Parking Lots…to Creeks…to Puget Sound

Melinda J. Fohn
Kitsap County Health District

Introduction

Dyes Inlet is a marine embayment located in west Puget Sound. The watershed is approximately 30,000 square acres with 16,000 residents. The marine shoreline is moderately developed with the urban center of Silverdale located at the northern point of the inlet. The upland areas are a mixture of roads, semi-rural, rural and forested land uses (May and Cullinan, 2005).

Figure 1. Aerial view of Silverdale, stormwater outfalls are shown in red.

Dyes Inlet is rich in shellfish resources and recreational activities. Shellfishing in Dyes Inlet was closed by the Washington State Department of Health (WSDOH) in the 1960s. Due to a cooperative effort to re-evaluate Dyes Inlet by the Navy, WSDOH, City of Bremerton, Suquamish Tribe, Kitsap County and Kitsap County Health District (KCHD) and others, WSDOH re-classified approximately half of the 3,000 acres of shellfish beds to "Conditionally Approved" in 2003 (WSDOH, 2003). However, FC pollution problems continue to threaten public health and shellfish resources in portions of Dyes Inlet.

Public health risk is elevated in the presence of fecal coliform (FC) contamination due to primary contact and shellfish consumption. The mission of the Kitsap County Health District (KCHD) Water Quality Program is to "protect the public from waterborne illness…".

Figure 2 shows the current shellfish classifications in Dyes Inlet. The northern area, near the mouth of Clear Creek, is classified as "Prohibited". WSDOH, using their sanitary survey methods, water quality data, and other studies have determined that Clear Creek and stormwater runoff from Silverdale are significant FC pollution sources in this area (WSDOH, 2003, ENVVEST, 2005, KCHD, 2005).

In response to the ongoing FC pollution problems, KCHD has been conducting pollution identification and correction projects in the watershed since 1994. These projects have focused on correcting failing on site sewage systems (OSS) and poor animal waste management as the primary sources of FC pollution, and have resulted in water quality improvements. .

The principle of the PIC program is involving the community in solving the FC pollution problem. PIC project activities include public notification, property inspections to locate and correct FC pollution sources, property owner and resident education, free technical assistance and enforcement capabilities.

This project employs the principles of the successful KCHD PIC program and applies the methods to the commercial corridor of Silverdale in addressing FC pollution from stormwater runoff. Additionally, traditional FC pollution sources are considered as this project takes a holistic and long-term approach to reducing pollution from a moderately urban community.

The goal of the project is to identify and correct FC sources in order to protect the "Conditionally Approved" area and restore the "Prohibited" area in north Dyes Inlet.

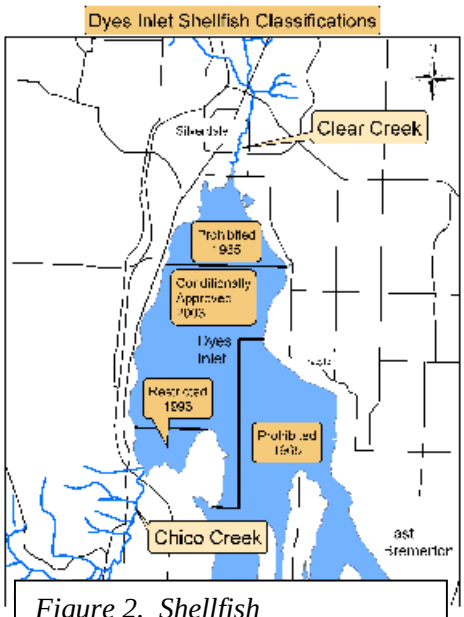

Figure 2. Shellfish Classifications of Dyes Inlet.

Methods

Historical water quality and the watershed attributes were reviewed and considered in designing the methods to be used. Clear Creek is the major freshwater contributor to northern Dyes Inlet. In water year 2005, the mouth station (CC01) had a high geometric mean of 143 FC/100 ml based upon monthly random systematic samples. This exceeds both Part 1 and Part 2 of the Washington State Water Quality Standard (WAC Chapter 173-201A, 1992). The highest concentrations occur during the stream low-flow summer months. It is posted with a warning as a public health hazard (Figure 3) since risk of illness is increased due to it's dry weather geometric mean of 896 FC/100ml, well over the trigger level of 270 FC/100ml. Marine water FC exceedances at monitoring stations in northern Dyes Inlet occurred during both storm events and dry weather conditions (KCHD, 2005, May and Cullinan, 2005). No sewer illicit connections were found during routine dry weather monitoring (Dave Tucker, Kitsap County Surface and Stormwater Management, personal communication, 2006) ruling out sewer cross-connections as sources.

Figure 3. Warning sign at mouth station of Clear Creek.

Clear Creek water quality was good north of the commercial corridor with poor water quality occurring in the commercial corridor. The commercial corridor is sewered with a few OSS remaining. Approximately 90% of the sewered infrastructure was installed since the 1970s, and a majority of the stormwater drainage area was installed from the 1980s to the present. No agricultural practices are found in the project area.

Two mechanisms responsible for the FC pollution were postulated. The first is that FC bacteria bind to fine particles and are easily transported to receiving waters during storm events (Serdar, 1993). The second is that the moist fine material in

stormwater catch basins and vaults, as well as slow-moving streams, provide good habitat for the growth of FC bacteria. So, once the FC are seeded in the sediments, a perpetual source of contamination is produced. These two mechanisms provide a highly possible source of FC bacteria, and associated public health risk, into Clear Creek and Dyes Inlet. Therefore, it was determined that the most likely mechanism of FC transport to the receiving waters was the stormwater conveyance system. The focus was to address the storm drainage system and reduce the FC-contaminated sediments in the storm system from being transported to the receiving waters and to reduce FC sources entering the storm drainage system. Reducing FC contaminated sediments in the storm drainage system would be accomplished by two methods: 1) stormwater system inspection and 2) food source control. Reducing FC from pet waste and human waste (OSS and sewer infrastructure) would be accomplished using existing field methods, and will be covered briefly.

Stormwater System Inspection

KCHD partnered with the Kitsap County Surface and Stormwater Management Drainage Inspection Program (DIP). Both KCHD and DIP are funded by the Kitsap County Surface and Stormwater Management. However, a Washington State Centennial Clean Water Fund Grant from the Washington State Department of Ecology (Ecology) provided 75% of the funding for this unique partnership and project.

Two hundred seven (207) commercial properties were targeted in the Silverdale commercial corridor, with sixty-seven (67) commercial properties in basins discharging directly to Clear Creek. The remaining 140 properties discharge to basins with outfalls on the shoreline in the "Prohibited" area or smaller streams (piped and naturally) discharging to Dyes Inlet.

Commercial property owners were notified by letter about the project and FC pollution problem in Dyes Inlet. They received a fact sheet and were invited to the public meeting held in January of 2006. Commercial property tenants were notified by hand-delivery of the fact sheet and invited to the public meeting. An article about the project appeared in the local KitsapSUN newspaper, and the public meeting was attended by the area County Commissioner.

The first phase of property inspections was performed February to June 2006, focusing on properties in the Clear Creek drainage first, with the second phase performed in February and March of 2007. Property inspections were jointly performed by the KCHD and DIP. Stormwater system deficiencies, as determined by the Ecology standards (Stormwater Management Manual for Western Washington, 2005) were noted. Briefly, each structure, including catch basins, vaults, and oil/water separators, were inspected for sediment accumulation. Bioswales, ponds, and flow control structures were inspected for the ability to properly function. If deficiencies were identified, the property owner, if present, was notified verbally and by letter. Follow-up inspection by DIP was performed after the deficiency was corrected.

Properties that passed inspection or corrected the deficiencies were sent a folder with a drawing of their stormwater system, education information about managing their site for clean runoff, and a thank you letter for maintaining their stormwater system for a clean Dyes Inlet. A window cling was included for their business (Figure 4).

Figure 4. Window Cling for businesses.

Food Source Control

Recent genetic testing of stormwater demonstrates a wide variety of sources of FC, including birds, rats, and raccoon (May and Cullinan, 2005). Concentrating this urban wildlife around stormwater systems may result in excessive FC sources from the wildlife and the food waste itself. During stormwater system inspections, sites with excessive rattraps or food waste/grease spillage entering the storm drain system were noted. These sites were then subject to an additional inspection by KCHD, DIP and Kitsap County Wastewater Grease Inspection Program (KCWW). Upon completion of inspections the three program team met with the property owner and solutions were discussed.

Pet Waste and Human Waste

High use pet areas were identified and the property owner contacted. Free pet waste dispensers, one case of bags and education were offered.

Two OSS located near the mouth of Clear Creek were identified for property inspections. Inspections were performed according to the KCHD "PIC Manual" (KCHD, 2003).

The sanitary sewer crosses underneath Clear Creek upstream of the mouth station and adjacent to some Clear Creek tributaries. The system and pump station were inspected and FC sampling performed upstream and downstream of these locations. Pressure testing and/or video inspection were performed if indicated.

Water Quality Analysis

Fresh and marine water samples were analyzed according to KCHD protocol (ref). Samples were analyzed for FC using standard method 9221, 5 tube Most Probable Number (MPN). Seven monitoring stations were established on Clear Creek in 2004 and sampled monthly or twice monthly. They are located downstream of large volume stormwater outfalls in the commercial corridor of Silverdale.

Statistical Analysis of Water Quality Data

Sufficient FC water quality data was available to perform analysis before and after stormwater and OSS inspections performed in 2006. The Mann-Whitney U test was used to test for significant difference.

Results and Discussion

Stormwater System Inspections

One hundred fifty-four (154) of 207 targeted properties were inspected in the first two quarters of 2006 following the public notification of property owners and tenants. Forty-one (41%) percent were determined to be deficient, with a majority of the deficiencies being excess sediment in catch basins, oil/water separators or vaults. By October 2006, 95% of the deficient properties had maintained their system and a follow-up inspection was completed. Fifty-three (53) inspections

were performed in the first quarter of 2007. Only 8% of properties were determined to be deficient.

One-hundred percent of the targeted properties have been inspected and 29% of the total properties are located in storm basins discharging to Clear Creek. Over 95% of all properties with deficiencies have complied.

Property owners were responsive to requests to maintain deficient stormwater systems. Through notification of a local water quality problem they seemed to make the connection between their stormwater system and good water quality. After the first year of the program, the deficiency rate dropped from 41% to 8% of inspected properties. Clearly, the owners have placed stormwater system maintenance as a priority for managing their properties.

Food Source Control

Forty-three of the 207 (21%) properties were determined to have the potential to provide a food source for urban wildlife or discharge food waste to storm drain systems. After inspection of dumpster, restaurant cleaning areas and food compactor areas, 7 properties were identified to discharge food waste to the storm drain system. Two of the properties discharge to Clear Creek. Of the 7 properties, 4 were notified by enforcement letter from KCHD using the Solid Waste Regulations (Bremerton-Kitsap County Health District, 2000). Violation was usually for illegal discharge of waste from an industrial process and lack of rodent control. As of April 2007, three of the four properties have complied. Two of the properties were large chain restaurants, which discharged grease to the storm drain system. Both chose to install a permanent solution to this chronic problem by building a covered wash area with drains connecting to the sanitary sewer. Corporate funding and building permits were required so that completion took approximately 10 months.

Previous to this project, DIP would forward such a violator to Kitsap County Code Enforcement. Code Enforcement was required to perform their own documentation after the violation was discovered and apply the county's illicit discharge ordinance. Stormwater system maintenance was not a high priority for Code Enforcement and these complaints would not be processed in a timely manner. After discussion, the KCHD and DIP found that sites discharging food waste was considered to be "an industrial process waste" and was subject to Kitsap County Health District Solid Waste Regulations. Enforcement by KCHD was more efficient because they were a member of the inspection team and would document the violation and contact the property owner immediately. Applying local KCHD regulations seemed to have more weight with restaurants since they already are subject to inspections for their food service permit by KCHD.

Pet Waste and Human Waste

Two high use pet areas were identified: the Clear Creek Trail and the Port of Silverdale. Both have installed pet waste stations. Additionally, two apartment complexes have installed the stations.

One failing OSS located at the mouth of Clear Creek was connected to sanitary sewer. This OSS was located immediately upstream of the mouth station of CC01. Video inspection of a gravity main and pressure testing of a force main adjacent to a FC contaminated tributary of Clear Creek contamination were negative.

Water Quality Results

FC Clear Creek stream sample data were analyzed in two ways. First, water year 2005 (representing before the project was initiated), was compared to water year 2006 (after the first year of the project. Second, data were separated into dry season (May through October) and wet season (November through April) groups.

FC reductions were apparent at stream monitoring stations in the commercial corridor of Silverdale after the FC identification and correction activities for both the water year data and dry season data alone. Figure 5 shows the dry season data before and after the first phase of the project. The FC geometric mean is shown on the y-axis and the stations, downstream on the left and moving upstream to the right, on the x-axis. Statistically significant reduction in FC concentration (p=0.05) occurs at stations CC01 and CC02A. The failing OSS is located directly upstream of CC01 and was corrected before the dry season sampling period. The remaining stations are influenced by stormwater runoff from the commercial properties.

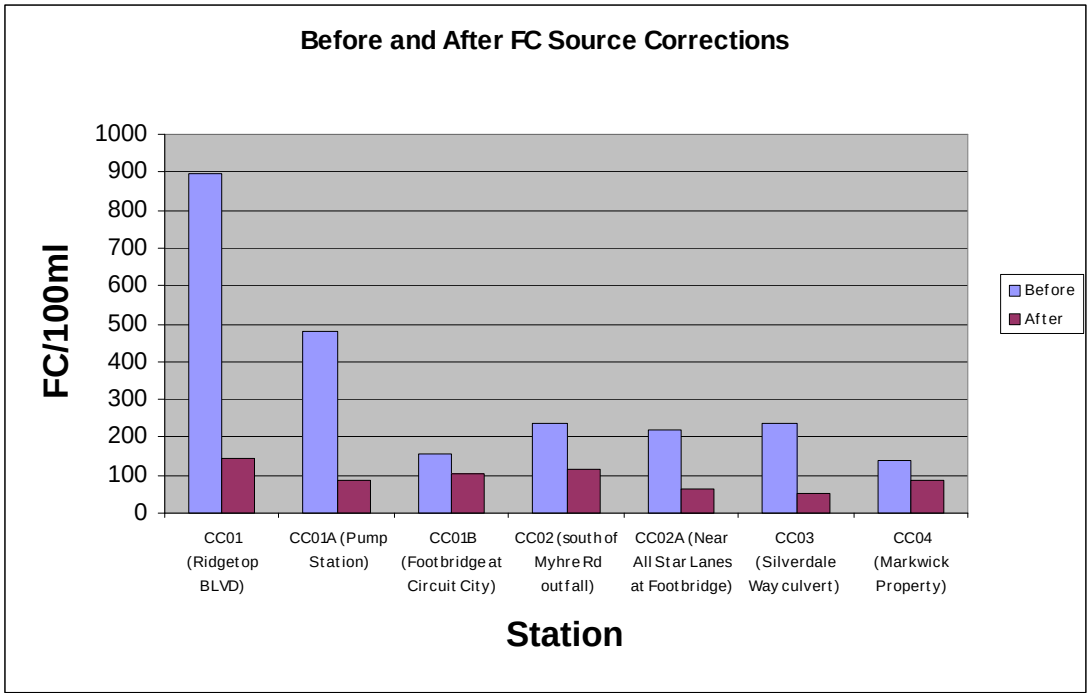

Figure 5. FC geometric means at Clear Creek stream station before and after 2006 inspections and corrections.

Even though no statistically significant differences in evaluating the wet season or the entire water year FC data was found, FC reductions are demonstrated. Box and whisker plots of the stormwater-influenced stream stations are shown in Figure 6. Reductions in the maximum FC concentrations and 75% levels are apparent. These reductions occur predominately during the dry season.

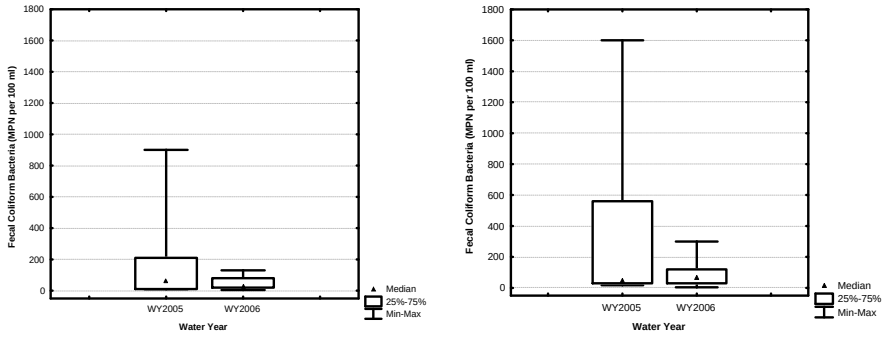

Figure 6. Box and whisker plots of CC01A and CC02 stormwater influenced Clear Creek stations.

It is clear FC reductions at CC01 were attributed to correcting the failing OSS upstream of the station. However, the dry season FC reductions seen at the stations influenced by stormwater runoff may be due to less FC contaminated sediments entering the stream resulting in FC reductions in the stream sediments.

Conclusions

A comprehensive FC reduction project was performed in the northern Dyes Inlet watershed resulting in improved water quality of Clear Creek. Measuring FC in stormwater and showing reductions is difficult, so receiving water quality was used as the measure of improvement. Marine stations in northern Dyes Inlet do not show FC reductions at this time and more work will be performed on stormwater systems discharging to the shoreline and smaller streams. This unique approach partnering the KCHD and DIP resulted in a successful program to address FC pollution in stormwater runoff.

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