Puget Sound Naval Shipyard & Intermediate Maintenance Facility

Project ENVVEST Community Update: Guide to Accompanying Compact Disk (CD)

August 2006

Ecology Publication Number 06-10-054

Contents

Introduction 2
Fecal Coliform TMDL Study for Sinclair and Dyes Inlets 3
Integrated Modeling of the Sinclair and Dyes Inlet Watershed 5
Storm Event Sampling 7
Ambient Water Quality Monitoring 8
Watershed Monitoring 10
Sediment Studies 10
Biota Sampling 13
Current Meter Study 15
Schedule 16
Summary 17
References 18
A-D 18
E-J 19
K-L 20
M-S 21
T-Z 23

List of Acronyms and Abbreviations Used

ADCP – Acoustic Doppler Current Profiler
ASTM – American Society for Testing and Materials
CD – Compact Disk
CH3D – Curvilinear hydrodynamics in 3-dimensions
COB – City of Bremerton
CoBI – City of Bainbridge Island
CoPO – City of Port Orchard
CSO – Combined Sewer Overflow
CuCC – Copper Complexation Capacity
DMR – Discharge Monitoring Report
DOC – Dissolved Organic Carbon
EC_{50} – Effect Concentration for 50th percentile
Ecology – Washington State Department of Ecology
ENVVEST – ENVironmental InVESTment
EPA – Environmental Protection Agency
FC – Fecal coliform bacteria
HSPF – Hydraulic Simulation Model FORTAN
KCHD – Kitsap County Health District
KPUD – Kitsap Public Utility District
MCUL – Maximum Cleanup Level
MEL – Manchester Environmental Lab (EPA/Ecology)
MM5 – weather model (mesoscale model)
NPDES – National Pollutant Discharge Elimination System
OUB – Operable Unit "B" (marine sediments)
PAHs – polycyclic aromatic hydrocarbons
PCBs – polychlorinated biphenyls
POM – Princeton Ocean Model
PSAMP – Puget Sound Ambient Monitoring Program
PSNS&IMF – Puget Sound Naval Shipyard & Intermediate Maintenance Facility
ROD – Record of Decision
SEDQUAL – Sediment quality database
SQS – Sediment Quality Standard
SSWM – Surface and Storm Water Management
TMDL – Total Maximum Daily Load or Water Quality Improvement Project studies are conducted to determine the amount of pollutant loading that a given water body can receive and still meet water quality standards
UW – University of Washington
WDFW – WA State Department of Fish and Wildlife
WDOH – WA State Department of Health

Introduction

The Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF), the Environmental Protection Agency (EPA), the Washington State Department of Ecology (Ecology), and other technical stakeholders are cooperating in an ENVironmental inVESTment (ENVVEST) project to develop and demonstrate alternative strategies for protecting and improving the ecological integrity of Sinclair and Dyes Inlets and their surrounding watershed in the Puget Sound, WA.

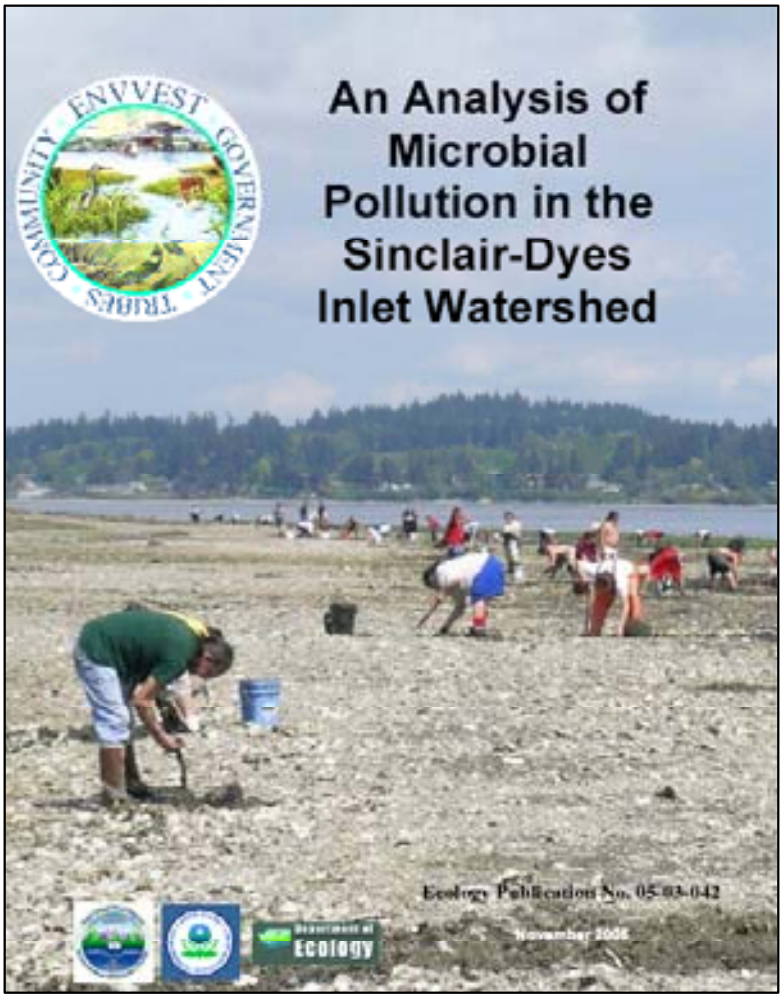
Project ENVVEST will allow environmental protection strategies to be focused on the pollutants that have the highest potential to adversely affect the health of the watershed. Key elements include the development of a unified monitoring and modeling program and electronic database for the Inlets. The contents of this compact disk (CD) are provided as an update of activities being conducted by Project ENVVEST. This document contains a summary of recent progress and provides links to obtain more detailed information about the project. For more information about Project ENVVEST please contact:

PSNS&IMF Congressional & Public Affairs Office
Phone: (360) 476-7111 Email: pao@psns.navy.mil

Fecal Coliform TMDL Study for Sinclair and Dyes Inlets

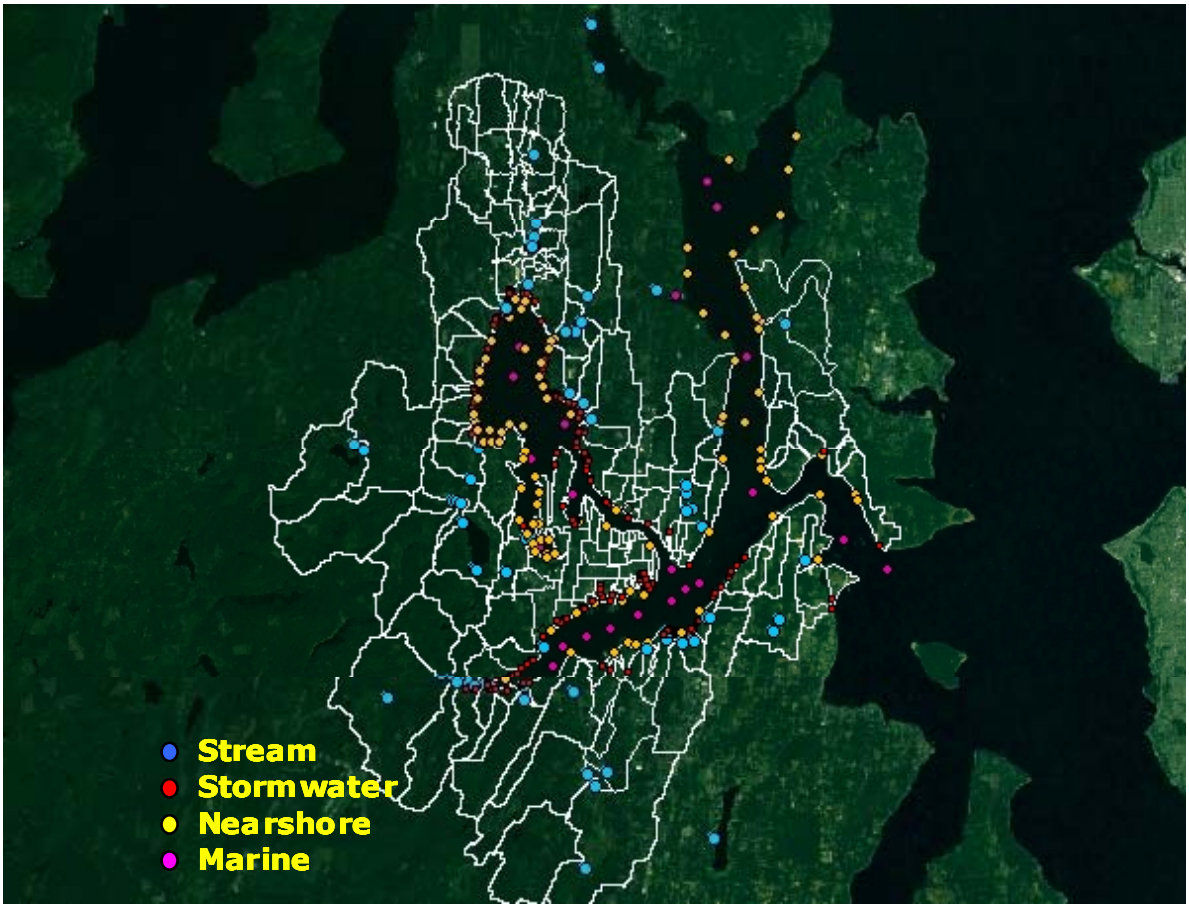
Under the Clean Water Act, Ecology has the authority to establish water quality standards for surface waters of the state and develop water quality improvement plans (Total Maximum Daily Load, or TMDL plans) for pollutants, where the waters do not meet water quality standards. In Sinclair and Dyes Inlets watersheds, PSNS&IMF and EPA are working with Ecology as part of Project ENVVEST to develop a TMDL for fecal coliform (FC) bacteria. Under the partnership, the Navy as technical lead has designed and carried out a study that meets Ecology and EPA requirements for a TMDL and the first part of the TMDL technical study has been completed (May et al. 2005). The TMDL will establish the capacity of the two inlets to accept discharges of FC bacteria from streams, stormwater outfalls, sewage treatment plants, and surface runoff, and still meet water quality standards.

Microbial pollution occurs when FC bacteria from diverse sources such as failing septic systems, leaks from sewer infrastructure, and releases of pet, livestock and wildlife waste cause surface waters to exceed state water quality standards. The pollution can result in the loss of beneficial uses of the water body for drinking, swimming and shellfish harvesting. The goals of the study were to identify microbial pollution problems within the watershed and to provide a comprehensive assessment of microbial pollution from all identifiable sources (ENVVEST 2002b, Johnston et al. 2004). In addition to data collected during the study period from spring 2001 to summer 2005, the study relied on historical data collected by the Kitsap County Health District (KCHD 2002, 2003a, 2004), the Washington State Department of Health (WDOH, Determan 2001, 2003, WDOH 2005a, b), and Kitsap County Surface and Storm Water Management (SSWM 2002a, b).



Cover of technical report showing Suquamish Tribal members harvesting clams in Dyes Inlet.

The study found numerous sources of bacterial pollution in the watershed that could impact water quality and shellfish harvesting areas. In general, microbial pollution was higher in subwatersheds with greater population densities, in areas with a greater percentage of impervious area, and in areas served by older sewer infrastructures or onsite wastewater treatment (septic) systems.



Sampling stations and watershed boundaries used during the microbial pollution TMDL study for Sinclair and Dyes Inlets. The watershed scale is the appropriate scale to address environmental issues and engage stakeholders including Kitsap County, Cities of Bremerton, Port Orchard, and Bainbridge Island, the Suquamish Tribe, Karcher Creek Sewer District, Kitsap Public Utilities District, and others.

Exceedances of the water quality standards for bacteria were more likely in streams with higher stormwater inputs and in streams draining areas with more development. Increased bacterial pollution levels and exceedances of water quality standards were also more likely following major storm events due to increased stormwater runoff entering marine waters via streams and stormwater outfalls. Elevated bacterial pollution levels in nearshore areas appeared to be localized and persisted for only a short period after storm events or during extended periods of rainfall. But, elevated chronic bacterial pollution was persistent in some nearshore and estuarine areas where shoreline development was intense or where urbanized streams and stormwater outfalls were common. Microbial pollution levels found during storm season sampling were about ten times higher than those for non-storm periods, especially for nearshore sites adjacent to highly urbanized drainage basins. Investigations of the relationship between bacterial pollution and land-use showed that the loss of natural forest cover and the increase in impervious surfaces associated with suburban and urban levels of development were significantly correlated with pollution levels and exceeding water quality standards.

The value of an integrated watershed approach to water-quality management was demonstrated during this project. The number and variety of sources for bacterial pollution throughout the study area does not support a conventional “end-of-pipe” approach to pollution control. Elevated bacteria concentrations may indicate the presence of viruses and human pathogens that can be filtered from marine waters and concentrated by shellfish. The WDOH monitoring program for shellfish growing areas relies on water quality measurements of bacteria to determine whether

shellfish can be safely harvested. The safety of marine and freshwater beaches for swimming also is determined by measurements of indicator bacteria. Therefore, the detection, quantification, and correction of existing sources of bacterial pollution should be a high priority for watershed and water-resource managers, as should the development and implementation of an effective prevention program.

- An analysis of microbial pollution in the Sinclair-Dyes Inlet Watershed
- Winter 2004 FC Sampling and Logistics Plan

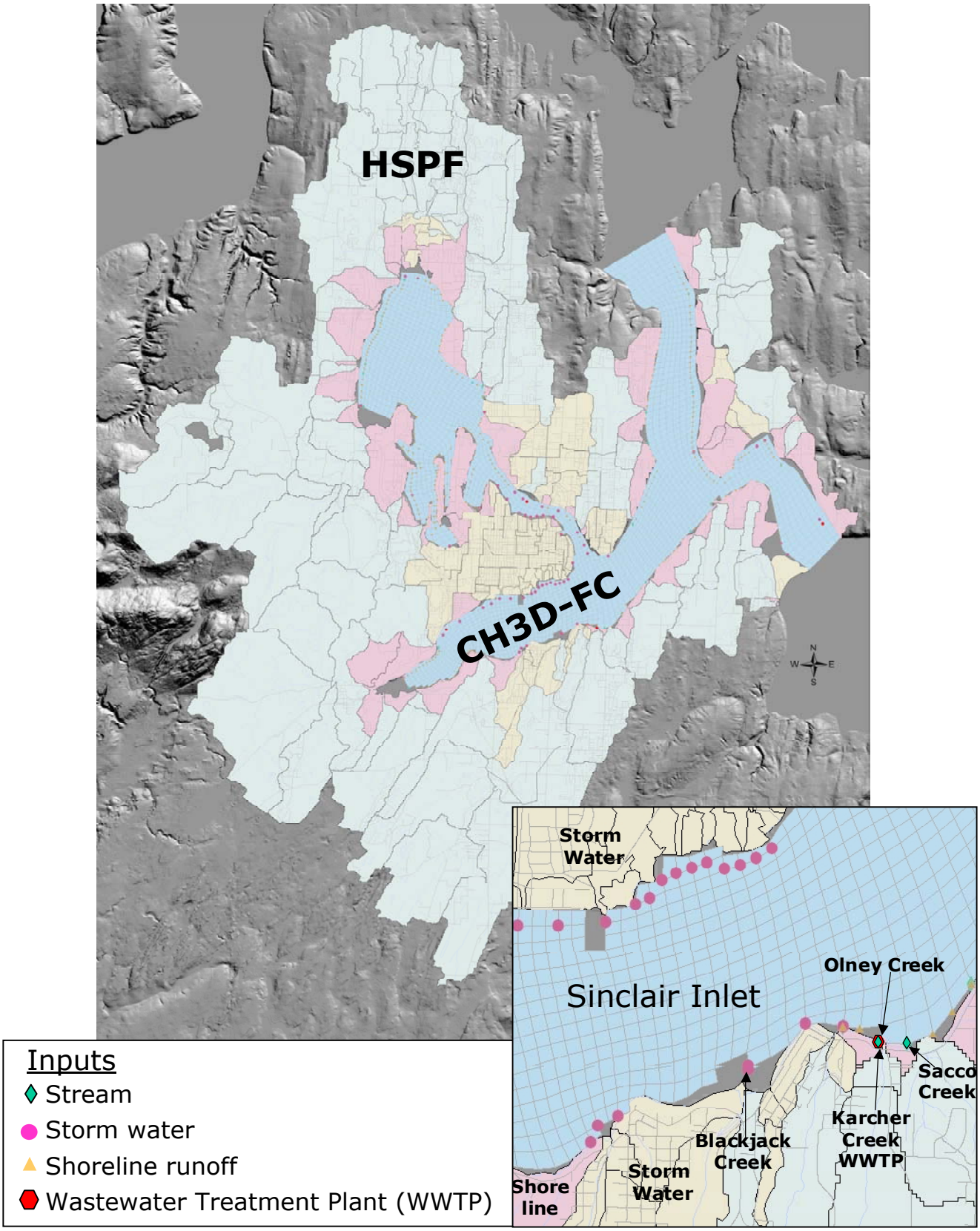
Integrated Modeling of the Sinclair and Dyes Inlet Watershed

An integrated model that links a model of the watershed (hydraulics simulation program FORTRAN – HPSF) with a model of the marine waters in Sinclair and Dyes Inlets (curvilinear hydrodynamics in 3 dimensions – CH3D) has been developed as part of Project ENVVEST (Johnston et al. 2003a). The integrated model is capable of simulating runoff from the watershed and explicitly includes discharges (pour points) from streams, stormwater outfalls, shoreline drainage areas, and wastewater treatment plants. Previously, the CH3D model was used to simulate combined sewer overflows (CSOs) in the Port Washington Narrows (Wang et al. 2005) and the modeling results contributed to the re-opening of shellfish beds in Northern Dyes Inlet to commercial harvesting (WDOH 2003b, Dunagan 2003). Currently, the integrated model simulates 137 separate discharges into the Inlets consisting of 39 streams, 50 stormwater outfalls, 44 shoreline drainage areas, and 4 treatment plant outfalls consisting of the City of Bremerton's (COB's) main treatment plant in Sinclair Inlet and the east side treatment facility in the Port Washington Narrows, the Karcher Creek/City of Port Orchard (CoPO) treatment plant, and the City of Bainbridge Island's (CoBI) Fort Ward treatment plant in Rich Passage.

The integrated model is being used to simulate the total microbial pollutant load into the Inlets from as many sources as possible. The loading analysis conducted as part of the FC bacteria pollution TMDL study (May et al. 2005) was used to assign microbial pollution loads for each of the stream, stormwater, and shoreline pour points draining from the watershed. Data from the wastewater treatment plants' National Pollutant Discharge Elimination System (NPDES) Discharge Monitoring Reports (DMRs) submitted to Ecology were used to simulate microbial pollution loads from the treatment plants.

The model is being used to simulate weather conditions and pollutant loads for water year 2003 (Oct. 1, 2002 to Sept. 30, 2003) and storm events sampled in 2004 to compare to field data collected during those periods. The modeling results are currently being reviewed by Ecology and the ENVVEST Technical Working Group to evaluate model performance and define the modeling scenarios that will be simulated to support water cleanup plans for microbial pollution in the Inlets.

- Simulation Examples and Data Animation Page
- Sinclair/Dyes Inlets Water Quality Improvement Project (TMDL)



The integrated wastershed (HSPF) and receiving water (CH3D-FC) model is capable of modeling runoff and transport of pollutants from streams (green watersheds), stormwater catchments (yellow watersheds), and shoreline areas (pink watersheds), as well as discharges from wastewater treatment plants (insert).

Storm Event Sampling

A major effort to conduct storm event and base flow sampling and ambient monitoring in the Inlets was planned and executed by Project ENVVEST during 2004-2005 (Johnston et al. 2005a). The major emphasis of the sampling was to collect storm event samples from streams and storm water outfalls that were being monitored for flow within the watershed. Additional goals were to obtain data to support total loading and modeling analysis of heavy metal and toxic organic contaminants, nutrients, and suspended particulates discharged into Sinclair and Dyes Inlets Brandenberger et al. 2005a, 2005b, 2005c), develop preliminary data on contaminant levels in nonpoint source runoff in Gorst at the head of Sinclair Inlet, 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 streams and selected storm water outfalls were screened for pesticide and herbicide compounds.

The data obtained from this sampling effort is being used to develop relationships between water quality and watershed hydrology, land use, land cover, and support further development of the integrated watershed and receiving water models being implemented for the Sinclair and Dyes Inlet watershed (Skahill 2004, 2005, Skahill and Johnston 2005, Skahill and Doherty 2006, Wang et al. 2005). The modeling will provide the basis for calculating total maximum daily loads for key environmental contaminants within the watershed.

- 2005 Storm Event Sampling and Logistics Plan
- Data Directory

Actual measurements of chemicals and bacteria in stormwater draining from the watershed can be used to calculate loading as a function of upstream land use.

Ambient marine monitoring was conducted to measure the impact of runoff on receiving waters and obtain data needed to verify modeling results.

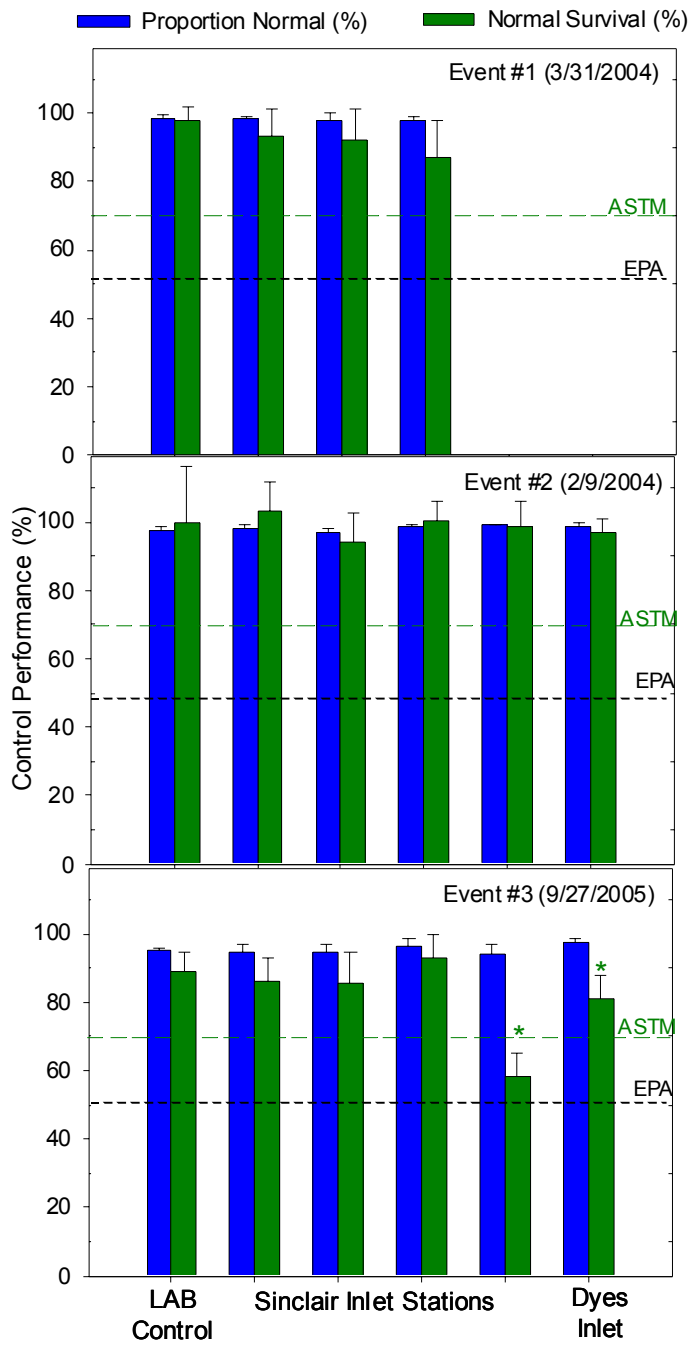
Ambient Water Quality Monitoring

Ambient water quality monitoring was conducted by Project ENVVEST to assess the impact of storm event runoff on the water quality of the Inlets, 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 the Shipyard. The marine sampling was primarily focused on heavy metals (copper, cadmium, lead, and zinc) 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 2002b, 2002c). The work also complemented the sediment studies 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. 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, 2004b).

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 study of copper toxicity evaluated the bioavailability of copper in Sinclair Inlet by spiking ambient water samples from Sinclair and Dyes Inlets with various concentrations of copper prior to conducting laboratory bioassays with mussel embryos (Rosen et al. 2004a, 2004b). Spiking copper into ambient Sinclair Inlet water resulted in EC_{50} (concentration causing an effect in 50% of the test animals) values averaging 40-60% higher, on a dissolved basis, than laboratory water spiked with same concentrations of copper. This indicates that conditions within the Inlets were responsible for reducing the toxicity of copper to mussel embryos by a factor of 1.4, based on the three sampling events used for the study.

The ambient water samples from Sinclair Inlet were not toxic to mussel embryos during the test, and had dissolved copper concentrations (range 1.0 – 1.6 µg/L, Brandenberger et al. 2006c) that were about two to three times lower than the ambient water quality criteria for continuous (3.1 µg/L [chronic]) and about 4 times lower than maximum (4.8 µg/L [acute]) exposure. Copper complexation capacity (CuCC), a chemical measure of bioavailability based on free copper measurements, and dissolved organic carbon (DOC) correlated very well ($r^2 > 0.7$) with copper effect levels (EC_{50}) indicating that measurements of CuCC and/or DOC may be a low cost alternative for evaluating site-specific toxicity of copper in Sinclair Inlet (Rosen et al. in prep).



* Result statistically different than Control
ASTM (American Society of Testing and Materials) and EPA acceptable thresholds are also shown

Results of copper toxicity studies showed no indication of ambient toxicity in the waters of the Inlets. The toxicity detected at two stations during event #3 was due to a toxic algae bloom that was present during the sampling event.

- 2005 Storm Event Sampling and Logistics Plan
- Data Directory

Watershed Monitoring

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. Data on precipitation and other meteorological data are also monitored by KPUD and the City of Bremerton (COB) for the study area. These data have been combined with historical stream data collected by the KPUD (1999a, 1999b) to develop a very extensive record of hydrological data to model stream flow with the watershed model.

Chico Bay near the mouth of Chico Creek in Dyes Inlet. Photo from Ecology's shoreline atlas (http://apps.ecy.wa.gov/shorephotos/).

As part of the In-Stream and Storm Water Flow Sampling conducted by The Environmental Company (TEC), thirteen storm water drainage basins were also monitored for flow. 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 2003b). The 35 outfalls selected for evaluation were selected from more than 150 storm water outfalls and channelized streams (> 12 inches in diameter) located within the study area. The 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. The final list of 13 stations selected for monitoring were the highest-ranking stations that would provide the most representative data on storm water outfalls within the study area, based on the cost and equipment available for the sampling effort.

This sampling was made possible by cooperation among PSNS&IMF, COB, Kitsap SSWM, CoBI and CoPO to share equipment and provide access to stream and stormwater conveyance systems. Due to the ongoing efforts of KPUD, SSWM, COB, CoBI, PSNS&IMF and Project ENVVEST, the critically important stream and stormwater flow-monitoring network developed for the study is continuing to collect data. Watershed studies are also being conducted to monitor habitat quality. By partnering with Kitsap County's Stream Team a county-wide benthic macro-invertebrate sampling program has been established. An assessment of salmonid passage and habitat characteristics was also conducted for culverts along the Navy's railroad line from Shelton to Bangor (May et al. 2004).

- Storm Water Flow and Storm Event Sampling
- Data Directory

Sediment Studies

Integrating contaminated sediment clean up and restoration issues within the larger perspective of watershed management are especially critical in populated coastal and estuarine areas with multiple sources of stress from urbanization and development as well as sediment contaminated from past sources. Historically, Sinclair and Dyes Inlets were polluted with discharges of

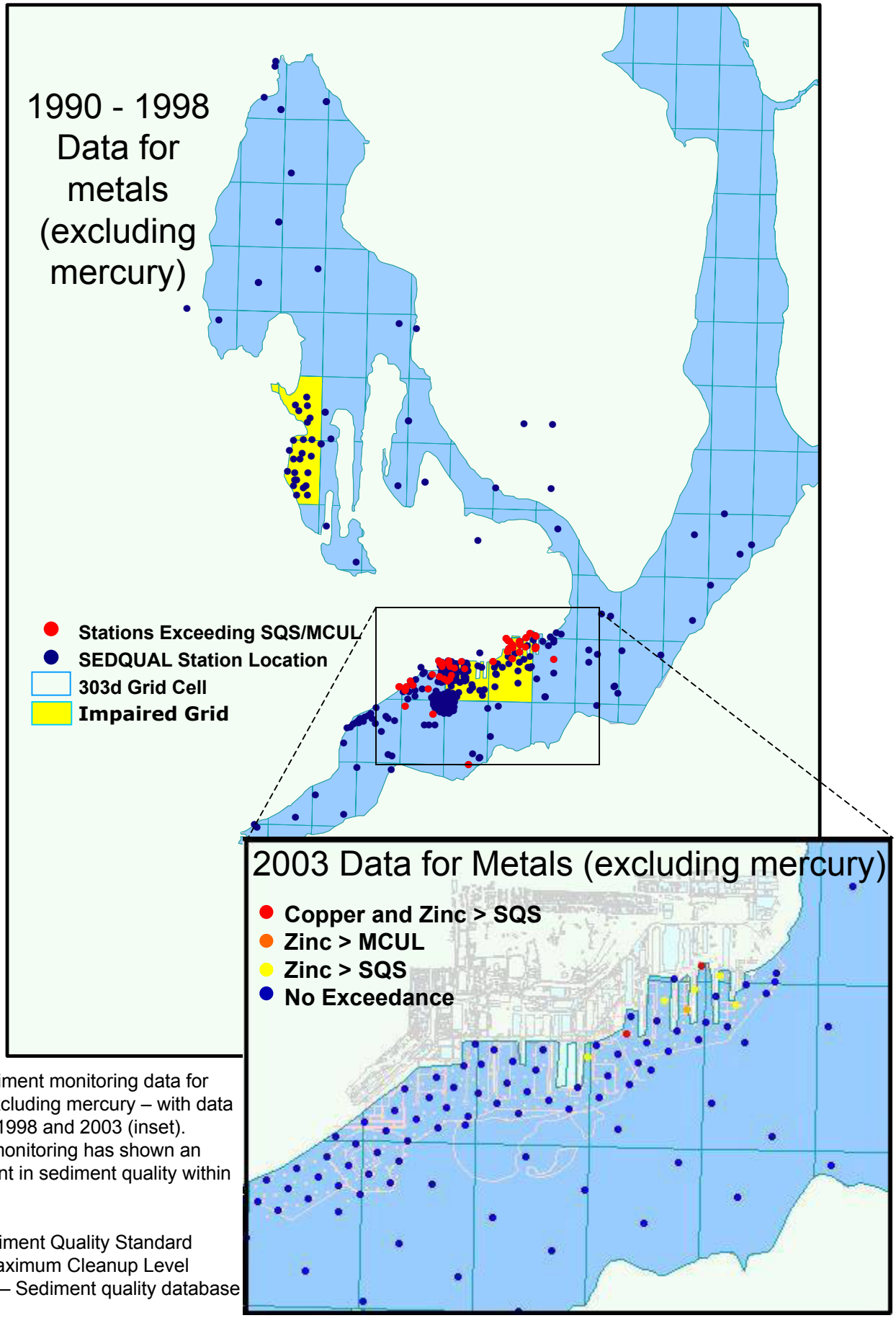
contamination from military installations, industrial activities, municipal outfalls, and other nonpoint sources. As part of the Record of Decision (ROD) to remediate contaminated sediments near PSNS&IMF in Sinclair Inlet, sediments were dredged from contaminated areas, placed in an adjacent confined aquatic disposal pit, and covered with clean material dredged to deepen the navigational channel and turning basin (Operational Unit B Marine – OUB, U.S. EPA 2000, URS 2001). Other cleanup activities included restoring shoreline areas to minimize contaminated soil infiltration, improving shoreline habitat, and conducting cleaning, inspection, and repair of the Shipyard's stormwater system (U.S. EPA 2004, Leisle 2005, ATSDR 2005). Concurrently, major improvements to Bremerton's combined sewer and stormwater system have significantly reduced CSOs and achieved improvements in the water quality of the Inlets (COB 2006).

Historical trends of contamination in the Inlets obtained from age-dated sediment cores collected from areas of sediment accumulation in Sinclair and Dyes Inlets showed that maximum contamination levels occurred between the 1940s and 1960s followed by a decreasing trend of contamination in the most contaminated cores for the more recent deposits (Crecelius et al. 2003). Sediment cores collected by previous studies from the main basin of the Puget Sound also showed that maximum pollution levels occurred between 1945 and 1965 followed by a trend of decreasing contamination in more recent deposits (Bloom and Crecelius 1987, Lefkovitz et al. 1997). These trends are similar to trends of mercury deposition reported in ice cores sampled from the Upper Fremont glacier in the Wind River Range of Wyoming (isolated from local sources of mercury contamination), which showed peaks of contamination associated with volcanic eruptions, pre-industrial gold mining, World War II manufacturing, and the increase of industrialization in the 20th Century followed by a decreasing trend of mercury deposition after 1970 (Schuster et al. 2002). Sedimentation rates for the Inlets, estimated from the age-dated cores, ranged from 0.06 g/cm^2/yr to 0.20 g/cm^2/yr (dry sediment) and the thickness of the contaminated layer of sediment ranged from 0-15 cm to 0-45 cm (Crecelius et al. 2003).

Surface sediments (0-10 cm) were also sampled throughout the Inlets to develop a map of sediment texture needed to model contaminant transport and assess changes in sediment texture following cleanup and dredging activities (McLaren 2004). Between 1997/1998 and 2003 (following cleanup dredging) the surface sediments in Sinclair and Dyes Inlets changed significantly in texture by becoming coarser (from medium to coarse silt), suggesting that coarser sediment was deposited in the Inlets between the sampling periods (McLaren 2004). It is unlikely that coarser grain size will affect long-term sedimentation rates because the currents and amount of suspended sediment available for deposition control the rate of sediment accumulation.

To further address contaminated sediments in the Inlets, a study plan was developed and executed in conjunction with OUB monitoring (Kohn et al. 2003, Kohn et al. 2005b) to address sediment contaminants listed on the 1998 303(d) list for the Inlets. The study was conducted to determine the current levels of toxic metal and organic contamination in the sediments, verify whether any sediment grids should be on the 303(d) list, and determine whether there has been a decrease in sediment contamination since cleanup and source reduction activities at PSNS&IMF and Jackson Park have been conducted. Ecology also conducted a study to assess sediment toxicity in Ostrich Bay (Blakley 2005) and found toxicity exceeding the biological regulatory criteria for sediment quality at six of the 12 sampling stations. The cause of the observed sediment toxicity is currently unknown (Blakley 2005).

A change in the 303(d) listing policy for sediment, implemented by Ecology for the 2004 list, resulted in fewer sediment listings for Sinclair and Dyes Inlets on the 2004 list than was on the 1998 list (Ecology 2005). Additionally, an evaluation of the most recent sediment data collected



Map of sediment monitoring data for metals – excluding mercury – with data from 1990-1998 and 2003 (inset). Sediment monitoring has shown an improvement in sediment quality within the Inlets.

SQS – Sediment Quality Standard
MCUL – Maximum Cleanup Level
SEDQUAL – Sediment quality database

in 2003 (Kohn et al. 2005a, Kohn et al. in prep) showed improvement in the number of chemicals meeting sediment quality standards in Sinclair and Dyes Inlets. However, mercury and some toxic organic compounds are still listed in Category 5 (polluted waters that require a TMDL). Category 2 listings (waters of concern) include listings for groups of toxic, persistent organic compounds known as PCBs (polychlorinated biphenyls) and PAHs (polycyclic aromatic hydrocarbons) as well as silver, cadmium, and sediment toxicity. Category 2 listings do not automatically require a TMDL but more data are necessary to determine the severity and extent of the impairment.

- Metals Verification Study Final Report
- Data Directory

Biota Sampling

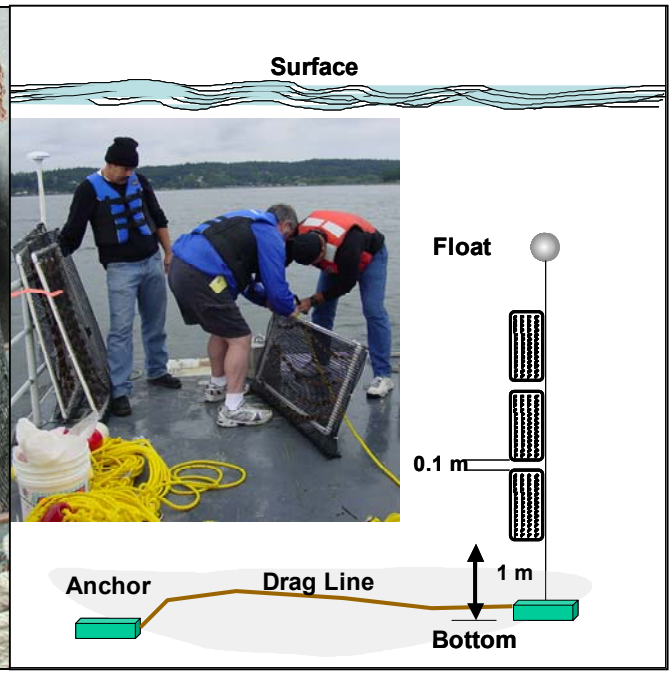
Evaluating the deposition and transport of contaminants within Sinclair and Dyes Inlets and assessing the impact of these contaminants on the local marine biota requires the cooperation of the various stakeholders conducting environmental monitoring programs in the region. The Puget Sound Ambient Monitoring Program (PSAMP) is a multi-agency effort to monitor the health of Puget Sound. The spatial and temporal trends in contaminant exposure in Puget Sound fish and macro-invertebrates and the effects of contaminant exposure on the health of these resources is assessed by trawl sampling at various sampling stations throughout Puget Sound (WDFW 2003).

Sorting the 2005 PSAMP demersal fish catch. Photo by Tom Ostrom, Suquamish Tribe.

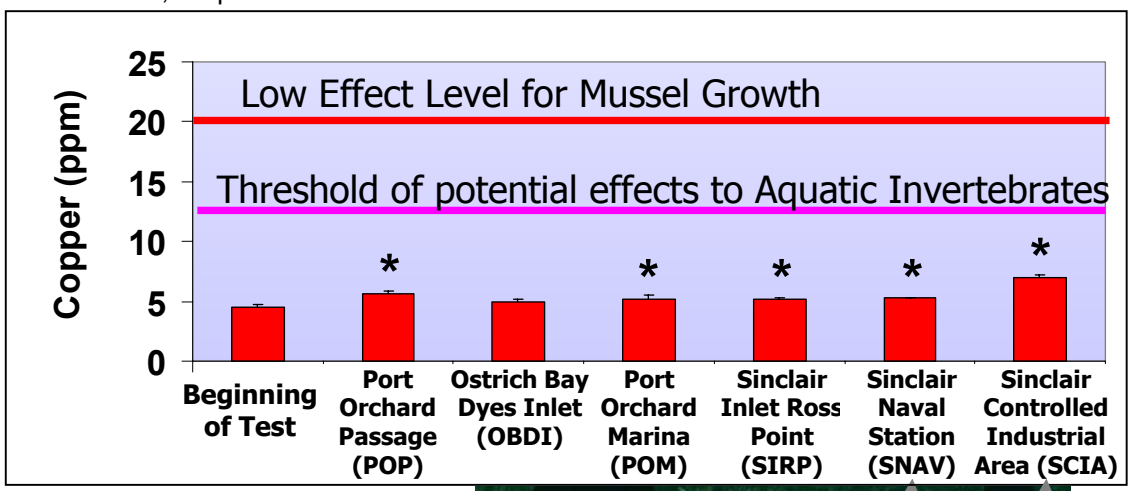
In order to increase the data yield from these efforts, Project ENVVEST collaborated with WDFW to collect additional biological samples for contaminant bioaccumulation analysis (Brandenberger et al. 2006a) and the collection of selected tissue samples to measure biomarkers of sublethal stress. To learn more about water quality and the protection of natural resources in Sinclair Inlet, caged mussels were deployed from June – September 2005 (84 days) at locations inside the Shipyard and at reference locations within the Inlets. The mussels were obtained from a mussel culturing facility near Shelton, Washington, placed in nylon cages, and deployed near the bottom. At the end of the deployment the mussels were retrieved to measure their growth, overall health, and the level of contaminants they accumulated during their stay in the Inlets. The results showed that the mussels remained healthy throughout the deployment. Although copper levels increased slightly at 5 of the 6 sites, the levels did not appear to accumulate to harmful levels (Brandenberger et al. 2006b, Salazar et al. 2006). See figure on next page.

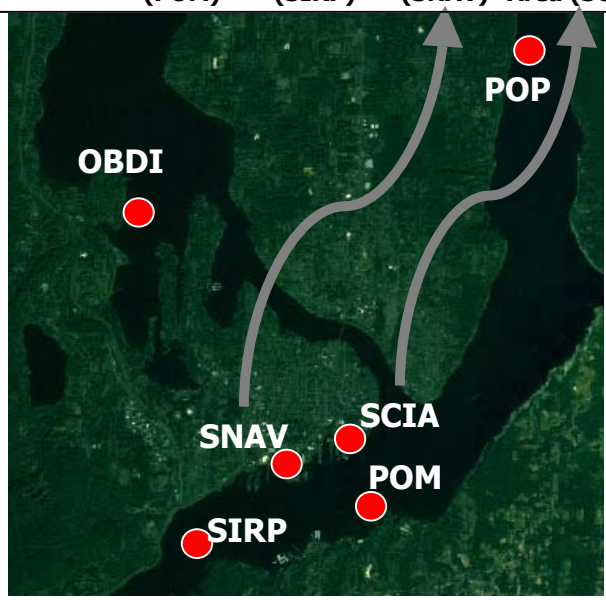
- Biological Sampling and Analysis Plan
- Data Directory

Demersal fish trawl in Sinclair Inlet. Photo by Tom Ostrom, Suquamish Tribe.



Configuration of caged mussel deployment.

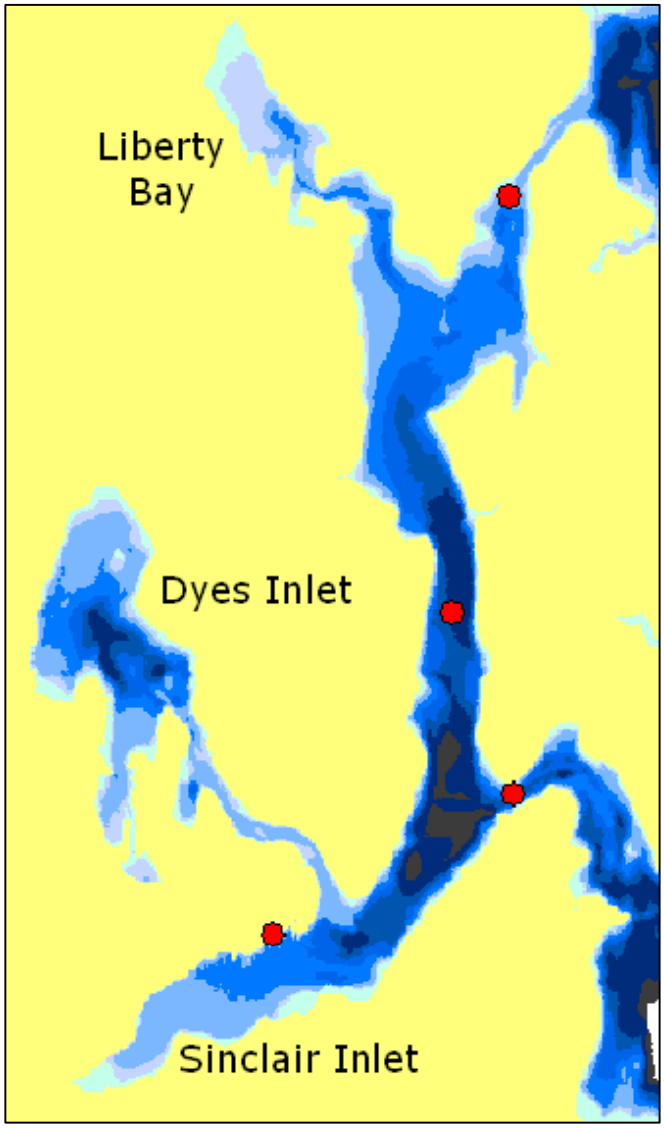




Results of copper levels accumulated by mussels during the deployment (* indicates levels were statistically higher than at the beginning of the test).

Current Meter Study

The inlet-scale integrated model for the Sinclair and Dyes Inlet watershed has been developed to simulate hydrodynamic mixing and transport, dynamic loading from the surrounding watershed, and exchange with the greater Puget Sound. In a related effort, being conduct by the University of Washington (UW), a Puget Sound-scale circulation model has been developed using the Princeton Ocean Model (POM) to simulate velocity, temperature, salinity, and mixing within the Puget Sound (Kawase 2002). Recently, the Puget Sound POM circulation model was programmed to use wind and rain from the MM5 weather model (mesoscale model, Albright and Mass 2002) to simulate the resulting Puget Sound circulation every 24-hours (Sarason 2004, 2005).



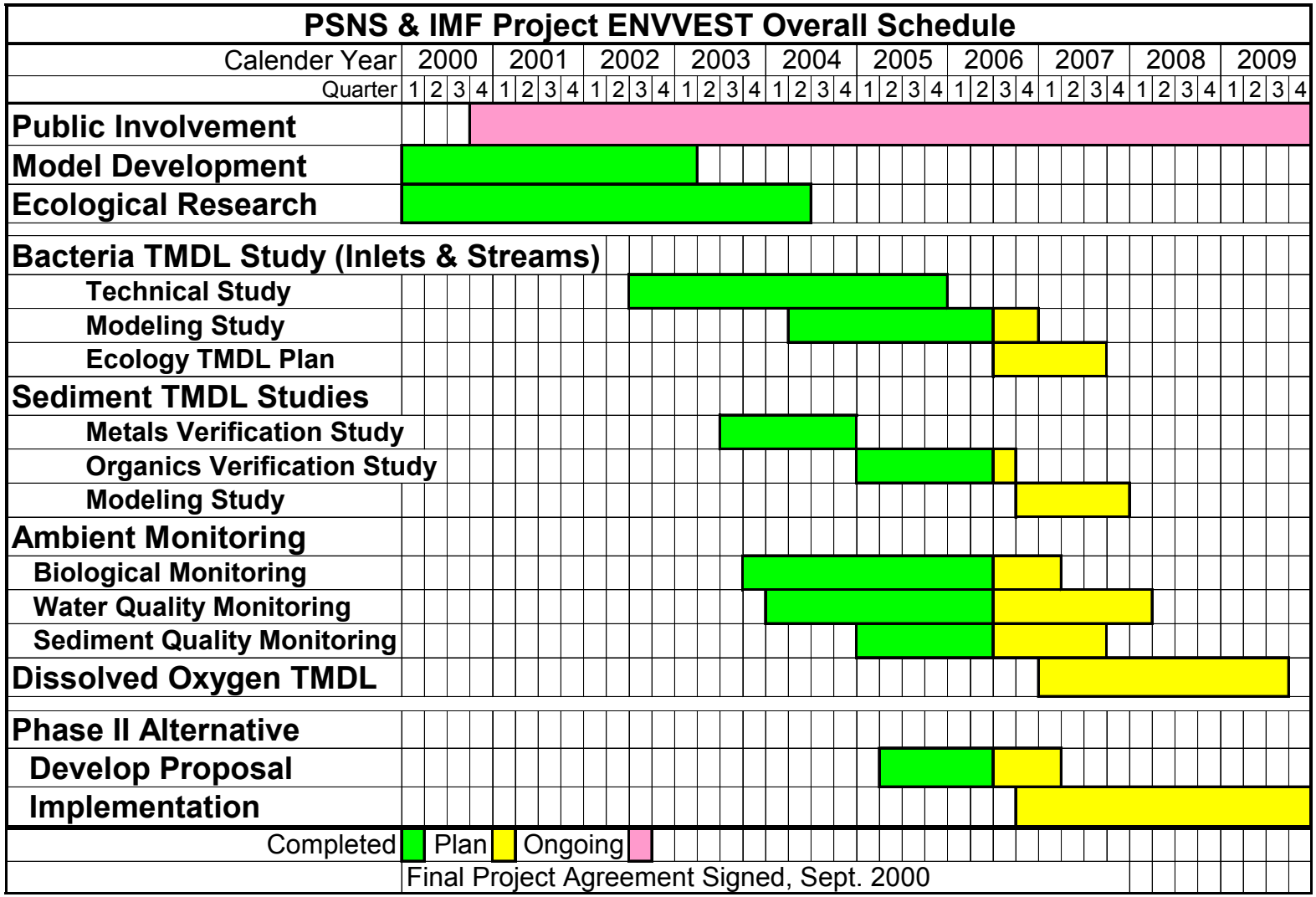
Depth contours and location of current meter monitoring stations.

As part of the Puget Sound Marine Environmental Modeling partnership, the inlet-scale CH3D model for Sinclair and Dyes Inlets has been expanded to include Port Orchard Passage, Liberty Bay, and Agate Passage. This will facilitate coupling with the POM circulation model and, eventually, result in the ability to simulate the exchange of constituents between the Inlets and the Puget Sound (Johnston and Wang 2005).

To support this work, the Navy and Ecology executed a current meter study to collect the data needed to calibrate and verify the expanded model. Three upward-looking Acoustic Doppler Current Profilers (ADCP) were deployed on the bottom at strategic locations within the passages to obtain continuous current records during the Fall of 2005 (Johnston and Albertson 2005). The deployment included the full range of tidal conditions and representative storm events that occurred during the Fall 2005 (Sep. – Dec. 2005). Data from this study will be used to calibrate and verify linking between the inlet-scale CH3D model and the Puget Sound-scale POM circulation model.

- Current Meter Sampling Plan
- Data Directory

Schedule



Since the Final Project Agreement was signed in September 2000, Project ENVVEST has leveraged model development and ecological research to conduct technical studies that are assisting Ecology in addressing impairments listed on the 1998 303(d) list for the watershed. The bacterial TMDL study addresses listings in the Inlets and tributary streams, the sediment TMDL studies are addressing numerous metal and toxic organic listings in the sediments of the Inlets, and ambient monitoring studies are helping to address tissue residue listings and document the quality of water and sediment in the Inlets. Future work may also address low dissolved oxygen in the Inlets. All work for Project ENVVEST was performed to support the development of a Phase II proposal to regulate discharges at PSNS&IMF. The Phase II proposal is intended to result in increased efficiency and/or effectiveness of the Shipyard's environmental program.

Summary

Significant progress has been made on the technical study of fecal coliform bacteria in Sinclair and Dyes Inlets, which has benefited from the collaboration and cooperation of many stakeholders in the watershed. The study, when combined with modeling of FC bacteria inputs from numerous watershed sources under critical loading conditions, will form the basis of Ecology's bacteria TMDL for the two inlets. The model simulates inputs of bacteria from streams, stormwater outfalls, and nonpoint source runoff into the Inlets and is being verified with data collected from the watershed and the nearshore and marine waters of the Inlets. Progress has also been achieved sampling stormwater and streams during storm events, evaluating sources of contamination from the watershed, and assessing contamination in the sediments of the Inlets. In addition, the accumulation of contaminants in the food chain is being assessed by analyzing species of fish and invertebrates from Sinclair Inlet and reference areas in the Puget Sound for metals, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons. Project ENVVEST has accumulated a wealth of new data that can help provide a better understanding of the current environmental conditions in Sinclair and Dyes Inlets. This understanding will provide a basis for improving the efficiency and effectiveness of the Shipyard's environmental compliance program and assure the protection of aquatic resources.

Mt. Rainer from Port Orchard Passage on a clear day.

References

A-D

ATSDR 2005. Public Health Assessment for Bremerton Naval Complex Including Puget Sound Naval Shipyard Bremerton, Kitsap County, Washington EPA Facility Id: Wa2170023418 September 16, 2005. http://www.atsdr.cdc.gov/hac/pha/BremertonNavalComplex/BremertonNaval091605PHA.pdf

Albright, M. and Mass, M. 2002. Pacific Northwest MM5 Weather Forecasts: Information. Department of Atmospheric Sciences, University of Washington, Seattle, WA. http://www.atmos.washington.edu/mm5rt/info.html

Blakley, N. 2005. Ostrich Bay Sediment Toxicity Evaluation. Washington Department of Ecology, Environmental Assessment, publication number 05-03-023, 75pp. http://www.ecy.wa.gov/biblio/0503023.html

Bloom, N. S., and E. A. Crecelius. 1987. "Distribution of Silver, Mercury, Lead, Copper and Cadmium in Central Puget Sound Sediments." Marine Chemistry 21:377-390.

Brandenberger J. M., C.R. Suslick, R. K. Johnston, 2006a Biological Sampling and Analysis in Sinclair and Dyes Inlets, Washington: Chemical Analyses for 2005 Puget Sound Biota Study. Report PNNL-15834 May 2006. Prepared for the Puget Sound Naval Shipyard and Intermediate Maintenance Facility Project ENVVEST Bremerton, Washington, under Contract DE-AC06-76RLO 1830. Pacific Northwest National Laboratory Richland, Washington, 125pp.

Brandenberger J. M., C.R. Suslick, R. K. Johnston, 2006b. Biological Sampling and Analysis in Sinclair and Dyes Inlets, Washington: Chemical Analyses for the Caged Mussel Study. Report PNNL-15835 May 2006. Prepared for the Puget Sound Naval Shipyard and Intermediate Maintenance Facility Project ENVVEST Bremerton, Washington, under Contract DE-AC06-76RLO 1830. Pacific Northwest National Laboratory Richland, Washington, 122pp.

Brandenberger J. M., C.R. Suslick, R. K. Johnston, 2006c. Data Report: Metal and Conventional Water Chemistry Data for the 2005 Ambient Marine and Model Boundary Events in Support of the Storm Water Studies in Sinclair and Dyes Inlet, Washington. Report PNNL – 15594, Jan. 2006. Prepared for the Puget Sound Naval Shipyard and Intermediate Maintenance Facility Project ENVVEST Bremerton, Washington, under Contract DE-AC06-76RLO 1830. Pacific Northwest National Laboratory Richland, Washington, 100pp.

Brandenberger J. M., C.R. Suslick, R. K. Johnston, 2005a. Data Report: Organic Water Chemistry for 2005 Storm Events in Support of the Storm Water Studies in Sinclair and Dyes Inlet, Washington. Report PNNL-15564, Dec. 2005. Prepared for the Puget Sound Naval Shipyard and Intermediate Maintenance Facility Project ENVVEST Bremerton, Washington, under Contract DE-AC06-76RLO 1830. Pacific Northwest National Laboratory Richland, Washington, 288pp.

Brandenberger J. M., C.R. Suslick, R. K. Johnston, 2005b. Data Report: Metal Contaminants in 2005 Storm Events in Support of the Storm Water Studies in Sinclair and Dyes Inlet, Washington. Report PNNL-15562, Dec. 2005. Prepared for the Puget Sound Naval Shipyard and Intermediate Maintenance Facility Project ENVVEST Bremerton, Washington, under Contract DE-AC06-76RLO 1830. Pacific Northwest National Laboratory Richland, Washington, 239pp.

Brandenberger J. M., C.R. Suslick, R. K. Johnston, 2005c. Data Report: Conventional Water Chemistry for 2005 Storm Events in Support of the Storm Water Studies in Sinclair and Dyes Inlet, Washington. Report PNNL-15563, Dec 2005. Prepared for the Puget Sound Naval Shipyard and Intermediate Maintenance Facility Project ENVVEST Bremerton, Washington, under Contract DE-AC06-76RLO 1830. Pacific Northwest National Laboratory Richland, Washington, 234pp.

Brandenberger, Jill, Chris May, Eric Crecelius, Martin Miller, Robert K. Johnston, and Jerry Sherrell, 2005. The ENVVEST Approach for Stormwater Pollutant Loading in the Sinclair- Dyes Inlet Watershed. Presentation at the 2005 Puget Sound Georgia Basin Research Conference, Seattle, WA, March 29-31, 2005.

Brandenberger, J.M. R. K. Johnston, E. A. Crecelius, J. Sherrell, and R. Pingree, 2005. Storm Water Loading in the Sediment Mass Balance for Sinclair and Dyes Inlets, Puget Sound, Washington Integrating Sediment Cleanup and Watershed Management for Sinclair and Dyes Inlets, WA USA. Third International Conference on Remediation of Contaminated Sediments, January 24-27, 2005. New Orleans, LA. http://www.battelle.org/sedimentscon

City of Bremerton (COB) 2006. CSO Reduction. http://www.cityofbremerton.com/content/csoreduction.html

Crecelius, Eric, Robert K. Johnston, Martin Miller, Jill Brandenberger, Jim Leather and Joel Guerrero, 2003. Contaminant Mass Balance for Sinclair and Dyes Inlets, Puget Sound, WA. Manuscript submitted for conference proceedings. Georgia Basin Puget Sound Research Conference, Vancouver, BC, Canada April 2, 2003

Diefenderfer, N.P. Kohn, E.A. Crecelius, R.K Johnston, G.M. Sherrell 2003. Final Draft: Technical Approach to Address Section 303(d) Listings for Metals in Sinclair and Dyes Inlets. PSNS Project ENVVEST.

Determan, Tim, 2001. Status and Trends in Fecal Coliform Pollution in Puget Sound Year 2000. A Report for the Puget Sound Ambient Monitoring Program. Washington State Department of Health Office of Food Safety and Shellfish Programs August, 2001. http://www.doh.wa.gov/ehp/sf/Pubs/fecalreport00.pdf

Determan, Tim, 2003. Atlas of Fecal Coliform Pollution in Puget Sound: Year 2001 A Report for the Puget Sound Ambient Monitoring Program Washington State Department of Health Office of Food Safety and Shellfish Programs January 2003. http://www.doh.wa.gov/ehp/sf/Pubs/fecalreport01.pdf

Dunagan, C., 2003. LANDMARK DECISION Dyes Inlet shellfish get clean bill of health. The Sun. http://www.thesunlink.com/redesign/2003-11-01/local/300757.shtml

E-J

Ecology 2005. Washington State's Water Quality Assessment [303(d) & 305(b) Report] Contaminated Sediment Listings by Category http://www.ecy.wa.gov/programs/wq/303d/2002/2004_documents/seds_listings-cat.html

ENVVEST 2002a. Dye Release Study in Port Washington Narrows, Draft Sampling Plan. Prepared by PSNS ENVVEST CSO Modeling Subworking Group, Final Draft February 4, 2002.

ENVVEST 2002b. PSNS Project ENVVEST Technical Work Masterplan, of May 2002, prepared by PSNS Project ENVVEST Technical Steering Committee.

ENVVEST 2002c. Fecal Coliform Total Maximum Daily Load Study Plan For Sinclair and Dyes Inlets PSNS Project ENVVEST Regulatory Working Group, prepared for Washington State Department of Ecology, Watershed Assessments Sections, October 4, 2002.
http://www.ecy.wa.gov/programs/wq/tmdl/watershed/sinclair-dyes_inlets/fc_tmdl_studyplan_final_draft_print.pdf

ENVVEST Technical Steering Committee. 2002. 303d Scoping Summary for Sinclair and Dyes Inlets and Watershed. Puget Sound Naval Shipyard Project ENVVEST, Bremerton, Washington. September 20, 2002.

Johnston, R.K., P.F. Wang, H. Halkola, K.E. Richter, V.S. Whitney, B.E. Skahill, W.H. Choi, M. Roberts, R. Ambrose, and Mitsuhiro Kawase, 2003. An Integrated Watershed-Receiving Water Model For Sinclair and Dyes Inlets, Puget Sound, Washington, USA. Presentation at Estuarine Research Federation 2003 Conference Estuaries on

the Edge: Convergence of Ocean, Land and Culture, September 14-18, 2003, Seattle, WA. http://www.psmem.org/models/psns-spawar.html

Johnston, R.K., Gerald M. Sherrell, Will Kendra, Dave Garland and Sally Lawrence, Michael Rylko and Martha Turvey, Christopher W. May, Kenneth E. Richter, Thomas Ostrom, and M. Mecham 2003b Improving environmental quality in Sinclair and Dyes Inlets, WA by partnering at the watershed scale. Presented at the Pacific Northwest Regional Water Conference October 29-30, 2003, Stevenson, WA

Johnston, R.K., C.W. May, V.S. Whitney, J.M. Wright, and B. Beckwith 2004. Fecal Coliform Model Verification Sampling Plan Winter 2004. Addendum to the Fecal Coliform Total Maximum Daily Load Study Plan For Sinclair and Dyes Inlets. Prepared by Puget Sound Naval Shipyard & Intermediate Maintenance Facility Project ENVVEST For Washington State Department of Ecology. February 19, 2004. http://www.ecy.wa.gov/programs/wq/tmdl/watershed/sinclair-dyes_inlets/w2004_fc_sap_final_ecy.pdf*

Johnston, R.K. and P.F. Wang 2004. A Partnership for Modeling the Marine Environment of Puget Sound, Washington – Puget Sound Naval Shipyard/Space and Naval Warfare Systems Center Report. FY2005 Progress Report. National Ocean Partnership Program, Office of Naval Research.

Johnston, R.K. and Skip Albertson, 2005. Current Meter Study for Agate, Port Orchard, and Rich Passages Study Plan. Puget Sound Marine Environmental Modeling and Project ENVVEST

Johnston, R.K., J. Brandenberger, C.W. May, V.S. Whitney, J.M. Wright, B. Beckwith, and R. Pingree 2005a. Storm Event Sampling in the Sinclair and Dyes Inlet Watershed: FY2005 Quality Assurance Project Plan. Prepared by Puget Sound Naval Shipyard & Intermediate Maintenance Facility Project ENVVEST For Washington State Department of Ecology. Jan 18, 2005.

Johnston, R.K., J. Brandenberger, E. Crecelius, S. Steinert, M. Salazar, and S. Salazar, 2005b. Biological Sampling and Analysis in Sinclair and Dyes Inlets, WA FY2005 Quality Assurance Project Plan. Puget Sound Naval Shipyard & Intermediate Maintenance Facility Project ENVVEST, Mar. 31, 2005, 52pp.

Johnston, RK, Sherrell, GM, Leisle, DE, Lawrence, S, Roberts, M., May, CM, Keiss, J and Ostrom, T, 2006. Improving Environmental Quality in Sinclair and Dyes Inlets, Washington. Presentation at the 2006 annual meeting of the Pacific Northwest Chapter of the Society of Environmental Toxicology and Chemistry, Port Townsend, WA, April 13-15, 2006.

Johnston, R.K. and P.F. Wang 2005. A Partnership for Modeling the Marine Environment of Puget Sound, Washington – Puget Sound Naval Shipyard/Space and Naval Warfare Systems Center Report. FY2005 Progress Report. National Ocean Partnership Program, Office of Naval Research. http://www.psmem.org/assets/PRIVATE/omjohnst05b.pdf

K-L

Katz, C.N. and A. Blake 2004. Puget Sound Naval Shipyard & Intermediate Maintenance Facility Dry Dock Discharge Dye Study. Space and Naval Warfare Systems Center, San Diego, CA.

Katz, C.N., B. Davidson, R.K. Johnston, and B. Beckwith, 2004. Sinclair Inlet Dye Study: Sampling Plan for Puget Sound Naval Shipyard & Intermediate Maintenance Facility Dry Dock and Storm Water Outfalls (April 2004). Space and Naval Warfare Systems Center, San Diego, CA.

Kawase, M. 2002. Modeling Puget Sound Circulation. University of Washington, PRISM Retreat, Seattle, WA. http://www.prism.washington.edu/lc/PSSOFF/kawase.ppt

(KCHD) Kitsap County Health District 2002. Water Quality Program 2000-2001 WATER QUALITY MONITORING REPORT. Executive Summary, Introduction, Dyes Inlet Watershed, Sinclair Inlet Watershed. http://www.kitsapcountyhealth.com/environmenta_health/water_quality /stream_marine.htm

KCHD 2003a. Water Quality Program 2001-2002 Water Quality Monitoring Report. Introduction, Dyes Inlet Watershed, Sinclair Inlet Watershed. http://www.kitsapcountyhealth.com/environmenta_health/water_quality /stream_marine.htm

KCHD 2003b. Water Quality Trend Monitoring Plan, Streams and Marine Waters, Water Quality Program, Last Updated 5/30/2003.

KCHD 2005. 2004-2005 WATER QUALITY MONITORING REPORT Water Quality Close to Home. Water Quality Program (accessed May 23, 2006). http://www.kitsapcountyhealth.com/environmenta_health/water_quality/stream_marine.htm

(KPUD) Kitsap Public Utilities District 1999a. Kitsap County Washington Stream Monitoring Sites. http://www.kpud.org/gis/documents/4_2.pdf

KPUD 1999b. Kitsap County Washington Spatial Distribution of Precipitation http://www.kpud.org/gis/documents/3_1.pdf

Kohn, N.P, M.C. Miller H. L. Diefenderfer, R.K. Johnston, G.M. Sherrell, and B. Beckwith. 2003. Sampling and Analysis Plan Sediment Metals Verification Study for Sinclair and Dyes Inlet, Washington. Prepared by PNNL Marine Sciences Laboratory for PSNS & IMF Project ENVVEST, August 2003.

Kohn, N.P, M.C. Miller H. L., Brandenberger, and Johnston, R.K. 2005a. Metals Verification Study for Sinclair and Dyes Inlets, Washington. Prepared by BSML and SSC-SD in support of PSNS&IMF Project ENVVEST http://www.ecy.wa.gov/PROGRAMS/WQ/TMDL/WATERSHED/sinclair-dyes_inlets/bacteria_rpt/pnnl-14872.pdf

Kohn, N.P., M.C. Miller, R.K. Johnston, J. Leather, J. Guerrero, G.M. Sherrell, B. Beckwith 2005b. Addendum to Sampling and Analysis Plan To Include Organics Verification Study Sediment Metals Verification Study for Sinclair and Dyes Inlet, Washington. Project ENVVEST January 18, 2005.

Kohn, N.P., et al. in prep. Organics Verification Study for Sinclair and Dyes Inlet, Washington. Project ENVVEST.

Lefkovitz, L.F., V.I. Cullinan, and E.A. Crecelius. 1997. "Historical trends in the accumulation of chemicals in Puget Sound." National Oceanic and Atmospheric Adminstration, Silver Springs, Maryland. Technical Memorandum NOS ORCA 111. 60pp. and appendices.

Leisle, D.E., G.M. Sherrell, R.K. Johnston, P.F. Wang, D. Ginn, C. Berthiaume, E. Crecelius, J. Brandenberger, N. Kohn, P. McLaren, and B.E. Skahill 2005. Integrating Sediment Cleanup and Watershed Management for Sinclair and Dyes Inlets, WA USA. Third International Conference on Remediation of Contaminated Sediments, January 24-27, 2005. New Orleans, LA. http://www.battelle.org/sedimentscon

M-S

May, C.W., Gerald Sherrell, Robert K. Johnston, Frank Meriwether, Tim Determan, Will Kendra, Stuart Magoon, Stuart Whitford, and James Zimney, 2003b. Assessment of Bacterial Contamination in the Sinclair-Dyes Inlet Watershed: The Initial Phase of a Watershed-based TMDL Implementation Program, presented at the Pacific Northwest Regional Water Conference, October 29-30, 2003, Stevenson, WA.

May C.W., M.C. Miller, and J.A. Southard, 2004. An Analysis of Stream Culvert Fish Passage on the Navy Railroad Line between Bremerton and Shelton, Washington, Battelle Marine Sciences Laboratory, Sequim, Washington, December 2004.

May, C.W. Dana Woodruff, Valerie Cullinan, Nathan Evans, Lohna O'Rourke, Lee Miller, Robert K. Johnston, P.F. Wang, Heather Halkola, K.E. Richter, B. Davidson, Victoria Whitney, and Joseph Wright, 2005. An analysis of microbial pollution in the Sinclair-Dyes Inlet Watershed. Washington Department of Ecology, Report No. 05-03-042, 428pp + Appendices.

McLaren, Patrick, 2004. The Sediments of Dyes and Sinclair Inlets: An Assessment Of Change Between 1997-8 and 2003.Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS) Project Environment Investment (ENVVEST) Purchase Order Number: N6600104MJ071, GeoSea® Consulting (Canada) Ltd. 789 Saunders Lane Brentwood Bay, BC, V8M 1C5 Canada.

Rosen, G., I. Rivera-Duarte, and R.K. Johnston, 2004a. Sinclair Inlet Toxicity Assessment: Sampling Plan for Puget Sound Naval Shipyard & Intermediate Maintenance Facility Surface Water Copper Bioavailability and Toxicity Study. FINAL DRAFT, 6 APRIL 2004. Space and Naval Warfare Systems Center, San Diego, CA.

Rosen, G., I. Rivera-Duarte, and R.K. Johnston, 2004b. Sinclair Inlet Toxicity Assessment : Puget Sound Naval Shipyard & Intermediate Maintenance Facility Surface Water Copper Bioavailability and Toxicity Study, Draft Interim Report, September 2004, Space and Naval Warfare Systems Center, San Diego, CA.

Rosen, G., I. Rivera-Duarte, and R.K. Johnston, in prep. Sinclair Inlet Toxicity Assessment : Puget Sound Naval Shipyard & Intermediate Maintenance Facility Surface Water Copper Bioavailability and Toxicity Study, Draft Final Report, Space and Naval Warfare Systems Center, San Diego, CA.

Salazar, MH, Salazar, SM, Johnston, RK, Davidson, BM, Steinert, SA, CSC, San Diego, CA; and Brandenberger JM., 2006. Using Caged Mussels To Characterize Exposure And Effects Over Small Spatial Scales in Sinclair & Dyes Inlet, Washington. Presentation at the 2006 annual meeting of the Pacific Northwest Chapter of the Society of Environmental Toxicology and Chemistry, Port Townsend, WA, April 13-15, 2006.

Sarason, Christian, 2004. Puget Sound Circulation Model. Puget Sound Marine Environmental Modeling Puget Sound Modeling Workshop, April 23, 2004, University of Washington, Seattle, WA. http://www.psmem.org/workshop.4.23.04.html

Sarason, C. 2005. Welcome tima.ocean.washington.edu, home of the Puget Sound POM model. University of Washington, Seattle, WA. http://tima.ocean.washington.edu/

Schuster, Paul F., et al. 2002. Atmospheric Mercury deposition during the last 270 years: a glacial ice core record of natural and anthropogenic sources. Environmental Science and Technology 36: 2303-2310. http://pubs.acs.org/cgi-bin/article.cgi/esthag/2002/36/i11/html/es0157503.html

Skahill, Brian E. 2003. Preliminary Hydrological Simulation Program – Fortran (HSPF) Model Hydrologic Calibration for Streams in the Sinclair–Dyes Inlet Watershed, Draft Report. US Army Engineer Research and Development Center Vicksburg, MS, September 2003.

Skahill, Brian E. 2004a. Hydrological Simulation Program – Fortran (HSPF) Model Hydrologic Calibration for Streams in the Sinclair–Dyes Inlet Watershed, Draft Report. US Army Engineer Research and Development Center Vicksburg, MS, April 2004.

Skahill, Brian E. 2004b. Addendum: HSPF Calibration - Missing Streams and Preliminary Storm Water Evaluation. Addendum to Hydrological Simulation Program Fortran (HSPF) Model Hydrologic Calibration for

Streams in the Sinclair–Dyes Inlet Watershed US Army Engineer Research and Development Center Vicksburg, MS.

Skahill, Brian E. 2005. Addendum: HSPF Calibration - Storm Water Plots. Addendum to Hydrological Simulation Program – Fortran (HSPF) Model Hydrologic Calibration for Streams in the Sinclair–Dyes Inlet Watershed US Army Engineer Research and Development Center Vicksburg, MS.

Skahill Brian E and John Doherty 2005. Regularization as a Methodology for Watershed Model Calibration: Case Study Applications to Chico Creek in Kitsap County, WA, USA. Presentation at the annual meeting of the American Water Resources Association Meeting in Seattle, WA.

Skahill Brian and Robert K. Johnston 2005. "Technical Studies in the Sinclair and Dyes Inlet Watershed." Invited presentation at special session on restoring Hood Canal at the annual meeting of the American Water Resources Association Meeting in Seattle, WA.

Skahill Brian E. and John Doherty, 2006. Efficient accommodation of local minima in watershed model calibration • ARTICLE *Journal of Hydrology, In Press, Corrected Proof, Available online 20 March 2006,* Abstract | Full Text + Links | PDF (613 K)

(SSC-SD) Space and Naval Warfare Systems Center 2003. Marine Environmental Quality Branch, Environmental Services Capabilities. SSC-SD Environmental Sciences, San Diego, CA. http://environ.spawar.navy.mil/randd/MESC/default.htm

(SSWM) Kitsap County Public Works Surface and Stormwater Management 2002. Annual Report 2002a. http://www.kitsapgov.com/download/pw_4901.pdf

SSWM 2002b. Storm Water Outfall Database. Kitsap County Surface and Stormwater Management.

T-Z

(TEC) The Environmental Company 2002a. Final Quality Assurance Project Plan for In-Stream Storm Flow Sampling PSNS Project ENVVEST Study Area Bremerton, Washington October 2002. Prepared by The Environmental Company, Inc. Bellevue, WA Contract No.: N44255-98-D-4416, Contract Task Order: 0050

TEC 2002b. Final Sampling and Analysis Plan for In-Stream Storm Flow Sampling PSNS Project ENVVEST Study Area Bremerton, Washington. October 2002. Prepared by The Environmental Company, Inc. Bellevue, WA Contract No.: N44255-98-D-4416, Contract Task Order: 0050

TEC 2002c. Final Health and Safety Plan for In-Stream Storm Flow Sampling PSNS Project ENVVEST Study Area Bremerton, Washington. October 2002. Prepared by The Environmental Company, Inc. Bellevue, WA Contract No.: N44255-98-D-4416, Contract Task Order: 0050

TEC 2003a. Annual Report 2002-2003 In-Stream Storm Flow Sampling Puget Sound Naval Shipyard (PSNS) Project Environmental Investment (ENVVEST), July 2003. Prepared by The Environmental Company, Inc. Bellevue, WA Contract No.: N44255-98-D-4416 Contract Task Order: 0060.

TEC 2003b. Draft Sampling and Analysis Plan for Sampling and Analysis of In-Stream and Storm Water Chemical and Flow Characteristics PSNS Project ENVVEST Study Area Bremerton, Washington ENVIRONMENTAL SERVICES MONITORING Long-Term Monitoring 19 September 2003. Prepared by:The Environmental Company, Inc. Bellevue, WA Contract No.: N44255-98-D-4416 Contract Task Order: 0068

TEC 2003d. Annual Report 2002-2003 In-Stream Storm Flow Sampling Puget Sound Naval Shipyard (PSNS) Project Environmental Investment (ENVVEST), July 2003.

TEC 2004. Storm Event Sampling for 2004. Work Plans, Field Sampling Reports, and Raw Data.

TEC 2005. Storm Event Sampling for 2005. Work Plans, Field Sampling Reports, and Raw Data.

(URS) URS Greiner Woodward Clyde Federal Services 2001. Draft final feasibility study report: Operable Unit B, Bremerton Naval Complex, Bremerton, WA, July 23, 2001. Contract No. N62474-89-D-9295 CTO 0131.

U.S. EPA 2000. EPA Superfund Record of Decision: PUGET SOUND NAVAL SHIPYARD COMPLEX EPA ID: WA2170023418 OU 02 BREMERTON, WA 06/13/2000, EPA/ROD/R10-00/516 2000 http://www.epa.gov/superfund/sites/rods/fulltext/r1000516.pdf

U.S. EPA 2004. EPA Superfund Record of Decision: PUGET SOUND NAVAL SHIPYARD COMPLEX EPA ID: WA2170023418 OU 05 BREMERTON, WA 03/08/2004, EPA/ROD/R10-04/711 2004. http://www.epa.gov/superfund/sites/rods/fulltext/r1004711.pdf

Wang, P.F., R.K. Johnston, H. Halkola, R.E. Richter, and B. Davidson, 2005. A Modeling Study of Combined Sewer Overflows in the Port Washington Narrows and Fecal Coliform Transport in Sinclair and Dyes Inlets, Washington. Prepared by Space and Naval Warfare Systems Center, San Diego for Puget Sound Naval Shipyard & Intermediate Maintenance Facility Project ENVVEST, Final Report, June 22, 2005**,** 26pp. http://www.ecy.wa.gov/programs/wq/tmdl/watershed/sinclair-dyes_inlets/bacteria_rpt/appendices/appendixf_cso_modeling_study.pdf

(WDFW) Washington State Department of Fish and Wildlife 2003. Puget Sound Ambient Monitoring Program. Washington State Department of Fish and Wildlife http://www.wdfw.wa.gov/fish/psamp/index.htm

WDOE 1999. Guidance Document for Developing Total Maximum Daily Loads (TMDLs) -- Water Cleanup Plans. http://www.ecy.wa.gov/biblio/9923.html

(WDOH) Washington State Department of Health 2003a. Sanitary Survey of North Dyes Inlet. October 2003. Office of Food Safety and Shellfish Programs. 50pp.

WDOH 2003b. Shellfish harvesting opens in Northern Dyes Inlet, News Release Oct. 31, 2003. http://www.doh.wa.gov/Publicat/2003_News/03-176.htm

WDOH 2003c. Northern Dyes Inlet Proposed Classification Boundaries. Office of Food Safety and Shellfish Programs. http://ww4.doh.wa.gov/scripts/esrimap.dll?name=bioview&Cmd=Map&Step=1

WDOH 2005a. 2004 Annual Inventory: Commercial & Recreational Shellfish Areas of Washington State. Office of Food Safety and Shellfish, Washington Department of Health, June 2005 http://www.doh.wa.gov/ehp/sf/Pubs/2004annualinventory.pdf

WDOH 2005b. Annual Growing Area Review, Northern Dyes Inlet, Office of Food Safety and Shellfish Programs, Washington Department of Health, December 2005 http://www.doh.wa.gov/ehp/sf/Pubs/gareports/05dyes.pdf