KITSAP COUNTY HEALTH DISTRICT
ENVIRONMENTAL HEALTH DIVISION
WATER QUALITY PROGRAM

KITSAP LAKE AND CHICO BAY POLLUTION IDENTIFICATION AND CORRECTION PROJECT

FINAL REPORT

By
Mindy Fohn
Environmental Health Specialist

December 31, 2005

Funded through a Centennial Clean Water Fund Grant
from the Washington State Department of Ecology, City of Bremerton and Kitsap County Surface and Stormwater Management

WASHINGTON STATE DEPARTMENT OF ECOLOGY

KITSAP COUNTY SSWM Surface and Storm Water Management

CITY OF BREMERTON

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACKNOWLEDGMENTS

The author would like to thank the residents of the Kitsap Lake and Chico Bay watersheds for their cooperation during the survey, and their demonstrated commitment to water quality. The author would also like to thank Health District staff (current and past) that contributed to the success of this project: Leslie Banigan, Stuart Whitford, Margarite Juarez Thomas, Michael Drew, Jim Zimny, Shawn Ultican and Preston Greer.

This project would not have been possible without grant funding from the Washington State Department of Ecology, City of Bremerton and matching funds from Kitsap County's Surface and Stormwater Management (SSWM) Program. SSWM's core purpose is to address non-point pollution, which has been identified as the primary source of pollution in Kitsap County's surface waters. SSWM funds a variety of activities oriented toward non-point pollution control, flood reduction, and fish passage improvement. SSWM provides a stable funding source for Health District fecal pollution identification and correction activities.

KITSAP LAKE AND CHICO BAY POLLUTION IDENFICATION AND CORRECTION PROJECT
FINAL REPORT

EXECUTIVE SUMMARY

History

Kitsap Lake and Chico Bay were identified as 303 (D) listed impaired water bodies for fecal coliform (FC) bacteria by the Washington State Department of Ecology (WSDOE) in 1998. In the recent reorganized 2004 classification system Kitsap Lake, Kitsap Creek, and Chico Creek were listed as Category 5 Impaired Waters for FC, and Chico Bay is a Category 4 Water of Concern. In addition to FC contamination, Kitsap Lake is on the 1998 303 (D) list and the 2004 list as a Category 5 Water for phosphorous. To correct the FC and phosphorus contamination problems, the Kitsap County Health District (Health District) conducted a pollution identification and correction project (PIC Project) for these water bodies in the Chico watershed. Therefore, the goals of the project were to:

- Protect public health and the environment by identifying and correcting sources of FC contamination from failing OSS and inadequate animal waste management.
- Prevent future FC and nutrient contamination of Kitsap Lake through public education about OSS operation and maintenance, fertilizer and adequate animal waste management.
- Prevent future FC contamination of Chico Bay through public education about OSS operation and maintenance and adequate animal waste management.

The long term goals are to restore water quality in Kitsap Lake and Chico Bay to a point that would allow:

- Removal from the state Clean Water Act Section 303(D) List of Threatened and Impaired Waterbodies.
- Upgrade of shellfish beds in Chico Bay from *Restricted* to *Conditionally Approved*.

Project Results

The findings of the Kitsap Lake and Chico Bay Pollution Identification and Correction Project are:

- Public participation was high as indicated by the 92% participation rate of OSS surveys.
- Fifteen (15) FC pollution sources were identified during the project, including 14 failing OSS and 1 urban wildlife waste source. All 15 FC sources have been corrected.
- FC levels are statistically stationary but show non-statistical reductions in Chico Bay, Kitsap Lake inlet stream, Kitsap Creek and Chico Creek. Phosphorous levels in Kitsap Lake show non-statistical reductions in the Spring, but a recent elevated Fall sampling may indicate a new problem.
- Age of the OSS and homeowner maintenance were the primary reasons for OSS failure in the project area. Three (3) OSS were determined to directly discharge to Kitsap Lake and four (4) were determined to directly discharge to Chico Bay.

- Shoreline surveys in Chico Bay resulted in a high OSS failure rate (37%), confirming the usefulness of shoreline surveys on marine shorelines to target FC pollution problems. Shoreline surveys on Kitsap Lake were less successful due to the lack of accessible discharge points during high winter lake levels. Many discharge points may be covered.
- Impact monitoring showed local stormwater runoff to be a significant source of FC during rain events.
- Monitoring of best management practices at eight (8) FC contaminated sites showed significant FC reductions in flows to Kitsap Lake or Chico Bay.

Recommendations

Based upon the project results of the Kitsap Lake and Chico Bay Pollution Identification and Correction Project, the Health District recommends the following:

- The Health District continue monitoring Kitsap Lake, Kitsap Creek, Kitsap Lake inlet stream, Chico Creek and Chico Bay as part of the baseline water quality-monitoring program.
- The Health District continue monitoring Kitsap Lake for nutrients and algae blooms.
- The Health District complete investigating two water quality complaints for FC sources. Any sources found will be corrected.
- The Health District partner with the City of Bremerton to reduce FC contamination of local stormwater runoff into Kitsap Lake.
- The Health District expolores funding sources for studies to identify non-failing OSS contributing phosphorus.
- The Health District partner with the City of Bremerton to educate residents about reducing nutrients impacts from residential properties in the Kitsap Lake watershed.
- The Health District request Washington State Department of Health to perform an analysis of Chico Bay water quality for the purpose of upgrading the shellfish beds from *Restricted* to *Conditionally Approved.*

KITSAP LAKE AND CHICO BAY POLLUTION IDENTIFICATION AND CORRECTION PROJECT
FINAL REPORT

1.0 INTRODUCTION

Kitsap Lake is classified as a "Extraordinary Primary Contact" water, Kitsap Creek and Chico Creek are classified as "Primary Contact" waters and Dyes Inlet is classified as a "Primary Contact" water by the "Water Quality Standards for Surface Waters of the State of Washington", Chapter 173-201A WAC. Lake class waters require that:

Fecal coliform organism levels shall both not exceed a geometric mean value of 50 colonies/100 mL (Part 1) and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 mL (Part 2)

Primary Contact freshwaters such, as Kitsap Creek and Chico Creek required that:

Fecal coliform organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL (Part 1) and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 mL (Part 2)

Primary Contact marine waters such as Chico Bay require that:

Fecal coliform organism levels shall both not exceed a geometric mean value of 14 colonies/100 mL (Part 1) and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 43 colonies/100 mL (Part 2)

Kitsap Lake and Chico Bay were identified as 303(D) listed impaired water bodies for fecal coliform (FC) bacteria by the Washington State Department of Ecology (WSDOE) in 1998. Kitsap Lake, Kitsap Creek, and Chico Creek were listed in the recent reorganized 2004 classification system as Category 5 Waters for FC. A Category 5 Water is described as "Waters for which at least one characteristic or designated use is impaired, as evidenced by failure to attain the applicable water quality standard for one or more pollutants." Chico Bay is listed in the 2004 classification system as a Category 4 Water, "Waters where the data are not sufficient for listing a waterbody segment as impaired but may still raise a concern about water quality." In addition to FC contamination, Kitsap Lake is on the 1998 303 (D) list and the 2004 list as a Category 5 Water for phosphorous.

Potential sources of FC pollution in Kitsap Lake and Chico Bay, and phosphorus pollution in Kitsap Lake include failing onsite sewage systems (OSS), stormwater runoff, animal waste and waterfowl.

The purpose of the pollution identification and correction project was to identify and correct sources of FC contamination impacting Kitsap Lake and Chico Bay. To accomplish this, the Health District completed the following tasks:

- Conducted door-to-door surveys of 85 properties in the Kitsap Lake watershed to locate failing onsite sewage (OSS) systems.

- Conducted shoreline surveys of the Kitsap Lake shoreline to locate FC contaminated drainages.

- Conducted shoreline surveys of the Chico Bay shoreline to locate FC contaminated flows to the marine water.

- Conducted surveys of 19 properties in the Chico Bay project area as a result of identification of FC contaminated flows to the marine water.

- Conducted "impact" monitoring in tributaries entering Kitsap Lake to assist in the location of FC sources.

- Conducted ongoing "trend" monitoring for FC in Kitsap Lake inlet stream, Kitsap Lake outlet stream, Chico Creek and Chico Bay, and phosphorus in Kitsap Lake to assess the effectiveness of the project over time.

- Conducted educational activities including public meetings and a workshop on OSS operation and maintenance and lake nutrient management.

The following report will discuss each aspect of the project and present recommendations for future work to protect water quality in Kitsap Lake and Chico Bay.

2.0 PROJECT AREA DESCRIPTION

2.1 KITSAP LAKE AND CHICO BAY WATERSHEDS

Please see **Figure 1** for a map of the Kitsap Lake and Chico Bay Watershed and project area.

Kitsap Lake and Chico Bay are located in the Chico watershed of Kitsap County, Washington. The outlet of Kitsap Lake, Kitsap Creek, is joined by several tributaries and flows into Chico Creek. Chico Creek discharges to Chico Bay in the southwestern corner of Dyes Inlet.

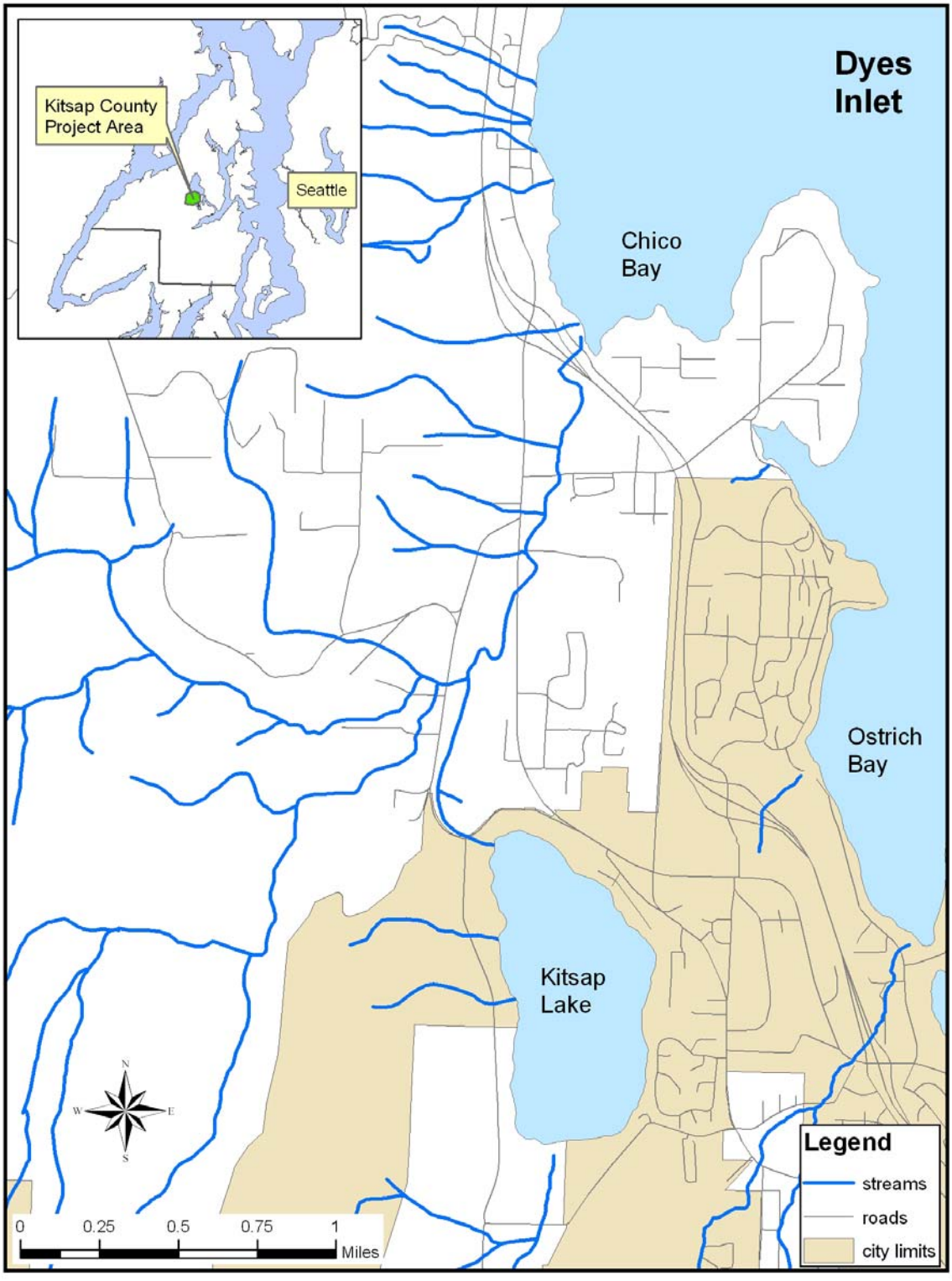
Dense residential development and numerous recreational opportunities make Kitsap Lake and Chico Bay popular destinations among Kitsap County residents. From a public health perspective, this popularity makes these water bodies a high priority area to identify and correct sources of bacterial contamination.

Kitsap Lake is a popular destination for boaters, fishers and swimmers. Not only lake residents partake in these activities, but also the lake has two public boat ramps and a dock. Approximately half of Kitsap Lake is served by sanitary sewer within the Bremerton City limits, which was installed in the mid 1970's with an extension installed in the early 1990's. The remainder of the lake is located in unincorporated Kitsap County with no sanitary sewer service available.

Chico Bay is surrounded by dense shoreline residential development. Residents enjoy kayaking, swimming, shellfishing and beach walking. The Chico Creek Fall Chum salmon run attracts

fisherman. Commercial and recreational shellfish harvesting occurs in the bay. No sewer service is available to shoreline residents, therefore the method of sewage disposal is individual OSS.

Figure 1. Project Area Location Map


Kitsap County Project Area
Seattle
Dyes Inlet
Chico Bay
Ostrich Bay
Kitsap Lake
N
W
E
S
0
0.25
0.5
0.75
1
Miles
Legend
streams
roads
city limits

2.2 POLLUTION IDENTIFICATION AND CORRECTION PROJECT AREA

There were a total of 113 properties selected for property surveys in Kitsap Lake and Chico Bay. For Kitsap Lake, those residents served by OSS along the shoreline and in limited upland areas with documented FC contaminated drainages were selected. These properties were considered to be the highest priority for FC source identification. A total of ninety-two (92) properties located in Kitsap Lake, with 75 located on the shoreline, were selected for surveys. For Chico Bay, those properties adjacent to FC contaminated drainages were selected for surveys. Twenty-one (21) properties were identified in the Chico Bay watershed, with ten (10) of these properties on the marine shoreline, the remaining eleven (11) were located upland of Chico Bay or on Kitsap or Chico Creeks.

Historically, average annual rainfall is 49 inches as measured by the City of Bremerton, Public Works and Utilities, 3027 Olympus Drive, Bremerton, Washington. In the past ten years, rainfall has averaged 49 inches with a maximum of 68 inches in the 1998-1999 water year (October 1 – September 30), and a minimum of 34 inches in the 2000-2001 water year. The majority of this rainfall occurs between the months of October and April, a period of time generally classified as the "wet season".

As presented in the "Soil Survey of Kitsap County Area, Washington" (SCS, 1980), soils in the project area consist of Alderwood-Harstine Gravelly Sandy Loam, Neilton Gravelly Loam, Kitsap Silt Loam, Kapowsin Variant Gravelly Clay Loam, all of which are deep well drained soils. However; portions of the project area contain Tacoma Silt Loam and Semiahmoo Muck, which are poor soils for onsite sewage system performance due to wetness and shallow depth to hardpan.

3.0 HISTORY OF WATER QUALITY PROBLEMS IN THE KITSAP LAKE AND CHICO BAY WATERSHEDS

Kitsap Lake has a history of problems associated with high levels of FC bacteria. The 1996 and 1998 303d listings for FC were based upon a study that was conducted in 1983 (Parametrix 1984). Review of Health District historical files reveals swimming beach closures due to elevated levels of bacteria dating back to 1953. Lake shoreline FC survey work performed in the 1980's showed significant FC contamination of the western shoreline. In 1996 the monitoring indicator was changed to E. coli because it has a better correlation with human health for swimming beach advisory purposes. E. coli monitoring during the summer bathing season of May to October at public beaches has resulted in periodic beach closures annually. FC stream monitoring stations downstream of the Kitsap Lake outlet (KC01) have intermittently failed Part 2 of the state Class A freshwater FC standard. Additionally, the stream mouth station at Chico Creek, which receives drainage from Kitsap Lake, intermittently failed Part 2 of the state Class A freshwater FC standard. These data are summarized in **Appendix A**.

In addition to FC contamination, Kitsap Lake is on the 1998 303D list as impaired for phosphorous. The 1998 303D listing is based upon data from 1983 (Parametrix, 1984) and has been confirmed by monitoring conducted by the Health District between 1996 and 1998, and

most recently in 2002 (KCHD Annual Monitoring Reports, 1997, 1999, 2003). Monitoring is conducted with funding from the Kitsap County Surface & Stormwater Management Program, and pursuant to the Health District's Lake Trophic Assessment Monitoring Plan (KCHD, 2004). In 2002, Kitsap Lake was classified as eutrophic due to elevated phosphorus levels (KCHD, 2003). Elevated phosphorous has led to annual Fall potentially toxic (and in one case toxic) blue-green algae blooms in Kitsap Lake in recent years. These blooms require swimming beach closures and public health advisories for the lake as a whole.

In 1993, shellfish beds in Chico Bay were upgraded from *Prohibited* to *Restricted* by the Washington State Department of Health due to water quality improvements. The *Restricted* classification remains due to ongoing FC pollution problems preventing the upgrade to *Conditionally Approved*. Commercial shellfish growers are required to relay harvested product to a cleaner bay prior to shipping to their market.

The Health District has been sampling Chico Bay since January of 1996. Based on data from the last 30 samples prior to implementation of this project at station DY20 (see **Figure 2** for station location), Chico Bay failed to meet Part 2 of the State Water Quality Standard (see **Appendix A**).

4.0 GOALS AND OBJECTIVES

The goals of the Kitsap Lake and Chico Bay Pollution Identification and Correction Project are to:

- Protect public health and the environment by identifying and correcting sources of FC contamination from failing OSS and inadequate animal waste management.
- Prevent future FC and nutrient contamination of Kitsap Lake through public education about OSS operation and maintenance, fertilizer and adequate animal waste management.
- Prevent future FC contamination of Chico Bay through public education about OSS operation and maintenance and adequate animal waste management.

The long term goals are to restore water quality in Kitsap Lake and Chico Bay to a point that would allow:

- Removal from the state Clean Water Act Section 303(D) List of Threatened and Impaired Waterbodies.
- Upgrade of shellfish beds in Chico Bay from *Restricted* to *Conditionally Approved*.

To meet the project goals, the following objectives were developed and implemented:

- Track, isolate and identify fecal pollution sources and areas in need of corrective action;
- Enforce correction of failing OSS under Bremerton-Kitsap County Board of Health Ordinance No. 1996-8, "Rules and Regulations Governing Onsite Sewage Systems" (Health District, 1996). Hereinafter referred to as "OSS Regulations".
- Educate homeowners and occupants about OSS operation and maintenance, nutrient management and adequate animal waste management. Help residents recognize and avoid OSS stresses/problems to get the longest possible system lifespan.

- Achieve a high percentage of participation by holding public meetings, taking as much time as necessary with each resident/property owner, and providing free technical assistance.
- Thoroughly assess all properties in the project area, including investigating surface water flows from properties where owners/residents deny access or do not participate.

5.0 PROJECT DESIGN AND METHODS

The project design consisted of the following components:

5.1 POLLUTION IDENTIFICATION AND CORRECTION SURVEY

All work performed was conducted according to the methods contained in the "Manual of Protocol: Fecal Coliform Bacteria Pollution Identification and Correction Projects" (Health District, 2003) (*PIC Protocols)*.

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

Based upon the results of each survey, OSS were categorized as Failing; Suspect; Non-Conforming; No Records or No Apparent Problems (see **Appendix B** for rating category criteria). Properties found to be vacant or rated Suspect were re-contacted and surveyed when changes were noted. Failing OSS were corrected pursuant to OSS Regulations.

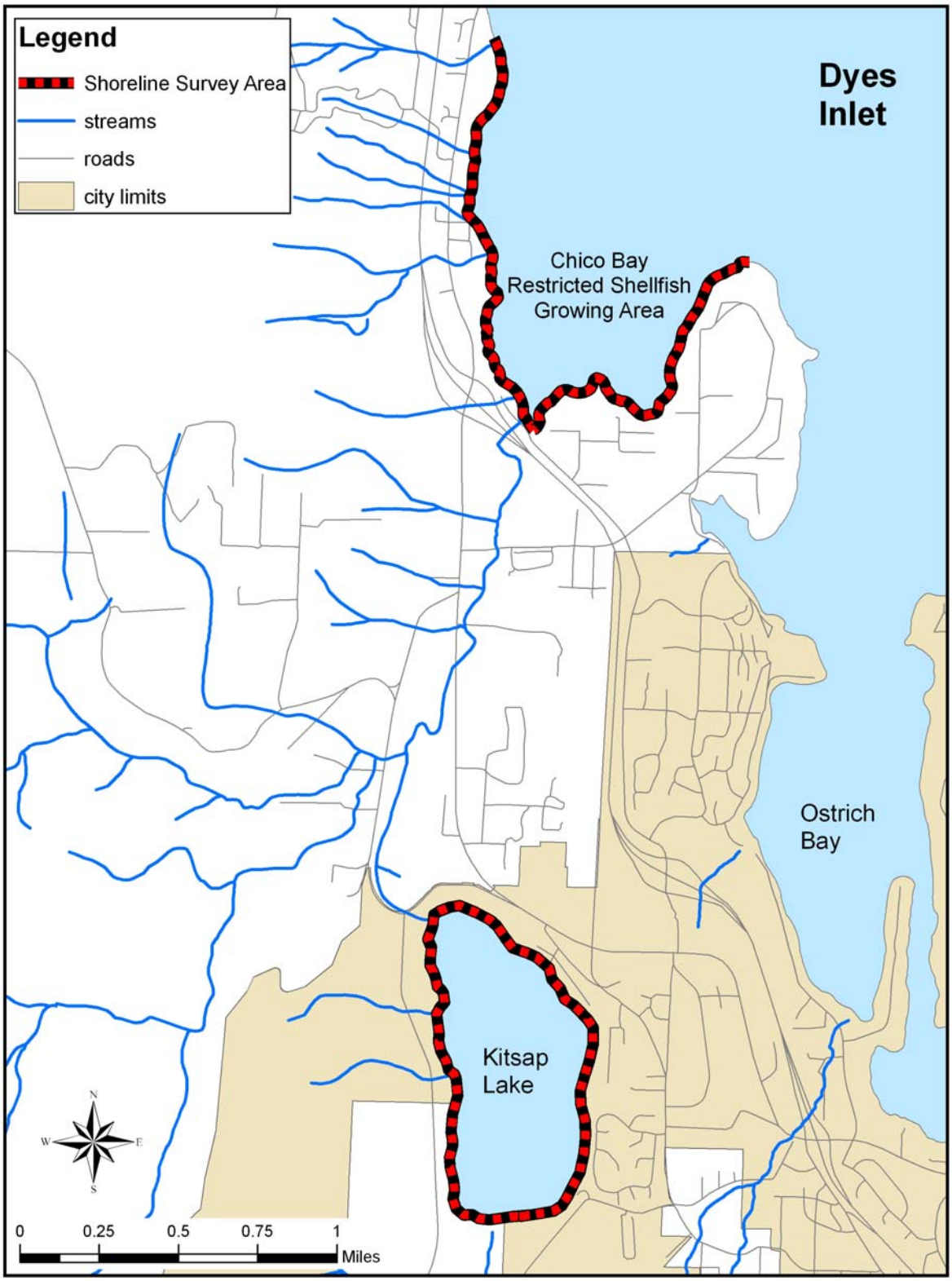
5.2 KITSAP LAKE SHORELINE SURVEYS

Shoreline survey sampling of discharges into Kitsap Lake was performed to assist in the identification of fecal contaminated drainages. Two shoreline surveys were performed according to Section 4.1.2 of the *PIC Protocols*, one during wet weather and one during dry weather. F**igure 2** shows the Kitsap Lake shoreline area surveyed.

5.3 CHICO BAY SHORELINE SURVEYS

Shoreline survey sampling of discharges into Chico Bay was performed to assist in the identification of fecal contaminated drainages. Two shoreline surveys were performed according to the *PIC Protocols*, one during wet weather and one during dry weather. **Figure 2** shows the Chico Bay shoreline area surveyed.

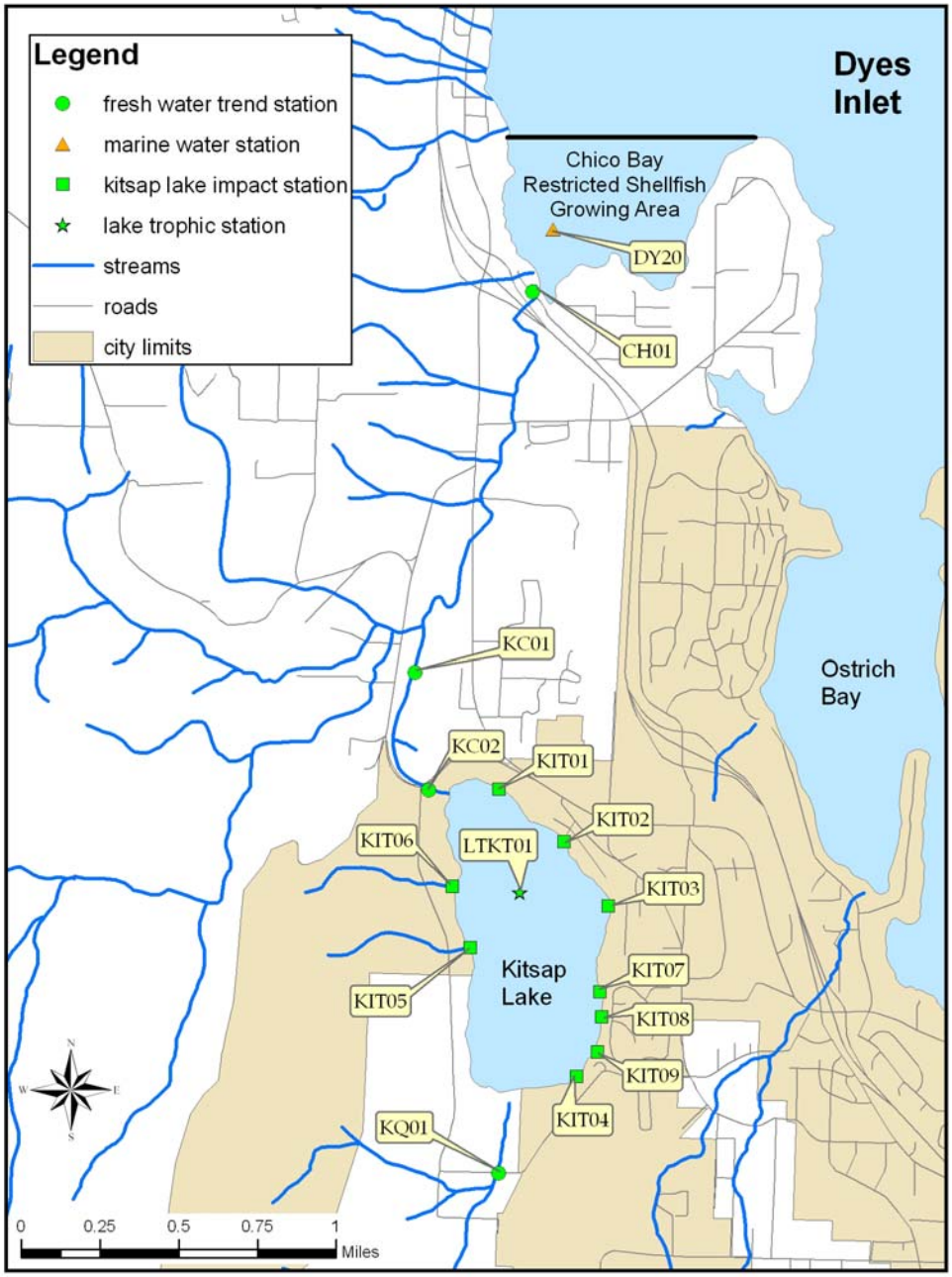
Figure 2. Shoreline Survey Location Map



5.4 WATER QUALITY MONITORING

See **Figure 3** for stream and marine water monitoring station locations, and **Appendix C** for station list. All water quality monitoring was conducted pursuant to the Kitsap Lake/Chico Bay /Quality Assurance Project Monitoring Plan (KCHD, 2003). This document will hereafter be referred to as the QAPP. In the QAPP water samples were to be analyzed for both FC and *E.coli* in anticipation of a planned change in bacterial indicator. However, the change did not occur and, with the approval of Ecology, *E. coli* analysis was not performed.

Figure 3. Kitsap Lake and Chico Bay Trend and Impact Monitoring Stations



The Health District currently conducts monthly monitoring of four (4) stream stations and bimonthly monitoring of one (1) marine station in the Kitsap Lake/Chico Bay area (see **Figure 3** and **Appendix C**). In addition to trend monitoring, the Health District also conducted "impact monitoring" to identify specific sources of FC pollution. Therefore, "impact monitoring" for this project included sampling ten (10) tributaries entering Kitsap Lake during three (3) storm events (i.e. ≥0.5 inches of rainfall over a 24 hour period) to assess their contribution to the in-lake FC problem. Nine (9) of these are impact stations and one (1) is a trend monitoring station.

5.5 EDUCATIONAL ACTIVITIES

The homeowner/resident OSS survey included a strong educational component to proactively educate property owners about how to properly operate and maintain their OSS, to identify any non-conforming conditions that could cause premature OSS failure, and in the Kitsap Lake watershed, reducing nutrient contamination. Educational brochures and water conserving fixtures were made available to all participants. Lake shoreline residents served by sanitary sewer were visited, informed of the project and provided educational materials about reducing nutrient contamination and FC pollution from non-OSS sources, such as pet waste.

One Health District sponsored educational workshop was conducted during the project period to inform residents about onsite sewage system operation and maintenance and nutrient management. Supplemental presentations about the project were given to the Kitsap Lake Neighborhood Association, the Chico Bay Watershed Planning Public Meeting, the Bremerton City Council District 9, and the Kitsap Lake Fair in 2004 and 2005.

6.0 RESULTS AND DISCUSSION

6.1 POLLUTION IDENTIFICATION AND CORRECTION SURVEY

Pollution identification and correction property surveys were conducted from February 2003 through September 2005. During this period, a total of 113 properties were selected for surveys, including 75 lake shoreline and 17 upland properties in Kitsap Lake and 10 marine shoreline and 11 upland properties in Chico Bay. In addition, OSS records were located and evaluated, residents were interviewed, water samples were collected, OSS were dye-tested (when necessary), and OSS and other potential sources were rated according to the *PIC Protocols.*

T**ables 1, 2,** and **3,** and **Figures 4** and **5** summarize the project OSS survey results. OSS were rated according to "Criteria for Rating OSS Inspection Results" in **Appendix B.** A descriptive list of the OSS failures is found in **Appendix D**.

6.1.1 Kitsap Lake Survey Results

Approximately half of the properties were located in the City of Bremerton. The City provided funding to survey properties in the city limits. Additionally, City staff provided free technical assistance to properties with failing OSS that required connection to the sanitary sewer system. Below is a summary of the survey results.

- **7** OSS failures (**8%**) were found
- **2** suspect OSS (**2%**) were found.
- **19** non-conforming OSS (**22%**) were found.
- **28** OSS (**33%**) with no records were found.
- **29** OSS (**34%**) were rated as no apparent problems.
-

Of the seven (7) OSS failures four (4) connected to the sanitary sewer system. The remaining three (3) properties were not within the sewer service boundary and were repaired on-site. The 8% failure rate found in the Kitsap Lake basin is in the middle of the range of failure rates (3% - 16%) found in other areas of Kitsap County surveyed by the Health District over the last twelve years.

6.1.2 Chico Bay Survey Results

Properties bordering Chico Bay, Kitsap Creek and Chico Creek impact the overall water quality of Chico Bay. FC shoreline surveys and complaint investigations during the project period located FC "hotspots" and only properties adjacent to the identified FC "hotspots" were surveyed. This approach resulted in an unusually high OSS failure rate of 37%. Below is a summary of the survey results.

- **7** OSS failures (**37%**) were found.
- **1** suspect OSS (**5%**) was found.
- **7** non-conforming OSS (**37%**) were found.
- **4** OSS (**21%**) were rated as no apparent problems.

6.1.3 Chico Watershed Survey Results

The overall goal of the project is to improve water quality in the Chico Watershed. Therefore, the combined surveyed properties in Kitsap Lake, the creeks and Chico Bay are shown in **Table 3** and **Figure 4**. The total project OSS survey results are:

- **14** OSS failures (**13%**) were found.
- **3** suspect OSS (**3%**) was found.
- **26** non-conforming OSS (**25%**) were found.
- **28** OSS (**27%**) with no records were found.
- **33** OSS (**32%**) were rated as no apparent problems.

One hundred four (104) (**92%)** of the homes in the project area were surveyed, 1 (**1%**) was vacant, 2 (**2%**) did not participate, and 4 (**5%**) denied access for inspection. "Did not participate" means that the property owner and/or occupant never responded to multiple Health District attempts to contact them. The four properties which denied access, and two, which did not participate, were investigated further. Of these six properties, one Kitsap Lake property connected to sewer, four properties were sampled at the shoreline and demonstrated no contribution of FC in the surface water flows, and one property on the Kitsap Lake shoreline remains under investigation for a failing OSS. The participation rate of 92% is in the high end of the participation rate of past projects (73-94%). In general, residents in the project area were

concerned about bacterial pollution and nutrient contamination and readily participated in the project. See **Figure 5** for a summary of the results.

Table 1 Summary of OSS Sanitary Survey Results for Kitsap Lake

Total Properties	Participating properties		Failing		Suspect		Non-Conforming		No Records		No Apparent Problems	
	#	%	#	%	#	%	#	%	#	%	#	%
92	**85**	**92**	**7**	**8**	**2**	**2**	**19**	**22**	**28**	**33**	**29**	**34**

Table 2 Summary of OSS Sanitary Survey Results for Chico Bay

Total Properties	Participating properties		Failing		Suspect		Non-Conforming		No Records		No Apparent Problems	
	#	%	#	%	#	%	#	%	#	%	#	%
21	**19**	**90**	**7**	**37**	**1**	**5**	**7**	**37**	**0**	**0**	**4**	**21**

Table 3. Summary of OSS Sanitary Survey Results for Kitsap Lake and Chico Bay

Total Properties	Participating properties		Failing		Suspect		Non-Conforming		No Records		No Apparent Problems	
	#	%	#	%	#	%	#	%	#	%	#	%
113	**104**	**92**	**14**	**13**	**3**	**3**	**26**	**25**	**28**	**27**	**33**	**32**

Figure 4. Kitsap Lake and Chico Bay OSS Survey Breakdown by Final Rating

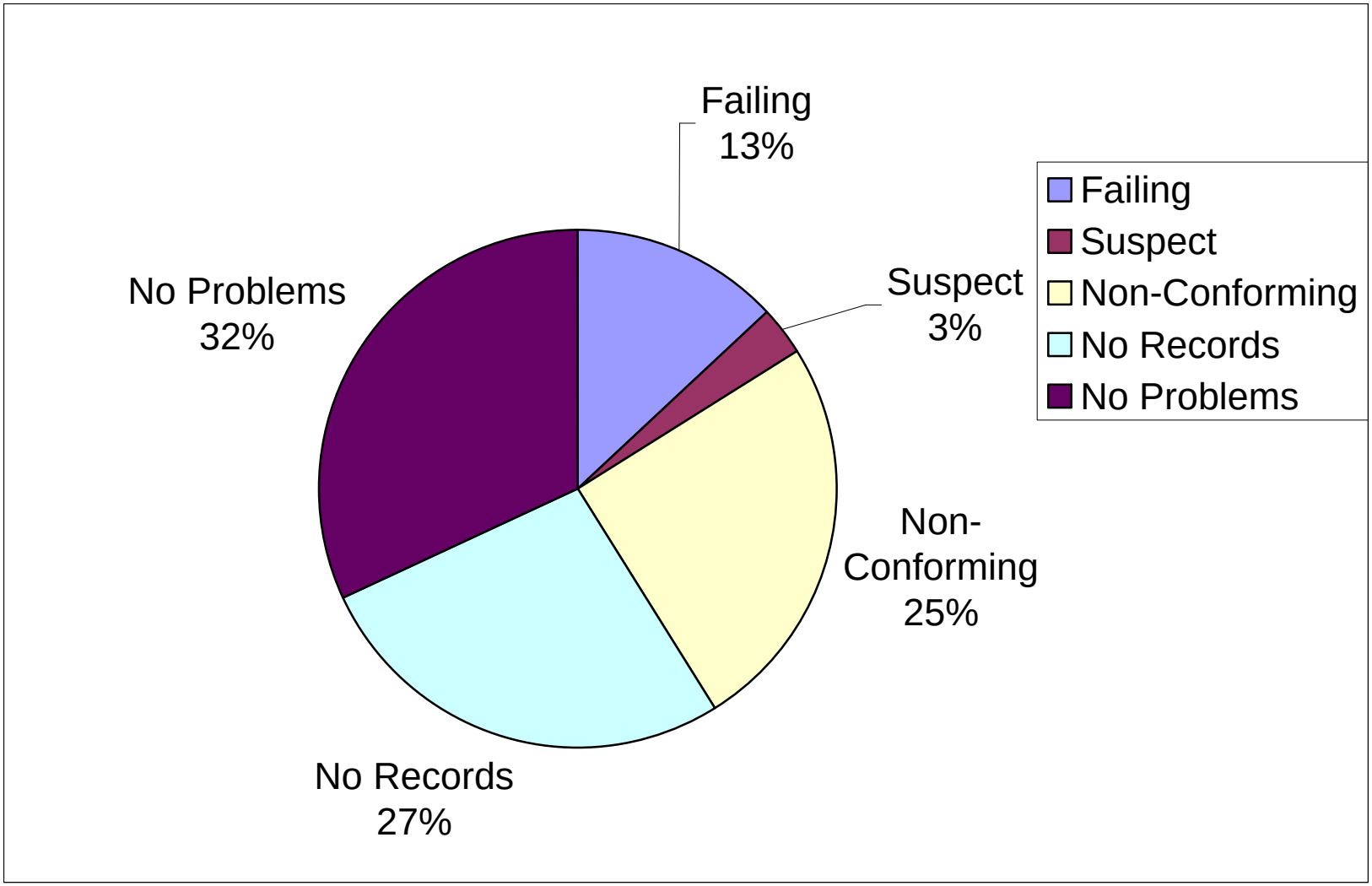
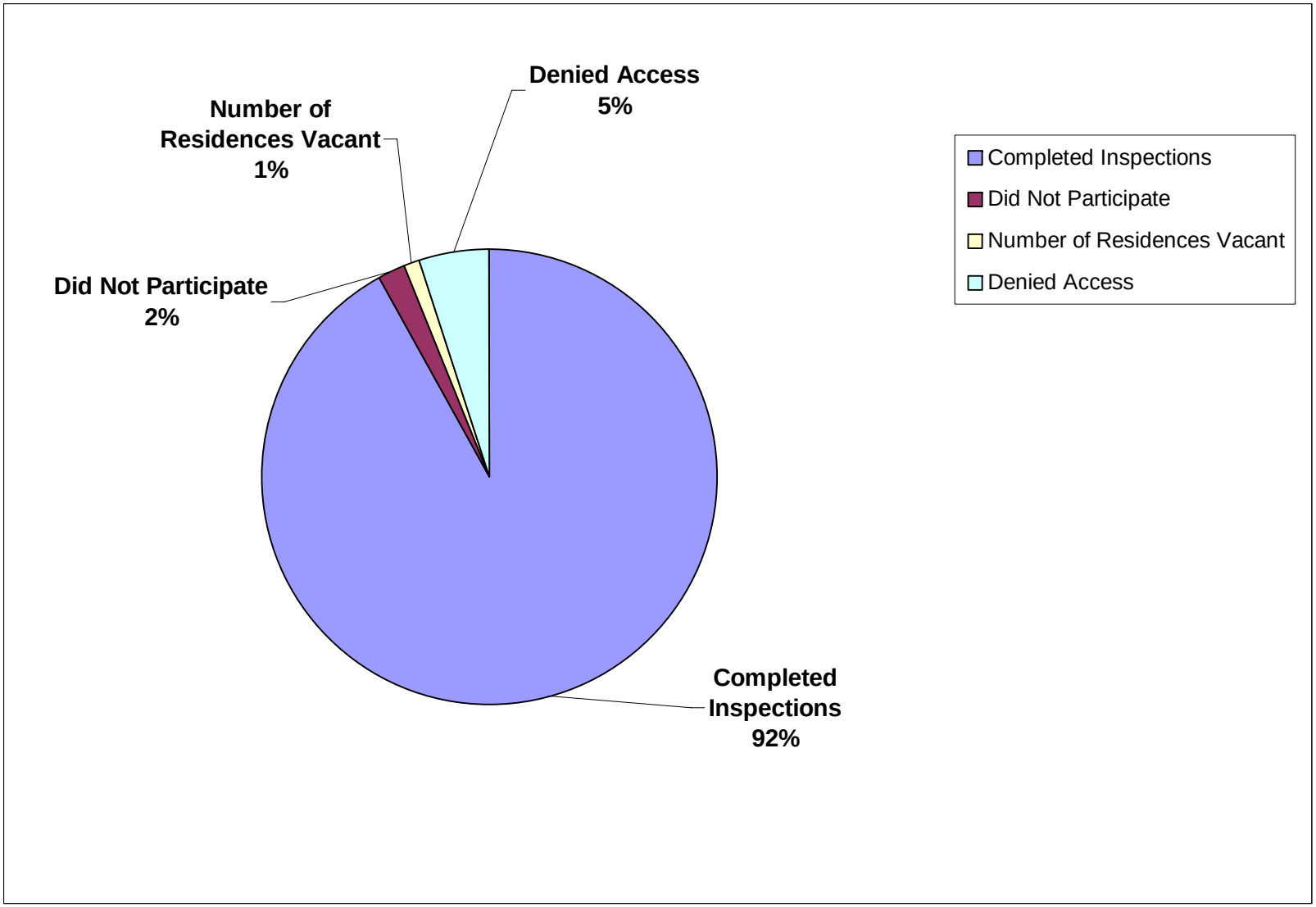


Figure 5. Analysis of Participation



6.1.4 Analysis of Failures

In Kitsap Lake three of the seven (43%) failing OSS discharged directly to the lake. Another three (43%) discharged directly to a roadside ditch upstream of the Kitsap Lake inlet stream station, KQ01. The remaining one (14%) failing OSS was upland but sewage reached the lake during heavy rain events. Four of the seven (57%) were within the City of Bremerton sewer service area and connected.

In Chico Creek and Chico Bay four of the seven (57%) failing OSS discharged directly to the bay. Two of these were grey water discharges. Three of the seven (43%) discharged directly to a roadside ditch upstream of Chico Creek. One of these was a grey water discharge. Additionally, a FC contaminated curtain drain on Chico Bay was found to be caused by a raccoon latrine located at the base of the curtain drain. The latrine was removed and the neighbors have stopped feeding the local raccoon population. Follow-up FC sampling has shown a reduction in FC in the curtain drain discharge.

The following factors have been related to OSS failure in previous surveys. Of these, age of the OSS and homeowner maintenance of the OSS have been the most prevalent causes of failure:

- Age of the OSS;
- Close proximity of the OSS to surface water bodies;
- 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.

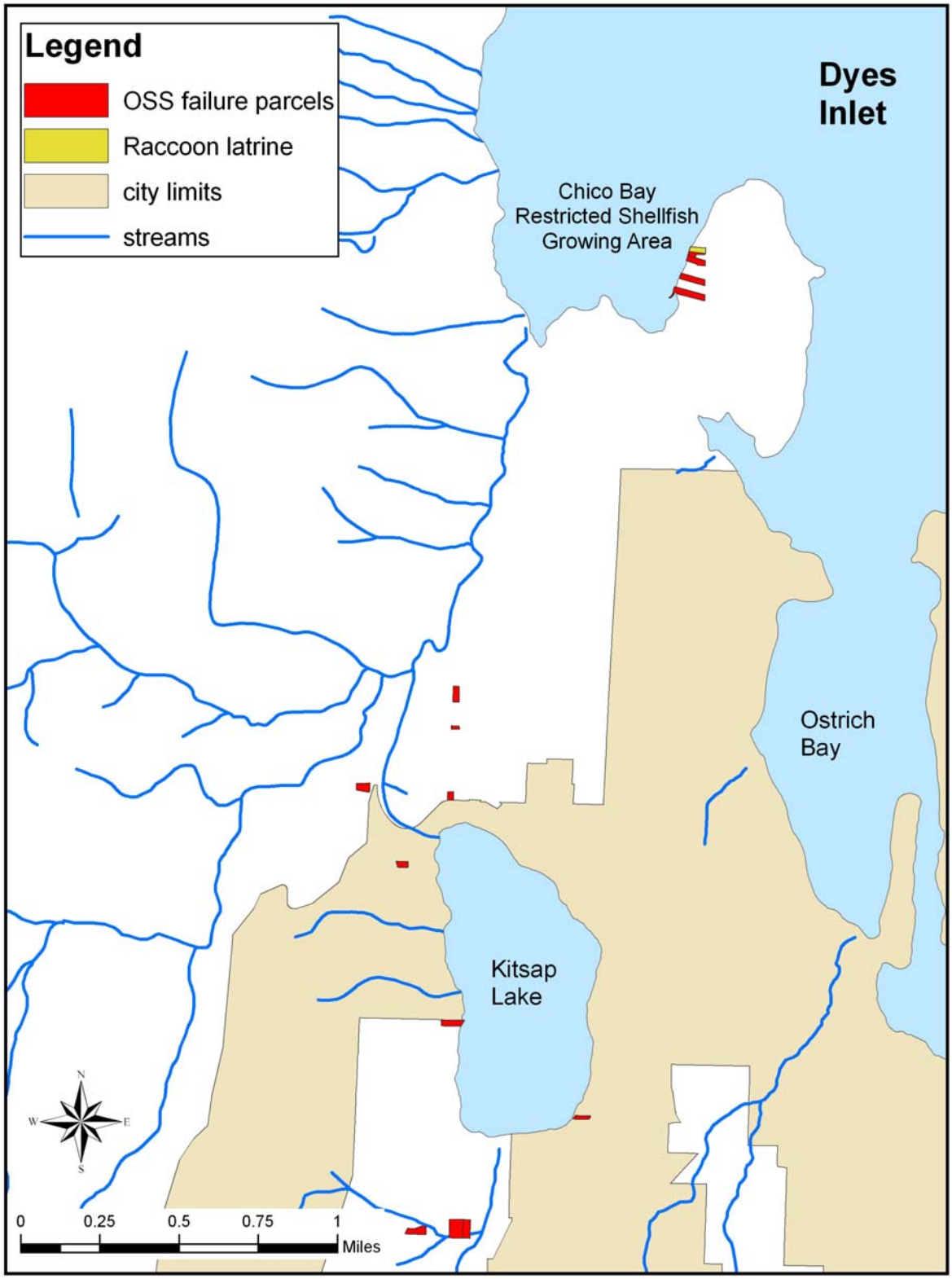
Analysis of failing OSS found in the Kitsap Lake and Chico Bay project area shows that:

- 13 of 14 (93%) of the failing OSS were 20 years old or older;
- 5 of 14 (35%) of the failing OSS were linked to system abuse, damage to the drainfield area, or lack of maintenance;
- 3 of 14 (21%) of the failing OSS had failed, and been repaired, at least once in the past;
- 3 of 14 (21%) of the failing OSS were grey water discharges.

As shown above, age of the system and homeowner maintenance were the most common cause of failure. A map of the FC sources in the project area is shown in **Figure 6.**

All fourteen failing OSS have been repaired (100%). Four (29%) connected to sewer, three (21%) rerouted greywater to the septic tank, one was repaired with a standard gravity system on a drainfield easement, one was repaired with an alternative OSS, and five were repaired by modifications to the existing OSS: abandoned curtain drain, replaced broken distribution box, added curtain drain to divert groundwater from the drainfield, replaced broken transport line, and standard tank maintenance. The five OSS repaired by modifications were verified as corrected with follow up dye testing and FC sampling.

Figure 6. FC Source Location Map



6.2 POLLUTION IDENTIFICATION RELATED WATER QUALITY MONITORING– SHORELINE SURVEY AND IMPACT MONITORING RESULTS

The purpose of the shoreline surveys and impact monitoring were to assist with identification of FC contaminated drainages. Shoreline surveys were performed according to the *PIC Protocols.* Shoreline discharges were rated as low, medium or high priority dependent upon the FC geometric mean of the two samples. See **Figure 3** for the locations of the shoreline areas surveyed.

6.2.1 Kitsap Lake Shoreline Surveys

Two shoreline surveys of the Kitsap Lake shoreline were performed. One survey was performed September 20, 2002 under dry weather conditions, no previous rainfall for seven days. Eight (8) shoreline discharge samples were collected and one (1) was confirmed to be a high priority level of fecal bacteria with additional sampling.

The wet weather shoreline survey was conducted on December 17, 2002. The rainfall total during the previous 24 hours was 0.96 inches. Fifteen (15) shoreline discharge samples were collected and two (2) were confirmed be of moderate or high priority levels of fecal bacteria with follow-up sampling. More samples from the shoreline were expected. However, since the lake level is higher in the winter, many shoreline curtain drains are covered and are not accessible to collected discrete samples representative of flows from the property.

The one confirmed high FC site from the dry weather survey was a sump pump discharge from a small residential pond. Of the two priority discharges from the wet weather surveys, one was found to be a failing OSS. The remaining discharge was investigated and no source was positively identified.

6.2.2 Chico Bay Shoreline Surveys

Two shoreline surveys of the Chico Bay shoreline were performed. The first wet weather survey was performed on the shoreline section at the mouth of Chico Creek to the northern border of the survey area (see **Figure 3**) on November 19, 2003. The rainfall total during the previous 24 hours was 1.76 inches. Fifteen (15) shoreline discharge samples were collected and one (1) was confirmed be of moderate priority level for fecal bacteria. The second wet weather survey was performed on the shoreline section at the mouth of Chico Creek to the southern border of the survey area on January 22, 2003. The rainfall total during the previous 24 hours was 0.71 inches. Nineteen (19) shoreline discharge samples were collected and five (5) were confirmed be of moderate priority level for fecal bacteria.

Three (3) of the five (5) moderate and high priority sites resulted in identifying two failing OSS. One priority site was due to raccoon waste and another priority site was due to waterfowl residing on a residential lawn.

6.2.3 Impact Monitoring Results

Nine impact stations and trend monitoring station KQ01, inlet stream to Kitsap Lake, were sampled during three wet weather events. They were sampled on January 22, 2003, April 21, 2003 and May 26, 2004. The previous 24 hour rainfall was 0.71 inches, 0.27 inches, and 0.32 inches, respectively. The geometric mean of each station is shown in **Figure 7** and **Table 4**. Each station is color coded according to the PIC Protocols priority rating of low, medium and high where the geometric mean is 0-200 FC/100ml, 201-499 FC/100ml, and >500 FC/100ml, respectively.

Figure 7. Impact Station Monitoring Results Map

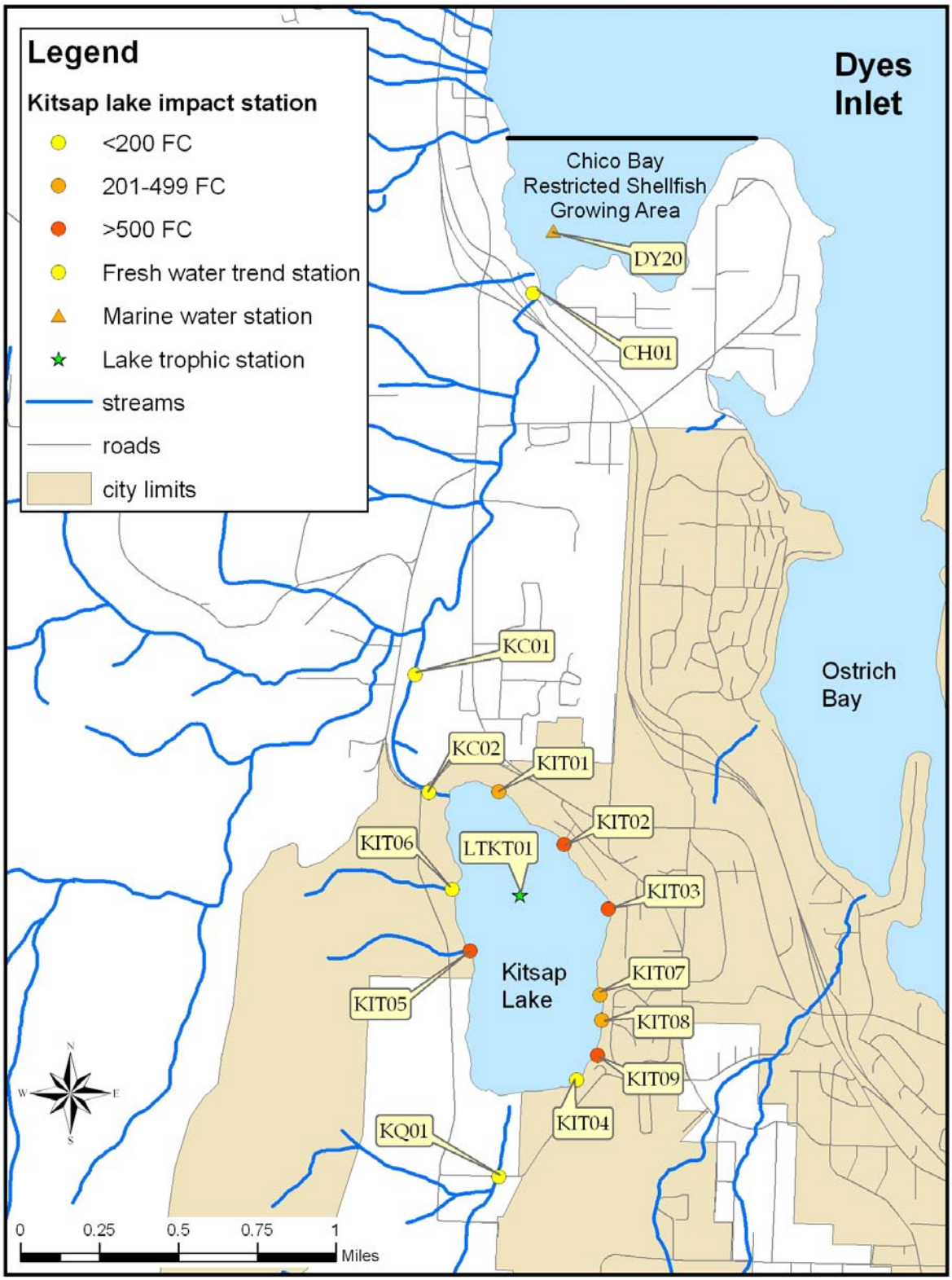


Table 4. Summary of Impact Monitoring for Kitsap Lake

Station Name	Basin Description	FC Geometric Mean	FC Priority
KIT01	Drainage ditch from residential area served by OSS and stormwater runoff	344	Medium
KIT02	Drainage ditch from residential area served by sewer and stormwater runoff	1126	High
KIT03	Drainage ditch from residential area served by sewer	1744	High
KIT04	Drainage ditch from residential area served by sewer	200	Low
KIT05	Drainage area from undeveloped land	970	High
KIT06	Drainage area from undeveloped land	3	Low
KIT07	Residential stormwater piped conveyance system, sewered	252	Medium
KIT08	Residential stormwater piped conveyance system, sewered	379	Medium
KIT09	Residential stormwater piped conveyance system, sewered	761	High
KQ01	Stream inlet to Kitsap Lake, residential area served by OSS	183	Low

Four sites; KIT02, KIT03, KIT05, and KIT09; were rated as "high" priority due to FC pollution concentrations greater than 500 FC/100ml. Three of these impact sites; KIT02, KIT03 and KIT09, are basins served predominately by the City of Bremerton sewer system. The high priority sites in the City of Bremerton were investigated and one OSS was found in the KIT03 drainage. The OSS was dye tested and was found to be functioning properly. FC pollution may be from other sources including stormwater runoff, pet waste, or failing sewer infrastructure. KIT05, the fourth high priority drainage, is located in an area of undeveloped land. This drainage is in an area of a known high density population of raccoons, which may be the source of the FC pollution.

6.3 POLLUTION CORRECTION RELATED WATER QUALITY MONITORING – TREND, LAKE TROPHIC, RAINFALL CORRELATION AND BMPE RESULTS

Pursuant to the grant agreement, all raw data collected for this project has been provided in **Appendix E**, and an electronic version will be delivered on compact disk. The following water quality monitoring will be discussed:

- Trend monitoring of Chico Bay (DY20) , the stream mouth of Chico Creek (CH01), the inlet and outlet streams of Kitsap Lake (KQ01 and KC02, respectively) and Kitsap Creek (KC01);
- Analysis of trend data and the correlation of rainfall;
- Phosphorous data for trophic classification of Kitsap Lake; and
- Best management practices effectiveness monitoring.

Please see **Figure 2** and **Appendix C** for station locations. Please see **Appendix E** for raw data. Below are descriptions of each type of monitoring and the corresponding results:

6.3.1 FC Trend Monitoring

Below are the data tables and statistical analysis for each trend monitoring station.

Table 5
Kitsap Lake Inlet Creek (KQ01) FC Results Summary, Water Years 2003 - 2005

Water year	Number of Samples	Range (FC/100ml)	GMV[1] (FC/100ml)	# Samples >200 FC/100ml	% Samples >200 FC/100ml	Meets WQ Standard[2]
2003	9	8 - 900	45	2	22%	No
2004	12	<2 – >1600	55	3	25%	No
2005	12	2 – 900	36	2	17%	No

Shaded entries indicate an exceedance of the applicable water quality standard (Chapt.173 – 201A-030 WAC)
[1] Geometric mean value
[2] State standard- FC levels shall not exceed a GMV of 100 FC/100ml and not have more than 10% of all samples exceed 200 FC/100 ml.

Figure 8. FC Trend Analysis for Kitsap Lake Inlet Creek, KQ01

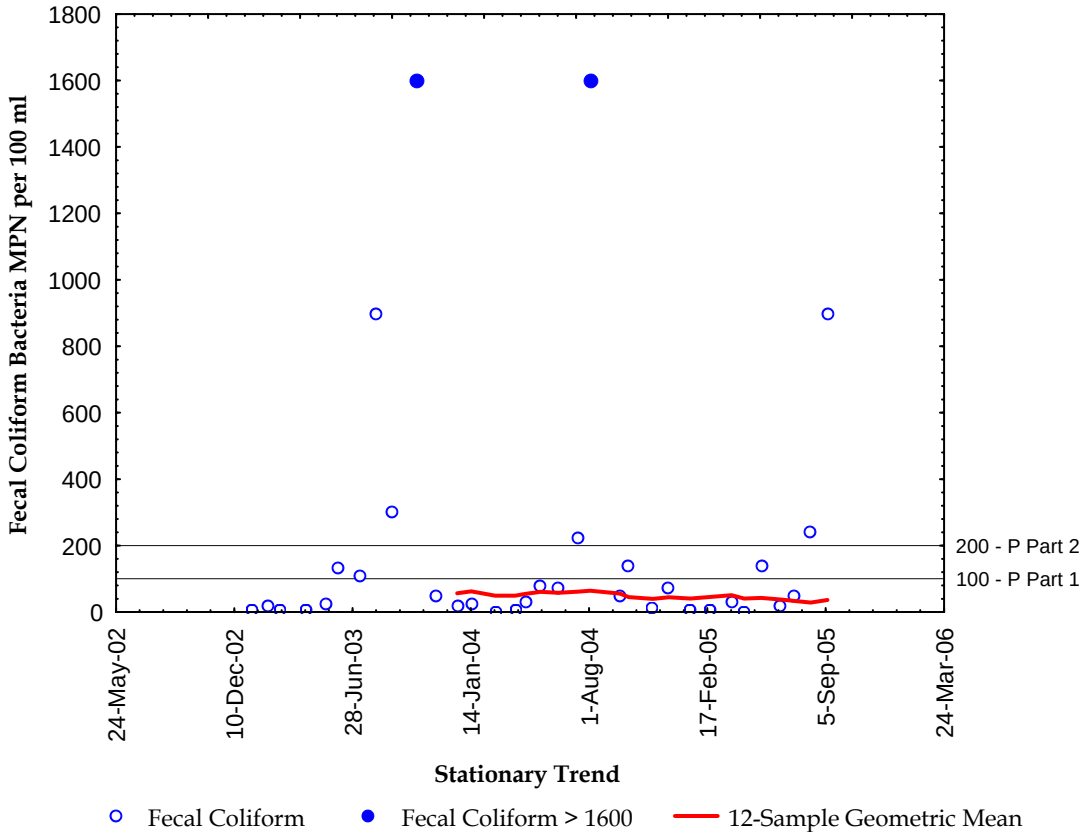


Table 6
Kitsap Creek, Lake Outlet, (KC02) FC Results Summary, Water Years 1996 - 2005

Water year	Number of Samples	Range (FC/100ml)	GMV[1] (FC/100ml)	# Samples >200 FC/100ml	% Samples >200 FC/100ml	Meets WQ Standard[2]
2002	12	17 - 900	77	4	33%	No
2003	12	2 - 170	16	0	0%	Yes
2004	12	<2 –300	12	1	8%	Yes
2005	12	<2 –300	19	2	17%	No

Shaded entries indicate an exceedance of the applicable water quality standard (Chapt.173 – 201A-030 WAC)
[1] Geometric mean value
[2] State standard- FC levels shall not exceed a GMV of 100 FC/100ml and not have more than 10% of all samples exceed 200 FC/100 ml.

Figure 9. FC Trend Analysis for Kitsap lake Outlet Creek, KC02

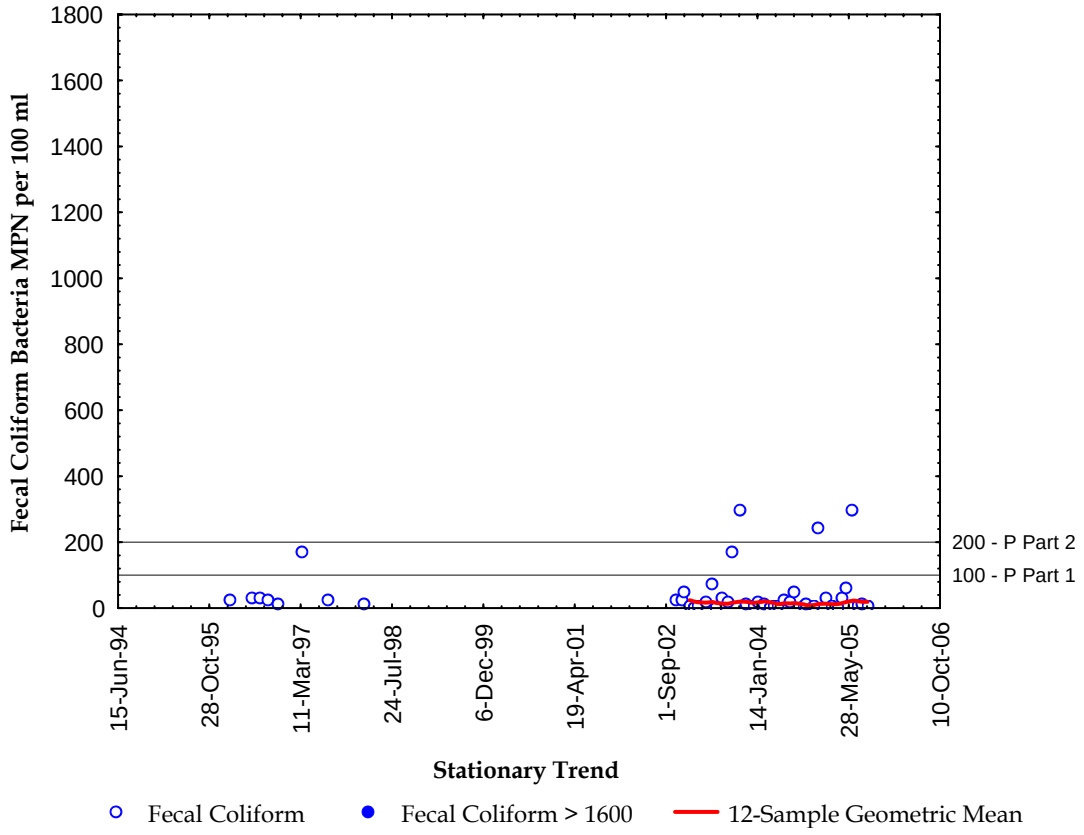


Table 7
Kitsap Lake Creek (KC01) FC Results Summary, Water Years 1996 - 2005

Water year	Number of Samples	Range (FC/100ml)	GMV[1] (FC/100ml)	# Samples >200 FC/100ml	% Samples >200 FC/100ml	Meets WQ Standard[2]
1996	4	13 - >900	58	1	25%	No
1997	6	30 - 1600	101	2	33%	No
1998	9	2 - 500	24	1	11%	No
1999	8	4 - 50	17	0	0%	Yes
2000	5	4 - 170	27	0	0%	Yes
2001	11	2 – 900	33	1	9%	Yes
2002	12	<2 - 240	18	1	8%	Yes
2003	12	2 - 300	19	1	8%	Yes
2004	12	8 – 900	72	3	25%	No
2005	11	2 – 900	36	2	18%	No

Shaded entries indicate an exceedance of the applicable water quality standard (Chapt.173 – 201A-030 WAC)
[1] Geometric mean value
[2] State standard- FC levels shall not exceed a GMV of 100 FC/100ml and not have more than 10% of all samples exceed 200 FC/100 ml.

Figure 10. FC Trend Analysis for Kitsap Creek, KC01

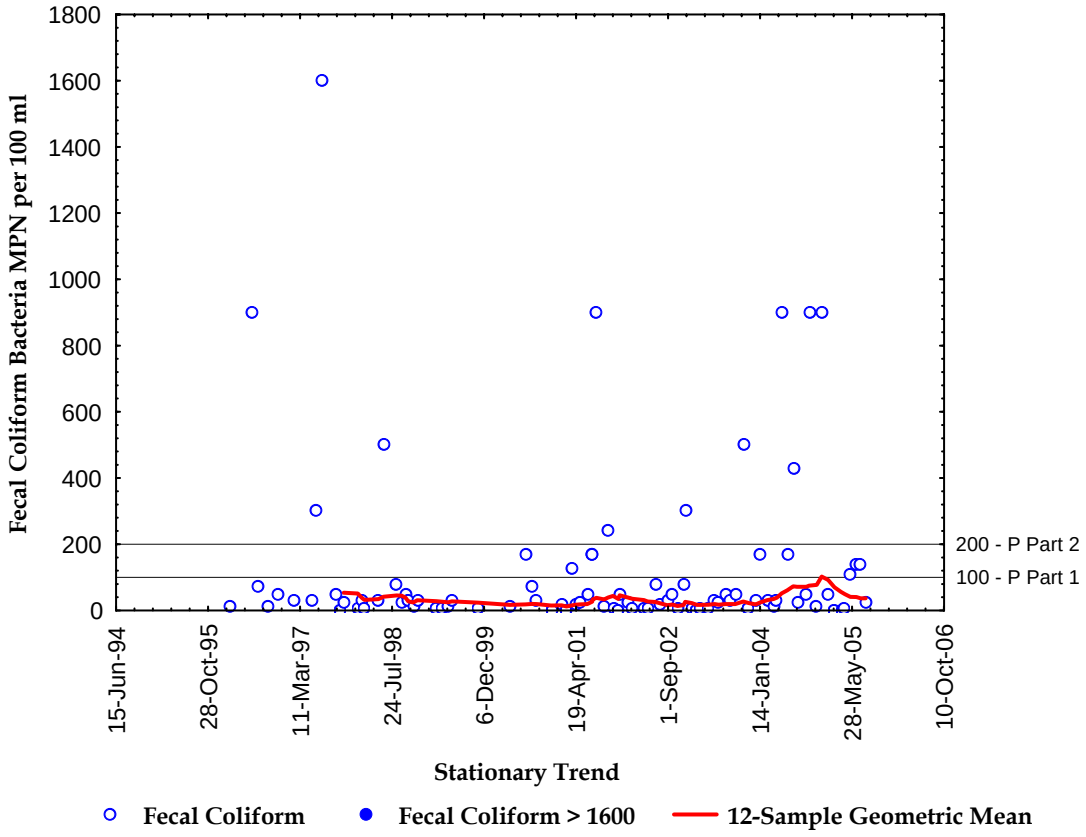


Table 8
Chico Creek (CH01) FC Results Summary, Water Years 1996 - 2005

Water year	Number of Samples	Range (FC/100ml)	GMV[1] (FC/100ml)	# Samples >200 FC/100ml	% Samples >200 FC/100ml	Meets WQ Standard[2]
1996	5	14 - 300	80	2	40%	No
1997	9	8 - ≥1600	76	3	33%	No
1998	9	4 - ≥1600	39	1	11%	No
1999	10	3 - 49	23	0	0%	Yes
1900	8	2 - 170	43	0	0%	Yes
2001	13	4 - 110	21	0	0%	Yes
2002	12	7 - 170	31	0	0%	Yes
2003	12	4 - 80	28	0	0%	Yes
2004	12	7 – 900	45	1	8%	Yes
2005	12	4 – 220	38	1	8%	Yes

Shaded entries indicate an exceedance of the applicable water quality standard (Chapt.173 – 201A-030 WAC)
[1] Geometric mean value
[2] State standard- FC levels shall not exceed a GMV of 100 FC/100ml and not have more than 10% of all samples exceed 200 FC/100 ml.

Figure 11. FC Trend Analysis of Chico Creek, CH01

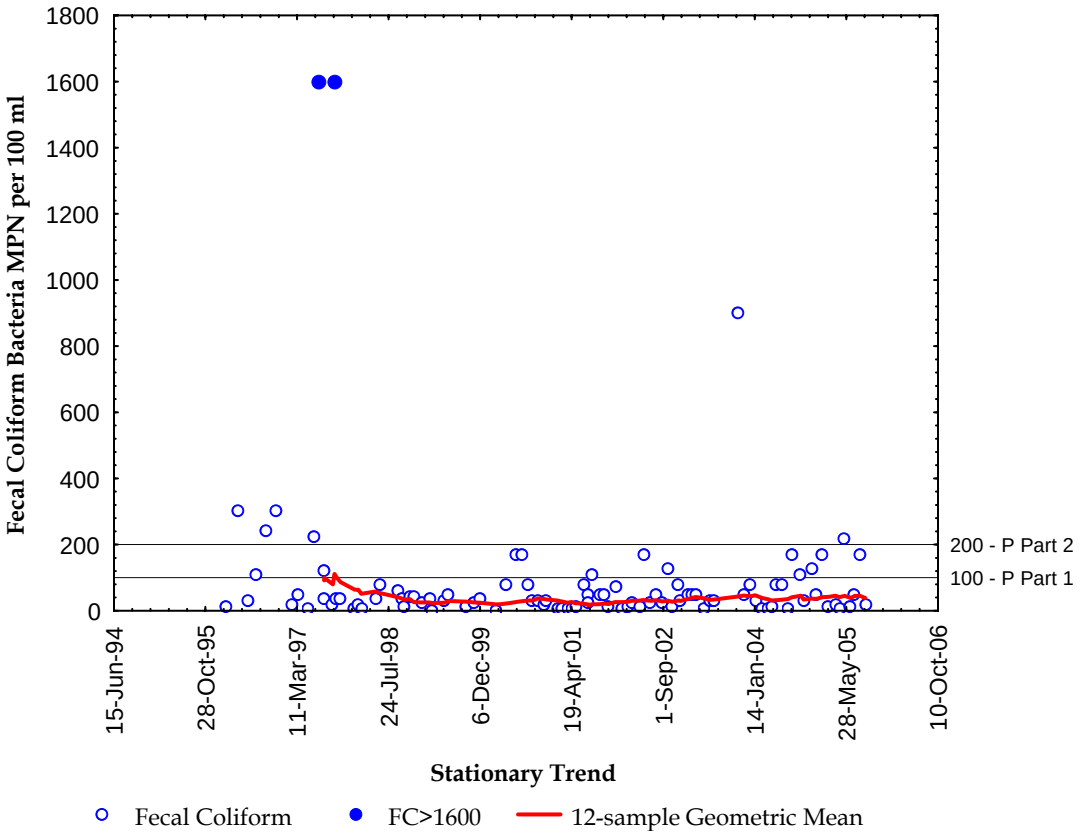


Table 9
Dyes Inlet Chico Bay (DY20) FC Results Summary, Water Years 1996 - 2005

Water year	Number of Samples	Range (FC/100ml)	GMV[1] (FC/100ml)	# Samples >43 FC/100ml	% Samples >43 FC/100ml	Meets WQ Standard[2]
1996	3	<2 - 23	3	0	0%	Yes
1997	8	<2 - 59	6	2	25%	No
1998	9	<2 - 75	7	2	22%	No
1999	8	<2 - 85	7	1	13%	No
2000	4	2 - 50	5	1	25%	No
2001	6	<2 - 300	6	1	17%	No
2002	6	<2 - 170	4	1	17%	No
2003	11	<2 - 80	3	1	9%	Yes
2004	6	2 – 80	16	2	33%	No
2005	6	<2 – 21	3	0	0%	Yes

Shaded entries indicate an exceedance of the applicable water quality standard (Chapt.173 – 201A-030 WAC)
[1] Geometric mean value
[2] State standard- FC levels shall not exceed a GMV of 14 FC/100ml and not have more than 10% of all samples exceed 43 FC/100 ml.

Figure 12. FC Trend Analysis for Dyes Inlet Chico Bay, DY20

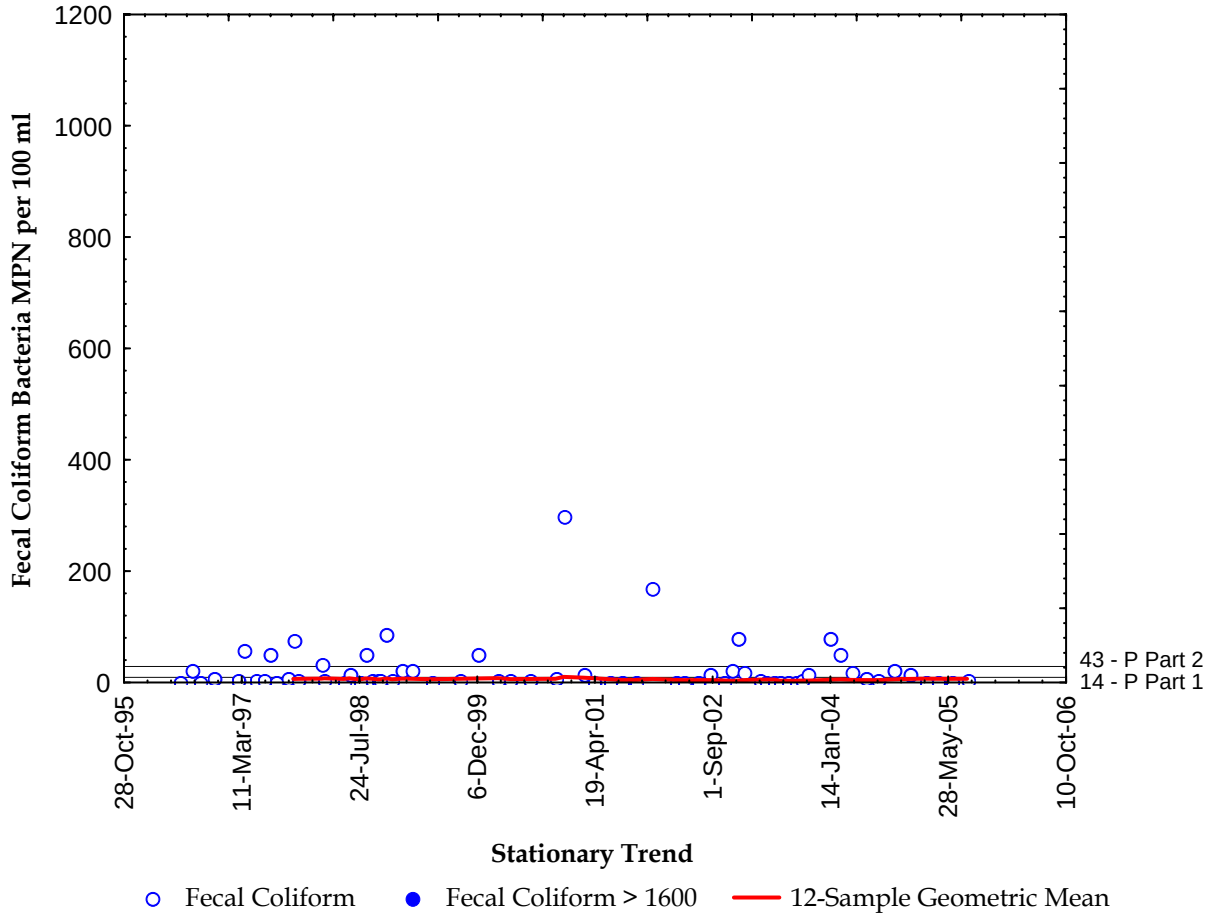


Table 10
Dyes Inlet Chico Bay (DY20) FC Results Summary, Last 30 Samples, July 30, 2001-September 30, 2005

Number of Samples	Range (FC/100ml)	GMV[1] (FC/100ml)	# Samples >43 FC/100ml	% Samples >43 FC/100ml	Meets WQ Standard[2]
30	<2 - 170	4	4	13%	No

Shaded entries indicate an exceedance of the applicable water quality standard (Chapt.173 – 201A-030 WAC)

[1] Geometric mean value

[2] State standard- FC levels shall not exceed a GMV of 14 FC/100ml and not have more than 10% of all samples exceed 43 FC/100 ml.

Property surveys began in February 2003 and were completed in September 2005. A majority of the FC pollution corrections were performed in 2003 and 2004 in Kitsap Lake, and 2005 in Chico Bay. Statistical trends at all stations are stationary. However, freshwater stations located at Kitsap Lake Inlet (KQ01) and Kitsap Lake Creek, (KC01) show slight FC improvements in both the Part 1 and Part 2 FC standards. During Water Year 2004 DY20, Chico Bay, failed both Parts of the standard for the first time in eight years. However, in Water Year 2005, the station met both parts of the FC standard for only the third time in ten years. Analysis of the most recent thirty samples at DY20 shows that it meets Part 1 and fails Part 2. If the apparent water quality

improvements are maintained, this station may improve to meet Part 2 in the 30 sample geometric mean and 90th percentile analysis used by WSDOH.

6.3.2 Lake Trophic Monitoring

Phosphorous is the limiting nutrient in Kitsap Lake. In excess, it is a food source for algae. Kitsap Lake has experienced blue green algae blooms annually during the Fall since the 1980's. Phosphorous is a component of human sewage and can be contributed in significant amounts by a failing OSS, especially if it is a grey water discharge.

A total of three failing OSS that discharged directly to Kitsap Lake were found and corrected. One of these failing OSS one was a direct greywater discharge. The remaining four failing OSS reached the lake through roadside ditches or during rain events.

The Health District monitors selected lakes in Kitsap County to determine the trophic status. Kitsap Lake is sampled in the Fall and Spring in the deepest portion. **Figure 13** and **Figure 14** show the Fall and Spring phosphorous concentrations for Kitsap Lake. The Ecology action level for phosphorus is 20 ug/ml.

Figure 13. Kitsap Lake Spring Phosphorous Concentrations

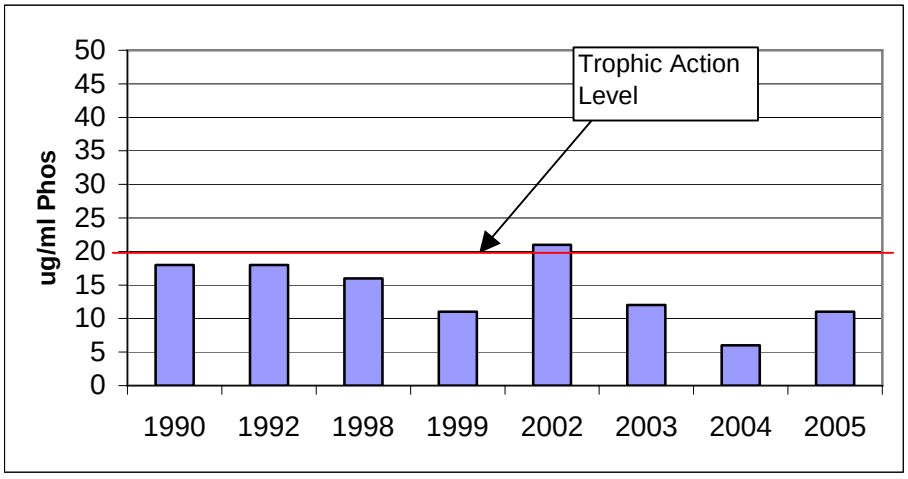
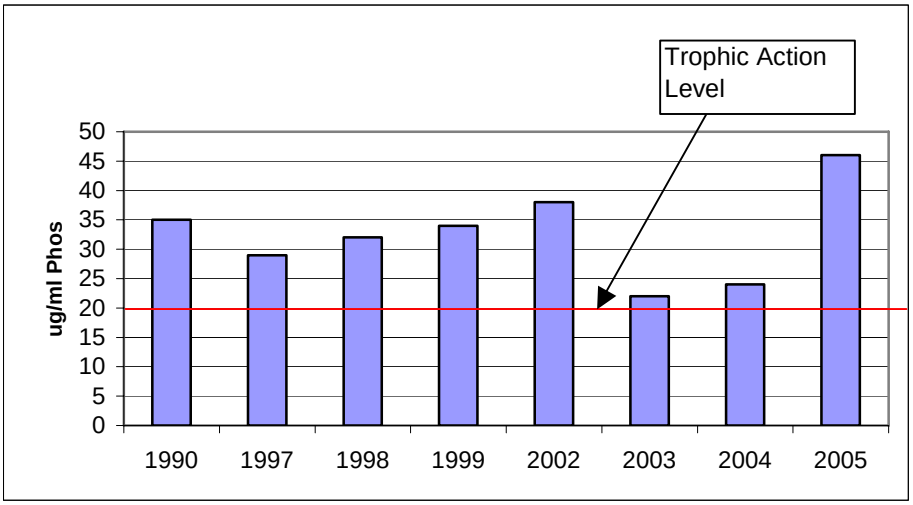


Figure 14. Kitsap Lake Fall Phosphorous Concentrations



The spring phosphorus concentrations are well below the action level, except in 2002. The Fall phosphorus concentrations are above the action level. The phosphorous level appeared to decline in 2003 and 2004. However, in 2005 a sharp increase in phosphorous was observed. Additionally, it is interesting to note that 2005 was the first Fall the lake did not experience a severe algae bloom, which it experienced annually since 1996. The Health District will continue to monitor phosphorous levels in Kitsap Lake which may verify an increasing or declining trend.

6.3.3 Rainfall Correlation and FC

Trend monitoring data was analyzed for correlation of FC and previous 24, 48 and 72 hour rainfall depths. Data collected during the project period of February 2003 through September 2005 were selected. FC and rainfall for all previous rainfall depth periods at Kitsap Lake inlet stream (KQ01), outlet stream (KC02), Kitsap Creek (KC01) and Chico Creek (CH01) showed weak insignificant correlations. However, at Chico Bay (DY20) there was a good correlation at 48 hours previous rainfall depth, with a total correlation of 0.67. When the data were separated into ebb (outgoing) and flood (incoming) tidal conditions, the correlation improved under flood tide conditions, at 0.96. WSDOH has determined that contamination in Chico Bay is more likely under ebb tide conditions, during which the FC concentrations are higher at some Chico Bay monitoring stations (Bob Woolrich, WSDOH, personal communication). These higher FC concentrations are not as correlated to rainfall and may be more associated with the failing OSS discharges that were found in this project.

Table 11. Correlation of 48 Hour Previous Rainfall and FC at Chico Bay DY20

	Correlation Coefficient
All Data	0.67
Ebb Tide Only	0.37
Flood Tide Only	0.96

6.3.4 Best Management Practices Effectiveness Monitoring

Eight sites, three (3) on Chico Bay, one (1) on Chico Creek and four (4) on Kitsap Lake, were monitored for the effectiveness of the best management practice implemented. **Table 12** summarizes the FC concentrations of the flows before and after the correction process was completed. All sites showed FC concentration reductions or cessation of the contaminated flow after the identified FC sources were corrected.

Table 12. Summary of Water Quality Monitoring Before and After Corrections

Property Identification	Before Correction GMV FC/100ml (number of samples)	After Correction GMV FC/100ml (number of samples)	Type of Correction
Chico Creek #1	>1600 (2)	9 (3)	Maintenance of OSS
Chico Bay #2	>1600 (2)	72 (3)	Replace broken D-box
Chico Bay #3	>1600 (2)	No flow	Grey water discharge routed to septic tank
Chico Bay #4	>1600 (2)	120 (2)	Racoon Latrine removed
Kitsap Lake #1	>1600 (2)	4 (2)	Removed curtain drain
Kitsap lake #2	>1600 (1)	No flow	Broken transport line repaired
Kitsap Lake #3	>1600 (1)	No flow	Connected to sewer
Kitsap Lake #4	>1600 (1)	170 (2)	Connected to sewer

6.4 EDUCATIONAL ACTIVITIES

Two public meetings were conducted by Health District staff during the project period: Project "Kick Off" and Project Update & Nonpoint Source Pollution Workshop. Direct mailings and press releases were used to inform residences of the meetings. A total of 57 property owners attended these meetings.

Septic system operation and maintenance and nutrient management were the primary focuses of the Kitsap Lake and Chico Bay Project. The Nonpoint Source Pollution Workshop featured guest speakers from the Kitsap Surface and Stormwater Management and Kitsap County Public Works with presentations about stormwater runoff and natural yard care practices. Health District staff provided homeowners surveyed with educational brochures and a copy of their sewage disposal permit/as-built (if available) for their home. Lake nutrient management education was provided to Kitsap Lake residents surveyed in the 39 shoreline properties served

by the City of Bremerton sewer, at the Kitsap Lake Neighborhood Association meetings and the Kitsap Lake Fair.

7.0 CONCLUSIONS

The findings of the Kitsap Lake and Chico Bay Pollution Identification and Correction Project are:

- Public participation was high as indicated by the 92% participation rate.
- Fifteen (15) FC pollution sources were identified during the project, including 14 failing OSS and 1 urban wildlife waste source. All 15 FC sources have been corrected.
- FC levels are statistically stationary but show non-statistical reductions in Chico Bay, Kitsap Lake inlet stream, Kitsap Creek and Chico Creek. Phosphorous levels in Kitsap Lake show non-statistical reductions in the Spring, but a recent elevated Fall sampling may indicate a new problem. The Health District will continue to monitor phosphorous levels in Kitsap Lake to verify the increasing or declining trend.
- Age of the OSS and homeowner maintenance were the primary reasons for OSS failure in the project area. Three (3) OSS were determined to directly discharge to Kitsap Lake and four (4) were determined to directly discharge to Chico Bay.
- Shoreline surveys in Chico Bay resulted in a high OSS failure rate (37%), confirming the usefulness of marine shoreline surveys on marine shorelines to target FC pollution problems. Shoreline surveys on Kitsap Lake were less successful due to the lack of accessible discharge points during high winter lake levels. Many discharge points may be covered.
- Impact monitoring showed local stormwater runoff to be a significant source of FC during rain events.
- Monitoring of best management practices at eight (8) FC contaminated sites show significant FC reductions in flows to Kitsap Lake and Chico Bay.

8.0 RECOMMENDATIONS

Based upon the conclusions of the Kitsap Lake and Chico Bay Pollution Identification and Correction Project, the Health District recommends the following:

- The Health District continue monitoring Kitsap Lake, Kitsap Creek, Kitsap Lake inlet stream, Chico Creek and Chico Bay as part of the baseline water quality-monitoring program.

- The Health District continue monitoring Kitsap Lake for nutrients and algae blooms.

- The Health District complete investigating two water quality complaints for FC sources. Any sources found will be corrected.

- The Health District partner with the City of Bremerton to reduce FC contamination of local stormwater runoff into Kitsap Lake.

- The Health District explores funding sources for studies to identify non-failing OSS contributing phosphorus.

- The Health District partner with the City of Bremerton to educate residents about reducing nutrients impacts from residential properties in the Kitsap Lake watershed.

- The Health District request Washington State Department of Health to perform an analysis of Chico Bay water quality for the purpose of upgrading the shellfish beds from *Restricted* to *Conditionally Approved.*

9.0 REFERENCES

Washington State Department of Ecology, Clean Water Act Section 303(d) List of Impaired Surface Waters, 1996, 1998, and 2005.

Kitsap County Health District. Manual of Protocol: Fecal Coliform Bacteria Pollution Identification and Correction Projects, 2003.

Washington State Department of Ecology. Chapter 173-201A of the Washington Administrative Code Water Quality Standards for Surface Waters of the State of Washington, 1992.

Parametrix, Inc., Kitsap Lake-A Restoration Analysis and Watershed Management Plan, 1983.

Bremerton-Kitsap County Board of Health, Ordinance Number 1996-8, Rules and Regulations of the Governing Onsite Sewage Disposal, 1996.

Washington State Department of Natural Resources, Soil Survey of Kitsap County Area, Washington, 1980.

Bremerton Kitsap County Health District. Water Quality Monitoring Report, 1997, 1999, and 2003.

Bremerton Kitsap County Health District . Kitsap Lake/Chico Bay Pollution Identification and Correction Project Quality Assurance Project Plan, June 2003.

Washington State Department of Health, Office of Shellfish Programs, Sanitary Survey of Chico Bay, December 1993.

Kitsap County Health District. Lake Trophic Assessment Monitoring Plan. 2004.

Appendix A. Historical Water Quality Data for Kitsap Lake and Chico Bay

Table 1
Fresh Water Stream Fecal Coliform (FC) Results
Kitsap Creek (KC01), Water Years 1996 - 2002

Water year	Number of Samples	Range (FC/100ml)	GMV[1] (FC/100ml)	# Samples >200 FC/100ml	% Samples >200 FC/100ml	Meets WQ Standard[2]
96	4	13 - 900	58	1	25%	No
97	6	30 - 1600	101	2	33%	No
98	9	2 - 500	24	1	11%	No
99	7	8 - 50	21	0	0%	YES
00	5	4 - 170	27	0	0%	YES
01	11	2 - 900	33	1	9%	YES
02	11	4 - 240	24	1	9%	YES

Shaded entries indicate an exceedance of the applicable water quality standard (Chapt.173 – 201A-030 WAC)
[1] Geometric mean value
[2] Class A - FC levels shall not exceed a GMV of 100FC/100ml and not have more than 10% of all samples exceed 200 FC/100 ml.

Table 2
Fresh Water Stream Fecal Coliform (FC) Results
Chico Creek (CH01), Water Years 1996 - 2002

Water year	Number of Samples	Range (FC/100ml)	GMV[1] (FC/100ml)	# Samples >200 FC/100ml	% Samples >200 FC/100ml	Meets WQ Standard[2]
96	5	14 - 300	80	2	40%	No
97	9	8 - ≥1600	76	3	33%	No
98	9	4 - ≥1600	39	1	11%	No
99	10	3 - 49	23	0	0%	Yes
00	8	2 - 170	43	0	0%	Yes
01	13	4 - 110	21	0	0%	Yes
02	12	7 - 170	31	0	0%	Yes

Shaded entries indicate an exceedance of the applicable water quality standard (Chapt.173 – 201A-030 WAC)
[1] Geometric mean value
[2] Class A - FC levels shall not exceed a GMV of 100 FC/100ml and not have more than 10% of all samples exceed 200 FC/100 ml.

Marine Water

Table 3

Marine Water Fecal Coliform Results for DY20 Last 30 Samples, November 199-February 2002					
Station	**Number of Samples**	**Range (FC/100ml)**	**GMV (FC/100ml)**	**% Samples >43 FC/100ml**	**Meets WQ Standard**
DY20	**30**	**<2-300**	**7**	**27%**	**NO**

Appendix B. Criteria for Rating OSS Inspection Results

Rating Classification	Criteria for Meeting Classification[1]
No Apparent Problems	• **Completed/signed** Sewage Disposal Permit on file at Health District, or available from owner. • No illegal repairs or alterations have been performed on OSS. • All applicable setbacks and conditions in effect at the time of permitting are in place.
No Records	• No **completed/signed** Sewage Disposal Permit on file at the Health District, or in possession of the owner/occupant . • No Non-Conforming, Suspect or Failure criteria were observed .
Non-Conforming	• Repairs or alterations have been performed on OSS without a permit • Additional bedrooms have been added to the home (or business) without a permit. • Non-conforming conditions exist (such as insufficient setbacks from surface waters or wells, no reserve area, vehicular traffic on drainfield).
Suspect	• Drainfield area is saturated. • Collected water sample results from bulkhead drains, curtain drains, or other pipes or seeps, at or above 500 FC/100 ml. **and** negative dye-test. • Collected water sample results from bulkhead drains, curtain drains, or other pipes or seeps, less than 500 FC/100 ml. **and** positive dye-test.
Failure [2]	• Sewage backing up into, or not draining out of a structure caused by slow soil absorption of septic tank effluent. • Sewage leaking from a septic tank, pump tank, holding tank, or collection system. • Surfacing sewage in a documented drainfield area. • Collected water sample result from bulkhead drains, curtain drains, or other pipes or seeps, at or above 500 FC/100 ml. **and** positive dye-test results. • Straight discharge (gray or blackwater) from any indoor plumbing is observed and documented.

[1]Not all criteria in each rating classification must be met in order to rate a system; in some cases only meeting one of the criterion is required.

[2]As defined in the Bremerton-Kitsap County Board of Health Rules and Regulations Governing On-Site Sewage, 1996-8.

Appendix C
List and Description of Monitoring Stations

	Matrix	Watershed	Water Body	Station ID	Type	Location Description	GPS Coordinates
1	FW	DYES	Kitsap Lake Inlet	KQ01	Trend/ Impact	Inlet of Kitsap Lake at Price Rd	**N** 47.56179 **W** 122.70644
2	FW	DYES	Kitsap Creek	KC02	Trend	Outflow from Kitsap Lake, upstream of Northlake Way	**N** 47.57938 **W** 122.71245
3	FW	DYES	Kitsap Creek	KC01	Trend	Downstream bridge behind 2520 Northlake Way	**N** 47.58568 **W** 122.71327
4	FW	DYES	Chico Creek	CH01	Trend	Downstream Kittyhawk Dr culvert	**N** 47.60243 **W** 122.70591
5	MW	DYES	Chico Bay	DY20	Trend	Nearshore SW corner Chico Bay near Chico Creek mouth	**N** 47.6059 **W** 122.70212
6	FW	DYES	Stormwater Outfall	KIT01	Impact	Culvert at 6813 Kitsap Way	**N** 47.53289 **W** 122.63755
7	FW	DYES	Stormwater Outfall	KIT02	Impact	Corner of Francis St and Lake Dr	**N** 47.57777 **W** 122.70242
8	FW	DYES	Stormwater Outfall	KIT03	Impact	End of Cedarwood Rd	**N** 47.57458 **W** 122.69943
9	FW	DYES	Stormwater Outfall	KIT04	Impact	Tributary South of City Park	**N** 47.56562 **W** 122.70221
10	FW	DYES	Stormwater Outfall	KIT05	Impact	Culvert across street from Camp McKean	**N** 47.57190 **W** 122.71060
11	FW	DYES	Stormwater Outfall	KIT06	Impact	Large culvert at 1400 block of Kitsap Lake Rd	**N** 47.57540 **W** 122.71228
12	FW	DYES	Stormwater Outfall	KIT07	Impact	Type II catch basin at 6058 Osprey Circle	**N** 47.56821 **W** 122.69943
13	FW	DYES	Stormwater Outfall	KIT 08	Impact	Type II catch basin at 6052 Osprey Circle	**N** 47.56897 **W** 122.69932
14	FW	DYES	Stormwater Outfall	KIT 09	Impact	Type II catch basin at 6040 Osprey Circle	**N** 47.56996 **W** 122.69925

Appendix D.
Kitsap Lake/Chico Bay Pollution Identification and Correction Project
Descriptive List of OSS Failures

STREET	NUMBER	Kitsap Lake, Chico Bay or Chico Creek?	DATE FOUND FAILING	DATE REPAIRED	TYPE FAILURE	TYPE REPAIR	CAUSE OF FAILURE
Kitsap Lake Rd NW	11B	Kitsap Lake	Mar-03	Mar-03	Broken Transport Line	Repaired Transport Line	Broken component
Cook Lane	1970	Kitsap Lake	Sep-03	Oct-03	Surfacing at Drainfield	Connect to Sewer	Age/Poor Maintenance
Kitsap Lake Rd NW	856	Kitsap Lake	Jul-03	Dec-03	Cut bank into drainfield	Connect to Sewer	Homeowner cut bank into drainfield
Northlake Way NW	1610	Kitsap Lake	May-03	Nov-03	Surfacing discharge to ditch	Connect to Sewer	Age/hydraulic overload
Kitsap Lake Rd NW	4197	Kitsap Lake	Dec-03	Dec-03	Curtain drain cross-connect	Disconnect curtain drain	Unpermitted curtain drain
Kitsap Lake Rd NW	4243	Kitsap Lake	Feb-04	Sep-04	Surfacing at Drainfield	Pump to gravity, Easement	High groundwater
Kitsap Lake Rd NW	1565	Kitsap Lake	Mar-05	May-05	Surfacing at Drainfield	Connect to Sewer	Poor Installation
Hilltop Lane NW	2450	Chico Creek	Feb-04	Mar-04	Curtain drain cross-connect	Drainfield lines cleaned and tank pumped	Age/Poor Maintenance
Hilltop Lane NW	2320	Chico Creek	Mar-05	May-05	Surfacing at Drainfield	Glendon	Age/Poor Maintenance
Lebers Lane NW	4792	Chico Creek	Aug-04	Sep-04	Greywater discharge	Reroute to septic tank	Direct Discharge
Erlands Pt. Rd. NW	5087	Chico Bay	Jan-05	Apr-05	Curtain Drain	New Curtain Drain	Age/Curtain drain cross-connect
Erlands Pt. Rd NW	4779	Chico Bay	Jan-05	Jan-05	Broken D-Box	Replaced D-Box	Broken component
Erlands Pt. Rd NW	4855	Chico Bay	Mar-04	Mar-04	Greywater discharge	Rerouote to septic tank	Direct Discharge
Erlands Point Rd NW	4999	Chico Bay	Sep-05	Sep-05	Greywater discharge	Reroute to septic tank	Direct Discharge

Impact Water Quality Data

Station ID	Visit Date	24hr (inches)	48hr (inches)	72hr (inches)	FC/100ml
KIT01	1/22/2003	0.99	1.12	0.72	290
KIT01	4/21/2003	0.41	0.13	0.2	500
KIT01	6/24/2003	0	0	0	60
KIT01	5/26/2004	0.31	0.41	0.37	1601
KIT02	1/22/2003	0.99	1.12	0.72	990
KIT02	4/21/2003	0.41	0.13	0.2	900
KIT02	5/26/2004	0.31	0.41	0.37	1601
KIT03	1/22/2003	0.99	1.12	0.72	2070
KIT03	4/21/2003	0.41	0.13	0.2	1601
KIT03	5/26/2004	0.31	0.41	0.37	1601
KIT04	1/22/2003	0.99	1.12	0.72	100
KIT04	4/21/2003	0.41	0.13	0.2	50
KIT04	5/26/2004	0.31	0.41	0.37	1601
KIT05	1/22/2003	0.99	1.12	0.72	1140
KIT05	4/21/2003	0.41	0.13	0.2	500
KIT05	5/26/2004	0.31	0.41	0.37	1601
KIT06	1/22/2003	0.99	1.12	0.72	1
KIT06	4/21/2003	0.41	0.13	0.2	8
KIT07	1/22/2003	0.99	1.12	0.72	200
KIT07	4/21/2003	0.41	0.13	0.2	50
KIT07	5/26/2004	0.31	0.41	0.37	1601
KIT08	1/22/2003	0.99	1.12	0.72	680
KIT08	4/21/2003	0.41	0.13	0.2	50
KIT08	5/26/2004	0.31	0.41	0.37	1600
KIT09	1/22/2003	0.99	1.12	0.72	550
KIT09	4/21/2003	0.41	0.13	0.2	1600
KIT09	5/26/2004	0.31	0.41	0.37	500
KQ01	1/22/2003	0.99	1.12	0.72	170
KQ01	4/21/2003	0.41	0.13	0.2	40
KQ01	5/26/2004	0.31	0.41	0.37	900

Kitsap Lake Trophic Water Quality Data

Kitsap Lake

Trophic State: Eutrophic
TP Criterion: 20ug/l
Status: Exceeds Action Value for Puget Lowlands (20ug/l); needs lake specific study and/or TMDL

Date	TP (micrograms/l)	pH	Conductivity
10/2/1996	13		
8/26/1997	29		
6/22/1998	16		
9/21/1998	32		
6/13/2002	21	8.3	90.9
10/14/2002	38	7.2	108.2
5/8/2003	12	7.8	82.1
10/23/2003	22	8.2	90.8
4/21/2004	6	7.9	86.3
10/20/2004	24	7.5	105.4
5/24/2005	20		
9/14/2005	46	8.1	112.4
AVERAGE:	**23**	**8**	**97**
TSI TP:	**50**		

Appendix E
Water Quality Data Collected for the Kitsap Lake / Chico Bay Pollution Identification Correction Project
Trend and Impact Data

Fresh Water Data

Station	FC	VisitDate	Temp	pH	DO	DO % Sat	Conductivity	Turbidity	24hr (inches)	48hr (inches)	72hr (inches)
CH01	50	01/09/03	5.7	6.8	10.7	84.30	63.5	6.6	0.00	0.00	0.00
CH01	50	02/05/03	6.5	7.3	12.3	99.10	62.4	6.1	0.00	0.08	0.05
CH01	50	02/26/03	5.7	7.2	12.0	95.10	68.4	4.5	0.00	0.00	0.06
CH01	4	04/09/03	10.1	7.6	11.2		60.1	1.6	0.59	0.00	0.03
CH01	30	05/14/03	11.8	7.6	10.3	94.70	74.0	0.0	0.00	0.00	0.00
CH01	30	06/04/03	13.6	7.5	9.2	87.70	86.5	0.0	0.00	0.00	0.00
CH01	50	07/09/03							0.00	0.00	0.00
CH01	8	08/06/03	17.5	7.7	9.7	100.60	100.0	0.0	0.05	0.00	0.00
CH01	50	09/02/03	16.6	7.6	9.0	90.60	101.1	0.0	0.00	0.00	0.00
CH01	900	10/15/03	10.7	7.4	10.5	94.20	88.1	13.7	0.02	0.00	0.02
CH01	50	11/15/03	5.6	7.6	12.1	96.90	83.6	4.6	0.08	0.00	0.00
CH01	80	12/22/03	5.6	7.3	10.6	83.30	69.7	8.0	0.00	0.10	0.11
CH01	30	01/15/04	6.4	7.8	13.4	108.50	60.0		0.41	0.22	0.11
CH01	8	02/24/04	7.7	7.5	11.5	97.30	62.2	5.5	0.03	0.02	0.00
CH01	7	03/29/04	10.5	7.5			60.6	6.3	0.02	0.00	0.31
CH01	13	04/15/04							0.08	0.11	0.00
CH01	80	05/11/04							0.27	0.04	0.00
CH01	80	06/10/04							0.02	0.03	0.00
CH01	8	07/13/04							0.00	0.00	0.53
CH01	170	08/03/04	16.8	7.9	10.4	106.40	104.3		0.02	0.01	0.00
CH01	110	09/22/04	13.1	7.3	9.5	90.70	101.2	6.9	0.00	0.00	0.00
CH01	30	10/07/04	12.2	7.5	9.8	92.30	103.8	6.0	0.00	0.23	0.00
CH01	130	11/17/04	8.1	7.7	7.8	66.00	97.4	8.4	0.05	0.08	0.11
CH01	50	12/14/04	8.3	7.7	12.0	97.20	68.3	14.7	0.56	0.02	0.00
CH01	170	01/19/05	7.4	7.8	11.2	92.70	55.3	26.9	1.10	1.49	0.61
CH01	11	02/22/05	4.2	8.4	12.1	92.10	80.6	5.2	0.00	0.00	0.00
CH01	17	03/30/05	7.5	7.6	11.0	90.70	64.3	7.3	0.01	0.33	0.06
CH01	4	04/20/05	10.9	7.8	9.6	85.80	69.1	5.1	0.00	0.00	0.00
CH01	220	05/19/05	13.1	7.6	9.8	94.10	77.3	4.5	0.59	0.64	0.16
CH01	13	06/21/05	15.2	7.5	8.4	83.00	91.6	2.5	0.00	0.00	0.00
CH01	50	07/14/05	15.0	7.5	8.8	86.80	96.3	3.7	0.00	0.00	0.00
CH01	170	08/11/05	14.6	7.5	8.3	81.20	105.4	3.7	0.00	0.00	0.00
CH01	17	09/08/05	13.0	7.5	8.0	75.60	108.2	2.6	0.00	0.00	0.00

Station	FC	VisitDate	Temp	pH	DO	DO % Sat	Conductivity	Turbidity	24hr (inches)	48hr (inches)	72hr (inches)
KC01	8	01/09/03	6.3	6.7	11.9	95.40	85.1	0.3	0.00	0.00	0.00
KC01	1	02/05/03	7.4	7.7	12.8	104.90	81.3	3.7	0.00	0.08	0.05
KC01	4	02/26/03	7.7	7.6	12.0	99.20	82.2	3.8	0.00	0.00	0.06
KC01	8	04/09/03	11.7	8.1	10.3	94.80	81.4	0.7	0.59	0.00	0.03
KC01	30	05/14/03	15.1	7.9	9.7	96.10	81.4	0.0	0.00	0.00	0.00
KC01	23	06/04/03	17.2	7.8	8.8	89.80	86.9	0.0	0.00	0.00	0.00
KC01	50	07/09/03							0.00	0.00	0.00
KC01	30	08/06/03	16.0	8.0	7.7	78.40	94.4		0.05	0.00	0.00
KC01	50	09/02/03	14.5	7.7	8.2	79.40	92.8	0.0	0.00	0.00	0.00
KC01	500	10/15/03							0.02	0.00	0.02
KC01	8	11/15/03	9.4	7.6	10.8	93.10	90.6	5.4	0.08	0.00	0.00
KC01	30	12/22/03	5.6	7.8	11.2	88.00	85.4	4.0	0.00	0.10	0.11
KC01	170	01/15/04	4.3	7.7	15.1	114.00	83.1	0.4	0.41	0.22	0.11
KC01	30	02/24/04	7.4	7.8	12.4	104.20	79.9	4.9	0.03	0.02	0.00
KC01	13	03/29/04	9.8	7.4	10.4	91.30	85.6	5.9	0.02	0.00	0.31
KC01	30	04/15/04							0.08	0.11	0.00
KC01	900	05/11/04							0.27	0.04	0.00
KC01	170	06/10/04							0.02	0.03	0.00
KC01	430	07/13/04							0.00	0.00	0.53
KC01	23	08/03/04	18.2	7.5	6.4	67.30	99.4		0.02	0.01	0.00
KC01	50	09/22/04	16.5	7.6	9.5	97.80	105.2	9.8	0.00	0.00	0.00
KC01	900	10/07/04	13.3	7.7	9.8	93.80	104.6	3.7	0.00	0.23	0.00
KC01	11	11/17/04	9.1	7.8	10.8	93.60	100.3	4.3	0.05	0.08	0.11
KC01	900	12/14/04	7.8	7.9	11.8	97.90	95.6	11.2	0.56	0.02	0.00
KC01	50	01/19/05	5.8	8.0	11.9	94.20	89.5	4.7	1.10	1.49	0.61
KC01	1	02/22/05	5.1	9.0	12.5	97.30	92.5	4.8	0.00	0.00	0.00
KC01	1	03/30/05	9.5	7.9	10.2	89.10	89.7	5.2	0.01	0.33	0.06
KC01	6	04/20/05	13.3	8.1	8.9	83.90	95.4	3.9	0.00	0.00	0.00
KC01	110	05/19/05	16.2	7.9	9.4	95.30	93.8	3.5	0.59	0.64	0.16
KC01	140	06/21/05	19.1	7.8	7.9	85.60	98.8	2.8	0.00	0.00	0.00
KC01	140	07/14/05	18.7	7.8	8.0	86.00	102.2	3.3	0.00	0.00	0.00
KC01	22	08/11/05	15.4	7.7	8.5	85.10	105.6	1.9	0.00	0.00	0.00

Station	FC	VisitDate	Temp	pH	DO	DO % Sat	Conductivity	Turbidity	24hr (inches)	48hr (inches)	72hr (inches)
KC02	4	01/09/03							0.00	0.00	0.00
KC02	2	02/05/03	7.5	7.5	11.8	96.70	80.6	3.2	0.00	0.08	0.05
KC02	8	02/26/03							0.00	0.00	0.06
KC02	17	04/09/03							0.59	0.00	0.03
KC02	70	05/14/03							0.00	0.00	0.00
KC02	2	06/04/03							0.00	0.00	0.00
KC02	30	07/09/03							0.00	0.00	0.00
KC02	17	08/06/03							0.05	0.00	0.00
KC02	170	09/02/03							0.00	0.00	0.00
KC02	300	10/15/03							0.02	0.00	0.02
KC02	11	11/15/03							0.08	0.00	0.00
KC02	4	12/22/03							0.00	0.10	0.11
KC02	17	01/15/04							0.41	0.22	0.11
KC02	13	02/24/04							0.03	0.02	0.00
KC02	1	03/29/04							0.02	0.00	0.31
KC02	4	04/15/04							0.08	0.11	0.00
KC02	4	05/11/04							0.27	0.04	0.00
KC02	23	06/10/04							0.02	0.03	0.00
KC02	17	07/13/04							0.00	0.00	0.53
KC02	50	08/03/04							0.02	0.01	0.00
KC02	8	09/22/04							0.00	0.00	0.00
KC02	13	10/07/04							0.00	0.23	0.00
KC02	8	11/17/04							0.05	0.08	0.11
KC02	240	12/14/04							0.56	0.02	0.00
KC02	30	01/19/05							1.10	1.49	0.61
KC02	8	02/22/05							0.00	0.00	0.00
KC02	1	03/30/05							0.01	0.33	0.06
KC02	30	04/20/05							0.00	0.00	0.00
KC02	60	05/19/05							0.59	0.64	0.16
KC02	300	06/21/05							0.00	0.00	0.00
KC02	8	07/14/05							0.00	0.00	0.00
KC02	13	08/11/05							0.00	0.00	0.00
KC02	8	09/08/05							0.00	0.00	0.00

Station	FC	VisitDate	Temp	pH	DO	DO % Sat	Conductivity	Turbidity	24hr (inches)	48hr (inches)	72hr (inches)
KQ01	8	01/09/03							0.00	0.00	0.00
KQ01	17	02/05/03							0.00	0.08	0.05
KQ01	8	02/26/03							0.00	0.00	0.06
KQ01	8	04/09/03							0.59	0.00	0.03
KQ01	23	05/14/03							0.00	0.00	0.00
KQ01	130	06/04/03							0.00	0.00	0.00
KQ01	110	07/09/03							0.00	0.00	0.00
KQ01	900	08/06/03							0.05	0.00	0.00
KQ01	300	09/02/03							0.00	0.00	0.00
KQ01	1601	10/15/03							0.02	0.00	0.02
KQ01	50	11/15/03							0.08	0.00	0.00
KQ01	17	12/22/03							0.00	0.10	0.11
KQ01	26	01/15/04							0.41	0.22	0.11
KQ01	1	02/24/04							0.03	0.02	0.00
KQ01	8	03/29/04							0.02	0.00	0.31
KQ01	30	04/15/04							0.08	0.11	0.00
KQ01	80	05/11/04							0.27	0.04	0.00
KQ01	70	06/10/04							0.02	0.03	0.00
KQ01	220	07/13/04							0.00	0.00	0.53
KQ01	1601	08/03/04							0.02	0.01	0.00
KQ01	50	09/22/04							0.00	0.00	0.00
KQ01	140	10/07/04							0.00	0.23	0.00
KQ01	11	11/17/04							0.05	0.08	0.11
KQ01	70	12/14/04							0.56	0.02	0.00
KQ01	8	01/19/05							1.10	1.49	0.61
KQ01	4	02/22/05							0.00	0.00	0.00
KQ01	30	03/30/05							0.01	0.33	0.06
KQ01	2	04/20/05							0.00	0.00	0.00
KQ01	140	05/19/05							0.59	0.64	0.16
KQ01	17	06/21/05							0.00	0.00	0.00
KQ01	50	07/14/05							0.00	0.00	0.00
KQ01	240	08/11/05							0.00	0.00	0.00
KQ01	900	09/08/05							0.00	0.00	0.00

Marine Water Data

Station	FC	VisitDate	Temp	PH	DO	DO % Sat	Salinity	Turbidity	24hr (inches)	48hr (inches)	72hr (inches)
DY20	17	1/14/2003	8.1	7.3	7.90	78.3	26.6	2.1	0.23	0.03	1.17
DY20	4	3/20/2003	9.6	8.0		61.1	26.1	0.3	0.63	0.07	0.12
DY20	1	4/15/2003	11.2		12.60	131.6	26.3	1.2	0.04	0.09	0.69
DY20	1	5/21/2003	15.3	8.3	9.30	110.6	26.5	0.0	0.05	0.00	0.00
DY20	1	6/12/2003	14.8	8.6	11.60	135.2	28.2	0.0	0.00	0.00	0.00
DY20	1	7/21/2003	21.4	8.4	12.80	166.5	28.5	0.0	0.00	0.00	0.00
DY20	1	8/19/2003	20.4		19.30	200.0	29.0	0.0	0.00	0.00	0.00
DY20	2	9/17/2003							0.10	0.01	0.00
DY20	13	10/14/2003	14.2		8.20	95.2	30.1	1.9	0.00	0.02	0.81
DY20	80	1/14/2004							0.22	0.11	0.00
DY20	50	2/25/2004	8.1	7.8	7.00	71.7	28.6	4.1	0.07	0.03	0.02
DY20	17	4/12/2004	11.0	8.4	11.80	128.4	28.3	0.2	0.00	0.00	0.00
DY20	8	6/9/2004							0.03	0.00	0.00
DY20	2	8/5/2004	17.1	8.2	10.70	134.0	31.3	6.6	0.98	0.14	0.02
DY20	21	10/6/2004	15.0	8.1			31.9	12.2	0.23	0.00	0.00
DY20	13	12/20/2004	9.3	7.6	7.70	78.0	29.2	3.2	0.18	0.00	0.02
DY20	1	2/23/2005							0.00	0.00	0.00
DY20	1	4/19/2005	12.6	8.4	14.00	130.2	28.9	2.8	0.00	0.00	0.00
DY20	1	6/14/2005	15.9	8.3	11.80	143.2	29.5	4.6	0.00	0.13	0.39
DY20	2	8/16/2005	17.1	8.0	8.00	100.5	30.4	4.7	0.00	0.00	0.00