Storm Event Sampling in the Sinclair and Dyes Inlet Watershed:

FY2005 Quality Assurance Project Plan

Water Body Numbers

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

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Puget Sound Naval Shipyard & Intermediate Maintenance
Facility Project ENVVEST

For

Washington State Department of Ecology
Assessments Sections

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1. Introduction

This document presents the 2005 storm-event sampling plan for the Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF) Project ENVVEST. This plan has been prepared under the Project ENVVEST Final Project Agreement as a cooperative project among PSNS&IMF, the Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology), and technical stakeholders to help improve the environmental quality of the Sinclair and Dyes Inlet Watershed (US Navy, EPA and Ecology 2002). This sampling plan describes specific sampling activities to obtain data necessary to determine the loading and model the fate and transport of contaminants entering the receiving waters of Sinclair and Dyes Inlets (Table 1). This document identifies the objectives, procedures, and quality assurance/quality control (QA/QC) requirements for storm event sampling to be completed by Project ENVVEST for 2005. Upon completion of logistical planning and coordination with project participants and stakeholders, the 2005 sampling will commence in January 2005 and continue until sampling objectives are completed (June 2005). The major emphasis of the sampling will be to collect storm event samples from streams and storm water outfalls currently being monitored for flow within the watershed (Figure 1). Additional goals are to obtain data to support total loading and modeling analysis of contaminants discharged into Sinclair and Dyes Inlets, develop preliminary data on contaminant levels in nonpoint source runoff in Gorst to evaluate the potential for developing restoration alternatives, and assess the impact of storm event runoff on the water quality of the Inlets. Also, in cooperation with Ecology's Manchester Environmental Laboratory (MEL), a subset of stream and selected storm water outfalls will be screened for pesticide and herbicide compounds. Technical data and information from this study will be used to support the development of a Phase II alternative regulatory strategy for PSNS&IMF, assist in the implementation of a water clean up plan for the Sinclair/Dyes Inlet watershed, and help to improve the environmental quality of the Sinclair and Dyes Inlet Watershed.

2. Objectives

The objectives of this sampling plan are to:

1. Collect flow and water quality data from representative streams and storm water outfalls in the Sinclair and Dyes Inlets watershed during storm events. Streams and storm water outfalls will be sampled for physical and conventional parameters, nutrients, metals, and toxic organics (Table 2) to obtain "event mean" concentrations of contaminants being discharged.

2. Obtain data to support total loading and modeling analysis of contaminants discharged into Sinclair and Dyes Inlets.

3. Collect preliminary data on Cu, Cd, Pb, and Zn levels in nonpoint source runoff at the head of Sinclair Inlet in Gorst to evaluate the potential for developing restoration alternatives to reduce contaminant loading in nonpoint source runoff.

4. Assess the impact of storm event runoff on the water quality of the Inlets by monitoring ambient water quality during storm and non-storm conditions.

5. Screen a selected subset of streams and storm water outfalls for pesticide and herbicide compounds.

The data obtained from this sampling effort will be used to develop relationships between water quality and watershed hydrology, land use, and land cover (May et al. 2004), support further development of the integrated watershed and receiving water models being implemented for the Sinclair and Dyes Inlet watershed (Skahill 2004a, b, Johnston et al. 2003, Wang et al. 2004) and provide the basis for calculating total maximum daily loads for key environmental contaminants within the watershed.

3. Background

An alternative model for developing and implementing new environmental regulations within the clean water act is being tested through an ENVironmental inVESTment Project Agreement (ENVVEST) among PSNS&IMF, EPA and Ecology. This model is specifically addressing the development of Total Maximum Daily Loads (TMDL)s for the Sinclair/Dyes Inlet surface water system adjacent to PSNS&IMF and assisting the Shipyard in meeting current and future National Pollution Discharge and Elimination System (NPDES) requirements (ENVVEST 2002a, b). Understanding and addressing all sources of pollution coming into the Inlets will help regulatory agencies prioritize pollution control and water cleanup plans and focus resources on obtaining measurable improvements in the quality of the environment. Both point and nonpoint pollution sources are being quantified because they will have a direct bearing on setting allowable discharges for industrial activities at the Shipyard.

3.1 Summary of ongoing work

This work plan is a continuation of work, initiated by Project ENVVEST and participating stakeholders, to obtain representative data on stream and storm water runoff quality as a function of hydrology, land use, and land cover with the watershed (ENVVEST 2002a, ENVVEST 2004a, May et al. 2004). 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. Currently, flow monitoring stations are being maintained through the efforts of KPUD, Kitsap County Surface and Storm Water Management (SSWM), City of Bremerton, and Project ENVVEST for the major drainage basins within the watershed (Table 3). Data on precipitation and other meteorological data are also monitored by KPUD and the City of Bremerton for the study area. 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 the Hydrologic Simulation Program Fortran (HSPF) model developed for the watershed (Skahill 2003, 2004a, 2004b). The watershed model is being linked to the Curvilinear Hydrodynamics in 3 Dimensions (CH3D) model for the Inlets (Wang et al. 2003, Johnston et al. 2003, Richter 2004, Wang et al. 2004). 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). The reopening came about because the city of Bremerton has nearly eliminated combined sewer overflow (CSO) events and the model, developed by Project ENVVEST, showed 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 is being verified (Johnston et al. 2004) 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) and water clean up plan for the Sinclair/Dyes Inlet watershed.

During the winter of 2002-2003, storm event sampling in streams was conducted by The Environmental Company (TEC) for Project ENVVEST and samples were analyzed for conventional parameters, nutrients, metals, and toxic organics (PAHs, PCBs, and phalates, see list of parameters sampled in streams during 2002-2003) by Battelle Marine Sciences Laboratory (BMSL) and Columbia Analytical Services (CAS). A total of nine storms with more than 0.25" of rain in a 24-hr period were sampled to obtain samples from the streams during the storm event (Table 4A, TEC 2003a, b). Briefly, ISCO autosamplers were programmed to collect ~150 ml aliquots of sample water every 15 min continuously during the storm event, which filled a 3.8 L (1 gallon) glass jar in about 6hr. Generally, 4 6-hr composite samples were combined and analyzed for the parameters of interest to obtain an "event mean" concentration for each storm event (Table 4A). In addition, some 6-hr composite samples from selected streams were also analyzed for some parameters to obtain data on "first flush" and "peak flow" conditions of the storm hydrograph (TEC 2003b).

Since April 2004, as part of the storm water flow monitoring being conducted by TEC, thirteen storm water drainage basins have been monitored for flow and sampled during three storm events (Table 4B). 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 2003c). 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 (SSWM 2002a, b, TEC 2003c). The 35 outfalls were ranked based on the ability to obtain accurate flow rates and flow-weighted composite samples, logistics, health and safety concerns, watershed characteristics and cost (TEC 2003c). The 13 highest ranked outfalls were selected for monitoring. These stations were selected to provide the most representative data on storm water outfalls within the study area based on the cost and equipment available for the sampling effort and the assistance of the participating stakeholders.

The storm event sampling for storm water utilized automated ISCO samplers and discrete grab samples to obtain an estimate of the "event mean" concentrations for the parameters of interest (Table 4B, see list of parameters sampled during the 2004 storm water monitoring). For the storm water sampling the ISCO samplers were programmed to fill the 3.8 L (gallon) jars in about 3 hrs. Immediately following the storm event, data from each of the flow monitors were downloaded and processed to produce the storm hydrograph for each station. The storm hydrograph and physical data for temperature, conductivity (salinity), turbidity and pH, collected with *in situ* multi-probe sensors at selected sites, were used to develop a *post-hoc* composting scheme to best represent the flow hydrograph sampled and eliminate periods of tidal intrusion and low-to-no flow for the resulting "event mean" composite sample (see Field Sampling Reports TEC 2004a, b, c, see also field sampling procedures used for storm event sampling conducted in FY2004).

Additional studies related to storm water monitoring and potential effects of discharges on the receiving waters included a dye study of drydock discharges from the Shipyard (Katz et al. 2004b, Katz and Blake 2004) and an evaluation of copper toxicity in the receiving waters of

Sinclair Inlet (Rosen et al. 2004a, b). The dye study measured the amount and spatial extent of dilution of discharges from the dry docks under normal operational conditions as the discharges mixed into Sinclair Inlet. Data from the dye study should prove useful in validating numerical plume models that can be used to address a variety of discharge and tidal conditions at these locations (Katz and Blake 2004).

The copper toxicity study evaluated the relative bioavailability of copper in Sinclair Inlet by spiking ambient water samples from Sinclair Inlet with various concentrations of copper prior to conducting laboratory bioassays with mussel embryos (Rosen et al. 2004a, b). Spiking copper into ambient Sinclair Inlet water resulted in EC_{50} (concentration causing an effect in 50% of the test animals) values averaging 44% higher, on a dissolved basis, than laboratory water spiked with same concentrations of copper. This indicates that site-specific conditions of Sinclair Inlet were responsible for reducing the toxicity of copper by a factor of 1.44, based on the one sampling event used for the study. The ambient water samples from Sinclair Inlet were nontoxic to mussel embryos, and had dissolved copper concentrations (range 1.0 – 1.6 μg/L) well below ambient water quality criteria (3.1 [chronic] and 4.8 μg/L [acute]). Copper complexation capacity (CuCC), a chemical measure of bioavailability based on free copper measurements, correlated very well with EC_{50} values indicating that measurements of CuCC may be a low cost alternative for evaluating site-specific toxicity of copper in Sinclair Inlet (Rosen et al. 2004b).

4. Overview of Sampling

The stream and storm water stations to be sampled are located in watersheads currently being monitored for flow (Figure 1, Table 5). These watersheds are representative of the land use, land cover, and flow regimes of the subbasins within the Sinclair/Dyes Inlet System (Table 6, Table 7, May et al. 2004). In addition, these watersheds with their mix of urban/industrial, suburban/rural, and undeveloped/developed watersheds, are typical of the landuse characteristics of the Kistsap Peninsula (Water Resource Inventory Area – WRIA 15) and medium to low density areas of the Puget Sound lowlands (excluding high density development in the major metropolitan areas). Therefore, this data should be widely applicable to other areas of Kitsap County, WRIA 15, and the Puget Sound as well.

In order to accommodate manpower and sampling resources available for the 2005 sampling, subsets of stations have been grouped into geographic units for sampling during specific events. The groupings are the GORST, SINCLAIR, and DYES sampling events (Table 5, Figure 2, Figure 3, Figure 4). 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 (ENVVEST 2002b, Fecal Coliform TMDL Study Plan for Sinclair/Dyes Inlets). The GORST, SINCLAIR, and DYES stations will be sampled for two, three, and two storm events, respectively (Table 5). In addition, effluents from the wastewater treatment plants (WWTP) will also be sampled; the Bremerton and Karcher Creek plants will be sampled during the GORST and SINCLAIR events and the Fort Ward plant will be sampled during the DYES event. In the event that Bremerton's East Side Treatment Facility is online and discharging during a storm event, effluent from that facility will be sampled as well. Stations to collect storm water runoff near the GORST RESTORATION sites will be sampled for metals and other ancillary data during the GORST and SINCLAIR events. Sampling of marine and nearshore stations

(SINCLAIR MARINE SAMPLING) will be conducted during the SINCLAIR events to obtain data on ambient marine conditions during storm events. Marine and nearshore samples will also be collected during non-storm conditions to characterize ambient and boundary conditions for the model. Samples will also be obtained to screen for the presence of pesticide and herbicide compounds at selected stream and storm water locations (Table 5G). The sampling procedures, chain-of-custody, sample-holding times, and laboratory procedures to be used for this study are specified below (click here for link to the Puget Sound Naval Shipyard & Intermediate Maintenance Facility Project ENVVEST 2005 Storm Event Sampling and Logistics page).

5. Sampling Design

5.1 Technical Approach

The sampling will be initiated on or following January 2, 2005 and will most likely be completed by June 2005. 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 (ENVVEST 2002c, FC TMDL Study Plan). Each sampling event will be targeted for one of three focus areas within the study area: GORST (Figure 2), SINCLAIR (Figure 3), or DYES (Figure 4). During the sampling period, flow monitoring at the 13 stations monitored for flow by TEC will be maintained (flow monitoring is currently scheduled to continue through April 2005). Prior to sampling a storm event, all sites to be sampled will be staged for sampling and armed to trigger at the onset of rainfall (TEC 2004d) and sample bottles, labels, and chain-of-custody forms will be provided to all sampling teams (see 2005 Storm Event Sampling and Logistics page). The sampling procedures and operations to be conducted by TEC are provided in the 2005 Sampling and Analysis Plan, QA/QC Plan and Health and Safety Plan (TEC 2004d, e, f, respectively).

5.2 Field Sampling Procedures

It is envisioned that at least three sampling teams will be mobilized to collect the required samples: these are the TEC, WWTP and ENVVEST teams. The TEC samples will be collected by TEC as part of the flow monitoring and water quality sampling tasks (TEC 2003b, TEC 2004d, e, f). Samples from the WWTP plants samples will be collected by WWTP personnel for pickup by ENVVEST representatives. The ENVVEST team will collect the MARINE samples from a vessel provided by PSNS & IMF. Marine samples will collected within 24 to 48 hr of the onset of the storm event, if possible. A pre-sampling meeting will be conducted with all parties to assign team captains and coordinate on sample identification, custody, and processing procedures. The sample handling and field procedures identified in the FC TMDL Study Plan (ENVVEST 2002c, Johnston et al. 2004) will be followed, including collecting *in situ* data on temperature, pH, dissolved oxygen (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 (click here for link to the 2005 Storm Event Sampling and Logistics page). Samples will be collected following ultra-clean trace metal sampling procedures (PSAT 1997, US EPA 1996) utilizing the "clean hands" and "dirty hands" sampling technique (click here for link to ultra-clean trace metal sampling procedures training session). Any deviations from this plan will be documented in writing and appended to this sampling plan.

5.3 Stream and Storm Water Sampling

Automated ISCO samplers will be used to collect the stream and storm water samples (TEC 2004d, e, f), except for the Pine Rd. (B-ST01) station, which will be sampled by collecting 3 representative grab samples during the storm event.[1] The autosamplers used at stream sites will be programmed to collect 3.8 L (1 gallon) of water every 6 hrs, resulting in 4 6-hr composite samples for the full 24 hr sampling period. The stream and storm water samples will be composited and analyzed for conventional parameters, nutrients, metals, and toxic organics (Table 2, Table 8). All compositing will be performed by BMSL at the Sequim Laboratory under ultra clean laboratory conditions (see BMSL 2000a, b, c for SOPs applicable to storm event sampling).

The sites to be sampled for each sampling event are listed in (Table 5). The major drainage basins at the head of Sinclair Inlet including Gorst Creek, Anderson Creek, and Navy City will be sampled during the Gorst Event (Figure 2, Table 5A, B). Gorst Creek will be sampled with ISCO samplers at both the upper, relatively pristine, station (GC) and below the major tributaries at the lower station (GC-SAN). Samples at Annapolis Creek (LMK136), Port Orchard Blvd (PO-POBLVD), and Manchester (LMK038) will also be collected during the GORST EVENT (Figure 2, Table 5A and 5B). The SINCLAIR EVENT will feature the major outfalls discharging from downtown Bremerton (B-ST28 and B-ST/CSO16), the Shipyard (PSNS015, PSNS124, and PSNS126), and Blackjack (BL) and Olney (OC) Creeks (Table 5A and 4B, Figure 3). The DYES EVENT will obtain data on the major streams discharging into Dyes Inlet (Chico – CH, Strawberry – SC, Clear – CC, and Barker – BA Creeks), sizeable storm water outfalls draining Silverdale (SW6) and East Bremerton (B-ST01 and B-ST12), and Springbrook Creek (BI-SBC) on Bainbridge Island (Table 5A and 5B, Figure 4).

During one of the storm events sampled for GORST, and "field duplicate" ISCO sample will be obtained by operating two ISCO samplers side-by-side at one station (AC). The samples collected will provide information on the variability of two samples collected at the same time, with the same methods, from the same location.

- Click here to view photos of storm water sampling sites (May 2004)
- Click here to view photos of stream sampling sites (Jan 2003, Jan-Feb 2002)

5.4 Waste Water Treatment Plants

Effluents from the Bremerton and Karcher Creek Waste Water Treatment Plants (WWTP) will be collected during the GORST and SINCLAIR EVENTS and samples from the Fort Ward (WWTP) will be collected during the DYES EVENTS (Table 5C). In conjunction with the plant operators, grab samples will be collected as close to the beginning (first flush), middle (peak flow), end (tail) of the storm as is possible (during normal working hours). Bremerton's East Side Treatment Facility (B-EFT) will be sampled only if the treatment facility is on line and discharging during a storm event. The samples will be collected either directly into

[1] The current plan is to collect grab samples at this site because the sampling site is located in the middle of the street and the small manhole opening precludes using a standard-size ISCO sampler.

pre-cleaned, 1L Teflon bottles provided by BMSL, or if it is not feasible to collect directly into the Teflon bottle, a pre-cleaned 500 ml bailer bottle, made of Low Density Polyethylene (LDPE), will be used to collect the sample and transfer it into the Teflon bottle. Samples will be collected following ultra-clean trace metal sampling procedures (PSAT 1997, US EPA 1996) utilizing the "clean hands" and "dirty hands" sampling technique (click here for link to ultra-clean trace metal sampling procedures training session). Records of flow rate from the WWTPs during the storm events sampled will also be maintained and transferred to Project ENVVEST data coordinator.

5.5 Gorst Restoration Sites

The possibility of reducing nonpoint source pollution through wetlands restoration as a possible alternative strategy for Project ENVVEST was discussed during recent Project ENVVEST Working Group Meetings (Sherrell 2004, ENVVEST 2004). Meanwhile, Kitsap County has received a grant from EPA to develop a Brownfields Redevelopment pilot project to restore parts of the Gorst Estuary (Kitsap County 2004). There is interest in determining whether an opportunity to use wetlands restoration as a means of reducing nonpoint source pollution and improving environmental quality as a basis for developing a possible pollutant trading program for metals (especially copper) could be pursued. To help address this issue, and in coordination with the Washington State Department of Transportation (WDOT) and other stakeholders, a series of stations were identified that are representative of storm water runoff from highways, parking lots, and commercial land use within the Gorst area (GORST RESTORATION SITES, Figure 2, Table 5D). The Gorst area is a heavily trafficked area, averaging about 60,000 to 80,000 cars per day (Richard Tveten, WDOT, personal communication). Based on data from WDOT's storm water monitoring program, highway runoff sampled from roadways with Average Daily Traffic (ADT) of 100,000 –150,000 cars per day ranged between 3.9 – 220 ug/L for total Cu (average 27.2 ug/L), 2.0 – 18.0 ug/L for dissolved Cu (average 6.12 ug/L), 17.0 – 1200 ug/L for total Zn (average 154.0), and 8.9 – 100.0 for dissolved Zn (average 52.8 ug/L) (WDOT 2004).

The purpose of sampling the GORST RESTORATION stations is to develop data on the levels of metals (Al, Cu, Zn, Cd, and Pb) that are present in storm water runoff that is currently draining, mostly unimpeded, into Sinclair Inlet. Individual grab samples will be collected using ultra-clean trace metal sampling procedures and analyzed for total and dissolved Cu, Zn, Cd, and Pb, total Al, total and suspended solids, total organic carbon, and dissolved organic carbon. Ancillary data on *in situ* temperature, conductivity, turbidity, pH and dissolved oxygen will also be recorded. GORST RESTORATION stations will be sampled by TEC during the GORST EVENTS and by the ENVVEST Team during the SINCLAIR sampling events. Stations to be sampled include the lower reaches of Anderson (AC-LOW) and Gorst Creeks (GC-LOW) and sites directly adjacent to the highway curb drains along State Route 16 (WADOT-02 and WADOT-03) and State Route 3 (WADOT-01A). An additional station located in a roadside swale near along State Route 3 will also be sampled (WADOT-01B). The heavily trafficked curb site in the middle of Gorst, in front of Gorst Subaru (WASDOT-03), will only be sampled by TEC to reduce safety risks. Due to tidal influence, the station at the mouth of Gorst Creek (GC-M) will only be sampled at low tide, if possible.

- Click here to see photos from the Gorst Site Visit (Oct 2004).

5.6 Sinclair Marine Sampling

The purpose of the MARINE sampling is to assess the impact of storm event runoff on the water quality of the Inlet, evaluate the potential ecological significance of discharges in the Inlets, and provide data that can be used to support the development of a Phase II alternative regulatory strategy for PSNS&IMF. The marine sampling is primarily focused on heavy metals (Cu, Cd, Pb, and Zn) because these metals are of most concern for regulation under the Shipyard's NPDES permit. Additionally, metals (copper) were identified as the next parameter group to be addressed following completion of the FC TMDL Study in the Project ENVVEST Technical Work Masterplan (ENVVEST 2002a, b). This work will also complement the sediment metal and organics verification study being conducted to characterize the current levels of contaminants (Diefenderfer 2002, Kohn et al. 2002, Kohn et al. 2004), by quantifying the current loading of contaminants into the Inlets. Furthermore, developing a total loading analysis for copper and other metals would be the necessary first step in developing alternative regulatory strategies aimed at addressing NPDES requirements (click here to review a summary of water quality data for Sinclair and Dyes Inlets).

Marine and nearshore samples will be collected in conjunction with the SINCLAIR sampling events (Table 5E). Stations to be sampled include stations along the industrialized waterfront of the Shipyard and Naval Station (P1, P2, and P3), along the Port Orchard waterfront (BJ-EST, SN12), the mouth of the Port Washington Narrows (DY01) ambient waters in the middle of Sinclair Inlet (M3.1, M3.3, and M4), and ambient waters in the middle of Dyes Inlet (M6) (Figure 5). Trace metal samples will be collected following ultra-clean trace metal sampling procedures (PSAT 1997, US EPA 1996, click here for link to ultra-clean trace metal sampling procedures training session). Surface grabs (0 – 1 m depth) will be collected by dipping precleaned Teflon 1L bottles attached to a 5-m PVC rod from the bow of the sampling vessel. Six SINCLAIR MARINE surveys will be completed, three will be conducted within 24 to 48 hrs of storm event sampling, and three surveys will be conducted during nonstorm winter, spring, and summer conditions. Discrete samples will be analyzed for total solids and suspended solids, total organic carbon, dissolved organic carbon, oceanographic-precision salinity, total Al, Cu, Cd, Pd, and Zn and dissolved Cu, Cd, Pb, and Zn (Table 8). A subset set of samples (i.e. samples collected from stations M3.1, M3.3, and P3) will also be analyzed for nutrients and total Hg (Table 8).

As part of the SINCLAIR MARINE sampling, plume-mapping will be conducted with the Marine Environmental Survey Capability's (SSC-SD 2003) mini-MESC system to map out freshwater and particle plumes generated from storm water and/or drydock discharges during storm and nonstorm conditions. The survey vessel will be equipped with the mini-MESC system to continuously record vessel position and depth of the sensors and measure salinity, temperature, bottom depth, pH, dissolved oxygen, oxygen saturation, and fluorescence at a 4-Hz data rate within the Inlet. The mini-MESC system will be used to map out the surface water (~1 m depth), detect any plumes generated by a storm water or dry dock discharges, and identify locations to take additional discrete samples for chemical analysis (PLUME samples, Table 5E). Vertical profiles will also be collected to assess the depth of the plumes and characterize mixing processes in the Inlet. The data from the plume mapping will be used to generate maps of the spatial extent of the plumes and assess the effect of storm water discharge on the receiving waters of the Inlets. Data from this study will provide information for modeling contaminant loading into the Inlets and assessing the long-term impact of storm water discharge on sediment and water quality of the Inlets. (Katz et al. 2004, Katz and Blake 2004).

Toxicity evaluation of the receiving waters of Sinclair Inlet will be conducted on samples collected from representative locations in Sinclair Inlet near the Shipyard. Samples will be collected and provided to SSC during the Project ENVVEST sampling scheduled for Winter 2005/Spring 2005 (Appendix 11.5). The toxicity evaluation will follow established protocols developed for evaluating site-specific water quality criteria with particular emphasis on evaluating processes that that affect the bioavailability of copper, such as complexation capacity (Rosen et al. 2004) and the biotic ligand model (BLM, Niyogi and Wood 2004, U.S. EPA 2003, WEF 2004a, b). These data will also support implementing a module to simulate copper speciation and fate into the CH3D model for Sinclair and Dyes Inlets and developing the capability to model the transport of different size classes of particles within the Inlets.

Samples for toxicity testing and/or copper complexation capacity (CuCC) analysis will collected during three of the Sinclair Marine Sampling events, roughly corresponding to one late winter event (Feb/Mar 2005), one spring/summer event (Jun/July 2005), and one late summer/fall event (Aug/Sept 2005). The CuCC will be measured in 10 samples for each of these events, and Cu toxicity evaluations will be performed on 5 samples from two of the events (winter and late summer). The toxicity testing will be performed on samples from station M3.1, M4, P3, SN12 in Sinclair Inlet and station M6 in Dyes Inlet (Figure 5). CuCC will be measured in samples collected from stations M3.1, M3.2, M4, P1, P2, P3, SN12, BJ-EST, DY01, in Sinclair Inlet and Station M6 from Dyes Inlet.

5.7 Model Boundary

Additional stations within Dyes Inlet (M5, M7, and M8), Rich Passage (M1), and Port Orchard Passage (M9, M10, M10.1, M11) will be included during the summer SINCLAIR MARINE survey. These samples will be analyzed for the same parameters as SINCLAIR MARINE samples. These data will be used to provide a synoptic picture of water quality within the Sinclair and Dyes Inlet system and provide data to support ongoing modeling studies (Figure 6, Johnston and Wang 2004).

5.8 Pesticides/Herbicides

A subset of streams and storm water outfalls will be screened for pesticide and herbicide compounds. Recent studies have implicated pesticides and herbicides as contaminants of concern in storm water runoff (King County 2004, Schneider and Rickel 2003) and Dieldrin and Aldrin in fish tissue were listed on the 1998 303d list for Sinclair Inlet (ENVVEST 2002a, b). Samples for pesticide and herbicide analysis will be obtained from the storm event mean composite sample collected at the following sites:

- Streams – Springbrook (BI-SBC), Barker (BA), Clear (CC), Strawberry (SC), Chico (CH), Blackjack (BL), Olney (OC), Gorst (GC-SAN), Anderson (AC), Annapolis (LMK136) Creeks

- Storm water outfall sites in Port Orchard (PO-POBLVD), East Bremerton (B-ST12, B-ST01), Manchester (LMK038), Silverdale (SW6), and the Shipyard (PSNS015) (Table 5G).

These stations were selected based on their upstream drainage area, the type of land use and land cover present, the likelihood of detecting pesticide/herbicide compounds, and the ability to get enough water to collect the sample. Only one "event mean" sample will be analyzed from each of the selected stream and storm water stations.

The pesticide/herbicide sample will consist of two 2.4 L samples (one for pesticides and one for herbicides) obtained from the "event mean" composite sample for each site. Each sample will be placed into one of the glass jars used to contribute to the "event mean" composite, securely sealed, labled, and placed on ice until transport to MEL for analysis. If any of the screened samples shows high levels of pesticides or herbicide compounds, up to two additional samples could be processed to verify the result (verification samples, Table 5G).

6. Laboratory Measurements and Quality Control Procedures

Analytical chemistry analysis of samples for trace metals and organics will be performed by Battelle Marine Sciences Laboratory (BMSL), Sequim WA, and Columbia Analytical Services (CAS), Kelso, WA will conduct the analyses of the conventional parameters and nutrients. The pesticide and herbicide analysis will be performed by Ecology's Manchester Environmental Laboratory (MEL), Port Orchard, WA. The following documents the QA/QC requirements of this study.

6.1 Quality Objectives and Criteria for Measurement Data

6.1.1 Data Quality Objectives (DQO)

The DQOs for the Sinclair and Dyes Inlet Study are presented in Table 1. This table documents the way in which the collected data will be summarized and used to make project decisions. It defines:

- Objectives of the intended sampling and analysis;
- Underlying design assumptions for each sample type and matrix;
- How each data type will be assessed;
- Method that will be used to determine whether or not the data support the design assumptions; and
- How the data will be used in interpretation.

6.1.2 Measurement Quality Objectives

Measurement quality objectives for the analyses conducted for this study can be expressed in terms of accuracy, precision, completeness, and sensitivity goals. Accuracy and precision are monitored through the analysis of quality control samples. Analytical Parameters, Holding Times, and Detection Limits are provided in Table 2.

Accuracy is defined as the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations.

Precision is defined as the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms.

Completeness is the amount of data collected as compared to the amount needed to ensure that the uncertainty or error is within acceptable limits. The goal for data completeness is 100%. However, the project will not be compromised if 90% of the samples collected are analyzed with acceptable quality.

Comparability is a measure of the confidence with which one data set can be compared to another. This is a qualitative assessment and is addressed primarily in sampling design through use of comparable sampling procedures or, for monitoring programs, through accurate re-sampling of stations over time. In the laboratory, comparability is assured through the use of comparable analytical procedures and ensuring that project staff is trained in the proper application of the procedures. Within-study comparability will be assessed through analytical performance (QC samples).

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population. This is a qualitative assessment and is addressed primarily in the sample design, through the selection of sampling sites, and procedures that reflect the project goals and environment being sampled. It is ensured in the laboratory through (1) the proper handling, homogenizing, compositing, and storage of samples and (2) analysis within the specified holding times so that the material analyzed reflects the material collected as accurately as possible.

Sensitivity is the capability of a test method or instrument to discriminate between measurement responses representing different levels (*e.g.*, concentrations) of a variable of interest. Sensitivity is addressed primarily through the selection of appropriate analytical methods, equipment, and instrumentation. The methods selected for the Sinclair and Dyes Inlet Study were chosen to provide the sensitivity required for the end-use of the data. This is a quantitative assessment and is monitored through the instrument calibrations and calibration verification samples and the analysis of procedural blanks with every analytical batch.

Method Detection Limits (MDLs) for organic compounds must be determined annually according to Code of Federal Regulations 40 CFR Part 136 Appendix B for each method of interest by instrument, matrix, and compound of interest. Sediment MDLs are determined by spiking clean sediment or a solid matrix such as pre-baked sodium sulfate with all parameters of interest and processing them according to the methods defined in Section 3.4. MDLs for water samples are determined by spiking ASTM type II (MilliQ) water with all parameters of interest and processing them according to the methods defined in Section 3.4. MDLs for gas chromatography/electron-capture detector (GC/ECD) analysis are determined on the primary column. MDLs for PCBs and pesticides must also be determined on a confirmation column if data from confirmatory analyses will be reported. In these instances, the MDLs determined from confirmation column analysis must be less than those determined from the primary column.

The MDLs for trace metals are determined annually according to 40 CFR Part 136 Appendix B for each method of interest by instrument, matrix, and compound of interest. Because completely metal-free matrices for sediment do not exist, MDLs for metals in sediment samples are calculated from the MDLs generated by a fresh water MDL study, taking into account the anticipated sample dilution factors that would be used in actual sediment samples. MDLs for fresh water samples are determined by spiking deionized water with all metals of interest and processing them according to the methods defined in Section 3.4.

Reporting Limits (RLs) for organic compounds are empirical values based on instrument sensitivity and day-to-day operations. For organic compounds, the RL is calculated as

RL = (Low Standard Concentration)(Pre-injection volume)(Dilution Factors)(1/ Sample Size)

The actual reporting limit can be lowered by increasing the sample size and decreasing the pre-injection volume of the sample. Detected values that are less than the reporting limit will be qualified as estimates and used with caution during any assessment.

For trace metals, the RL is calculated by multiplying the target analyte MDL by 3.18. The value 3.18 is based on the Student's-t value for 7 to 10 replicates, the number of replicates usually analyzed to generate the MDL. The data qualifier "J" will be added to any reported values that are less than the RL at the direction of the PSNS&IMF Project ENVVEST Manager.

6.2 Sample Handling and Custody

6.2.1 Sample Processing

6.2.1.1 Sample Custody

Sample custody records are the administrative records associated with the physical possession and/or storage history of each individual sample from the purchase and preparation of each sample container and sampling apparatus to the final analytical result and sample disposal. MSL-A-002, *Sample Chain-of-Custody*, (Battelle 2000a, b, c) defines field and laboratory custody procedures.

Sample containers will be labeled with waterproof, adhesive-back labels. Sample labels must provide sufficient detail to identify each storm event and station to allow tracking to field activities. Sample labels must include a unique sample identification number, station ID, sample event, sample type (grab A, B, C), collection date/time, and analysis codes. An example is provided below.

Sample custody will be documented from “cradle to grave” on a chain-of-custody form

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Sample ID: P4000-A

Station Code: PSNS081.1 Aliquot: TOC

Storm No.: 2 Grab No.: 1

Lab ID: ____________________

Collection Date: ________ Time: ________

Matrix: storm water Storage: Cool 4°C

(COC). Samples should not be left unattended unless properly secured. Each laboratory has a formal, documented system designed to provide sufficient information to reconstruct the history of each sample, including preparation of sampling containers, sample collection and shipment, receipt, distribution, analysis, storage or disposal, and data reporting within the laboratory. Laboratory documentation must provide a record of custody for each sample (versus a sample batch) throughout processing, analysis, and disposal.

6.2.2 Sample Receipt

Immediately upon receipt by a laboratory, the condition of samples must be assessed and documented. The contents of the shipping container must be checked against the information on the chain-of-custody form for anomalies. If any discrepancies are noted, or if laboratory acceptance criteria or project-specific criteria are not met, the laboratory must contact the Field Manager for resolution of the problem. The discrepancy, its resolution, and the identity of the person contacted must be documented in the project file. The following conditions may cause sample data to be unusable and must be communicated to the laboratory team leader:

- The integrity of the samples is compromised (*e.g.,* leaks, cracks, grossly contaminated container exteriors or shipping cooler interiors, obvious odors, etc.);
- The identity of the container cannot be verified;
- The proper preservation of the container cannot be established;
- Incomplete sample custody forms (*e.g.,* the sample collector is not documented or the custody forms are not signed and dated by the person who relinquished the samples);
- The sample collector did not relinquish the samples; and,
- Required sample temperatures were not maintained during transport (4°C ± 2).

The custodian must verify that sample conditions, amounts, and containers meet the requirements for the sample and matrix. A unique sample identifier must be assigned to each sample container received at the laboratory, including multiple containers of the same sample.

6.2.3 Sample Handling

Sample holding conditions and holding times are defined in Table 9. Holding times are to be calculated from the time of sample collection. Documentation must be sufficient to track sample holding, processing, and analysis times to ensure that holding times are met. Documentation of sample collection must include both date and time.

Field samples will be held for six months after sample collection. Disposal records for unextracted samples, extracted samples, sample containers, and sample extracts must be sufficient to provide tracking from collection, through laboratory receipt, to sample disposal in a waste drum that is directly traceable to a disposal manifest.

6.3 Analytical Methods

6.3.1 Battelle Laboratory Analyses

Battelle MSL will perform the analysis of trace metals and organic compounds identified as contaminants of potential concern (COPCs) according to low-level methods developed for the National Oceanic and Atmospheric Administration (NOAA) Status and Trends Program.

Stormwater samples will be extracted and analyzed by gas chromatography/mass spectrometry to identify and quantify polynuclear aromatic hydrocarbons (PAH). In addition, the extracts will be analyzed by gas chromatography using an electron capture detection to identify and quantify selected PCB congeners.

Quantification of mercury (Hg) will be determined using cold vapor atomic fluorescence (CVAF) following EPA Method 1631 revision E. Quantification of the additional metals will depend on the salinity of the samples. Salinity will be determined using a refractometer and samples containing greater than 5 part per trillion salinity will be prepared as “seawater” samples in order to eliminate the instrumental interferences resulting from the dissolved salts. Seawater samples will be preconcentrated using an iron/palladium reductive precipitation method. Preconcentrated samples will be analyzed by inductively coupled plasma-mass spectroscopy (ICP-MS) for all metals except silver (Ag). Due to an instrumental interference with the preconcentration reagents, Ag will be analyzed by graphite furnace atomic absorption (GFAA). Freshwater samples will be analyzed directly by ICP-MS. Prior to analyses, unfiltered samples will be digested using a total recoverable metals method.

6.3.2 Columbia Analytical Services

See CAS laboratory SOPs (CAS 2002)

6.3.3 Manchester Environmental Laboratory

Pesticides will be analyzed with a gas chromatograph (GC) equipped with an atomic emission detector (AED) in accordance with EPA method 8085 or by GC mass spectroscopy (MS) in accordance with EPA method 8270. Herbicides samples will be analyzed with a GC equipped with a mass spectrometer in accordance with EPA method 8270. See MEL laboratory SOPS (WDOE 2002). Positive identifications between the MDL and reporting limit will be reported and qualified as estimates since they are below the calibration curve.

6.4 Quality Control Requirements

This section defines the quality control (QC) program for the Sinclair and Dyes Inlet Study. Appropriate laboratory QC procedures are designated in order to assess data quality through the measures of accuracy and precision. If data fall outside the specified accuracy or precision criteria defined for a procedure or measurement, or if problems affecting comparability are identified, the chemistry task leader must contact the PNNL Program Manager and the ENVVEST Program Manager to discuss options available for rectifying the out-of-control situation.

6.4.1 Analytical Laboratory

6.4.1.1 Quality Control Samples

The study design and QC samples are intended to assess the major components of total study error, which facilitates the final evaluation of whether environmental data are of sufficient quality to support the related decisions. The QC sample requirements are designed to provide measurement error information that can be used to initiate corrective actions with the goal of limiting the total measurement error.

The QC samples and frequency applicable to analytical chemistry laboratories are detailed in Table 10. Table 11 defines the required accuracy and precision for QC samples, along with corrective actions that must be implemented if QC criteria are not met. Table 12 provides formulas for the calculation of QC sample assessment statistics. All QC sample failures and associated corrective actions will be documented. If data must be reported with failing QC results, then data qualifiers will be assigned to the QC sample data.

6.5 Instrumentation/Equipment Testing, Inspection, and Maintenance

6.5.1 Laboratory Equipment

All analytical instruments and equipment are to be maintained according to SOPs and the manufacturers' instructions. Equipment and instrument and maintenance and frequency are defined in SOPs and are summarized in Table 13 and Table 14. All routine maintenance and non-routine repairs are to be documented in a bound logbook. The information recorded should include analyst initials, date maintenance was performed, a description of the maintenance activity, and (if the maintenance was performed in response to a specific instrument performance problem) the result of re-testing to demonstrate that the instrument performance had been returned to acceptable standards prior to re-use. The return to analytical control is demonstrated by successful calibration.

6.6 Documentation and Records

6.6.1 Laboratory Documentation

Documentation of all activities is critical for tracking data and evaluating the success of any activity. Laboratory documentation requirements are defined in Battelle MSL standard operating procedures (Battelle 2000a, b).

6.6.2 Documentation Standards

All data generated during the course of this project must be able to withstand challenges to their validity, accuracy, and legibility. To meet this objective, data are recorded in standardized formats and in accordance with prescribed procedures. The documentation of all environmental data collection activities must meet the following minimum requirements.

- Data must be entered directly, promptly, and legibly. All reported data must be uniquely traceable to the raw data. All data reduction formulas must be documented.
- Handwritten data must be recorded in ink. All original data records include, as appropriate, a description of the data collected, units of measurement, unique sample identification (ID) and station or location ID (if applicable), name (signature or initials) of the person collecting the data, and date of data collection.
- Any changes to the original (raw data) entry must not obscure the original entry. The reason for the change must be documented, and the change must be initialed and dated by the person making the change.
- The use of pencil, correction fluid, and erasable pen is prohibited.

Any changes to the QAPP or FSP (*e.g.*, QA procedures, analytical procedures, sampling locations and frequencies, etc) must be documented in writing and approved by the PNNL QA Officer, PNNL Program Manager, prior to implementation of the changes.

Minor deviations from the QAPP or FSP (*e.g.,* those that would not impact the study objectives, design, or data quality) will be reported to and approved by the appropriate team leader and the PNNL Project Manager. Major deviations (*e.g.,* those that could impact the study objectives, design, or data quality) will additionally be reported to the PNNL Program Manager, the PNNL QA Manager, and the ENVVEST Project Manager.

6.7 Data Management

Data generated in support of the Sinclair and Dyes Inlet Study will be tracked and reviewed by the PNNL Program Manager. Data management (*e.g.,* paper flow; data tracking, data entry, etc.) and data assessment (*e.g.,* verification, validation, and Data Quality Assessment

(DQA)) activities require adequate QC procedures to ensure that the SOPs will be followed and result in records and reports that are accurate and appropriate. QC procedures include peer review of each step and management review of a certain percentage of the data.

6.7.1 Laboratory Data

Data management at the laboratory begins with the receipt of samples. Samples are logged in and assigned unique identification numbers that are used to identify samples throughout storage, processing, analysis, and reporting. A combination of hand-recorded and electronically captured data is generated. Hand-recorded data include sample processing and spiking procedures. Hand-recorded data are transcribed to spreadsheets using established formats. (The raw data are maintained in the project files and the transcribed data are 100% verified). Data will be entered into an EDD using a format supplied by the ENVVEST Technical Coordinator.

6.8 DATA VALIDATION AND USABILITY

Data review includes data verification, validation, and oversight, as well as reconciliation of the data quality with user requirements. The data verification process includes the initial review of the data packages to ensure that the analyses requested have been provided. Data validation is the process of reviewing data and accepting, qualifying, or rejecting data on the basis of sound criteria. Data will be reviewed by the Chemistry Task Leader to assure that it is complete. Data qualifier codes are provided in Table 15.

7. Summary

This sampling plan describes specific sampling activities to obtain data necessary to determine the loading and model the fate and transport of contaminants entering the receiving waters of Sinclair and Dyes Inlets (Table 1). This document identifies the objectives, procedures, and quality assurance/quality control (QA/QC) requirements for storm event sampling to be completed by Project ENVVEST for 2005. The data obtained from this sampling effort will be used to develop relationships between water quality and watershed hydrology, land use, and land cover (May et al. 2004), support further development of the integrated watershed and receiving water models being implemented for the Sinclair and Dyes Inlet watershed (Skahill 2004a, b, Johnston et al. 2003, Johnston and Wang 2004, Wang et al. 2004) and provide the basis for calculating total maximum daily loads for key environmental contaminants within the watershed.

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9. Tables

Table 1. Data quality objectives for storm event sampling in Sinclair and Dyes Inlets.

<table>
<tr><td>Storm Event Sampling Data Quality Objectives</td></tr>
<tr><td>STEP 1: State the Problem
Sinclair and Dyes Inlets are listed as impaired waterbodies on 303d list due to contamination from heavy metals, toxic organics, and low dissolved oxygen. Data are needed to characterize contaminant loading from the watershed during storm events to support development of Total Maximum Daily Loads, calculate the mass balance of contaminants within the receiving waters, and assess the impact of contaminants discharged into receiving waters of the Inlets.</td></tr>
<tr><td>STEP 2: Identify the Decision
1. Are discharges from streams and storm water outfalls during storm events impacting the water and sediment quality of the Inlets?
2. Can relationships between land use, land cover, and hydrology within the watershed be used to predict contaminant loading from the watershed?</td></tr>
<tr><td>STEP 3: Identify Inputs to the Decision
1. Establish a network of flow monitoring stations and watershed model to characterize flow regime within the watershed.
2. Select stream and stormwater sampling locations that that are representative of land use, land cover, and hydrologic conditions watersheds for detailed monitoring.
3. Conduct replicate sampling of typical storm events (>0.25” of rainfall in a 24-hr period) to develop estimates of event mean concentrations of parameters of interest.</td></tr>
<tr><td>STEP 4: Define the Study Boundaries
Spatial boundaries are Sinclair and Dyes Inlets and their surrounding watersheds.</td></tr>
<tr><td>STEP 5: Develop a Decision Rule
The data collected will be used to develop relationships between runoff quality and LULC and assess the impact of storm event runoff on water and sediment quality of the Inlet</td></tr>
<tr><td>STEP 6: Evaluate Decision Errors
Data will be evaluated to assure accuracy, precision, completeness, comparability, and representativeness.</td></tr>
<tr><td>STEP 7: Optimize the Design for Obtaining Data
Collect flow and water quality data from representative streams and storm water outfalls in the Sinclair and Dyes Inlets watershed during storm events. Streams and storm water outfalls will be sampled for physical and conventional parameters, nutrients, metals, and toxic organics (Table 2) to obtain “event mean” concentrations of contaminants being discharged. Obtain data to support total loading and modeling analysis of contaminants discharged into Sinclair and Dyes Inlets. Collect preliminary data on Cu, Cd, Pb, and Zn levels in nonpoint source runoff at the head of Sinclair Inlet in Gorst to evaluate the potential for developing restoration alternatives to reduce contaminant loading in nonpoint source runoff. Assess the impact of storm event runoff on the water quality of the Inlets by monitoring ambient water quality during storm and non-storm conditions. Screen a selected subset of streams and storm water outfalls for pesticide and herbicide compounds.</td></tr>
</table>

Table 2. Analytical Parameters, Holding Times, and Detection Limits for the 2005 storm event sampling. (A) Conventional/physical, nutrients, and metal parameters.

Analytical Parameter	Total Sample Volume (L)	Min volume needed from each replicate (L)	Lab Preser-vation	Holding Time	Detection Limit[1] Value	Detection Limit[1] Units	Priority for Isco
Conventionals/Physicals							
Measured In Situ							
Conductivity				-	-	μ-Simns/cm^2-	
Salinity						PSU	
Temperature				-	-	°C	
Turbidity				-	0.01	NTU	
Collected with ISCO							
Conventionals							
Alkalinity, Total (as $CaCO_3$)	0.250	0.063	Cool, 4°C	14 days	1	mg/L, $CaCO_3$	**7**
Hardness (as $CaCO_3$)	0.250	0.063	HNO_3 to pH<2.0	6 months	2	mg/L, $CaCO_3$	**6**
Total Solids	1.000	0.250	Cool, 4°C	7 days	5	mg/L	**5**
Total Suspended Solids				7 days	5	mg/L	
LISST Solids	0.125	0.100	Cool, 4°C	6 months			**2**
Nutrients and TOC							
Total Organic Carbon (TOC)	1.000	0.250	Cool, 4°C, H_2SO_4 to pH<2.0	28 days	0.25	mg/L	**3**
Dissolved Organic Carbon (DOC)				28 days	0.1	mg/L	
(Nitrate + Nitrite) Nitrogen				28 days	0.03	mg/L	
Ammonia Nitrogen				28 days	0.006	mg/L	
Total Nitrogen (TKN)				28 days	0.1	mg/L	
Total Phosphorus				28 days	0.003	mg/L	
Metals							**1**
Total Metal	0.500	0.500					
Aluminum			HNO_3 to pH<2.0	6 months	1.0	μg/L	
Arsenic				6 months	0.01	μg/L	
Cadmium				6 months	0.005	μg/L	
Chromium				6 months	0.02	μg/L	
Copper				6 months	0.005	μg/L	
Lead				6 months	0.005	μg/L	
Mercury				90 days	0.0001	μg/L	
Silver				6 months	0.003	μg/L	
Zinc				6 months	0.05	μg/L	
Dissolved Metal (0.45 um filter)			Filtered within 24 hours, HNO_3 to pH<2.0				
Cadmium				6 months	0.005	μg/L	
Copper				6 months	0.005	μg/L	
Lead				6 months	0.005	μg/L	
Silver				6 months	0.003	μg/L	
Zinc				6 months	0.05	μg/L	

Table 1. Continued. (B) Organic parameters.

Analytical Parameter	**Total Sample Volume (L)**	**Min volume needed from each replicate (L)**	**Preservation and Holding Time**	**Detection Limit[1]**		**Priority for Isco**
				Value	**Units**	
Organics[2]	1.000	0.250	Cool, 4°C			4
2-methylnaphthalene			7 days / 40 days[3]	5	µg/L	
Acenaphthene			7 days / 40 days[3]	5	µg/L	
Acenaphthylene			7 days / 40 days[3]	5	µg/L	
Anthracene			7 days / 40 days[3]	5	µg/L	
Benz(a)Anthracene			7 days / 40 days[3]	5	µg/L	
Benzo(a)pyrene			7 days / 40 days[3]	5	µg/L	
Benzo(g,h,i)perylene			7 days / 40 days[3]	5	µg/L	
Bis (2-ethylhexyl) phthalate			7 days / 40 days[3]	5	µg/L	
Butyl benzyl phthalate			7 days / 40 days[3]	5	µg/L	
Chrysene			7 days / 40 days[3]	5	µg/L	
Dibenzo (a,h) Anthracene			7 days / 40 days[3]	5	µg/L	
Di-n-butyl phthalate			7 days / 40 days[3]	5	µg/L	
Fluoranthene			7 days / 40 days[3]	5	µg/L	
Fluorene			7 days / 40 days[3]	5	µg/L	
Indeno (1,2,3,-cd) pyrene			7 days / 40 days[3]	5	µg/L	
Naphthalene			7 days / 40 days[3]	5	µg/L	
PCB Congener (NOAA NS&T 20 congeners)			7 days / 40 days[3]	0.001	µg/L	
Phenanthrene			7 days / 40 days[3]	5	µg/L	
Pyrene			7 days / 40 days[3]	5	µg/L	
Total benzofluoranthenes			7 days / 40 days[3]	5	µg/L	
Total PCBs			7 days / 40 days[3]	0.01	µg/L	
PESTICIDES (see Table 1C)	2.4	0.600	7 days / 40 days[3]	0.0025 - 0.025	µg/L	**4**
HERBICIDES (see Table 1C)	2.4	0.600	7 days / 40 days[3]	0.01	µg/L	**4**

Notes: [1] Method Detection Limit.
[2] Water samples are to be collected in amber bottles.
[3] Holding times are for "maximum holding time until extraction / maximum extract holding time," respectively.

$CaCO_3$ = Calcium Carbonate, EPA = U.S. Environmental Protection Agency, g = grams, kg = kilograms, L = liter, µg = micrograms, mg = milligrams, mL = milliliters

	Total	**Each Replicate**
Volume Needed	**9.025**	**2.675**

Table 1. Continued. (C) Pesticide and herbicide compounds.

Chlorinated Pesticides [a]	Organo Phosphorous Pesticides [a]	Nitrogen-based Pesticides [a]	Herbicides [a]
2,4'-DDD	Azinphos (Guthion)	Alachlor	2,3,4,5-Tetrachlorophenol
2,4'-DDE	Azinphos Ethyl	Ametryn	2,3,4,6-Tetrachlorophenol
2,4'-DDT	Bolstar (Sulprofos)	Atraton	2,4,5-T
4,4'-DDD	Carbophenothion	Atrazine	2,4,5-TP (Silvex)
4,4'-DDE	Chlorpyriphos	Benefin	2,4,5-Trichlorophenol
4,4'-DDT	Demeton-O	Bromacil	2,4,6-Trichlorophenol
Aldrin	Demeton-S	Butachlor	2,4-D
alpha-BHC	Diazinon	Butylate	2,4-DB
beta-BHC	Dimethoate	Carboxin	3,5-Dichlorobenzoic Acid
Captafol	Disulfoton (Di-Syston)	Chlorothalonil (Daconil)	4-Nitrophenol
Captan	EPN	Chlorpropham	Acifluorfen (Blazer)
cis-Chlordane (alpha)	Ethion	Cyanazine	Bentazon
Cis-nonachlor	Ethoprop	Cycloate	Bromoxynil
delta- BHC	Fenamiphos	Di-allate (Avadex)	Dacthal (DCPA)
Dieldrin	Fenitrothion	Dichlobenil	Dicamba I
Endosulfan I (Alpha-endosulfan)	Fensulfothion	Diphenamid	Dichlorprop
Endosulfan II (Beta-endosulfan)	Fenthion	Diuron	Diclofop-Methyl
Endosulfan sulfate	Fonofos	Eptam	Dinoseb
Endrin	Imidan	Ethalfluralin (Sonalan)	Ioxynil
Endrin Aldehyde	Malathion	Fenarimol	MCPA
Endrin Ketone	Merphos (1 & 2)	Fluridone	MCPP (Mecoprop)
Gamma-BHC (Lindane)	Methyl Chlorpyrifos	Hexazinone	Pentachlorophenol
Heptachlor	Methyl Parathion	Metalaxyl	Picloram
Heptachlor epoxide	Parathion	Metolachlor	Trichlopyr
Hexachlorobenzene	Phorate	Metribuzin	
Kelthane	Ronnel	MGK264	
methoxychlor	Sulfotepp	Molinate	
Mirex		Napropamide	
Oxychlordane		Norflurazon	
Pentachloroanisole		Oxyfluorfen	
trans-Chlordane (gamma)		Pebulate	
Trans-Nonachlor		Pendimethalin	
		Profluralin	
		Prometon (Pramitol 5p)	
		Prometryn	
		Pronamide (Kerb)	
		Propachlor (Ramrod)	
		Propargite	
		Propazine	
		Simazine	
		Tebuthiuron	
		Terbacil	
		Terbutryn (Igran)	
		Treflan (Trifluralin)	
		Triadimefon	
		Triallate	
		Vernolate	

[a] Reporting limits; Note that the method detection limits are about 10 times lower than the reporting limits.

~0.02 - 0.09 ug/L 3 liter sample size	~0.02 - 0.05 ug/L 3 liter sample	0.04-0.2 ug/L 3 liter sample	~0.08 ug/L 3 liter sample

Table 3. Stream gauges, period of record, and status of flow monitoring stations maintained by KPUD and the City of Bremerton within the Project ENVVEST Study area.

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 4. Summary of storm events and parameters sampled by autosampler (ISCO) or discrete grabs (GRAB) at stream and storm water sites sampled in 2002-2003 (**A**) and 2004 (**B**).

Station	Name	Date Sampled	Rainfall (in)	Conven-tionals	Nutrients	Metals	Hg	PCB/PAH/ Phalates
A. STREAM STATIONS (2002-2003)								
CH	CHICO CREEK (Main Stem)	Dec 15, 2002	0.97 *	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 11, 2003	1.31	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 22, 2003	1.69	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 29, 2003	0.28	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 30, 2003	0.42		ISCO	ISCO	ISCO	ISCO
		Feb 16, 2003	0.25	ISCO	ISCO	ISCO		
		Feb 17, 2003	0.58		ISCO	ISCO	ISCO	ISCO
		Mar 12, 2003	3.09	ISCO	ISCO	ISCO	ISCO	ISCO
CT	CHICO CREEK at Taylor Rd	Jan 22, 2003	1.74	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 29, 2003	0.31	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 30, 2003	0.45		ISCO	ISCO		
		Feb 16, 2003	0.24	ISCO	ISCO	ISCO	ISCO	ISCO
		Feb 17, 2003	0.64		ISCO	ISCO	ISCO	
SC	STRAWBERRY CREEK	Dec 15, 2002	0.97 *	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 11, 2003	1.03	ISCO	ISCO	ISCO	ISCO	ISCO
		Mar 8, 2003	0.98		ISCO	ISCO		
		Mar 12, 2003	3.19	ISCO	ISCO	ISCO	ISCO	ISCO
BA	BARKER CREEK	Dec 15, 2002	0.97 *	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 11, 2003	1.19	ISCO	ISCO	ISCO	ISCO	ISCO
		Mar 8, 2003	0.87		ISCO	ISCO		
		Mar 12, 2003	3.10	ISCO	ISCO	ISCO	ISCO	ISCO
CC	CLEAR CREEK (Main)	Dec 15, 2002	0.97 *	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 11, 2003	1.12	ISCO	ISCO	ISCO	ISCO	ISCO
		Mar 8, 2003	1.03		ISCO	ISCO		
		Mar 12, 2003	3.43	ISCO	ISCO	ISCO	ISCO	ISCO
CE	CLEAR CREEK (East)	Dec 15, 2002	0.97 *	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 11, 2003	1.11	ISCO	ISCO	ISCO	ISCO	ISCO
		Mar 8, 2003	1.00		ISCO	ISCO		
		Mar 12, 2003	3.40	ISCO	ISCO	ISCO	ISCO	
CW	CLEAR CREEK (West)	Dec 15, 2002	0.97 *	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 11, 2003	1.10	ISCO	ISCO	ISCO	ISCO	ISCO
		Mar 8, 2003	0.97		ISCO	ISCO		
		Mar 12, 2003	3.30	ISCO	ISCO	ISCO	ISCO	ISCO
AC	ANDERSON CREEK - BREM.	Jan 22, 2003	1.56	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 29, 2003	0.41	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 30, 2003	0.64		ISCO	ISCO	ISCO	ISCO
		Feb 16, 2003	0.93	ISCO	ISCO	ISCO	ISCO	ISCO
GC	GORST CREEK Upper	Jan 22, 2003	1.45	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 29, 2003	0.88	ISCO	ISCO	ISCO	ISCO	ISCO
		Feb 16, 2003	0.89	ISCO	ISCO	ISCO	ISCO	ISCO
BL	BLACKJACK CREEK	Jan 22, 2003	1.37	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 29, 2003	0.97	ISCO	ISCO	ISCO	ISCO	ISCO
		Feb 16, 2003	0.73	ISCO	ISCO	ISCO	ISCO	ISCO
		Mar 8, 2003	0.83	ISCO	ISCO	ISCO	ISCO	ISCO
OC	OLNEY CREEK (KARCHER C	Jan 22, 2003	1.33	ISCO	ISCO	ISCO	ISCO	ISCO
		Jan 29, 2003	0.77	ISCO	ISCO	ISCO	ISCO	ISCO
		Feb 16, 2003	0.58	ISCO	ISCO	ISCO	ISCO	ISCO
		Mar 8, 2003	0.72	ISCO	ISCO	ISCO	ISCO	ISCO

Table 4b. Summary of storm events and parameters sampled by autosampler (ISCO) or discrete grabs (GRAB) at stream and storm water sites sampled in 2002-2003 (**A**) and 2004 (**B**).

Station	Name	Date Sampled	Rainfall (in)	Conven-tionals	Nutrients	Metals	Hg	PCB/PAH/ Phalates
B. STREAM AND STORM WATER STATIONS (2004)								
BI-SBC	SPRINGBROOK CREEK	Apr 19, 2004	0.2	GRAB	GRAB	GRAB	GRAB	GRAB
		May 26, 2004	0.42	GRAB	GRAB	GRAB	GRAB	GRAB
		Oct 18, 2004	0.44	GRAB	GRAB	GRAB	GRAB	GRAB
B-ST28	Callow Ave (SW2)	Apr 19, 2004	0.26 *	ISCO	ISCO	ISCO	ISCO	ISCO
		May 26, 2004	0.39 *	ISCO	ISCO	ISCO	ISCO	ISCO
		Oct 18, 2004	0.53 *	ISCO	ISCO	ISCO	ISCO	ISCO
B-ST12	Trenton Ave (SW 4)	Apr 19, 2004	0.26 *	GRAB	GRAB	GRAB	GRAB	GRAB
		May 26, 2004	0.39 *	ISCO	ISCO	ISCO	ISCO	ISCO
		Oct 18, 2004	0.53 *	ISCO	ISCO	ISCO	ISCO	ISCO
B-ST/CSO16	Pacific Ave (SW3)	Apr 19, 2004	0.26 *	ISCO	ISCO	ISCO	ISCO	ISCO
		May 26, 2004	0.39 *	ISCO	ISCO	ISCO	ISCO	ISCO
		Oct 18, 2004	0.53 *	ISCO	ISCO	ISCO	ISCO	ISCO
B-ST01	Pine Rd (SW1)	Apr 19, 2004	0.26 *	GRAB	GRAB	GRAB	GRAB	GRAB
		May 26, 2004	0.39 *	GRAB	GRAB	GRAB	GRAB	GRAB
		Oct 18, 2004	0.53 *	GRAB	GRAB	GRAB	GRAB	GRAB
PSNS015	Naval Station McDonalds	Apr 19, 2004	0.26	ISCO	ISCO	ISCO	ISCO	ISCO
		May 26, 2004	0.46	ISCO	ISCO	ISCO	ISCO	ISCO
		Oct 18, 2004	0.50	ISCO	ISCO	ISCO	ISCO	ISCO
PSNS124	PSNS CIA Building 438 near D	Apr 19, 2004	0.24	GRAB	GRAB	GRAB	GRAB	GRAB
		May 26, 2004	0.46	GRAB	GRAB	GRAB	GRAB	GRAB
		Oct 18, 2004	0.53 *	GRAB	GRAB	GRAB	GRAB	GRAB
PSNS126	PSNS Downstream of CSO 16	Apr 19, 2004	0.21	ISCO	ISCO	ISCO	ISCO	ISCO
		May 26, 2004	0.38	ISCO	ISCO	ISCO	ISCO	ISCO
		Oct 18, 2004	0.46	ISCO	ISCO	ISCO	ISCO	ISCO
LMK122	Navy City	Apr 19, 2004	0.31	ISCO	ISCO	ISCO	ISCO	ISCO
		May 26, 2004	0.36	ISCO	ISCO	ISCO	ISCO	ISCO
		Oct 18, 2004	0.66	ISCO	ISCO	ISCO	ISCO	ISCO
SW6	Silverdale Mall LMK001+2	Apr 19, 2004	0.25	ISCO	ISCO	ISCO	ISCO	ISCO
		May 26, 2004	0.27	ISCO	ISCO	ISCO	ISCO	ISCO
		Oct 18, 2004	0.65	ISCO	ISCO	ISCO	ISCO	ISCO
LMK038	Manchester	Apr 19, 2004	0.15	ISCO	ISCO	ISCO	ISCO	ISCO
		May 26, 2004	0.37	ISCO	ISCO	ISCO	ISCO	ISCO
		Oct 18, 2004	0.29	ISCO	ISCO	ISCO	ISCO	ISCO
LMK136	Annapolis Creek	Apr 19, 2004	0.26 *	GRAB	GRAB	GRAB	GRAB	GRAB
		May 26, 2004	0.39 *	GRAB	GRAB	GRAB	GRAB	GRAB
		Oct 18, 2004	0.50	GRAB	GRAB	GRAB	GRAB	GRAB
PO-POBLVD	Port Orchard Blvd	Apr 19, 2004	0.26 *					
		May 26, 2004	0.39 *	ISCO	ISCO	ISCO	ISCO	ISCO
		Oct 18, 2004	0.46	ISCO	ISCO	ISCO	ISCO	ISCO

* Average rainfall recorded from all rain gauges for storm event.

Table 5. Summary of station locations, types of samples, and sampling events planned for 2005.

			EVENTS					
code	location		GORST		SINCLAIR		DYES	
		type	ISCO	GRAB	ISCO	GRAB	ISCO	GRAB
A. Stream Sites (With Flow Monitoring)								
BI-SBC	SPRINGBROOK CREEK	ISCO					1	
BA	BARKER CREEK	ISCO					1	
CC	CLEAR CREEK (Main)	ISCO					1	
SC	STRAWBERRY CREEK	ISCO					1	
CH	CHICO CREEK (Main Stem)	ISCO					1	
LMK136	ANNAPOLIS CREEK	ISCO	1					
BL	BLACKJACK CREEK	ISCO			1			
OC	OLNEY CREEK (KARCHER CREEK)	ISCO			1			
GC	GORST CREEK Upper	ISCO	1					
GC-SAN	GORST CREEK at San Christophersc	ISCO	1					
AC	ANDERSON CREEK - BREM.	ISCO	1					
B. Stormwater Sites (With Flow Monitoring In-Place)								
B-ST28	Callow Ave (SW2)	ISCO			1			
B-ST12	Trenton Ave (SW 4)	ISCO					1	
B-ST/CSO16	Pacific Ave (SW3)	ISCO			1			
B-ST01	Pine Rd (SW1)	GRAB						3
PSNS015	Naval Station McDonalds	ISCO			1			
PSNS124	PSNS CIA Building 438 near DD2	ISCO			1			
PSNS126	PSNS Downstream of CSO 16 (460)	ISCO			1			
LMK122	Navy City	ISCO	1					
SW6	Silverdale Mall LMK001+2	ISCO					1	
LMK038	Manchester	ISCO	1					
PO-POBLVD	Port Orchard Blvd	ISCO	1					
C. WWTP Sites								
B-WWTP	Bremerton Waste Water Treatment Pl	GRAB		3		3		
B-ETF	Bremerton Eastside Treatment Facility	GRAB*						
KAR-WWTP	Karcher Creek Waste Water Treatmer	GRAB				3		
FW-WWTP	Fort Ward Waste Water Treatment Pla	GRAB						3
D. GORST RESTORATION Sites (Metals Only)								
AC-LOW	Lower Anderson Creek	GRAB		3				
GC-LOW	Lower Gorst Creek at Mouth	GRAB		3		3		
WADOT-01A	Before Viking Fence from drain	GRAB		3		3		
WADOT-01B	Before Viking Fence from roadside dit	GRAB		3		3		
WADOT-02	Past Elanden Gardens from drain	GRAB		3		3		
WADOT-03	In front of Gorst Subaru from drain	GRAB		3				
		Samples per eve	3	21	5	12	2	6
	Total Events	Replicate Events	2	2	3	3	2	2
		Total Samples	6	42	15	36	4	12
		ISCO Composites	6		15		4	
		SW GRABS						6
		WWTP COMPOSITE GRABS		6		18		6
		GORST METALs GRAB		30		36		0

*Sampled if facility is online during storm event

Table 5 Cont. Summary of station locations, types of samples, and sampling events planned for 2005.

code	location	type		EVENTS GORST ISCO	GORST GRAB	SINCLAIR ISCO	SINCLAIR GRAB	DYES ISCO	DYES GRAB
		type		ISCO	GRAB	ISCO	GRAB	ISCO	GRAB
E. SINCLAIR MARINE SAMPLING									
PSNS CIA	P1, P2, P3, P4, P5	GRAB					5		
SINCLAIR	M3, M3.2, M4, M4.1, SN01	GRAB					5		
Port Orchard	SN13, BJ-EST, SN12	GRAB					3		
PW Narrows & Dyes	DY01 (Incoming, Outgoing), M6	GRAB					3		
PLUME	Optional Samples taken during survey	GRAB					6		
Nutrients & Hg	M3, M4, P3	GRAB					3		
	MetalsSamples per event						25		
	Nutrient and Hg samples per Event						6		
			Events				6		
	Total Metals Samples						150		
	Total Nutrient and Hg						18		
F. MODEL BOUNDARY									
Surface	M1, M2, M5, M7, M8, M9, M10, M11.1, M11						9		
Deep	M1, M2, M4, M9, M10, M11						6		
G. PESTICIDES/HERBICIDES									
Streams/Major SW	BI-SBC BA CC SC CH BL OC GC-SAN AC LMK136 PO-POBLVD B-ST12 B-ST01 LMK038 SW6 PSNS015			5		4		8	1
	Events			1		1		1	1
				5		4		8	1
	Verification (replicate samples)		2						
H. SAMPLE SUMMARY BY LAB									
	BMSL								
	FY04 Extra Samples	7							
	TEC ISCO Samples	25							
	TEC SW GRABS	6							
	WWTP COMPs	10							
	GORST METALs	66							
	SINCLAIR MARINE	150							
	SINCLAIR MARINE Nutrients and Hg	18							
	MODEL Boundary	15							
	MEL								
	PESTICIDE FRACTION	20							
	HERBICIDE FRACTION	20							

Jurisdiction

	City of Bainbridge Island
	City of Bremerton
	City of Port Orchard
	Kitsap County
	U.S. Navy
	Washington Dept. of Transportation

Table 6. The land use and land cover characteristics of the stream and storm water drainage areas to be sampled in 2005. Delineation from May et al. (2004).

			Watershed Land Use and Land Cover													
Stream Sites (With Flow)		HSPF#	**Basin Area (acres)**	**Average Annual Flow (cfs)***	**% Mixed Forest**	**% Deciduous Forest**	**% Coniferous Forest**	**% Shrub**	**% Natural Vegetation**	**% Grass or Turf**	**% Rural (LD Residential)**	**% Suburban (MD Residential)**	**% Urban (HD Residential)**	**% Commercial/ Industrial**	**%TIA**	**% Forest**
CH	CHICO CREEK (Main Ste	91	10033.1	1,071,917	6.3%	22.1%	40.6%	1.6%	70.6%	10.7%	2.3%	6.9%	2.7%	1.8%	8.0%	69.0%
BL	BLACKJACK CREEK	200	6902.7	517,750	1.5%	15.7%	36.2%	0.9%	54.3%	11.6%	15.3%	6.1%	5.7%	4.9%	13.1%	53.4%
GC-1	GORST CREEK Lower	55	6142.3	558,698	4.3%	22.4%	48.0%	1.1%	75.8%	9.8%	2.6%	3.3%	3.3%	3.9%	8.3%	74.7%
CC	CLEAR CREEK (Main)	127	5004.3	296,913	0.9%	14.3%	32.1%	0.9%	48.1%	5.0%	1.6%	10.5%	14.6%	19.4%	26.0%	47.2%
GC-UPPER	GORST CREEK Upper	51+49	3196.9	346,638	2.7%	16.9%	56.1%	1.0%	76.7%	13.1%	1.2%	2.1%	2.3%	3.2%	6.8%	75.7%
BA	BARKER CREEK	58	2597.8	217,067	1.2%	20.1%	17.8%	0.5%	39.6%	7.3%	15.0%	8.0%	13.0%	15.7%	23.9%	39.1%
SC	STRAWBERRY CREEK	94	1914.2	107,343	0.8%	14.4%	30.7%	0.5%	46.4%	3.7%	3.2%	22.0%	11.8%	12.7%	24.1%	46.0%
BI-SBC	SPRINGBROOK CREEK	198	1539.6	82,636	25.0%	19.1%	33.8%	3.7%	81.6%	0.2%	13.7%	0.0%	0.0%	2.6%	5.5%	77.9%
AC	ANDERSON CREEK - BR	56	1265.9	123,076	4.3%	29.3%	43.0%	1.9%	78.4%	9.3%	2.8%	6.9%	1.9%	0.5%	6.6%	76.5%
OC	OLNEY CREEK (KARCHE	63	1245.4	145,446	0.3%	11.6%	16.5%	0.0%	28.5%	1.2%	0.4%	9.2%	36.8%	23.6%	39.5%	28.5%
LMK136	ANNAPOLIS	187	401.6	38,437	1.1%	16.4%	3.5%	0.6%	21.5%	1.3%	0.0%	19.1%	16.7%	41.3%	43.4%	21.0%
Storm Water Sites (With Flow)																
B-ST01	Pine Rd (SW1)	7	863.8	102,264	5.9%	7.7%	9.2%	0.5%	23.3%	1.2%	4.9%	6.8%	31.4%	32.2%	41.9%	30.6%
B-ST28	Callow Ave (SW2)	158	454.6	59,093	0.0%	0.0%	3.5%	0.0%	3.5%	0.0%	0.0%	5.7%	47.0%	43.7%	56.3%	3.5%
LMK122	Navy City	184	346.3	38,437	0.5%	31.7%	7.1%	0.5%	49.8%	16.6%	0.0%	4.4%	4.8%	22.7%	21.8%	70.9%
SW6	Silverdale Mall LMK001+2	138	283.6	31,119	0.0%	2.0%	1.0%	0.0%	3.3%	3.0%	0.0%	5.0%	9.0%	78.0%	59.0%	5.0%
B-ST12	Trenton Ave (SW 4)	16	156.3	19,456	0.0%	10.4%	0.1%	0.0%	10.5%	4.8%	0.1%	5.4%	44.4%	34.7%	49.7%	20.9%
B-ST/CSO16	Pacific Ave (SW3)	164	140.1	16,187	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	23.8%	76.2%	62.6%	0.0%
LMK038	Manchester	181	131.7	2,900	2.9%	14.9%	15.5%	3.4%	36.7%	1.5%	55.7%	0.3%	0.3%	5.4%	13.2%	48.1%
PSNS015	Naval Station McDonalds	167	103.4	13,884	0.0%	0.0%	1.1%	1.1%	2.2%	0.0%	0.0%	6.7%	19.4%	71.8%	59.7%	1.1%
PO-POBLVD	Port Orchard Blvd	183	87.0	27,470	0.0%	8.4%	0.0%	1.0%	9.5%	0.0%	0.0%	21.2%	44.5%	24.3%	48.0%	16.9%
PSNS126	PSNS Bldg 460	177	17.8	2,235	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	81.3%	52.8%	0.0%
PSNS124	PSNS CIA Building 438	176	9.3	2,018	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	65.0%	0.0%

*Modeled Average Annual Flow WY2001-WY2003

Table 6. The land use

Stream Sites (With Flow)		Stream Characteristics						50 m Ripaian Buffer										
		Road Length (km)	Road Density (km/ km^2)	Stream Length (km)	Drain-age Density (km /km^2)	Stream-Road Intersections	Stream-Cros-sings/ Stream-Length (#/km)	% Urban (HD Resi-dential)	% Commercial/ Indus-trial	% Subur-ban	% Rural (LD Resi-dential)	% Agri-cultural	%Devel-oped	%TIA	% Decidu-ous Forest	% Conifer-ous Forest	% Mixed Forest	% Forest
CH	CHICO CREEK (Main Ste	218.0	5.4	92.3	2.3	34	0.4	2.0%	0.8%	5.4%	0.9%	8.4%	17.5%	6.1%	34.8%	32.2%	4.9%	71.9%
BL	BLACKJACK CREEK	334.8	12.0	51.8	1.9	26	0.5	1.0%	1.9%	2.4%	10.0%	17.4%	32.7%	7.1%	25.0%	33.3%	1.4%	59.6%
GC-1	GORST CREEK Lower	216.7	8.7	56.3	2.3	29	0.5	2.1%	2.7%	1.5%	0.4%	6.4%	13.1%	5.9%	39.5%	37.6%	5.7%	82.8%
CC	CLEAR CREEK (Main)	333.8	16.5	27.3	1.3	33	1.2	10.1%	8.5%	8.3%	3.0%	7.4%	37.2%	16.5%	32.4%	25.7%	2.5%	60.6%
GC-UPPER	GORST CREEK Upper	51.3	4.0	25.3	2.0	11	0.4	0.0%	0.0%	0.0%	0.0%	5.4%	5.4%	2.8%	53.6%	19.9%	13.3%	86.7%
BA	BARKER CREEK	234.7	22.3	27.9	2.7	25	0.9	6.2%	8.3%	7.0%	9.0%	8.8%	39.3%	14.7%	33.4%	18.8%	1.5%	53.7%
SC	STRAWBERRY CREEK	132.6	17.1	11.5	1.5	14	1.2	9.3%	11.0%	20.4%	0.6%	6.6%	47.9%	21.3%	31.1%	19.2%	1.2%	51.5%
BI-SBC	SPRINGBROOK CREEK	58.3	9.4	14.7	2.4	5	0.3	0.0%	0.0%	15.0%	10.0%	0.0%	25.0%	7.0%	40.0%	20.0%	15.0%	75.0%
AC	ANDERSON CREEK - BF	40.9	8.0	11.1	2.2	5	0.5	2.3%	0.7%	5.8%	0.5%	3.9%	13.2%	5.7%	26.2%	56.8%	2.9%	85.9%
OC	OLNEY CREEK (KARCH	140.9	28.0	8.8	1.7	9	1.0	5.5%	1.3%	7.0%	0.0%	0.0%	13.8%	9.0%	74.2%	9.2%	0.2%	83.6%
LMK136	ANNAPOLIS	38.9	23.9	3.2	2.0	7	2.2	13.9%	19.4%	8.9%	0.0%	3.3%	45.4%	25.3%	47.1%	4.5%	0.0%	51.6%

Storm Water Sites (With Flow)

B-ST01	Pine Rd (SW1)
B-ST28	Callow Ave (SW2)
LMK122	Navy City
SW6	Silverdale Mall LMK001+2
B-ST12	Trenton Ave (SW 4)
B-ST/CSO16	Pacific Ave (SW3)
LMK038	Manchester
PSNS015	Naval Station McDonalds
PO-POBLVD	Port Orchard Blvd
PSNS126	PSNS Bldg 460
PSNS124	PSNS CIA Building 438

*Modeled Average Annual Flow WY2

Table 7.. Monthly flow and average annual flow modeled by HSPF for watersheds to be sampled in 2005.

Modeled Monthly Flow (Sites with Flow Monitoring)

	CH	GC-1	BL	GC-UPPER		CC
	CHICO CREEK (Main	GORST CREEK Lo	BLACKJACK CREE	GORST CREEK Upper		CLEAR CREEK (M
Location	91	55	200	51	49	127
AVERAGE FLOW (cfs)						
2000/10	6.10	9.30	3.20	1.80	4.00	2.10
2000/11	18.40	18.60	13.00	3.60	7.90	7.40
2000/12	39.10	31.60	28.40	6.20	13.40	8.40
2001/01	29.10	20.90	15.80	4.10	8.90	6.90
2001/02	29.10	16.20	14.20	3.20	6.90	6.50
2001/03	19.10	9.30	10.70	1.80	4.00	5.60
2001/04	13.60	8.30	8.60	1.60	3.50	5.00
2001/05	15.70	6.80	6.20	1.30	2.90	3.80
2001/06	6.80	4.40	2.80	0.80	1.90	3.80
2001/07	2.50	2.80	1.90	0.50	1.20	2.70
2001/08	10.00	2.00	2.60	0.30	0.90	3.70
2001/09	4.70	1.30	1.40	0.20	0.60	2.00
2001/10	5.80	0.90	1.70	0.10	0.40	2.50
2001/11	76.80	27.20	35.40	5.00	11.70	19.50
2001/12	149.00	81.30	64.70	15.80	34.60	25.00
2002/01	123.00	69.00	60.20	13.50	29.30	27.90
2002/02	66.90	37.70	36.10	7.40	16.00	14.40
2002/03	56.70	29.20	28.60	5.80	12.40	14.80
2002/04	32.70	13.80	15.00	2.70	5.90	10.00
2002/05	11.10	4.30	5.20	0.80	1.80	6.70
2002/06	6.20	1.30	3.30	0.20	0.60	5.50
2002/07	4.30	1.90	2.30	0.30	0.90	4.40
2002/08	2.00	0.70	1.60	0.10	0.30	3.40
2002/09	1.50	0.10	1.10	0.00	0.10	2.70
2002/10	1.40	0.00	0.80	0.00	0.00	2.20
2002/11	11.30	1.30	2.20	0.20	0.60	3.80
2002/12	54.40	16.50	19.90	3.10	7.10	10.70
2003/01	104.00	55.40	53.30	10.80	23.60	22.80
2003/02	40.90	27.20	18.70	5.40	11.60	8.50
2003/03	92.80	39.80	39.60	7.80	16.90	25.90
2003/04	42.40	25.60	20.00	5.00	10.90	12.10
2003/05	12.80	7.70	5.60	1.50	3.30	7.50
2003/06	5.30	1.60	3.10	0.30	0.70	5.70
2003/07	2.80	0.30	2.10	0.10	0.10	4.50
2003/08	1.80	0.10	1.50	0.00	0.00	3.50
2003/09	1.70	0.00	1.00	0.00	0.00	2.80

TOTAL ANNUAL FLOW (cfs)

WY2001	564,940	383,280	317,050	74,277	163,580	168,830
WY2002	1,563,050	780,538	744,370	151,433	333,082	399,470
WY2003	1,087,760	512,275	491,830	99,405	218,136	322,440

AVERAGE ANNUAL FLOW (cfs) WY2001-WY2003

Annual Flow	**1,071,917**	**558,698**	**517,750**	**108,372**	**238,266**	**296,913**
				346,638		

Table 7.. Monthly flow and average annual flow modeled by HSPF for watersheds to be sampled in 2005.

Modeled M

	BA	OC	AC	SC	B-ST01	BI-SBC
	BARKER CREEK	OLNEY CREEK (K	ANDERSON CREE	STRAWBERRY CR	Pine Rd (SW1)	SPRINGBROOK C
Location	58	63	56	94	7	198
AVERAGE						
2000/10	1.60	2.10	0.80	1.40	1.30	0.50
2000/11	4.90	5.70	3.10	4.60	4.20	2.10
2000/12	7.50	6.70	6.70	4.60	3.60	4.50
2001/01	5.60	4.20	3.80	3.10	2.60	2.50
2001/02	5.10	3.50	3.40	2.60	1.90	2.30
2001/03	4.10	3.20	2.50	2.10	1.60	1.70
2001/04	3.80	2.30	2.10	1.80	1.40	1.40
2001/05	2.70	1.30	1.50	1.10	0.70	1.00
2001/06	2.80	1.00	0.70	1.10	1.20	0.50
2001/07	1.70	0.40	0.40	0.70	0.40	0.30
2001/08	2.90	1.90	0.60	1.00	2.30	0.50
2001/09	1.40	0.30	0.30	0.50	0.30	0.20
2001/10	2.10	1.80	0.40	0.70	1.70	0.30
2001/11	14.80	13.60	8.50	7.10	11.80	5.70
2001/12	18.60	16.20	15.30	9.70	8.90	10.30
2002/01	19.80	15.80	14.30	10.40	9.90	9.60
2002/02	10.80	8.90	8.60	5.50	4.40	5.80
2002/03	10.80	6.30	6.80	5.30	4.10	4.50
2002/04	7.20	3.70	3.60	3.40	2.30	2.40
2002/05	4.60	0.80	1.20	2.00	0.90	0.80
2002/06	3.60	0.80	0.80	1.50	0.90	0.50
2002/07	2.70	0.40	0.60	1.00	0.50	0.40
2002/08	2.00	0.20	0.40	0.60	0.40	0.20
2002/09	1.60	0.10	0.30	0.40	0.30	0.20
2002/10	1.30	0.10	0.20	0.30	0.20	0.10
2002/11	3.50	2.90	0.60	1.10	2.90	0.40
2002/12	9.00	8.90	4.80	4.10	7.00	3.20
2003/01	17.00	15.80	12.70	8.60	9.90	8.50
2003/02	7.30	3.20	4.40	3.70	1.60	2.90
2003/03	17.70	11.10	9.40	9.10	9.60	6.30
2003/04	9.50	4.60	4.70	4.60	3.10	3.20
2003/05	5.30	0.80	1.30	2.60	1.20	0.90
2003/06	3.60	0.30	0.70	1.70	0.70	0.50
2003/07	2.60	0.20	0.50	1.10	0.50	0.30
2003/08	2.00	0.10	0.30	0.70	0.40	0.20
2003/09	1.60	0.10	0.20	0.50	0.30	0.20
TOTAL AN						
WY2001	128,600	94,971	75,603	72,370	62,761	50,887
WY2002	287,500	199,429	176,775	138,500	133,901	118,700
WY2003	235,100	141,938	116,851	111,158	110,131	78,321
AVERAGE						
Annual Flow	**217,067**	**145,446**	**123,076**	**107,343**	**102,264**	**82,636**

Table 7.. Monthly flow and average annual flow modeled by HSPF for watersheds to be sampled in 2005.

Modeled M

	B-ST28	**LMK122**	**LMK136**	**SW6**	**PO-POBLVD**	**B-ST12**
	Callow Ave (SW2)	Navy City	ANNAPOLIS	Silverdale Mall LMK	Port Orchard Blvd	Trenton Ave (SW 4
Location	158	184	187	138	183	16
AVERAGE						
2000/10	0.87	0.66	0.49	0.47	0.26	0.27
2000/11	2.56	1.28	1.35	1.37	0.95	0.82
2000/12	2.12	2.15	1.62	1.13	0.92	0.69
2001/01	1.50	1.40	1.00	0.80	0.67	0.49
2001/02	1.05	1.08	0.84	0.55	0.57	0.36
2001/03	0.90	0.63	0.77	0.47	0.47	0.30
2001/04	0.81	0.57	0.55	0.42	0.41	0.27
2001/05	0.37	0.49	0.31	0.19	0.27	0.13
2001/06	0.70	0.34	0.24	0.37	0.29	0.23
2001/07	0.15	0.22	0.10	0.07	0.17	0.06
2001/08	1.50	0.17	0.46	0.79	0.41	0.46
2001/09	0.16	0.11	0.08	0.07	0.13	0.06
2001/10	1.13	0.09	0.43	0.61	0.26	0.35
2001/11	7.36	2.04	3.17	3.93	2.54	2.34
2001/12	5.02	5.58	3.86	2.62	2.55	1.67
2002/01	5.57	4.64	3.76	2.93	2.80	1.85
2002/02	2.44	2.51	2.13	1.28	1.26	0.82
2002/03	2.21	1.95	1.52	1.15	1.28	0.75
2002/04	1.24	0.93	0.89	0.64	0.75	0.42
2002/05	0.37	0.30	0.19	0.18	0.39	0.14
2002/06	0.45	0.10	0.20	0.23	0.33	0.16
2002/07	0.20	0.17	0.09	0.09	0.23	0.08
2002/08	0.14	0.06	0.04	0.07	0.17	0.06
2002/09	0.12	0.01	0.04	0.06	0.13	0.05
2002/10	0.09	0.00	0.02	0.04	0.09	0.03
2002/11	1.97	0.12	0.68	1.06	0.42	0.60
2002/12	4.55	1.22	2.08	2.43	1.37	1.42
2003/01	5.88	3.81	3.75	3.12	2.51	1.91
2003/02	0.75	1.81	0.79	0.38	0.62	0.27
2003/03	5.48	2.70	2.64	2.89	2.66	1.82
2003/04	1.69	1.72	1.10	0.89	0.97	0.58
2003/05	0.53	0.53	0.20	0.26	0.48	0.20
2003/06	0.26	0.11	0.08	0.12	0.32	0.10
2003/07	0.19	0.02	0.06	0.09	0.24	0.08
2003/08	0.14	0.00	0.04	0.07	0.17	0.06
2003/09	0.10	0.00	0.03	0.05	0.13	0.04
TOTAL AN						
WY2001	37,051	26,576	22,731	19,603	16,060	12,080
WY2002	76,507	53,682	47,596	40,192	37,014	25,332
WY2003	63,722	35,052	33,752	33,562	29,337	20,957
AVERAGE						
Annual Flow	**59,093**	**38,437**	**34,693**	**31,119**	**27,470**	**19,456**

Table 7.. Monthly flow and average annual flow modeled by HSPF for watersheds to be sampled in 2005.

Modeled M

	B-ST/CSO16	PSNS015	LMK038	PSNS126	PSNS124
	Pacific Ave (SW3)	Naval Station McDo	Manchester	PSNS Bldg 460	PSNS CIA Building
Location	164	167	181	177	176
AVERAGE					
2000/10	0.25	0.21	0.04	0.04	0.03
2000/11	0.73	0.62	0.11	0.10	0.09
2000/12	0.59	0.50	0.13	0.08	0.07
2001/01	0.42	0.36	0.08	0.06	0.05
2001/02	0.28	0.25	0.07	0.04	0.04
2001/03	0.24	0.21	0.06	0.03	0.03
2001/04	0.22	0.19	0.04	0.03	0.03
2001/05	0.09	0.08	0.02	0.01	0.01
2001/06	0.19	0.17	0.02	0.03	0.02
2001/07	0.03	0.03	0.01	0.00	0.00
2001/08	0.43	0.36	0.04	0.06	0.05
2001/09	0.04	0.03	0.01	0.00	0.00
2001/10	0.33	0.28	0.04	0.05	0.04
2001/11	2.09	1.77	0.28	0.29	0.26
2001/12	1.35	1.17	0.32	0.19	0.17
2002/01	1.51	1.30	0.31	0.21	0.19
2002/02	0.66	0.57	0.18	0.09	0.08
2002/03	0.59	0.51	0.12	0.08	0.07
2002/04	0.33	0.28	0.07	0.04	0.04
2002/05	0.08	0.08	0.01	0.01	0.01
2002/06	0.11	0.10	0.01	0.01	0.01
2002/07	0.04	0.04	0.01	0.00	0.00
2002/08	0.03	0.03	0.00	0.00	0.00
2002/09	0.03	0.02	0.00	0.00	0.00
2002/10	0.02	0.02	0.00	0.00	0.00
2002/11	0.58	0.48	0.06	0.08	0.07
2002/12	1.31	1.10	0.20	0.18	0.17
2003/01	1.63	1.39	0.32	0.23	0.21
2003/02	0.18	0.16	0.07	0.02	0.02
2003/03	1.50	1.29	0.22	0.21	0.19
2003/04	0.45	0.39	0.09	0.06	0.06
2003/05	0.13	0.11	0.01	0.02	0.01
2003/06	0.05	0.05	0.01	0.01	0.01
2003/07	0.04	0.04	0.00	0.00	0.00
2003/08	0.03	0.03	0.00	0.00	0.00
2003/09	0.02	0.02	0.00	0.00	0.00
TOTAL AN					
WY2001	10,248	8,754	1,826	1,422	1,284
WY2002	20,836	17,903	3,961	2,867	2,590
WY2003	17,478	14,994	2,914	2,415	2,180
AVERAGE					
Annual Flow	**16,187**	**13,884**	**2,900**	**2,235**	**2,018**

Table 8. . Number of samples and estimated cost for 2005 storm event and ambient marine sampling.

Events	Samples	Comments										
FY04 Extra Samples	7	3 SW and 4 Marine										
TEC ISCO Samples	25	Flow-Weighted composite samples taken by ISCO										
TEC SW GRABS	6	SW grabs (3 grabs composited for ogranics)										
WWTP COMPs	10											
GORST METALs	66											
SINCLAIR MARINE	150											
MODEL Boundary	15											
PESTICIDE FRACTION	20											
HERBICIDE FRACTION	20											
Parameter									**QA/QC**			
	Est $/Sample	**TEC ISCO Samples**	**TEC SW GRABS**	**FY04 Extra Samples**	**WWTP COMPs**	**GORST METALs**	**SINCLAIR MARINE**	**MODEL Boundary**	**Equipment/ Field Blanks**	**Field Dups/MSD**	Total Samples	Cost$
Conventionals/Physicals	Subcontrator											
Alkalinity, Total (as $CaCO_3$)	$ 15.00	25	6	3	10						44	$ 660.00
Hardness (as $CaCO_3$)	$ 15.00	25	6	3	10						44	$ 660.00
Biological Oxygen Demand (BOD) (5 days, 20 °C)	$ 45.00										0	$ -
Chemical Oxygen Demand (COD)	$ 30.00										0	$ -
Total Solids	$ 15.00	25	6	3	10	66	150	15			275	$ 4,125.00
Total Suspended Solids	$ 15.00	25	6	3	10	66	150	15			275	$ 4,125.00
Total Petroleum Hydrocarbon (TPH) - diesel	$ 52.50										0	$ -
Total Petroleum Hydrocarbon (TPH) - oil	$ 52.50										0	$ -
Sechi Disk Depth												$ -
Total Organic Carbon (TOC)	$ 40.00	25	6	7	10	66	150	15			279	$ 11,160.00
Dissolve Organic Carbon (DOC)	$ 50.00	25	6	7	10	66	150				264	$ 13,200.00
Oceanographic Salinity	$ 15.00			4			150				154	$ 2,310.00
Laser Induced Suspended Solids LISST (Grain Size)		25	6	7	10						48	$ -
Nutrients											0	$ -
Ammonia Nitrogen	$ 21.00	25	2		10		4	15			56	$ 1,176.00
(Nitrate + Nitrite) Nitrogen	$ 23.00	25	2		10		4	15			56	$ 1,288.00
Total Nitrogen (TKN)	$ 32.00	25	2		10		4	15			56	$ 1,792.00
Total Phosphorus	$ 24.00	25	2		10		4	15			56	$ 1,344.00
Orthophosphate Phosphorus	$ 18.00										0	$ -
									Subcontract subtotal		$ 41,840.00	
Analytical Subcontract Overhead (15%)												$ 6,276.00
METALS												$ -
Metal Processing	$ 110.00	25	6	7	10	66	150	15		14	293	$ 32,230.00
Total Metal (Seawater) w/o Hg	$ 287.00			4			4	15		2	25	$ 7,175.00
Total Metal (Freshwater) w/o Hg	$ 192.00	25	6	3	10					3	47	$ 9,024.00
ALUMINUM ARSENIC CADMIUM CHROMIUM COPPER LEAD SILVER ZINC												
Total Metal Gorst Subset (FW Al, Cu, Zn, Cd, Pb)	$ 90.00					66				4	70	$ 6,300.00
Total Sinclair Marine Subset (Al, Cu, Cd, Pb, Zn)	$ 120.00						146			8	154	$ 18,480.00
Total MERCURY	$ 100.00	25	2		10		4	15		3	59	$ 5,900.00
Dissolved Metal (0.45 um filter) Seawater	$ 215.00			4			4	15		2	25	$ 5,375.00
Dissolved Metal (0.45 um filter) Freshwater	$ 145.00	25	6	3	10					3	47	$ 6,815.00
CADMIUM COPPER LEAD SILVER ZINC												
Dissolved Gorst Metal Subset (Cu, Zn)	$ 70.00					66				4	70	$ 4,900.00
Dissolved Sinclair Marine Subset (Cu, Pb, Zn	$ 129.00						146			8	154	$ 19,866.00
											0	$ -
Organics											0	$ -
PAHS & PHATHALATES	$ 380.00	25	2							2	29	$ 11,020.00
PCB Congeners	$ 380.00	25	2							2	29	$ 11,020.00
BMSL Project Management and EDD (20%)												$ 37,244.20
BMSL Total Estimated Analytical Cost												$ 223,465.20
Manchester Environmental Laboratory												
PESTICIDES	$ 455.00	20							1	2	23	$ 10,465.00
Chlorinated Pesticides												
Organo Phosphorous Pesticides												
Nitrogen-based pest												
HERBICIDES	$ 185.00	20							1	2	23	$ 4,255.00
Herbicides												
Total MEL												$ 14,720.00

Table 9. Sample Containers, Sample Size, Preservative Requirements, and Holding Time[2] for Analytical Samples.

Parameter	Method	Detection Limit	Sample Preservative	Holding Time [2]x/y
Conventionals (mg/L)				
Alkalinity, Total (as CaCO3)	EPA 310.1	1.00	Cool, 4ºC	14 days
Hardness (as CaCO3)	EPA 130.2	2.00	HNO_3 to pH<2.0	6 months
Total Solids	EPA 160.3	5.00	Cool, 4ºC	7 days
Total Suspended Solids	EPA 160.2	5.00	Cool, 4ºC	7 days
Total Organic Carbon	EPA 41502	0.250	Cool, 4°C, H_2SO_4 to pH <2	28 days
Total Dissolved Carbon	EPA 41502	0.10	Cool, 4°C, H_2SO_4 to pH <2	28 days
Nutrients (mg/L)				
Ammonia Nitrogen	EPA 350.1	0.030	Cool, 4°C, H_2SO_4 to pH <2	28 days
Nitrate + Nitrite	EPA 353.2	0.006	Cool, 4°C, H_2SO_4 to pH <2	28 days
Total Nitrogen (TKN)	EPA 351.4	0.100	Cool, 4°C, H_2SO_4 to pH <2	28 days
Total Phosphorus	EPA 365.3	0.003	Cool, 4°C, H_2SO_4 to pH <2	28 days
Organic Compounds				
Polycyclic aromatic hydrocarbons. Pthalates, PCBs	MSL-O-015 MSL-O-016	Sample Specific	4º±2°C	7 days/40 days
Trace Metals (Units μg/L, MDL will vary for seawater)				
Total Hg	MSL-I-013	0.00012	HNO_3 pH<2.0	90 days
Total Al	MSl-I-022	1.0	HNO_3 pH<2.0	6 months
Total As	MSl-I-022	0.018	HNO_3 pH<2.0	6 months
Total/Dissolved Cd	MSl-I-022	0.0050	HNO_3 pH<2.0	6 months
Total Cr	MSl-I-022	0.020	HNO_3 pH<2.0	6 months
Total//Dissolved Cu	MSl-I-022	0.0050	HNO_3 pH<2.0	6 months
Total/Dissolved Pb	MSl-I-022	0.0052	HNO_3 pH<2.0	6 months
Total/Dissolved Ag	MSl-I-022 and MSL-I-029 (seawater)	0.0028	HNO_3 pH<2.0	6 months
Total/Dissolved Zn	MSl-I-022	0.045	HNO_3 pH<2.0	6 months

[2] "x" days/"y" days refers to the maximum number of days from sampling to extraction/the maximum number of days from extraction to analysis, once samples are identified for analysis.

Table 10. Definitions, Requirements, and Frequency for Typical Quality Control Samples.

QC Sample	Definition	Frequency
	LABORATORY QUALITY CONTROL	
Method or Procedural Blank (MB)	A combination of solvents, surrogates, and all reagents used during sample processing, processed concurrently with the field samples. Monitors purity of reagents and laboratory contamination.	1/sample batch[2] A processing batch MB must be analyzed with each sequence.
Standard Reference Material (SRM)	An external reference sample which contain a certified level of target analytes; serves as a monitor of accuracy. Extracted and analyzed with samples of a like matrix (not available for all analytes)	1/ batch[2]
Matrix Spike (MS)	A field sample spiked with the analytes of interest is processed concurrently with the field samples; monitors effectiveness of method on sample matrix; performed in duplicate.	1/sample batch[2]
Duplicate Sample	Second aliquot of a field sample processed and analyzed to monitor precision; each sample set should contain a duplicate.	1/sample batch[2]
Recovery Internal Standards (RIS)	All field and QC samples are spiked with recovery internal standards just prior to analysis; used to quantify surrogates to monitor extraction efficiency on a per sample basis.	Each sample analyzed for organic compounds
Surrogate Internal Standards (SIS)	All field and QC samples are spiked with a known amount of surrogates just prior to extraction; recoveries are calculated to quantify extraction efficiency.	Each sample analyzed for organic compounds

[1] The field duplicate is a collocated sample defined as a sample collected as near in space and time to the original field sample as the sampling equipment and procedure allows.

[2] A batch is defined as 20 field samples processed simultaneously and sharing the same QC samples.

Table 11. Measurement Quality Criteria.

QC Parameter	Acceptance Criteria	Corrective Action
Accuracy		
Method Blank (MB)	MB<RL If MB>RL; sample values ≤10X MB, then perform corrective action Method criteria for all other parameters	Perform corrective action re-process (extract, digest) sample batch. If batch cannot be re-processed, notify client and flag data.
• *Standard Refernce Material (SRM)*	Metals: ≤20% PD. Determined vs. certified range. Analyte concentration must be 10xMDL to be used for DQO. Method criteria for all other parameters	Review data to assess impact of matrix. Reanalyze sample and/or document corrective action. If other QC data are acceptable then flag associated data if sample is not reanalyzed.
• *Matrix Spike (MS)/MS Duplicate (MSD)*	Organic compounds: 40 - 120% recovery Metals: 70 - 130% recovery Method criteria for all other parameters	Review data to assess impact of matrix. If other QC data are acceptable and no spiking error occurred, then flag associated data. If QC data are not affected by matrix failure or spiking errors occurred, then re-process MS. If not possible, then notify client and flag associated data.
• *Surrogate Spike (SIS)*	Organic compounds: 40 - 120% recovery	Review data. Discuss with Project Manager. Reanalyze, re-extract, and/or document corrective action and deviations.
• *Laboratory Control Sample (LCS)*	Organic compounds: 40 - 120% recovery Metals: 70 - 130% recovery Method criteria for all other parameters	Perform corrective action. Re-analyze and/or re-process sample batch. If batch cannot be re-processed: notify client, flag data, discuss impact in report narrative.
Precision: *Laboratory Duplicates*	Organic compounds (MSD): <30% RPD Metals: <30% RPD Method criteria for all other parameters	Review data to assess impact of matrix. If other QC data are acceptable, then flag associated data. If QC data are not affected by matrix failure, then re-process duplicate. If not possible, then notify client and flag associated data.

Table 12. Calculation of Quality Control Assessment Statistics.

Percent Recovery

The percent recovery is a measurement of accuracy, where one value is compared with a known/certified value. The formula for calculating this value is:

$$Percent\ \ Recovery = \frac{amount\ \ detected}{amount\ \ expected}\ x\ 100$$

Percent Difference

The percent difference (PD) is a measurement of precision as an indication of how a measured value is difference from a "real" value. It is used when one value is known or certified, and the other is measured. The formula for calculating PD is:

$$Percent\ \ Difference = \frac{X_2 - X_1}{X_1}\ x\ 100$$

where: X_1 = known value (*e.g.*, SRM certified value)

X_2 = determined value (*e.g.*, SRM concentration determined by analyst)

Relative Percent Difference

The relative percent difference (RPD) is a measurement of ***precision***; it is a comparison of two similar samples (matrix spike/matrix spike duplicate pair, field sample duplicates). The formula for calculating RPD is:

$$RPD = \left| \frac{2\ x\ (X_1 - X_2)}{(X_1 + X_2)} \right|\ x\ 100$$

where: X_1 is concentration or percent recovery in sample 1

X_2 is concentration or percent recovery in sample 2

Note: Report the absolute value of the result -- the RPD is always positive.

Relative Standard Deviation

The relative standard deviation (RSD) is a measurement of ***precision***; it is a comparison of three or more similar samples (*e.g*., field sample triplicates, initial calibration, MDLs). The formula for calculating RSD is:

$$\%RSD = \frac{\textit{Standard Deviation of All Samples}}{\textit{Average of All Samples}} \times 100$$

Table 13. Maintenance Procedures for General Laboratory Equipment

Equipment	Activity	Frequency
Deionized water system	Replace seals Replace cartridges	As needed for leaks and to maintain resistivity > 18 mOhms
MilliQ deionized water system	Replace seals Replace cartridges	Every 6 months or as needed for leaks and to maintain resistivity > 18 mOhms
Electronic balances	Clean	As needed
Freezers/refrigerators	Clean Defrost	As needed
Ovens	Clean	As needed
Glass thermometers	Store in protective case	Always except when in use
Digital thermometer	Avoid bending thermocouples	Always

Table 14. Maintenance Procedures for Analytical Instruments.

Equipment	Activity	Frequency
GC/MS Maintenance		
Rough pumps Turbomolecular pump Diffusion pumps	Routine service (service contract) Check fluid levels	Six months Weekly
Foreline traps Helium gas traps	Inspect trap pellets for color change Replace adsorbent pellets	Routinely 6-12 months, as needed
Injection port septum	Replace	As needed to maintain EPC pressure
Injection port liners	Replace	Approximately every 30-40 samples
Precolumn	Replace	As needed to improve peak shape, resolution, or sensitivity
Calibration vial (PFTBA)	Refill	4 months or as needed
Back grills of the MS	Vacuum dust	6 months or as needed
Ion source	Clean	As indicated when usage-dependent surface deposits degrade ion source function
GC Maintenance		
Injection port	Replace	Weekly (~50 injections) or as needed
Injection port liner	Replace	Weekly or as needed
Injection port	Clean	Monthly or as needed
Column	Clip	As needed to maintain performance
Precolumn	Replace	As needed when chromatographic degradation is observed
Gas cylinders	Replace	When PSI is < 300
Autosampler rinse vial	Fill	Prior to analysis
Autosampler syringe	Replace/align	As needed
Ferrule	Replace	As needed for leaks
Gas drying/purification traps	Replace	Annually or as needed
Column, detector	Bakeout	As needed
ICP-MS Maintenance		
Argon supply	Check and record; replace as needed	Daily
Vacuum	Check and record	Daily
Cooling chiller	Check and record temperature	Daily
Nebulizer flow	Check and adjust	Daily or as needed
Sensitivity and stability	Check and record	Daily
Auto sampler tubing	Change	As needed

Maintenance of Analytical Instruments (continued).

Equipment	Activity	Frequency
Cones	Clean or change	As needed
GFAA Maintenance		
Graphite furnace tube	Check and replace (~500 burns)	Daily and as needed
Contact cylinders	Check and replace as needed (10,000 burns)	Daily and as needed
Windows	Clean	Whenever tubes are changed or as needed
Water recirculator fluid level	Check and refill	Daily
CVAA Maintenance		
Soda lime	Check and change	Checked daily, changed weekly
Reagents ($SnCl$,3% HNO_3, rinse water)	Check and change	Checked daily, changed weekly
Carbon trap	Check and change	Checked daily, changed bimonthly
Filters	Check and change	Checked daily, changed bimonthly
Sample injection syringe	Check and change	Checked weekly, changed as needed
Tubing	Check and change	Checked weekly, changed as needed
Connectors	Check and change	Checked weekly, changed as needed
Lamp	Check and change	Checked weekly, changed as needed
Autosampler arm	Lubricate	Bimonthly

Table 15. Data qualifier codes.

Method Qualifiers	
A	Method qualifier - Flame AA
AV	Method qualifier - Automated cold vapor
C	Method qualifier - Manual spectrophotometric
CV	Method qualifier- Manual cold vapor
F	Method qualifier - Furnace AA
NR	Method qualifier - Analyte was not required
P	Method qualifier - ICP
X	Method qualifier – XRF screening
I	Method qualifier – Immunoassay screening
Data Qualifiers	
B	Analyte found in both sample and associated blank. The "B" will be reported on the result associated with the field samples, not the blank
C	Presence confirmed by GC/MS (Pesticides only)
D	Dilution run. Initial run outside linear range of instrument. Organics only.
E	Estimate, result outside linear range of instrument. GC/MS only
J	Estimated concentration between the MDL and RL
U	The concentration is less than the MDL, or the analyte was not detected
W	Post-digestion spike out of control limits
Quality Control Qualifiers	
M	Duplicate inject precision did not agree, organics only
N	Spiked sample recovery not within control limits
&	Accuracy result not within control limits (outside recovery of SRM)
*	Precision result not within control limits

10. Figures

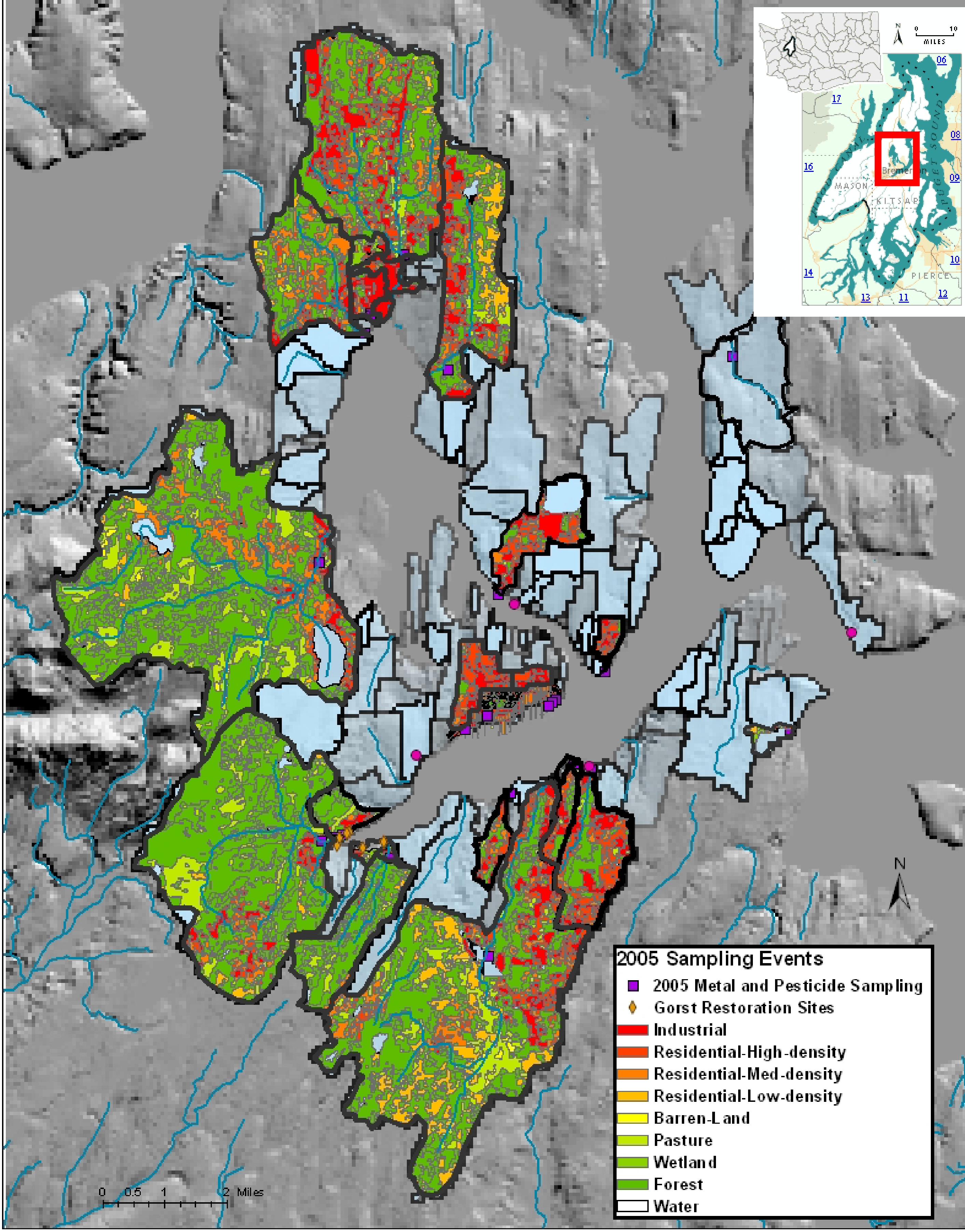

Fig. 1. Watersheds with flow monitoring in place to be sampled in 2005.

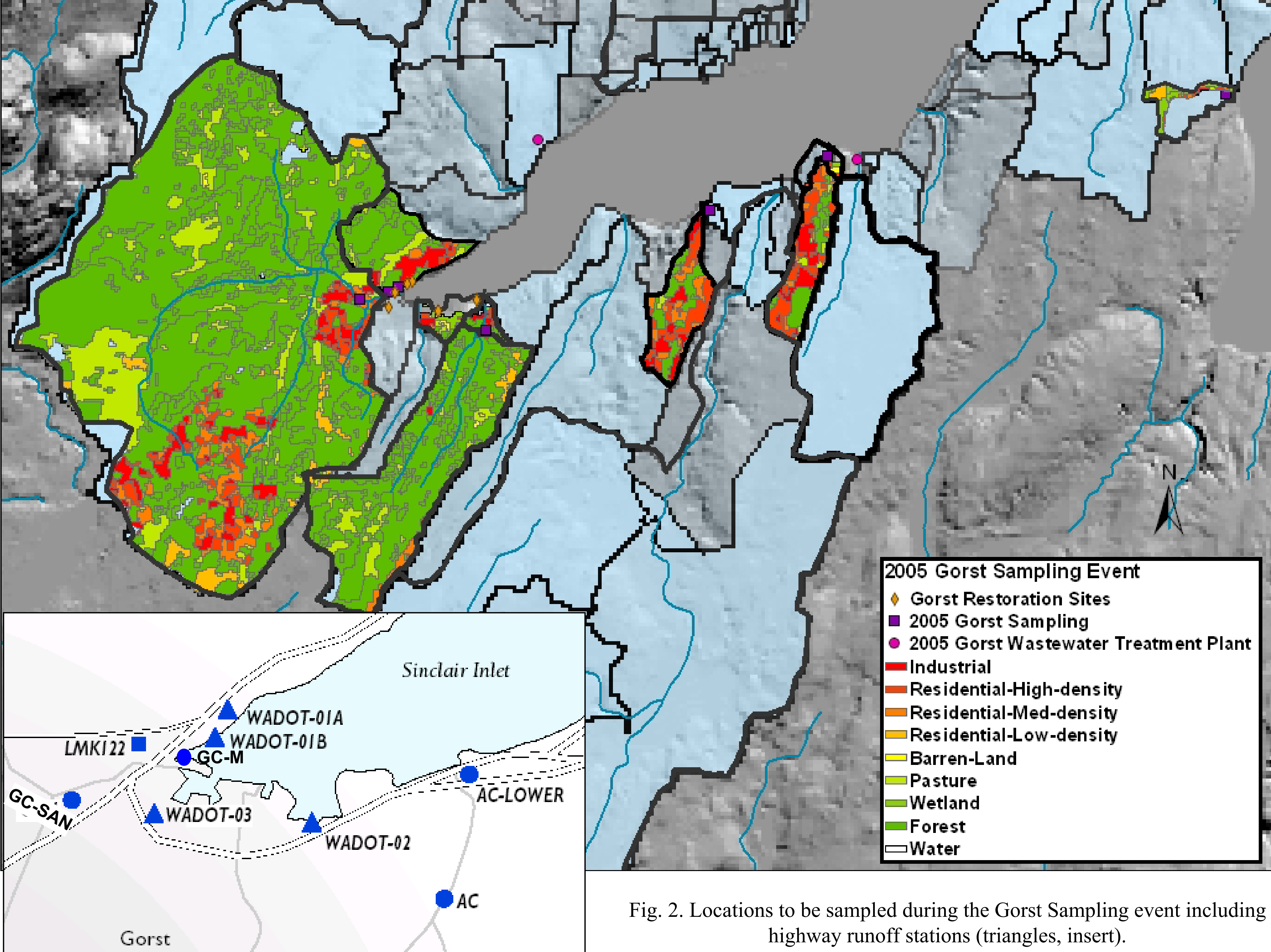

Fig. 2. Locations to be sampled during the Gorst Sampling event including highway runoff stations (triangles, insert).

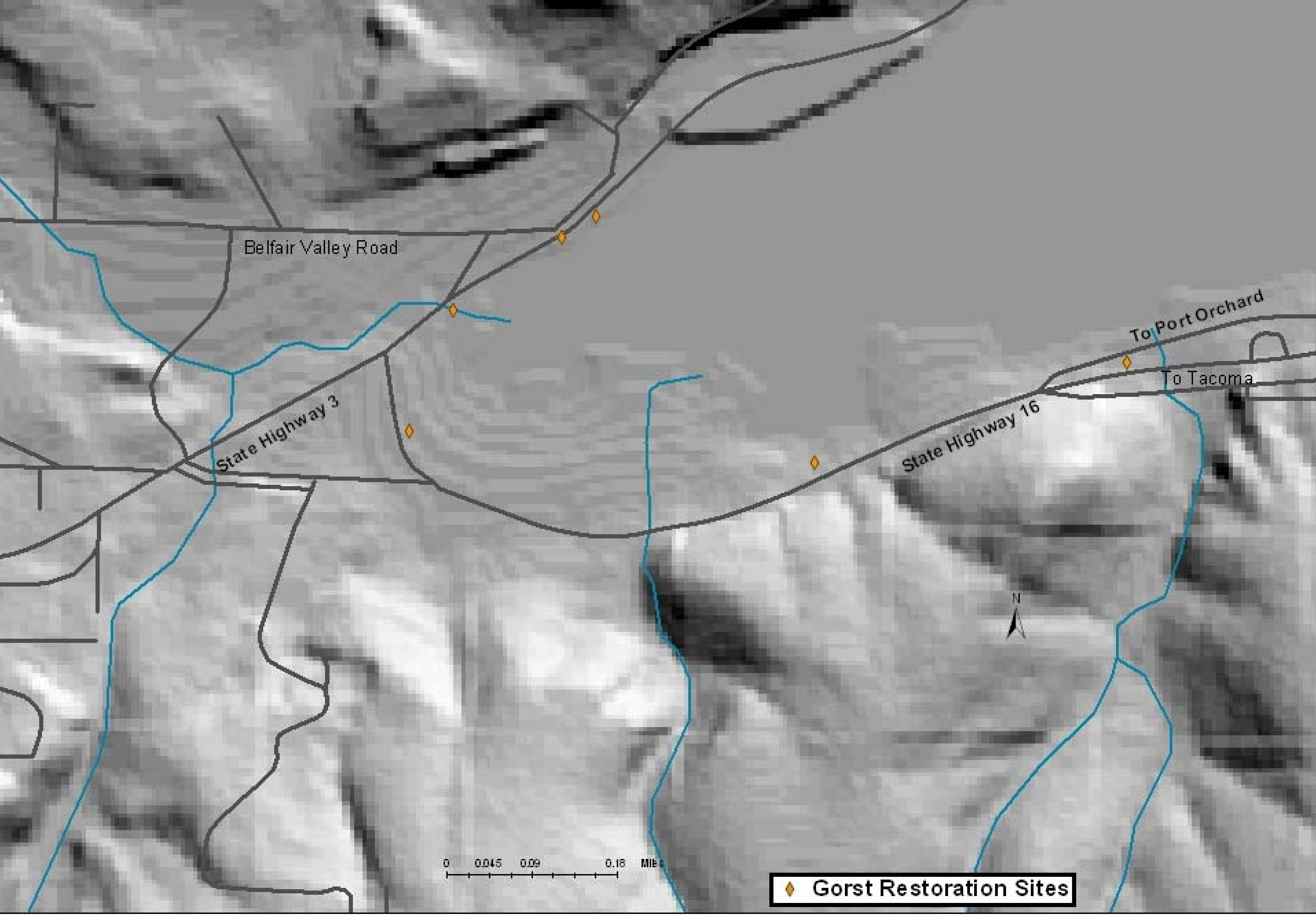

Figure 2b. Close up of Gorst Restoration sampling sites.

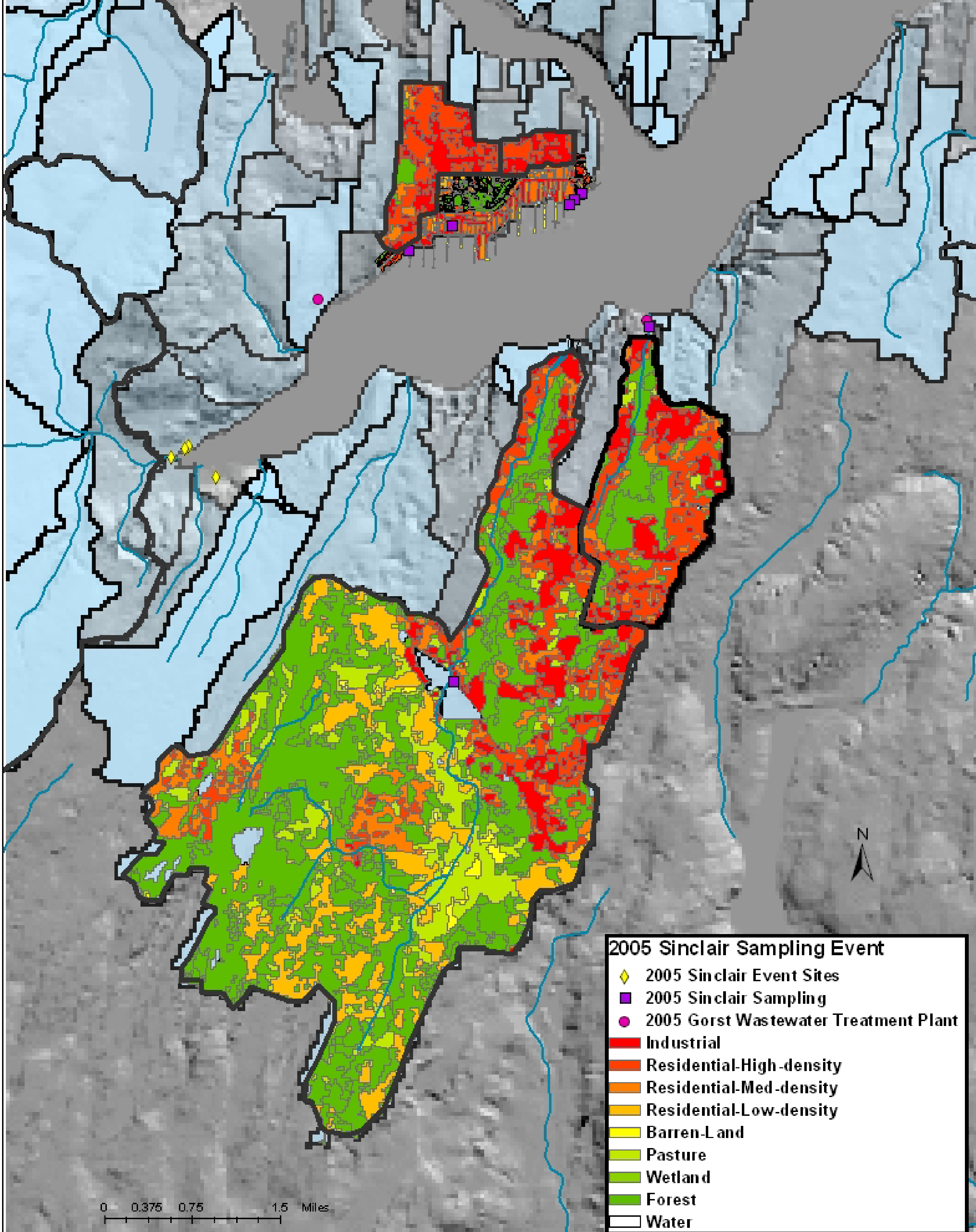

Figure 3. Locations to be sampled during the Sinclair Events.

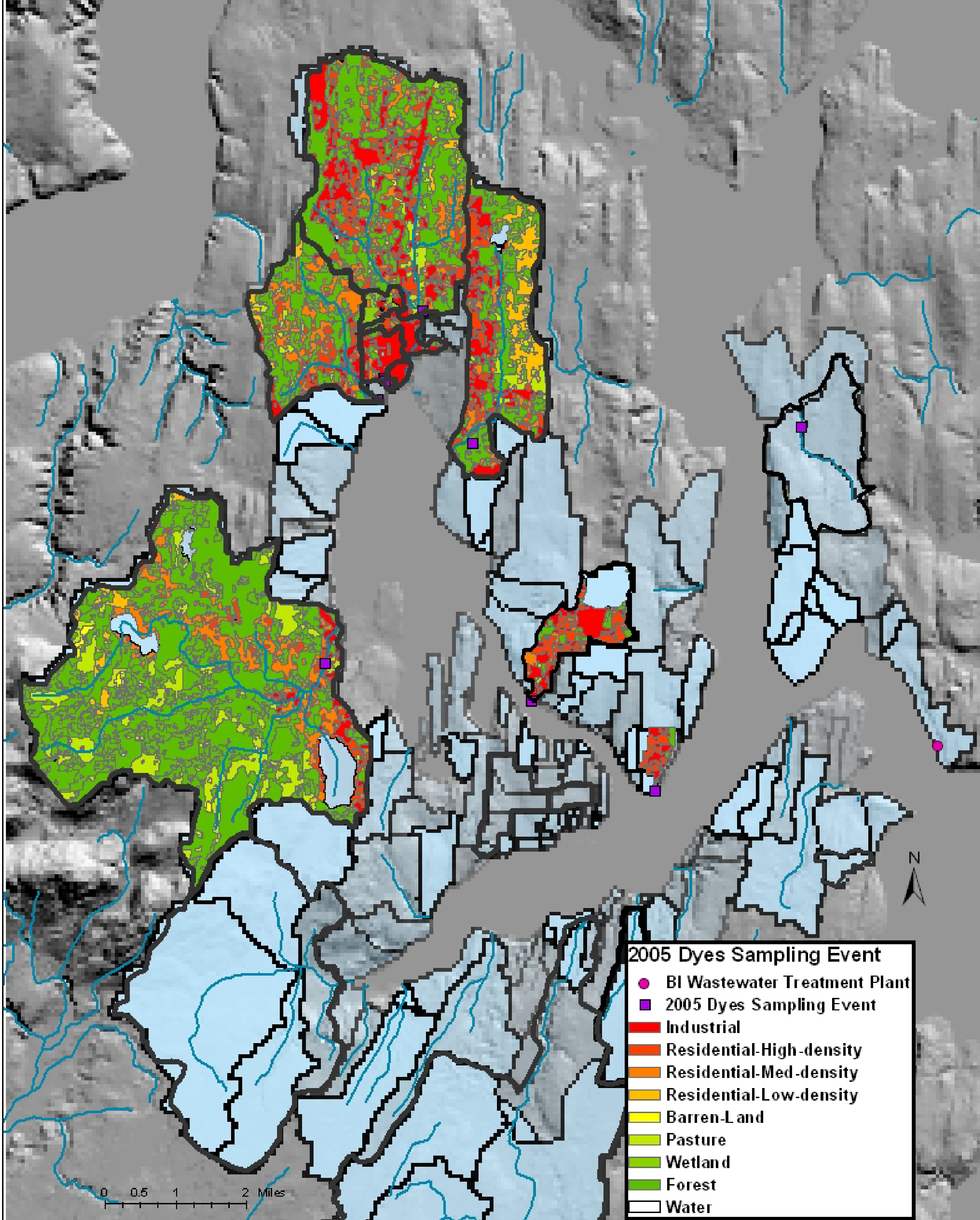

Figure 4. Locations to be sampled during the Dyes sampling Events.

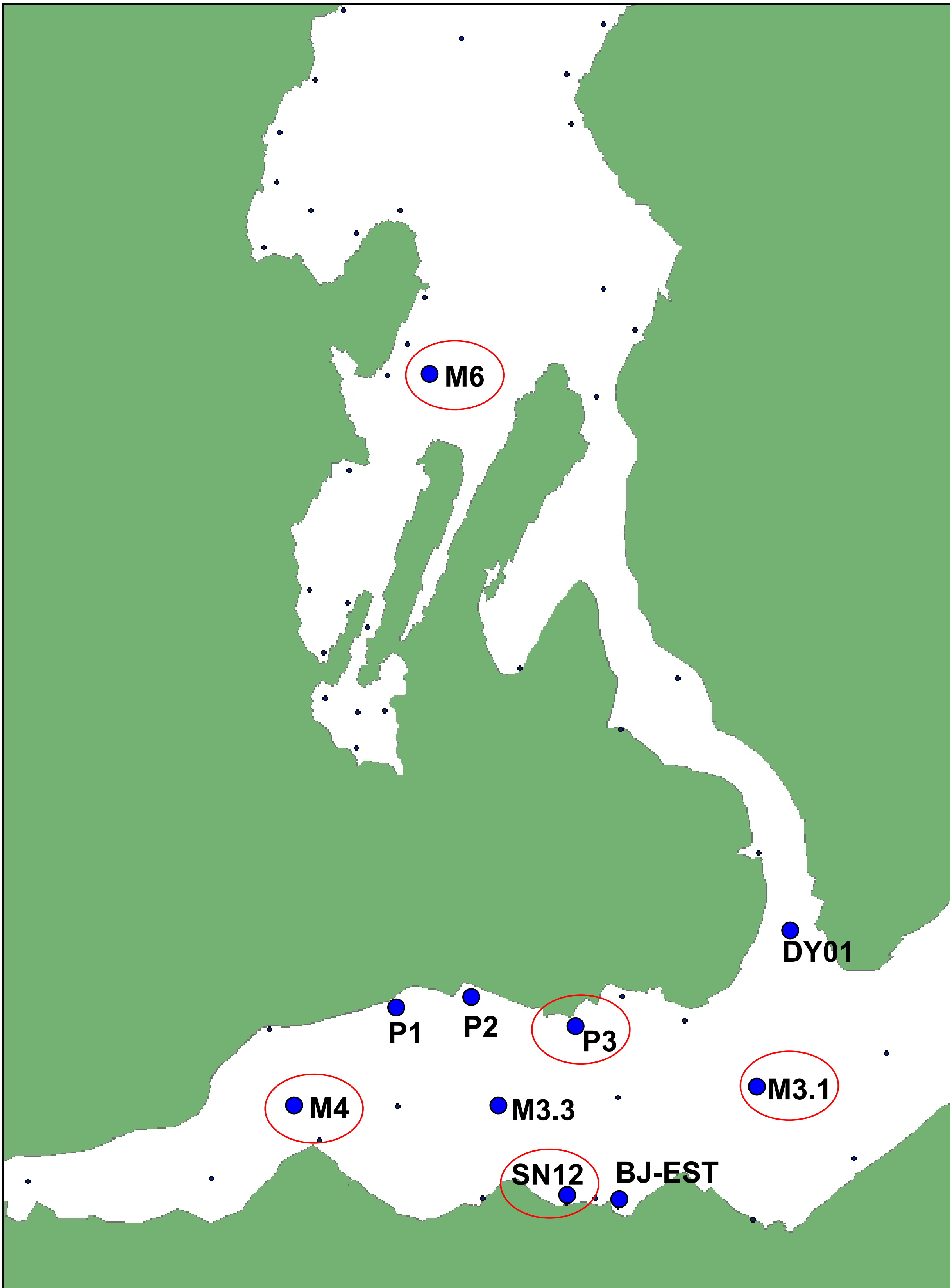

Figure 5. Marine stations in Sinclair and Dyes Inlets. Red circles indicate stations for Cu toxicity testing samples.

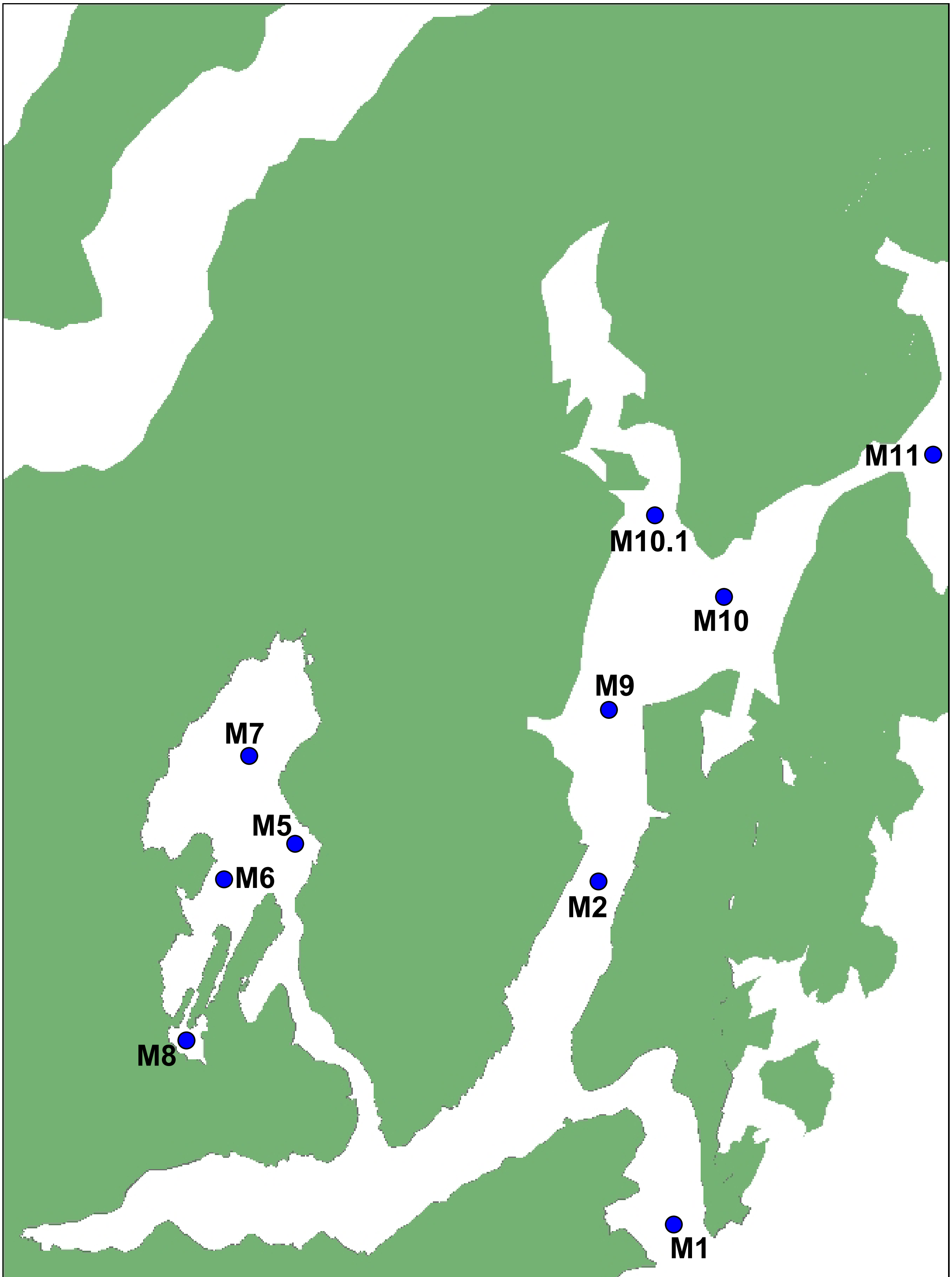

Figure 6. Model boundary stations to be sampled in Dyes Inlet and Port Orchard Passage.

11. Appendices

11.1 Laboratory Specific Standard Operating Procedures

Available upon request

11.2 Field Sampling Procedures

11.3 The Environmental Company

Field Sampling and Analysis Plan (No Equip. Manuals 1.5 mb)

Field Sampling and Analysis Plan (w/ Equip. Manuals 13 mb)

Field Quality Assurance Project Plan

Field Health and Safety Plan

11.4 PSNS & IMF Project ENVVEST Sampling SOPs

Protocol for ENVVEST Sampling Procedures and Checklist

Nearshore/Marine Sampling Procedures and Checklist

11.5 Space and Naval Warfare Systems Center (SSC), San Diego Procedures

11.5.1 Sample Collection and Storage

Site water will be collected from surface waters (depth of approximately 1 m) using clean techniques (US EPA 1995c). Samples will be stored in pre-cleaned 1-L HDPE containers, and shipped on ice overnight to SSC. Upon arrival, samples will be kept at 4 °C, and testing will be initiated within the 48 h period recommended (USEPA 1994a). Additional samples will also be collected for copper analysis (see Copper Measurements below), as well as total suspended solids (TSS) and dissolved organic carbon (DOC).

11.5.2 Toxicity Assessment Procedures

11.5.2.1 Site Water Preparation

If predators are suspected, passing the sample through a 50 µm mesh screen will be considered. Because site water salinities are expected to be within the range of that tolerated by the test species (26-34 ppt), samples should not require any salinity adjustment. If it is required, however, hypersaline brine will be used to raise the salinity, and appropriate controls added to the test design. No other manipulation of site water samples is expected to be required.

11.5.2.2 Test Species

Toxicity testing will be conducted with embryos of the Mediterranean mussel, *Mytilus galloprovincialis*. This species is relevant because it is sensitive to copper at very low concentrations (e.g. < 10 ppb)(USEPA 1995b), and is present as a commercially important species in the Puget Sound area (Taylor Shellfish Farms 2004). *Mytilus galloprovincialis* has also been used as a test species for caged mussel deployments in Sinclair Inlet during the installation restoration investigations conducted for the Shipyard (URS 2001).

11.5.2.3 Toxicity Tests

Toxicity tests will be conducted following EPA guidance for whole effluent toxicity (US EPA 1995a) and for determining WERs (USEPA 1994a). Site and laboratory water samples will be spiked with a series of copper concentrations (approximately eight), ranging from 0 to 50 ∝g/L. In this case, laboratory water will be filtered (0.45 µm), open coastal seawater from the research pier at Scripps Institute of Oceanography (SIO). Copper stock solutions will be made from copper sulfate and confirmed by stabilized temperature graphite furnace atomic absorption (STGFAA) spectroscopy prior to use. The same stock solution will be used for both laboratory and site waters. Test concentrations will be prepared separately in 125 mL Erlenmeyer flasks. From each flask, 10 mL will be distributed to each of five replicate pre-conditioned glass 20 mL scintillation vials for the bioassay. A sixth replicate from each concentration will be used for water quality measurements during the tests, while a seventh replicate will be will be saved for later quantification of total recoverable and dissolved copper by STGFAA. An equilibration period of approximately 1 to 3 h will be allowed following copper additions before addition of embryos.

M. galloprovincialis will be obtained from Carlsbad Aquafarm, Carlsbad, CA on the same day tests are to be initiated. Mussels will be induced to spawn by thermal shock. Approximately 200 embryos at or beyond the 2-cell stage (within four hours of fertilization) will be added to each test vial. Vials will then be incubated at 15 ± 1 °C for 48 h under a 16 h light: 8 h dark photoperiod. Water quality (pH, temperature, dissolved oxygen, salinity) will be recorded at test initiation and test end. The proportion of normal D-shaped, straight-hinged larvae relative to the number of normal embryos in a set of initial density vials will be determined. Larvae will be evaluated with the aid of an inverted compound microscope.

11.5.2.4 Data Analysis

The proportion of normal larvae from each test concentration will be used to generate EC50 values for each water sample. EC50s will be calculated with ToxCalc™ version 5.0, using the appropriate point estimate technique for the resulting dataset as recommended by the EPA. EC50 values will be calculated based on nominal, total recoverable, and dissolved copper concentration. Potential ambient toxicity will be assessed by comparison of development success in the controls for each test (site water with no added copper) with test acceptability criteria. Control development in the site waters will also be compared with that in the lab water using one-way ANOVA and multiple comparison techniques.

11.5.3 Copper Measurements

Concurrent with the toxicity samples, additional water samples will be collected for measurement of total recoverable, dissolved, and free copper ion concentrations, as well as copper complexation capacity. Total and dissolved copper concentrations will be used to support the toxicity assessment by allowing precise EC50 determination for each form. Free copper ion concentrations will be used for copper complexation capacity determinations, which are expected to complement the toxicity assessment, demonstrating the method's usefulness as an alternative to biological testing.

11.5.3.1 Total recoverable and dissolved copper

Sampling protocols for the ambient waters will be those of EPA Method 1669, EPA's Trace Metals Sampling Technique (US EPA, 1995c). These include the use of acid-cleaned apparatus and materials made up of polyethylene, and "clean hands/dirty hands" techniques. Preservation, handling and analysis of the samples will be done in class-100 trace metal clean working areas. Enough ULTREX grade nitric acid will be added to the samples in order to decrease the pH to less than 2. Copper concentrations will be measured by stabilized temperature graphite furnace atomic absorption (STGFAA) spectroscopy either by direct injection (for effluent samples) or after liquid-liquid preconcentration with dithiocarbamates (for ambient samples) following Bruland et al (1985). The standard reference material (SRM) CASS4 (coastal seawater) from the National Research Council of Canada will be used to quantify the recovery of the preconcentration, and SRM 1643d (trace metals in water) of the National Bureau of Standards will be used to evaluate the precision and accuracy of the STGFAA analysis.

11.5.3.2 Free copper ion and copper complexation capacity

The concentration of the free aqueous copper ion ($[Cu(II)_{aq}]$) will be measured with an Orion 94-29 Cu(II) ion selective electrode (Cu-ISE), following procedures used by Zirino *et al* (1998), and Cu-CC was measured as detailed in Rivera-Duarte and Zirino (2003); however, a brief description of the procedures is provided here. Both measurements will be made in a dark, class-100 working station, with constant stirring at 25 ± 0.1°C, by the electrode potential (mV) between a Cu-ISE and an Orion Ag/AgCl double-junction reference electrode. The electrodes will be calibrated with seawater Cu-activity buffers made with $2\cdot10^{-4}$ M Cu in filtered (0.45 μm) seawater and either $1\cdot10^{-3}$ M ethylenediamine or $1\cdot10^{-3}$ M glycine (Belli and Zirino 1993, Zirino et al. 1998). Since $[Cu(II)_{aq}]$ in each buffer will be calculated with a specific ion-interaction model for the measured pH and the concentrations of major ions (Belli and Zirino 1993), the calibrated response of the Cu-ISE is reported as the pCu (i.e., $-\log [Cu(II)_{aq}]$) of the solution.

The change in the response of the Cu-ISE during a titration with copper will be used for the measurement of the Cu-CC (Rivera-Duarte and Zirino, 2003). The titrations will be performed with a TTT 85 Titrator and an ABU 80 Autoburette, both from Radiometer Copenhagen, connected to a personal computer for continuous automatic recording of the data. First, the electrodes will be calibrated and then allowed to equilibrate overnight in an aliquot of the seawater sample. The next day, an aliquot of 250-300 g of fresh seawater sample will be weighed into a Teflon beaker, and the electrodes allowed to equilibrate in it for several minutes before starting the titration. The titration will proceed automatically by additions of 10 μL each once the potential has stabilized to within 0.1 mV sec^{-1} and will be completed after 99 mL of the titrant are added, which is equivalent to an average change in concentration of $7.6\cdot10^{-7}$ M (48.2 μg L^{-1}, n= 78). The titrant will be made with 200 μL of 1000 ± 3 μg mL^{-1} High Purity Copper Standard added to 1L of 18-M. water containing 32 g NaCl. Cu-CC is estimated from the inflection point of the resulting titration curve using a MATLAB routine (Rivera-Duarte and Zirino, 2003).

11.5.4 For references see: Section 8 References