Quality Assurance Project Plan

Willapa River Fecal Coliform Bacteria Verification Study

by
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Abstract

The Washington State Department of Ecology (Ecology) is required under Section 303(d) of the federal Clean Water Act and the U.S. Environmental Protection Agency (EPA) regulations to (1) develop and implement Total Maximum Daily Loads (TMDLs) for impaired waters, and (2) evaluate the effectiveness of the water clean-up plan in achieving the needed improvement in water quality.

The Willapa River and several tributaries are on the 1998 303(d) list of impaired waterbodies due to violations of one or more water quality criteria. The mainstem and several tributaries have parameters that exceed (do not meet) the water quality criteria for fecal coliform bacteria, dissolved oxygen, and temperature. The EPA requires states to develop and implement clean-up programs through the development of TMDLs for listed parameters and to periodically monitor progress toward compliance with TMDL targets. The TMDL is a tool for achieving improvement in water quality conditions with the ultimate goal of eventually meeting standards under the Clean Water Act for streams and lakes.

In 1997, Ecology's Southwest Region Water Quality Section conducted a Watershed Needs Assessment that included the Willapa River watershed. The basin was identified as a high priority for a TMDL technical study. The focus of this study is fecal coliform bacteria, with other parameters to be addressed at a later date.

This is a plan to collect monitoring data for verification of results from studies conducted since 1997 by the state Department of Health Shellfish Protection Program, Pacific County, and Ecology. Fecal coliform concentrations during a 1997-98 study by Ecology found that only five of 30 sites sampled met water quality standards for fecal coliform bacteria. 2004 data show that conditions have improved significantly in many parts of the basin, especially in the lower stretch of the river. Results from this study will verify where the river meets standards and focus local efforts on areas where bacteria problems continue to exist.

This Quality Assurance Project Plan describes the technical study that will further evaluate fecal coliform concentrations in the mainstem Willapa River and selected tributaries. The project objectives are to (1) clarify pollution sources and compare current conditions to Washington State water quality criteria for fecal coliform bacteria, (2) compare current and previous monitoring data, and (3) provide data for decisions on local TMDL implementation planning/responses. The study will be conducted by Ecology's Environmental Assessment Program.

Background

The Willapa River drains a basin of about 260 square miles before discharging into northeastern Willapa Bay, Washington (Figure 1). Rate of flow in the Willapa River has been recorded since 1947 (continuously since 1961) at USGS station 12013500 (Willapa River near Willapa, WA), which has a contributing area of about 130 square miles. Mean monthly flow is highest in December (1,509 cfs) and lowest in August (48.7 cfs). The mean annual flow at the USGS station is 636 cfs.

Major sub-basins include numerous sloughs and creeks that are tributary to the Willapa River. The largest of these are the South Fork Willapa River, and Wilson, Mill, Trap, Fork, and Fern creeks. The upper Willapa River is mostly freshwater while the lower river is a tidal estuary characterized by a mixture of Willapa Bay marine waters and freshwater from the river and other tributaries. Tidal effects on river height can be observed near Camp One Road at River Mile (RM) 14.5 which supports the idea that saline marine water probably moves 10 miles or more up the river (Pickett, 1998).

The primary land use activities in the Willapa River watershed are forest (80%), agriculture (8%), and other (12%) that comprise non-forest, developed land, open water, or wetlands. The upper, steeper part of the watershed is dominated by commercial forest that is managed by a mixture of private owners, state, and federal agencies. With the decreasing slope, a relatively wide valley floor develops and the primary land cover changes to agriculture with dairy farms dominating the land use (Gove et al., 2001). There are about four large dairy operations in the basin and numerous other livestock operations for beef and young stock.

The population of Pacific County is 20,984 according to the 2000 U.S. Census. With the exception of the cities of Raymond and South Bend on the lower river, the Willapa River basin is largely rural. Timber and seafood (mostly oysters) are the principal industries in the cities, while agricultural land uses dominate the rest of the river valley with silviculture as the main practice. There are several small towns along the upper river (Pickett, 1998).

In 1997, the Southwest Regional Office (SWRO) Water Quality Section of the Department of Ecology (Ecology) conducted a Watershed Needs Assessment that included the Willapa River watershed. The Willapa River was identified as high priority for a Total Maximum Daily Load (TMDL) technical study for fecal coliform (FC) bacteria and dissolved oxygen problems. The river is currently listed under section 303(d) of the federal Clean Water Act as not meeting water quality standards for FC bacteria and dissolved oxygen, because of inadequate controls of point or nonpoint sources. Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) regulations require states to develop and implement TMDLs for impaired waters, and to evaluate the effectiveness of the water clean-up plan in achieving the needed improvement in water quality.

FC bacteria are the principal indicators of water suitability for domestic use, shellfish culture, and other uses. FC bacteria density can be used as a measure of pollution and sanitary quality and have been used for creating bacterial water quality criteria.

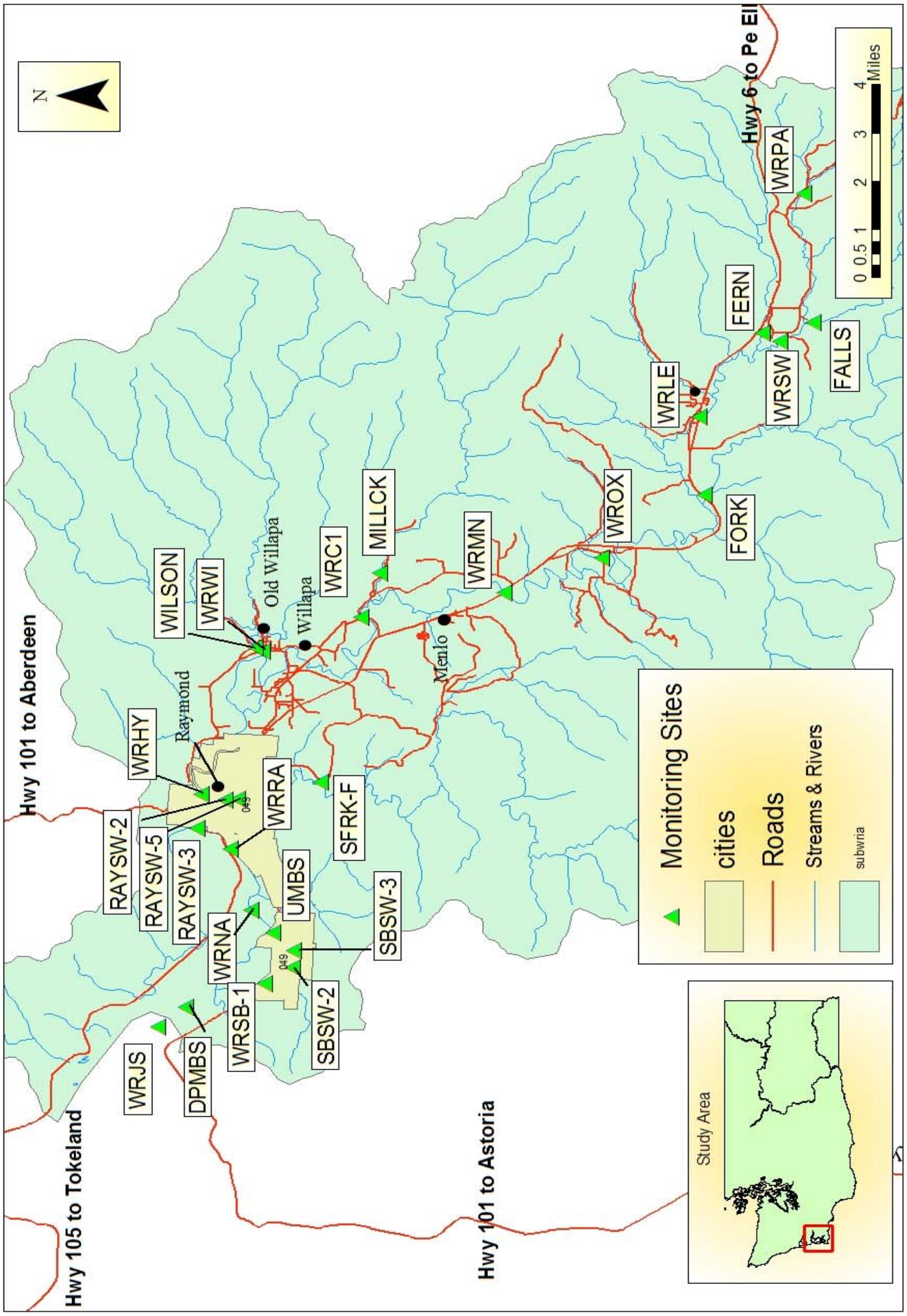

Figure 1. Willapa River Fecal Coliform Study Sites.

Pollution Sources

Potential sources of bacteria in the Willapa River basin include both point and nonpoint sources. There are five permitted NPDES dischargers – two wastewater treatment plants (WWTPs) and three seafood processing plants – that release treated effluents to the Lower Willapa River in the study area. These facilities have the potential to affect FC bacteria. Table 1 lists the facilities under permit from Ecology that have permit limitations for bacteria.

Table 1. Permitted Point Sources of Bacteria

Facility Name	NPDES ID	Permit Flow (mgd)	Permit FC Bacteria (cfu/100ml)	Max. FC Reported 1998-2002 (cfu/100ml)
City of Raymond WWTP	WA000023329	1.500	200	502
City of South Bend WWTP	WA0037591	0.375	200	532
South Bend Packers	WA0040941	0.010	*	1,600
East Point Seafood	WA0001104	0.320	*	2,200
Coast Seafood	WA0002186	0.099	*	44,000

* = Presently no permit limit; only monitoring required. Limits will be set in 2006

Nonpoint sources of bacteria in the basin include:

- On-site septic systems
- Urban stormwater run-off
- Boats and marina areas
- Livestock
- Wildlife

Sanitary surveys in the early 1990s found a high rate of failure (about one-third) for onsite septic systems in the Willapa River basin. Many of these problems have been corrected, yet unsewered residential areas are still possible sources of bacteria, especially under saturated soil conditions (Pickett, 1998). Seyferlich and Joy (1993) researched and described these sources in detail.

Urban stormwater runoff can carry a variety of pollutants from urban areas including bacteria from pet wastes, surface wastewater from failing septic tank systems, excess nutrients from lawns and gardens, metals, oil and grease, and other pollutants associated with activities such as car washing and sidewalk cleaning. Urban areas like Raymond and South Bend have been identified as possible bacteria sources. Apart from urban stormwater runoff, concentrated moorage facilities such as South Bend Boat Haven and the Port of Willapa docks may be sources of bacteria.

There are about four commercial dairies and numerous small livestock operations in the Willapa River basin. Data collected by the Pacific Conservation District in 1990 estimated a total of about 5800 head of cattle in the basin, with only about one-third accounted for by the dairies. With recent trends in the dairy industry, it is likely that the number of head at the dairies have increased. Pacific Conservation District has been active in the basin helping farms to develop and implement farm waste management plans (Pickett, 1998).

According to an upper watershed study done for Pacific County by Herrera Environmental (2005), wildlife is another source of FC bacteria loading in this watershed. The precise levels of FC loading from wildlife and other human or livestock sources are uncertain, but all sources were confirmed.

Historical Information

This evaluation includes earlier work by Ecology's Environmental Assessment (EA) Program. The EA Program has collected ambient monitoring data from three freshwater stations and two marine water stations (Table 2). The EA Program has operated long-term freshwater monitoring stations since 1970. The current program conducts monthly monitoring of 12 water-quality constituents and flow at 62 stations across the state, including one on the Willapa River at Camp One. This station measures impacts from the upper Willapa River system. Normally, these long-term monitoring stations are generally located near the mouths of major rivers and below major cities. These stations are assumed to represent the cumulative effect of human disturbances within the watershed. Twenty "basin" stations are monitored for one year at a time statewide, including two Willapa River basin former stations (Table 2).

Table 2. Ecology Ambient Monitoring Stations.

station code	station name *link to monitoring results*	type	class	last yr sampled	sampling history: 1960 1970 1980 1990 2000
24B090	Willapa R nr Willapa RM 17.5 (Camp One)	long-term	A	2005	XX XXXXXX XXXXXX XXXXXXXXX XXXXXXXXXX
24B130	Willapa R @ Lebam RM 33.2	basin	A	1992	XXX X XXXXXXXXXXXXXXX
24C070	SF Willapa R @ South Bend RM 7.1	basin	A	1973	XX
WPA003	Willapa R @ Johnson Slough RM 0.5	long-term	A	2005	XXX XX XXXXXXXXXXXXXXXXXXXXXXXX
WPA001	Willapa R @ Raymond RM 6.4	long-term	A	2005	XXX XX XXXXXXXXXXXXXXXXXXXXXXXX

Ecology currently conducts monthly sampling at two stations near the river mouth and at two additional stations on the mainstem upper river. FC bacteria data analysis from these stations shows the highest FC levels are generally found from March through November, and the lowest levels in February. This pollution pattern shows concentrations that are relatively continuous throughout the year. The resulting higher levels during the dry months relate to low instream dilutions during this period. Comparison of FC data from the freshwater stations to antecedent precipitation show no significant relationship (Pickett, 1998). This is evidence that bacteria sources are better characterized as continuous sources rather than related to rainfall runoff. A major review of bacteria issues and findings in the Willapa Bay watershed are reported in Seyferlich and Joy (1993). In addition, a more current review can be found in the Willapa River TMDL Study Data Summary Report (Pickett, 2000).

Water Quality Standards

The water quality standards for Washington State are found in WAC 173-201A. The freshwater Class A standards apply to the upper Willapa River where salinity is below 10 parts per thousand (ppt):

> *"Fecal coliform organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 mL."*

The Willapa River and its tributaries in the study area are compared to Class A freshwater standards, with the exception of the downstream 1.8 miles that are compared to Class A marine water standards.

The marine Class A water quality standards apply to the lower 1.8 miles of the Willapa River as specified in WAC 173-201A-140 Specific classifications-Marine water. (26) Willapa Bay seaward of a line bearing 70 degrees true through Mailboat Slough light (Willapa River, river mile 1.8):

> *"Fecal coliform organism levels shall both not exceed a geometric mean value of 14 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 43 colonies/100 mL."*

Waterbodies that do not meet these applicable water quality standards despite the presence of technology-based pollutant controls are listed as impaired under Section 303(d) of the Clean Water Act. Several segments of the Willapa River watershed were listed in 1998 for exceeding the FC bacteria water quality standard. The listing requires development of a TMDL intended to provide guidance for the protection of beneficial uses within the basin. The TMDL may be apportioned between point sources (wasteload allocations or WLAs) and nonpoint or background sources (load allocations or LAs) of pollution. The allocations (WLAs and LAs) may be implemented through NPDES permits, state waste discharge permits, grant projects, watershed action plans, and other nonpoint source control activities. Local activities and efforts for bacteria pollution control are evident as water quality continues to improve in the Willapa basin.

Project Description

As stated earlier, the Willapa River and several tributaries are on the 1998 303(d) list of impaired waterbodies due to FC bacteria violations. This water quality violation results in the waterbody not meeting and maintaining the designated beneficial uses. This Quality Assurance Project Plan describes a FC bacteria verification study in the Willapa River basin.

Project Objectives

The project goals are to gather support for the FC bacteria TMDL implementation actions; to support the systematic review and improvement of water quality; and to determine compliance with water quality standards or TMDL targets.

Objectives of the proposed study are as follows:

1. Clarify location of pollution sources and compare current conditions to state water quality criteria for fecal coliform bacteria.
2. Compare current and previous monitoring data.
3. Provide data for decisions on local TMDL implementation planning/responses.

The results of this TMDL evaluation study will help Ecology and basin stakeholders focus efforts on priority pollution sources within the study area. The project desired outcomes are:

- Collection of credible FC data that promotes confidence in the TMDL process.
- Public awareness on the level of pollutant reductions required and why.
- Mobilization of resources to control nonpoint pollution.

The data collected to date suggest that the FC water quality problem is not limited to a single season or source, but concentrations in the river may be flow-related. FC bacteria information will be collected monthly from all sites for a 12-month period (see Table 7). Monitoring data are essential for better description of the spatial and temporal extent of water quality problems as well as for describing current conditions. Final results of this study will be reported in a technical memo including a table displaying geometric mean values (GMV) and 90th percentile values for each station.

Statistical values such as geometric means and 90th percentiles will be generated for FC bacteria concentrations on an annual and seasonal basis, depending on the availability of data. Only data from sites within the study area that meet all quality control requirements will be used in this evaluation.

There are many reasons for missing samples in a monitoring program, and they include: inclement weather or flooding, hazardous driving or monitoring conditions, and illness or unavailability of other monitoring staff. Routinely missed samples could impart bias in expressions generated from final data. Sampling events will be rescheduled when missed in order to maintain integrity of the characterization effort. Field monitoring data loss due to equipment failure may occur, and backup equipment will be available in order to minimize this problem. Apart from weather, unforeseen occurrences are random relative to water quality conditions and will not affect long-term data analyses, except for effects from potential reduction in sample size.

Project Organization and Schedule

The roles and responsibilities of staff involved in this project are provided in Table 3.

Table 3. Project Staff and Responsibilities

Name/Address	Title	Responsibilities
George Onwumere Environmental Assessment Program Freshwater Monitoring Unit (360) 407-6730	Project Manager/ Principal Investigator	Responsible for overall project supervision and for a draft of the Quality Assurance Project Plan (QAPP), project design, collecting and analyzing data, developing graphs and figures, and writing and editing a draft and final technical memo.
David Rountry Southwest Regional Office Water Quality Section (360) 407-6276	Co-Project Manager	Responsible for QAPP review of both draft and final copy, consultation with stakeholders including meetings, overall project monitoring and consultation, and reviewing draft and final technical memo.
Robert W. Plotnikoff Environmental Assessment Program Freshwater Monitoring Unit (360) 407-6687	Freshwater Monitoring Unit Supervisor	Responsible for internal review of the project QAPP and draft technical memo as well as approving the QAPP and project budget.
Bob Cusimano Environmental Assessment Program Environ. Monit. & Trends Section (360) 407-6596	Section Manager	Responsible for approving the project QAPP and technical memo.
Stuart Magoon Manchester Environmental Lab. (360) 871-8801	Director, Manchester Environmental Laboratory	Responsible for approving the project QAPP.
Will White/Karin Feddersen Manchester Environmental Lab. (360) 871-8860	Manchester Environmental Laboratory Staff	Responsible for sample delivery and analysis/reporting of chemical data.
Cliff Kirchmer Environmental Assessment Program (360) 407-6455	Quality Assurance Coordinator, EA Program	Responsible for providing technical assistance in the implementation of QA requirements, and reviewing and approving the project QAPP.
William R. Kammin Environmental Assessment Program (360) 895-6177	Quality Assurance Officer, Ecology	Responsible for reviewing and approving the project QAPP.
Kim Mckee Southwest Regional Office Water Quality Section (360) 407-6407	Unit Supervisor	Responsible for internal review of the project QAPP and draft technical memo as well as approving the final QAPP.

Table 3. Project Staff and Responsibilities (Cont'd)

Name/Address	Title	Responsibilities
Kelly Susewind Southwest Regional Office Water Quality (360) 407-6271	Section Manager	Responsible for internal review of the project QAPP and approval of the final QAPP.
Mike Johnson Pacific County Conservation District (360) 875-9424	Manager	Responsible for involving the CD, local cooperators and Willapa Bay Water Resources Coordinating Council to review the draft QAPP, provide consultation and receive the final technical memo.
Rebecca Chafee North Pacific County Infrastructure Action Team (NPCIAT) (360) 942-3422	Coordinator	Responsible for involving local cooperators and North Pacific County Infrastructure Action Team (NPCIAT) to review the draft QAPP, provide consultation and receive the final technical memo.
Mr. Ulrich Board of Directors, Swiss Society (360) 748-0026	Chairman	Responsible for reviewing the draft QAPP, providing consultation and receiving the final technical memo.
Mike Desimone County Health Department (360) 642-9382	Contact	Responsible for reviewing the draft QAPP, providing consultation and receiving the final technical memo.

Table 4 shows the proposed schedule for the FC TMDL verification project.

Table 4. Proposed Schedule

Reconnaissance survey Run	November 2005
Verification sampling	January to December 2006
Data compilation, verification, and validation	January 2007
Data review and analysis	February 2007
Draft Technical memo	March 2007
EIM[1] entry complete	March 2007
Final report	June 2007

[1] Ecology's Environmental Information Management data base

Cost Estimate

The budget for the cost of monitoring is outlined in Table 5. The total cost of the project is $11,000 with Environmental Assessment Program funding the whole project.

Table 5. Budget Summary

	Laboratory Method	
Waterbody Segment	FCMF	MPN
20 Sites FCMF, 1 dual FCMF/MPN	20	1
4 Downstream FCMF Rainy season sampling for 5 months	4	--
Cost per analysis	$21.00	$39.00
Cost including QA samples	$25.20	$46.80
Analysis Cost per run	$504.00	$46.80
Cost for annual sampling events	$6,678.00	$561.60
Total Laboratory Analysis Cost	$7,400.00 per year	
Lodging & per diem ($150.00 x 12x2)	$3,600.00 per year	
Total Project Cost	$11,000.00	

1) FCMF – Fecal Coliform Membrane Filter.
2) MPN - Most Probable Number.

Quality Objectives

Quality objectives are statements of the precision, bias, and lower reporting limits necessary in order to generate data that address project objectives. The primary determinants for data quality are precision and bias; when combined they express data accuracy by the following relationship:

Accuracy = Bias + Precision
Precision = (±1Standard Deviation) = Relative Standard Deviation = RSD
Accuracy = Bias + 2·RSD

Precision, expressed as one standard deviation and derived from replicate sample analyses, is a measure of data consistency while subject to random error. Bias is a measure of the difference due to systematic errors between the result for a parameter and the true value. Potential sources of systematic errors include sample collection, physical and chemical instability of samples, interference effects, instrument calibration, and contamination. Random error affects bias; thus bias estimates can be difficult to determine. Consequently, dedication to established protocols is one method used to reduce concern over sources of bias (Lombard and Kirchmer, 2004). Environmental Assessment Program field staff will take every precaution to minimize bias by following the protocols outlined in this report (Ward, 2001) for measurement, collection, and storage of environmental samples.

Bacteria and nutrient samples periodically suffer from contamination problems. Table 6 gives the Measurement Quality Objectives (MQOs) for this project.

Measurement quality objectives will vary for parameters based on their measurability in the natural environment. Parameters with inherently large field and laboratory variability such as fecal coliform will be described by increased numbers of duplicate samples. This will improve precision estimation and confidence in decision-making. These issues are the subject of further discussion in Sampling Design, Field Procedures, Laboratory Procedures, and Quality Control Sections.

Table 6. Field and Laboratory Measurement Quality Objectives

Analysis	**Accuracy** (% deviation from true value)	**Precision** (Relative Standard Deviation)	**Bias** (% deviation from true value)	**Lower Reporting Limits or Range**
Field Measurements				
Temperature *	±0.2 °C	N/A	N/A	1 to 40 °C
Conductivity	25	10	5	0.1 umhos/cm
Laboratory Analyses				
Fecal Coliform (MF)	N/A	28.3 **	N/A	1 cfu/100 mL
Fecal Coliform (MPN)	N/A	28.3 **	N/A	1.8 MPN/100ml

RSD = Relative standard deviation
RPD = Relative percent difference
* As units of measurement, not percentages
** Based on Manchester Environmental Laboratory RPD < 40% for fecal coliform and *E. coli* analysis.

Sampling Process Design

General Approach

The monitoring sites for this evaluation are on the mainstem Willapa River and tributaries (Table 7). Most of these sites were chosen for one of the following: Willapa River TMDL Quality Assurance Project Plan in 1998; Lower and Upper Willapa River FC bacteria evaluations in 2004; or 303(d) listing information.

The intent of this study is to collect FC bacteria data over a long time-span to meet objectives of this project. Beyond collecting high quality environmental samples, it is necessary that data be representative of actual conditions and that they are comparable to historical efforts. In cases where historical data quality differs for comparison, it is still important for the current round of sampling to maintain high quality effort for future comparisons. Representativeness and comparability include elements like seasonality and overall time-span of the study (Onwumere and Batts, 2004). A one-year time-span is considered to represent variation among seasons.

Table 7. Willapa River Sampling Locations, Parameters, and Frequency.

River Mile	Sampling Station	Site Code	Parameter and Frequency		
			FC Bacteria	Temperature	Conductivity
41.2	Willapa R below Patton Creek	WRPA	M	M	M
37.7	Falls Ck above Retreat Center	FALLS	M	M	M
37.1	Willapa R at Swiss Picknik Rd	WRSW	M	M	M
36.2	Fern Creek at Elk Prairie Rd	FERN	M	M	M
33.2	Willapa R at Lebam	WRLE	M	M	M
30.5	Fork Creek at State Hatchery	FORK	M	M	M
25.2	Willapa R at Oxbow Road	WROX	M	M	M
21.4	Willapa R at SR 6 near Menlo	WRMN	M	M	M
17.9	Mill Creek at 1st Mill Ck Rd Br	MILLCK	M	M	M
17.5	Willapa R at Camp One Rd	WRC1	M	M	M
13.7	Willapa R at Willapa Road	WRWI	M	M	M
12.0	Wilson Creek near Willapa	Wilson	M	M	M
7.7	Willapa R at Hwy 101 Br	WRHY	M	M	M
7.2	**Riverdale Creek at Lions Club Park**	**RAYSW-3**	M during rainy season	M during rainy season	M during rainy season
7.1	So Fk Willapa R at Golf Course Rd	SFRK-F	M	M	M
6.4*	Willapa R at Raymond (near Port)	WRRA	M	M	M
5.9	**Raymond SW at Delaware St.**	**RAYSW-2**	M during rainy season	M during rainy season	M during rainy season
5.0*	Willapa R at the Narrows	WRNA	M	M	M
4.5*	Willapa R at South Bend - 2 (inlet to Upper Mailboat Slough)	WRSB-2	M	M	M
3.0*	Willapa R at South Bend - 1 (1 Mile Upstream Potter Slough)	WRSB-1	M	M	M
1.5*	Willapa R at South Bend - 3 (Downstream Potter/Mailboat Sloughs)	WRSB-3	M	M	M
3.75	**S Bend SW Pipe at SB Packers**	**SBSW-3**	M during rainy season	M during rainy season	M during rainy season
3.1	**Creek at Coast Seafoods**	**SBSW-2**	M during rainy season	M during rainy season	M during rainy season
0.40*	Willapa R at Johnson Slough	WRJS	M	M	M

M = Monthly
* = Requires a boat
Highlighted Sites = Stormwater drain locations (5 months sampling during rainy season)

Monitoring will continue year-round so that data will represent all seasonal conditions. Seasonal sampling will isolate critical conditions for water quality impairments.

Water quality will be monitored 12 times (monthly) during the year (January – December 2006). The parameters measured in the field are temperature and conductivity. Water samples will also be collected for laboratory analyses of FC bacteria.

Sampling and field measurement procedures used during this study will follow the stream sampling protocols report (Ward, 2001). All surface water samples will be collected directly into pre-cleaned bottles supplied by MEL and described by MEL (2005).

Measurement Procedures

Field Procedures

Safety

Safety procedures are described in Environmental Assessment Program's Safety Manual (2002). Field operations will be discontinued any time personnel determine that driving conditions, site access, or sampling conditions are unsafe for that site and parameter.

Sampling

Field sampling and measurement protocols will follow those described in these stream sampling protocols (Cusimano, 1993; Ward, 2001). Bacteria grab samples will be collected directly into pre-cleaned containers supplied by the laboratory and described in MEL (2005). Samples will be collected from the stream center of flow thalweg whenever possible. Samples will be labeled, transferred to a cooler, placed in crushed or cube ice, and kept at between 0°C and 4°C. All samples will be delivered to Manchester Laboratory no later than 24 hours after collection.

Laboratory Procedures

Laboratory analyses of FC bacteria will be performed in accordance with MEL protocols (MEL, 2005). According to the MEL manual (2005), the reporting limits for laboratory data in Table 6 can be achieved by using analytical methods listed in Table 8. The MEL laboratory staff will consult the project manager if there are any changes in procedures over the course of the project, or if other matrix difficulties arise.

Also, analytical method MPN 9221 E2 (*Standard Methods 20th edition*) will be used for one of the Lower Willapa River sampling sites with the following assumptions/requirements:

1. Holding temperature is to be between zero and four degrees C (per MEL),
2. Holding time is not to exceed 24 hours (per MEL), and
3. The FDA MPN chart will be used, not the Standard Methods chart.

Monitoring crews will continually communicate with the laboratory to ensure microbiological media and other laboratory resources are available. The project team will follow normal procedures for sample notification and scheduling. With adequate communication, sample quantities and processing procedures should not overwhelm the MEL capacity. When laboratory-sample load capacities are heavy, rescheduling of individual surveys may be possible.

Table 8. Summary of Sampling and Analysis Procedures for Field and Laboratory Parameters.

Analysis	Method or Equipment	Estimated Range	Detection Limit	Holding Time	Preservation	Container
Temperature	Alcohol thermometer	-10 – 40 deg C	N/A	N/A	N/A	N/A
Conductivity	Orion Model 125	1 uS/cm – 199 ms/cm in four ranges	1 uS/cm	N/A	N/A	N/A
Fecal Coliform (MF)	/MF9222D	<1 - > 5000 cfu/100 mL	1 cfu/100mL	24 Hours	Cool to 4 °C	500 mL glass or poly autoclaved
Fecal Coliform (MPN)	/MPN9221 E2	<1 - > 5000 cfu/100 mL	1 cfu/100mL	24 Hours	Cool to 4 °C	500 mL glass or poly autoclaved

Quality Control Procedures

Quality control (QC) procedures used during field sampling and laboratory analysis will provide estimates for determining accuracy of the monitoring data. All samples will be analyzed at the MEL following standard QC procedures (MEL, 2005). The laboratory's data quality objectives and QC procedures are documented in the MEL Lab Users and Quality Assurance Manuals (MEL, 2005; MEL, 2001). The results of the laboratory QC sample analyses should be used in determining compliance with measurement quality objectives (Table 6). Variation will be described for field and laboratory results by examining replicate samples and comparing to measurement quality objectives. Laboratory QC data for fecal coliform duplicates will be compared to the MQOs for precision.

Replicate samples will be collected at frequencies indicated in Table 9. Bacteria samples tend to have high field variability compared to other water quality analyses. Consequently, bacteria samples will be collected at the rate indicated in Table 9. The number of field duplicates collected at a station is increased so that a better overall estimate of variability is generated.

Acceptable precision for all parameters is listed in Table 6.

Field meters used in measuring water temperature and conductivity will be checked and calibrated against known standards at the start of each sampling day and will follow Ambient Monitoring Procedures described in these stream sampling protocols (Cusimano, 1993; Ward, 2001). Meter calibration will be performed in accordance with the manufacturer directions. Field duplicate samples will be split at the laboratory to assess the variability in laboratory sample analyses.

Table 9. Summary of Field and Laboratory Quality Control Procedures

Analysis	Field Blanks	Field Replicates	Lab Check Standard	Lab Method Blank	Lab Replicates	Matrix Spikes
Field Measurements						
Temperature	N/A	1/10 samples	N/A	N/A	N/A	N/A
Conductivity	N/A	1/10 samples	N/A	N/A	N/A	N/A
Laboratory Analysis						
Fecal Coliform (MF)	N/A	1/5 samples	N/A	1/run	1/5 samples	N/A
Fecal Coliform (MPN)	N/A	1/5 samples	N/A	1/run	1/5 samples	N/A

Data Management Procedures and Reports

Laboratory Data

Procedures outlined in the Manchester Laboratory Users Manual (MEL, 2005) will be followed for laboratory data reduction, review, and reporting. Laboratory staff will be responsible for the following functions:

- Data verification
- Proper transfer of data to the Laboratory Information Management System (LIMS)
- Reporting data to the project manager

All water quality data will be subsequently entered into Ecology's Environmental Information Management (EIM) system. The project manager and principal investigators will perform the following functions:

- Review all the data for errors on a quarterly basis and make adjustments with field or laboratory procedures or the measurement quality objectives.
- Apply corrective measures to eliminate errors and validate the quality of the data.

Major changes will require notification of QA Project Plan signature parties. The project manager may approve data that do not meet measurement quality objectives for use with appropriate qualification and consultation with the project team.

Laboratory Reports

MEL will report all laboratory results to the project manager within 30 days of sample delivery. The reports will include narratives, numerical results, data qualifiers, and costs.

High FC densities ($\geq$ 200 cfu/100 mL) will be reported to Ecology's Southwest Regional Office (SWRO) and the project manager in accordance with the Environmental Assessment Program's official notification procedure. All other data will be made available to the SWRO for disbursement after quality control and EIM entry are completed.

Field Data

Field data will be entered into a Microsoft Excel® spreadsheet for later integration with laboratory data and before exporting to Ecology's EIM data base. Data entry and validation will be performed by staff within Ecology's Environmental Assessment Program. All data entered will be validated by an internal, independent reviewer; and errors found will be identified, flagged, and corrected by the project manager. No project report is required for this project except a technical memo to Dave Rountry (SWRO Water Quality Section).

Project Report

The technical memo will compare observed FC geometric mean values (GMVs) and 90th percentiles to target concentrations. Current FC levels will be reported to better characterize current water quality conditions in the watershed. Estimation of univariate statistical parameters - which may include arithmetic mean, geometric mean, median, standard deviation, and range of data by station and sampling survey, and graphical presentation of the data - may be generated using Microsoft Excel® or other appropriate computer software. The technical memo will also synthesize data and information from Ecology's Ambient Marine flight sampling in the Lower Willapa River for 2006.

Data Verification and Validation

Both data verification and validation require adequate documentation of the process.

Data Review

Accurate transfer of data at each stage, including checking data that will be entered into the EIM system for accuracy, is vital to project success. Environmental Assessment Program's staff are responsible for reviewing, documenting, and entering field and lab results into a Microsoft Excel® spreadsheet before exporting to Ecology's EIM data base. The individual tasked with the data entry is responsible for reviewing the data in order to ensure completeness, consistency, and correctness as well as documenting the data reviewing process.

Data Verification

Data verification involves examining the data for errors, omissions, and compliance with quality control (QC) acceptance criteria. MEL is responsible for performing the following functions:

- Reviewing and reporting QC checks on instrument performance such as initial and continuing calibrations.
- Reviewing and reporting case narratives, including comparison of QC results with method acceptance criteria, such as precision data, surrogate and spike recoveries, laboratory control sample analysis, and procedural blanks.
- Explaining flags or qualifiers assigned to sample results.
- Reviewing and assessing MEL's performance in meeting the conditions and requirements set forth in this sampling plan.
- Reporting the above information to the project manager or lead.

After measurement results have been recorded, they are verified to ensure that:

- Data are consistent, correct, and complete, with no errors or omissions.
- Results of QC samples accompany the sample results.
- Established criteria for QC results were met.
- Data qualifiers are properly assigned where necessary.
- Data specified in Sampling Process Design were obtained.
- Methods and protocols specified in the QA Project Plan were followed.

MEL is responsible for verifying all analytical results (report of results and case summaries provide adequate documentation of the verification process). MEL analytical data will be reviewed and verified by comparison with acceptance criteria according to the data review procedures outlined in the Lab User's Manual (MEL, 2005). Appropriate qualifiers will be used to label results that do not meet quality assurance requirements. An explanation for data qualifiers is provided.

Field results will also be verified by staff before leaving the site after measurements are made. Detailed field notes will be kept to meet the requirements for documentation of field measurements. The field lead is responsible for checking that field data entries are complete and error free. The field lead should check for consistency within an expected range of values, verify measurements, ensure measurements are made within the acceptable instrumentation error limits, and record anomalous observations.

Data Validation

Data validation is the next step following verification. Data validation involves a detailed examination of the data package using professional judgment to determine whether the method quality objectives (MQOs) have been met. The project manager examines the complete data package in order to determine compliance with procedures outlined in the QA Project Plan and Standard Operating Procedures. The project manager is also responsible for data validation by ensuring that the MQOs for precision, bias, and sensitivity are met.

Part of the data validation process is an evaluation of precision and will be assessed by calculating relative percent differences (RPDs) for:

1. field duplicates, and
2. duplicates from laboratory sample splits.

Acceptable precision performance is outlined in Table 6. Laboratory duplicates will yield estimates of precision performance at the laboratory whereas field duplicates will indicate overall variability (environmental + sampling + laboratory).

Completeness will be assessed by examining: number of samples collected compared to sampling plan; number of samples shipped and received at MEL in good condition; MEL's ability to produce usable results for each sample; and sample results accepted by the project manager.

Data Quality (Usability) Assessment

Data quality will be assessed to determine whether this portion of the project objectives has been met. The project manager will make this determination by examining the data and all of the associated quality control information. The project lead will be guided by the methods and procedures reported in this QA Project Plan. The project lead will continually assess field procedures and sampling conditions to identify sources for bias. The project lead will review all field and laboratory data to identify sources of bias which will be reported in the final project technical memo.

Geometric mean (GMV) and 90th percentile values will be calculated and compared to previous monitoring data.

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