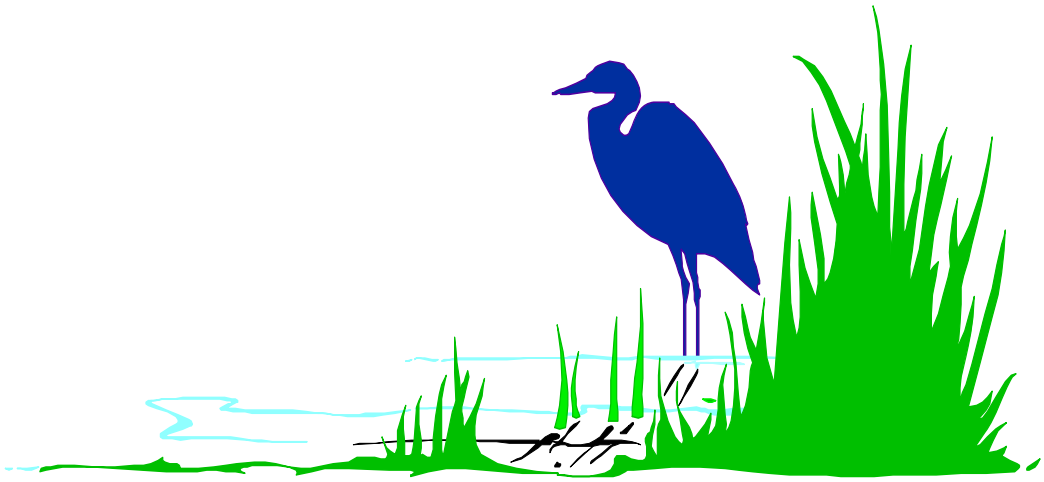
MASON COUNTY PUBLIC HEALTH
Hood Canal Marine Recovery Area On-site Septic System Discovery and Pollution Abatement Project
Quality Assurance Project Plan



January 29th, 2010

Funded by:

The State of Washington
Department of Ecology
Federal Clean Water Act
Non-point Source Fund (Section 319)
G1000278

Prepared by:
Amy Georgeson

MASON COUNTY
Hood Canal Marine Recovery Area On-site Septic System Discovery and Pollution Abatement Project
QUALITY ASSURANCE PROJECT PLAN

Funded By:

Federal Clean Water Act
Non-point Source Fund (Section 319)

GRANT AGREEMENT BETWEEN
THE STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
AND
MASON COUNTY PUBLIC HEALTH

Approved as to form and content

_____	_____
Tammy Riddell *date*	Debbie Riley, R.S. *date*
Grant Officer	Project Manager
Washington State Department of Ecology	Mason County Public Health

Distribution List

Name	Affiliation	Title	Phone	Address/Email
Tammy Riddell	Dept. of Ecology	Contract Administrator	(360) 407-6295	W.S. Dept. of Ecology Water Quality PO Box 47775 Olympia, WA 98504-7775 trid461@ecy.wa.gov
Debbie Riley	Mason County Public Health	Environmental Health Manager	(360) 427-9670 ext. 358	PO Box 1666 Shelton, WA 98584 dlr@co.mason.wa.us
Amy Georgeson	Mason County Public Health	EHS III	(360) 427-9670 ext. 544	PO Box 1666 Shelton, WA 98584 amyg@co.mason.wa.us
Carol Spaulding	Mason County Public Health	EHS III	(360) 427-9670 ext. 580	PO Box 1666 Shelton, WA 98584 cns@co.mason.wa.us
Cindy Waite	Mason County Public Health	EHS III	(360) 427-9670 ext. 353	PO Box 1666 Shelton, WA 98584 cew@co.mason.wa.us
Kathy Krogslund	University of Washington Marine Lab	Laboratory Manger	(206) 543-9235	School of Oceanography Univ. of Washington Box 355351 Seattle, WA 98195 kkrog@u.washington.edu

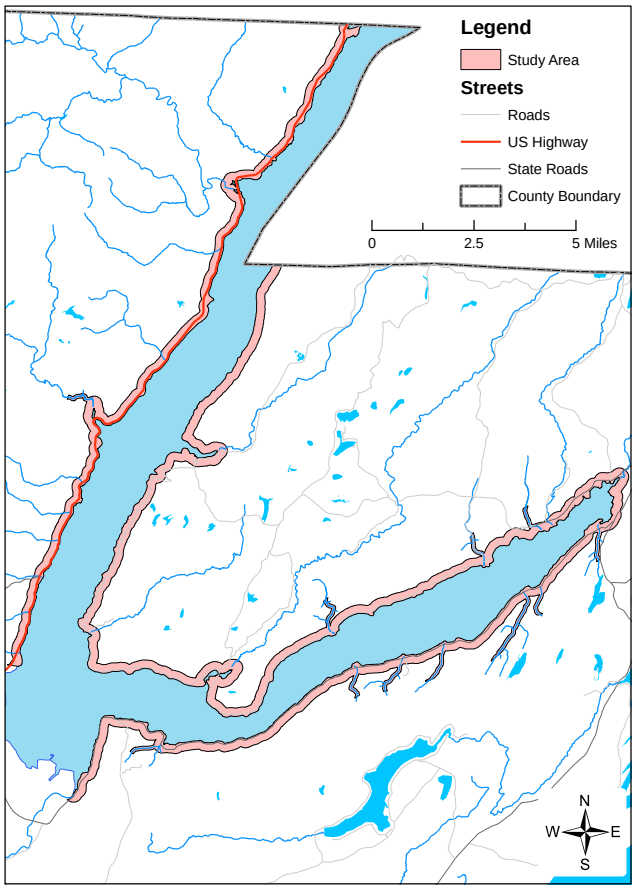
Acronyms and Abbreviations

DOE	Washington State Department of Ecology
DOH	Washington State Department of Health
DI	De-ionized Water
EPA	US Environmental Protection Agency
FC	Fecal Coliform
GMV	Geometric mean value
HCDOP	Hood Canal Dissolved Oxygen Program
HCSEG	Hood Canal Salmon Enhancement Group
KCHD	Kitsap County Health District
MCPH	Mason County Public Health
MCWL	Mason County Water Laboratory
mg/L	milligram per liter (equivalent to parts per million)
mL	milliliter
NH4	Ammonium
MPN	Most Probable Number
NO2	Nitrite
NO3	Nitrate
PO4	Phosphate
ppt	parts per thousand
O&M	Operation and Maintenance
OSS	On-site Septic System
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
Si(OH)4	Silicic Acid
SM	Standard Method
SOP	Standard Operating Procedure
TMDL	Total Maximum Daily Load
UW MCL	University of Washington Marine Chemistry Lab
WAC	Washington Administrative Code

1. Background and Problem Statement

Hood Canal is a deep, fjord-like body of water, its length bounded by the Olympic Mountains to the west and steep slopes from the Kitsap Peninsula to the east. Its 'L' shape extends from the Strait of Juan de Fuca southwest toward Annas Bay where it turns and continues northeast to Belfair. It is a valuable recreational and commercial resource to three Washington Counties, Jefferson and Kitsap to the north and Mason to the south. The canal receives snowmelt and rain via many rivers and streams. An underlayment of glacial till and basalt, along with a sloped and developed shoreline prevents most deep infiltration. As a result, western Washington rains contribute huge volumes of water that carry surface contaminants to the canal. This large volume of freshwater contributes to the highly stratified temperature and salinity – as well as to the pollution load of the canal.

Figure 1 Hood Canal Streams Study Area



This project will focus on the 303(d) fecal coliform listed streams (303(d) streams) that are within Mason County and flow into Hood Canal and the nearshore area of Hood Canal (See Figure 1). Monitoring will occur near the mouth of freshwater creeks above the marine influence. The analysis will focus on fecal coliform pollution. However, physical parameters and nutrient analyses will also be performed at each monitoring location. The additional analyses will assist staff in determining the pollution source(s) and location(s). The bacteria criteria guiding corrective action will be based on Chapter 173-201A of the Washington Administrative Code (WAC).

1.1. Fecal Coliform Pollution

Fecal pollution is the result of untreated wastes. Fecal Coliform (FC) bacteria exist in the intestines of warm-blooded animals; including, humans, pets, livestock, birds, wildlife, etc. FC found in water samples can indicate the presence of untreated human sewage and animal waste and their associated pathogens.

Previous water quality data and shoreline assessments have demonstrated known and potential FC pollution problems in the Mason County Hood Canal Region. FC pollution has been identified by several agencies; including, the State of Washington Department of Health (DOH) and Department of Ecology (DOE), the Hood Canal Dissolved Oxygen Study Project (HCDOP), the Hood Canal Salmon Enhancement Group (HCSEG) and Mason County. These groups have monitored marine and shoreline drainages; including, streams, seeps, storm water runoff and bulkhead drains.

There are thirteen rivers listed on the 303(d) list for fecal coliform that flow into Hood Canal within Mason County (Table 1). The focus of the project will be each of these listings except for the Skokomish River, which already has a TMDL. Information on the Skokomish River TMDL report (water cleanup plan) can be found at http://www.ecy.wa.gov/programs/wq/tmdl/skokomish/index.html. Project highlights can be found at http://www.ecy.wa.gov/biblio/0810008.html In addition, there are nine marine water areas listed on the 303(d) list for fecal coliform. Six of these areas are adjacent to mouths of 303(d) listed streams (Table 2). The following tables contain the fecal coliform listings within Mason County that are related to Hood Canal.

Table 1 TMDL 303(d) Listed Fresh Water in Mason County

Water Body Name	Parameter	Listing Number / Map Link
SKOKOMISH RIVER	Fecal Coliform	7663
BIG BEND CREEK	Fecal Coliform	45568
DEVERAUX CREEK	Fecal Coliform	45567
HAPPY HOLLOW CREEK	Fecal Coliform	40619
HOLYOKE CREEK	Fecal Coliform	6965
LILLIWAUP CREEK	Fecal Coliform	9889
LITTLE MISSION CREEK	Fecal Coliform	6962
MULBERG CREEK	Fecal Coliform	45581
SHOOFLY CREEK	Fecal Coliform	6960
STIMSON CREEK	Fecal Coliform	6959
TRAILS END CREEK	Fecal Coliform	6966
TWANOH CREEK	Fecal Coliform	6961
TWANOH FALLS CREEK	Fecal Coliform	6964

Table 2 TMDL 303(d) Listed Marine Waters

Water Body Name	Parameter	Listing Number / Map Link
GREAT BEND / LYNCH COVE	Fecal Coliform	6937
GREAT BEND / LYNCH COVE	Fecal Coliform	6939
GREAT BEND / LYNCH COVE	Fecal Coliform	6940
GREAT BEND / LYNCH COVE	Fecal Coliform	6941
GREAT BEND / LYNCH COVE	Fecal Coliform	6942
GREAT BEND / LYNCH COVE	Fecal Coliform	40075
GREAT BEND / LYNCH COVE	Fecal Coliform	40081
GREAT BEND / LYNCH COVE	Fecal Coliform	13930
HOOD CANAL (SOUTH)	Fecal Coliform	40227

The Washington State Department of Health (DOH) classifies commercial shellfish harvesting areas. DOH has classified 566 acres as prohibited, 53 acres as conditional and 9347 acres as approved for commercial shellfish harvest in Hood Canal within the boundaries of Mason County. In addition, DOH performs shoreline surveys to identify potential fecal pollution sources in order to classify commercial shellfish beds. In shoreline surveys of the Mason County Hood Canal shoreline (Hood Canal Growing Areas 4 through 9) from 1996 to 2005, DOH identified approximately 826 "potential sources" of fecal pollution based upon field observations. These properties are located adjacent to Hood Canal within Mason County.

Analyzing stream discharges for FC bacteria can help identify sources of human and animal waste. Mason County Public Health (MCPH) follows the Pollution Identification and Correction (PIC) protocols, outlined in the Mason County Water Quality Standard Operating Procedures (SOP), January 2007. These procedures outline a standardized method of evaluating discharges and identifying and correcting FC sources such as failing onsite sewage systems and inadequate animal waste management.

The mouth of Hill Creek

Several of these creeks were placed on the 303(d) list for fecal coliform based on unpublished monitoring results from MCPH in the early 1990s. Monitoring has occurred at all of the streams within the last ten years. Using existing in-house data and data culled from DOE's Environmental Information Management (EIM) database, MCPH compiled fecal coliform data from the 303(d) listed streams (Table 3). Several streams are listed twice in Table 3 due to inclusion of MCPH and DOE data from different monitoring periods.

Table 3 Summary of FC Monitoring from the Hood Canal 303(d) Creeks

Name	# samples	min	max	GMV	Meets GMV standard	# samples >100	% samples > 100	Meets % standard	Sampling Start Date	Sampling Finish Date	Data Source
Lilliwaup Creek	24	2	52	12.6	Yes	0	0%	Yes	1/27/2004	11/13/2006	MCPH
Lilliwaup Creek	13	1	350	19.6	Yes	3	23%	No	10/16/97	4/20/05	DOE
Big Bend Creek	14	1	290	15.1	Yes	3	21%	No	1/5/04	5/17/05	DOE
Twanoh Creek	17	1	216	9.1	Yes	4	24%	No	1/5/04	8/7/08	DOE
Twanoh Falls Creek	14	1	64	5.5	Yes	0	0%	Yes	1/5/04	5/17/05	DOE
Mulburg Creek	14	1	310	11.3	Yes	3	21%	No	1/5/04	5/17/05	DOE
Happy Hollow Creek	14	1	160	10.0	Yes	1	7%	Yes	1/5/04	5/17/05	DOE
Holyoke Creek	14	1	68	6.5	Yes	0	0%	Yes	1/5/04	5/17/05	DOE
Trails End Creek	3	3	18	6.0	Yes	0	0%	Yes	3/22/05	5/17/05	DOE
Deveraux Creek	12	1	532	9.1	Yes	2	17%	No	1/5/04	5/17/05	DOE
Little Mission Creek	31	2	1600	17.9	Yes	4	13%	No	11/15/2004	6/26/2007	MCPH
Little Mission Creek	12	1	510	13.0	Yes	2	17%	No	10/29/02	9/23/03	DOE
Stimpson Creek	37	2	240	12.3	Yes	3	8%	Yes	1/20/2004	6/26/2007	MCPH
Stimpson Creek	20	1	180	12.9	Yes	2	10%	No	10/29/02	9/7/04	DOE
Shoofly Creek	28	2	300	6.7	Yes	2	7%	Yes	1/20/2004	9/19/2006	MCPH
Shoofly Creek	8	2	76	11.3	Yes	0	0%	Yes	3/4/04	9/7/04	DOE

- All data is for Fecal Coliform colonies/100mL of water. MCPH uses MPN method, MCPH did not research what method was utilized for the data that was obtained from EIM, although it is likely to be membrane filtration.
- GMV is the Geometric Mean Value
- Cells colored blue represent sites that have had at least 10 monitoring events either as listed in EIM or from MCPH's existing data.
- Cells colored orange do not meet either the geometric mean value or percentile standard. These sites should all meet the Extraordinary Water Contact Standard.

MCPH staff will perform sanitary surveys to educate residents on best land-use practices to correct forms of fecal pollution, such as malfunctioning On-site Septic Systems (OSS) or improper management of animal wastes, in order to reduce overall pollution originating from their properties. When failing OSSs are identified as FC sources, staff

will initiate the correction process for those systems and demonstrate a reduction in the FC pollution associated with them, by performing post correction monitoring.

1.2. Nutrient Pollution

Most aquatic life needs dissolved oxygen in order to breathe. Hood Canal has had a history of low dissolved oxygen levels, which have caused periodic fish kills. Records of fish kill date back to the early 1960s. Recent oxygen levels are the lowest in recorded history, prompting increased concerns about the long-term health of the canal.

In June and October of 2003, and again in September of 2006, low-oxygen conditions killed thousands of juvenile perch and left numerous octopuses, sea cucumbers and other marine life suffocating and dying. In the winter of 2006, oxygen levels generally rebounded with an exchange of water from the ocean. Data from the DEPARTMENT monitoring stations in Hood Canal show that hypoxic conditions may persist year-round in the southern portion. Further, the monitoring station in the north (Bangor) shows that hypoxia may be spreading north with conditions of biological stress for up to six months of the year (http://www.hoodcanal.washington.edu/).

The organic materials associated with fecal pollution deplete dissolved oxygen as they break down in the surface water. In addition, nutrients associated with fecal pollution may provide a nutrient source for algae to bloom. When algae die, their decomposition also consumes oxygen from the water.

Nitrate-nitrogen is considered the primary nutrient of interest and is a major contributor to low dissolved oxygen conditions. However, water samples will also be analyzed for ammonium and phosphorus because of their use in identifying improperly functioning septic systems.

The direct relationship of fecal pollution and nutrient pollution is not fully understood. It has been proposed that both functioning as well as failing OSS may contribute to the nutrient load. Nutrient sampling will be conducted in creeks to better understand the relationship between fecal coliform and nutrient pollution and to better understand how an OSS may be failing.

MCPH identified the nutrient 'level of concern' based on the 90th percentile of the ~600 samples that were taken over the course of a previous grant. MCPH found that most sites that had nutrients above the level of concern were associated with failing OSSs. Nutrient 'levels of concern' monitoring locations did not always correspond directly with monitoring locations with elevated fecal coliform levels; however, they were often found in adjacent monitoring locations, which gave a more complete picture of how the septic system may be malfunctioning.

1.3. Logistical Problems

MCPH anticipates that there may be logistical problems encountered in the course of this project such as:

- Storm events may present impassable or dangerous sections preventing access.
- Sampling may be somewhat tidally dependent; to ensure that monitoring occurs above the marine water influence.

- Access to the properties adjacent to the creeks may necessitate gaining permission from owners. MCPH will attempt to utilize the road right of way when identifying monitoring locations.
- Limited project time frame and budget.

2. Project Description

The presence of FC pollution, which can indicate conditions that may be detrimental to human health, has been documented in Hood Canal. In this project, MCPH will identify and correct sources of FC pollution. Issues regarding excess nutrients, including their contribution to the low levels of dissolved oxygen in the canal and their possible relationship with FC levels, will be investigated. The communities in the watershed play a vital role in addressing these concerns. MCPH will continue to educate area residents concerning Hood Canal pollution issues, and support best land-use practices in order to minimize collective anthropogenic pollution inputs.

2.1. **Goals and Objectives**

This project has the following distinct goals:

- Reduce FC pollution in Hood Canal from a variety of sources, including failing OSS and inadequate animal waste management as contributed by the 303(d) listed streams.
- Provide water quality data to establish a baseline of the cumulative inputs of freshwater nutrients into the marine water.
- Provide further water quality data to determine if there is a relationship between FC levels and nutrients in streams that discharge to Hood Canal.
- Provide water quality data to determine if correction of FC sources leads to a reduction of nutrients.
- Educate residents of the Hood Canal watershed about the FC and nutrient impacts on the Canal and actions they can take to limit their effect.

The specific objectives of this project are:

- Monitoring of 12 303(d) streams: 18 samples will be taken from six of the streams and 24 samples will be taken from the six that have been targeted for pollution reductions by the end of this project.
- Measure FC and nutrient concentrations in TMDL 303(d) listed streams that flow into the Hood Canal.
- Completion of sanitary surveys and dye tests to identify and abate fecal coliform pollution sources.
- Determine FC and nutrient concentrations in discharges where FC pollution sources are identified before and after FC source correction.
- The reduction of actual fecal coliform and nutrient loads from 303(d) listed streams and the reduction of those pollutants in the marine water.
- The recommendation to the DEPARTMENT to remove 40% to 100% of streams from the 303(d) list that are addressed under this project.
- The recommendation to DOH to open commercial shellfish harvest areas.

The target population of this project is freshwater 303(d) streams listed for FC that flow into Hood Canal within Mason County. Water quality data for FC and nutrients will be

collected from 303(d) streams that flow into Hood Canal within Mason County. The samples will be analyzed for ammonium (NH4), Nitrite (NO2), Nitrate (NO3), Phosphorus (P) and Silicic Acid (Si(OH)4). Flow and physical parameters will be measured at each site in the field. Physical parameters will include temperature, conductivity and dissolved oxygen.
There are two main study areas. The first area includes parcels that are located within 1000' of Hood Canal. The second area includes parcels that are located within 3500' of Hood Canal and 250' of the 303(d) listed streams (see Figure 1).

This study has two field components. One component is the water quality monitoring at the 303(d) streams listed for fecal coliform. The second component is performing sanitary surveys and dye tests. Initially, sites will be prioritized for sanitary surveys based on Operation and Maintenance (O&M) data from Mason County's Carmody O&M database within the study area.

The creeks targeted in this proposal are:

1. Lilliwaup Creek
2. Big Bend Creek
3. Twanoh Creek
4. Twanoh Falls Creek
5. Mulburg Creek
6. Happy Hollow Creek
7. Holyoke Creek
8. Trails End Creek
9. Deveraux Creek
10. Little Mission Creek
11. Stimpson Creek
12. Shoofly Creek.

The creeks in this proposal for monitoring and fecal coliform identification and corrective actions have been chosen for several reasons:

- Mason County decided to focus on all of the creeks at once because of the limited amount of development that is located adjacent to their shorelines. The development in almost all cases is concentrated along the marine shoreline, near the mouths of these creeks. Mason County Public Health is concerned with areas of development since that is where anthropogenic fecal coliform usually originate (i.e. failing onsite septic systems, pet waste and some in some cases, wildlife waste where humans attract wildlife (i.e. by leaving pet food outside). Generally, there is forestland in the upper reaches of the creeks.
- Most of these creeks are short in total length, between ~1 and ~7 miles, with most of the development located near the mouth of the creeks. Also, the creeks have small drainage basins, making it easy to prioritize and delineate each creek that receives additional investigations.
- There is relatively little development along these creeks (between ~1 and ~30 developed properties per creek). There are a total of ~200 parcels identified as developed directly adjacent to the shorelines of these creeks.

MCPH will recommend removal of 40% to 100% of the streams currently on the 303(d) list that flow into Hood Canal, based on water quality results that meet the

DEPARTMENT's criteria. This is monumental because it will reduce the total pollution loads entering Hood Canal and within the streams themselves. By removing the streams from the 303(d) list, the DEPARTMENT will not be required to perform TMDLs on those streams. This will save the DEPARTMENT and its potential TMDL partners' significant time and resources.

Figure 2 Lynch Cove Aerial Imagery, Hillshade and Study Area

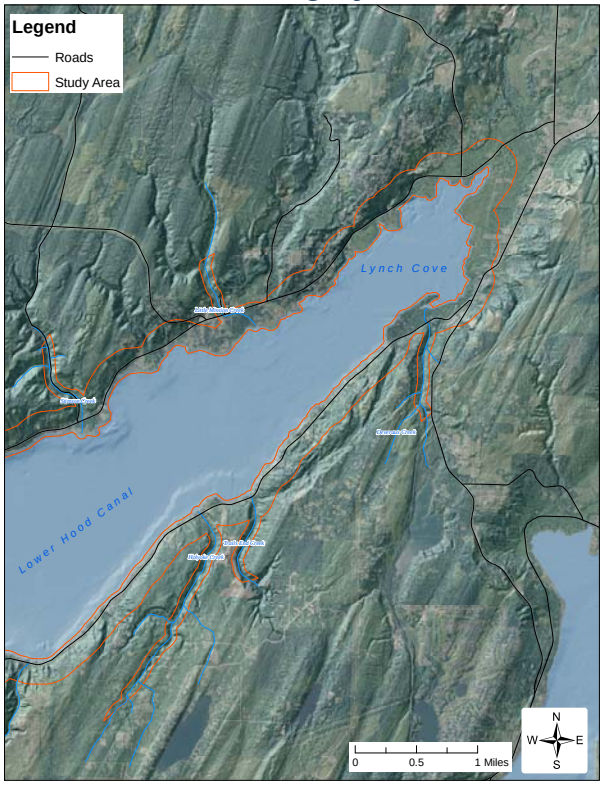


Figure 3 Mid-Lower Hood Canal Aerial Imagery, Hillshade and Study Area

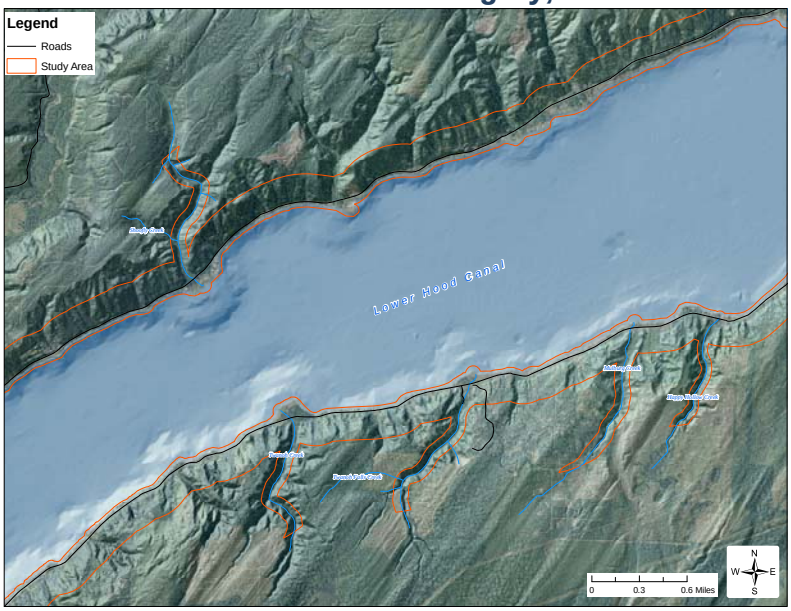
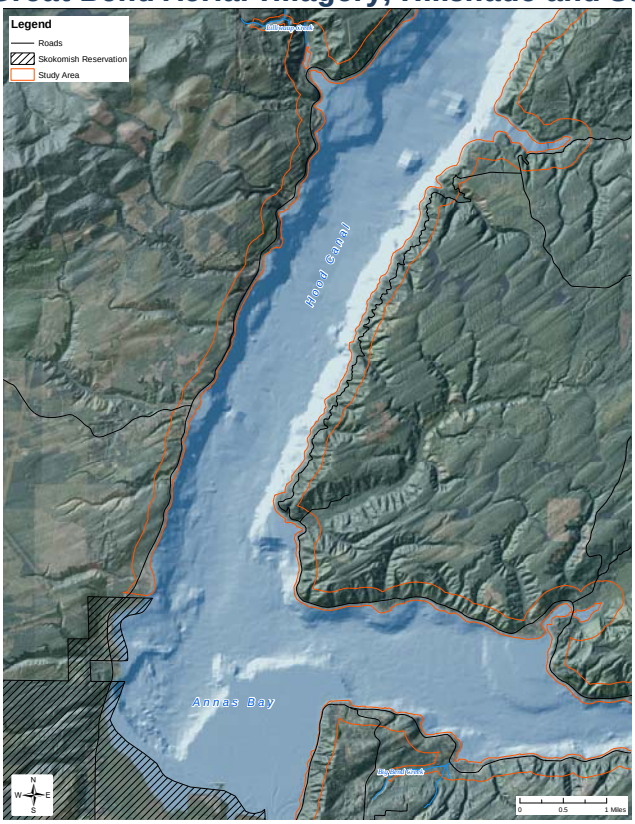


Figure 4 Great Bend Aerial Imagery, Hillshade and Study Area



MCPH will identify FC sources following the Mason County Sanitary Survey procedures (Sanitary Survey) outlined in the Mason County Water Quality Standard Operating Policies and Procedures (SOP), January 2007. Pollution sources will be corrected whenever possible. MCPH will ensure that OSSs are not the source of the fecal pollution through dye testing of appropriate nearby residences. MCPH will educate residents about proper domestic animal waste management. OSS repairs can take many months and may only be initiated, and not necessarily completed, during the period of this contract.

Nutrients, especially nitrogen, are the limiting growth factors for algae in Hood Canal. Algal blooms occur when nutrients are plentiful, and days are warmer and sunnier – typically in late summer. As the blooms die and decompose, dissolved oxygen is consumed from the water. In 2003 and 2006 low dissolved oxygen caused fish kills that originated in the Potlatch/Annas Bay area (and then extended north). Also, HCDOP has identified a chronic low dissolved oxygen problem in much of the Lower Hood Canal (the area located east of the 'Great Bend"). Furthermore, this dead zone may play a significant role in the episodic fish kills that occur near the Great Bend/Annas Bay area.

Therefore, MCPH will perform nutrient and FC monitoring. Since many of these sites were also monitored under the Hood Canal Dissolved Oxygen Program (HCDOP), this monitoring will provide on-going data from these sites. MCPH will assess nutrient loads that are entering the marine waters from the 303(d) streams. This data, in combination with the data collected from the Hood Canal Pollution Identification and Correction Projects, will provide a more complete picture of nutrients entering the marine shoreline.

In all streams that are monitored, we will record changes in fecal coliform and nutrient levels before and after pollution correction(s) occur. We will analyze samples for nitrite, nitrate, ammonium, phosphate and silicic acid (Section 4.4 Summary of Sampling Design for FC and Nutrients). Other nutrients/analytes will not be addressed due to time and budget constraints. This project may reduce oxygen demand from nutrient contamination to Hood Canal.

Monitoring of the 303(d) listed streams may not completely answer the above stated objectives due to unknown variables such as the contribution of background, non-OSS or animal waste sources of FC and nutrients or the spatial, temporal or environmental variation of FC and nutrients. In addition, storm events may limit the ability to access monitoring locations, or may make access unsafe.

Wendy Mathews performing stream monitoring along the west side of Hood Canal

3. Project Organization and Schedule

3.1. Project Organization

The following individuals are key to this plan's development, and to its implementation:

Tammy Riddell, (360) 407-6295, Washington State Dept. of Ecology Southwest Regional Office. Contract Administrator. *Responsible for general project oversight/management for non-point pollution (activity) water quality grants and loans administered through the Water Quality Program. Confirms adherence to contract requirements.*

Debbie Riley (360) 427-9670 x358, Mason County Public Health. Environmental Health Manager. *Responsible for supervising field staff and ensuring that all aspects of the grant agreement are carried out.*

Amy Georgeson (360) 427-9670 x544, Mason County Public Health. Lead field staff. *Responsible for writing the QAPP, over-all project planning, performing stream monitoring, sanitary surveys, laboratory analysis, quartly and final report writing and public education activities*

Cindy Waite (360) 427-9670 x353, Mason County Public Health. OSS/Water Quality Lead, field staff. Responsible for coordinating staff, performing sanitary surveys, laboratory analysis and public education activities

Arlene Hyatt (360) 427-9670 x293, Mason County Public Health. Field staff. *Responsible for QAPP review and editing, performing stream monitoring, sanitary surveys, laboratory analysis and public education activities*

Penny Orth (360) 427-9670 x547, Mason County Public Health. Field staff. *Responsible for performing sanitary surveys, laboratory analysis and public education activities*

Amanda Reynolds (360) 427-9670 x279, Mason County Public Health. Field staff. *Responsible for performing stream monitoring, sanitary surveys, laboratory analysis and public education activities*

Stephanie Kenny (360) 427-9670 x581, Mason County Public Health. Field staff. *Responsible for performing stream monitoring, sanitary surveys, laboratory analysis and public education activities*

Carol Spaulding (360) 427-9670 x580. Mason County Water Laboratory. Laboratory Manager. *Responsible for performing laboratory analysis and QA/QC for fecal coliform*.

Kathy Krogslund, (206) 543-9235, University of Washington, Marine Chemistry Lab. Laboratory Manager. *Responsible for performing laboratory analysis and QA/QC for nutrients*.

3.2. Project Schedule

Table 4 Shoreline Survey Project Schedule

	2010											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monitoring (12 streams)												
Site Selection												
Corrective action*												
Conduct sanitary surveys												
Public meetings												
QAPP preparation												
QAPP approval												
Data entry into EIM												
Progress reports (15th)												

	2011											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monitoring (6 streams)												
Corrective action*												
Conduct sanitary surveys												
Public meetings												
Data entry into EIM												
Progress reports (15th)												

	2012											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monitoring (6-12 streams)												
Corrective action*												
Conduct sanitary surveys												
Public meetings												
Data entry into EIM												
Progress reports (15th)												
Draft and Final report												

** Septic system replacement will occur during the dry months; however minor fixes may occur at any time.

In addition to the above listed items, MCPH will also send out ~830 O&M reminders per year to owners of OSS that are out of compliance with the Carmody tracking schedule. The Carmody Tracking schedule is different from DOH's homeowner required O&M defined in WAC 246-272A-027. Each system type has different requirements. The reason for the different time limits is MCPH wanted to create a sustainable tracking system. MCPH will also be researching, verifying and validating all MCPH records from all parcels within the project study area (~6500 parcel records). These records will then be scanned into Mason County's parcel record program, Land Records. By the end of 2011, the records will be made available to the public via the Mason County website.

MCPH will attempt to utilize the road right-of-way for access to monitoring locations. However, if there are sites where the road access is not near the mouth of the stream, MCPH will seek access from adjacent property owners prior to the initial monitoring event. Monitoring will be coordinated with both the MC water lab (FC) and the University of Washington Marine Chemistry Lab (UW MCL) (nutrients). Both labs are accredited for the parameters identified.

4. Field Sampling Design

4.1. Survey Area Description

MCPH will monitor 12 TMDL 303(d) streams listed for FC within Mason County. MCPH will identify one monitoring location near the mouth of each of the streams above marine water influence. This Quality Assurance Project Plan explains the specific details of the water monitoring and prioritization of sanitary surveys to be conducted by MCPH. It is a supplement to the standard protocols defined in Mason County's SOP. Figure 1 shows the 303(d) streams listed for FC and the overall study area. Figures 2-4 show the 303(d) streams and study area in more detail.

Water quality data for FC and nutrients will be collected from 303(d) streams that are listed for FC that flow into Hood Canal within Mason County. The samples will be analyzed for the following chemical parameters: ammonium (NH4), nitrite (NO2), nitrate (NO3), phosphate (PO4) and silicic acid (Si(OH)4) at the UW MCL. The samples will also be analyzed for fecal coliform (FC) bacteria in the Mason County Laboratory. Flow and physical parameters will be measured at each site in the field. Physical parameters will include temperature, conductivity and dissolved oxygen. MCPH will determine loading for nutrients and FC.

MCPH will compare the FC data collected to the Extraordinary Primary Contact Recreation Water Quality Standard (WAC173-201A Table 200 (2) (b)). The standard states that the FC levels cannot exceed a geometric mean value of 50 colonies/ 100mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 100 colonies/100mL. Hood Canal and all waters flowing into Hood Canal are classified as Extraordinary Primary Contact as per WAC 173-201A.

Stream names, the approximate number of residences in each creek's watershed, and length of the stream in miles are shown in Table 5. See Figures 3 through 11 for maps showing the individual streams and the adjacent developed parcels.

Table 5 Shoreline Survey Segments

Name	FC Listing ID	Length ~miles	~ # Developed Properties
Lilliwaup Creek	9889	7	25
Big Bend Creek	45568	1	30
Twanoh Creek	6961	1.5	1
Twanoh Falls Creek	6964	1.7	30
Mulburg Creek	45581	1.5	15
Happy Hollow Creek	40619	1.1	20
Holyoke Creek	6965	2.5	16
Trails End Creek	6966	1.7	13
Deveraux Creek	45567	1.45	20
Little Mission Creek	6962	3.6	10
Stimson Creek	6959	3	4
Shoofly Creek	6960	1.8	10

Approximately 826 properties along the Mason County Hood Canal shoreline were classified during DOH shoreline surveys as "potential" sources of contamination. MCPH will prioritize these properties for pollution risk and assess them as time allows. MCPH will especially focus on those sites that are adjacent to the 303(d) listed streams.

4.2. Yearly Monitoring Overview and Prioritization

Parcel records will be reviewed prior to all sanitary surveys. Parcel data will be scanned, if not already scanned.

As per the MCPH SOP, a photo of each monitoring location, written description and GPS coordinates of each sampling location will be collected.

4.2.1. Year 1 – 2010

In the first year, MCPH will monitor each stream monthly for the first 10 months. Ideally, this will be completed by December 2010; however, sampling is dependent upon QAPP approval and the sampling may be extended into 2011, in order to obtain 10 samples from each stream. MCPH will utilize the results from this initial monitoring for two purposes.

- After monitoring is complete and FC data are analyzed, MCPH will identify any streams that are eligible for removal from the 303(d) list. According to DOE's Water Quality Program Policy 1-11, a 303(d) listed stream is eligible for consideration for removal from the 303(d) list when 10 samples from within a period of 12 consecutive months meet the water quality standard. If any streams are eligible, MCPH will draft a letter of recommendation for removal to the DEPARTMENT.

- MCPH will then prioritize at least 6 streams for additional monitoring in 2011.

MCPH will perform sanitary surveys in the first year. The initial sanitary surveys will be prioritized based on failed service events as reported in MCPH's Carmody Operation & Maintenance (O&M) database and on their proximity to the 303(d) listed streams or marine water. Once MCPH has at least six months of

monitoring results, MCPH may begin to prioritize sanitary surveys along 303(d) streams that have high pollution loads. The goal is to perform ~42 sanitary surveys and ~7 dye tests in the first year. However, this may be adjusted throughout the contract period depending on the prioritization and on field staff availability.

MCPH will also identify and begin research of the ~6500 parcels within the designated study area. MCPH plans to research and scan ~2170 existing parcel records and ~600 new parcel records per year over the course of this contract.

4.2.2. Year 2 – 2011

In the second year, MCPH will prioritize at least six streams to sample during a minimum of six monitoring events. MCPH proposes to monitor the streams in the following months: February, March, May, June, August and October. The monitoring will be more frequent during the beginning of the year, to help prioritize sanitary surveys. Also, these months will hopefully provide data from wet and dry weather conditions and low flow and saturated conditions. The proposed months may be adjusted depending on staff availability and results of the initial year of monitoring.

In 2011, MCPH will focus sanitary surveys around the 303(d) listed streams that are prioritized for additional monitoring in year two. MCPH will again utilize the Carmody O&M database to identify sites of concern. MCPH will attempt to perform sanitary surveys at as many developed properties along the 303(d) listed streams as possible to eliminate them as pollution sources. The goal is to complete ~84 sanitary surveys and ~14 dye tests.

4.2.3. Year 3 – 2012

In the final year, MCPH will monitor all of the original streams, except for those streams recommended for removal from the 303(d) list in year one or two. MCPH will monitor each stream so as to obtain a total of 10 samples in a 12 month period. For those streams that were prioritized for additional monitoring in year two, this could mean fewer than 10 samples are taken in the final year, as long as there are 10 results from within a 12 consecutive month period.

MCPH will focus sanitary surveys on any streams that continue to have elevated levels of fecal coliform or at sites that have failed service events from the Carmody O&M database. The goal is to complete ~56 sanitary surveys and ~10 dye tests. Again, these goals may be adjusted depending on the work that has been completed during the first two years of this contract.

Figure 3 Lilliwaup Creek

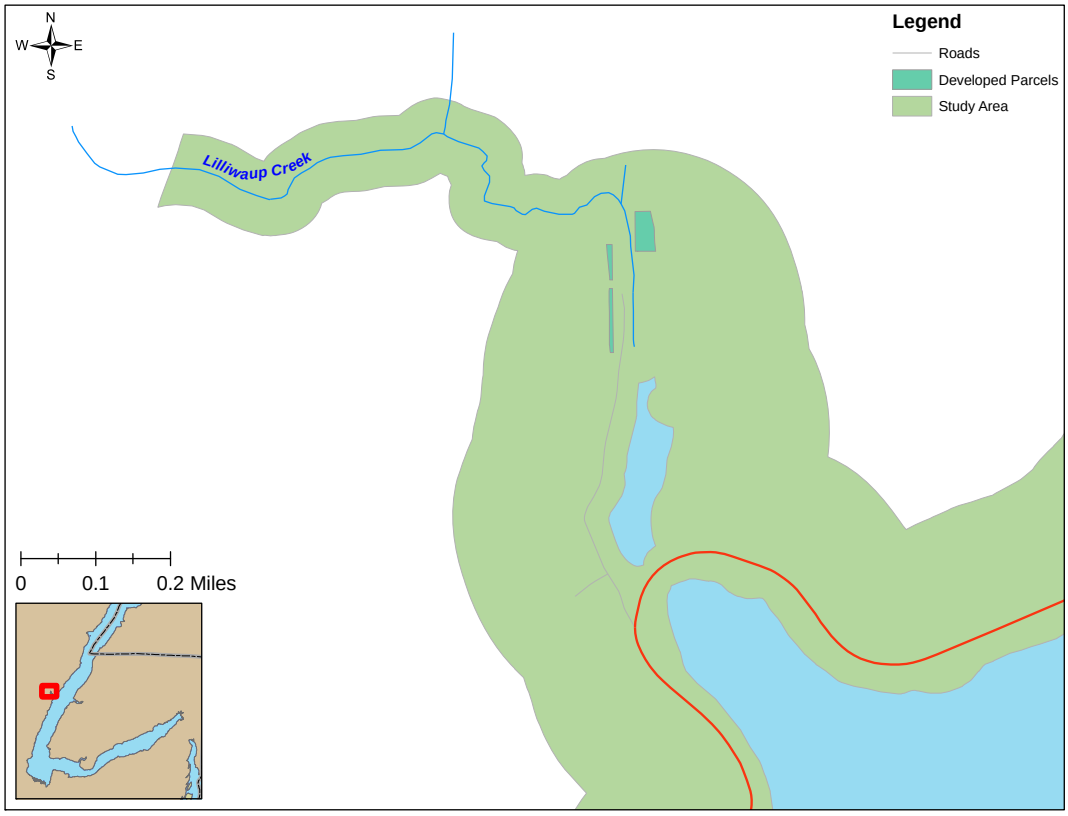


Figure 4 Big Bend Creek

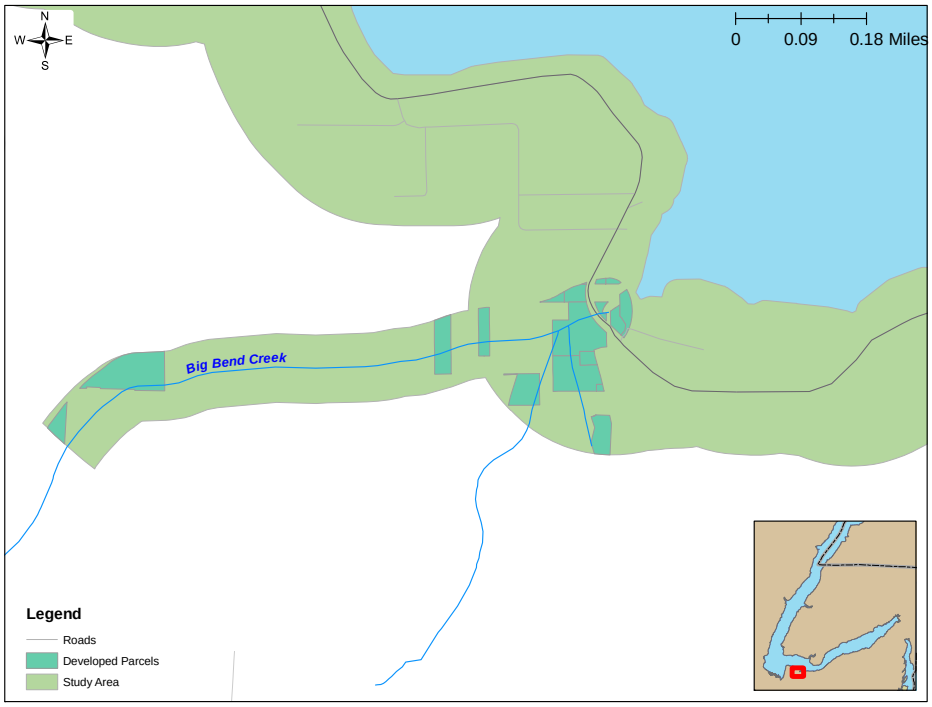


Figure 5 Twanoh and Twanoh Falls Creeks

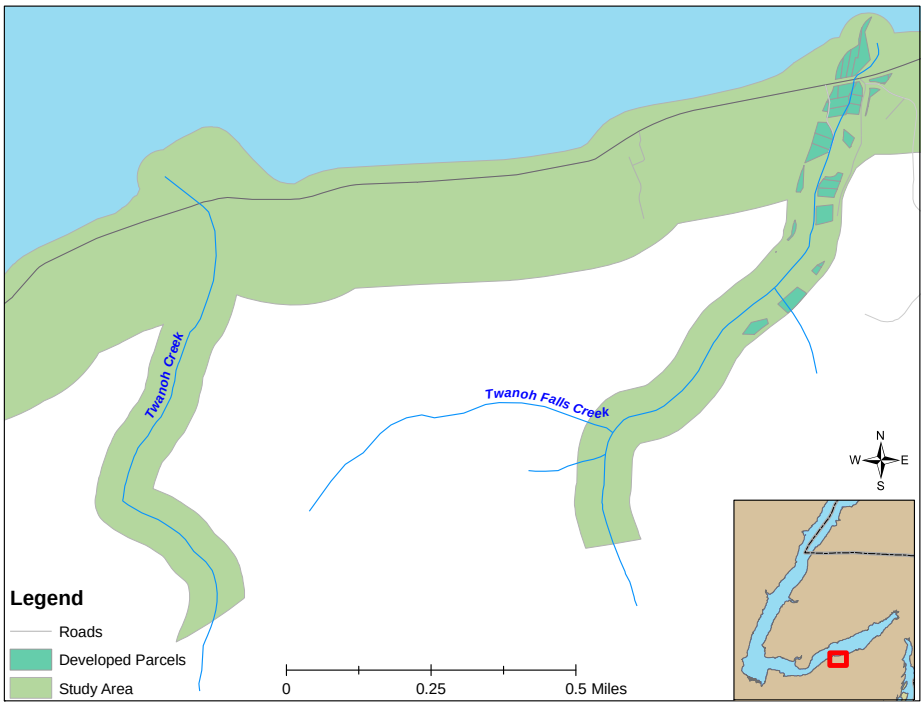


Figure 6 Mulberg Creek

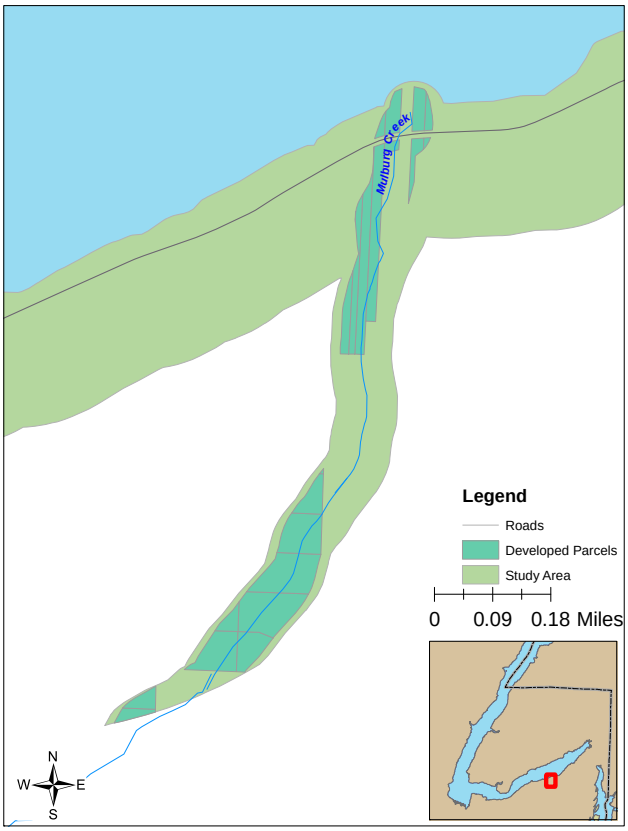


Figure 7 Happy Hollow Creek

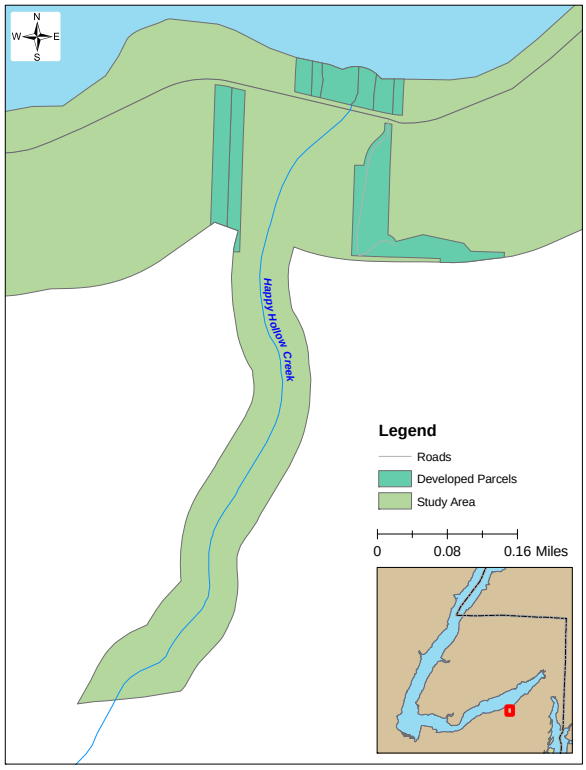


Figure 8 Holyoke and Trails End Creek

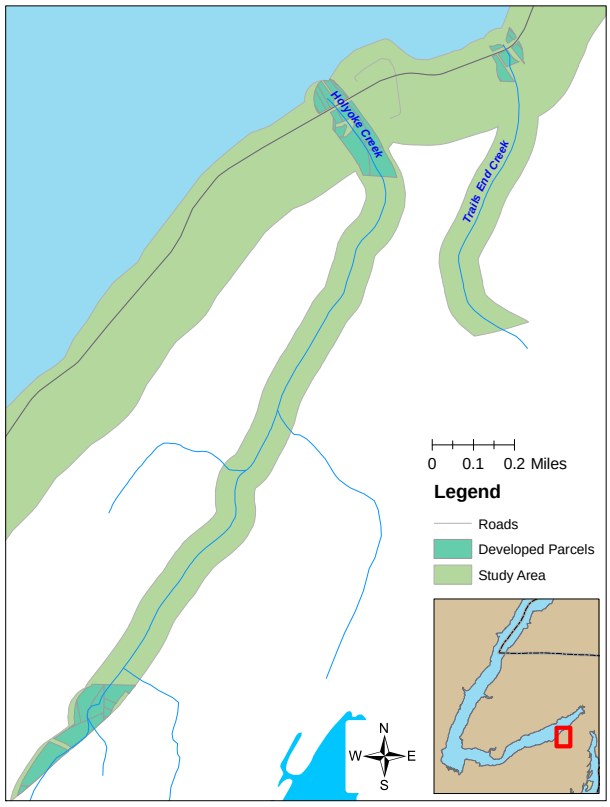


Figure 9 Deveraux Creek

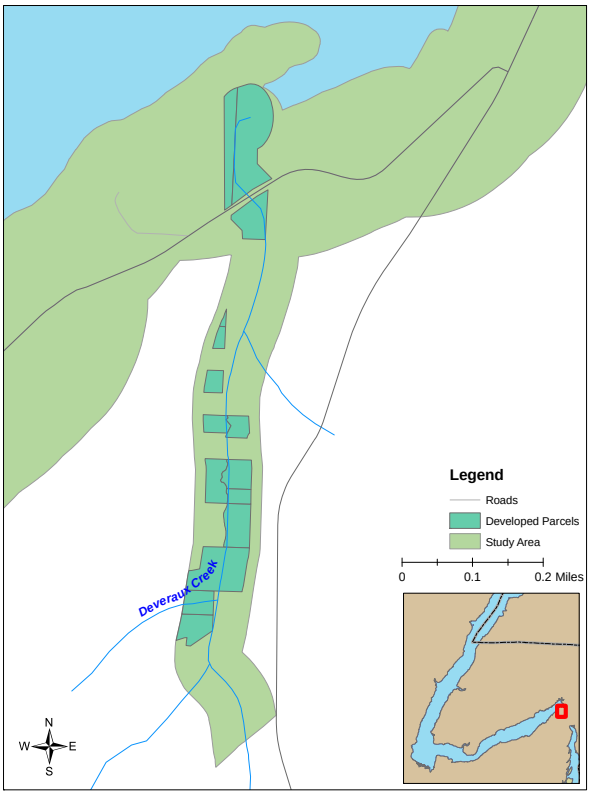


Figure 10 Little Mission Creek

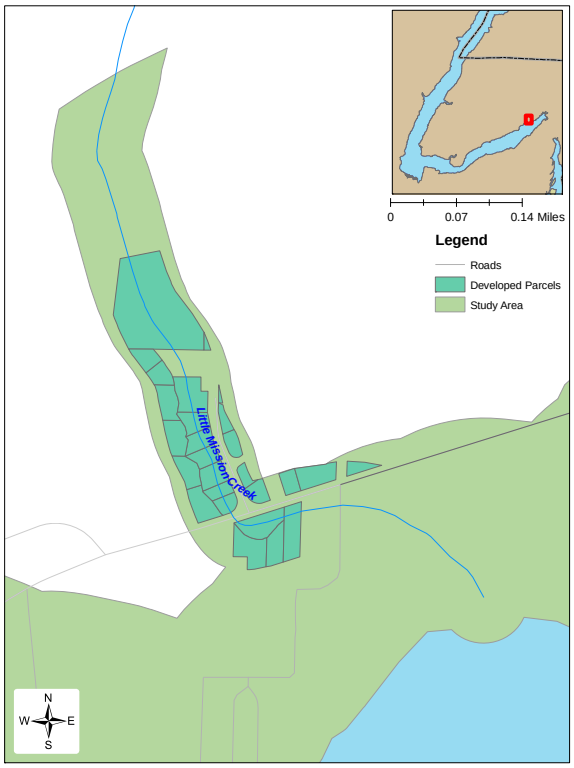
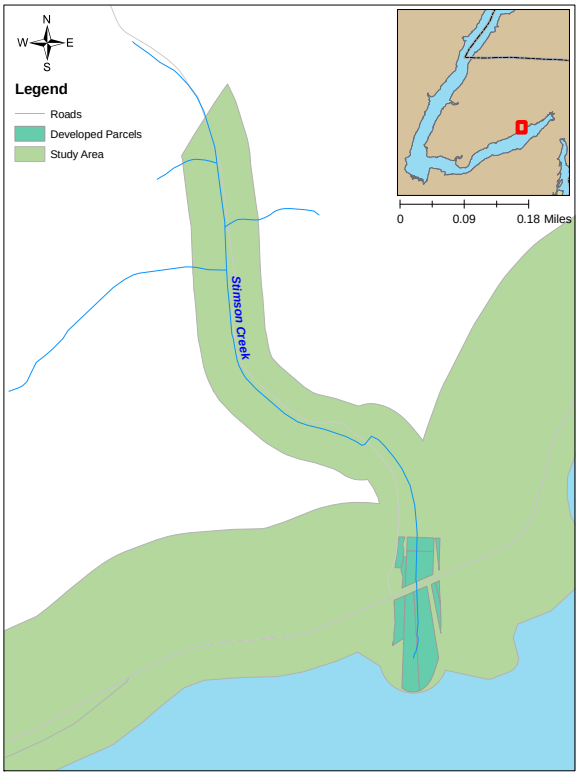


Figure 11 Stimson Creek



4.3. Sanitary Surveys

FC source identification and correction will be performed as described in Section 4.1 Sanitary Survey, MCPH SOP.

A Sanitary Survey may produce evidence that an existing septic system is not functioning properly (broken baffles or leaky tank, clogged drainfield, etc.). Once a septic system is determined to be malfunctioning or failing, the information will be transferred to the MCPH On-site Program for correction. Please see a complete description of the sanitary survey procedure in Section 4.1 Sanitary Survey, MCPH SOP.

However, if a septic system is not found to be the source of the pollution, the Sanitary Survey may produce evidence of another source, such as animal waste, being carried to the sample location by storm water. Staff will address such sources by educating the homeowner on best landuse and household practices to prevent such contamination. Staff will also report the most likely source of fecal coliform pollution, if a failing OSS is not determined to be the source.

As time and funding allow, a similar process will occur when sampling results show nutrient levels of concern. A Sanitary Survey will be conducted in an effort to discover the source of high nutrients, such as septic issues, piles of grass clippings, or household/landuse practices (determined through the homeowner interview). When such evidence is found, staff will conduct homeowner education to abate the pollution source, or refer the case to MCPH Onsite program if a septic system failure is

found. Sanitary Survey procedures will be adapted (to exclude FC-specific protocols) from the procedures found in Section 4.1 Sanitary Survey, MCPH SOP. Some of these streams may have nutrient concerns from the forest industries in the upper watersheds. This project will not address forest practices as pollution source.

4.4. Summary of Sampling Design for FC and Nutrients

A *stratified random sampling* strategy is used to determine current conditions and track long-term water quality trends.

Stratified random sampling involves some limited grouping of the population of interest, and then randomly sampling each group or stratum. This type of approach is often used in water quality sampling because certain parameters are known to vary by the time of day, season, precipitation levels and duration, or other factor(s). The advantages of a stratified random sampling strategy include (MacDonald, 1991; Journal, 1989):

- Improves the efficiency of sampling;
- Provides separate data (i.e., data collected during different times, seasons, and weather conditions) on each stratum (or matrix); and
- Enhances the sensitivity of future statistical tests by separating the variability among the strata (e.g., station locations, surrounding land uses, etc.) from variability within the strata (e.g., season, time of day, tide cycle, precipitation conditions, etc).

A stratified random sampling approach is employed by both the state Department of Health (DOH) Shellfish Program in their classification of commercial and recreational shellfish areas, and the state Department of Ecology Environmental Investigations and Laboratory Services Program for their ambient marine water monitoring for the Puget Sound Ambient Monitoring Program (PSAMP). (Kitsap County Health District, 2001)

Monitoring will be performed and samples will be analyzed for nitrite (NO2), nitrate (NO3), ammonium (NH4), phosphate (PO4) and silicic acid (Si(OH)4). Although, MCPH is mainly concerned with the nitrogen and phosphorus parameters, Si(OH)4 is automatically included in the suite of monitoring parameters that will be analyzed by UW MCL.

Approximately 40-50% of total nitrogen (originating as ammonia-nitrogen and converted to nitrate-nitrogen) in septic tank influent is removed by conventional on-site systems (Kitsap County Health District, January 2005). Although plant uptake may account for up to 50% of additional nitrogen removal, OSSs are suspected to be a source of nitrogen to Hood Canal due to incomplete nitrogen uptake.

Phosphorus can be an indicator of an illegal grey-water discharge. Additionally, phosphorus is a nutrient required to increase primary productivity in freshwater systems and may be present in septic tank influent. However, phosphorus migrates through soils more slowly and binds to soil particles. It may be a contributor to nutrient problems from overloaded, older drainfields or illegal gray water discharges.

Nutrient concentrations, especially nitrite+nitrate, demonstrate a seasonal pattern. Nutrient data from King County Land and Water Resources, monthly stream monitoring (http://your.kingcounty.gov/dnrp/library/2002/kcr931/NLWS05.pdf) shows that nutrients are consistently higher during December and January; concentrations naturally decline in February and March.

Monitoring will occur approximately monthly throughout the year. This should ensure that samples will be collected during high groundwater conditions (which typically end in early April) to assure movement of nutrients through the substrate. Monitoring will also be collected during the summer season, which is important, because many residences of Hood Canal demonstrate a seasonal occupancy. An additional consideration for observing nutrients in the dry season is the tendency for denitrification in hydric soils.

The overall design is to collect FC and nutrient samples from the same sites and compare the results. Monitoring for nutrients will be performed in conjunction with FC sampling. If a pollution source is identified and corrected (repaired or replaced septic system, animals restrained from water flows, etc.), MCPH will perform post-correction monitoring for both FC and nutrients. Post-correction monitoring will be performed at least once. Post-correction monitoring will may be performed at the individual site, at the stream monitoring location or both.

MCPH expects that all natural sources of nutrients should be below 1 mg/L. MCPH will utilize the 90th percentile from data collected in the previous Hood Canal Shoreline survey as the "level of concern" for nutrients. The following are the levels from the previous nutrient monitoring performed along Hood Canal by Mason County:

Table 6 Hood Canal Pollution Identification and Correction Nutrient Monitoring Results

Analyte	'Level of Concern'	Minimum	Median	Maximum
NH3	0.12	0.01	0.02	52.90
NO2+NO3	0.89	0.01	0.21	21.80
OP	0.65	0.01	0.06	7.06

All results are in mg/L
Based on 593 monitoring results

4.4.1. Evaluation of Relationship between FC and Nutrients

Mason County Public Health staff will collect water samples from streams and analyze for FC according to Section 2.3.3 Water Quality Evaluation, MCPH SOP.

Nutrient sample collection before and after FC source correction will be performed so as to minimize seasonal influences.

Field notes will be collected during sampling events and will include observed potential impacts such as visible impacts to drainfields, pet waste on or near the shoreline, presence of livestock, birds or other animals. Additionally, each discharge can be assessed for potential human impacts from aerial photos. This information may be used to better understand or interpret the resulting data.

MCPH will utilize the nutrient and fecal coliform data to attempt to answer the following questions:

- Is there a change in nutrient level if there is a change in FC levels?
- What are the cumulative freshwater 303(d) listed stream inputs of nutrients to Hood Canal?
- Is there a relationship between FC and nutrient concentrations?

Nutrient and FC results will be compared to determine whether any relationship exists between the pollutants.

Each sample location, where a pollution source is identified and corrected for FC and/or nutrients will include a data analysis and a narrative. The narrative will discuss observations that may have an effect on the results such as wildlife, piles of grass clippings, gray water discharges, etc., as well as temporal effects (i.e. wet or dry season) and occupancy.

4.5. Monitoring Parameters

Water samples will be collected and transported according to the methods specified in Chapter 2.0 Monitoring Parameters and Procedures, MCPH SOP. FC will be analyzed according to Table 8 Laboratory Measurement Methods (see Section 6 Laboratory Procedures).

Samples for nutrients will be analyzed for dissolved ammonium-nitrogen, nitrate-nitrogen, nitrite-nitrogen, silicic acid and phosphate.

Samples will then be stored and/or preserved, and analyzed according to Section 6 Laboratory Procedures, below.

Physical parameters including temperature, dissolved oxygen and conductivity will be collected in situ with a YSI 556 Multiparameter Water Quality Meter. Flow measurements will also be taken during each monitoring event for all wadeable streams.

Salinity will be measured in parts per thousand (ppt) using a refractometer (0-10% salinity). Salinity values are used to distinguish between marine and freshwater which have different FC standards. MCPH will attempt to obtain samples above the marine water influence.

5. Field Procedures

Field Procedures will be conducted according to Chapters 2.0, 4.1 and 4.2 of MCPH's SOP (Appendix A), which outline the Monitoring Procedures, Sanitary Surveys and Pollution Identification and Correction. Also included in the SOP are the field log entry requirements.

Safety is the primary concern when collecting samples. If roadside hazards, weather, accidents, on-going construction, etc. make sample collection dangerous, then that station will be skipped. The reason will be noted in the Trimble Juno GPS Handheld

Computer. If the hazard is a permanent condition, relocation of the station may be necessary.

5.1. Sampling Procedures

Monitoring will be performed in the following order:

1. Salinity measurements will be taken in situ using a refractometer. The refractometer calibration will be checked using DI water during each sampling event. Calibrations will be made in the field or lab to 0 ppt for DI water. Sites where the salinity is ≥25 ppt should be sampled at a different time, when the site is not being tidally influenced.

2. FC samples will be collected in 125-mL Nalgene bottles and analyzed for FC only.

3. Nutrient samples will be collected in HDPE 60-mL bottles and analyzed for Ammonium (NH4), Nitrite (NO2), Nitrate (NO3), Phosphate (PO4) and Silicic Acid (Si(OH)4).

4. Temperature, DO and Conductivity will be collected in situ with a YSI 556 Multi-Parameter Water Quality Meter.

5. Flow measurements will be collected using a Global Water Flow Probe.

Sampling for FC monitoring can be conducted on Mondays, Tuesdays and Wednesdays during dry and wet sampling events. Monitoring on Thursday may occur if coordinated with the laboratory in advance. Samples will be transported by cooler at or below 10° Celsius and stored in the Mason County Laboratory refrigerator. Analysis will be performed within 24 hours of the sampling time at the Mason County Water Lab. A laboratory bench sheet, which includes the sampling sites, holding temperature and sampler initials will accompany the samples from the field to the lab (Appendix A).

MCPH will notify the UW MCL as early as possible prior to nutrient monitoring events. Sampling for nutrient evaluation will be performed on Monday, Tuesday, Wednesday or Thursday. Samples will be stored in Mason County Laboratory refrigerator until transport. Samples will be transported the day following the monitoring event, in a cooler with ice to the UW MCL, arriving by 5:00pm. The UW MCL will analyze the samples within 48 hours of the time the sample was taken, or will freeze per the analytical method listed in Table 8 in Section 6 Laboratory Measurement Methods, for holding no more than 28 days. A chain of custody form will accompany the samples from the field to the lab.

The YSI multi-parameter meter will be calibrated according to the manufacturer's recommendation against known standards at the beginning of each field day. The parameter will be placed in the stream in the monitoring location and allowed to equilibrate before the measurement average is logged by the YSI.

Flow measurements for this project will be determined using a Global Water Meter. For streams under 5' in width, measurements will be taken at approximately half-foot intervals or a minimum of 5 measurements. For streams widths > 5' a minimum of 10

measurements will be taken. Many of these streams have smaller flows. Rapid flow measurements will keep the costs associated with determining flow low, while still providing relevant data for determining stream flow. Velocity measurements will be averaged throughout the water column, as computed by the Global Water Meter. More detailed flow monitoring instructions can be found in the TFW Monitoring Program Manual for Wadeable Stream Discharge Measurement (1999), which is located here:

http://www.fishlib.org/library/Bibliographies/Protocols/Documents/007/007.pdf

Station number, stream name and total stream width and depth will be recorded in the Juno GPS device or in field notebooks for each flow monitoring station.

Table 7 Sample Containers, Preservation and Holding Times

Parameter	Minimum Quantity Required	Container	Holding Temp	Holding Time
Ammonium-Nitrogen	50 mL	HDPE 60 mL acid washed bottle	4°C (or freeze)*	48 Hrs (28 days)*
Dissolved Nitrite-Nitrogen	50 mL	HDPE 60 mL acid washed bottle	4°C (or freeze)*	48 Hrs (28 days)*
Dissolved Nitrate-Nitrogen	50 mL	HDPE 60 mL acid washed bottle	4°C (or freeze)*	48 Hrs (28 days)*
Dissolved Phosphate	50 mL	HDPE 60 mL acid washed bottle	4°C (or freeze)*	48 Hrs (28 days)*
Silicic Acid	50 mL	HDPE 60 mL acid washed bottle	4°C (or freeze)*	48 Hrs (28 days)*
Fecal Coliform	100 mL	Nalgene 125mL bottle	<10°C	24 Hours

*If analysis is not possible within 48 hours, samples will be frozen and analyzed within 28 days.

6. Laboratory Procedures

University of Washington Marine Chemistry Laboratory, Inc. in Seattle is accredited by the Department of Ecology (#A1084) and will conduct nutrient measurements, as well as corrective action procedures in conformance with their Quality Assurance program. Samples for nutrients will be analyzed for dissolved ammonium, nitrate, nitrite, silicic acid and phosphate.

Mason County Public Health Laboratory in Shelton is accredited by the Department of Ecology (#M1464) and will conduct fecal coliform measurements in conformance with our Quality Assurance program. Also, see MCPH SOP, Chapter 3.0 Quality Assurance/Quality Control.

The analytes, sample matrix, analytical methods, method detection limits and holding times for these nutrients are summarized in Table 8 below:

Table 8 Laboratory Measurement Procedures

Analyte	Samples[1] [Number]	Range[2]	Reporting Limit	Sample Prep Method	Previous Range of Results[3]
Ammonium	Max. allowed: 80/day Ave. submittal: 12/day	0-0.050 mg/L	0.01 mg/L	Filter	0.01 – 52.9 mg/L
Nitrite	Max. allowed: 80/day Ave. submittal: 12/day	0-0.050 mg/L	0.01 mg/L	Filter	N/A
Nitrate	Max. allowed: 80/day Ave. submittal: 12/day	0-0.350 mg/L	0.01 mg/L	Filter	0.01 – 21.8 mg/L*
Phosphate	Max. allowed: 80/day Ave. submittal: 12/day	0-0.100 mg/L	0.01 mg/L	Filter	0.01 – 7.06 mg/L
Silicic Acid	Max. allowed: 80/day Ave. submittal: 12/day	0-1.400 mg/L	0.01 mg/L	Filter	N/A
Fecal Coliform	Max. allowed: 60/day Ave. submittal: 12/day	<2 to ≥1600 MPN fc/100mL	<2 MPN fc/100mL	APHA Procedure 9221-E, MPN Fecal Coliform Direct Test (A-1 Medium)	<2 to ≥160000 MPN fc/100mL

[1] Sample arrival dates will be variable, but will happen approximately monthly mainly dependent on field staff availability.
[2] Serial dilutions allow for higher detection limits. Nutrient sample results that are greater than the upper limit of the range will be diluted and reanalyzed to determine the actual result. However, the Mason County lab must be notified prior to sample analysis. Most serial dilutions would be performed during confirmation samples from sites that originally had sample results of 1600 or ≥1600. Serial dilutions may also be used based on professional judgment in the field, i.e. a site where field staff identifies a visible OSS failure.
[3] Previous ranges of results are from the Hood Canal Pollution Identification and Correction project.
* Previous results were for nitrite+nitrate-nitrogen; it is included under the nitrate, since nitrate is usually the larger amount of the two, for illustrative purposes.

Table 9 Laboratory Measurement Methods

Lab and DOE Lab Accreditation Number	Analyte	Sample Matrix	Laboratory Analytical Method (DOE-Accredited)	Method Detection Limit
UW Oceanography Marine Chemistry Lab (A1084)	Ammonium	Non-potable Water (filtered)	Slawyk and MacIsaac (1972)	0.0005 mg/L
UW Oceanography Marine Chemistry Lab (A1084)	Nitrite	Non-potable Water (filtered)	JGOFS Chapter 8, Sections 8.3	0.0001 mg/L
UW Oceanography Marine Chemistry Lab (A1084)	Nitrate	Non-potable Water (filtered)	JGOFS Chapter 8, Section 8.2	0.0010 mg/L
UW Oceanography Marine Chemistry Lab (A1084)	Phosphate	Non-potable Water (filtered)	JGOFS Chapter 8, Section 8.1	0.0004 mg/L
UW Oceanography Marine Chemistry Lab (A1084)	Silicic Acid	Non-potable Water (filtered)	JGOFS Chapter 8, Section 8.4	0.0188 mg/L
Mason County Water Lab (#M1464)	Fecal Coliform	Non-potable Water	APHA Procedure 9221-E, MPN Fecal Coliform Direct Test (A-1 Medium)	<2 to ≥1600* fc/100mL

7. Quality Assurance / Quality Control

Quality Assurance/Quality Control (QA/QC) procedures are measures taken to ensure that data are accurate and useful primarily by measuring and minimizing errors. The Mason County Public Health Water Quality Program staff has developed the Water Quality Standard Operating Procedures (SOP) so that water quality activities are conducted in a consistent and reliable manner. Any deviation from this QAPP or the SOP will be documented in the final report. These deviations will be recorded either in the GPS units or field notebook(s) while in the field or on our office computers while in the office.

Data collected for this project will aim to be unbiased, precise, representative, and have good comparability. Field, laboratory and office procedures will be followed in order to assess precision of data and overall variability (natural environmental variability of the measured parameter, sampling variability, and lab variability), as well as precision and overall variability of each parameter.

All information in the following QA/QC sections can be more thoroughly examined in the Mason County Water Quality Standard Operating Procedures.

7.1. Quality Control Procedures

7.1.1. Field Quality Control

Field staff will utilize the Trimble GPS Juno Handheld Computer to record field notes that include specific cataloging of sample location data (sample number, site number, time, etc.) as well as all relevant observations (any feature or occurrence that may affect the sample). GPS points as well as photos will be taken from each location and also recorded in the Juno. Staff will follow the procedures in the SOP for aspects such as sample collection, sample storage and sample transport to the laboratory.

In addition, at each location, laboratory sheets (used to identify and track samples as they move from the field to the lab) will be filled out with essential data for submittal to the lab. The information will be retained for review and for verification of data entry into computer databases where Quality Assurance procedures will be applied (see below).

7.1.1.1. Replicates

Field replicate sampling for bacteria will provide an additional field quality control. Replicates are two samples collected at the same time and location. Although bacteria typically "clump" and may show great variability between samples, the difference can be measured to determine the precision. Please see the Precision section under Quality Assurance Procedures below.

7.1.1.2. Blanks

Field blanks for bacteria will be included for each sampling event. De-ionized (DI) water is carried into the field and then poured into a sample bottle by field staff. The field blank is handled, transported and analyzed in the lab

like any other sample in order to assure adherence to proper field techniques by staff. Please see the Bias section under Quality Assurance Procedures below. MCPH will not include nutrient blanks, mainly due to costs.

7.1.1.3. Temperature

Temperature control is maintained in the field and during transport by packing samples in a cooler with ice or blue ice. One temperature control bottle per cooler is carried with samples during the sampling event and temperature is measured upon arrival at the Mason County Water Lab. See MCPH SOPs for details of the procedure.

7.1.1.4. Field Meter Calibration

Field personnel will routinely inspect equipment for damage and perform routine preventative maintenance and cleaning of field equipment based on manufacturers' recommendations.

Conductivity, DO and Temperature Probes will be calibrated against known standards at the beginning of each field day. If the monitoring results are higher or lower than expected, MCPH will also calibrate at the end of the day.

7.1.2. Laboratory Quality Control

7.1.2.1. Fecal Coliform Analysis

The Washington Department of Ecology accredits the Mason County Water Laboratory (MCWL) (accreditation #: 1464). Lab processes must produce valid results for data acquired through sample analysis to be useful. The MCWL performs the following procedures to validate results:

- Positive and negative culture controls, sterility controls and pH tests are performed for each batch of media.
- Sterility control analyses are performed on sample bottles and autoclave. Sterility and pH control analyses are performed on each batch of freshly made media and buffer solution.
- Monthly Heterotrophic Plate Count (HPC), pH, chlorine residual and conductivity checks are performed on DI water. Also, monthly calibration of top-loading balance is performed.
- 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 Environmental Health Manager and corrective action(s) will take place.
- Precision and overall variability is assessed through analysis of field replicate samples, laboratory method duplicates and laboratory method recovery results.

7.1.2.2. Nutrient Analysis

The University of Washington Marine Chemistry Laboratory (UW MCL) is accredited by the Washington Department of Ecology (accreditation # A1084) and will be performing all nutrient analyses. UW MCL QA/QC Manual

is attached as Appendix B. Also, the standard method that is referenced can be located here:

http://unesdoc.unesco.org/images/0009/000997/099739eo.pdf

Table 10 QC Samples, Types and Frequency

Parameter	Field		Laboratory	
	Blanks*	Replicates	Check Standards	Analytical Duplicates
Ammonium	N/A	1 per sampling event	2 per run	N/A
Nitrite	N/A	1 per sampling event	2 per run	N/A
Nitrate	N/A	1 per sampling event	2 per run	N/A
Phosphate	N/A	1 per sampling event	2 per run	N/A
Silicic Acid	N/A	1 per sampling event	2 per run	N/A
Fecal Coliform	1 per sampling event	1 per sampling event	N/A	10%

*Blanks may be performed for nutrient samples that receive serial dilutions.

7.2. Quality Assurance Procedures

Quality Assurance (QA) provides a process for ensuring the reliability and value of measured data. Sound QA practices are essential to acquire data of the necessary type and quality for their intended use. To be scientifically and legally defensible, data must be of documented quality.

7.2.1. Data Quality Objectives

The primary data quality objective is to estimate the concentration of bacteria and specified field parameters at sampling sites. These results will be used to assess compliance with the state standards, and may trigger sanitary surveys, dye traces, and septic system repairs or replacements. These results will also be used to recommend removal of streams from the 303(d) list for bacteria.

7.2.1.1. Bias

Bias is considered the consistent deviation of measured values from the true value, caused by systematic errors in a procedure. Potential sources of bias include; sample collection, physical or chemical instability of samples, interference effects, inability to measure all forms of a determinant, calibration of the measurement system and contamination. Bias within the sampling process will be reduced to the extent practicable by the following:

- Strict adherence to the sampling procedures of the SOP, including collection, preservation, transportation and storage of samples
- Periodic reviews and evaluations of field sampling procedures
- Complete data entry, standardized organization, and data retention.
- Analyzing data in an appropriate manner based upon pertinent variables, such as temporal variations

- Regular and documented field meter calibration and maintenance
- Any monitoring event where the blank has a value greater than a non-detect will not be used and the monitoring event will be repeated.
- Any deviations from standard procedures, as described in the SOP and this QAPP, will be documented in the final report.

7.2.1.2. Precision

Precision describes the repeatability of the methods. It is a measure of the variability in the results of replicate measurements due to random error. Random errors are always present due to normal variability in the many factors affecting the measurement results.

- Documentation of ongoing field equipment maintenance, calibration, and operation.

7.2.1.3. Data Representativeness

Representativeness of the data is described as an adequate number of samples and monitoring events to satisfy program objectives. It describes how well the sample represents the environmental condition being measured. Representativeness will be primarily achieved through the following:

- Strict adherence to the specific procedures of all SOPs.
- Thorough documentation of applicable environmental factors (e.g., weather and tidal conditions, observable changes, wildlife present, etc.).
- Recording all data for each site in appropriate spreadsheets from the Trimble GPS Juno and the lab sheet, and attaching photos and GPS identifiers.
- A determination of whether the project objectives and data quality objectives have been met for specific sets of data and information at the time of reporting.
- Obtaining a minimum of 10 samples from a 12 consecutive month period for assessing the stream for potential removal from the 303(d) list.

7.2.1.4. Data Completeness

The EPA has defined completeness as a measure of the amount of valid data that needs to be obtained from a measurement system. Data will be considered complete when all streams have at least 10 consecutive monitoring events within a twelve month period. Some streams will have 24 monitoring events over the three-year course of this project. A statement of completeness will be included in reports compiled at the end of a project, and may include qualifying data, observations, and/or complications encountered during the project. Sampling events will include qualifying data and the recording of observations and/or complications in designated Trimble GPS Juno and/or databases.

7.2.1.5. Data Comparability

Data Comparability describes how well the data can be compared with other data. Comparability will be ensured by strict adherence to appropriate SOP,

project and sampling plans, data management, and field and laboratory QAQC procedures. This data will be comparable to HCDOP monitoring efforts.

7.2.2. Field Quality Assurance

Quality assurance for the field activities covered under the SOP will be achieved through documentation of the following:

- Consistent use of the standard operating procedures
- Consistent use of, and adherence to, this QAPP

7.2.2.1. Sampling Procedures

Consistent and properly implemented monitoring procedures are an essential element to collecting scientifically valid and defensible data. Staff will reference Section 5 Field Procedures of this document and Chapter 2.0 Monitoring Parameters and Field Procedures of the SOP for detailed instructions regarding sampling activities.

7.2.3. Maintaining and Calibrating Field Equipment

Having well maintained and properly calibrated monitoring equipment is an essential element to collecting scientifically valid and defensible data of known precision. See Section 5 of this document and Chapter 5.0 of the MCPH SOP for information regarding Equipment Calibration and Maintenance. Field equipment to be used under this contract includes the following:

- A YSI 556 multi-meter with temperature, conductivity and dissolved oxygen probes.
- A refractometer.
- A Global Water Flow Meter
- A Trimble Juno GPS Handheld Computer with built-in camera and Window's Mobile 6.

7.2.4. Laboratory Quality Assurance

Laboratory QA/QC will be assured through the labs' participation in the Washington State Department of Ecology Laboratory Accreditation program.

The Mason County Water Lab is currently accredited for the MPN method of fecal coliform analysis. The Mason County Water Lab will follow the QA/QC requirements specified in the fecal coliform MPN method, laboratory SOPs, and accreditation requirements (see Section 7.1.2 Laboratory Quality Control, above).

UW MCL is currently accredited for nutrient analyses listed in Tables 8 and 9. See Table 10 for specific QC procedures, as well as Section 7.1.2 Laboratory Quality Control above.

Table 11 Measurement Quality Objectives (Laboratory Analyses of Water Samples)

	Check Standard (LCS) % Recovery Limits	Lowest Concentrations of Interest	Relative Percent Difference (RPD) on Duplicates
Ammonium	99% - 101%	0.01	20%
Nitrite	99% - 101%	0.01	20%
Nitrate	99% - 101%	0.01	20%
Phosphate	99% - 101%	0.01	20%
Silicic Acid	99% - 101%	0.01	20%
Fecal Coliform	N/A	2	N/A

Precision and accuracy for nutrient results will be ensured by:

- Nutrient data will have ≤ 1% error margin. The error margin will be determined by the standard curve or check standards performed during each run. When the error margin is > 1%, the data will be reanalyzed and the error margin will be checked again.

7.2.5. Office Quality Assurance

Quality Assurance in the office will be ensured through careful record keeping and documentation.

The field person turning in the samples initials lab sheets for the Mason County Water Lab. Also recorded on the lab sheet are; the samplers' names, date, time each sample was taken, date and time of submittal to the lab, temperature of temperature control sample, weather conditions for the sampling event, type of sampling, matrix, and project code. Lab sheets are submitted to the lab with the samples collected that day. After results have been entered onto the lab sheet, the original is filed in the lab's office and a copy is provided to the staff. The results and other pertinent data are entered into the appropriate Excel spreadsheets and then filed into a 3-ring binder in the staff office. Verification of data is done following data entry by comparing values in the database to values on the lab sheet.

Chain of Custody sheets will be used to submit nutrient samples to the UW MCL, in Seattle. Chain of Custody sheets will accompany samples and will be delivered by courier to the UW MCL. Each person handling the coolers containing the samples will sign off when s/he receives or relinquishes the coolers. Sampling times will be coordinated with the UW MCL to assure analysis can be done within holding times. Results will be returned to staff via electronic mail with a hard copy to follow. All results will be entered into project databases and binders. Verification of data is done following data entry by comparing values in the database to values on the lab sheet.

There are three levels of data verification:

- Verification of data occurs at the time data is transferred from GPS unit to GIS, where staff can visually inspect if the GPS point is in the approximate correct location.
- Verification of data also occurs when the data is transferred from the GPS to the GIS. Staff will look over data for any blatant errors. Preferably, this is done relatively soon after work in the field so that staff is still familiar with the sites that were monitored.
- The final verification of data occurs after the results have been recorded into the Results spreadsheet. Staff will visually inspect the Results spreadsheet compared to Lab Bench Sheets to ensure that the data is consistent.

Observations such as the presence of birds or other wildlife, or the presence of a large development above a sampled storm drainage, can help explain the results from a particular site. This information will be recorded in either the GPS data or in Window's Mobile Word program for download when back in the office.

All paperwork generated during the project (copies of lab sheets with results, photos, maps, etc.) will be kept in 3-ring binders in our staff office and all computer documents will be maintained in the Mason County Environmental Health computer network.

8. Data Management

Detailed observations and field data will be collected in the Trimble TerraSync software, Window's Mobile 6 Word or Excel. In the event that the GPS unit is not functioning, all data will be collected in field notebooks and then transferred to the appropriate database in the office. All data will be retained by Mason County Public Health. Data validation and verification will be performed in accordance with procedures delineated in Section 7 Quality Assurance /Quality Control above.

MCPH will utilize data dictionaries created in the office and loaded into the GPS Juno unit to be used with the TerraSync Software. Data dictionaries will allow for standardized data entry and will minimize incorrect data entry. The data dictionaries will include drop down menus and manual entry fields that will collect EIM-appropriate data while in the field. Data dictionaries attach, in the form of an attribute table, the data collected to the GPS point. Therefore, when the data is downloaded into GIS, all of the attributes are already attached to the GPS point. MCPH will create GIS shape files for monitoring locations with all monitoring parameter results.

All fecal coliform, salinity, temperature, conductivity, dissolved oxygen and nutrient monitoring results will be submitted for inclusion to DOE's EIM database. MCPH utilized DOE's EIM upload location and result spreadsheets, but customized and combined the spreadsheets so that MCPH can update GIS and easily analyze data. Excel spreadsheets will help organize and facilitate analysis of the fecal coliform and nutrient data. In addition to the required EIM data, spreadsheets will include:

- Sampling results.
- Geometric mean calculations.
- Number of samples at each monitoring location.
- Percent of samples greater than 100 FC/100mL.

- Whether each site meets the WQ standard.

Transferring data from the field to office:

- All photos and GPS coordinates and other attributes that are collected in the field will be downloaded in the office using Pathfinder Office.
- Once this data is downloaded into ArcGIS, the attribute tables (with the EIM related data) will be utilized to populate MCPH's EIM data download spreadsheet. The location data will be entered into the Location spreadsheet. The results related data will be entered into the Results spreadsheet.
- Once the laboratory analysis is complete, the result will be added to the other data, which was downloaded from Juno GPS, in the Results spreadsheet.
- Photos are attached to the GPS point in the Juno GPS system and become hyperlinks in the attribute table within ArcGIS.
- Descriptions written in the field and recorded on the Lab Bench Sheets will be compared to photos at the time they are attached and labeled in the database.
- GIS maps will be used to further verify the data, by ensuring that locations are in the appropriate area and that the photos correspond with monitoring locations.

The Hood Canal 303(d) OSS Tracker (Excel spreadsheet) will include data in tabular form of all OSS and Sanitary Survey information gathered under this contract.

Reports, spreadsheets, educational materials and any other information pertaining to this grant will be maintained by the County on the Environmental Health network. MCPH will distribute all quarterly and final reports to the DEPARTMENT via e-mail. Hard copies may be made available by request. MCPH will also make these reports available to the public via the Mason County Web Page. Although the link is not yet active, information regarding this project can be found here:

http://www.co.mason.wa.us/health/envhealth/surface_water/hood_canal.php

Reports will be compiled by Mason County Public Health Staff.

BIBLIOGRAPHY

APHA, 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition.

Cogger, C.G., 1988. *On-site septic systems: Assessing the risk of ground water contamination.* Journal Environmental Health 51:12-16.

Frans, L.M., Paulson, A.J., Huffman, R.L., and Osbourne, S.N., 2006. *Surface-water Quality in Rivers and Drainage Basins Discharging to the Southern Part of Hood Canal, Mason and Kitsap Counties, Washington, 2004*. U.S. Geological Survey Scientific Investigations Report 2006-5073, 24 p.

Georgeson, A., and Mathews, W., 2007. *Mason County Public Health Water Quality Standard Operating Procedures & Protocol*. Mason County Public Health, 48 p.

Georgeson, A., and Mathews, W., 2007. *Mason County Septic System Surveys and Database Enhancement Quality Assurance Project Plan*. Mason County Public Health, 27 p.

Georgeson, A., Mathews, W., and Orth, P., 2008. *Hood Canal Pollution Identification and Correction Project Final Report*. Mason County Public Health, 52 p.

Georgeson, A., 2010. *Northshore Hood Canal Pollution Identification and Correction*. Mason County Public Health, 28 p.

Hopkins, B., Hallock, D., Wiseman, C., Plotnikoff, R., and Ehinger, W., 2001. *Stream Sampling Protocols for the Environmental Monitoring and trends Section*. Washington State Department of Ecology, Environmental Assessment Program, Publication # 01-03-036.

Kitsap County Health District, Water Quality Program, 2001. *Water Quality Trend Monitoring Plan Streams and Marine Waters.*

Kitsap County Health District, 2005. *Hood Canal Shoreline Survey Quality Assurance Project Plan (EPA).*

Kitsap County Health District, 2006. *Hood Canal Shoreline Survey Quality Assurance Project Plan (DOE).*

Journel, A.G., and Alabert, F., 1989. *Terra Nova*, 1, 2: 123 - 134.

Lombard, S.M., and Kirchmer, C.J., 2004. *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Draft),* Washington State Department of Ecology Environmental Assessment Program, Ecology Publication No. 04-03-030.

MacDonald, L. H. 1991. *Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska*. EPA-910/9-91-001.

Messman, S.A., 1991. *South Hood Canal, A Water Quality Issue Paper*. Washington Department of Ecology, 21 p.

Michaud, J., and Britton, E., 2005. *Preliminary Assessment of Lower Hood Canal Streams: 2004 Study*. EnviroVison Corp., 38 p.

Pleus AE, 1999. *TFW Monitoring Program Method Manual for Wadeable Stream Discharges.* Washington State Department of Natural Resources under the Timber, Fish and Wildlife Agreement, TFW-AM9-99-009. DNR#111. http://www.fishlib.org/library/Bibliographies/Protocols/Documents/007/007.pdf

Puget Sound Water Quality Authority, 1990. *Recommended Protocols for Measuring Conventional Water Quality Variables and Metals in Fresh Water of the Puget Sound Region*.

Washington State Department of Ecology's List of Accredited Labs. http://www.ecy.wa.gov/apps/eap/acclabs/lab.asp?id=1084.

Washington State Department of Ecology, 2004. *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*. Publication No. 04-03-030.

Washington State Department of Ecology (Ecology), 2006. *Assessment of Water Quality for the Section 303(d) List*. WQP Policy 1-11: http://www.ecy.wa.gov/programs/wq/303d/wqp01-11-ch1Final2006.pdf.

Washington State Department of Ecology, 2008. Washington State Water Quality Assessment 303(d) List. EIM Query, January 2010.

Washington State Department of Ecology, 2010. Washington State Mason County Hood Canal Water Quality Parameters and Results. EIM Query, January 2010.