Fecal Coliform Model Verification Sampling Plan

Winter 2004

Addendum to the

Fecal Coliform Total Maximum Daily Load Study Plan For Sinclair and Dyes Inlets

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Water Body Numbers

WA-15-0040 Sinclair Inlet
WA-15-0050 Dyes Inlet

Prepared by
Puget Sound Naval Shipyard & Intermediate Maintenance Facility Project ENVVEST

For

Washington State Department of Ecology
Assessments Sections

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Water Body Numbers
WA-15-0040 Sinclair Inlet
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1. Introduction

This document presents the Winter 2004 Fecal Coliform (FC) model verification sampling plan prepared in support of the FC Total Maximum Daily Load (TMDL) Study Plan for Sinclair and Dyes Inlets, WA (TMDL Study Plan). The sampling plan describes specific sampling activities to obtain data necessary to verify the watershed and receiving water models being developed for FC fate and transport in Sinclair and Dyes Inlets (Figure 1) and support the development of a water clean up plan for the Sinclair/Dyes Inlet watershed. This sampling plan has been revised to address comments received on the draft document (Appendix 12.1 Response to Comments from Ecology (M. Roberts) of 26 JAN 2004). This plan has been prepared by Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS & IMF) Project ENVVEST as an addendum to the TMDL Study Plan, and, unless otherwise noted, the data quality objectives, quality control/quality assurance (QA/QC) requirements, and sampling procedures identified in the TMDL Study Plan are applicable.

2. Objectives

The objectives of this plan are to:

1. Provide FC data coupled with flow data from 13 representative storm water outfalls (these are the outfalls and streams being monitored for flow by The Environmental Company (TEC) for PSNS & IMF Project ENVVEST – TEC-FLOW stations, Table 1, Figure 2) selected from within the study area.
2. Provide synoptic data on FC concentrations in sources from stream (STREAM), storm water outfall (SW), and wastewater treatment plant (WWTP) effluent stations, and adjacent marine and nearshore receiving water stations (MARINE) during representative storm events.

The data obtained from this study will be used to verify the linkage between the hydraulic simulation model (HSPF) being developed for the watershed (Skahill 2003) and the curvilinear hydrodynamics in three dimensions – fecal coliform (CH3D-FC) model developed for the receiving waters (Wang et al. 2003, Johnston et al. 2003, Wang et al. in prep). Once verified, the integrated watershed-receiving water model will be used to conduct simulations to support TMDL development.

3. Overview of Sampling

The Winter 2004 FC TMDL sampling for model verification will consist of three sampling events to be scheduled following March 1, 2004. A qualifying event for sampling is a storm event that results in more than 0.25 inches of rain within a 24-hr period, following a discernable period of no rainfall (TMDL Study Plan). Each sampling event will be targeted for one of three focus areas within the study area: DYES INLET, BREMERTON, or PORT ORCHARD (Figure 3). Each sampling event will consist of sampling the storm water outfalls at the 13 flow monitoring stations (TEC-FLOW) and sampling additional stations located at stream (STREAM) storm water outfall (SW), wastewater treatment plant outfall (WWTP) and marine (MARINE) stations located within the focus area being sampled. In order to not exceed the analytical laboratory's ability to process the samples and meet the holding times specified in the

TMDL Study Plan, sampling for each event will be staged over two days. Day one will consist of collecting samples from potential sources including the TEC-FLOW, STREAM, SW, and WWTP stations, followed by the MARINE sample collection at the end of the event (every effort will be made to collect the marine samples within 24 h of the storm event). All sampling procedures, chain-of-custody, sample-holding times, and laboratory procedures specified in the TMDL Study Plan will be followed for samples collected during this study (Project ENVVEST Fecal Coliform TMDL Study Sampling and Logistics Plan Winter 2004).

4. Background

As specified in the TMDL Study Plan, more than 1200 FC samples were collected from Sinclair and Dyes Inlets and surrounding watershed during the winter of 2002-2003 (see map of station locations). These data were combined with historical data collected by the Kitsap County Health District (KCHD 2002, 2003a), the Washington State Department of Health (WDOH, Determan 2001, 2003), and Kitsap County Surface and Storm Water Management (SSWM 2002a, b) to characterize FC sources, estimate FC loading into the Inlets, evaluate the impact on the quality of marine waters, and support the development of a water clean-up plan for the Sinclair/Dyes Inlet watershed (May et al. 2003). Currently, these data and other information are being used to define modeling scenarios that will be simulated to support the development of a TMDL for FC within the Inlets.

Since water year 2000 (WY2000), the Kitsap Public Utilities District (KPUD) has monitored and developed continuous records of stream flow for the major streams within the study area (Figure 4). Data on precipitation and other meteorological data are also monitored by KPUD and the City of Bremerton for the study area (Figure 5). These data have been combined with historical stream data collected by the KPUD (1999a) and rain data from the study area (KPUD 1999b) to develop a very extensive record of hydrological data to model stream flow with HSPF (Skahill 2003, Figure 6). Due to the efforts of KPUD, SSWM, City of Bremerton, and ENVVEST, the critically important stream flow-monitoring network developed for the study area will be continued through WY2004 (Table 2). The results obtained from calibration and validation of stream flows from the gauged systems will be used to simulate stream flow for the ungauged streams within the study area (Skahill 2003). The flow data needed to calibrate and validate the storm water systems will be also collected during WY2004 (see below).

As part of the In-Stream and Storm Water Flow Sampling being conducted by The Environmental Company (TEC) for PSNS & IMF Project ENVVEST, 13 storm water drainage basins have been selected for flow monitoring and storm event sampling (Table 1, Figure 2, Appendix12.2 Summary of TEC FLOW Stations). The storm water outfalls selected for flow monitoring were determined by a technical evaluation of 35 storm water outfalls (including streams and other urbanized natural drainage areas) located within the City of Bremerton, City of Port Orchard, City of Bainbridge Island, Kitsap County, and the Shipyard (see Table ES-1 of TEC 2003a). The 35 outfalls selected for evaluation were down selected from more than 150 storm water outfalls and channelized streams (> 12 inches in diameter) located within the study area. The 35 outfalls were selected for evaluation based the size of upstream drainage area, the upstream land use and land cover, availability of historical data, and local knowledge about the sites (TMDL Study Plan). The technical evaluation conducted by TEC ranked the outfalls based on the ability to obtain accurate flow rates and flow-weighted composite samples, logistics, health and safety concerns, watershed characteristics and cost (see Table ES-1 of TEC 2003a). The final list of 13 stations selected for monitoring were the highest-ranking stations that would provide the most representative data on storm water outfalls within the study based on the cost and equipment available for the sampling effort (Table 1, Figure 2).

The objectives of TEC's study include obtaining verifiable flow rates for the outfalls under a variety of storm conditions, collecting FC concentrations associated with representative storm events, and collecting data on hydrology and water quality parameters, including data on metals, toxic organics, nutrients, and other conventional parameters during baseline and storm conditions (TEC 2003b). The data obtained from the storm water sampling will be comparable to the data obtained from the in-stream storm events sampled during the Winter of 2002-2003 (TEC 2003c).

The ENVVEST modeling studies have developed models for simulating runoff and loading from the watershed (Skahill 2003) and fate and transport of FC bacteria in the Inlets (Wang et al. 2003, Johnston et al. 2003, Wang et al. in prep). The ability to simulate FC fate and transport in the Inlets assisted in the reopening of 1500 acres of shellfish beds in Dyes Inlet (Dunagan 2003, WDOH 2003a, b, c, see map of conditionally approved area). The reopening came about because the city of Bremerton has nearly eliminated combined sewage overflows and the model, developed by ENVVEST, shows that FC released from CSO events mostly dissipates before reaching the shellfishing areas subject to the new classification (WDOH 2003a, b, c). Currently, the integrated watershed-receiving water model needs to be verified so that the models can be used to simulate FC loading scenarios to determine waste load allocation (WLA) and load allocation (LA) targets needed for the TMDL (WDOE 1999). This study plan has been developed to provide synoptic samples of FC sources (streams, storm water outfalls, and WWTPs) and receiving water during representative storm events so that the watershed model can be calibrated and validated for storm water flows and the integrated watershed-receiving water model can be verified for modeling FC.

5. Sampling Design

5.1 Technical Approach

The sampling will consist of three sampling events to be scheduled following March 1, 2004. A qualifying event for sampling is a storm event that results in more than 0.25 inches of rain within a 24-hr period, following a discernable period of no rainfall (TMDL Study Plan). Each sampling event will be targeted for one of three focus areas within the study area: DYES INLET, BREMERTON, or PORT ORCHARD (Figure 3). Each sampling event will consist of sampling the storm water outfalls at the 13 flow monitoring stations (TEC-FLOW) and sampling additional stations located at stream (STREAM) storm water outfall (SW), wastewater treatment plant outfall (WWTP) and marine (MARINE) stations located within the focus area being sampled. In order to not exceed the analytical laboratory's ability to process the samples and meet the holding times specified in the TMDL Study Plan, sampling for each event will be staged over two days. The day of the storm will be focused on collecting samples from the TEC-FLOW, SW, STREAM, and WWTP sites. Ideally, the marine samples should be collected within one tidal cycle following the storm's peak flow, however that may not be practical. Every effort will be made to collect the marine samples within 24 h of the storm event. All sampling procedures, chain-of-custody, sample-holding times, and laboratory procedures specified in the TMDL Study Plan will be followed for samples collected during this study.

The idealized storm hydrograph shown in Figure 7 shows the beginning of the storm, “first flush,” “peak flow,” and “tail of storm” for a hypothetical storm event and illustrates the optimum sampling intervals for sampling. The storm begins when the rainfall from a candidate storm is greater than 0.05 in of rain within a one hour period (TEC 2003b, c). Generally, there may be a delay from the beginning of the storm before an increase in flow is evident and the “first flush” occurs. The TEC samples should be collected regularly throughout the storm beginning with the prestorm baseflow condition and capturing as best as possible the storm hydrograph (Figure 7). The WWTP samples should be collected at regular intervals once a discernable increase in effluent flow at the Treatment Plant is observed. The SW samples should be collected as close as possible to the peak flow conditions of the storm, stream samples should represent high flow and tail of the storm, and the marine samples should be collected within 24 h following the storm event (Figure 7).

5.2 Field Sampling Procedures

It is envisioned that at least four sampling teams will be mobilized to collect the required samples. The TEC-FLOW samples will be collected by TEC as part of the flow monitoring tasks for each storm event (TEC 2003b). Sampling teams from Kitsap SSWM, Bremerton, and Karcher Creek Sewer District will assist in collecting samples from outfalls within their jurisdictions. An ENVVEST sampling team will also assist in collecting samples and transporting samples to the laboratory for analysis. The MARINE samples will be collected from a vessel provided by PSNS & IMF and coordinated with regularly scheduled sampling conducted by KCHD (2002), if possible. A pre-sampling meeting was held on February 4, 2004 to review sampling objectives, assign team captains, and coordinate on sample identification, custody, and processing procedures. The sample handling and field procedures identified in the TMDL Study Plan will be followed, including collecting *in situ* data on temperature, pH, DO, conductivity, and turbidity at the time of sample collection and obtaining field duplicates for about 10% of the field samples collected during the study (Project ENVVEST Fecal Coliform TMDL Study Sampling and Logistics Plan Winter 2004). Any deviations from the plan will be documented in writing and appended to this sampling plan.

The TEC-FLOW stations will be sampled during each sampling event. Six FC samples will be collected over the course of the storm (TEC 2003b). If possible, the first sample will be taken shortly before the storm (e.g. baseline conditions, if flow is present), then at the beginning of the storm event, and periodically thereafter during the event until the event is over. If possible, one of the samples will be collected at or near the peak flow of the storm event. Because storm water flow will be monitored, the TEC sampling team will be able to collect extra samples for each site, and by examining the hydrograph obtained for the station, determine the optimal samples for FC analysis (i.e. select the samples that best represent the time series of the hydrograph sampled, see Figure 7).

Two samples will be collected from the additional SW and STREAM stations during the storm event. If practical, the SW samples will be taken during high flow conditions and the STREAM samples will be taken during high flow and tail of storm conditions (Figure 7). During the BREMERTON and PORT ORCHARD sampling events, four samples from the Bremerton and Karcher Creek WWTPs will be obtained periodically once a discernable increase in effluent flow at the Treatment Plant is observed (e.g every six hours during and immediately following the storm event, see Figure 7) The WWTP plant flow rates will also be recorded and reported for the same sampling event. The MARINE samples will be collected within 24 h of the storm event, or the soonest as is practical. Ideally, the marine samples should be collected within one tidal cycle following the storm's peak flow, however that may not be practical. Every effort will be made to collect the marine samples within 24 h of the storm event. One sample will be collected from each MARINE site, except for the station at the mouth of Dyes Inlet (DY09) and the station at the mouth of the Point Washington Narrows (DY01). These stations will be sampled twice, once during the outbound transit and again during return transit of the vessel to characterize the inflow/outflow to Dyes Inlet for the DYES INLET event and the inflow/outflow from the Port Washington Narrows for the BREMERTON and PORT ORCHARD events.

5.3 Fecal Coliform Sampling Locations

5.3.1 Dyes Inlet Sampling Event

The sites to be sampled for the DYES INLET sampling event are listed in (Table 3). The sites include the 13 TEC-FLOW stations, 5 additional storm water stations, 8 stream stations, and 27 marine stations (Figure 8). The additional storm water sites includes the major storm water outfalls located in the northern portion of Dyes Inlet (SSWM 2002b). The stream sites are the mouths of the major streams entering Dyes Inlet as well as the stream gage locations at Chico and Clear Creek main stems (Table 3, Figure 8). The MARINE stations consist of the shellfish monitoring stations established by WDOH and KCHD and additional stations established by ENVVEST for model verification (Figure 9). The MARINE stations are located in areas that would most likely be impacted from stream and storm water sources including designated shellfishing areas (Figure 9).

DYES INLET Total Samples (Including Field Duplicates)			
DYES	Day 1	Day 2	Event total
TEC TEAM	**42**	**41**	**83**
SSWM TEAM	**18**	**6**	**24**
ENVVEST TEAM	**11**	**4**	**15**
MARINE TEAM		**30**	**30**
Total	**71**	**81**	**152**

5.3.2 Bremerton Sampling Event

The sites to be sampled for the BREMERTON sampling event are listed in (Table 4). The sites include the 13 TEC-FLOW stations, 12 additional storm water stations, 2 stream stations, 3 WWTP stations, and 31 marine stations (Figure 10). The storm water outfall sites are representative of the major storm water drainages from the City of Bremerton and the Shipyard (TMDL Study Plan). The drainage basins include catchments and urbanized drainage areas in East Bremerton, West Bremerton, and along the waterfront of the Shipyard and the Bremerton Naval Station (Figure 10). Two additional stream sites on Dee Creek and Oyster Bay Creek will also be monitored (Figure 10). These streams have been identified as problem areas during recent monitoring by the KCHD (2002, 2003a). The MARINE stations include shellfish monitoring sites in Oyster Bay and Ostrich Bay, coves and beach areas in the Port Washington Narrows, including Phinney Bay (Figure 11), and stations along the industrialized waterfront in northern Sinclair Inlet (Table 4, Figure 12). The MARINE stations are located in areas that would most likely be impacted from stream and storm water sources.

BREMERTON Total Samples (Including Field Duplicates)			
DYES	Day 1	Day 2	Event total
TEC TEAM	**42**	**41**	**83**
BREMERTON TEAM	**17**	**5**	**22**
SSWM TEAM	**9**	**0**	**9**
ENVVEST TEAM	**9**	**0**	**9**
KARCHER TEAM	**2**	**2**	**4**
MARINE TEAM		**35**	**35**
Total	**79**	**83**	**162**

5.3.3 Port Orchard Sampling Event

The sites to be sampled for the PORT ORCHARD sampling event are listed in (Table 5). The sites include the 13 TEC-FLOW stations, 4 additional storm water stations, 8 stream stations, 3 WWTP stations, and 20 marine stations (Figure 13). The storm water outfall sites are representative of the major storm water drainages from the City of Port Orchard and surrounding unincorporated Kitsap County (TMDL Study Plan). The drainages include catchments and urbanized drainage areas in Port Orchard and Gorst (Figure 13). The mouths of the major streams draining along the southern shore of Sinclair Inlet will be sampled, along with the sites located at the stream gage site on Blackjack Creek and the mouth of Beaver Creek in Clam Bay (Figure 13). The MARINE stations include the head of Sinclair Inlet, marina areas around Port Orchard, Clam Bay, and the boundary stations in Port Orchard and Rich Passage (Table 5, Figure 14). The MARINE stations are located in areas that would most likely be impacted from stream and storm water sources. During the marine sampling for the PORT ORCHARD event, surface and deep samples will be collected at the boundary stations M1 and M2 to determine if there are any differences in the surface and deep-water exchange with the central Puget Sound.

PORT ORCHARD Total Samples (Including Field Dups)			
DYES	Day 1	Day 2	Event total
TEC TEAM	**42**	**41**	**83**
ENVVEST SW TEAM	**9**	**0**	**9**
ENVVEST STREAMS	**9**	**9**	**18**
BREMERTON TEAM	**4**	**3**	**7**
KARCHER TEAM	**2**	**2**	**4**
MARINE TEAM		**25**	**25**
Total	**66**	**80**	**146**

5.4 Trace Metal Sampling

During the BREMERTON sampling event additional samples for trace metal and organic analysis will be collected. In conjunction with the ISCO and grab sampling being conducted by TEC (2003b) additional samples for trace metal analysis will be collected from the storm water outfalls in the shipyard, the WWTP outfalls, and marine stations near the shipyard (Table 6). The samples will be collected in ultra-clean Teflon 1-liter bottles, using ultra-clean sampling techniques at the same time the FC samples are collected. The samples will be preserved on ice and transported to the Battelle Marine Sciences Laboratory where they will be analyzed for the dissolved and particulate metals in the same fashion as the samples being collected by TEC (2003b). If enough sample water is available, a subset of samples from each outfall will be composited for analysis of toxic organic compounds. These samples will provide additional data from storm water outfalls, WWTP, and marine locations to support future modeling studies.

5.5 Dye Study in Sinclair Inlet

A dye study for outfalls discharging from the Shipyard is being developed to measure the mixing of discharges released into Sinclair Inlet (SSC-SD in prep). The dye study will utilize the Marine Environmental Survey Capability's (SSC-SD 2003) mini-MESC system to map out freshwater, particle, and dye plumes generated from storm water and/or drydock discharges during storm events and normal operations. Similar to the dye-release study conducted in the Port Washington Narrows (ENVVEST 2002), the mixing zone study will focus on collecting salinity, temperature, light transmission, and dye fluorescence data at a 4-Hz data rate offshore of selected outfalls during storm events. Briefly, the mini-MESC system will be used to map out the surface water (~1 m depth) plume generated from discharges by traversing the region immediately offshore the outfall. Vertical profiles will also be collected to assess the depth of the plumes. The data from the dye study will be used to generate maps of the spatial extent of the plumes as a function of time, quantify the amount of dilution as a function of location, and assess the potential impact of discharges on the receiving waters of the Inlet (SSC-SD in prep). Due to logistics and scheduling constraints the dye study will be scheduled independently of the FC sampling described in this sampling plan.

6. Laboratory Measurements

The Washington State Department of Ecology Manchester Laboratory will perform the fecal coliform analysis using a Membrane Filter Technique. The analytical laboratory is responsible for calibration and maintenance of analytical laboratory equipment and instruments and the maintenance of laboratory personnel qualifications. The laboratory supervisor is responsible for timely completion of calibration and maintenance. Records of these activities will be made available upon request.

The laboratory's standard data quality acceptance criteria will be used. Acceptance criteria will focus on ensuring an appropriate level of data quality to meet the project objectives. Method blanks and laboratory duplicate samples will be analyzed to evaluate and monitor analytical results. Throughout this study, acceptance criteria will be periodically reviewed for appropriateness and adequacy in meeting the study goals and objectives. Acceptance criteria will be modified if conditions warrant. The laboratory SOPs to be used for this study are provided in Appendix H of the TMDL Study Plan.

7. Modeling

7.1 Model Verification

The results obtained from calibration and validation of stream flows from the gauged systems will be used to simulate stream flow for the ungauged streams within the study area (Skahill 2003). Data from the storm water flow monitoring will be used to calibrate and validate the HSPF model for storm water discharge. Results obtained from the calibrated and validated storm water systems will be used to simulate storm water flow for the other storm water drainage basins in the study area (Figure 1). Once the watershed model has been satisfactorily calibrated and verified it will be used to route flows into the receiving water model CH3D-FC (Johnston et. al. 2003). Loading estimates of FC from the streams and storm water outfalls will be developed based on the empirical data observed in the TMDL study (May et al. 2003, Roberts and Pellitier 2001, see meeting notes from Oct. 23, 2003). The relationships among FC loading and landuse landcover, storm intensity, time of year, antecedent dry period, etc will be used to estimate the potential FC loading from the streams and storm water outfalls for which empirical data are not available. These activities will result in a fully developed model to route flow and FC into the CH3D-FC receiving water model.

The CH3D-FC model will be verified by programming the receiving water model with the conditions observed during the sampling events (rainfall rate, flow discharge, and fecal coliform loading from streams and storm water outfalls) and then routing the watershed model outputs as inputs into the CH3D-FC simulations. The CH3D-FC model will be programmed to recreate the storm, wind, and tidal conditions present during the sampling events and the simulation will produce a time series of FC concentrations for the nodes located at the MARINE sites sampled during the verification sampling events. Each of the verification sampling events for DYES INLET, BREMERTON, and PORT ORCHARD will be simulated with the integrated watershed-receiving water model to determine agreement with FC data observed in the Inlets.

The verified model will be used to conduct simulation scenarios to support the TMDL (see CSO simulation scenarios for example model animations, time series, and domain exceeded plots). Nodes from the receiving water model will be selected (e.g. nodes corresponding to the MARINE sample locations) for generating time series plots of FC concentrations for the length of the simulation. The time-series data will be statistically analyzed to determine if the data suggests that the marine standard for shellfish harvesting or marine recreational use would be exceeded:

> **(2) (b) Shellfish harvesting bacteria criteria.** To protect shellfish harvesting, fecal coliform organism levels must not exceed a geometric mean value of 14 colonies/100 mL, and not have more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 43 colonies/100 mL (i) Shellfish growing areas approved for unconditional harvest by the state department of health are fully supporting the shellfish harvest goals of this chapter, even when comparison with the criteria contained in this chapter suggest otherwise.

(ii) When averaging bacteria sample data for comparison to the geometric mean criteria, it is preferable to average by season and include five or more data collection events within each period. Averaging of data collected beyond a thirty-day period, or beyond a specific discharge event under investigation, is not permitted when such averaging would skew the data set so as to mask noncompliance periods. The period of averaging should not exceed twelve months, and should have sample collection dates well distributed throughout the reporting period.

(iii) When determining compliance with the bacteria criteria in or around small sensitive areas, it is recommended that multiple samples are taken throughout the area during each visit. Such multiple samples should be arithmetically averaged together (to reduce concerns with low bias when the data is later used in calculating a geometric mean) to reduce sample variability and to create a single representative data point. (WAC 173-201A (2) (b)).

(3) (b) Water contact recreation bacteria criteria. Fecal coliform organism levels must not exceed a geometric mean value of 14 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 41 colonies/100 mL

(i) When averaging bacteria sample data for comparison to the geometric mean criteria, it is preferable to average by season and include five or more data collection events within each period. Averaging of data collected beyond a thirty-day period, or beyond a specific discharge event under investigation, is not permitted when such averaging would skew the data set so as to mask noncompliance periods. The period of averaging should not exceed twelve months, and should have sample collection dates well distributed throughout the reporting period.

(ii) When determining compliance with the bacteria criteria in or around small sensitive areas, such as swimming beaches, it is recommended that multiple samples are taken throughout the area during each visit. Such multiple samples should be arithmetically averaged together (to reduce concerns with low bias when the data is later used in calculating a geometric mean) to reduce sample variability and to create a single representative data point.

(iii) As determined necessary by the department, more stringent bacteria criteria may be established for waters that cause, or significantly contribute to, the decertification or conditional certification of commercial or recreational shellfish harvest areas, even when the preassigned bacteria criteria for the water is being met.

(iv) Where information suggests that sample results are due primarily to sources other than warm-blooded animals (e.g., wood waste), alternative indicator criteria may be established on a site-specific basis by the department. (WAC 173-201A (3) (b)).

The above criteria suggest that the modeling scenarios for the TMDL should be developed to assess critical conditions of FC loading for periods less than a month for sensitive areas such as shellfish harvesting areas and swimming beaches. Currently, it is envisioned that once verification is completed, the integrated model will be used to simulate FC concentrations within the Inlets for WY2003 either for the whole year, or for specific segments (30-60 day simulations), whichever is more technically feasible. The results of the WY2003 simulations will demonstrate the model's ability to mimic FC loading in the Inlets and help define the critical conditions for the TMDL scenarios. Once the critical conditions have been defined, TMDL simulation scenarios will be developed for model runs. How the model output will be evaluated to determine WLA and LA targets is being developed by the TMDL Modeling Working Group, led by Ecology and made up of technical stakeholders participating in the TMDL process. One possibility is that specific nodes in model could be selected to extract model output from the TMDL simulation scenarios for calculating the mean and 90th percentile statistics to compare to the FC water quality standards over an appropriate time period (Figure 15). Once the working group reaches a consensus on how the model output will be evaluated and what scenarios should be run, a TMDL modeling scenario plan will be developed to document the modeling scenarios that will be simulated to support the development of a TMDL for FC within the Inlets.

7.2 Uncertainty

In order for model verification to be valid, all FC sources must be identified, quantified, and programmed into the model. Despite the best efforts, certain sources of FC may remain unidentified and unquantified, and therefore unrepresented in the model. Possible unidentified sources of FC pollution could include contaminated groundwater discharges in nearshore or subtitdal areas, bacterial sources from sediment resuspension, bacteria from marine mammals birds, and other wildlife, and the release of bacteria and pathogens from beach wracks and other rotting debris along the shoreline. Although it is assumed that these sources are negligible considering the magnitude of FC concentrations measured in streams and storm water outfalls (May et al. 2003), such sources may be locally important and may hinder model verification and accurate determination of WLA and LA targets.

8. Summary

This sampling plan describes specific sampling activities to obtain data necessary to verify the watershed and receiving water models being developed for FC fate and transport in Sinclair and Dyes Inlets. If successfully implemented, this plan will provide FC data coupled with flow data from 13 representative storm water outfalls and provide synoptic data on FC concentrations in sources and adjacent receiving waters during representative storm events. These data will be suitable to conduct verification of the watershed-receiving water models being used for the Sinclair and Dyes Inlet FC TMDL study.

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10. Tables

Table 1. Station locations, jurisdiction, size of catchment area (acres) for stormwater outfalls to be monitored for flow.
The FC concentrations observed during the Winter 2002-2003 sampling are also listed for each station.

			<estimate>			Observed FC Concentrations[1] fcu/100 ml			
StationID	**Basin Name**	**Jurisdiction**	**Size (acres)**		**n**	**GeoMean**	**min**	**90th%**	**max**
BI-SBC	Spring Brook Creek	Bainbridge Island	1655.7		5	83	43	192	231
B-ST01 (SW1)	Pine Rd	Bremerton	793.0		11	885	30	7147	7260
B-ST28 (SW2)	Callow Ave	Bremerton	489.8		8	1145	520	2367	2376
B-ST12 (SW4)	Trenton Ave	Bremerton	155.7		13	33	1	1110	3600
B-ST/CSO16 (SW3)	Pacific Ave	Bremerton	129.1		15	328	37	2146	2376
LMK122 (ANNAP)	Navy City	Kitsap County	373.4		17	132	14	883	2100
LMK136	Annapolis	Kitsap County	316.8		16	303	29	2033	3700
(SW6)[2] LMK001	Silverdale Mall	Kitsap County	256.1		17	150	8	985	1100
+LMK002					17	256	20	1818	2500
LMK038	Manchester	Kitsap County	142.9		17	421	60	2253	3800
PO-POBLVD	Port Orchard Blvd	Port Orchard	314.6		17	291	20	3119	14000
PSNS015	Naval Station McDonalds	PSNS	109.5		12	1629	77	10741	13000
PSNS124	PSNS CIA Building 438 near DD2	PSNS	18.8		13	11	1	252	1300
PSNS126	PSNS Downstream of CSO 16 (460)	PSNS	17.3		12	1935	1	89134	16830

1. Data summary from the Winter 2002-2003 ENVVEST sampling, exculding outliers (May et al. 2002)
2. Outfall includes discharge from LMK001 + LMK002

Table 2. The network of stream gages monitored by KPUD and City of Bremerton within the study area for WY2004.

Stream Gage	Code	Period of Record	Status	Equipment Provided by	Station Serviced by
CLEAR CREEK (MAIN)	CC	10/1990 - Present	ACTIVE	KPUD	KPUD
ANDERSON CREEK - BREM.	AC	1/1991 - Present	ACTIVE	KPUD	KPUD
KARCHER CREEK	OC	4/1997 - Present	ACTIVE	KPUD	KPUD
CHICO CREEK (MAIN)	CH	3/1991 - 4/1996, 7/1999 - Present	ACTIVE	KPUD	KPUD
DICKERSON CREEK	DI	10/2000 - Present	ACTIVE	SSWM	KPUD
WILDCAT CREEK at LAKE OUTLET	WC	10/2000 - Present	ACTIVE	SSWM	KPUD
KITSAP LAKE at CONTROL	KL	10/2000 - Present	ACTIVE	SSWM	KPUD
KITSAP CREEK at LAKE OUTLET	KC	10/2000 - Present	ACTIVE	SSWM	KPUD
CHICO TRIB. at TAYLOR ROAD	CT	10/2000 - Present	ACTIVE[1]	SSWM	KPUD
CLEAR CREEK - EAST	CE	1/2001 - Present	ACTIVE	ENVVEST	KPUD
CLEAR CREEK - WEST	CW	1/2001 - 9/2003	INACTIVE	ENVVEST	KPUD
BARKER CREEK	BA	1/1991 - 11/1996, 1/2001 - Present	ACTIVE	ENVVEST	KPUD
STEEL CREEK	SL	1/2001 - 6/2002	INACTIVE	ENVVEST	KPUD
STRAWBERRY CREEK	SC	1/1991 - 4/2000, 10/2001 - Present	ACTIVE	ENVVEST	KPUD
BLACKJACK CREEK	BL	1/1993 - 12/1997, 1/2001 - Present	ACTIVE	ENVVEST	KPUD
GORST CREEK (ABOVE JARSTEAD)	GC	10/1990 - 9/1996, 1/2001 Present	ACTIVE	ENVVEST	BREMERTON
PARISH CREEK	PA	2/28/2002 - Present	ACTIVE	ENVVEST	BREMERTON
HEINS CREEK	HE	6/2002 - Present	ACTIVE	ENVVEST	BREMERTON
GORST CREEK (LOWER)	GCL	9/2003 - Present	ACTIVE	ENVVEST	BREMERTON

1. Stream gage damaged during storm of Fall 2003, awaiting repair

Table 3. DYES

EVENT_DYES_INLET					
Table 3. Station locations and samples to be collected during the DYES INLET sampling event.					
STATION	**LOCATION**	**LatDD**	**LongDD**	**DAY_1**	**DAY_2**
TEC SAMPLING TEAM					
BI-SBC	Springbrook Creek @ New Brooklyn Rd	47.643	-122.567667	2	1
B-ST/CSO16	Manhole at Park Ave and Pacific Ave	47.56	-122.628889	3	3
B-ST01	Pine Rd-2 blocks east of outfall SW3	47.586111	-122.646389	3	3
B-ST12	Trenton Ave	47.568056	-122.608333	3	3
B-ST28	Callow Ave	47.554167	-122.656667	3	3
LMK001	Silverdale West Bucklin Hill Road	47.651333	-122.693	3	3
LMK002	Silverdale at Sandpiper	47.650833	-122.692833		
LMK038	Manchester 038	47.555667	-122.5432	3	3
LMK122	Gorst Navy City Metals	47.547333	-122.697	3	3
LMK136	Port Orchard 136 (Annapolis Cr)	47.55	-122.62	3	3
PO-POBLVD	Port Orchard Residential MD TBD	47.534247	-122.634689	3	3
PSNS015	Naval Station Coml/Res/Rec (McD drthr)	47.560911	-122.649091	3	3
PSNS124	PSNS CIA Building 438 near DD2	47.561881	-122.625516	3	3
PSNS126	PSNS Downstream of CSO 16 (460)	47.56027	-122.6266	3	3
Field DUPs				4	4
SSWM SAMPLING TEAM					
LMK026	West Bank of Clear Ck. North of Bucklin Hill RD	47.650667	-122.6865	2	
LMK055	Kitsap SSWM Tracyton Boat Dock 055 Residential draina	47.6085	-122.6578	2	
LMK374	36" Out fall that comes out under Bucklin Hill Rd. Bridge	47.6505	-122.6855	2	
BA	KPUD BARKER CREEK At Gaging Site	47.63913	-122.66276	2	1
CC	KPUD CLEAR CREEK At Gaging Site	47.66505	-122.68268	2	1
CC01	DWNSTRM RIDGETOP BLVD. CULVERT	47.65357	-122.68507	2	1
MS01	Mosher UPSTRM TRACYTON BLVD/SCHUYLER CULVE	47.61235	-122.65491	2	1
PA01	Pharman Cr. DWNSTRM TRACYTON BLVD CULVERT	47.621	-122.69	2	1
Field DUPs				2	1
ENVVEST SAMPLING TEAM					
LMK004	Across from 9361 Bayshore. (Knit n Stitch).	47.648667	-122.6935	2	
LMK014	New steel culvert. Replaced concrete outfall winter of 200	47.6405	-122.7005	2	
CH01	CHICO CR DWNSTRM KITTYHAWK DR CULVERT	47.60243	-122.70591	2	1
CH	At Main Stem Gaging Site - Country Club Bridge	47.593	-122.70903	2	1
SC	KPUD STRAWBERRY CREEK At Gaging Site	47.64667	-122.69417	2	1
Field DUPs				1	1

Table 3. Cont. DYES

Table 3. Cont.	EVENT_DYES_INLET				
STATION	**LOCATION**	**LatDD**	**LongDD**	**DAY_1**	**DAY_2**
MARINE SAMPLING TEAM					
DY27	Clear Creek Estuary	47.64976	-122.6859		1
SHOTEL	Silverdale West Coast Hotel	47.6493	-122.69252		1
DYHD	Head of Dyes Inlet just S. of old pilings	47.6453	-122.688		1
DY24	Silverdale Water Park	47.64345	-122.69365		1
DY29	NEARSHORE BARKER CREEK MOUTH	47.63717	-122.68533		1
WDOH-464	Offshore of the drainage South of the tennis court	47.63548	-122.701		1
WDOH-483	At a break in the bulkhead South of Barker Creek	47.63357	-122.67427		1
WDOH-477	Over on the Southwest side of Clam Island	47.63353	-122.68561		1
WDOH-482	Offshore of a drainage with rope swing and pier	47.62981	-122.70288		1
WDOH-484	Offshore of the drainage North of the old pier between two	47.62947	-122.67773		1
WDOH-481	Offshore of a drainage at the small brown beach cabin	47.62625	-122.70577		1
WDOH-462	Offshore of the road end at Windy Pont	47.62508	-122.67911		1
WDOH-465	Offshore of 2 story cedar house w/attached office-stairs	47.62303	-122.70613		1
WDOH-492	Offshore between the point and some old pilings	47.62225	-122.67694		1
WDOH-491	Offshore of a white boat house, with a 4" PVC pipe on the	47.6177	-122.70628		1
DY32	NEARSHORE TRACYTON BOAT LAUNCH	47.61	-122.66		1
WDOH-469	Offshore of a two story house with a flagpole and a small l	47.60848	-122.70035		1
WDOH-470	Midway between Stations #471 and #469	47.60848	-122.70584		1
WDOH-480	Offshore of the drainage North of the dock	47.61277	-122.70815		1
DY28	NORTH END MID CHANNEL	47.3364	-122.665		1
DY20	NEARSHORE SW CORNER CHICO BAY NEAR CHICO	47.6082	-122.69505		1
WDOH-471	Offshore of some old concrete foundation pilings	47.60804	-122.70584		1
WDOH-468	Offshore of North Erland Point, by a concrete bulkhead wi	47.60789	-122.69529		1
M7	Site Sampled on Dec-17-2002 - Windy Point	47.63448	-122.69189		1
M5	Marine Rocky Point Dyes Inlet	47.61044	-122.66637		1
DY09 (Outbound	MID-CHANNEL EAST OF BASS POINT	47.59993	-122.6595		1
DY09 (Return)	MID-CHANNEL EAST OF BASS POINT	47.59993	-122.6595		1
Field DUPS					3
	Total samples for each day			71	81
	Total Samples for Event				152

Table 4. BREMETON

EVENT_BREMERTON					
Table 4. Station locations and samples to be collected during the BREMERTON sampling event.					
STATION	**LOCATION**	**LatDD**	**LongDD**	**DAY_1**	**DAY_2**
TEC SAMPLING TEAM					
BI-SBC	Springbrook Creek @ New Brooklyn Rd	47.643	-122.5677	2	1
B-ST/CSO16	Manhole at Park Ave and Pacific Ave	47.56	-122.6289	3	3
B-ST01	Pine Rd-2 blocks east of outfall SW3	47.58611	-122.6464	3	3
B-ST12	Trenton Ave	47.56806	-122.6083	3	3
B-ST28	Callow Ave	47.55417	-122.6567	3	3
LMK001	Silverdale West Bucklin Hill Road	47.65133	-122.693	3	3
LMK002	Silverdale at Sandpiper	47.65083	-122.6928		
LMK038	Manchester 038	47.55567	-122.5432	3	3
LMK122	Gorst Navy City Metals	47.54733	-122.697	3	3
LMK136	Port Orchard 136 (Annapolis Cr)	47.55	-122.62	3	3
PO-POBLVD	Port Orchard Residential MD TBD	47.53425	-122.6347	3	3
PSNS015	Naval Station Coml/Res/Rec (McD drthr)	47.56091	-122.6491	3	3
PSNS124	PSNS CIA Building 438 near DD2	47.56188	-122.6255	3	3
PSNS126	PSNS Downstream of CSO 16 (460)	47.56027	-122.6266	3	3
Field DUPs				4	4
BREMERTON TEAM					
B-ST04	City of Bremerton Campbell Way Outfall at Campbell Way	47.58028	-122.6278	2	
B-ST27	City of Bremerton Evergreen Park Evergreen Park @ 14th	47.57389	-122.6269	2	
B-ST26	City of Bremerton Oyster Bay Ave Outfall at Oyster Bay A	47.56889	-122.6731	2	
B-ST03 (SW5)	City of Bremerton Stephenson Creek Outfall at Lendt Park	47.58167	-122.6369	2	
B-NAD (Alt 3)	City of Bremerton NAD Park Outfall	47.57806	-122.6175	2	
BREM-WWTP	Outfall from the West Bremerton Waste Water Treatment Plant			2	2
BREM-ETF	Outfall from the Bremerton Eastside Treatment Facility, if operational			2	1
OB01	Ostrich Bay Creek Mouth UPSTRM SHOREWOOD DR C	47.5748	-122.683	1	1
Field DUPs				2	1
SSWM SAMPLING TEAM					
LMK164	Outfall for National Ave W. Located across SR 304 from I	47.54933	-122.6665	2	
LMK020	Kitsap SSWM Phinney Bay Rocky Point residential area	47.62967	-122.6608	2	
LMK060	Kitsap SSWM Tracyton 060 Residential drainage ditch ou	47.6015	-122.6575	2	
DEECRK	Kitsap SSWM DEE CREEK End of Jacobson Rd	47.58013	-122.6031	2	
Field DUPs				1	0
ENVVEST TEAM					
PSNS081.1	PSNS PSNS Motor Pool CIA Industrial Waterfront Dry Do	47.56085	-122.6278	2	
PSNS101	PSNS PSNS Industrial Nondrydock CIA Bldg 431	47.56085	-122.6278	2	
PSNS115.1	PSNS PSNS Dry Dock CIA Industrial Waterfront - W of Dr	47.55778	-122.6389	2	
PSNS008	PSNS Naval Station Industrial Naval Station InActive Ship	47.5558	-122.652	2	
Field DUPs				1	0

Table 4. Cont. BREMETON

Table 4. Cont.	EVENT_BREMERTON				
STATION	**LOCATION**	**LatDD**	**LongDD**	**DAY_1**	**DAY_2**
KARCHER TEAM					
KARCHER-WWTP	Outfall from Karcher Creek Waste Water Treatement Plant			2	2
MARINE TEAM					
DY01 (Outbound)	MOUTH AT SOUTH END PORT WASHINGTON NARRO	47.56572	-122.6173		1
DY09	MID-CHANNEL EAST OF BASS POINT	47.59993	-122.6595		1
WDOH-467	Offshore at end of sand spit-inside of pilings	47.61004	-122.6915		1
WDOH-478	Offshore of bowpickers & rock w/marker	47.60184	-122.6844		1
WDOH-479	Offshore of last house next to vacant lot	47.59915	-122.6852		1
M6	Marine Erlands Point Dyes Inlet	47.59924	-122.6811		1
JACKPK	Nearshore Dye's Inlet - Ostrich Jackson Park Rec Area	47.58997	-122.6861		1
WDOH-576	Along shoreline of NAD park in Ostrich Bay	47.556	-122.549		1
WDOH-578	Offshore of 2 story natural color shingled house	47.57649	-122.6827		1
DY15	NEARSHORE HEAD OF OSTRICH BAY	47.57708	-122.6817		1
WDOH-485	In Oyster Bay, offshore of a small cove with a flagpole	47.57957	-122.6774		1
WDOH-490	At the cove between the point and the dock	47.57308	-122.6795		1
M8	Center of - Oyster Bay	47.57276	-122.6739		1
WDOH-487	Offshore of the pointhouse with deer statues	47.57439	-122.6727		1
WDOH-489	Over the diffuser pipe between a white stand pipe and a r	47.56941	-122.6729		1
DY07	NEARSHORE HEAD OF PHINNEY BAY	47.58105	-122.6609		1
DY05	NEARSHORE LIONS PARK SOUTH OF BOAT LAUNCH	47.58592	-122.6469		1
ANCOVE	Site Sampled on Nov-14-2002 - Anderson Cove	47.5793	-122.6474		1
EVGPK	Nearshore Port Washington Narrows Evergreen Park	47.57375	-122.6263		1
DY01 (Return)	MOUTH AT SOUTH END PORT WASHINGTON NARRO	47.56572	-122.6173		1
M3	Site Sampled on Dec-17-2002 - Sinclair Outer	47.56279	-122.6037		1
M3.1	Sinclair Inlet offshore of ferry terminal	TBD	TBD		1
M3.2	Sinclair Inlet Offshore of CIA	TBD	TBD		1
M3.3	Sinclair Inlet Offshore of NAVSTA	TBD	TBD		1
M3.4	Sinclair Inlet Offshore of INACTIVE FLEET	TBD	TBD		1
M4	Marine Sinclair Inner Sinclair Inlet	47.54215	-122.6649		1
SN03	NEARSHORE HWY 3 MERGER NEAR PILINGS (BREM	47.54685	-122.6711		1
P1	PSNS PIER INACTIVE FLEET	47.55236	-122.6591		1
P2	PSNS PIER NAVSTA	47.5553	-122.6487		1
P3	PSNS PIER W. OF DD6	47.55603	-122.6385		1
P4	PSNS PIER S. OF DD 2	47.55927	-122.6352		1
P5	PSNS PIER BTWN PSNS & FERRY TERMINAL	47.55978	-122.6257		1
Field DUPS					3
	Total samples for each day			79	83
	Total Samples for Event				162

Table 5. PORT_ORCHARD

EVENT_PORT_ORCHARD					
Table 5. FC samples to be collected during the PORT ORCHARD sampling event.					
STATION	**LOCATION**	**LatDD**	**LongDD**	**DAY_1**	**DAY_2**
TEC SAMPLING TEAM					
BI-SBC	Springbrook Creek @ New Brooklyn Rd	47.643	-122.567667	2	1
B-ST/CSO16	Manhole at Park Ave and Pacific Ave	47.56	-122.628889	3	3
B-ST01	Pine Rd-2 blocks east of outfall SW3	47.586111	-122.646389	3	3
B-ST12	Trenton Ave	47.568056	-122.608333	3	3
B-ST28	Callow Ave	47.554167	-122.656667	3	3
LMK001	Silverdale West Bucklin Hill Road	47.651333	-122.693	3	3
LMK002	Silverdale at Sandpiper	47.650833	-122.692833		
LMK038	Manchester 038	47.555667	-122.5432	3	3
LMK122	Gorst Navy City Metals	47.547333	-122.697	3	3
LMK136	Port Orchard 136 (Annapolis Cr)	47.55	-122.62	3	3
PO-POBLVD	Port Orchard Residential MD TBD	47.534247	-122.634689	3	3
PSNS015	Naval Station Coml/Res/Rec (McD drthr)	47.560911	-122.649091	3	3
PSNS124	PSNS CIA Building 438 near DD2	47.561881	-122.625516	3	3
PSNS126	PSNS Downstream of CSO 16 (460)	47.56027	-122.6266	3	3
Field DUPs				4	4
ENVVEST SW TEAM					
PO-BAYST	Port Orchard Port Orchard Buisness District Off Bay	47.53462	-122.63518	2	
PO-BETHEL	Port Orchard Port Orchard Urban Bethel Road next	47.53461	-122.61834	2	
PO-WILKENS	Port Orchard Port Orchard Mixed TBD Wilkens Roa	47.53385	-122.63611	2	
LMK128	Kitsap SSWM Gorst Subaru Located behind Subaru	47.52617	-122.69733	2	
Field DUPs				1	0
ENVVEST STREAM TEAM					
SACCO (SC01)	ECOLOGY SACCO CR Stream Mouth south of Bea	47.55253	-122.60112	1	1
BL-KFC (BJ01)	ECOLOGY BLACKJACK CREEK (KFC) Behind KF	47.54172	-122.62777	1	1
OC	KPUD OLNEY CREEK (KARCHER CREEK) At Ga	47.54417	-122.61167	1	1
GR01	Gorst Creek DWNSTRM HWY 3 CULVERT	47.52754	-122.69804	1	1
AN01	Anderson Crk @ Mouth	47.52743	-122.68217	1	1
BL	KPUD BLACKJACK CREEK At Gaging Site	47.50194	-122.64389	1	1
RS02	Ross Creek downstream of Hwy 16			1	1
BE-LOW	ECOLOGY BEAVER CREEK Lower segment At cu	47.57017	-122.5565	1	1
Field DUPs				1	1
BREMERTON TEAM					
BREM-WWTP	Outfall from the West Bremerton Waste Water Treatment Plant			2	2
BREM-ETF	Outfall from the Bremerton Eastside Treatment Facility, if operational			2	1
KARCHER TEAM					
KARCHER-WWTP	Outfall from Karcher Creek Waste Water Treatement Plant			2	2

Table 5. Cont. PORT_ORCHARD

Table 5. Cont.	EVENT_PORT_ORCHARD				
STATION	**LOCATION**	**LatDD**	**LongDD**	**DAY_1**	**DAY_2**
MARINE TEAM					
DY01 (Outbound)	MOUTH AT SOUTH END PORT WASHINGTON N/	47.56572	-122.61725		1
M3	Marine Sinclair Outer Sinclair Inlet	47.56258	-122.60348		1
SN15	NEARSHORE SACCO CR MOUTH	47.55368	-122.60635		1
SN13	NEARSHORE BETWEEN ANNAPOLIS DOCK & P.	47.54714	-122.6115		1
BJ-EST	Nearshore Sinclair Inlet mouth of Blackjack estuary	47.54401	-122.62628		1
SN12	NEARSHORE BLACKJACK CR ESTUARY	47.54663	-122.62772		1
SN11	NEARSHORE P.O. PUBLIC BOAT RAMP EAST P.	47.54375	-122.6353		1
SN10	NEARSHORE OBSERVATION DOCK NEAR TWEI	47.54087	-122.6428		1
SN08	NEARSHORE ROSS POINT	47.53983	-122.663		1
M4.5	Marine Sinclair West of Ross Point	47.5357	-122.6693		1
SN05	MID INLET AT HEAD OFF PILINGS BY PIONEER	47.52916	-122.69088		1
M4	Marine Sinclair Inner Sinclair Inlet	47.54215	-122.66491		1
M3.4	Sinclair Inlet Offshore of NAVSTA				1
M3.3	Sinclair Inlet Offshore of CIA				1
M3.2	Sinclair Inlet offshore of ferry terminal				1
M3.1	Sinclair Inlet Mouth of Port Washington Narrows				1
DY01 (Return)	MOUTH AT SOUTH END PORT WASHINGTON N/	47.56572	-122.61725		1
M1 (surface)	Marine Port Orchard Passage Port Orchard Passag	47.63285	-122.58476		1
M1 (deep)	Marine Port Orchard Passage Port Orchard Passag	47.63285	-122.58476		1
M2 (surface)	Marine Rich Passage Rich Passage	47.5784	-122.53643		1
M2 (deep)	Marine Rich Passage Rich Passage	47.5784	-122.53643		1
CLAMBAY	Nearshore Clam Bay head of clam bay	47.57033	-122.54996		1
Field DUPS					3
	Day Total			66	80
	Event Total				146
	Total Samples all EVENTS				460

Table 6. Metals Samples

Table 6. List of sampling teams and station locations for collection of trace metals during the Bremerton event.					
				No. of samples	
STATION	**LOCATION**	**LatDD**	**LongDD**	**DAY_1**	**DAY_2**
BREMERTON TEAM					
BREM-WWTP	Outfall from the West Bremerton Waste Water Treatment Plant			2	2
BREM-ETF	Outfall from the Bremerton Eastside Treatment Facility, if operational			2	1
KARCHER TEAM					
KARCHER-WWTP	Outfall from Karcher Creek Waste Water Treatement Plant			2	2
ENVVEST TEAM					
PSNS081.1	Motor Pool CIA Industrial Waterfront Dry Dock 6/5 Bld 455	47.56085	-122.6278	3	
PSNS101	Industrial Nondrydock CIA Bldg 431	47.56085	-122.6278	3	
PSNS115.1	Dry Dock CIA Industrial Waterfront - W of Dry Dock 1	47.55778	-122.6389	3	
PSNS008	Naval Station Industrial Naval Station InActive Ships	47.5558	-122.652	3	
Field DUPs				2	0
MARINE TEAM					
DY01 (Outbound)	MOUTH AT SOUTH END PORT WASHINGTON NARROWS	47.56572	-122.6173		1
DY01 (Return)	MOUTH AT SOUTH END PORT WASHINGTON NARROWS	47.56572	-122.6173		1
M3	Site Sampled on Dec-17-2002 - Sinclair Outer	47.56279	-122.6037		1
SN03	NEARSHORE HWY 3 MERGER NEAR PILINGS (BREM WWTP OF)	47.54685	-122.6711		1
M4	Marine Sinclair Inner Sinclair Inlet	47.54215	-122.6649		1
M3.1	Sinclair Inlet offshore of ferry terminal	TBD	TBD		1
M3.2	Sinclair Inlet Offshore of CIA	TBD	TBD		1
M3.3	Sinclair Inlet Offshore of NAVSTA	TBD	TBD		1
M3.4	Sinclair Inlet Offshore of INACTIVE FLEET	TBD	TBD		1
P1	PSNS PIER INACTIVE FLEET	47.55236	-122.6591		1
P2	PSNS PIER NAVSTA	47.5553	-122.6487		1
P3	PSNS PIER W. OF DD6	47.55603	-122.6385		1
P4	PSNS PIER S. OF DD 2	47.55927	-122.6352		1
P5	PSNS PIER BTWN PSNS & FERRY TERMINAL	47.55978	-122.6257		1
Field DUPS					2
	Total samples for each day			20	21
	Total Samples for Event				41

11. Figures

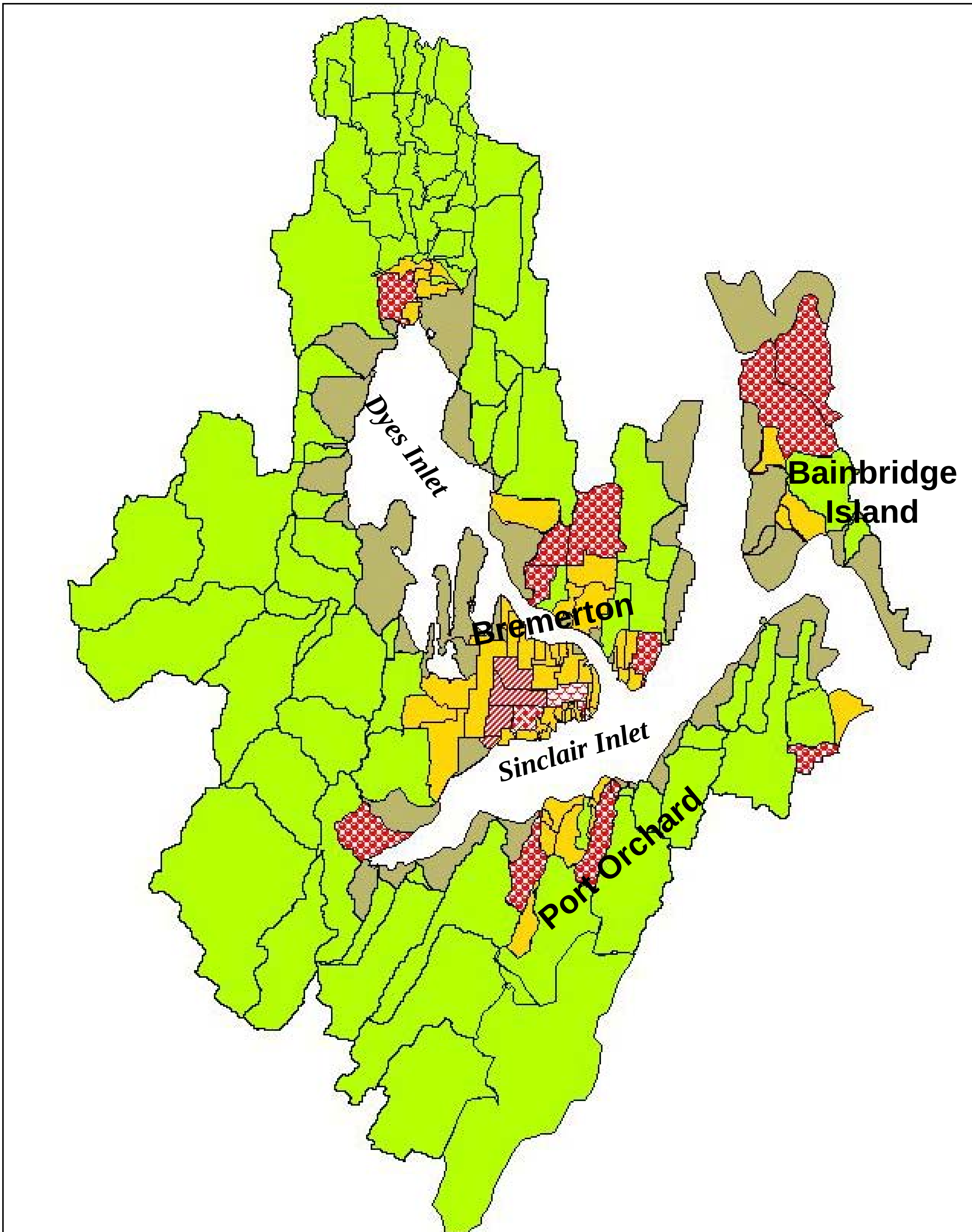


Figure 1. The Project ENVVEST study area for the FC TMDL study for Sinclair and Dyes Inlets. The figure shows the watershed represented as open channel streams (green), piped storm water outfalls (yellow), and sheet-flow shoreline (tan) catchments in the HSPF model. The red cross hatch segments are the catchments being monitored for storm water flow.

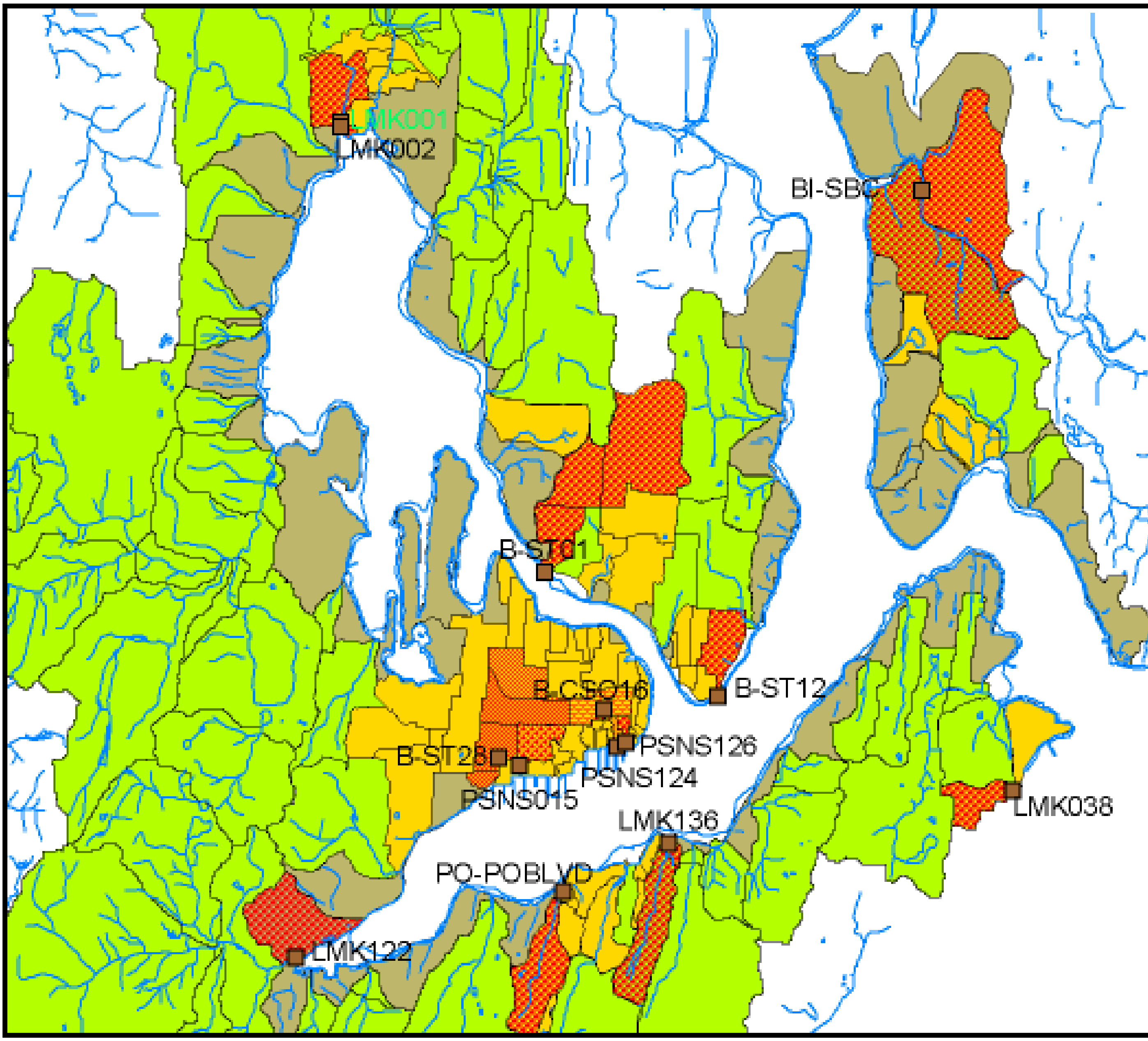


Figure 2. The storm water outfalls being monitored for flow and FC concentrations (TEC-FLOW stations). The red cross hatch segments are the catchments being monitored for storm water flow.

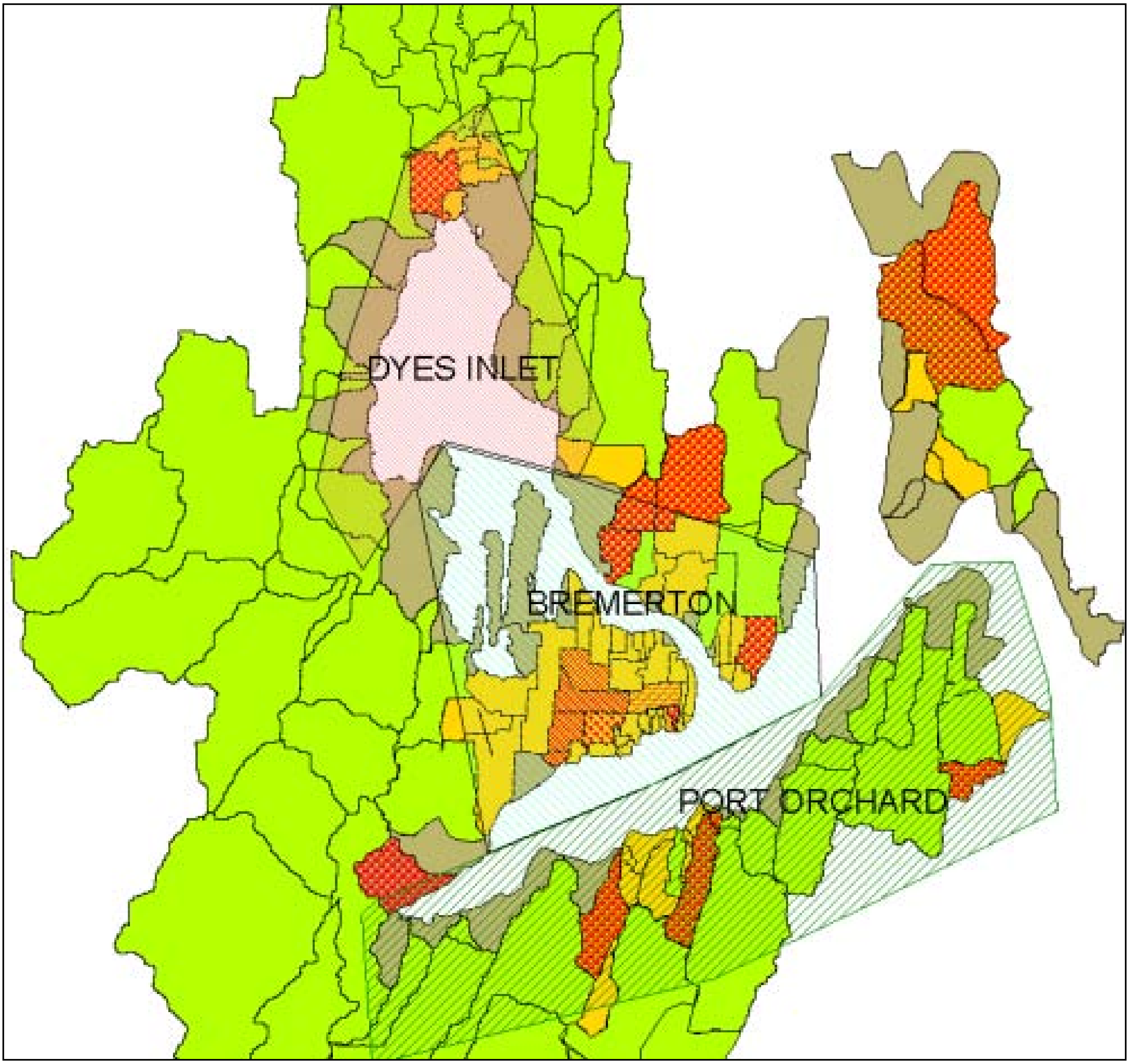


Figure 3. The three focus areas for event sampling.

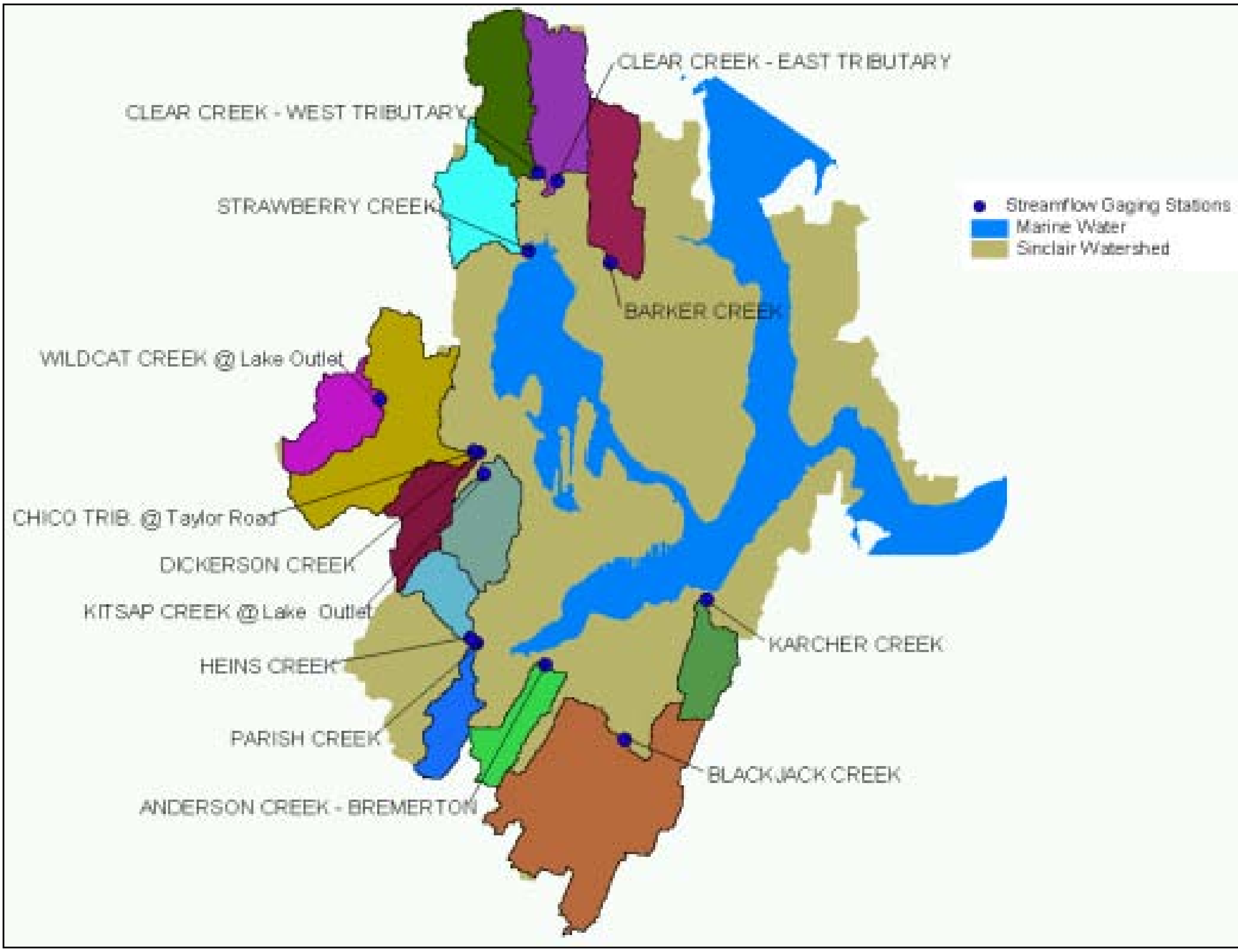


Figure 4. Watershed systems within study area for which an HSPF model has been calibrated to available stream flow data (Skahill 2003).

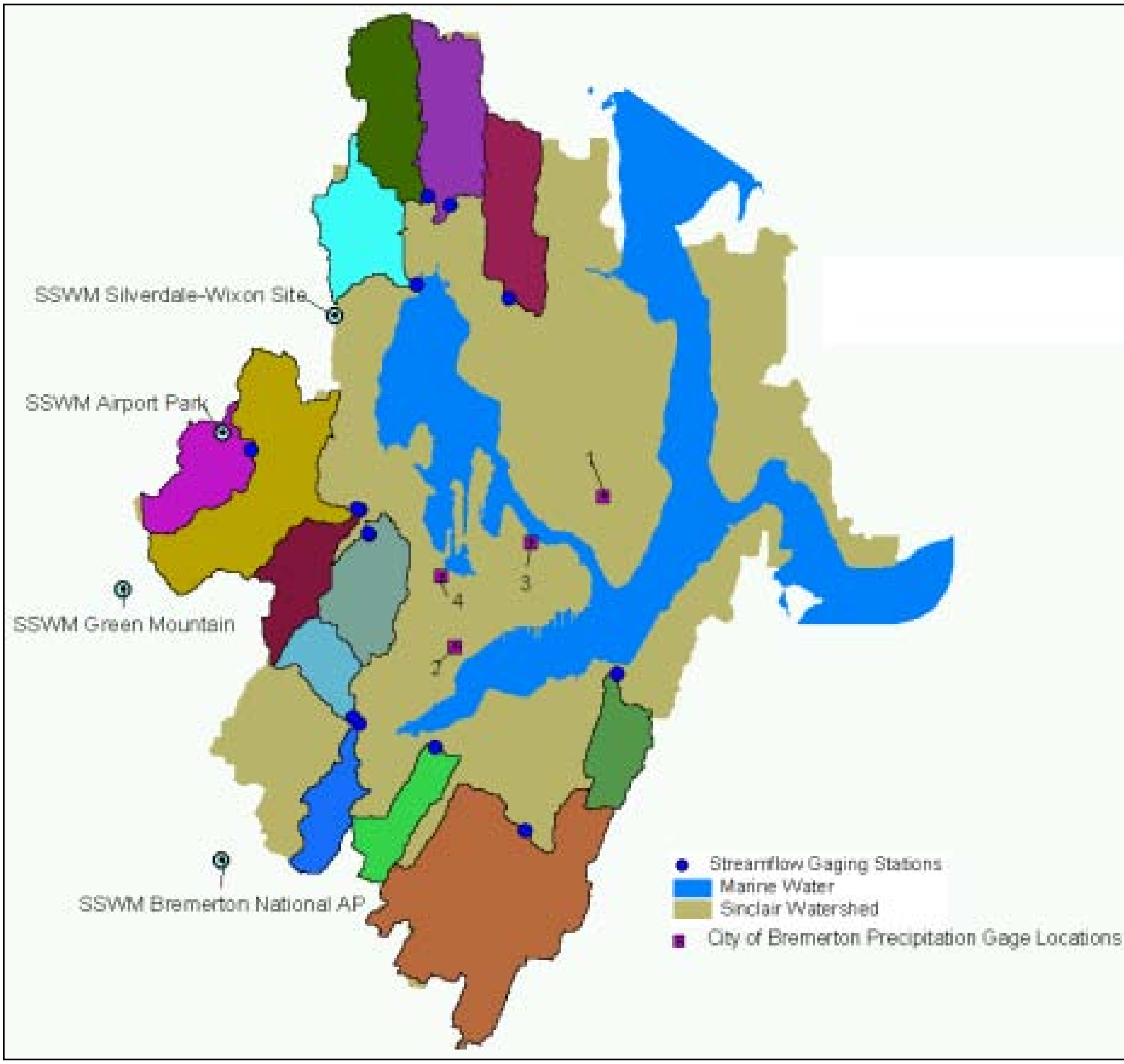
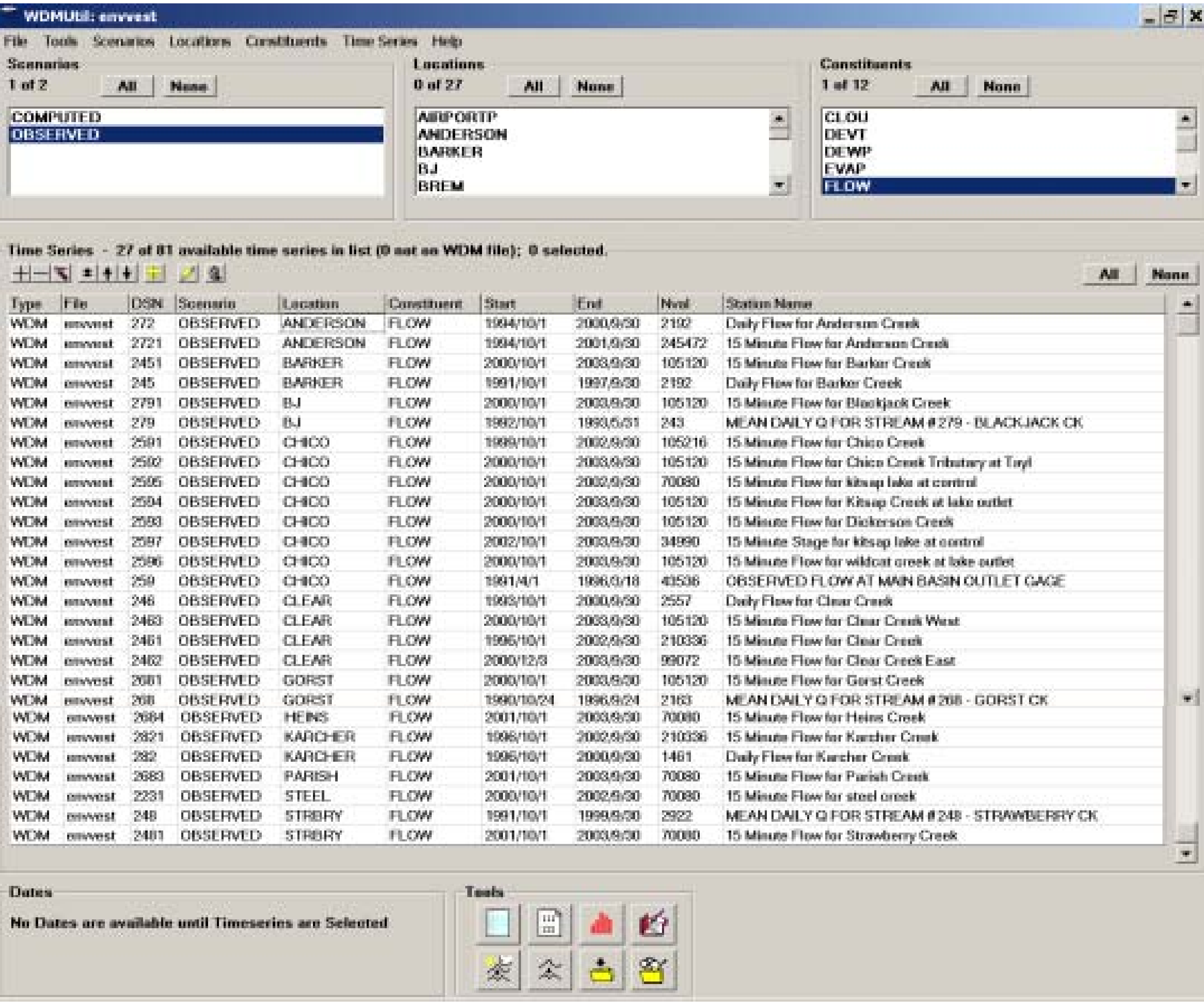


Figure 5. Location of rain gages monitored by KPUD (green circles) and City of Bremerton (purple squares) being used in HSPF model development (Skahill 2003).



Type	File	DSN	Scenario	Location	Constituent	Start	End	Nval	Station Name
WDM	envvest	272	OBSERVED	ANDERSON	FLOW	1994/10/1	2000/9/30	2192	Daily Flow for Anderson Creek
WDM	envvest	2721	OBSERVED	ANDERSON	FLOW	1994/10/1	2001/9/30	245472	15 Minute Flow for Anderson Creek
WDM	envvest	2451	OBSERVED	BARKER	FLOW	2000/10/1	2003/9/30	105120	15 Minute Flow for Barker Creek
WDM	envvest	245	OBSERVED	BARKER	FLOW	1991/10/1	1997/9/30	2192	Daily Flow for Barker Creek
WDM	envvest	2791	OBSERVED	BJ	FLOW	2000/10/1	2003/9/30	105120	15 Minute Flow for Blackjack Creek
WDM	envvest	279	OBSERVED	BJ	FLOW	1992/10/1	1993/5/31	243	MEAN DAILY Q FOR STREAM #279 - BLACKJACK CK
WDM	envvest	2591	OBSERVED	CHICO	FLOW	1999/10/1	2002/9/30	105216	15 Minute Flow for Chico Creek
WDM	envvest	2592	OBSERVED	CHICO	FLOW	2000/10/1	2003/9/30	105120	15 Minute Flow for Chico Creek Tributary at Toyl
WDM	envvest	2595	OBSERVED	CHICO	FLOW	2000/10/1	2002/9/30	70080	15 Minute Flow for kitsap lake at control
WDM	envvest	2594	OBSERVED	CHICO	FLOW	2000/10/1	2003/9/30	105120	15 Minute Flow for Kitsap Creek at lake outlet
WDM	envvest	2593	OBSERVED	CHICO	FLOW	2000/10/1	2003/9/30	105120	15 Minute Flow for Dickerson Creek
WDM	envvest	2597	OBSERVED	CHICO	FLOW	2002/10/1	2003/9/30	34990	15 Minute Stage for kitsap lake at control
WDM	envvest	2596	OBSERVED	CHICO	FLOW	2000/10/1	2003/9/30	105120	15 Minute Flow for wildcat creek at lake outlet
WDM	envvest	259	OBSERVED	CHICO	FLOW	1991/4/1	1996/3/18	40536	OBSERVED FLOW AT MAIN BASIN OUTLET GAGE
WDM	envvest	246	OBSERVED	CLEAR	FLOW	1993/10/1	2000/9/30	2557	Daily Flow for Clear Creek
WDM	envvest	2463	OBSERVED	CLEAR	FLOW	2000/10/1	2003/9/30	105120	15 Minute Flow for Clear Creek West
WDM	envvest	2461	OBSERVED	CLEAR	FLOW	1996/10/1	2002/9/30	210336	15 Minute Flow for Clear Creek
WDM	envvest	2462	OBSERVED	CLEAR	FLOW	2000/12/3	2003/9/30	99072	15 Minute Flow for Clear Creek East
WDM	envvest	2681	OBSERVED	GORST	FLOW	2000/10/1	2003/9/30	105120	15 Minute Flow for Gorst Creek
WDM	envvest	268	OBSERVED	GORST	FLOW	1990/10/24	1996/9/24	2163	MEAN DAILY Q FOR STREAM #268 - GORST CK
WDM	envvest	2684	OBSERVED	HEINS	FLOW	2001/10/1	2003/9/30	70080	15 Minute Flow for Heins Creek
WDM	envvest	2821	OBSERVED	KARCHER	FLOW	1996/10/1	2002/9/30	210336	15 Minute Flow for Karcher Creek
WDM	envvest	282	OBSERVED	KARCHER	FLOW	1996/10/1	2000/9/30	1461	Daily Flow for Karcher Creek
WDM	envvest	2683	OBSERVED	PARISH	FLOW	2001/10/1	2003/9/30	70080	15 Minute Flow for Parish Creek
WDM	envvest	2231	OBSERVED	STEEL	FLOW	2000/10/1	2002/9/30	70080	15 Minute Flow for steel creek
WDM	envvest	248	OBSERVED	STRBRY	FLOW	1991/10/1	1999/9/30	2922	MEAN DAILY Q FOR STREAM #248 - STRAWBERRY CK
WDM	envvest	2481	OBSERVED	STRBRY	FLOW	2001/10/1	2003/9/30	70080	15 Minute Flow for Strawberry Creek

Figure 6. The periods of record for stream flow data collected by KPUD for use in HSPF model development.

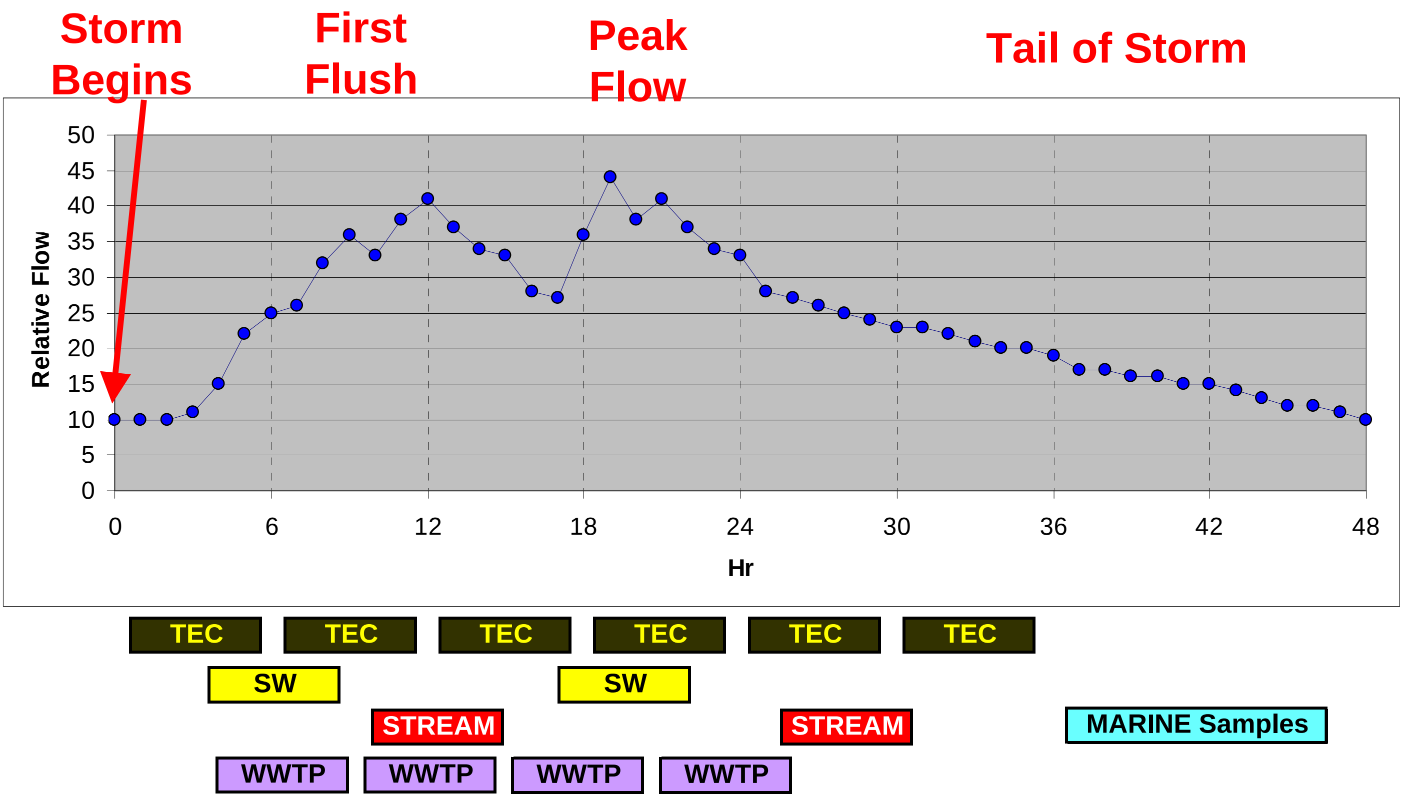


Figure 7. Idealized flow hydrograph for storm event showing the beginning of the storm, first flush, peak flow, and tail of storm event and the sampling intervals for sampling.

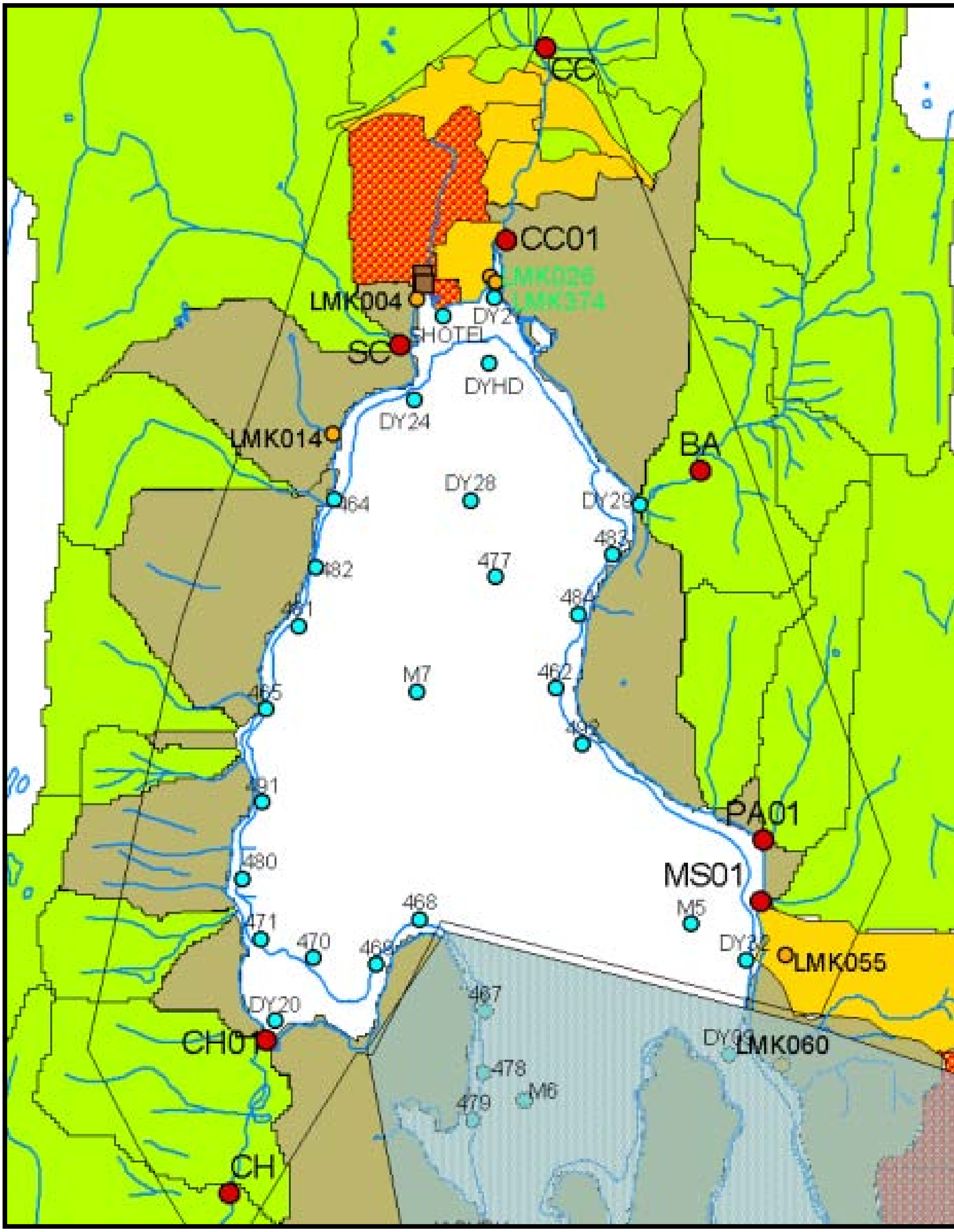


Figure 8. The stations to be sampled for the DYES INLET sampling event. Stations include TEC-FLOW (brown squares), storm water outfalls (yellow circles), streams (red circles), and marine (blue circles) sites.

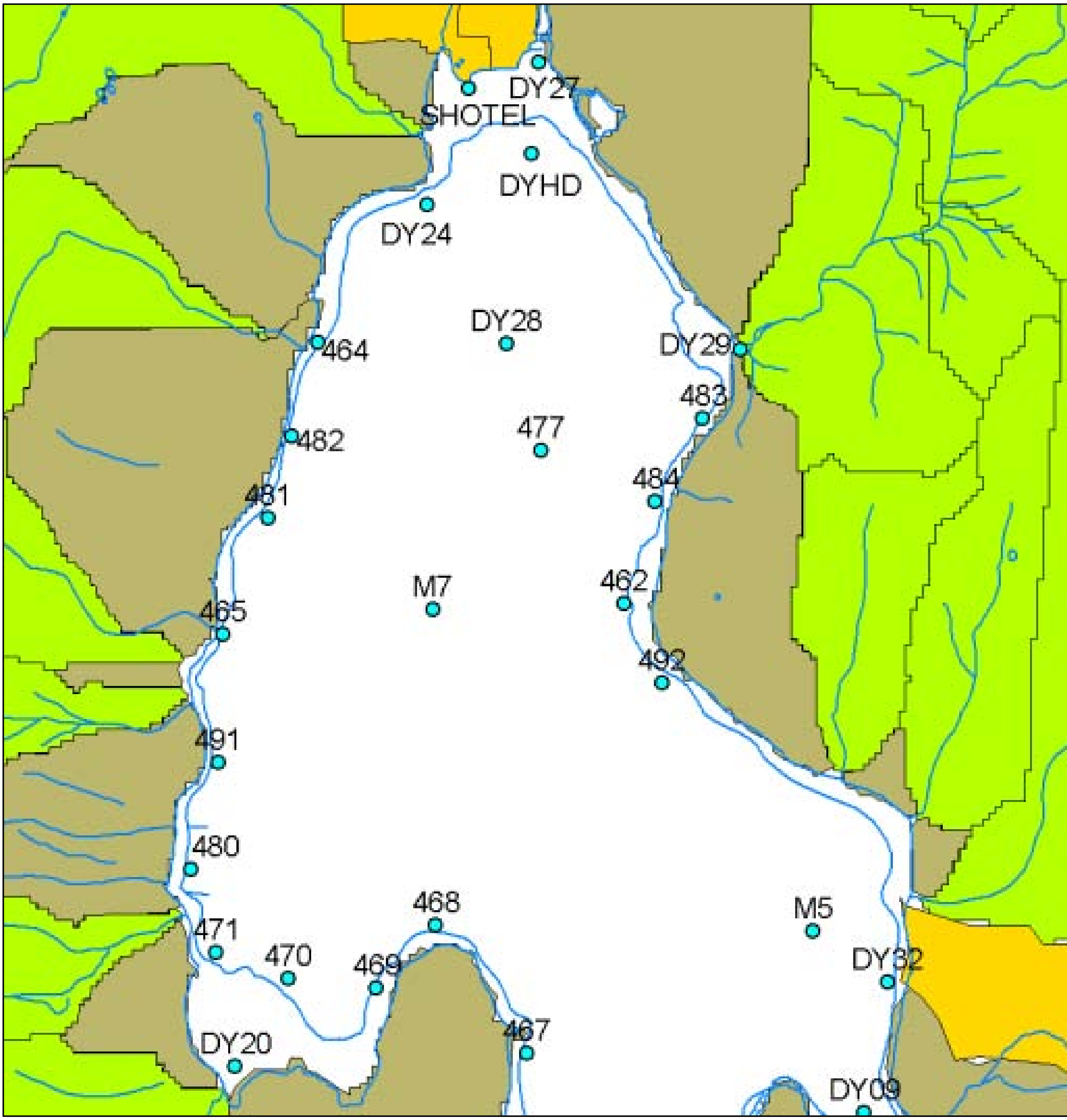


Figure 9. Dyes Inlet Marine Stations

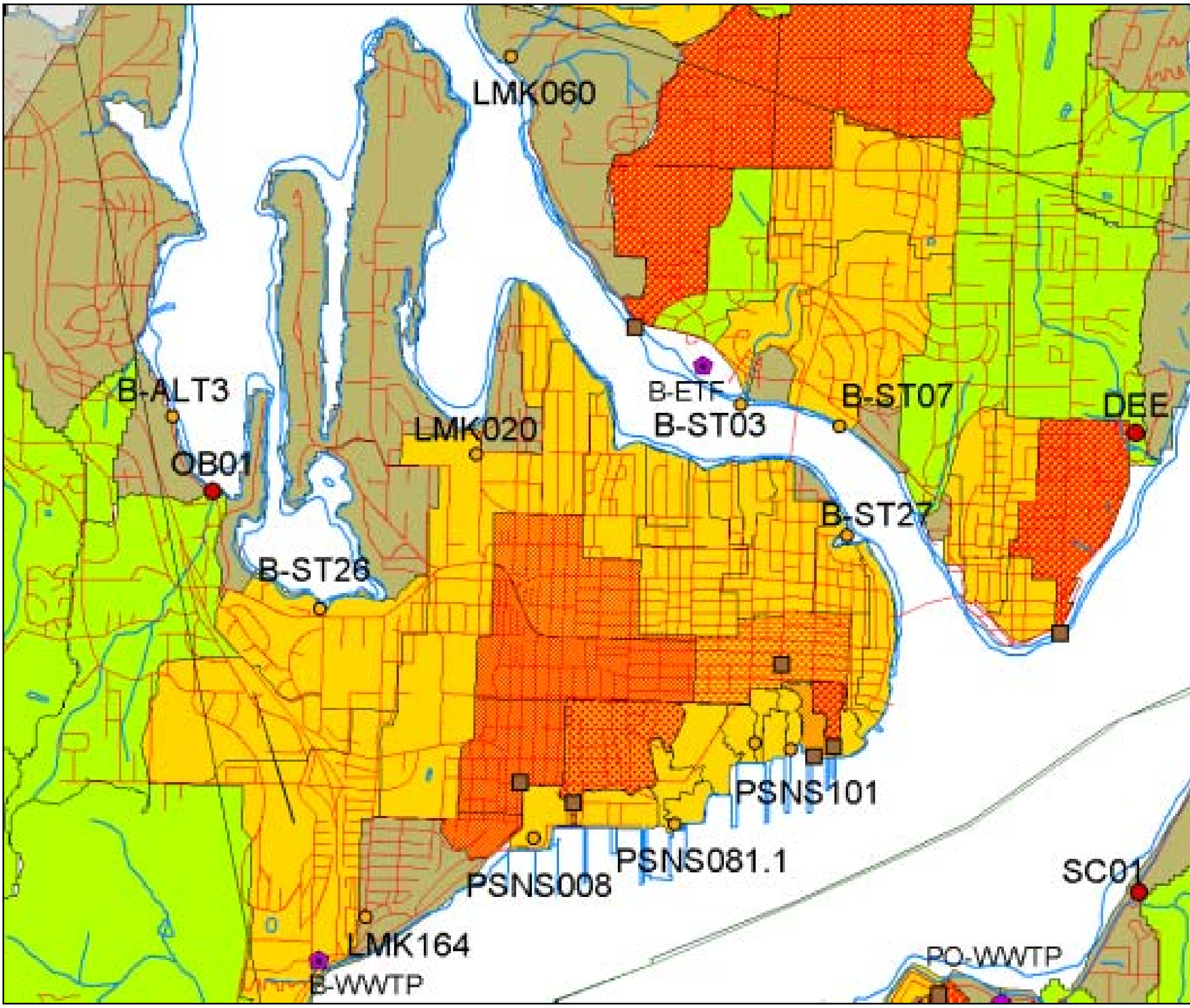


Figure 10. Stations to be sampled for the BREMERTON sampling event. Stations include TEC-FLOW (black squares), storm water outfall (yellow circles), WWTP (purple hexagons), and stream (red circles) stations.

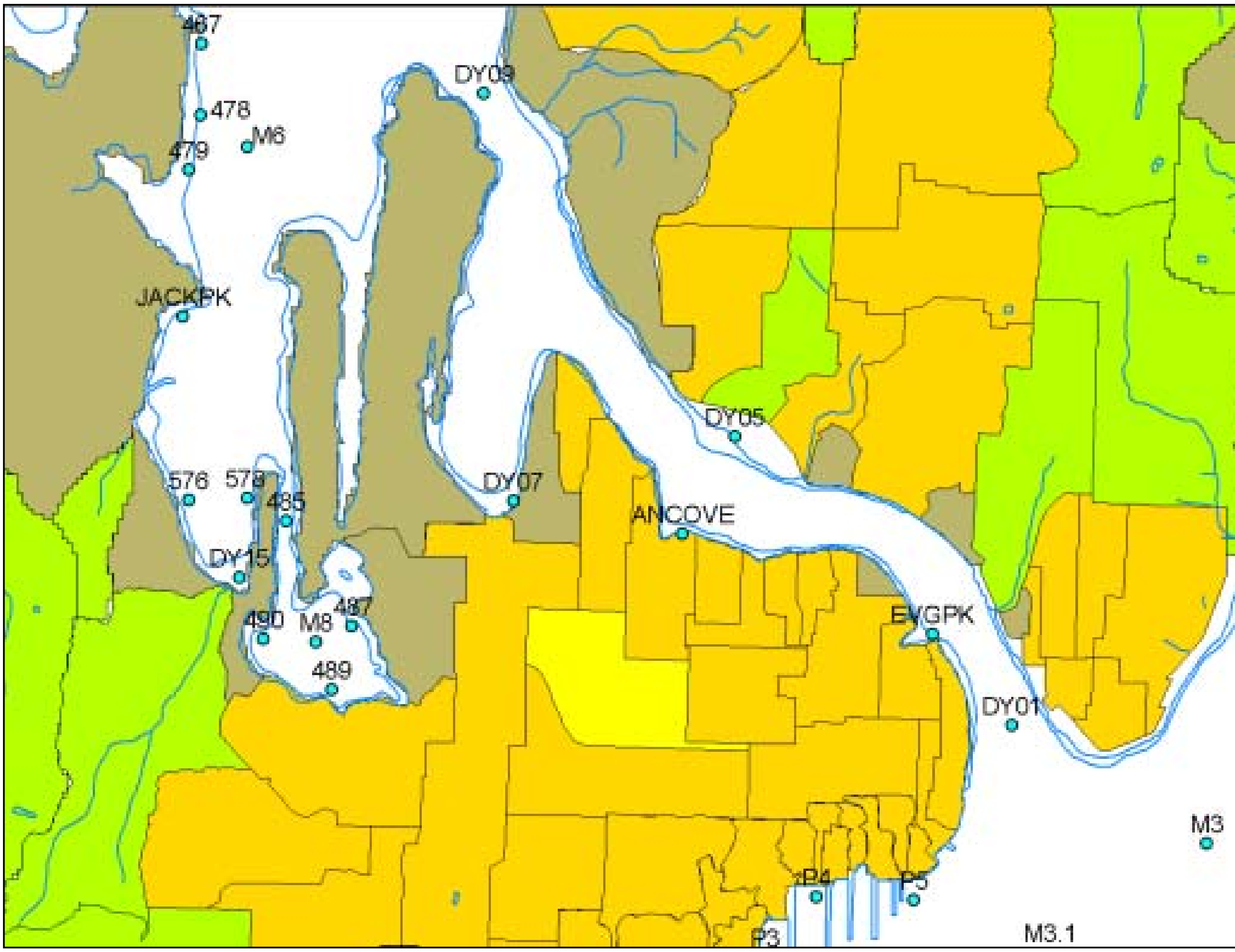


Figure 11. Marine Stations in Oyster Bay, Ostrich Bay, and Port Washington Narrows for the BREMERTON sampling event.

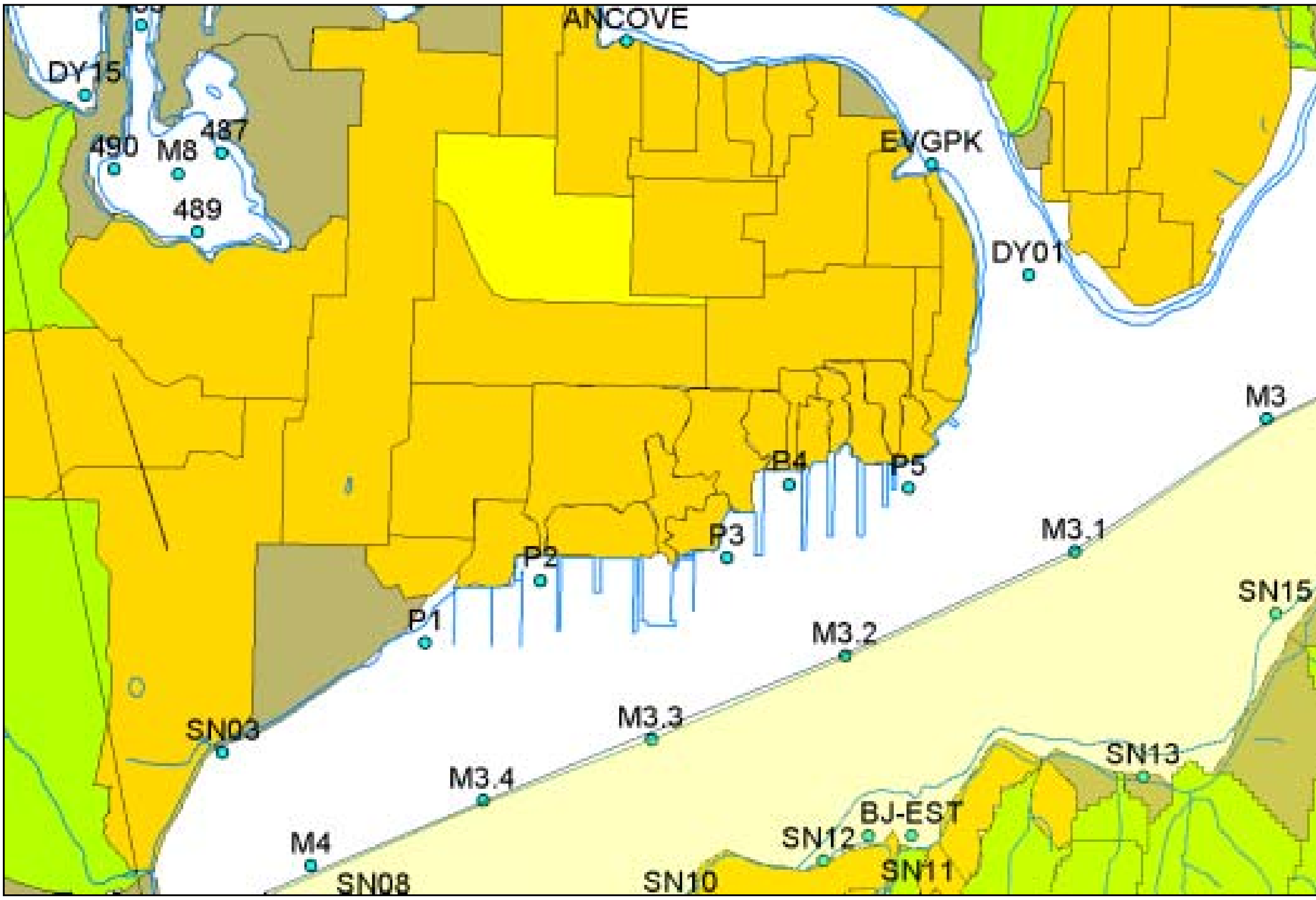


Figure 12. Marine stations near the Naval Station and Shipyard for the BREMERTON sampling event.

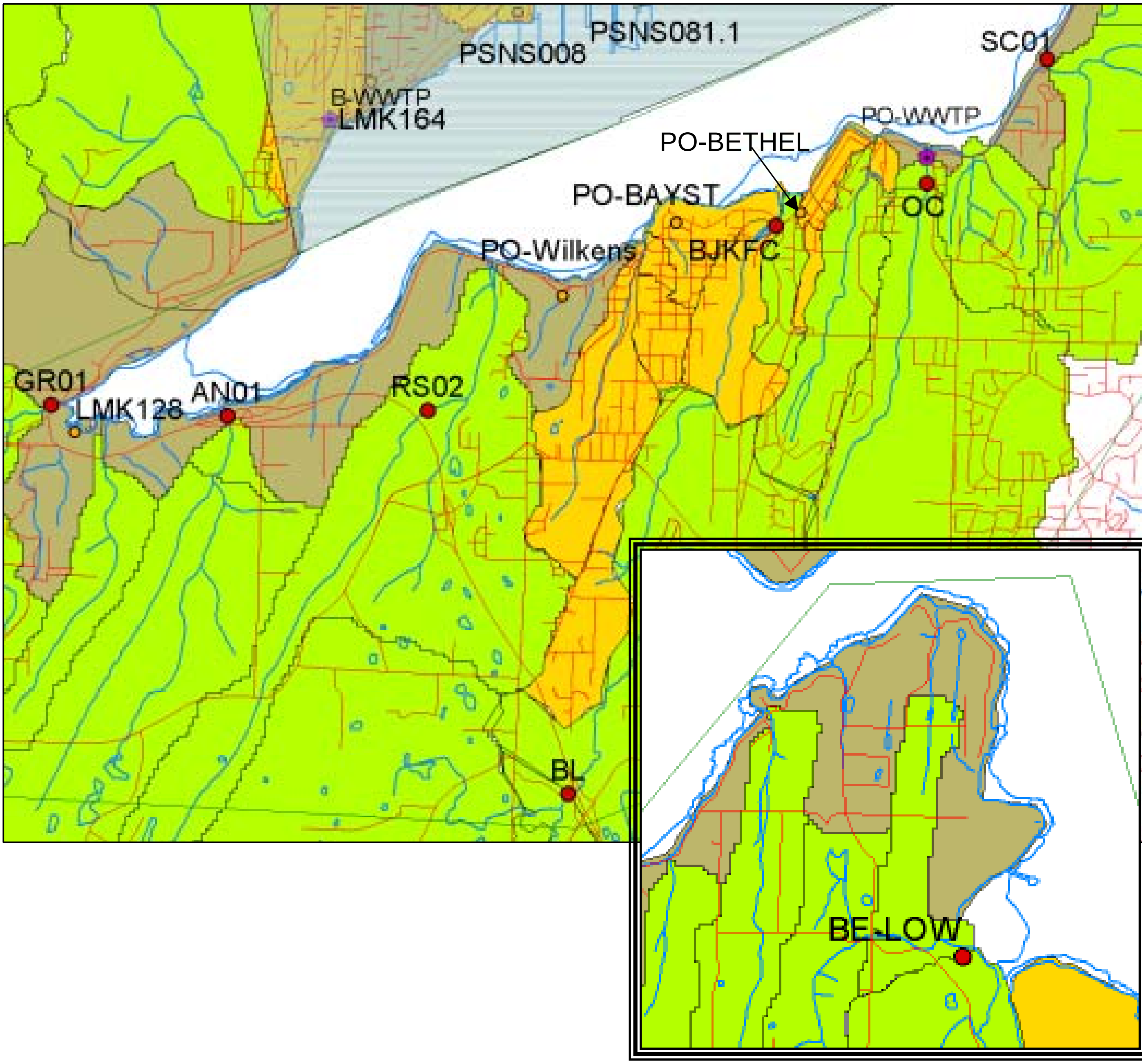


Figure 13. Additional storm water outfalls (yellow circles), WWTP (purple hexagons), and streams (red circles), to be sampled for the PORT ORCHARD sampling event.

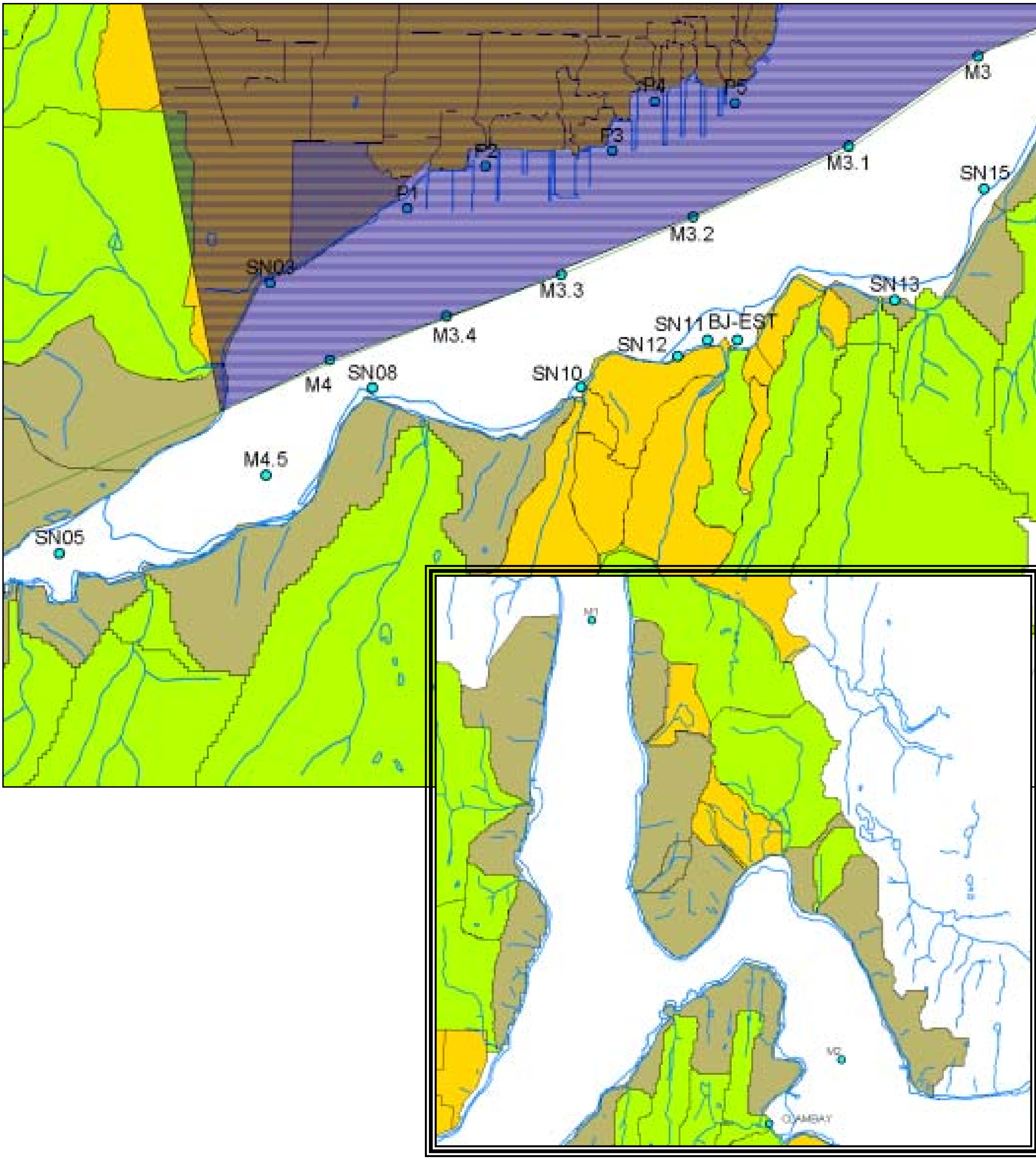


Figure 14. Marine stations for the PORT ORCHARD sampling event.

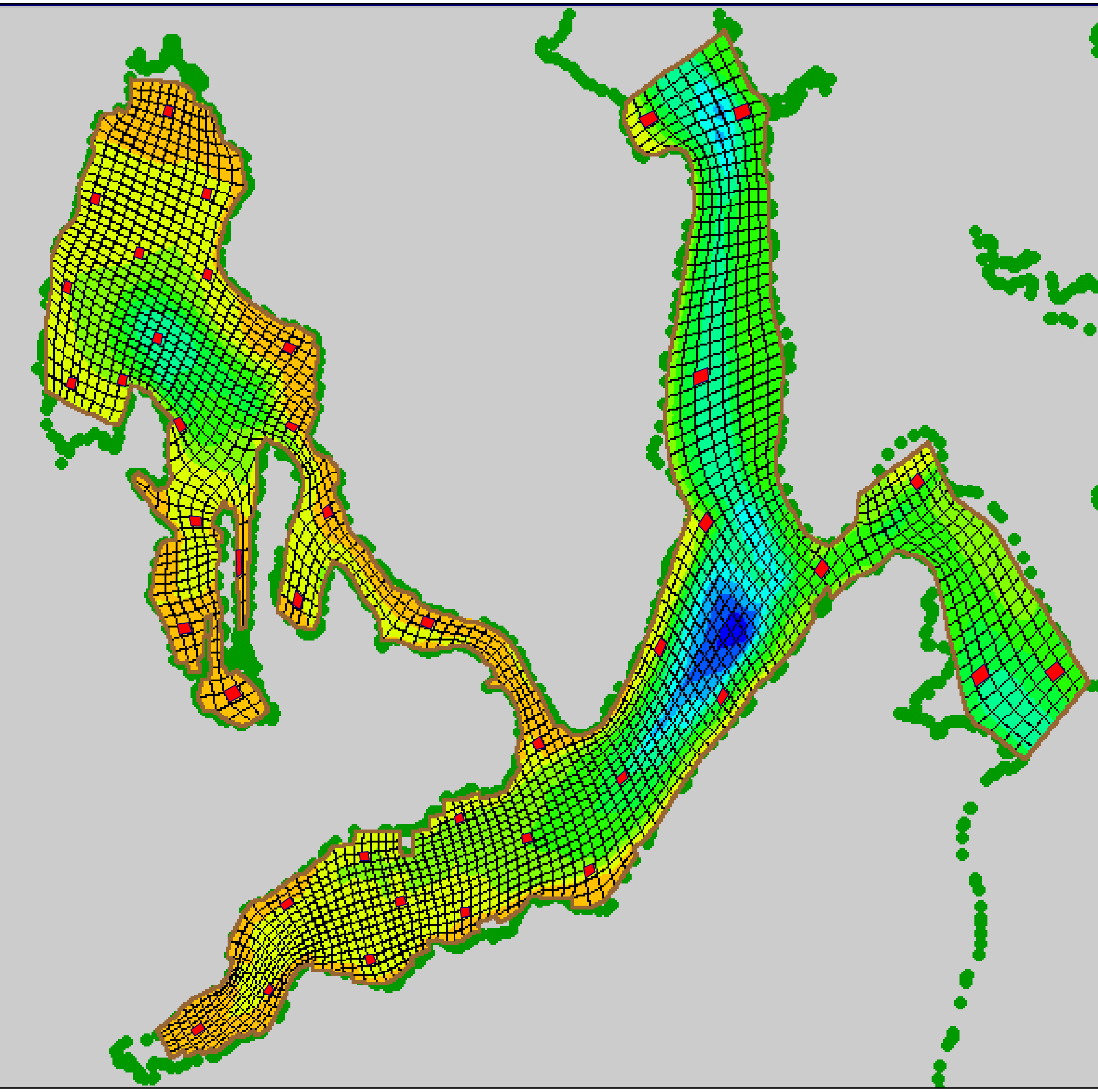


Figure 15. Example of nodes that could be selected to extract model output from TMDL simulation scenarios for calculating mean and 90th percentile statistics to compare to the FC water quality standards.

12. Appendices

12.1 Response to Comments from Ecology (M. Roberts) of 26 JAN 2004.

Comment	Response
The sampling plan has good spatial coverage. My main comment is with the 3-day plan for the storms. I'm afraid that most of the marine bacteria will be diluted or dead by the third day and wouldn't be useful for verification. I recall from the CSO and SSO(?) simulations that the plumes pretty much disappeared after a few tidal cycles. (You should double-check with your modelers.)	The sampling plan has been revised to collect all the samples within 2 days of the storm event. Day one will focus on obtaining samples from the source sites during the storm and Day 2 will provide for processing the marine samples taken following the storm event. Every effort will be made to collect the marine samples within 24 h of the storm event.
I understand the lab capacity limitations. I would suggest monitoring non-marine sites on Day 1 of the storm, then marine sites on Day 2. You will be collecting 6 fecal coliform samples from the TEC-FLOW stations and 3 samples from the SW and STREAM stations over the course of the storm. I suggest collecting all of these on Day 1, or as many as the lab can handle. I don't think you should delay until the third day to collect the marine samples, so better to cut out a day of land-side monitoring.	The sampling plan has been compressed to obtain all the samples within two days. The day of the storm will be focused on collecting samples from the TEC-FLOW, SW, STREAM, and WWTP sites. Ideally, the marine samples should be collected within one tidal cycle following the storm's peak flow, however that may not be practical. Every effort will be made to collect the marine samples within 24 h of the storm event.
On page 9, Model Verification, you discuss producing a time series of FC concentrations at the MARINE sites for verification. Because the currents are complicated near many of the MARINE sites, I suggest producing a contour map of surface or maybe depth-averaged fecal coliform concentrations to compare with the monitoring data. In other words, you might collect from just outside of a current/plume but model that site as within the plume. But, if you can interpret the results against the backdrop of a contour map of the general region rather than just a single trace, your results will be better supported.	The following has been added: In addition to the time series for the MARINE sites, model output will also include an animation of the fecal coliform (FC) concentrations as a time varying contour maps. The animations can show the surface, depth averaged, and maximum concentrations predicted by the model. Snap shots corresponding to the time of the MARINE sample collection can be captured from the animation to compare to field data collected during the verification sampling. The agreement between modeled and observed data will be used to assess the accuracy of the model.
On page 11, first whole paragraph, you discuss calculating mean and 90th percentile statistics to compare to the standards. I would add "over an appropriate time period" to that statement, as we discussed last fall. Precisely what that means will be developed by Ecology, the Navy, etc.	The phrase has been added to the sentence. How the model output will be evaluated for determine WLA and LA targets is being developed by the TMDL Modeling Working Group, led by Ecology and made up of technical stakeholders participating in the TMDL process. Thank you for your helpful comments.

12.2 Summary of TEC FLOW Stations

ADDENDUM
17 FEBRUARY 2004

1.0 INTRODUCTION

The following is an addendum to the Sampling and Analysis Plan (SAP) prepared by The Environmental Company (TEC) for U.S. Navy Engineering Field Activity Northwest (EFA NW) under Contract Task Order (CTO) 068 and Puget Sound Naval Shipyard (PSNS), dated September 2003. (TEC 2003b).

As described in the SAP, a total of 20 sites were selected for performing storm water sampling and flow monitoring in the PSNS Project ENVVEST Study Area. However, following the finalizing of the report, due to budget constraints, equipment and material resources, and input from project stakeholders, the original list of 20 was revised to the following 14 stations. The following pages present a brief description of each station, as well as why the site was chosen. In addition, Table 1-1 presents the sampling locations and sampling actions and Figure 2 shows the locations of the sites.

A total of 10 Isco Automatic Composite samplers have been made available for use during the sampling season. As 1 sampler will be kept in reserve in case of 1 of the other 9 failing, composite sampling will only occur at 9 of the 14 sites during each storm event. However, all sites will be sampled for fecal coliform analysis, and flow data will be collected from all 14 sites during each event. A total of 3, 24-hour storms will be sampled by the TEC team. Flow data will be recorded at 15 minute intervals until on or about 31 October 2004, and the data will be downloaded approximately every 2 weeks.

Table 1-1. Sampling Locations and Data Acquisition Type

Location	Code	Composite	Fecal
Pine Road	BST 1	Grab	6 per storm
Trenton Avenue	B-ST 12	Isco	6 per storm
Pacific Avenue	B-ST 28-	Isco	6 per storm
Callow Avenue	B-ST/CSO 16	Isco	6 per storm
Silverdale West Bucklin Hill	LMK 001	Isco w/ LMK002	6 per storm
Silverdale at Sandpiper	LMK 002	w/ LMK001	6 per storm
Manchester	LMK 038	Isco	6 per storm
Gorst Navy City Metals	LMK 122	Isco	6 per storm
Annapolis Creek	LMK 136	Grab	6 per storm
PSNS Com/Res/Rec	PSNS 015	Isco	6 per storm
PSNS CIA	PSNS 124	Grab	6 per storm
PSNS/CSO 16	PSNS 126	Isco	6 per storm
Port Orchard Boulevard	PO 4	Isco	6 per storm
Springbrook Creek	BI-SBC	None	3 per storm

(See Figure 2 for locations sampling stations and storm water drainage basins.)

2.0 SAMPLING SITES

2.1 City of Bremerton

2.1.1 Pine Road (BST 1)

Pine Road is a 24” diameter corrugated metal storm water outfall pipe located in the middle of Pine Road, west of Lyon’s Field in East Bremerton, approximately 14’ beneath a 24” (offset to 18”) diameter access cover. Approximately 95% of the 790-acre Pine Road Watershed is developed and contains deciduous forest (~5%), medium-density residential-suburban (~10%), high-density residential-urban (~33%), and commercial and industrial (~47%) land use/land cover categories. BST 1 was primarily chosen as it represents a large, mixed-use residential land use watershed, characteristic of several other un-sampled watersheds within the PSNS Project ENVVEST Study Area. Access to the catchment is through an small 18” manhole thourgh which a standard size ISCO sampler will not fit. This and in addition to the fact that the manhole is located in the middle of a relatively busy street requiring additional manpower for traffic control were why this station was selected for grab rather than ISCO sampling.

2.1.2 Trenton Avenue (BST 12)

Trenton Avenue is a 12” diameter smooth bore concrete storm water outfall pipe located in the middle of Trenton Avenue near the intersection of Trenton and East 10th Street in East Bremerton, approximately 7’ beneath an 18” diameter access cover. Approximately 99% of the 169-acre Trenton Avenue Watershed is developed and contains medium-density residential-suburban (~6%), high-density residential-urban (~64%) and commercial and industrial (~28%) land use/land cover categories. BST 12 was primarily chosen because it has one of the lowest costs associated with installing sampling gear and obtaining data. In addition, the watershed is representative of typical residential watersheds, especially in the City of Bremerton, found throughout the project area. Access to the catchment is through an small 18” manhole through which a standard size ISCO sampler will not fit. However, the City of Bremerton has provided a slimmer ISCO autosampler to facilitate sampling of this site.

2.1.3 Pacific Avenue (BST/Combined Sewer Overflow [CSO] 16)

Pacific Avenue is a 24” diameter smooth bore concrete storm water outfall pipe located near the intersection of 4th and Park in West Bremerton, approximately 9’ beneath a 24” diameter access cover located approximately 3’ from the curb. The entire 140-acre Pacific Avenue Watershed is developed and contains high-density residential-urban (~24%) and commercial and industrial (~76%) land use/land cover categories. BST/CSO 16 was primarily chosen as it represents the landuse of downtown Bremerton.. In addition, the site has a relatively low installation and sample acquisition cost.

2.1.4 Callow Avenue (BST 28)

Callow Avenue is a 72” diameter smooth bore concrete storm water outfall pipe located near the Charleston Avenue Gate entrance to PSNS, approximately 8’ beneath a 24” diameter access cover located approximately 75’ from the guard post station on Callow Avenue. Approximately 99% of 490-acre Callow Ave Watershed is developed and contains an equal mix of high-density residential-urban and commercial and industrial land use/land cover categories. BST 28 was primarily chosen as it is the major stormwater drainage area for West Bremerton and it contains many representative landuses found within the study area.

2.2 Kitsap County SSWM Sites

2.2.1 Silverdale West Bucklin Hill Road (LMK 001)

Silverdale West Bucklin Hill Road is a 42” diameter smooth bore concrete storm water outfall that daylights just to the west of the Silverdale at Sandpiper outfall and flows via the same drainage ditch into Dyes Inlet. Approximately 94% of the 237-acre Silverdale West Bucklin Hill Road Watershed is developed and contains deciduous and coniferous forest (~5%), high-density residential-urban (~8%), and commercial and industrial (~77%) land use/land cover categories. LMK 001 and LMK 002 will be sampled together as 1 site just downstream from the confluence of the 2 outfalls. These sites were primarily chosen as they provided the best northern sampling location for storm water entering Dyes Inlet from a common commercial-heavy land use watershed.

2.2.2 Silverdale at Sandpiper (LMK 002)

Silverdale at Sandpiper is a 42” diameter smooth bore concrete storm water outfall that daylights into a drainage ditch just before entering Dyes Inlet near the Sandpiper Restaurant. LMK 002 is located adjacent to LMK 001. Approximately 98% of the 45-acre Silverdale at Sandpiper Watershed is developed and contains high-density residential-urban (~10%) and commercial and industrial (~84%) land use/land cover categories.

2.2.3 Manchester 038 (LMK 038)

Manchester 038 is a 30” diameter smooth bore concrete storm water outfall that daylights onto Manchester Beach approximately 200’ downstream from the access cover. The site is located approximately 5.5’ below a 16” x 22” access cover. Approximately 45% of the 346-acre Manchester 038 Watershed is developed and contains a mix of low-density residential, commercial, and forest land use/land cover categories. LMK 038 was primarily chosen as it contains a high percentage of low-developed land use, characteristic of many of the watersheds found within the project area, especially in South Kitsap.

2.2.4 Gorst Navy City Metals (LMK 122)

Gorst Navy City Metals is a creek located behind Navy City Metals in Gorst. Upon reaching the road, the creek flows into a 36” smooth bore concrete pipe that then flows beneath the access roadway and Highway 3, towards Sinclair Inlet. The site is accessible from the inflow only as no access cover is located in the immediate area. Approximately 48% of the 627-acre Gorst Navy City Metals Watershed is developed and contains medium-density residential-suburban (~5%), high-density residential-urban (~11%), grassland/turf/pasture (~14%) coniferous forest (~16%), commercial and industrial - (~17%), and deciduous forest (~30%) land use/land cover categories. LMK 122 was primarily chosen as it is a large non-creek watersheds which is highly influenced by roadways, highways, and high traffic in the surronding area. In addition, the watershed contains a large percentage of low to medium density development.

2.2.5 Port Orchard 136 (LMK 136)

Port Orchard 136 (Annapolis Creek) transitions from a natural creek into a 36” smooth bore concrete pipe beneath Arnold Drive in Port Orchard at the intersection with Lawrence Road behind several storage unit buildings. Approximately 72% of the 313-acre Port Orchard 136 Watershed is developed and contains medium-density residential-suburban (~7%), grassland/turf/pasture (~8%), deciduous and coniferous forest (~27%), high-density residential-urban (~27%), and commercial and industrial (~30%) land use/land cover categories. LMK 136 was primarily chosen as it is a relatively large mixed-used watershed and data has been collected from this site in previous years.

2.3 PSNS SITES

2.3.1 Naval Station Commercial/Residential/Recreational (PSNS 015)

Naval Station Com/Res/Rec is a 36” diameter smooth bore concrete storm water outfall pipe located adjacent to McDonalds, near the south side of the drive-through exit lane. The site is located approximately 15’ beneath a 24” access cover. The majority of the 92-acre Naval Station Com/Res/Rec Watershed contains recreational (ball field), residential, and commercial land use/land cover categories. PSNS 015 was primarily chosen as it is the largest catchment area within the Navy area and it represents a mix of land use categories found at PSNS.

2.3.2 Controlled Industrial Area (PSNS 124)

The Controlled Industrial Area (CIA) is a 30” diameter terracotta storm water outfall pipe located just SE of Building 017, east of Dry Dock #2. The site is located approximately 12’ beneath a 24” access cover. All of the 10-acre watershed is used for industrial operations. PSNS 124 was primarily chosen as it represents typical watershed land use found throughout PSNS and data will be comparatively easier to obtain from the site than others evaluated.

2.3.3 Downstream of CSO 16 (PSNS 126)

CSO 16 is a 30” diameter smooth bore terracotta storm water outfall pipe located at the SW side of Building 460. The site is located approximately 10’ beneath a 24” access cover. All of the 20-acre watershed contains industrial land use/land cover categories and the drainage system is located downstream of the City of Bremerton’s CSO 16. PSNS 126 was primarily chosen as it also represents typical watershed land use patterns present throughout PSNS and it too will be an easier site to obtain data from.

2.4 City of Port Orchard Site

2.4.1 Port Orchard Boulevard (PO 4)

Port Orchard Boulevard is a stream that flows into a 42” diameter culvert which then flows approximately 250’ to Sinclair Inlet. The site is located in the back corner of a gravel parking lot behind a house at the corner of Port Orchard Boulevard and Port Orchard Bypass. The site is accessible from the inflow only as no access cover is located in the immediate area. Approximately 77% of the 380-acre Port Orchard Boulevard Watershed is developed and contains medium-density residential-suburban (~17%), deciduous forest (~20%), commercial and industrial (~22%), and high-density residential-urban (~38%) land use/land cover categories. PO 4 was primarily chosen as it is the most representative of typical watershed land use conditions found within the City of Port Orchard and also had the lowest costs associated with installing equipment and subsequently obtaining storm water data as compared to the other sites located within the city limits.

2.5 City of Bainbridge Island Site

2.5.1 Springbrook Creek (BI SBC)

Springbrook Creek flows beneath NE New Brookland Road in west Bainbridge Island via a 60” diameter culvert on its way to Fletcher Bay and Port Orchard Reach. The site is located on the north side of the road, downstream of the culvert at the first notched concrete weir structure.

Approximately 70% of the approximately 350-acre Springbrook Creek is developed and contains mostly low-density residential-rural land use/land cover categories. BI SBC was chosen for flow and fecal coliform sampling because there is no flow and fecal coliform data available from anywhere on Bainbridge Island. Developing a continuous data record for this stream will be very important calibrating modeled flows on Bainbridge Island.. In addition, the watershed contains a mix of land use that are typical for the Southwestern portion of Bainbridge Island.