Quality Assurance Project Plan

Nutrient Reduction Project: Murden Cove

GRANT G1300087

February 2013

Prepared by:

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Environmental Health Specialist 3

Prepared for:

Kitsap Public Health District and
Washington State Department of Ecology

Public Information

Studies conducted for the United States Environmental Protection Agency (EPA), or the Washington State Department of Ecology (Ecology) that produce new environmental data, analyze existing data, or involve environmental modeling must have an approved Quality Assurance (QA) Project Plan (QAPP) describing the objectives of the study and the procedures to be followed to achieve those objectives.

This QAPP describes pollution identification and control (PIC) monitoring and investigations that will be conducted over a period of three years (2013-2015). The work is funded wholly or in part by the EPA through its National Estuary Program (NEP) via a grant (G1300087) from Ecology as the NEP lead organization for 'Toxics and Nutrients Prevention, Reduction and Control'. The QAPP and final project report will be available on request from Kitsap County Public Health District or Ecology.

The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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1.0 Title Page

Quality Assurance Project Plan

Nutrient Reduction Project: Murden Cove

February 2013

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2.0 Abstract

This project proposes to assess nutrient levels in the Murden Cove watershed, which includes Murden Creek and the shoreline along Murden Cove located on Bainbridge Island. Recent water quality data shows elevated levels of nitrogen and phosphorous in the watershed, which directly impacts Puget Sound. These data also reveal elevated fecal bacteria levels that exceed both Part 1 and Part 2 of the State water quality standards, Murden Cove aquatic habitat has been 303(d) listed since 2004 for a year round cover of ulvoid algae attributed to human activity and the 2010 proposed Washington State Water Quality Assessment lists the cove as impaired for bacteria.

Kitsap Public Health will implement Pollution Identification and Correction methodology to reduce nutrient and fecal bacteria loading and improve water quality. The scope of this project will include an assessment of residential sources of nutrient pollution.

This project will include routine water quality monitoring, an evaluation of land use practices including inspections of onsite septic systems, the use of fertilizers and the dissemination of information and resources to the public. We will also coordinate our efforts with the City of Bainbridge Island and a local citizen volunteer group, the Bainbridge Island Watershed Council.

The anticipated outcomes of this project include:

1. Identification and correction of nutrient pollution sources
2. Reduction of nutrient loading
3. Reduction in bacterial pollution and harmful algae which will result in a rebound in dissolved oxygen concentration.

This Quality Assurance Project Plan (QAPP) guides activities conducted for routine and investigative water quality monitoring.

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3.0 Background

Surface water quality provides early warning for determining whether development, land use, and other human activities are being managed to effectively protect public health and the environment in the Murden Cove watershed. This project proposes to implement a proven, on-the-ground Pollution Identification and Correction methodology to investigate and correct sources of nutrient and fecal bacteria pollution sources. The goals of this project are to reduce nutrient loading, bacterial pollution, and harmful algae growth and show an improvement in dissolved oxygen concentration. These improvements in water quality will protect critical aquatic habitat, shellfish and public health.

3.1 Study Area and Surroundings

Murden Cove is an open bight located on the eastern shore of Bainbridge Island, north of Eagle Harbor, and includes 3.3. miles of shoreline. The area is classified as an approved shellfish growing area. Kitsap Public Health has identified approximately 130 waterfront homes within 200 ft of the shoreline and 45 homes along Murden Creek that are serviced by aging septic systems (> 25 years old). Due to this residential density there is also a possiblity of over use of fertilizers.

The Murden Cove watershed is one of the largest watersheds on Bainbridge Island, comprising 2041 acres. Land use within this basin consists of various densities of residential, commercial, light industrial and schools. Murden Creek is one of the island's eight combined stream networks, comprised of a main stem and two tributaries (Woodward and Meig's creeks) totaling 3.7 miles. These drain directly to Murden Cove. Maps for both Murden Cove and Murden Creek are found in Figures 1 and 2 in section 7 of this document.

3.2 Logistical Problems

PIC staff are experienced at coordinating project requirements with logistical challenges such as tides, weather, coordination with partners and laboratory scheduling. It is not anticipated that these logistical issues will cause problems to negatively impact the outcome of the project.

3.3 History of Study Area

Both Murden Cove and Murden Creek are aquatic habitat for numerous species that include shellfish and salmonids, specifically coho, chum and cutthroat. In 2004, the State Department of Ecology 303(d) list included habitat in Murden Cove due to a year round cover of ulvoid algae due to human causes. The proposed 2010 assessment also listed the cove for fecal bacteria.

3.4 Contaminants of Concern

The purpose for this project is to identify sources of both nutrient and fecal bacteria pollution. Water quality monitoring will be conducted to sample for the following nutrients; nitrate-nitrite, nitrogen, phosphorous, ammonia. Flow measurements will also be conducted to determine loading. Physio-chemical data will also be collected including; pH, salinity, conductivity, dissolved oxygen and temperature. Nutrients and fecal bacteria are contaminants of concern because they not only degrade water quality but also pose a threat to public health. Fecal coliform bacteria contain pathogenic bacteria and viruses that cause human diseases such as shigellosis, campylobacter enteritis, viral gastroenteritis, giardiasis, and cryptosporidiosis.

These contaminants are also associated with land use practices such as the use of fertilizers, livestock waste management, as well as the care and maintenance of onsite septic systems.

3.5 Results of Previous Studies

The City of Bainbridge Island has been conducting water quality monitoring in Murden Creek for several years (2007-2011). The City's results from Murden Creek have shown dissolved oxygen concentrations below water quality standard (9.5 mg/L) and frequent excursions beyond acceptable pH, temperature and phosphorous levels to be of moderate concern according to Ecology's stream water quality index (e.g. in water year 2010 and 2011, total phosphorous levels increased to range from 0.29 mg/L to 1.6mg/L). Increasing levels of nitrogen were measured in water years 2010 and 2011, with dry season values of 0.28 and 0.235 mg/L respectively and a wet season nitrate contraction in 2011 of 0.746 mg/L. The City has also observed increasing warm weather algae blooms. Bacterial concentrations in Murden Creek consistently failed to meet water quality standard, with annual geomeans ranging from 82-121 col/100 ml between water years 2007 and 2010.

Therefore based on the water quality data, and the concentration of residential properties with older onsite septic systems, this has been selected as a high priority area for this project. Kitsap Public Health will collaborate with several local entities, such as the City of Bainbridge and a local citizen volunteer Watershed Council to continue to conduct water quality monitoring for bacterial and nutrient loading and implement a pollution identification and correction project along Murden Creek and the shoreline of Murden Cove.

3.6 Regulatory Criteria or Standards

The water quality standard we will use for fecal bacteria is 200 colonies per 100 ml, per the Washington State Department of Ecology water quality standard (173-201A-200) for freshwater designated uses. When water samples results are greater than 200 FC/100ml confirmation sampling will be conducted. Then when the geometric mean from three samples exceeds 200 FC/100 ml investigative source tracking will be initiated.

4.0 Project Description

4.1 Project Goals

The primary goals for this project are to reduce nutrient and fecal bacteria loading and improve water quality in the Murden Cove watershed.

4.2 Project Objectives

The project objectives include the following:

1. Assess land use practices related to the use of fertilizers, yard maintenance, onsite septic systems, management of pet and/or livestock waste through door to door property inspections.
2. Assess water quality with respect to fecal bacteria, nutrients and loading by conducting routine and investigative water quality monitoring throughout the project area.
3. Educate residents about the project through public meetings, news releases and during door to door property inspections.

4.3 Information Needed and Resources

The information needed for the selection of this priority watershed was included the City of Bainbridge Island's State of the Island's Water Quality Report 2012 (4). It provided information and data about the Murden Cove watershed and indicated why it was considered a priority watershed due to elevated levels of fecal bacteria and nutrients. Washington State Department of Ecology's 2010 water quality assessment was also used for the selection of this project area (7).

4.4 Target Population

The target population of the project is Bainbridge Island residents and visitors who utilize the streams and shoreline for recreation including beach walking, recreational shellfish harvesting, and educational purposes.

4.5 Study Boundaries

The project area boundaries are shown in Figures 1 and 2, located in section 7 of this document.

4.6 Tasks Required

Task 1: Project Management

Project oversight and tracking; preparation and submittal of progress reports and final report; submittal of payment vouchers, fiscal forms, compliance with applicable procurement, preparation and submittal of Quality Assurance and Project Plan per the grant contract agreement.

Task 2: Pollution Identification and Correction

Kitsap Public Health staff will conduct door to door property inspections of approximately 175 properties along Murden Creek and the shoreline of Murden Cove. Property inspections will be conducted in accordance with the Health District's "Pollution Source Identification and Correction Protocol Manual" (2011). Kitsap Public Health District staff will assess residential fertilizer use, presence of appropriate vegetated buffer adjacent to shorelines, proper use of herbicides and pesticides, proper disposal of composts and grass cuttings, and animal waste management. If during the course of PIC inspections poor land use practices are discovered, Kitsap Public Health District will work with property owners to voluntarily correct the problem. However, when violations of either solid waste or onsite sewage system regulations are confirmed, Health District staff will implement corrective actions through enforcement.

Kitsap Public Health District staff will participate with members of the Bainbridge Island Watershed council to conduct a stream walk to investigate potential non-point sources of pollution. Kitsap Public Health District will collect samples of all outfalls suspected to be impacting the creek to analyze for nutrients and bacteria to determine whether additional investigation is warranted.

Kitsap Public Health District will correct all identified nutrient and fecal coliform pollution sources identified during property surveys by:

- Promoting voluntary correction through education and providing free technical assistance and information about potential funding sources available.
- Addressing non-cooperative property owners through enforcement of existing local onsite sewage regulations, solid waste regulations, state sewage regulations, and local municipal illicit discharge ordinances.

Kitsap Public Health District will track inspections parcel-by-parcel and document the following nine metrics:

- Number of completed PIC inspections.
- Number of OSS failures identified.
- Number of OSS failures repaired.
- Livestock pollution problems identified.
- Livestock pollution problems successfully resolved.
- Residential fertilizer use problems identified.
- Residential fertilizer use problems successfully resolved.
- Other problematic land use practices identified.
- Other problematic land use practices successfully resolved.

Kitsap Public Health District will produce a final report summarizing; monitoring information, successes and failures of the program to address nutrient sources, recommendations for future work, calculations of nutrient load concentrations and reductions, summary of education and outreach efforts, results of mail in survey following door to door inspections, and final numbers for the nine metrics listed above.

Task 3: Public Education and outreach:

Kitsap Public Health District, in collaboration with the City of Bainbridge Island, will conduct two public meetings to present information about the purpose, outputs and outcomes for the project. The first public meeting will introduce the project and the final meeting will summarize the project and report findings. The meetings will also present basic information related to care and maintenance of onsite septic systems, the use of fertilizers, as well as agricultural and pet waste management.

Kitsap Public Health has brochures available that focus on nutrient and fecal pollution reduction which will be distributed in the project area. Brochures available from the City of Bainbridge Island may also be used. Kitsap Public Health staff will create and print project-specific fact sheets for distribution during door to door property inspections and at public meetings.

Kitsap Public Health will conduct an evaluation of the property inspections. The evaluations will measure the effectiveness of the site inspection, with respect to what information was found to be useful by the resident, and what behavior change they may or may not adopt as a result of the visit. This evaluation will target nutrient related activities as well as care of onsite septic systems. This information will be shared at the final public meeting to demonstrate the

effectiveness of the property inspections. Kitsap Public Health District will also assess the effectiveness of public meetings and workshops using a training evaluation form.
Task 4 – Water quality monitoring

Kitsap Public Health District will conduct routine and investigative water quality monitoring of the Murden Cove watershed as specified in this Ecology-approved QAPP.

Kitsap Public Health District will conduct routine monthly monitoring during the term of the project. Due to the reduced annual rainfall on Bainbridge Island, compared to other parts of Kitsap County, and logistics such as time/day of storm events and tides a minimum of one storm sampling event per year will be conducted.
Kitsap Public Health District will assess water quality for fecal coliform bacteria, dissolved oxygen, pH, temperature, salinity, conductivity, and nutrients (total phosphorous, total nitrogen, nitrate-nitrite, and ammonia).

4.7 Practical Constraints

Practical constraints associated with this project include access to properties for both surveys and sampling. Typically property owners grant access to Kitsap Public Health staff. Occasionally, owners may deny access to their property for the door to door site inspection or simply choose not to participate. When shoreline access is denied (which does not occur very often), alternative locations are found.

During investigations of pollutant sources; if there is a potential that a source may originate from a property that has denied access to Kitsap Public Health staff, then a wet weather assessment will be conducted. If water is seen flowing from the property and into a road right of way or some other public area, water samples will be collected. If the samples are elevated for bacteria or nutrients, the owner will be contacted and a site visit requested. If they do not respond or continue to deny access, preliminary enforcement steps will be taken.

4.8 Systematic Planning Process Used

The systematic planning process used was the development of the Financial Ecosystem and Accounting Tracking System (FEATS) and the Quality Assurance Project Plan (QAPP).

5.0 Organization and Schedule

5.1 Key Individuals and Their Responsibilities

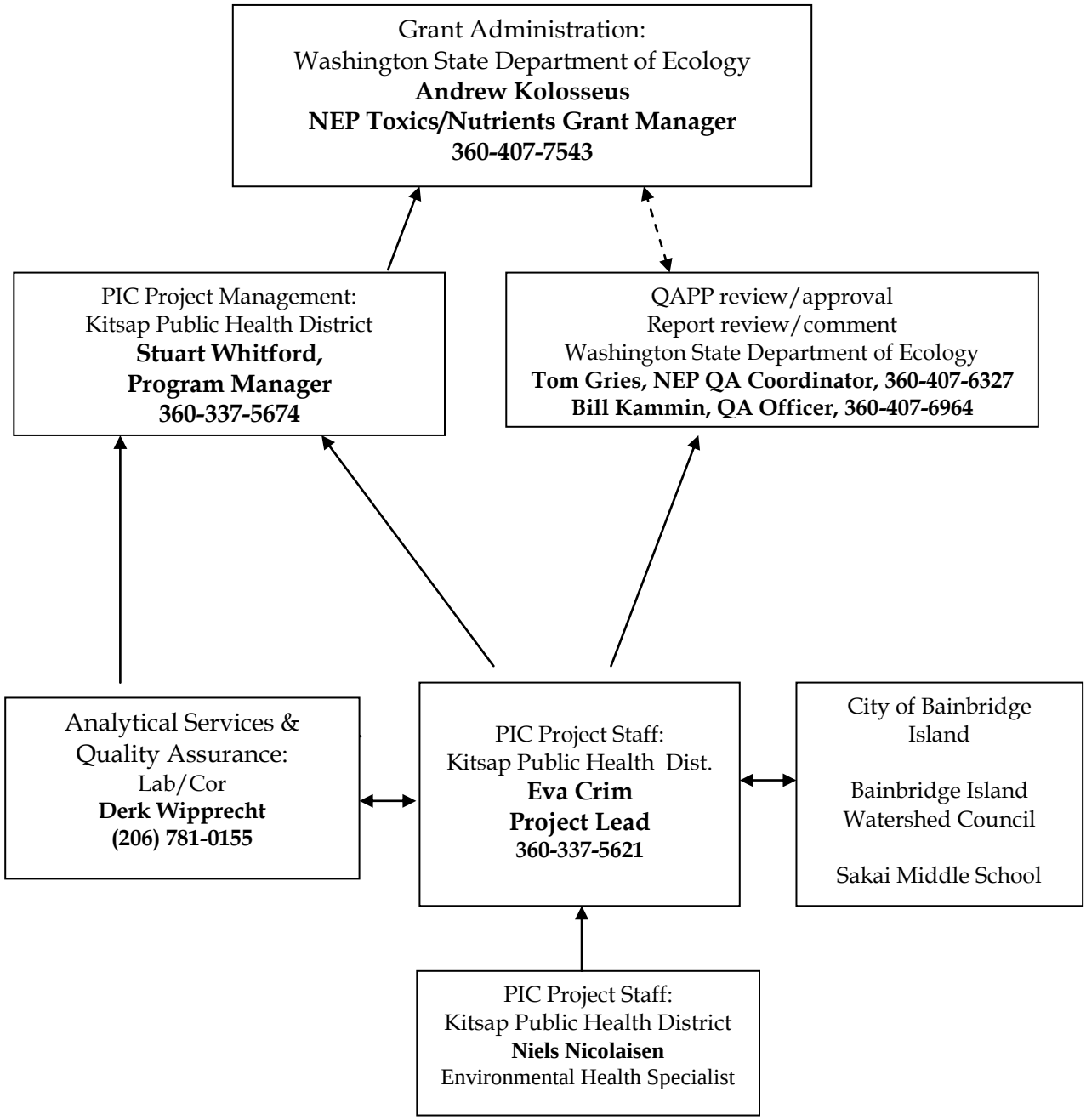
See Table 1.

Table 1. Project Staff and Responsibilities

Staff	Title	Responsibilities
Andrew Kolosseus Washington State Department of Ecology (360) 407-7543	NEP Toxics/Nutrients Grant Manager	Manages Toxics/Nutrients Reduction grant Ensures compliance with contract and QAPP Reviews reports and billing
Thomas H. Gries Washington State Department of Ecology (360) 407-6327	NEP QA Coordinator	Reviews and recommends approval of QAPP Reviews and comments on draft project report
William Kammin Washington State Department of Ecology (360) 407-6964	Ecology Quality Assurance Officer	Reviews and approves QAPP
Stuart Whitford Kitsap Public Health District (360) 337-5674	PIC Program Manager	PIC Project Management Reviews QAPP, reports and billing
Eva Crim Kitsap Public Health District (360) 337-5621	Environmental Health Specialist 3	Prepare QAPP and budget Review water quality data and project results Negotiate Contract Project lead
Derk Wipprecht Lab/Cor (206) 781-0155	Laboratory Manager	Manages Analytical contract Oversees QA/QC compliance Oversees reporting

5.2 Organization Chart

Figure 1. Project Organization Chart



5.3 Project Schedule

Table 2. Project Schedule and Timeline

Project Administration	Start date	End date	Objective	Deadline
Quality Assurance Project Plan (QAPP)	1/1/ 2013	3/1/ 2013	Fulfill EPA requirement	TBD by EPA
Semi-Annual Performance Reports	3/31/2013	10/15/2015	Fulfill EPA requirement	4/15/2013 10/15/2013 4/15/2014 10/15/2014 4/15/2015 10/15/2014
Final Performance Report	11/1/2015	12/31/2015	Fulfill EPA requirement	12/31/2015
Pollution Identification and Correction				
Conduct door to door property inspections	5/1/ 2013	10/1/2015	Completed inspections	10/1/2015
Identify and correct pollution sources	5/1/ 2013	11/1/2015	Corrections completed	12/1/2015
Education and Outreach				
Prepare Press Releases and postcard invitations for public meetings	3/1/2013 And 11/1/2015	5/1/2013 and 12/1/2015	Issue Press Releases and mail invitations	4/1/2013 And 12/1/2015
Conduct two public meetings	5/1/2013 and 12/1/2015	12/1/2015	Complete meetings	5/1/2013 and 12/1/2015
Provide site-specific education during site inspections, e.g. septic, animal waste, fertilizers.	5/1/ 2013	12/1/2015	Summary report of property inspections and results	10/1/2015
Develop Fact Sheets	4/1/ 2013	5/1/ 2013	Completed Fact Sheets	5/1/2013
Water quality monitoring				
Routine sample collection	4/1/13	10/31/15	Fulfill objective	10/31/15
Investigative sampling	5/1/13	10/31/15	Fulfill objective	10/31/15

5.4 Limitations on Schedule

Limitations on the schedule may include severe weather, lab capacity, and land owner access to property.

5.5 Budget and Funding

Table 3. Project Budget

Budget Item	Task from Project Narrative				Totals
	Task 1	Task 2	Task 3	Task 4	
Personnel	$1282.78	$85518.89	$8551.89	$42759.45	$138113.00
Benefits	$476.73	$31782.04	$3178.20	$15891.02	$51328.00
Travel		$3000.00		$2500.00	$5500.00
Equipment					0
Supplies (dye testing and water conservation kits)		$2500.00			$2500.00
Contractual (Lab Analyses for FC and nutrients)				$8000.00	$8000.00
Other – educational materials and Mailings			$3000.00		$3000.00
Indirect (25% of Personnel & Benefits)	$439.879	$29325.23	$2932.52	$14662.62	$47360.25
Totals	$2199.393	$154576.20	$14962.62	$84063.08	$255,801.25

Personnel

The Project Manager in Task 1 is budgeted for 30 hours to coordinate grant contract activities, review and approve billing, review semi-annual and final reports.

PIC inspector time has been budgeted for a total of 3200 hours for the development of the quality assurance project plan, preparation of semi-annual and final reports, property inspections, education and water quality monitoring; Tasks 1, 2, 3 and 4.

All four tasks are scheduled to occur over the 36 months between January 2013 and December 2015. Personnel costs account for 67% of the project budget. Kitsap Health has found that the most effective way to manage non-point pollution is to directly contact and educate as many watershed residents as possible via direct contact during the property inspection and evaluation process.

Travel

Travel has been budgeted at the current IRS reimbursement rate of 55 cents per mile. An estimated 10000 miles has been budgeted for Tasks 2, 3 and 4, with the majority of the miles being driven to conduct the door to door property inspections and water quality monitoring.

Contractual
For Task 4, $8,000 has been budgeted for laboratory analysis of water samples for fecal bacteria and nutrients.

Supplies
For Task 2, $2,500 has been budgeted for dye testing supplies and analysis and distribution of water conservation kits. Dye testing is conducted at properties with potential onsite septic system failures to either confirm or rule out that the septic system is the cause of an identified fecal pollution problem. Water conservation kits are offered to residents who have older onsite septic systems since conserving water is one of the key elements to extending the life of the septic system.

Other
For Task 3, we have budgeted $3,000 for educational materials, public meetings, news releases and mailings in conjunction with the education and outreach activities.

6.0 Quality Objectives

6.1 Decision Quality Objectives

The primary data quality objective is to identify through monitoring activities where FC and nutrients exceed regulatory standards indicating potential impacts to human health. These results will be used to target efforts and to report water quality changes over the duration of the project.

6.2 Measurement Quality Objectives

Measurement quality objectives (MQO's) are dependent upon the parameter to be analyzed. Table 4 below shows the MQO's for FC and nutrients monitoring. Lab/Cor, Inc. follows the quality control guidelines set forth by the EPA under the Total Coliform Rule, as well as those listed specifically in Standard Methods for the Examination of Water & Wastewater 20th Edition. Aquatic Research follows the quality control guidelines set forth in Standard Methods for the Examination of Water and Wastewater 20th Edition.

The accredited laboratory will perform the following measures to ensure accurate FC results:

- Sterility controls are run on each batch of freshly-made media, buffer solution (new batch), and vessels.
- Preventive maintenance of equipment is performed.
- In the event of equipment failure/malfunction, no data will be reported, and the chain of custody will be marked as "invalid test due to equipment failure." The incident will be discussed with the Project Manager and corrective action(s) will take place.
- Laboratory and Project Manager will rely on analysis of field duplicates for an assessment of overall variability in FC sample results.

6.2.1 Table of Targets

Table 4. Measurement Quality Objectives

Parameter	Field Blanks	Field Duplicates*	Lab Medium Sterility	Negative Control	Positive Control	Lab Duplicates
Fecal coliform (FC)	1 per event	10%	Tracked by lot	Daily	Daily	5%
Total Nitrogen	1 per event	10%	NA	NA	NA	5%
Nitrate-Nitrite	1 per event	10%	NA	NA	NA	5%
Total Phosphorous	1 per event	10%	NA	NA	NA	5%
Ammonia	1 per event	10%	NA	NA	NA	5%

**precision addressed in 6.2.1.1*

Table 5. Sample Containers, Preservation, and Holding Times

Parameter	Matrix	Minimum Quantity Required	Container	Preservative	Holding Time
FC	Freshwater	100 ml	Polyethylene	10^{o} C	24 hours
Total Nitrogen	Freshwater	50 ml	Polyethylene	H_2SO^4 pH <2, 4^{o} C	28 days
Nitrate-Nitrite	Freshwater	50 ml	Polyethylene	H_2SO^4 pH <2	48 hours
Total Phosphorous	Freshwater	50 ml	Polyethylene	H_2SO^4 pH <2	28 days
Ammonia	Freshwater	50 ml	Polyethylene	H_2SO^4 pH <2	48 hours

Table 6. Measurement Methods

Analyte	Sample Matrix	Expected Range of Results	Reporting Limit	Sample Preparation Method	Analytical Method
FC	Freshwater	<1 - >200 no dilution	1 - > 200 no dilution	None	Standard Method (SM) 9222D membrane filtration
Total Nitrogen	Freshwater	0.050	0.050-4.00mg/L	Persulfate digestion	SM204500NC
Nitrate-Nitrite	Freshwater	0.010	0.010-2.00 mg/L	None	SM204500NO3F
Total Phosphorous	Freshwater	0.010	0.002-2.00 mg/L	Persulfate digestion	SM20 4500PF
Ammonia	Freshwater	0.010	0.010-2.00 mg/L	None	SM 4500NH3H

Table 7. Physio-chemical parameters

Analytical Parameter	Analytical method	Detection and Reporting Limits		
		Minimum Detection Limit value (MDL)	Reporting Limit value (RL)	Units
Conductivity	HydroLab	0	0-100	mS/cm
Salinity	HydroLab	0	0-100	Ppt
pH	HydroLab	0	0-14	pH units
Dissolved oxygen	HydroLab	0	0-50	mg/L
Temperature	HydroLab	-5	-5 to 50	^{0} F

6.2.1.1 Precision

Precision is the extent of random variability among replicate measurements of the same property a data quality indicator. If field duplicates are within 20% relative percent difference (RPD), they are acceptable. For duplicate RPD values that are greater than 20%, all data that exceed 20% RPD will be assessed to determine whether the following apply:

- RPD results may be misleading at low concentrations within five times the detection limit. If this is the case, the data will be accepted.
- RPD values that do not meet the above criteria but are less than 35% RPD for water samples will be considered for inclusion as an estimated value if all other lab QA for that parameter is acceptable.
- Results with RPDs of greater than 35% for water samples will be considered for rejection.

6.2.1.2 Bias

Bias is considered the consistent deviation of measured values from the true value, caused by systematic errors in a procedure. Bias within the project will be reduced to the extent practicable by the following:

- Strict adherence to the sampling procedures of the project work plan and protocols.
- Complete data collection and organization.
- Regular maintenance of field equipment.
- Periodic reviews and evaluations of field sampling procedures.
- Analyzing data in an appropriate manner based upon essential considerations, such as temporal variations.

The accredited lab adheres to specific general policy on microbiological sample receipt, holding, preparation, and analysis as specified in their sampling procedure, specifically rejection criteria (Section B, page 8 SOP).

6.2.1.3 Sensitivity

Sensitivity is the capability of a test method or instrument to discriminate between measurement responses representing different levels of a variable of interest. Sensitivity is assured primarily through the selection of appropriate analytical methods, equipment, and instrumentation, and is expressed in terms of method detection limits (MDL) and reporting limits (RL).

6.2.2 Targets Developed For:

6.2.2.1 Comparability

Comparability is a measure of the confidence with which one data set can be compared to another. This is a qualitative assessment and is addressed primarily in sampling design through use of comparable sampling procedures or, for monitoring programs, through accurate sampling of stations over time. In the laboratory, comparability is assured through the use of comparable analytical procedures and ensuring that project staff are trained in the proper application procedures.

6.2.2.2 Representativeness

Representativeness is the degree to which data accurately and precisely represents a characteristic population. This is a qualitative assessment and is addressed primarily in the sample design, through the selection of sampling sites, and procedures that reflect the project goals and environment being sampled. It is ensured in the laboratory through proper handling of samples and analysis within specific holding times.

6.2.2.3 Completeness

Completeness is the amount of data collected as compared to the amount needed to ensure that the uncertainty or error is within acceptable limits. The goal for data completeness is 100% but 90% completeness will be acceptable.

7.0 Sampling Process Design (Experimental Design)

The study design is based on the approved PIC Pollution Identification and Correction Protocol Manual and PIC Water Quality trend monitoring plan (**Appendix A-1 and A-2**). This PIC project will utilize FC sampling to find fecal and nutrient pollution. Fecal pollution sources will be confirmed through the dye test process as described in the PIC Pollution Identification and Correction Protocol Manual. Land use practices such as the application of fertilizers, other landscape chemicals, yard waste and composting will be assessed during the door to door property inspections.

Non-participating properties will be evaluated by investigating water quality across the parcel.

7.1 Study Design

Routine and investigative water quality monitoring will be conducted in the watershed to determine levels of fecal bacteria and nutrients. Flow measurements will also be collected to determine loading.

7.1.1 Sampling Location and Frequency

- Routine sampling for FC and nutrients will be collected monthly at three stations on Murden Creek (the mouth station and two upland stations) during the project term, shown in Figure 1.
- FC sampling will be conducted during one storm event for each year of the project.
- Investigative sampling will be conducted when routine monitoring results are elevated for either bacteria or nutrients. Parcel and segment specific samples will be collected to identify potential sources.
- A stream walk of Murden Creek will be conducted. All freshwater flows into the creek will be collected and analyzed for bacteria and nutrients. Investigative monitoring will be conducted when elevated levels are reported.

7.1.2 Parameters to be Determined

Fecal coliform (FC) and nutrients will be the parameters used for routine and investigative sampling. The nutrients to be used will include; total nitrogen, nitrate-nitrite, total phosphorous, and ammonia.

7.1.3 Field Measurements

In addition to sampling for bacteria and nutrients, the following parameters will also be measured using field equipment; pH, temperature, dissolved oxygen, conductivity and salinity. Optical brighteners can also be measured using a field fluorometer when there is evidence of a potential gray water discharge, e.g. appearance of suds, detergent like odors, etc. Instructions for the use of the field fluorometer are maintained with the equipment. PIC staff have each been trained in how to use the instrument and instructions for calibration and use are kept with the instruction manual. This information will be added to a future revision of the PIC Pollution Identification and Correction Protocol Manual.

7.2 Maps or Diagram

Figure 2, 3, and 4 show maps of the project areas.

Figure 2. Murden Cove Watershed Project sampling locations

Figure 3. Murden Cove

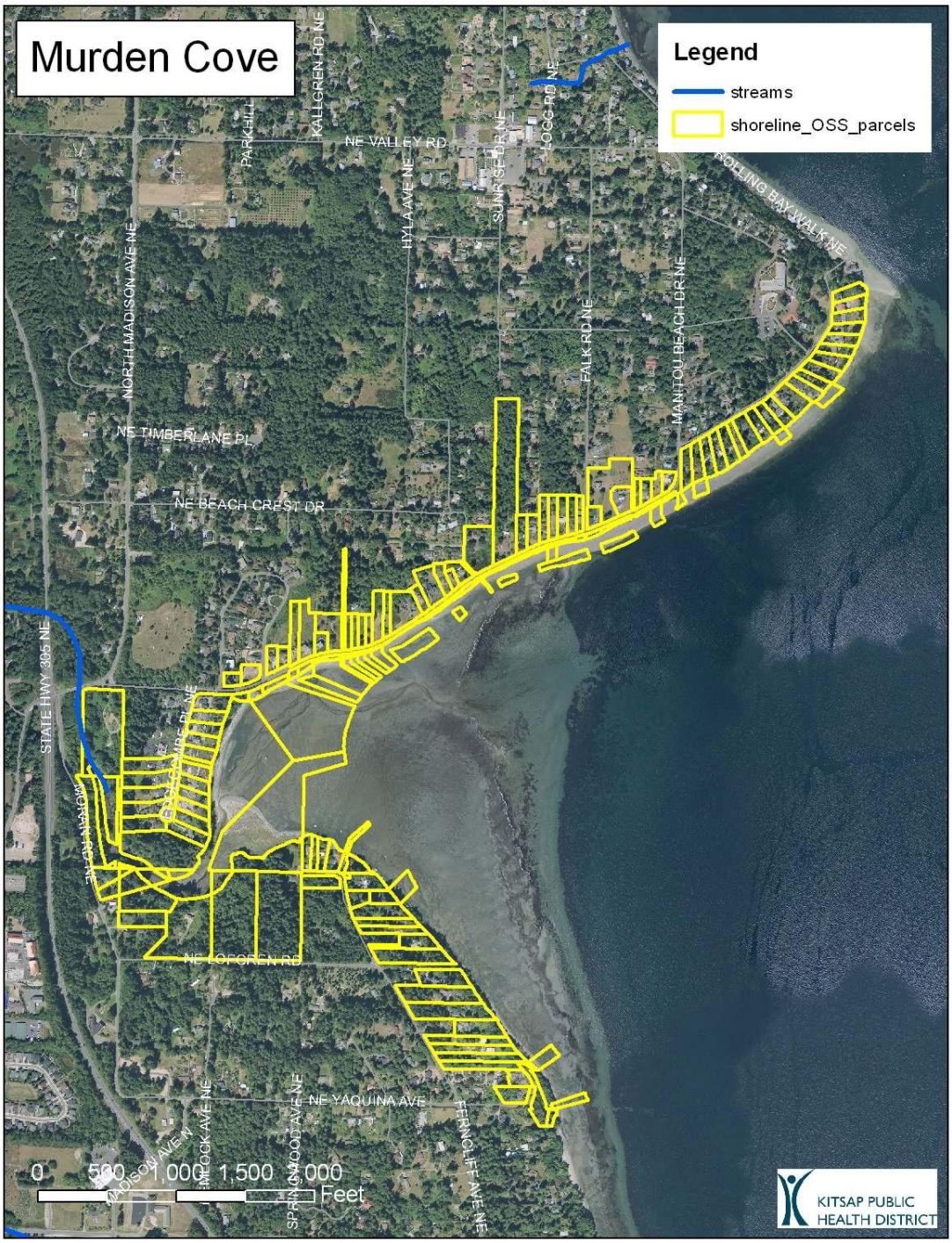
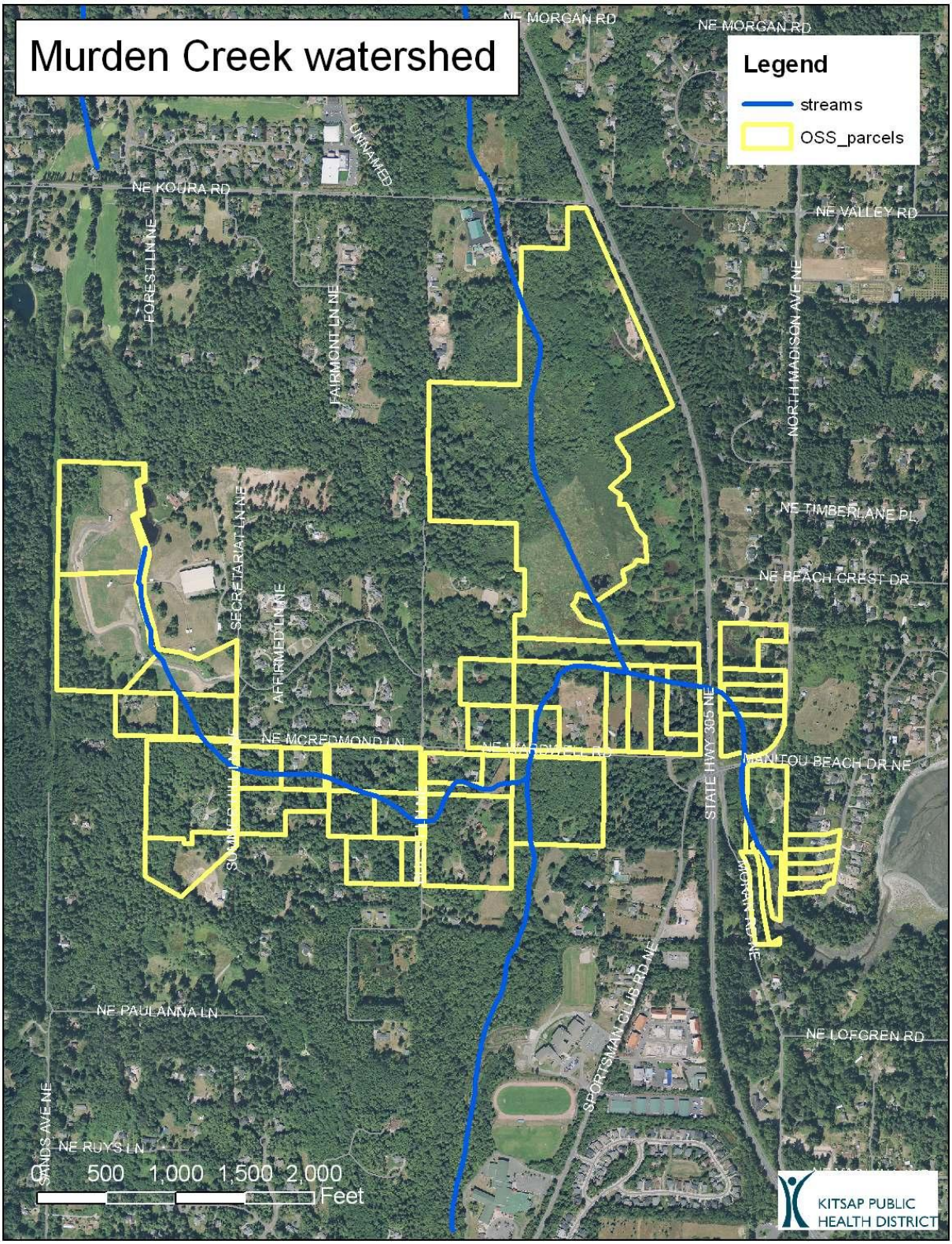


Figure 4, Murden Creek



7.3 Characteristics of Existing Data

Existing data used for this project were collected by the City of Bainbridge Island water quality monitoring program using an approved Department of Ecology QAPP. The City of Bainbridge Island will continue to conduct water quality monitoring at established stations according to their water quality program.
Kitsap Public Health will collect additional water quality samples at alternate sites. Data will be shared between agencies. The sampling locations for Kitsap Public Health and the City of Bainbridge Island are shown in Figure 1.

8.0 Sampling Procedures

8.1 Field Measurement and Field Sampling SOPs

Sampling for this project will include routine monitoring of three stations, two on Murden Creek and one at the mouth of the creek. These are shown on Figure 1. Investigative parcel-specific sampling will also be conducted. It is anticipated that the investigative sampling locations will either be associated with sites (properties) located along the creek or on the shoreline. The properties to be inspected during this project are shown in Figures 2 and 3. Investigative sampling may occur in these general areas. Other storm water conveyances, streams, and tributaries may be monitored as necessary. Stream samples shall be collected by approaching the sample point from a downstream direction with care taken not to disturb the bottom sediments. Samples are collected while facing upstream (against the flow) at approximately 12 inches below the water surface, or at half the depth of the water column (when the depth of the stream is 23 inches or less). Sample bottles will be filled using the "U" scoop motion, to ensure that the sample will not be biased with bacteria that concentrate in the surface micro-layer.

Field staff are provided with a copy of this approved QAPP and are familiar with the goals and objectives for the project. They have training and experience in water quality sampling techniques and pollution identification and correction as described in both the Trend monitoring plan and the PIC protocol manual.

During sample collection field staff note any unusual odors, sheen, matting, vegetative growth, laundry lint, food waste, temperature, animal tracks, animal waste, or any other characteristics that may indicate an FC source at or near the water sample. Field descriptions will include location and orientation of photographs and observations.

For sample locations that do not have distinctive identifiers (i.e. a property with a specific address) a GPS device will be used to mark the location of the sample being taken. The sample will be given a unique identifier and entered in the GPS per procedures outlined in the owner's manual.

In case of high FC counts, visual confirmation of a direct sewage discharge, or suspected grey water discharge permission would be asked of the homeowner to conduct a dye test. The procedure for conducting a dye test is found in the PIC Pollution Identification and Correction Protocol Manual.

8.2 Measurement and Sample Collection

The procedures to be followed for sample collection are described in Chapter 2 "Sample Collection and Testing" of the KPHD Protocol Manual for Pollution Source Identification and Correction (**Appendix A-1**), and Section 8 of the Water Quality Trend Monitoring Plan for Streams and Marine Waters (**Appendix A-2**).

8.3 Containers, Preservation Methods, Holding Times

Water samples are collected in sterile 100 milliliter (ml) bottles for bacteria and 250 ml bottles for nutrient analysis. Each bottle will be clearly labeled with the sample name and/or identification number, collection time, and date.

Sample analysis will begin no later than 24 hours from collection for bacteria and 48 hours for nutrient analysis (NO3+NO2 and Ammonia). Water sample handling is the responsibility of project field staff. Water samples for bacteria are collected in 100 ml sterile water bottles and stored at $< 10^0$ C while transported. Water samples for nutrients are collected in 250 mL sterile containers and stored at < 4 degrees Celsius while transported. Following collection of samples in the field the samples are placed in a dedicated sample cooler with ice and either delivered directly to the KPHD's contract laboratory or brought back to the KPHD offices in Bremerton, where they are placed in a designated refrigerator.

8.4 Invasive Species Evaluation

Invasive species for this project area would typically be noxious weeds and will be reported to the Kitsap County's Noxious Weed Program for investigation.

8.5 Equipment Decontamination

Water samples bottles are sterile per laboratory quality assurance plan. They are single use bottles. Refer to PIC protocols for dye test cross-contamination avoidance.

8.6 Sample Identification

Sample identification for routine monitoring will be labeled with a unique alpha-numeric station identifier. The GPS coordinates and a short description of the station will also be associated with this identifier. Investigative samples associated with specific properties will be labeled by address and sample locations (i.e. 123 Main Street mailbox).

8.7 Chain-of-Custody

A laboratory services/chain-of-custody form is completed by project field staff. The information on the chain-of-custody form includes project area name, staff name and contact information, billing information, sample identification, time collected, method of analysis and any comments pertinent to the sample. The form is signed and dated by the project field staff, and also by lab staff who verify receipt of samples. The samples are brought to the contract laboratory the same day they are collected. A copy of this form is found in **Appendix A-3**.

8.8 Field Log Requirements

- Clearly record the sample name, collection time, location, drainage size, pipe diameter, and pipe material (if applicable) in the field notebook.

- Record detailed parcel-oriented sample descriptions in the field notebook so that outfalls can be re-sampled by different staff, if necessary.
- Record latitude and longitude of the discharge with a GPS unit and take digital photographs. Photographs are helpful for locating sampling stations during subsequent surveys.
- Enter the sample information in the field notebook.
- Print the project name at the top of the page, the start/end locations, include the date, staff initials and the weather and tide conditions. See Table 7.

Table 8. Sample Field Notebook

Murden Creek watershed **Staff Initials** **DATE**

Weather conditions (e.g. Rain, Temp 50F, wind S at 10 mph)

Sample ID	Time	Latitude	Longitude	Description	Comments
Mur01	10:15	xx.xxxxx	xx.xxxxx	Mouth station	Approximately 10 waterfowl in area

8.9 Other Sampling-Related Activities

There will be no special training or certification required for project personnel above and beyond what is required per the project staff's KPHD Environmental Health job classifications. Project staff are trained to demonstrate competency in the water quality monitoring program components (**Appendix A-1 and A-2**).

Kitsap Public Health District Policy #A-22 describes the types of training provided for staff and associated documentation of this training. The purpose for this administrative policy is "to identify the procedures for employee training and development to improve employee performance, and to build an agency workforce capable of achieving the District's mission and performance goals." Current training required for project personnel is sufficient to fulfill the goals and objectives for this project.

9.0 Measurement Methods

9.1 Lab Measurement Methods Table

See section 9.1.4

9.1.1 Analyte

Laboratory samples collected will be analyzed for FC bacteria and the following nutrients; total nitrogen, nitrate-nitrite, total phosphorous, and ammonia.

9.1.2 Matrix

The project matrix for this project will be freshwater sources in the area including streams, creeks, stormwater, and any other fresh water flows in question.

9.1.3 Number of Samples

The estimated number of samples is based on the sample plan components:

Table 9. Estimated Number of Samples

Plan components	Matrix	# stations	frequency	Total Number FC and Nutrients Samples
				(includes 1 field blank and 1 duplicate per event every 10 samples)
Routine sampling	Fresh water	3	monthly	108
Investigative sampling	Fresh water	TBD*	TBD*	As needed

* TBD to be determined

9.1.4 Expected Range of Results

Refer to Tables 6 and 10.

9.1.5 Analytical Method

FC samples are analyzed at the KPHD contracted laboratory, Lab/Cor, Inc., which is accredited by the Department of Ecology and National Voluntary Laboratory Accreditation Program. Nutrient samples are analyzed at Aquatic Research which is accredited by the Washington State Department of Ecology.

The samples are transported by project staff. The lab will use the membrane filtration technique for FC analysis of freshwater samples. The analysis follows SM 9222D membrane filtration described in Standard Methods for the Examination of Water and Wastewater (APHA, 1999)[6]. In the event there is high turbidity in the sample, then the laboratory will utilize the MPN Colilert 18 SM 9223 B method. The method detection limit (MDL) for both methods is < 1 without dilution.

9.1.6 Sensitivity/Method Detection Limit (MDL)

Typically the MDL for a 100 ml sample submission would be <1. However, the MDL does not pertain to this analysis since it dependent on the prepared volume which can vary from sample to sample.

9.2 Sample Preparation Method(s)

- Clean and disinfect sample preparation hood. Place all necessary equipment in hood.
- Set-up the Millipore filtration manifold and switch the vacuum pump to 'on'.

- If not sampled directly into an appropriate vessel (non-compliance samples only), shake and aseptically add 100 ml of the parent sample to an appropriately labeled IDEXX 120 ml vessel.
- Shake bottle vigorously 25 times prior to filtration to assure adequate sample mixing.
- Place a Pall, 0.45um, gridded microfunnel onto the manifold.
- With the valve in the off' position, slowly pour the sample into the column.
- Allow the sample to equilibrate for 10-25 seconds prior to applying vacuum as to provide a uniform colony loading
- Once filtration is complete, remove the microfunnel and separate the base from the column
- Remove the gridded filter and place onto an FC media plate using aseptic techniques.
- Vacuum seal the samples and submerge upside-down in a water bath maintained at 44.5^0 +/- 0.20^0 C.
- Samples can be removed from the water bath 24 hours post incubation
- Quantify CFU/ 100ml ensuring that all dilutions and filter fractions are taken into consideration.
- Record sample/preparation information on the sample bench sheet.

9.3 Special Method Requirements

There are no special method requirements associated with this project.

9.4 Field Procedures and Analysis

The following field measurements will be conducted during routine sampling

Table 10. Field Procedures and Analysis

Parameter	Method	Range	Measurement Increment	Units
Conductivity & Salinity	Hydrolab water quality multiprobe	0-100	0.1	mS/cm
pH	Hydrolab water quality multiprobe	0-14	0.1	pH Units
Temperature	Hydrolab water quality multiprobe	-5 to 50	0.1	Degree C
Dissolved oxygen	Hydrolab water quality multiprobe	0 to 50	1	mg/L
Total Nitrogen	SM20 4500NC	0.05-4.0	0.001	mg/L
Nitrate-Nitrite	SM20 4500NO3F	0.010-2.0	0.001	mg/L
Ammonia	SM20 4500NH3H	0.010-2.0	0.001	mg/L
Total Phosphorous	SM20 4500PF	0.002-2.0	0.001	mg/L
Fecal coliform	SM 9222D membrane filtration Without dilution	<1->200	0.1	FC/100ml

9.5 Lab(s) Accredited for Method(s)

Kitsap Health has contracted with Lab/Cor, Inc and Aquatic Research which are both Washington Department of Ecology-accredited laboratories.

10.0 Quality Control (QC) Procedures

10.1 Table of Field and Lab QC Required

Please refer to Section 6 for relevant MQO's.

Laboratory quality control samples will include laboratory blanks, laboratory duplicates, medium sterility, and laboratory control samples (LCS). The following laboratory quality control procedures apply to the entire data set for a given parameter measured during a specific laboratory "batch" or uninterrupted series of analyses and are summarized as follows:

- The quality control objective for the laboratory blank is to achieve a concentration less than the analyte detection limit. If the blank is greater than the field sample concentration, the results will be rejected or reanalysis will be requested, unless the field samples are below the non-detectable limit. The laboratory QA manager will review laboratory procedures and decide if samples should be re-analyzed if blank contamination is noted.
- A laboratory duplicate is one sample that has been split and analyzed twice. If both results are below laboratory reporting limits, no evaluation of duplicates is required. If duplicates are within 20% relative percent difference (RPD), they are acceptable. For duplicate RPD values that are greater than 20%, all data that exceed 20% RPD will be assessed to determine whether the following apply:
  - RPD results may be misleading at low concentrations within five times the detection limit. If this is the case, the data will be accepted.
  - RPD values that do not meet the above criteria but are less than 35% RPD for water samples will be considered for inclusion as an estimated value if all other lab QA for that parameter (blanks, LCS, and matrix spikes) is acceptable.
  - Results with RPDs of greater than 35% for water samples will be considered for rejection.
- LCS acceptance criteria varies with the analytical method. Current laboratory QC charts will be used to assess LCS recovery. If the results fall outside the Warning Limits, the laboratory QA manager or laboratory manager will determine the laboratory's next course of action. If the results fall outside the Action Limit, the analysis will be repeated, if possible, and assigned a data qualifier if re-analysis is not possible.

10.2 Corrective Action Processes

Control cultures are to be performed with each new media/ medium lot. Known positive and negative control cultures are used against new lot media/medium for the organism under test.

- Sterility and positive/negative controls are to be performed on all prepared media.
- If the media fails sterility or growth control, the product is to be pulled from use and/or replaced (or until the source of the problem is identified).
- Dye tests must be conducted pursuant to Chapter 2 of the PIC Pollution Identification and Correction Manual (Appendix A-1) in order to be enforceable.

11.0 Data Management Procedures

11.1 Data Recording/Reporting Requirements

Proper data management is essential for the successful completion of this project and for all water quality assessment activities performed by the PIC program. Table 10 provides a summary of the data that will be collected for this project and how it will be managed. Data management procedures are described in more detail in the Manual of Protocol and the Water Quality Trend Plan (**Appendix A-1 & A-2**).

Table 10. Data Recording/Reporting

Task	Type of Data or Information	Method of Data Collection/Storage
Routine and investigative sampling	Water sampling FC bacteria results Nutrient results Physio-chemical parameters Flow measurements Optical brighteners	Chain-of-custody Laboratory analytical results Water quality database Excel spreadsheets (for submission to EIM)
PIC property surveys	PIC survey form	Project files, PIC database
Mail-in survey following PIC property site visits	Postcard survey form	Project files, spreadsheet
Training evaluation forms	Evaluation form collected following OSS workshops	Project files, spreadsheet

Data is reviewed prior to entry to ensure that all required data sets have been included, parameters monitored are characteristic of expected results, and laboratory analytical results are characteristic of expected results. When project staff determine the dataset is either incomplete or includes uncharacteristic results, the Project Lead or Program Manager will be consulted for a decision regarding the validity of the data. Data may only be excluded with the approval of the Project Lead or Program Manager. Once it is determined that the data is acceptable, staff export

data and/or perform data entry. All data input to the database will have a 100% review after input is complete to assure no transcription errors have occurred. The water quality database and servers for Excel spreadsheet files are automatically backed-up on a daily basis to minimize the loss of data caused by electrical or computer malfunctions.

Dye testing is utilized to provide a visual link between a failing onsite septic system (OSS) and hot spot drainages. A dye test is considered positive when dye is observed from the eluted charcoal placed at the location of the hotspot.

- Example water sampling data fields include station ID, location (GPS coordinates), sample date and time, and any pertinent observations. All data collected through this program will be stored in the PIC program project files and electronically in the Water Quality database, or in a spreadsheet. Electronic data will also be provided to Ecology in EIM format. The parcel-specific monitoring data collected for this project will be entered into spreadsheets and organized by address.
- The management and retention of all records will be conducted in accordance with KPHD Administrative Policy A-30, Records Management (effective date April 1, 2009).
- Computerized information systems are maintained by the KPHD Information Technology (IT) program. Hardware and software licenses, upgrades, and maintenance are managed by the IT program to ensure data is accessible, regularly backed-up and retained.

11.2 Laboratory Data Package Requirements

- Lab/Cor, Inc. and Aquatic Research provides a completed chain-of-custody, a final report, and an analysis report cover for all water samples. The chain-of-custody enumerates the FC and nutrient results including dates and times samples were received. It includes a review box for date and initials.
- The analysis report cover includes the FC results and results of the negative and positive controls. It details the standard method SM 9222D membrane filtration and is signed by the analyst.

11.3 Electronic Transfer Requirements

Electronic transfer of data will not be required for routine and investigative sampling for this project.

11.4 Acceptance Criteria for Existing Data

The only existing data that will be used for this project will be water quality data (for FC and nutrients) collected by the City of Bainbridge Island.

11.5 EIM data Upload Procedures

PIC staff will submit data to Ecology's EIM system according to the upload procedures specified by Ecology. Kitsap Public Health has submitted data to EIM for several years and staff are trained and experienced with the upload procedures.

12.0 Audits and Reports

12.1 Number, Frequency, Type, and Schedule of Audits

Laboratory quality control data is reviewed monthly by the analysts and annually during the internal audit process. The internal audit evaluations are either performed by the laboratory director or quality assurance officer. Verification of the quality control data must show count agreement within 10% by verified and duplicate analyses. Quality control samples that are out of acceptable limits are responded to according to the lab's corrective action procedures.

12.2 Responsible Personnel

Laboratory audits are conducted monthly by laboratory analysts and annually by the laboratory director or quality assurance office.

12.3 Frequency and Distribution of Report

Semi-annual reports will be submitted by April 15, 2013, October 15, 2013, April 15, 2014, October 15, 2014, April 15, 2015, October 15, 2015. A final report draft will be submitted December 31, 2015.

12.4 Responsibility for Reports

The project lead will prepare semi-annual and final reports. The final report will be reviewed internally by PIC staff, and also sent to the Ecology for review. The project manager, Stuart Whitford will review and submit reports.

13.0 Data Verification

13.1 Field Data Verification, Requirements, and Responsibilities

Field staff calibrate field equipment and review field data during collection to ensure that all required data has been collected and that parameters monitored are characteristic of expected results.

Information collected during PIC property surveys are recorded on the PIC survey form. This information is reviewed for accuracy and completeness by project staff and is maintained electronically by transferring it to the PIC database. The hard copy of the property survey form is filed with the PIC project files. The front page of the form is scanned and can be made available electronically upon request. Component sketches, based on homeowner recollection, will be drawn on the back side of the property survey form and scanned into the OSS records for properties with "unknown" septic systems.

13.2 Lab Data Verification

- FC bacteria and nutrient data will be verified by the laboratory and an analysis report will be submitted with the completed chain-of-custody. Field staff and project lead will review the report and determine whether the laboratory analytical results are characteristic of expected results as detailed in Tables 4, 5, and 6.
- Project staff will review the data and determine that whether the dataset is complete and whether the data meets the requirements of this QAPP.

- If results are not characteristic or are not complete, the project lead or program manager will review all QC sample results and determine the validity of the data. Data may only be excluded with the approval of the project lead and program manager.
- Once it is determined that the data is acceptable, staff export data and/or perform data entry. All data input to the database will have a 100% review after input is complete to assure no transcription errors have occurred. The water quality database and servers for spreadsheet files are automatically backed-up on a daily basis to minimize the loss of data caused by electrical or computer malfunctions.
- Charcoal pack duplicates from non-visual dye test are sent to Ozark Underground Laboratory for spectrofluorophotometric analysis.

13.3 Validation Requirements

Data validation will not be conducted as part of this project.

14.0 Data Quality (Usability) Assessment

14.1 Process for Determining Whether Project Objectives Have Been Met

Please refer to section 6.2 above for details about how data usability will be assessed.

The Project Lead will review the grant contract agreement and this QAPP and compare project progress to the due dates. Semi-annual performance reports will include a comparison of actual accomplishments to the outputs/outcomes established in the contract agreement for the period. If established outputs/outcomes were not met, the report will include an explanation. The report will also include comments regarding additional tasks that were accomplished during the reporting period.

14.2 Data Analysis and Presentation Methods

Data generated for this project will be utilized for identifying fecal and nutrient pollution and assessing land use practices with respect to onsite septic systems, use of fertilizers, pet and livestock manure management.

14.3 Treatment of Non-Detects

The low end of the expected range of results for the fecal coliform APHA SM 9222D membrane filtration is < 1 FC/100ml. These will be treated reported as 0.5 for data entry purposes.

Charcoal packs from dye tests will be sent to Ozark Underground Labs for analysis of non-visual dye concentrations. OSS with non-visual positive dye results are rated as suspect and may require a follow-up dye test.

14.4 Sampling Design Evaluation

Sampling design will be evaluated in conjunction with lab data verification. The results will be reported in semi-annual and final reports. The number and location of samples will also be evaluated annually.

14.5 Documentation of Assessment

Project assessments will be documented in the final report.

The format for the final report will include; Background and Problem statement, Project description, Goals and Accomplishments, Project Design and methods, Results and discussion, Conclusions, Recommendations and References. Additionally, PIC staff will incorporate any recommendations provided by Ecology regarding format.

15.0 References

1. Kitsap Public Health District, 2011 Water Quality Monitoring Report.

2. Kitsap Public Health District, Pollution Source Identification and Correction; Manual of Protocol, 2011.

3. Kitsap County Health District, Water Quality Trend Monitoring Plan, Streams and Marine Waters, March 2011.

4. City of Bainbridge Island, Water Quality Program's State of the Island's Water Quality Report 2012.

5. United States Department of Agriculture, Soil Conservation Service, Soil Survey of Kitsap County Area, Washington, September 1980.

6. Standard Methods for the Examination of Water & Wastewater 20th Edition, by Andrew D. Eaton and Arnold E.Greenburg, 1/1/1999, by American Public Health Association Publications.

7. Washington State Department of Ecology, 2010. Impaired Water Body [303(d)] Listing (http://www.ecy.wa.gov/programs/wq/303d/index.html)

8. Washington State Department of Ecology, Water quality standards (http://www.ecy.wa.gov/programs/wq/swqs/index.html)

16.0 Appendices

APPENDICES A-1 → A-6 ARE AVAILABLE ON REQUEST

Appendix A-1 Kitsap Public Health District
Pollution Source Identification and Correction Protocol Manual
Appendix A-2 Kitsap County Health District
Water Quality Monitoring Trend Plan for Streams and Marine Waters
Appendix A-3 Laboratory Chain of Custody and Laboratory Results Forms
Appendix A-4 Laboratory Standard Operating Procedure
Appendix A-5 Pollution Identification and Correction Program Property Survey Form
Appendix A-6 Follow-up Property Visit Survey Form

Appendix B -- Glossary, Acronyms, and Abbreviations

Appendix B. Quality Assurance Glossary, General Terms, and Abbreviations

QA Glossary

Accreditation - A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data. For Ecology, it is "Formal recognition by (Ecology)…that an environmental laboratory is capable of producing accurate analytical data." [WAC 173-50-040] (Kammin, 2010).

Accuracy - The degree to which a measured value agrees with the true value of the measured property. US EPA recommends that this term not be used, and that the terms precision and bias be used to convey the information associated with the term accuracy (USGS, 1998).

Analyte - An element, ion, compound, or chemical moiety (pH, alkalinity) which is to be determined. The definition can be expanded to include organisms, e. g. fecal coliform, Klebsiella, etc. (Kammin, 2010).

Bias - The difference between the population mean and the true value. Bias usually describes a systematic difference reproducible over time, and is characteristic of both the measurement system, and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI) (Kammin, 2010; Ecology, 2004).

Blank - A synthetic sample, free of the analyte(s) of interest. For example, in water analysis, pure water is used for the blank. In chemical analysis, a blank is used to estimate the analytical response to all factors other than the analyte in the sample. In general, blanks are used to assess possible contamination or inadvertent introduction of analyte during various stages of the sampling and analytical process (USGS, 1998).

Calibration - The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured (Ecology, 2004).

Check standard - A substance or reference material obtained from a source independent from the source of the calibration standard; used to assess bias for an analytical method. This is an obsolete term, and its use is highly discouraged. See Calibration Verification Standards, Lab Control Samples (LCS), Certified Reference Materials (CRM), and/or spiked blanks. These are all check standards, but should be referred to by their actual designator (i.e. CRM, LCS, etc.) (Kammin, 2010; Ecology, 2004)).

Comparability - The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator (USEPA, 1997).

Completeness - The amount of valid data obtained from a data collection project compared to the planned amount. Completeness is usually expressed as a percentage. A data quality indicator (USEPA, 1997).

Continuing Calibration Verification Standard (CCV) - A QC sample analyzed with samples to check for acceptable bias in the measurement system. The CCV is usually a midpoint calibration standard that is re-run at an established frequency during the course of an analytical run (Kammin, 2010).

Control limits - Statistical warning and action limits calculated based on control charts. Warning limits are generally set at +/- 2 standard deviations from the mean, action limits at +/- 3 standard deviations from the mean (Kammin, 2010).

Data Integrity- A qualitative DQI that evaluates the extent to which a dataset contains data that is misrepresented, falsified, or deliberately misleading (Kammin, 2010).

Data Quality Indicators (DQI) - Data Quality Indicators (DQIs) are commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity (USEPA, 2006).

Data Quality Objectives (DQO) - Data Quality Objectives are qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA, 2006).

Dataset - A grouping of samples, usually organized by date, time and/or analyte (Kammin, 2010).

Data validation - An analyte-specific and sample-specific process that extends the evaluation of data beyond data verification to determine the usability of a specific data set. It involves a detailed examination of the data package, using both professional judgment, and objective criteria, to determine whether the MQOs for precision, bias, and sensitivity have been met. It may also include an assessment of completeness, representativeness, comparability and integrity, as these criteria relate to the usability of the dataset. Ecology considers four key criteria to determine if data validation has actually occurred. These are:

- Use of raw or instrument data for evaluation
- Use of third-party assessors
- Dataset is complex
- Use of EPA Functional Guidelines or equivalent for review

Examples of data types commonly validated would be:

- Gas Chromatography (GC)
- Gas Chromatography-Mass Spectrometry (GC-MS)
- Inductively Coupled Plasma (ICP)

The end result of a formal validation process is a determination of usability that assigns qualifiers to indicate usability status for every measurement result. These qualifiers include:

- No qualifier, data is usable for intended purposes
- J (or a J variant), data is estimated, may be usable, may be biased high or low
- REJ, data is rejected, cannot be used for intended purposes (Kammin, 2010; Ecology, 2004)

Data verification - Examination of a dataset for errors or omissions, and assessment of the Data Quality Indicators related to that dataset for compliance with acceptance criteria (MQO's). Verification is a detailed quality review of a dataset (Ecology, 2004).

Detection limit (limit of detection) - The concentration or amount of an analyte which can be determined to a specified level of certainty to be greater than zero (Ecology, 2004).

Duplicate samples - two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis (USEPA, 1997).

Field blank - A blank used to obtain information on contamination introduced during sample collection, storage, and transport (Ecology, 2004).

Initial Calibration Verification Standard (ICV) - A QC sample prepared independently of calibration standards and analyzed along with the samples to check for acceptable bias in the measurement system. The ICV is analyzed prior to the analysis of any samples (Kammin, 2010).

Laboratory Control Sample (LCS) - A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples (USEPA, 1997).

Measurement Quality Objectives (MQOs) - Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness (USEPA, 2006).

Measurement result - A value obtained by performing the procedure described in a method (Ecology, 2004).

Method - A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed (EPA, 1997).

Method blank - A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples (Ecology, 2004; Kammin, 2010).

Method Detection Limit (MDL) - This definition for detection was first formally advanced in 40CFR 136, October 26, 1984 edition. MDL is defined there as the minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, and reported to be greater than zero (Federal Register, October 26, 1984).

Percent Relative Standard Deviation (%RSD) - A statistic used to evaluate precision in environmental analysis. It is determined in the following manner:

Percent relative standard deviation, %RSD = (100 * s)/x where s = sample standard deviation, and x = sample mean (Kammin, 2010).

Parameter - A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene, nitrate+nitrite, and anions are all "parameters" (Kammin, 2010; Ecology, 2004).

Precision - The extent of random variability among replicate measurements of the same property; a data quality indicator (USGS, 1998).

Quality Assurance (QA) - A set of activities designed to establish and document the reliability and usability of measurement data (Kammin, 2010).

Quality Assurance Project Plan (QAPP) - A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives (Kammin, 2010; Ecology, 2004).

Quality Control (QC) - The routine application of measurement and statistical procedures to assess the accuracy of measurement data (Ecology, 2004).

Relative Percent Difference (RPD) - RPD is commonly used to evaluate precision. The following formula is used:

Abs(a-b)/((a+b)/2) * 100

Where a and b are 2 sample results, and abs() indicates absolute value

RPD can be used only with 2 values. More values, use %RSD.

(Ecology, 2004)

Replicate samples - two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled (USGS, 1998).

Representativeness - The degree to which a sample reflects the population from which it is taken; a data quality indicator (USGS, 1998).

Sample (field) – A portion of a population (environmental entity) that is measured and assumed to represent the entire population (USGS, 1998).

Sample (statistical) – A finite part or subset of a statistical population (USEPA, 1997).

Sensitivity - In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit (Ecology, 2004).

Split Sample – The term split sample denotes when a discrete sample is further subdivided into portions, usually duplicates (Kammin, 2010).

Standard Operating Procedure (SOP) – A document which describes in detail a reproducible and repeatable organized activity (Kammin, 2010).

Systematic planning - A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning (USEPA, 2006).

References

Ecology, 2004. Guidance for the Preparation of Quality Assurance Project Plans for Environmental Studies. http://www.ecy.wa.gov/biblio/0403030.html

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Kammin, 2010. Definition developed or extensively edited by William Kammin, 2010.

USGS, 1998. Principles and Practices for Quality Assurance and Quality Control. Open-File Report 98-636. http://ma.water.usgs.gov/fhwa/products/ofr98-636.pdf

General Terms

Ambient: Background or away from point sources of contamination.

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

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

Conductivity: A measure of water's ability to conduct an electrical current. Conductivity is related to the concentration and charge of dissolved ions in water.

Dissolved oxygen (DO): A measure of the amount of oxygen dissolved in water.

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

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

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

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

Nutrient: Substance such as carbon, nitrogen, and phosphorus used by organisms to live and grow. Too many nutrients in the water can promote algal blooms and rob the water of oxygen vital to aquatic organisms.

Parameter: A physical chemical or biological property whose values determine environmental characteristics or behavior.

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

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

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

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

Salmonid: Any fish that belong to the family *Salmonidae*. Any species of salmon, trout, or char is considered a salmonid. www.fws.gov/le/ImpExp/FactSheetSalmonids.htm

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

Streamflow: Discharge of water in a surface stream (river or creek).

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

Total Maximum Daily Load (TMDL): A distribution of a substance in a waterbody designed to protect it from not meeting (exceeding) water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a margin of safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

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

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

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

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

BMP	Best management practices
DL / MDL	Detection Limit / Method Detection Limit
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management (Ecology database)
EPA	U.S. Environmental Protection Agency
FC	Fecal Coliform bacteria
GIS	Geographic Information System software
GPS	Global Positioning System
KPHD	Kitsap Public Health District
LCS	Laboratory Control Standard?
MQO	Measurement quality objective
OSS	On-site Septic System
NEP	National Estuary Program (EPA)
PIC	Pollution (Source) Identification and Control
QA	Quality assurance
QAPP	Quality Assurance Project Plan
RL	Reporting Limit
RPD	Relative percent difference
SOP	Standard operating procedures
TMDL	(See Glossary above)
WAC	Washington Administrative Code
WRIA	Water Resources Inventory Area

Units of Measurement

°C	degrees centigrade
°F	degrees Farenheit
FC/100 ml	fecal coliform per 100 milliliter
mg/L	milligrams per liter (parts per million)
mS/cm	millisiemens per centimeter
ppt	parts per thousand