Drayton Harbor Community Shoreline Water Quality Sampling Program

FINAL REPORT

Submitted to
Whatcom County Water Resources Division
Shellfish Protection Program
by

Geoff Menzies through the Puget Sound Restoration Fund

February 1, 2002

Introduction

Project Goals and Objectives

The purpose of this project was to involve citizen volunteers in sampling priority freshwater drainages into Drayton Harbor from the eastern shoreline, to determine which if any pose the greatest threat to nearby marine water quality. Of particular concern was the influence of these drainages on nearby Department of Health's marine sampling stations, which represent the site of the current Drayton Harbor Community Oyster Farm project. This was accomplished by monthly collection of freshwater and marine samples for water quality, and measuring flow from each drainage where practical. Most of the sites which were sampled have not been routinely sampled since 1995 when they were checked intensively for one summer month (Cykler and Haggerty, 1995).

This report is intended to stimulate follow-up work to better delineate sources and lead to remediation efforts for source reduction and/or treatment programs. The intent is to reduce or eliminate bacterial pollution from this shoreline which negatively impacts water quality and shellfish harvesting in Drayton Harbor.

This project was developed through strong volunteer interest in association with the Drayton Harbor Community Oyster Farm project. It has provided an additional opportunity for citizen volunteers to play a key role in shellfish restoration in Drayton Harbor. Community involvement and pollution source identification are two very high priorities of the Drayton Harbor Shellfish Protection District Advisory Committee. The May 2000 Status Report and Water Recovery Plan listed several high priority recommendations including:

- **Objective Four- Control Stormwater Sources, Task 1**: "Investigate potential sources impacting priority storm water drainages around the entire shoreline of Drayton Harbor. Report findings to DHSPDAC and take prompt action to abate pollution sources when found. " This recommendation identified several partners including the City of Blaine, Whatcom County, the shellfish committee and a volunteer community program.
- **Objective 8- General Recommendations, Task 6**: "Increase efforts regarding community involvement and education primarily through newsletter and volunteer water quality monitoring efforts in priority drainages."

Project Rationale

Shellfish harvesting in Drayton Harbor is classified as "Prohibited" by the Washington State Department of Health (DOH). Storm water runoff has been identified by DOH as a pollution source in both the 1995 and 1999 Sanitary Surveys of Drayton Harbor. DOH ambient monitoring stations 4, 6,and 8 (see Figure 1) exceed the 90th percentile standard for fecal coliform bacteria (43 FC organisms/100 ml water). Station 8 exceeds the standard by the greatest amount, but both stations 4 and 6 have occasional spikes, which influence the 90^{th} percentile value and continue to threaten shellfish restoration efforts in Drayton Harbor. In a recent marine sampling (May 17, 2001) DOH reported fecal coliform levels of 350FC/100ml at station 4; 33FC/100ml at station 6; and 130FC/100ml at station 8. This was during an ebb tide. Sites 4 and 6 are very important because they are located over the prime commercial oyster growing area in the harbor. Informal circulation studies conducted in cooperation with DOH in 1995 showed that on an ebb tide, flow from Dakota Creek follows a quite direct path towards DOH station 4. The numerous storm outfalls north of Dakota Creek also drain westward running across the tide flats potentially influencing these important sites. Under the same ebb tide, water flowing from the mouth of California Creek tends to move toward the southwestern shoreline of Drayton Harbor. For this reason, this project focused on priority drainages on the eastern shoreline of Drayton Harbor. These particular storm outfalls and streams have been selected for this project based upon a recent shoreline walk which confirmed that they have significant flow, and a review of two shoreline studies conducted by Western Washington University in 1992 and 1995.

The Community Oyster Farm Project has set a goal of May 2004 for a shellfish upgrade in Drayton Harbor. This timing will allow for the harvest and sale of two acres of oysters, which were planted in June 2001under a unique agreement between DOH and the Department of Natural Resources, Aquatic Lands Division. In order to achieve an upgrade, the community must actively identify pollution sources and move

swiftly to correct them on the ground. This project has identified drainages which appear to pose the greatest threat of fecal coliform contamination from freshwater sources on the eastern shoreline. This report will be shared with the Shellfish Advisory Committee and with various agencies that have responsibility in pollution control in Drayton Harbor including: City of Blaine, Department of Ecology , Whatcom County Water Resources Division, Whatcom County Health Department , Whatcom County Council, and the Washington State Department of Health. It is these agencies which will be convened to review these results and to assume leadership in follow-up efforts which meet the intent of this project.

Materials and Methods

Volunteer Training
Six citizen volunteers were trained on site by Don Lennartson, of the Washington State Department of Health Office of Shellfish Programs(DOH) , to collect water samples and deliver them to the laboratory for analysis of fecal coliform bacteria. Sampling, field data entry, quality control, and delivery to the laboratory was conducted in accordance with the water sampling protocol detailed by the Washington State Department of Health, Office of Shellfish Programs.

Laboratory Analysis
Freshwater samples were analyzed for fecal coliform bacteria concentrations by the City of Blaine, which uses the membrane filtration technique (SM 9222 D). This sewage treatment plant laboratory is accredited by Ecology for this analytical method. Marine samples were analyzed by DOH, which uses their standard most probable number technique (SM9221E).

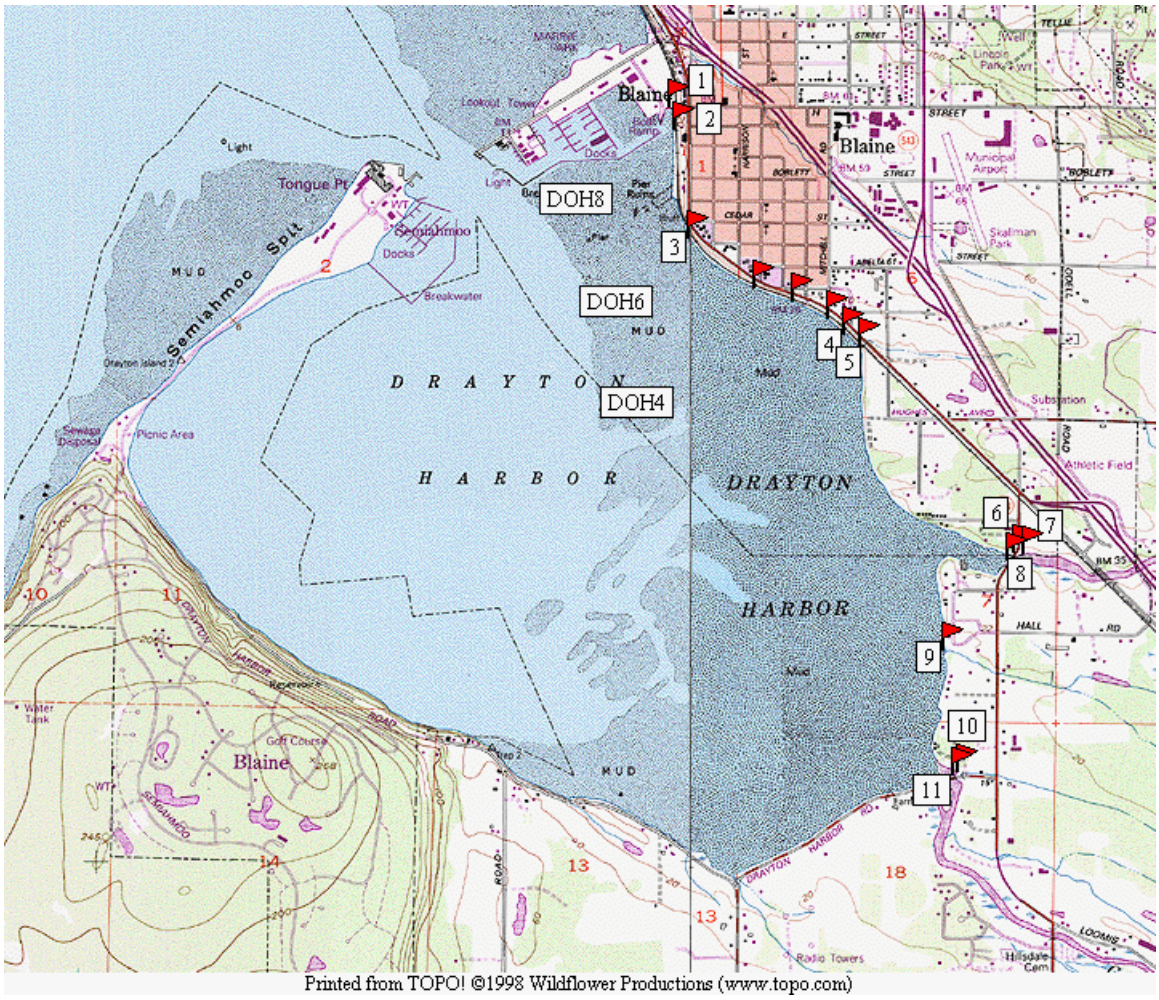
Freshwater Site Selection
Eleven freshwater sites were selected after review of the 1995 Cykler, Haggerty study, the 1992 Saban, Matthews study and upon completion of two shoreline walks to confirm significant flow of water from each of these drainages. The focus on drainages north of California Creek reflects findings from previous circulation studies which show that drainage from these areas are most likely to impact the commercial shellfish growing area during ebb tides.

A map showing sampling site locations and descriptions of each is shown in Figure 1. A hand held GPS unit was used to record longitude and latitude at sites not easily located by landmarks, and the site location is also described. Red flags shown on this map with no corresponding number had little or no flow during the two beach walks conducted in June. Sites 8 and 11 (the mouths of both creeks) are influenced by marine waters depending on the tidal condition. Because our interest was to identify freshwater fecal bacteria contributions from these sources, samples were taken late in the ebbing tide, when possible in order to minimize the expected dilution effect from saltwater within Drayton Harbor. A total of six samples were taken monthly from July through December 2001. The selection of sampling dates was based upon availability of all of the cooperators in this project which included DOH, City of Blaine, Citizen volunteers, and Environment Canada, which oversees a shoreline sampling program north of the border from the International boundary to Kwomais Point, west of White Rock.

Sample Collection
Freshwater samples were collected for fecal coliform analysis from ten locations from Marine Drive to the mouth of California Creek from July 2001 through December 2001. On each sampling day, each site , with the exception of Dakota Creek and California Creek (sites 8 and 11), were inspected for flow status and temperature was measured. Discharge and temperature was measured and fecal coliform samples were collected only from sites that were actively flowing.

Discharge measurements were made by directly catching either the total flow when possible or a portion of the flow over a measured amount of time. The collected water was measured and reported on site as number of liters per number of seconds. Where it was only possible to collect a portion of the flow this was recorded on the field report as a percentage of total flow and converted at a later time. On several occasions, particularly during high flow events when the total flow could not be captured, two or three flow measurements were recorded in the field and then averaged.

Marine samples were collected in coordination with DOH from DOH sites 4, 6 and 8 from July through October, 2001. Samples were not collected in November due to rough weather, nor in December due to scheduling difficulties with DOH personnel. Extra marine samples were taken in and around the Blaine Marina in August, September and October. This marine sampling was conducted usually within an hour of the completion of the shoreline sampling.



Sample Site Number	Location and Description
1	Small surface stream in mudflat east of the boat ramp
2	Small surface stream due east of the eastern end of the Blaine Harbor breakwater (48.99306 / 122.75294)
3	36" black drain pipe near Peace Portal and 4th (48.98774 / 122.75134) (Possibly Cykler and Haggerty site 1)
4	30"by 36" concrete pipe across from "Psychic Palm Reader" (Cykler, Haggerty site 6) (48.98324 / 122.74056)
5	36" by 42" concrete pipe across from Nikki's Restaurant (Cykler, Haggerty site 3) (48.98261 / 122.73915)
6	Surface ditch on West side of Blaine Rd drains into Dakota Creek (Cykler, Haggerty site 9A)
7	Surface ditch on East side of Blaine Rd drains into Dakota Creek (Cykler, Haggerty site 9B)
8	Mouth of Dakota Creek
9	Mouth of "No Name Creek" 20 m south of hall Rd and Dearborn (Cykler, Haggerty site 10) (48.96819 / 122.73340)
10	Concrete storm drain immediately north of California Creek Bridge
11	Mouth of California Creek

Figure 1: Marine and Freshwater Sampling Locations

Results and Discussion

Rainfall

Rainfall preceding the sampling events is shown in Table 1 below. One "flushing event" was captured during this sampling period in late August, which consisted of a prolonged dry period followed by a short term rain event. Monthly rainfall is also shown in this table. It illustrates the typically heavy rain experienced in this area in the late fall and winter months; October thru December.

Table 1: Summary of Rainfall for Sample Dates

Sample Date	48 Hour	72 Hour	Total Month	Comments
7/24	0.02	0.02	0.74	Preceding weeks were very dry
8/22	0.82	0.82	2.59	First Flush Event; Two weeks prior to the 20th had no rainfall.
9/12	0.00	0.00	1.17	No rainfall in the 10 days preceding this sample
10/23	0.78	0.87	5.13	Regular rainfall in preceding weeks
11/13	0.21	0.21	4.96	No rain 6th thru 10th; 0.8 inches rain 3rd thru 5th.
12/12	0.40	0.61	5.94	Regular rainfall for ten days preceding this sample – saturated soil conditions

Rainfall data for the 48-hr. and 72-hr. periods preceding sampling.
Also shows total monthly rainfall
Rainfall data were obtained from the Blaine Wastewater Treatment Plant

Freshwater - Fecal Coliform Concentrations

There was never enough discharge from site 7 to warrant sampling during this period. Fecal coliform concentrations at the other freshwater sites ranged from 2 to 49,000 colonies per 100 ml of sample water. This range of concentrations is very similar to that found in previous studies at these same locations. Of the total of 55 samples analyzed, 27 samples (49%) exceeded 100 colonies per 100 ml of sample water. Table 2 below shows the frequency at each site of exceeding this level over the sampling period. All stations exceeded this concentration in the August collection, following the only "flushing event" that was captured. This concentration has some significance in that Part A of the Washington State Freshwater Standards for Class A waters is a geometric mean not to exceed 100 fecal colonies per 100 ml of water. There are no specific standards established for storm water but for the purposes of this study, and given the sensitive nature of the receiving waters, there is some logic in comparing these results to Freshwater standards. **Site 3** exceeded this concentration every time it was sampled (5/5); **Site 2** exceeded this concentration most of the time (5/ 6) and **Sites 5 and 6** exceeded it more than half of the time (3/5). **Sites 4 and 9** exceeded this level half of the time (3/6) and **Site 1** exceeded it one third of the time (2/6). **Sites 8,10, and 11** only exceeded this concentration once during the sampling period.

The actual counts and geometric means are shown in Table 3 below. The geometric mean at seven of ten locations exceeded the standard (shown in **bold**). The mouths of Dakota Creek (site 8), California Creek (site 11), and the storm drain adjacent to the mouth of California Creek (site 10) were the only locations which met this portion of the Freshwater standards.

Based on the frequency of fecal concentrations above 100 colonies/100 ml, **sites 2,3,5, and 6** would appear to be **high priority** for follow-up investigation. In their 1995 study, Cykler and Haggerty placed stations with a geometric mean greater than 500 colonies/100 ml in a **high priority** classification. If we were to apply this guideline, **sites 2,3, and 6** would be selected for closer scrutiny (Table 3).

Table 2

Frequency of Exceeding 100 FC colonies/ 100 ml water

Freshwater Sites	24-Jul	22-Aug	12-Sep	23-Oct	13-Nov	12 Dec
1	●	●	○	○	○	○
2	●	●	●	●	○	●
3	●	●	--	●	●	●
4	●	●	●	○	○	○
5	--	●	●	○	○	●
6	--	●	○	●	○	●
7	--	--	--	--	--	--
8	○	●	○	○	○	○
9	●	●	○	●	○	○
10	--	●	--	○	○	○
11	○	●	○	○	○	○

● Fecal Coliform exceeded 100 colonies /100ml water
○ Fecal Coliform did not exceed 100 colonies /100ml water
-- Not enough flow to take a sample

Table 3

Actual Count of Fecal Coliform Colonies / 100 ml of water

Freshwater Site	24-July	22-Aug	12-Sep	23-Oct	13-Nov	12-Dec	Geomean
1	1,070	1,531	100	58	27	70	**162**
2	4,433E	2,800	600	254	40E	1,160	**667**
3	1,520E	6,100	--	600	247	3,000	**1,327**
4	800E	11,200	1,300	88	100E	80	**449**
5	--	12,000	181	40	80*	144	**251**
6	--	49,000	<100	139	85	380	**685**
7	--	--	--	--	--	--	--
8	28	270	<100	44	40	65	61
9	196	16,000	<100	246	53	20E	**241**
10	--	2,000	--	82	2E	29E	56
11	16	630	<100	29	35	74	60

Samples reported as <100 are a result of over-dilution at the laboratory. In these samples, no fecal coliform were detected but based on the actual dilutions, concentration would be <100 colonies/100 ml water.
Sample results followed by "E" indicate estimated numbers by the Blaine STP Laboratory
** Due to initial lab error on 11/13, this site was resampled on 11/15.*

Marine Water – Fecal Coliform Concentrations

The marine stations which are most meaningful in this project are DOH sites 4 and 6, which represent the old commercial oyster beds and the current site of the Community Oyster Farm project. The Washington State marine water quality Standards for shellfish harvest include Part A: fecal coliform concentrations not to exceed a geometric mean of 14 colonies per 100 ml of water and Part B: 90th percentile not to exceed 43 colonies per 100 ml of water. Both parts of this Standard are usually only applied to a minimum of 15 samples for any one station, and the Standard is usually applied to the most recent thirty samples. In spite of this, the Standard does provide some reference point for this short-term study.

Over this short period, water quality appears to be acceptable at both stations 4 and 6, but inferior at site 8 (Table 4). Based upon the regular ambient water quality monitoring program conducted by DOH in Drayton Harbor through November 2001, Station 8 exceeds both parts of the shellfish standard and stations 4 and 6 exceed only part B of the standard. It is interesting to note the increase in fecal concentration in August at both stations 4 and 6 when compared to the other sampling dates. This indicates some sensitivity of these sites to "flushing events".

When time allowed, extra samples were taken within the commercial portion of the Blaine Marina and at the boat launch which is very near freshwater sites 1 and 2. These sampling results confirm that at least on some occasions, excessive concentrations of fecal coliform bacteria are present inside of the Blaine Marina. These results suggest that it is timely to more closely evaluate sources in and around the commercial and recreational portions of the Blaine Marina.

Table 4

Number of Fecal Coliform Colonies/ 100 ml water

Drayton Marine Sites	**24-Jul**	**22-Aug**	**12-Sep**	**23-Oct**	**13-Nov**	**12-Dec**
DOH 4	<1.8	7.8	4.5	2.0	--	--
DOH 6	4.5	22	1.8	<1.8	--	--
DOH 8	49	23	23	4.5	-	--
Extra Marine Sites inside Blaine Harbor		**22-Aug**	**12-Sep**	**23-Oct**	**13-Nov**	**12-Dec**
Basin near boat ramp		1600	--	350	--	--
Sea-K Dock		1600	--	--	--	--
Blaine Crab dock		>2400	--	--	--	--
Boundary Fish dock		920	540	--	--	--
Westman Marine dock		540	--	--	--	--
Dakota Fish dock		1600	240	--	--	--

Estimated Flow and Fecal Coliform Loading

Flow, when measurable, ranged from 1.2 to 600 liters per minute (Table 5). There was a general correlation between 48-hr preceding rainfall and flow at all sites from July through September. Given the preceding 48- hour rainfall in October (.78"), which was comparable to the August "flushing event", flows did not increase as much as might have been expected at sites 1, 2, 3. It is possible that late August repairs made by the city of Blaine to the sewer line along Marine Drive eastward of the railroad tracks may have eliminated leakage of infiltrating storm water and sewage from this collection system. Site 1 is the most immediate drainage down-gradient of this repair site. This lack of clear correlation may also be due to the inherent probability of error in estimating flows in this project, although sampling was conducted by the same volunteers at these sites in August and October. Flow at sites 3, 4, 5, 6, 9, and 10 all increased significantly in November and in December (Table 5), responding to saturated soil conditions and regular rainfall for the two weeks preceding this sample.

The exceptionally high flow at **site 3** in December(Table 5) with a correspondingly high fecal coliform count (3,000 colonies/100ml) raises concerns about possible cross-connections with the sanitary sewer. This was the highest fecal coliform concentration recorded for this site during the 6-month sampling period. Normally under high flow conditions with no change in the source, the pollutant would be diluted over a greater volume. There have been problems with cross -connections between sewer and storm water lines along Peace Portal in the past and it is thought that all cross -connections have been eliminated.

Table 5

Flow expressed as liters per minute							
Freshwater Site	24-Jul	22-Aug	12-Sep	23-Oct	13-Nov	12-Dec	**Geomean**
1	9.9	227.0	--	12.0	9.3	50.0	**26.0**
2	22.9	233.0	5.4	83.0	18.5	100.0	**41.0**
3	1.2	78.0	--	10.0	27.0	550.0	**27.0**
4	19.3	60.0	11.4	51.0	96.0	266.0	**51.1**
5	--	45.0	--	30.0	270.0	600.0	**122.0**
6	--	11.0	--	--	15.0	75.0	**23.0**
7	--	--	--	--	--	--	**--**
8	ns	ns	ns	ns	ns	ns	**ns**
9	--	27.0	--	43.0	540.0	330.0	**120.0**
10	--	4.2	--	30.0	43.0	225.0	**33.0**
11	ns	ns	ns	ns	ns	ns	**ns**

-- = Flow was not measured at these sites on this day because it is too low or not flowing at all.
ns = Flow was never measured at either of the creek mouths

Table 6: Summary of Flow and Estimated Daily Loading

Site Number	n	Range in Flow (liters/minute)	Range in Loading (Fecal Coliform colonies/day)
1	5	9.3 – 227	3.62E+06 – 5.00E+09
2	6	5.4 – 233	8.64E+05 – 9.39E+09
3	5	1.2 – 550	2.63E+07 – 2.38E+10
4	6	11.4 – 266	1.87E+06 – 9.68E+09
5	3	30.0 – 600	1.73E+07 – 7.78E+09
6	3	11.0 – 75	1.84E+07 – 7.76E+09
7	0	**NOT SAMPLED**	
8	0	Dakota Creek Mouth Not Measured	
9	4	27.0 – 540	9.50E+07 – 6.22E+09
10	4	4.2 - 225	1.24E+06 – 1.20E+08
11	0	California Creek Mouth Not Measured	

n = number of times flow measurements were taken
We did not have a practical method to measure flow from Dakota and California Creek mouth sites.
Station 7 was never sampled due to extremely low flow throughout the study period.
Scientific/Exponential numbering is used for loading values, for example: (3.62E+06 is equivalent to 3.62 million colonies/day and 5.00E+09 is equivalent to 5 billion colonies/day)
Loading is calculated by multiplying the fecal concentration times the estimated flow.

The loading estimates shown in Table 6 are very similar to the findings in previous studies along this shoreline (Cykler and Haggerty). These calculations are very sensitive to the accuracy of the flow measurements. They should be viewed with caution in a volunteer sampling program such as this, although every effort was taken to minimize error. **Sites 2, 3, and 4** would be considered **high priority** for follow up based upon peak loading estimates. This report sheds no light on either Dakota or California Creek in terms of loading, as flow measurements were not taken at these sites. In a 1995 study, (Cykler and Haggerty) California and Dakota Creeks were ranked an **Intermediate priority** despite their high load, due to the consistency of their coliform counts.

Table 7 below shows the monthly loading estimates and geometric mean for each of the sites where flow was regularly measured. It is interesting to note that with the exception of Site 3 in December, all sites experienced highest fecal loading in the "flushing event" which was captured in August. The highest loading at site 3 was in December, when flow was extraordinarily high for this site and the fecal concentration was also the highest measured at this site, as discussed above.

Table 7

Fecal Coliform Colonies per Day

Site	n	24-Jul	22-Aug	12-Sep	23-Oct	13-Nov	12-Dec	geomean
1	5	1.53E+08	5.00E+09		1.00E+07	3.67E+06	5.04E+07	6.76E+07
2	6	1.46E+09	9.39E+09	8.64E+05	3.04E+08	1.07E+07	1.67E+09	2.00E+08
3	5	2.63E+07	6.85E+09		8.64E+07	9.60E+07	2.38E+10	5.13E+08
4	6	2.22E+08	9.68E+09	1.87E+06	6.64E+07	1.38E+08	3.06E+08	1.50E+08
5	3		7.78E+09		1.73E+07	**	1.24E+09	5.15E+08
6	3		7.76E+09			1.84E+07	4.10E+08	3.88E+08
9	4		6.22E+09		1.52E+08	4.12E+08	9.50E+07	4.39E+08
10	4		1.21E+08		3.54E+07	1.24E+06	9.40E+07	2.66E+07

*** due to lab error on 11/13, this site was resampled on 11/15 and flow was too fast to measure. Therefore no loading estimate is shown for this site in November.*

Conclusions and Recommendations

Conclusions

Flow and fecal concentrations from these freshwater drainages vary dramatically over time. Every drainage on at least one occasion violated freshwater standards and some violated the standards more than half of the time. During this sampling period, the "flushing event" captured in late August accounted for the greatest fecal coliform loading at all sites with the exception of one site that experienced extraordinarily high flow in December with an accompanying high concentration of fecal coliform bacteria. It is probably these flushing events after prolonged dry periods which have the greatest potential impact on water quality in Drayton Harbor.

The mouths of both Dakota and California Creek as well as the storm drain near the mouth of California Creek were the only sites which met part A of the Freshwater Standards during this sampling period.

Drainages which are more rural in nature (sites 9 and 10), tended to have the highest relative flows in November and December once soil had reached the saturation point after weeks of accumulated rainfall. It appears that the urban drainages respond more quickly to rain events early in the winter season. This is logical given the increased percentage of impervious surfaces associated with urban areas.

Marine water quality over the Community Oyster Farm site was in the acceptable range for shellfish harvesting during this short, 4 – month testing period. Counts increased slightly during the August "flushing event". However, every water sample collected within the Blaine Marina had high fecal coliform concentrations, and far surpassed the levels allowed in "approved" shellfish growing areas. Restoring water quality in the Blaine Marina is important because on a flooding tide, water moves from this area southward towards the oyster growing portions of the harbor.

Recommendations

1. All of the participants in this project should be brought together as soon as possible to review and discuss the results of this study and identify appropriate follow-up actions where needed.

2. Based upon the sampling results in this study, continued sampling from March through June, combined with upstream investigations seems warranted at those sites which exceeded the Freshwater standard 50% or more of the time. This would include **Sites 2, 3, 4, 5, 6, and 9.**

3. Particular attention should be given to **site 3** in order to rule out any possibility of a cross connection with the sanitary sewer. This could possibly be accomplished by dye-testing at the pump station next to Chuck's Diner when rainfall approaches 1 inch in a four day period. This was the situation that contributed to the high flow and high fecal concentrations at this site on December 12.

4. Although sampling within the Blaine Marina was not the focus of this project, it is clear that efforts need to be made to better understand and control the sources of pollution impacting this area. Known sources must be controlled as soon as possible.

    - The major known source in this area, which has not been controlled to date is the fish processors waste stream. A dis-infection system should be in place as soon as possible.
    - Best Management Practices around fish processing facilities, if available, should be implemented. These would focus on minimizing food sources which attract wildlife; particularly seagulls and rodents.
    - Boaters within the Blaine Marina should be targeted now with educational materials discussing the current water quality status and the importance of proper human waste management in this marina, given its proximity to shellfish growing waters. Dye tablets placed in vessel heads are required in some sensitive marinas like this one. This could be a requirement in moorage agreements in the Blaine Marina.
    - Following the October completion of significant repairs to the Blaine sanitary sewer line and numerous manholes along Marine Drive, the city should consider dye-testing the collection lines and manholes to determine whether human sewage is as a source impacting the Blaine Marina.
    - Consideration should be given to conducting an Antibiotic Resistance Analysis of fecal coliform bacteria in this area for fecal source identification (human vs. animal). This is described by Glasoe and Bower in *Puget Sound Notes*, number 45, pp. 2-8 and is based on a case study in Tillamook Bay, Oregon.

Acknowledgements

Credit needs to be given to the following people and groups for their contributions to this study. This includes all of the citizen volunteers including Tom and Kathryn Cullen, Richard and Jodee Arnold, Ron Leach, and Barbara Monson for the time and effort they provided to attend training, sample collection, and their continued interest in this project; Don Lennartson, DOH for volunteer training, marine water sample collection, and laboratory work provided by DOH; Grant Stewart, Frank Arnett, Mike Trueblood, and Clifford Ness, City of Blaine for laboratory analysis of freshwater samples; Heather Goble, Environment Canada for coordinating sampling times in a similar shoreline sampling program occurring in the White Rock area; Amy Stillings, Whatcom County Water Resources Division for assisting with sample collection; Betsy Peabody, Puget Sound Restoration Fund for assisting in project management; and Bruce Roll, Whatcom County Water Resources Division for financial support of this timely community involvement project.

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A complete version of this report, with the appendices containing the color photos of the sample drains and the monthly raw data sheets, is available in the Water Resources Division library located at 322 N. Commercial St. Suite 110, Bellingham, WA 98225.