Quality Assurance Project Plan

McAllister Creek Source Identification: Water Quality Monitoring for Fecal Coliform Bacteria and Nitrate+Nitrite-N in Medicine Creek

December 2007

Publication Number 07-10-105

Quality Assurance Project Plan

McAllister Creek Source Identification: Water Quality Monitoring for Fecal Coliform Bacteria and Nitrate+Nitrite-N in Medicine Creek

Prepared by:

Betsy Dickes
Washington State Department of Ecology
Water Quality Program

December 2007
Publication Number 07-10-105

You can print or download this document from our website at:
www.ecy.wa.gov/biblio/0710105.html

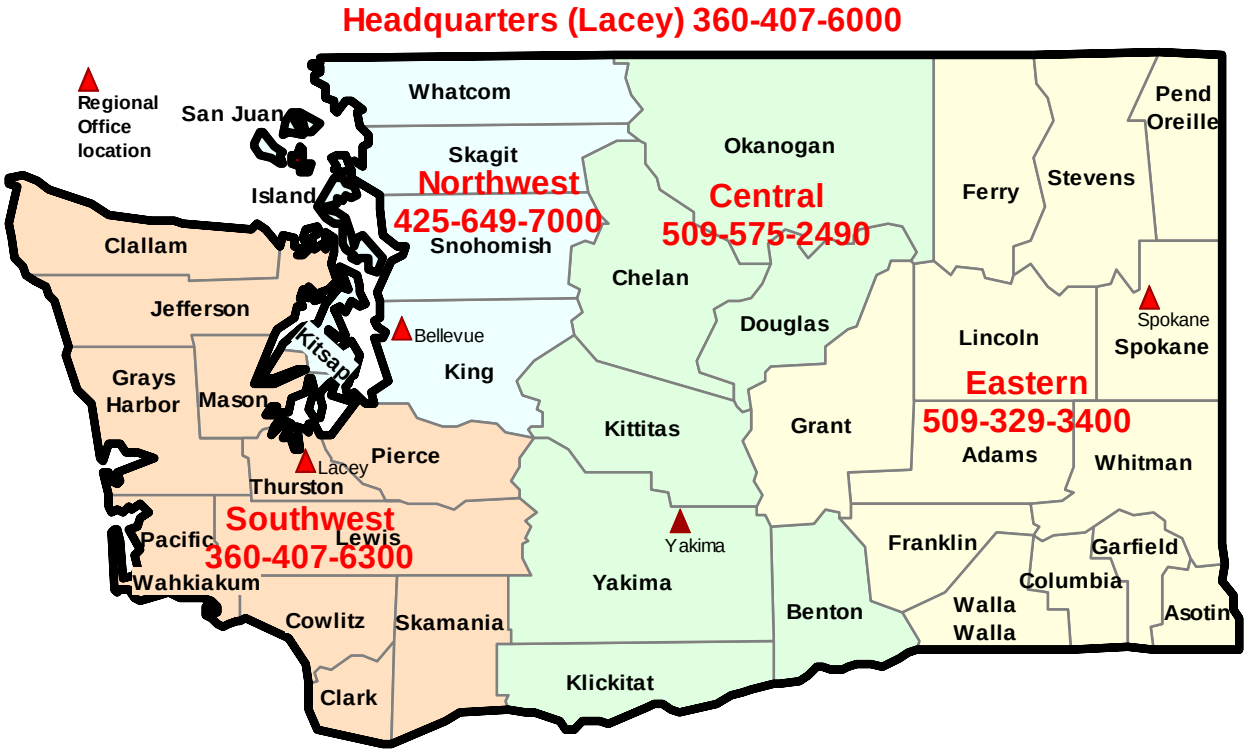
For more information contact:

Department of Ecology
Water Quality Program
Southwest Regional Office
P.O. Box 47775
Olympia, WA 98504-7775

Telephone: 360-407-6300

303(d) Listings Addressed in this Study

McAllister Creek, Waterbody ID LD26OX, Fecal Coliform Bacteria



Persons with a hearing loss can call 711 for Washington Relay Service.
Persons with a speech disability can call 877-833-6341.

Any use of product or firm names in this publication is for descriptive purposes only and does not imply endorsement by the author or the Department of Ecology.

If you need this publication in an alternate format, please call the Water Quality Program at 360-407-6300. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Quality Assurance Project Plan

McAllister Creek Source Identification: Water Quality Monitoring for Fecal Coliform Bacteria and Nitrate+Nitrite-N in Medicine Creek

Accepted by:	**12/17/07**
Betsy Dickes, Project Manager, Water Cleanup and Technical Assistance Unit, Water Quality Program, Southwest Regional Office	
Accepted by:	**12/17/07**
Cindy James, TMDL Lead for South Puget Sound WQMA, Water Quality Program, Southwest Regional Office.	
Accepted by:	**12/18/07**
Kim McKee, Unit Supervisor, Water Cleanup /Technical Assistance Unit, Water Quality Program, Southwest Regional Office	
Accepted by:	**12/18/07**
Garin Schrieve, Section Manager, Southwest Regional Office, Water Quality Program	

Table of Contents

List of Figures

List of Tables

Abstract

Washington State Department of Ecology performed a Total Maximum Daily Load (TMDL) study for fecal coliform (FC) bacteria in the Nisqually River basin from March 2002 through September 2003. The goal was to investigate impaired water bodies as identified in Ecology's 1998 303(d) list. One of the impaired water bodies sampled was McAllister Creek; Medicine Creek was sampled as one of its tributaries. The 2005 Nisqually TMDL technical report identified Medicine Creek as a source of fecal coliform bacteria to the mainstem McAllister Creek. High nitrate-nitrite-nitrogen (NO_3+NO_2-N) concentrations were also found in the lower Medicine Creek reach. This water quality assurance project plan is designed to characterize the lower reach of Medicine Creek for fecal coliform bacteria and NO_3+NO_2-N.

Background

Medicine Creek is a tributary of McAllister Creek. McAllister Creek flows into Nisqually Reach (Figures 1 and 2). As a result of past water quality violations, McAllister Creek and Nisqually Reach were placed on Ecology's 1998 list of impaired water bodies (303(d) list) for FC bacteria.

Under the federal Clean Water Act of 1972, a Total Maximum Daily Load (TMDL) must be performed on water bodies on the 303(d) 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 to bring water bodies back into compliance with water quality criteria. The TMDL developed for the Nisqually River basin included McAllister Creek and its tributary Medicine Creek (Sargeant et al., 2005). The Environmental Protection Agency (EPA) approved the Nisqually TMDL on August 5, 2005. McAllister Creek is now classified as a 4a water body (Appendix 1) on the 2004 (303d) list. This category signifies that the water body is "impaired but a TMDL has been conducted."

This monitoring study stems from conclusions in the Nisqually TMDL technical report (Sargeant et al., 2005). The technical report identified elevated FC bacteria from Medicine Creek as a source to McAllister Creek. The Nisqually TMDL study also identified elevated NO_3+NO_2-N levels in Medicine Creek. Currently, Washington State does not have surface water standards for NO_3+NO_2-N or other nutrients. But nitrate concentrations in streams reflect a close association with land use. NO_3+NO_2-N concentrations can result from runoff from fertilizers, septic tank leakage and sewage/manure, and erosion of natural deposits. Monitoring changes in NO_3+NO_2-N may assist in identifying sources of bacteria.

The current water quality standards classify McAllister Creek as an Extraordinary Primary Contact Recreational water (Appendix 2). Therefore, since Medicine Creek discharges into McAllister Creek, it too is classified as an Extraordinary Primary Contact Recreational water. The standard for this classification requires that "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" (Washington State Department of Ecology, 2006).

This water quality project is designed to further investigate FC and NO_3+NO_2-N levels in the lowermost reach of Medicine Creek. Sampling Medicine Creek for water quality will provide data on current conditions. If bacteria concentrations are still elevated, efforts can be directed toward identifying specific source areas and working toward their reduction. If bacteria water quality standards can be met in Medicine Creek, it is likely that the positive impacts will translate into improved water quality in McAllister Creek and Nisqually Reach.

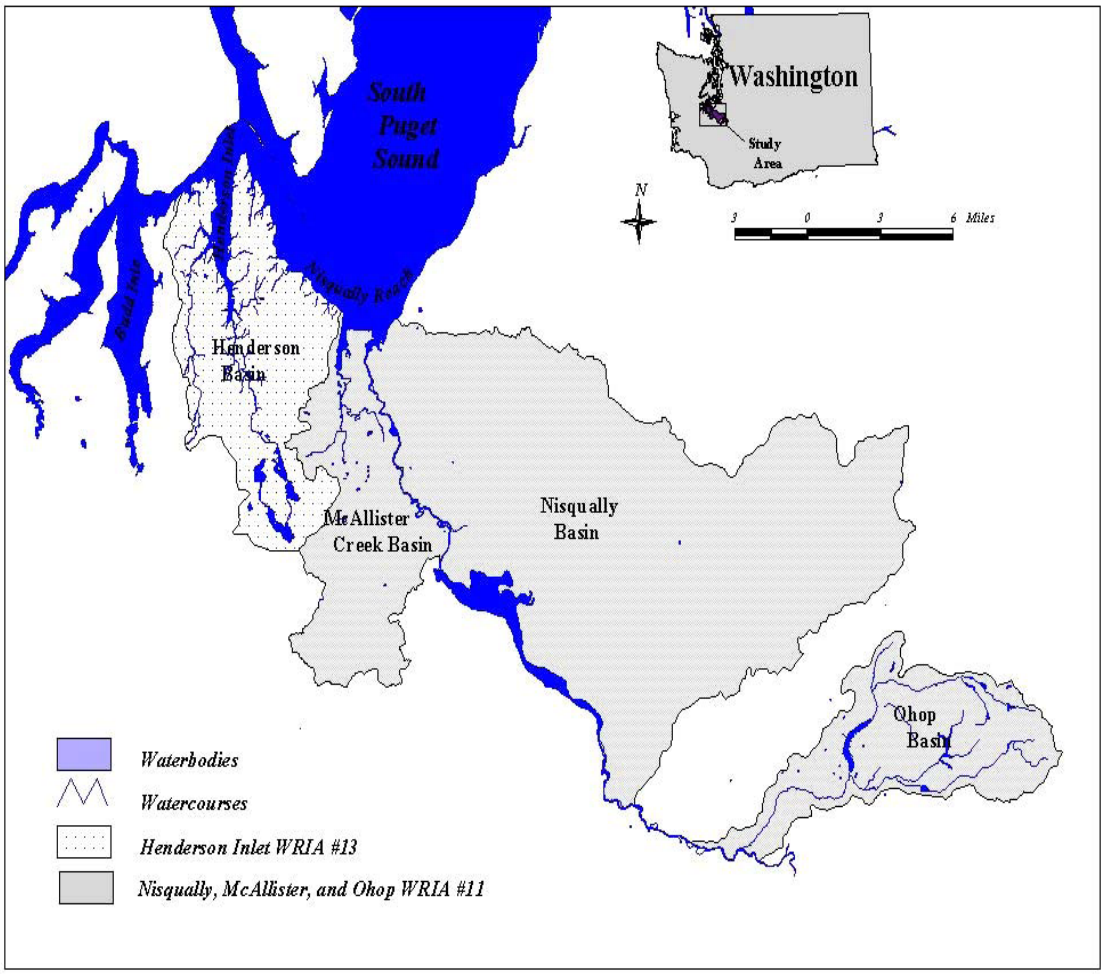


Figure 1. Map of general area including surrounding watershed.

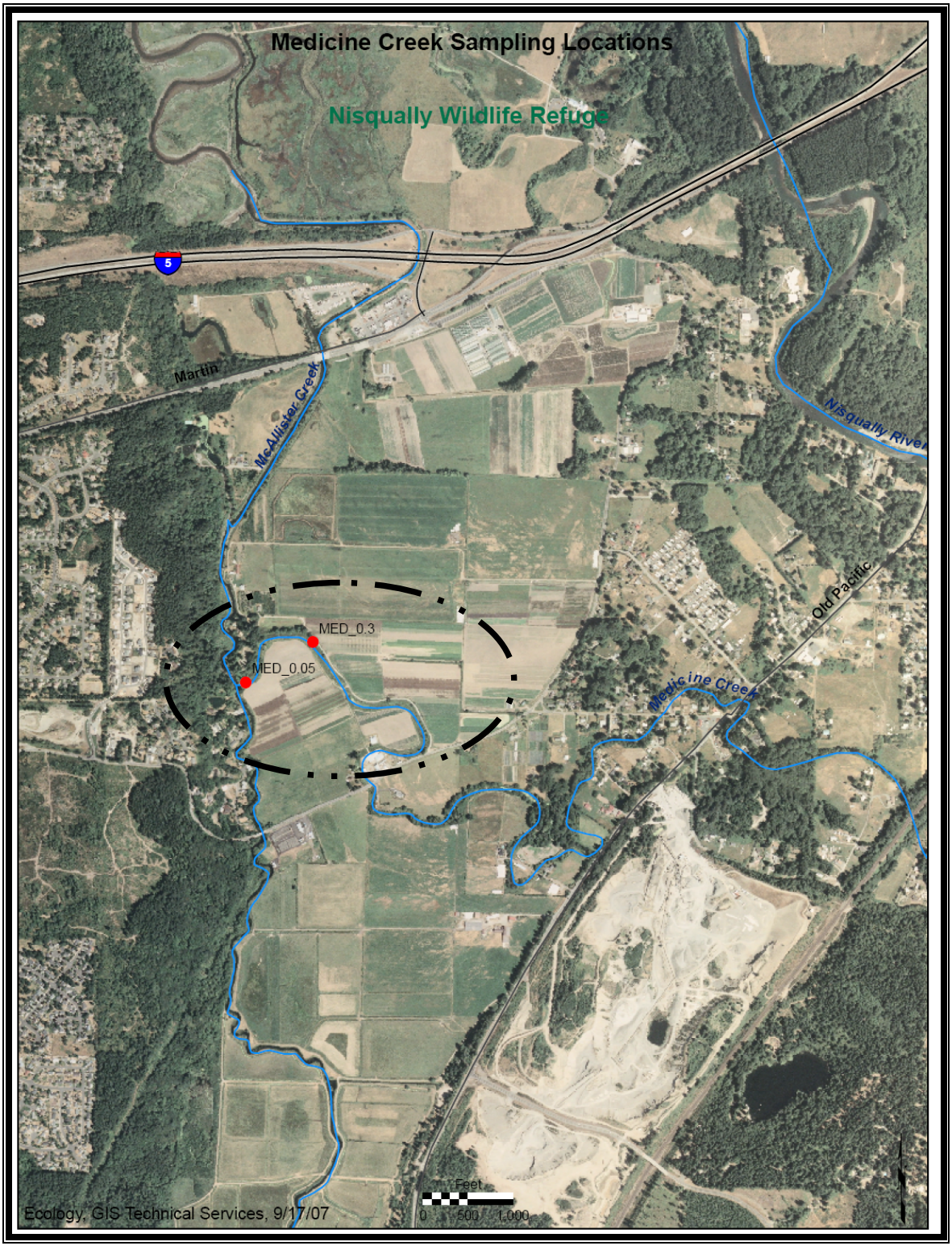


Figure 2. Study area with the Medicine Creek sampling area outlined by the dashed line (located near the middle of the map).

Project Description

Medicine Creek is approximately 3.5 miles long. The creek has been extensively ditched and altered. Currently there is almost no riparian canopy cover. The channel is narrow and weed-choked. Medicine Creek enters McAllister Creek at RM 4.4. Potential sources for bacterial pollution in the watershed include failing on-site septic systems, domesticated animals, agriculture, and wildlife.

The project goal for water quality monitoring in Medicine Creek is:

- Identify FC bacteria and NO_3+NO_2-N concentrations in the lower reach of the Medicine Creek watershed.

Project objectives for Medicine Creek water quality monitoring are:

- Collect water quality samples to be analyzed for FC bacteria and NO_3+NO_2-N.
- Assess compliance with State Extraordinary Primary Contact Recreational water quality standards for FC bacteria.
- Document current water quality conditions in the lower reach for FC bacteria source areas and NO_3+NO_2-N that may be contaminating McAllister Creek.

Sampling Process Design

Water samples will be collected from Medicine Creek every other week from October 8, 2007, through March 24, 2008. Samples will be appropriately stored overnight and delivered to Ecology's Manchester Environmental Laboratory (MEL) by an Ecology courier on the following morning. Samples will be collected corresponding to low tide and with consideration of the 24-hour analytical holding time for bacteria.

The sampling site at river mile 0.3 (MED_0.3) is the same site used in the Nisqually TMDL (Sargeant et al., 2005). The site located at the mouth (MED_0.05) is as close to the mouth of Medicine Creek as possible, considering safety and without a boat (see Table 1). Discharge will not be measured due to the deep mud substrate at both sites. At least 10 sample events are planned.

Table 1. Site description and locations.

Site Name	Site Description	Latitude*	Longitude
MED_0.05	**Near the mouth, right bank.**	**N47° 03'‘ 21.0'**	**W122° 43" 35.1'**
MED_0.3	**Mid channel. Upstream side of field bridge. Just upstream from the wooden culvert.**	**N47° 03" 16.7'**	**W122° 43" 21.2'**

*obtained using a Garmin 76CSx handheld GPS

The creek will be sampled downstream (MED_0.05) to upstream (MED_0.3). However, care will be taken to not disturb the sediments at either location. Water samples will be collected using a sampling pole. The sampling pole securely holds the sample bottle and resolves issues with unsafe bank access.

Both sample sites are within 50 feet of the vehicle. Samples will be placed into an ice-filled cooler stored in the vehicle as soon after collection as possible. The van will be locked whenever Ecology personnel are not present.

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). 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 bottle breakage and sample loss. Loss of preservative in the NO_3+NO_2-N bottle will be prevented by keeping the bottle upright when sampling. Samples will be collected from the stream thalweg (center of flow). Samples will be collected from below the surface of the water to avoid collecting material caught in the surface film. Caution will be exercised not to stir up sediment. Each sample will be labeled and immediately placed in a dark thermal 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. This is critical for the bacteria samples (see Table 2).

The sample bottles will be labeled with:

- Project name
- Date
- Site name
- Name of lead sampler
- Laboratory ID number
- Analyte
- Sampling time

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 records are legible.

The lead staff will coordinate sampling dates, laboratory identification numbers, and methods 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 will be transferred to the lab vehicle using chain of custody protocol.

The mouth site, MED_0.05, is tidally influenced. Sampling will be coordinated with an outgoing low tide. The tide will be determined using information for the DuPont Wharf, Nisqually (Nisqually) tide station (Station ID 1093). Debby Sargeant (personal communication, December 6, 2007) has found, during her previous work in the system, that low tide at the mouth of Medicine Creek has a two hour lag from the low tide reported at the Nisqually tide station.

Storm Events
At least one storm event (>0.25 inches in the previous 24 hours) will be targeted.

Measurement Procedures

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

Analysis	Method or Equipment	Estimated Range	Lower Reporting Limit	Holding Time	Preservation	Container	# Samples*
Fecal Coliform	**Standard Methods, Membrane Filter 9222D**	**0 - 1000 cfu/100mL**	**1cfu/100 mL**	**24 hours**	**Cool to 4ºC**	**250 ml autoclaved poly-bottle**	**4**
Nitrate+Nitrite-N	Standard Methods 4500-NO3-l	**0-1.0 ppm**	**0.010 ppm**	**48 hours**	**H2SO4 to pH < 2, Cool to 4° C**	**150 clear poly-bottle**	**3**

* per sampling event

Quality Control Procedures

Total variation for field sampling and laboratory determination will be assessed by collecting replicate samples. Bacteria samples are inherently variable compared to other water quality parameters. Bacteria sample precision will be assessed by collecting replicate samples. There will be 100% sample replication for FC and 50% for NO_3+NO_2-N. 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 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** deviation from true value due to systematic error	**Lower reporting Limits** Concentration Units
Nitrate+Nitrite-N	25	10%	5%	0.010 ppm
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% 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, 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% of the data entries will be selected at random and reviewed for errors. If errors are detected, another 25% 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 procedures or the measurement quality objectives will be made, as necessary. Quality Assurance Project

Plan (QAPP) 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 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, and 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 that:

- 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 that 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 their respective analytical results. Analytical data will be reviewed. It will be verified 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. Professional judgment will be used 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 QAPP were followed. The usability determination will entail evaluation of field and laboratory results and relative standard deviation 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).

Laboratory values below the detection limit will be assumed to be the detection limit for analysis purposes. Data from field replicates will be arithmetically averaged for data analysis.

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

Cindy James, *TMDL Lead, South Puget Sound 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 approval of the QAPP and final report.

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

Debby Sargeant, *Environmental Assessment Program.* Verifies sample locations. Reviews, and comments, on the QAPP and draft final report to ensure technical merit.

Deborah Case, *Environmental Assessment Program.* Receives and processes incoming samples. Ensures chain of custody.

Nancy Jensen, *Microbiologist, 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 coolers and specific number of appropriately cleaned sample bottles in time for sampling events.

Schedule

The following schedule may need to be updated periodically.

Completion of Final Approved QA Project Plan	December 2007
Sampling Start/End	October 2007 – May 2008
Draft Study Report	July 31, 2008
Final Report	September 30, 2008
Submit Data to the Environmental Information Management System (EIM)	October 31, 2008

Laboratory Budget

The laboratory budget in Table 4 includes all analyses that will be conducted for this project by Manchester Environmental Laboratory.

Table 4. Medicine Creek Laboratory Cost Estimate for 2007/2008.

Parameter	No. of Events	Samples per Event	Total Samples	Cost per sample	Subtotal	Total Cost
Fecal coliform (MF)	10	4	40	21	840	
NO3+NO2-N	10	4	40	12	480	
						$1,320

References

APHA, 1998. *Standard Methods for the Examination of Water and Wastewater*, 20th Edition. United Book Press, Inc. Baltimore, Maryland.

Cusimano, 1993. *Field Sampling and Measurement Protocols for the Watershed Assessments Section*. Publication Number 93-e04. Washington State Department of Ecology, Olympia, Washington. www.ecy.wa.gov/pubs/93e04.pdf

Lombard, S. and C. Kirchmer. 2004. *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-030. www.ecy.wa.gov/biblio/0403030.html.

Manchester Environmental Laboratory Quality Assurance Manual (MEL). 2001. *The Quality Assurance manual for the Washington State Department of Ecology Manchester Environmental Laboratory*. Washington Department of Ecology, Manchester, WA.

Manchester Environmental Laboratory (MEL). 2005. *Manchester Environmental Laboratory Users Manual*. 8th Edition. Washington Department of Ecology, Manchester, WA.

Mathieu, N. 2006. *Replicate Precision for 12 TMDL Studies and Recommendations for Precision Measurement Quality Objectives for Water Quality Parameters.* Washington State Department of Ecology, Olympia, Washington Publication No. 06-03-044.

Sargeant, D. and M. Roberts, and B. Carey, 2005. *Nisqually River Basin Fecal Coliform Bacteria and Dissolved Oxygen Total Maximum Daily Load Study*, May 2005. Washington State Department of Ecology, Olympia, Washington Publication No. 05-03-002.

Washington State Department of Ecology, 2006.*Water Quality Standards for Surface Waters of the State of Washington, Chapter 173-201A WAC*, Amended November 20, 2006. Washington State Department of Ecology, Olympia, Washington Publication No. 06-10-091

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."

(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."

(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."

Compliance is based on meeting both the geometric mean criterion and the 10% of samples (or single sample if less than ten total samples) limit. These two measures used in combination ensure that bacterial pollution in a waterbody 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.