Washington

Totten and Eld Inlet
Section 319
National Monitoring Program Project

Figure 52: Totten and Eld Inlet (Washington) Project Location

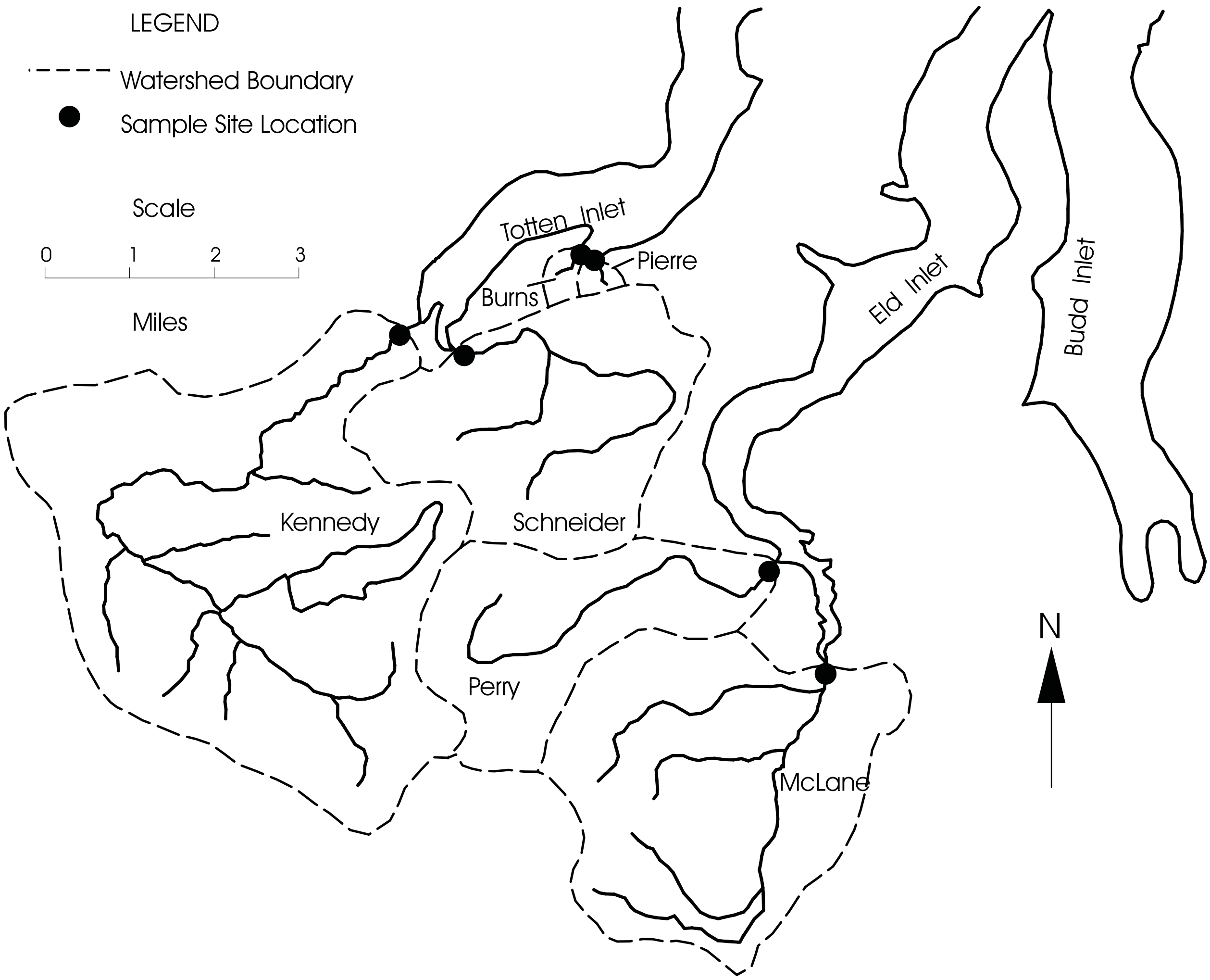

Figure 53: Water Quality Monitoring Stations for Totten and Eld Inlet (Washington)

PROJECT OVERVIEW

Totten and Eld Inlets are located in southern Puget Sound (Figure 52). These adjacent inlets are exceptional shellfish production areas. The rural nature of the area makes it an attractive place in which to live. Consequently, stream corridors and shoreline areas have experienced considerable urban, suburban, and rural growth in the past decade. Located in the area are many recreational, noncommercial farms that keep various livestock. Both upland and lowland areas have highly productive forest lands.

The most significant nonpoint source pollution problem in these inlets is bacterial contamination affecting shellfish production. Totten Inlet is currently classified by the Department of Health (DOH) as an 'approved' shellfish harvest area but is considered threatened due to bacterial non-point-source pollution. Eld Inlet is currently classified by DOH as 'approved' for shellfish harvest, except for the extreme southern-most portion which was reclassified from 'conditionally approved' to 'unclassified' several years ago, and remains so at this time. A designation of 'unclassified' means shellfish may not be commercially harvested, although this may not be an issue if an area is not otherwise (independent of pollution concerns) suitable for shellfish growing or harvest. The southern DOH 'approved' portion of Eld Inlet had been classified 'conditional' (shellfish could not be harvested for 3 days following rain events greater than 1.25 inches in 24 hours) until early 1998. Eld Inlet is still threatened due to bacterial non-point-source pollution sources. As with Totten Inlet, the major sources of fecal coliform (FC) bacteria are on-site wastewater treatment systems and livestock-keeping practices along stream corridors and marine shorelines.

The Totten and Eld Inlet Clean Water Projects evolved from the combined efforts and resources of local and state government. Watershed action plans were completed in 1989 for both Totten and Eld Inlet. While a significant level of public involvement and planning occurred, material resources for implementing on-the-ground best management practices (BMPs) were scarce. In 1993, revenue from property assessments and grants provided funds for local government to implement remedial actions in targeted areas within these watersheds. The goal of the remedial efforts was to minimize the impacts of nonpoint source pollution by implementing farm plans on priority farm sites and identifying and repairing failing on-site wastewater treatment systems. In part, these efforts have been hampered by a shift in political climate from regulatory/mandatory compliance to voluntary efforts. Grant-funded BMP efforts lasted into 1999 for the four Totten-Inlet sub-basins, and into 2000 for the two Eld-Inlet sub-basins.

In 1992, a water quality monitoring program was initiated to evaluate the effectiveness of remedial land treatment practices on water quality. The monitoring effort was formalized in 1995 into a U.S. Environmental Protection Agency (USEPA) Section 319 National Monitoring Program (NMP) project. The monitoring effort targeted six sub-basins within the larger Totten and Eld Inlet watersheds. The goal of the water quality monitoring program was to monitor water quality over time to measure the effectiveness of watershed-based land management programs. A paired watershed design was used for two sub-basins while a single site approach was used for four sub-basins. Water quality monitoring was conducted from mid-November to mid-April on a weekly basis for at least 21 consecutive weeks each year. Fecal coliform bacteria, suspended solids, turbidity, flow, and precipitation were the main parameters of interest. Farm-plan BMP implementation was tracked via information provided by the Conservation Districts. Washington State NMP staff did not have control over any aspect of BMP design, implementation, or monitoring.

The project post-BMP monitoring period concluded as of spring, 2002. A final report was published July 2003, and is available at *http://www.ecy.wa.gov/biblio/0303010.html*.

PROJECT BACKGROUND

Project Area

The Totten and Eld Inlets Section 319 National Monitoring Program project area consists of six sub-basins within the Totten and Eld Inlets. The Totten watershed is approximately 44,300 acres and the Eld Inlet watershed is approximately 22,900 acres.

Relevant Hydrologic, Geologic, and Meteorologic Factors

The topography of the project area includes the rugged Black Hills area southwest of the city of Olympia, upland prairies, fresh and estuarine wetlands, high and low gradient stream reaches, and rolling hills. Pleistocene glacial activity was the most recent major land-forming process.

The predominant soil type is glacial till, generally consisting of compact silts and clays.

Wet, mild winters and warm, dry summers are characteristic of the Puget Sound region. The climate and precipitation of the project area are similar. Rainfall ranges from about 50 to 60 inches per year, depending on elevation and longitude. The precipitation received in the area usually occurs mostly between October and April.

Land Use

Land Use	Totten/Little Skookum Inlet % Land Use	Eld Inlet % Land Use
Forest	82.0%	63.0%
Residential	4.3%	6.3%
Agriculture	5.0%	5.1%
Public Use	0.3%	5.1%
Undeveloped	7.5%	19.8%
Other	0.9%	0.7%

Water Resource Type and Size

Totten and Eld Inlets are estuaries separated by peninsulas in southern Puget Sound. The total drainage basin for the two inlets is approximately 67,200 acres. Six sub-basins have been selected for this monitoring project. They are as follows:

Totten Inlet		
Burns	82-acre	single site
Kennedy	13,046-acre	paired site
Pierre	65-acre	single site
Schneider	4,588-acre	paired site
Eld Inlet		
McLane	7,425-acre	single site
Perry	3,857-acre	single site

Water Uses and Impairments

Important beneficial uses of the Totten and Eld Inlet marine waters include shellfish culturing, finfish migration and rearing, wildlife habitat, and primary and secondary contact recreation.

Important beneficial uses of the freshwater streams that drain into the Totten and Eld Inlets include finfish migration, spawning, and rearing; domestic and agricultural water supply; primary and secondary contact recreation; and wildlife habitat.

The most significant non-point-source pollution problem in these inlets is bacterial contamination affecting shellfish production.

Pollutant Sources

Sources of fecal coliform bacteria are failing on-site wastewater treatment systems, and livestock-keeping practices along stream corridors and marine shorelines. Wet season (October-April) soil saturation hampers the ability of many on-site systems to operate correctly. Saturated soils and stormwater runoff also contribute to water quality problems associated with overgrazed pastures, manure-contaminated runoff, and livestock access to streams. The major source of pollution in the monitoring sub-basins is considered to be animal-keeping practices. Livestock common to these farms include horses, beef cattle, llamas, donkeys, goats, sheep, and chickens. Animal types and numbers from inventories were converted to animal units (1 AU = 1,000 lbs animal weight) in order to estimate the wet season animal population for each basin. Estimates are based on conservation district surveys --primarily windshield surveys, except the 2002 survey, which was conducted by Ecology.

Animal unit surveys by sub-basin and period

	1989	1992-93	1996	1996-97	2002
BUR	9.2	8.2	6.5	7.7	10.8
KND	9.9			1	5
MCL	112	89.7		142	46.5
PIE		2	2	5	1
PRY	56.1	77.8	59.8	44.3	5.7
SHN		35	56.2	93	69.6

Water Quality Standards

Kennedy, Schneider, Burns, and Pierre creeks are designated by the state as class AA streams. The class AA water quality standard for fecal coliform (FC) bacteria requires that the geometric mean value (GMV) not exceed 50 colony-forming units per 100 milliliters (cfu/100ml) and that not more than 10% of samples exceed 100 cfu/100 ml. McLane and Perry creeks are class A streams, allowing a GMV no greater than 100 cfu/100ml, and no more than 10% of the samples may exceed 200 cfu/100ml.

Pre-Project Water Quality

During the pre-BMP calibration period, Kennedy Creek (the control) did not exceed the fecal coliform water quality standard; Schneider exceeded three out of three years; McLane and Perry each exceeded one out of two years; and Burns and Pierre exceeded three out of three years. These results are based on entire wet-season calculations.

Post-Calibration Period Water Quality

Kennedy Creek did not exceed fecal coliform water quality standards from the calibration period through 2002. Perry did not exceed through the study except for the last wet-season. McLane exceeded one year after calibration and before BMP grant issue, and then again the last wet-season. Schneider exceeded three years; one excursion took place after the onset of BMP grants, and the other two took place well into the grants. Burns and Pierre creeks exceeded water quality standards all years. These results are based on entire wet-season calculations; analysis of moving-averages and of data outside the project sampling window yielded more water quality exceedances.

Comparison of Fecal Coliform data to water quality standards

Geometric Means for Wet Seasons (cfu/100ml)

Site	Class	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02
Kennedy	AA	5	5	5	5	9	7	8	4	4	8
Schneider	AA	23	15	21	11	8	12	19	15	10	19
McLane	A	37	24	36	24	17	32	80	30	41	43
Perry	A	14	8	17	12	6	10	11	8	10	25
Pierre	AA	**52**	**81**	**405**	**115**	**124**	**53**	**89**	**53**	45	45
Burns	AA	**95**	**222**	**227**	**80**	**62**	**110**	**311**	**237**	**266**	**109**

Percent of Samples Exceeding WQ Standard Part 2

Site	Class	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02
Kennedy	AA	0	0	0	0	0	0	4	0	0	0
Schneider	AA	**17**	9	**17**	4	0	9	**13**	4	**13**	9
McLane	A	4	4	4	4	0	9	4	9	9	**22**
Perry	A	0	0	4	0	0	0	0	0	0	**17**
Pierre	AA	**22**	**50**	**91**	**57**	**45**	**17**	**39**	**17**	**14**	**17**
Burns	AA	**35**	**75**	**79**	**30**	**32**	**39**	**83**	**70**	**74**	**39**

Bold values indicate violations of water quality standards:

Class AA Standard
Part 1 - geometric mean value (GMV) shall not exceed 50 colonies/100Ml
Part 2 - not more than 10% of the samples used for calculating the GMV shall exceed 100 colonies/100mL

Class A Standard
Part 1 - geometric mean value (GMV) shall not exceed 100 colonies/100mL
Part 2 - not more than 10% of the samples used for calculating the GMV shall exceed 200 colonies/100mL

Looking at five week moving averages for the same period, water quality violations occurred with higher frequency as indicated below. This table summarizes violations of part 1 or part 2 of the standards.

Wet Seasons with 5-week moving-average water quality violations

Site	Class	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02
Kennedy	AA							X			
Schneider	AA	X	X	X	X		X	X	X	X	X
McLane	A	X	X	X			X	X	X	X	X
Perry	A			X							X
Pierre	AA	X	X	X	X	X	X	X	X	X	X
Burns	AA	X	X	X	X	X	X	X	X	X	X

Sampling was extended before and after the regular NMP sampling-window for the 1998-1999 and later seasons. Water quality fecal coliform standards were exceeded during these dry-seasons through summer 2001.

Water Quality Objectives

Pierre Creek

- reduce median fecal coliform concentration by 69% (reduce to 10 cfu/100ml)

Burns Creek

- reduce median fecal coliform concentration by 63% (reduce to 20 cfu/100 ml)

Schneider Creek

- reduce median fecal coliform concentration by 50% (reduce to 10 cfu/100 ml)

McLane Creek

- reduce median fecal coliform concentration by 44% (reduce to 22 cfu/100 ml)

Project Time Frame

1993 through 2002

PROJECT DESIGN

Nonpoint Source Control Strategy

The nonpoint source treatment in the project area was designed to reduce the amount of nonpoint source pollution via repair of failing on-site wastewater treatment systems and implementation of farm plans on priority farm sites. Priority farm sites are those farms that potentially threaten the quality of receiving waters due to a variety of physical and managerial properties such as closeness to stream, numbers of animals, and lack of pollution prevention practices. The nonpoint source control strategy involved surveying all potential pollution sources in critical areas, estimating the water quality impact, and finally, planning and implementing corrective actions.

Resource management plans (farm plans) were developed cooperatively by landowners and local conservation districts. The farm planning process identified potential water quality impacts and recommended BMPs to mitigate those impacts. Conservation district staff and each landowner discussed implementation costs and schedules of BMPs and cost-share opportunities. The landowner then chose what he or she was willing to implement and agreed to implement the plan as funding allowed. Specific BMPs most likely to be employed for nonpoint source control in project watersheds include pasture and grazing management, stream fencing, stream buffer zones, rainwater and runoff management, livestock density reduction, and animal waste management. Monies from the Farm Service Agency, State Revolving Fund, U.S. Fish and Wildlife Service, and other sources were sought for cost-share or low interest loan contracts.

Voluntary participation (prompted by education/outreach activities and local ordinances) was anticipated to be the major mechanism for implementation of farm plans. Farm owners whose operations had deleterious effects on water quality and who did not comply with local ordinances were to become involved in a formal compliance procedure, which was outlined by a memorandum of agreement between the Ecology Water Quality Program and each conservation district.

Project Schedule

Sites or Activities	Pre-BMP	BMP Implementation	Post-BMP
Burns	1988-1993	1993-1995	1995-2002
Pierre	1986-1990	1989-1993	1993-2002
Perry	1983-1989	1989-2000	2000-2002
McLane	1983-1989	1988-2000	2000-2002
Kennedy	No BMPs designed; monitoring 1986-2002		
Schneider	1988-1993	1993-1995	1995-2002

TYPE AND NUMBER OF BMPs IMPLEMENTED IN STUDY SUB-BASINS

BMP#	BMP Description	Units	Burns	McLane	Pierre	Perry	Schneider
312	Waste Management	each					
313	Waste Storage	each	2	1			1
322	Channel Vegetation	acres		2			
342	Critical Area Planting	acres					2
344	Crop Residue Use	acres	23				
352	Deferred Grazing	acres	19.1	24.5			
382	Fencing	feet	2000	14401	50	1499	9952
393	Filter Strip	acres	1.5	12	0.5	4	33
395	Fish Stream Improvement	feet		7194		220	6200
412	Grassed Waterway	acres	6				
430	Irrigation Pipeline	feet		271			
472	Use Exclusion	each	17.2	53.5	3	4	79
490	Forest Site Preparation	acres					427
510	Pasture & Hayland Mgmt	each		134			127
512	Pasture & Hayland Planting	acres	9.6	25			
516	Pipeline	feet	890	495			
528	Prescribed Grazing	acres	34.1	11	3		110
530	Proper Woodland Management	each					
556	Planned Grazing System	acres	22.5	28			
558	Roof Runoff Management	each	3	3		2	
561	Heavy Use Area Protection	acres		3.25			
575	Livestock Crossing	each		1			30
580	Streambank Protection	acres		2550			2000
590	Nutrient Management	acres	41.6	42			110
612	Tree/Shrub Establishment	acres	15				
614	Trough	each	4	17		6	
633	Waste Utilization	acres		38.5			111
644	Wildlife Wetland Habitat Mgmt	acres		5			
645	Wildlife Upland Habitat Mgmt	acres	51	287			600
654	Forest Harvest Trails	acres					427
660	Tree/Shrub Pruning	acres					427
666	Forest Stand Improvement	acres					427
	Total BMP units installed		3139.6	25598.75	56.5	1735	21063
	Total BMP units planned		3164.8	32557.8	61.5	17234	21367.1
	Percent of BMP units installed		99.2%	78.6%	91.9%	10.1%	98.6%
	Uncertain BMP units installed		0	1777.75	0	2736	0
	Percent of BMP units installed including uncertain BMPs		99.2%	84.1%	91.9%	25.9%	98.6%

Water Quality Monitoring

A paired watershed approach was used for the Kennedy/Schneider sub-basins to document the change in water quality as a result of BMP implementation. Kennedy was a background (control) sub-basin, while Schneider was the treatment sub-basin (Figure 51). A single site approach was applied to Burns, Pierre, Perry and McLane sub-basins (Figure 51).

Variables Measured

Biological
Fecal coliform (FC)

Covariates
Conductivity
Daily precipitation
Flow
Temperature
Total suspended solids (TSS)
Turbidity

Water quality monitoring was conducted from early November through mid-April. Grab samples were collected on a weekly schedule (usually Tuesdays) for at least 21 consecutive weeks each year of the project. During 1994, some additional samples were collected each season during runoff events at each site. The sample sites are located near the mouth of each stream.

The Puget Sound Protocols for freshwater and general quality assurance/quality control (Tetra Tech, 1986) were followed for water sample collection, identification, preservation, storage, and transport. Replicate samples (two samples taken from the same location at nearly the same time) for at least 10% of the total number of laboratory samples were taken and analyzed each week. All sample sites are represented every sampling season.

Environmental monitoring data prior to November 1992 were collected by Thurston County under a different sampling scheme than that used for NMP monitoring.

Monitoring Scheme for the Totten and Eld Inlet Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of Primary Parameter Sampling	Duration
Single downstream	Burns Pierre Perry McLane	FC	Conductivity Daily precipitation Flow Temperature TSS Turbidity	Weekly (Nov. to mid-April)	Schneider Burns Pierre: 1 yr. pre-BMP 3 yrs BMP 3+yrs post-BMP Perry:
Paired watershed	Kennedy/ Schneider	FC			3 yrs pre-BMP 3 yrs BMP 2 yrs post-BMP McLane: 1 yr pre-BMP 5 yrs BMP 2 yrs post-BMP

Land Treatment Monitoring

Land treatment monitoring was expected of the county and conservation district. Grant requirements for monitoring and reporting were lacking or incomplete, so data have been difficult to obtain, and are incomplete.

Modifications Since Project Started

During the 1993-1994 sampling-year of the project, a Washington State Supreme Court decision was issued declaring that under existing law, administrative search warrants could not be used for inspection programs; as this was later deemed to apply to on-site sanitary surveys. Thurston County modified its administrative code in 1995 to allow such warrants, but early in 1996, on advice from legal counsel, the Board of Health decided not to proceed with search warrants. Consequently, participation dropped from 93% during 1992-1993 to 72% during 1995-1996 (Hofstad et al., 1996). Voluntary participation in the 1996-97 survey in Schneider basin was low, with only 36% of homeowners allowing their on-site wastewater systems to be inspected.

Voluntary participation in the farm plan development was also less than expected. Ten of 22 priority farms in the Schneider, Burns, and Pierre sub-basins developed farm plans. Five of these farm plans resulted from some level of pressure by the local health department. Originally, owners whose operations had deleterious effects on water quality and who did not comply with local ordinances were to become involved in a formal compliance procedure, which was to be outlined by a memorandum of agreement (MOA) between the Ecology Water Quality Program and the conservation district. However, there is some debate as to the interpretation of the MOA requirement, and the extent to which the drafted MOA met the intent of the original language. Regardless, no known formal compliance procedures have been activated via the MOA. It is uncertain if farm planning for the remaining 12 priority farms in Schneider sub-basin will occur. Farm planning and implementation in McLane and Perry sub-basins continued until June 30, 2000 via a state to conservation district grant extension.

Changes have occurred in the definition of pre- and post-BMP sampling periods for each sub-basin as BMP grants have been extended and additional BMP implementation data has become available.

The 1998-99 and later sampling seasons were each started a month early, and extended a month past the usual cutoff dates, then into the summer, although at a reduced sampling frequency. Fecal coliform loading has been added to analysis for all years.

Enterococci were added to the analysis suite for the 2000-01 sampling season.

Progress To Date

Three on-site wastewater treatment systems were inspected in Burns and Pierre sub-basins in 1994. In Schneider sub-basin, 12 of a targeted 33 On-site Sewage Systems (OSSS) were surveyed in 1997; 21 of the 33 homeowners chose not to participate in the survey. No on-site wastewater treatment system surveys were scheduled for the McLane or Perry basins during this project. About 120 OSSS in the Summit Lake drainage area, in the Kennedy sub-basin, were also inspected and remedial actions were undertaken. However, it is unlikely that remedial actions will affect bacteria levels at the Kennedy Creek monitoring site, because in-lake bacterial levels have historically been at or below detection limits.

About 180 of 234 planned agricultural BMPs were implemented on 30 sites in Schneider, McLane, Perry, Burns, and Pierre sub-basins between 1986 and 1997. These pollution controls were installed on noncommercial farms that keep various types of livestock. About 61% of these controls were installed from 1993 and 1997, while about 39% were installed from 1986 to 1992. Most farm planning and BMP installation activities in the Totten basins ended in 1997; Eld basin grant-funding for BMPs concluded mid-2000.

Within each sub-basin, the average number of BMPs planned per farm ranged from 7.8 to 10.5 while the average number of BMPs implemented per farm ranged from 5.0 to 8.7. The number of individual practices installed per farm ranged from 1 to 14. The most frequently applied BMPs included fencing, prescribed grazing, filter strips, livestock exclusion, nutrient management, and watering troughs. Other commonly employed practices included roof runoff management and fish stream improvement.

The completeness or rate of implementation of a farm plan is defined as the percentage of planned BMPs actually implemented. Over half of farm operators signed their farm plans symbolizing some level of commitment to implementing the farm plan. For all sub-basins, 53% of farms implemented all of their planned BMPs, while 30% of farms had implementation rates of less than 60%. For the remaining farms, the completeness of farm plan implementation was better than 70%.

For Burns and Pierre sub-basins, all priority farms entered the farm planning process. In Schneider sub-basin, 24% of the priority farms entered the farm planning process. Several prioritizations were done in McLane and Perry sub-basins, and 33% to 52% of priority farms entered the farm planning process depending on which prioritization scheme is considered.

Reporting for work completed under the last state-issued BMP grant in Eld Inlet (McLane and Perry creeks) has been obtained. It will take considerable time and effort to extract the needed data.

DATA MANAGEMENT AND ANALYSIS

Data Management and Storage

Water quality data were stored and managed in spreadsheets and later transferred to Ecology's Environmental Information Management (EIM) data base. As funding allows, Ecology is committed to transferring data from EIM to USEPA's STORET. Data evaluation and analysis strategies included the following:

- Determining statistically significant temporal trends in water quality by comparison of 95% Confidence Interval about seasonal medians using notched boxplots (single site approach); linear regression of monthly or seasonal medians over time, and the significance of slope tested to indicate a decreasing trend of FC concentrations over time (single site approach); change in linear relationship of FC concentrations between paired basins (paired watershed approach); comparison of frequencies of water quality standards violations between years; and comparison of the 95% Confidence Interval about the median of pre- and post-BMP data sets. This approach uses historical data from 1986–1992 (n=4 per season); these data were collected by the Thurston County Environmental Health Division. Ecology started weekly wet-season sampling November, 1992.
- Determining temporal trends in BMP implementation by bar graph of BMPs (individual or grouped) implemented over time and plot of cumulative histogram of BMPs implemented over time (individual measures or groups of measures).
- Evaluating combined water quality and BMP trends by linear regression of FC as a function of BMPs (individually or grouped) such as livestock management, acres treated, farm plans implemented, and stream-bank protected; and graphical expression of water quality and BMP information plotted over the same time scale (e.g. seasonal median FC values with cumulative histogram of fully implemented farm plans).

NPSMS Data Summary

Burns Creek FCMF cfu/100ml | **Percentiles**

	n	75	50	25
92-93	23	190	54	36
93-94	24	390	180	106
94-95	24	340	200	94
95-96	23	230	53	32
96-97	22	150	65	21
97-98	23	160	91	44
98-99	24	880	205	123
99-00	23	650	250	76
00-01	23	638	170	96
01-02	23	320	61	25

Pierre Creek FCMF cfu/100ml | **Percentiles**

	n	75	50	25
92-93	23	96	32	18
93-94	22	150	80	30
94-95	23	830	460	270
95-96	23	210	120	84
96-97	22	273	98	63
97-98	23	79	52	27
98-99	23	150	85	53
99-00	23	91	57	35
00-01	21	59	36	28
01-02	23	91	45	15

Kennedy Creek FCMF cfu/100ml | **Percentiles**

	n	75	50	25
92-93	23	11	5	2
93-94	24	16	6	1
94-95	23	18	4	1
95-96	23	14	5	1
96-97	22	30	12	3
97-98	23	10	7	3
98-99	24	17	8	3
99-00	23	18	3	1
00-01	23	14	5	1
01-02	23	31	8	3

Schneider Creek FCMF cfu/100ml | **Percentiles**

	n	75	50	25
92-93	23	56	20	8
93-94	23	31	13	7
94-95	23	38	17	7
95-96	23	26	12	6
96-97	22	22	12	2
97-98	23	22	11	5
98-99	24	66	16	6
99-00	23	31	14	10
00-01	23	36	9	3
01-02	23	48	20	7

McLane Creek FCMF cfu/100ml — **Percentiles**

	n	**75**	**50**	**25**
92-93	23	64	39	25
93-94	23	49	20	12
94-95	23	92	35	20
95-96	23	44	22	14
96-97	22	37	26	11
97-98	23	88	25	15
98-99	24	110	83	61
99-00	23	56	30	14
00-01	23	120	70	14
01-02	23	212	38	19

Perry Creek FCMF cfu/100ml — **Percentiles**

	n	**75**	**50**	**25**
92-93	23	31	10	7
93-94	24	28	6	3
94-95	23	32	14	5
95-96	23	44	11	4
96-97	22	17	8	4
97-98	23	21	10	3
98-99	24	37	12	5
99-00	23	29	12	4
00-01	23	26	10	4
01-02	23	51	24	7

Final Results

Pre- and post-BMP periods were defined by examining available farm and BMP implementation data (see the following table). For the paired-watershed analysis, Kennedy data were paired according to pre- and post-BMP period data for Schneider. Two approaches were used to evaluate water quality: comparison of pre- and post-BMP median FC concentrations. Pre-treatment (calibration) periods varied depending on sub-basin; post (treatment) periods are 1999-2002. Univariate statistical tests are used for before/after streams, and regression is used for the paired watershed (Kennedy-Schneider).

Pre- and Post-BMP Periods in Study Sub-Basins

Basin	Pre-BMP period	Post-BMP period
Kennedy	none	none
Schneider	1988-1993, 5 seasons	1995-2002, 7 seasons
McLane	1986-1988, 2 seasons	2000-2003, 3 seasons
Perry	1986-1989, 3 seasons	2000-2003, 3 seasons
Burns	1989-1993, 4 seasons	1996-2002, 6 seasons
Pierre	1986-1989, 3 seasons	1993-2002, 8 seasons

The next table summarizes the results of the pre- and post-BMP comparison of the median FC concentration. These results use the past three years as the post-period in all cases.

Median FC Concentrations from Pre- and Post-BMP Periods

Basin	Pre-BMP median FC and (n)	Post-BMP median FC and (n)	Change Direction
McLane	30 (7)	35 (71)	increase
Perry	5 (10)	13 (71)	increase
Schneider	25 (39)	13 (71)	decrease
Burns	84 (35)	205 (71)	increase
Pierre	25 (11)	47 (69)	increase

For the paired-watershed analysis with Kennedy and Schneider, pre- and post-BMP period, regression outputs were examined after Zar (1984), EPA (1993), and Grabow et al. (1998). The slopes of these regressions were not significantly different while the y-intercepts were different. The difference in intercepts, rather than slopes, indicates a parallel shift in the regression equation. This shift in the regression represents a 46% decrease from the pre-BMP period. There is some possibility that changes in loading at Schneider result from the presence or absence of livestock as a consequence of land ownership changes at one site, and not as a result of BMPs at that site.

Early results of linear regression analyses showed that flow and Antecedent Precipitation Index (API) correlated poorly with FC. API slope, TSS, and turbidity correlate more strongly with FC but were generally inconsistent among the stations or between years. Results suggest that the hydrologic characteristics in the study basins will make poor covariates of FC data for use in trends analyses or pre-and post-BMP comparisons.

Analysis for the entire project period is complete. For the ten-year monitoring period, the FC trend was up significantly (a=0.05) at McLane, and down at all other streams, but significantly only at Pierre. The FC loading trend was up significantly at McLane, and up, but not significantly, at Schneider and Kennedy. The trend was down, but not significantly, at the other streams. Incorporating historical data back to 1983, the FC trend was up significantly at McLane, and down at all other streams, but significantly only at Perry. Post pollution-control FC levels - both concentrations and loadings - have fluctuated considerably from year to year. Significant improvement occurred at Schneider and Perry after BMPs were installed; but in all cases where significant improvement occurred for at least one two-year averaged period, the average of the last monitoring period (2000-2002) is higher than the prior low value. All streams violated state water quality standards for FC at some time during the study after best management practices were implemented; Burns and Pierre violated the standards every year of the study. McLane contributes as much FC loading to marine waters as the other five streams combined.

Linking water quality changes to BMPs and grant programs

	Burns	Pierre	McLane	Perry	Schneider
1. Has there been significant improvement?	No	No	No	Yes	Yes
2. Is the improvement continuing or at least holding?	n/a	n/a	n/a	Maybe	Maybe
3. Can improvement be linked to improvements in land treatment?	n/a	n/a	n/a	Maybe	Yes, qualified
4. Are the land treatment changes and grant programs connected?	Yes	Partially	Partially	Partially	Yes

INFORMATION, EDUCATION, AND PUBLICITY

There are a variety of educational and informational resources within the project counties (Thurston and Mason counties) that address land and water stewardship. Local and state initiatives over past years have resulted in stewardship activities that cover the spectrum of personal commitment activities, including awareness, learning, experience, and personal action programs. Many educators involved with these activities share ideas, resources, and programs through a stewardship-focused Regional Education Team.

A Section 319 Clean Water Act grant funded a watershed resident survey in August, 1994. The survey explored public awareness and opinions regarding water quality and environmental issues. The survey targeted the Totten and Eld Inlet watersheds in southern Puget Sound, as well as northern Puget Sound watersheds in Whatcom, Skagit, and Snohomish counties. Approximately 1300 residents responded to the mail survey. The survey was designed to help state and local governments evaluate levels of public awareness and effectiveness of current educational programs, and determine where educational efforts, and efforts to involve the public, should be directed (Elway Research, 1994).

The objective of the state's public involvement and education component has been to participate in and lend support to established public information and education activities addressing environmental stewardship in the project areas and in the larger South Puget Sound area.

TOTAL PROJECT BUDGET

The estimated budget for the Totten and Eld Inlet National Monitoring Program project for the period of FY 1993–2003 (ten years):

Project Element	Funding Source ($)			
	Federal	State	Local	Total
Proj Mgt	NA	NA	NA	NA
I&E, LT, & OSSS	NA	1,411,000	462,000	1,873,000
WQ Monit	537,708	358,472	NA	896,181
TOTALS	537,708	1,769,472	462,000	2,769,180

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

In response to increased and persistent closures of shellfish harvest areas and threats to close additional areas, state and local groups developed the Shellfish Protection Initiative (SPI). This program provided $3 million from State Referendum 39 funds for implementing BMPs in targeted watersheds. The Totten Basin, a targeted watershed, received $1.3 million in grant funds as part of the SPI. Eld Inlet, although not selected as an SPI project, received $260,000 from the SPI program to augment ongoing nonpoint source control efforts in specific areas. In addition, $331,000 was targeted for farm planning and implementation activities in the Eld watershed from 1996 to 1999. The Eld watershed grant was later extended another year through Spring of 2000.

An identified issue was that there is no institution charged with or mechanism in place for tracking maintenance of BMPs. This lack impedes the ability to correlate BMP implementation with any water quality changes.

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