Quality Assurance Project Plan for Dungeness River/Matriotti Creek Fecal Coliform Bacteria Total Maximum Daily Load Study

by
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Washington State Department of Ecology
Environmental Assessment Program
Watershed Ecology Section

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Introduction

History

Dungeness Bay has been classified as "Approved" for commercial shellfish harvest by the Washington State Department of Health (DOH). The DOH Office of Shellfish Programs is charged with classifying commercial shellfish beds in Washington State. They conduct ambient water quality monitoring to ensure that all commercial shellfish areas meet National Shellfish Sanitation Requirements for water quality. The DOH has 13 monitoring stations in the Dungeness Bay (Figure 1). In late 1997 a station near the mouth of the Dungeness River, station 11, showed increases in fecal coliform levels. In December 1997 the DOH changed the area around this station from "Approved" to "Inactive" status due to poor water quality. "Inactive" status means the area is not under DOH classification because no commercial shellfish harvest is occurring.

In response to the water quality problems in the bay, in November 1997 the Jamestown S'Kllallam Tribe (Tribe) began conducting water quality monitoring of tributaries adjacent to station 11. The Tribe, in cooperation with Clallam County, hoped to find a definitive source that would explain recent water quality problems. Unfortunately, no one probable source was identified. The monitoring program expanded to include more sites and additional tributaries of the Dungeness River. It became evident that poor water quality in the bay was due to a number of water quality problems in the basin.

In 1996 Matriotti Creek, a tributary to the Dungeness River, was placed on Washington's 303(d) list of impaired waters because of fecal coliform (FC) bacteria violations. The 303(d) list (required by section 303(d) of the federal Clean Water Act) is a list of water bodies that are not meeting water quality standards. Ecology is required by the Clean Water Act to conduct a total maximum daily load (TMDL) evaluation for waterbodies on the 303(d) list. The evaluation begins with a water quality technical study. The technical study determines the capacity of the waterbody to absorb pollutants and still meet water quality standards. The study also evaluates the likely sources of those pollutants, and the amounts pollutant sources need to be reduced to reach that capacity. After the technical study Ecology will work with other agencies and local citizens to identify water quality-based controls based on the sources found in the study.

In 1999 the Dungeness River Management Team and the Jamestown S'Kllallam Tribe requested that Ecology conduct a water quality study to identify bacterial sources that contribute to poor water quality in the bay. Ecology is also required to conduct a TMDL evaluation on Matriotti Creek. Ecology agreed to conduct a water quality study to identify FC bacteria sources in the lower Dungeness River watershed and to develop a TMDL study for Matriotti Creek.

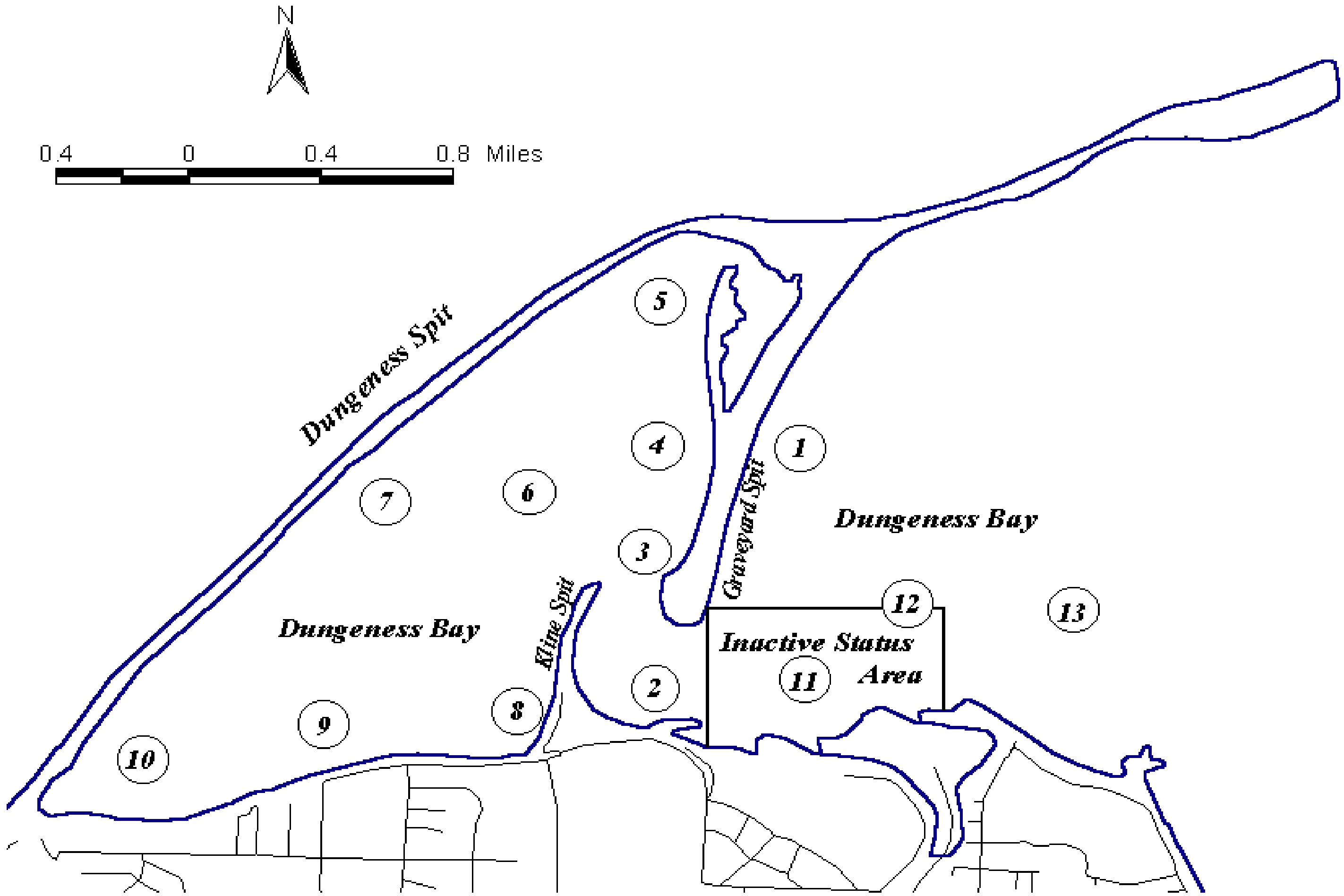

Figure 1. Department of Health Marine Monitoring Stations in Dungeness Bay.

Setting

Dungeness Bay

Dungeness Bay is located on the southern shore of the Strait of Juan de Fuca. The Bay is enclosed by the main and outer Dungeness Spit, doubly-recurved Graveyard Spit, and Cline Spit on the mainland coast. Dungeness Bay is comprised of East and West Dungeness Bay (Figure 1). West Dungeness Bay is almost completely enclosed by the three sand spits. The entrance to West Dungeness Bay opens to East Dungeness Bay. The major freshwater tributary is Dungeness River which flows into East Dungeness Bay. Meadowbrook Creek is a small tributary that enters the Bay to the east of the Dungeness River.

Dungeness River

The Dungeness River is located in the northeast corner of the Olympic Peninsula. The river is 32 miles long and drains 172,517 acres (Clark and Clark, 1996). It is free flowing from headwaters to tidewaters. The upper two-thirds of the watershed is national forest and national park. The lower 13-mile stretch of river flows through mostly private land (which includes the riverbed itself). The Dungeness River emerges through the foothills at about river mile (RM) 10 to the relatively flat Dungeness valley. This study focuses on the Dungeness River and its tributaries below RM 3.2 (north of the Highway 101 bridge). Tributaries in this stretch include Matriotti Creek and Hurd Creek. This study will also include Meadowbrook Creek and its tributaries.

The area climate is mild because it lies in the rain shadow of the Olympic Mountains and close to the Strait of Juan de Fuca and the Pacific Ocean. Precipitation varies from 15 inches annually near Sequim to 80 inches annually in the headwaters of the Dungeness River. Due to the low rainfall, the lower Dungeness valley contains an extensive irrigation system to support agricultural crops in the valley. The irrigation land system begins with five diversions from the river between RM 11.1 and 6.7. There are more than 97 miles of irrigation ditches, with approximately 11,000 acres irrigated (PSCRBT, 1991). Flows in both Matriotti and Meadowbrook creeks are augmented as a result of irrigation and ditch leakage, and directly from ditch tailwaters and stormwater.

Matriotti Creek

Matriotti Creek is 9.3 miles long, and drains 13.6 square miles (Figure 2). It enters the Dungeness on the left bank at RM 1.90. Land uses include residential, commercial, agricultural, and livestock use, including a large animal park, the Olympic Game Farm, located near the mouth of Matriotti Creek. With increasing urbanization of the Sequim area, residential use is becoming a more predominant land use. While the city of Sequim is on sewer, residences and commercial establishments in the Matriotti Creek watershed are on on-site sewage treatment systems.

Matriotti Creek is used as a conveyance for the irrigation system. Clean irrigation water from the Dungeness enters Matriotti at creek mile (CM) 6.00 near Atterbury Road. Bear Creek and Mudd Creek enter Matriotti Creek at CM 3.80 and 1.95 respectively. Both creeks receive irrigation tailwater returns. There are also irrigation tailwater return ditches in the vicinity of CM 0.45.

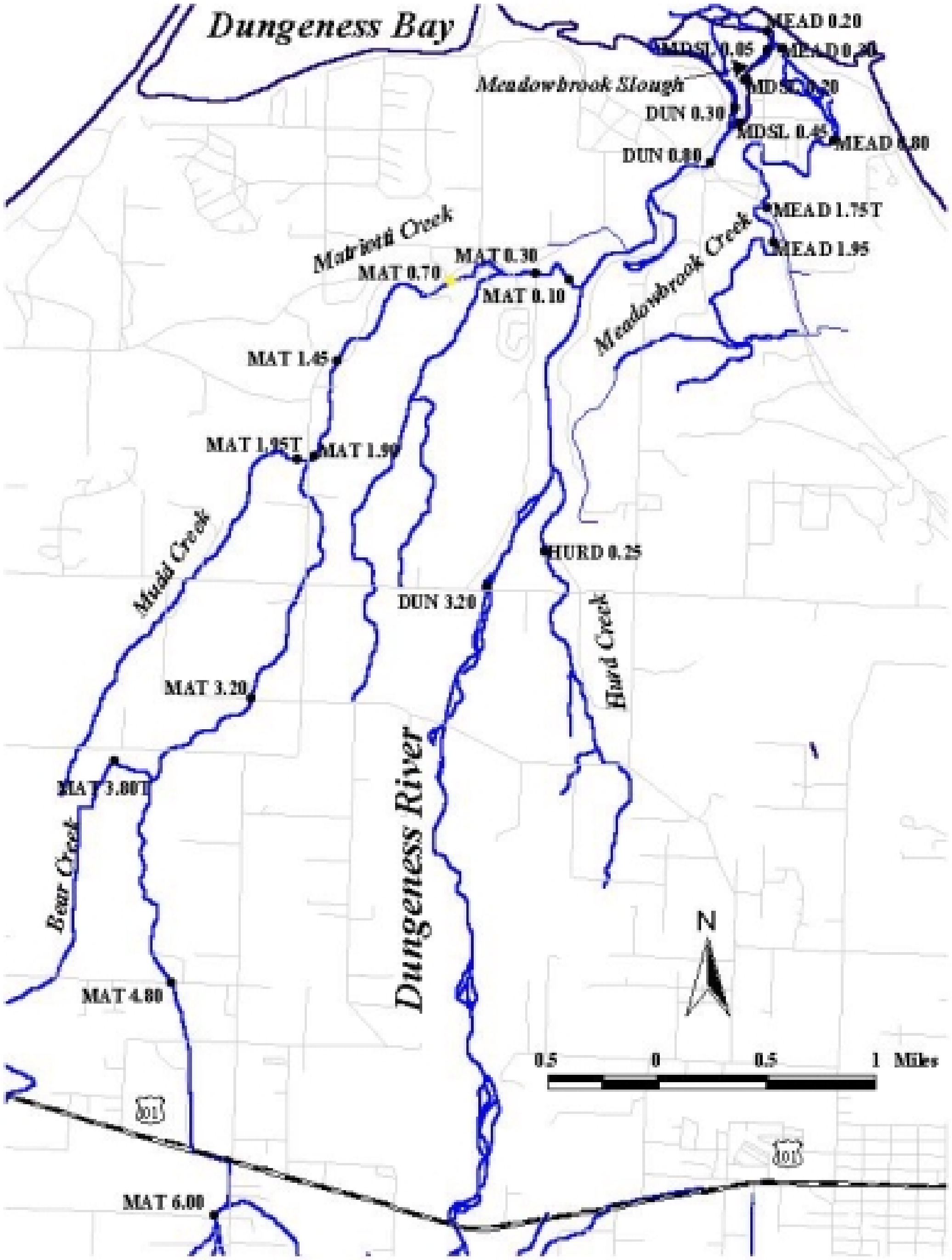

Figure 2. Proposed Monitoring Sites for the Dungeness River/Matriotti Creek Water Quality Study.

Hurd Creek
Hurd Creek is approximately1.0 mile in length and flows into the Dungeness River on the right bank at RM 2.7. Hurd Creek starts as a spring and is augmented at times by tailwater from the irrigation system.

Land use on the creek includes a fish hatchery at CM 0.50 and residential use. All homes in the area are on on-site sewage treatment systems.

Meadowbrook Creek
Meadowbrook Creek is a small creek located to the east of Dungeness River. The creek is approximately 3.0 miles long. An irrigation ditch flows into Meadowbrook Creek at CM 1.75. This ditch also receives irrigation tailwater return and stormwater from Sequim-Dungeness Avenue. There is a 0.5 mile slough at Meadowbrook CM 0.25. The slough is fed at times with Dungeness River water; a landowner on the Dungeness controls flow in the slough. Since 1995 the mouth of Meadowbrook Creek has been migrating eastward. In 1995 it flowed into the Dungeness River just above the mouth; currently it flows into Dungeness Bay east of the Dungeness River.

Land uses along Meadowbrook Creek include a horse farm near the mouth, a wetland bird refuge, agricultural residential, and some commercial use in the community of Dungeness. Land use along Meadowbrook slough includes residential use and a private wildlife area near the mouth. All residences and commercial properties are on on-site sewage treatment systems.

Water Quality Standards

Appendix A lists the characteristic beneficial uses and water quality criteria for marine classification AA and freshwater classifications A and AA. To determine if the fresh or marine standard applies, the following criteria are used for fecal coliform: the freshwater criteria shall be applied at any point where 95% of the vertically averaged daily maximum salinity values are less than or equal to 10 parts per thousand or greater (Chapter 173-201A Washington Administrative Code).

Dungeness Bay is marine water Class AA. The bay supports commercial and recreational harvests of salmon and bottomfish, as well as important salt marsh habitat and eelgrass beds for brant, fish, and shellfish. Oysters, hardshell clams, butter and horse clams are harvested commercially and recreationally in Dungeness Bay, for a total of 1,183 acres of certified shellfish beds (PSCRBT, 1991). Dungeness crabs are also harvested commercially and recreationally in the bay. Other uses in the area include recreational waterfowl hunting, bird watching, nature study, hiking and beach combing, commercial and recreational boat use, and scuba diving.

The Jamestown S'Klallam Indians have always harvested fish and shellfish from Dungeness Bay for food, trade, and cultural ceremonies. In addition to subsistence harvest in the bay, the Tribe currently harvests clams commercially, and they own and operate commercial oyster and clam farms in the area (Muench, 1999).

The Dungeness River from the mouth to Canyon Creek (RM 10.8) is freshwater Class A. The Dungeness River supports fisheries such as chinook, coho, pink and chum salmon, summer and winter-run steelhead, cutthroat trout, rainbow trout, and Dolly Varden. The river is a source and conveyance for irrigation water for crops and stock watering. Recreational use includes swimming, boating, fishing, and aesthetic enjoyment.

Tributaries to the Dungeness River, such as Hurd Creek and Matriotti Creek, are freshwater Class A. Hurd Creek is used for irrigation water conveyance, and water is withdrawn from the creek for a fish hatchery. Hurd Creek is used by a variety of fish including coho, chum, steelhead, cutthroat trout, and Dolly Varden. Matriotti Creek is used for irrigation water conveyance, agricultural irrigation, and stock watering. Fisheries use in the creek includes coho and chum.

Meadowbrook Creek and slough are classified freshwater AA. In accordance with the water quality standards, all unclassified surface waters that are tributaries to Class AA waters (Dungeness Bay) are classified Class AA. Beneficial uses of Meadowbrook Creek and slough include irrigation water conveyance, wildlife use, and fisheries use such as coho and chum.

Historical Data

Clallam County Monitoring and Planning

In 1991 the Puget Sound Cooperative River Basin Team (PSCRBT) prepared a Dungeness River Area Watershed Characterization (PSCRBT, 1991). The purpose of the characterization was to assist in development of the Dungeness River Area Watershed Management Plan (Clallam County, 1993), a plan to control and prevent nonpoint source pollution. The Dungeness Watershed Management Plan and Characterization (Characterization) included the entire watershed. The Characterization describes nonpoint sources of pollution and beneficial uses of water in the watershed. It also includes information about stream corridors wetlands and land uses. In the summary of findings their conclusions regarding bacterial sources were:

- Significant bacterial contamination and nutrient loading from animal waste were found on both commercial and small farms with high livestock concentrations and poor management;
- Existing on-site septic systems are potentially contributing bacterial contamination and nutrients to both surface and groundwater due to soil conditions and inadequate maintenance; and
- Irrigation water is often used for non-agricultural purposes, and the ditches often convey pollutants to receiving waters.

Clallam County also conducted water quality monitoring as a part of the Dungeness River Area Watershed Management Plan. Monitoring of some of the irrigation ditches, Matriotti Creek, Hurd Creek, Meadowbrook Creek, and the Dungeness River was conducted from July 1991 through September 1992. Monitoring included flow discharge, temperature, conductivity, dissolved oxygen, pH, turbidity, fecal coliform, and occasionally nitrogen and phosphorus. The study found fecal coliform bacteria exceeding water quality standards at numerous locations in the watershed. Other parameters of concern were high temperatures and low dissolved oxygen in the Dungeness River, high turbidity levels associated with high flow events and cattle access to streams and ditches, and high nitrogen levels in groundwater-fed streams (Clallam County, 1993).

The Dungeness River Area Watershed Management Plan contained many actions necessary to control bacterial pollution in the watershed. Since monitoring in 1991-92, the Sequim area has experienced rapid growth and land use practices have changed from predominantly agricultural to low and medium density residences, many with ownership of horses and other animals. Natural Resource Conservation Service and the Clallam Conservation District have worked with a number of property owners to develop farm management plans, fence animals out of waterways, and restore creek habitat.

However, recent water quality problems in Dungeness Bay have renewed concerns about water quality in the area. Water quality information from this study will be used to develop a recovery strategy for the shellfish beds in Dungeness Bay. While the recovery strategy may be very similar to the watershed management plan, the strategy is more focused on the area that impacts the shellfish beds, and will result in a water clean-up plan for the lower Dungeness River and its tributaries. The Watershed Management Plan can be used as a framework for the strategy. The Watershed Management Plan and recovery strategy will be incorporated into the water clean-up plan.

Department of Health Marine Monitoring

Department of Health has been conducting marine monitoring of Dungeness Bay since 1989. The DOH has 13 stations in the Dungeness Bay area (Figure 1). In late 1997 a station near the mouth of the Dungeness River, station 11, showed increases in fecal coliform levels. Bacteria levels were above the limit for approved shellfish harvest. Since then, stations 2 and 3 to the west of station 11 also show increases in fecal coliform levels (Melvin, 1999). Stations 2 and 3 may be closed for shellfish harvest by next year.

Analysis of the DOH marine data showed that there was a relationship between lower salinity levels and higher fecal coliform levels at station 11 (adjusted r^2=0.49). In looking at freshwater inputs to the bay near station 11, the Dungeness River contributes the majority of freshwater, with mean daily discharge averaging from 120 to 720 cfs depending on the time of year, in comparison to Meadowbrook Creek flows of 4 to 6 cfs (Thomas et al., 1999).

Recent Monitoring

In response to the water quality problems in the Bay, the Jamestown S'Kllallam Tribe and Clallam County began conducting water quality monitoring in November 1997 of tributaries adjacent to DOH station 11. Monitoring was conducted on the Dungeness River, Meadowbrook Creek, and Meadowbrook Slough.

In February 1998 monitoring was targeted to low tide events, and a station was added at the mouth of a tidal slough west of the Dungeness River. Additional stations were added, as it became apparent there were a variety of bacterial pollution sources.

In 1998 Clallam County organized a volunteer monitoring program, Bay Watchers. The Bay Watchers monitored near-shore marine water for bacteria. Occasionally high levels of bacteria were found (Muench, 1999).

In August 1998 the Clallam Conservation District began monitoring in Matriotti Creek. The purpose of the monitoring was to determine the effectiveness of best management practices. High fecal coliform levels were found in Matriotti Creek.

Recent monitoring data from the Tribe, county, and conservation district were analyzed by Ecology. Results are described in Appendix B. A summary of the results is as follows:

Dungeness River

The Dungeness River meets water quality standards for fecal coliform at both sampling sites. The upstream site meets the more stringent marine standard, but the downstream station does not. A paired t-test was used to compare fecal coliform data from both stations. The t-test showed that bacteria levels downstream are significantly higher than upstream levels. This points to bacterial sources of contamination between the upstream and downstream stations.

Linear regressions were done to compare fecal coliform concentrations at the downstream station to previous rainfall and the antecedent precipitation index. Results show a moderate to weak relationship (r^2=0.46) with fecal coliform and preceding 24-hour rainfall. A multiple linear regression was done to examine the relationship between fecal coliform concentrations, flow, and seasonality. Results showed a strong relationship with seasonality (r^2=0.73) indicating seasonality is significantly correlated ($P<0.05$) to observed fecal coliform values, whereas flow is not. The most critical seasons are May through August and December through February. May through August falls within the irrigation season of April 15th through September 15th. The December through February period overlaps with the rainiest period of November through January.

Meadowbrook Creek and Slough

None of the stations on Meadowbrook Creek met water quality standards for fecal coliform. One of five stations in Meadowbrook Slough met standards. On Meadowbrook Creek the highest levels of fecal coliform are found at the upstream stations, with fecal coliform levels decreasing downstream. On Meadowbrook Slough lower levels of fecal coliform are generally found upstream, with higher values at the downstream sites.

In Meadowbrook Creek higher levels of fecal coliform were seen during the irrigation season at the upstream sites. Meadowbrook Slough showed no pattern, except at the most downstream station which had slightly higher levels of fecal coliform during the wet season.

Matriotti Creek

Two of seven stations on Matriotti Creek met water quality standards. A statistically significant increase in fecal coliform levels was seen between the stations at CM 1.90 and 1.45, and between CM 0.70 and 0.30. During the irrigation season fecal coliform levels tended to be higher.

Project Objectives

Objectives of the proposed study are as follows:

- Characterize fecal coliform bacteria concentrations and identify major bacterial loading sources along Matriotti, Meadowbrook, and Hurd creeks, and the lower Dungeness River.

- Determine maximum acceptable fecal coliform load and concentrations allowable at the mouth of the Dungeness River to meet marine standards at DOH station 11.

- Determine maximum fecal coliform bacteria loading levels allowable to meet water quality standards in Matriotti Creek.

- Determine the percent reductions necessary for bacteria sources to meet the above loading capacities.

Study Design

Project objectives will be met through a combination of water quality monitoring, flow monitoring, and data analysis. Source evaluations will be conducted to quantify contributions along the most highly impacted reaches of the river and creeks.

Sampling Sites and Monitoring Parameters

Monitoring is planned at the sites shown in Figure 2. Laboratory monitoring parameters will include fecal coliform bacteria for all sites. Fecal coliform analyses will be used primarily because of the historical reliance on fecal coliform data, and because state water quality regulations are currently based on them. Fecal coliform will be analyzed using the membrane filter method (MF) at all sites, and the most probable number (MPN) method at the mouths of the river and creeks. The DOH uses the MPN method for fecal coliform testing. Using the same method at the mouths of the major tributaries will allow more accurate comparison of the relationship between fresh and marine water data. *Escherichia coli* (E-coli) bacteria have been proposed as an indicator in fresh water by the U.S. Environmental Protection Agency. E-coli is under consideration for possible inclusion in the state standards, thus selected sites will be tested for E-coli.

For the Dungeness River stations and for the mouth stations on Meadowbrook, Matriotti, and Hurd creeks, samples will be analyzed for turbidity and nutrients including ammonia nitrogen (NH3), nitrate-nitrite nitrogen (NO3-2), nitrite nitrogen (NO2), orthophosphate (PO4), and total persulfate nitrogen (TPN). Nutrients, turbidity, and dissolved oxygen are included in this study for the following reasons:

- USGS is currently conducting a hydrogeological assessment of the Sequim-Dungeness area, including nitrates in ground water;

- There is concern about increased nutrient input to Dungeness Bay; and

- There is interest in fish restoration.

These parameters will provide additional water quality information. Load analysis will not be done on these parameters. Table 1 shows sampling sites and laboratory parameters. Laboratory analysis will be conducted by Manchester Environmental Laboratory (MEL).

Field measurements include temperature, pH, conductivity, and flow discharge measurements. Dissolved oxygen measurements will be obtained May through September.

Table 1. Laboratory monitoring parameters for each station (Numbers indicate the number of samples taken at that site).

Sample site	Site name/ location	Fecal coliform (MF)	Fecal coliform (MPN)	E-coli (MF)	Nutrients	Turbidity
Dungeness River						
Dun RM 3.20	US from R15	2		2	2	2
Dun RM 0.80	R3	2	2	2	2	2
Dun RM 0.30	R32	2				
Matriotti Creek						
Mat CM 6.00	Atterbury Rd.	1		1		1
Mat CM 4.80	MAT2	1		1		
Mat CM 3.80Trib	Bear Creek	1				
Mat CM 3.20	MAT3	1		1		
Mat CM 1.95Trib	Mudd Creek	1				
Mat CM 1.90	MAT4	1		1		
Mat CM 1.45	MAT5	1		1		
Mat CM 0.70	MAT6	1		1		
Mat CM 0.30	MAT7	1		1		
Mat CM 0.10		1	1	1	1	1
Hurd Creek						
Hurd CM 0.25	DS Hatchery	1	1	1	1	1
Meadowbrook Creek						
Mead CM 1.95	R20	1		1		1
Mead CM 1.75Trib	R30	1				
Mead CM 0.80	R9	1		1		
Mead CM 0.30	R7/R16	1		1	1	1
Mead CM 0.20	R1	1	1	1	1	1
Meadowbrook Slough						
MDSL 0.45	R29/30	1				
MDSL 0.20	R17 and R5	2				
MDSL 0.05	R6	1		1		
2 Reserve Stations		2				
Duplicates		5-6	1	3-4	1	1

Field Surveys

Sampling will begin in November 1999 and continue through October 2000. Eighteen sample events are planned. Monthly monitoring will be conducted with additional sample events in the wet season (December, January, and February); and the irrigation season (June, July, and August). Additional storm event sampling may be necessary if a minimum of three storm events (0.25” or more in previous 48 hours) are not captured.

Freshwater sampling will be conducted the same day as DOH or Ecology marine sampling of Dungeness Bay. The DOH Shellfish Programs will be conducting monitoring once every two months in the Bay. The Ecology marine ambient sampling group is planning a monthly sampling of Dungeness Bay in 2000.

Sampling at stations influenced by tide, Meadowbrook Creek and Meadowbrook Slough will occur at the lowest tide possible during the day.

Staff gauges will be installed at selected sites. During the field surveys, flows will be measured at selected stations or staff gauge readings will be recorded. A flow rating curve will be developed for sites with a staff gauge.

Continuous flow gauging stations will be installed at three locations in the basin on Meadowbrook Creek, Matriotti Creek, and Dungeness River. Flow estimates will be determined by the Ecology Environmental Assessment Program, Environmental Monitoring and Trends Section, Stream Hydrology Unit. Estimation of discharge and instantaneous flow measurement will follow the Stream Hydrology Unit protocols manual (Ecology, 1999). Flows will be calculated from continuous stage height records, and rating curves developed prior to and during the project. Stage height will be measured by pressure transducer and recorded on data loggers every 15 minutes. All station data loggers will have data downloaded every two weeks for the first two months and monthly after that. If during the study continuous flow monitoring proves impractical, flows will be estimated by regression analysis of instantaneous measurements of gauged versus ungauged sites and by estimates of watershed runoff using hydrographic methods.

Sampling for each survey will be conducted in one day by a team from Ecology and the Jamestown S'Kllallam Tribe.

Samples will be taken as grab samples from a single location for sites on Meadowbrook Creek and Meadowbrook Slough, Matriotti Creek, and Hurd Creek. Two grab samples will be taken from a bridge at each Dungeness River site, 1/3 and 2/3 distance from the shoreline.

Data Analysis and Modeling

All project data will be entered in Microsoft Excel spreadsheets and Ecology's Environmental Information Management (EIM) system. Statistical calculations will be made using the database spreadsheets and by importing the data from the spreadsheets to either SYSTAT (SPSS Inc, 1997) or WQHYDRO (Aroner, 1992) statistical software.

Schedule, Budget, and Project Organization

Project Schedule

Field Sampling Surveys	November 1999 through October 2000
Draft Report to Unit Supervisor	July 2001
Draft Report to Client	August 2001
Draft Report Public Review	September 2001
Final Report	November 2001

Project Budget

The laboratory budget is presented in Table 2. Total laboratory expenses are projected to be approximately $33,894 for the entire study.

Table 2. Estimated Laboratory Costs for Dungeness\Matriotti Study.

Parameter	Cost/analysis water only	Number of samples per survey inc., field duplicates	Cost per survey	Total cost 18 surveys
Fecal Coliform (MF)	$ 30	33	$ 990	$ 17820
E-coli (MF)	$ 5 (with FC)	21	$ 105	$ 1890
Fecal Coliform (MPN)	$ 39	6	$ 234	$ 4212
Nutrients	$ 53	9	$ 477	$ 8586
Turbidity	$ 7	11	$ 77	$ 1386
TOTAL			**$ 1883**	**$ 33894**

Project Organization

This section identifies all individuals with responsibilities for supervision or implementation of the project and describes their responsibilities. The following individuals and organizations will be involved in the project.

Department of Ecology

- *Debby Sargeant (Watershed Studies Unit*). Principal Investigator responsible for overall project management, preparation of Quality Assurance Project Plan (QAPP), supervision, completion of field sampling, analysis of project data, and preparation of draft and final reports. Main contact for public outreach regarding technical study.

- *Paul Pickett (Watershed Studies Unit*). Project Lead responsible for oversight of project and reviewing QAPP and all drafts of the report. Responsible for providing advice on sampling protocols, data analysis, model development, report structure, and public outreach regarding TMDLs.

- *Sarah O'Neal (Watershed Studies Unit).* Responsible for assistance in field sampling and data reduction activities.

- *Jim Shed (Stream Hydrology Unit).* Responsible for continuous flow monitoring sites including set-up, maintenance, and data collection.

- *Jan Newton (Marine Monitoring Unit).* Contact for Ecology's marine monitoring.

- *Karol Erickson (Watershed Studies Unit). U*nit Supervisor responsible for review of draft QAPP and draft final report, as well as budget and staffing decisions.

- *Stuart Magoon, Pam Covey (Manchester Environmental Laboratory (MEL)).* All samples collected during field studies will be submitted to MEL for analysis by lab staff under the direction of Stuart Magoon. Pam Covey will be responsible for coordinating requests for analysis, scheduling the processing of analytical samples, and providing final project data.

- *Jeannette Barreca, Darrel Anderson, and Keli McKay (Southwest Region Water Quality Section).* Client contact, TMDL Unit Supervisor, and Section Supervisor respectively, responsible for stakeholder contacts, coordination with other agency staff, permit-related information, review of draft QAPP and draft final report, and implementation of report recommendations.

- *Cynthia Nelson (SEA Program).* Basin coordinator responsible for product review, stakeholder contacts, and coordination with the Dungeness River Basin Management Team.

Jamestown S'Klallam Tribe

- *Lyn Muench and Laurie DeLorm* will review QAPP and reports, provide assistance with field sampling, data collection, and stakeholder contact.

Department of Health, Shellfish Programs

- *Don Melvin* will provides a point of contact between Ecology monitoring activities and DOH Dungeness Bay monitoring activities.

Data Quality Objectives and Analytical Procedures

Analytical methods and detection or precision limits for field measurements and laboratory analyses are listed in Tables 3a and 3b. The laboratory's data quality objectives and quality control procedures are documented in the Manchester Environmental Laboratory's Lab Users Manual (MEL, 1994). Expected ranges for laboratory parameters are listed in Table 3b. Expected ranges for fecal coliform are based on 1997-99 data collected by the Tribe and the Conservation District. Expected ranges for turbidity and nutrients are based on 1992 data collected by Clallam County (Clallam County, 1993).

Table 3a. Summary of field measurements, methods, and accuracy.

Parameter	Method	Accuracy
Field Measurements		
Velocity	Current Meter	± 0.1 f/s
Specific Conductivity	Field Meter	± 5%
pH	Field Meter	± 0.2
Temperature	Red Liquid Thermometer	± 0.2 ºC
Dissolved Oxygen	Winkler Modified Azide (EPA360.20 Field Meter	± 0.1 mg/L ± 0.2 mg/L

Field sampling and measurement protocols will follow those listed in the Watershed Assessment Section protocols manual (Ecology, 1992). All meters will be pre- and post-calibrated in accordance with the manufacturer's instructions. Pre- and post-checks with standards will evaluate field measurement accuracy. Ten percent of all conductivity and dissolved oxygen measurements will be checked by laboratory analysis for conductivity and a modified Winkler titration for dissolved oxygen. Five percent of all flow measurements will be repeated to determine the accuracy of flow measurements. Samples for laboratory analysis will be stored on ice and delivered to MEL within 24 hours of collection.

Table 3b. Summary of laboratory measurements, methods, lower reporting limits, and expected ranges.

Laboratory parameters	Method	Lower reporting limit	Expected range
Fecal Coliform – Membrane Filter (MF)	SM18 Membrane Filter 9222D	1 cfu/100 mL	<1 – 4000
Fecal Coliform – Most Probable Number (MPN)	SM18 MPN 9221E (A-1 medium)	3 MPN/100 mL	<1 – 4000
E-coli – Membrane Filter	EPA 1105	1 cfu/100 mL	<1 – 4000
Turbidity	EPA 180.1	1 NTU	<1 - 100
Total persulfate nitrogen	SM 4500 N C	0.10 mg/L	<0.01 – 3.4
Ammonia-nitrogen	EPA 350.1	0.10 mg/L	<0.01 - 0.66
Nitrite/nitrate nitrogen	EPA 353.2	0.10 mg/L	<0.01 – 3.4
Orthophosphate P	EPA 365.1	0.10 mg/L	<0.01 – 0.18
Total Phosphorus	EPA 365.1	0.10 mg/L	no previous data available

SM=Standard methods for the examination of waste and wastewater. Twentieth edition (1998). American Public Health Association, American Water Works Association, and Water Environment Federation. Washington, D.C.

EPA=Methods for the chemical analysis of water and wastes. Environmental Monitoring Supply Laboratory. U.S. Environmental Protection Agency. Cincinnati, OH. EPA-600/4-74-020. 1983.

Precision

Analytical precision available using the methods selected for this project will be adequate to make a determination of reasonable potential for all parameters. The total precision for field replicate measurements and for the results from replicate samples (with the exception of bacteria analysis) should not exceed 20% relative standard deviation (%RSD) for results at or above the reporting limit. For bacterial results precision up to 50% RSD is acceptable. At levels close to the method detection limit, % RSDs will be greater than 50%, which is to be expected and will be acceptable. In general, pooled results will be evaluated, with the higher %RSDs of low values taken into account. Data variability will be taken into consideration in using the data for modeling and other analysis, and interpreting results.

Bias

Analytical bias will be minimized by adherence to the methods listed in Table 3b. The laboratory will use quality control procedures appropriate for the analytical methods, including analysis of check standards, method blanks, and matrix spikes as required.

Quality Control Procedures

Field and laboratory sample variability are addressed by using duplicate and blank samples at various stages of the sample process. Bacteria samples tend to have a high %RSD compared to other water quality analyses. Total variation for field sampling and laboratory analysis of bacteria samples will be assessed by collecting duplicates for approximately 20% of samples in a run. A standard 10% duplication rate will be used for other water quality parameters.

Ten percent of the filtered orthophosphorus samples sent will be filter blanks to ensure filter and container quality.

Data Reduction review and reporting

Standard laboratory procedures for analytical data reduction, review, and reporting will be followed (MEL, 1994). Microbiologists and chemists will immediately inform the project manager of any problems with sample shipment conditions, holding times, or analyses.

MEL will send an electronic copy of the data via EIM and a hard copy of the data to the project manager. Lab and field analytical data will be matched with sample times and locations. Field data will be screened for questionable values and problems and then entered into the EIM database.

Results from quality control samples (i.e., field duplicate samples and blanks) will be statistically analyzed after data from the first monitoring run have been reported, and then every other run afterwards. Numbers of duplicates, high or low range duplicate stratification, or other adjustments for sampling and laboratory analyses will be made as required.

All data collected during the project will be available in the final report or upon request, after the data have been reviewed for quality assurance. The final report will be available on Ecology's web site. Data used in tables, figures, and in water quality models may be summarized. However, data reduction procedures will be explained in the text of the final report.

References

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Appendix A

Class A (excellent) fresh water quality standards and characteristic uses, and Class AA marine and fresh water quality standards and characteristic uses for selected parameters.

	Class A (Fresh water)	**Class AA (Fresh water)**	**Class AA (Marine water)**
General Characteristic:	Shall meet or exceed the requirements for all, or substantially all uses.	Shall markedly and uniformly exceed the requirements for all, or substantially all uses.	Shall markedly and uniformly exceed the requirements for all, or substantially all uses.
Characteristic Uses:	Shall include, but not be limited to, the following: domestic industrial, and agricultural water supply; stock watering; salmonid and other fish migration, rearing, spawning, and harvesting; wildlife habitat; primary contact recreation, sport fishing, boating, and aesthetic enjoyment; and commerce and navigation.	Same as A	Shall include, but not be limited to, the following: domestic industrial, and agricultural water supply; stock watering; salmonid and other fish migration, rearing, spawning, and harvesting; clam,oyster, and mussel rearing, spawning, and harvesting; crustaceans and other shellfish rearing spawning, and harvesting; wildlife habitat; primary contact recreation, sport fishing, boating, and aesthetic enjoyment; and commerce and navigation.
Water Quality Criteria:			
Fecal Coliform:	Shall not exceed a geometric mean value of 100 organisms/100 mL, with not more than 10% of samples exceeding 200 organisms/100 mL.	Shall not exceed a geometric mean value of 50 organisms/100 mL, with not more than 10% of samples exceeding 100 organisms/100 mL.	Shall not exceed a geometric mean value of 14 organisms/100 mL, with not more than 10% of samples exceeding 43 organisms/100 mL.
Dissolved Oxygen:	Shall exceed 8.0 mg/L	Shall exceed 9.5 mg/L	Shall exceed 7.0 mg/L. When natural conditions occur causing the dissolved oxygen to be depressed near or below 7.0 mg/L, natural dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities.
Temperature:	Shall not exceed 18.0º due to human activities. When conditions exceed 18.0º C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3ºC. Increases from non-point sources shall not exceed 2.8ºC.	Shall not exceed 16.0º due to human activities. When conditions exceed 16.0º C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3ºC. Increases from non-point sources shall not exceed 2.8ºC.	Same as AA (fresh water)

Appendix A (cont’d)

Water Quality Criteria:	**Class A (Fresh water)**	**Class AA (Fresh water)**	**Class AA (Marine water)**
pH:	Shall be within the range of 6.5 to 8.5 with a man-caused variation with a range of less than 0.5 units.	Shall be within the range of 6.5 to 8.5 with a man-caused variation with a range of less than 0.2 units.	Same as AA (fresh water)
Turbidity	Shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10% increase in turbidity when the back ground is more than 50 NTU.	Same as A	Same as A

Appendix B

Discussion of Recent Water Quality Results from sampling done by Jamestown S'Klallam Tribe and Clallam Conservation District.

Dungeness River

Data analysis and comparisons to the water quality standards was performed on data collected by the Tribe from November 1997 through September 1999.

Tribal data shows the mouth of the Dungeness River (RM 0.80) meets fresh water quality standards (tribal data from two stations are combined; R18 and R2), with a geometric mean (GM) of 20 organisms/100 mL, and with no samples exceeding 200 organisms/100 mL. This criterion however, is far less stringent than the marine criterion of a GM value of 14 organisms/100 mL, with not more than 10% of samples exceeding 43 organisms/100 mL. Table B-1 shows the difference between the two standards and compares compliance with the standards at the upstream and downstream Dungeness station.

Table B-1. Comparison of Dungeness River fecal coliform levels with the Class A Fresh water and Class AA Marine Standard.

Site	Freshwater Class A Standard for Fecal Coliform	
	GM below #100/100 mL?	10% or less of all samples for calculating GM exceed #200/100 mL?
Dungeness River (RM 3.20)	YES (GM=3)	YES, 0 of 21 samples exceeded 200
Dungeness River (RM 0.80)	YES (GM=20)	YES, 0 of 21 samples exceeded 200
	Marine water Class AA Standard for Fecal Coliform	
	GM below #14/100 mL?	10% or less of all samples for calculating GM exceed #43/100 mL?
Dungeness River (RM 3.20)	YES (GM=3)	YES, 1 of 21 samples exceeded 43
Dungeness River (RM 0.80)	NO (GM=20)	NO, 5 of 22 samples exceeded 43

A paired t-test showed that fecal coliform levels at Dungeness RM 0.80 are significantly higher than at RM 3.20 ($P>0.05$).

Regressions were done to examine the relationship between fecal coliform concentration and 24, 48, and 72-hour previous rainfall, the antecedent precipitation index (API), and average daily discharge for the Dungeness River at RM 0.1. Regressions showed a moderate to weak relationship between fecal coliform concentration and previous 24 hour rainfall (adjusted $r^2=0.46$) and a weak relationship with previous 48 and 72 hour rainfall (adjusted r^2 of 0.30 and 0.35 respectively).

A multiple linear regression was used to examine the relationship between flow or seasonality (independent variables) and fecal coliform concentration (dependent variable) for the Dungeness River at RM 0.80. Discharge measurements were obtained for USGS station 12048000 on the Dungeness River. Fecal coliform concentrations and flows were log transformed (n=17). Results showed a strong relationship with seasonality ($r^2=0.73$) indicating seasonality is significantly correlated ($P<0.05$) to observed fecal coliform values, whereas flow is not. The most critical seasons are May through August and December through February. May through

August falls within the irrigation season of April 15th through September 15th. The December through February time period overlaps with the rainiest period of November through January.

Meadowbrook Creek and Slough

From November 1997 through September 1999 the Tribe has monitored several stations and an irrigation ditch on Meadowbrook Creek and slough. For the purposes of data analysis, data from two stations at Meadowbrook Creek mile (CM) 0.30, R7 and R16, were combined.

Meadowbrook Creek

None of the Meadowbrook Creek stations met either part of the water quality standard for fecal coliform; a comparison of the results to the standards is described in Table B-2.

Table B-2. Comparison of Meadowbrook Creek fecal coliform levels with the Class AA Freshwater Standard.

Site	Freshwater Class AA Standard for Fecal Coliform	
Meadowbrook Creek Upstream to Downstream	GM below #50/100 mL?	10% or less of all samples for calculating GM exceed #100/100 mL?
R20: CM 1.85	NO (GM=103)	NO, 7 of 11 samples exceeded 100
R10: CM 1.50	NO (GM=91)	NO, 9 of 24 samples exceeded 100
R30: CM 1.45 Irrigation tail water	NO (GM=83)	NO, 1 of 4 samples exceeded 100
R9: CM 0.95	NO (GM=73)	NO, 8 of 24 samples exceeded 100
R16 and R7: CM 0.30	YES (GM=47)	NO, 8 of 34 samples exceeded 100

A paired t-test was done to compare fecal coliform levels at the mouth (CM 0.30; R16 and R7) and stations upstream R10 and R9. For the paired t-test data must be available for both stations for the same day, so in comparing the mouth to station R10 and R9, 24 sets of data were available for comparison. The results showed that station R10 had significantly higher fecal coliform levels than the mouth station at CM 0.30 ($P>0.05$). Station R9 tends to be higher than the mouth station (note GM in table 3), but not at a statistically significant level ($P>0.05$).

To compare seasonal differences, 1998-9 fecal coliform data from the irrigation season (April through September) and the wet season (November through February) were examined separately. Geometric mean fecal coliform levels for all stations were higher during the irrigation season as shown in Figure B-1. The geometric mean was calculated for stations with 5 or more data points only.

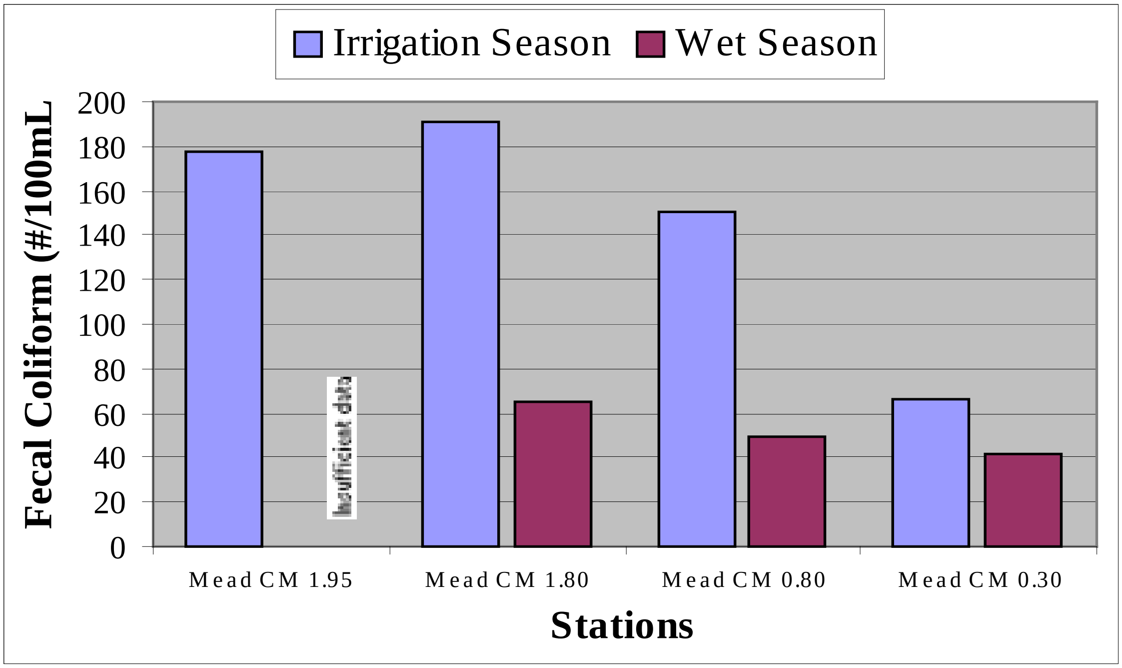

Figure B-1. 1997-99 Geometric Mean Fecal Coliform Levels for the Irrigation and Wet Season on Meadowbrook Creek.

Linear regressions were done to examine the relationship between fecal coliform concentrations and previous rainfall (24, 48, and 72 hour) and the antecedent precipitation index (API). For the Meadowbrook Creek mouth station and R10 no relationship was found between fecal coliform concentration, and 24, 48, 72 hour previous rainfall or API.

Meadowbrook Slough

The Tribe also monitored several stations on Meadowbrook slough. Water is diverted from the Dungeness River to the slough. Initially the Tribe monitored three stations on the slough, now there are six stations. Monitoring occurred from November 1997 through September 1999. The only station to meet water quality standards for fecal coliform on Meadowbrook Slough is the most upstream station, located just downstream of the inlet for Dungeness water. A comparison of the results to the standards is described in Table B-3.

Table B-3. Comparison of Meadowbrook Slough fecal coliform levels with the Class AA Freshwater Standard.

Site	**Freshwater Class AA Standard for Fecal Coliform**	
Meadowbrook Slough Upstream to Downstream	GM below #50/100 mL?	10% or less of all samples for calculating GM exceed #100/100 mL?
R29: CM 0.45	YES (GM=16)	YES, 0 of 4 samples exceeded 100
R5: CM 0.20	YES (GM=25)	NO, 3 of 23 samples exceeded 100
R17: CM 0.20	YES (GM=14)	NO, 2 of 17 samples exceeded 100
R8: CM 0.12	NO (GM=103)	NO, 4 of 7 samples exceeded 100
R6: CM 0.05	YES (GM=33)	NO, 6 of 22 samples exceeded 100

A paired t-test was done to compare fecal coliform levels at R5 and R6. These stations had the most data available for analysis. There was no significant difference between these two stations ($P>0.05$).

To compare seasonal differences 1997-9 fecal coliform data from the irrigation season (April through September) and the wet season (November through February) was examined separately. Only two stations had enough data to do this, R6 and R5. Station R5 had a GM of 26 (n=12) in the wet season and 29 (n=8) during the irrigation season. Station R6 had a GM of 53 (n=14) during the wet season and 17 during the irrigation season (n=6).

Linear regressions were done to examine the relationship between fecal coliform concentrations and previous rainfall (24, 48, and 72 hour) and the antecedent precipitation index (API). For the Meadow Slough station R5, no relationship was seen between fecal coliform concentration, and 24, 48, 72 hour previous rainfall or API.

Matriotti Creek

From August 1998 through July 1999 the Clallam Conservation District and the Tribe monitored seven stations on Matriotti Creek. Two out of seven stations on the Creek met fecal coliform water quality standards. A comparison of the results to the standards is described in Table B-4.

Table B-4. Comparison of Matriotti Creek fecal coliform levels with the Class A Freshwater Standard.

Site	**Freshwater Class A Standard for Fecal Coliform**	
Matriotti Creek Upstream to Downstream	GM below #100/100 mL?	10% or less of all samples for calculating GM exceed #200/100 mL?
Mat 1: CM 5.35	YES (GM=25)	YES, 0 of 13 samples exceeded 200
Mat 2: CM 4.80	NO (GM=306)	NO, 7 of 10 samples exceeded 200
Mat 3: CM 3.20	NO (GM=251)	NO, 8 of 15 samples exceeded 200
Mat 4: CM 1.90	YES (GM=92)	YES, 1 of 15 samples exceeded 200
Mat 5: CM 1.45	NO (GM=148)	NO, 7 of 15 samples exceeded 200
Mat 6: CM 0.70	YES (GM=97)	NO, 2 of 15 samples exceeded 200
Mat 7: CM 0.30	NO (GM=440)	NO, 9 of 12 samples exceeded 200

A paired t-test was done to compare fecal coliform levels upstream to downstream at all stations on Matriotti Creek. The results showed downstream fecal coliform values were significantly higher than the upstream monitoring site at the following sites: CM 1.90 (upstream) to 1.45 (downstream), and at CM 0.70 (upstream) and 0.30 (downstream) ($P>0.05$).

To compare seasonal differences 1998-9 fecal coliform data from the irrigation season (April through September) and the wet season (November through February) was examined separately. Geometric mean fecal coliform levels for all stations were higher during the irrigation season as shown in Figure B-2. Geometric mean was calculated for stations with 4 or more data points only.

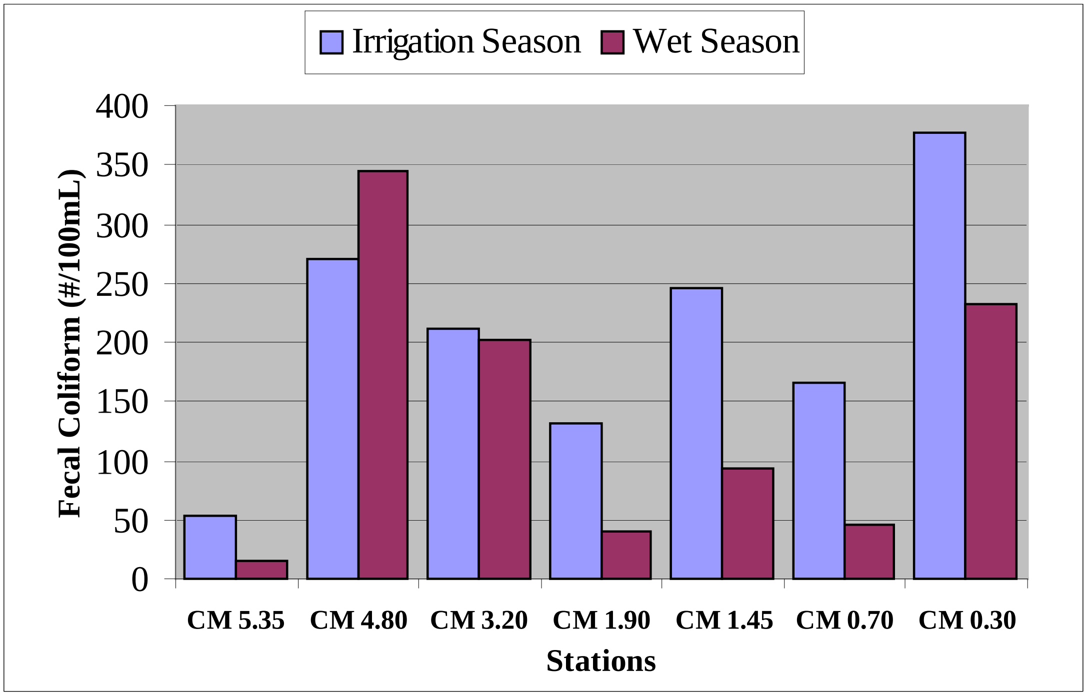

Figure B-2. 1998-99 Geometric Mean Fecal Coliform Levels for the Irrigation and Wet Season on Matriotti Creek.

Linear regressions were done to examine the relationship between fecal coliform concentrations and previous rainfall (24, 48, and 72 hour) and the antecedent precipitation index (API) for the two stations on Matriotti Creek that had the highest fecal coliform concentrations, CM 4.80 (Mat2) and CM 0.30 (Mat7). For these stations there was no strong relationship seen between 24, 48, 72 hour previous rainfall or API.