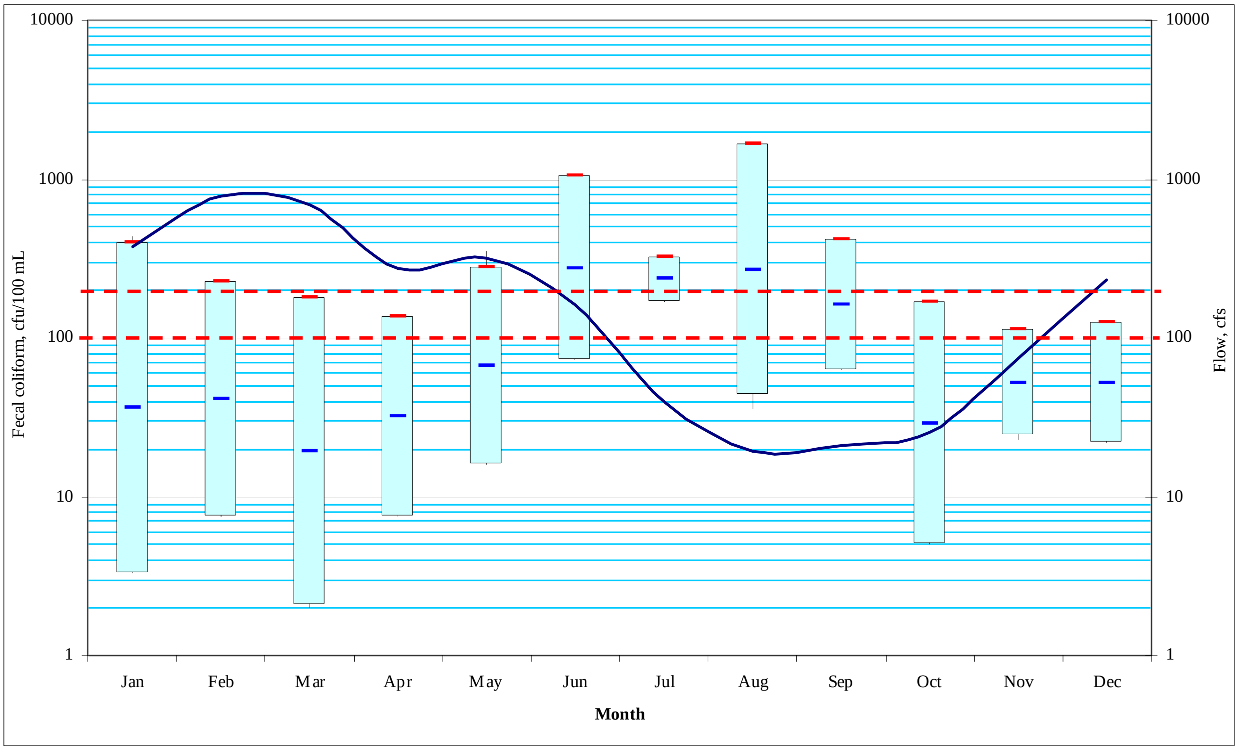


Figure 11. Fecal coliform (FC) box-plots (annual minimum, 10th percentile, geometric mean, 90th percentile, and maximum) for monthly samples collected by Ecology (site 32B070) in water years 1990, 1992, 1997, and samples collected from the Touchet River at Touchet in June 2002 to June 2003 Mean monthly streamflow based on the instantaneous measurements at the sample collection time is also shown as a solid line. Dashed lines are FC water quality criteria of 200 cfu/100 mL and 400 cfu/100 mL.

Fecal coliform data collected in 2000 by the Washington State University Center for Environmental Education showed that the upper Touchet River had numerous water quality violations. Samples were taken from nine water quality stations in the Columbia County portion of the Touchet River. The data indicated higher FC concentrations in the summer and no major changes in FC levels as water traveled downstream (Krause et al., 2001). Patit Creek had elevated FC counts over 100 cfu/100 mL in several months. Samples collected from the Touchet River at Lewis and Clark State Park in November through January also were elevated.

Mill Creek

Monthly FC data were collected twice a month near the mouth of Mill Creek at Swegle Road (32C070) by Ecology in July – September 1972 and all of water year 1974 and 1975 (Ecology, 2005a). The geometric mean and range (based on two to six FC samples) for each month were compared to the recent Ecology TMDL and Freshwater Monitoring Unit (FMU) data (Swanson, 2005; and Ecology, 2005a).

The FC results collected during the 2002-03 TMDL and the historical FMU surveys were generally higher during the dry season and lower during the wet season than the monthly 1972 to 1975 geometric means. The data comparison shows seasonal fluctuations of FC concentrations to be more extreme during the 2002-03 surveys (Figure 12). Average wet-season flows for the 1972 – 1975 dataset were significantly higher than the flows recorded in 2002-03, so dilution was not a factor in the lower 2002-03 FC concentrations. Average dry-season flows were comparable for both historical and recent data.

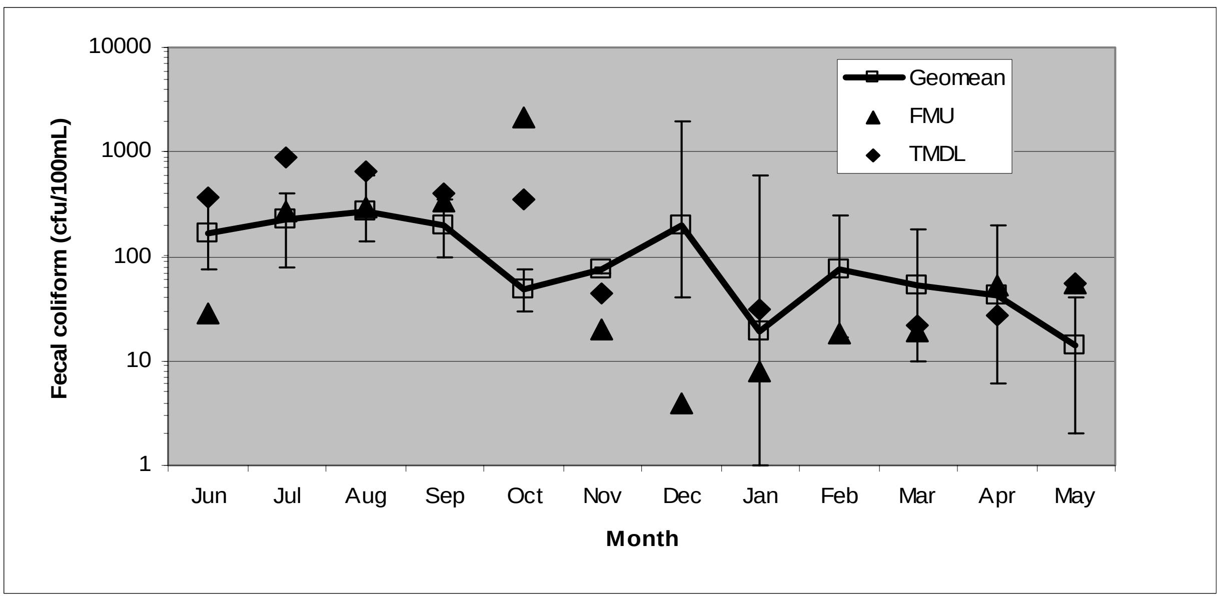


Figure 12. Fecal coliform sample results collected in June 2002 – June 2003 by Ecology's TMDL survey crews and the Ecology Freshwater Monitoring Unit (FMU) from Mill Creek at Swegle Road (32C070, river mile 0.5). Results are compared to the monthly geometric mean, minimum, and maximum fecal coliform concentrations at site 32C070 from 1972 to 1975.

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Findings

General Observations

Understanding the sources of, and concentration changes in, fecal coliform (FC) bacteria can be assisted by measuring other water quality parameters. Water-borne bacteria are often associated with particulate materials, sediments, and other chemicals that can be measured. In addition, conducting additional comparisons between E. coli and FC samples collected at the same time and place can confirm a warm-blooded fecal source.

Chloride, total suspended solids, and streamflow usually were not reliable predictors of FC at individual sites, within sub-basins, or within the study area. General predictions of elevated or lower FC concentrations could be made at some sites in lower Mill Creek. Stream discharge was especially well correlated with FC concentrations at the 9th Avenue site in Mill Creek (see *Mill Creek Results)*. Chloride was somewhat corroborative of waste input along the mid-reaches of the Touchet River (see *Touchet River Results*).

Approximately 40% of the ambient water samples and 100% of the WWTP effluent samples collected were analyzed for both FC and E.coli (Swanson, 2005). Figure 13 shows that E.coli was the dominant coliform group present in the FC samples from ambient waters. Results were similar for WWTP effluent results with a few exceptions discussed for Dayton WWTP.

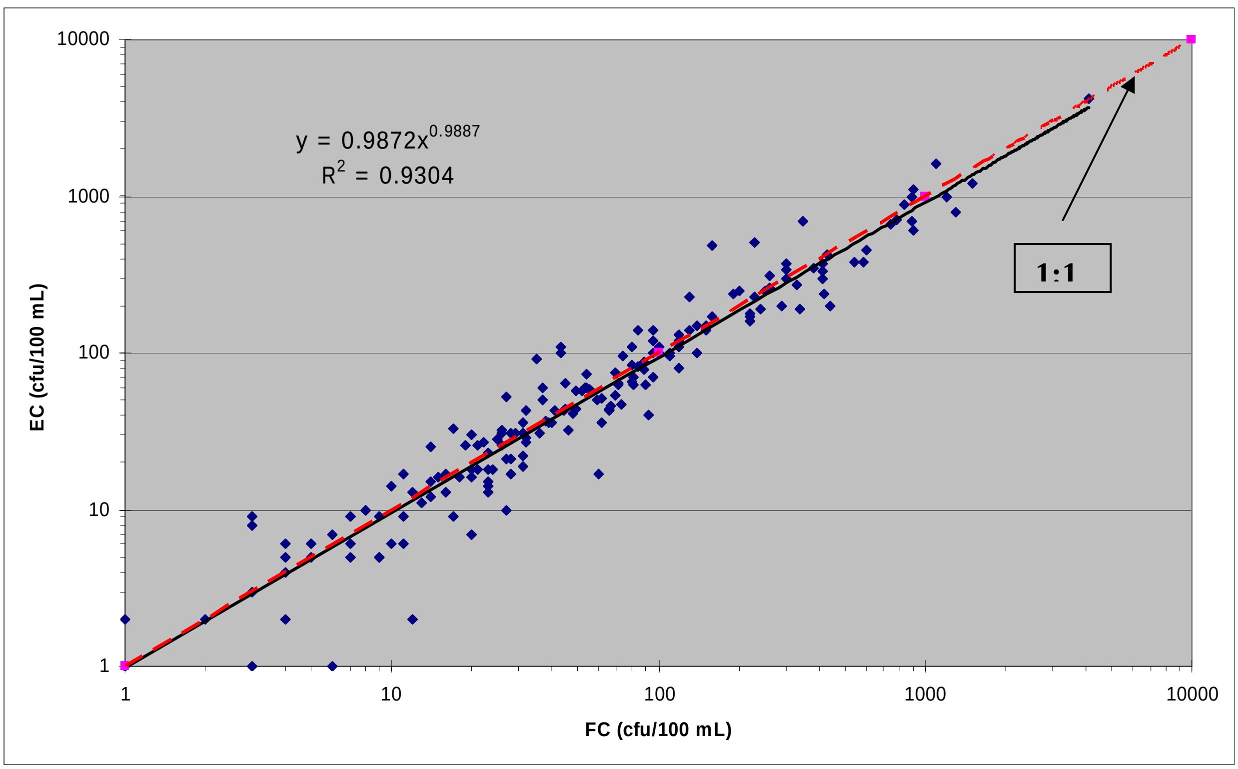

Figure 13. Fecal coliform and E. coli results compared for concurrent samples collected from rivers and streams in the Walla Walla basin.

The variability between the FC and E. coli results was similar to the variability calculated by Swanson (2005) for replicate samples of FC and E. coli.

Mill Creek Results

In 2002 to 2003, FC samples were collected at 15 sites along Mill Creek between river mile (RM) 0.5 and 21.1 (Table 6). Eleven sites were located above 13th Street (RM 6.4) where Washington State *Primary Contact Recreation* criteria apply; three were located downstream where *Secondary Contact Recreation* criteria apply. The Walla Walla WWTP was also sampled when effluent was discharging to Mill Creek.

Table 6. Summary statistics for fecal coliform bacteria samples collected from sites along Mill Creek, June 2002 – June 2003.

River Mile	Location	Site ID Number	Geomean. or Result (cfu/100mL)	90th %tile	Samples greater 200/400[1]	Q[2] (cfs)	No. Samples	WQ criteria Classification
21.1	Mill Ck Rd nr Kooskooskie	MIL-21.1	5	22	0	85	16	Primary ↓
12.8	Five Mile Road	MIL-12.8	26	173	0	76	5	
10.5	Mill after Diversion	MIL-11.5	7	30	0	71	15	
8.5	Roosevelt Street	MIL-08.5	273	901	75%	32	4	
7.4	Colville Street	MIL-07.4	220		100%	2.2	1	
7.3	1st and Main Street	MIL-07.3	360		100%	2.2	1	
7.2	3rd Avenue	MIL-07.2	760		100%	1.4	1	
7.1	4th Avenue	MIL-07.1	289		100%	8.3	2	
7.0	5th Avenue	MIL-07.0	1200		100%	1.4	1	
6.9	6th Avenue	MIL-06.9	663		100%	7.9	2	
6.7	9th Avenue	MIL-06.7	430	4639	75%	66	16	
4.8	Gose Street	MIL-04.8	25	132	0	68	16	Secondary ↓
2.8	Wallula Avenue	MIL-02.8	57	142	0	70	15	
0.5	Swegle Road	MIL-00.5	97	773	25%	79	28[3]	
5.8	Walla Walla WWTP	WAL-WWTP	12	107	0	8.5	6	NPDES permit

[1] Percentage of samples greater than the applicable "not more than 10%" *Contact Recreation* criterion, or the weekly NPDES permit limit.
[2] Mean streamflow based on instantaneous streamflows measured during sample collection.
[3] Twelve of the 28 samples were collected by Ecology's Freshwater Monitoring Unit.

Data collected at the three Mill Creek sites above the diversion suggest that the water quality met *Primary Contact Recreation* bacteria standards during the June 2002 – June 2003 sampling period. Several streamside homes are present above the Kooskooskie site and down to Five-Mile Road; however, no septic system failures or other nonpoint sources were evident from the FC data. Mill Creek at Five-mile Road (RM 12.8) and at the diversion dam (RM 10.5) were active, informal swimming and recreational areas. Kooskooskie and Five-mile Road had lower estimated FC loads during the wet season (November through early June) than during the dry season (mid-June through October).

Sites on Mill Creek downstream of the diversion (RM 10.5) experienced higher FC concentrations (Table 6). Mill Creek at Roosevelt Street (MIL-08.5), the beginning of the concrete-lined channel through Walla Walla, had very low or no flow (usually one cfs or less) from late June through October 2002 and was dry by early June 2003. Fecal coliform samples were collected in June and August 2002 and April and May 2003. Only the April sample (76 cfu/100 mL) was below 200 cfu/100 mL.

As mentioned earlier, the reach of Mill Creek between MIL-10.5 to MIL-08.5 has energy dissipater weirs that create a wide, shallow channel during the summer. The reach becomes a marsh when winter and spring floods have not scoured-out vegetation. After flows drop, the marsh is an ideal nesting area for wildfowl. The wildlife could be contributing FC loads not adequately diluted because of reduced flows. When Mill Creek was flowing contiguously after October, other nonpoint FC inputs may have been contributing to the reach.

Most or all water at 9th Avenue (MIL-06.7) during the dry season originated from springs and/or other sources downstream of Roosevelt Street. Mill Creek flows through residential areas and under the city business center at Colville Street (RM 7.4) and daylights at 3rd Avenue (RM 7.2). During low flow (1-5 cfs), FC concentrations from MIL-8.5 to MIL-6.7 were higher than times of greater streamflow (42-82 cfs at MIL-8.5). Data showed a strong inverse relationship between FC concentration and streamflow at MIL-6.7, indicating a relatively fixed input of FC bacteria upstream of this site (Figure 14).

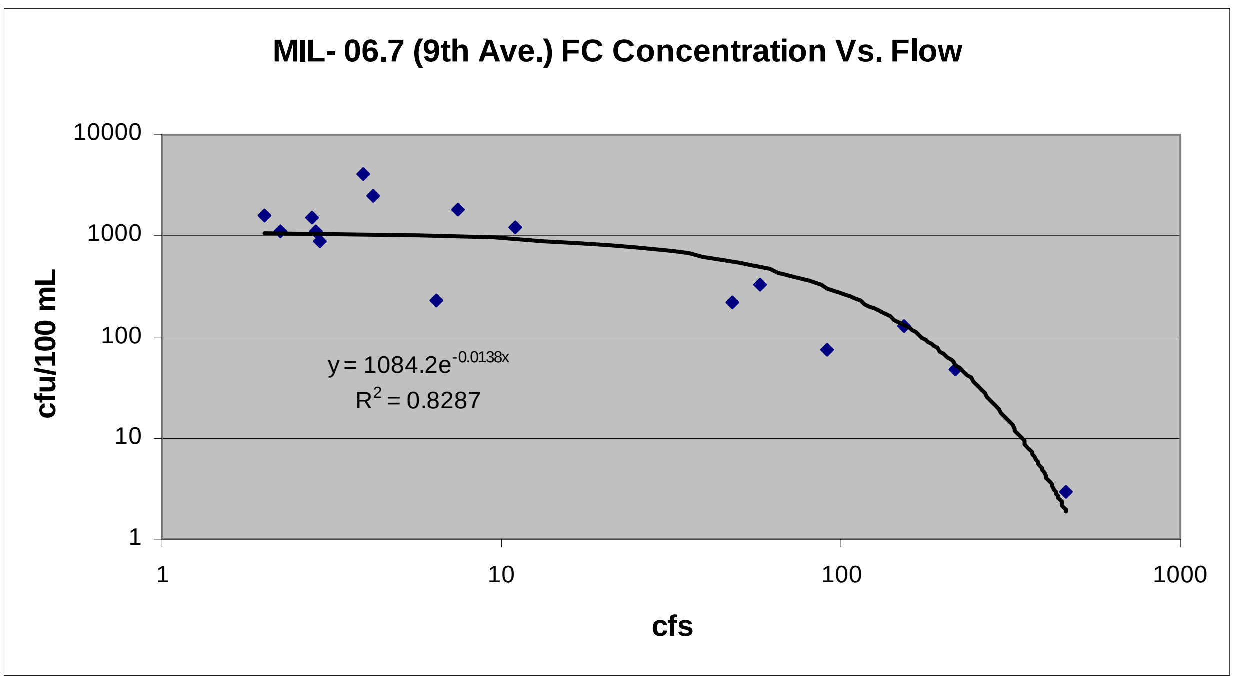

Figure 14. Fecal coliform and streamflow in Mill Creek at 9th Avenue showing an inverse relationship, June 2002 – June 2003.

After consistently detecting elevated FC concentrations at 9th Avenue and making inquiries to the City, Ecology sampled sites between 9th Avenue at RM 6.7 and Colville Street at RM 7.4 once or twice during low flows in October and November 2002 and June 2003 (Figure 15). Ecology TMDL field crews also walked the channel to track the source of high FC at MIL-06.7. They sampled the only pipe draining a significant amount of water into Mill Creek in this area. The pipe was located under the 6th Avenue Bridge (RM 6.9), but it carried no bacteria (< 1 cfu/100 mL).

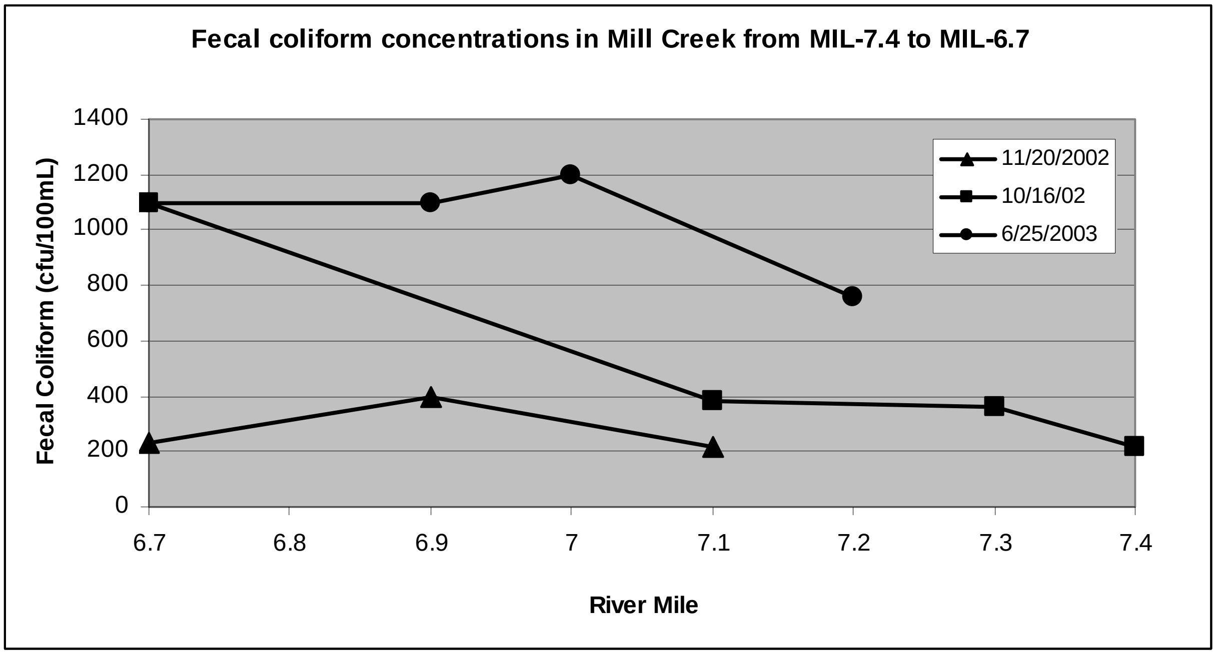

Figure 15. Longitudinal profiles of fecal coliform concentrations from samples collected by Ecology's TMDL crew along Mill Creek under the Walla Walla business district, 2002-03.

During sampling and stream walks, the Ecology TMDL crew observed large flocks of pigeons roosting above the channel under portions of the business district. The flocks were just upstream of 3rd Street and near the small visible segment of Mill Creek at First and Main Street in downtown Walla Walla. More roosts were assumed to exist under the many bridges and covered areas downtown. The bird droppings from these roosts were suspected to be the major source of FC bacteria to the creek observed at RM 6.7, but other sources may be contributing as well.

Fecal coliform counts at Gose Street (RM 4.8) indicated fairly complete bacteria die-off from upstream sources. Although the reach is only required to meet the *Secondary Contact Recreation* criteria, none of the FC samples collected at the site were over 200 cfu/100 mL (Table 6). Upstream of Gose Street, the flood control weirs create a wide channel between MIL-06.7 and MIL-04.8. The weirs cause water to pool and percolate through the streambed during the low-flow period. The water is also exposed to extended periods of sunlight in the pools, all of which may be reducing FC concentrations before the water reaches Gose Street.

Essentially, Mill Creek was a series of isolated pools just below MIL-06.7 between July and October 2002, with 0.15 to 0.45 cfs resurfacing at the Gose Street fish ladder (RM 4.8). Since downstream irrigation return flows were intermittent, instream flows were often unpredictable and non-contiguous. These lower reaches of Mill Creek occasionally ran dry before reaching Last Chance Road at RM 1.9. MIL-00.5 (Swegle Road) often had very little flow during the dry season. Ecology measured the lowest flow there (0.13 cfs) on August 1, 2002.

Fecal coliform concentrations at Wallula Avenue (RM 2.8) were sometimes higher than at Gose Street, but still met *Secondary Contact* criteria by being below 200 cfu/100 mL throughout the sampling period (Table 6). Springs kept Mill Creek at Wallula Avenue flowing at about 2.5 cfs throughout the dry season. Nonpoint sources of FC loading, including those carried by irrigation returns, may be present upstream to Gose Street.

The site at Swegle Road (MIL-00.5) showed marked seasonal FC concentration fluctuations that overall did not meet the *Secondary Contact* criteria (Table 6). When summer and early fall streamflows fell below 10 cfs and the creek was non-contiguous, most FC counts were above 400 cfu/100mL (Figure 16) and did not meet *Secondary Contact* criteria. When upper Mill Creek water was diverted back into lower Mill Creek and flows rose above 10 cfs (November to early June), all FC counts fell below 60 cfu/100mL – well within the criteria.

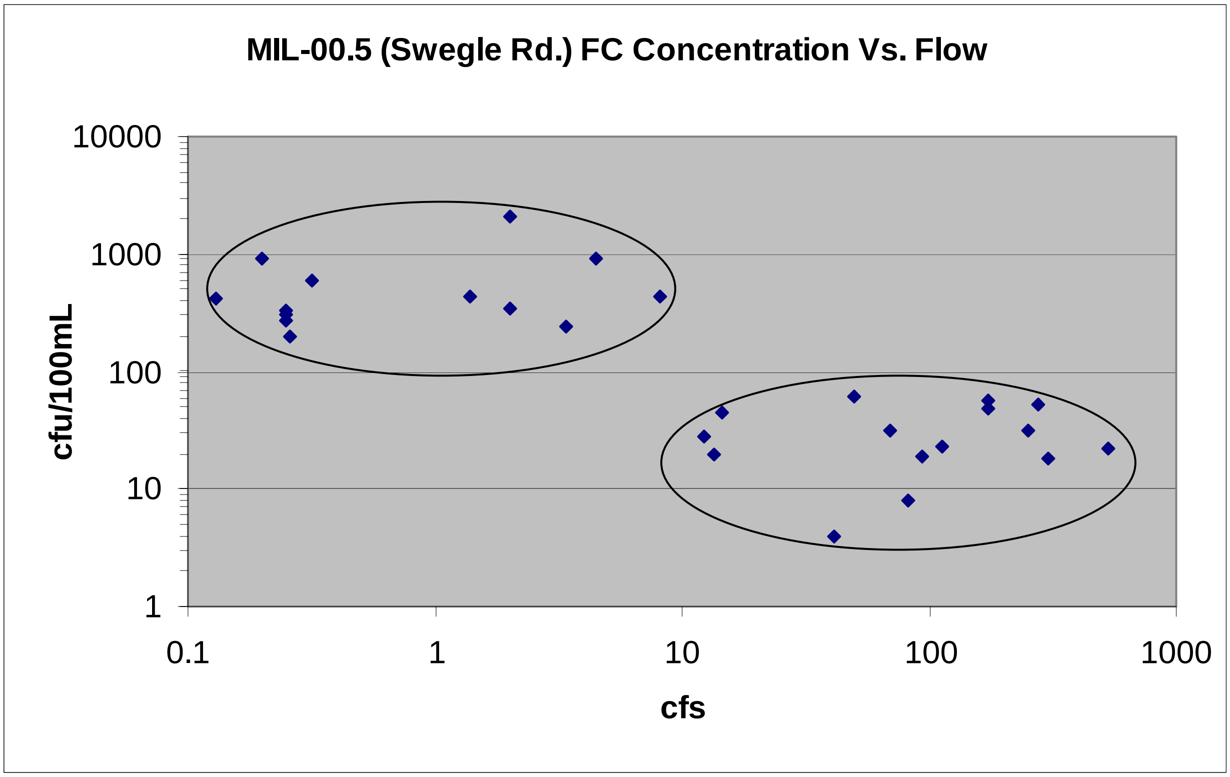

Figure 16. Fecal coliform results versus streamflow at Swegle Road. When Mill Creek is non-contiguous and flowing below 10 cfs, more than 200 cfu/100mL were consistently found. Above 10 cfs (contiguous streamflow), FC concentrations were below 60 cfu/100mL and met state standards.

During the high-flow season, FC concentrations at Swegle Road and Wallula Avenue were similar; however, FC concentrations were significantly higher at Swegle Road during the low-flow season. It is doubtful that FC loads at Wallula Avenue affected FC concentrations at Swegle Road during the low-flow period because of the stream discontinuity. Dry-season-only sources could be carried from irrigation returns between MIL-02.8 and MIL-00.5, Cold Creek and Doan Creek, or other unidentified mainstem nonpoint sources (e.g., livestock, septic tanks, and wildlife).

Rainfall events are often important for pollutant loading, especially in urbanizing areas like Walla Walla and College Place. The March, April, and May 2003 survey events occurred when 5-day antecedent rainfall measured 0.57”, 0.53”, and 0.20”, respectively. Corresponding, Mill Creek streamflows were 460, 220, and 150 cfs. Sampling on April 8 was conducted the day after the greatest 24-hr rainfall, and the March and May sampling surveys were conducted two or more days after the 24-hr period with the most rain.

During January through May, FC loads increased as Mill Creek passed through the city of Walla Walla (Figure 17). Relative to the FC loads at the diversion at Reservoir Road, loads increased significantly at Roosevelt Street, remained elevated through to Gose Street, and on to the mouth of Mill Creek at Swegle Road. The few surveys conducted during the high-flow season suggest that storm events did not significantly change FC loading through these urban reaches compared to non-storm events (Figure 17). The contributions of urban, suburban, and roadway stormwater to Mill Creek could not be quantified from this data set, and the impact of stormwater sources on Mill Creek is inconclusive.

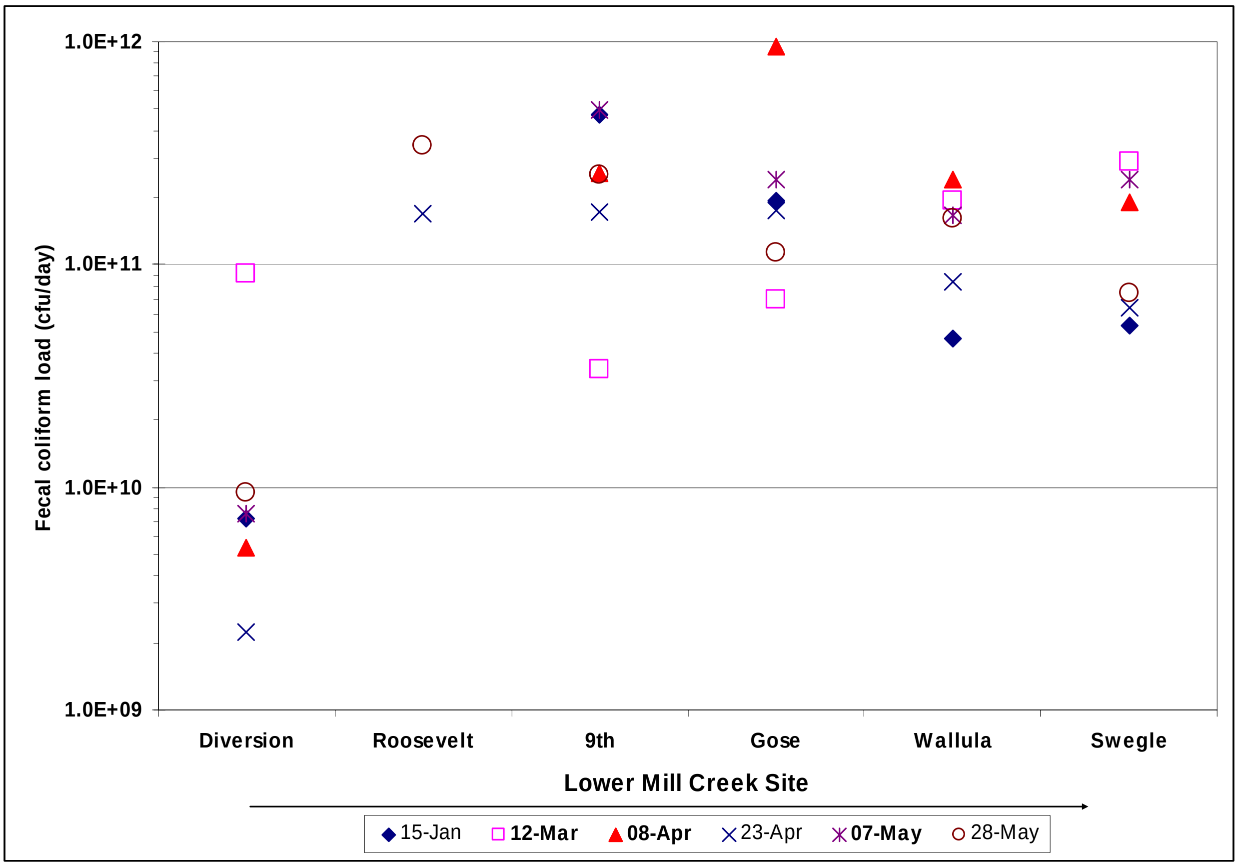

Figure 17. Longitudinal profiles of fecal coliform (FC) loads in Mill Creek during high-flow events (bold dates) in early March, April, and May 2003. FC loads from other wet-season surveys are shown for comparison.

Walla Walla Wastewater Treatment Plant

The City of Walla Walla wastewater treatment plant (WWTP) discharges effluent into Mill Creek at RM 5.8 from December through May. From May through November, the City is required to divert up to 7.2 million gallons per day (approximately 11 cfs) of effluent to the Blalock and/or Gose Irrigation Districts under a 1927 water rights consent order. The irrigation districts distribute the effluent to fields, store it in ponds, or return it to Mill Creek downstream of Gose Street (RM 4.8). Of the nine dry-season irrigation returns, six flow directly to Mill Creek, and three are located near the headwaters of Doan Creek and Cold Creek, tributaries to Mill Creek.

Walla Walla WWTP has different fecal coliform NPDES permit limits for its two effluent discharge modes. The technology-based limits apply when the effluent is discharged to Mill Creek, and land application-based limits apply when effluent is routed to the irrigation districts (Appendix A). Ecology sampled the Walla Walla WWTP effluent only while it was directly discharging to Mill Creek from December 2002 to April 2003. All FC concentrations were well within the technology-based NPDES permit limits.

Yellowhawk and Garrison Creek

Yellowhawk and Garrison creeks are diversion channels from Mill Creek at Reservoir Road (MIL-11.5). Fecal coliform samples were regularly collected at the diversion point (MIL-11.5) and at the mouths of Yellowhawk and Garrison creeks before their confluences with the Walla Walla River (Table 7). Fifteen or more samples were collected at each site. Yellowhawk Creek at McDonald Rd./Plaza Way (RM 3.5) was sampled only once. Two tributaries to Yellowhawk Creek (Russell, and Cottonwood creeks) and the College Place WWTP effluent to Garrison Creek were sampled. *Primary Contact Recreation* criteria apply on both creeks and their tributaries.

Table 7. Summary statistics for fecal coliform bacteria samples (cfu/100 mL) collected from sites along Yellowhawk, Garrison, Russell, and Cottonwood creeks, June 2002 – June 2003.

River Mile	Stream and Location	Site ID Number	Geomean. or Result	90^{th} %tile	Samples greater 200/400[1]	Q[2] (cfs)	No. Samples
8.5	Yellowhawk Creek at Diversion	MIL-11.5	7	30	0%	24	15
3.5	Yellowhawk at McDonald Rd./Plaza Way	YEL-03.5	150		0%		1
0.2	Yellowhawk at Old Milton Hwy	YEL-00.2	171	313	50%	48	16
9.8	Garrison Ck at Diversion	MIL-11.5	7	30	0%	3.1	15
0.5	Garrison Ck at Mission Rd	GAR-00.5	204	1065	56%	2.7	16
0.1	Russell Creek	RUS-00.1	315	596	80%	2.7	5
1.0	Cottonwood Ck	COT-01.0	29	312	20%	4.5	5
NA	College Place WWTP before lagoons	COL-WWTP	35	478	12.5%	1.4	8
NA	College Place WWTP before lagoons, w/o outlier	COL-WWTP	20	111	0%	1.4	7
NA	College Place WWTP after last lagoon	COL-GARR	543	4767	66%	1.2	3

[1] Percentage of samples greater than the applicable "not more than 10% over 200 cfu/100 mL" *Primary Contact Recreation* criteria, or the weekly NPDES permit limit

[2] Mean streamflow based on instantaneous discharge volumes measured during sample collection

Yellowhawk Creek FC concentrations increased downstream from its source to the confluence with the Walla Walla River. Bacteria water quality in Mill Creek at the diversion structure met *Primary Contact* criteria; none of the FC samples was over 100 cfu/100 mL. More than 50% of the FC samples at the lowermost site on Yellowhawk Creek (YEL-00.2) were greater than 200 cfu/100 mL (Table 7).

Yellowhawk Creek flows through residential neighborhoods and parks in the city of Walla Walla and agricultural areas south of the city. Nonpoint sources such as pets, residential runoff, wildlife, and poorly maintained septic systems likely affect upper Yellowhawk Creek bacteria concentrations. Livestock, wildlife, and homes along the creek may be sources of FC bacteria in the lower reaches.

Five FC samples were collected from Russell and Cottonwood creeks during the June 2002 – June 2003 TMDL surveys. Russell Creek had higher FC concentrations and FC loads than Cottonwood Creek, even though it had half the flow volume in the wet season (Table 7). All five FC samples collected from Russell Creek had greater than 100 cfu/100 mL. Cottonwood Creek had only one sample with FC concentrations greater than 100 cfu/100 mL (310 cfu/100 mL in August 2002).

Both Russell and Cottonwood creeks flow from rural and suburban areas west into Yellowhawk Creek below McDonald Rd./Plaza Way (YEL-03.5). Sources of FC are unknown in these drainages, but likely were from nonpoint sources such as residential runoff, wildlife, leaking septic systems, or other human activities. During the 2002-03 study period, Russell Creek contributed about 15% of the dry-season FC load to Yellowhawk Creek, and approximately 10% as an annual average. Cottonwood Creek FC contributions were only around 5% in the dry season and about 1% or less on an annual basis.

Garrison Creek winds its way through residential areas in the south part of the city of Walla Walla and through College Place. Only 2.5 to 5 cfs are diverted to the creek from Mill Creek throughout the year. It may pickup more flow from springs and groundwater, but in the dry season most water is diverted out of the creek by the time it reaches the College Place WWTP. Only about 1 cfs or less remained in the creek at Mission Road near its mouth, and the chemical characteristics of the water were similar to the WWTP effluent. In the 2002-03 wet season, the flow increased slightly, up to 8 cfs in April.

More than 50% of the FC concentrations at the lowermost site on Garrison Creek (GAR-00.5) were greater than 200 cfu/100 mL. College Place WWTP, located approximately one river mile upstream of GAR-00.5, may affect Garrison Creek FC concentrations at times; however, White et al. (1998) found elevated FC concentrations in September above the College Place WWTP outfall. They suspected nonpoint sources, including leaking septic systems, upstream in the residential areas of College Place and the city of Walla Walla, and suburban areas along the western city limits. Wet-season FC loads were higher on average than dry-season FC loads, so stormwater runoff may be an additional source.

College Place Wastewater Treatment Plant

During the dry season, most or all of Garrison Creek's water was used for irrigation, and the creek was dry before reaching the College Place WWTP. Most, if not all, water collected by the Ecology TMDL survey crews at site GAR–00.5 during the dry season originated from the College Place WWTP. Water from the treatment plant was piped to treatment wetlands, used for field irrigation, or discharged to Garrison Creek.

Ecology sampled the WWTP effluent discharging from the wetlands three times. On August 1, 2002, the FC concentration coming out of the last treatment wetland and into Garrison Creek was 77 cfu/100 mL. The results of two samples taken in the same place on the morning and afternoon of September 11, 2002 were 1300 and 1600 cfu/100 mL respectively. Waterfowl may have added bacteria to the treatment wetlands after treatment and thus to the water released to Garrison Creek.

Ecology started sampling directly from the WWTP outflow to the first treatment wetland during subsequent surveys to get a better idea of FC concentrations coming directly from the WWTP. The geometric mean and 90th percentile of eight samples taken from December 2002 through June 2003 can be seen in Table 7.

One sample taken on June 11, 2003 contained 1900 cfu/100mL. Bob Jamison, the WWTP manager, assured Ecology that this sample was not typical (Jamison, 2003). Earlier, the WWTP began using only one UV reactor to save energy cost and bulb life. The operators were pressing solids during Ecology's sampling, creating larger decants for the day. Increased flow volume meant that the water did not have the contact time in the vessel for proper disinfection.

To prevent this from happening again, the operators must now verify that at least two reactors are operating before the press is started. The WWTP changed the bulbs in their primary UV reactor as an additional measure. Ecology is confident that the College Place WWTP corrected its problem and is now functioning correctly. However, more sampling might be needed to determine if a problem exists in the treatment wetlands between the treatment plant and Garrison Creek.

Touchet River

The Touchet River was monitored for FC at 20 locations along 54 miles from the forks above Dayton to the mouth near the community of Touchet (Figure 5). The North and South Forks Touchet River, Dayton WWTP, Patit Creek, and Coppei Creek were included in the sampling. The June 2002 – June 2003 FC data results are summarized in Table 8.

The monitored areas of Touchet River are *Primary Contact* recreational waters formerly classified as Class A for recreational water contact uses (Chapter 173-201A WAC). Fecal coliform bacteria criteria are: a geometric mean of less than 100 cfu/100 mL with not more than 10% of the samples exceeding 200 cfu/100 mL. *Extraordinary Primary Contact* recreational water criteria (formerly Class AA) apply to the North Fork Touchet River above RM 3, but this bacteria TMDL survey did not extend into those areas.

Table 8. Summary statistics for fecal coliform bacteria samples (cfu/100 mL) collected from sites along the Touchet River, June 2002 – June 2003.

River mile	Location	Site ID Number	Geometric Mean	90th percentile	Samples greater 200/400[1]	Q[2] (cfs)	No. Samples
	North Fork Touchet River	NFT-00.0	14	61	0%	108	16
	South Fork Touchet River	SFT-00.0	9	32	0%	19	14
53.9	Dayton City Park	TOU-53.9	14	37	0%	119	6
	Dayton WWTP	DAY-WWTP	12	99	7%	0.4	68*
	Patit Creek	PAT00.1	45	1209	20%	6.8	5
51.2	Ward Road	TOU-51.2	12	89	6%	115	16
48.4	Lewis and Clark St. Pk.	TOU-48.4	10	19	0%		5
46.2	Lower Hogeye Road	TOU-46.2	14	68	0%	187	16
44.2	Highway 12 in Waitsburg	TOU-44.2	19	95	0%		5
	Coppei Creek	COP-00.5	97	569	60%	6.6	5
40.5	Highway 124	TOU-40.5	21	101	0%	107	21[3]
36.6	Hart Road	TOU-36.6	257	1415	40%	122	5
34.2	Highway 125	TOU-34.2	53	335	19%	116	16
30.6	Pettyjohn Road	TOU-30.6	113	302	20%		5
25.0	Lamar Road	TOU-25.0	65	194	20%		5
17.8	Luckenbill Road	TOU-17.8	28	136	12.5%	78	16
14.2	North Touchet Road	TOU-14.2	32	75	0%		5
7.0	Above Hofer Diversion	TOU-07.0	34	130	6%		16
2.0	Cummins Road	TOU-02.0	95	532	30%	127	23[3]
0.5	Highway 12	TOU-00.5	80	565	37.5%	193	16

[1] Percentage of samples greater than the applicable "not more than 10%" *Contact Recreation* criterion, or the weekly NPDES permit limit.
[2] Mean streamflow based on instantaneous discharge volumes measured during sample collection.
[*] Includes 58 weekly FC samples collected by Dayton WWTP personnel and reported June 2002 – June 2003.
[3] Twelve of the samples were taken by Ecology's Freshwater Monitoring Unit.

The samples collected at the mouths of the North and South Forks of the Touchet River met *Primary Contact Recreation crit*eria (Table 8). None of the samples collected at either site throughout the 2002-03 survey period had FC concentrations greater than 80 cfu/100 mL. The greatest FC loads at these locations occurred in the spring.

The excellent bacterial water quality continued below the confluence and through Dayton, despite the intermittently elevated FC loads from the Dayton WWTP and Patit Creek (Table 8). Samples collected at Dayton City Park above the WWTP outfall, at Ward Road below Dayton and Patit Creek, Lewis and Clark State Park, and at Lower Hogeye Road all met *Primary Contact Recreation* criteria. Of the 43 collective samples from these four sites, only one at Ward Road had a FC concentration greater than 100 cfu/100 mL.

Patit Creek was sampled only five times, and only one sample exceeded 100 cfu/100 mL. The sample collected in June 2003 had an estimated FC concentration of 1300 cfu/100 mL. The creek was discharging less than 1 cubic foot per second (cfs) of water at the time. The source of the elevated FC concentrations was unknown. Elevated FC counts had been documented in Patit Creek in an early study as well (Krause et al., 2001).

Estimated annual average FC loads increased gradually downstream of Dayton through Waitsburg (RM 44), but FC concentrations appeared to stay within *Primary Contact Recreation* criteria in the reaches monitored in Waitsburg (RM 44.2) and at the Highway 124 Bridge (RM 40.5) below town (Table 8). Poor bacterial water quality in Coppei Creek and the presence of the Waitsburg wastewater infiltration wetlands upstream of the Highway 124 site did not put the site out of compliance with criteria (Table 8).

Three of the five Coppei Creek FC concentrations were around 200 cfu/100 mL. The estimated average FC load from Coppei Creek was similar to the FC load calculated for Patit Creek.

On five occasions, FC samples were taken on two consecutive days at the Highway 124 Bridge (RM 40.5) monitoring site. Some variability in FC concentrations between the two days was observed, but no predictable pattern was evident. On September 2 and 3, the FC concentrations were 140 and 5 cfu/100 mL, respectively. Other days had smaller differences. The data demonstrate the potential short-term variability in the data, which could be from a combination of source behavior and conditions in the Touchet River.

Fecal coliform samples collected at the next four sites downstream near Prescott suggest one or more fecal bacteria sources in the area. Four of five samples collected at Hart Road Bridge (RM 36.6) were greater than 100 cfu/100 mL, and two of those were greater than 1000 cfu/100 mL. At the Highway 125 Bridge below the town of Prescott (RM 34.2), the FC loads and concentrations were lower, but still not meeting the *Primary Contact Recreation* criteria (Table 8).

Preliminary analyses suggest that some of the FC contamination at Highway 125, and farther downstream at Pettyjohn Road (RM 30.6) and Lamar Road (RM 25), could be residual from the source(s) above Hart Road Bridge (Figure 18). Sampling was limited at Pettyjohn and Lamar roads, but samples suggest this entire reach, from Hart Road to Lamar Road, may not comply with *Primary Contact Recreation crit*eria.

The critical period for elevated FC concentrations in this reach was July through September, although the limited sampling at Hart Road suggested that FC sources are present upstream throughout the year. Fecal coliform loads were highest in the spring and summer. Only a few farms are located along the Touchet River between the Highway 124 (RM 40.5) and Hart Road (RM 36.6) bridges. Potential nonpoint sources include livestock access or corral runoff, concentrations of wildlife or waterfowl, or failing on-site sewage systems.

Fecal coliform bacteria are killed by exposure to ultraviolet light (UV), among other things. Cloud cover, water turbidity, water depth, turbulence, and stream velocities the day of sampling affect UV exposure and bacteria ‘die-off’ rates. Apparent die-off rates on the warm and sunny days in July and September during low-flow periods were faster than rates under cooler and cloudier conditions in April and May (Figure 18).

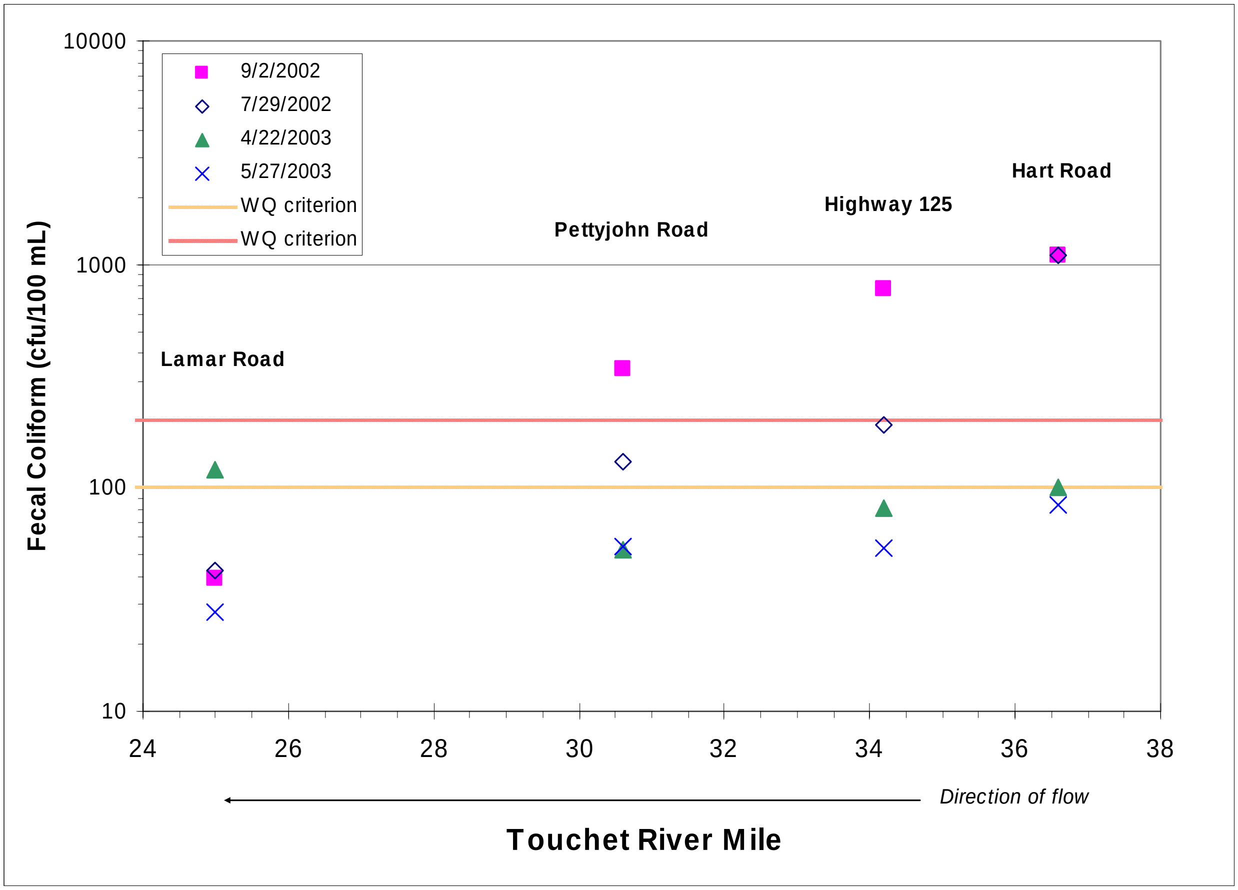

Figure 18. Fecal coliform concentrations along the middle reaches of the Touchet River during four survey runs, September 2002 – May 2003.

Fecal coliform concentrations and loads were lower at the next three downstream sites between RM 17.8 and 7.0. The geometric means and 90th percentiles met *Primary Contact Recreation* criteria at Luckenbill Road (RM 17.8), North Touchet Road (RM 14.2) and above the Hofer Diversion Dam (RM 7) (Table 7). Two elevated FC concentrations did not appear to be related to the Hart Road to Lamar Road FC sources. Few homesteads are near the river, and few livestock were observed.

Approximately 20 cfs is withdrawn from the Touchet River for the Eastside/Westside Irrigation District at RM 4.1, Hofer Dam. Touchet River streamflows below the diversion from July through September are often less than 10 cfs. Water from the Eastside/Westside operations is not returned to the Touchet River. The loss of water becomes a problem for diluting any FC sources in the downstream reaches.

Two sites were monitored in the last reach of the Touchet River below the irrigation diversion and bracketing the community of Touchet (Figure 5): Cummins Road Bridge (RM 2) and at Highway 12 near the mouth (RM 0.5). Cummins Road was also an Ecology ambient network station (32B075) from October 2002 through September 2003, and has been a flow-gaging site since June 2002 (Ecology, 2005a). The Highway 12 site was a historical ambient network station (32B070) during various periods between 1972 and 1997 (Ecology, 2005a).

The two sites exhibited similar FC statistics and did not meet *Primary Contact Recreatio*n criteria (Table 8). The FC concentrations at Highway 12 were usually slightly higher than concentrations collected upstream at Cummins Road the same day. The difference in the estimated FC and streamflow statistics between the two sites in Table 8 may be an artifact of sampling dates. A Wilcoxon paired-sample test (Zar, 1984) indicated there was no difference between FC concentrations at two sites on days when both sites were sampled.

The sources of FC loading upstream of the Cummins Road and Highway 12 sites are not apparent. A few farms lie close along the river and some livestock are present, but none of the livestock was observed in the river during the survey visits. Land uses around the community of Touchet did not appear to add statistically significant FC loads to the river.

Dayton Wastewater Treatment Plant

Some of the FC counts from the Dayton WWTP effluent were troubling. Four of ten samples collected by Ecology staff at the WWTP during the 2002-03 TMDL survey were greater than the permitted average weekly limit of 400 cfu/100 mL; three were greater than 1000 cfu/100 mL (Table 9). The 58 weekly FC samples analyzed by Dayton WWTP staff were all within the NPDES permit limits (Ecology, 2003). The geometric mean and 90th percentile statistics for the combined data are well within permit limits.

Table 9. Effluent fecal coliform (cfu/100mL), *Escherichia coli* (cfu/100mL), and temperature (°C) data from samples collected by Ecology and the Dayton Wastewater Treatment Plant staff.

Date	Fecal Coliform		FC Replicate	E. coli	Temperature	
	Ecology	Dayton	Ecology	Ecology	Ecology	Dayton
Jul. 30, 2002	34			14	19.5	17.8
Sep. 11, 2002	6			3	-	21.1
Dec. 2, 2002	>4000			>4000	9.4	8.9
Dec. 3, 2002	5400			4100	9.1	8.9
Jan. 14, 2003	9	4	-	11	10.1	10
Feb. 25, 2003	430	55	290	80	-	7.2
Mar. 11, 2003	1300	4	-	8 est.	10.6	11.1
Apr. 7, 2003	23	7	-	23	10.6	12.2
May 6, 2003	9		4	19	12.9	13.3
Jun. 10, 2003	1		2	2	18.7	17.8

From all appearances, the ultraviolet (UV) system was working normally when the Ecology samples were collected. However, other analytical problems cause some concern for data interpretation. For example, the E. coli concentrations in February and March are far lower than the FC concentrations, so either non-E. coli organisms were present or the counts in the effluent, samples, or analytical detection were highly variable.

Subsequent samples collected and analyzed by two other laboratories could not detect a problem with laboratory methods conducted at the Dayton WWTP (Hampton, 2005). The FC samples analyzed by the laboratories also had concentrations within Dayton's permit limits. Hampton (2005) stated that iron film on the UV bulbs, short pulses of turbid effluent, or FC re-growth during long sample holding times could be other possible sources of the elevated FC counts.

Walla Walla River

Fecal coliform (FC) samples were collected at ten sites along the mainstem Walla Walla River between RM 9.3 and 38.7 (Figure 5). Six sites were located above the confluence of Dry Creek at RM 27.2 where *Primary Contact Recreation* criteria apply; four were located downstream where *Secondary Contact Recreation* criteria apply. The following tributaries were also sampled at various frequencies:

- Yellowhawk Creek (previously discussed)
- Garrison Creek (previously discussed)
- West branch Little Walla Walla River
- Mill Creek (previously discussed)
- Dry Creek
- Mud Creek
- Pine Creek
- Touchet River (previously discussed)

Some tributaries and irrigation returns were not sampled: Birch Creek, east branch Little Walla Walla River, Stone Creek, and returns from several irrigation districts.

The applicable criteria were not met at four of the ten Walla Walla River sites based on all of the data collected from June 2002 – June 2003 (Table 10). The sites located at Detour Road Bridge (RM 32.8), Swegle Road (RM 34), and Last Chance Road (RM 35.2) did not meet the *Primary Contact* criteria. (The Swegle Road site was sampled only twice because of access problems from construction activities.) The site at the Touchet-Gardena Road Bridge (RM 22.7) did not meet the *Secondary Contact* criteria. The highest FC counts occurred during June and July. The highest bacteria loads generally occurred from April through June.

Table 10. Summary statistics for geometric mean (cfu/100 mL) and 90th percentile concentrations for all fecal coliform samples collected along the Walla Walla River, June 2002 – June 2003.

River mile	Location	Site ID Number	Geometric Mean	90th percentile	Samples > 200/400[1]	Q[2] (cfs)	No. Samples	WQ criteria Classification
38.7	Highway 125	WAL-38.7	52	164	6%	101	16	↑
35.2	Last Chance Road	WAL-35.2	154	290	40%	195	5	
34.0	Swegle Road	WAL-34	140	-	0%		2	
32.8	Detour Road	WAL-32.8	84	224	15%	100	13	
29.3	McDonald Road Bridge	WAL-29.3	36	114	6%	65	16	
27.4	Lowden Road Bridge	WAL-27.4	33	123	0%		16	Primary
22.7	Touchet-Gardena Road	WAL-22.7	96	777	25%	297	16	Secondary
15.6	Cummins Road Bridge*	WAL-15.6	52	172	4%	419	28	
12	Highway 12 Bridge	WAL-12	33	48	0%	806	5	
9.3	Pierce's RV Park	WAL-9.3	39	153	0%	476	16	↓

[1] Percentage of samples greater than the applicable "not more than 10%" *Contact Recreation* criterion
[2] Mean streamflow based on instantaneous discharge volumes measured during sample collection
* Combined Ecology site 32A070 and TMDL site WAL-15.6

Walla Walla River pollutant loading evaluations are difficult because of the numerous diversions and returns that operate along the 40 miles from the Oregon border. Recent changes in water management also make comparisons to historical FC data less useful than they could be. For example, summer low streamflows coming across the state line in 2001, 2002, and 2003 gradually increased compared to previous years because of a water settlement agreement between the Oregon irrigation districts and the U.S. Fish and Wildlife Service in 2000 (Mendel et al., 2004). Flows at RM 36.7 also were increased under the agreement with the Gardena Farms Irrigation District in Washington.

The state line is a potential 'background' point for the Walla Walla River in Washington. Downstream of the state line, FC concentrations in 2002 and 2003 at Highway 125 (RM 38.7) were highest from June to September while FC loads were highest in the spring. *Primary Contact Recreation* criteria were met for the whole data set, but the eight samples collected from June through September 2002 had a 90th percentile of 212 cfu/100 mL, which does not meet criteria.

Oregon uses E. coli as an indicator (OAR 340-041-009). None of the E. coli concentrations collected at Highway 125 was greater than the 406 cfu/100 mL single sample state criterion. The 126 cfu/100 mL E. coli geometric mean (GM) is more difficult to assess since the Oregon standards state the GM must be based on five samples collected within 30 days. Two of the three samples collected in June and July 2002 were greater than 126 cfu/100 mL with a GM for all three samples of 85 cfu/100 mL.

Ecology collected semi-monthly water quality data at Highway 125 (RM 38.7) from 1972 to 1975 (Ecology site 32A110). For that period, the highest FC concentrations occurred between July and September and would not have met the *Primary Contact* criteria because more than 10% of the samples were greater than 200 cfu/100 mL. The 90th percentile for the 18 samples was 234 cfu/100 mL.

The comparison of recent to historical FC data suggests that flows have increased and FC concentrations have decreased between the 1970s and 2002. However, the median FC load has doubled during the summer. If flows were to decrease again without taking measures upstream to decrease FC loads, FC concentrations may violate state criteria once more.

FC concentrations and summer streamflows increased significantly in the Walla Walla River downstream of Highway 125. Five samples collected at Last Chance Road (RM 35.2), located a mile below Garrison Creek, indicated a FC problem throughout the year (Table 10). The number of samples was not ideal for a full assessment, but the data suggest that *Primary Contact* criteria were not met. Streamflows at Last Chance Road were generally two to three times greater than at Highway 125 in June through September 2002.

Garrison Creek is the closest tributary source of FC loading upstream of the site, but Yellowhawk Creek, Stone Creek, and the east branch of the Little Walla Walla River also enter the river upstream. Loads from Yellowhawk and Garrison creeks were sufficient to explain the observed FC increases in the mainstem (Table 11). The east branch of the Little Walla Walla and Stone Creek were not monitored, but may also be contributing FC loads. Potential nonpoint sources such as septic tanks and livestock along the mainstem could also be present.

Table 11. Summary statistics for geometric mean (cfu/100 mL) and 90th percentile concentrations for fecal coliform samples collected from tributaries to the Walla Walla River, June 2002 – June 2003.

River Mile*	Location	Site ID Number	Geometric Mean	90th percentile	Samples > 200/400[1]	Q[2] (cfs)	No. Samples	WQ criteria Classification
38.2	Yellowhawk Creek-mouth	YEL-00.2	187	276	50%	37	16	Primary
36.2	Garrison Creek-mouth	GAR-00.5	204	1065	56%	2.6	16	Primary
33.7	West Little Walla Walla	WLW-00.8	140	271	33%	3.2	3	Primary
33.6	Mill Creek	MIL-00.5	76	716	25%	92.3	25	Secondary
27.2	Dry Creek	DRY-00.5	207	383	50%	6.8	5	Primary
25.8	Mud Creek	MUD-00.5	249	450	50%	2.7	4	Primary
23.4	Pine Creek	PIN- 01.4	113	254	25%	3.9	4	Primary
19.8	Touchet River	TOU-00.5	80	565	37.5%	193	16	Primary

* River mile on the Walla Walla River
1 Percentage of samples greater than the applicable “not more than 10%” *Contact Recreation* criterion
2 Mean streamflow based on instantaneous discharge volumes measured during sample collection

In the next downstream reach of the Walla Walla River between Last Chance Road (RM 35.2) and Detour Road (RM 32.8), the west branch Little Walla Walla River and Mill Creek join the mainstem. Mainstem streamflows were similar at both sites during the 2002 and 2003 summer irrigation seasons (Mendel et al., 2004).

Fecal coliform results from Detour Road show that bacterial water quality in the mainstem continued to be impaired (Table 10). The 90th percentile for the 13 samples collected at Detour Road did not meet *Primary Contact Recreation* criteria. The highest FC concentrations at Detour Road occurred in June and July 2002 when flow volumes in the reach were consistently held around 45 cfs.

Fecal coliform loads from the tributaries could be contributing to the problem. FC loads from Mill Creek and the west branch Little Walla Walla were substantial, but not enough to account for the load increase at Detour Road. This indicates additional sources along the reach. As shown earlier, Mill Creek FC concentrations did not meet the less stringent *Secondary Contact* Criteria (Table 11). The west branch of the Little Walla Walla River was only sampled a few times, but those samples suggest that it does not meet *Primary Contact* criteria (Table 11). The Smith Ditch also has a small return in the area (Neve, 2004), but it was not monitored.

Fecal coliform concentrations and loads downstream at McDonald Bridge (RM 29.3) and at Lowden Road (RM 27.4) met the *Primary Contact* criteria (Table 10). Streamflows also decreased by half, so that overall FC loading was reduced as well. Bergevin/Williams, Garden City/Lowden #2, Old Lowden Ditch, and other diversions are all located within the reach (Neve, 2004). The area also is a groundwater gaining reach (Marti, in preparation) that may help dilute upstream FC concentrations.

Secondary Contact Recreation criteria apply to the Walla Walla River below the mouth of Dry Creek (RM 27.2). Sample results downstream at Touchet-Gardena Road (RM 22.7) indicate that the reach does not meet the criteria for FC (Table 10). Fecal coliform concentrations were highest in June and July 2002, and FC loads were highest in March and April 2003.

Dry Creek, Mud Creek, and Pine Creek contribute FC loads to the reach between Lowden Road (RM 27.4) and Touchet-Gardena Road (RM 22.7), and were monitored a few times during the 2002-03 TMDL survey period (Table 11). They are nearly dry for most of the summer irrigation period, but can be seasonally significant (Mapes, 1969). Their major FC load contributions to the Walla Walla River appear to occur in the spring during snowmelt. None of the three tributaries appear to meet the *Primary Contact* criteria (Table 11). Other sources along the mainstem may be contributing FC loads to the reach.

The city of Weston, Oregon, is allowed to discharge treated municipal WWTP effluent to Pine Creek from November through June at a rate of no more than 1/30th of the stream's flow. Based on the few samples collected, it is unlikely that WWTP effluent could significantly contribute to FC loads three miles downstream in Washington. Nonpoint sources in the watershed may be present.

The FC data collected from the combined Ecology site 32A070 and the TMDL site WAL-15.6 indicate that the *Secondary Contact Recreation* criteria were met from June 2002 – June 2003 (Table 10). These two sites are less than 0.3 miles apart, and no significant tributaries, diversions, or potential sources of FC are located between them. The highest FC concentration, 410 cfu/100 mL, was recorded in October 2002 at the TMDL site. A FC count of 780 cfu/100 mL was recorded later at 32A070 in September 2003 (Ecology, 2005a).

Samples collected at the Highway 12 Bridge (WAL-12.0) at RM 12 and at the most downstream site in the TMDL study at RM 9.3 in a recreational vehicle park (WAL-9.3) usually had lower FC concentrations than at Cummins Road upstream. None of the samples at either site had FC concentrations greater than 400 cfu/100 mL, and the sites met *Secondary Contact* criteria.

The generally lower FC concentrations and loads at the last two sites in the study area suggest that few FC sources are present in the lower reaches of the Walla Walla River. The river has only a few intermittent tributaries entering along these reaches, and only a few homesteads are located in the narrow valley. Livestock were occasionally observed in the riparian area. River velocities decrease as the river enters Lake Wallula at RM 6. The lake was not included in the 2002-03 TMDL study area.

Seasonal Variation and Critical Conditions

The federal Clean Water Act requires TMDLs to identify seasonal variations and establish the TMDLs to protect beneficial uses during the most critical period. The critical period can be considered in two ways: 1) when the highest FC counts are present, and 2) when the greatest FC loads are present. The *Primary* and *Secondary Contact Recreation* FC criteria are concentration-based, while source controls would be load-based.

The critical conditions for the Walla Walla River basin are determined by the concentration-based analyses. Load-based analyses are used to help identify potential sources, and to determine if the sources are present in the same intensity through various hydrologic/seasonal regimes.

The critical condition for FC concentrations varied somewhat by site through the study area, but June through September was the most common period when FC concentrations were elevated. Historical data previously described from the Touchet River show the typical pattern (Figure 11). Basin-wide, the percentage of FC counts over 200 cfu/100 mL during the June 2002 – June 2003 surveys was greater in June through September (approximately 26% to 40%) than in October through May (15%). Some sites had more FC counts over applicable *Contact Recreation* criteria when irrigation operations were active in June, but other sites violations did not occur until flows dropped in July and August.

Critical conditions for some sites were not apparent or were slightly different from the June through September period. The mouth of Yellowhawk Creek (YEL-0.05) had elevated FC counts throughout the 2002-03 survey period. The analysis presented earlier illustrated that historical data collected at the long-term monitoring site on the Walla Walla River near Cummins Road (32A070) had a May through June critical period (Figure 6).

Fecal coliform loads were generally highest in March through June during the 2002-03 study period. Historical data at a few sites on the Walla Walla and Touchet rivers indicated that FC loads also can be substantial during fall and winter months when rain-on-snow events occur (Figure 10). At some sites, highly-elevated FC concentrations during low-flow conditions yield the greatest loads of the year.

Storm events were not part of the monitoring strategy in this TMDL assessment. It is not uncommon for municipal areas and unprotected rural lands to deliver elevated FC loads during storm events. These can then be another critical condition in the TMDL assessment. The limited monitoring (three surveys) conducted in 2002-03 in Mill, Yellowhawk, and Garrison creeks in the municipal areas of Walla Walla and College Place indicated higher FC loads during the wetter, high-streamflow season.

As discussed for the Mill Creek results, stormwater loads could not be quantified as a significant FC source when comparing storm-event to non-storm-event loads (see *Findings – Mill Creek*). Future assessments and municipal stormwater sewer system (MS4) Phase 2 activities will need to explore this issue in detail.

Loading Capacity

Definition and Determination

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

Washington State fecal coliform (FC) bacteria TMDLs use a combination of mass-per-time units and statistical 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 statistical targets are referenced in the Washington State FC criteria and provide a better measure of the loading capacity during the most critical period. The Walla Walla River basin FC loading capacities are the applicable two 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 90^{th} percentile value of samples is used in TMDL evaluations for the latter criteria statistic. The FC TMDL target loading capacities in the following tables are the criteria, or they are statistics that estimate the reductions necessary to meet the criteria.

The percentage reduction values in the following tables indicate the relative degree the waterbody 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 their loading capacity 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.

Since the loading capacity and statistical values are based on the critical condition, the tables include the critical period to provide water quality managers with a sense of when FC sources are creating criteria violations. If there is no critical period, then no seasonal changes were noted and data from the entire year was used. Stormwater events were not specifically monitored, but stormwater is assumed to have potential FC loads at any time of the year.

Mill Creek

The fecal coliform (FC) loading capacity in the upper Mill Creek watershed was adequate to handle current FC source loading. The *Primary Contact Recreation* FC criteria were met at the three sites from RM 10.5 at the diversion dam to RM 21.1 near Kooskooskie (Table 12). Fecal coliform source reductions do not appear to be necessary at this time in the reaches above RM 10.5.

At the Diversion, water from Mill Creek flows into three channels: Mill Creek, Yellowhawk Creek, and Garrison Creek. The Mill Creek branch is depleted of water as the dry season progresses. Samples collected on this branch at the sites located from Roosevelt Street (RM 8.5) to 9th Avenue (RM 6.7) usually had FC concentrations greater than 200 cfu/100 mL, the upper *Primary Contact* criterion. Mill Creek above Roosevelt Street requires a 76% FC load reduction to come into compliance with criteria (Table 12).

Table 12. Mill Creek, Yellowhawk Creek, Garrison Creek, and tributary fecal coliform load reductions based on critical condition data meeting water quality criteria for *Primary Contact* and *Secondary Contact* recreational uses.

River Mile	Location	Site ID Number	Critical Period	Class	No. Samples	FC Reduction	FC Target Capacity (cfu/100mL)	
							90th % tile	Geomean.
21.1	Mill Ck Rd near Kooskooskie	MIL-21.1	none	Primary	16	—	200	100
12.8	Five Mile Road	MIL-12.8	none	Primary	5	—	200	100
10.5	Mill after Diversion	MIL-11.5	none	Primary	15	—	200	100
8.5	Roosevelt Street	MIL-08.5	Jun – Nov[1]	Primary	3	76%	180	100
7.4	Colville Street	MIL-07.4	Jun – Nov[1]	Primary	1	82%	200	84
7.3	1st and Main Street	MIL-07.3	Jun – Nov[1]	Primary	1	82%	200	84
7.2	3rd Avenue	MIL-07.2	Jun – Nov[1]	Primary	1	82%	200	84
7.1	4th Avenue	MIL-07.1	Jun – Nov[1]	Primary	2	82%	200	84
7.0	5th Avenue	MIL-07.0	Jun – Nov[1]	Primary	1	82%	200	84
6.9	6th Avenue	MIL-06.9	Jun – Nov[1]	Primary	2	82%	200	84
6.7	9th Avenue	MIL-06.7	Jun – Nov	Primary	10	94%	200	64
4.8	Gose Street	MIL-04.8	none	Secondary	16	—	400	200
2.8	Wallula Avenue	MIL-02.8	none	Secondary	15	—	400	200
0.5	Swegle Road	MIL-00.5	Jun – Oct	Secondary	13[2]	62%	400	174
8.5	Yellowhawk Ck at Diversion	MIL-11.5	none	Primary	15	—	200	100
3.5	Yellowhawk Ck at McDonald Rd/ Plaza Way	YEL-03.5	none	Primary	1	42%[3]	183	100
0.2	Yellowhawk Ck at Old Milton Hwy	YEL-00.2	none	Primary	16	42%	183	100
9.8	Garrison Ck at Diversion	MIL-11.5	none	Primary	15	—	200	100
0.5	Garrison Ck at Mission Rd	GAR-00.5	none	Primary	16	81%	200	38
0.1	Russell Ck at McDonald Rd/ Plaza Way	RUS-00.1	none	Primary	5	68%	189	100
1.0	Cottonwood Ck at Braden Rd	COT-01.0	none	Primary	5	36%	200	18

[1] Statistics estimated from combining three sets of samples collected from MIL-07.4 to MIL-06.9.
[2] Statistics based on data collected by Ecology's Freshwater Monitoring Unit and TMDL survey crews.
[3] Fecal coliform load reduction based on downstream reduction recommendation at YEL-00.2.

Downstream of Roosevelt Street, the FC load of Mill Creek is beyond the capacity of the creek as it passes through the city of Walla Walla. The critical period of noncompliance occurs as flows drop in June through November. To meet *Primary Contact* criteria, FC reductions of 76% to 94% need to be implemented through town to 9th Street. General public access to the channel through this reach is prohibited, but bacterial water quality needs to be maintained to protect inadvertent contact with the water. Excessive FC can also indicate other pollutant source problems.

Fecal coliform loads at Gose (MIL-04.8) and Wallula (MIL-02.8) downstream of the city of Walla Walla were not exceeding the capacity of Mill Creek (Table 12). Instream measures during the critical period and throughout the year appeared adequate to reduce upstream FC loads through die-off and dilution. No additional FC load reductions are required for these reaches.

Mill Creek FC concentrations at Swegle Road (RM 0.5) were often greater than 400 cfu/100 mL and did not meet the *Secondary Contact Recreation* criteria (Table 12). The low-flow conditions present in June through October had exceptionally poor bacterial water quality. A FC load reduction of 62% is needed to bring the reach into compliance with *Secondary Contact* criteria. The FC load reductions will also contribute to reducing Walla Walla River FC loads at Detour Road (see *Walla Walla River*).

Yellowhawk and Garrison Creeks

The Yellowhawk Creek branch of Mill Creek and two monitored tributaries, Russell Creek and Cottonwood Creek, exceeded their FC load capacities (Table 12). The cumulative FC load delivered to Yellowhawk Creek along its length throughout the year exceeded its capacity to meet *Primary Contact Recreation* criteria near its confluence with the Walla Walla River (YEL-00.2).

The FC load reduction required to meet the load capacity of Yellowhawk Creek near the mouth is 42%, the geometric mean being the more restrictive statistic for the basis. Although only one FC sample was collected, it appeared that Yellowhawk Creek above McDonald Road/Plaza Way (YEL-03.5) may not be meeting *Primary Contact* criteria. As a margin of safety, the FC reduction applied to the lower Yellowhawk Creek site (42%) was applied to McDonald Road as well.

Fecal coliform loads from Russell and Cottonwood creeks just downstream of Plaza Way contributed to further bacterial water quality degradation in Yellowhawk Creek because the creeks exceeded their respective FC load capacities (Table 12). Russell Creek requires a 68% reduction, and Cottonwood Creek requires a 36% reduction to meet *Primary Contact* criteria.

Garrison Creek (GAR-00.5) requires a 79% FC load reduction to meet its FC load capacity near the confluence with the Walla Walla River (Table 12). The creek is usually dry above the College Place WWTP outfalls during the June – October critical season, but the FC reduction is extended upstream as well. The bacterial water quality of Garrison Creek above the WWTP outfalls was not evaluated directly, but data collected by White et al. (1998) and WWTP effluent

FC concentrations during the wet season indicate that FC reductions are necessary upstream of the WWTP.

Touchet River

The upper reaches of the Touchet River appear to have low FC loading. All sites from the confluence of the North and South Forks downstream 13.5 miles to below Waitsburg (TOU-40.5) met *Primary Contact Recreation crit*eria and do not require load reductions (Table 13). The North and South Forks also met criteria, and each had significant reserve capacities.

Table 13. Touchet River and tributary fecal coliform reductions and target concentrations to meet load capacities based on the *Primary Contact Recreation crit*eria.

River Mile	Location	Site ID Number	Critical Period	Class	No. Samples	FC Reduction	FC Target Capacity (cfu/100mL)	
							90^{th} % tile	Geomean.
–	N F Touchet River	NFT-00.0	none	Primary	16	—	200	100
–	S F Touchet River	SFT-00.0	none	Primary	14	—	200	100
53.9	Dayton City Park	TOU-53.9	none	Primary	6	—	200	100
–	Patit Creek	PAT-00.1	May – Sep	Primary	4	80%	200	24
51.2	Ward Road	TOU-51.2	none	Primary	16	—	200	100
48.4	Lewis and Clark St. Pk.	TOU-48.4	none	Primary	5	—	200	100
46.2	Lower Hogeye Rd	TOU-46.2	none	Primary	16	—	200	100
44.2	Hwy 12 Waitsburg	TOU-44.2	none	Primary	5	—	200	100
–	Coppei Creek	COP-00.5	May – Sep	Primary	4	44%	169	100
40.5	Highway 124	TOU-40.5	none	Primary	21	—	200	100
36.6	Hart Road	TOU-36.6	none	Primary	5	86%	200	36
34.2	Highway 125	TOU-34.2	Jun – Sep	Primary	8	72%	200	34
30.6	Pettyjohn Road	TOU-30.6	Jun – Sep	Primary	3	46%	198	100
25.0	Lamar Road	TOU-25.0	Jun – Sep	Primary	3	16%	200	60
17.8	Luckenbill Road	TOU-17.8	none	Primary	16	—	200	100
14.2	N Touchet Road	TOU-14.2	none	Primary	5	—	200	100
7.0	Above Hofer Diversion	TOU-07.0	none	Primary	16	—	200	100
2.0	Cummins Road	TOU-02.0	Jun – Sep	Primary	11[1]	81%	200	52
0.5	Highway 12	TOU-00.5	Jun – Sep	Primary	8	78%	200	58

[1] Statistics based on fecal coliform data combined from Ecology sites 32B075 and TOU-02.0.

Patit and Coppei creeks that discharge to these reaches require FC load reductions to meet their own load capacities, but they do not appear to significantly impair the Touchet River. The reductions for the two creeks were calculated using data collected from May through September. The calculated FC reduction for Patit Creek may be more than is necessary, but future monitoring can be used to revise the estimated FC reduction needed to meet the criteria.

The next 15 miles of the Touchet River, RM 40.5 to RM 25, will require FC load reductions of 86% to 16% to meet *Primary Contact Recreation* criteria (Table 13). As described earlier, a FC source or sources upstream of Hart Road (TOU-36.6) cause significant downstream FC contamination throughout the year. The upstream FC loading may cause the FC load capacity to be exceeded as far downstream as Lamar Road (TOU-25.0) during the low-flow season of June through September. Future investigations should be cognizant of other sources that may be present as well.

The recommended FC load reductions gradually decrease downstream from Hart Road, and the river appears to be depurated as it reaches Luckenbill Road (TOU-17.8). The *Primary Contact* criteria are met, and FC loading is low in the river reaches from Luckbill Road to the North Touchet Road crossing (TOU-07.0) above the Hofer diversion at RM 4.0.

The declining flow volumes in the Touchet River from June through September appear to play a significant factor in the FC load capacities downstream of the Hofer Diversion. The reaches above Cummins Road (TOU-02.0) to the mouth at Highway 12 (TOU-00.5) require significant FC load reductions (Table 13). The data suggest that FC sources upstream of Cummins Road may be influencing FC concentrations at Highway 12. A FC load reduction of approximately 80% is estimated for the river to meet *Primary Contact* criteria. The reduction should also significantly reduce FC loads in the Walla Walla River.

Walla Walla River

As described earlier, the upper and lower reaches of the river have different criteria and load capacities. The *Primary Contact Recreation* criteria for the upper reaches are more stringent than the *Secondary Contact Recreation* criteria below the confluence of Dry Creek at RM 27.2.

Meeting the loading capacity of the Walla Walla River is dependent on the FC load transported from Oregon, the tributary and irrigation return loads, unidentified FC loads along the river, and the natural processes in the river for removing FC bacteria. Some reaches of the Walla Walla do not meet criteria seasonally or at any time, and need to have FC loading reduced (Table 14). Other reaches do meet criteria, and natural processes appear to be able to handle the FC loads.

Based on samples collected June – September, the FC load capacity of the Walla Walla River is exceeded near the border with Oregon at Highway 125 (WAL-38.7). A FC load reduction of 6% is required to meet the *Primary Contact* criteria. As mentioned earlier, June – September E. coli concentrations in 2002-03 were in the range of concern for Oregon geometric mean criteria.

Walla Walla River reaches above Last Chance Road and Detour Road receive cumulative FC loads from several tributaries that exceed the FC load capacity of the river, requiring reductions by approximately one-third (Table 14). As mentioned earlier, Yellowhawk, Garrison, and Mill creeks require FC load reductions in the range of 42% to 79% to meet their respective load capacities. The west branch of the Little Walla Walla also requires a 46% FC load reduction (Table 14). Additional reductions may be required of unmonitored tributaries and near-channel FC loads.

As water is diverted from the Walla Walla River below Detour Road, groundwater inflow or other mechanisms reduce the FC loads so that the river meets its load capacity in reaches above McDonald Road (WAL-29.3) and Lowden Road (WAL-27.4). It appears that FC load reductions are not necessary in these reaches to meet *Primary Contact* criteria (Table 14).

Table 14. Walla Walla River and tributary fecal coliform reductions and target concentrations to meet load capacities based on the *Primary Contact* and *Secondary Contact Recreation* criteria.

River Mile	Location	Site ID Number	Critical Period	Class	No. Samples	FC Reduction	FC Target Capacity (cfu/100mL)	
							90th % tile	Geomean.
38.7	Highway 125	WAL-38.7	Jun - Sep	Primary	8	6%	200	92
35.2	Last Chance Road	WAL-35.2	none	Primary	5	35%	188	100
32.8	Detour Road	WAL-32.8	Jun - Sep	Primary	7	33%	200	84
29.3	McDonald Road	WAL-29.3	none	Primary	16	—	200	100
27.4	Lowden Road	WAL-27.4	none	Primary	16	—	200	100
22.7	Touchet-Gardena Road	WAL-22.7	Jun - Sep	Secondary	9	60%	400	105
15.6	Cummins Road	WAL-15.6	May - June	Secondary	30*	32%	400	118
12	Highway 12	WAL-12.0	none	Secondary	5	—	400	200
9.3	Pierce's RV Park	WAL-9.3	none	Secondary	16	—	400	200
38.2	Yellowhawk Creek	YEL-00.2	none	Primary	16	42%	183	100
36.2	Garrison Creek	GAR-00.5	none	Primary	16	81%	200	38
33.7	W. Little Walla Walla	WLW-00.8	none	Primary	3	46%	147	100
33.6	Mill Creek	MIL-00.5	Jun - Oct	Secondary	13*	62%	400	174
27.2	Dry Creek	DRY-00.5	none	Primary	5	45%	200	93
25.8	Mud Creek	MUD-00.5	none	Primary	4	60%	180	100
23.4	Pine Creek	PIN- 01.4	none	Primary	4	21%	200	89
19.8	Touchet River	TOU-00.5	Jun - Sep	Primary	8	78%	200	58

* Statistics based on fecal coliform data combined from Ecology TMDL and Ecology Freshwater Monitoring Unit surveys.

The Walla Walla River at Touchet-Gardena Road did not meet the *Secondary Contact Recreation* criteria and requires a 60% FC load reduction (Table 14). Dry Creek, Mud Creek, and Pine Creek FC loads discharge into the reaches above this site, and they also require reductions to meet *Primary Contact* criteria in the range of 21% to 60%.

Because TMDL guidelines require that all available data are used and that conservative assumptions be applied to attain a margin of safety in the analysis, the reductions in FC needed to meet the TMDL targets must be estimated from the largest, stable period of record. As described earlier, FC loads have not significantly changed in the Walla Walla River at Cummins Road (RM 15.6) since 1980. For the May and June critical period from 1990 to 2004, the geometric mean and 90th percentile FC statistics are 173 cfu/100 mL and 585 cfu/100 mL, respectively.

The 90th percentile value does not meet the *Secondary Contact* criterion of 400 cfu/100 mL. A 32% reduction in FC is needed in reaches upstream of Cummins Road to bring the lower Walla Walla River into compliance. Reduction of the Touchet River FC load to meet *Primary Contact Recreation* criteria should help to reduce FC loads observed in the Walla Walla River at this site.

Additional FC reductions do not appear to be necessary for the reaches between Cummins Road at RM 15.6 and the lowest site monitored on the river at RM 9.3 (WAL-9.3). Seasonal critical conditions were not observed, and *Secondary Contact Recreation* criteria were met (Table 14).

Walla Walla Cumulative Load Analysis

Data collected during the June 2002 – June 2003 TMDL surveys were used to estimate the various loads along the Walla Walla River and from the monitored tributaries. A Beales ratio estimator formula (Dolan et al., 1981) was used to calculate the annual loads (not only the critical season) for tributaries and mainstem sites with more than ten data (Appendix C). The estimated FC load from Oregon sampled at RM 38.7 and the tributary loads are listed in Table 15.

Table 15. Current estimated fecal coliform loads (cfu/day) delivered to the Walla Walla River in Washington from Oregon (RM 38.7) and from various tributaries, June 2002 to June 2003.

River Mile	Location	2002 – 2003 Load	TMDL Load
38.7	Walla Walla at Highway 125	1.8×10^{11}	1.7×10^{11}
38.2	Yellowhawk Creek at mouth	1.5×10^{11}	8.9×10^{10}
36.2	Garrison Creek	2.5×10^{10}	5.2×10^{9}
33.7	West Little Walla Walla River	1.6×10^{10}	8.5×10^{9}
33.6	Mill Creek near mouth	7.4×10^{10}	2.8×10^{10}
27.2	Dry Creek near mouth	2.9×10^{10}	1.6×10^{10}
25.8	Mud Creek	1.8×10^{10}	7.2×10^{9}
23.4	Pine Creek	2.0×10^{10}	1.6×10^{10}
19.8	Touchet River near mouth	4.4×10^{11}	9.6×10^{10}
	Total Tributary and upstream FC loads	9.5×10^{11}	4.3×10^{11}

The estimated Touchet River FC load was the largest because of the elevated FC concentrations and the relatively large volume of water delivered to the Walla Walla River. The FC loads from Oregon and Yellowhawk Creek are half as large as the Touchet River load. The Walla Walla River from Oregon discharges a volume of water similar to the Touchet, but with lower FC concentrations. Yellowhawk Creek has much smaller water volumes, but the FC concentrations are chronically elevated. Mill Creek has seasonally low streamflow as water is diverted to Garrison and Yellowhawk, so its annual FC load contribution is reduced.

The cumulative annual average FC loads from measured inputs were compared to FC loads at key sites along the mainstem. The difference between the two loads was used as an estimate of additional FC loads to a reach or of significant FC losses. Figure 19 shows the results of the Walla Walla River analysis for four reaches:

1. Oregon Border (RM 40) to Detour Road (RM 32.8)
2. Detour Road (RM 32.8) to Lowden Road (RM 27.4)
3. Lowden Road (RM 27.4) to Touchet-Gardena Road (RM 22.7)
4. Touchet-Gardena Road (RM 22.7) to Cummins Road (RM 15.6)

Figure 19. Measured and unmeasured annual average fecal coliform loads and losses at four sites along the Walla Walla River, June 2002 – June 2003.

Additional FC loading in Reaches 1 and 3 could be from many possible sources. Reach 1 FC loads could be from the unmonitored tributaries of Little East Walla Walla River and Stone Creek, Smith Ditch irrigation return, and nonpoint sources along the mainstem channel. The FC load from the west branch of the Little Walla Walla River may have been underestimated as well. Reach 3 has some unmonitored irrigation returns, and the FC loads from Dry, Pine, and Mud creeks may have been underestimated because only a few samples were collected for each of these tributaries. Nonpoint sources along the mainstem channel may also be present.

Losses in FC loads in Reaches 2 and 4 could be from the replacement of diverted river water with groundwater returns, natural bacterial die-off mechanisms, and sedimentation. Long-term data comparing Touchet and Walla Walla FC loads described earlier also suggest FC load losses in Reach 4. Additional synoptic monitoring during different hydrological conditions would be necessary to determine the causes of FC losses or gains along the Walla Walla River.

Table 15 listed sites along the Walla Walla River, Touchet River, Mill Creek, and other tributaries in the basin that require FC bacteria reductions to meet *Contact Recreation* criteria. The reduced average annual FC tributary loads were compared to the recommended FC load capacities along the four reaches of the mainstem Walla Walla River. The comparison suggests that the tributary load reductions will be adequate to meet the mainstem reductions (Figure 20). The reserve FC loads are the estimated additional FC loads the reaches could receive before their load capacities are met.

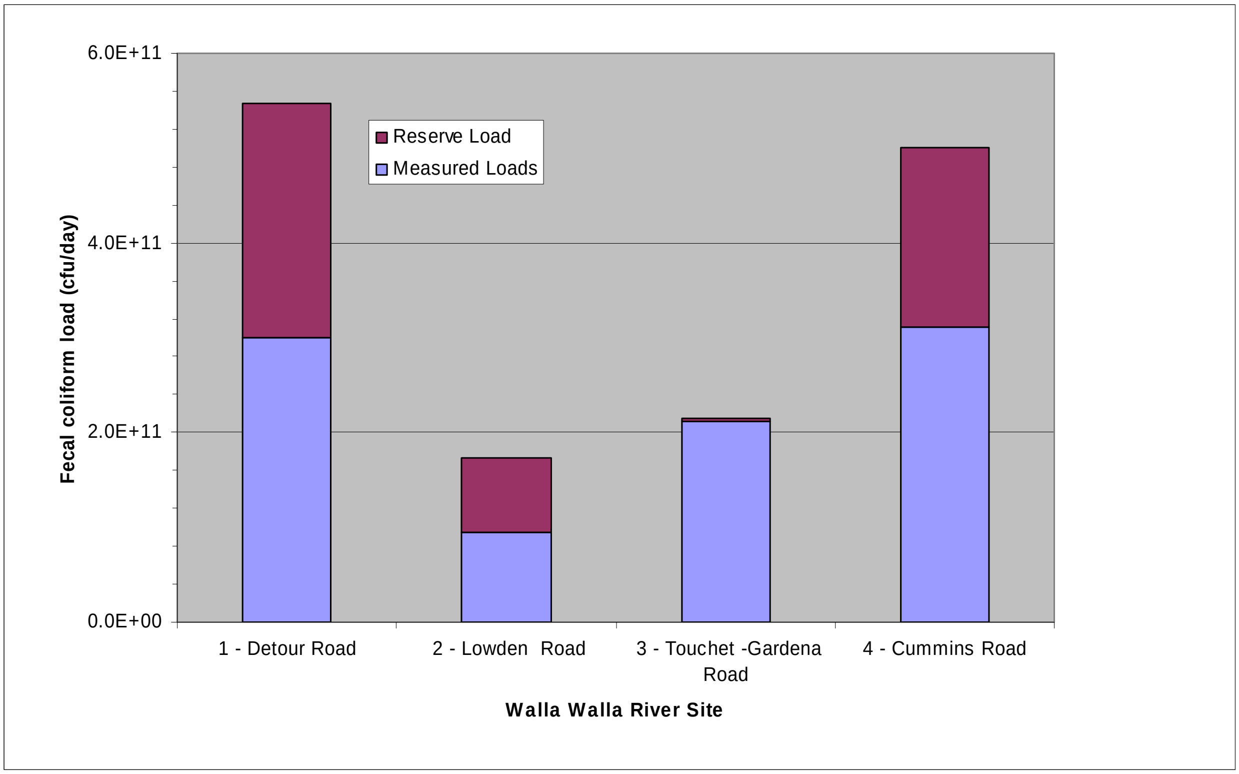

Figure 20. Estimated annual average fecal coliform loads from measured sources and reserve loads at four sites along the Walla Walla River after recommended load reductions have been accomplished.

All of the reaches have some estimated reserve capacity if FC reduction measures are successful in the tributaries. The analysis assumes that Reaches 1 and 2 remain classified for *Primary Contact Recreation*, and that Reach 3 and 4 remain *Secondary Contact Recreation*. As with other sites that meet the FC load capacity and meet water quality criteria, the earned-reserve FC load is considered part of natural background and is not reallocated to a particular nonpoint load or point source. Efforts to eliminate FC sources along these reaches would be expected to continue whether or not the tributary TMDL targets are met.

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Load and Wasteload Allocations

This Total Maximum Daily Load (TMDL) technical evaluation of the Walla Walla River basin demonstrated that contact recreation is impaired in each of the three major watersheds that were investigated and that fecal coliform (FC) load reductions are necessary. Most of the FC load sources are nonpoint in nature and require load allocations. The point sources in the basin are assigned wasteload allocations based on their NPDES permit limits, or on adjusted permit limits if water-quality based limits are necessary.

The FC allocations may be expressed as loads, concentrations, or other appropriate measures [40 CFR 130.2(I)]. Fecal coliform TMDL target reductions are expressed as both concentrations and loads in this report. Washington State uses concentrations of FC as the most appropriate measure of meeting allocations because FC can be directly compared to the water quality standards under all streamflow scenarios. Fecal coliform loads (as cfu/day) are used as a relative measure of pollutant flux between river reaches or from tributary and point source inputs.

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

Mill Creek Watershed

Fecal coliform reductions in Mill Creek are not needed in reaches upstream of RM 10.5 (Figure 21). Reductions are needed after the creek divides into three branches at RM 10.5, at the diversion dam upstream of the city of Walla Walla. Yellowhawk Creek, Garrison Creek, and the continuing branch of Mill Creek require different levels of FC reduction (Table 16). Both load allocations for nonpoint sources and wasteload allocations for point sources were evaluated for the three branches.

Several reaches of Mill Creek below the diversion dam require FC load reductions based on low-streamflow conditions from June through October (Table 16). Roosevelt Street (compliance point above most of the residential and urban area), 9th Street (compliance point for through the downtown urban area), and the mouth of Mill Creek require FC reductions on nonpoint loads to meet *Primary Contact Recreation* criteria. The TMDL target load allocations are set so that the sum of residual nonpoint loads and background FC loads should result in less than 10% of the FC samples being under 200 cfu/100 mL at Roosevelt Street and 9th Street.

Stormwater runoff was not demonstrated to be a significant FC load during the June – October critical period; November – May stormwater FC loads were not quantifiable during the wet-weather monitoring surveys. Evaluation of stormwater systems and implementation of best management practices should be undertaken under the Phase 2 municipal stormwater permit so that any storm-generated FC loads are reduced to meet the *Primary Contact Recreation* water quality standards in receiving waters.

The Walla Walla Wastewater Treatment Plant (WWTP) does not require a modification of its NPDES permit limits for its FC wasteload allocation. The WWTP discharges effluent directly into Mill Creek from December through April, and discharges to irrigation districts from May through November. Mill Creek at 9th Street is upstream, and Gose Street is immediately below, the WWTP outfall location. Since the WWTP does not discharge directly to the creek during the June through October critical season for the 9th Street FC reductions, and the Gose Street site does not require FC reductions, the current NPDES permit FC limits for the WWTP appear to be adequate, and no seasonal wasteload allocation is necessary.

The irrigation returns downstream of Gose Street that contain all or some WWTP effluent are not under permit. The WWTP effluent quality has stringent FC limits for reclaimed water use, so FC loads in irrigation returns are from nonpoint sources. These irrigation districts will be expected to participate in reducing FC loads by 62% to meet both parts of the *Secondary Contact Recreation* FC criteria at the mouth of Mill Creek throughout the year.

The Yellowhawk Creek branch with Russell and Cottonwood creeks require FC reductions, and load allocations are set in Table 16 to meet *Primary Contact* criteria. The TMDL target load allocations are for background and residual nonpoint sources. A load allocation upstream of Russell Creek is set to encourage nonpoint source controls in the upper reaches of Yellowhawk Creek and ensure that *Primary Contact* criteria are met. The estimated FC reduction necessary to meet water quality standards in the upper reaches may be better estimated after more monitoring.

As with Mill Creek, stormwater runoff was not a quantifiably significant FC load in Yellowhawk Creek and Garrison Creek during the wet-weather monitoring surveys. Evaluation of stormwater systems and implementation of best management practices should be undertaken by the City of Walla Walla, City of College Place, Walla Walla County, and the Washington State Department of Transportation under the Phase 2 municipal stormwater permit so that any storm-generated FC loads are reduced to meet the *Primary Contact* standards in the receiving waters.

Garrison Creek requires FC load allocations to nonpoint sources upstream and downstream of the College Place WWTP to meet *Primary Contact* criteria. The WWTP has been given a wasteload allocation; the proposed NPDES permit total coliform limits appear to be adequate to meet the wasteload allocation FC target. A FC load allocation was set above the WWTP outfall to encourage nonpoint source controls, especially for on-site systems, and *Primary Contact* criteria compliance in Garrison Creek as it passes through Walla Walla and College Place.

College Place WWTP had a draft NPDES permit under review until June 2005 (Ecology, 2005b). The permit limits for bacteria are based on Class C reclaimed water total coliform limits of a 7-day median of 23 cfu/100 mL (Anderson, 2005). A TMDL target FC geometric mean of 38 cfu/100 mL was calculated for the mouth of Garrison Creek. The wasteload allocation for the College Place WWTP assumes all of the total coliform is FC, and no dilution is present.

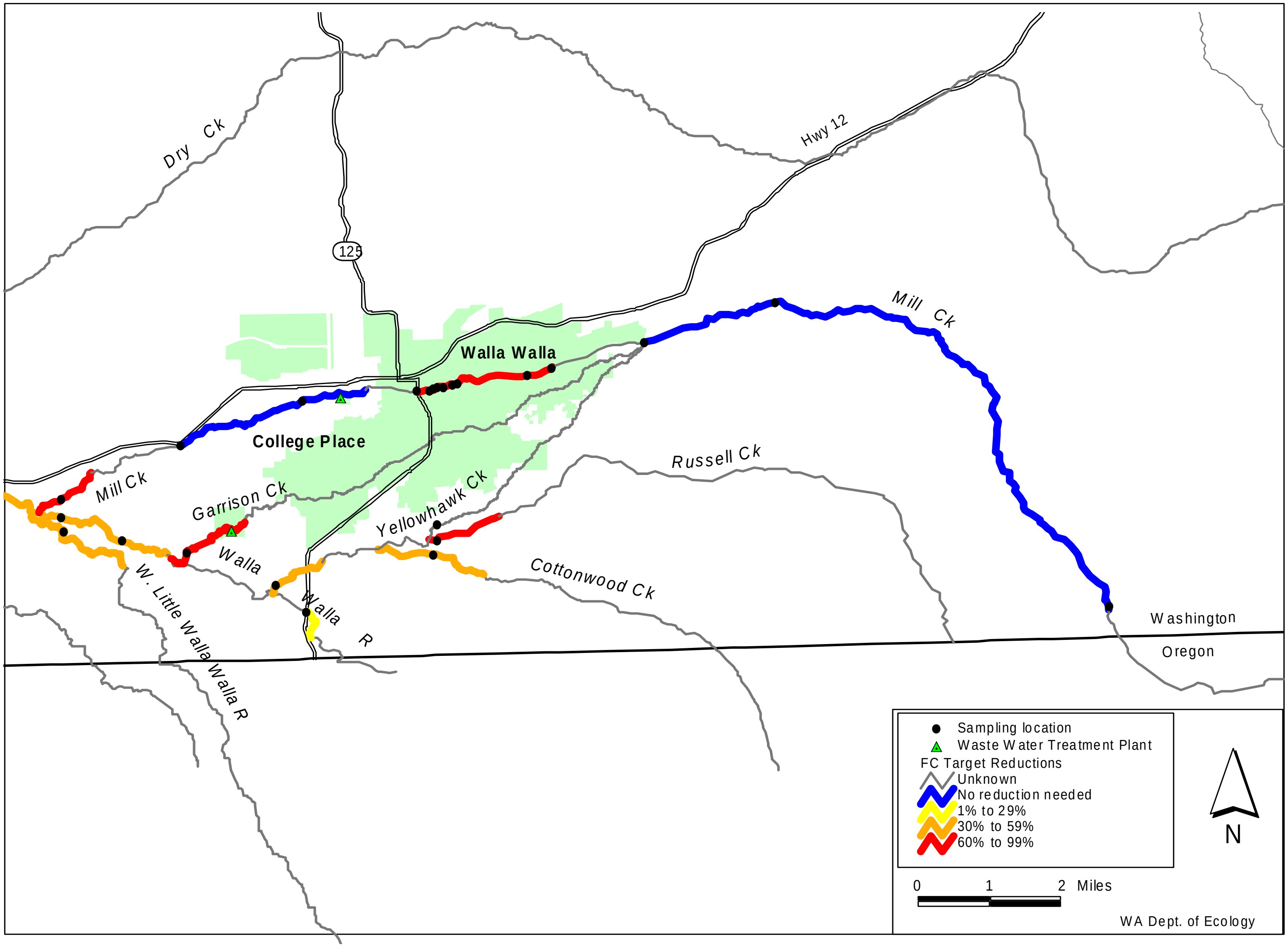

Figure 21. Recommended fecal coliform reduction targets for Mill Creek, Yellowhawk Creek, Garrison Creek, and nearby streams.

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Table 16. Mill Creek watershed fecal coliform wasteload allocations (WLA) and load allocations (LA).

Mill Creek Reach, Point Source, or Tributary	WLA/Load Allocation (cfu/day)	Current Load (cfu/day)	Target Reduction (%)	Target Basis WLA/LA WQ criterion	Contact Recreation Standards
Mill Creek at Diversion	–	2.2×10^{10}	no reduction required		Primary
Mill Creek Branch	–	1.2×10^{10}	no reduction required		Primary
Mill Creek at Roosevelt	3.0×10^{10}	1.2×10^{11}	76%	10% > 200	Primary
Phase 2 stormwater[1]		NC	94%	10% > 200	Primary
Mill Creek at 9th Street	1.3×10^{10}	2.2×10^{11}	94%	10% > 200	Primary
Walla Walla WWTP[2]	1.5×10^{11}	9.7×10^{9}	current permit limits		Secondary
Mill Creek at Gose	–	1.1×10^{11}	no reduction required		Secondary
Mill Creek at Wallula	–	1.3×10^{11}	no reduction required		Secondary
Phase 2 stormwater[1]		NC	62%	10% > 400	Secondary
Mill Creek at mouth	2.8×10^{10}	7.4×10^{10}	62%	10% > 400	Secondary
Yellowhawk Branch	–	9.2×10^{9}	no reduction required		Primary
Yellowhawk Creek[3]	NC	NC	42%	GM > 100	Primary
Phase 2 stormwater[1]		NC	42%	GM > 100	Primary
Russell Creek	4.5×10^{9}	1.4×10^{10}	68%	GM >100	Primary
Cottonwood Creek	1.1×10^{9}	1.8×10^{9}	36%	10% > 200	Primary
Yellowhawk Creek	8.9×10^{10}	1.5×10^{11}	42%	GM > 100	Primary
Garrison Creek Branch	–	1.3×10^{9}	no reduction required		Primary
Garrison Creek[4]	NC	NC	81%	10% > 200	Primary
Phase 2 stormwater[1]		NC	81%	10% > 200	Primary
College Place WWTP[5]	1.7×10^{9}	1.7×10^{10}	new permit requirements		Primary
Garrison Creek	4.7×10^{9}	2.5×10^{10}	81%	10% > 200	Primary

[1] Potential Phase 2 stormwater permit holders as appropriate for the location: City of Walla Walla, Walla Walla County, City of College Place, and Washington State Department of Transportation.
[2] November through April estimated FC load to Mill Creek at 400 cfu/100 mL at 9.6 million gallons/day.
[3] Yellowhawk Creek FC loading above Russell Creek not calculated (NC), but assumes FC reductions needed.
[4] Assumes FC reductions needed upstream of College Place WWTP outfall when streamflow is present. FC loading capacity not calculated (NC).
[5] Load capacity/WLA assumes all total coliform are FC and discharged directly to Garrison Creek (see text).

Touchet River Watershed

Several reaches of the Touchet River require FC load reductions and have load allocations for nonpoint sources to meet *Primary Contact* criteria (Table 17). A wasteload allocation for the Dayton WWTP has also been calculated. The Washington State Department of Transportation (WSDOT) is the only potential Phase 2 stormwater permit holder in the watershed. State Highways 12, 124, and 125 cross or follow along portions of the Touchet River, so wasteload allocations in some areas are recommended as 'placeholders' until evaluation of the existing system under the permit can be undertaken.

The mainstem Touchet River does not require FC load reductions from the confluence of the North and South Forks at RM 53.9 to the Highway 124 crossing at RM 40.5 (Figure 22). One point source, transportation stormwater sources, and two tributaries in this set of reaches are listed in Table 17.

The Dayton WWTP is the only point source within this stretch of the river. It has been given a wasteload allocation to maintain effluent quality adequate to protect *Primary Contact* recreational uses downstream. The WLA is based on the current technology-based NPDES permit limits. Additional monitoring to ensure UV disinfection effectiveness is recommended because of some inconsistent effluent FC results. The elevated FC counts initially observed during the 2002-03 TMDL surveys (Table 9) were not verifiable in additional monitoring. Therefore, Ecology believes more stringent FC permit limits would not provide additional reductions in current FC loads from the WWTP.

The WSDOT Phase 2 stormwater permit wasteload allocations are provided to encourage best management practices on highways near Dayton, Waitsburg, and at all surface water crossings in the upper watershed. Although stormwater effects from highways were not assessed in this evaluation, WSDOT should ensure that stormwater FC loads do not increase instream FC concentrations above water quality criteria for *Primary Contact Recreation.*

Patit Creek and Coppei Creek are tributaries to the river. Background and residual nonpoint sources are given load allocations to meet *Primary Contact* criteria in the creeks. Additional FC load reductions were not necessary to protect Touchet River mainstem water quality. If Patit Creek and Coppei Creek implementation measures are successful, FC loads will be further reduced in the Touchet River.

The mainstream reaches upstream of Hart Road at RM 36.6 to Lamar Road at RM 25 require FC load reductions of 86% to 16% (Table 17 and Figure 23). Other than the WLA for WSDOT stormwater, a FC load allocation is needed for nonpoint sources to bring the river back into compliance with *Primary Contact Recreation* criteria. It may be that reducing or removing the FC source upstream of Hart Road will bring the 11.6-mile stretch of the Touchet River into compliance.

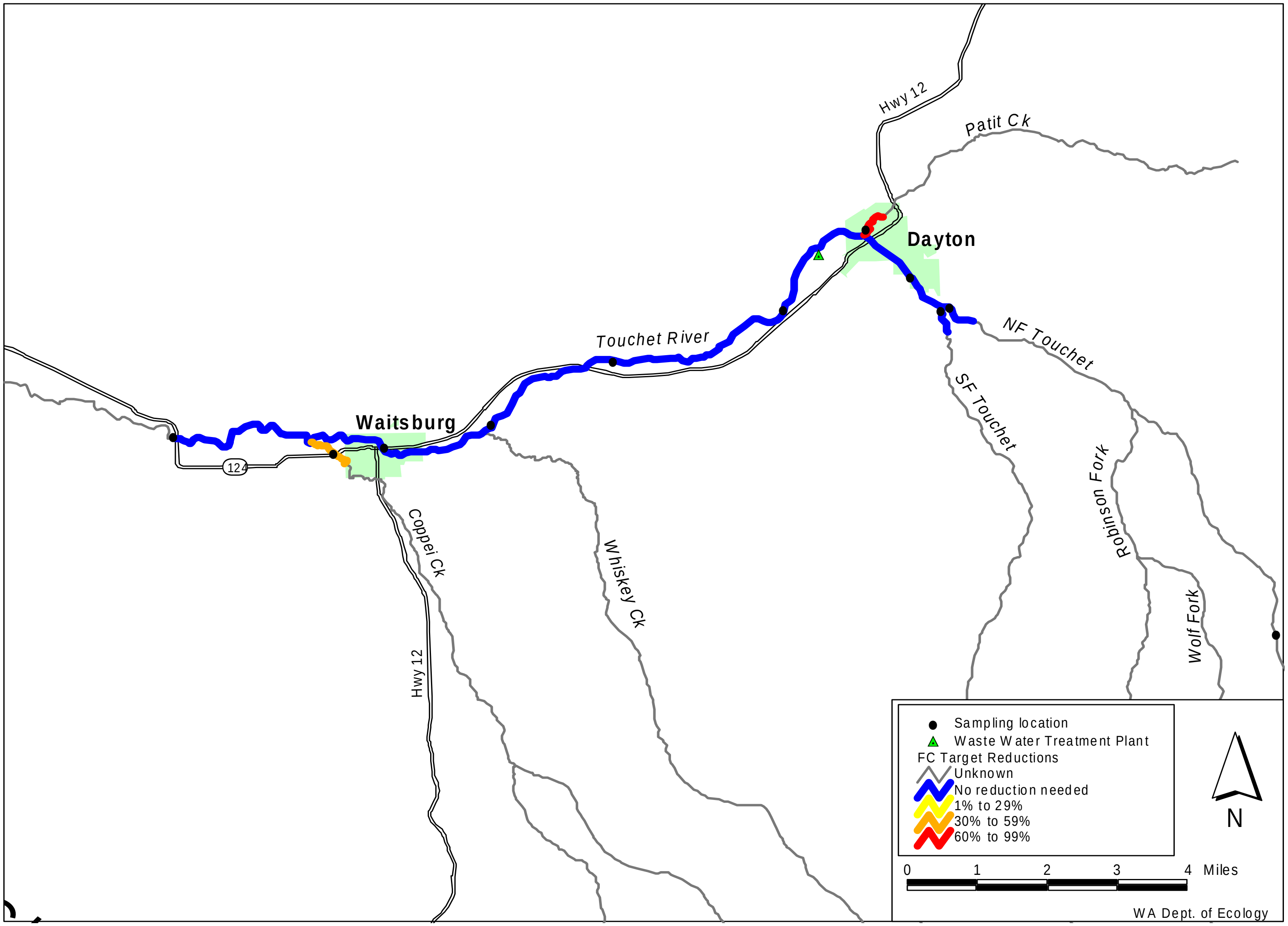

Figure 22. Recommended fecal coliform reduction targets for the upper Touchet River.

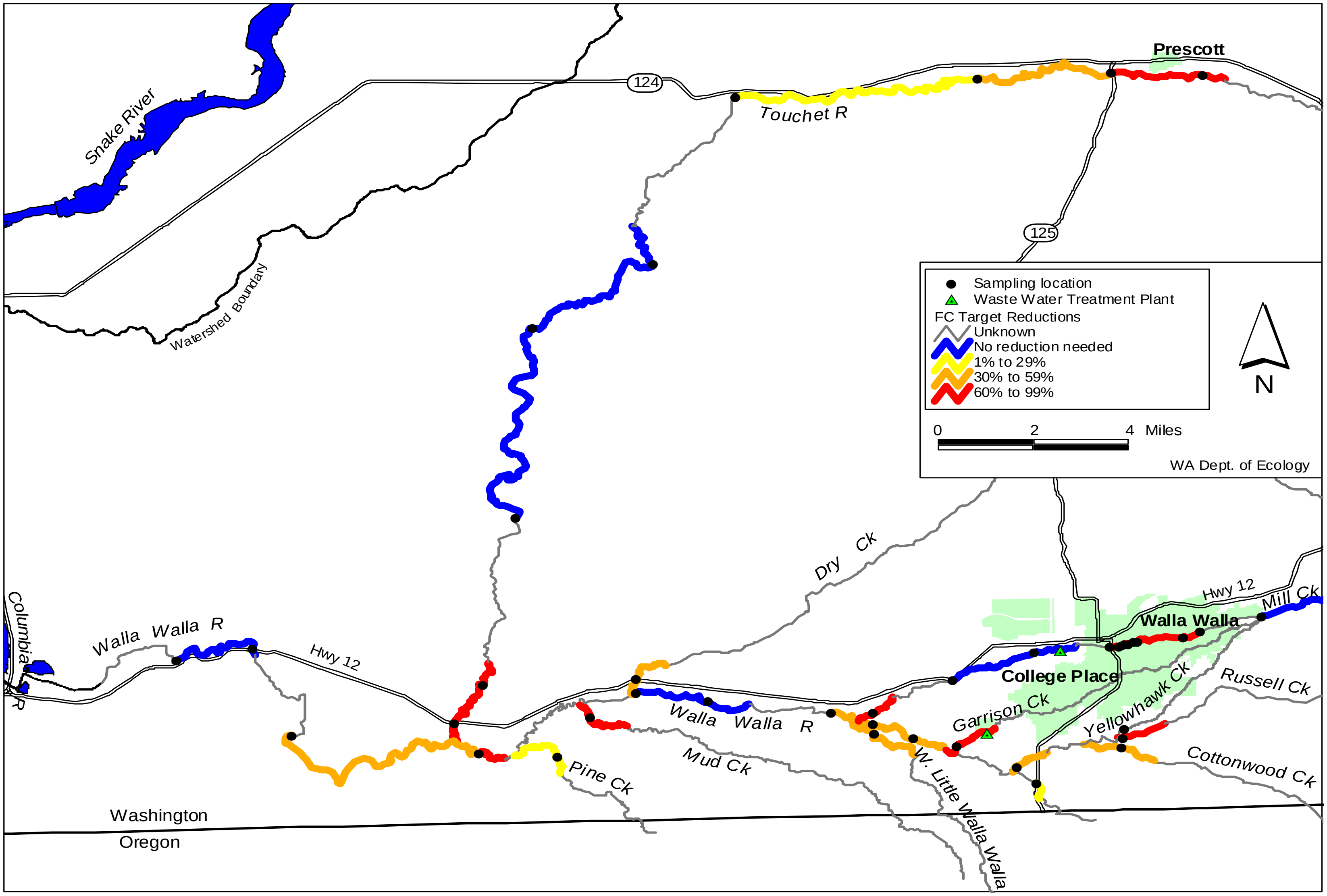

Figure 23. Recommended fecal coliform reduction targets for the lower Touchet River, and the Walla Walla River and tributaries.

Table 17. Touchet River watershed wasteload allocations (WLA) and load allocations (LA).

Touchet River Reach, Point Source or Tributary	WLA/Load Allocation (cfu/day)	Current Load (cfu/day)	Target Reduction (%)	Target Basis WLA/LA WQ criterion	Contact Recreation Standards
North Fork Touchet River	–	4.1×10^{10}	no reduction required		Primary
South Fork Touchet River	–	7.4×10^{9}	no reduction required		Primary
Dayton WWTP	2.3×10^{9}	2.3×10^{9}	current permit limits		Primary
Patit Creek	1.5×10^{9}	7.0×10^{9}	80%	10% > 200	Primary
Phase 2 stormwater[1]	NC	NC	NC	10% > 200	Primary
Ward Road	–	6.3×10^{10}	no reduction required		Primary
Coppei Creek	4.3×10^{9}	7.7×10^{9}	44%	GM > 100	Primary
Highway 124	–	1.3×10^{11}	no reduction required		Primary
Phase 2 stormwater[1]	NC	NC	NC	10% > 200	Primary
Hart Road	8.8×10^{10}	6.3×10^{11}	86%	10% > 200	Primary
Highway 125	9.1×10^{10}	3.3×10^{11}	72%	10% > 200	Primary
Phase 2 stormwater[1]	NC	NC	72%	10% > 200	Primary
Pettyjohn Road	1.3×10^{11}	2.4×10^{11}	46%	GM > 100	Primary
Lamar Road	2.0×10^{11}	2.4×10^{11}	16%	10% > 200	Primary
Luckenbill Road	–	2.1×10^{11}	no reduction required		Primary
North Touchet Road	–	2.1×10^{11}	no reduction required		Primary
Above Hofer Diversion	–	2.4×10^{11}	no reduction required		Primary
Cummins Road	7.0×10^{10}	3.7×10^{11}	81%	10% > 200	Primary
Highway 12	9.6×10^{10}	4.4×10^{11}	78%	10% > 200	Primary
Phase 2 stormwater[1]	NC	NC	78%	10% > 200	Primary

1 Actual stormwater FC loads were not calculated (NC), but focus areas are shown for the Washington State Department of Transportation to evaluate best management practices and reduce fecal coliform loads as a Phase 2 stormwater permit holder.

Fecal coliform load reductions are not needed on the mainstem between Luckenbill Road at RM 17.8 and the North Touchet Road crossing at RM 14.2 above the Hofer Diversion (Figure 23). No state highways are present along this stretch of the mainstem Touchet River, so a wasteload allocation for stormwater is not needed.

The lower reaches of the Touchet River require significant FC load reductions (Table 17 and Figure 23). The 80% reduction at Cummins Road and Highway 12 are primarily load allocations to nonpoint sources. The WSDOT is responsible for stormwater runoff from Highway 12, and a wasteload allocation is recommended to ensure that stormwater FC loads do not increase instream FC concentrations above water quality criteria for *Primary Contact Recreation.*

Walla Walla River

As the Walla Walla River enters Washington from Oregon, it has a FC load in excess of the river's capacity to meet *Primary Contact Recreation* water quality criteria. The load allocation at the Highway 125 Bridge (RM 38.7) is necessary to reduce nonpoint sources in Oregon and Washington (Table 18 and Figure 23). Wasteload allocations for Highway 12 and urbanized areas of Walla Walla County stormwater runoff are also recommended to ensure that stormwater FC loads do not increase instream FC concentrations above water quality criteria for *Primary Contact Recreation.* The Washington State Department of Transportation will be assessing its stormwater systems in eastern Washington under its Phase 2 stormwater permit.

The FC load allocations to meet *Primary Contact* criteria for the Walla Walla River upstream of Last Chance Road (RM 35.2) to Detour Road (RM 32.8) implicitly include loads from the major tributaries of the Mill Creek watershed, west branch Little Walla Walla River, and potential loads from the unmonitored east branch Little Walla Walla River, Stone Creek, Smith Ditch irrigation return, and nonpoint sources along the mainstem channel (Figure 23). Walla Walla County urban census blocks are also located along the river (Figure 4), so a FC wasteload allocation is reserved on the Detour Road reach for reducing stormwater effects (Table 18).

Table 18. Walla Walla River load allocations and wasteload allocations (WLA).

Walla Walla River Reach, or Point Source	WLA/Load Allocation (cfu/day)	Current Load (cfu/day)	Target Reduction %	Target Basis WLA/LA WQ criterion	Contact Recreation Standards
Highway 125	1.7×10^{11}	1.8×10^{11}	6%	10% > 200	Primary
Phase 2 stormwater[1]	NC	NC	6%	10% > 200	Primary
Last Chance Road	3.1×10^{11}	4.8×10^{11}	35%	GM > 100	Primary
Detour Road	5.5×10^{11}	8.1×10^{11}	33%	10% > 200	Primary
Phase 2 stormwater[1]	NC	NC	33%	10% > 200	Primary
McDonald Road	–	2.6×10^{11}	no reduction required		Primary
Lowden Road	–	2.6×10^{11}	no reduction required		Primary
Touchet-Gardena Road	2.1×10^{11}	5.4×10^{11}	60%	10% > 400	Secondary
Cummins Road	5.0×10^{11}	7.3×10^{11}	32%	10% > 400	Secondary
Phase 2 stormwater[1]	NC	NC	32%	10% > 400	Secondary
Highway 12	–	5.6×10^{11}	no reduction required		Secondary
Pierce's RV Park	–	5.2×10^{11}	no reduction required		Secondary
Tributaries:					
W. Little Walla Walla River	8.5×10^{9}	1.6×10^{10}	46%	GM > 100	Primary
Dry Creek	1.6×10^{10}	2.9×10^{10}	45%	10% > 200	Primary
Mud Creek	7.2×10^{9}	1.8×10^{10}	60%	GM > 100	Primary
Pine Creek	1.6×10^{10}	2.0×10^{10}	21%	10% > 200	Primary

[1] Actual stormwater FC loads were not calculated (NC), but focus areas for the Walla Walla County and the Washington State Department of Transportation to evaluate best management practices and reduce fecal coliform loads as a Phase 2 stormwater permit holder are shown.

Fecal coliform reductions are not needed in the Walla Walla River in reaches above McDonald Road (RM 29.3) to Lowden Road (27.4), the downstream limit of the *Primary Contact* criteria classification (Table 18 and Figure 23).

Several tributaries enter the Walla Walla River above Touchet-Gardena Road where the FC load allocation is based on FC criteria for *Secondary Contact Recreation* (Table 18). Dry Creek, Mud Creek, and Pine Creek have FC load allocations assigned assuming nonpoint sources are responsible and that *Primary Contact Recreation* is a designated use (Figure 23). The Weston WWTP in Oregon discharges to Pine Creek several miles upstream of the mouth, but its FC load is considered negligible. Therefore, a wasteload allocation was not assigned to this source.

After the Touchet River enters the Walla Walla River, the FC load capacity increases and the likelihood of *Secondary Contact* water quality criteria violations decrease. The load allocation at Cummins Road (RM 15.6) on the Walla Walla River is assigned to reduce nonpoint sources, especially those with FC loads during the high-streamflow period of May and June (Table 18 and Figure 23). Although the two downstream monitoring sites showed no need for additional FC reductions, a wasteload allocation is set at the Cummins Road reduction level for highway-generated runoff to meet *Secondary Contact* criteria.

Status of 303(d)-Listed Waterbodies

The Clean Water Act requires states, tribes, and other jurisdictions to evaluate water quality every two years. Waterbodies on the impaired list, called the 303(d) list, are of particular interest. As new data are evaluated, the categorization of waterbodies can change. For example, a stream placed in 1996 on the 303(d) list (categorized as not meeting FC criteria) may be removed from the 1998 303(d) list when data show that sustained improvements are demonstrated.

The 2004 statewide water quality assessment used all available data to place waterbodies in one of five categories (Ecology Water Quality Program Policy 1-11). Only Category 5 constitutes the 303(d) list of impaired waterbodies. However, Category 2 waters are those that are not known to be impaired, but are ‘Waters of Concern’. Category 2 waters have some water quality data, but not enough to determine if water quality is impaired or not. Tables 19 and 20 summarize the FC TMDL status of waterbodies in the Walla Walla basin on two 303(d) lists. Category 2 FC listings of the 2004 assessment are also shown in Table 21.

Table 19. Fecal coliform reductions required for waterbody segments listed on the 1996 or 1998 303(d) list.

Waterbody	Old WBID	New WBID	Fecal Coliform Reduction	1996 List	1998 List
Walla Walla River at Cummins Road	WA-32-1010	QE90PI	32%	Yes	Yes
Touchet River at Highway 12	WA-32-1020	LV94PX	78%	Yes	Yes
Mill Creek at Tausick Road (RM 10)	WA-32-1070	SS77BG	None	Yes	No

A majority of the data used for the 2004 FC listings were generated by the TMDL surveys in 2002-03. Those data are discussed in this TMDL evaluation report. Therefore, all of the Category 5 and Category 2 waters have been evaluated. Although the waters in Table 21 were listed as Waters of Concern using Policy 1-11 guidelines, the TMDL evaluation has shown them to be currently meeting water quality criteria for FC bacteria. As with all TMDLs, periodic monitoring of the watershed will demonstrate if water quality standards continue to be met.

Table 20. Fecal coliform reductions required for waterbody segments not listed in 1996 or 1998, but “Impaired” and in the 2004 statewide water quality assessment.

Waterbody	New WBID	Fecal Coliform Reduction	2004 Category*	Listing ID**
Walla Walla River at Highway 125	QE90PI	6%	2	41669
Walla Walla River at Last Chance Road	QE90PI	35%	5	41668
Walla Walla River at Detour Road	QE90PI	33%	5	41666
Walla Walla River at Touchet-Gardena Road	QE90PI	60%	5	41713
Touchet River at Hart Road	LV94PX	84%	5	41246
Touchet River at Highway 125	LV94PX	72%	5	41245
Touchet River at Pettyjohn Road	LV94PX	46%	2	41244
Touchet River at Lamar Road	LV94PX	16%	2	41243
Touchet River at Cummins Road	LV94PX	81%	5	41652
Patit Creek	MG48HJ	80%	2	41647
Coppei Creek	RT07DK	44%	2	41634
Mill Creek at Roosevelt Street	SS77BG	76%	5	41645
Mill Creek from Roosevelt to 9th Street	SS77BG	94%	5	41638, 41
Mill Creek at Swegle Road	SS77BG	62%	5	41710
Yellowhawk Creek at mouth	RK92TG	42%	5	41649
Russell Creek at mouth	GU90FL	68%	5	41671
Cottonwood Creek at mouth	HU10XJ	36%	2	41635
Garrison Cr. above College Place WWTP	DH35GB	81%	5	12381
Garrison Creek at mouth	DH35GB	81%	5	12382
Dry Creek at Highway 12	OT03FJ	45%	5	41636
Mud Creek at Borgen Road	AN63IZ	60%	5	41646
Pine Creek at Sand Pit Road	ZX47PC	21%	2	41648
West branch Little Walla Walla River	YA44BO	46%	2	41670

* Categories in the 2004 assessment are:
2 = water of concern, not known to be impaired
5 = 303(d) list impaired water
** Identification number of specific data used for the 2004 assessment

Table 21. Waterbody segments that do not require fecal coliform reductions although they are categorized in the 2004 statewide water quality assessment as “Waters of Concern” or “Impaired”.

Waterbody	New WBID	2004 Category*	Listing ID**
Walla Walla River at Lowden	QE90PI	2	16788
Walla Walla River at McDonald Road	QE90PI	2	16788
Walla Walla River at RV Park	QE90PI	2	41661
Touchet River at Ward Road	LV94PX	2	41659
Touchet River at Highway 124	LV94PX	5	16784
Touchet River above Hofer Diversion	LV94PX	2	41653
Mill Creek at Five-mile Bridge	SS77BG	2	41716

* Categories in the 2004 assessment are:
2 = water of concern, not known to be impaired
5 = 303(d) list impaired water
** Identification number of specific data used for the 2004 assessment

Margin of Safety

The federal Clean Water Act requires that Total Maximum Daily Loads (TMDLs) be established with margins of safety (MOS). The MOS account 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). But, 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 Walla Walla River basin fecal coliform (FC) TMDL evaluation. The FC database in most areas of the basin was limited, so this increased the level of uncertainty in the FC loads and receiving water quality. The FC reductions and allocations are conservatively set to protect human health and beneficial uses to the fullest extent. The following are conservative assumptions that contribute to the MOS.

- The statistical rollback method was applied to FC data from the most critical season, and 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 (i.e., 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 population greater than any of the sample results used to calculate the value. This is especially true at sites with fewer than 20 data.

- The FC loading capacities and TMDL target load reductions for the Touchet River at Cummins Road and the Walla Walla River at Cummins Road were conservatively calculated by including a historical data set with more frequent criteria violations.

- The cumulative tributary FC loads to the Walla Walla River will be reduced by 54% under the TMDL targets, even if instream die-off is not considered. The terminal compliance site on the Walla Walla River requires a FC reduction of 32%.

- The Phase 2 stormwater permit wasteload allocations were included to focus future permit-holders' activities even though the critical conditions for most FC problems in the basin are during low-streamflow conditions.

- Load allocations were set at several sites on the Touchet River and on Mill Creek 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 criteria, but the downstream sites add assurance that any other FC nonpoint (diffuse) sources will be identified and reduced.

- The wasteload allocation calculated for the College Place WWTP assumes all total coliform load allowed under the NPDES permit is FC, which is unlikely.

- Load reductions calculated for the lower reaches of Garrison Creek and Yellowhawk Creek were applied to the upper reaches as well. The reductions will ensure implementation and monitoring will be conducted in these urbanizing reaches to help meet the total FC reductions required in the creeks.

- If efforts to increase summer and fall instream flows succeed in the Walla Walla basin, the additional streamflow should provide more dilution during the critical conditions when FC criteria violations occur. The TMDL target FC reductions are based on future conditions without additional flows.

Recommendations for Monitoring

As a result of this Total Maximum Daily Load study, the following recommendations are made:

- Compliance with fecal coliform water quality criteria and reduction goals should be measured at the sites where data were used to generate those goals. Monitoring should focus on critical conditions (e.g., June – September), but sampling during all seasons is recommended.

- Intensive monitoring to identify fecal coliform sources and problem stream reaches is helpful, but data used in these investigations should not be blended with routine, long-term monitoring data to determine the overall progress of TMDL-related activities.

- Fecal coliform loading considerations should be included in the stormwater system evaluations required in the Phase 2 municipal stormwater permits given in the basin.

- Oregon and Washington jurisdictions need to continue to work cooperatively to monitor and alleviate cross-border sources of fecal coliform contamination in the mainstem Walla Walla River, Mud Creek, Pine Creek, and branches of the Little Walla Walla River.

- The College Place Wastewater Treatment Plant (WWTP) permit should include periodic fecal coliform effluent analysis along with the total coliform analyses.

- Dayton WWTP fecal coliform samples should be periodically split with another laboratory for confirmation. The alleged problem of incomplete disinfection by ultraviolet light (UV) treatment should be cooperatively investigated by the Department of Ecology, City of Dayton, City of College Place, and other permit holders with UV systems.

- To estimate fecal coliform loads, streamflow measurements should be taken when samples are collected. Continuous gaging at a few key sites in each watershed should be established to better determine seasonal and annual loads.

- Implementation of TMDL-based activities should be documented so that improvements in water quality can be linked to those activities.

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Appendices

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Appendix A. Point Source and TMDL Study Site Descriptions

Table A1. Current (pre-2005) National Pollutant Discharge Elimination System (NPDES) permit limits for wastewater treatment plants located in the Walla Walla River basin in Washington State.

Facility	Type of Treatment	Discharge Location	Season	Effluent Volume		NPDES Permit Limits						
				Maximum month avg. (mgd)	Maximum daily (mgd)	BOD mo/week (mg/L)	TSS mo/week (mg/L)	Fecal coli mo/week (cfu/100 mL)	pH daily range (s.u.)	Temp. daily max. (degrees C)	Ammonia mo./day (mg/L)	Chlorine mo./day (mg/L)
Walla Walla	Trickling filters w/ activated sludge & duo-media filtration	Mill Creek/ Irrigation	Dec-May Jun-Nov	9.6	12.3	15 / 22* 16 / 24	30/45 10/15	200 / 400 2.2 / 23	6 - 9 7 - 9	--	8 / 12**	0.009/ 0.012
College Place	Activated sludge (sequencing batch reactor)	Garrison Cr/ wetland or spray fields	Apr-Nov Dec-Mar	1.65	2	15 / 23	15/23	23 / 240*** - / 23***	6 - 9	20	1 / 2 2 / 3	--
Waitsburg	Oxidation ditch to infiltration lagoon	Hyporheic zone of Touchet R.	Dec-May Jun-Nov	--	0.236	15 / 20	15 / 20	100 / 200	7 - 9	--	7 - 14 5.8 - 11.6	--
Dayton	Trickling filter w/ nitrification & UV disinfection	Touchet R.	--	0.75	2.25	30 / 45	30 / 45	200 / 400	6.5 - 8.5	--	--	--
Touchet	Infiltration lagoon	Hyporheic zone of Touchet R.	--	--	--	--	--	--	--	--	--	--

* Biochemical oxygen demand (BOD) regulated for City of Walla Walla as carbonaceous biochemical oxygen demand (CBOD).

** Interim limit until December 2003 or if the ammonia TMDL for Mill Creek is modified before then. After December 2003, ammonia limits become 1.49 / 3.9 mg/L.

*** Total coliform, not fecal coliform. Limits are 7-day median and daily maximum counts.

Table A2. Identification numbers, locations, and general descriptions of sites monitored during the 2002-03 *Walla Walla River Basin Fecal Coliform Total Maximum Daily Load Study*.

Station ID	River or Tributary Mile	Station Description
32COL-GARR	NA	College Place WWTP at outfall to Garrison Creek
32COL-WWTP	NA	College Place WWTP at sump before lagoons
32COP-00.5	0.5	Coppei Creek at Hwy 124
32COT-01.0	1.0	Cottonwood Creek at Braden Rd.
32DAY-WWTP	NA	Dayton WWTP just before outfall to Touchet River
32DRY-00.5	0.5	Dry Creek at Hwy 12
32GAR-00.5	0.5	Garrison Creek at Mission St.
32MIL-00.5	0.5	Mill Creek at Swegle Rd.
32MIL-02.8	2.8	Mill Creek at Wallula Ave.
32MIL-04.8	4.8	Mill Creek at Gose St.
32MIL-06.7	6.7	Mill Creek at 9th St.
32MIL-06.9	6.9	Mill Creek at 6th St.
32MIL-07.0	7.0	Mill Creek at 5th St.
32MIL-07.1	7.1	Mill Creek at 4th St.
32MIL-07.2	7.2	Mill Creek at 3rd St.
32MIL-07.3	7.3	Mill Creek at 1st and Main
32MIL-07.4	7.4	Mill Creek at Colville St.
32MIL-08.5	8.5	Mill Creek at Roosevelt St.
32MIL-08.9	8.9	Mill Creek at Wilbur St.
32MIL-11.5	11.5	Mill Creek near Reservoir Rd.
32MIL-12.8	12.8	Mill Creek at Five Mile Rd.
32MIL-21.1	21.1	Mill Creek at Mill Ck. Rd. near Kooskooskie
32MIL-PIPE	NA	Pipe feeding into Mill Creek at 6th St.
32MUD-00.5	0.5	Mud Creek at Borgen Rd.
32NFT-00.0	0.0	North Fork Touchet R. at South Fork confluence
32NFT-08.9	8.9	North Fork Touchet R. abv. Jim Creek
32PAT-00.1	0.1	Patit Creek at Front St.
32PIN-01.4	1.4	Pine Creek at Sand Pit Rd.
32RUS-00.1	0.1	Russell Creek at McDonald Rd./Plaza Way
32SFT-00.0	0.0	South Fork Touchet R. at N. Fork confluence
32TOU-00.5	0.5	Touchet River at Hwy 12
32TOU-02.0	2.0	Touchet River at Cummins Rd.

Station ID	River or Tributary Mile	Station Description
32TOU-07.0	7.0	Touchet River at N. Touchet Rd.
32TOU-14.2	14.2	Touchet River at N. Touchet Rd.
32TOU-17.8	17.8	Touchet River at Luckenbill Rd.
32TOU-25.0	25.0	Touchet River off of Lamar Rd.
32TOU-30.6	30.6	Touchet River at Pettyjohn Rd.
32TOU-34.2	34.2	Touchet River at Hwy 125
32TOU-36.6	36.6	Touchet River at Hart Rd.
32TOU-40.5	40.5	Touchet River at Hwy 124
32TOU-44.2	44.2	Touchet River at Hwy 12 in Waitsburg
32TOU-46.2	46.2	Touchet River at Lower Hogeye Rd.
32TOU-48.4	48.4	Touchet River at Lewis and Clark State Park
32TOU-51.2	51.2	Touchet River at Ward Rd.
32TOU-53.9	53.9	Touchet River at Dayton City Park
32WAL-09.3	9.3	Walla Walla River at Pierce’s RV Park
32WAL-12.0	12.0	Walla Walla River at Hwy 12
32WAL-15.6	15.6	Walla Walla River at Cummins Bridge
32WAL-22.7	22.7	Walla Walla River at Touchet-Gardena Rd.
32WAL-27.4	27.4	Walla Walla River at Lowden Rd.
32WAL-29.3	29.3	Walla Walla River at McDonald Rd.
32WAL-32.8	32.8	Walla Walla River at Detour Rd.
32WAL-34.0	34.0	Walla Walla River at Swegle Rd.
32WAL-35.2	35.2	Walla Walla River at Last Chance Rd.
32WAL-38.7	38.7	Walla Walla River at Hwy 125
32WAL-WWTP	NA	Walla Walla WWTP at outfall to Mill Creek
32WLW-00.8	0.8	West branch Little Walla Walla River
32YEL-00.2	0.2	Yellowhawk Creek at Old Milton Highway
32YEL-03.5	3.5	Yellowhawk Creek at McDonald Rd./Plaza Way

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Appendix B. Equations for Statistical Analysis

Statistical Theory of Rollback

The statistical rollback method proposed by Ott (1995) describes a way to use a numeric distribution of a water quality parameter to estimate the distribution after abatement processes are applied to sources. The method relies on basic dispersion and dilution assumptions and their effect on the distribution of a chemical or a bacterial population at a monitoring site downstream from a source. It then provides a statistical estimate of the new population after a chosen reduction factor is applied to the existing pollutant source. In the case of the Total Maximum Daily Load (TMDL), compliance with the most restrictive of the dual fecal coliform (FC) criteria will determine the reduction factor needed.

As with many water quality parameters, FC counts collected over time at an individual site usually follow a lognormal distribution. That is, over the course of sampling for a year, or multiple years, most of the counts are low, but a few are much higher. When monthly FC data are plotted on a logarithmic-probability graph (the open diamonds in Figure C1), they appear to form nearly a straight line.

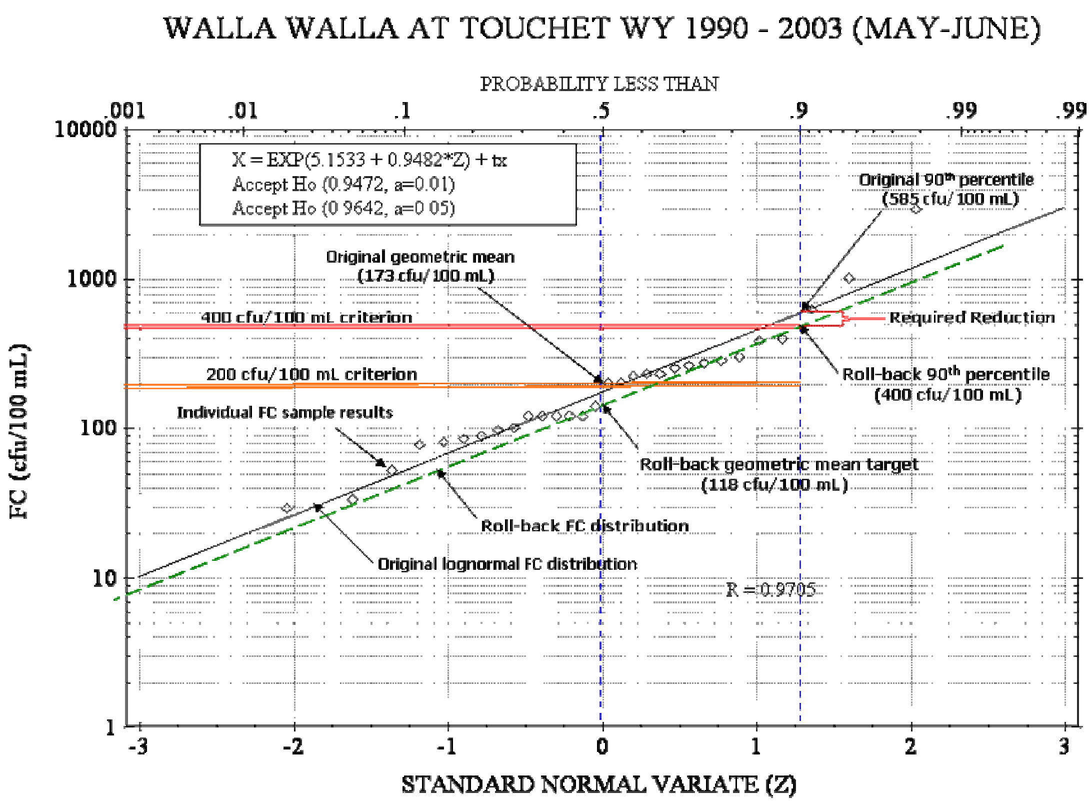

Figure B1. A graphical presentation of the Statistical Rollback Method.

The 50th percentile (an estimate of the geometric mean) and the 90th percentile (a representation of the level over which 10% of the samples lie) can be located along a line plotted from an equation estimating the original monthly FC data distribution.

In Figure C1, these numbers are 173 cfu/100 mL and 585 cfu/100 mL, respectively. Using the statistical rollback method, the 90th percentile value is then reduced to 400 cfu/100 mL (*Secondary Contact Recreation* 90th percentile criterion), since 173 cfu/100 mL meets the *Secondary Contact* geometric mean criterion. The new distribution is plotted parallel to the original. The estimate of the geometric mean for this new distribution, located at the 50th percentile, is 118 cfu/100 mL. The result is a geometric mean target of a sample distribution that would likely have less than 10% of its samples over 400 cfu/100 mL. A 32% FC reduction is required from combined sources to meet this target distribution from the simple calculation: (585 - 400) / 585 = 0.316 * 100 = 31.6% (rounded to 32%).

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

1. If Q = the concentration of a contaminant at a source, and D = the dilution-diffusion factor, and X = the concentration of the contaminant at the monitoring site, then X = Q*D.
2. Successive random dilution and diffusion of a contaminant Q in the environment often result in a lognormal distribution of the contaminant X at a distant monitoring site.
3. The coefficient of variation (CV) of Q is the same before and after applying a "rollback" (i.e., the CV in the post-control state will be the same as the CV in the pre-control state). The rollback factor = r, a reduction factor expressed as a decimal (a 70% reduction would be a rollback factor of 0.3). The random variable Q represents a pre-control source output state and rQ represents the post-control state.
4. If D remains consistent in the pre-control and post-control states (long-term hydrological and climatic conditions remain unchanged), then CV(Q)*CV(D)=CV(X), and CV(X) will be the same before and after the rollback is applied.
5. If X is multiplied by the rollback factor, then the variance in the post-control state will be multiplied by r^2, and the post-control standard deviation will be multiplied by r.
6. If X is multiplied by the rollback factor, the quantiles of the concentration distribution will be scaled geometrically.
7. If any random variable is multiplied by r, then its expected value and standard deviation also will be multiplied by r, and its CV will be unchanged. (Ott uses "expected value" for the mean.)

Statistical Formulae for Deriving Percentile Values

The 90th percentile value for a population can be derived in several ways. The set of FC counts collected at a site were subjected to a statistically-based formula (Zar, 1984). The estimated 90th percentile is calculated by:

(a) Calculating the arithmetic mean and standard deviation of the sample result logarithms (base 10);
(b) Multiplying the standard deviation in (a) by 1.28;
(c) Adding the product from (b) to the arithmetic mean;
(d) Taking the antilog (base 10) of the results in (c) to get the estimated 90th percentile; and

The 90th percentile derived using this formula assumes a log-normal distribution of the FC data. The variability in the data is expressed by the standard deviation, and with some datasets it is possible to calculate a 90th percentile greater than any of the measured data.

Beales Ratio Equation

Beales ratio estimator from *Principles of Surface Water Quality Modeling and Control* by Thomann and Mueller (1987) provides a mass loading rate estimate of a pollutant. The formula for the unbiased stratified ratio estimator is used when continuous flow data are available for sites with less frequent pollutant sample data. The average load is then:

$$\overline{W}_p = \overline{Q}_p \cdot \frac{\overline{W}_c}{\overline{Q}_c} \cdot \left[\frac{1 + \left(1/n \right) \cdot \left(S_{QW} / \left(\overline{Q}_c \overline{W}_c \right) \right)}{1 + \left(1/n \right) \cdot \left(S_Q^2 / \overline{Q}_c^2 \right)} \right]$$

where,

$\overline{W}_p$ is the estimated average load for the period,
p is the period,
$\overline{Q}_p$ is the mean flow for the period,
$\overline{W}_c$ is the mean daily loading for the days on which pollutant samples were collected,
$\overline{Q}_c$ is the mean daily flow for days when samples were collected,
n is the number of days when pollutant samples were collected.

Also,

S_{QW} = [1 / (n-1)]* $\left[\left(\sum_{i=1}^{n} Q_{ci} * W_{ci} \right) - n * \overline{W_c} \, \overline{Q_c} \right]$

and

S^2_Q = [1/ (n-1)]* $\left[\left(\sum_{i=1}^{n} Q_{ci}^2 \right) - n * \overline{Q_c^2} \right]$

where,

Q_{ci} are the individually measured flows, and
W_{ci} is the daily loading for the day the pollutant samples were collected.

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Appendix C. Historical Data Evaluations

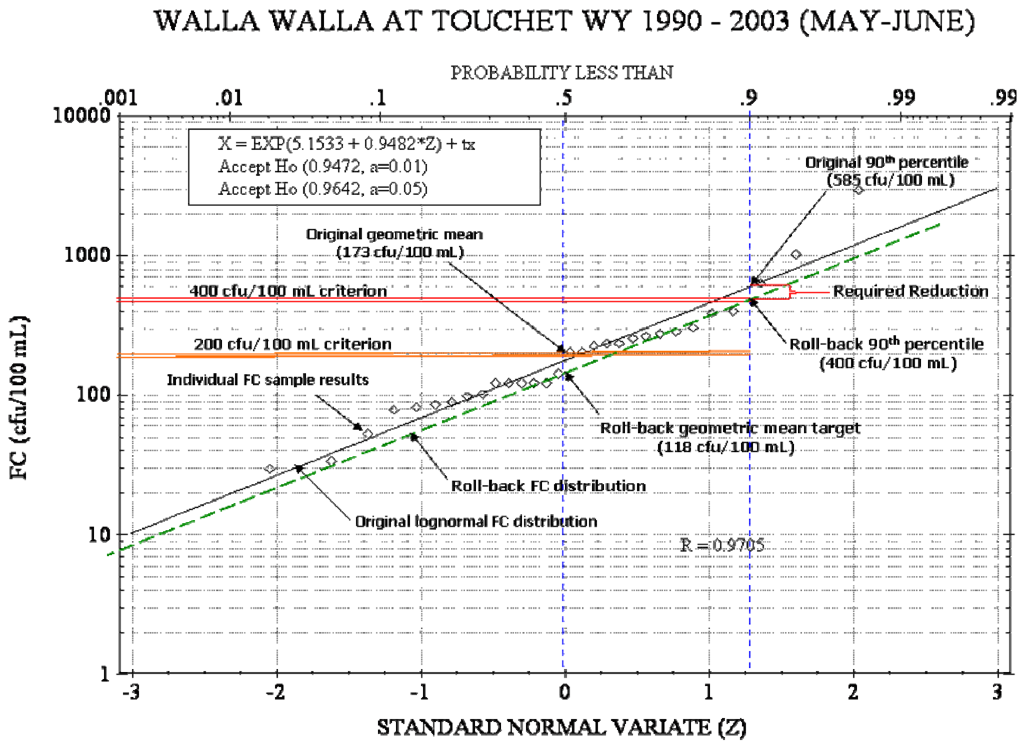

Figure C1. Probability plot and roll-back estimates for fecal coliform data collected from the Walla Walla River near Touchet in May and June, 1990 – 2003.

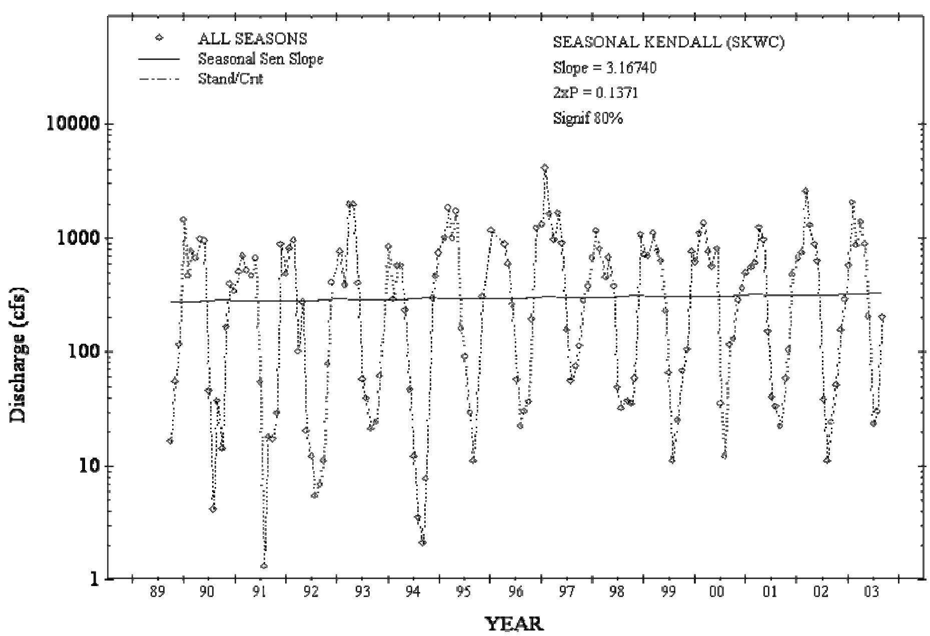

Figure C2. Streamflow trend for the Walla Walla River near Touchet (Ecology station 32A070), water years 1990 to 2003.

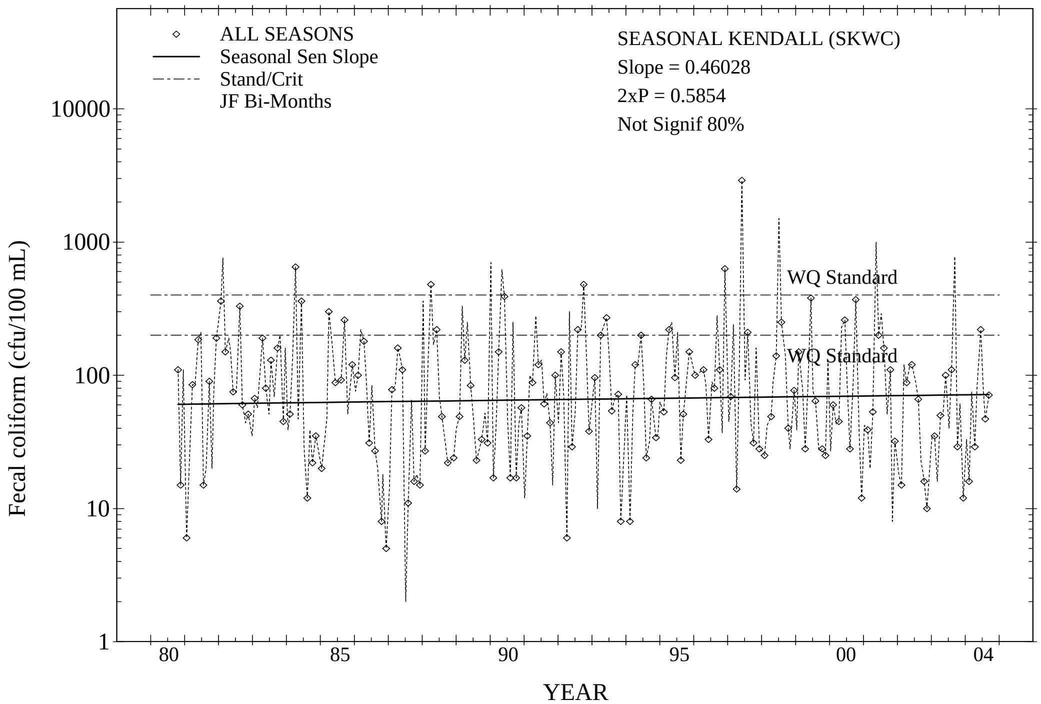

Figure C3. Trend analysis for bimonthly fecal coliform sampling (e.g., May and June are averaged) at the Walla Walla River near Touchet (station 32A070), 1980 to 2004.

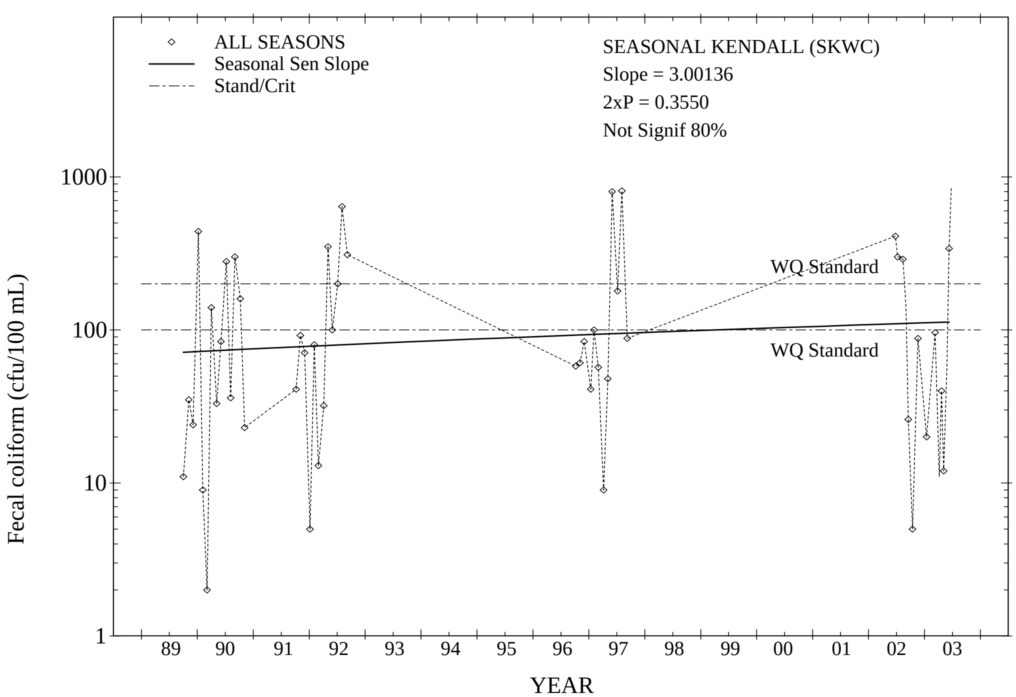

Figure C4. Trend analysis for fecal coliform data collected from the Touchet River at Touchet (Ecology station 32B070), 1989 to 2003.