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Quality Assurance Project Plan

Fecal Coliform Monitoring of Freshwater Seeps and Ditches along Inner Dungeness Bay

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Each study conducted by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completing the study, Ecology will post the final report of the study to the Internet.

The plan for this study is available on Ecology's website at www.ecy.wa.gov/biblio/1110089.html.

Data for this project will be available on Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm. Search User Study ID, BEDI0018.

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Quality Assurance Project Plan

Fecal Coliform Monitoring of Freshwater Seeps and Ditches Along Inner Dungeness Bay

December 2011

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Abstract

Dungeness Bay is located in Clallam County near Sequim, Washington, on the northeast coast of the Olympic Peninsula. Dungeness Bay is marine water designated for extraordinary aquatic uses, shellfish harvest, and primary contact recreation. Eight seeps and four ditches along inner Dungeness Bay will be monitored for fecal coliform bacteria (FC). The seeps and ditches will be characterized by comparing the FC concentrations to the freshwater extraordinary primary contact criterion for FC. Data will be used by Ecology and the Dungeness Clean Water Workgroup to determine what implementation actions may be needed to improve water quality.

Background

Dungeness Bay is located in Clallam County near Sequim, Washington, on the northeast coast of the Olympic Peninsula (Figure 1). The area is in Elwha-Dungeness Water Resource Inventory Area (WRIA) 18. The outer edge of Dungeness Bay is defined by Dungeness Spit, extending in a narrow 51/2 mile curve into the Straits of Juan de Fuca. The Bay is nearly divided by Graveyard Spit, which extends south from Dungeness Spit, and Cline Spit which extends north from the mainland. A relatively narrow opening between these two spits allows tidal waters to flow between West Dungeness Bay (the inner bay) and East Dungeness Bay (the outer bay). The Dungeness River is the main freshwater tributary to the Bay (Streeter et al., 2004).

Dungeness Bay is marine water designated for extraordinary aquatic uses, shellfish harvest, and primary contact recreation. The bay supports recreational harvest of salmon and bottom fish as well as providing important salt marsh habitat. Dungeness crab, oysters, and clams are harvested commercially and recreationally in the Bay. Other uses of the area include recreational waterfowl hunting, bird watching, hiking, and boating. The area also includes the Dungeness National Wildlife Refuge which provides additional areas for recreation and habitat for marine birds and mammals.

Land uses in Dungeness watershed include residential, commercial and agricultural. However, the area is seeing a noticeable increase in residential development. The city of Sequim is on a sewer system, but residences and commercial properties in the rural areas are on on-site septic systems.

FC bacteria concentrations in the watershed are of key interest. FC bacteria are common in the intestines of warm-blooded animals and are used as a water quality indicator of fecal contamination in the environment. They can indicate a direct discharge of waste from mammals or birds, agricultural and stormwater runoff, or from human sewage. While FC bacteria may not be directly harmful, they can indicate a higher risk of pathogens present in the waters, which may cause water borne illnesses and contamination of shellfish for human consumption.

The Washington State Department of Health (DOH) reported increasing levels of FC in Dungeness Bay near the mouth of the Dungeness River in 1997. Bacteria levels continued to increase, with higher levels also occurring in inner Dungeness Bay. In 2000, as a result of higher levels, the DOH closed 300 acres near the mouth of the Dungeness River to shellfish harvest. In particular, stations 104, 105 and 113. In 2001, 100 more acres in the vicinity of station 108 were added to the closure area. In 2003, the DOH changed the classification of the inner bay to

"conditionally approved" for shellfish harvest. This classification required the “conditionally approved” portion of inner Dungeness Bay be closed to shellfish harvest each year from November 1 through January 31(Sargeant, 2004).

The Washington State Department of Ecology (Ecology) conducted Total Maximum Daily Load (TMDL) studies for the Dungeness River watershed in 2002 and for Dungeness Bay in 2004. These studies found that FC concentrations did not meet water quality standards at several monitoring locations. The studies attributed the pollution to nonpoint sources including failing septic systems, stormwater runoff, and waste from livestock, pets, and wildlife. Restoration activities, including piping of irrigation ditches, pasture management, manure storage, investigation and repair of on-site septic systems, and outreach and education efforts with area residents, have been implemented to reduce FC loading to the bay (The Cadmus Group, 2010).

Effectiveness monitoring sampling was conducted in 2008-2009. The data were combined with previous data collected from 1999-2009. The result of the effectiveness monitoring study provides strong evidence that FC concentrations have decreased in Matriotti Creek and to a lesser degree in the Dungeness River. Despite these improvements, nine out of 13 Dungeness Bay tributary stations did not meet water quality standards and TMDL targets. There is moderately strong evidence that FC concentrations have decreased in Dungeness Bay between 1999 and 2009. (The Cadmus Group, 2010). Recently, the four stations near the mouth of the Dungeness River, stations 105, 104, 113, and 114, have been upgraded to conditionally approved (Figure 2) during February through October and closed from November 1 through January 31.

This project is being performed at the request of the Dungeness Clean Water Workgroup (Workgroup). The Workgroup is made up of representatives from federal, state, and local governments, the Jamestown S’Klallam tribal government, and citizens. The Workgroup was initiated in 2001 in response to the shellfish closure response process. The members have been intently focused on cleaning up the waters over the years. This study is important to the Workgroup as part of the on-going TMDL implementation to clean up water quality. The freshwater contributions and seasonal pattern of FC concentrations from the seeps and ditches are not clear. There is concern that these waters may be contributing FC bacteria and concentrations found in the inner bay. This study will characterize FC bacteria concentrations over a 12-month period and may point to potential sources of bacteria for cleanup.

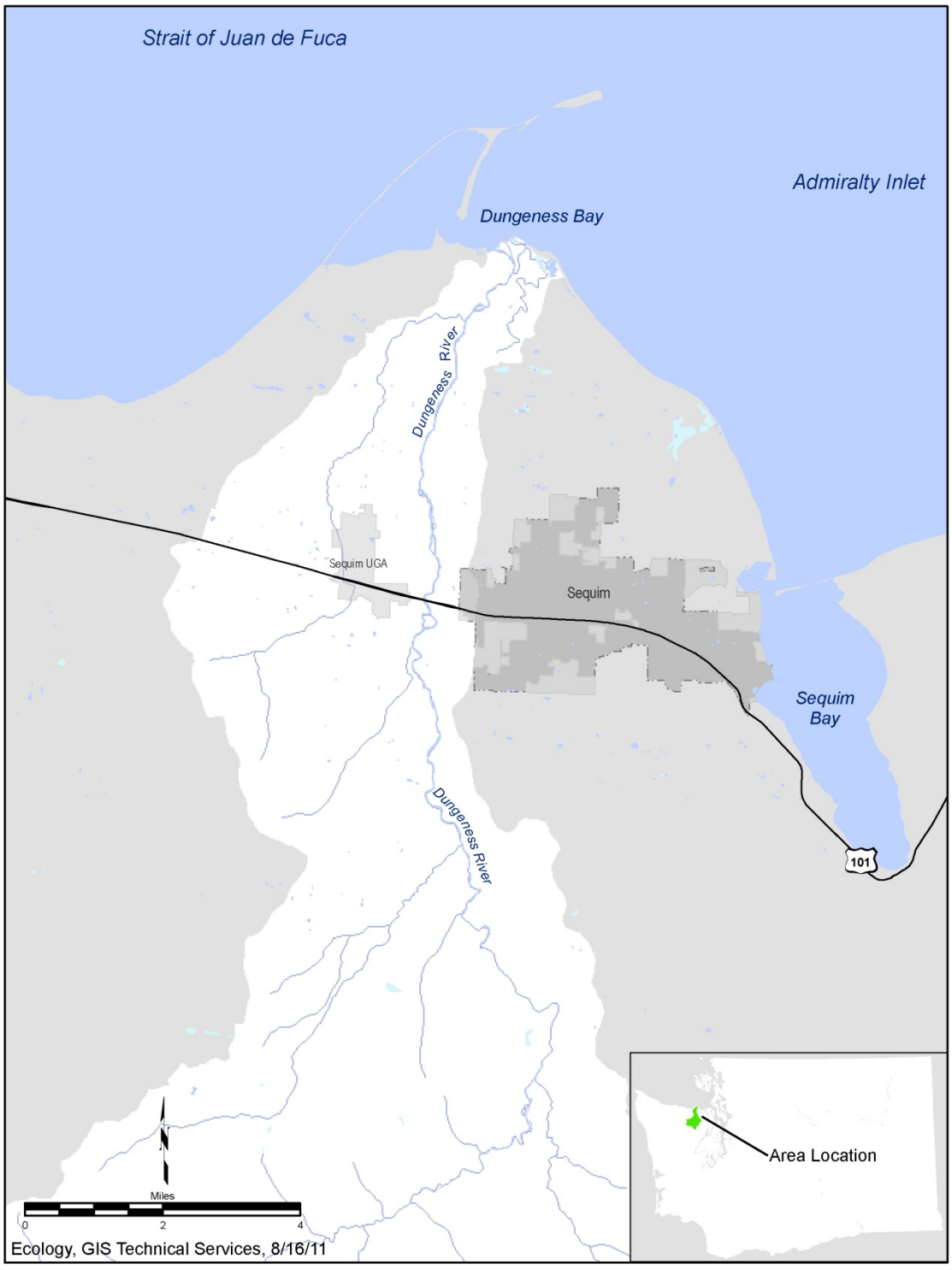

Figure 1. Map of Dungeness Bay and surrounding area.

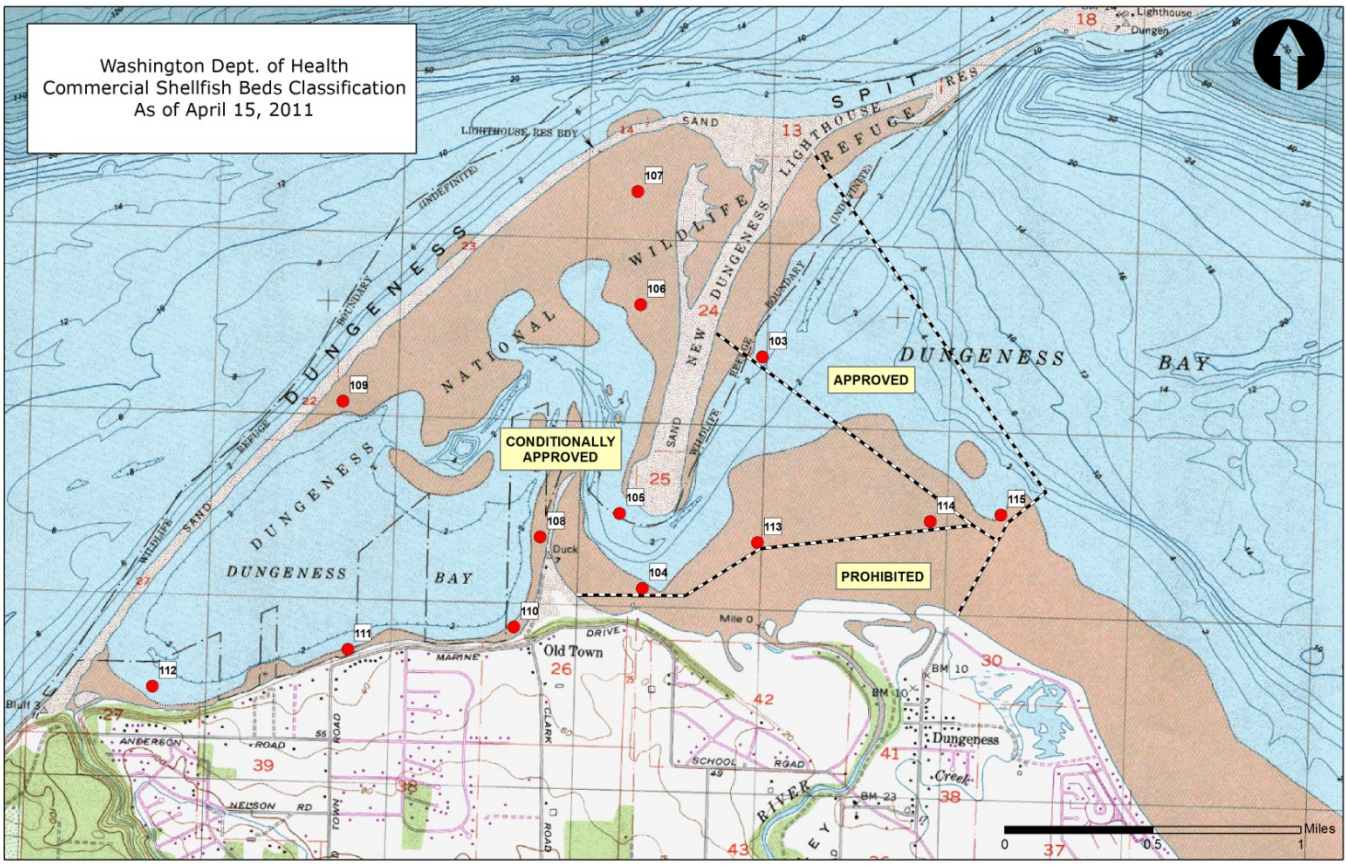

Figure 2. Department of Health shellfish beds and classification in Dungeness Bay.

Project Description

The goal of this study is to help reduce FC contamination in the 303(d) listed portions of Dungeness Bay. The 303(d) listed waters are those that are impaired and fail to meet water quality standards. Targeted sampling locations are seeps that enter from the base of the bluff of inner Dungeness Bay and stormwater ditches at the top of the bluff.

The objectives of this study are to:

- Characterize FC concentrations from the select freshwater seeps and stormwater ditches during the winter and summer seasons.
- Compare results to the water quality criterion. For these waters it is the extraordinary primary contact criterion for fresh water. The criterion states that fecal coliform levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than 10 sample points exist) obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.
- Use study results to guide water quality implementation activities for cleaner water and shellfish beds.

Eight seeps and four ditches will be sampled (Table 1 and Figure 3). The locations are those selected and sampled previously by the Dungeness Clean Water Workgroup partners. Sample sites are named based on names already in Ecology's Environmental Information Management (EIM) database. Sampling will be timed to correspond to low tide in order to access the seeps by foot.

This study is not a TMDL or an effectiveness monitoring project, but findings are intended to support water cleanup efforts.

Table 1. Location descriptions of sampling sites.

EIM Location ID	Location Description	Latitude	Longitude
SEEPS			
DUN-SEEP 1	Base of Inner Dungeness Bay bluff	48.147851	-123.170942
DUN-SEEP 2	Base of Inner Dungeness Bay bluff	48.147337	-123.172346
DUN-SEEP 3	Base of Inner Dungeness Bay bluff	48.14609	-123.17846
DUN-SEEP 4	Base of Inner Dungeness Bay bluff	48.14165	-123.17884
DUN-SEEP 5	Base of Inner Dungeness Bay bluff	48.14611	-123.17938
DUN-SEEP 6	Base of Inner Dungeness Bay bluff	48.14603	-123.17989
DUN-SEEP 7	Base of Inner Dungeness Bay bluff	48.14619	-123.18043
DUN-SEEP 8	Base of Inner Dungeness Bay bluff	48.14630	-123.18080
DITCHES			
BD2_BLUFF (B DITCH 2)	Ditch at 520 Marine Drive	48.14973	-123.15588
BD3_BLUFF (THORNDIT)	Ditch at small bridge at Thornton and Marine Drive	48.14937	-123.16124
BD4_BLUFF (B DITCH 4)	Ditch at 80 Marine Drive	48.14899	-123.16519
BD7_ANDERSON RD (CCD2)	Ditch at 134 W Anderson Road	48.14509	-123.1695

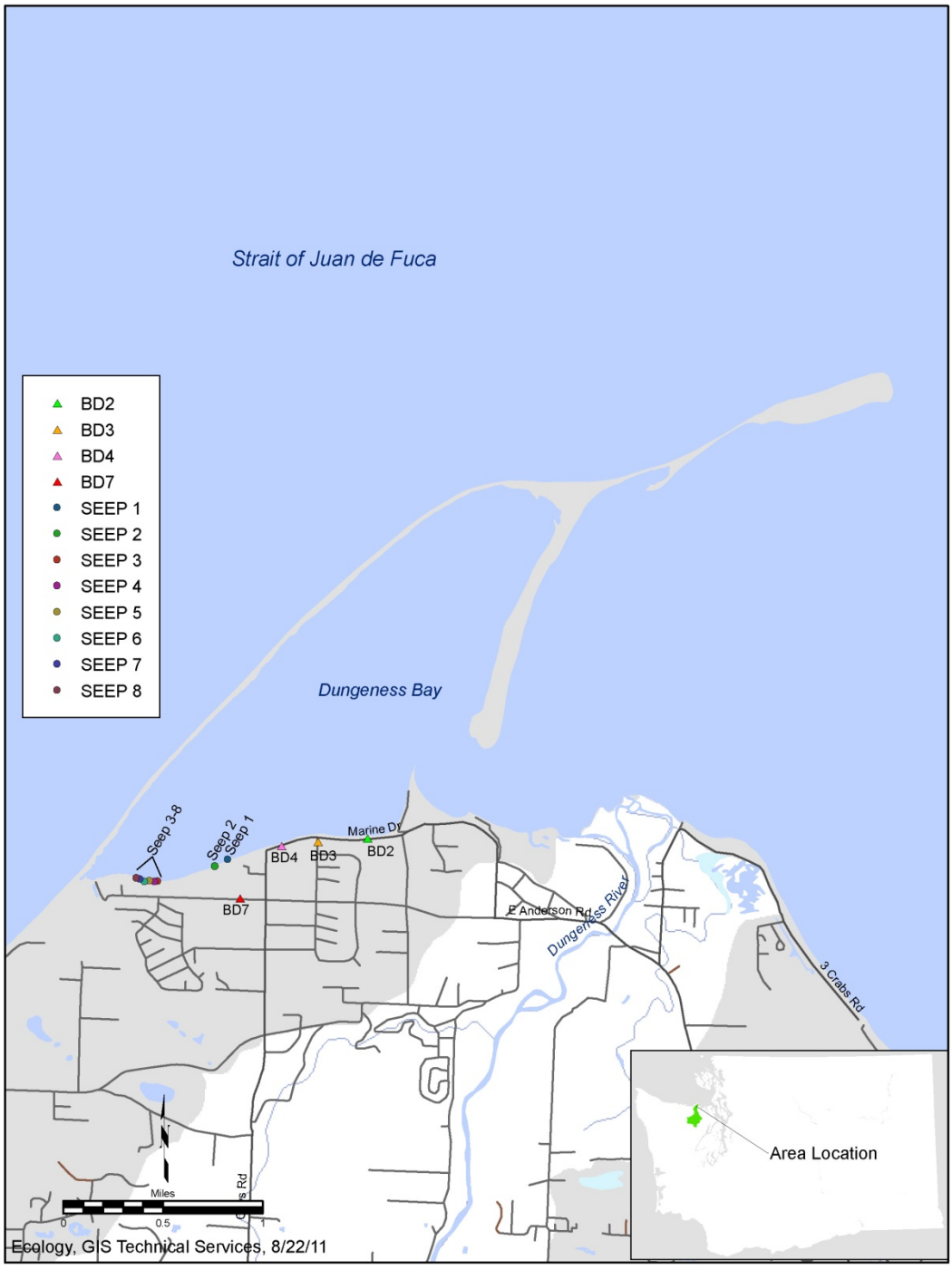

Figure 3. Study sample locations. *The site names are abbreviated from Table 1 to better fit on this map.*

Organization and Schedule

Table 2 lists the people involved in this project. Table 3 presents the proposed schedule for this project.

Table 2. Organization of project staff and responsibilities.

Staff	Title	Responsibilities
Lydia Wagner Water Quality Program Southwest Region Phone: 360-407-6329 Lydia.Wagner@ecy.wa.gov	Eastern Olympic Water Quality Management Area Water Cleanup Coordinator, Client	Provides internal review of the Quality Assurance Project Plan (QAPP) and approves the final QAPP.
Betsy Dickes Water Quality Program Southwest Region Phone: 360-407-6296 Betsy.Dickes@ecy.wa.gov	Project Manager/ Principal Investigator	Clarifies project scope. Writes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data, analyzes and interprets data, and enters data into Ecology's Environmental Information Management database. Writes the draft and final report.
Lori DeLorm (Jamestown S'Klallam tribe)	Field Assistant	Assists in choosing sampling sites, identifying locations of the sampling sites and collecting samples.
Kim McKee Water Quality Program Southwest Region Phone: 360-407-6407	Unit Supervisor for the Project Manager	Provides review and approval of the project scope and budget, tracks progress, and approves the QAPP and technical report.
Bob Bergquist Water Quality Program Southwest Region Phone: 360-407-6271	Section Manager for the Project Manager	Provides review and approval of the project scope and budget, and approves the QAPP and technical report.
Stuart Magoon Manchester Environmental Laboratory Phone: 360-871-8801	Laboratory Director	Reviews and approves the QAPP and provides laboratory staff and resources.
Mike Herold Water Quality Program Phone: 360-407-6434	Quality Assurance Coordinator	Provides review of the QAPP.

Table 3. Proposed schedule for completing field and laboratory work, data entry into EIM, and reports.

Field and laboratory work	Due date	Lead staff
Field work initiated	November 2011	Betsy Dickes
Field work completed	October 2012	
Laboratory analyses completed	October 2012	
Environmental Information System (EIM) database		
EIM user study ID	BEDI0018	
Product	Due date	Lead staff
EIM data loaded	December 2012	Betsy Dickes
Final report		
Author lead / Support staff	Betsy Dickes	
Schedule		
Draft due to supervisor	February 2012	
Draft due to client/peer reviewer	March 2012	
Draft due to external reviewer(s)	April 2012	
Final (all reviews done) due to publications coordinator	May 2012	
Final report due on web	June 2012	

Sampling budget

The estimated laboratory budget for this project is $4500. This budget is based on 14 samples per month for 12 consecutive months at a cost of $23.88 for each FC sample.

Quality Objectives

Measurement quality objectives (MQO) will vary for parameters based on their ability to be measured in the natural environment. Quality objectives are statements of the precision, bias, and lower reporting limits necessary to address project objectives. Precision and bias together express data accuracy. Other considerations of quality objectives include representativeness and completeness.

Precision is defined as the measure of variability in the results of replicate measurements due to random error. This random error includes error inherently associated with field sampling and laboratory analysis. Field and laboratory errors are minimized by following strict protocols for sampling and analysis. Precision for replicates will be expressed as percent relative standard deviation (RSD). RSD is the standard deviation of the replicates divided by the average of the replicates, expressed as a percentage. Precision quality will follow the guidelines established by Mathieu, 2006 (Table 4). Two field replicates will be collected for every 12 samples collected.

Table 4. Measurement quality objectives.

Analysis	Method	Field Replicate MQO*	Lab Duplicate MQO	Reporting Limit
Fecal Coliform - MF	SM 9222D	50% of replicate pairs <20 % RSD 90% of replicate pairs <50% RSD	40% RPD	1 cfu/100 mL

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

SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition (APHA et al., 1998)

Bias is a measure of the systematic error between an estimated value for a parameter and the true value. Systemic errors can occur through poor technique in sampling, sample handling, or analysis. We will minimize the bias through strict adherence to standard operating protocols (SOPs). Field staff will follow the SOPs for FC bacteria (Ward, et al. 2011). Sample contamination will be prevented through careful sample collection and avoiding contact with the substrate.

Representativeness will be assured through the use of standardized Ecology protocols (Ward, et al. 2011). However, fecal coliform values are known to be highly variable over space and time. FC bacteria will be analyzed using the membrane filter method (MF).

Completeness is defined as a measure of the amount of valid data needed to be obtained from a measurement system (Lombard, et al., 2004). It will be assessed by examining:

- The number of samples collected compared to the sampling plan;
- The number of samples shipped and received at the Manchester Environmental Laboratory (MEL) in good condition;
- The laboratory's ability to produce usable results for each sample; and
- Sample results accepted by the project manager.

The objective for sampling completeness is 90%. However, at times there may be practical constraints, such as staff availability, weather/road conditions, tidal height during daylight hours, and safety concerns that may limit the ability of project staff to collect the number of samples or sample events expected. The other possibility is that a seep or ditch may be dry during any particular sampling event.

Sampling Process Design (Experimental Design)

Fecal coliform samples will be collected at 8 freshwater seep sites at the base of inner Dungeness Bay bluff and four drainage ditches that come off the top of the bluff of inner Dungeness Bay (Figure 3). Sample locations for the seeps and ditches are the same as previously identified by the Jamestown S'Klallam tribe, Battelle Marine Sciences Laboratory Clallam County and/or Ecology. Routine sampling will occur once a month over the period of 12 months.

The following is an estimated sampling schedule:

2011
- November 2
- December 5

2012
- January 16
- February 14
- March 13
- April 10
- May 8
- June 5
- July 17
- August 15
- September 17
- October 15

Sampling Procedures

Safety

Field personnel have the authority to ensure their safety. Reviewing environmental conditions for safety will always be a priority before accessing a sampling site. Personnel can refuse to proceed if they believe safety hazards are present.

Sampling

Standard Ecology protocols will be used for sample collection. Field sampling will follow those described in Ward et al., 2011.

Staff will collect grab samples for FC directly into pre-cleaned containers supplied by the MEL (MEL, 2008). Plastic bottles will be used to prevent bottle breakage and sample loss. Samples will be collected in a manner to prevent bottle contamination and to avoid contamination with sediment. Each sample will be labeled and immediately placed in a dark thermal cooler with ice. Samples will be kept in conditions between 0˚C and 4˚C until the samples are processed by the laboratory. Samples will arrive and be processed at the MEL within 24 hours of collection.

The sample bottles will be labeled with:
- Project name
- Date
- Site name
- Name of lead sampler
- Laboratory ID number
- Parameter
- Sampling time

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

The project manager will provide training for anyone who is assisting with the fieldwork. This will include discussion of quality assurance and contamination prevention. Upon completion of sampling at each site, the project manager will review the field notes. This will ensure all activities are performed and that the records are legible.

The project manager will coordinate sampling dates, laboratory identification numbers and methods with MEL, using standard Ecology protocol. The samples and completed Laboratory Analysis Required form will be picked up at the Ecology Headquarters Chain of Custody room by the MEL courier. The courier will transfer the cooler containing samples and ice to the lab vehicle and transport the samples the MEL using chain of custody protocols.

Laboratory Measurement Procedures

Laboratory analyses will be performed in accordance with the MEL User's Manual (MEL, 2008). The laboratory staff will consult with the project manager if there are any changes in procedures over the course of the project. Table 5 summarizes laboratory analysis procedures for FC.

The field crew will communicate with the laboratory staff to ensure that laboratory resources are available. The project team will follow MEL procedures for sample notification and scheduling. With adequate communication, sample quantities and processing should not overwhelm the laboratory capacity.

Table 5. Estimated range and detection limit, holding time, preservation, and container for fecal coliform analysis.

Method	Estimate Range (cfu/100 mL)	Detection Limit (cfu/100 mL)	Holding Time	Preservation	Container
FC_MF	<1 - 5000	1	24 hours	Chill (4˚C)	250 mL poly bottle

Quality Control Procedures

Variability that comes from field sampling and from laboratory analyses will be assessed by collecting replicate samples and by performing replicate analyses. Bacteria sample concentrations are inherently variable compared with other water quality parameters. Bacteria sample precision will be assessed by collecting replicates at two out of 12 sample locations. The MEL will analyze a duplicate sample from each sampling event to determine the presence of bias in analytical methods.

All water samples will be analyzed at MEL following standard quality control procedures (MEL, 2006). Field sampling will follow quality control protocols (Ward et al., 2011). If any of these quality control procedures are not met, the associated results will be qualified and used with caution. Professional judgment and peer review will determine if the data are used in analysis.

Data Management Procedures

Data reduction, review, and reporting will follow the procedures outlined in MEL's Lab Users Manual (MEL, 2008). Laboratory staff will be responsible for internal quality control verification, proper data transfer, and reporting data to the project manager via the Laboratory Information Management System (LIMS).

Water quality data will be electronically transferred from LIMS into an EXCEL® spreadsheet. Data will be verified and reviewed for errors. If any errors are found they will be corrected. Data will then be uploaded into Ecology's Environmental Information Management (EIM) system by the project manager.

The project manager will assess the quality of the data received from the laboratory and collected in the field. The review of measurement quality objectives will be performed within one month of data collection and adjustments will be made to field or laboratory procedures as necessary. The Eastern Olympic Water Quality Management Area Water Cleanup Plan Coordinator will be notified if major changes are made to the sampling plan.

The laboratory microbiologist will notify the project manager by e-mail when FC results are greater than 200 cfu/100 mL. Elevated FC concentrations will be reported to the Eastern Olympic Water Quality Management Area Water Cleanup Plan Coordinator as soon as possible.

Laboratory values below detection limit will be assumed to be the detection limit for analysis. Data from field replicates will be arithmetically averaged for data analysis. Estimation of univariate statistical parameters and graphical presentation of the data will be made using EXCEL® software (Microsoft, 2007). Data will be looked at by wet season (October – March) and dry season (April – September).

Audits and Reports

MEL will submit laboratory reports and chain-of-custody records to the project manager. Documentation from the lab should include any quality control results associated with the data in order to evaluate the accuracy of the data and to verify that the quality objectives are met.

The project manager is responsible for verifying data completeness. The project manager is also responsible for writing the final technical report. The final report will include analyses of results that form the basis of conclusions and recommendations. The final report will undergo the peer review process by staff with appropriate expertise.

Data Verification and Validation

Qualified and experienced laboratory staff will examine lab results for errors, omissions, and compliance with quality control criteria. Analytical data will be reviewed; it will be verified according to the data review procedures outlined in the Lab User's Manual (MEL, 2008). Results that do not meet quality assurance requirements will be labeled with appropriate qualifiers. Findings will be documented in each case narrative sent to the project manager.

The project manager will examine the complete data package in detail to determine whether the procedures in the QAPP were followed. The project manager is responsible for verifying that field data entries are complete and correct. Data verification involves examining the data for errors, omissions, and compliance with quality control criteria. Once measurement results have been recorded, they are verified to ensure that:

- Data are consistent, correct, and complete.
- Results for quality control sample accompany the sample results.
- Established criteria for quality control samples are met.
- Data qualifiers are assigned where appropriate.
- Data specified in the sampling design were obtained.
- Methods and protocols specified in the QAPP were followed.

Data Quality (Usability) Assessment

Usability determination will entail evaluation of field and laboratory results and relative standard deviation between field replicates. Adherence to established protocols should eliminate most sources of bias (Lombard, et al., 2004). Laboratory duplicates estimate laboratory precision. Field replicates should indicate overall variability (environmental, sampling, and laboratory).

The project manager will verify that all measurement and data quality objectives have been met for each monitoring station. If the objectives have not been met (such as percent RSD for FC replicated exceed the MQO) then consideration will be taken to qualify the data, how to use it in analysis, or whether it should be rejected. Decisions for data quality and usability will be documented.

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