HOOD CANAL WATERSHED

2005-2011 Pollution Identification and Correction
Status Report

Photo taken by Kitsap Public Health District

Hood Canal Coordinating Council
National Estuary Program
Washington State Department of Health contract number N194466
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BACKGROUND

Hood Canal is a natural, glacier-carved fjord more than 60 miles long, which forms the westernmost waterway and margin of the Puget Sound basin. It is situated in Jefferson, Kitsap, and Mason Counties. It begins in the north in Admiralty Inlet between Tala Point and Foulweather Bluff and extends southwesterly about 45 miles to the Great Bend at Annas Bay. From there its "hook" extends northeasterly 15 miles to its head at the Union River estuary near Belfair (HCCC, 2012).

The canal has great cultural, economic, and recreational value to Washington state residents and tribes. A significant portion of the western Hood Canal upland watershed is located within the Olympic National Park and Olympic Forest. Marine resources include many boat docks, several marinas, with popular shrimp and crab events and commercial and recreation clam and oyster harvesting. Several state parks are located in the area. Local tribes rely on Hood Canal as their usual and accustomed treaty rights area.

Fecal pollution at the mouths of freshwater streams and along shorelines has caused closures of commercial and recreational shellfish beds. Bacterial pollution in shellfish growing areas is an important public health, economic, and community issue.

The combination of poor flushing, water stratification and oxygen depletion make Hood Canal particularly sensitive to nutrient pollution. Low dissolved oxygen events in Hood Canal marine waters have resulted in significant fish kills (Herrera, July, 2010).

Hood Canal was identified as a particularly important and vulnerable part of Puget Sound and designated as an Aquatic Rehabilitation Zone by Revised Code of Washington (RCW) 90.88 (Herrera, June 23, 2010). It is also designated as a shoreline of Statewide Significance by RCW 90.58.030. Kitsap County, Mason County, and Jefferson County Local Management Plans designated Hood Canal as a Marine Recovery Area.

There are five major jurisdictions in the Hood Canal watershed. Clockwise from the northwest are Jefferson County, Port Gamble S'Klallam Tribe, Kitsap County, Mason County and the Skokomish Tribe.

Table 1: County Demographics*

County	Population			Land Area	Population Density	Assessed Value	Personal Income
	Total	Unincorporated	Incorporated	square miles	population per square mile	per capita	per capita
	2011	2011	2011		2011	2010	2009
Jefferson	30,050	20,870	9,180	1,803.70	16.66	181,481	$43,100
Kitsap	253,900	171,395	82,505	394.94	642.88	113,244	$43,404
Mason	61,100	51,245	9,855	959.42	63.68	132,814	$31,411

*(WSOFM, 2012)

Ecology has designated 62 Water Resource Inventory Areas (WRIA) to represent Washington's 62 major watersheds. Hood Canal is located in WRIAs 16/14B, 15 and 17.

The Hood Canal Coordinating Council (HCCC) is a watershed-based council of governments. It was established in 1985 in response to community concerns about water quality problems and related natural resource issues in the watershed. HCCC is comprised of Mason, Kitsap, and Jefferson counties and the Skokomish and Port Gamble S'Klallam Tribes. The Council works together to coordinate efforts to protect the economic and environmental resources of Hood Canal.

The Hood Canal Aquatic Rehabilitation Program was created in 2005 by the Hood Canal Management Bill (ESHB 2097/RCW 90.88), designating the HCCC as the Local Management Board for Hood Canal. The focus of the Aquatic Rehabilitation Program is to work with the Aquatic Rehabilitation Technical Advisory Committee (TAC) to develop strategic actions to improve water quality in Hood Canal. The Aquatic Rehabilitation TAC is divided into workgroups based on areas of expertise. The Aquatic Rehabilitation TAC workgroups include experts from Mason, Kitsap, and Jefferson Counties' staff, and Skokomish and Port Gamble S'Klallam Tribes' staff, State and Federal agency staff including Ecology, the Puget Sound Partnership, Washington State Department of Health (WSDOH), Washington State Department of Transportation, the Environmental Protection Agency, University of Washington researchers, and local organizations including the Hood Canal Salmon Enhancement Group and the Lower Hood Canal Watershed Coalition. The TAC has two active workgroups: one for wastewater and onsite septic systems (OSS) and another for stormwater and land use practices. These groups are addressing actions related to their focus area. Other groups will be added to focus on specific habitat topics, such as alder trees.

Low Dissolved Oxygen

Low dissolved oxygen levels in Hood Canal are due to marine waters depleted in oxygen and rich in nitrogen entering Hood Canal from marine sources and from human sources that runoff from the watershed into Hood Canal. The pathway by which nitrogen leads to oxygen reduction in estuaries is that nitrogen, acting as a fertilizer, causes algae to grow. This algae grows near the surface as it needs light for photosynthesis. As the algae dies, it sinks to the bottom where it decomposes. This decomposition process requires oxygen. In conditions where there is too much nitrogen available, excess algae is produced and the available dissolved oxygen can be substantially reduced. The majority of nitrogen in Hood Canal is marine nitrogen transported from the ocean. Human-based sources of nitrogen in Hood Canal include wastewater, nitrogen from alder trees, and stormwater runoff.

The Hood Canal Dissolved Oxygen Project (HCDOP, 2005) was established in 2005 by twenty-eight entities, including local, state and federal agencies, tribal governments, non-profits, and universities, in part to scientifically study the sources of nitrogen and other nutrients in Hood Canal and their impacts on marine life. The HCDOP conducted extensive research to understand the dynamics and causes of low dissolved oxygen in Hood Canal.

Due to differing conclusions among researchers, the HCCC requested that the Department of Ecology and EPA review the available low dissolved oxygen research to provide a review of human impacts on dissolved oxygen in Hood Canal. EPA and Ecology worked with researchers to review the available science. An independent peer-review of the EPA and Ecology was coordinated by the Puget Sound Institute. In the fall 2012, the HCCC TAC Workgroups provided a stakeholder review of the draft EPA and Ecology science review report. The final EPA and Ecology report is anticipated to be released in the spring of 2013.

The draft conclusions of the EPA and Ecology report were, in summary, that there is no significant human impact on dissolved oxygen in the main stem of Hood Canal (Cope and Roberts, 2012). However, the extent of human impact in Lower Hood Canal is inconclusive based on the available research. The human impact in Lower Hood Canal is greater than the main stem. Further research is needed to resolve uncertainties regarding impacts in Lower Hood Canal and impacts of low dissolved oxygen on marine organisms.

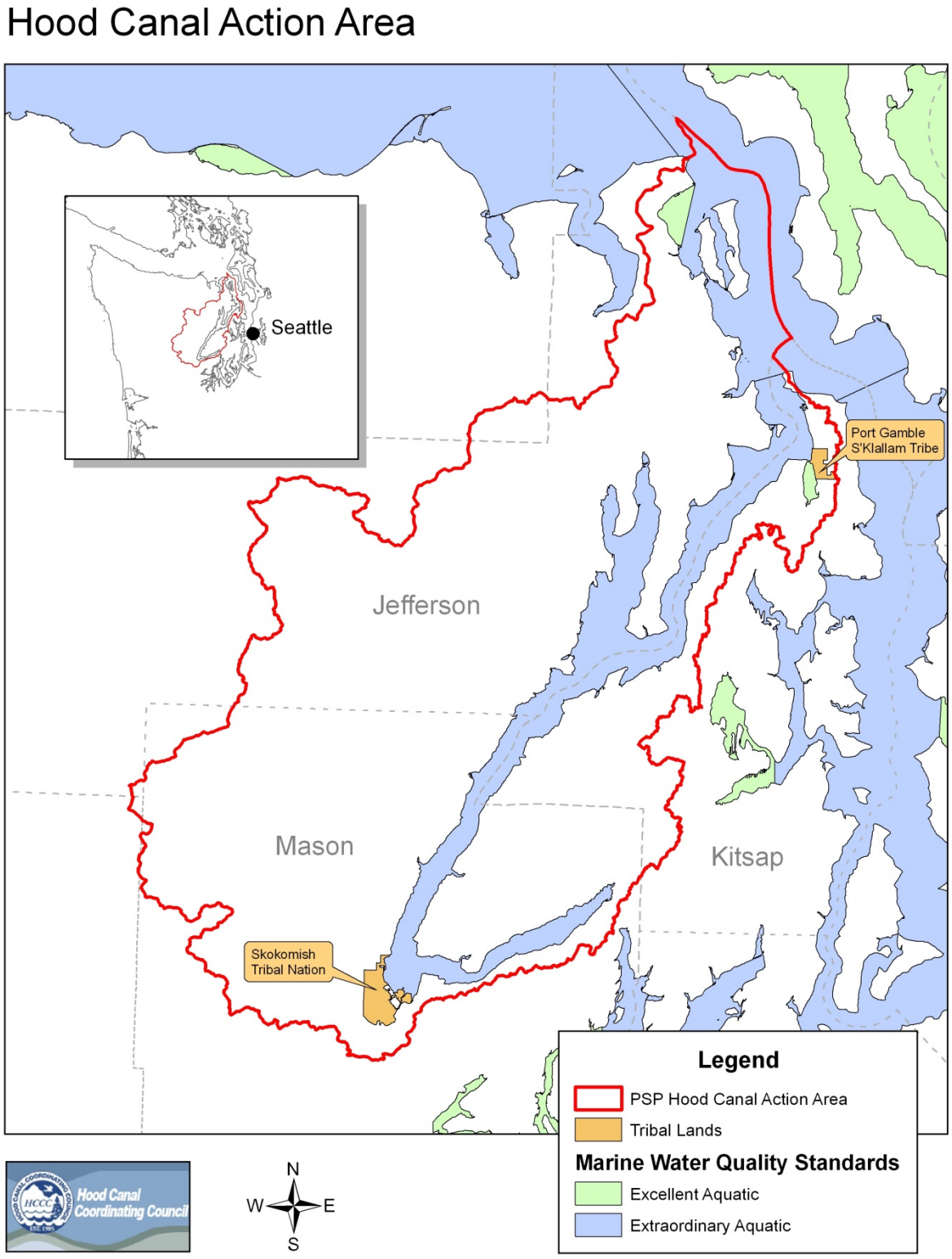
Development of the Hood Canal Regional Pollution Identification and Correction Program
During the 2010-11 year of the Aquatic Rehabilitation Program, the TAC Workgroups developed lists of initial wastewater-onsite septic system and stormwater and land use practices actions. The focus of these initial actions is to build on successful efforts, to have multiple water quality benefits, and to provide information needed to evaluate, prioritize, or develop the management tools and technologies for potential long-term actions. The development of the Hood Canal Regional Pollution Identification and Correction Program (HCPIC) was determined to be a priority initial action for these TAC Workgroups.

HCCC was granted National Estuaries Program funding to develop a HCPIC program to enable efficient, prioritized, and coordinated responses by Hood Canal jurisdictions. The geographic scope of the HCPIC program is the Hood Canal Action Area (Figure 1). The ambitious project includes: a summary report of water quality monitoring and pollution identification and correction (PIC) work efforts in the Hood Canal Action Area since 2005; updating the Hood Canal GIS OSS Maps; developing a Hood Canal Monitoring Plan, Regional PIC Protocol, and 5-year work plan; developing an OSS failure definition and review of Jefferson, Kitsap, and Mason County OSS regulations and policies; developing a strategy for stormwater and animal waste management; and producing a sustainable funding strategy.

The summary is an inventory of significant work conducted in the watershed including: water quality monitoring (marine and fresh)with a focus on bacterial and nitrogen constituents, shoreline surveys, fecal hotspot investigations, parcel surveys, and educational events. It reflects the large amount of work accomplished by Hood Canal jurisdictions between 2005 and 2011, demonstrating a commitment to protect and restore this watershed. There are important water quality monitoring and corrective actions efforts that have been advanced for other constituents/pollutants. However, in order to focus the scope of this project, they are not included in this report. The Hood Canal Regional PIC partnership is made up of representatives from these jurisdictions that are motivated and ready to proceed.

This report summarizes the large amount of work accomplished by Hood Canal jurisdictions between 2005 and 2011, demonstrating a strong commitment to protect and restore the watershed. The Hood Canal Regional PIC partnership is motivated and ready to proceed.

Figure 1: Puget Sound Partnership's Hood Canal Action Area



METHODS

The goal of this report is to collect and summarize information that will help guide regional monitoring and pollution identification and correction efforts in Hood Canal.

Water Quality Standards
Bacterial pollution monitoring data, associated with human health and shellfish bed approval, was selected as top priority. Due to the low dissolved oxygen conditions in Hood Canal, nutrient data was reviewed.

Fecal coliform (FC) and/or E. Coli (EC) in surface water provides an early warning for determining whether land use, development and human activities are being managed to effectively protect public health, shellfish harvesting, and the environment.

Fecal waste from warm-blooded animals can contain pathogenic bacteria and viruses that cause human diseases such as shigellosis, campylobacter enteritis, viral gastroenteritis, giardiasis, and cryptosporidiosis. Fecal contamination of surface waters is caused by human and animal waste discharged or leaked to the ground or surface waters. During rain events, flowing surface water picks up pollutants, such as fecal waste, and transports them to local streams, bays, and lakes. Additionally, as impervious surfaces are increased in watersheds, pollutants are transported rapidly to receiving waters.

Surface water quality standards are established by Ecology and described in Chapter 173-201A of the Washington Administrative Code (WAC). Having specific standards also sets pollution limits, and provides goals for water clean-up projects. The biological water quality standards which apply in Hood Canal are summarized below. State law also places bodies of water in different classifications, i.e. Primary or Extraordinary, depending on designated beneficial uses such as human recreation or fish habitat (Figure 1). Classifications for more pristine areas, like Extraordinary, are generally more stringent.

Table 2: Washington State Surface Water Quality Standards

	Freshwater Standard		**Marine Water Standard**	
Parameters	Extraordinary Primary Contact	Primary Contact	Extraordinary Aquatic, Primary Contact	Excellent Aquatic, Primary Contact
Fecal Coliform Bacteria (FC)	**Part 1**: **≤50 FC**/100 ml (geometric mean) **Part 2:** Not more than 10% of all samples obtained for calculating a geomean **>100 FC**/100 ml	**Part 1**: **≤100 FC**/100 ml (geometric mean) **Part 2:** Not more than 10% of all samples obtained for calculating a geomean **>200 FC**/100 ml	**Part 1: ≤14 FC**/100 ml (geomean) **Part 2:** Not more than 10% of all samples obtained for calculating a geomean **>43 FC**/100 ml	Same as Extraordinary Aquatic - Primary Contact waters

These standards use a geometric mean value (or GMV) for bacteria, which measures the central tendency of a data set. The geometric mean is especially useful for groups of data that contain a broad range of values. Since sample results for bacterial concentrations tend to be highly variable, the geometric mean is a more appropriate tool for analyzing this type of data than using an arithmetic mean or average.

Finding and correcting fecal pollution sources requires a combination of water quality monitoring, investigations, and parcel surveys. Key methods summarized in this report include: marine water assessment, fresh water assessment, shoreline survey assessment, and parcel surveys.

Marine Water Assessment

WSDOH Shellfish Program monitors Hood Canal marine waters through their Puget Sound shellfish and water protection program. WSDOH prepares an annual growing area review and conducts a shoreline survey and pollution source report for each area on a rotating basis every few years. They utilize this data to reclassify shellfish growing areas as needed. WSDOH also keeps track of and establishes closure zones for confirmed fecal sources in the correction process.

There are eighteen shellfish growing areas in the Hood Canal action area: Hood Canal 1-9, Annas Bay, Quilcene Bay, Dabob Bay, Port Ludlow, Mats Mats Bay, Oak Bay, Mystery Bay, Kilisut Harbor, and Port Townsend. WSDOH samples these areas for FC, temperature, salinity and tidal condition six times each year. Shellfish beds are classified based on fecal sample results as specified by the National Shellfish Sanitation Program.

This report will utilize WSDOH's most recent annual growing area review for Hood Canal watersheds assessing water quality data collected from March 7, 2006 through December 31, 2011.

Fresh Water Assessment

In June 2010, an Inventory of Stream and River Monitoring Efforts in Hood Canal, was prepared for WRIA 16/14B Planning Unit, by Herrera Environmental Consultants and Aspect Consulting (Herrera, July 2010). A significant finding was that the number of local, state, tribal and federal entities involved in monitoring Hood Canal more than doubled since a 2003 study. This has resulted in a substantial increase in the amount of data collected. Most of this has been FC bacteria in an effort to reduce the public health threat from fecal pollution hotspots. The majority of monitoring implemented over the last decade has been short-term monitoring on selected streams due to funding sources.

WRIA 16/14B also contracted with Herrera Environmental Consultants to develop a comprehensive, long-term monitoring strategy for streams that flow into Hood Canal. The purpose of the strategy is to provide a comprehensive evaluation of the current status of Hood Canal freshwater streams, and track trends in water quality over time. The strategy resulted in River and Stream Water Quality Monitoring Plan for the Hood Canal Watershed (Herrera, July 2010).

The WRIA 16/14B monitoring plan selected an approach that combines continuous, routine, seasonally-focused monitoring and the rotating sub-basin strategy. This strategy reduces costs by

limiting monitoring to only the highest priority streams in the watershed and to time periods of the greatest interests. Eleven highest priority streams were identified for Tier 1 routine monitoring.

The strategy divided the Hood Canal basin into four sub-regions, identifying eight prioritized Tier 2 monitoring stations in each sub-region, each of which to be monitored for a full year on a 5-year rotating cycle. It recommended monitoring for lab parameters: FC, total phosphorous, soluble reactive phosphorus, total suspended solids, total nitrogen, nitrate+nitrite nitrogen (NO_2+NO_3), ultimate biochemical oxygen demand; and field parameters: temperature, pH, dissolved oxygen, turbidity, conductivity, and flow.

The strategy provides a thoughtful and comprehensive framework that can inform a phased regional approach as funding is available. The intent is to develop a long-term evaluation of seasonal variability and long-term trends. It is a useful starting framework for a Hood Canal regional monitoring plan and pollution identification and correction plan.

WRIA 17 (East Jefferson Watershed Council) summarized water quality in 2000 and 2003 (Parametrix 2000, Golder 2003). These and other technical reports are available at www.ejwc.org. Golder 2003 establishes a monitoring plan that was never fully implemented, although many high-priority monitoring goals have been accomplished in the subsequent 9 years. An updated, countywide water quality monitoring plan has been the goal of the Jefferson County Clean Water District Advisory Council, formed in 2012. Resources to create this plan have yet to be determined.

Jefferson County stream monitoring has generally been performed monthly for one full water year, every other year on a rotating basis to cover more geographic areas. WRIA 17 streams have not been separated into Tier 1 and Tier 2 categories. Highest priority in the Hood Canal Action Area has been on the Chimacum Creek basin, with 28 stations monitored since 2007 and other data collected since the 1980s.

PIC investigations are usually conducted through FC or EC monitoring and enforcement is based on state bacterial standards. Nutrient water quality data is important in this watershed due to the low dissolved oxygen events. However, nutrient water quality data is of secondary importance for this project because there are no nutrient surface water enforcement standards. Dissolved oxygen and temperature data are also important in Hood Canal due to the low dissolved oxygen events, but are of tertiary importance due to enforcement challenges.

This report will focus on FC data with the goal of updating this report with nutrient, dissolved oxygen and temperature data as time permits. Fresh water monitoring is generally collected by water year (October through September). This report will begin by compiling monitoring data collected on Tier 1 and Tier 2 streams for the six water years between October 2005 and September 2011. A summary table was compiled for the Tier 1 and Tier 2 stations with a geometric mean (GMV) of the current water year and a GMV for all six water years between 2005 and 2011.

Shoreline Survey Assessment

A shoreline survey is the inventory and bacterial assessment of all flowing discharges to the project area shoreline. Dry season events, May 1 through Sept 30, can identify problems in areas

where storm water masks FC sources or where residences are only occupied in the summer. Wet season assessments, Oct. 1 through April 30, can identify OSS failures caused by high seasonal groundwater and surface water drainage issues. Wet weather conditions are met when water is flowing off parcels and stormwater is flowing in roadside ditches or storm systems.

Samples are collected at low tide to target the discharge of fresh groundwater versus the drainage of residual marine water. Detailed field notes, photographs and global positioning system waypoints were collected in support of samples. Confirmation samples are collected in drainages with FC results at or above a predetermined threshold. In Kitsap and Mason County this threshold is established at 200 FC/100ml. In Jefferson County confirmation samples were collected for shoreline sites above 100 FC/100mL when time was available, and for all sites greater than 500 FC/100mL. For E. coli sampling, Jefferson County collected confirmation samples for sites greater than 100 EC/100mL. FC hotspots are investigated for potential FC sources.

Parcel Surveys

Door-to-door PIC inspections are conducted in top-priority areas to identify and correct fecal pollution sources. The purpose for the PIC survey is to provide education to the owner/occupant so that they may get the most life out of their septic system and for staff to conduct an inspection of the OSS (walk over the drainfield, assess the condition of OSS, and rate the system based on this inspection) and identify and correct failures and other FC sources. The inspection is designed to help property owners and residents protect their OSS investment and prevent fecal pollution of surface waters and premature system failure by knowing how to operate and maintain the system.

MARINE WATER QUALITY SUMMARY 2005-2011

Overall, marine water quality is very good in the eighteen Hood Canal growing areas (Hood Canal 1-9, Anna's Bay, Quilcene Bay, Dabob Bay, Port Ludlow, Mats Mats Bay, Oak Bay, Mystery Bay, Kilisut Harbor and Port Townsend) with most of the stations meeting the *Approved* standard for shellfish harvest.

The following table shows the WSDOH Hood Canal growing area shellfish bed classification changes between 2005 and 2011 (WSDOH, July 2011) . The net result is 146 acres upgraded from *Prohibited* to *Approved*, 70 acres upgraded from *Restricted* to *Approved*, and 40 acres from *Prohibited* to *Conditionally Approved*.

Table 3: 2005-2011 Hood Canal Shellfish Bed Classification Changes (WSDOH, 2012)

Growing Area	Downgrade	Upgrade
Anna Bay	2005 - 300 acres from *Approved* to *Prohibited*	2009 - 300 acres from *Prohibited* to *Approved*
Hood Canal 1	2009 - one acre from *Approved* to *Prohibited*	
Hood Canal 3		2010 - 70 acres from *Restricted* to *Approved*
Hood Canal 5		2007 - 22 acres from *Prohibited* to *Approved*
Hood Canal 6		2006 - 70 acres from *Prohibited* to *Approved*
		2006 - 40 acres from *Prohibited* to *Conditionally Approved*
Hood Canal 9		2006 - 55 acres from *Prohibited* to *Approved*
Mystery Bay	2009 - 44 acres from *Approved* to *Conditionally Approved*	2010 - 44 acres from *Conditionally Approved* to *Approved*
NET	**147 acres from *Prohibited* to *Approved***	
	70 acres from *Restricted* to *Approved*	
	40 acres from *Prohibited* to *Conditionally Approved*	

Two of the thirteen Hood Canal growing areas (Hood Canal 6 and Port Townsend Bay) are listed as Threatened based on 2011 water quality data (WSDOH, 2012). WSDOH early warning system shows four growing areas of concern (WSDOH, 2012):

Annas Bay (Mason)	Stations 195 and 198 due to water quality concerns
Hood Canal 3 (Jefferson)	Stations 136 and 137 due to water quality concerns
Port Townsend (Jefferson)	Station 33 due to boat moorage

Hood Canal experienced a number of emergency shellfish closures in 2010: eight closures for a total of 108 days in Annas Bay due to flooding, five days in Hood Canal 7 due to excessive rainfall, seven days in Hood Canal 8 and 9 due to excessive rainfall, and seven days in Quilcene Bay due to flooding.

In 2011, Hood Canal also had a number of emergency closures: seven closures for a total of 69 days in Annas Bay due to flooding, seven days in Hood Canal 7, 8 and 9 due to excessive rainfall, and 15 days in Quilcene Bay due to improper waste disposal.

Mats Mats Bay was threatened with a downgrade in 2007 based on WSDOH water quality results at stations 9 and 10. Jefferson County Public Health sampled for FC at WSDOH marine stations in Mats Mats Bay from 2009 to 2012. Monthly samples were taken on alternating months to augment the WSDOH sampling schedule and effectively double the amount of data being collected during the Mats Mats Bay Water Quality Improvement Project period. Marine

results during the project period have shown that the Bay has been meeting water quality standards and that previous high hits have not been reconfirmed. Mats Mats Bay has limited mixing due to a long, narrow entrance. The basin has a relatively densely developed residential shoreline and very few agricultural activities. A basalt rock quarry on the shoreline has been inactive for several years. Commercial shellfishing is practiced in the Bay.

FRESH WATER QUALITY SUMMARY 2005-2011

The following table summarizes fresh water FC data collected between 2005 and 2011. The list was based on the 11 Tier 1 monitoring stations identified in the monitoring plan. The jurisdictions added monitoring stations in areas with water quality and shellfish concerns, some of which are Tier 2 monitoring stations from the monitoring plan.

Table 4: 2005-2011 Fresh Water Quality Summary (KPHD, 2011)

Waterbody		WY2011 FC GMV	Meets WY2011 WQ Standard?	2005-2011 FC GMV
Big Anderson Creek (BA01)	Tier 2	20	**Failed Part 2**	14
Big Beef Creek (BB01)	Tier 1	22	Yes	12
Big Bend Creek (I-73)	Tier 1	39	**Failed Part 2**	40[1]
Big Quilcene River	Tier 1	No Data		2010 GMV 3.29
Chimacum Creek (CH/0.1)	Jefferson	2011-12 GMV 76	**2010 Failed both parts**	2009-10 GMV 61
Dewatto River (33)	Tier 1	No Data		7[2]
Donovan Creek (DV/0.0)	Jefferson	2012 GMV 412 EC	**2010 Failed Part 2**	2010 GMV @ DV/0.4 42
Duckabush River (DUC/0.0)	Tier 1	2011-12 GMV 4	Yes	2007-10 GMV < 7 EC
Gamble Creek (PG01)	Tier 1	31	Yes	21
Jorsted Creek (17)	Tier 1	No Data		10[3]
Jump Off Joe Creek (JJ01)	Tier 2	41	**Failed Part 2**	34
Kinman Creek (KN01)	Tier 2	119	**Failed both parts**	53
Leland Creek	Jefferson	No Data		
Little Anderson Creek (LA02)	Tier 2	11	Yes	10
Little Quilcene River	Jeferson	No Data		
Seabeck Creek (SB01)	Tier 2	12	Yes	11
Skokomish River (at HWY 106)	Tier 1	21	**Failed Part 2**	14
Stavis Creek (SV01)	Tier 2	18	Yes	14
Tahuya River (35)	Tier 1	No Data		10[4]
Tarboo Creek (TB/0.0)	Jefferson	2012 GMV 334.2 EC	**2010 Failed Part 2**	2009-10 GMV @ TB0.9 17
Trail's End Creek	Tier 1	24	**Failed Part 2**	30[5]
Union River (40)	Tier 1	No Data		32[6]

[1] 14 Samples collected between 8/10/10 and 9/6/11
[2] 24 Samples collected between 11/15/04 and 6/26/07
[3] 20 Samples collected between 10/5/04 and 11/13/06
[4] 28 Samples collected between 11/1/04 and 6/26/07
[5] 14 Samples collected between 8/11/10 and 9/6/11
[6] 17 Samples collected between 11/1/04 and 3/21/06

Individual Stream Data

BIG ANDERSON CREEK – Tier 2

Big Anderson Creek watershed is located in the westernmost part of Kitsap County and discharges near Holly. The creek and its tributaries make up 17 miles of stream corridor within its 3000 acre watershed. Land use in the Big Anderson Creek drainage is primarily commercial timber with some rural residential. Recent water quality has been very good, and statistical analysis for the creek now shows a stationary trend.

Big Anderson monitoring station BA01 upstream of Holly Road

BIG BEEF CREEK – Tier 1

Big Beef Creek and its tributaries combine for over 15 miles of stream corridor including Lake Symington and Morgan's Marsh. The stream discharges into the eastern shoreline of Hood Canal near Lone Rock in central Kitsap County. Land use in the drainage is a combination of rural residential, agricultural, and commercial timber. The University of Washington operates a fisheries research and field station near the mouth of Big Beef Creek. Recent water quality has been very good, but statistical analysis for the creek shows a worsening trend over the last 3 years. Bacteria levels remain relatively low, and Health District will continue to monitor the stream to determine if problems persist.

The University of Washington facility, with monitoring station BB01 in the foreground

BIG BEND CREEK – Tier 1

The Big Bend Creek sub-basin is a mix of forestlands, commercial and residential development. Big Bend Creek is approximately one mile long. The upper reach passes through mostly forested land. There are less than 30 developed parcels, almost all within 1000' of the creek mouth. Big Bend Creek currently has a Category 5 FC listing (listing ID 45568). The WSDOH Shellfish Program lists the area that Big Bend Creek flows into as *Conditionally Approved*. This is due to the Alderbrook sewer outfall located east of the creek mouth. There were three FC results that exceeded 100

MCPH staff collects flow measurements at the mouth of Big Bend Creek station I-73

FC/100mL, collected from Big Bend Creek between August, 2010 and August 2011. Big Bend Creek does not currently meet the Extraordinary Water Quality Standard. MCPH is currently conducting investigations in the area to identify pollution source(s).

BIG QUILCENE RIVER - Jefferson

The Big Quilcene River basin lies partially within Olympic National Forest. The river supplies the City of Port Townsend with drinking water. A federal salmon hatchery is located above Highway 101 and an Ecology flow gauge and monitoring station is located at Linger Longer Road. Ecology has collected FC data sporadically; the most recent monitoring was in 2010 (GMV 3.29). Shoreline sampling for E. coli in 2008-12 did not exceed 40 EC/100 mL. Intense use of the river by fishermen during salmon season and lack of sanitary facilities has led to isolated higher EC counts (139.6 EC in September 2011). Concerns about human waste along the river bank prompted WSDOH to temporarily close a portion of the Quilcene Bay shellfish growing area in fall 2011. Jefferson County Public Health arranged to have temporary facilities for the 2012 season, but a long term solution is still needed. Increased FC monitoring will be performed under Phase 2 of the Hood Canal Watershed project and short-term EC sampling to assess if there is any impact associated with the 2012 fishing season is currently underway.

Big Quilcene River near the mouth.

CHIMACUM CREEK - Jefferson

Chimacum Creek and its tributaries experienced a generally improving water quality trend for 20 years. FC levels have increased in the last 5 years. Many stations regularly fail extraordinary primary contact standards for FC. The Chimacum basin is rural with greater density of septic systems than many other rural parts of Jefferson County and a greater concentration of agricultural activities. The Conservation District targeted reaches with 303d listings for temperature and dissolved oxygen with riparian restoration and weed control projects. Most monitoring and PIC work has been performed under Ecology CCWF grant funding. Two hundred fifty three sanitary surveys were completed. Microbial source tracking is currently being performed along with continued monitoring and agricultural BMP implementation under an EPA grant.

Recent riparian plantings near station CH/3.4 on Chimacum Creek's main stem.

DEWATTO RIVER – Tier 1

The Dewatto River is located on the Tahuya Peninsula and flows into Hood Canal's eastern Shoreline. The river is approximately 7.4 miles long, with a 23 square mile drainage area - 82% of which is located within Mason County. The Dewatto River sub-basin is mostly undeveloped. Land cover within the Dewatto Watershed includes mostly timberlands, which includes large tracts of land owned by timber companies. Land use by area primarily consists of resource (85%), undeveloped (10%) and residential parcels (3%).

The Dewatto River has one segment on the 303(d) list for FC (Category 5 - listing ID 53077), located in Kitsap County just before the river enters Mason County. The adjacent marine waters are not associated with any 303(d) listings and are classified as *Approved* for growing shellfish. Summer Chum are documented in the Dewatto River, but the stock was considered extinct by the 2002 SaSI update. The update declared the fall chum stock healthy and the winter steelhead stock as depressed (WDFW, 2002). Priority wildlife species mountain quail and osprey are mapped in area adjacent to the river (WDFW, 2011).

DONOVAN CREEK - Jefferson

A small drainage at the head of Quilcene Bay, Donovan Creek passes through rural residential and agricultural pastures. In 2010 Donovan Creek failed Part 2 of the FC standard. E. coli screening in 2012 indicated high levels of pathogens and PIC work is beginning in the basin through the Hood Canal Watershed project. Riparian restoration projects are occurring on several properties.

Donovan Creek north of E. Quilcene Rd bridge

DUCKABUSH RIVER – Tier 1

Though most of the Duckabush basin is within Olympic National Park or Olympic National Forest, rural residential development in the lower reaches of the river is relatively dense, including a number of parcels in flood zones. Shoreline sampling for E. coli through the Hood Canal Clean Water Project included the mouth of the Duckabush. All samples 2007-2010 were less than 10 EC/100 mL. Three monitoring stations have been created along the Duckabush for monthly monitoring under the Hood Canal Watershed

The Duckabush delta at Highway 101.

project and sampling began in 2012. Intensive sanitary survey work has been initiated based on the high number of OSS near the river that are unknown or were permitted before 1985. An Ecology ambient monitoring station (16C090) provides baseline data upstream of all residential land use. This upstream station has consistently met extraordinary primary contact standards over the last 5 years.

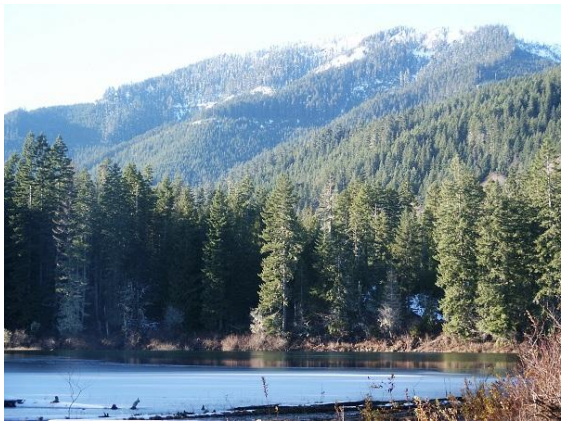
GAMBLE CREEK – Tier 1

Gamble Creek is one of two streams in Kitsap's Upper Hood Canal Watershed designated as Primary Contact waters by the state. (The rest of the watershed is classified as Extraordinary Primary Contact.) The stream's headwaters are located northeast of Poulsbo, east of Stottlemeyer Road. Gamble Creek's mainstem and tributaries consist of almost four miles of stream corridor, which discharge into the southern end of Gamble Bay. Land use in the Gamble Creek drainage is predominately rural residential and agricultural. Recent water quality has been good, but statistical analysis shows a worsening trend over the last three years.

KPHD staff collecting samples at Gamble Creek monitoring station PG01

JORSTAD CREEK – Tier 1

Jorstad Creek originates in the foothills of the Olympic Mountains, within the Olympic National Forest. The estimated length of the creek and its tributaries is 19 miles, with a drainage area of approximately 5 square miles. The Jorstad Creek sub-basin is mostly undeveloped. Land cover in the watershed is mostly forested lands. Development is near the mouth or adjacent to the river. Land use in the watershed consists primarily of undeveloped (69%), resource (27%) and residential (2%) parcels. There are no known water quality concerns in this drainage basin or in the surrounding marine waters.



JUMP OFF CREEK – Tier 2

The headwaters of Jump off Creek (formerly Jump Off Joe Creek) are located near the Pioneer Hill Industrial Park in north Kitsap County. From there, it flows north approximately one mile to Hood Canal, near the Edgewater Community area. Land use in the Jump Off Creek drainage is predominately residential and some commercial/light industrial. A pollution correction project for the creek has been completed, with 273 properties inspected and 12 failing septic systems discovered. Water quality has gotten better

Jump Off Creek as it flows into Hood Canal downstream of monitoring station JJ01

over the last few years, and because of this improvement the State Department of Health lifted a shellfish closure around the mouth of Jump Off Creek. Statistical analysis for the creek now shows a stationary trend.

KINMAN CREEK – Tier 2

From its headwaters on Big Valley Road, Kinman Creek flows approximately three miles in a northerly direction to discharge into Hood Canal north of Kitsap Memorial State Park. Land use in the Kinman Creek drainage is a combination of rural residential and agricultural. Water quality has been very poor, with frequent periods of elevated bacteria. Statistical analysis for the creek shows a worsening trend over the last three years. A project is underway to investigate the bacterial pollution in the creek. Because of the elevated bacteria levels in Kinman Creek, the State Department of Health has designated a shellfish closure area within 50 feet on both sides of the stream.

Kinman Creek monitoring station KN01

LELAND CREEK - Jefferson

Leland Creek, a tributary to the Little Quilcene River, drains Jefferson County's largest lake. The lake and stream sides include residential development, agricultural pasture and forest lands. Leland Creek has several Category 5 listed reaches for temperature, dissolved oxygen and pH. FC has not been monitored in recent years but monitoring is planned under the Hood Canal Watershed project. A goal of the project is to identify a riparian restoration site to begin addressing 303d listings and improve salmonid habitat. A local homeowners group and the non-profit Pacific Ecological Institute have, among others, have expressed concern over the water quality of Leland Creek.

Start of Leland Creek at the outlet of Lake Leland at Leland Valley Road crossing showing unused fish trap and staff gauge.

LITTLE ANDERSON CREEK – Tier 2

Little Anderson Creek and its tributaries originate near Newberry Hill Road and combine for over three miles of stream corridor. The stream discharges into the east shore of central Hood Canal near Lone Rock. Land use in the Little Anderson Creek drainage is a combination of rural residential, agricultural, and commercial timber. Current water

Little Anderson Creek upstream of monitoring station LA02 near Anderson Hill Road

quality is very good, and overall trend analysis for the creek shows a stationary trend.

LITTLE QUILCENE RIVER - Jefferson

The smaller of two rivers flowing through the town of Quilcene, the Little Quilcene river supplies a portion of the City of Port Townsend drinking water via the Lords Lake reservoir. An Ecology stream gauge is located at Center Road. Two reaches are listed impaired for temperature. No recent FC monitoring results are known; monitoring is planned under the Hood Canal Watershed project. Recent restoration efforts have re-meandered portions of the channel, removed dikes to allow salt marsh restoration and planted riparian areas.

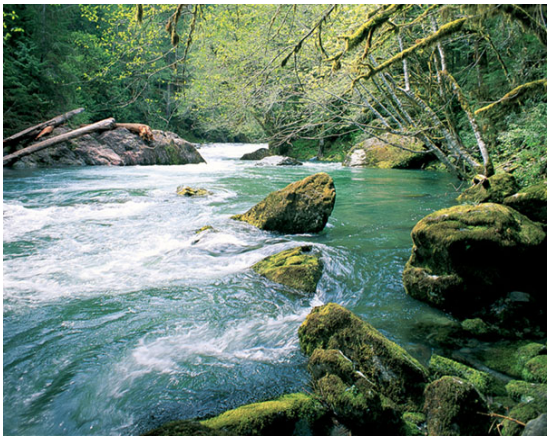
Little Quilcene River at low flow

SEABECK CREEK – Tier 2

Seabeck Creek and its tributaries combine for over six miles of stream corridor in central Kitsap. The headwaters are located between Hite Center Road and Larson Lane. The stream flows northwest and discharges into Seabeck Bay in central Hood Canal. Land use in the Seabeck Creek drainage is predominately rural residential, agricultural and commercial timber. Current water quality is very good over all, but a study by the University of Washington indicates higher nutrients in Seabeck Creek compared to other streams nearby. Statistical analysis now shows a stationary trend.

Seabeck Creek monitoring station SB01 upstream of Miami Beach Road

SKOKOMISH RIVER – Tier 1



The Skokomish River has the largest drainage area (approximately 247 sq. mi.) of any Hood Canal stream and is the largest freshwater input into Hood Canal. The Skokomish originates in the Olympic Mountains and discharges to Annas Bay. There is low residential growth potential due to a moratorium on floodplain development. The river is affected by forestry activities. The basin faces future in-stream flow concerns due to aggradation, a process where sediment raises streambed elevation with a corresponding decrease in channel capacity. Water quality monitoring by the Skokomish Tribe in 1995-97 identified elevated bacterial concentrations in the mainstem of the Skokomish River and some tributaries. Agriculture is the primary source of bacteria (Skokomish Tribe, 2012). Failing septic systems and improper disposal of human waste are also sources. In 1998, Ecology added several sections of the lower Skokomish River and tributaries to the 303(d) list for FC exceedences (EPA, 2009). Ecology and the Skokomish Tribe developed a TMDL study in

2001. The study set FC load reduction targets for sections of the Skokomish River, Ten Acre Creek, Purdy Creek, and Weaver Creek. DOH listed 300 acres of the shellfish growing area in Annas Bay as prohibited in 2005. Extensive efforts by numerous partners including Mason Conservation District, Mason County, the Skokomish Tribe, Ecology and EPA improved bacterial concentrations. In 2008, the Skokomish River at the HWY 101 Bridge was removed from the 303(d) list and in 2009 Annas Bay shellfish growing area was upgraded to *Approved*. However, areas of Annas Bay are listed by DOH as a concerned status (WSDOH, 2012). Several 303(d) listed sections have seen improvements, but have ongoing TMDL studies. If standards are met in the future, Ecology may remove them from the 303(d) list (EPA, 2009).

STAVIS CREEK – Tier 2

Stavis Creek originates north of the Seabeck-Holly Road, at Albert Pfundt Road, and flows approximately four miles to its discharge point along the eastern shore of central Hood Canal in south Kitsap. Land use in the Stavis Creek drainage is a combination of rural residential, agricultural and commercial timber. Current water quality is very good, and overall trend analysis for the creek shows a stationary trend.

Stavis Creek monitoring station SV01 at Stavis Bay Road

TAHUYA RIVER – Tier 1

The Tahuya River is the largest river on the Tahuya Peninsula. The Tahuya River drainage area is 49 square miles, with 72% located within Mason County. Land use in the watershed is mostly undeveloped (56%), resource (29%) and residential (8%) parcels.

The Tahuya River has one segment on the 303(d) list for dissolved oxygen (listing ID 52984), located in the upper watershed in Mason County. The adjacent marine waters are not on the 303(d) list and are classified as *Approved* for growing shellfish. However, the Tahuya River does drain into a portion of Hood Canal that is experiencing severe hypoxia (low dissolved oxygen).

Critical habitat has been designated for the Hood Canal ESU summer-run chum salmon in the lower reach of the Tahuya River downstream to Hood Canal (WDFW, 2011). The DNR Natural Heritage Program has identified shore pine-Douglas fir and salal as priority vegetation for the Tahuya River watershed (DNR, 2009). Summer Chum were considered extinct in the Tahuya

River by Washington Department of Fish and Wildlife in 2003; however, the stock has been reestablished through supplementation from the Union River stock by the Hood Canal Salmon Enhancement Group. The Tahuya River is one of the main production areas for fall chum and the stock is considered healthy (WDFW 2002). The river supports a small number of spawning fall Chinook salmon, but the number was below the escapement goal for the stream in 2003. The stock status of winter steelhead was considered depressed in 2002 (WDFW, 2002).

TARBOO CREEK - Jefferson

The largest stream entering Dabob Bay, Tarboo Creek drains agricultural and rural residential areas. The Tarboo estuary is one of the most intact estuaries in Puget Sound and is partially protected by the Dabob Natural Area and privately held conservation land. Little long-term FC monitoring has been done but recent sampling for E. coli has shown elevated levels at numerous sites. Tarboo Creek failed part 2 of the FC standard in 2010. Additional monitoring will be performed under the Hood Canal Watershed project.

Collecting a sample in Tarboo Bay.

TRAILS END CREEK – Tier 1

The Trails End Creek Sub-basin consists of forestland and some residential development. There are many parcels in the drainage area that are not developed. There are 3 developed parcels at the mouth and 10 developed parcels in the upper reaches of Trails End Creek. The creek is approximately 1.7 miles long.

MCPH Staff prepares to monitor flows at the mouth of Trails End Creek

Trails End Creek currently has a Category 5 FC listing (listing ID 6966). There are no known FC concerns in the marine water. There were four FC results that exceeded 100 FC/100mL, collected between August, 2010 and August 2011. Trails End Creek does not currently meet the Extraordinary Water Quality Standard. MCPH is working to identify the FC pollution source(s).

UNION RIVER – Tier 1

The Union River originates upstream of Union River Reservoir, which was completed in 1957 and supplies drinking water to the City of Bremerton and the Puget Sound Shipyard (Kuttel, 2003). The Union River drainage area consists of approximately 23 square miles, of which 41% is located within Mason County. The stream mouth drains into Hood Canal at Lynch Cove, the terminus of Hood Canal. The upper

drainage basin has been modified by industrial forestry and water diversion and storage. The lower basin is used for residential development, small farms and some forestry (Kuttel, 2003). Land use in Mason County primarily consists of resource (43%), undeveloped (21%) and residential parcels (15%).

The Union River is listed on the 303(d) list of impaired waters (Category 5) for dissolved oxygen and for FC (Category 4a - listing ID 6958). The marine waters of Lynch Cove, adjacent to the mouth of the Union River, are also 303(d) listed for FC. The area has chronic issues low dissolved oxygen issues and the area that Union River flows into is prohibited for shellfish harvesting. Other potential impacts to the watershed include the Olympic View Sanitary Landfill (closed), Bremerton National Airport, Port of Bremerton Industrial Park, Christmas tree farms, and several sand and gravel operations. The Ecology-listed facilities and sites inventory include a Leaking Underground Storage Tank.

Critical habitat has been designated on the Union River for the Hood Canal ESU summer-run chum salmon in the lower reach of Union River downstream to Hood Canal. Priority species bald eagle and habitats (bald eagle, waterfowl concentrations and Estuarine Zone) have been mapped along the stream (WDFW, 2011). Summer Chum populations were considered healthy enough by 2003 to become a donor stock for reintroducing Summer Chum to the Tahuya River. In addition, the Union River is one of the main production streams of winter steelhead in the area (Kuttel, 2003).

SHORELINE SURVEYS

Table 5: Shoreline Surveys 2005-2011
FC Monitoring Summary

County/Tribe	Shoreline Miles	Confirmed Hotspots	OSS Failures Found
Jefferson	75.0*	29	10
Kitsap	48.0*	50	24
Mason	44.4 26.4*	37	9
TOTAL	193.8	116	43

*wet and dry season

JEFFERSON COUNTY

Hood Canal Clean Water Project (Dawson, June, 2012)

Jefferson County Public Health began shoreline sampling and sanitary surveys on Hood Canal in 2006 for the Hood Canal Sanitary Survey Project. This short term project led into a larger Hood Canal Clean Water Project in 2007 that culminated in May 2012. Seventy-five miles of Hood Canal shoreline were screened during wet season and dry season sampling for E. coli. More than 1,000 samples were collected at almost 700 freshwater discharges. High hits (>200 EC) were found throughout the project area over the project period but the majority were transitory, with subsequent low geomeans from resampling. However sampling results did lead to identifying and correcting several failed septic systems. Most OSS failures were found during sanitary surveys, of which 725 were completed. Eighty-nine percent of OSS surveyed had no problems

identified during the survey. Seven septic failures and 11 other violations were found. Several hotspots were found to have sources farther from the shoreline and are being addressed through the Hood Canal Watershed project.

Mats Mats Bay Water Quality Improvement Project (Dawson, Fickeisen, December 2012)
A threatened downgrade of the Mats Mats Bay shellfish growing area due to FC levels at WSDOH marine sampling stations prompted Jefferson County Public Health to begin a Clean Water Project there in 2009. One mile of shoreline was surveyed in wet and dry seasons and summarized in an annual water quality report http://www.jeffersoncountypublichealth.org/index.php?clean-water-projects). Six hotspots were identified along the shoreline. One hundred fifty-two sanitary surveys were completed. Three OSS failures and two other OSS violations were identified and are in the correction process. Additional surveys will be conducted through the remainder of 2012 when the project ends.

Northeast Jefferson Clean Water Project
A 2011 CCWF grant was awarded to Jefferson County Public Health to address concerns in remaining areas of East Jefferson County not addressed by other projects. The project will include shoreline surveys in Port Townsend, Marrowstone Island and Oak Bay, and other areas. Sampling will begin in 2013.

KITSAP COUNTY

Port Gamble Pollution Identification and Correction (KPHD, June 2001),
KPHD initiated a pilot PIC project in Port Gamble Bay in November 1995 in response to WSDOH's early warning and ultimate downgrade of the Cedar Cove shellfish beds in August 1996 due to fecal pollution. The region formed a Shellfish Protection District and KPHD conducted a Nonpoint Source Tracking and Identification Monitoring Plan for Southern Port Gamble Bay from October 1996 through 1999 to track and identify sources of FC pollution In May 1999, State Health upgraded to status of the commercial shellfish beds in Cedar Cove from Prohibited to *Approved*.

KPHD elected to proactively prevent future FC contamination in Port Gamble Bay by conducting periodic shoreline surveys, during wet and dry conditions. In 2007, KPHD conducted a wet season and a dry season shoreline survey of Port Gamble Bay from Middle Creek south. No fecal hotspots were identified. Additional wet weather shoreline surveys were conducted in February 2010 and April 2011 and no fecal hotspots were identified.

Upper Hood Canal Pollution Identification and Correction (KPHD, 2006)
KPHD conducted an early action pollution identification and correction (PIC) project during 2005-2006 in the Upper Hood Canal watershed from Warrenville (Ioka Way, Silverdale) south to the Kitsap-Mason County line. The project assessed fecal pollution impacts from Hood Canal shoreline adjacent parcels. Funding was provided by Puget Sound Action Team and the United States Environmental Protection Agency. Matching funds were provided by Kitsap County Surface and Stormwater Management Program (SSWM). A final report was submitted January 23, 2006.

KPHD was also awarded an Ecology CCWF 2006 grant to complete the investigation of Kitsap County's Upper Hood Canal shoreline (KPHD, 2008). The project extended the project area

north to Salisbury Point, north of the Hood Canal Bridge, and assessed shoreline discharges during the dry weather season (May – September), in addition to the wet weather season.

These two grants allowed KPHD to conduct a dry and a wet season shoreline survey along the entire Kitsap County Hood Canal shoreline with the exception of Bangor Submarine base between 2005 and 2008 (Upper Hood Canal PIC). Twenty-nine discharges were confirmed as fecal hotspots. Fourteen OSS failures were identified and corrected through shoreline survey efforts, two were greywater direct discharges identified by observing laundry discharges during shoreline surveys.

Jump Off Joe Creek Restoration Project (KPHD, 2011)

KPHD was awarded CCWF funding for the Jump Off Joe Creek Watershed Pollution and Identification Project in 2008(Jump Off Joe Creek PIC). In June 2010, the Jump off Joe Restoration Project was expanded to conduct marine shoreline surveys in the Hood Canal 1 shellfish growing area to locate fecal pollution sources and correct them to prevent future downgrades in classification. Twenty-one shoreline fecal hotspots were confirmed and ten failing OSS were found and corrected. A final project report was submitted December 2011.

Shellfish Restoration and Protection Project

KPHD was awarded an Environmental Protection Agency Puget Sound Restoration program grant for Shellfish Restoration and Protection in 2010 (EPA PIC). During 2011 through June of 2012, KPHD conducted two wet season and two dry season shoreline surveys of Hood Canal 2 shellfish growing area.

MASON COUNTY

Hood Canal Pollution Identification and Correction Project (Georgeson, Mathews, Orth, Hyatt, 2008)

Mason County Public Health (MCPH) was awarded an Ecology CCWF grant to conduct Pollution Identification and Correction in the Hood Canal watershed between July 2005 and August 2008. MCPH collected samples from approximately 1416 individual monitoring locations. The project included a shoreline survey of 44.4 miles of Hood Canal, located between Triton Head on the northwestern shore of Hood Canal in Mason County to Belfair. Mason identified 97 sites (7%) that needed an additional confirmation sample. Eighty-six of these were sampled and 29 exceeded the investigation threshold. The remaining eleven sites were not resampled mainly due to the sample location was dry during each follow-up visit or tides. Mason recommended:

> "*reducing sample areas in order to facilitate multiple monitoring events at each site rather than large sample areas, which allow for limited monitoring events per site.*"

Mason identified four shoreline segments of concern due to dense development, poor soils, increased water run-off and OSS located near bulkheads. These areas are located near Hoodsport, Union, and two areas along the south shore near Lynch Cove.

North Shore Hood Canal Pollution Identification and Correction Project (Georgeson, 2011)

MCPH was awarded an Ecology CCWF grant to conduct this project between October 2009 and December 2011. This was a continuation of the Hood Canal Pollution Identification and

Correction project that concluded in 2008. MCPH staff conducted 26.4 miles of shoreline surveys along the northeast shore of Hood Canal to complete the Mason County Hood Canal shoreline survey. Segments were surveyed twice, with the exception of the area north of Rendsland Creek that was not accessible during winter. The focus was on fresh water discharges and FC samples were collected when salinity, measured in the field using a refractometer, was less than 10 parts per thousand.

MCPH collected more than 800 samples from 467 individual monitoring locations and identified 36 monitoring locations (5%) that needed confirmation samples. MCPH obtained confirmation samples from 28 sites. Only eight monitoring locations had initial and confirmation samples that exceeded the 200 FC/100 ml threshold. MCPH recommended that seven sites (associated with 8 monitoring locations) needed further investigation. One OSS failure was found to have a cracked transport line under the structure, which was built over the water. This house was posted for non-occupancy.

MCPH found far fewer shoreline discharges on the northern and eastern shores of Hood Canal compared to the western and southern shorelines.

PARCEL SURVEY SUMMARY

Table 6: Parcel Survey Summary
Hood Canal Parcel Surveys
2005 - 2008

Agency	Parcel Surveys	OSS Failures	OSS Repairs
Jefferson	1130	27	21*
Kitsap	605	63	60**
Mason	113	38	36
TOTAL	1848	128	117

*4 repairs are in progress
**3 repairs are in progress

JEFFERSON COUNTY

Chimacum Creek Clean Water Project (Dawson, June, 2011)
Jefferson County Public Health researched 327 properties known or suspected to generate wastewater within 250 feet of streams in the project area. Surveys were conducted according guidelines of the Ecology-approved Manual of Protocol; Sanitary Survey Projects (JCPH 2005). Survey data was entered into the Jefferson County permit database. The survey process involved a research phase in which property and permit records were gathered and maps were analyzed; a fieldwork phase in which door to door surveys were conducted; a data entry phase; and a follow-up phase when suspect or failed systems were addressed. The process was refined during the course of the grant and lessons learned were applied to all Jefferson County projects.

Priority was placed on surveying properties that were located near Chimacum Creek and tributaries. Properties that were near sample locations with elevated FC levels were also prioritized. Early in the project it became clear that bacteria loads were higher at the lower reach of Chimacum Creek. Declining water quality was also discovered at two sites on West Valley Road. These three areas were the primary targets of the surveys, although other sites were surveyed on a less intensive basis.

The survey involved distributing and gathering information about the type of system, repair history and plumbing problems, water use, ending with an OSS field inspection. After three site visits attempts, a self-addressed survey card and letter were mailed explaining the purpose of the study and asking some basic questions about the septic system. Many return mailer cards were not returned. In most cases when the cards were returned, Public Health personnel completed the sanitary survey.

A major educational component of the survey is to inform the public about state-mandated monitoring requirements of an operation and maintenance (O&M) inspection every three years for gravity systems and annually for alternative systems. Inspections are also required when the property is sold. The majority of residents contacted were unaware of this requirement. Jefferson County is planning on a revision to county code that will allow enforcement.

Site-specific tips for prolonging the life of the septic system were provided along with a *Basic Facts: On-site Sewage System* brochure and Chimacum Creek Clean Water Project brochure, a list of O&M providers, and a flyer about the regional septic loan program Enterprise Cascadia. This is a low-cost septic loan program available to Jefferson County residents through a non-profit organization to make repairs affordable. Information was also distributed where appropriate about the United States Department of Agriculture (USDA) Rural Development Section 504 loan and grant program.

Two hundred fifty-three sanitary surveys were completed. Twenty people (6%) declined participation. Thirty-five people (11%) were not reachable despite three visits and a mailed questionnaire.

Of the 253 surveys completed, 12 failures (4.8%) were identified. Eighteen parcels were rated suspect (7.1%), and 223 had no apparent problems (88.1%).

The failures found included: surfacing sewage from a malfunctioning system, unpermitted systems with components not meeting code, and direct discharges of greywater or untreated sewage. One participant secured repair funding through the USDA program.

Suspect systems had conditions that could be a problem including: drainfields that had been driven on, components that could not be located, and tanks without risers. Suspect systems received additional outreach by Public Health staff, usually in the form of a letter describing the concerns and recommending site specific actions for owners to protect their system.

Jefferson County Conservation District also worked with North Olympic Salmon Coalition staff to improve water quality by working with landowners to implement agricultural best management practices. The focus was reducing bacteria inputs by excluding livestock from streams by fencing buffers, planting riparian vegetation, and removing

aquatic vegetation that was impacting stream flow and dissolved oxygen levels. Riparian vegetation was planted, and volunteers were trained in riparian zone and nursery planting and maintenance.

Hood Canal Sanitary Survey Project

A pilot project to develop a PIC program on Hood Canal was conducted in 2006 along the Jefferson County portion of the Hood Canal shoreline. This project helped to develop a PIC program in Jefferson County and laid the groundwork for future projects.

Hood Canal Clean Water Project (Dawson, June 2012)

One thousand, one hundred and thirty properties were researched and contacted. Seven hundred twenty five surveys were completed. Responses to mail-in requests are still being collected and a small number of surveys are still being performed. A high percentage (30%) of residents did not respond to survey attempts. Many of the shoreline properties are seasonal vacation properties with residents who reside out of the area. Survey efficiency was hampered by 2-hour driving times from the Port Townsend JCPH office to low density areas in southern Jefferson County. The protocol of attempting three times to conduct the survey was modified with permission from Ecology due to these factors. Towards the end of the project, survey cards were mailed to many landowners after less than three contact attempts. The cards also included basic outreach about septic system care and maintenance.

Of the 725 surveys completed, nine OSS were failing (1.3%). Forty six were rated suspect (6.3%) and 670 (92.4%) had no apparent problems.

The OSS failures included: direct discharge of untreated sewage, OSS installed without a permit. Failures were corrected through enforcement of state and local code by the Jefferson County Environmental Health Division. Financial assistance information was always provided along with enforcement. Two sites are in the process of obtaining financial assistance for repairs. These cases will continue to be monitored after the project ends until repairs are completed. Some repairs were initiated on a voluntary basis after they were discovered. A total of 28 permits were issued by Jefferson County Environmental Health for repairs and upgrades during the project.

Suspect OSS had situations including: unknown drainfield locations, drainfields with potential impacts inconclusive sample and dye test results. Suspect systems received additional outreach by Public Health staff, usually a letter describing concerns and recommending actions that owners could take to protect their system.

Eighteen public complaints about septic systems were investigated by staff. Corrective action or enforcement was utilized when complaints were confirmed. For example, one house under construction in the Wolfe Property State Park vicinity was found to have no septic permit. Construction was halted until the OSS was permitted. Another resident in the Shine area called in about concerns that a transport line was leaking. This was verified and repairs were made immediately. Repairs and follow-up activities are summarized in Table 4.

KITSAP COUNTY

Upper Hood Canal PIC (KPHD, 2006; KPHD, 2008)
KPHD conducted an early action PIC project during 2005-2006 in the Upper Hood Canal watershed from Warrenville (Ioka Way, Silverdale) south to the Kitsap-Mason County line. Forty-five PIC parcel surveys were conducted and twelve OSS failures were found and corrected.

KPHD received a 2006 grant to complete the investigation of the county's upper Hood canal shoreline through Ecology CCWF. Seventy-three PIC shoreline parcel surveys were conducted and nineteen OSS failures were found and corrected.

Primary reasons for OSS failures found between 2005 and 2008 were age of the system and proximity to surface water.

- twenty-four (24) of the thirty-one (31) failing OSS were more than twenty years old; and
- twenty (20) had a non-conforming setback less than 100 feet from surface waters (65%).

Shoreline surveys were an effective method of finding OSS failures.

- Sixteen (16) of the thirty-one (31) OSS failures (52%) found in Hood Canal between 2005 and 2008 were found through shoreline surveys.
- Twenty-two (22) percent of the shoreline survey FC hotspots found in Hood Canal were found to have OSS failure sources.

Public and professional outreach programs were another effective means of finding OSS failures between 2005 and 2008. Stormwater utilities, like Kitsap County Surface and Stormwater Management Program fund outreach programs that build public trust, thereby encouraging public sewage complaints and contractor referrals.

- Seven (7) OSS failures were found through public sewage complaints (23%) and
- Four (4) through outreach to OSS contractors (13%).

Jump off Joe Creek Restoration Project (KPHD, 2011)
The Jump off Joe Creek project was awarded to the KPHD in November 2007 to address serious FC pollution problems in Jump off Joe Creek. Pollution identification and correction (PIC) work by the Health District in 2008 and 2009 resulted in decreasing FC concentrations in Jump off Joe Creek allowing WSDOH to remove the shellfish closure zone at the mouth of Jump off Joe Creek in October 2009. In 2008 the project area was expanded to include Lofall Creek, Kinman Creek, and Vinland Creek watersheds.

PIC surveys were performed at 430 properties in the Vinland, Jump off Joe, Lofall and Kinman Creek watersheds. Twenty-eight onsite sewage system OSS failures were discovered and repaired during the project.

Shellfish Restoration and Protection Project
KPHD was awarded an Environmental Protection Agency Puget Sound Restoration program grant for Shellfish Restoration and Protection in 2010 (EPA PIC). During 2011 through June of 2012, KPHD completed 57 parcel surveys in the Hood Canal 2 growing area, Four OSS failures were identified. One has been repaired and the other three are in progress.

MASON COUNTY

Skokomish Annas Bay Restoration Study (MCPH, 2008)
In August 2005,WSDOH downgraded 300 acres of the Annas Bay shellfish growing area from *Approved* to *Prohibited* due to high FC bacteria levels in marine water samples. Mason County responded by forming a shellfish protection district surrounding Annas Bay. In June 2006, an EPA grant administered by Ecology was awarded to conduct the Skokomish Annas Bay Restoration Study.

As part of the project, MPHD conducted 21 sanitary surveys of properties along the eastern shoreline of Annas Bay in areas near WSDOH marine stations with poor water quality. Twelve OSS failures were found and corrected. A broken sewage line was found to be discharging sewage near the marine station that triggered the Annas Bay closure. MCPH staff forwarded three off-reservation parcels owned by Skokomish Tribal members with elevated FC discharges to the Tribe for correction.

MCPH also investigated the Biorecycling Corporation's biosolids land application site.

Hood Canal Pollution Identification and Correction Project (Georgeson, Mathews, Orth, & Hyatt, 2008)
MCPH conducted this PIC project during 2005-2008. MCPH staff identified 29 parcels for parcel survey. Seventeen PIC parcel surveys were conducted (41%). Eight OSS failures were identified: seven from the eleven dye tests conducted and one surfacing sewage failure. Five of these failures were repaired.

Primary reasons for OSS failure were age of system and proximity to surface water. Six of the 8 properties with OSS failures were less than 20 feet from surface water, most were behind the bulkhead. All of these properties experienced excess storm, surface or groundwater runoff that may have contributed to the OSS failure. Seventy-five percent (6) of the failures were associated with gravity drainfields.

Mission Creeks Water Quality Assessment (HCSEG, 2009)
The Hood Canal Salmon Enhancement Group was awarded a grant from Ecology Clean Water Act Section 319 Nonpoint Source Funds. They partnered with MCPH to conduct a two-year investigation of FC bacteria sources on Big Mission Creek and Little Mission Creek. Both creeks flow into Hood Canal commercial and recreational shellfish beds that are *Restricted* due to elevated FC levels.

Twelve stream stations were monitored monthly from August 2006 through July 2007. The results demonstrated that the lower segments of the streams had the highest fecal pollution. Based on these results, the next year sampling was targeted in the lower watershed.

Two intensive monitoring surveys were conducted to assess FC concentrations fluctuations throughout the day at the mouth of Big Mission Creek. The results showed a large variability in FC over the course of a day.

MCPH conducted twenty-four parcel surveys and one dye test. No confirmed failing septic systems were found. Twenty of the parcels had dogs and were provided information about pet

waste disposal. Many of the dogs were observed to run free. Dogs were also observed in Belfair State Park, many were unleashed and unattended.

One parcel in lower Big Mission Creek had two horses and another had chickens, turkeys, peacocks and three goats. The horse property was surveyed and noted to have animal waste management issues. The landowner made a pledge to install fencing to restrict the horse from the stream.

North Shore Hood Canal Pollution Identification and Correction Project (Georgeson, 2011)
MCPH staff conducted parcel surveys in areas where shoreline discharges exceeded 200 FC/100ml for the initial and confirmation sample, and sites with high fecal pollution potential based on site or OSS features, prior survey data or service data. Fifty-one parcels were surveyed.

MCPH found and corrected one OSS failure through this project. Another 19 OSS failures were corrected in the area during the project.

NUTRIENT MONITORING AND STUDIES

Hood Canal is a nitrogen-limited system and experiences eutrophication predominantly due to marine nitrogen inputs. Eutrophication results in reduced dissolved oxygen concentrations, at times to very low levels that are harmful to marine life. Due to the low dissolved oxygen problems in Hood Canal, limiting additional nutrient contributions from human sources has been identified as a priority.

The Hood Canal Dissolved Oxygen Program and other studies have studied Hood Canal nutrient dynamics. This section focuses specifically on 1) measured nitrogen concentrations in streams in the Hood Canal watershed and 2) shoreline surveys, with a focus on the relationship between FC and nutrient concentrations.

Stream Nitrogen Concentrations
The Hood Canal Dissolved Oxygen Program conducted a study, The influence of watershed characteristics on nitrogen export to and marine fate in Hood Canal, Washington, USA, measuring stream nutrient concentrations in 43 Hood Canal streams monthly, over a two year period (Steinberg, 2010). The results indicate that 2-year flow-weighted mean stream dissolved inorganic nitrogen concentrations ranged from 0.011mg/L to 0.909 mg/L DIN. The highest twenty-five percent of streams based on mean flow-weighted DIN concentrations are listed in Table 7.

Table 7: Stream Dissolved Inorganic Nitrogen

STREAM/RIVER	2 -year flow weighted DIN concentration (mg/L)
Devereaux	0.909
Tarboo	0.724
Mulberg	0.604
Little Quilcene	0.599
Seabeck	0.516
Trails End	0.430
Thorndyke	0.390
Hill	0.389
Union	0.380
Holyoke	0.352
Big Beef	0.295

Stream sampling for nutrients was also conducted through the counties' PIC programs, the Ecology Ambient Monitoring Program and the Skokomish Tribes' water quality program. Please note that the concentrations below are not flow weighted.

Ecology monitored nutrients in two Jefferson County streams in recent years: the Duckabush River and the Big Quilcene River as part of their Ambient Monitoring Program. From January 2012 through September 2011, station 16C090 at the Duckabush River near Brinnon was monitored monthly, including NO_2+NO_3 nitrogen (NO_2+$NO_{3)}$ samples. From October 2009 through September 2010, monthly monitoring including NO_2+NO_3 and NH_3 was performed at station 17A060 at the Big Quilcene River near the mouth.

During these time periods the range of NO_2+NO_3 in the Duckabush was less than 0.01 to 0.06 mg/L with a mean of 0.027mg/L. In the Big Quilcene the range was less than 0.013 to 0.085 mg/L with a mean of 0.042. Ammonia was undetected in the Big Quilcene except in one sample at 0.011 mg/L.

Kitsap County measured nutrient and FC data from mouth stations were analyzed over the course of the Jump off Joe Restoration Project to determine if corrective measures in the watershed improved water quality at the marine/fresh water interface (KPHD, 2011). Salinity was measured concurrently with nutrients and did not influence nutrient results. The seasonal Kendall statistical method was used to plot nutrient data trends over time and determine if there was a statistically significant change. Although graphical representation of the results shows a decrease in FC at Lofall Creek and a decrease in ammonia at Jump off Joe Creek, the only statistically significant result noted was the decrease in ammonia concentrations at the mouth station of Kinman Creek, with a p-value of 0.0389 at the 95% confidence level.

Ammonia concentrations at the stream months, ranged from <.01 to .12 mg/L. Average values are .027 for Jump Off Joe Creek, .022 for Kinman Creek, .030 for Lofall Creek, and .034 for Vinland Creek.

NO_2+NO_3 concentrations ranged from <.01 to 3.25 mg/L. Average values are 1.721 for Jump Off Joe Creek, 1.227 for Kinman Creek, 1.928 for Lofall Creek, and 2.215 for Vinland Creek.

The Skokomish Tribe measured nitrate concentrations in the Skokomish River at four locations. Data from 2006 through 2011 is aggregated in the Table 8 below (Skokomish Tribe, 2012).

Table 8. Skokomish Rover nitrate data from 2006-2011 (Skokomish Tribe, 2012)

Site (from mouth to upstream)	**Mean (mg/L)**	**Median (mg/L)**	**Range (mg/L)**
Nalley's Slough	1.77	0.67	0.16-17.08
Skokomish R. 106 Br.	0.64	0.38	0.06-3.64
Skokomish R. @Bobby Allens	1.53	0.66	0.1-11.04
Skokomish R. 101 Br.	0.64	0.64	0.06-5.31

Mason County measured nutrient and FC levels from the mouths of 12 streams that are currently on the 303(d) list for fecal coliform between August 2010 and December 2012. This monitoring was performed under an ECY CCWG #G1000278. The final report for this data will be available at the end of 2013.

Shoreline Survey and Sanitary Survey - Nutrient Assessments

JEFFERSON COUNTY

In Jefferson County, screening samples for NO_2+NO_3 collected under the 2006 Hood Canal Sanitary Survey Project and the 2007-12 Hood Canal Clean Water Project. Shoreline survey work in 2005 to 2006 sampled for NO_2+NO_3 along with E. coli from streams, seeps and pipes discharging to the shoreline. Only about 10% of the total project sites were sampled for NO_2+NO_3. The range of results from all sites was less than 0.01 to 5.34 mg/L with a mean of 0.95 mg/L.

Two shoreline surveys for NO_2+NO_3 were conducted in 2009 and 2012 as part of the Hood Canal Clean Water Project. Major streams were sampled during two shoreline surveys. The range for all samples was 0.02 to 0.4 mg/L with a mean of 0.13 mg/L. Larger streams had lower concentrations. Values of 0.2 mg/L and higher were found in smaller streams in the Quilcene area. More sampling, especially in smaller discharges are needed to fully assess nutrient inputs in Jefferson County.

KITSAP COUNTY

<u>Upper Hood Canal Pollution Identification and Correction</u> (KPHD, 2008)
KPHD conducted a pilot nutrient study between 2005 and 2008. The study had two parts: a correlation study of FC and NO_2+NO_3, and a before and after correction investigation.[23]

Fecal coliform and nitrate+nitrite nitrogen correlation study
Fifty-one FC and NO_2+NO_3 samples were collected and discharge flows were measured when possible, from a densely developed shoreline segment south of Big Beef Creek and north of the Seabeck Marina. Nineteen sample sets were collected from undeveloped shorelines north and

south of Holly. Most of the shoreline discharges were estimated due to the difficulty measuring flow on low-gradient or well-drained beaches or from leaky pipes.

KPHD's contract statistician, Math Handyman, found no correlation between NO_2+NO_3 and FC in any of the developed or undeveloped shorelines sampled between 2005 and 2008. NO_2+NO_3 levels were very low and were diluted during rain conditions.

Before and After Correction Investigation (BACI)

FC, NO_2+NO_3, NH_3, and ortho-phosphorous (PO_4) samples were collected from FC contaminated drainages and similar control drainages before and after FC source correction. Salinity was measured and flows were measured where possible, or they were estimated. Samples were collected at seven (7) shoreline discharge locations with failing OSS and similar, nearby control locations. Samples were collected before and after the OSS failure was corrected.

Shoreline discharges with failing OSS showed elevated NO_2+NO_3 nitrogen, NH_3 or PO_3 concentrations compared to control discharges before OSS correction. Failing OSS may contribute nitrogen in the form of NO_2+NO_3, NH_3, and/or PO_4 depending upon the mechanism of the failing OSS.

BACI results showed the following statistically significant reductions at the 95% confidence level after OSS correction compared to controls:

- FC reduction at one (1) of seven (7) locations (14%);
- NO_2+NO_3 nitrogen reductions at two (2) locations (29%);
- NH_3 reductions at one (1) location (14%); and
- PO_4 reduction at one (1) site (14%).

The NO_2+NO_3 levels found in shoreline discharges impacted by OSS failures indicate that failing OSS do not always discharge elevated NO_2+NO_3 nitrogen levels.

MASON COUNTY

<u>Hood Canal Pollution Identification and Correction Project</u> (Georgeson, Mathews, Orth, & Hyatt, 2008)

In 2007 & 2008, MCPH monitored 8.3 miles of Hood Canal Shoreline for nutrient inputs. MCPH collected over 580 shoreline samples from 514 individual monitoring locations. Samples were analyzed for FC, salinity, and NO_2+NO_3, NH_3, and . MCPH identified 82 samples with at least one nutrient above the 90th percentile. Washington State does not have a nutrient surface water standard, MCPH determined the 90th percentile based on all data collected for the project. Nutrient sites that exceeded the 90th percentile were designated above "level of concern".

Nutrient "Level of Concern"

	NH_3 Nitrogen	**$NO_{2+}NO_3$ Nitrogen**	**PO_4 Phosphorus**
90th Percentile	0.12	0.89	0.70

All units are mg/L.

Samples were collected at thirteen (13) shoreline discharge locations associated with 8 identified failing OSS. Samples were collected before and after the OSS failure at 4 parcels.

Shoreline discharges with failing OSS showed elevated FC, NO_2+NO_3, NH_3 or PO_4 concentrations. Failing OSS may contribute nitrogen in the form of NO_2+NO_3 or NH_3, and depending upon the mechanism of the failing OSS. MCPH found that most of the nutrient samples that exceeded the 90th percentile were associated with failing OSS.

MCPH found that at locations where a failing OSS was identified there was at least one site with a nutrient result above the 'level of concern.' Nutrient results above the 'level of concern' did not always correspond directly to monitoring locations with elevated FC results; however, when they did not correspond directly, they were found in adjacent monitoring locations, which gave a more complete idea of how the septic system may be malfunctioning. For example, at sites where the OSS failure was located within close proximity to the monitoring location, FC, NH_3-N and PO_4 results were elevated, while if the location of the failure was further from the monitoring location, NO_2+NO_3 and FC were elevated (Georgeson, Mathews, Orth, & Hyatt, 2008).

Post-OSS repair monitoring provided mixed information. Only one site had a year span between the original monitoring event and the post-correction event. This site showed a 99.9% reduction in NH_3, 98% reduction in NO_2+NO_3, 98.5% reduction in PO_4 and a 99.9% reduction of FC. At the other sites, which had less time between OSS-correction and post-correction monitoring, the reductions were not as pronounced. MCPH proposed periodic follow-up FC and nutrient sampling over the course of a year after OSS correction.

MCPH identified 8.3 miles of Hood Canal as shorelines of concern for nutrients due to their proximity to the areas normally affected by fish kills. The segments reach from the northern border of Hoodsport south to the Skokomish Nation and from the east side of the Skokomish River north to Union and then west to Alderbrook. They sampled freshwater drainages for nutrients along with FC. Samples were analyzed for NH_3, NO_2+NO_3, and PO_4. Five hundred and ninety three samples were collected, 50 of which were associated with properties with confirmed or suspected OSS failures. All eight of the fresh water drainages with failing OSS were found to have elevated nutrient levels. MCPH defined a result as elevated, if it was greater than the 90th percentile for that parameter.

The final project report notes that:

> *"Based on the correlation and the strength of the relationships, it appears that the sets of data that include monitoring locations associated with failing OSS demonstrate a significant relationship between both fecal coliform and ammonia and between ammonia and orthophosphate. Whereas those sets of data that are not associated with failing OSS, do not demonstrate a significant relationship between any of the variables that were compared."*[18]

MCPH identified 8 failing OSSs. Of the eight (8) systems, 100% were found to have nutrient "levels of concern" associated with the property. Four (4) of the failing OSS were found to have elevated levels of NH_3 and PO_4. The other four (4) properties were found to have elevated levels of NO_2+NO_3.

MCPH conducted post-OSS repair monitoring. Only one site that showed a significant nutrient reduction following correction: 99.9% reduction in NO_2+NO_3, 98% reduction in PO_4 and 99.9% reduction of FC. This was the only site that had a one year span between the original monitoring and post-correction monitoring.

North Shore Hood Canal Pollution Identification and Correction Project (Georgeson, 2011)
MCPH continued nutrient monitoring of shoreline discharges along the north shore of the Great Bend area, to determine whether anthropogenic sources were discharging excess nutrients to Hood Canal, and to determine if there is a connection between FC and nutrients. Some segments were monitored in both wet and dry seasons. Of the segments that were selected, two were selected for intensive nutrient analysis due to high development density. Data was utilized to establish a nutrient baseline.

MCPH collected 351 nutrient samples and found that 40 (12%) were associated with FC results greater than100 FC/100ml. The North Shore project had lower overall nutrient levels than the Hood Canal PIC project that identified more failing OSS. MCPH recommended further investigation of monitoring locations with nutrient results above the 90th percentile level of concern. Thirty of the 347 samples had at least one nutrient analyte above the level of concern. Six of the seven sites MCPH identified for sanitary surveys, based on two elevated FC results, and also had at least one nutrient result about the level of concern.

MCPH recommended that flow measurements be taken to enable nutrient loading calculations. They also suggested that post-corrective nutrient monitoring be conducted in order to determine levels of nutrient concentrations in discharges at intervals following OSS correction. MCPH recommended exploring funding to conduct intensive nutrient studies along the southern shore of Hood Canal due to the persistent low dissolved problem from Lynch Cove to the Great Bend.

Table 9: Mason County HCPIC and NS-HCPIC projects summary data
HCPIC and NS-HCPIC Summary Statistics of Nutrient Monitoring Results

	Ammonia (NH_3) as Nitrogen	Nitrate+Nitrite (NO_2+NO_3) as Nitrogen	NH_3-N + NO_2+NO_3 Nitrogen	Ortho-Phosphorus (PO_4)	Fecal Coliform (FC)	Salinity
Average	0.24	0.39	0.62	0.16	312	4
Median	0.01	0.15	0.19	0.04	4	0
Mode	0.01	0.06	0.03	0.01	2	0
Max	52.90	21.80	65.30	7.06	160000	30
Min	0.01	0.01	0.02	0.01	2	0
90th Percentile	0.09	0.74	0.87	0.33	216	15
St. Dev.	2.51	1.08	3.00	0.50	5317	7
Count	940	940	940	940	940	779

Figure 2. Summary Map of Mason County Monitoring Locations with elevated FC levels or Nutrient levels above the 90th percentile

GIS OSS MAPPING

The HCCC Aquatic Rehabilitation Technical Advisory Committee's Wastewater-OSS Workgroup developed the first phase of a project to create visual GIS representations of wastewater-OSS treatment in the Hood Canal watershed as a tool to assist assessing current wastewater treatment and inform future water quality and OSS management. This project was conducted in the fall - winter of 2010. The objectives of the project were to better understand the locations of wastewater infrastructure (OSS, sewers, planned sewers, and large OSS) and to map this information along with land use and watershed characteristics. Hood Canal jurisdictions provided all available OSS data. The point data for this GIS study was created using the centroid (center) of the parcel. These points do not accurately reflect the actual location of the OSS tank or drainfield. The following table summarized the OSS types and numbers for the Hood Canal counties.

Table 10: 2010 Hood Canal OSS Summary

OSS TYPE	Kitsap County	%	Mason County	%	Jefferson County	%
Alternative	1,582	15%	2,295	22%	883	23%
Community System	0	0%	25	0%	0	0%
Conventional	3,690	34%	3,790	36%	2,659	70%
Holding Tank	2	0%	23	0%	35	1%
Seepage Pits	0	0%	103	1%	20	1%
Sewer	8	0%	0	0%	0	0%
Unknown	5,476	51%	4,213	40%	190	5%
TOTALS	10,758		10,449		3,787	

Following this OSS GIS Mapping Project, jurisdictions updated OSS databases. This updated information will be added in a second phase of the GIS project, as part of the Hood Canal PIC Phase I.

Information regarding OSS in close proximity to shorelines was of interest in the OSS GIS Mapping Project. Since data on actual OSS location was not available from any jurisdiction yet, the centroid (center) of the parcel was used to estimate the location of the OSS to surface water. Table 11 summarizes this information, which will be revised as part of the update.

Table 11: Hood Canal OSS Summary – Parcel Centroid Within 100 Feet of Shoreline

OSS TYPE	Kitsap County	Mason County	Jefferson County
Alternative	340	335	262
Community System	0	10	0
Conventional	466	675	509
Holding Tank	1	4	15
Seepage Pits	0	46	6
Unknown	910	532	40
TOTALS	**1,717**	**1,602**	**832**

In addition to OSS data, many land use and watershed characteristics were mapped, including parcel data, population densities, sewered areas, soil data, build-out analyses, water quality data (multiple sources), biosolids application sites, critical areas and sensitive areas. The combination of these data sets can help inform our understanding of water quality and OSS in the watershed, as shown in the figure below.

Since the 2010 Hood Canal OSS GIS analysis, Mason County continued assessment through their North Shore Hood Canal Pollution Identification and Correction Project. MCPH identified 1509 developed parcels within the North Shore area. At the time of the report, MCPH had 1297 parcels included in their OSS O&M database, which were known or assumed to be served by OSS. Five hundred and nine (39%) of the parcels had installation records and 151 (12%) did not. One hundred thirty four sites (10%) had been confirmed to have a drainfield within 100’ of the shoreline and 523 (40%) had drainfields greater than 100’ from the shoreline or have an approved variance. Nine hundred fifty-eight (74%) of the OSS have a known installation date. Thirty-eight percent of those were installed more than 30 years ago.

EDUCATIONAL AND OUTREACH SUMMARY

One focus of PIC projects is to provide property owners and residents with information to recognize and reduce fecal pollution and nutrient contributions from their properties. Door-to-door surveys include a strong educational component to proactively educate property owners about how to operate and maintain their OSS and to identify any non-conforming conditions that could cause premature OSS failure. Property owners are given OSS records, information about how to reduce bacterial and nutrient pollution sources to Hood Canal from their property, and information about loan programs.

JEFFERSON COUNTY

Education and outreach was performed through each Clean Water Project that JCPH conducted. The primary focus is direct contact through door-to-door sanitary surveys. This allows information to be directly conveyed to and tailored to the needs of each landowner. Brochures were created and distributed to landowners during sanitary surveys. These included a project brochure on water quality projects giving an overview of monitoring and pollution control activities, a septic brochure on tips for operating and maintaining OSS and financial assistance information for septic repairs. A list of certified O&M professionals available in Jefferson County was included with the OSS brochure. Starting in 2013, a rebate brochure was also distributed. Rebates are available for O&M inspections and riser installation.

Septics 101 classes were offered to residents throughout the project areas at various intervals. These classes give practical advice for the care and maintenance of OSS. Starting in 2013, a Septics 201 class will also become available. Homeowners who complete the classes may become eligible to perform some of the regular required O&M inspections on their OSS.

Public meetings were offered at the beginning, middle and end of each project giving area residents an opportunity to hear about project goals and outcomes and ask questions. Powerpoint slideshows were developed for each series of meetings. Project information was also discussed and distributed at other area meetings where overlapping involvement of different groups was favorable, such as Habitat for Humanity's recent Quilcene Neighborhood Initiative.

Newsletters were written and mailed to project area residents with articles on water quality, septic systems, agricultural practices, restoration efforts, etc. At times newsletters were written for specific project areas and at other times were combined into a general county-wide focus. Web pages were designed for the water quality program and Clean Water Project reports were posted there.

Outreach classes were taught for local Beach Watchers, training volunteers to be aware of water quality issues. The Jefferson County Conservation District coordinated with local schools to train volunteer water quality monitors.

KITSAP COUNTY

Upper Hood Canal PIC (KPHD, 2008)

KPHD conducted a number of educational activities through the 2005 early action grant including:

- Recipients of the Hood Canal early action education projects were asked to coordinate educational messages. Hood Canal Watershed Education Network (HCWEN) works to coordinate the educational water quality messages to Hood Canal residents which has resulted in better coordination and reduced costs.
- Conducted three neighborhood water quality workshops "How to Keep Bacteria and Nutrient Out of Hood Canal" in 2005 at Seabeck Conference Center, Olympic View Community Club, and Edgewater Beach Community Club. A total of 43 people attended these workshops, which featured an overview of Hood Canal water quality and presented tools to prevent and reduce bacterial and nutrient pollution. Flyers were posted at local businesses by community group representatives. Mailed approximately 1,800 postcards to community group mailing lists. Guest speakers from SSWM discussed watersheds, stormwater, and natural yard care, Health District staff presented OSS tips and Puget Sound Action Team/WSU Cooperative Extension presented Low Impact Development techniques.
- Coordinated with Kitsap County Surface and Stormwater (SSWM) program to develop a Pollution Solutions brochure, a visually-oriented brochure (18,000 produced) about actions property owners can take to reduce oxygen demand and nutrient contributions to Hood Canal. Brochures were distributed at the June water quality workshop and made available at all site visits from June through December 2005.
- Produced and distributed a Hood Canal memo board to remind Hood Canal residents about how to reduce bacterial and nutrient pollution to the canal. Health District community educator and graphic artist produced an attractive dry erase memo board with tips and contact information. This was produced in association with WSU Extension Mason County. The Health District distributed 917 memo boards and WSU distributed 688 memo boards.

KPHD conducted additional educational activities between 2006 and 2008 including[23] [16]:

- Distributed project information and information about the Shorebank Septic Loan program to OSS contractors in the project area, resulting in several repair plan submissions in the area.
- Conducted four public presentations for this project:
  1. KPHD was invited to present at the 2007 Puget Sound Georgia Basin research conference in Vancouver BC in April 2007. The supporting paper, "Pollution Identification and Correction: A Public Health Approach to Low Dissolved Oxygen in Hood Canal", was published on-line under 2007 Proceedings at http://www.engr.washington.edu/epp/psgb/ and on the Health District website at http://www.kitsapcountyhealth.com/environmenta_health/water_quality/docs/hoodcanal_lowoxygen.pdf.
  2. PIC project methods and results were presented at the Washington Environmental Protection Agency Bacteriological Conference in Tacoma on March 26 and 27, 2007.
  3. The Hood Canal Coordinating Council invited KPHD to provide a project update and "How to Keep Bacteria and Nutrients Out of Hood Canal" presentation for the Community Nearshore Restoration Program at the Seabeck Christian Conference Center on November 15, 2007.
  4. KPHD staffed an informational booth about the project at Kitsap County Natural Resources Nearshore Workshop at the Driftwood Keys Community Club on June 24, 2008.

Jump Off Joe Creek Restoration Project (KPHD, 2011)
KPHD conducted educational activities as part of the Jump off Joe Restoration Project. Three public meetings were held in the project area to provide project updates and more detailed education for property owners and their tenants. The Health District also attended and provided educational displays at local events like the Kingston Open House, Kitsap County Fair and North County Futures Festival.

Shellfish Restoration and Protection Project
KPHD conducted a public meeting in 2011 in Hood Canal presenting the project and an OSS workshop.

Other Educational Activities
KPHD also conducted general educational activities and events in the Hood Canal watershed during this reporting period.

2005 Hood Canal Youth Summit, Fort Flagler (OSS, operation & maintenance, shellfish, PIC)
Klahowya Secondary School (general water quality class)
2006 Klahowya Secondary School (environmental science class)
2007 Jump off Joe PIC Project Kick Off, Breidablik Elementary School
Klahowya Secondary School (2 stream biology classes)
2008 Little Boston branch of Kitsap Regional Library (OSS workshop)
Driftwood Keys Community Club, Kitsap County Nearshore workshop (water quality, PIC)
Driftwood Keys Community Club (OSS workshop)
2009 Klahowya Secondary School (water quality class)
Great Peninsula Futures Festival (environmental health, PIC)
2011 Seabeck Conference Center (OSS workshop)
Jump off Joe PIC Project Final Report, Breidablik Elementary School

MASON COUNTY

Skokomish Annas Bay Restoration Study (MCPH, 2008)
MCPH facilitated eight meetings of the Annas Bay Shellfish Protection District Closure Response Committee to draft a Closure Response Strategy.

MCPH conducted seven public meetings, distributed an article about the project to the WRIA 16 region, and mailed a final progress report to all watershed residents. Additional progress reports were provided to the Skokomish Tribe for distribution to tribal members and residents.

During the property surveys, Annas Bay residents were provided with a DVD with information about how to get involved with cleaning up Hood Canal, including a home fertilizer use fact sheet, a small farm handout, and handouts on the Shore Stewards and Hood Canal Watershed Pledge programs. A separate mailer with the same materials was sent to the 38 Annas Bay shoreline residents who did not participate in the survey.

MCPH staff participated in a Kids With Conservation Knowledge field event at on June 5, 2007 for 3rd graders from local schools including Hood Canal. The event was held at a site owned by Little Skookum Shellfish Growers. MCPH staff illustrated the importance of picking up pet

waste to prevent fecal pollution of surface waters. They discussed FC bacteria, and conducted an activity where students learned how to safely pick up pet waste represented by wrapped candies.

MCPH staffed a station at the annual Environmental Explorations event for 900 middle school students in May 2006-2008. The event has been held for eleven years at Belfair State Park on the north shore of the Hood Canal.

On April 12, 2006, MCPH staff worked with the Americorp "Coastal America" program for a native plant installation and demonstration project to illustrate shoreline friendly practices. They trained Americorp volunteers to conduct water quality sampling along Annas Bay.

MCPH staff educated 8th graders about fecal pollution and shellfish beds and swimming beaches at the 2006 Youth Summit at Twanoh State Park. They trained students to collect FC samples and field measurements.

In 2007, MCPH staff worked with a North Mason science educator at the Theler Center in Belfair to utilize existing materials to help 8th graders prepare for the annual Students in the Watershed event sponsored by Washington State Department of Natural Resources. Staff guided six project related field trips with Hood Canal and North Mason Schools.

MCPH staff worked with an 8th grade teacher to educate students about water quality and land management to protect salmon. They trained the students about what parameters could be used to assess water quality and how to collect samples and data.

MCPH staffed a water quality display at the 2006 and 2007 Kid's Day at Oysterfest in Shelton, at the 2007 Clean Water Festival at Theler Center in Belfair, at the 2007 Earth Day celebration at Shelton Civic Center, and at the 2007 Earth Day at Olympic College in Shelton.

<u>Hood Canal Pollution Identification and Correction Project</u> (Georgeson, Mathews, Orth, Hyatt, 2008)

MCPH staff conducted fourteen public meetings, workshops and water quality related events. Meetings included presentations intended to educate the public about the issues surrounding FC and nutrient pollution in Hood Canal. In addition, MCPH Onsite Program performed an additional ten OSS workshops with Mason Conservation District and Mason WSU-Ext.

Table 12: Public Meeting Summary

HCPIC, OSS and Best Land Use Practices Workshop/Displays Data			
Date	**Location**	**Event**	**# of participants**
4/13/06	Hoodsport Library	HCPIC and OSS	16
6/3/06	N Mason School	Twanoh Falls HOA	approx. 50
7/2/06	Community member's house	Star White/Indian Beach HOA	approx 25
7/22/06	Theler Center	Clean Water Festival	approx. 50
7/15/06	Alderbrook	Community Nearshore Restoration	50
8/5/06	Theler Center	Community Nearshore Restoration	67
8/26/06	Harmony Hill	Summerfest	
10/1/06	Shelton Fair Grounds	Oysterfest - Display	hundreds pass by
11/17/06	Alderbrook	HCCC Awards - Poster	approx. 40
3/15/07	Belfair Library	HCPIC and OSS	4
5/2/07	Twanoh State Park	Truman High School	approx. 20
6/15/07	Colony Surf Club House	Colony Surf HOA	approx. 10
7/9/07	N Mason School	LHCWC presentation	approx. 20
10/7/07	Shelton Fair Grounds	Oysterfest - Display	hundreds pass by

MCPH also had poster presentations at the 2008 HCDOP IAM workshop in Kitsap County and the 2009 Puget Sound Georgia Basin Conference in Tacoma, WA both of which highlighted outcomes of this project.

Mission Creeks Water Quality Assessment (HCSEG, 2009)

MCPH began the project with a mailing recruiting volunteers to participate in the project on the steering committee and/or assisting with water sampling. Several community volunteers were trained to monitor.

Project information was presented at the Theler Community Center during the Clean Water Festival in July 2006, and the Healthy Hood Canal Celebration in July 2008.

Watershed landowners received another mailing midway through the project requesting permission to access properties to conduct surveys. Direct landowner contact was found to be the most effective method of relaying project information. Informational doorhangers were left at properties where no one was home.

A mobile informational booth was established during the intensive monitoring events near Belfair State Park to distribute project information

North Shore Hood Canal Pollution Identification Project (Georgeson, 2011)

MCPH presented project status and results to the Lower Hood Canal Watershed Coalition in March 2011 and December 2011. They collaborated with WSU-ext MC to present an OSS class highlighting the project at Belfair Timberland Library in February 2011.

SKOKOMISH TRIBE (Skokomish Tribe, 2012)

The Skokomish Tribe, under the auspices of the EPA 319 Non-Point Source grant, has delivered a variety of educational programs as part of the ongoing NPS Outreach program. Field trips, displays and in-class presentations are the main focus of the Education and Outreach programs.

The list of activities below is from the 2012 EPA 319 NPS report; however, similar activities have been delivered over the last eight years (Skokomish Tribe, 2012).

- **Field Trips**
  Field trips were undertaken to present restoration projects to local groups and school children. Beach cleanups were conducted to demonstrate the importance of proper garbage disposal.

- **Skokomish Estuary Earth Day Celebration**
  On April 19th of 2012, the Tribe held the second annual Skokomish Estuary Earth Day Celebration. The event successfully captured the celebratory efforts for the Estuary restoration with NPS pollution education. Over 300 Hood Canal School and Head Start children along with many community members attended the event. Outreach designed to affect the participants incorporated NPS pollution themes coupled with an estuary restoration celebration. Garbage was collected along the banks of the Skokomish Estuary and the Skokomish River. An article was published in the Skokomish Sounder and a presentation was given to the Skokomish Watershed Action Team concerning the day's events.

- **Hood Canal Salmon Enhancement Group's "Salmon Camp"**
  Youth from around the Hood Canal were invited to the Skokomish Estuary to witness the natural processes that help clean water and provide food for fish and wildlife.

- **Student Watershed Investigation and Monitoring (SWIM) Program**
  Skokomish DNR staff assisted 50 8th graders from Hood Canal School to complete two water quality sample events for the SWIM program in 2012.

- **Hood Canal School Rain Garden**
  In 2011, the Skokomish Tribe with the Mason Conservation District completed a rain garden demonstration project at Hood Canal School. The demonstration Rain Garden is designed to treat 168,000 gallons of storm water per year and show people how to better manage stormwater on their own properties. The project has been utilized as a major Outreach and Educational tool. Several students from the Hood Canal School, were directly and personally involved in the construction phase of this project. A working knowledge of the soil matrix, filtration rates and native plant identification were stressed as well as the importance of recharging groundwater resources. Most of the Skokomish community members are exposed to the Hood Canal School Rain Garden on a daily basis as it is located along state route 106 which runs through the reservation's residential area.

- **Displays**
  Displays were used to convey NPS pollution messages to the public at large at large gatherings.

- **Health Fair Display**
  The Department of Natural Resources display booth at the Skokomish Annual Health Fair provided information on how to protect private well water from contamination. Over a hundred people attended the event and the effort resulted in a number of Skokomish Reservation residents signing up to have additional information sent to them.
- **Shellfest**
  A public event held by Washington State Parks was held on August 4, 2012 at Potlatch State Park which is adjacent to the Skokomish Reservation. A tribal elder presented an oral history from the immediate area. A table was set up with NPS pollution handouts and poster displays.
- **Safe Drinking Water Week**
  A display was presented at the Hood Canal School for Safe Drinking Water Week (May 6-12). The display showed students how pollution on the land's surface may affect the groundwater they drink and Skokomish DNR staff was on hand to answer questions.

- **Hood Canal School Eighth grade class presentations**
  Two in-class presentations to Hood Canal School student on NPS pollution were conducted in 2012.

- **Skokomish Sounder Articles**
  Articles were placed in the Skokomish Sounder which focused on field trips, outreach efforts and solid waste cleanups. Field trip and outreach articles were also published on the Northwest Indian Fisheries Commission web site and news magazine.

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