KITSAP COUNTY HEALTH DISTRICT
ENVIRONMENTAL HEALTH DIVISION
POLLUTION IDENTIFICATION & CORRECTION PROGRAM

DYES INLET RESTORATION PROJECT

FINAL REPORT

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KITSAP COUNTY HEALTH DISTRICT

KITSAP COUNTY SSWM Surface and Storm Water Management

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DYES INLET RESTORATION PROJECT
FINAL REPORT

EXECUTIVE SUMMARY

This project addressed a fecal coliform bacteria (FC) contamination problem in the Dyes Inlet watershed in Kitsap County. This project has also implemented "early actions" for the Total Maximum Daily Load (water quality clean up plan) currently being finalized by the Washington State Department of Ecology.

Health District FC data collected at Clear Creek, Ostrich Bay Creek, Phinney Bay Creek, Enetai Creek, Kitsap Mall Creek, and Strawberry Creek since 1996 showed ongoing violations of the fresh water FC standards. Additionally, two marine stations in Dyes Inlet were failing to meet standard, and Dyes Inlet had been listed as impaired for FC pollution on Washington State's Water Quality Assessment (303d List) since 1996. And, until 2003, most of Dyes Inlet was classified as "prohibited" for commercial shellfish harvest due to violations of the state freshwater FC standard along the Dyes Inlet shoreline.

To address the water quality problems specified above and protect the newly approved commercial shellfish growing area, the Health District initiated the Dyes Inlet Restoration Project October 2005. This project was a cooperative effort of the Health District, Kitsap County Surface Stormwater Management (KCSSWM), and the local community to conduct an intensive Pollution Identification and Correction survey that included "door to door" property surveys, shoreline surveys, and commercial property inspections of stormwater systems. Funding was provided with a Washington State Department of Ecology (DOE) Centennial Clean Water grant.

As you can see in **Table 1**, the project was a success as most project area streams including Clear Creek, Ostrich Bay Creek, Phinney Bay Creek, Enetai Creek, Kitsap Mall Creek, and Strawberry Creek are showing significant reductions in FC concentrations. Additionally, 19 of 21 marine stations are currently meeting standard.

The PIC OSS survey was conducted from October 2005 to November 2009. The project area consisted of 750 parcels with a total of 569 parcels participating. The results of this survey were:

- A project total of 82 OSS failures (14%) were found.
- A project total of 22 suspect OSS (4%) were found.
- A project total of 90 non-conforming OSS (16%) were found.
- A project total of 126 "no records" OSS (23%) were found.
- A project total of 249 "no apparent problems" OSS (44%) were found.

With a project size of 750 parcels to survey, a total of 82 septic systems (14%) were found to be failing within the Dyes Inlet Restoration Project. That places the Dyes Inlet Restoration Project at the high end of the 3% - 15% failure rate observed for all PIC projects completed in Kitsap County since 1995. Parcel surveys located 62 out of 82 failures. The remaining failures were identified as part of inspections related to public complaints and reports submitted by Health District certified maintenance specialists and pumpers.

Table 1. 2005 – 2009 Water Quality Comparison

Waterbody	Long term trend	Short term trend	Meets WQ Standard?	2005 FC Bacteria GMV	2005 Health Advisory?	2009 FC Bacteria GMV	2009 Health Advisory?
Chico Creek (CH01)	↗	→		38	No	18	No
Clear Creek (CC01)	→	↗		143		30	No
Enetai (Dee) Creek (DE01)	↗	→		47	56	No	No
Mosher Creek (MS01)	↗	→		42		14	No
Ostrich Bay Creek (OB01)	→	→		249		88	
Parmann Creek (PA01)	→	→		78	No	13	No
Phinney Creek (PH01)	→	→		1005		364	
Strawberry Creek (SR01)	→	→		119	No	29	No
Overall marine water[1]	↗	None	**# Stations Meeting Standard**	**12 of 14**		**19 of 21**	

[1] Dyes Inlet watershed marine waters include Dyes Inlet and Port Washington Narrows

Monitored tributary stream(s) without trend analysis

- Kitsap Creek *(tributary to Chico Creek)*
- Ridgetop Creek *(tributary to Clear Creek)*

Factors that have affected the failures found during the project are typical of other pollution identification projects. The age of the system, poor soil types, proximity to surface waters, high water table, and tidal effects all contributed to the high number of failures found during the survey. Repairs of the failures have ranged from minor repairs, complete replacement of OSS, and connections to sanitary sewer. Maintenance and monitoring contracts were required on 36 replacement OSS which should prevent premature failure of these systems.

Shoreline sampling was a useful tool for locating FC sources along the Dyes Inlet Shoreline. A total of 701 FC samples were collected from 20 miles of Dyes Inlet shoreline. Fifty five FC hotspots draining to the beach were identified and 20 OSS failures were found.

In addition to OSS parcel surveys and shoreline surveys, stormwater system inspections were completed in partnership with KCSSWM. A total of 207 commercial properties were inspected in the Silverdale commercial corridor, and seven properties were inspected in the lower reach of Chico Creek. Inspections were performed from February 2006 thru March of 2007.

The most common deficiency identified during the inspections was excess sediment buildup in 85 of the 207 properties with stormwater facilities. Additionally, 47 properties were determined to have the potential to provide a food source for urban wildlife or to discharge food waste to the storm drain. All deficiencies were corrected using a combination of education and enforcement. After the first year of inspections, the deficiency rate for inspections dropped from 41% to 8% of inspected properties.

Stream sample data were analyzed at stations located downstream of stormwater runoff before and after the initiation of the commercial property inspection program. A statistically significant improvement was noted at three Clear Creek stations (CC01A, CC02, and CC02) during dry weather. Additionally, marine water stations located near the mouth of Clear Creek (DY24 and DY27), showed a statistically significant improving trend for the 3-year period after the project. For the 12-year data record station DY27 was one of the two stations to show a significant improving trend for both wet and dry season data. These data indicate that the correction of stormwater deficiencies and other sources in the Clear Creek watershed led to significant water quality improvements.

Based upon the finding of the Dyes Inlet Restoration Project, the Health District's Pollution Identification and Correction Program offers the following recommendations:

- The Health District will continue to work with the property owners on the correction of the remaining failing OSS.

- The Health District recommends conducting future shoreline surveys in Dyes Inlet to maintain the improvements gained by the Dyes Inlet Restoration Project. The older gravity OSS still operating along the shoreline will continue to fail. Connections to sanitary sewer or upgrading these older systems to alternative OSS with Maintenance and Monitoring (MM) contracts will add another level of protection in the form of yearly inspections.

- The Health District will continue to work with the KCSSWM Drainage Inspection Program (DIP) to identify deficient stormwater systems and illicit discharges to protect public health and future downgrades of shellfish growing areas to the south.

- The Health District will continue to be involved in the Dyes Inlet watershed. Involvement will be through the public complaint response, water quality trend monitoring, and follow-up of reports submitted by certified monitoring and maintenance specialists and pumpers. In addition, properties with ongoing concerns will be flagged in Health District records to assist future inspections.

- Local residents are encouraged to continue to be proactive in OSS maintenance. Those with alternative OSS will receive a yearly report on the condition of their system. Those with standard gravity OSS should have their septic tanks and drainfields inspected every three years (at minimum).

- Commercial property owners and their tenants are encouraged to continue to be proactive in stormwater facility maintenance of grease interceptors, and food compactor areas. Those properties that lie within unincorporated Kitsap County will receive annual inspections by KCSSWM DIP inspectors.

1.0 BACKGROUND AND PROBLEM STATEMENT

The "Water Quality Standards for Surface Waters of the State of Washington" are codified in Chapter 173-201A of the Washington Administrative Code (WAC). As defined in chapter 173-201A of the WAC, the Dyes Inlet watershed has been designated as "primary contact waters."

The fresh water standard for FC bacteria is:

"Fecal coliform organism levels shall not exceed a geometric mean value of 100 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 mL".

The marine water FC standard is:

Fecal coliform organism levels must not exceed a geometric mean value of 14 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 43 colonies/100 mL.

This project addressed a fecal coliform bacteria (FC) contamination problem in the Dyes Inlet watershed in Kitsap County:

- A Total Maximum Daily Load (water quality clean up plan) is currently underway to address FC pollution of fresh and marine waters in Dyes and Sinclair Inlets.

- Health District FC data collected at Clear Creek, Ostrich Bay Creek, Phinney Bay Creek, Enetai Creek, Kitsap Mall Creek, and Strawberry Creek since 1996 showed ongoing violations of the fresh water FC standard described above. All other Dyes Inlet drainages with ongoing violations of the freshwater FC standard include Barker Creek, Mosher Creek, and Pharman Creek which were addressed through the Barker Creek Restoration Project in 2004.

- Dyes Inlet marine waters have been listed as "impaired" by FC pollution in Washington State's Water Quality Assessment (303d) List since 1996.

- Violations of the FC standard along the Dyes Inlet shoreline have resulted in the Washington State Department of Health (DOH) classifying most of Dyes Inlet and associated embayments as "Prohibited" for shellfish harvest.

This project was also designed to protect the North Dyes Inlet shellfish growing area which was "approved" by the Washington State Department of Health in 2003.

To accomplish these goals, the Health District applied its fecal coliform bacteria pollution identification and correction process as outlined in its "Manual of Protocol: Fecal Coliform Bacteria Pollution Identification and Correction (November 2003). In addition to inspecting onsite sewage systems (OSS) and animal waste management practices in the project area,

stormwater facilities at commercial properties in the northern Dyes Inlet and Chico Creek areas were also investigated to reduce FC pollution from stormwater runoff.

The project was funded by a grant from the Washington State Department of Ecology Centennial Clean Water Fund (CCWF), with matching funds provided by the Kitsap County Surface and Stormwater Management Program.

2.0 PROJECT AREA DESCRIPTION

Dyes Inlet is a marine embayment located in west Puget Sound on the Central Kitsap Peninsula. The watershed is approximately 35,000 square acres and includes the major urban centers of Bremerton and Silverdale. Land use include forests, rural, semi-rural, commercial and high-density residential. **Figure 1** provides a map of the Dyes Inlet watershed.

The project area has approximately 22 miles of marine shoreline and 90 stream miles that include ten named streams that discharge into Dyes Inlet. The natural freshwater drainages within the project area have been altered by development, increasing the demands on stormwater conveyances and existing OSS due to additional surface and groundwater flows.

The Dyes Inlet watershed has been designated as "primary contact waters" by Washington State Department of Ecology (DOE). **Figure 2** provides a map of Dyes Inlet commercial shellfish growing areas.

Shoreline and streamside parcels were selected for FC source investigation in Clear Creek, Ostrich Bay Creek, and Phinney Bay Creek. The project was expanded to include the areas of Enetai Creek, Rocky Point, Tracyton, Eldorado Hills, Windy Point South, and Erlands Point in order to better protect public health and the beneficial uses of Dyes Inlet.

In addition to identifying nonpoint sources that include failing OSS, this project also addressed the impacts from urban stormwater in Silverdale (Clear Creek, Strawberry and Kitsap Mall Creeks), Ostrich Bay Creek, Phinney Bay Creek, and Chico Creek. **Figure 3** provides a map of the project area.

Figure 1. Dyes Inlet Watershed Map

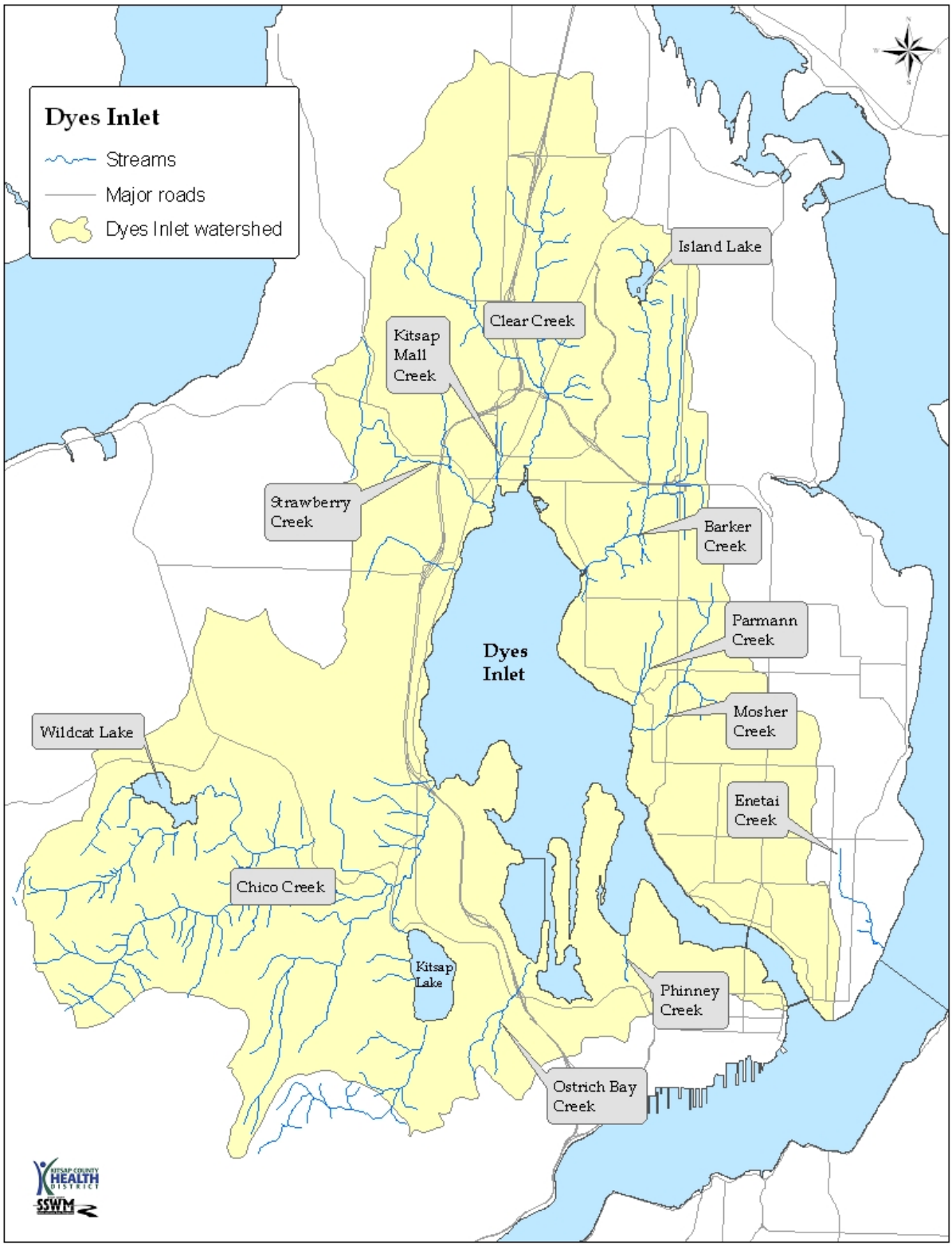


Figure 2. Dyes Inlet DOH Shellfish Growing Area Map

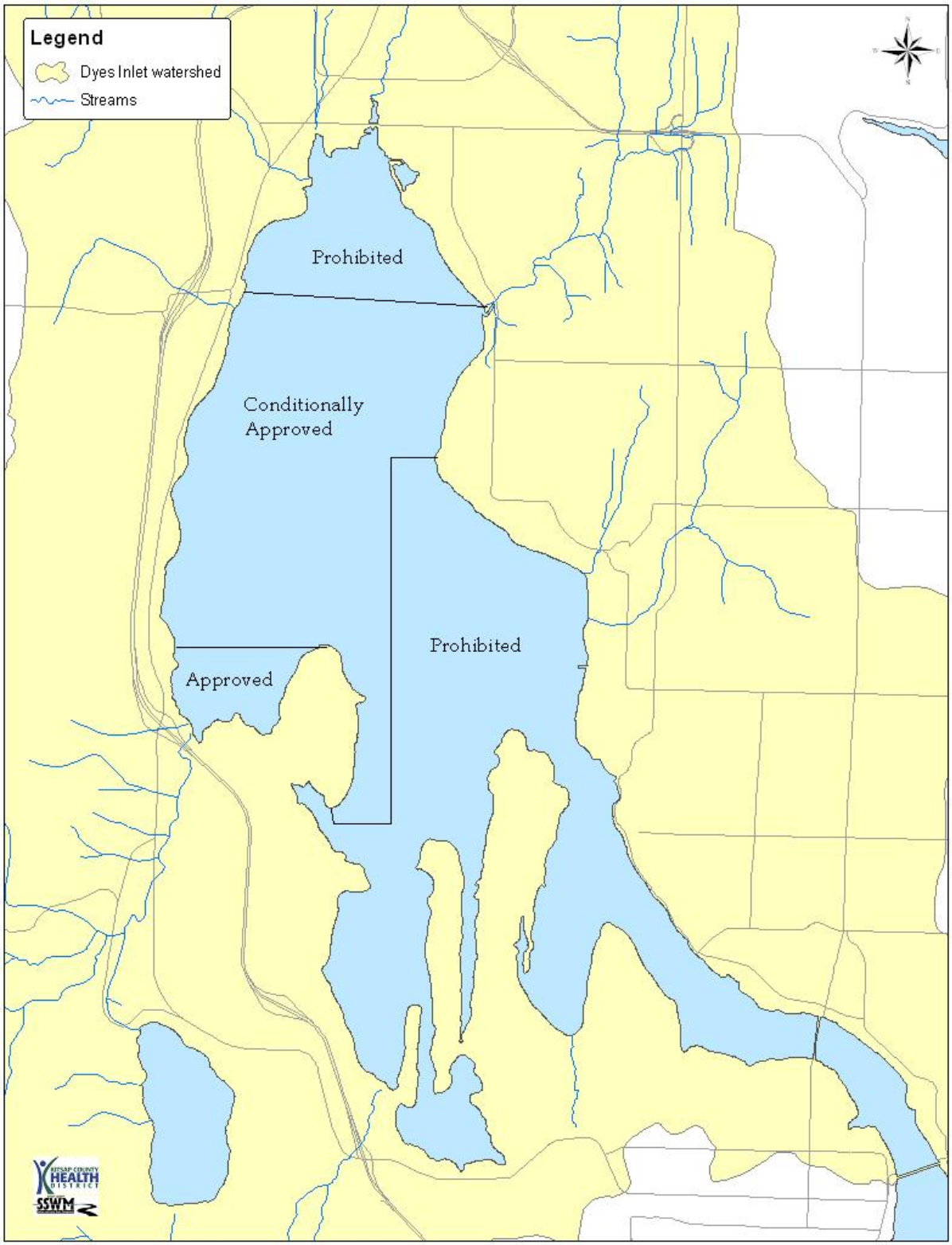
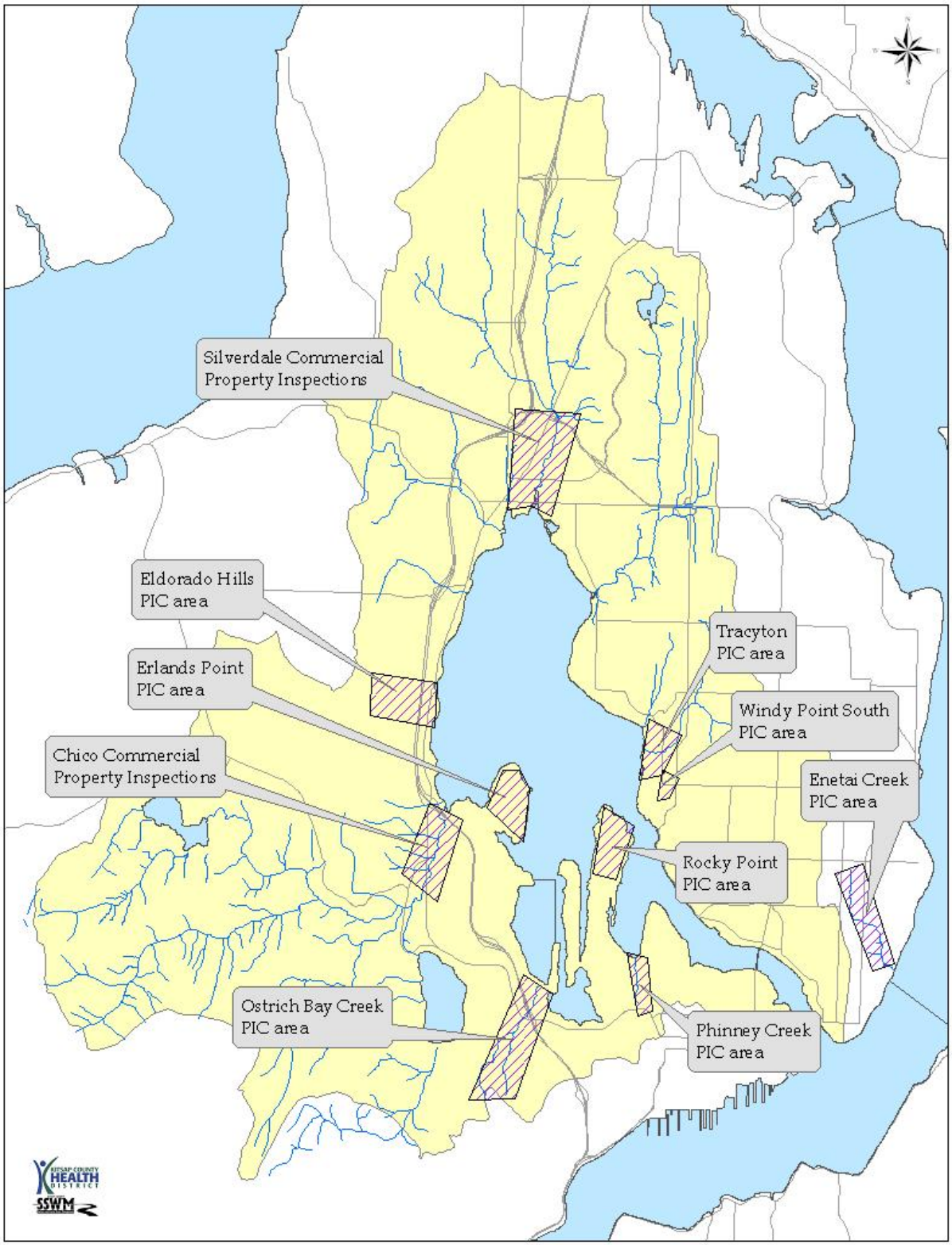


Figure 3. Dyes Inlet Project Area



3.0 GOALS AND OBJECTIVES

The goals of the Dyes Inlet Restoration Project were to:

- Reduce FC concentrations in Clear Creek, Ostrich Bay Creek, Phinney Bay Creek, Chico Creek, and Chico Bay.
- Reduce FC contamination from freshwater discharges to the north and southeast (south of Windy point) of Dyes Inlet shoreline.
- Prevent the downgrade of areas in the northern and western border of the recently upgraded North Dyes Inlet Shellfish Growing area.
- Provide DOH with water quality information for classification of the northern and southeast shorelines of Dyes Inlet.
- Investigate 80% of approximately 200 residential properties in the Ostrich Bay Creek and Phinney Bay Creek drainage basins served by OSS for FC sources.
- Investigate 80% of approximately 185 participating commercial and residential properties in the lower Clear Creek and lower Chico Creek drainage basins for FC sources. Stormwater systems to be inspected and monitored by Kitsap Health and Kitsap County Surface & Stormwater Management (KCSSWM) Program staff.
- Locate failing OSS associated with FC "hot spots" identified during the marine shoreline survey.
- Repair all failing OSS in accordance with local health District regulations.
- Work with public sewer purveyors in the project area to assess water quality impacts.
- Increase awareness of actions commercial and residential owners/occupants can take to prevent FC pollution through public meetings, press releases and door to door parcel surveys.
- Educate commercial and residential property owners and the community about the feasibility and benefits of implementing Low Impact Development methods for reducing FC and facilitate pilot project in the watershed.

To accomplish these goals, the following objectives were completed:

- Identify specific sources of FC pollution in the northern and southeastern shoreline of Dyes Inlet through sampling of all fresh water drainages.
- Identify specific sources of FC pollution in the largest fresh water drainages to Dyes Inlet (Clear Creek and Chico Creek), and in the most polluted freshwater drainages (Ostrich Bay Creek and Phinney Bay Creek), through comprehensive site-by-site property parcel evaluations.
- Correct all identified FC and turbidity pollution sources through education, technical assistance, referral and enforcement.
- Track, evaluate, and report on water quality improvements resulting from implementation and completion of the project.
- Prevent FC pollution and solicit and foster community support and stewardship through public information, education, and involvement.

4.0 PROJECT DESIGN AND METHODS

OSS and agricultural property surveys were conducted according to the methods contained in the "Manual of Protocol: Fecal Coliform Bacteria Pollution Identification and Correction" (Health District, 2003). Stormwater facility inspections were conducted according to maintenance guidelines in the Kitsap County Stormwater Management Manual (Kitsap County, 1997). The project design consisted of the following components:

4.1 PROPERTY SURVEYS

Surveys performed included property surveys for failing OSS or agricultural waste management problems, shoreline surveys for FC "hotspots" and commercial property stormwater system inspections for inadequate maintenance and FC sources.

4.1.1 OSS Property Surveys

Shoreline and streamside parcels were considered the highest priority for FC source investigation in Clear Creek, Ostrich Bay Creek, and Phinney Bay Creek. Expansion areas were then added to the project in the areas of Enetai Creek, Rocky Point, Tracyton, Eldorado Hills, and Erlands Point due to historical evidence of OSS problems, deficient maintenance reports, and response to DOH Shellfish Programs "Early Warning System" (EWS).

The property survey consisted of an OSS record search, homeowner/resident interview, field inspection, and water samples and dye test when necessary. The purpose of the survey was to identify all potential sources of FC contamination (including failing OSS and inadequate animal waste management).

The survey included a strong educational component to educate property owners about how to properly operate and maintain their OSS and to identify any non-conforming conditions that could cause premature OSS failure. Property owners were given copies of OSS records, information about how to reduce bacterial pollution sources to Dyes Inlet from their property, and information about the Shorebank Septic Loan program.

Other properties were added based on DOH recommendations, public sewage complaints and "deficient" OSS monitoring and maintenance and pumper reports.

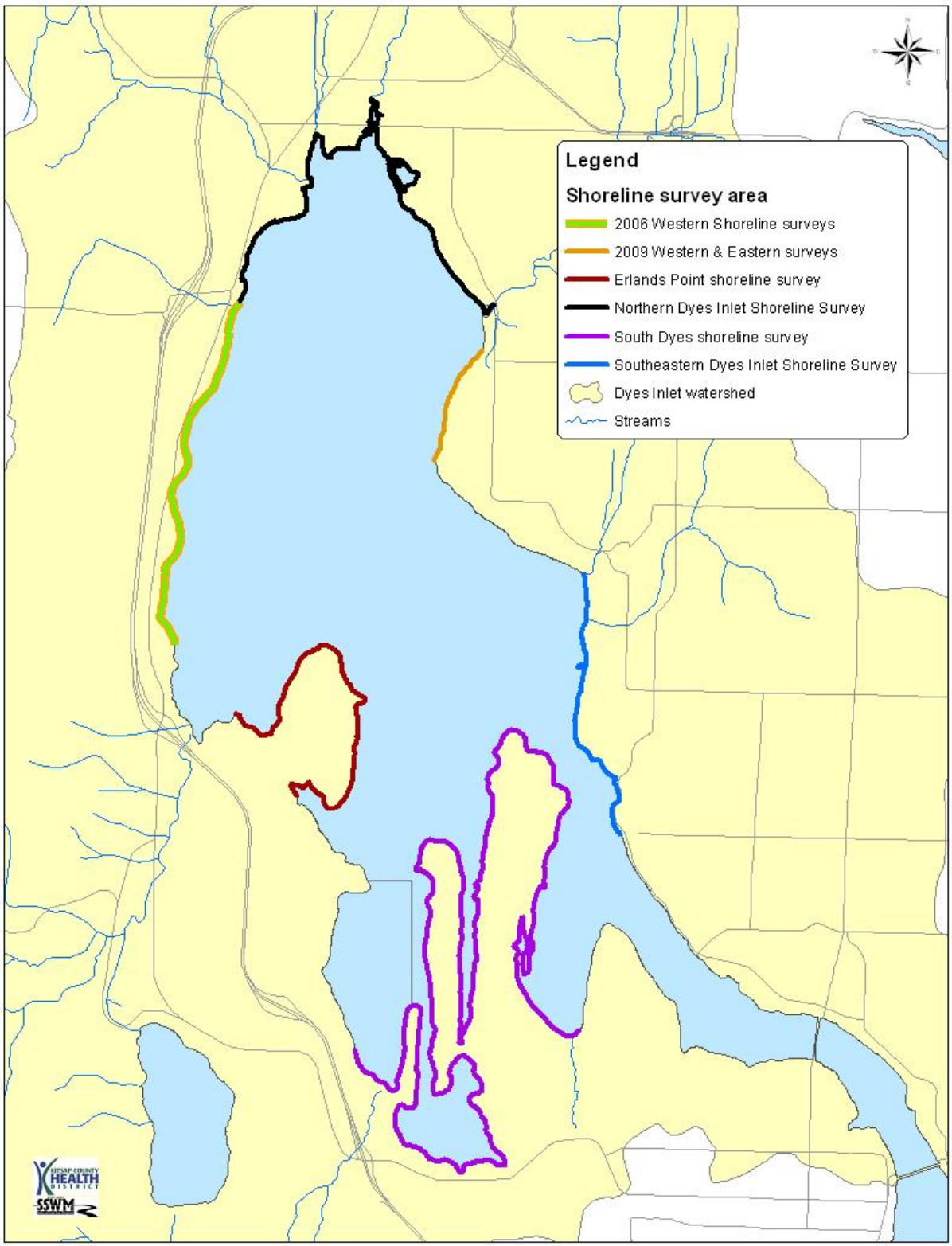
4.1.2 Shoreline Surveys

Two shoreline surveys were completed along the north and southeastern shoreline of Dyes Inlet. These surveys became a useful tool in locating FC contamination on the shore. As this was recognized, four more shoreline survey areas were added to the project to accomplish the goal of FC source correction along the western, eastern, and south shores of Dyes Inlet to include Erlands Point. Due to the wide variance in weather conditions, the number of sampling events and water samples taken for each survey area varied.

Sampling stations were given an identification name in sequence from the starting point to the ending point of the survey. As new locations were added they were photographed, noted, and global position system (GPS) coordinates were recorded. Location descriptions were recorded at each sample station, and flow was photographed.

All accessible discharges in each shoreline segment, including curtain drains, bulkhead drains, drainage culverts, overland flows, and significant beach flows from nearshore properties were sampled for FC. Samples were 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 were collected in drainages with FC results at or above the threshold of 200 FC/100ml. FC hotspots were investigated for potential FC sources. Please see **Figure 4** for a map of the shoreline survey areas.

Figure 4. Dyes Inlet Shoreline Survey Area



4.1.3 COMMERCIAL PROPERTY INSPECTIONS

The Health District partnered with the Kitsap County Surface and Stormwater Management (KCSSWM) Drainage Inspection Program (DIP) to perform commercial property inspections in the Silverdale and Chico Creek areas. Before the project started, commercial property storm system inspections were not performed on a regular basis.

Commercial property inspections included identification and correction of deficient stormwater facilities that included catch basins, retention/detention facilities, and other various components of the storm drain system. The inspection consisted of a stormwater records search, field inspection, and source tracking when an illicit discharge was suspected.

The purpose of the inspection was to identify deficiencies related to facility condition, control structure and source control. These three categories addressed deficiencies such as excess sediment, removal of vegetation, access improvements, and illicit discharges from dumpster/equipment washing areas.

Two hundred seven (207) commercial properties were targeted in the Silverdale commercial corridor, and 28 in the lower reaches of Chico Creek. All commercial property owners were notified by letter about the project and the FC pollution problem in Dyes Inlet. The commercial property inspection consisted of inspection of stormwater facilities to assure compliance with established maintenance standards (Kitsap County, 1997 Appendix 8A). See **Appendix A** for Kitsap County Maintenance Standards. Information was provided to the property owner about the type of facilities present, including a site map, and maintenance requirements needed to minimize the release of pollutants into the stormwater system.

The first phase of property inspections was performed in the Clear Creek drainage between February and June 2006. The second phase was performed in the lower reaches of Chico Creek between February and March of 2007. If deficiencies were identified, the property owner was notified verbally and by letter. Follow-up inspection by DIP was performed after the deficiency was corrected. All properties were subjected to a second round of inspection in 2008.

The inspection also included a strong educational component to educate commercial property owners about how to properly maintain their systems and offered site specific BMP's where problems are noted.

4.2 WATER QUALITY MONITORING

Water quality monitoring was conducted pursuant to the "Dyes Inlet Restoration Project Quality Assurance Project Plan" (October 2005).

4.2.1 Trend Monitoring

The Health District has conducted trend monitoring of Kitsap County streams and marine waters since January 1996, using KCSSWM funding. Trend monitoring of the Dyes Inlet Watershed began in 1996. Monitoring is conducted pursuant to the Health District's Trend Monitoring Plan, see **Appendix B** for Trend Plan.

The Health District conducted monthly trend monitoring of nine stream stations and semi monthly monitoring of eleven marine stations in the project area. Please see **Appendix C** for a list of monitoring stations, and **Figures 5** for their locations.

4.2.2 Stream Impact Monitoring

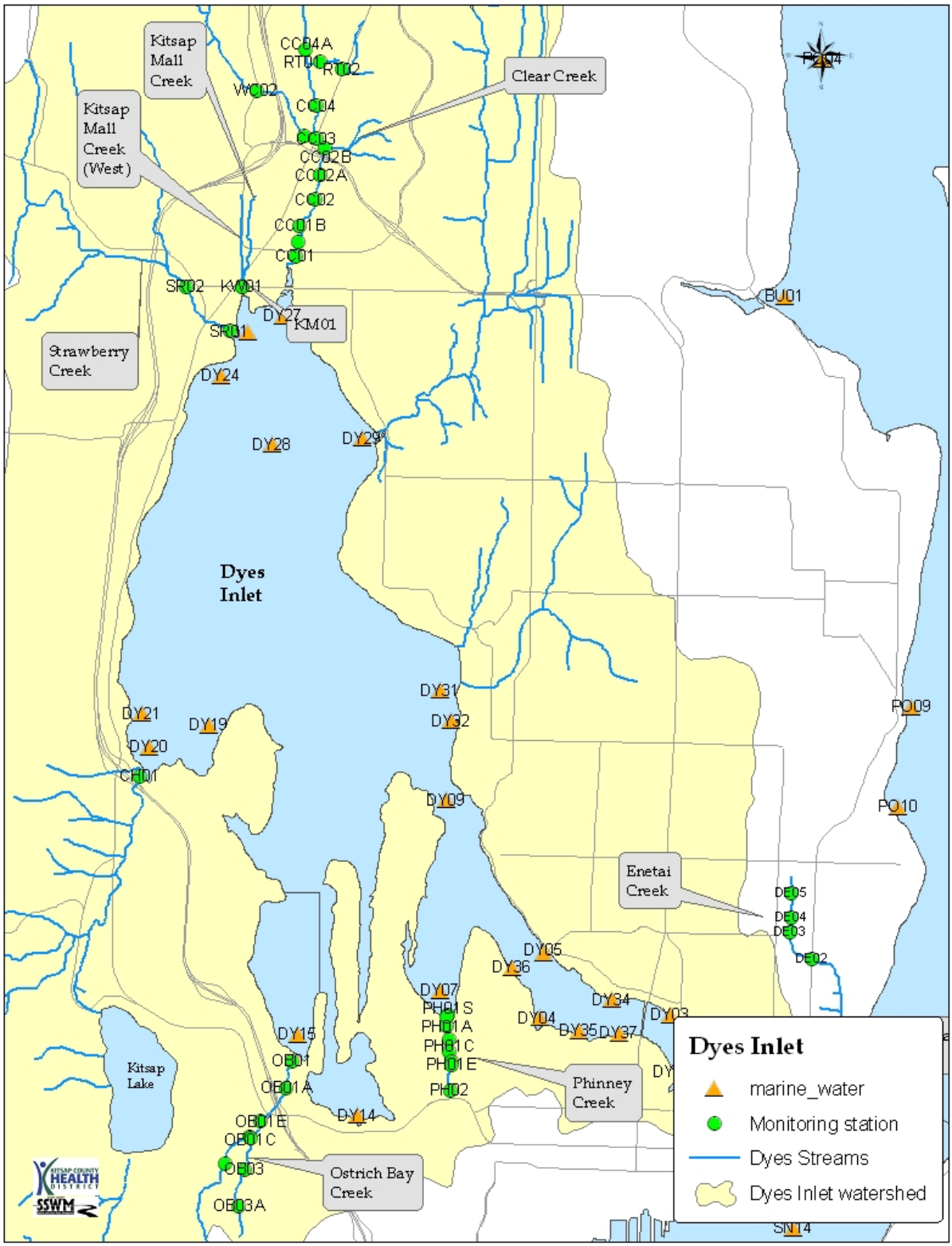
The purpose of impact monitoring is to characterize FC water quality of watershed stream segments. Impact monitoring began with monthly sampling of nine trend stations, and 29 impact monitoring stations in the project area. Additional stations were added during the project to facilitate source identification. Numerous investigative samples were collected to further segment streams and parcels to identify FC sources. Impact monitoring was conducted using the same field procedures as set forth in the Trend Monitoring Plan." Please see **Appendix D** for a list of Impact Monitoring stations, **and Figure 5** for their locations.

4.2.3 Stormwater Monitoring

The purpose of stormwater impact monitoring was to determine the effectiveness of commercial property inspections at reducing bacterial pollution levels in Clear Creek and Dyes Inlet marine water, and to identify a potential relationship between total suspended solids (TSS) and FC.

Stormwater impact monitoring began with targeting rain events and sampling of 20 stormwater stations and 14 stream stations to compare stormwater station values with area stream station values. Six rainfall events were targeted to characterize stormwater outfalls in the project area. Qualifying sampling events were defined as a 24 hour period with no less than 0.25 of rainfall. Stormwater outfalls discharging to Clear Creek, Ostrich Bay Creek, Phinney Bay Creek, Chico Creek, and Kitsap Mall Creek were tested for TSS and FC. Please see **Appendix E** for a list of Stormwater Monitoring stations and their locations.

Figure 5. Trend & Impact Monitoring Stations



4.2.4 Best Management Practice Monitoring

Best Management Practice (BMP) monitoring was conducted (if possible) on properties that were documented FC contributors to surface waters. BMPs in the project included management of animal waste, maintenance of stormwater facilities, and waste disposal areas. The intent of the monitoring is to verify whether or not the BMP implementation was successful in reducing FC contamination.

4.3 EDUCATION AND OUTREACH

The Health District's homeowner/resident OSS survey included a strong educational component to educate property owners about how to properly operate and maintain their OSS, to identify any non-conforming conditions that could cause premature OSS failure, reduce nutrient contamination, and to adequately manage animal waste. Educational brochures and water-conserving fixtures were made available to all participants.

For commercial property owners and their tenants, Health District and KCSSWM provided educational material that addressed grease management, proper dumpster areas, structural recommendation and maintenance of grease interceptors, food compactor areas and requirements of local codes. In addition to food source control information, property owners and managers were contacted and offered storm drain markers to be installed by local environmental steward groups stating "…Only Rain…Down the Drain" and window clings stating "Business for Clean Runoff." Materials were provided by mail and public meetings.

In addition, six public meetings were held in the project area to provide project updates and more detailed education for residential and commercial property owners and their tenants. The Health District sought out additional educational opportunities whenever possible. This included working with local environmental groups and schools.

5.0 RESULTS AND DISCUSSION

5.1 OSS PROPERTY SURVEY RESULTS

Pollution Identification and Correction (PIC) OSS surveys were conducted from October 2005 to November 2009. The project area consisted of 750 parcels in the residential and commercial areas of Clear Creek, Ostrich Bay Creek, Phinney Bay Creek, Enetai Creek, Rocky Point, Eldorado Hills, Tracyton, Windy Point South, and Erlands Point.

The OSS survey consisted of two parts. First, there was an interview with the homeowner that involved a discussion of the existing septic system, and its care and operation. The second part was a field inspection of the system, which involved inspecting OSS components and walking around the building. Suggestions were offered to the homeowner as to how performance of the system could be improved. Often these inspections revealed non conforming conditions and potential problems, such as improper placement of downspouts, damage to a drainfield by parking vehicles over the laterals, or unwanted growth of blackberry and tree roots that could plug the disposal lines.

Some of the surveys required additional inspections due to conditions that suggested a failing OSS. These "suspect" systems might require laboratory samples of surface water and dye testing the OSS. A system with suspect conditions, such as a saturated drainfield area, or a clean dye test with high FC counts, received a rating of "suspect", and the homeowner was encouraged to take the necessary steps to improve the operation of the OSS. When an OSS received a rating of "non-conforming", such as non-permitted repairs or alterations, or additional bedrooms added to the home, the homeowner was informed of the issues, their impact on the OSS, and the necessary steps to resolve the issues. Suspect and non-conforming systems found during this project were recorded in Health District records without corrective enforcement. Inspectors also identified potential non OSS FC sources like pet waste, livestock waste, as well as nutrient sources during the survey.

A total of **569** properties were surveyed in the project area:

- A project total of 82 OSS failures (14%) were found.
- A project total of 22 suspect OSS (4%) were found.
- A project total of 90 non conforming (16%) were found.
- A project total of 126 "no records" OSS (23%) were found.
- A project total of 249 "no apparent problems" OSS (43%) were found.

Based upon the results of each survey, OSS were categorized as "Failing", "Suspect", "Non-Conforming", "No Records", or "No Apparent Problems." **Table 2** summarizes the project OSS survey results. OSS were rated according to "Criteria for Rating OSS Inspection Results" in **Appendix F.**

As presented in **Table 1**, a project total of **82** OSS failures (**14%**) were found. A descriptive list of the OSS failures is contained in **Appendix G**. The **14%** failure rate found in the project areas is at the high end for similar projects conducted by the Health District since 1995. (2% - 15%). The high failure rate is consistent with previous PIC projects that focused corrective efforts on shoreline areas that typically have less permeable and shallow soils. Failing OSS were corrected pursuant to state and local OSS regulations.

Table 2. Summary of Pollution Identification and Correction Results 2005 – 2009

Project Areas	Participating Properties	Failing		Suspect		Non Conforming		No Records		No Problems	
		#	%	#	%	#	%	#	%	#	%
Chico Creek	7	4	57	0	0	1	14	0	0	2	29
Ostrich Bay Creek	116	19	17	3	3	3	3	51	45	40	35
Phinney Bay Creek	29	7	19	2	7	4	15	4	15	12	44
Erlands Point	161	13	8	5	3	49	31	27	17	67	42
Rocky Point	29	1	7	1	3	0	0	0	7	27	83
Tracyton	57	7	12	5	9	7	12	11	19	27	47
Enetai Creek	71	5	7	2	3	15	21	15	21	34	48
Eldorado Hills	9	2	22	0	0	5	56	2	22	0	0
Dyes Shoreline	85	24	28	3	4	5	6	16	19	37	44
Windy Point South	5	0	0	1	20	1	20	0	0	3	60
Total Project Area	**569**	**82**	**14**	**22**	**4**	**90**	**16**	**126**	**23**	**249**	**44**

5.1.1 Analysis of Failures

Sixty (60) of eighty two (73%) of the failing OSS were located adjacent to surface waters (<100 feet), and 22 of eighty two (27%) were located 100 feet or more from surface waters. Fifty (50) of eighty two (70%) failing OSS discharged directly to the Dyes inlet marine shoreline. Twelve (12) of the eighty two (15%) failures were due to greywater discharges.

Sixty five (65) of the eighty two (79%) failures were found during routine survey inspections by Health District staff. Five (5) of the eighty two (6%) failures were reported by maintenance professionals, and occurred after an initial survey inspection had been conducted. Twelve (12) of the eighty two (15%) failing OSS were found during Dyes Inlet shoreline surveys. The following factors have been related to OSS failure in previous surveys:

- Age of the OSS;
- Poor soil types and shallow depth to water table/impervious layer;
- Inadequate or lack of maintenance of the OSS;

- Number of previous repairs (failure history); and
- Grey water discharge.

Of these, the age of the OSS, and homeowner maintenance of the OSS, has been the most prevalent causes of failure in other PIC areas:

Analysis of failing OSS found in the Dyes Inlet Restoration project area showed that:

- Sixty eight (68) of eighty two (83%) of the failing OSS were 20 years old or older;
- Fourteen (14) of eighty two (17%) of the failing OSS had failed, and was repaired 10 years previously;
- Sixty (60) of eighty two (73%) of the failing OSS were located less than 100 feet from surface waters;
- Twelve (12) of eighty two (15%) of the failing OSS was the result of grey water discharges; and
- Eight (8) of eighty two (10%) of the failing OSS were linked to system abuse through hydraulic overload

Age of the system and proximity to surface waters were the most common causes of failure in this project area.

5.1.2 Types of OSS Repairs and Maintenance Requirements

New state and local regulations require that all OSS be properly maintained and monitored. The requirements of Bremerton-Kitsap County Board of Health Ordinance 1995-14, "Regulations for Operation and Maintenance of On-Site Sewage Treatment Systems" and 2008 – 01, "Onsite Sewage System and General Sanitation Regulations" are currently in place, and were applied to OSS issues during this project. All alternative septic systems are required to have ongoing operation and maintenance, and all standard gravity septic systems require tank inspection every three years.

Seven (9%) of the eighty two failing OSS are pending repair, and began the repair process in summer and fall of 2009. Seventy five (75) of eighty two (91%) failing OSS have been repaired: 36 (44%) were repaired with alternative on-site systems, five (6%) were repaired with standard gravity systems, six (7%) were repaired by vacating the residence, 17 (21%) were repaired with minor repairs, and 11 (13%) were repaired by connecting to sewer.

5.1.3 Public Participation Results

Table 3 summarizes the public participation in the OSS survey. As presented in **Table 2**, 569 of (75%**)** of the homes in the project area were surveyed, 27 (**4**%) were vacant, 181 (25%) did not participate, and 18 (**3**%) denied access for inspection. "Did not participate" means that the property owner and/or occupant never responded to Health District attempts to contact them through repeated attempts with door hangers and letters. The Health District believes that the lower participation rate may be due to the economic downturn and resident fear of the costs of repairing or replacing their onsite sewage systems.

Table 3. Summary of Public Participation 2005 – 2009

	Total Properties	Participating Properties	Did Not Participate	Denied Access	Vacant
Shoreline	633	459	174	8	19
Upland	117	110	7	10	8
Total	**750**	**569**	**181**	**18**	**27**

5.2 SHORELINE SURVEYS RESULTS

Shoreline sampling was a useful tool to locate FC sources along the Dyes Inlet Shoreline. As shown in Figure 4, six different areas within Dyes Inlet were surveyed. A total of 550 FC samples and 151confirmation samples were collected from Dyes Inlet shoreline properties. Fifty seven (57) FC hotspots were identified and 20 OSS failures were identified and corrected. See **Appendix H** for shoreline survey area results. The following is a summary of results organized by subarea:

North Shoreline

Shoreline surveys along the north shoreline of Dyes Inlet were conducted in 2006 and 2007 and consisted of 3.8 miles of marine shoreline from Barker Creek North to Newberry Hill Road. All areas north of a line projected east to west from Barker Creek to Newberry Hill are "Prohibited" for shellfish harvest and are served by both OSS and sanitary sewer. A total of 63 samples were collected during the survey. The number of samples collected with FC levels ≥200 FC was three of 63 samples, or 5%. Of the three identified "hot spots", one was confirmed and is pending a joint investigation by the local wastewater jurisdiction and Health.

Southeastern Shoreline

Shoreline surveys south of Windy Point in 2006 consisted of 2.2 miles of marine shoreline from NW Peterson Road to NW Heritage Lane. The majority of this area is "Prohibited" for shellfish harvest and is served by OSS. A total of 62 samples were collected during the survey with additional upland investigative monitoring. Four of the 62 samples (3%) collected had FC levels ≥200 FC. Of these four identified "hot spots", two were confirmed for further investigation.

Based on historical OSS deficiencies, Health expanded property surveys in the area of Windy Point South. One failure was confirmed.

Erlands Point Shoreline

Shoreline surveys on Erlands Point from 2007 and 2008 consisted of 2.5 miles of marine shoreline from Donida Lane (Chico Bay) to Trails End Road. The majority of this area is "Conditionally Approved" for shellfish harvest and is served by OSS. A total of 76 samples were collected during the survey with additional upland investigative monitoring. The number of samples collected with FC levels ≥200 FC was three of 76, or 4%. Of these three identified "hot spots", three warranted further investigation. Based on historical OSS deficiencies and proximity to shellfish growing areas, Kitsap Health expanded property surveys in the area of Erlands Point. Twelve (12) failing OSS were identified and corrected.

Western Shoreline – 2006 Response to DOH "Early Warning System"

Shoreline surveys on the western shoreline of Dyes Inlet in 2006 consisted of 2.8 miles of marine shoreline, between Newberry Hill and Meredith Lane. The majority of this area is "Conditionally Approved" for shellfish harvest and is served by OSS and sanitary sewer. A total of 36 samples were collected during the survey with additional investigative monitoring of four perennial drainages. The number of samples collected with FC levels of ≥200 FC was four of 36, or 11%. Of the four identified "hot spots", four warranted further investigation. Due to the high number of hot spots, historical OSS deficiencies, and proximity to shellfish growing areas, Kitsap Health also expanded property surveys in the shoreline area of Chico Way. One greywater discharge was identified on the shoreline and one OSS failure was identified in the upland.

Western & Eastern Shoreline - 2009 Response to DOH "Early Warning System"

Shoreline surveys on the western and eastern shore of Dyes Inlet in 2009 consisted of a total of 2.8 miles of marine shoreline: 2.0 miles between Newberry Hill and Meredith Lane, and 0.80 miles on the eastern shoreline between Windy Point and Barker Creek. The majority of this area is "Conditionally Approved" for shellfish harvest and is served by OSS and sanitary sewer. A total of 99 samples were collected during the survey. The number of samples collected with FC levels of ≥200 FC was 13 of 99, or 13%. Of the 13 total identified "hot spots", 10 were confirmed for investigation. No conclusive findings of failing OSS have been confirmed. Urban wildlife may be a potential source for FC contamination.

South Dyes Shoreline

Shoreline surveys in south Dyes Inlet consisted of a total of 11.8 miles of marine shoreline: 1.3 miles between N.A.D. Park and Marine Drive, 2.3 miles along Madrona Point and Oyster Bay, 5.1 miles along Rocky Point, and 3.3 miles along Phinney Bay. The majority of this area is "prohibited" to shellfish harvest due to fecal pollution. A total of 223 samples were collected during this survey. The number of samples collected with FC levels of ≥200 FC was 28 of 223, or 12.5%. Eighteen (18) of the 28 identified "hot spots" warranted further investigation. Five (5) failing OSS have been confirmed. Due to the high number of hot spots and historical OSS

deficiencies, Health expanded property surveys in the area of Rocky Point. See **Table 2** for a summary of pollution identification and correction results.

In addition to routine OSS inspections from shoreline survey hot spots, Health coordinated with local wastewater jurisdictions to identify potential FC contributions to surface waters from suspect sanitary sewer lines located on the beach. During the survey, a total of four confirmed sanitary sewer breaks were identified and corrected in Oyster and Ostrich Bay. Of the four confirmed failures, two resulted from sewage mains, and two from side sewer connections.

5.3 COMMERCIAL PROPERTY INSPECTIONS

Stormwater system inspections were completed for 91% of the properties in the Silverdale and lower Chico Creek commercial corridor in 2007; all properties were inspected and met maintenance compliance by June 2007. The most common deficiency identified during inspections was excess sediment buildup in 85 of the 207 properties with stormwater facilities. After the first year of the program, the deficiency rate dropped from 41% to 8% of inspected properties. Maintenance letters from KCSSWM and property owner cooperation contributed to this improvement.

Forty–three (43) of the two hundred and seven, (21%) of the commercial properties in Silverdale were determined to have the potential to provide a food source for urban wildlife or to discharge food waste to storm drain systems. After inspection of dumpster, restaurant cleaning areas and food compactor areas, seven properties were identified to discharge food waste to the storm drain. Two of the properties discharged runoff directly to Clear Creek. Of the seven properties, three complied immediately and four complied after notification by enforcement letter from KCHD.

5.4 WATER QUALITY MONITORING

5.4.1 Trend Monitoring Results

Trend monitoring has been conducted in the Dyes Inlet watershed since October 1996. Several new trend stations were added in preparation for the Dyes Inlet Restoration Project. These characterized FC water quality in upland and shoreline stream segments. Nearshore marine water stations were also monitored. A summary of the freshwater and marine water results are listed in **Table 4, 5 and 6** below.

Table 4. Freshwater Trend Monitoring (FC) Results 10/01/2005 to 9/30/2009

Station	Number of samples	Range (FC/100ml)	GMV (FC/100ml)	% Samples >200FC/100ml	Meets FC Standard?
CC01	49	4 - 1600	69	20%	**NO**
CH01	49	< - 240	22	4%	YES
OB01	49	13 - ≥1600	**139**	39%	**NO**
PH01	58	23 - ≥1600	**461**	75%	**NO**
SR01	48	<2 - 1600	43	15%	**NO**
KM01	36	<2 - ≥1600	53	25%	**NO**
DE01	48	8 - 1600	78	38%	**NO**

Table 5. Freshwater Trend Monitoring (FC) Results for 2005 – 2009 Water Years

Water Year	Station	Number of samples	Range (FC/100ml)	GMV (FC/100ml)	% Samples >200FC/100ml	Meets FC Standard?
2005 - 06	CC01	12	4 - 300	78	25%	**NO**
	CH01	12	13 – 240	38	8%	YES
	OB01	12	133	4	33%	**NO**
	PH01	12	70 - ≥1600	8	73%	**NO**
	SR01	12	7 -300	62	25%	**NO**
	KM01	-	-	-	-	-
	DE01	12	13 - 900	**122**	58%	**NO**
2006 - 07	CC01	12	23 -1600	**137**	25%	**NO**
	CH01	12	4 -220	19	8%	YES
	OB01	12	13 - ≥1600	**212**	50%	**NO**
	PH01	12	300 - ≥1600	52	8%	YES
	SR01	12	2 - 220	52	8%	YES
	KM01	12	<2 - ≥1600	49	17%	**NO**
	DE01	12	13 - 1600	**116**	42%	**NO**
2007 - 08	CC01	13	11 – 1600	71	15%	**NO**
	CH01	13	4 – 80	18	0%	YES
	OB01	13	30 – 900	150	46%	**NO**
	PH01	12	50 - ≥1600	316	69%	**NO**
	SR01	13	8 – 1600	36	8%	YES
	KM01	12	7 - ≥1600	49	17%	**NO**
	DE01	12	11 - 170	47	17%	**NO**
2008 - 09	CC01	12	4 – 300	30	17%	**NO**
	CH01	12	<2 -80	18	0%	YES
	OB01	12	17 – 500	88	25%	**NO**
	PH01	12	23 - ≥1600	364	58%	**NO**
	SR01	12	<2 -900	29	17%	**NO**
	KM01	12	<2 - ≥1600	63	42%	**NO**
	DE01	12	8 - 1600	56	33%	**NO**

Table 6. Marine Water Trend Monitoring (FC) Results 10/01/2005 to 9/30/2009

Station	Number of Samples	Range (FC/100ml)	GMV (FC/100ml)	# Samples > 43 FC/100ml	% Samples > 43 FC/100ml	Meets FC Standard?
DY02	31	<2 – 23	3	0	0%	YES
DY03	31	<2 – 30	2	0	0%	YES
DY04	31	<2 – 30	2	0	0%	YES
DY05	33	<2 – 500	6	4	**12%**	**NO**
DY07	31	<2 – 300	3	1	3%	YES
DY14	31	<2 – 34	2	0	0%	YES
DY15	31	<2 – 30	2	0	0%	YES
DY19	2	8-13	10	0	0%	YES
DY20	31	<2 – 80	3	1	3%	YES
DY21	31	<2 – 17	2	0	0%	YES
DY24	33	<2 – 17	2	0	0%	YES
DY25	33	<2 – 300	8	7	**21%**	**NO**
DY27	33	<2 – 500	5	6	**18%**	**NO**
DY28	31	<2 – 23	2	0	0%	YES
DY29	31	<2 – 50	3	1	3%	YES
DY31	31	<2 – 13	2	0	0%	YES
DY32	29	<2 – 300	3	2	7%	YES
DY33	31	<2 – 500	2	1	3%	YES
DY34	31	<2 – 500	5	5	**16%**	**NO**
DY35	31	<2 – 13	2	0	0%	YES
DY36	33	<2 – 130	3	2	6%	YES
DY37	24	<2 – 50	2	1	4%	YES

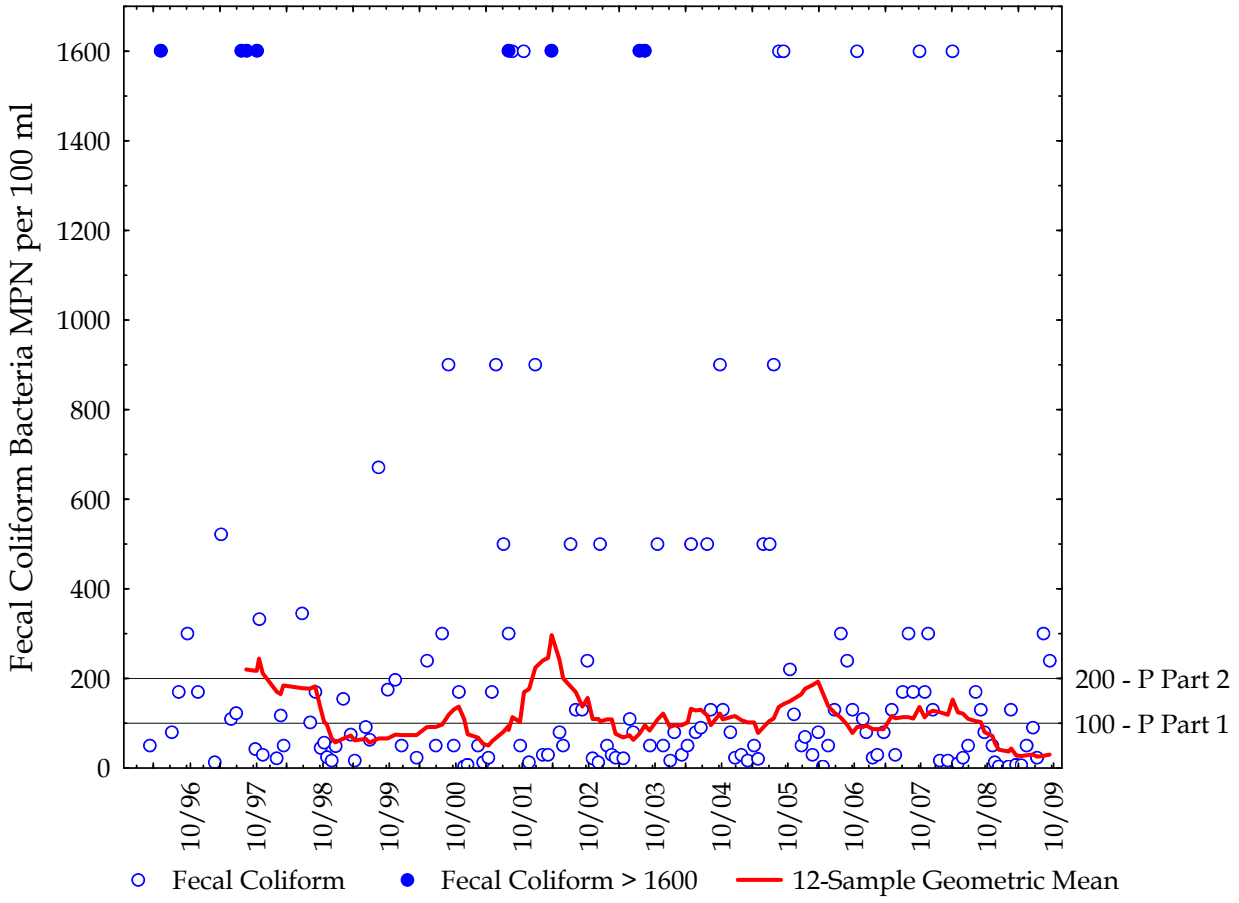
5.4.2 Trend Analysis

Statistical analysis of FC data was performed on the seven fresh water streams flowing to Dyes Inlet. The 2008-09 Kitsap County Health District Water Quality Report listed Clear Creek, Chico Creek, Ostrich Bay Creek, Phinney Bay Creek, Kitsap Mall Creek, Strawberry Creek, and Enetai Creek. See **Figures 6, 7, 8, 9, 10, 11, and 12** for a summary Trend results.

For a trend to be significant the p-value for the Seasonal Kendall Test statistic must be less than 0.05 and the 12 monthly Kendall Tests must be homogenous with a common trend. If the Seasonal Kendall Test statistic is significant, the magnitude of the trend is given by the Kendall Slope. A negative slope corresponds to an improving condition; a positive slope corresponds to a worsening condition. The Kendall Slope is only provided if there is a significant trend. Kendall Seasonal z-value is provided only if the monthly tests show a homogeneous and common trend.

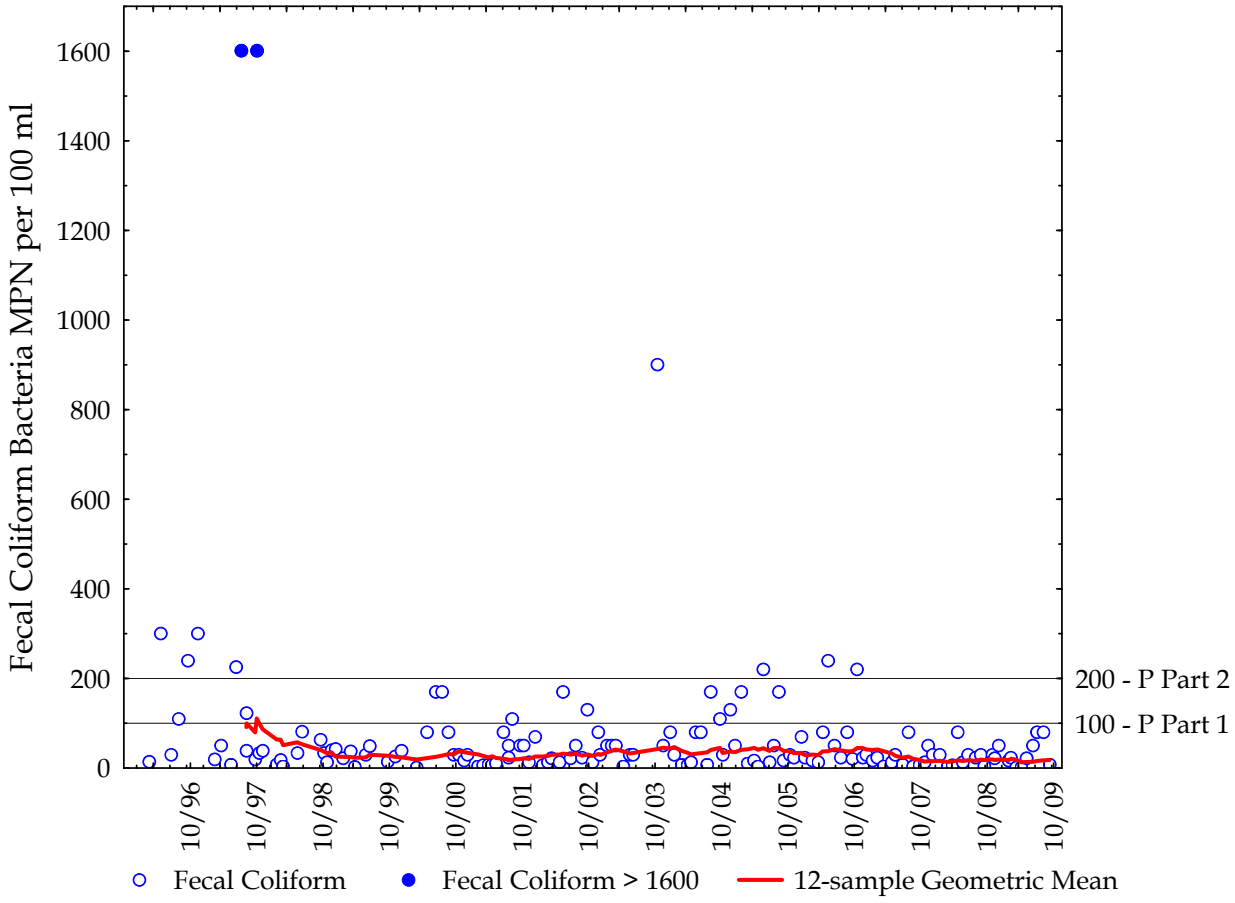
FC data for each of the seven stream stations were also separated by dry season (May – September) and wet season (November – April) for seasonal analysis. This analysis indicates that FC levels are significantly higher during the dry season then during the wet season. The reasons for this are not clear. **Appendix I** contains a seasonal analysis of the FC data.

Figure 6. Fecal Coliform Bacteria Trend Analysis Clear Creek (Station CC01), 1996 - 2009



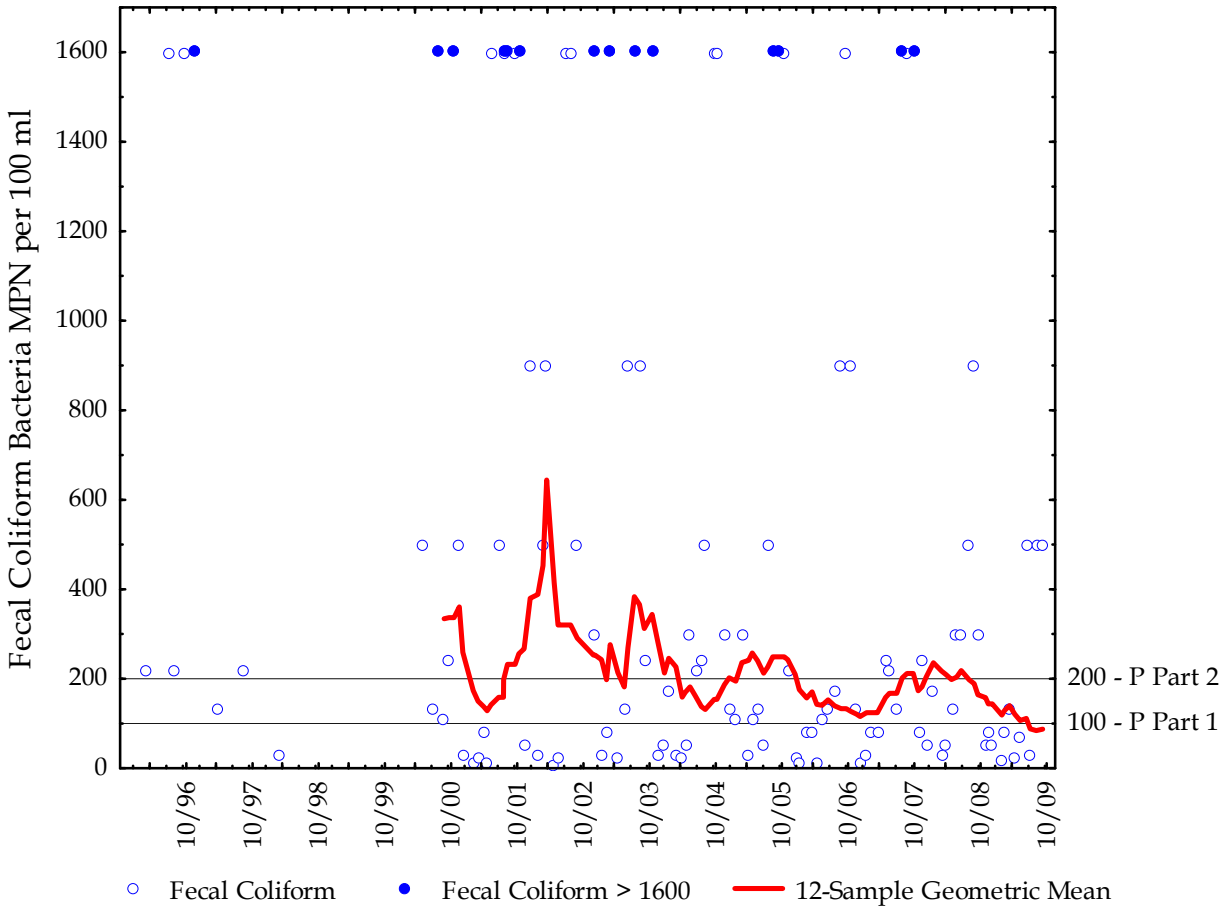
Water quality in Clear Creek in 2008 has been moderate, with some periods of elevated fecal bacteria levels. However, the creek has an improving trend.

Figure 7. Fecal Coliform Bacteria Trend Analysis of Chico Creek (Station CH01), 1996 - 2009



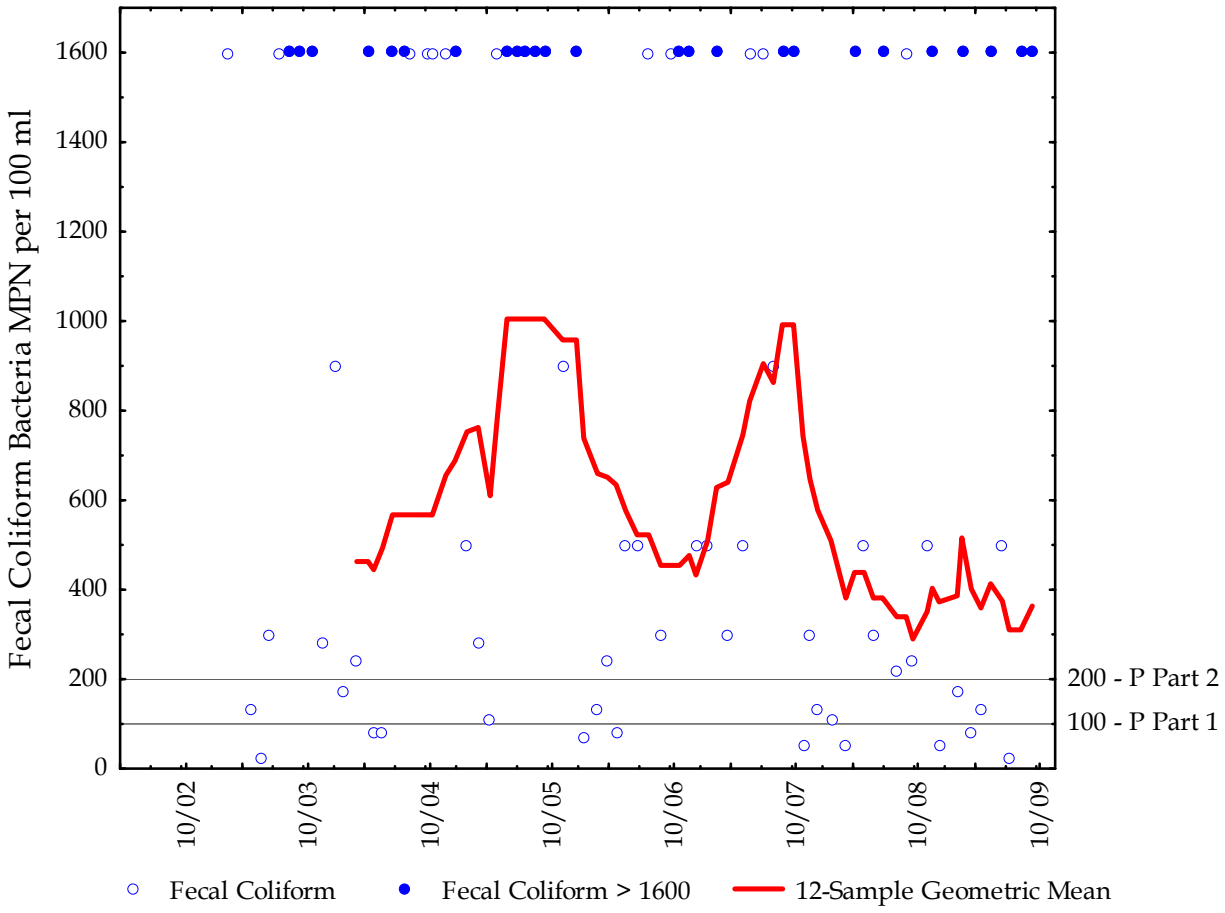
Current water quality for Chico Creek is excellent, and the statistical analysis for the creek shows an improving long-term trend.

Figure 8. Fecal Coliform Bacteria Trend Analysis of Ostrich Creek (Station OB01), 1996 - 2009



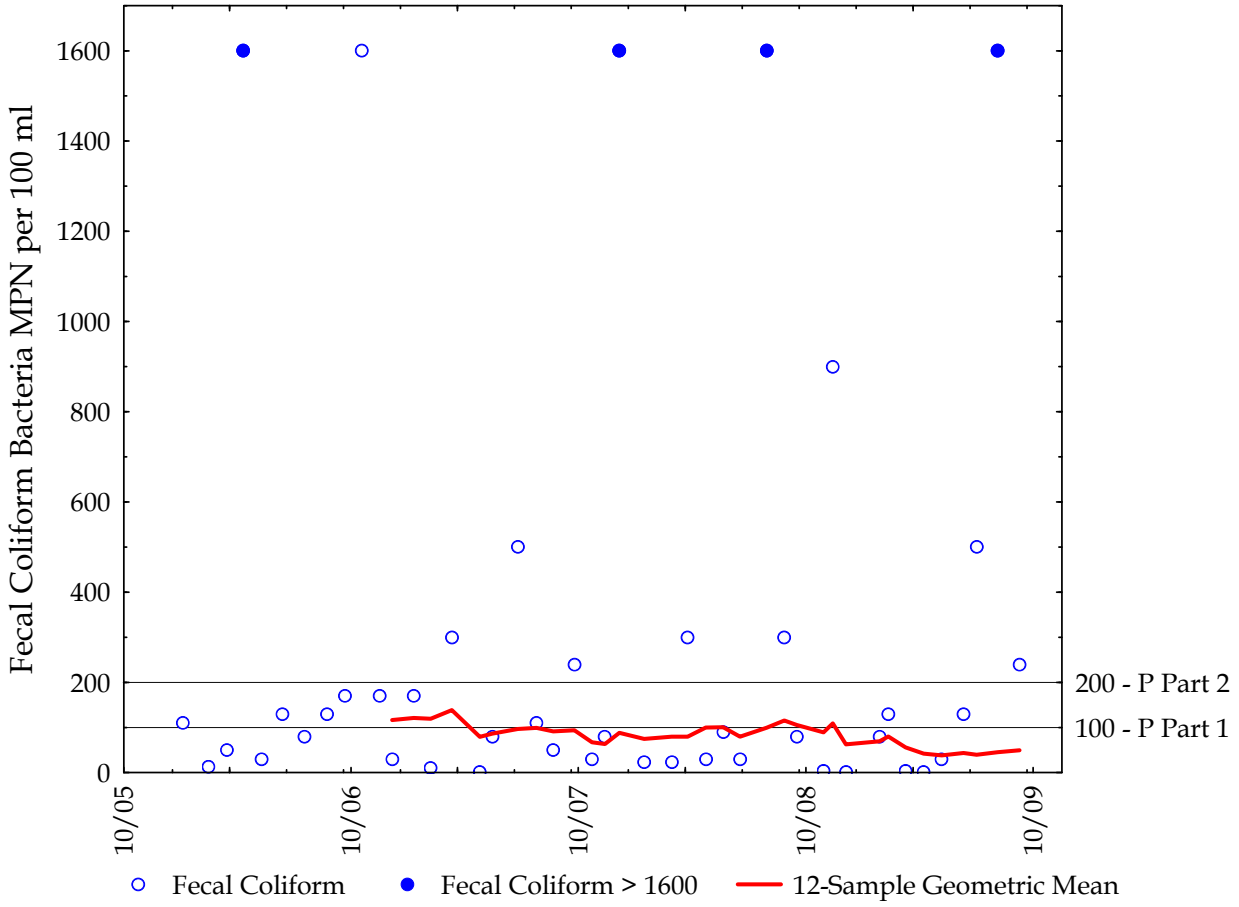
Although statistically the creek has a **stationary** trend, the graph above shows a gradual improvement in bacteria levels.

Figure 9. Fecal Coliform Bacteria Trend Analysis of Phinney Creek (Station PH01), 2003 - 2009



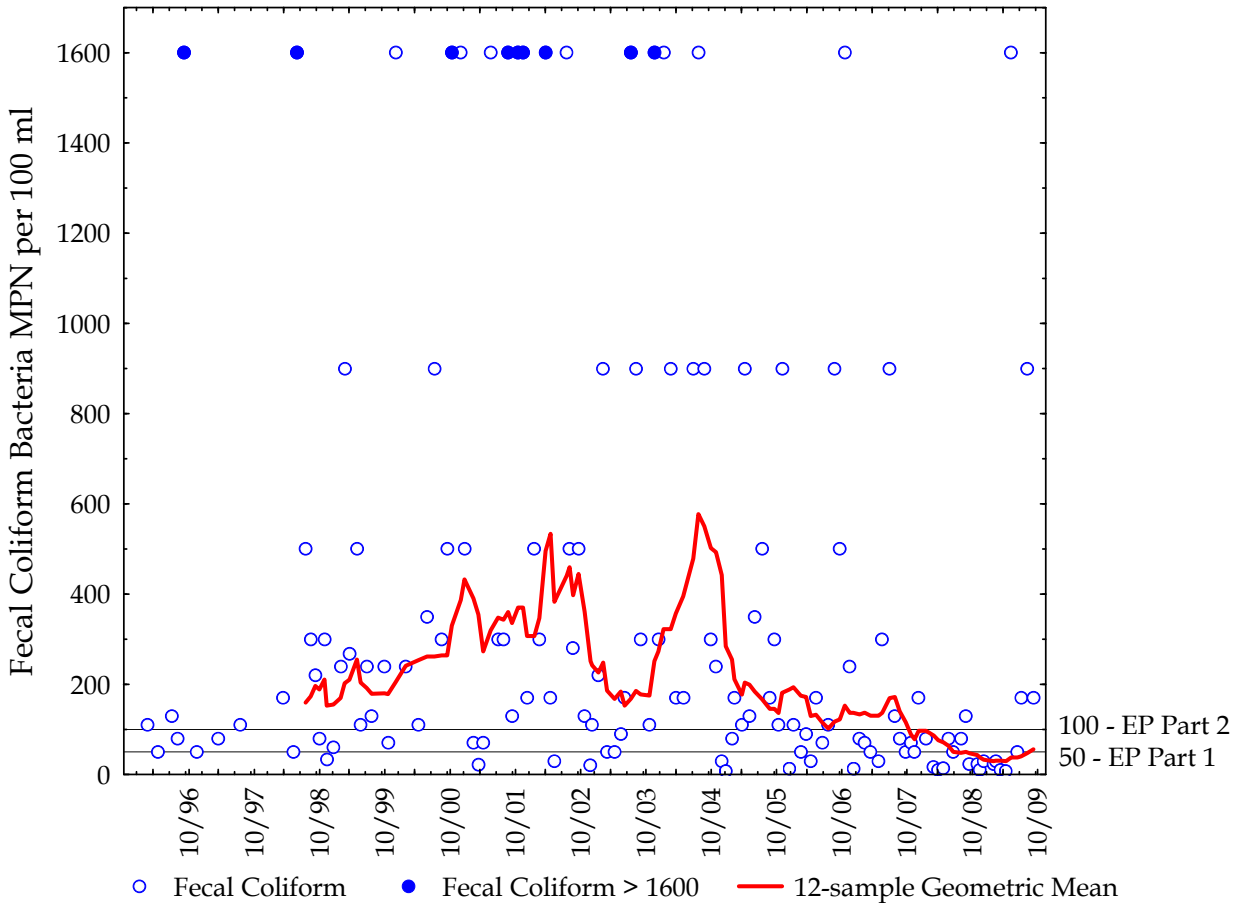
Although Phinney Bay Creek has a **stationary** trend, water quality has improved dramatically in the past couple years as shown in the graph above.

Figure 10. Fecal Coliform Bacteria Trend Analysis of Kitsap Mall Creek West (Station KW01), 2006 - 2009



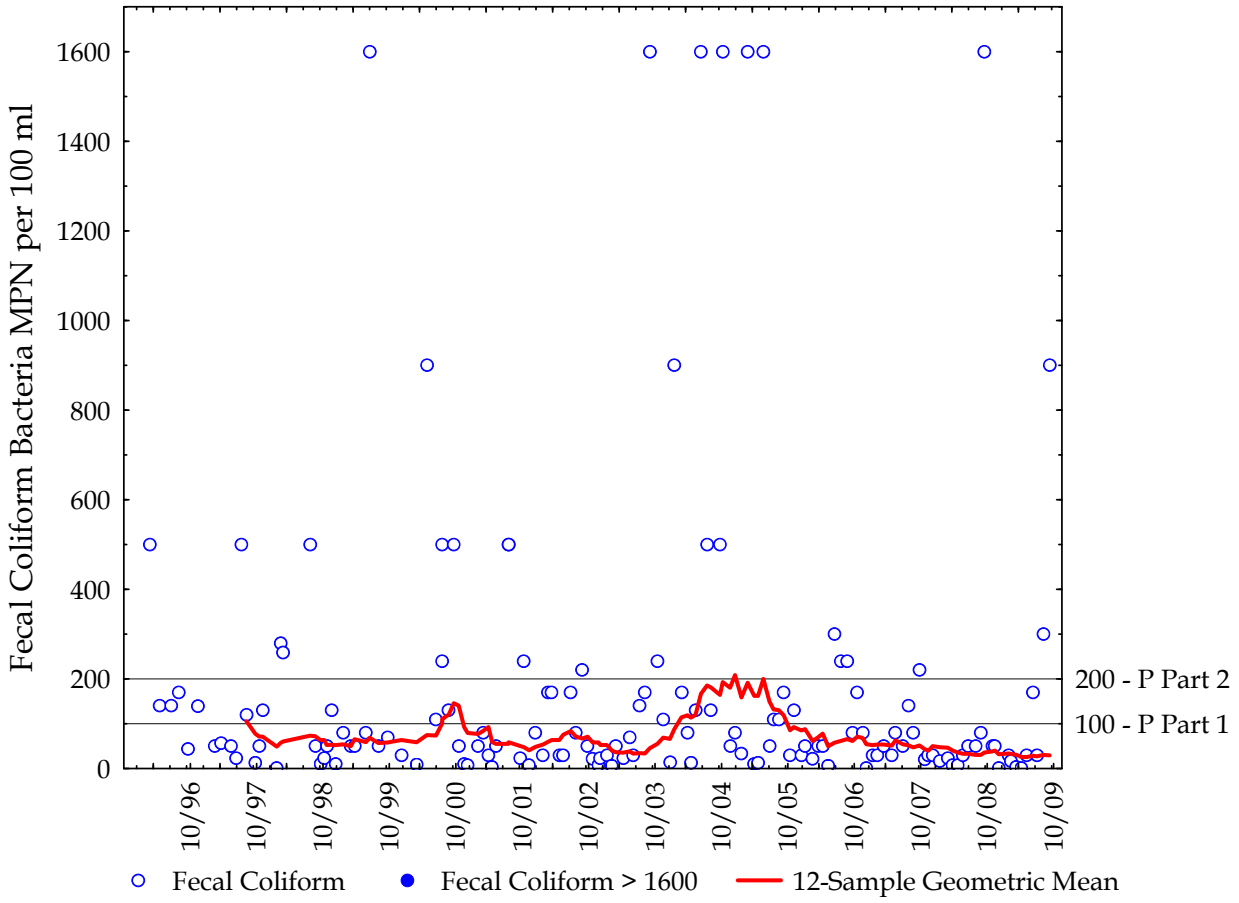
Current water quality is for Kitsap Mall Creek is moderate, with periods of elevated bacteria.

Figure 11. Fecal Coliform Bacteria Trend Analysis of Enetai Creek (Station DE01), 1996 - 2009



Dramatic improvements in water quality are shown in the graph above for Enetai Creek. Although the creek still fails to meet the state water quality standard, statistical analysis confirms a significant **improving trend**.

Figure 12. Fecal Coliform Bacteria Trend Analysis of Strawberry Creek (Station SR01), 1996 - 2009



Strawberry Creek water quality has improved somewhat over the last few years, and is currently moderate. Statistical analysis for the creek shows a **stationary trend** in bacterial concentrations.

5.4.3 Trend FC and Rainfall Correlations

Trend monitoring data was analyzed for correlation of FC and previous 24, 48 and 72-hour rainfall depths using the Pearson correlation coefficient value. Data collected during the project period of October 2005 through October 2009 were selected. FC and rainfall for all previous rainfall depth periods at CC01, CH01, OB01, PH01, KM01, SR01, and DE01 showed insignificant correlations for 72, 48, and 24 hour rainfall depths, ranging from -0.40 to 0.79. See **Table 7** below for the results.

Table 7. Correlations of FC trend data and rainfall

Station	72 hour rainfall	48 hour rainfall	24 hour rainfall
CC01	-0.35	0.15	0.15
CHO1	-0.40	-0.11	-0.11
OB01	-0.06	0.49	0.49
PH01	0.33	-0.15	-0.15
KM01	-0.23	-0.20	-0.20
SR01	-0.17	0.01	0.01
DE01	0.79	-0.19	-0.19

5.4.4 Impact Monitoring Results

Freshwater impact monitoring of the Dyes Inlet watershed began in October 2005. This is "investigative" monitoring designed to segment streams to locate bacterial "hot spots". Thirteen (13) of the stations were located on the main channel of Clear Creek; eight on Ostrich Bay Creek; eight on Phinney Bay Creek; one on Chico Creek; two on Kitsap Mall Creek; one on Strawberry Creek; and 12 on Enetai Creek. Freshwater impact analysis results are shown in **Table 8.**

Table 8. Freshwater Impact Analysis (FC) Results

Station	Number of Samples	Range (FC/100ml)	GMV (FC/100ml)	# Samples >100 FC/100ml	% Samples >100 FC/100ml	Meets FC Standard?
CC01	32	4 – 900	54	8	**25%**	**NO**
CC01A	30	4 – 900	48	7	**23%**	**NO**
CC01B	30	2 – 900	43	3	**10%**	**NO**
CC02	29	8 – 500	45	3	**10%**	**NO**
CC02A	29	2 – 300	25	1	3%	YES
CC02B	27	2- 300	22	1	4%	YES
CC03	28	<2 – 500	21	3	**11%**	**NO**
CC04	31	4 – 900	41	4	**13%**	**NO**
CC04A	26	4 – 900	25	2	8%	YES
DE01	10	17 – 500	90	3	**30%**	**NO**
DE02	10	23 – 300	**116**	5	**50%**	**NO**
DE03	9	14 – 170	57	0	0%	YES
DE04	10	2 – 1600	43	2	**20%**	**NO**

Table 9. Freshwater Impact Analysis (FC) Results (Continued)

Station	Number of Samples	Range (FC/100ml)	GMV (FC/100ml)	# Samples >100 FC/100ml	% Samples >100 FC/100ml	Meets FC Standard?
DE05	10	80 – 1600	**326**	7	**70%**	**NO**
EN01	10	8 – 300	78	4	**40%**	**NO**
EN04	7	2 – 50	9	0	0%	YES
EN05	4	2	2	0	0%	YES
EN12	6	30 - 500	**169**	3	**50%**	**NO**
EN14	12	4 – 500	39	2	**20%**	**NO**
KM01	14	2 – 500	37	2	**14%**	**NO**
KW01	14	2 - ≥1600	48	5	**36%**	**NO**
OB01	30	17 - ≥1600	**198**	15	**50%**	**NO**
OB01A	31	13 – 1600	**134**	12	**39%**	**NO**
OB01B	31	7 – 1600	**108**	11	**35%**	**NO**
OB01C	25	8 - ≥1600	85	7	**28%**	**NO**
OB01E	31	2 - ≥1600	88	10	**32%**	**NO**
OB02	30	14 - ≥1600	**141**	15	**50%**	**NO**
OB03	30	13 - ≥1600	**258**	19	**63%**	**NO**
OB03A	23	2 - ≥1600	85	7	**30%**	**NO**
PH01	30	30 - ≥1600	**422**	20	**67%**	**NO**
PH01A	32	13 – 1600	**169**	14	**44%**	**NO**
PH01B	17	2 - ≥1600	**129**	6	**35%**	**NO**
PH01C	19	<2 - ≥1600	17	2	**11%**	**NO**
PH01D	1	2	2	0	0%	YES
PH01E	16	2 – 300	15	1	6%	YES
PH02	11	2 – 900	43	2	**18%**	**NO**
ROSE	9	2 – 50	8	0	0%	YES
RT01	31	<2 – 500	50	6	**19%**	**NO**
RT02	4	23 – 50	30	0	0%	YES
SR01	4	11 – 280	50	1	**25%**	**NO**
SR02	22	4 - ≥ 1600	59	5	**23%**	**NO**
WC01	31	2 – 500	22	3	**10%**	**NO**
WC02	31	2 – 300	24	2	6%	YES

5.4.5 Stormwater Monitoring Results

Six (6) storm event flows were collected at 20 outfalls that flow to Clear, Chico, Ostrich, Kitsap Mall, and Phinney Bay Creeks during the 2006-2007 wet season for FC and TSS. Results were not assessed for two (2) of the outfalls in the Clear Creek drainage due to access issues and lack of flow. Of the 20 outfalls evaluated for FC contamination, eight outfalls were a low priority (>200FC/100ml), nine outfalls were a medium priority (200 - 499FC/100ml) and one was high priority (GMV >500 FC/100ml).

Outfall LMK008 was identified as a high priority and is pending investigation with the local wastewater jurisdiction to investigate possible FC contributions from nearby sanitary sewer lines. Remaining outfalls will be investigated through the Kitsap Regional Clean Runoff Project. **Table** 9 shows the 10 outfalls of medium and high priority from 2006 to 2007 and their locations.

Table 9. Stormwater Outfall FC Priority List

Station	Drainage	2006 -2007GMV[1] (FC/100ml)	Served by Sewer or OSS?	Priority Rating
LMK539	Chico	223	OSS	Medium
012	Silverdale	428	Sewer	Medium
008	Silverdale	997	Sewer	High
009	Silverdale	354	Sewer	Medium
005	Silverdale	314	Sewer	Medium
003	Silverdale	349	Sewer	Medium
024	Silverdale	422	Sewer	Medium
025	Silverdale	431	Sewer	Medium
374	Silverdale	431	Sewer	Medium
624	Silverdale	495	Sewer	Medium

FC pollution can be transported by stormwater systems. Also, the sediments in the system may be the source itself due to binding of FC bacteria to fine particles which are then resuspended in stormwater runoff (May and Cullinan, 2005).

Of the 32 outfalls and stream stations evaluated in the targeted drainages, twelve (12) or 38% of the outfalls had a low correlation (0 to +/-0.25), eighteen (18) or 56% had a moderate correlation (+/- 0.25 to 0.75) and two (2) or 6% had a high correlation (+/- 0.75 to 1.0) between FC and TSS. Statistical analysis using the Pearson correlation coefficient value indicates a low to moderate relationship between FC and TSS. Data results suggest a possible correlation between stormwater system maintenance (mainly removal of sediments) and FC levels in stormwater. **Appendix J** presents FC and TSS data and the degrees of correlation with coefficient values.

5.4.6 Best Management Practice Monitoring

Clear Creek Water Quality Improvements After Inspection Program Initiation

Five monitoring stations were established on Clear Creek in 2003 and sampled monthly. They are downstream of large volume stormwater outfalls in the commercial corridor of Silverdale.

Table 10 shows the relationship of four of the monitoring stations to the commercial property inspection drainage characteristics. Freshwater station CC01A is the southernmost station and is heavily influenced by stormwater runoff prior to discharge to Dyes Inlet. CC04 is further upstream and is a larger basin with fewer stormwater systems.

Table 10. Summary of Water Sampling Stations and Drainage Basin Characteristics.

Water Sampling Station	# Properties	Acres	# Storm Facilities	%TIA
CC01A (fresh)	60	206	471	64
CC04 (fresh)	11	377	77	28
DY27 (marine)	115	583	1,042	68
DY24 (marine)	52	73	201	69

Stream and marine water samples collected from Water Years (WY) 2003, 2004, and 2005 represented "before" initiation of the commercial property inspection program and data collected during WY 2006, 2007 and 2008 represented "after" initiation of the commercial property inspection program. Data was analyzed in two ways: monthly data and dry season only (May –October).

Clear Creek stream sample data were analyzed at stream stations located downstream of stormwater runoff before and after the initiation of the commercial property inspection program. No statistical significant difference was found when evaluating samples collected monthly. However, a statistical difference was found at station CC01A ($p=0.008$), CC02 ($p=0.015$) and CC04 ($p=0.034$) upon analysis of dry season data. Box and whisker plots of CC01A and CC04 are shown in **Figures 13 and 14.**

Figure 13. Box and Whisker Plot of CCO1A

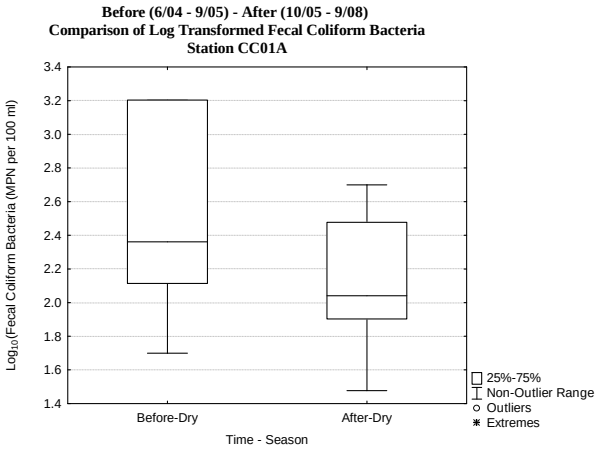
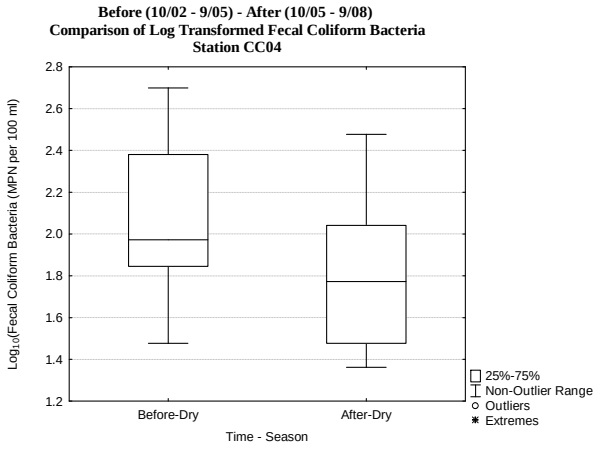


Figure 14. Box and Whisker Plot of CC04



Marine Water Quality Improvements After Inspection Program Initiation

Marine water stations were also analyzed using the Seasonal Kendall Test. Only stations located near the project area, DY24 and DY27, showed a statistically significant improving trend for the 3-year period after the project; see **Table 11** for details. For the 12-year data record station DY27 was one of the two stations to show a significant improving trend.

Table 11. Marine Water Trend Analysis for DY24 & DY27 2007 – 2008

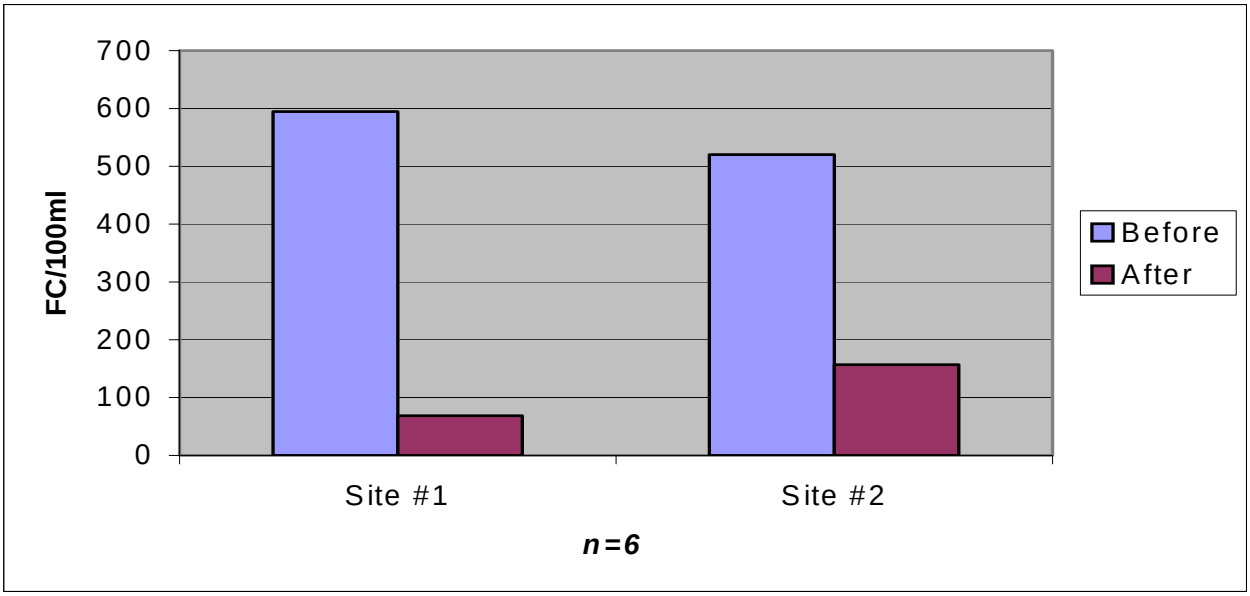
Dyes Inlet Watershed Marine Water Seasonal Kendall Trend Results through Water Year 2007-2008 3-Year Trend						Trend	Kendall Slope
Station	Earliest Date	n	χ^2_{Homo}	χ^2_{Trend}	Kendall Seasonal		FC / Month
DY05	10/11/05	21	0.337	0.384		S	
DY07	10/11/05	19	0.423	0.095		S	
DY14	10/11/05	19	0.296	0.724		S	0
DY15	10/11/05	19	0.804	0.188		S	
DY20	10/11/05	19	0.725	0.487		S	
DY21	10/11/05	19	0.947	0.067		S	
DY24	**10/11/05**	**21**	**0.938**	**0.034**	**-1.79 (0.037)**	**D**	**-0.5**
DY27	**10/11/05**	**21**	**0.860**	**0.016**	**-2.16 (0.015)**	**D**	**-8.5**
DY28	10/11/05	19	0.911	0.262		S	
DY29	10/11/05	19	0.962	0.081		S	
DY31	10/11/05	19	0.735	0.831		S	

*Bold Print indicates a significant trend. Trends are shown as S for stationary, D for decreasing (improving) and I for increasing (worsening)

Food Source Control Best Management Practice Monitoring

Two sites with food source control problems underwent retrofit construction to properly divert contaminated runoff to the sanitary sewer. Water samples collected after the retrofits showed reduction in FC concentrations of runoff from each site. **Figure 15** provides before and after results.

Figure 15. FC Concentrations Before and After Food Source Control Retrofit Construction.



Agricultural Best Management Practice Monitoring

Agricultural Best Management Practice (BMP) monitoring was performed on the following property:

205 Broad Street: This parcel is located directly upstream of sampling station OB02 on Ostrich Bay Creek in the City of Bremerton. Livestock were voluntarily removed by the property owner after water quality sampling determined a negative impact from lack of waste management. The property owners were not interested in working with the Kitsap Conservation District (KCD) on implementing animal waste management plans.

BMP monitoring was conducted (if possible) on parcels that were documented FC contributors to surface waters. Parcel monitoring was challenging in the Dyes Inlet watershed due to weather conditions during the project, which were predominately very wet or very dry thus leaving limited opportunities to collect representative surface water flows. Sample results for these locations offered an opportunity to verify whether or not BMP installation was successful in reducing FC contamination. **Table 12** summarizes the BMP monitoring results for the project.

Table 12. Summary of Pre and Post Correction Results

Station Location	Before Correction GMV FC/100ml (# of samples)	After Correction GMV FC/100ml (# of samples)	Type of Correction
205 Broad Street	702 (3)	108 (2)	Livestock Removal

5.5 EDUCATION AND OUTREACH

Educating homeowners on potential FC and nutrient sources and how to prevent them was a primary focus of the Dyes Inlet Restoration Project. Kitsap Health staff provided homeowners with educational brochures, a copy of the sewage disposal permit, and/or as-built Health District OSS plans for their home. Health District staff emphasized to homeowners that proper operation and maintenance is crucial to prevent premature septic system failures, and for protecting water and shellfish quality in the Dyes Inlet watershed.

During the OSS inspection, the Health District staff shared site-specific ideas on how to get the most life out of the septic system. Any practice that might stress the system or reduce performance was identified and possible solutions were provided.

A total of six public meetings were held in the project area to provide project updates and more detailed education for residential and commercial property owners and their tenants. At these meetings, Kitsap Health presented water quality data showing a FC pollution problem in the Dyes Inlet watershed, explained the pollution identification and correction process, stormwater maintenance requirements, and low impact development practices.

The public meeting schedule was as follows:

- North Dyes Inlet Restoration Project Kick Off Public Meeting - **November 9, 2005**
- North Dyes Inlet Restoration Project Mid-Project Meeting - **November 1, 2007**
- South Dyes Inlet Restoration Project Kick Off Public Meeting - **December 8, 2005**
- South Dyes Inlet Restoration Project Update - **November 8, 2007**
- South Dyes Inlet Restoration Project (Erlands Point) - **December 17, 2007**
- ENVEST Public Meeting – Dyes Inlet Restoration Project Update – **February 28, 2008**

In addition to educational brochures and public meetings, storm drain markers and mutt mitt dispensers were installed by Clear Creek Task Force and Central Kitsap High School students along the commercial corridor of Clear Creek. Over 500 storm drain markers and seven mutt mitt stations were provided to commercial properties and the Clear Creek Task Force. The Health District sought out additional educational opportunities whenever possible, working with the Central Kitsap Kiwanas Salmon in the Classroom, Rotary presentations, Earth Day events, and the annual Water Festival held at Olympic College.

6.0 CONCLUSIONS

The goals of the Dyes Inlet Restoration Project have been achieved:

- Kitsap Health's trend monitoring in Clear Creek, Chico Creek, Ostrich Bay Creek, and Phinney Bay Creek, Enetai Creek, Kitsap Mall Creek, and Strawberry Creek between 2005 and 2009 indicate water quality improvements since the projects beginning. However, analysis of wet and dry season monitoring indicates that FC levels are significantly higher during the dry season then during the wet season.

- Age and proximity to shoreline are challenges to Dyes Inlet watershed OSS.

- Shoreline surveys were an effective method of finding OSS failures in this project. Twenty (20) of the eighty two (82) OSS failures (24%) were found through shoreline surveys. Thirty five (35%) percent of the shoreline survey FC hotspots found in Dyes Inlet were found to have OSS failure sources.

- DOH reclassified Chico Bay from "restricted" to "conditionally approved" for commercial shellfish harvest due to water quality improvements from the correction of 14 failing OSS, and one urban wildlife source.

- Commercial property inspections were an effective method of finding stormwater deficiencies in this project. The major deficiency identified was excess sediment in stormwater facilities. After the first year of inspections, the deficiency rated dropped from 41% to 8% of inspected properties. Additionally, FC concentrations at two marine stations influenced by Clear Creek and stromwater runoff show statistically improving trend during the time period after initiation of the commercial property inspections program.

- Sanitary sewer systems located on marine beaches were investigated in the areas of Silverdale and South Dyes Inlet in response to shoreline survey follow-up and special investigations. Joint site visits were made with local wastewater jurisdictions to identify any potential FC contributions to surface waters. Of the five investigations initiated by Health, two system failures were confirmed in Ostrich Bay, two in Oyster Bay, and one pending investigation at Silverdale Waterfront Park. Four of the five suspected failures have been confirmed, and one is pending investigation.

- The Ostrich and Phinney Bay Creek drainages continue to have FC pollution problems. Although statistically both drainages have a stationary trend, recent 2008 – 09 water quality data show gradual improvements in bacterial levels. Both drainages areas are older residential areas where most of the parcels were platted and developed prior to existing OSS regulations. The natural physical conditions of the area, primarily the surface and ground water conditions and the soil types and depths are not conducive for the utilization of "standard gravity" OSS.

7.0 RECOMMENDATIONS

Based upon the conclusions of the Dyes Inlet Restoration Project, the Health District's Pollution Identification and Correction Program offers the following recommendations:

- Complete correction of the remaining seven OSS failures that will involve one connection to sewer, three OSS repairs pending appropriate weather conditions, two possible enforcement actions, and one pump-out order until funding for repair can be determined.
- Re-inspect the six parcels vacated in lieu of a repair.
- Re-inspect the 22 parcels that have an OSS rating of "Suspect."
- Investigate the 18 properties that denied access, using enforcement tools, if necessary.
- Conduct future shoreline surveys to protect shellfish growing areas and continue to maintain other improvements gained by the Dyes Inlet Restoration Project.
- Investigate remaining FC hotspots found through the 2009 "EWS shoreline survey.
- Share project results with DOH's shoreline survey program to remove closure zones from areas established around OSS failure zones.
- Continue to explore ways to work in partnership with other agencies to more effectively meet goals.
- Research and test assessment methods to determine public education and outreach effectiveness and shoreline resident/visitor water quality information needs.
- Research potential methods to better build public trust, in order to increase participation rates, by actively working to provide accurate and representative data upon which to base regulation and legislation.
- Research and develop education and outreach material for property owners and tenants regarding stormwater maintenance.
- While existing sewage and stormwater regulations are sufficient for ensuring compliance, continued oversight from KCHD and KCSSWM are necessary for long term source control.
- Continue partnership at KCSSWM DIP to reduce stormwater impacts to Dyes Inlet to protect public health and future downgrades of shellfish growing areas.

8.0 REFERENCES

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