Final Draft

Technical Approach to Address Section 303(d) Listings for Metals in Sinclair and Dyes Inlets

August 7, 2003

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August 2003

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

H.L. Diefenderfer, N.P. Kohn, and E.A. Crecelius were supported under a Related Services Agreement with the U.S. Department of Energy, under Contract DE-AC06-76RLO 1830, Pacific Northwest National Laboratory Richland, Washington 99352

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1. Introduction

This document proposes an approach to address Section 303(d) listings for metals in the sediments of Sinclair and Dyes Inlets watershed. One of the stated goals of the Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS & IMF) Project Environmental Reinvestment (ENVVEST) is to assist the Washington State Department of Ecology (Ecology) in addressing contaminants included on the State's 303(d) list of impaired water bodies (ENVVEST 2002a). As identified in the 303(d) scoping summary for the Sinclair and Dyes Inlets watershed (ENVVEST Technical Steering Committee 2002), toxics in sediment were identified as the next priority for TMDL development following the high priority for fecal coliform listings in marine waters and tributary streams. The ENVVEST Executive Overview (ENVVEST Project Management Team in review) recommended that metals in sediment would be the next 303(d) listings to be tackled by the ENVVEST Technical Working Groups following successful progress on the execution of the Total Maximum Daily Loading (TMDL) study for fecal coliforms in Sinclair and Dyes Inlets (ENVVEST Regulatory Working Group 2002). The proposed approach described here is based on a review of available information on the Section 303(d)-listed water bodies in the Sinclair and Dyes Inlets Watershed (Figure 1), including the preliminary compilation of available sediment and water data, to identify data gaps and make recommendations for field sampling.

Specific objectives of this document are to:

1. Define a process for addressing metals in sediments listed on the 1998 303(d) list in Sinclair and Dyes Inlets.

2. Develop data quality objectives and rationale for addressing sediment metals within the frameworks of the TMDL and Toxic Cleanup Programs.

3. Summarize existing data and information on sediment contamination that has a bearing on 303(d) listings in Sinclair and Dyes Inlets.

Comprehensive monitoring and data assessment have been identified as critical and often neglected underpinnings of the TMDL process (Karr and Yoder, in review). The focus of our review was to identify the most significant sources of uncertainty and develop recommendations for new data collection. Other activities conducted during the development of this technical approach and reported at the ENVVEST technical workshop March 5, 2003 included the development of objectives, preliminary source assessment, and the identification of existing water and sediment datasets.

1.1 Background

The 1998 303(d) list included Arsenic (As), Cadmium (Cd), Copper (Cu), Lead (Pb) Mercury (Hg), and Zinc (Zn) in sediments of Sinclair Inlet and Cd, Hg, and Silver (Ag) in the sediments of Dyes Inlet (Table 1, Ecology 1998). The 1998 303(d) listings were largely based on sediment data collected as part of the cleanup program conducted for the Bremerton Naval Complex, consisting of PSNS and Naval Station Bremerton in Sinclair Inlet (U.S. Navy 2000a, U.S. Navy 2003) and Jackson Park in Dyes Inlet (U.S. Navy 2000b). Under the Navy's Installation Restoration (IR) Program, clean up and navigational dredging were conducted for

Operable Unit B Marine (the sediments located offshore of PSNS) in 2000-2001 and post-remediation monitoring activities are being planned (URS 2002a). The post-remediation monitoring will be focused on goals of the Record of Decision (ROD U.S. Navy 2000a). The goals of the ROD were to (1) reduce the area-weighted concentration of PCBs to the minimum clean up goal of 3 mg of PCB per 1 kilogram of organic carbon (3 mg PCB/Kg OC) within 10 years, (2) selectively remove high concentrations of Hg collocated with PCBs, and (3) control shoreline erosion of contaminated fill (U.S. Navy 2000a). Onshore remediation and source controls were also implemented in 2000-2001 at Jackson Park to reduce potential contaminant migration into Dyes Inlet (U.S. Navy 2000b).

To determine whether TMDLs are warranted for metals, a verification study is needed to assess the current status of heavy metals in the sediments of the Inlets. Since Hg is being addressed as part of post-remedial monitoring for Operable Unit B Marine (URS 2002a), and it is well documented that ambient Hg concentrations exceed sediment quality standards (Crecelius et al. 2003a, b), verification sampling for Hg is not warranted at this time. Furthermore, Hg methylation cannot be modeled with the fate and transport models currently under development for Project ENVVEST[1].

1.2 Summary of Proposed Approach

Our review of data in Washington State Department of Ecology's (Ecology's) Sediment Quality Information System (SEDQUAL) indicated that sediment samples that have exceeded sediment quality criteria in Sinclair and Dyes Inlets are mostly located in the vicinity of the Shipyard. However, since the last sediment samples in this area were collected, analyzed, and reported an extensive cleanup program consisting of dredging and creation of a pit confined aquatic disposal (Pit CAD) site was conducted during 2000-2001 for the Shipyard and Naval Station (U.S. Navy 2000b, 2003). For these reasons, it is advisable to verify the existing conditions prior to initiating the development of TMDLs for metal parameters, which are listed based on sediment quality standards (not water quality criteria). A systematic approach is proposed to assess the current and proposed metal listings on 303(d) list in Sinclair and Dyes Inlets (Figure 2). The approach consists of three main elements:

1) An evaluation of the existing data and the basis of the listings will be performed to identify the contaminants of concern (COCs). A metals verification sampling and analysis plan will be developed to assess sediment contamination in areas previously identified as contaminated and throughout the study area. The study will determine whether development of TMDLs for metals is warranted based on the current condition of the water bodies. The study design will ensure that results are compatible with U.S. Environmental Protection Agency (EPA) and Ecology requirements for compliance with Sediment Management Standards (WAC 173-204, Washington State 1995) and the 303(d) listing policy (Ecology 2002a, b). Data quality objectives are summarized in Table 2.

[1] The models currently under development for Project ENVVEST are capable of modeling fecal coliform, divalent metals (excluding Hg), toxic organics, and dissolved oxygen.

2) Upon approval by Ecology, field sampling will be conducted and a data report will be prepared. The data report will provide the basis for determining, for each COC, whether no longer listing the parameter can be justified, or a more detailed study plan is needed because the COC continues to exceed sediment management standards (Figure 2).

3) Based on the results of the verification study, if a more detailed study is not required for any metal parameters on the 303(d) list, a TMDL for metals will not be needed. In that case, the focus would to conduct water quality monitoring and modeling of future loading scenarios to support the development of National Pollution Discharge Elimination System (NPDES) permits, or other management considerations, to assure that future loading will not cause sediment concentrations to exceed standards. If the basis for listing a specific parameter (COC) is confirmed, then a TMDL Study will be necessary. If further source reductions are required to meet standards, then Waste Load Allocations (WLA) for nonpoint sources, Load Allocations (LA) for point sources, and a Water Cleanup and Implementation Plan (IP) for the watershed will be developed. If the source of impairment is from past practices, the site will continue to be managed under the Toxic Cleanup Program's (TCP) contaminated sediment site program (Figure 2).

2. Rationale for Proposed Approach

2.1 Geographic Scope of Section 303(d) Metals Listings in Sinclair and Dyes Inlets Watershed

Both Sinclair and Dyes Inlets appear on the 1998 Section 303(d) list for metals. With respect to metals listings, the only expected changes on the 2002 list are new listings for mercury (W. Kendra, PSNS Project ENVVEST Technical Working Group Workshop, pers. com. 2003). None of the creeks in the watershed, including the major subbasins (Figure 2), appear on the 1998 Section 303(d) list for any metals, nor are they expected to be listed for metals on the 2002 list (Ecology 2003a, W. Kendra, personal communication 2003). On this basis, metals TMDLs are not currently planned for the streams, but may be required for Sinclair and Dyes Inlets. It is also possible that undocumented sources of metal loadings may exist within the watershed. Concentrations of metals are being analyzed in watershed monitoring efforts being conducted under ENVVEST (TEC 2002a, b) and will be included in the development of a metals TMDL for Sinclair and Dyes Inlets. If a stream is listed based on new data, the stream will probably require a separate TMDL effort.

2.2 Metals Parameters Listed for Sinclair and Dyes Inlets

The metals for which Sinclair and Dyes Inlets are listed on the 1998 Section 303(d) list are shown in Table 3. These metals are expected to be listed as Category 2 “Waters of Concern” on the 2002 list (Sally Lawrence, Personal Communication, ENVVEST Sediment SubWorking Group Meeting, July 29, 2003). Mercury will require a more sophisticated model because of its chemistry, and is not included in this proposed technical approach. Ecology has recommended that Dyes Inlet be delisted for antimony based on new data and analysis (Johnson and Roose 2002a). If this revision is made, it will not be necessary to address antimony in this metals TMDL approach. Ecology has also recommended delisting Sinclair and Dyes Inlets for arsenic in edible tissue based on new data (Johnson and Roose 2002b); however, arsenic in sediment is

listed at two grids near PSNS: 47122F6F3 and 47122F6F4 (Table 1, Figure 3). On this basis, arsenic should be included in the verification study plan.

To be consistent with the metals being analyzed in technical studies being conducted under Project ENVVEST all samples will be analyzed for suite of nine metals (Ag, As, Cd, Cr, Cu, Fe, Ni, Pb, and Zn). The target metals are the metals included on the 1998 303(d) list (Ag, As, Cd, Cu, Pb, and Zn). Because hydrodynamic modeling efforts showing significant transport between Sinclair and Dyes Inlets (ENVVEST 2003), it is appropriate to combine the listed metals in one study plan. Currently, two grids in Sinclair Inlet are listed for these metals of concern (47122F6F3 and 47122F6F4) and one in Dyes Inlet (47122F618) (Figure 3).

2.3 Basis of Section 303(d) Metals Listings for Sinclair and Dyes Inlets

Water bodies are listed based on compliance with the standards and criteria shown in Table 4. According to the decision matrices prepared by Ecology, water quality criteria were not exceeded in the study area, and listings for the six metals are based solely on sediment data, with the exception of the current listing for arsenic and mercury, which includes tissues (Table 3, Ecology 2003b). The three studies cited in the decision matrices on which the listings are based, were published in 1994 and 1995 and contained early 1990s data associated with Navy installation restoration investigations. Our February 2003 review of the SEDQUAL database showed that sediment from 375 stations in Sinclair and Dyes Inlets had been analyzed for one or more of the six metals parameters of interest (Figure 4). Between 360 and 375 data points were returned by SEDQUAL for each metals parameter in the study area. Our comparison of these results with the Sediment Quality Standards (SQS) and Minimum Cleanup Levels (MCUL) for each metals parameter showed that all of the stations with levels exceeding the SQS or MCUL occurred in the vicinity of the PSNS (Figure 5). (Note that exceedences for Cd and Ag in Dyes Inlet were not returned by the SEDQUAL query[2]).

2.4 Existing Data

Since the data on which the 1998 listings are based were collected, dredging, capping, and stabilization activities were conducted at sites near PSNS in 2000 to 2001 (Figure 6, URS 2002b, U.S. Navy 2002). The target contaminants of this cleanup were polychlorinated biphenyls (PCBs) and mercury, and follow-up monitoring for those parameters is planned for September 2003 (URS 2002a). In addition, source controls and onsite remediation were done in Dyes Inlet (Jackson Park). In the area of sediment contamination near PSNS, sediment data have not been collected and analyzed since the cleanup (Figure 7). As a result, the present condition of the water body, especially in the Operable Unit B Marine (OUB-Marine) area offshore of PSNS, is unknown. This uncertainty represents a significant data gap, particularly for arsenic, which has

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[2] The document cited in the 303(d) list for the cadmium listing of grid 47122F6I8 in Dyes Inlet states: "EA Engineering Science and Technology, 1995, state sediment quality criteria are exceeded at 13 locations." These 13 locations with cadmium exceedances do not appear to be in the SEDQUAL database. For silver, same grid, the document states, "EA Engineering Science and Technology, 1995, state sediment quality criteria are exceeded at 2 locations." These locations are also not in SEDQUAL. For mercury, same grid, the document states, "Station Cluster (Jackson Park) exceeds sediment quality standards in 3/8/96 assessment." More work will be required to track down the data cited in these references.

been recommended for delisting throughout the remainder of the study area. Additionally, previously-sampled stations tend to be clustered near the shipyard, publicly-owned treatment works (POTWs), or other nearshore facilities.

As part of the sediment mass balance study fluvial deposits associated with major streams (8 Streams) and storm water outfalls (16 sediment grabs near outfalls) were sampled (Miller et al. 2003) and sediment cores and traps were collected in the main depositional basins of Sinclair and Dyes Inlets (Figure 8, Crecelius et al. 2003a, b, c). In addition, Inlet water, stream, and storm water samples were collected during winter 2002 and summer 2003 baseflow conditions (Miller et al. 2003), and in-stream storm event samples were collected for seven storm events during the winter of 2002-2003 (Pingree 2003). The copper mass balance study shows that sediments are a sink for copper; therefore, copper (& other metals) in the water column have potential to impact sediment concentrations (Crecelius et al. in 2002a, b, c). Sediment in the vicinity of potential water loading may not have been adequately characterized.

The Puget Sound Ambient Monitoring Program (PSAMP) conducts periodic studies of sediment and benthic conditions within the Puget Sound. A long-term benthic monitoring station was established in Sinclair Inlet to monitor trends in sediment contamination and benthic infauna (Figure 9, Partrigde et al. 2003). The station in Sinclair Inlet was noted as the highest among the stations monitored for metals with Hg consistently exceeding the SQS. The Washington State Department of Ecology and the National Oceanic and Atmospheric Administration, conducted sediment quality sampling in 1998 at 100 locations in central Puget Sound including the Sinclair and Dyes Inlet watershed (Figure 10). The survey was conducted to assess sediment quality and assess the spatial extent of chemical contamination, toxicity, and adverse alterations to benthic infauna (Long et al. 2000). The findings for Sinclair and Dyes Inlet showed relatively low incidences of bulk sediment and pore water toxicity (Figure 11), but many areas exceeded SQS criteria (Figure 12) due to elevated levels of Hg (Long et al. 200). Currently, the PSAMP monitoring program has been refined using a spatially-balanced generalized random tessellation stratified (GRTS) design to sample five strata within each of the eight regions of the Puget Sound on a rotational cycle (Dutch et al. 2003).

In the summer of 2001, before dredging and cleanup operations were conducted, benthic flux measurements were made at 10 locations within the Inlets (Figure 13, Chadwick et al. 2002). The benthic flux provided direct measurements of diffusive metal flux from the sediments. The benthic flux rates provide an estimate of mass transfer between sediment and seawater. Using measurements of benthic flux, sediment metal concentrations, total organic carbon (TOC), and percent fines, the flux of metals for Sinclair and Dyes Inlets was predicted (Halkola et al. 2003). The sediment concentrations for the ENVVEST study area were based on data from the SEDQUAL database. Therefore, there is considerable uncertainty associated with modeled results, which could be improved upon by obtaining more recent sediment chemistry data. Present-day sediment concentrations are critical to estimates of contaminant loading and flux. The latter is important because in the recent copper mass-balance study for Sinclair and Dyes Inlets, Crecelius et al. (2003a, b, c) determined that metals in sediment contribute to the mass in the water column that is recirculated or exported, though sediments appear to be functioning as a net sink.

Data gaps, or lack of information, that were identified included the lack of data on post-remediation metals concentrations in the sediments around the shipyard, the uncertainty associated with contaminant flux predictions based on data that are not representative of present

conditions, and the lack of spatially distributed sediment metals data necessary to support TMDL modeling efforts.

3. Goals of Proposed Approach

The questions to be addressed by the metals verification study plan are:

- What is the current condition of sediment metal contamination within the Inlets?
- Should the sediments be listed for metal contamination on the 303(d) list?
- Has there been a decrease in sediment metal contamination since cleanup and source control activities have been initiated?

In addition, data will be gathered that can be used to support modeling of metal transport within the Inlets, identify any problem areas that require more detailed investigations, and support sediment management goals. The sampling and analysis plan will be developed to meet the data quality objectives detailed in Table 2.

3.1 Verification of Current Conditions to Support TMDL Process

The study design for the sediment metals verification sampling should ensure that the study will provide enough data to form the basis for updating the 303(d) list for metals. A field sampling and analysis plan (SAP) for the metals verification study will be developed following Ecology SAP guidance for sediment evaluations. To the degree possible, the sediment metals verification plan will incorporate the requirements of Sediment Management Standards regulation (WAC 173-204, Washington State 1995) and the 303(d) listing policy (WDOE 2002a, b). A standard suite of metals (Table 5.) will be analyzed in all samples to ensure that a current, comprehensive post-dredging dataset is considered in the TMDL process.

In order to obtain as much cost-effective information as possible, the sediment sampling and analysis plan will incorporate sediment screening with laboratory confirmation. As was described in the QAPP developed for the "Development of a Contaminant Mass Balance for Sediment in Sinclair and Dyes Inlets" (Miller et al. 2001), surface grab samples will be taken and sub-sampled for shipment to SSC where they will be analyzed by rapid screening X-ray fluorescence (XRF) techniques for metals. A sufficient amount of material of the sample (4 oz) will be sent to SSC for rapid screening by XRF for heavy metals and the remainder will be frozen and archived for later analysis as required. The XRF detection limits for arsenic, copper, lead, and zinc are substantially below sediment management standards, but are close to or above the standards for cadmium and silver (Table 5). Approximately 25% of the samples collected will also be analyzed by ICP/MS to further develop the quantitative relationship between XRF metals and ICP/MS metals being developed for Project ENVVEST (Figure 14)

3.2 Determination of Necessity of Additional Sampling and Analysis to Support Section 303(d) Listings

Through the verification study, a determination can be made whether further sampling and analysis may be required. For example, the sampling may identify areas in excess of the standards, in which case, additional sampling and biological testing may be useful to define the extent of contamination and support management measures. If the data from the verification study shows that a comprehensive TMDL study is needed, the data will be useful in developing the technical approach needed to address metal speciation, accumulation, bioavailability and assimilative capacity.

3.3 Recommendations for Metals Verification Study Plan

The metals verification study plan should be developed to meet the requirements of 303(d) and Sediment Management Programs. The sampling program should also capitalize on the proposed monitoring program for OUB Marine inside Sinclair Inlet (Figure 15) and include enough stations outside Sinclair Inlet to support spatial coverage for short- and long-term contaminant transport modeling efforts. The sediment data from fluvial deposits sampled as part of the ENVVEST Mass Balance Study (Crecelius et al. 2003c) should also be incorporated into the design.

Based on recent calculations of sedimentation rates in Sinclair and Dyes Inlets, 2 cm represents about 3 to 12 yrs of accumulation (Crecelius et al. 2003a, b, c). The mass balance calculations for Cu show a net flux of Cu into sediment (Crecelius et al. 2003a, b, c), indicating that the sediment is a sink for contaminants. The surface 2-3 cm probably best represents the present day sediment conditions within the Inlets. Additionally, 2-3 cm is also the sample depth used in the PSAMP benthic monitoring program (Dutch et al. 1998). The fine-grain sediments within the inner part of Sinclair Inlet are highly anoxic and studies have shown that oxygen is depleted within the upper few mm (<0.5 cm) of the sediment (Chadwick et al. 1993) and that the sulfide concentrations were very high (~50 umol/g) in the surface sediments (0-5 cm) of cores collected in the fine grained muds near the shipyard (Johnston 1993). These data suggest that very little bioturbation is occurring below the upper 2-3 cm of the sediment surface. However, under sediment management guidelines, the top 10 cm are used in the regulatory program to determine whether sediments are in compliance with sediment quality standards. Although, the depositional rates measured by Crecelius et al. (2003a, b, c) are applicable to the central basins of the Inlets, there is considerable uncertainty about accumulation rates around piers, pilings, and dry docks and other nearshore areas that are subjected to disturbance and resuspension processes. Therefore, in order to be consistent with the regulatory program, it is recommended that the top 10 cm should be sampled for the metals verification study.

Recognizing that the proposed sampling plan will provide a unique opportunity to obtain synoptic data throughout the study area, consideration should be taken to assure that as much useable data are obtained as possible. Sediment samples should be handled, preserved, and archived so that future analysis can be conducted to determine organic contaminant levels, sediment texture and grain size, organic carbon content, acid volatile sulfides, and other geochemical properties of interest. It is anticipated that enough sediment material will be collected and archived to facilitate future analyses.

3.4 Supplemental Information to Support Management

In addition to data on sediment metal concentrations data on present day loading and bioaccumulation of metals is also being developed under Project ENVVEST. These data will provide supplemental lines of evidence on the overall status of sources of metal contamination and the potential for biological effects on marine organisms within the study area.

3.4.1 Stormwater Storm Event Sampling

The Environmental Company (TEC), under contract to the Navy, is developing a technical approach and sampling plan to measure flow and contaminants associated with selected storm water outfalls within the study area. The objectives of the study are to (1) collect samples to characterize contaminant concentrations entering the receiving waters during storm events, (2) measure flow rates of selected outfalls during storm events, and (3) use data to estimate/model loading from unmeasured outfalls (Johnston 2003). The goal is to capture a minimum of three discrete storm events at each sampling location. Flow measurements from selected outfalls will be used with concentration data to calculate loading into surface waters for measured outfalls as well as to estimate flow from unmeasured outfalls with similar land use categories associated with their respective drainage basins. These data will be used to calibrate storm water discharges in the watershed model being developed for the study area (Skahill 2003). Scheduled to begin sampling during the "first flush" at the onset of winter storms, the effort will entail evaluating flow and sampling requirements for selected outfalls, installing sampling infrastructure where needed, collecting storm samples, conducting chemical analysis of samples, and preparing a draft and final report.

3.4.2 Tissue Residue Analysis

Project ENVVEST is partnering with the Washington Department of Fish and Wildlife (WDFW) to evaluate tissue residues of metals and PCBs in biological samples collected from Sinclair Inlet. As part of the PSAMP otter trawl surveys conducted April-May 2003 to assess the status and trends of chemical contamination in fish and macro-invertebrates of the Puget Sound (WDFW 2003), representative demersal fish and invertebrate species were collected from Sinclair Inlet and reference locations (Straight of Georgia, Port Gardner, and Nisqually Reach) for chemical analysis. The objective of the sampling was to collect bottomfish species at up to 13 stations distributed throughout Puget Sound. Sampling in Sinclair Inlet was conducted on May 5, 2003. Sampling was conducted using a 400-mesh Eastern otter trawl from the FV Chasina, a 58 ft seiner rigged for trawling. The gear is designed to fish on a relatively flat/smooth bottom; however, it isn't selective and captures a variety of fish and invertebrate species. During the sampling in Sinclair Inlet, two members of the ENVVEST Technical Team, a PNNL fisheries scientist and a Suquamish Tribe fisheries biologist, went aboard the trawler to help collect representative samples of the species of interest. Approximately six individuals of each species were collected, placed in an appropriate container, placed in a cooler, and sent to the Sequim Marine Science Laboratory (MSL). At MSL the samples will be prepared for analysis of selected contaminants.

The focus of the WDFW's study is PCBs, Hg, and PAHs in English sole and crabs. The effort being conducted by ENVVEST will provide complimentary information on contaminant levels in other representative species collected from Sinclair Inlet and the reference locations. These data can be used to assess the potential for ecological effects from contaminant exposure in fish and invertebrates, screen for potential human health exposure scenarios, and help better delineate contaminant mass balance and biological availability of contaminants in the study area. Information about the specimens collected, the analytes to be analyzed, and the number of samples to be processed can be found at https://swdata.spawar.navy.mil/envvest/Biota/

4. Summary

An approach to address Section 303(d) listings for metals in the sediments of Sinclair and Dyes Inlets watershed was proposed. The approach defines a process for addressing metals in sediments within the context of sediment management and water quality requirements, develops data quality objectives and rationale for addressing sediment metals, and summarize existing data and information on sediment contamination that has a bearing on 303(d) listings in Sinclair and Dyes Inlets. The most significant sources of uncertainty were identified and recommendations for new data collection were developed. The questions to be addressed by the sampling plan are:

- What is the current condition of sediment metal contamination within the Inlets?
- Should the sediments be listed for metal contamination on the 303(d) list?
- Has there been a decrease in sediment metal contamination?

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6. Tables

Table 1. Grid cells and parameters on 303(d) list for sediment in Sinclair and Dyes Inlets (from Ecology 1998). (Metal parameters are highlighted.)

Grid Cell Number	Parameter	Medium	Was grid cell or segment on the 1996 list?	Water Body Identifier	Water Body Name
47122F6F1	Sediment Bioassay	Sediment	Yes	WA-15-0050	DYES INLET
47122F6F3	1,4-Dichlorobenzene	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	2,4-Dimethylphenol	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	4-Methylphenol	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	Arsenic	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	Benz(a)anthracene	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	Butylbenzyl phthalate	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	Cadmium	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	Chrysene	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	Copper	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	Indeno(1,2,3-cd)pyrene	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	Lead	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	Mercury	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	Phenol	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F3	Sediment Bioassay	Sediment	No	WA-15-0050	DYES INLET
47122F6F3	Zinc	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Arsenic	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Benzo(ghi)perylene	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Benzoic acid	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Bis(2-ethylhexyl) phthalate	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Butylbenzyl phthalate	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Cadmium	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Chrysene	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Copper	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Fluoranthene	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Indeno(1,2,3-cd)pyrene	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Lead	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Mercury	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Phenanthrene	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6F4	Zinc	Sediment	Yes	WA-15-0040	SINCLAIR INLET
47122F6I8	Bis(2-ethylhexyl) phthalate	Sediment	Yes	WA-15-0050	DYES INLET
47122F6I8	Cadmium	Sediment	Yes	WA-15-0050	DYES INLET
47122F6I8	Mercury	Sediment	Yes	WA-15-0050	DYES INLET
47122F6I8	Phenol	Sediment	Yes	WA-15-0050	DYES INLET
47122F6I8	Sediment Bioassay	Sediment	No	WA-15-0050	DYES INLET
47122F6I8	Silver	Sediment	Yes	WA-15-0050	DYES INLET

Table 2. Data quality objectives for metals verification study plan.

Metals Verification study Data Quality Objectives
STEP 1: State the Problem Available sediment data are the basis for 303(d) listings for metals in Sinclair and Dyes Inlets. Because of recent remediation and source reduction activities, existing sediment data does not adequately characterize current conditions. Several suspected sources of metals to the water body have not been adequately characterized, e.g., discharges from storm water outfalls and recreational vessel marinas..
STEP 2: Identify the Decision 1. Do present-day sediment concentrations in Sinclair and Dyes Inlets support the 1998-2002 303(d) listings for Cd, Cu, Pb, Ag, As, Zn, or Hg? 2. Do storm water discharges impact sediment metal concentrations?
STEP 3: Identify Inputs to the Decision 1. Concentrations of listed metals in Dyes Inlet surface sediment, particularly in listed grids and in areas of net sediment deposition. 2. Post-remediation concentrations of listed metals in Sinclair Inlet surface sediment that can contribute to flux of dissolved metals between sediment and overlying water. 3. Revised modeled metal flux using new surface sediment chemistry.
STEP 4: Define the Study Boundaries Spatial boundaries are Sinclair and Dyes Inlets, including the confluence of the inlets in Port Orchard Passage. Vertical boundary is the biologically active zone (10 cm).
STEP 5: Develop a Decision Rule Calibrate rapid screening data using results of confirmation samples. Compare results to Sediment Management Standards and 303(d) listing policy. Proceed with TMDL development for those metals that still exceed SMS
STEP 6: Evaluate Decision Errors Inadequate spatial coverage (addressed in sampling design) Uncertainty associated with measurement error (addressed by using high-resolution ICP-MS to calibrate XRF screening results)
STEP 7: Optimize the Design for Obtaining Data Consider existing sampling grids: overlay Ecology 303(d) grids, OU B Marine monitoring grids, PSAMP/NOAA strata, and WASP-box model boxes to ensure optimum sampling locations for all data needs Prepare SAP addendum in accordance with WA Ecology guidance for collection and analysis of sediment samples, and submittal of sediment chemistry data. Locate samples near suspected sources for which adequate characterization is lacking. Design sediment sampling to obtain adequate spatial coverage of basin area, but target depositional areas in both inlets. Design should include adequate spatial coverage for short-term (CH3D) and long-term (WASP box) contaminant transport modeling efforts. Reference stations should be sampled to assess boundary conditions and allow for comparison purposes

Table 3. Summary of Section 303(d) Metals Listings for Sinclair and Dyes Inlets Watershed.

Sinclair Inlet		Dyes Inlet	
Sediment	Tissue	Sediment	Tissue
			Antimony
Arsenic	Arsenic		Arsenic
Cadmium		Cadmium	
Copper			
Lead			
Mercury		Mercury	Mercury
		Silver	
Zinc			

Source: www.ecy.wa.gov/programs/wq/303d

Table 4. Marine Water Quality Criteria and Sediment Management Standards (SMS).

Substance	Water Quality Criteria (µg/L, **dissolved** fraction)		SMS SQS
	"Acute"	"Chronic"	(mg/kg dry wt)
Arsenic	**69.0**	**36.0**	**57**
Cadmium	**42.0**	**9.3**	**5.1**
Copper	**4.8**	**3.1**	**390**
Lead	**210.0**	**8.1**	**450**
Silver	**1.9**	**none**	**6.1**
Zinc	**90.0**	**81.0**	**410**

(Sources: Chapter 173-204 WAC Sediment Management Standards, Chapter 173-201A WAC Water Quality Standards for Surface Waters of the State of Washington; EPA 822-Z-99-001 National Recommended Water Quality Criteria-Correction.)

Table 5. The metal analytes to be measured in sediment samples collected for PSNS Project ENVVEST. The reliable detection limit (RDL) for metals measured by rapid screening xray fluorescence detection (XRF), the method detection limit for metals analyzed by ICP/MS, the ambient concentration of metal in Sinclair and Dyes Inlets, and the sediment management levels are presented.

					Washington State Management Standards[d]	
Analyte	Units	Reliable Detection Limit for XRF[a]	MDL for ICP/MS[b]	Ambient Concn. in Sinclair/Dyes Inlets[c]	Sediment Quality	Minimum Cleanup Level
Fe	%	0.01		2.70		
Ag	ug/g ppm	10.00	0.072		6.1	6.1
As	ug/g ppm	20.00	0.109	13.00	57.0	93.0
Cd	ug/g ppm	5.00	0.084	1.60	5.1	6.7
Cr	ug/g ppm	100.00	0.267	62.70	260.0	270.0
Cu	**ug/g ppm**	**18.00**	**0.225**	**145.00**	**390.0**	**390.0**
Hg	ug/g ppm	10.00	0.00208	0.70	0.41	0.59
Ni	ug/g ppm	50.00	0.306	41.60		
Pb	**ug/g ppm**	**8.00**	**0.171**	**94.40**	**450.0**	**530.0**
Zn	**ug/g ppm**	**16.00**	**0.363**	**210.00**	**410.0**	**960.0**

[a] J. Leather, SSC-SD, Personal Communication
[b] Battelle SOW 2002
[c]. Determined as the 50-percentile of data obtained June 2000 from SEDQAUL Database
[d]. http://www.ecy.wa.gov./programs/tcp/sum/sed_chem.htm

7. Figures

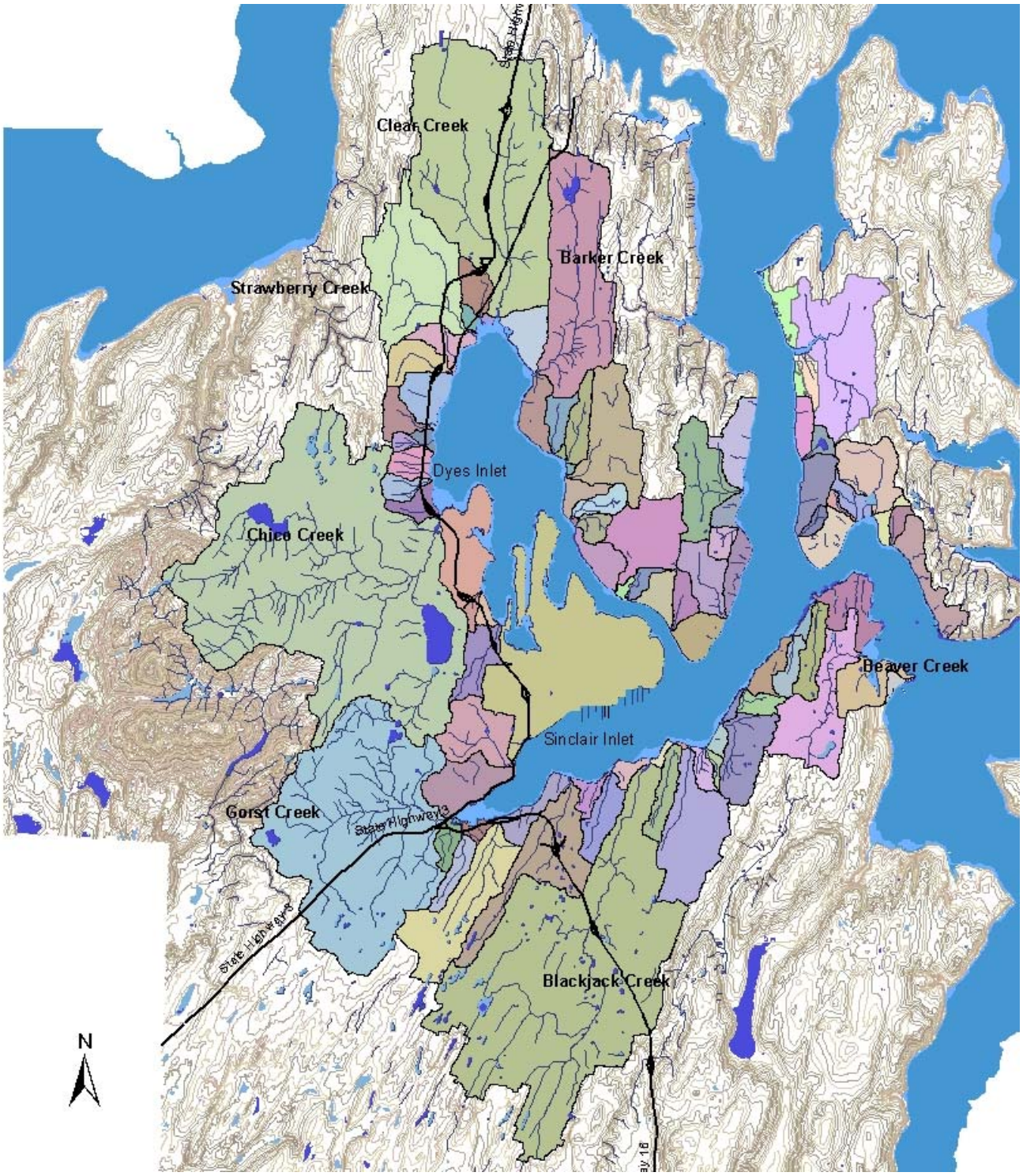


Figure 1. Major watersheds within the study area of the Sinclair and Dyes Inlets Watershed.

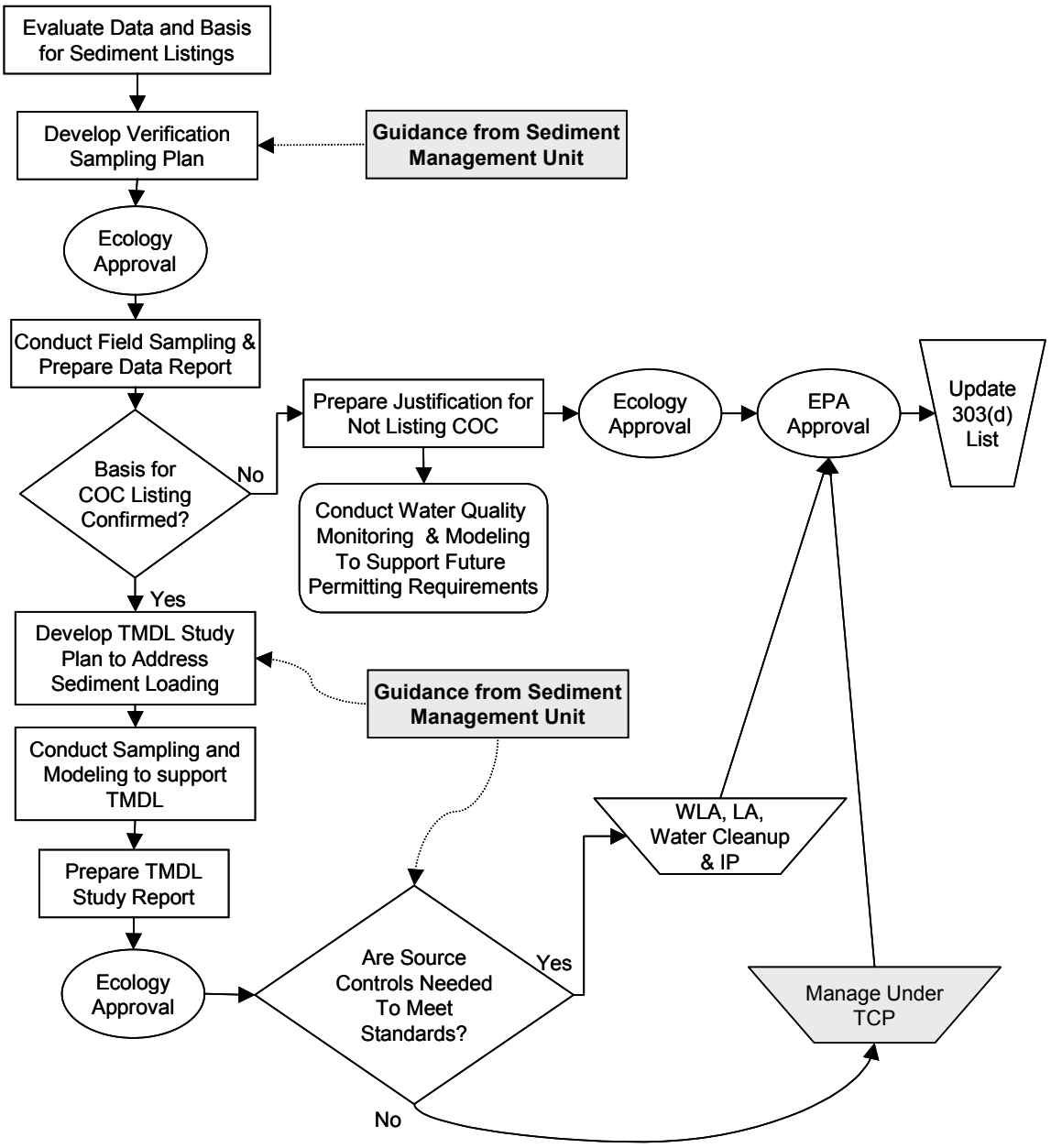


Figure 2. A schematic drawing of the process to assess metal listings on the 303(d) list for sediments in Sinclair and Dyes Inlets, WA. If the basis for listing a specific contaminant of concern (COC) is confirmed, then a TMDL Study will be necessary. If further source reductions are required to meet standards, then Waste Load Allocations (WLA) for nonpoint sources, Load Allocations (LA) for point sources, and a Water Cleanup and Implementation Plan (IP) for the watershed will be developed. If the source of impairment is from past practices, the site will continue to be managed under the Toxic Cleanup Program's (TCP) contaminated sediment site program.

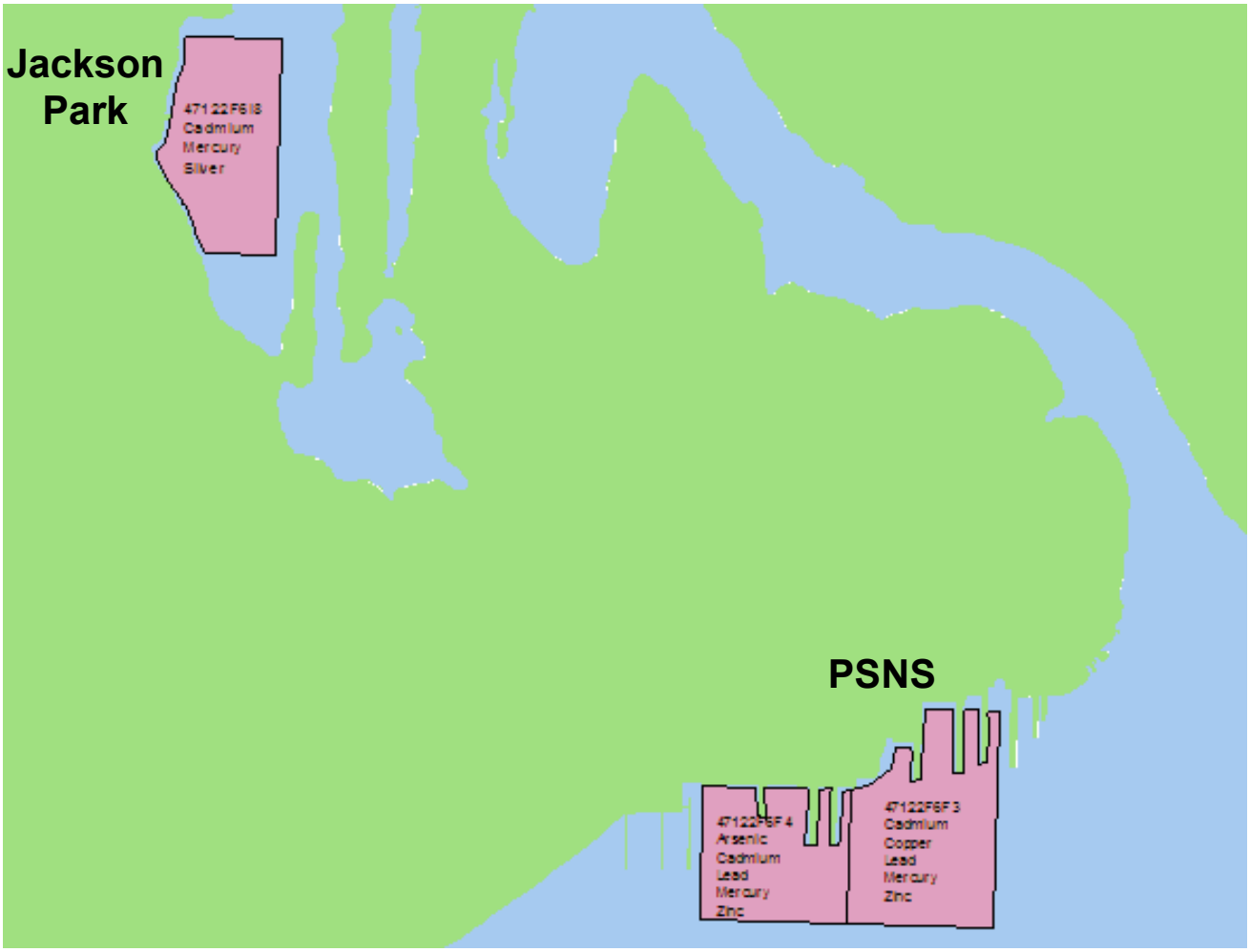
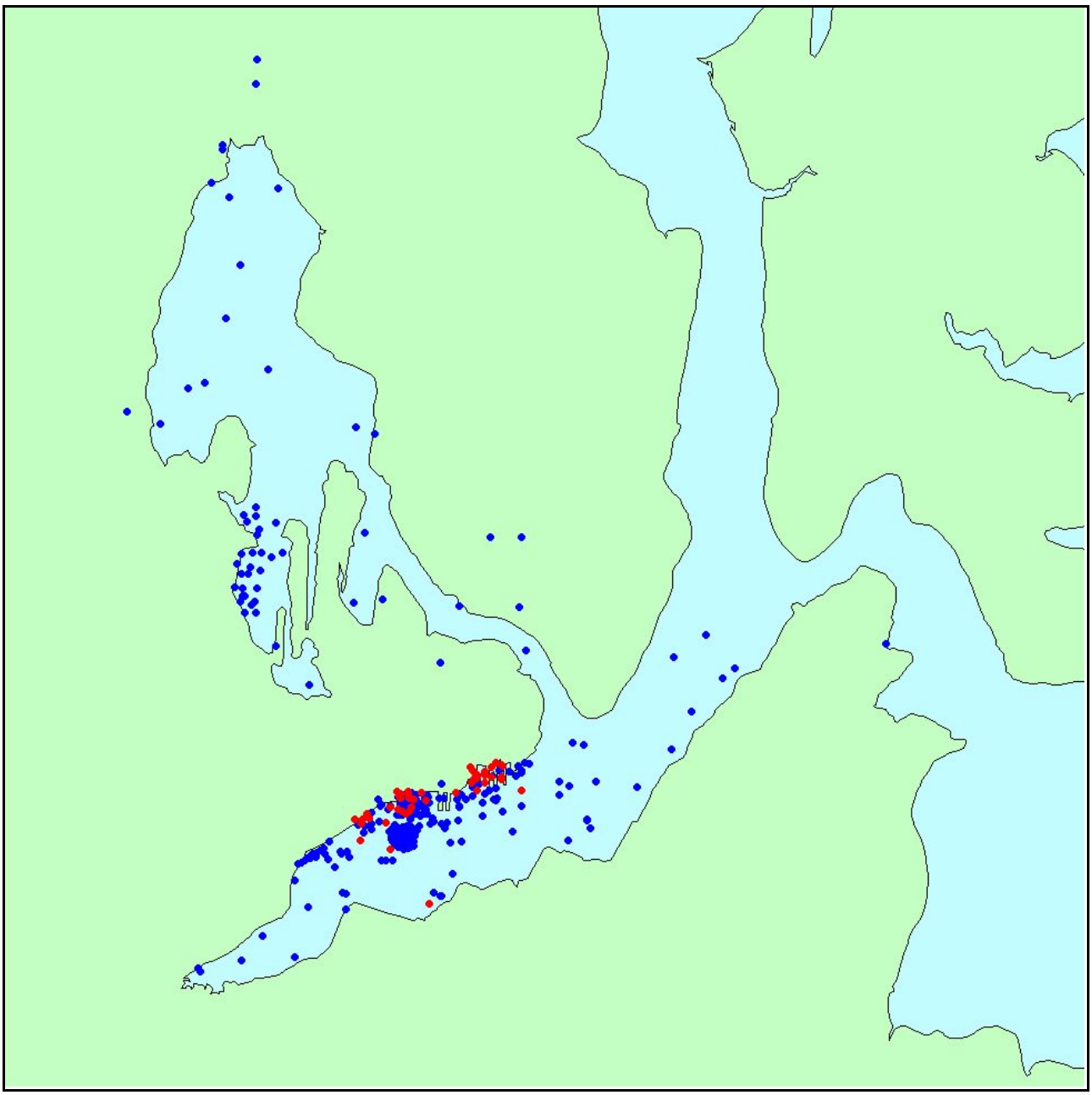
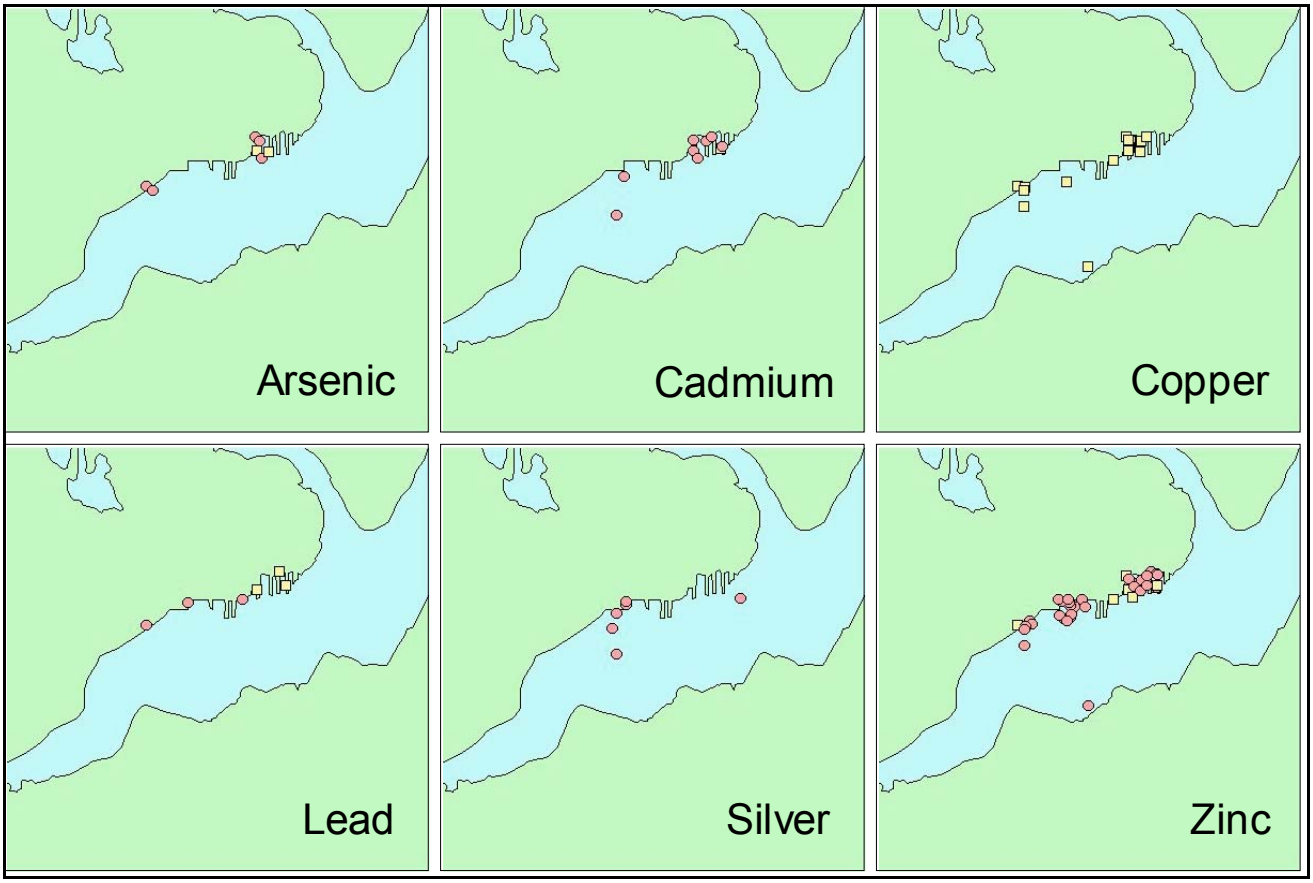


Figure 3. Sediment Grids and Contaminants on the 1998 Section 303(d) List for Sinclair and Dyes Inlets (supplied by Nigel Blakely, Ecology.)



blue = all stations with chemistry data for one or more of the six metals of concern
red = stations where one or more of the six metals exceeds the SQS or MCUL

Figure 4. All SEDQUAL data returned for the six target metals in the Study Area



pink circle = station with listed metal exceeding SQS
yellow square = station with listed metal exceeding MCUL

Figure 5. Stations with one or more of the target metals exceeding SQS or MCUL (note, for Cu, MCUL=SQS).

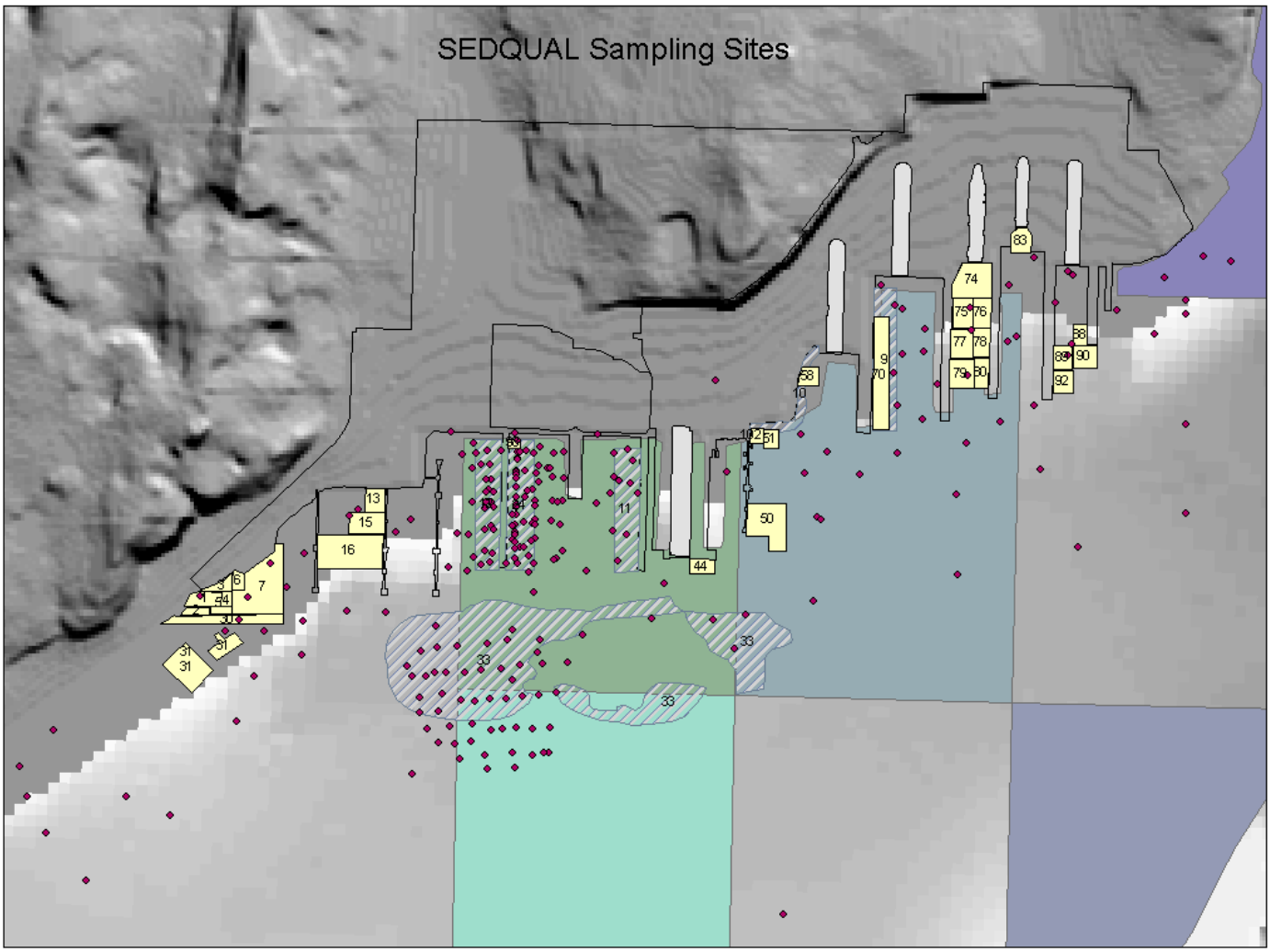


Figure 6. Location of clean up (yellow) and navigational dredging (diagonal crosshatch) areas offshore of PSNS, 303(d) segments (colored rectangles), and sediment sampling stations in Sinclair Inlet.

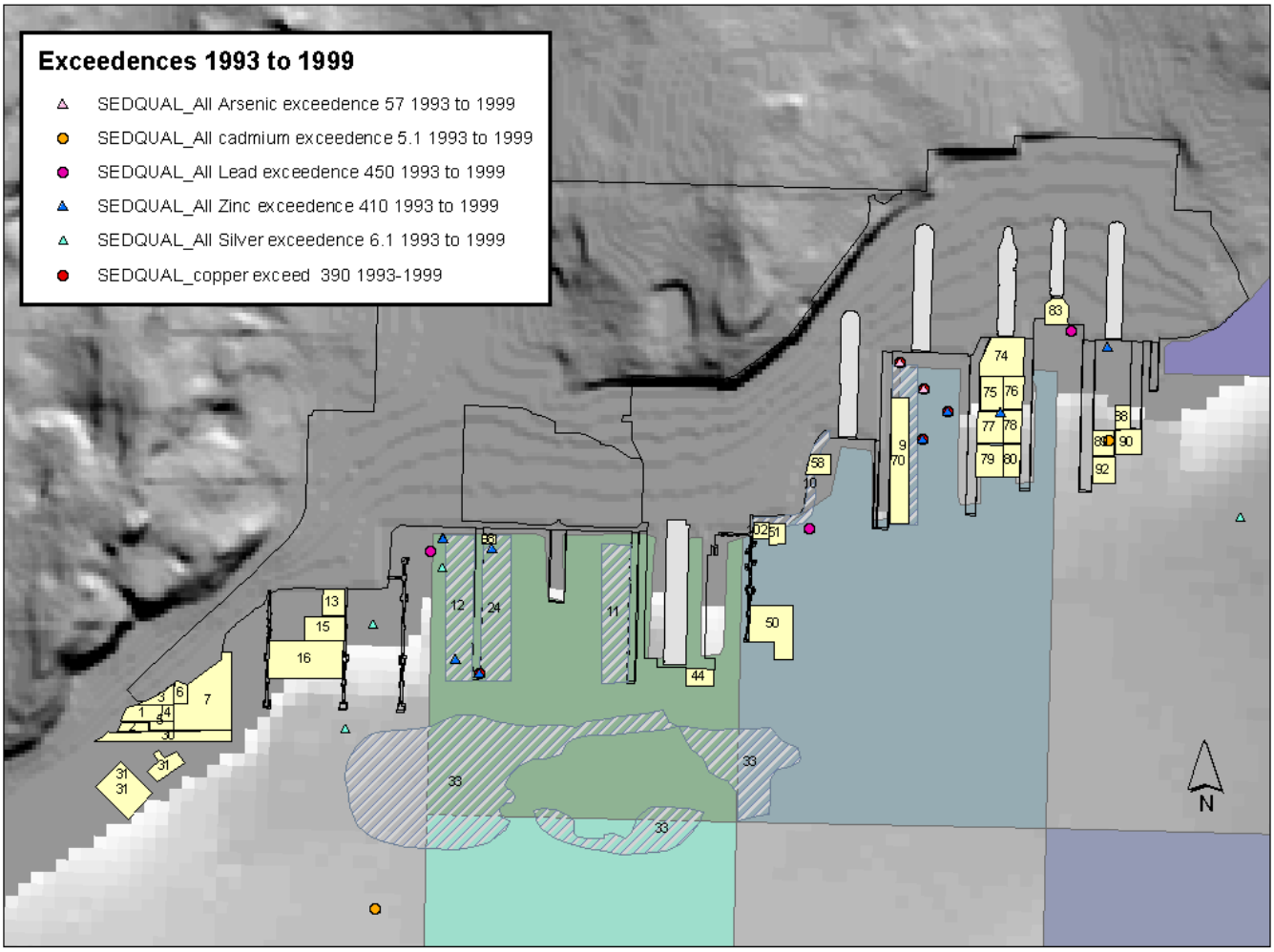


Figure 7. Location of stations with data on target metals collected within the last 10 years that exceeded sediment quality criteria in relationship to cleanup and dredging areas and 303(d) segments.

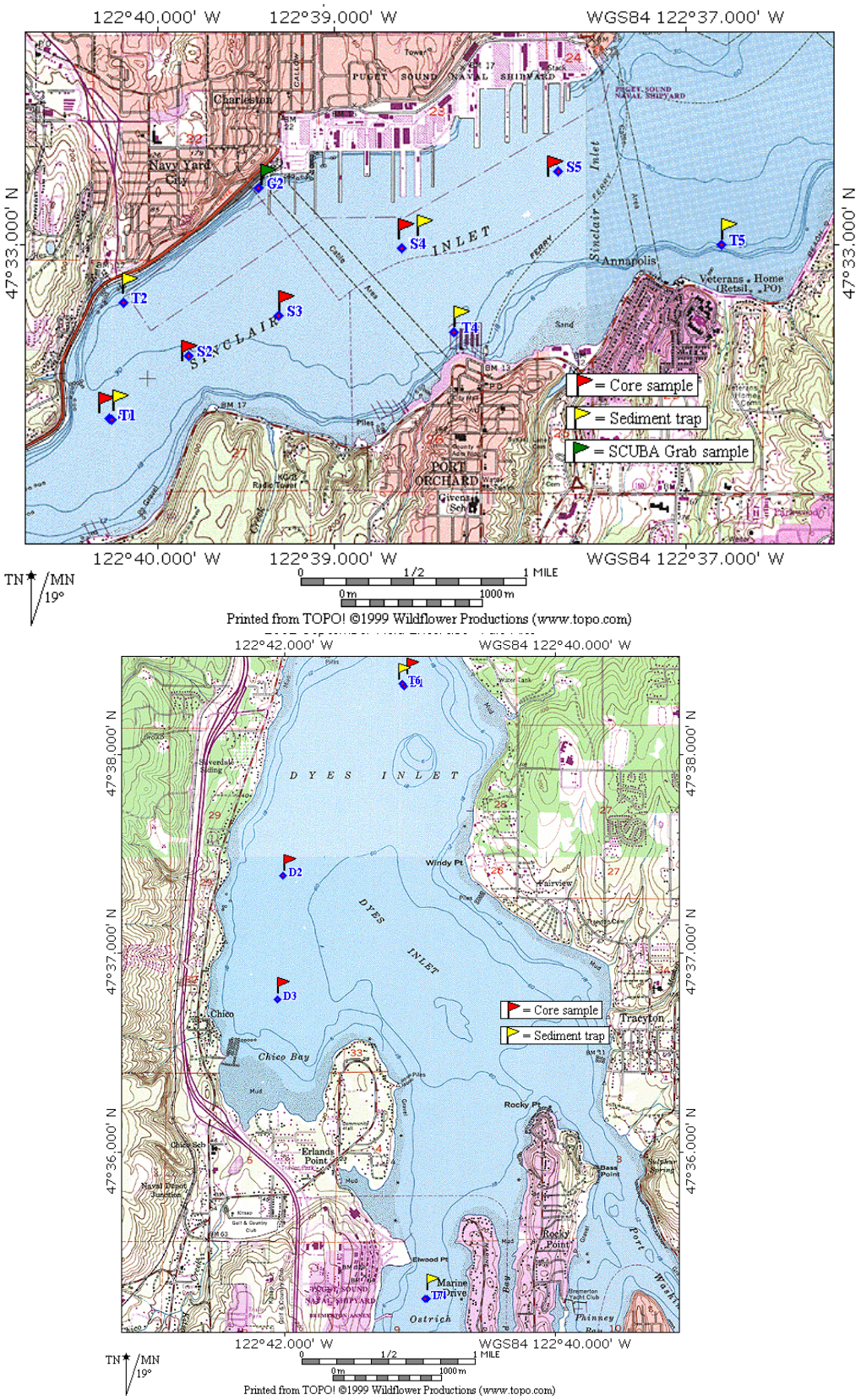


Figure 8. Location of sediment core, trap, and grab samples in the central basins of Sinclair (upper panel) and Dyes (lower panel) Inlets collected as part of the mass balance study (Crecelius and Brandenburger 2003).

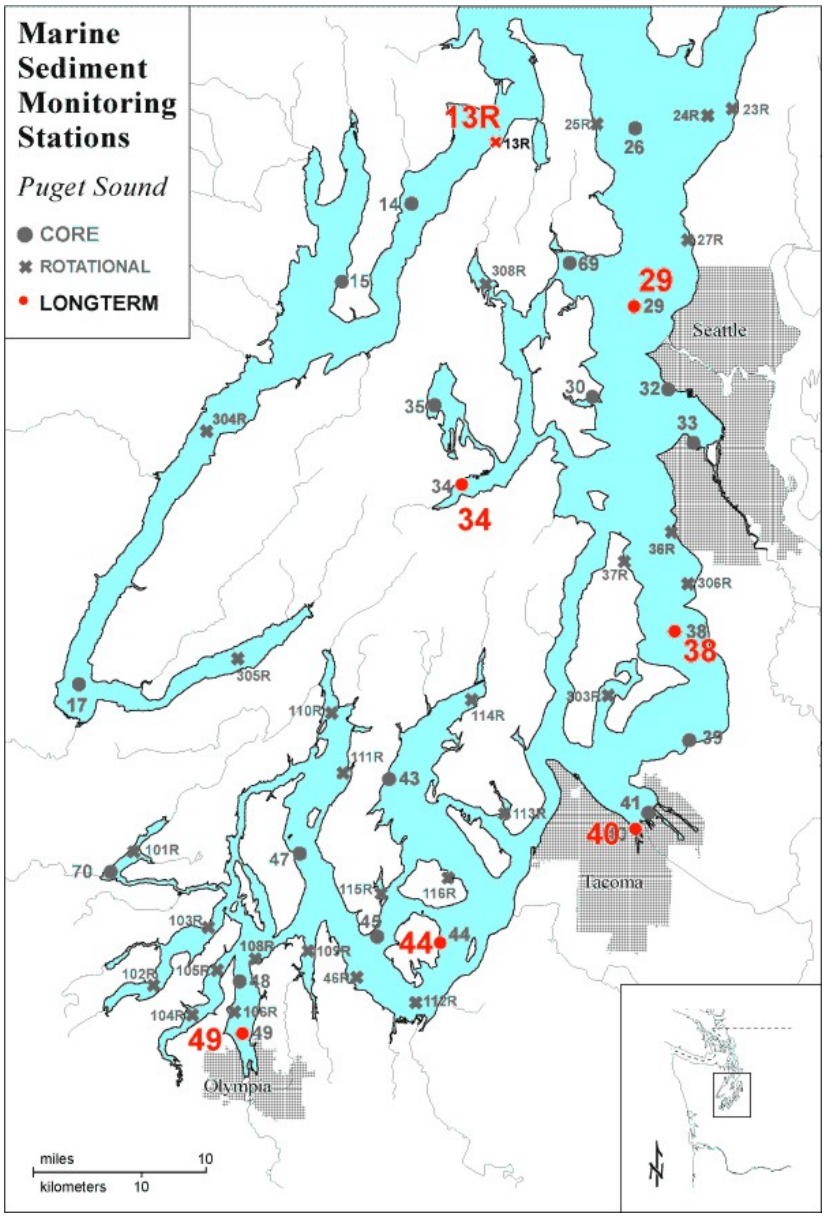


Figure 9. PSAMP Benthic Stations

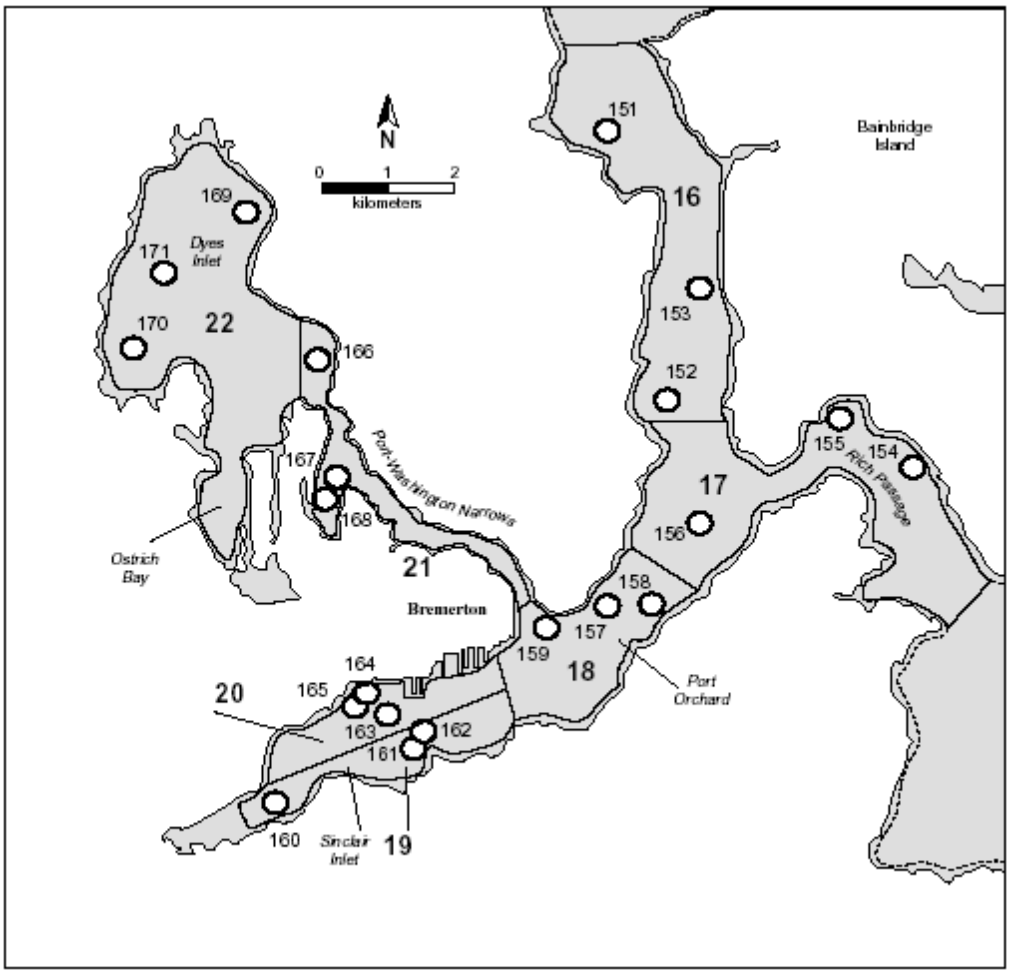


Figure 10. Station locations in Sinclair and Dyes Inlets sampled as part of Puget Sound sediment quality monitoring in 1998 (Long et al. 2000).

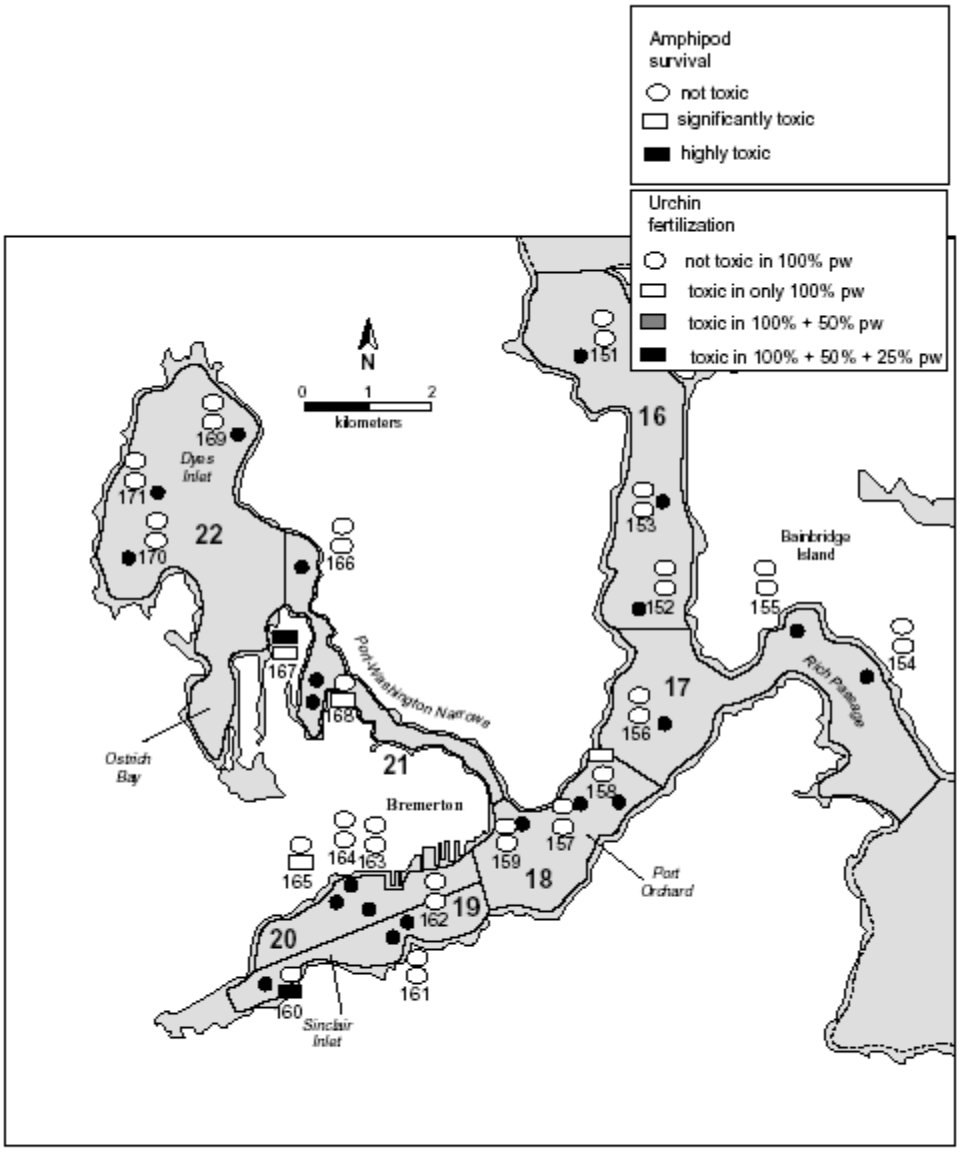


Figure 7. Summary of 1998 amphipod survival tests (top symbols) and sea urchin fertilization tests (in three porewater concentrations, bottom symbols) for stations in Bremerton to Port Orchard (strata 16 through 22). (Strata numbers are shown in bold. Stations are identified as sample number).

Figure 11. Results of bulk sediment (amphipod) and pore water (sea urchin) toxicity reported by Long et al. (2000).

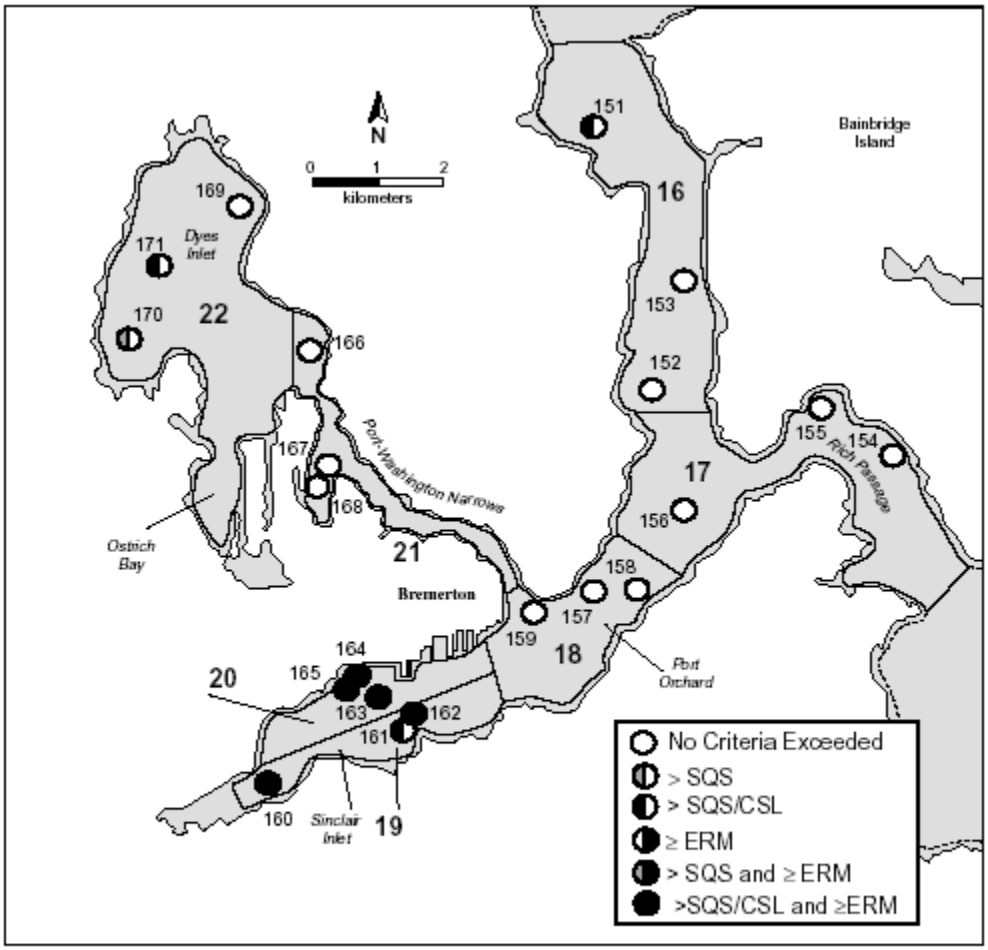


Figure 22. Sampling stations in Bremerton to Port Orchard (strata 16 through 22) with sediment chemical concentrations exceeding numerical guidelines and Washington State criteria. (Strata numbers are shown in bold. Stations are identified as sample number).

Figure 12. Results of sediment chemistry analysis reported by Long et al. (2000).

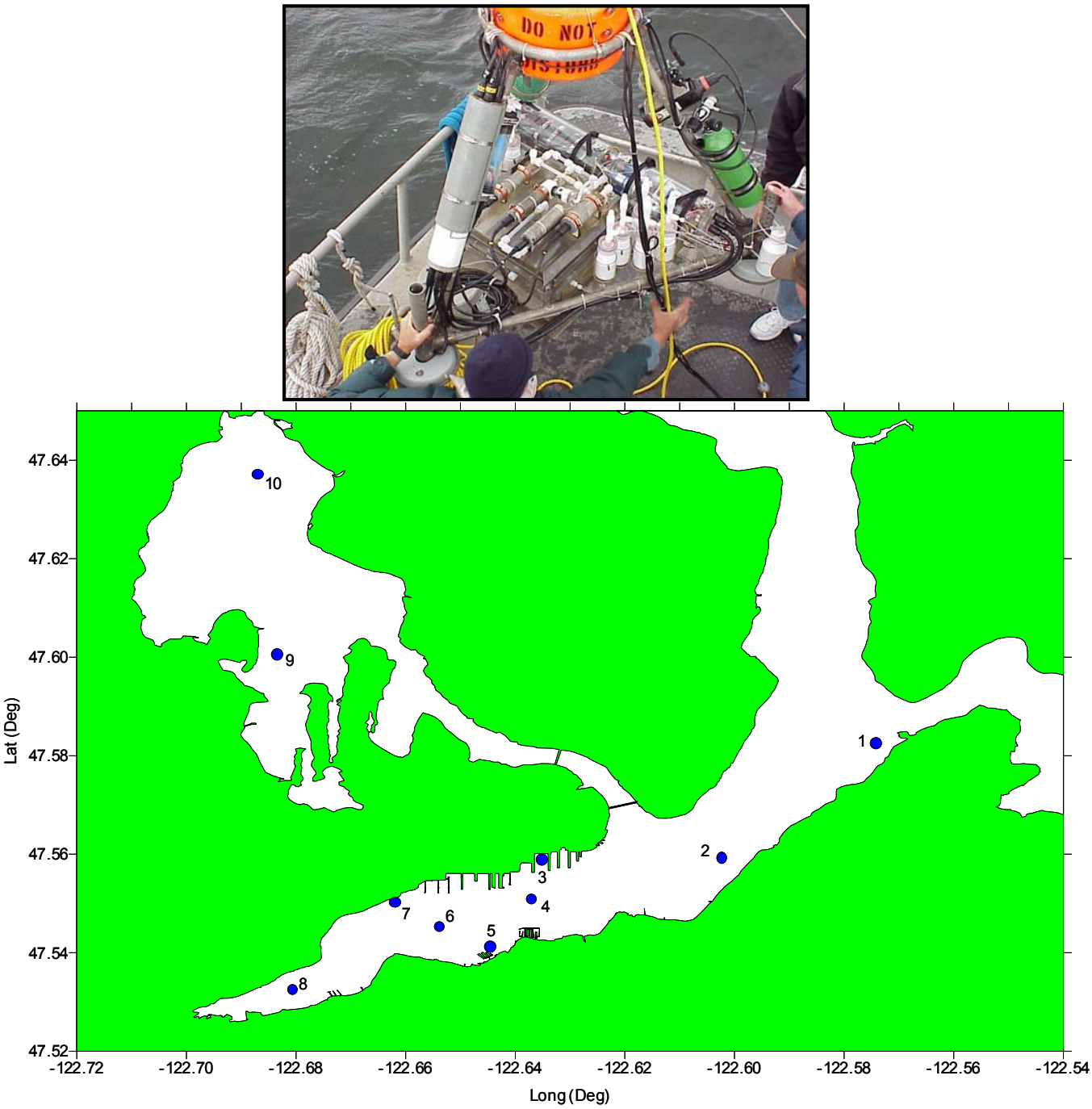


Figure 13. Benthic flux sampling device (upper panel) and location of benthic flux sampling sites (lower panel) (Chadwick et al. 2002).

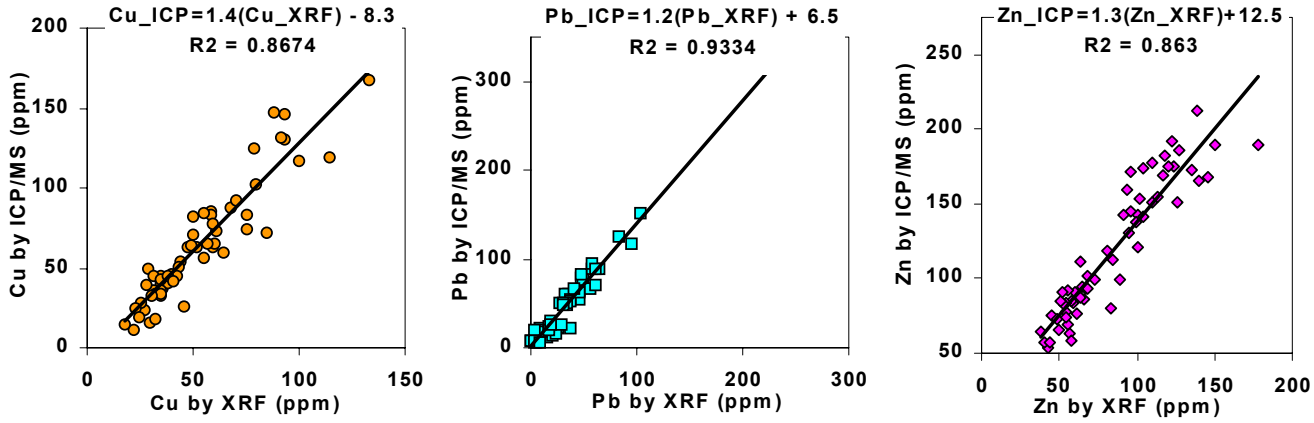
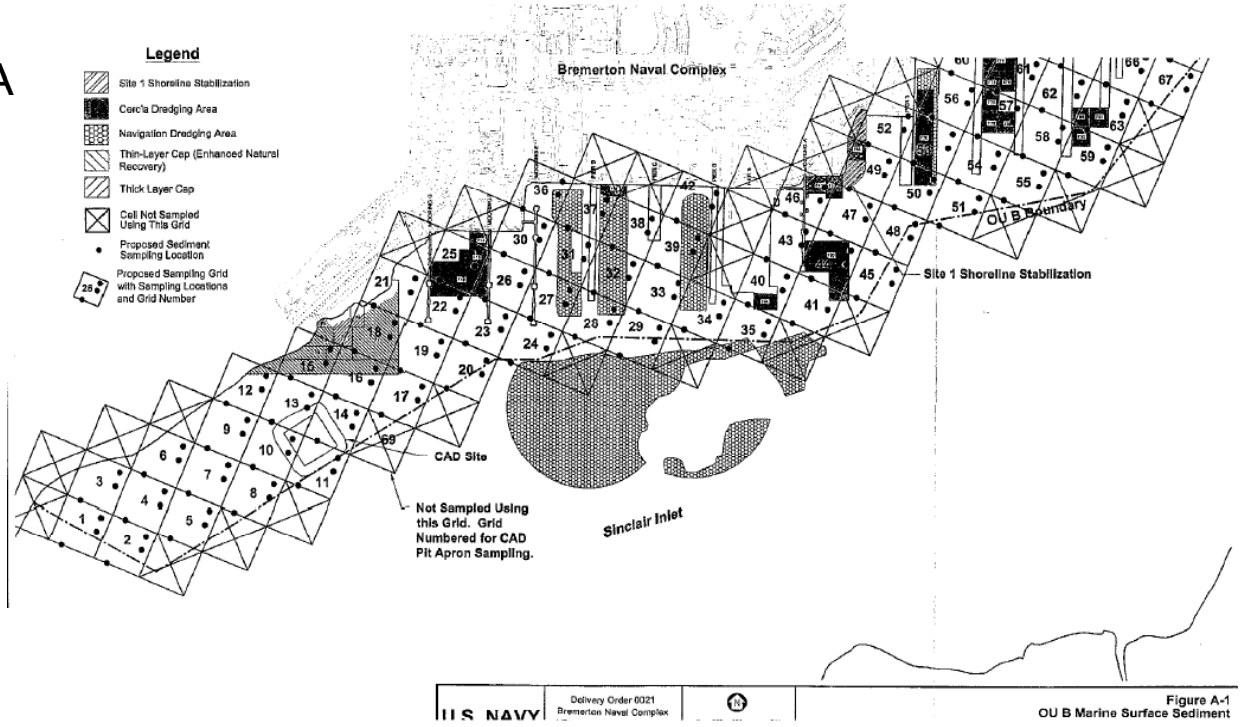


Figure 14. Relationship between Cu, Pb, and Zn measured by XRF and Cu, Pb, and Zn measured by ICP/MS (Lab) developed for sediment grab and core samples collected from Sinclair, Dyes, and Port Orchard Passage for Project ENVVEST (Crecelius et al. 2003a).

A



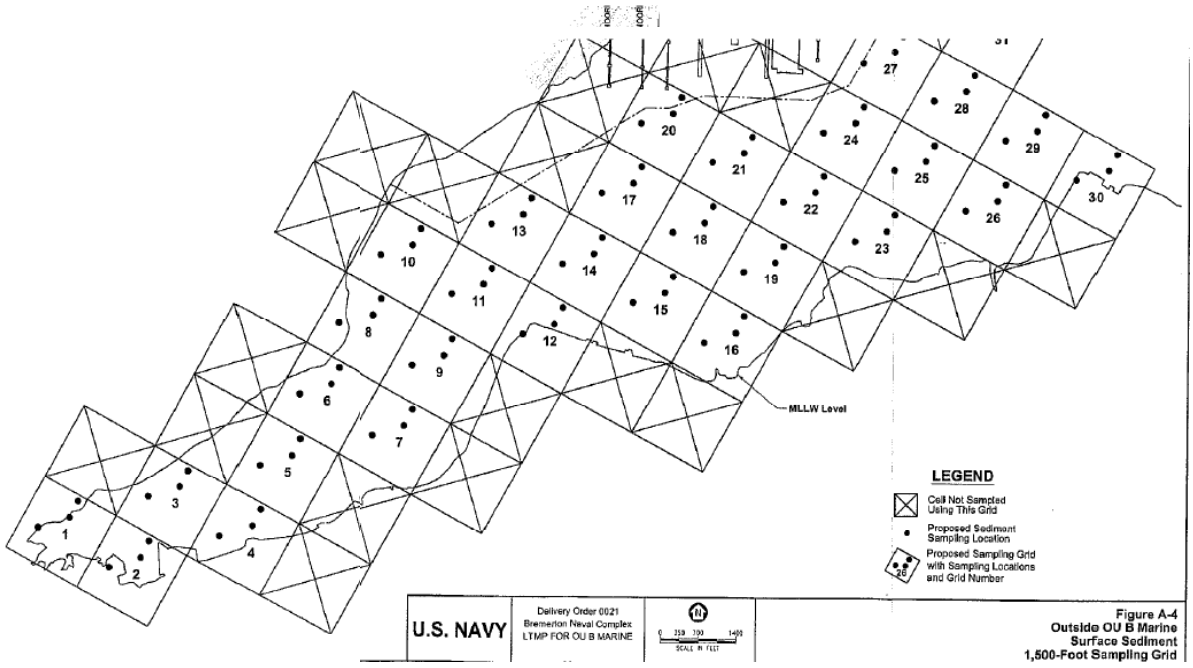


Figure 15. Proposed sampling grids for OU B Marine (A – 500 m grids) and Sinclair Inlet (B – 1500 m grids) monitoring (URS 2002).

Appendices

Appendix A. Response to comments from Ecology

Department of Ecology comments on "Technical Approach to Address Section 303(d) Listings for Metals in Sinclair and Dyes Inlets. Comment Draft. April 15, 2003." 5/22/03

Comment	Response
	Thank you very much for your comments.
1. General. The document should include information on NPL sediment remediation and post-remediation monitoring activities and clarify how the proposed sampling will mesh with those activities.	The following paragraph has been added to Section 1 Introduction: "1.1 Background The 1998 303(d) list included Arsenic (As), Cadmium (Cd), Copper (Cu), Lead (Pb) Mercury (Hg), and Zinc (Zn) in sediments of Sinclair Inlet and Cd, Hg, and Silver (Ag) in the sediments of Dyes Inlet. The 1998 303(d) listings were largely based on sediment data collected as part of the clean up program conducted for the Bremerton Naval Complex, consisting of PSNS and Naval Station Bremerton (NSB) in Sinclair Inlet (U.S. Navy 2000a, U.S. Navy 2003) and Jackson Park in Dyes Inlet (U.S. Navy 2000b). Under the Navy's Installation Restoration (IR) Program, clean up and navigational dredging were conducted for Operable Unit B Marine (the sediments located offshore of PSNS and NSB) in 2000-2001 and post-remediation monitoring activities are being planned. The post-remediation monitoring will be focused on the goals of the Record of Decision (ROD U.S. Navy 2000a). The remedial action objectives of the ROD for OUB Marine were to (1) reduce the area-weighted concentration of PCBs to the minimum clean up goal of 3 mg of PCB per 1 Kilogram of organic carbon (3 mg PCB/Kg OC) within 10 years, (2) selectively remove high concentrations of Hg collocated with PCBs, and (3) control shoreline erosion of contaminated fill (U.S. Navy 2000a). Onshore remediation and source controls were also implemented in 2000-2001 at Jackson Park to reduce potential contaminant migration into Dyes Inlet (U.S. Navy 2000b). To determine whether TMDLs for metals are warranted, a verification study is needed to assess the current status of heavy metals in the sediments of the Inlets. Since Hg is being addressed as part of post-remedial monitoring for Operable Unit B Marine (D. Leisle, PSNS, personal communication), and recent data shows that ambient Hg concentrations exceed sediment quality standards (Crecelius et al. in press), verification sampling for Hg is not needed at this time."
2. General. The primary regulatory decision framework is the Sediment Management Standards regulation (WAC 173-204). Decision rules or methods that are in conflict with the regulation may not be used to support a delisting.	The following sentence as been added to section 3.1 "To the degree possible the sediment metals verification plan will incorporate the requirements of the Sediment Management Standards (WAC 173-204, Washington State 1995) and the 303(d) listing policy (WDOE 2002a, b)."
3. General. Clarify somewhere in the document whether any biological testing is contemplated (see WAC 173-204-310(2)).	Paragraph 3.2 has been revised to read: "Through the verification study, a determination can be made whether further sampling and analysis may be required. For example, the sampling may identify areas in excess of the standards, in which case, additional sampling and biological testing may be useful to support management measures."
4. Page 2. Section 1.1. Line 29: "A number of other data gaps were also identified." It is not clear why the cleanup and dredging activities mentioned are considered a data gap.	Section 2.4 was revised to read: "Data gaps, or lack of information, that were identified included the lack of data on post-remediation metals concentrations in the sediments around the shipyard, the uncertainty associated with contaminant flux predictions based

	Data are available on where these activities have been conducted, and this information should be included in the document. Cross-reference Section 2.5 to clarify where these other data gaps are described. Also, briefly define what is meant by a "data gap".	on data that are not representative of present conditions, and the lack of spatially distributed sediment metals data necessary to support TMDL modeling efforts." A figure of the clean up and navigational dredging areas in relationship to historical data was added to the document.
5.	Page 3. Text and Figure 1. Here and elsewhere, revise to clarify that it is the grid that would be delisted, not the COC. A grid listing may be based on one or more COCs.	It is our understanding that each parameter-segment pairing constitutes a "listing", ie a segment is listed because one or more COCs exceeded standards. For example if a segment was listed for Cu, Hg, and Zn and it was found that Cu and Zn met sediment standards but Pb did not, the segment would not be listed for Cu and Zn, but would still be listed for Hg. Figure 1 text "COC can be delisted" has been revised to read "Prepare justification for not listing COC"
6.	Page 3. Figure 1. This appears to be a rough draft (e.g., yes/no mising from decision box). Another round of review is therefore recommended after it has been revised. Some additional comments on this figure: The purpose of the "Conduct Modeling to Support Future Loading Scenarios" action is unclear. What would be the function of this modeling effort if the COC is to be delisted? Also, please define WLA, LA, and IP in the figure.	"Yes" and "No" have been added to Figure 1. The purpose of "Conduct Modeling to Support Future Loading Scenarios" is stated on page 3, subparagraph 3). The subparagraph has been revised to read: "3) Based on the results of the verification study, if a more detailed study is not required for any metal parameters, a TMDL for metals will not be needed. In that case, the focus would to conduct water quality monitoring and modeling of future loading scenarios to support the development of National Pollution Discharge Elimination System (NPDES) permits, or other management considerations, to assure that future loading will not cause sediment concentrations to exceed standards.." The caption for Figure 1 has been revised to read: "Figure 1. A schematic drawing of the process to assess metal listings on the 303(d) list for sediments in Sinclair and Dyes Inlets, WA. If the basis for listing a specific contaminant of concern (COC) is confirmed, then a TMDL Study will be necessary. If further source reductions are required to meet standards, then Waste Load Allocations (WLA) for nonpoint sources, Load Allocations (LA) for point sources, and a Water Cleanup and Implementation Plan (IP) for the watershed will be developed. If the source of impairment is from past practices, the site will continue to be managed under the Toxic Cleanup Program's (TCP) contaminated sediment site program."
7.	Page 5. Section 2.2. While it may be appropriate to conduct the mercury TMDL on a different schedule from the other metals on the list, this should not preclude mercury from being included in this sampling plan. No compelling reason for excluding mercury is presented. On the other hand, sampling for silver in Sinclair Inlet does not seem justified (see Comment 11 below).	Please see response to comment 1. It is our understanding that there is no need to verify whether Hg exceeds sediment standards because recent data shows that Hg exceeds sediment standards (Crecelius et al. 2003b). Silver is included in the analytical suite of parameters analyzed in the ENVVEST project and does not appreciably affect the cost of metals analysis by ICP-MS. Hg must be analyzed by cold vapor AA and represents a significant additional cost to include it in the analysis.
8.	Page 5. Section 2.2. What are the "cleanup actions for mercury [that] are ongoing"?	Please see response to comment 1. Sentence has been revised to read: "Since Hg is being addressed as part of post-remedial monitoring for Operable Unit B Marine (URS 2002), and it is well documented that

	ambient Hg concentrations exceed sediment quality standards (Crecelius et al. 2003a, b), verification sampling for Hg is not warranted at this time. Furthermore, Hg methylation cannot be modeled with the fate and transport models currently under development for PSNS Project ENVVEST." [The models currently under development for PSNS Project ENVVEST are capable of modeling fecal coliform, divalent metals (excluding Hg), toxic organics, and dissolved oxygen.]
9. Page 5. Section 2.3. For sediments, listing and delisting decisions are based on compliance with the cleanup screening level (Ecology, 2002; Part 9). Table 2 should be revised to show these screening level values.	Table 2 has been revised to also show minimum clean up levels.
10. Page 6. Recommend revising Figure 3 to delete information relating to coliform and organics listings. For each grid with metals listings, show the metals involved.	Figure 3 was replaced with an updated figure from Nigel Blakely.
11. Page 7. Figure 5. The stations shown for silver are actually non-detects with detection limits above the SQS, with one exception (PSNSDR99 PB-51). Grid 47122F6I8 in Dyes Inlet is listed for silver. However, there seems to be little justification for sampling for silver in Sinclair Inlet.	Thank you for clearing that up. Please see response to comment 7. Silver is included in the analytical suite of parameters analyzed in the ENVVEST project and does not appreciably affect the cost of metals analysis by ICP-MS. Ag was analyzed in the, winter and summer baseflow samples collected in 2002, the In-Stream Storm Event samples collected winter 2002-2003, and will also be sampled in the storm water event samples planned for fall 2003. Please see PSNS Project ENVVEST Technical Work Masterplan, of May 2002. https://swdata.spawar.navy.mil/envvest/tech_master_plan_06_f2_web2b.pdf
12. Page 8. Section 2.5. This section should be expanded to include maps showing where remedial activities have been conducted in relation to areas where metals contamination has been found. These can be used to identify remaining "areas of presumptive contamination". In addition, include maps for the listed grids that help in identifying areas that may not have been adequately sampled. Also include information on the areas of sediment contamination that formed the basis for listing grids. Not all of these data are included in SEDQUAL, particularly in the case of grid 47122F6I8. However the data sources are identified in a PDF file available at http://www.ecy.wa.gov/programs/wq/303d/	Additional figures have been adding showing clean up and dredging areas and their releationship to sampling locations, exceedances of sediment quality criteria, and 303(d) segments. The PDF document cited in the comment states for the cadmium listing of grid 47122F6I8: "EA Engineering Science and Technology, 1995, state sediment quality criteria are exceeded at 13 locations." These 13 locations with cadmium exceedances do not appear to be in the SEDQUAL database. For silver, same grid, the document states, "EA Engineering Science and Technology, 1995 , state sediment quality criteria are exceeded at 2 locations." Again, I did not find these locations in SEDQUAL. For mercury, same grid, the document states, "Station Cluster (Jackson Park) exceeds sediment quality standards in 3/8/96 assessment." More work will be required to track down the data cited in these references.
13. Page 8. Section 2.5. Onsite remediation in Dyes Inlet alluded to here is apparently upland and not a sediment remediation. This again illustrates the need for more detail as	Please see response to Comment 1. Yes, upland remediation was conducted to prevent potential releases into the nearshore and marine environment and allow further natural attenuation to occur.

mentioned in Comment 1.	
14. Page 8. Section 2.5. While benthic flux is important, particulate concentrations could also be very important for any modeling effort since this would represent diluting material for any sediment recovery.	Yes we agree. Analysis of particulate and dissolved metal will be included if a TMDL study is required.
15. Page 8. Section 3.1. Within a listed grid there may be areas that have been remediated; areas of presumptive contamination (see Comment 12); areas where concentrations from previous sampling meet regulatory criteria; and areas that have not been adequately sampled. Describe the proposed approach (sampling, decisions) for each type of area.	The Sediment Metal Verification Plan will provide the requested information
16. Page 8. Section 3.1. XRF is not an accepted method under PSEP protocols, as required by the Sediment Management Standards regulation (WAC 173-204).	We are proposing to use XRF in conjunction with ICP-MS to develop a more comprehensive sampling design, than could otherwise be achieved with available resources. The XRF analysis will help identify which samples should be confirmed by ICP-MS.
17. Attachment A, Step 1. "Because of recent remediation activities, sediment as a source of metals to the water body cannot be adequately characterized with the existing data. In addition, several suspected sources of metals to the water body have not been adequately characterized, e.g., discharges from storm water outfalls and recreational vessel marinas." The relevance of these statement is unclear since the grid listings in Sinclair and Dyes Inlets are for sediments, not the water column. Some explanation is needed.	The following sentence has been added to Attachment A, Step 1. "The copper mass balance study shows that sediments are a sink for copper; therefore, copper (& other metals) in the water column have potential to impact sediment concentrations (Crecelius et al. in 2002a, b, c). Sediment in the vicinity of potential water loading may not have been adequately characterized."
18. Attachment A, Step 4. The default vertical boundary is 10 cm depth. Use of an alternative value would require consultation with and approval from the Ecology Sediment Management Unit.	Based on recent calculations of sedimentation rates in Sinclair and Dyes Inlets, 2 cm represents about 3 to 12 yrs of accumulation (Crecelius et al. 2003a, b, c). The mass balance calculations for Cu show a net flux of Cu into sediment (Crecelius et al. 2003a, b, c), indicating that the sediment is a sink for contaminants. The surface 2-3 cm probably best represents the present day sediment conditions within the Inlets. Additionally, 2-3 cm is also the sample depth used in the PSAMP benthic monitoring program (Dutch et al. 1998). The fine-grain sediments within the inner part of Sinclair Inlet are highly anoxic and studies have shown that oxygen is depleted within the upper few mm (<0.5 cm) of the sediment (Chadwick et al. 1993) and that the sulfide concentrations were very high (~50 umol/g) in the surface sediments (0-5 cm) of cores collected in the fine grained muds near the shipyard (Johnston 1993). These data suggest that very little bioturbation is occurring below the upper 2-3 cm of the sediment surface.

	However, under sediment management guidelines, the top 10 cm are used in the regulatory program to determine whether sediments are in compliance with sediment quality standards. Although, the depositional rates measured by Crecelius et al. (2003a, b, c) are applicable to the central basins of the Inlets, there is considerable uncertainty about accumulation rates around piers, pilings, and dry docks and other nearshore areas that are subjected to disturbance and resuspension processes. Therefore, in order to be consistent with the regulatory program, it is recommended that the top 10 cm should be sampled for the metals verification study.

Appendix B. Response to Comments from EPA

Response to EPA Comments on ENVVEST's Proposed Technical Approach to Address Section 303 9d) Listings for Metals in Sinclair and Dyes Inlets of 06/2/03

COMMENT	RESPONSE
	Thank you very much for your comments.
Overall Comment The proposed approach has multiple and distinct objectives. These distinct objectives may not be compatible given the scope, methods, and level of effort proposed. Additional focus and prioritization is necessary and must be explicitly linked to priority and secondary objectives and sampling areas.	The following has been added to Section 1 Introduction to clarify the purpose of the document: Specific objective of this document are to: 1. Define a process for addressing metals in sediments listed on the 1998-303(d) list in Sinclair and Dyes Inlets. 2. Develop data quality objectives and rationale for addressing sediment metals with the framework of the TMDL and Toxic Cleanup Programs. 3. Summarize existing data and information on sediment contamination that has a bearing on 303(d) listings in Sinclair and Dyes Inlets.
Stated objectives include: **1) Identification of most significant sources of contamination** - Intro. p. 2 "*The focus of [the] review was to identify the most significant sources of contamination (with the highest degree of uncertainties...)"*	Figure 1 has been revised to show how the proposed approach fits within the Sediment Management and TMDL frameworks. The passage has been revised to be clearer. The focus of our review was to identify the most significant sources of uncertainty and develop recommendations for new data collection.
2) 303(d) Verification Study for both Sinclair and Dyes Inlets - 1.1 Summary of Approach p. 2. "*A systematic approach is proposed to assess the current and proposed metal listings... in Sinclair and Dyes Inlets..."* ; "*...verification sampling and analysis will be developed to assess sediment in areas previously identified as contaminated throughout the study area"; the study design will ensure that results are compatible with EPA [and Ecology methods and requirements]"*	The following references have been added The study design will ensure that results are compatible with U.S. Environmental Protection Agency (EPA) and Ecology requirements for compliance with Sediment Management Standards (WAC 173-204, Washington State 1995) and the 303(d) listing policy (Ecology 2002a, b).
3) Site Remediation Verification Study - p. 2. section 1.1 Summary of Approach " *An extensive cleanup program consisting of dredging and pit-cad site was conducted in 2000-01*; p. 8. section 2.5 Existing Data Gaps "*Sediment data has not been collected and analyzed since this clean-up. Target contaminants of this clean-up were PCBs and Hg and follow-up moniotoring for those parameters is planned in 2003.* " p. 9 sec. 3.1 Verification."*A standard suite of metals will be analyzed in all samples to ensure* that a current, comprehensive post-dredging data set is considered."	No response necessary.
4) Calibration for establishing benthic flux rates of contaminants - p.8. section 2.5 Existing Data	In situ benthic flux measure show that under certain conditions there is a next flux of contaminants out

Gaps [Is sediment a source or sink?] What would be the necessary spatial sampling pattern for this work, assuming flux rates would be different in different areas?	of the sediment into the overlying water. Benthic flux studies need to be focused on representative areas for which measured flux rates can be applied.
5) Methods correlation study - "*10% of the total number of XRF samples will also be analyzed by ICP/MS to further develop the quantitative relationship between XRF metals and ICP/MS metals.."*	The metals verification plan will specify that about 25% of the samples will be analyzed by ICP/MS. Samples that have XRF results within 90% of the SQS or samples in which XRF result is much different (higher or lower) than expected results will be targeted for ICP/MS confirmation.
General Comments: a) Regarding objective #1 from above, EPA doesn't understand how we have ended up focusing on existing contaminated sediments - themselves - as one of the main "...sources of contamination...." . In the 01/02 QA Project Plan for Development of a Contaminant Mass Balance for Sediment in Sinclair and Dyes Inlets, Three project tasks were outlined: 1) "...determine an inventory of contaminants in the sediments, including defining present sources of contaminants and the natural rate of recovery..."; 2) ".. Collaborate on the application and inter-calibration of rapid assessment methods for integrating sampling and assessment [for developing] a sediment mass balance."; and 3) ".. to conduct technical analysis to support TMDL[s]..." This is different than beginning w/ the assumption that existing sediment is a big source. Within EPA, we are much more comfortable starting from the perspective that contaminated sediments are a problem, and we want more emphasis on broader source identification and loadings assessments that go beyond the re-characterization of existing sediment contamination. The emphasis that EPA was expecting within the development of a mass balance approach does not seem consistent with the TMDL verification objectives presented and emphasized in the metal study approach document. We seem to be taking a step back and the technical basis for doing so is again unclear. Of what specific benefit are the proposed samples given what we currently know about the inlet - without relying on a statement of general need for general verification?	The sediment metal verification plan is being developed to fill in a specific data gap identified in the TMDL process. The document has been revised to better explain the objectives of the sediment metal verification plan: • What is the current condition of sediment metal contamination within the Inlets? • Should the sediments be listed for metal contamination on the 303(d) list? • Has there been a decrease in sediment metal contamination since cleanup and remediation activities were initiated? The focus would to conduct water quality monitoring modeling of future loading scenarios to support the development of National Pollution Discharge Elimination System (NPDES) permits or other management considerations to assure that future loading will not cause sediment concentrations to exceed standards.
b) Regarding the proposed 303(d) verification studies (objective #2 above), EPA has several comments: i) With the exception of verification sampling within the areas dredged or capped, EPA does not believe an adequate basis or focus has been presented for the verification design. ii) The proposed approach would in essence use an experimental and screening level approach for 90% of the samples proposed for the verification study. This does not seem appropriate by definition of a verification study.	The document has been revised to more clear state the rationale and technical approach for the metals verification study. The metals verification study plan will present the details of the sampling and analysis procedures.

iii) The level of analytical effort among traditional and experimental approaches should be more balanced and geographically focused given the objectives presented and emphasized	The metals verification plan will specify that about 25% of the samples will be analyzed by ICP/MS. Samples that have XRF results within 90% of the SQS or samples in which XRF result is much different (higher or lower) than expected results will be targeted for ICP/MS confirmation.
c) The work to verify remediation areas (objective #3 above) is not directly relevant to the objectives of ENVVEST, which was to use these technical analyses to determine whether their was the potential for pollutant trading within the TMDL framework. In this sense, the proposed verification studies appear to be a distraction, at least as presented.	The metals verification study is a necessary step to move forward on the TMDL process and develop the information base necessary to support pollutant-trading alternatives.
d) The calibration issues described appear quite important to the development of the mass balance, and for comparing different methods. The locations and range of parameters for these samples could be different than for that of the verification studies proposed. The level of importance of correlating different methods is unclear. How much work needs to be undertaken to establish some of these relationships? Is the proposed scope and mix of samples adequate to accomplish this? Is this adequate sample overlap for correlating methods? Are there any pre-requisite spatial criteria for this data? Do the locations for dual methods analyses need to be randomly selected or can these locations be targeted?	The use of the combination of XRF and ICP/MS to determine sediment metal concentrations is turning out to be a very useful tool for Project ENVVEST. The use of these methods in the metals verification study will build on the strong correlations developed for the mass balance study (Crecelius et al. 2003a, b, c).
e) While the approach states an intent to provide a standard suite of metals will be analyzed in all samples to ensure a current and comprehensive data set, significant effort went into eliminating specific metals from the analysis. No connection is made to other parameters that could be linked to metal sources including PAH's and other signature pollutants. Instead, the design appears to emphasize the process of eliminating parameters of general concern or interest. An overly narrow interpretation of parameters of concern based only on 303(d) listed parameters is a concern.	The document has been revised to state: "To be consistent with the metals being analyzed in technical studies being conducted under Project ENVVEST all samples will be analyzed by the following suite of nine metals (Ag, As, Cd, Cr, Cu, Fe, Ni, Pb, and Zn). The target metals are arsenic, cadmium, copper, lead, silver, and zinc."
f) Overall, we have concerns regarding the breadth of questions and limited mix of samples. Too much is being expected of a data set that is relying on an analytical approach similar to screening level methods (Battelle, 01/2002). We would like some assurance that the quantitative design and sampling spread are appropriate for each of the objectives mentioned. We believe that the locations of these samples is critical and would like to see the suggested sampling grid as envisioned	The metals verification study has been better focused, specific concerns have been addressed, and the sampling plan will document the sampling locations and procedures to be used in the study.

Appendix C. Response to Comments from the Suquamish Tribe

24 July 2003
VIA EMAIL
Subject: Technical Approach to Address Section 303(d) Listings in Sinclair and Dyes Inlets

Comment	Response: Thank you very much for your comments.
Thank you for allowing the Tribe to comment on the draft ENVVEST document "Technical Approach to Address Section 303(d) Listings for Metals in Sinclair and Dyes Inlets." As you know, Dyes and Sinclair Inlets are part of the Suquamish Tribe's Usual and Accustomed area and contain treaty-reserved fishery resources. The Tribe currently prohibits its members from harvesting various fishery resources from these waterbodies due to contaminant levels detected in the inlets and the potential risk to human health from consuming these trust resources. Addressing 303(d) listings for metals is therefore of great concern and interest to the Tribe. The Tribe has the following concerns about the proposed technical approach: first, the verification study does not properly address all potential sources of contamination; second, by choosing SQS and MCUL criteria, the verification study has implicitly selected an ecological endpoint that may not support beneficial uses (such as fish and shellfish consumption); and third, the verification lacks sufficient discussion of uncertainties associated with the proposed sampling and analysis.	The metals verification study is just one component of Project ENVVEST and contaminant loading and source identification will continue to be addressed. The verification study is being designed to address the following questions: • What is the current condition of sediment metal contamination within the Inlets? • Should the sediments be listed for metal contamination on the 303(d) list? • Has there been a decrease in sediment metal contamination since cleanup and remediation activities were initiated? The SQS and MCUL criteria, defined by regulation, that must be addressed to determine waterbodies that should be listed on the 303(d) list. The metals verification sampling and analysis plan will discuss uncertainties associated with the proposed approach.
The verification study assumes that Navy clean-up activities have removed the principal sources of metals contamination in the Inlets. Based on this assumption, the study proposes that current conditions be assessed to determine if listings, TMDLs, and load allocations are now warranted. The Tribe appreciates the implicit concern of proceeding through the TMDL and load allocation process for parameters that are no longer causing impairment. However, the Tribe believes that the assumption that clean-up activities have reduced contaminant sources to a level that will not contribute to current and future impairment should be treated as a hypothesis and be thoroughly tested as part of the verification study.	The data from the metals verification study will be used to determine whether contamination levels have decreased, increased, or stayed the same since previous samples were collected.
The verification study proposes the use of SQS and MCUL as criteria for listing or de-listing contaminants in the Inlets. The Tribe is concerned that SQS and MCUL criteria may not be protective of human health associated with the beneficial use of consumption of shellfish and finfish from the Inlets. The Tribe believes that verification must include assessment of risks to human health via this beneficial use pathway. The Tribe suggests that the ENVVEST Technical Steering Committee explore approaches to evaluating the human health risks associated with consumption (including subsistence) of seafood from the Inlets. It may be	A detailed human health risk assessment was performed for the CERCLA clean up and remediation conducted for OU B marine in Sinclair Inlet. Please see URS 2002b The data from the biological samples obtained from the PSAMP demersal fish trawls can be used to "screen" against human health endpoints for the consumption of fish. This can provide a supplemental line of evidence to support the decisions with to list specific contaminants on the 303(d) list. Information about the fish tissue sampling and analysis can be obtain at: https://swdata.spawar.navy.mil/envvest/biota

possible to use tissues from biota recently collected from Sinclair Inlet to begin a characterization of such risks.	
The verification plan does not sufficiently address uncertainty associated with sampling and analysis. The Tribe is concerned with the potential for false negative errors in the verification approach. The Tribe believes that the Technical Steering Committee should first agree on acceptable probabilities for both type I (false positive) and type II (false negative) errors. The verification study (including the sampling plan and the analytical methods) could then be designed with those explicit requirements in mind.	The metals verification plan will propose the statistical analyses to be conducted on the data. The null hypothesis that there is no change in sediment contamination levels can be tested to the extent the data allows. However, whether a particular sediment segment should be listed on the 303(d) list or not, depends on the listing policy adopted by Ecology. The uncertainty associated with the analysis will be included in the study report.