Quality Assurance Project Plan

Water Quality Monitoring for Fecal Coliform Bacteria in Kennedy Creek

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Water Quality Program

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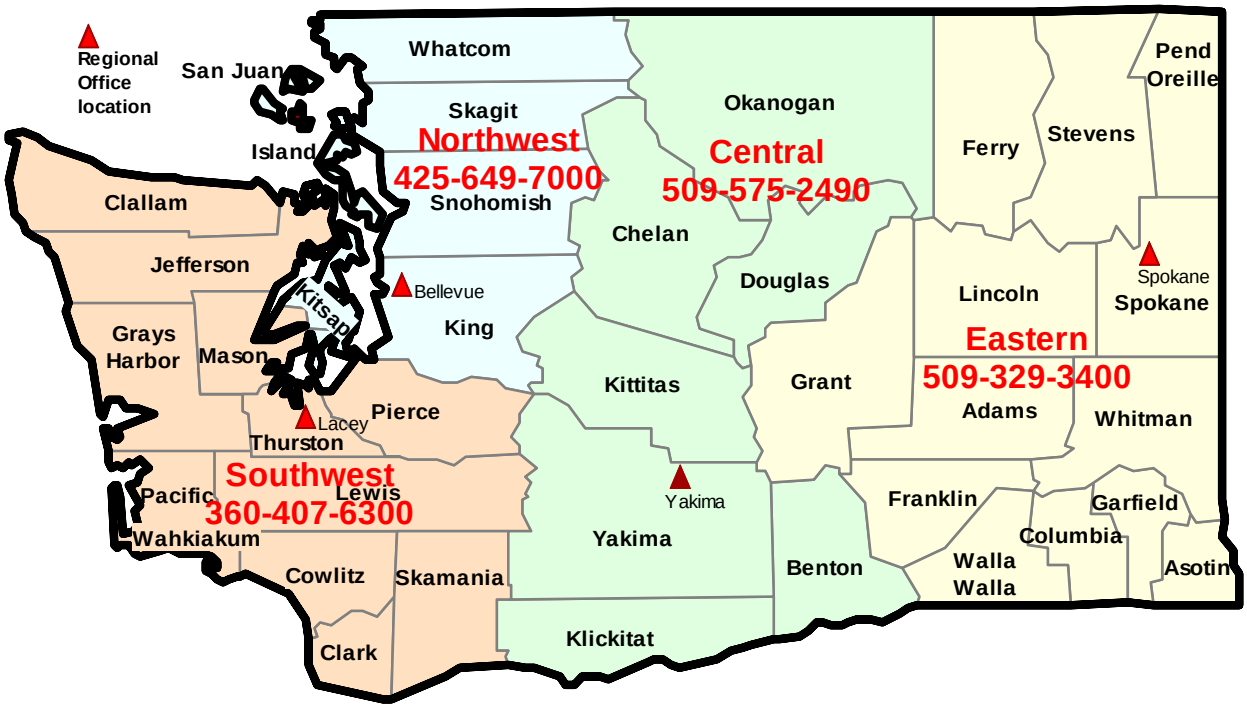

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Abstract

Kennedy Creek is a tributary to Totten Inlet in Puget Sound. The mouth area of the creek is in Mason County, but most of the creek flows through Thurston County. Washington Department of Ecology (Ecology) documented violations of Class AA water quality standards for fecal coliform bacteria (FC bacteria) at the mouth of Kennedy Creek (125 meters upstream of the Old Olympic Highway Bridge) during the 10-year period from 1992 through 2002. The lower reach of the creek was placed on Ecology's 303(d) list of impaired water bodies for FC bacteria. A Total Maximum Daily Load (TMDL)/Water Clean-up Plan was prepared using previous data sets. The TMDL was published in 2006. Water samples for this study will be collected at the TMDL mouth location and at additional upstream sites. Data will be used to identify potential sources of FC bacteria and compare with state water quality standards.

Background

Kennedy Creek flows into Totten Inlet which is in Water Resource Inventory Area 14 (Kennedy-Goldsborough Watershed). Most of the watershed is in Thurston County; however, the lower reach is in Mason County (Figure 1). Washington State Department of Ecology (Ecology) monitored the creek for ten years (1992 through 2002) as part of the comprehensive National Monitoring Program in Totten and Eld Inlets (Batts and Seiders, 2003a and 2003b). Kennedy Creek violated water quality standards for fecal coliform bacteria (FC bacteria), temperature and dissolved oxygen. As a result of water quality violations, Kennedy Creek was placed on Ecology's 2004 list of impaired water bodies ((303(d) list) for these parameters. The water quality monitoring study described in this QAPP will only address FC bacteria concentrations.

Under the federal Clean Water Act of 1972, Total Maximum Daily Load (TMDL) clean up plans are required to be performed on water bodies on the 303d list. A TMDL is the maximum pollutant loading a water body can tolerate and still meet Washington State's Water Quality Standards, Chapter 173-201A of the Washington Administrative Code. The TMDL analysis determines the best means of bringing the water bodies back into compliance with water quality standards. A TMDL was developed for tributaries to Totten and Eld Inlets based on technical analyzes of data previously collected by staff from Ecology, Thurston County, Squaxin Island Tribe, and Mason County (see Ahmed and Hempleman, 2006, for TMDL details). Kennedy Creek data were included in that analysis.

Currently, the Ecology 2002/2004 303(d) list has Kennedy Creek classified as Category 5, i.e., needing a TMDL (Appendix 1). However, Category 5 is now an incorrect classification. As mentioned previously, the federal Environmental Protection Agency (EPA) approved this TMDL on June 21, 2006. Therefore, the creek should be classified as a Category 4A – "impaired but a TMDL has been conducted." This update will be proposed by Ecology when the next 303d list is submitted to EPA.

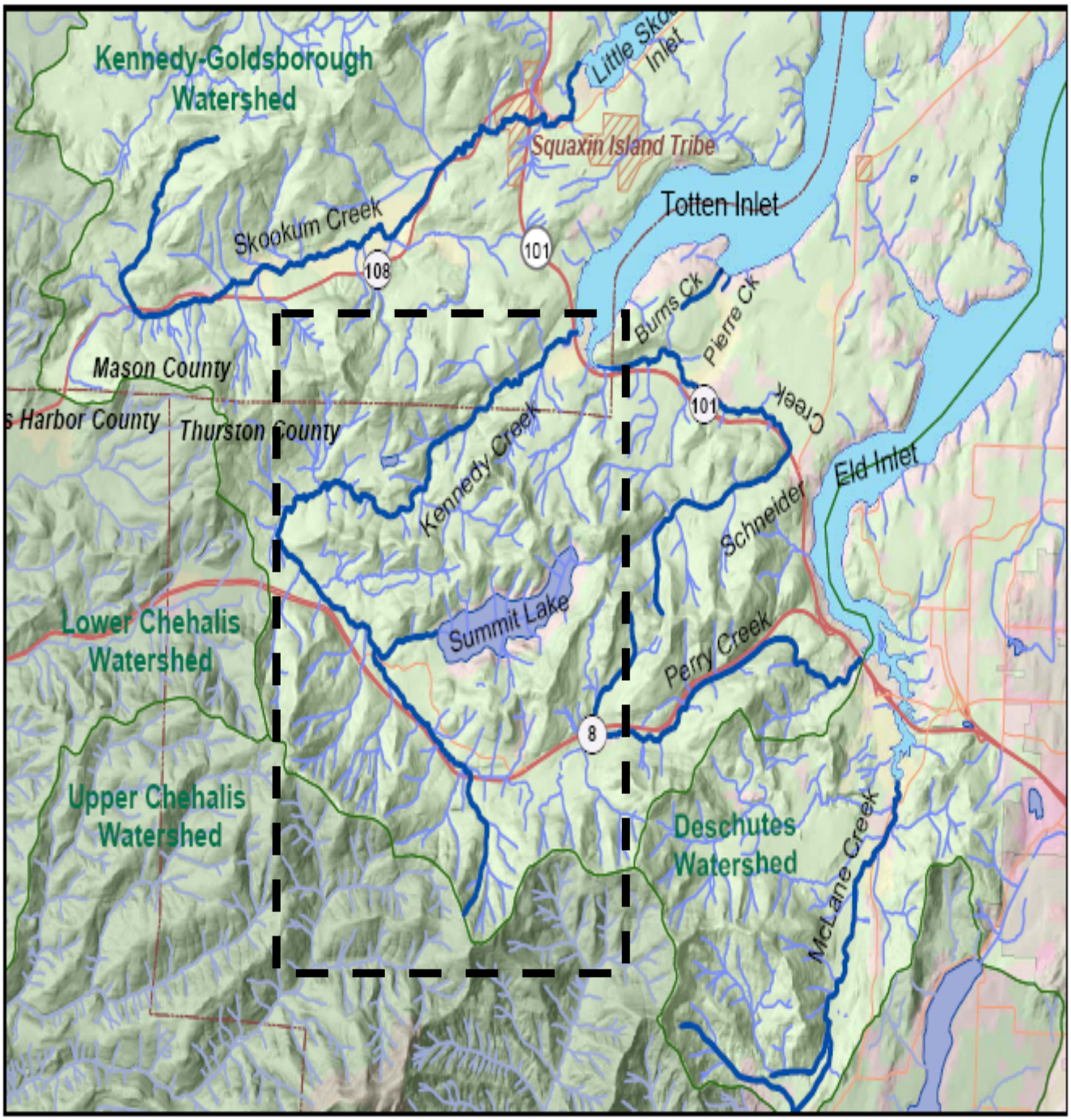

Figure 1. Study area with the Kennedy Creek sampling area outlined in a dashed line.

The current water quality standards classify Kennedy Creek as Extraordinary Primary Contact Recreational waters (Appendix 2). The standard for this classification requires FC bacteria levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.

Project Description

Kennedy Creek is a ten-mile long stream draining about 15 square miles. The creek originates in the Black Hills and discharges to the head of Totten Inlet, a high quality shellfish growing area. The land use is primarily forestry (49 percent) and undeveloped residential (41 percent), with approximately 4 percent residential development (Ahmed and Hempleman, 2006). There is recreational use throughout most of the watershed.

Potential sources for bacterial pollution in the watershed may be failing on-site septic systems, domesticated animals, areas used for recreation by individuals, and wildlife.

The project goal for water quality monitoring in Kennedy Creek is to identify current FC bacteria concentrations in the watershed.

Project objectives for Kennedy Creek Water Quality Monitoring are:

- Collect water quality samples to be analyzed for FC bacteria.
- Assess compliance with State Extraordinary Primary Contact Recreational water quality standards for FC bacteria.
- Identify FC bacteria source areas by sampling accessible segments of the creek that bracket geographical areas.

Sampling Process Design

Water samples will be collected from Kennedy Creek every week from July 31, 2007, through October 2007. Storm events will be targeted in November. Samples will be delivered to Ecology's Manchester Environmental Laboratory (MEL) by an Ecology courier on the following morning. Samples will be collected late morning to be sure the 24-hour analytical holding time is met. Flexibility on the collection time will also be determined by availability of daylight hours.

The sampling site at the mouth of the creek will be located as close as possible to that used in the National Monitoring Program (Batts and Seiders, 2003a and Batts personal communication May 2007). Additional sites for this monitoring study were chosen to bracket segments of the creek and characterize sources flowing into the mainstem (Table 1, Figure 2). Sites were also chosen for accessibility. Discharge will be measured at the mouth site. The TMDL for Kennedy Creek is based on flow and bacteria concentrations at this mouth site.

The creek mainstem will be sampled upstream to downstream. Sites will be sampled using a sampling pole designed to securely hold sampling bottles as well as provide for easy bottle removal. The smaller tributaries and ditches may be sampled from the bank of the creek. Sampling techniques will be in a manner that will not contaminate downstream sites.

Samples will be immediately placed into a handheld field cooler with ice. Samples are transferred to the larger ice-filled cooler stored in the vehicle as soon as possible. The van will be locked whenever Ecology personnel are not present. This is a protocol to secure the samples and ensure chain of custody.

Access to sites on private property will occur after permission is provided through the land owner or land owners formal representative.

Sampling Procedures

Safety
Field personnel have the authority to ensure their safety. Personnel can refuse to proceed if safety hazards are present.

Sampling
Standard Ecology Environmental Assessment Program protocols will be used for sample collection. Field sampling and measurement protocols will follow those described in *Field Sampling and Measurement Protocols for the Watershed Assessments Section* (Cusimano, 1993). Bacteria grab samples will be collected directly into pre-cleaned containers supplied by the laboratory and described in Manchester Environmental Laboratory (MEL) (2005). Plastic poly bottles will be used to prevent sample loss through bottle breakage. Samples will be collected from the stream thalweg (center of flow) either with a sampling pole or by reaching into the water directly with the bottle. Samples will be collected from below the surface of the water, with the sampling person downstream from the collection point. Caution will be exercised not to stir up sediment. Each bacteria sample will be labeled and immediately placed in a cooler with ice. Samples will be kept in conditions between 0°C and 4°C until the samples are processed by the laboratory. Samples will be received at the Manchester Laboratory within 24 hours of collection.

The sample bottles will be labeled with:

- Project name
- Date
- Site name
- Name of lead sampler
- Laboratory ID number
- Parameter (FC_MF)
- Sampling time

Table 1. Kennedy Creek sampling location names, description, and lattitude and longitude.

KENNEDY CREEK SITES							
N	SITE NAME	SITE DESCRIPTION	LATITUDE	LONGITUDE	RIVER MILE	LAB NUMBER	
						WEEK	IDENTIFIER
1	BBQ	Tributary at 10841 Kennedy Creek Road before goes under Hwy 8 near BBQ Ranch restaurant	N47° 01' 56.6'	W123° 06' 45.8			4105
2	BQW	Culvert - next main culvert west of restaurant - before 11325 mailbox - with orange tipped stakes	N47° 01' 58.0'	W123° 06" 58.0			4106
3	BWW	Culvert - continuing west before sign at 11315 with orange tipped stakes	N47° 02' 36.0'	W123° 07" 12.3			4107
4	TPK	Tributary at WSDOT Park and Ride	N47° 02' 53.7'	W123° 08" 38.3			4108
5	TCN	Tributary in from west at 12239 South Lakeshore Road just above where it enters Kennedy Creek. (Tributary at CoNfluence)	N47° 02' 57.7'	W123° 08" 29.6			4109
6	KCN	Kennedy Creek at 12239 Summit Lake Road above the confluence with the tributary (Kennedy Creek CoNfluence)	N47° 02' 57.3'	W123° 08" 29.4			4110
7	TLK	Summit Lake outflow at South Lakeshore Road/and Summit Lake Rd NW (This from LaKe)	N47° 02' 57.8'	W123° 08" 21.1			4111
8	KCS	Kennedy Creek at 12324 South Lakeshore Road	*Don't have yet*	*Don't have yet*			4112
9	FLS	Kennedy Creek Falls	N47° 04' 39.1'	W123° 07" 35.9			4113
10	MTH	Kennedy Creek Mouth	N47° 05' 40.4'	W123° 05" 32.7			4114
11	xxx r1	replicate					4115
12	nnn r2	replicate					4116

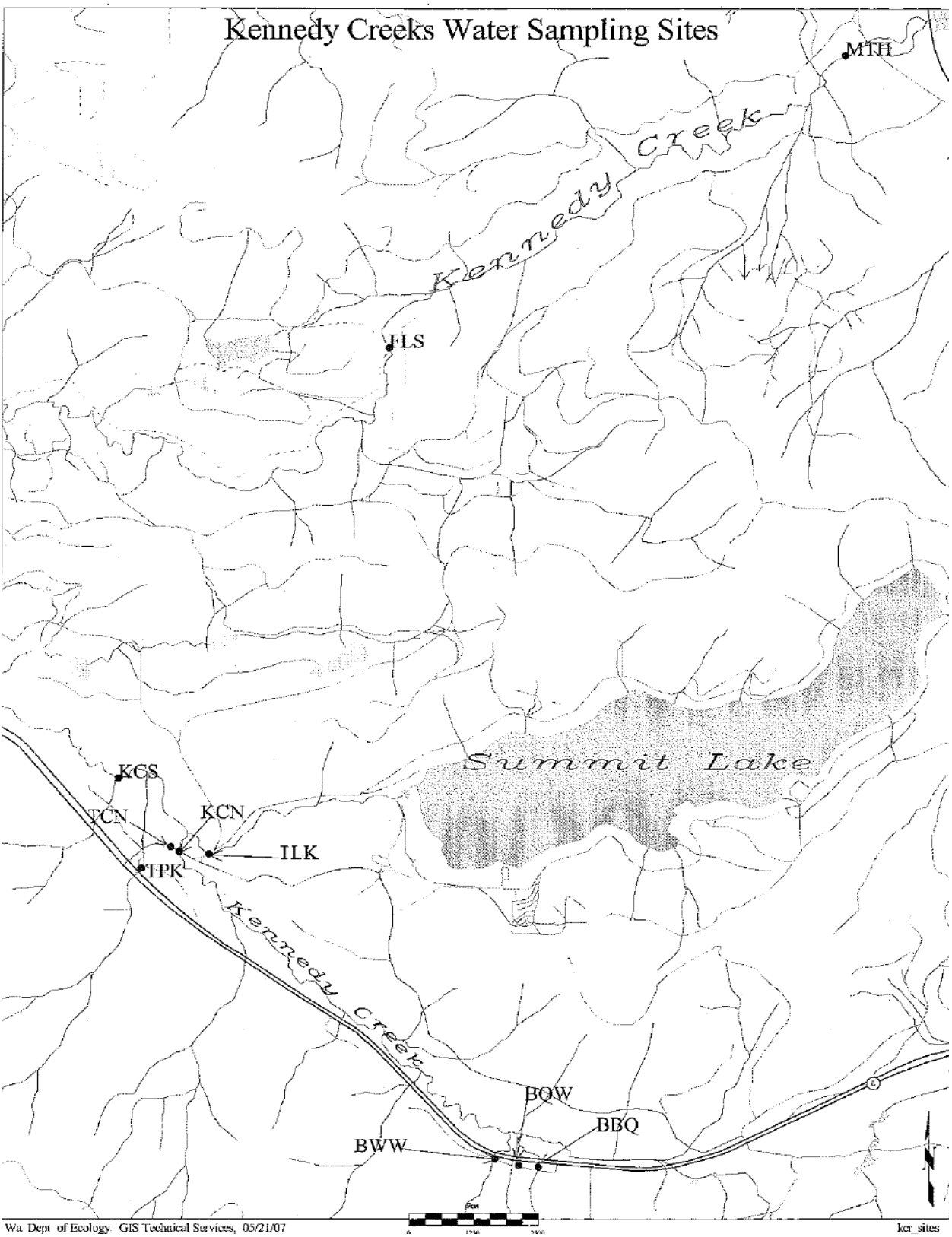

Figure 2. Kennedy Creek sampling locations.

A waterproof loose-leaf field notebook will be used to record typical field data and any unusual occurrence that may have impacts on the project or sample results.

The lead staff will train all field assistants with field protocol associated with this study. This will include quality assurance and contamination prevention. Upon completion of sampling at each site, the notes will be reviewed to ensure all activities were performed and the records are legible.

Coordination for sampling dates, lab numbers, and methods, will be made with MEL using standard Ecology protocol. The samples and completed Manchester Laboratory Analysis Required form will be picked up at the Ecology Headquarters Chain of Custody Room by the Manchester Courier. The sample cooler(s) will be transferred to the lab vehicle using chain of custody protocol.

Discharge will be measured at the downstream site using standard methods for estimating stream flow (Cusimano, 1993). Discharge will be measured in duplicate. If the staff gauge is still in place, readings will be taken before and after each x-section is completed. Safety will always take priority over a measuring stream flow.

Storm Events
Most of the sampling will be conducted during the dry season (end of July through September). The critical period for high bacteria concentrations is considered to be August and September (Ahmed and Hempleman 2006). At least one storm event (>0.25 inches in the last 24 hours) will be targeted in the fall. Sampling may be extended for at least another month if a storm event is not caught by the end of the planned sampling period.

Measurement Procedures

Table 2. Summary of sampling and analysis procedures for field and laboratory procedures.

Analysis	Method or Equipment	Estimated Range	Resolution	Holding Time	Preservation	Container	Estimated Samples
Water Velocity	Marsh-McBirney Flo-Mate 2000	0 - 6 ft/s	0.05 ft/s	N/A	N/A	N/A	2
Stream Gauge	Standard gauge plate	0 - 3 ft	0.1 unit	N/A	N/A	N/A	1
Fecal Coliform	Standard Methods, Membrane Filter 9222D	0 - 1000 cfu/100mL	1cfu/100 mL	24 hours	Cool to 4ºC	250 ml autoclaved poly bottle	20 during high flow

Quality Control Procedures

Total variation for field sampling and laboratory determination will be assessed by collecting replicate samples. Replicate results for bacteria samples tend to have a high relative percent difference (%RSD) compared to other water quality parameters. Bacteria sample precision will be assessed by collecting replicate samples. There will be at least 20 percent sample replication for each sample event. The downstream site will be replicated each sampling event. A second replicate will be selected among those sites expected to have FC bacteria concentration above the analytical detection limit. MEL will analyze a duplicate sample from each sampling event to determine the presence of bias in analytical methods. The difference between field variability and laboratory variability is an estimate of the field sample variability.

All samples will be analyzed at MEL following standard quality control procedures (MEL, 2005). Field sampling and measurements will follow quality control protocols described in *Field Sampling and Measurement Protocols for the Watershed Assessments Section* (Cusimano, 1993). If any of these quality control procedures are not met, the associated results will be qualified and used with caution. Professional judgment and peer review will determine if the data are used in analysis.

Data Quality Objectives

The measurement quality objectives are presented below in Table 3.

Table 3. Measurement Quality Objectives for Field and Laboratory Determinations.

Analysis	**Accuracy** percent deviation from true value	**Precision** Relative Standard Deviation (RSD)	**Bias** percent deviation from true value due to systematic error	**Lower reporting Limits** Concentration Units
Water Velocity	±2% of reading +0.05 ft/s	0.1 ft/s	N/A	0.01 ft/s
Fecal Coliform (membrane filter (MF))	N/A	20 - 50% RSD*	N/A	1 cfu/ 100mL

*replicate results with a mean of less than or equal to 20cfu/100mL will be evaluated separately.

Accuracy of measurements can be assessed by evaluating both precision and bias. Precision is a measure of data scatter due to random error, while bias is a measure of differences between a parameter value and the true value due to systematic errors. Precision will be quantified using relative standard deviation (%RSD). The target of 20-50 percent RSD for FC determinations is based on historical performances by MEL (Mathieu, 2006)

The laboratory's data quality objectives and quality control procedures are documented in the MEL Lab Users Manual (MEL 2005) and the MEL Quality Assurance Manual (MEL, 2001).

Data Management Procedures

Data reduction, review, and reporting will follow the procedures outlined in MEL's Lab Users Manual (MEL, 2005). Laboratory staff will be responsible for internal quality control verification, and for proper data transfer and reporting data to the project manager via the Laboratory Information Management System (LIMS).

All water quality data will be entered from LIMS into Ecology's Environmental Information Management (EIM) system. Data will be verified and 25 percent of the data entries will be selected at random and reviewed for errors. If errors are detected, another 25 percent will be reviewed until no errors are detected.

The project manager will validate the quality of the data received from the laboratory and collected in the field in reference to the measurement quality objectives. The review will be performed within one month of data collection, and adjustments to field or laboratory procedure or the measurement quality objectives will be made, as necessary. QA Project Plan signature parties will be notified of major changes. Data that do not meet objectives may be approved for use by the project manager but this data will be qualified appropriately.

Elevated fecal coliform densities (>200 cfu/100mL) will be reported to the TMDL Lead as soon as possible. Data analysis will include evaluation of data distribution characteristics and, if necessary, appropriate data transformations. Estimation of univariate statistical parameters and graphical presentation of the data (box plots, time series, regressions) will be made using Microsoft Excel software. Any additional statistical analysis will be determined based on results and time available. This study is not a TMDL or a formal effectiveness monitoring study.

Data Verification, Usability Determination, and Review

Data verification involves examining the data for errors, omissions, and compliance with quality control (QC) acceptance criteria. Once measurement results have been recorded, they are verified to ensure:

- Data are consistent, correct, and complete, with no errors or omissions.
- Results for 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.

The project lead is responsible for verifying field data entries are complete and correct (e.g., decimal point missing from an entry or something doesn't look right based on experience).

Qualified and experienced laboratory staff will examine lab results for errors, omissions, and compliance with QC acceptance criteria. Findings will be documented in each case narrative. MEL is responsible for verifying its respective analytical results. 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). Results that do not meet quality assurance requirements will be labeled with appropriate qualifiers, and an explanation will be provided in a quality assurance memorandum attached to the data package.

Data usability determination will follow verification. This determination is parameter-specific and involves a detailed examination of the data package, using professional judgment to determine whether objectives have been met. The project lead will examine the complete data package in detail to determine whether the procedures in the methods and procedures specified in this QA Project Plan were followed. The usability determination will entail evaluation of field and laboratory results and relative percent differences between field replicates. Adherence with established protocols should eliminate most sources of bias (Lombard and Kirchmer, 2004). Laboratory duplicates help estimate laboratory precision. Field replicates should indicate *overall* variability (environmental + sampling + laboratory) in the case of bacteria or (environment + instrumentation + sampling) in the case of flow and stream gauge.

Project Organization

The roles and responsibilities of Ecology staff involved in this project are provided below:

Betsy Dickes, *Project Manager, Water Quality Program, Southwest Regional Office (SWRO).* Responsible for overall project management. Defines final project objectives, scope, and study design. Responsible for writing the Quality Assurance Project Plan (QAPP), managing data collection, analysis, and entry into EIM. Prepares final report. (360) 407-6296 bedi461@ecy.wa.gov

Christine Hempleman, *TMDL Lead, Eastern Olympic WQMA, Water Quality Program, SWRO.* Submits initial project request based on needs identified in the TMDL. Reviews and comments on QAPP and final report. Will coordinate with the TMDL technical advisory group and coordinate subsequent cleanup efforts.

Kim McKee, *Unit Supervisor, Water Quality Program, Southwest Regional Office (SWRO).* Responsible for review and signature approval of the QAPP and final report.

Steve Eberl, *Section Manager, Acting, Water Quality Program, SWRO.* Responsible for review and approval of the QAPP and final report.

Anise Ahmed, *Environmental Assessment Program.* Reviews the QAPP for technical merit. Available for technical assistance on quality assurance issues and problems during the implementation and assessment phases of the project.

Pam Covey, *Environmental Assessment Program.* Receives and processes incoming samples. Ensures chain of custody.

Nancy Jensen, *Environmental Assessment Program.* Analyzes samples for FC bacteria. Provides analytical results for concentration (number of colonies/100mL).

Leon Weiks, *Environmental Assessment Program.* Sample Courier. Picks up samples from headquarters cooler ensuring chain of custody protocol is retained. Delivers specific number of appropriately cleaned sampling bottles in time for sampling events.

Schedule

The following schedule may need to be updated periodically.

Completion of Final Approved QA Project Plan	July 3, 2007
Sampling Start/End	July 31, 2007 – November 2007
Draft Study Report	April 14, 2008
Final Report	May 19, 2008
Submit Data to the Environmental Information Management System (EIM)	June 1, 2008

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APPENDICES

Appendix 1. The Water Quality Assessment Categories.

<table>
<tr><td>Category 1. Meets Tested Criteria</td><td rowspan="3">Not known to be impaired</td><td rowspan="5">EPA approval and TMDL not required</td></tr>
<tr><td>Category 2. Waters of Concern</td></tr>
<tr><td>Category 3. Lack of Sufficient Data</td></tr>
<tr><td>Category 4. Impaired But Does Not Require A TMDL because:</td><td rowspan="4">Impaired</td></tr>
<tr><td>4a. Already has a TMDL</td></tr>
<tr><td>4b. Has a Pollution Control Plan</td></tr>
<tr><td>4c. Impaired but a TMDL is Inappropriate</td></tr>
<tr><td>Category 5. Polluted Waters that Require a TMDL(303(d) List)</td><td>EPA approval and TMDL required</td></tr>
</table>

Appendix 2. Water Quality Criteria for Fecal Coliform bacteria.

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

Bacteria, Fresh Waters

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

Use Categories

There are three use categories related to the freshwater bacteria criteria in Washington:

(1) The *Extraordinary Primary Contact* use is intended for waters capable of "providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas." To protect this use category: Fecal coliform organism levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 100/colonies mL" [WAC 173-201A-200(2)(b), 2003 edition].

(2) The *Primary Contact* use is intended for waters "where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and waterskiing." More to the point, however, the use is to be designated to any waters where human exposure is likely to include exposure of the eyes, ears, nose, and throat. Since children are also the most sensitive group for many of the waterborne pathogens of concern, even shallow waters may warrant primary contact protection. To protect this use category: "Fecal coliform organism levels must not exceed a geometric mean value of 100 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200/colonies mL" [WAC 173-201A-200(2)(b), 2003 edition].

(3**)** The *Secondary Contact* use is intended for waters "where a person's water contact would be limited (e.g., wading or fishing) to the extent that bacterial infections of the eyes, ears, respiratory or digestive systems, or urogenital areas would be normally avoided." To protect this use category: "Fecal coliform organism levels must not exceed a geometric mean value of 200 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 400/colonies mL" [WAC 173-201A-200(2)(b), 2003 edition].

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