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EAST WATERWAY, EVERETT, WASHINGTON
TECHNICAL DOCUMENT REVIEW

Review of:

Tetra Tech, Inc. and PTI Environmental Services, September 1988, Everett Harbor Action Program: Analysis of Toxic Problem Areas TC-3338-26 Final Report, September 1988, prepared for United States Environmental Protection Agency, Region 10 - Office of Puget Sound, Seattle, Washington.

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Prepared For:

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EAST WATERWAY TECHNICAL DOCUMENT REVIEW

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ATTACHMENTS

1.0 INTRODUCTION AND CHRONOLOGY OF EVENTS

The document reviewed was funded by the Everett Harbor Action Program and used in the preparation of Everett Harbor Action Plans. It provides an excellent summary of information related to the Harbor. This review has been prepared by directly excerpting significant sections of the document in order to condense the wealth of information provided by its authors. The quoted material is presented in bold. References noted within this review are provided in Attachment A.

Briefly, the objectives of this report were:

- **Define spatial patterns and quantitative relationships of sediment contamination, toxicity, and biological effects**
- **Identify problem areas of sediment contamination and associated biological effects**
- **Rank problem areas relative to priority of evaluation of source controls and sediment remedial action**
- **Identify potential problem chemicals (i.e., chemicals that display high concentrations in association with adverse biological effects).**

The approach to identification and ranking of problem areas relies on empirical measurements of the environmental hazard of contaminated areas. The primary information used in the decision process includes:

- **Sediment characteristics**
  - **Contaminant concentrations** [Contaminants are listed in Attachment B]
  - **Conventional physical/chemical characteristics (e.g., grain size distribution, sulfides, total organic carbon content)**
- **Biological effects**
  - **Benthic invertebrate community structure**
  - **Sediment toxicity bioassays using amphipods**
  - **Concentrations of polychlorinated biphenyls (PCBs), chlorinated pesticides, and mercury in mussel tissue of English sole (_Parophrys vetulus_) and Dungeness crab (_Cancer magister_)**
  - **Prevalence of liver lesions in English sole.**

Tetra Tech (1985a, 1986e) described the rationale for selecting these five major kinds of data to characterize the environmental hazard of contaminated sediments.

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The environmental data on sediment contamination and biological effects were organized into a matrix of biological and toxicological indices used to compare study areas. This Action Assessment Matrix uses multiple independent indices termed "evaluations above reference" (EAR) to indicate the magnitudes of contaminant levels and biological effects relative to reference conditions. A decision to proceed with source evaluation and ranking of problem areas is limited to sites that exceed a minimum action level defined by one or more significant EAR. The Action-Level Guidelines provide a consistent framework [based on Apparent Effects Thresholds (AETs) or in some cases exceedance of the 90th percentile concentrations for chemical contaminants] for defining toxic problem areas based on the weight of evidence from evaluation of the selected hazard indicators. In the case of a single significantly elevated index, the magnitude of the evaluation must provide sufficient evidence of a problem to outweigh the absence of significant elevations in multiple indicators.

The Everett Harbor project area includes nearshore areas of Port Gardner, the Snohomish River Delta, and the lower Snohomish River estuary (Figure 2 [Attachment C]). For the purpose of this study, Everett Harbor is defined as the area east of a line joining Elliott Point in Mukilteo with the western point of Mission Beach at the entrance of Tulalip Bay. The Snohomish River Delta and the estuary east to Interstate 5 are included in the project area.

Reference areas included nine reference embayments in Puget Sound (including Port Susan) for sediment chemistry and Port Susan for fish pathology, bioaccumulation, sediment bioassays, and benthic infauna.

Chronology of Events

The chronology of significant events in Everett Harbor and other related locations in Puget Sound include:

- o Everett Harbor sampling and testing events:
  - Sediment Sampling: October 2-29, 1986
  - Benthic Macroinvertibrate Sampling: September 30 to October 15, 1986
  - Bioaccumulation, Fish Ecology, and Histopathology Sampling

    English Sole: August 25 - September 1, 1986
    Dungeness Crab: August 25 - October 21, 1986
  - Sediment Bioassays: October 2-29, 1986
- o Historical sediment sampling events for Puget Sound reference areas.

- Reference sites:

  1. Carr Inlet
  2. Samish Bay
  3. Dabob Bay
  4. Case Inlet
  5. Port Madison
  6. Port Susan
  7. Nisqually Delta
  8. Port Susan (1985)
  9. Port Susan (1986, this study)

  (Site 1) Tetra Tech (1985a); Mowrer et al. (1977)
  (Site 2) Battelle (1986)
  (Site 3) Battelle (1986)
  (Site 4) Malins et al. (1980); Mowrer et al. (1977)
  (Site 5) Malins et al. (1980)
  (Site 6) Malins et al. (1982)
  (Site 7) Barrick and Prahl (1987); Mowrer et al. (1977)
  (Site 8) PTI and Tetra Tech (1988); Stations PS-01 through PS-04
  (Site 9) This study.

o Historical Everett Harbor sediment data reports:

  - Storer and Arsenault (1987)
  - Anderson and Crecelius (1985), Crecelius et al. (1984), and U.S. Army Crops of Engineers (COE) (1985)
  - Battelle Northwest (1986)
  - U.S. EPA (1982)
  - Malins et al. (1982, 1985)
  - Chapman et al. (1984)

o Historical Everett Harbor sediment bioassay data reports:

  - Puget Sound Environmental Atlas (Evans-Hamilton and D.R. Systems 1987), Tetra Tech and E.V.S. Consultants 1986, Battelle Northwest 1986, U.S. Army COE (1985).

o Recent Historical Everett Harbor Benthic Macroinvertibrate Data System.

  - Navy Homeport Study (Parametrix 1985; U.S. Army COE 1985).

- o Recent Historical Everett Harbor Fish Histopathology Data Reports.

  - Malins, D.C., 21 November 1984, personal communication;
  - Malins et al. 1984, 1985, unpublished.

2.0 LEGAL AND REGULATORY ISSUES

N/A

3.0 DEMOGRAPHICS AND LAND USE

N/A

4.0 POTENTIALLY LIABLE PERSONS

No specific businesses, industries, agencies, etc. were named. A general statement was made that sediment contamination in East Waterway "...appears strongly related to pulp industry discharges, although additional sources may be important for some chemicals." In addition, the report also stated that contamination in the Nearshore Port Gardner area was "...probably derived from undetermined local sources rather than transport from the East Waterway."

5.0 IDENTIFICATION OF POLLUTION POINT SOURCES

Problem areas defined by indices of sediment contamination and adverse biological effects were localized within the Everett Harbor system. Broad areas of nearshore Everett Harbor and the lower Snohomish River displayed low elevations of chemical concentrations in sediments relative to Puget Sound reference areas (nine reference embayments including Port Susan). Because bioaccumulation and pathology were not significantly elevated ($P \leq 0.001$), large-scale problem areas were not identified by these area-wide indicators. On a finer spatial scale, 23 stations were designated as problems based on sediment chemistry, sediment toxicity, or benthic infauna impacts. At 21 of these stations, concentrations of one or more chemicals in sediments exceeded the high apparent effects thresholds (HAET) developed from matched chemical and biological data throughout Puget Sound. Seventeen of these stations were grouped into the following multi-station problems areas: East Waterway, and the nearshore area from Elliott Point in Mukilteo east to Powdermill Gulch.

In addition, the following single stations were identified as localized problem areas: ES-03, OG-01, SD-01, SD-03, SR-05, SR-07.

Please refer to Figure 66 (Attachment C).

6.0 IDENTIFICATION OF POLLUTION NON-POINT SOURCES

Please refer to Section 5.0.

7.0 CHEMICAL DATA

Sediment Chemistry

The sampling performed by Tetra Tech involved the analysis of subtidal and intertidal sediment samples collected from the seven study areas of the Everett Harbor system and the Port Susan reference area.

Sediment samples were collected from October 2 to 29, 1986. A summary of sediment analyses performed by station number can be found in Table 7 (Attachment D) in the reviewed document. Samples were analyzed for metals (antimony, arsenic, cadmiums, chromium, copper, lead, mercury, nickel, selenium, silver, iron, and manganese), volatile and semivolatile organic compounds (polychlorinated biphenyls [PCBs], pesticides, polycyclic aromatic hydrocarbons [PAHs], phenols and chlorinated phenols, phthalate esters, resin acids), tributyltin and conventionals (Total Organic Carbons [TOC], grain size analysis, total solids, total nitrogen, water soluble sulfides).

Samples were handled according to Puget Sound Estuary Program (PSEP) protocols as described in:

Tetra Tech, 1986, Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound, Final Report, prepared for EPA and COE.

Conventional Results

Analyses were performed according to PSEP protocols.

Grain Size. Average percentages of fine grained material in the seven study areas and Port Susan are presented in Figure 7 (Attachment C) of the reviewed document. East Waterway samples were typically the most fine grained in the study. A summary of East Waterway results is presented in Figure 8 (Attachment C). Most sediments were predominantly fine grained (>50 percent fine-grained material) with the finest sediment texture found at the head of the waterway (Stations EW-02 and EW-03, >90 percent fine grained material).

Sediments from Nearshore Port Gardner were the most coarse grained for all study areas.

Total Organic Carbon. Sediment TOC concentrations displayed similar trends to those observed for percent fine-grained material. East Waterway had extremely high levels of TOC (mean of 11 percent, EW-04 was 29 percent, EW-13 was 23 percent).

Average molar organic carbon to nitrogen ratios were relatively consistent (between 15 and 25) among Everett Harbor study areas. Offshore Port Gardner and East Waterway had average molar C/N ratios of approximately 40 with East Waterway stations EW-04 and EW-13 having high C/N ratios of 69 and 100, respectively.

Sulfides. The mean sulfide concentrations in study and reference areas were low (<120 mg/kg DW) with the highest mean (3,000 mg/kg DW) and individual (11,000 mg/kg DW) sulfide concentration occurring in East Waterway. Sediments near the head of the waterway contained the highest sulfide concentrations with the exception of EW-01. All the conventional data were considered acceptable without qualification. However, the 7-day holding time limit for sulfides recommended by PSEP was exceeded for 51 of 64 sample collected and it is unclear what effect this might have on sample integrity and chemical changes that occur in the sample.

Reviews of sediment chemistry data were performed in accordance with PSEP guidelines (Tetra Tech 1986g). QA/QC reviews of chemistry included assessments of accuracy [using standard reference materials (SRM), matrix spikes, and surrogate recoveries, when applicable], precision (using analytical replicates), initial and ongoing calibration and tuning, blank results, sample holding times, and initial performance tests or validation data for certain non-CLP procedures.

Metals Results

The samples were analyzed for 11 of the 13 EPA priority pollutant metals, and tributyltin (TBT) (in two samples) utilizing Zeeman Graphite Furnace Atomic Absorption (GFAA) and X-Ray Fluorescence (XRF) analytical techniques. Results were presented as dry weights.

Eight of eleven EPA priority pollutant metals analyzed in this study had concentrations exceeding the highest Puget Sound reference concentrations and are thus of concern (see Table 16, Attachment D). Nickel, selenium, and silver concentrations are below reference values (see Table 14, Attachment D). Chromium is not of concern because only one station had a concentration greater than the reference area concentration. The TBT concentration measured at one of the two study area stations exceeded the single reference area measurement. Maximum values of most metals occurred in East Waterway. Station EW-14 had the most elevated concentrations for all metals of concern.

Figure 14 of the reviewed document (Attachment C) contained the mean EAR values for metals of concern in Everett Harbor study areas. Cadmium and mercury concentrations exceeded maximum reference area concentrations at only four stations, all located in East Waterway. Copper concentrations exceeded maximum reference area concentrations in East Waterway and at station SR-07 in the Snohomish River. Lead concentrations exceeded maximum reference concentrations in East Waterway and at stations SR-07 and ES-01. Zinc and arsenic concentrations exceeded maximum reference concentrations in East Waterway and at stations SR-07, SR-04, SR-05, and ES-01.

Antimony had the greatest EAR of all metals measured in Everett Harbor study areas. Mean EAR values for antimony exceeded threshold EAR values in all study areas except area NG.

All metal results are considered acceptable as qualified. Discrepancies in analysis methods and results for antimony (XRF vs. "total metals") caused precision control limits to be exceeded, and thus resulted in all positive antimony data to be flagged with an "E" qualifier and considered estimated.

Reviews of sediment chemistry data were performed in accordance with PSEP guidelines (Tetra Tech 1986g). QA/QC reviews of chemistry included assessments of accuracy [using standard reference materials (SRM), matrix spikes, and surrogate recoveries, when applicable], precision (using analytical replicates), initial and ongoing calibration and tuning, blank results, sample holding times, and initial performance tests or validation data for certain non-CLP procedures.

Organic Compounds

Semivolatile Organic Compounds (BNA). The base/neutral/acid extractable organic compounds (BNA) were analyzed by gas chromatography/mass spectrometer (GC/MS) following PSEP procedure protocols. Utilizing the isotope dilution technique, all reported concentrations of compounds were corrected for recovery. Low, but acceptable recoveries of isotope labeled compounds as determined by the internal standard technique were found in the first batch of samples as compared to subsequent batches.

The data for BNA compounds are generally acceptable. The laboratory followed specified protocols with the following exceptions: 1) The relative response factor for N-nitrosodiphenylamine was outside control limits (25 percent difference) for 11 of the 15 daily standard analyses. Positive sample results for N-nitrosodiphenylamine in all samples associated with the standard analyses have been qualified in the database with an "E" (estimated); 2) Benzoic acid levels in one of the four blanks exceeded the PSEP control limit of 2.5 µg total. Analyses were not halted while investigating the cause of contamination. Therefore, benzoic acid values for the batch of samples run with this blank were qualified with an "E" after blank corrections.

Method blanks were analyzed with each extraction blank. Phenanthrene, pyrene, phenyl, naphthalene, and 2-methylnapthalene were detected at relatively low levels in some blanks.

Reviews of sediment chemistry data were performed in accordance with PSEP guidelines (Tetra Tech 1986g). QA/QC reviews of chemistry included assessments of accuracy [using standard reference materials (SRM), matrix spikes, and surrogates recoveries, when applicable], precision (using analytical replicates), initial and ongoing calibration and tuning, blank results, sample holding times, and initial performance tests or validation data for certain non-CLP [Contract Laboratory Program] procedures.

PAHs. In this study, the 16 individual EPA priority pollutants were treated as two groups: low molecular PAH (LPAH) and high molecular PAH (HPAH). The mean EAR for LPAH and HPAH were the highest in East Waterway as compared to any other study area. Four stations in East Waterway had the highest LPAH concentrations (EW-04, 25000; EW-07, 23000; EW-13, 24000; EW-14, 28000). Naphthalene was the predominant PAH compound in all East Waterway samples except station EW-01.

Outside of East Waterway, PAH concentrations were most elevated in areas OG and NG with all OG samples having very similar PAH compositions and naphthalene being the predominant compound found in all samples. PAH composition in area NG, unlike areas EW and OG, had higher relative proportions of HPAH.

Phenol and Alkyl Substituted Phenols. Of the compounds in this group (phenol, 2- and 4-methylphenol, and 2,4-dimethylphenol), phenol and 4-methylphenol were the most frequently detected compounds with 4-methylphenol having the highest concentration observed in East Waterway. The compound 4-methlyphenol was detected in over 90 percent of the samples in which it was analyzed and it occurred at the most elevated concentrations of any of the chemicals measured in this study. Of all of the study areas, the highest mean concentration was observed in East Waterway.

Phenol, like 4-methylphenol, was detected frequently (detection frequency >90 percent) but at a far lower concentration than 4-methylphenol. The mean EAR in East Waterway (40) was greater than that of any other study area and the maximum concentration was observed at Station EW-10 (29,000 µg/kg DW; EAR-88).

N-Nitrosodiphenylamine. N-Nitrosodiphenylamine was detected seven times with the highest concentration (57 µg/kg DW) occurring at station EW-01.

Resin Acids and Chlorinated Phenols/Guaiacal. Dedicated analysis methodologies for these compounds were developed since standard procedures of analyses were not available. These methodologies are reportedly described in the following reference:

Tetra Tech, 1988, Everett Harbor Action Program: Data Quality Assurance Assessment, final report, prepared for USEPA, Region 10.

Resin acids were analyzed by Full Scan GC/MS utilizing a fused silica capillary column while the chlorinated phenols were determined utilizing GC/MS-SIM (selective ion monitoring).

Of all the study areas, East Waterway had the most elevated resin acid concentration. DHA and abetic acid had the highest concentration of resin acids, were detected most frequently, and had mean EARs 13 times higher than those of other study areas. The maximum concentration in East Waterway of DHA (station EW-04, 83,000 µg/kg DW; EAR = 1,300) and abietic acid (station EW-13, 98,000 µg/kg DW; EAR = 650) occurred along the east shore of the waterway, similar to most other contaminants in this study.

Chlorinated phenols and gauiacols were detected most often and occurred at the highest concentrations in East Waterway. For the nine chlorinated phenols/guaiacols analyzed in this study (see Table 1, Attachment B) maximum EAR values in East Waterway ranged from 12 to 47 with a mean of 30 (N = 9) whereas outside of the waterway, maximum EAR from these compounds ranged from 0.5 to 14 with a mean of 3.9 (N = 9). Outside of East Waterway, chlorinated phenols and guaiacols were seldom detected at concentrations exceeding the maximum detection limits reported in the Puget Sound reference areas.

Overall data are acceptable except Palustric acid data, which were rejected based on 0 percent recovery in both matrix spikes. Data were qualified with an "E" for the following reasons: 1) data were reported at concentrations corresponding to less than half the lowest calibration standard; 2) data were associated with an ongoing calibration that was outside PSEP limits; or 3) mass spectra were only marginally acceptable.

PCBs. Total PCBs from extracts were analyzed by methods according to PSEP protocols employing GC/election capture detection (GC/ECD) and GC/MS.

Total PCBs were detected in only 7 of 54 stations and occurred at concentrations above the maximum reference area detection limits (50 µg/kg) in only three samples; EW-04 (9,600 µg/kg DW; EAR = 1,600) and EW-07 (87 µg/kg DW) in the East Waterway and sample NG-09 (5,500 µg/kg DW, EAR = 920) in the Nearshore Port Gardner study area.

Positive results are considered estimates only due to the fact that only single point calibration were used for GC/MS and GC/ECD standards instead of the specified five point calibrations. Additionally, extracts for GC/MS analysis were held longer than the 40 day holding limit specified by the EPA CLP. This may have resulted in an under-estimate of original sample concentration.

Chlorinated Pesticides. Nineteen pesticides were evaluated by GC/ECD following PSEP protocol methods. A modification of the methods allowed for quantitation and confirmation using a packed column and EPA CLP procedures.

The only pesticide detected above reference conditions was p,p'-DDT at Station SD-03 (23 µg/kg DW; EAR = 2.3). Detection limits for p,p'-DDT at nearby stations ranged from 1 to 10 µg/kg DW.

PSEP protocol were used to assess the acceptability of data and data qualifiers were not assigned to pesticide results.

Volatile Organic Compounds. Thirty-four volatile organic compounds are analyzed for by purge and trap GC/MS according to EPA Control Laboratory Program (CLP) protocols.

Acetone and total xylenes were detected infrequently and occurred only in East Waterway.

The data for volatile organic compounds are acceptable with the exception of data for methylene chloride (a common laboratory contaminant). Methylene chloride values were rejected because of excessive blank contamination.

Tentatively Identified Organic Compounds. Analyses were done for Tentatively Identified Organics (TIO) in extracts of Everett Harbor sediments analyzed for BNA compounds by GC/MS. Fifteen chemicals that occurred most frequently and at the highest concentrations were selected for routine searches in all samples and method blanks. Most (14/15) TIO compounds had maximum concentrations in East Waterway, and 11/15 had maximum concentrations at Station EW-04. Other compounds of notable detection frequencies and/or high concentration included benzoic acid, benzyl alcohol, and extractables related to PAHs.

Phthalate Ester. Bis(2-ethyl-hexyl)phthalate was detected in 39 of 54 stations with highest concentrations observed in East Waterway (Station EW-14, 930 µg/kg DW, EAR = 55). The other phthalate ester of concern (butyl benzyl phthalate) occurred above Puget Sound reference conditions at only three stations.

8.0 BIOLOGICAL DATA (FLORA/FAUNA)

Mercury

Mercury has a high potential for bioaccumulation and was the only EPA priority pollutant metal detected in fish and crab tissue. Digestion and instrumental techniques utilizing a cold vapor atomic absorption spectrophotometer followed PSEP protocols.

Mercury concentrations in edible tissue of Dungeness crab and English sole were homogeneous and low throughout the study areas. There is no evidence of mercury bioaccumulation above reference levels.

All data for mercury were within the PSEP guidelines except for sample holding time. Because the 28-day maximum was exceeded all sample results are qualified with an "E" as estimates.

PCB/Pesticides

The extraction, cleanup, GC/ECD analysis and quantification of PCBs/pesticides in Dungeness crabs and English sole followed PSEP and Tetra Tech (1986b) methodologies except for two modifications to the extraction process. Reportedly, laboratory performance was not compromised with these modifications. For both Dungeness crab and English sole, none of the 12 pesticides analyzed for were detected.

Interpretation of PCB data was limited by low analytical recoveries. Measured PCB levels were generally higher in Dungeness crab and English sole from the Mukilteo area, the Snohomish River, and the

East Waterway than in the Port Susan reference area. However, the maximum theoretical concentrations of PCBs (after adjustment for surrogate recoveries) in crab and fish samples were not elevated substantially above the reference area levels (i.e., maximum EAR of 3.7) and were low when compared to other urban embayments in Puget Sound. Historically, the PCB levels measured are similar to the present study.

All detected data for PCBs in tissue were qualified ("G", or greater than) because of low analytical recoveries and with an "E" as estimated because ongoing calibrations were outside control limits.

Sediment Bioassays

Sediment toxicity tests with *Rhepoxynuis abronius* were performed at 29 stations in the Everett Harbor system and 3 stations in the Port Susan reference area following PSEP protocols.

Of the 29 Everett Harbor stations tested, four of the sediments displayed significant toxicities in the amphipod bioassay when compared to Port Susan reference area. The most toxic study area was East Waterway with a mean mortality of 63 percent as compared to the Port Susan reference area mean mortality of 22 percent. One hundred percent mortality was observed at Stations EW-01 and NG-04 in Nearshore Port Gardner.

Even with limited historical data for sediment bioassay tests, there was agreement between the present study and previous Everett Harbor bioassays.

The amphipod bioassay results are considered acceptable for use in problem area identification.

Benthic Macroinvertebrates

The field sampling methods used to collect benthic macroinvertebrates samples during the Everett Harbor Study are outlined in the PSEP protocols and the "Quality Assurance Project Plan for Field Investigations to Support Development of the Everett Harbor Action Plan" (Tetra Tech 1986f).

There were 18 significant ($p \leq 0.001$) depressions in abundances detected among 64 statistical comparisons of four major taxonomic groups at 16 benthic stations in Everett Harbor. Out of the 18 depressions, 7 stations had one depression, one station exhibited 2 depressions, and 3 stations exhibited 3 depressions. Five stations in the harbor showed no depressions in the abundances of four major taxa selected for problem identification.

The most impacted stations in Everett Harbor included EW-01, EW-04, EW-07, EW-10, SD-01, and SR-07. The East Waterway study area had the greatest number of stations that exhibited significant depressions in abundances of the major taxonomic groups.

Quality control checks of sample sorting, organism enumeration, and identification followed the guidelines recommended by PSEP protocols and the "Quality Assurance Project Plan for Field Investigations to Support Development of the Everett Harbor Action Plan," (Tetra Tech 1986f) and resulted in an acceptable data set without qualification.

Fish Ecology and Histopathology

In comparison to the observed abundance of fish assembling in the Port Susan reference area, total abundance of fish assemblages in East Waterway and throughout most of the Snohomish Delta was higher. However, throughout most of the Everett Harbor study area, both the number of species and diversity of fish assemblages were lower than the observed value in Port Susan.

The most abundant family of fish in both Everett Harbor and Port Susan were Pleuronectidae and the most abundant member of the family was English sole.

Three kinds of hepatic lesions were considered in the study; neoplasms, foci of cellular alteration, and megalocytic hepatosis. The prevalences of all three lesions at many of the Everett Harbor transects were substantially but not significantly elevated above reference values.

Prevalences of neoplasms and foci of cellular alteration were correlated positively with fish age while megalocytic heptosis prevalence was higher in males than females.

Historical studies show that prevalences of megalocytic hepatosis are considerably lower in the present study whereas the absolute magnitude of lesion prevalences were similar between studies for neoplasms and foci of cellular alteration.

The final histopathology data were considered acceptable without qualification.

9.0 DATA QUALITY

The overall quality control for this study is presented below:

The decison-making framework developed for the Everett Harbor Toxics Action Program incorporates a preponderance-of-evidence approach to problem identification. A series of chemical, biological, and toxicological indices are used to relate conditions at sites within the project area to reference conditions in relatively uncontaminated embayments of Puget Sound. Study areas that exhibit high levels of contamination and adverse biological effects receive a ranking of "high priority" for evaluation of pollutant sources and remedial action.

The rationale for station locations is provided in the sampling and analysis plan for the Everett Harbor Toxics Action Program (Tetra Tech 1986h) and sections below. Briefly, stations were selected to:

- o Fill data gaps from previous studies
- o Define known areas of contamination more precisely
- o Determine large-scale gradients of contamination and bioeffects in relation to known sources
- o Detect localized areas of contamination and bioeffects near potential sources.

The primary kinds of data used in the decision-making process are listed below:

- o Sediment Quality
  - Contaminant concentrations
  - AET, relating sediment contamination and predicted biological effects
- o Sediment Toxicity
  - Amphipod mortality (10-day bioassay)
- o Benthic Infauna
  - Polychaete abundance
  - Crutacean abundance
  - Pelecypod abundance
  - Gastropod abundance
- o Fish Pathology
  - Lesion prevalence in livers of English sole.

The rationale for using the five general kinds of data is provided in Tetra Tech (1985a,b). The available Puget Sound AET (Tetra Tech 1986c, 1987) were used as sediment quality values to evaluate chemical data relative to predicted biological effects. Although many other variables were evaluated throughout the decision-making process, those shown above formed the basis for problem identification and priority ranking.

Target Chemicals--

A list of chemical contaminants analyzed for in sediments collected during the Everett Harbor studies is given in Table 1. Most of the substances on this list have at least one of the following two properties: they can bioaccummulate, possibly with adverse biological effects in the food chain if bioaccummulated, or they can produce adverse biological effects even when not bioaccummulated.

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The target contaminants measured during the Everett Harbor project have the potential to cause observed sediment toxicity or biological effects. However, the ability to identify poorly-understood chemical interactions (e.g., synergism and antagonism) is limited. Although interactive effects may not be distinguishable from other kinds of effects, they may be measured through the use of biological indicators explained below.

Biological Variables--

Selection of individual biological and toxicological variables was based on the following considerations:

- Analysis of several levels of potential biological effects
  - Bioaccumulation at the tissue level
  - Pathology at the tissue level
  - Mortality of amphipods in sediment bioassays
  - Chronic effects on benthic communities
- Use of each variable in past Puget Sound studies
- Documented sensitivity of each variable to contaminants
- Ability to quantify each variable within the resource and time constraints of the program.

Response variables were selected to characterize several important toxic effects in resident organisms of Everett Harbor. Although a study of effects on fish population was beyond the scope of the current project, a study of effects on individual fishes is possible through an assessment of liver lesion prevalence. Benthic macroinvertebrates were selected because of their sensitivity to sediment contamination, their importance in local trophic relationships, and their ability to establish site-specific response gradients relative to sediment contamination.

The use of Rhepoxynius abronius to determine the acute lethality of field-collected sediments has been documented by numerous authors (e.g., Swartz et al. 1982, 1985; Chapman et al. 1982a,b; Mearns et al. 1986). The use of this amphipod species as an indicator of contaminated areas is supported by its typical absence from natural populations in such areas (Swartz et al. 1982; Comiskey et al. 1984), and by its response to contaminated sediments in laboratory studies (Swartz et al. 1985). Because of potential concerns that uncontaminated fine-grain sediments may induce amphipod mortality, the data collected during the present study were screened to ensure that statistically significant toxicity could not be accounted for by gain-size effects alone.

SEDIMENT CHEMISTRY

Field Sampling

Full details of the sampling design and techniques are provided in the "Sampling and Analysis Design for Development of Everett Harbor Action Program" (Tetra Tech 1986h) and the "Quality Assurance Project Plan for Field Investigations to Support Development of the Everett Harbor Action Plan" (Tetra Tech 1986f). Field collection procedures followed the recommendations of the Puget Sound Estuary Program (PSEP) (Tetra Tech 1986g).

Quality Assurance/Quality Control Results

Reviews of sediment chemistry data were performed in accordance with PSEP guidelines (Tetra Tech 1986g). QA/QC reviews of chemistry included assessments of accuracy (using standard reference materials [SRM], matrix spikes, and surrogate recoveries, when applicable), precision (using analytical replicates), initial and ongoing calibration and tuning, blank results, sample holding times, and initial performance tests or validation data for certain non-CLP procedures.

BIOACCUMULATION

Field Sampling

English sole (Parophrys vetulus) were sampled at 10 transects in Everett Harbor and a 1 transect at Port Susan, a nonurban reference area (see Figure 6 [Attachment C]). Port Susan was used as a reference area because previous studies have found that the area is relatively uncontaminated (Malin et al. 1982). In addition, Malin et al. (1984) found no serious hepatic lesions in English sole collected from that embayment."

Quality Assurance/Quality Control Results

Reviews of bioaccumulation data were performed in accordance with PSEP guidelines (Tetra Tech 1986g). QA/QC reviews included assessments of accuracy (using standard reference materials, matrix spikes, and surrogate recoveries, when applicable), precision (using analytical replicates), initial and ongoing calibration and tuning, blank results, and sample holding times.

SEDIMENT BIOASSAY

Field Sampling

Sediment toxicity tests with Rhepoxynius abronius were performed at 29 stations in the Everett harbor system and three stations in the reference area (Port Susan). A subsample of the composite sediment sample collected for chemical analyses was tested for toxicity using the amphipod bioassay.

The infaunal amphipod R. abronius was collected subtidally from West Beach on Whidbey Island (Washington) using a bottom dredge. Amphipods were maintained and transported in clean coolers with ice, and were returned to the laboratory within 18 h of collection.

Quality Assurance/Quality Control Results

Mean mortality ranged from 4 to 10 percent in the clean sediment (Whidbey Island) controls. A mean mortality of 10 percent is considered acceptable for amphipod sediment bioassay controls (Swartz et al. 1985). ANOVA indicated no significant differences ($P>0.05$) in mean mortality values among the clean sediment controls. Mortality in cadmium-spiked seawater was 100 percent, which is consistent with the expected mortality rate. Interstitial salinities in nine sediment samples were not acceptable according to PSEP Protocols (Tetra Tech and E.V.S. Consultants 1986) and were adjusted following the PSEP Protocols. Dissolved oxygen concentrations in water overlying the sediments in the bioassay chambers were acceptably high.

The amphipod bioassay results are considered acceptable for use in problem area identification. However, it should be noted that the data for the following stations showed high variance (standard error >12), generally due to an extreme outlier replicate: SR-07, EW-10, and OG-03.

BENTHIC MACROINVERTEBRATES

Field Sampling

The field sampling methods used to collect benthic macroinvertebrate samples during the Everett Harbor survey are outlined in the PSEP protocols (Tetra Tech 1986g) and the "Quality Assurance Project Plan for Field Investigations to Support Development of the Everett Harbor Action Plan" (Tetra Tech 1986f).

Data Quality Assurance/Quality Control Results

QA/QC procedures resulted in an acceptable data set without qualification. Quality control checks of sample sorting, organism enumeration, and identification followed the guidelines recommended by PSEP protocols (Tetra Tech 1986g) and the "Quality Assurance Project Plan for Field Investigations to Support Development of the Everett Harbor Action Plan" (Tetra Tech 1986f).

FISH ECOLOGY AND HISTOPATHOLOGY

Field Sampling

English sole larger than 220-mm total length (TL) were selected for histopathological analysis. This size limit was used to ensure that most fish were greater than 2 yr old. A selection criterion based indirectly on age was used because English sole younger than 2 yr old have substantially lower prevalences of hepatic lesions than older fish (Malins et al. 1982). The present study therefore focused on those fish most likely to be afflicted with hepatic lesions.

Sixty English sole of appropriate length were collected at every transect, yielding a total of 714 fish for the overall study. Immediately after collection, each selected fish was sacrificed by a blow to the head, measured to the nearest millimeter (TL), examined for grossly visible external abnormalities (e.g., fin erosion, skin tumors, scoliosis, parasites), and transferred to the shipboard laboratory for liver removal.

In the shipboard laboratory, the liver of each fish was removed in its entirety, cut into multiple sections, and examined for the presence of grossly visible lesions. If lesions or discontinuities were noted, a subsample was taken from the affected area for histopathological analysis. If the liver appeared to be normal, a subsample was taken from the center of the organ at its broadest point. Each subsample was fixed in 10 percent neutral-buffered formalin. After the liver was removed from each individual, the sex of the fish was noted and the otoliths (sagittae) were removed for subsequent age determination.

All fishes in the remainder of the catch at each transect were identified to species and counted. All English sole not selected for histopathological analysis were measured (nearest mm TL) and counted.

Quality Assurance/Quality Control Results

Lesion identifications were confirmed by Mark Myers of the National Marine Fisheries Service. To ensure consistent identification of lesions between the three pathologists for this project, each examined slides from every station. For all three major kinds of lesions, the numbers of each lesion identified by the three pathologists were very similar, implying consistent diagnostic criteria. In addition, the relative prevalences of neoplasms and foci of cellular alteration among stations and among lesion types were similar to results from previous studies by the National Marine Fisheries Service (Malins et al. 1980). Although the relative prevalences of megalocytic hepatosis among stations were consistent with patterns identified by Malins et al. (1980), the absolute values found during this study were considerably lower than those found by Malins et al. (1980). The pathologists were aware of this apparent discrepancy shortly after the laboratory analyses began and therefore paid particular attention to identifying the presence of this abnormality. In addition, a review of selected slides by M. Myers confirmed the relatively low prevalence of megalocytic hepatosis. Therefore, it was concluded that the prevalences observed in this study were accurate. The final histopathology data were considered acceptable without qualification.

10.0 HYDROLOGIC AND HYDRODYNAMIC INFORMATION

As stated by the report's authors:

The project area watershed encompasses about 280 km^2 of primarily forest and agricultural lands within the Snohomish River basin. The

boundaries of the project watershed are roughly defined by Highway 9 to the east and Casino Road to the south, and extend as far north as the Arlington airport.

The cities of Everett, Marysville, and Mukilteo are the major urban centers within the project area. Surface-water runoff from Everett is collected by a combined sanitary and storm sewer system, treated at the Everett wastewater treatment plant, and discharged into the Snohomish River about 1.2 km downstream of the I-5 bridge. Before 1960, raw sewage was discharged to Port Gardner and the Snohomish River via 14 outfalls. Marysville and Mukilteo each have storm drain systems that are separated from their sewage collection systems. Storm drains within the Marysville area discharge into Quilceda Creek, Allen Creek, and Ebey Slough. Aside from two storm drains within the City of Mukilteo, most of the runoff from Mukilteo and southwest Everett is discharged to southern Port Gardner via numerous small streams. The northern portion of the project watershed comprises largely forested and agricultural lands that drain to Quilceda and Allen Creeks.

The Snohomish River is the largest source of fresh water to Port Gardner and the second largest freshwater inflow to Puget Sound. The Snohomish River basin covers about 4,400 km^2, extending to the crest of the Cascade Mountains. The average annual flow measured near Monroe by the U.S. Geological Survey was about 280 m^3/sec (1963-1983 data) (Williams et al. 1985). The Snohomish River estuary within the project area includes four main branches: Ebey Slough, Steamboat Slough, Union Slough, and the lower Snohomish River channel. The latter carries the major portion of the total river flow. During the dry season, tidal saltwater intrusions have been observed as far upstream as 11 km from Preston Point.

...Additional background information on the drainage system, physical oceanography, and beneficial uses of the bay is provided in Tetra Tech (1985b).

11.0 DREDGING AND DISPOSAL ISSUES AND DATA

The report reviewed refers to and identifies the Former Port Gardner Disposal site (the area formerly designated for disposal of dredged materials) and its future replacement site, the Puget Sound Dredged Disposal Analysis Unconfined Open-Water Disposal site; and the U.S. Navy Proposed Deep Confined Aquatic Disposal site (Figure 2, Attachment C).

12.0 ENVIRONMENTAL IMPACTS

The environmental data on sediment contamination and biological effects were organized into a matrix of biological and toxicological indices used to compare study areas. This Action Assessment Matrix uses multiple independent indices termed "elevations above reference" (EAR) to indicate the magnitudes of contaminant levels and biological effects relative to reference conditions. A decision to proceed with source evaluation and ranking of problem areas is limited to sites that exceed a minimum action level defined by one or more significant EAR. The action-level guidelines provide a consistent framework for defining toxic problem areas based on the weight of evidence from evaluation of the selected hazard indicators. In the case of a single significantly elevated index, the magnitude of the elevation must provide sufficient evidence of a problem to outweigh the absence of significant elevations in multiple indicators.

Broad areas of nearshore Everett Harbor system displayed concentrations of chemical contaminants in sediment above the maximum values for Puget Sound reference areas. Nevertheless, chemical elevations at most stations outside the East Waterway were not highly elevated above reference values. Because neither bioaccumulation nor pathological variables were significantly elevated in the study area ($P>0.001$), Tier I problem evaluation did not result in definition of large-scale problem areas. Areas of potential concern were defined based on exceedance of LAET for at least one chemical in sediments. As shown below, these areas of potential concern are largely contiguous with the problem areas defined in the Tier II analysis.

Information on the significance of EAR for all indicators at each station was compiled in an Action Assessment Matrix. Stations identified as Tier II problem sites (Figure 66 [Attachment C]) were considered for further priority ranking.

The following problem areas containing multiple stations were identified (Figure 66 [Attachment C]):

- o EW (the East Waterway)
- o NG (near the Mukilteo sewage discharge, ferry terminal and defense fuel storage depot).

In addition, the following single stations were identified as localized problem areas: ES-3, OG-01, SD-01, SD-03, SR-05, SR-07 (Figure 66 [Attachment C]).

RANKING OF PROBLEM AREAS

Ranking of problem areas within the Everett Harbor system was performed using the Action Assessment Matrix. Arithmetic mean EAR values compiled for each data type and each multi-station problem area (Tier II) are shown in Table 35 [Attachment C]. Reference values are shown on the right-hand side of the table. For each indicator, mean reference values across all stations within the reference area are shown for comparison. The original value for an indicator can be obtained by multiplying the EAR reported in the table by the appropriate reference value. Only the original data for the prevalences of liver neoplasms and megalocytic hepatosis are shown because the reference area prevalences were zero, resulting in infinite elevations at the study sites. Note that benthic infauna EAR are calculated as the inverse of the ratio used for other indicators (i.e., as the ratio of the reference value to the study site value) because a toxic effect is expected to produce a depression in abundance.

For perspective in interpreting Table 35 [Attachment E], each of the following represent a severe effect that is sufficient for definition of a problem area:

- o >40 percent amphipod mortality, which corresponds to an EAR of >1.8
- o ≥80 percent depression in abundance of one or more benthic taxa, which corresponds to an EAR of ≥5
- o Exceedance of the HAET or the 90th percentile (for selected chemicals without AET) for sediment chemistry
- o Significant elevation of any three indicators.

At least one of the four primary conditions just listed are met by each area shown in Table 35 [Attachment E]. Significant EAR for sediment chemistry and exceedances of HAET were found in all of the Tier II problem areas except Station SD-01, which exhibited severe depressions in the abundances of major taxa of benthic infauna, but not significant ($P<0.001$) amphipod mortality.

Total scores for sediment chemistry and biological effects were determined separately for each station. Ranking criteria were applied to the Action Assessment Matrix for single stations. The score for each multi-station area was calculated as the average of the scores for individual stations within the area. Normalized scores for the Tier II problem areas and single stations are presented in Figure 67 [Attachment C].

Of the two multi-station problem areas, the East Waterway ranked highest, with average scores of 58 percent for chemistry and 21 percent for biology. The multi-station problem area near Mukilteo received average scores of 34 percent for chemistry and 20 percent for biology. Biological scores varied greatly among stations within both of these areas. Sediment chemistry scores were heterogeneous within the East Waterway, but not within the NG problem area near Mukilteo.

Ten stations scored ≥50 percent based on either sediment chemistry or biological effects (Figures 67 and 68 [Attachment C]). Of the 10 highest priority stations, three scored ≥50 percent for both sediment chemistry and biological effects:

- o Station EW-01
- o Station EW-04
- o Station EW-07.

Stations EW-10, EW-13, and EW-14 scored ≥50 percent based on chemical variables alone. Stations NG-09, NG-11, SD-01, and SR-07 scored ≥50 percent based on biological variables alone. Station SD-01 received a high score for biology because benthic infauna were apparently impacted. However, swift currents within the delta channel where this station was located (as indicated by bathymetry and coarseness of the sediments) may be responsible for disturbance of the benthic community. Because bioassay mortality was low (15 percent) at Station SD-01, and because species composition of benthic infauna indicated an absence of impacts attributable to toxic chemicals, the designation of Station SD-01 as a problem area should be considered tentative. Sediment texture, hypoxia, or high sulfides concentrations at Station SR-07 may have contributed to the severe depressions in the abundances of infaunal taxa at that site. Station EW-14 received the maximum possible score of 100 percent for chemistry, but scored very low (6 percent) for biology. Despite the lack of statistical significance in some EAR for biological variables, increased toxicity of sediments to amphipods and effects on benthic infauna at Station EW-14 were apparent based on comparisons with adjacent stations.

13.0 INTERIM MEASURES/SPILL AND POLLUTION PREVENTION MEASURES

N/A

14.0 COMMUNITY RELATIONS INFORMATION

The Everett Harbor Toxics Action Program has benefited from the participation of an IAWG and a CAC. Duties of the IAWG and CAC members included: 1) reviewing program documents, agency policies, and proposed actions; 2) providing data reports and other technical information to EPA; and 3) disseminating action program information to respective interest groups or constituencies. Ms. Joan Thomas and Mr. Dave Murdock chair the IAWG, and Mr. Gary Wold chaired the CAC. Members of the IAWG and CAC are listed below.

Everett Harbor Interagency Work Group

Name	Affiliation
Mr. Chuck Dunn	U.S Fish and Wildlife Service
Ms. Katherine Fletcher	Puget Sound Water Quality Authority
Dr. Jack Gakstatter	U.S. Environmental Protection Agency
Mr. Dennis Gregoire	Port of Everett
Mr. Nathan Jacobsen	Snohomish Conservation District
Dr. David Jamison	Washington Department of Natural Resources
Mr. Edward Long	National Oceanic and Atmospheric Adminsitration
Mr. Edward Lukjanowicz	U.S Navy Home Porting Office
Mr. C.H. Mangum	Snohomish Health District
Mr. William Moore	Mayor of Everett
Mr. Dave Murdock	Washington Department of Ecology
Mr. Tom Niemann	Snohomish County Planning Department
Mr. Clair Olivers	City of Everett
Ms. Sandra O'Neill	Washington Department of Fisheries

Mr. David Peterson	Snohomish Health District
Ms. Clare Ryan	Washington Dept. of Ecology
Mr. Carl Sagerser	Washington Dept. of Social and Health Service
Mr. David Somers	Tulalip Tribes
Ms. Joan Thomas	Washington Department of Ecology
Mr. James Thornton	Washington Department of Ecology
Mr. John Underwood	U.S. Environmental Protection Agency
Mr. Frank Urabeck	U.S. Army Corps of Engineers, Seattle District
Mr. Harry Winder	Port of Everett
Mr. William Yake	Washington Department of Ecology
Lt. Cmdr. Greg Yaroch	Port Marine Safety Office

Everett Harbor Citizen's Advisory Committee

Name	Affiliation
Mr. Dennis Atkinson	Everett Chamber of Commerce
Mr. Tim Bechtel	Scott Paper Company
Mr. Ronald Brown	Friends of the Snohomish River
Mr. William Brust	Citizens for Everett's Future
Mr. T.M. Burns	Everett Chamber of Commerce
Mr. Carl Cady	Weyerhaeuser Company
Mr. Mike Deller	Snohomish County Economic Development Council
Mr. Al Friedman	Sierra Club
Ms. Anne Grubb	Pilchuck Audubon Society
Ms. Lorena Havens	Friends of Snohomish Delta
Mr. James Heil	Puget Sound Alliance
Mr. Mark Houser	Port Gardner Information League
Mr. Peter Hurley	Evergreen Coalition
Mr. Henry Kral	Everett Mountaineers
Mr. Don Kusler	Pilchuck Audubon Toxics
Ms. Sally Van Niel	Washington Environmental Council
Mr. Gary Wold	Trout Unlimited

15.0 RECOMMENDATIONS

The recommendations presented below are based on reviewing the report as a stand-alone document, and do not attempt to account for additional information potentially available. The additional information needed based on the review of the September 1988, Everett Harbor Action Program: Analysis of Toxic Problem Areas document is described below:

- o The sediment analysis of biological effects measured in this study should be re-evaluated using the recently published Ecology sediment standards (WAC 173-204) to determine if additional areas of concern exist based on these new standards.

16.0 FINAL COMMENTS

In the reviewers' best professional judgement, the data presented in this well written report meet the overall minimum levels of data quality for use in achieving the report's stated objectives identified in Section 1.0 of this review.

Attachment A

REFERENCES

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REFERENCES

Barrick, R.C., and F.G. Prahl, 1987, Hydrocarbon geochemistry of the Puget Sound Region, III, Polycyclic Aromatic Hydrocarbons in Sediments, Estuar. Coastal Shelf Sci. 25:175-191.

Chapman, P.M., M.A. Farrell, R.M. Kocan, and M.L. Landolt, 1982a, Marine Sediment Toxicity Tests in Connection with Toxicant Pretreatment Planning Studies, prepared for the Municipality of Metropolitan Seattle, E.V.S. Consultants, Vancouver, B.C., 15 pp.

Chapman, P.M., G.A. Vigers, M.A. Farrell, R.N. Dexter, E.A. Quinlan, R.M. Kocan, and M.L. Landolt, 1982b, Survey of Biological Effects of Toxicants Upon Puget Sound Biota, I, Broad Scale Toxicity Survey, NOAA Technical Memorandum OMPA-25, National Oceanic and Atmospheric Adminisration, Boulder, Colorado, 98 pp.

Comiskey, C.E., T.A. Farmer, C.C. Brandt, and G.P. Romberg, 1984, Puget Sound Benthic Studies and Ecological Implications, Technical Report C2, Toxicant Pretreatment Planning Study, Municipality of Metropolitan Seattle, Seattle, Washington, 373 pp.

Evans-Hamilton and D.R. Systems, 1987, Puget Sound Environmental Atlas, prepared for U.S. Environmental Protection Agency, Puget Sound Water Quality Authority, and U.S. Army Corps of Engineers, Seattle, Washington, Evans-Hamilton, Seattle, Washington.

Malins, D.C., November 21, 1984, Personal communication (letter to D. Moos, Washington Department of Ecology, regarding pollution-related problems with bottomfish in Puget Sound). National Oceanic and Atmospheric Administration, Northwest and Alaska Fisheries Center, Seattle, Washington, 8 pp.

Malis, D.C., B.B. McCain, D.W. Brown, A.K. Sparks, and H.O. Hodgins, 1980, Chemical Contaminants and Biological Abnormalities in Central and Southern Puget Sound, NOAA Technical Memorandum OMPA-2, National Oceanic and Atmospheric Administration, Rockville, Maryland, 295 pp.

Malins, D.C., B.B. McCain, D.W. Brown, A.K. Sparks, H.O. Hodgins, and S.-L. Chain, 1982, Chemical Contaminants and Abnormalities in Fish and Invertebrates from Puget Sound, NOAA Technical Memorandum OMPA-19, National Oceans and Atmospheric Administration, Rockville, Maryland.

Malins, D.C., B.B. McCain, D.W. Brown, S.-L.Chan, M.S. Myers, J.T. Landahl, P.G. Prohaska, A.J. Friedman, L.D. Rhodes, D.G. Burrows, W.D. Gronlund, and H.O. Hodgins, 1984, Chemical Pollutants in Sediments and Diseases of Bottom-Dwelling Fish in Puget Sound, Washington, Environ. Sci. Technol. 18:705-713.

Malins, D.C., M.M. Krahn, D.W. Brown, L.D. Rhodes, M.S. Myers, B.B. McCain, and S.-L. Chan, 1985, Toxic Chemicals in Marine Sediment and Biota From Mukilteo, Washington: Relationships With Hepatic Neoplasms and Other Hepatic Lesions in English Sole (Parophrys vetulus), J. Natl. Cancer Inst. 74:487-494.

Malins, D.C., B.B. McCain, M.S. Myers, D.W. Brown, and S.-L. Chan, (Unpublished), Liver Diseases of Bottom Fish From Everett Harbor, Washington, National Oceanic and Atmospheric Administration, Northwest and Alaska Fisheries Center, Seattle, Washington, 6 pp.

Mearns, A., R. Swartz, J. Cummins, D. Dinnell, P. Plesha and P. Chapman, 1986, Inter-Laboratory Comparison of a Sediment Toxicity Test Using the Marine Amphipod Rhepoxynius abronius, Mar. Environ. Res. 19:13-37.

Mowrer, J., J. Calambokidis, N. Musgrove, B. Drager, M.W. Beug, and S.G. Herman, 1977, Polychlorinated Biphenyls in Cottids, Mussels, and Sediment in Southern Puget Sound, Washington, Bull. Environ. Contam. Toxicol. 18:588-594.

Parametrix, 1985, Benthos of Everett Harbor, 1984, Draft Report, prepared for the U.S. Department of the Navy, San Bruno, California, Parametrix, Inc., 19 pp.

Swartz, R.C., W.A. DeBen, K.A. Sercu, and J.O. Lamberson, 1982, Sediment Toxicity and the Distribution of Amphipods in Commencement Bay, Washington, USA, Mar. Pollut. Bull. 13:359-364.

Swartz, R.C., W.A. DeBen,, J.K.P. Jones, J.O. Lamberson, and F.A. Cole, 1985, Phoxocephalid Amphipod Bioassay for Marine Sediment Toxicity, pp. 284-307; In: Aquatic Toxicology and Hazard Assessment: Seventh Symposium, R.D. Cardwell, R. Purdy, and R.C. Bahner (eds); ASTM STP 854, American Society of Testing and Materials, Philadelphia, Pennsylvania.

Tetra Tech, 1985a, Commencement Bay Nearshore/Tideflats Remedial Investigation, Final Report, EPA-910/9-85-134b, prepared for the Washington State Department of Ecology, Olympia, Washington, and U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Seattle, Washington, 2 vol. plus appendices, Tetra Tech, Inc., Bellevue, Washington.

Tetra Tech, 1985b, Everett Harbor Toxics Action Plan: Initial Data Summaries and Problem Identification, Draft Report, prepared for U.S. Environmental Protection Agency Region 10, Seattle, Washington, Tetra Tech, Inc., Bellevue, Washington.

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ecology and environment

Tetra Tech, 1986a, Analytical Methods for U.S. EPA Priority Pollutants and 301(h) Pesticides in Estuarine and Marine Sediments, Final Report, prepared for U.S. Environmental Protection Agency, Office of Marine and Estuary Protection, Washington, D.C., Tetra Tech, Inc., Bellevue, Washington.

Tetra Tech, 1986b, Bioaccumulation monitoring guidance: 4. Analytical Methods for U.S. EPA Priority Pollutants and 301(h) Pesticides in Tissues from Estuarine and Marine Organisms, Final Report, prepared for U.S. Environmental Protection Agency, Office of Marine and Estuarine Protection, Washington, D.C., Tetra Tech, Inc., Bellevue, Washington.

Tetra Tech, 1986c, Development of Sediment Quality Values for Puget Sound, Final Report, prepared for Resource Planning Associates under U.S. Army Corps of Engineers, Seattle District, for the Puget Sound Dredged Disposal Analysis and Puget Sound Estuary Programs, Seattle, Washington, Tetra Tech, Inc., Bellevue, Washington, 128 pp. plus appendices.

Tetra Tech, 1986d, Eagle Harbor Preliminary Investigation, Final Report, prepared for Black & Veatch Engineers-Architects and the Washington Department of Ecology, Olympia, Washington, Tetra Tech, Inc., Bellevue, Washington, 192 pp. plus appendices.

Tetra Tech, 1986e, Everett Harbor Toxics Action Program: Review of Existing Action Plans, Final Report, prepared for the U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Seattle, Washington, Tetra Tech, Inc., Bellevue, Washington.

Tetra Tech, 1986f, Quality Assurance Project Plan for Field Investigations to Support Development of the Everett Harbor Action Plan, prepared for U.S. Environmental Protection Agency Region 10, Seattle, Washington, Tetra Tech, Inc., Bellevue, Washington.

Tetra Tech, 1986g, Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound, Final Report, prepared for the U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, Tetra Tech, Inc., Bellevue, Washington.

Tetra Tech, 1986h, Sampling and Analysis Design for Development of Everett Harbor Action Plan, Draft Report, prepared for U.S. Environmental Protection Agency Region 10, Seattle, Washington, Tetra Tech, Inc., Bellevue, Washington.

Tetra Tech, 1987, Commencement Bay Nearshore/Tideflats Feasibility Study: Development of Sediment Criteria, Final Draft Report, prepared for the Washington Department of Ecology, Olympia, Washington, and U.S. Environmental Protection Agency, Tetra Tech, Inc., Bellevue, Washington.

Tetra Tech and E.V.S Consultants, 1986, Recommended Protocols for Conducting Laboratory Bioassays on Puget Sound Sediments, Final Report, prepared for the U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, Washington, Tetra Tech, Inc., Bellevue, Washington, 55 pp.

United States Environmental Protection Agency, 1982, Port Gardner Deep Water Sediment Survey, Unpublished data, U.S. Environmental Protection Agency, Region 10, Seattle, Washington, 18 pp.

Williams, J.R., H.E. Pearson, and J.D. Wilson, 1985, Streamflow Statisitics and Drainage-Basin Characteristics of the Puget Sound Region, Washington, Volume II, Eastern Puget Sound from Seattle to the Canadian Border, U.S. Geological Survey Open-File Report 84-144-B, U.S. Department of the Interior, Tacoma, Washington, 420 pp.

Attachment B

LIST OF CONTAMINANTS AND CONVENTIONAL VARIABLES FOR ANALYSIS

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TABLE 1. LIST OF CONTAMINANTS AND CONVENTIONAL VARIABLES FOR ANALYSIS IN EVERETT HARBOR PROJECT

Low Molecular Weight PAH
- naphthalene
- acenaphthylene
- acenaphthene
- fluorene
- phenanthrene
- anthracene

High Molecular Weight PAH
- fluoranthene
- pyrene
- benz(a)anthracene
- chrysene
- benzofluoranthenes (b and k)
- benzo(a)pyrene
- indeno(1,2,3-c,d)pyrene
- dibenzo(a,h)anthracene
- benzo(g,h,i)perylene

Total PCBs

Neutral Halogenated Compounds
- 1,2-dichlorobenzene
- 1,3-dichlorobenzene
- 1,4-dichlorobenzene
- 1,2,4-trichlorobenzene
- hexachlorobenzene (HCB)
- 2-chloronaphthalene
- hexachlorobutadiene
- hexachloroethane

Phthalate Esters
- dimethyl phthalate
- diethyl phthalate
- di-n-butyl phthalate
- butyl benzyl phthalate
- bis(2-ethylhexyl)phthalate
- di-n-octyl phthalate

Pesticides
- p,p'-DDE
- p,p'-DDD
- p,p'-DDT
- aldrin
- chlordane
- dieldrin
- endrin
- endosulfan I
- endosulfan II
- endosulfan sulfate
- endrin ketone
- heptachlor
- hepachlor epoxide
- alpha-HCH
- beta-HCH
- delta-HCH
- gamma-HCH (lindane)
- methoxychlor
- toxaphene

Phenol and Alkyl-Substituted Phenols
- phenol
- 2-methylphenol
- 4-methylphenol
- 2,4-dimethylphenol
- 4-chloro-3-methylphenol

Chlorinated Phenols/Guaiacols
- 2-chlorophenol
- 2,4-dichlorophenol
- 2,4,6-trichlorophenol
- 2,4,5-trichlorophenol
- 2,3,4,6-tetrachlorophenol
- pentachlorophenol
- 3,4,5-trichloroguaiacol
- 4,5,6-trichloroguaiacol
- tetrachloroguaiacol

Resin Acids
- abietic acid
- dehydroabietic acid
- 12-chlorodehydroabietic acid
- 14-chlorodehydroabietic acid
- dichlorodehydroabietic acid
- isopimaric acid
- neoabietic acid
- sandaracopimaric acid

Nitrogen-Containing Compounds
- N-nitrosodi-n-propylamine
- N-nitrosodiphenylamine
- nitrobenzene
- 2-nitrophenol
- 4-nitrophenol

TABLE 1. (Continued)

- 2,4-dinitrophenol
- 4,6-dinitro-2-methylphenol
- 4-chloroaniline
- 2-nitroaniline
- 3-nitroaniline
- 4-nitroaniline
- 2,4-dinitrotoluene
- 2,6-dinitrotoluene
- 3,3'-dichlorobenzidine

Halogenated Ethers
- bis(2-chloroethyl)ether
- bis(2-chloroisopropyl)ether
- bis(2-chloroethoxy)methane
- 4-chlorophenyl phenyl ether
- 4-bromophenyl phenyl ether

Miscellaneous Extractable Compounds[a]
- 2-methylnaphthalene
- dibenzofuran
- benzyl alcohol
- benzoic acid
- isophorone
- hexachlorocyclopentadiene

Volatile Organic Compounds
- acetone
- benzene
- bromodichloromethane
- bromoform
- bromomethane
- 2-butanone
- carbon disulfide
- carbon tetrachloride
- chlorobenzene
- chloroethane
- 2-chloroethylvinyl ether
- chloroform
- chloromethane
- dibromochloromethane
- dichloromethane
- 1,1-dichloroethane
- 1,2-dichloroethane
- 1,1-dichloroethene
- trans-1,2-dichloroethene
- 1,2-dichloropropane
- cis-1,3-dichloropropene
- trans-1,3-dichloropropene
- ethylbenzene
- 4-methyl-2-pentanone
- 2-hexanone
- styrene
- 1,1,2,2-tetrachloroethane
- tetrachloroethene
- 1,1,1-trichloroethane
- 1,1,2-trichloroethane
- trichloroethene
- toluene
- total xylenes
- vinyl acetate
- vinyl chloride

Metals
- antimony
- arsenic
- cadmium
- chromium
- copper
- iron
- lead
- manganese
- mercury
- nickel
- selenium
- silver
- zinc
- tributyltin

Conventional Variables
- total organic carbon
- total solids
- percent fine-grained material
- total nitrogen
- water-soluble sulfides

[a] Fifteen tentatively identified organic compounds were also analyzed and are listed in the Results section.

Attachment C

FIGURES

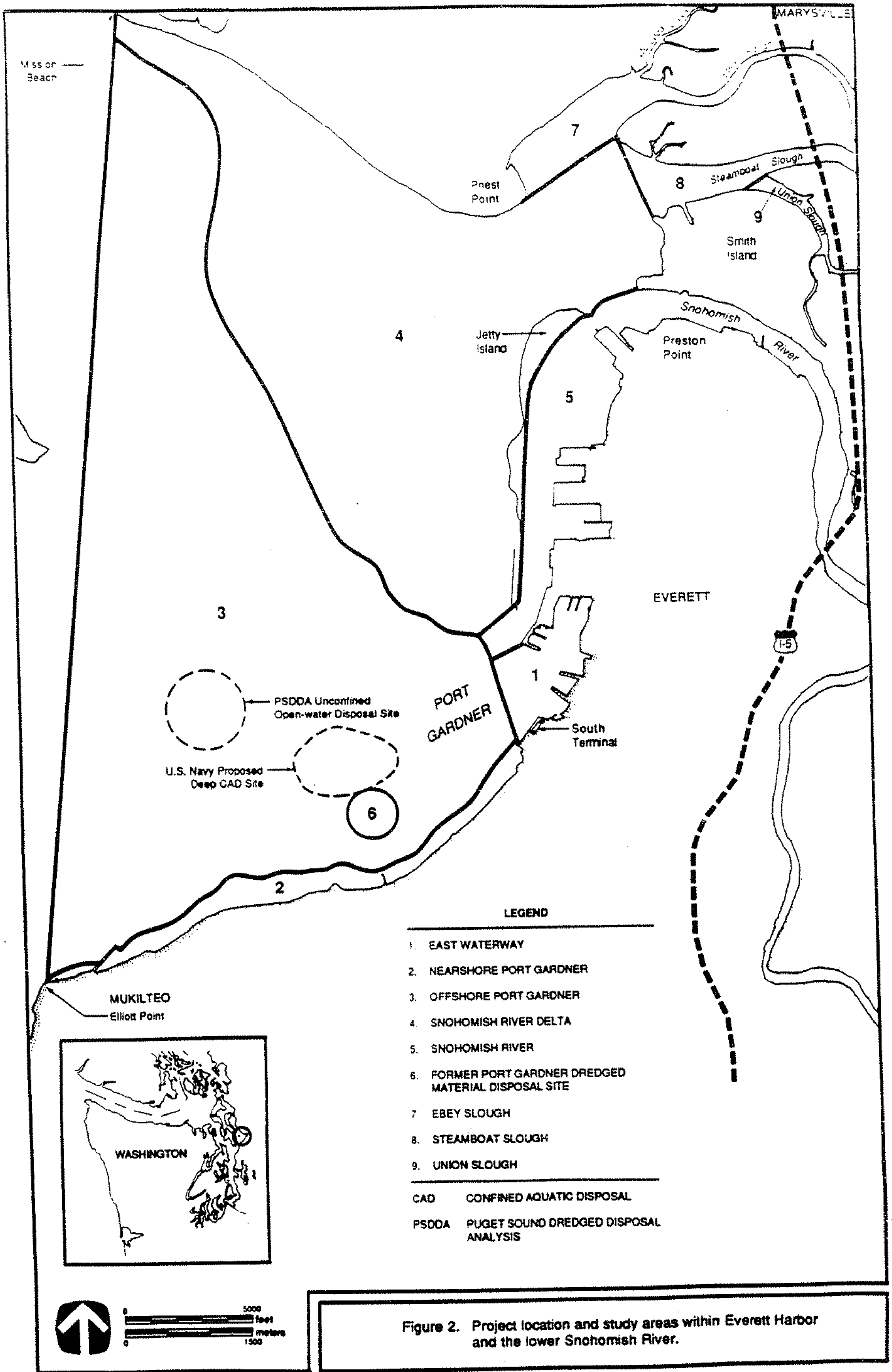

Figure 2. Project location and study areas within Everett Harbor and the lower Snohomish River.

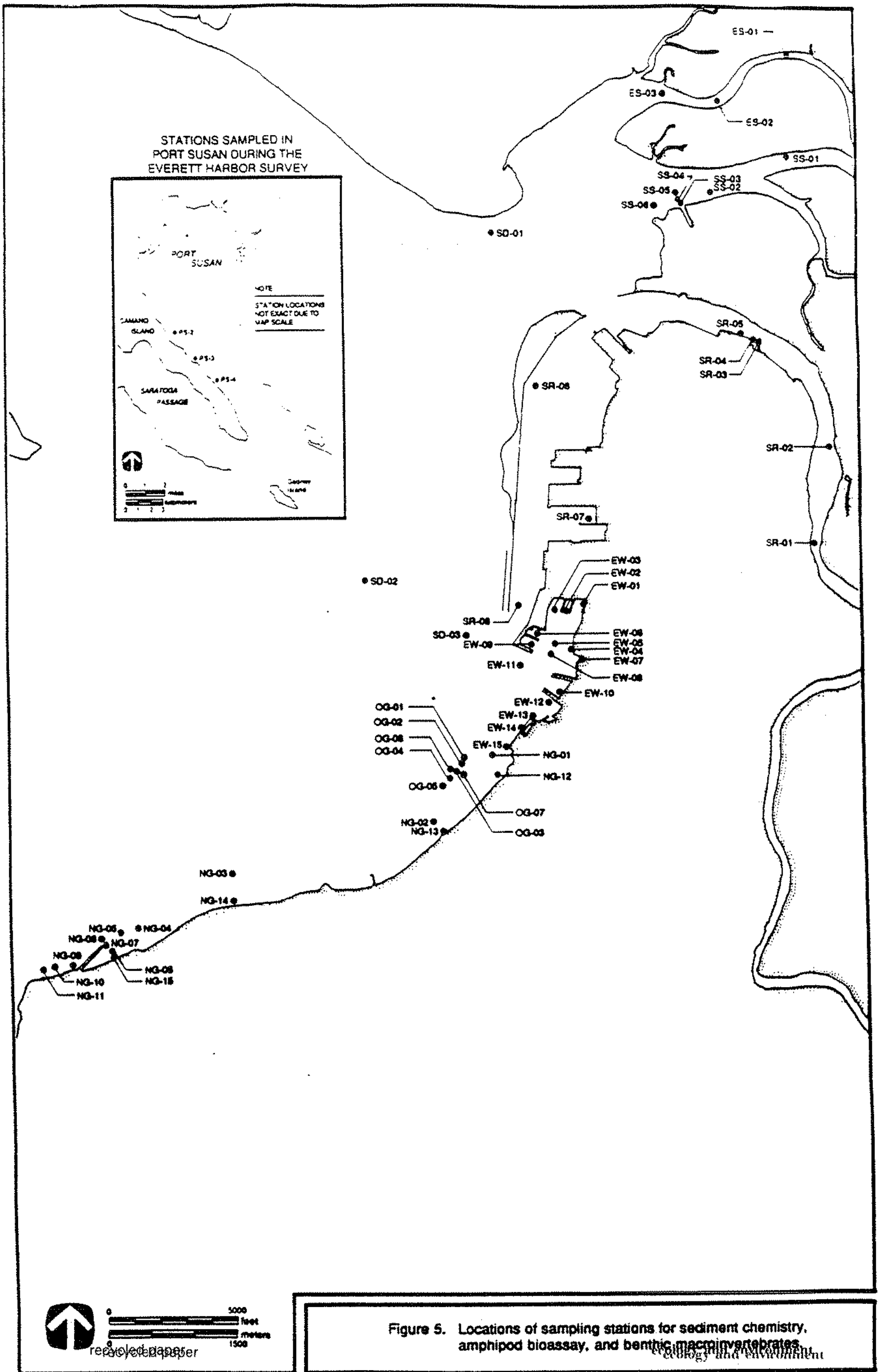

Figure 5. Locations of sampling stations for sediment chemistry, amphipod bioassay, and benthic macroinvertebrates.

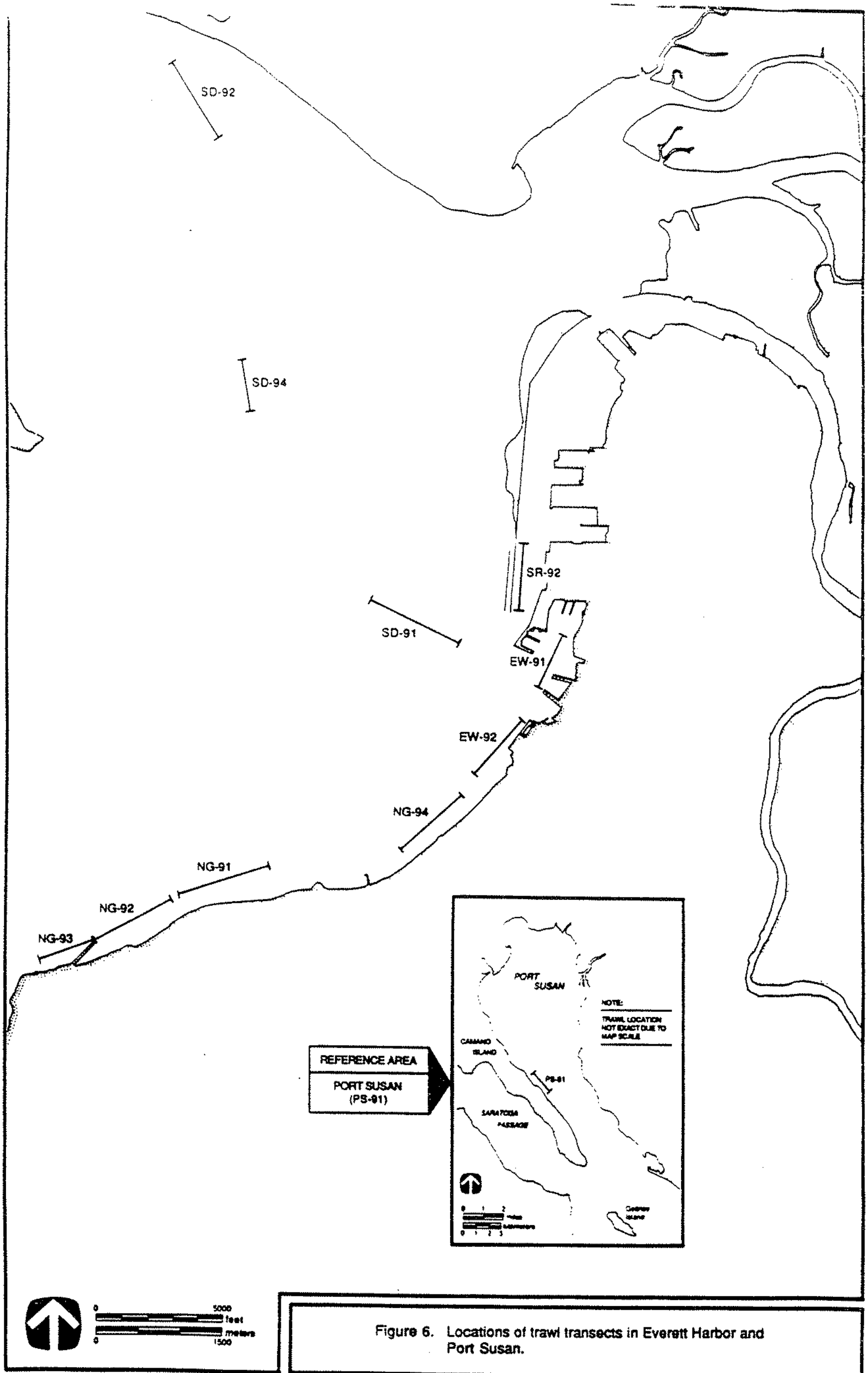

Figure 6. Locations of trawl transects in Everett Harbor and Port Susan.

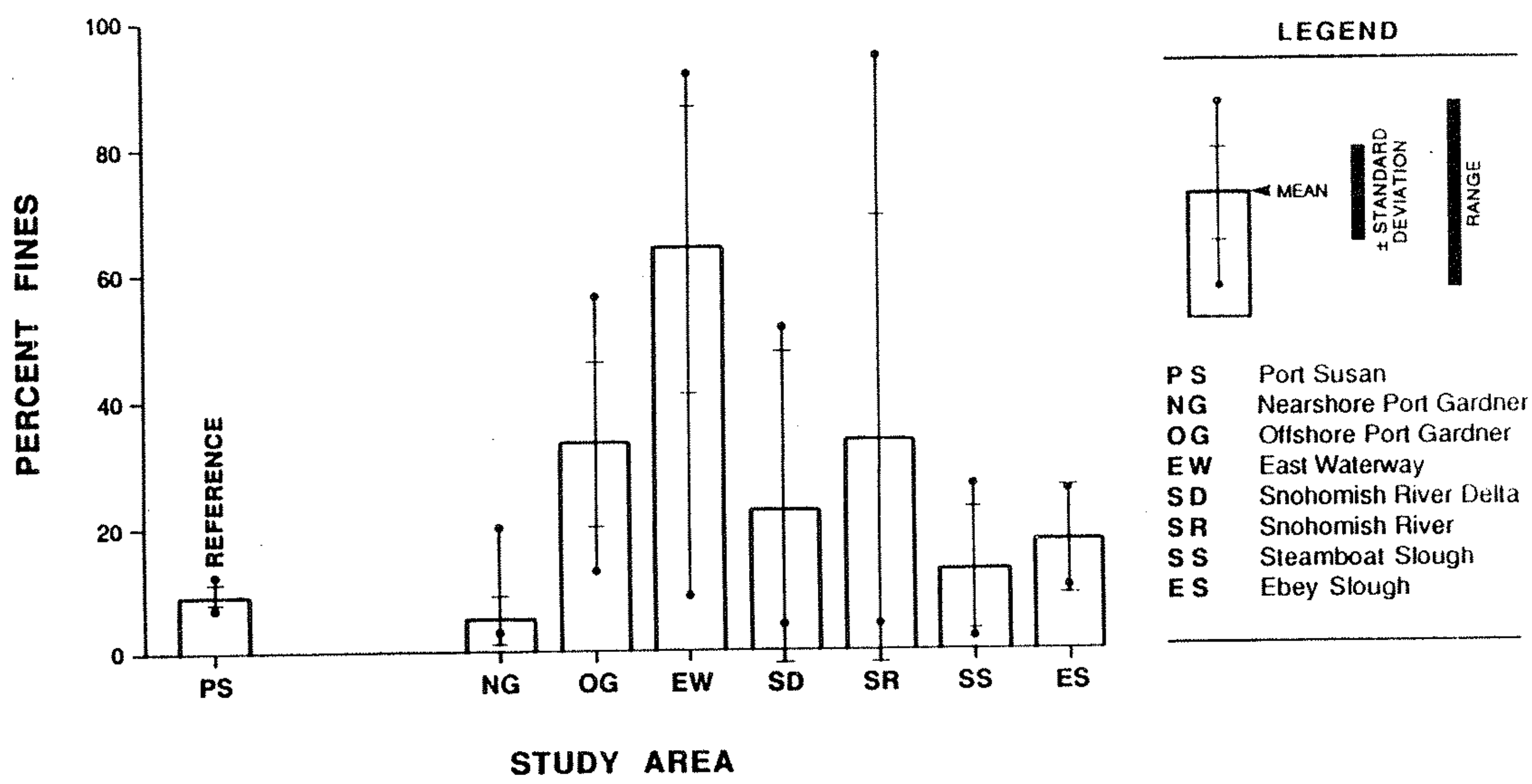

Figure 7. Average percent fine-grained material (silt plus clay) in sediments from all study areas.

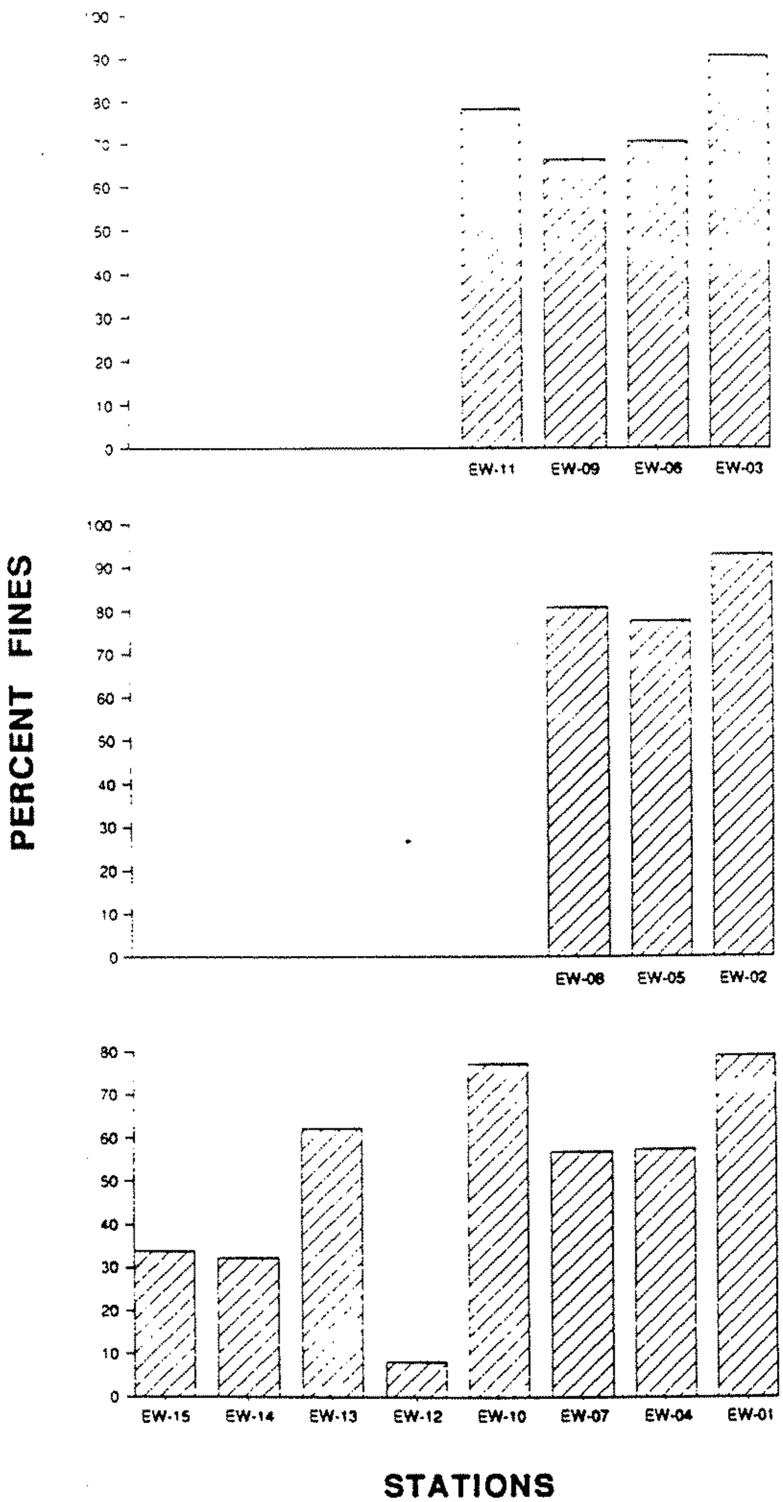

Figure 8. Percent fine-grained material (silt plus clay) in sediments of the East Waterway.

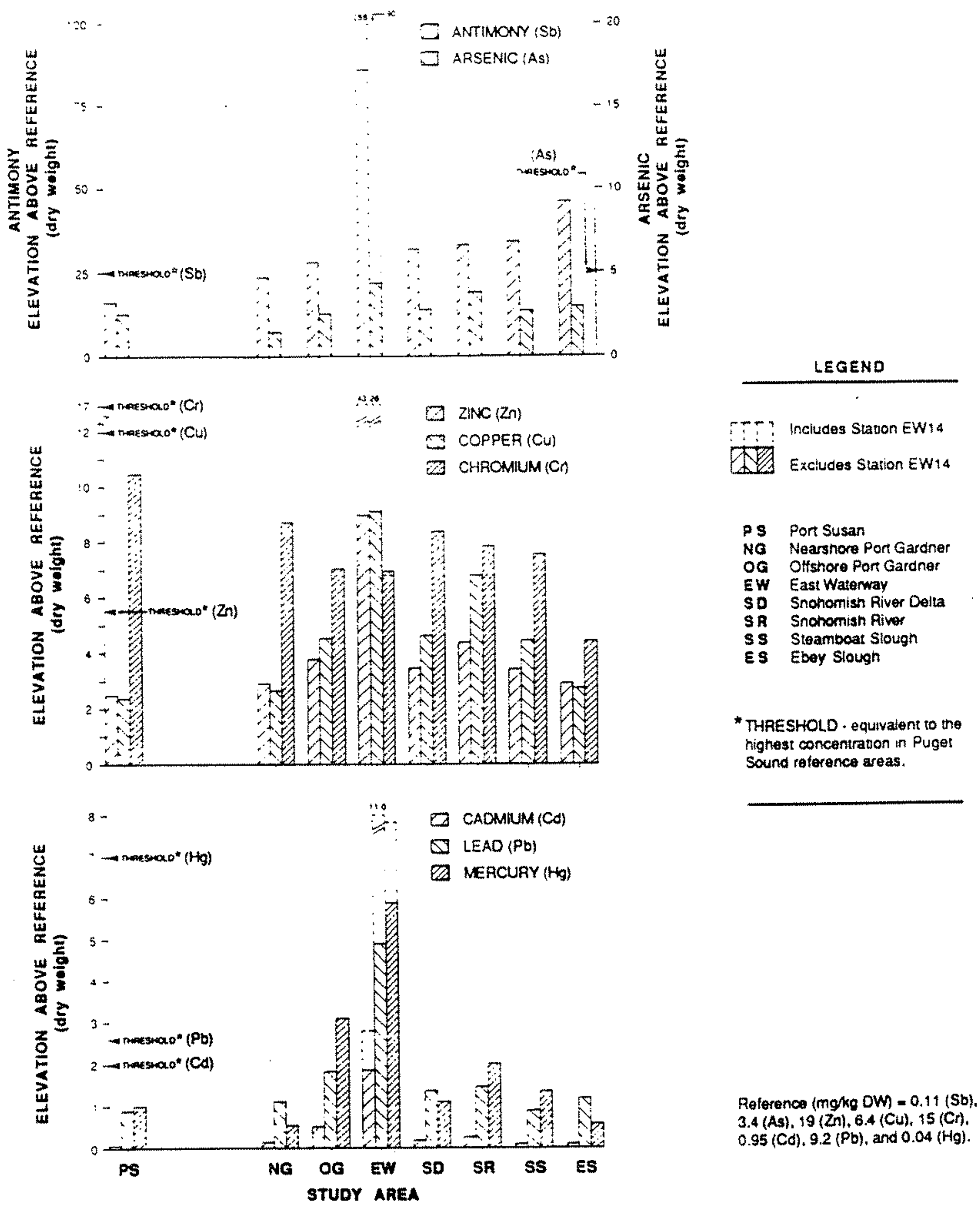

Figure 14. Mean EAR of metals of concern from all study areas.

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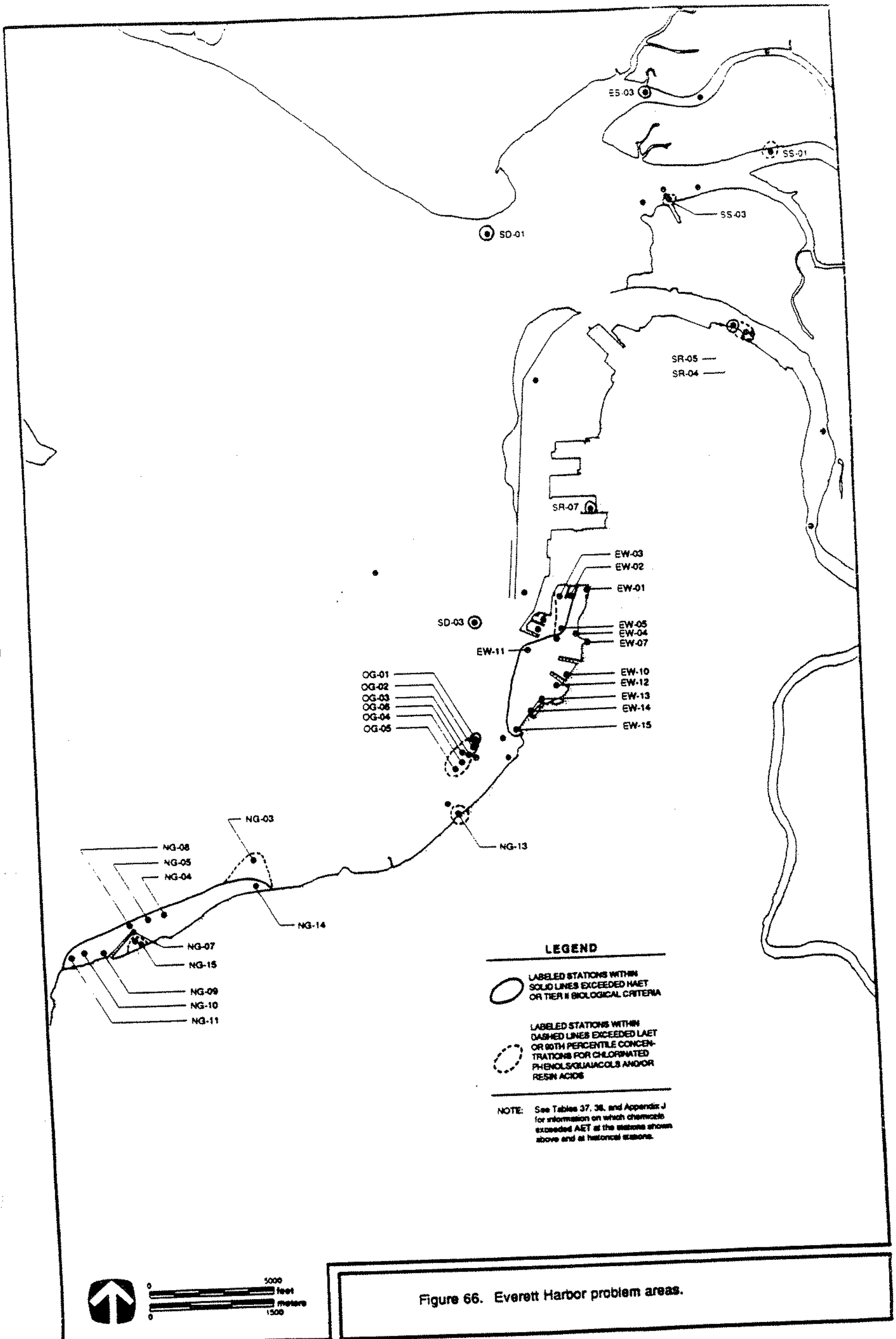
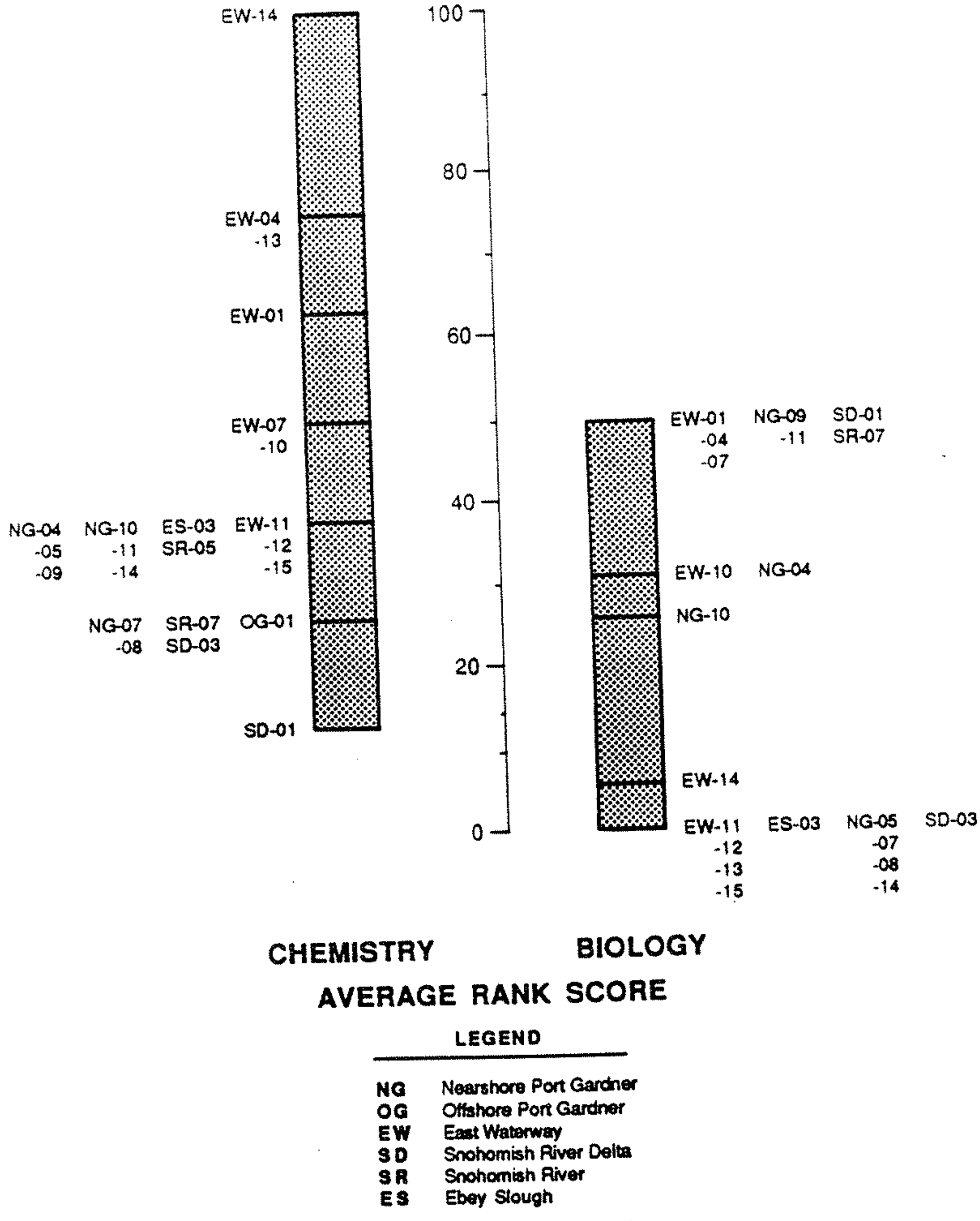
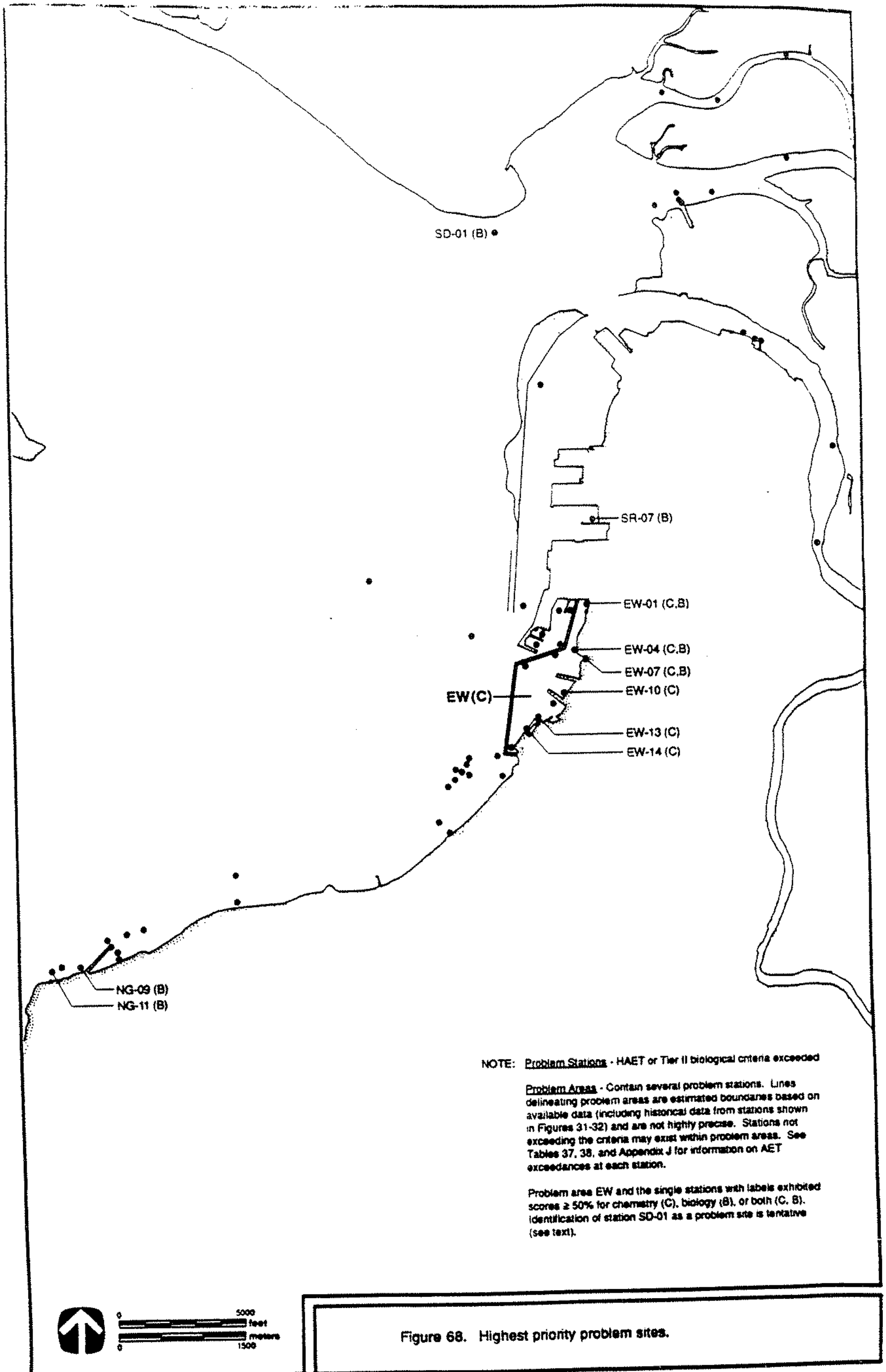


Figure 66. Everett Harbor problem areas.



NOTE: Limited biological data were available for most stations (see Appendix I).

Figure 67. Ranking of single stations classified as problem sites.



NOTE: Problem Stations - HAET or Tier II biological criteria exceeded

Problem Areas - Contain several problem stations. Lines delineating problem areas are estimated boundaries based on available data (including historical data from stations shown in Figures 31-32) and are not highly precise. Stations not exceeding the criteria may exist within problem areas. See Tables 37, 38, and Appendix J for information on AET exceedances at each station.

Problem area EW and the single stations with labels exhibited scores ≥ 50% for chemistry (C), biology (B), or both (C, B). Identification of station SD-01 as a problem site is tentative (see text).

Figure 68. Highest priority problem sites.

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Attachment D

TABLES

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TABLE 7. SUMMARY OF SEDIMENT ANALYSES BY STATION

Station	Semivolatile Organic Compounds[a]	Metals[b]	Conventionals[c]	Volatile Organic Compounds[d]	Resin Acids and Chlorinated Phenolic Compounds	Amphipod Bioassay	Benthic Infauna
ES-01	X	X	X			X	
ES-02	X	X	X	X		X	
ES-03	X	X	X			X	
EW-01	X	X	X	X	X	X	X
EW-02			X	X	X		
EW-03			X	X	X		
EW-04	X	X	X	X	X	X	X
EW-05			X	X	X		
EW-06			X	X	X		
EW-07	X	X	X	X	X	X	X
EW-08			X	X	X		
EW-09			X	X	X		
EW-10	X	X	X			X	X
EW-11	X	X	X		X		
EW-12	X	X	X			X	X
EW-13	X	X	X		X		
EW-14	X	X	X		X	X	X
EW-15	X	X	X		X		
NG-01	X	X	X			X	X
NG-02	X	X	X			X	X
NG-03	X	X	X			X	X
NG-04	X	X	X			X	X
NG-05	X	X	X	X			
NG-06	X	X	X	X		X	X
NG-07	X	X	X				
NG-08	X	X	X				
NG-09	X	X	X				
NG-10	X	X	X			X	X
NG-11	X	X	X				
NG-12[e]	X	X	X			X	
NG-13[e]	X	X	X			X	
NG-14[e]	X	X	X			X	
NG-15[e]	X	X	X			X	
OG-01	X	X	X				
OG-02	X	X	X		X		
OG-03	X	X	X	X	X	X	
OG-04	X	X	X		X		
OG-05	X	X	X				
OG-06	X	X	X		X		
OG-07	X	X	X	X	X		
PS-02	X	X	X	X	X	X	X
PS-03	X	X	X	X	X	X	X
PS-04	X	X	X	X	X	X	X
SD-01	X	X	X		X	X	X
SD-02	X	X	X		X	X	X
SD-03	X	X	X				

TABLE 7. (Continued)

Station	Semivolatile Organic Compounds[a]	Metals[b]	Conventionals[c]	Volatile Organic Compounds[d]	Resin Acids and Chlorinated Phenolic Compounds	Amphipod Bioassay	Benthic Infauna
SR-01	X	X	X			X	
SR-02	X	X	X	X		X	
SR-03	X	X	X		X		
SR-04	X	X	X		X	X	
SR-05	X	X	X		X		
SR-06	X	X	X				
SR-07	X	X	X			X	X
SR-08	X	X	X			X	X
SS-01	X	X	X			X	
SS-02	X	X	X		X		
SS-03	X	X	X	X	X	X	
SS-04	X	X	X		X		
SS-05	X	X	X		X		
SS-06	X	X	X		X		

[a] EPA priority pollutant acid/base/neutral organic compounds, PCBs, and pesticides (see Table 1 for complete list of target chemicals).

[b] EPA priority pollutant metals, except beryllium and thallium. Tributyltin was analyzed at Stations SR-07 and PS-02 only.

[c] Total organic carbon, total nitrogen, water-soluble sulfides, and grain-size composition.

[d] EPA priority pollutant volatile compounds.

[e] Intertidal station.

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TABLE 14. CONCENTRATIONS OF METALS AND TRIBUTYLTIN IN SURFACE SEDIMENTS OF EVERETT HARBOR AND PORT SUSAN

Chemical	Range (mg/kg dry wt)	Detection Frequency	Location of Maximum
Antimony	E1.21 - E203	54/54	EW-14
Arsenic	2.62 - 685	54/54	EW-14
Cadmium	0.04 - 7.94	54/54	EW-14
Chromium	51 - 271	54/54	NG-15
Copper	10.6 - 1,010	54/54	EW-14
Iron	16,600 - 90,600	54/54	EW-14
Lead	4.4 - 517	54/54	EW-14
Manganese	282 - 1,050	54/54	EW-14
Mercury	0.006 - 0.776	54/54	EW-14
Nickel	24.1 - 69[a]	54/54	SR-07
Selenium	U0.20 - 0.58[a]	17/54	NG-01
Silver	0.007 - 1.03[a]	54/54	EW-14
Zinc	38 - 5,910	54/54	EW-14
Tributyltin	U0.006 - 0.093	1/2	SR-07

[a] Maximum observed concentration in this study does not exceed the maximum concentration observed among Puget Sound reference areas.

TABLE 16. RANGE IN EAR FOR METALS OF CONCERN IN SEDIMENTS OF EVERETT HARBOR AND PORT SUSAN

Chemical	EAR[a] Range[b]	Median	Threshold[c]	Areas where Threshold Exceeded by 10 Times[d]
Antimony	11-1,850 (240)	29	25	EW-14
Arsenic	0.78-203 (8.0)	2.4	5.0	EW-14
Cadmium	0.04-8.4 (4.8)	0.14	2.0	--
Chromium	3.4-18 (18)	7.3	17	--
Copper	1.7-160 (15)	3.8	12	EW-14
Lead	0.48-56 (9.6)	1.2	2.6	EW-14
Mercury	0.15-19 (12)	1.2	7.0	--
Zinc	2.0-310 (14)	3.2	5.4	EW-14

[a] Dry-weight concentration in study area sediments divided by the average concentration measured in six Carr Inlet sediments (Tetra Tech 1985a).

[b] Value in parentheses is the maximum EAR value excluding Station EW-14.

[c] The threshold EAR is defined as the ratio of the maximum reference sediment concentration in Puget Sound divided by the average for six Carr Inlet reference sediments. Above the threshold EAR, the dry-weight concentration of a study area sediment contaminant would exceed the maximum concentration reported for any Puget Sound reference site listed in Table 15.

[d] The contaminant EAR values for the listed stations exceeded the threshold level by at least one order of magnitude. The factor of 10 was arbitrary, but was useful for indicating the areas of greatest contamination. Sediments from the underlined stations had the highest observed concentrations.

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TABLE 35. ACTION ASSESSMENT MATRIX OF SEDIMENT CONTAMINATION, TOXICITY, AND BIOLOGICAL EFFECT INDICES FOR EVERETT HARBOR PROBLEM AREAS

Variable	Problem Area Elevations[a]								Reference Value[b]
	East Waterway	Area NG	ES-03	OG-01	SD-01	SD-03	SR-05	SR-07	
Sediment Chemistry									
LPAH	310	31	4.4	21	1.1	9.8	21	12	<41 ppb
HPAH	89	36	3.6	8.4	0.70	3.6	22	17	<79 ppb
4-methylphenol	1,900	200	110	98	0.20	57	150	17	<13 ppb
Phenol	40	24	36	14		3.9	3.6	7.9	<33 ppb
2-methylphenol	40								U 7 ppb
2,4-dimethylphenol	14								U 7 ppb
Benzoic acid	14	5.4	5.2			5.3	6.9	1.4	<150 ppb
Dehydroabietic acid	430				0.50		56		<63 ppb
Benzyl alcohol	17					9.9	4.2		U 10 ppb
PCBs	180	120				3.2			<6 ppb
p,p'-DDT						2.3			U 10 ppb
1,2-dichlorobenzene	20	11							U 3.5 ppb
Copper	26	2.8	3.8	5.4	2.9	8.2	9.0	15	6.37 ppb
Zinc	43	3.0	3.6	4.4	2.7	4.8	5.5	8.1	19 ppb
Sediment Toxicity									
Amphipod mortality	2.9	1.7	0.68		0.68			1.5	22%
Infauna									
Polychaetes	2.3	1.7			160			5.4	1,570/m^2
Gastropods	7.4	0.08			taxon absent			5	50/m^2
Pelecypods	150	0.43			24			5.6	1,560/m^2
Crustaceans	3.6	0.4			5.2			63	1,000/m^2
Fish Pathology									
Neoplasms[c]	1	2.7				1.7			0%
Foci	0.71	1.9				0.49			7.1%
Megalocytic hepatosis[c]	8	2.7				0			0%
Bioaccumulation									
PCBs - English sole	3.2	3.8				2.8			8.3 ppb
PCBs - Dungeness crab	2.1	2.8				0.70			5.0 ppb

a Boxed numbers represent elevations of chemical concentrations that exceed all Puget Sound reference area values. and statistically significant (P<0.001) toxicity and biological effects at one or more stations compared with reference conditions in Port Susan. Significance tests were not performed on the bioaccumulation data (see **Results**). Chemicals shown in the table had concentrations exceeding HAET or EAR >1,000. The "U" qualifier indicates the chemical was undetected and the detection limit is shown. The "<" qualifier indicates the chemical was undetected at one or more stations. The detection limit is used in the calculations. Infauna EAR are based on the elevation in biological effects represented by reductions in infaunal abundances relative to reference conditions. EAR for all other variables reflect an increase in the value of the variable at Everett Harbor compared with reference conditions. Blank spaces in sediment chemistry columns indicate that the chemical was undetected throughout the problem area.

b EAR values shown for each area are based on Carr Inlet reference values for sediment chemistry and on Port Susan (1986) reference values for biological variables.

c Prevalences of neoplasms and megalocytic hepatosis at each problem area are shown in table instead of EAR because the reference values were 0%.

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Attachment E

ACTION ASSESSMENT MATRIX

Appendix

O

EAST WATERWAY, EVERETT, WASHINGTON
TECHNICAL DOCUMENT REVIEW

Review of:

URS Consultants, Inc., 1989a, East Waterway Cleanup Reconnaissance Study RI/FS and EIS Workplan - Preliminary Draft, Everett, Washington, prepared for the Washington State Department of Ecology, Olympia, Washington.

Contract No. C0089007

Document Control No. WD4030.1.0-0

January 1991

Prepared For:

WASHINGTON STATE DEPARTMENT OF ECOLOGY
Toxics Cleanup Program

ecology and environment, inc.
101 YESLER WAY, SEATTLE, WASHINGTON, 98104, TEL. 206/624-9537
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Appendix P

EAST WATERWAY TECHNICAL DOCUMENT REVIEW

TABLE OF CONTENTS CHECKLIST

1.0 INTRODUCTION AND CHRONOLOGY OF EVENTS

The document reviewed reviews/summarizes field studies performed between 1982 and 1989, including general methods used in sample collection and analyses conducted. Summaries of results were provided, based on specific characteristics (e.g., total organic carbon, sediment grain size, bioaccumulation, fish pathology, etc.). Twelve references were identified as providing primary sources of data and information (pg. 1-1).

2.0 LEGAL AND REGULATORY ISSUES

The authors propose the use of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation/Feasibility Study (RI/FS) format and approach, but the sampling plan was based on Puget Sound Dredged Disposal Analysis (PSDDA) Program Compliance. A sampling plan was developed without first completing a conceptual model of the site (the first stage of RI scoping) and without a historical data evaluation. Applicable or relevant and appropriate requirements (ARARs) were not identified.

3.0 DEMOGRAPHICS AND LAND USE

N/A

4.0 POTENTIALLY LIABLE PERSONS

N/A

5.0 IDENTIFICATION OF POLLUTION POINT SOURCES

N/A

6.0 IDENTIFICATION OF POLLUTION NON-POINT SOURCES

N/A

7.0 CHEMICAL DATA

Historical data collection activities were summarized with little evaluation. No data validation has been performed, although it is recommended before proceeding: "Much of the existing data was analyzed in the preparation of this workplan...Validation of existing data and complete inventory of existing data for each management unit was beyond the scope of this workplan...Much of the existing data is limited by high detection limits, an absence of critical analytes, no supporting biological data and poor definition of the depth of the contaminated layer" (pg. 1-17).

8.0 BIOLOGICAL DATA (FLORA/FAUNA)

N/A

9.0 DATA QUALITY

A data validation criteria list is provided which includes both field and laboratory parameters; however, no specific standards are provided. "Over 50 sample locations have been investigated in the East Waterway study area. Much of the data obtained at these locations are relevant to this investigation. However, the validity of the data must be determined prior to their acceptance in the remedial investigation. Furthermore, the sufficiency of the data must be assessed with respect to the goals of the sampling plan. The question of data sufficiency will focus the sampling efforts assuming all existing data are valid" (pg. 2-29).

10.0 HYDROLOGIC AND HYDRODYNAMIC INFORMATION

N/A

11.0 DREDGING AND DISPOSAL ISSUES AND DATA

These topics will be addressed as remedial action alternatives are evaluated.

12.0 ENVIRONMENTAL IMPACTS

Environmental impacts will be addressed as part of the National Environmental Policy Act/State Environmental Policy Act process implemented during the FS.

13.0 INTERIM MEASURES/SPILL AND POLLUTION PREVENTION MEASURES

N/A

14.0 COMMUNITY RELATIONS INFORMATION

A Community Relations Plan outline is provided with supporting information that identifies both issues and interested parties.

15.0 RECOMMENDATIONS

This planning document needs to be reviewed thoroughly by all project participants, within the context of developing a conceptual approach to the RI/FS. The material presented in Section 1 provides an extensive outline for the process of integrating RI/FS/Environmental Impact Statement activities. Section 2 provides an RI Sampling Plan that is premature - historical data validation/evaluation needs to be performed, and ongoing RI/FS activities at other Puget Sound sites also should be evaluated to generate the site model and conceptual RI/FS approach.

16.0 FINAL COMMENTS

A previous review of this document (performed for Scott Paper Company) was attached to the document and corroborates the concern over adequate RI scoping. This only can be done by evaluating historical data, evaluating related Puget Sound site program development, and focusing on basic RI/FS objectives, which appear to be reflected by the Puget Sound Estuary Program Action Plan Objectives:

- Identify specific toxic areas of concern in sediments based on chemical contamination and associated adverse biological effects;
- Identify historical and ongoing sources;
- Rank toxic problem areas and sources; and
- Implement corrective actions.

Bailey's comments also indicate that an assessment of natural recovery of the harbor should be incorporated into the conceptual model, due to changing point-source loading over the last 10 years.

EAST WATERWAY, EVERETT, WASHINGTON
TECHNICAL DOCUMENT REVIEW

Review of:

URS Consultants, Inc., 1989b, Draft, East Waterway Cleanup Reconnaissance Study - Associated Issues Report, prepared for Washington State Department of Ecology.

Contract No. C0089007

Document Control No. WD4030.1.0-P

January 1991

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EAST WATERWAY TECHNICAL DOCUMENT REVIEW

TABLE OF CONTENTS CHECKLIST

ATTACHMENTS

1.0 INTRODUCTION AND CHRONOLOGY OF EVENTS

Introduction

Under the direction of the Washington State Department of Ecology (Ecology), URS Consultants, Inc. was tasked to investigate relevant remaining issues concerning the future cleanup of the East Waterway of Everett Harbor. The East Waterway was identified as the highest priority area in the Ecology and United States Environmental Protection Agency (EPA) Region 10 Everett Harbor Action Program. The report reviewed focuses on specific issues associated with the cleanup. The bulk of the document is a review of relevant studies, and is not a work plan or sampling effort report.

The objectives of this study were to address three cleanup issues:

- o Land and point source ownership identification;
- o Identify contaminants of concern, transport and exposure pathways, and potentially affected resources; and
- o Circulation and flushing in the waterway.

Chronology of Events

The document provides a chronology of ownerships of properties along the East Waterway, which is summarized in Section 4.0 of this report. Other critical historic events influencing the industrial conditions that were presented in this report are discussed below:

1931	Port of Everett built Tract "O," which forms the north and western land masses of the East Waterway, and within which are the current locations of piers B, C, D, and E.
1950 to 1951	Weyerhaeuser and Sound View Pulp Company built a deep water industrial outfall (SW001) to discharge outside of the East Waterway area.

2.0 LEGAL AND REGULATORY ISSUES

Criteria outlined in 43 CFR 11.62, which define an injury to a biological resource upon the release of a hazardous substance, are discussed. This report discusses the application of this regulation in Natural Resource Damage Assessments. This topic is summarized in Section 12.0. Otherwise, this report does not address legal or regulatory issues.

3.0 DEMOGRAPHICS AND LAND USE

There are four principal current owners of parcels of land adjacent to the East Waterway (see Figure 2-1 and Table 2-1 in Attachments A and B, respectively):

- o United States Navy (Navy)
  - Proposed carrier battle group Homeport site
  - Naval Reserve center;
- o Scott Paper Company pulp and paper plant;
- o Port of Everett
  - Hewitt Avenue Terminal
    Dunlap Towing Company
    TAT (USA) Corporation
    Foss Tug Company
    Columbia Falls Aluminum Company
  - Port offices; and
- o City of Everett City Hall.

The document provides a general discussion of the industrial land use within the area along with its presentation of ownerships of properties along the East Waterway. This is summarized in Section 4.0 of this report.

4.0 POTENTIALLY LIABLE PERSONS

The report provides a general overview of ownerships and general land uses from the early 1900s to the present (see Table 2-1 in Attachment B and reference pages 2-4 to 2-8 and Appendix B in the original report). The report does not include specific details (dates, parcels, etc.) and specific uses or locations of on-site activities. For many ownerships, a general period of involvement is specified. The report lists the following chronology of ownership along the border of the waterway:

American Boiler Works (1960s to 19__)
American Lumber and Manufacturing Company (1920s)
American Packaging Company (1930s to 1950s)
American Tug Boat (1950s)
Bell Nelson Mill Company (1900s)
Burlington Northern Railroad (1970s to present)
City of Everett
Columbia Falls Aluminum Company (present)
Commissioner of Public Lands (1950s to 19__)
Dante and Russell (1960s to 1970s)
Dillingham Company (1960s to 1970s)
Dunlap Towing Company (present)
EJ McNeely Company (1900s)
Everett Dock and Warehouse (1930s)
Everett Improvement Corporation (1900s to 1920s)

Everett Pacific Shipbuilding and Dry-dock Company with the United States Government (1940s)
Fisherman's Pacific Corporation (1930s)
Foss Tug Company (1950s to 1960s)
General Petroleum (1930s)
Great Northern Railway (1950s to 19__)
International Terminal Company (1960s)
North Star Lumber (1930s)
Northern Pacific Railway (1930s to 19__)
Oriental Dock (1930s)
Pacific Boat and Towing (1930s to 1950s)
Pendleton Gilky Company (1930s)
Port of Everett
Puget Sound Bridge and Dry-dock (a.k.a. Lockheed) (1960s)
Robinson Manufacturing (1930s)
Russell Company (1960s)
Salewell Land Loan and Trust Company (1910s)
Scott Paper Company (1950s to present)
Sound View Pulp and Timber Company (1930s to 1950s)
Standard Oil Company (1930s)
TAT (USA) Corporation (present)
United States Navy (1980s to present)
Western Gear (1960s to 1980s)
Weyerhaeuser Timber Company (1930s to 1980s)

5.0 IDENTIFICATION OF POLLUTION POINT SOURCES

There are a total of eight surface water discharges, five combined sewer outfalls, two active industrial discharges, and nine abandoned or currently inactive industrial discharges into the East Waterway (see Figure 2-3 in Attachment A). In addition, there is an active, deep water industrial outfall located approximately 1,400 feet outside of the East Waterway in Port Gardner.

City of Everett

The City of Everett's North End Sewer System maintains five combined sewer outfalls which discharge into the East Waterway. Industrial use of this system is not discussed in this report.

Port of Everett

The Port of Everett maintains three active storm sewer outfalls from the Hewitt Avenue Terminal. There are four inactive industrial outfalls in the South Terminal area, two from which Weyerhaeuser discharged untreated washing, bleaching, and drying process wastewater (WT002 and WT003), one from which Weyerhaeuser discharged limestone cleaning water along with storm water (WT006), and one which was a Weyerhaeuser storm water discharge (WT004).

Scott Paper Company

The Scott Paper Company maintains four storm sewer outfalls from its main plant, and a fifth is shared with the Navy. All five outfalls drain into the East Waterway. The Scott Paper Company is currently the sole user of the offshore industrial outfall (SW001), which discharges the bulk of the primary treated mill effluent. The company also maintains two industrial outfalls that discharge into the East Waterway: Outfall S003, a nearshore diffuser of primary treated mill effluent that overflows from the offshore outfall (SW001); and Outfall S008, a nearshore main discharge of secondary treated mill effluent. There are two industrial outfalls from the Scott Paper Company mill that were abandoned in 1980: Outfall S002 was used to discharge untreated pulp bleaching wastewater, and Outfall S004 was used to discharge untreated bayline floor trench waters.

Navy

The Navy shares one storm water discharge with Scott Paper Company and has no active industrial outfalls. There is one abandoned industrial outfall from Western Gear in the eastern portion of the Navy parcel of property that was used for noncontact cooling water (WG003).

6.0 IDENTIFICATION OF POLLUTION NON-POINT SOURCES

The URS Consultants report does not address storm water from a non-point source perspective. As the discussion is limited to the location of outfalls, the summary of that material is presented in Section 5.0. There were no other identified discharges into the East Waterway that would be classified as non-point source.

7.0 CHEMICAL DATA

The report contains no original data. A table from the report summarizes contaminants of concern that have been documented as present in the East Waterway, along with maximum reported concentration levels. The table also summarizes the level that certain contaminants are elevated above a referenced background level (for contaminants with a large enough database). This summary is presented in Table 3-1 of Attachment C.

The data discussions in this report are summaries of data presented in three previous reports:

Tetra Tech/PTI, 1988, Everett Harbor Action Program: Analysis of Toxic Problem Areas;

Storer and Arsenault, 1987, City of Everett CSO Study, Phase II, Task 7 - Water Quality (Sediment Sampling); and

Anderson and Crecelius, 1985, Analysis of Sediments and Soils for Chemical Contamination for the Design of the Navy Homeport Facilities at East Waterway of Everett Harbor.

The main classes of compounds that are discussed in this report are:

- Organics:
  - Polynuclear Aromatic Hydrocarbons (PAHs)

    Low Molecular Weight PAHs (LPAHs): two rings, usually associated with petroleum products, present in high level throughout the waterway;

    High Molecular Weight PAHs (HPAHs): three or more rings, associated with combustion by-products, throughout waterway in levels lower than LPAHs;

- Nonchlorinated Resin Acids and Phenolics: likely associated with residuals of digested, but unbleached wood from pulp mill and natural decomposition of wood debris on harbor floor prevalent throughout waterway;

- Chlorinated Resin Acids and Phenolics: associated with bleach plant wastes from pulp and paper mills, widely distributed throughout the waterway;

- PCB and Phthalate Esters: sources are speculative, detected in high concentrations at localized points; and

- Metals: listed in Table 3-1 (provided in Attachment C) but not discussed in report.

8.0 BIOLOGICAL DATA (FLORA/FAUNA)

Data Summary

One of the two major efforts in this report was to summarize the natural resources issues associated with the East Waterway contamination. The first part of that presentation has already been summarized in Section 7.0 of this report.

Demersal Fish. The East Waterway provides juvenile and adult habitat areas for over 30 species of marine and anadromous fish. The commercially important marine species include:

- Pacific cod,
- Pacific hake,
- Walleye pollock,
- Rock fish species, and
- Flatfish species.

There is a general absence of bottom dwellers, like flatfish, in the East Waterway as compared to Port Gardner and the Snohomish River estuary. This population decline is attributed to contamination of the sediments.

Juvenile Salmonids. Shallow, protected estuarian waters, like the East Waterway, provide early nursery and foraging grounds, as well as protection from predators, for young salmonids. Juvenile pink, chum, and chinook salmon rely heavily on the nearshore areas of the East Waterway between May and June. Coho and steelhead do not rely on the nearshore areas as much.

A feeding study of East Waterway juvenile salmonids found an equal distribution of preferred prey in dissected fish stomachs (Schadt and Weitkamp 1985), along with a natural frequency of empty stomachs. This suggests that the juvenile salmonid food supply is abundant in the East Waterway. The report provided no discussion or opinion of the chemical integrity of the stomach contents.

Crab and Shrimp. The dungeness crab density of Port Gardner is approximately 100 crab per hectare (Dinnel et al. 1986). In the late winter breeding season, 90 percent of the crabs were females, and 78 percent of those were gravid. This suggests that Port Gardner is an important area for mature females. Port Gardner's shrimp population was one order of magnitude below similar Puget Sound embayments (Elliott Bay and Commencement Bay), at 24.2 shrimp per hectare. The reasoning was not discussed. The East Waterway was not sampled.

Benthic Invertebrate Community. The benthic invertebrate community is a major link in the food chain for Puget Sound benthic and pelagic fishes. The East Waterway had its greatest diversity of species outside the mouth of the waterway, with lower diversity toward the head (Osburn and Weitkamp 1985, Tetra Tech/PTI 1988). The dominant species, a polychaete worm Capitella capitata, is known to thrive in chemically stressed environments (i.e., toxics and organic rich). All benthic community indices strongly suggest serious environmental perturbations. The main contributing factors appear to be (Osborn and Weitkamp 1985a):

- Effects of wood waste,
- Organic enrichment from pulp mills,
- Combined sewer overflow outfalls, and
- Toxic chemicals.

Epibenthic Community. The epibenthic community is composed primarily of copeopods and amphipods in the littoral and shallow, subtidal areas. These provide the major food source for juvenile salmonids. An abundance and diversity study within the East Waterway (Osborn and Weitkamp 1985b) indicated that this population was relatively unaffected, but that the dominant species were stress-tolerant (Bulbamphiascus sp. and Nebalia sp.), indicating environmental stress toward the head of the waterway (Tetra Tech/PTI 1988).

Marine Mammals. California sea lions are the most abundant marine mammal, with winter counts in Everett Harbor of between 185 and 525 animals. This represents a five-fold increase from 1979 to 1985 (Richter and Dragavon 1985a). The report indicates that there are little or no data on the impact of the levels of contamination on the transient marine mammal population except to note that their position at the top of the food chain makes this group susceptible to bioaccumulation.

Sea Birds. Overwintering of sea birds is common in the East Waterway because of its proximity to the Snohomish River estuary. Forty-five sea bird species commonly use the East Waterway as a habitat at an estimated density of 223 birds/km^2 (Richter and Dragavon 1985b). The most significant food source for this group is the epibenthic crustacea, mussels and barnacles.

Data Gaps

The report identifies data gaps for the issues that are discussed in this report. The report concluded that the substances of concern are adequately studied.

Transport and Exposure. The basic transport and exposure scenarios are well studied, but the next level of clarification involves multiple routes and compound combinations and would come at high expense.

Injury Determination. The flatfish and benthic community organisms are those that are most closely associated with the contaminated sediments, and therefore have been the most thoroughly studied. Additional monitoring of other organism groups might reveal other impacts that are as yet unrecognized. However, for most other organisms common to the East Waterway, the baseline data have not been established. Additional information is needed on:

- o Relative toxicities of classes of substances in the East Waterway sediments;
- o Comparative study of the impacts of logging on a similar embayment that is not affected by the industrial activities that also affect the East Waterway; and
- o Bioaccumulation of toxics in the low-level food chain.

Damage Determination. Once the injury determinations are completed, other resource and economic damages can be assessed, like:

- o Survey of altered fishing or fish consumption habits of local residents as a result of posted warnings on consumption; and
- o Survey regarding impacts on the aesthetic value of the area.

9.0 DATA QUALITY

There are no original chemical or biological sampling data presented in this report. None of the summarized data are presented in reviewable format.

10.0 HYDROLOGIC AND HYDRODYNAMIC INFORMATION

The second major effort of the report was to conduct a computer model circulation and flushing study of the waterway. The investigators used the stationery-state simulation Generalized Longitudinal-Lateral-Vertical Hydrodynamics and Transport model to accomplish this second task.

The mean depth of the waterway for this application were 10 m at the head and 20 m at the mouth. Depths occur to 100 m in the Snohomish River delta channel. The Snohomish River discharges a mean 290 m^3/sec across the mouth of the East Waterway. Although there is limited freshwater drainage directly into the waterway (storm drainage), this proximity of the Snohomish River creates a unusual estuarian environment in which fresh water from the Snohomish is pushed into the waterway with the rising tide, so the source of fresh water for this "estuary" is at its mouth rather than at its head.

The tidal cycle is 24.8 hr, with a total volume of the East Waterway at 19.9 by 10^6 m^3 MLLW.

There is a mean water exchange per tidal cycle in the East Waterway of 27 percent (Downing et al. 1987) due to tidal prism and eddy effect at the mouth, with up to a seven-fold variability due to changing density effects (salinity and temperature). Proposed harbor alterations for the Navy Homeport would reduce the estimated exchange rate to 22 percent (Downing et al. 1987). A simulated dye test conducted through the report's modeling raised those exchange estimates to 30 and 24 percent, respectively.

The report reviewed describes details of the variables and physical processes that affect flushing (and therefore the model's performance) and assumptions that were adopted to use the model. The report suggests field evaluations that would collect data to augment the model's performance, including:

- Water elevations at the mouth of the waterway,
- Wind direction and speed data, and
- Field dye dispersion experiment.

A simulated dye test was applied through the model which concluded that the East Waterway has a mass decay rate of 22.4 percent/day in a neap tide period.

11.0 DREDGING AND DISPOSAL ISSUES AND DATA

N/A

12.0 ENVIRONMENTAL IMPACTS

Transport and Fate

The report observes that there have been few studies specific to the transport of contaminants in the East Waterway sediments. Contaminant transport is discussed on the basis of the principles associated with dissolution in water and movement of solids, and is not supported by specific data.

Studies outside the waterway indicate that sediment contamination is essentially limited to the waterway itself (Tetra Tech/PTI 1988). Some transport by dissolution of compounds is possible as a function of the solubility of the specific compound in seawater (variable) and by diffusion from the fine sediments that predominate the waterway floor (slow). The report observes that transport of compounds in the dissolved phase is of limited importance compared to disturbance of sediments with the redistribution of fines.

Nonchlorinated resin acids and phenolics may be subject to fairly rapid microbial degradation, whereas this process would be considerably slower for the chlorinated resin acids and phenolics. The low and high molecular weight PAHs are generally resistant to microbial assault.

Exposure Pathways

The report highlights three principal exposure pathways for organisms associated with the East Waterway:

- o Contact with water that has received dissolved contaminants from the sediments (e.g., susceptible pelagic species);
- o Ingestion of sediments, either as a feeding strategy (e.g., mollusks) or incidental (e.g., bottom-feeding fishes); and
- o Direct contact with sediments (e.g., benthic invertebrates).

The rate of contaminant dispersion from the sediments to the water is low compared to the flushing effect, thus a substantial portion of the risk is restricted to those organisms that reside and/or feed in benthic and epibenthic zones.

Damage Determination

The report discusses economic and scientific methodologies for evaluation of damages to resources lost as a result of East Waterway contamination. The potentially impacted resource categories are:

- o Developed resources with open market value (e.g., fisheries);
- o Resources with ecological value, but no direct market value (e.g., food chain organisms); and
- o Resources with aesthetic/social value but no market value (e.g., marine mammals).

Injury Identification. Criteria outlined in 43 CFR 11.62 identify an injury to a biological resource if release of a hazardous substance has resulted in the following situations:

1. Adverse changes in viability to any biological species, or
2. Contaminant concentrations in edible portions of organisms exceed federal, state, or local consumption criteria.

Benthic community impacts most obviously fit both these criteria, with the dominance of stress-resistant species, and the imposition of local notices warning against the consumption of crabs and bottom fish.

Elevated Levels of Contaminants in Edible Fish Tissue. There is limited bioaccumulation of mercury and polychlorinated biphenyls (PCBs) in bottom fish and crabs from the East Waterway (Tetra Tech/PTI 1988). This has resulted in a posting at public access points advising against the consumption of those bottom fish and crabs caught in the area.

In situ bioassays. The report discusses the drawback to this type of assay in the East Waterway, citing cost, the lack of an existing data baseline, and difficulties associated with extrapolating sample effects to the population level.

Laboratory toxicity testing. A high frequency of toxic responses have been reported in laboratory toxicity assays using East Waterway sediments (Tetra Tech/PTI 1988). The diversity of responses in these controlled assays was not discussed.

Fin Erosion. The report observes that damage associated from this category are unknown due to the complications of developing a ration of affected versus normal individuals in an open estuarian environment. Such an assessment must take into account factors like migration, competition, predation, and other disease.

Fish neoplasms. One cited study indicated no statistically significant occurrence of neoplasms on English sole from the East Water-way compared to Port Susan (Tetra Tech/PTI 1988), while in another study, no flatfish were observed in the East Waterway (Whitman and Weitkamp 1985). The later study noted no significant diversity between the pelagic species distribution in the East Waterway compared to Port Gardner, suggesting that sediment contamination was responsible for the absence of bottom dwelling fish.

Other histopathic lesions. The Tetra Tech/PTI study (1988) noted a significantly higher incidence of a particular liver lesion in English sole from the East Waterway compared to those from Port Susan. However, this report concludes that economic damages from this type of injury are not likely to be significant.

Physiologic malformations. The report discusses this category in relation to sea birds, noting that there are no data on effects on the indices like eggshell thickness or number of fledglings resulting from feeding within the East Waterway.

Decreased mammalian reproduction and/or increased mortality. Because of the migratory nature of the mammalian population of the East Waterway, the report concludes that it would be difficult to correlate effects to this category of response from the East Waterway contamination.

Benthic community alterations. Benthic community effects have been noted in the East Waterway, manifested by the predominance of organisms tolerant to toxics and organic enrichment. These alterations have been linked to mortality of organisms in laboratory toxicity studies. Apparent Effects Thresholds have been developed for Puget Sound, defining chemically specific concentration values above which biological effects (like benthic community depression) always occur. The report concludes that damages due to benthic community alterations are likely to be high.

13.0 INTERIM MEASURES/SPILL AND POLLUTION PREVENTION MEASURES

N/A

14.0 COMMUNITY RELATIONS INFORMATION

N/A

15.0 RECOMMENDATIONS

The report cites data gaps that would elaborate on existing knowledge and understanding of the East Waterway. Refinement of the existing knowledge bases for the issues covered in the report are probably necessary for the development of an acceptable Remedial Investigation/Feasibility Study (RI/FS) work plan, and are probably not necessary for the development of a remedial action plan.

16.0 FINAL COMMENTS

The report is a good synopsis of selected past East Waterway studies that were relevant to the objectives of the report. The report appears to accurately conclude that natural resource damages have occurred based on:

- o Benthic community alterations;
- o Elevated levels of contaminants in edible fish tissues resulting in a consumption advisory; and
- o Documented toxicity of bottom sediments in laboratory bioassays.

Injuries which may be occurring, but for which there are insufficient data or confounding factors that reduce statistical confidences are:

- o Flatfish disease and mortality, and
- o Cancrid crab mortality.

The report concludes that damage (economic and/or resource) from most of the discussed biological indices is not likely to be significant. The fact that adverse responses within any of these indices can be statistically demonstrated is in itself a significant fact. If aesthetic and ecologic damage is given the same weight as economic, then the conclusions within the report need to be reassessed.

Attachment A

MAPS

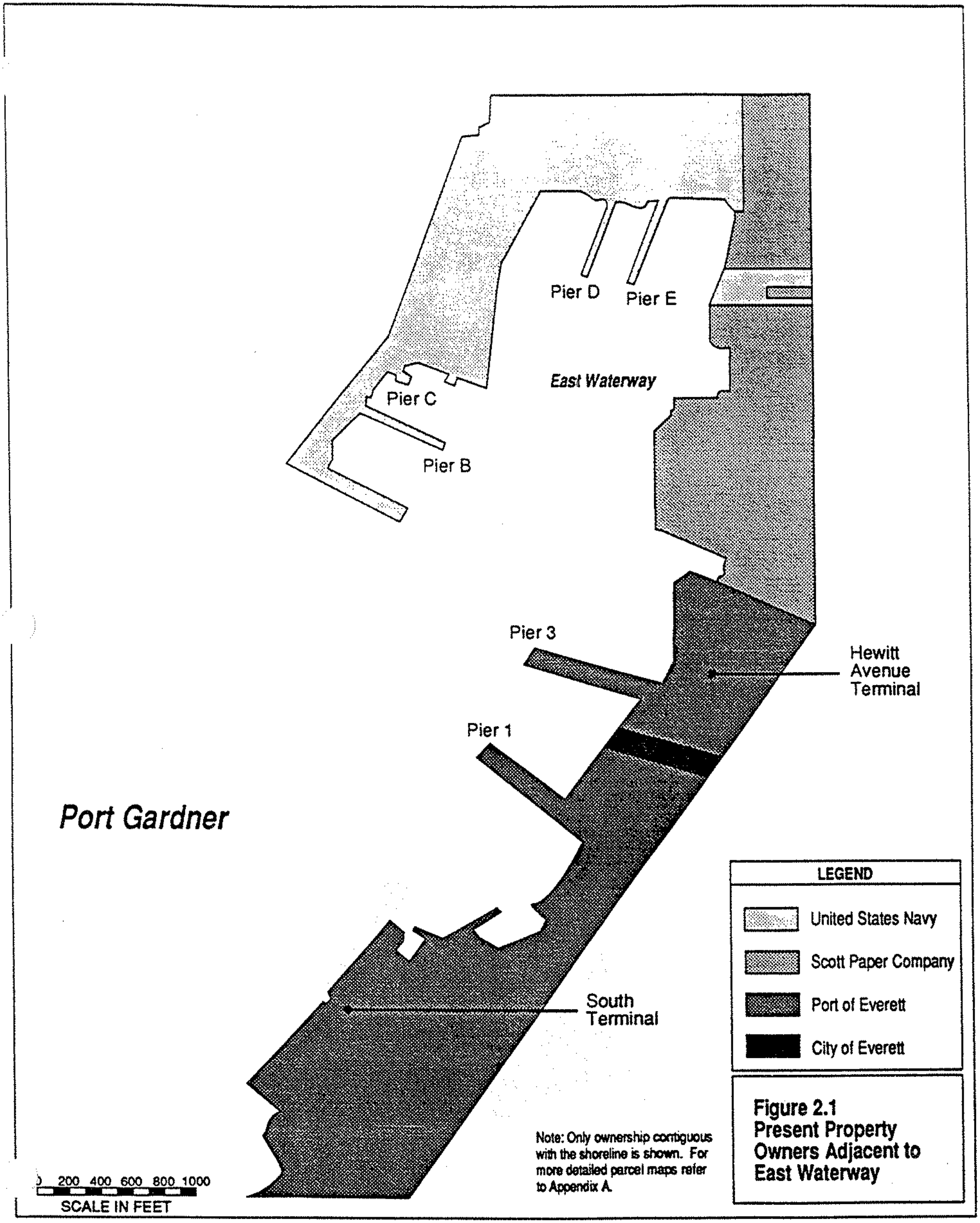

Figure 2.1
Present Property Owners Adjacent to East Waterway

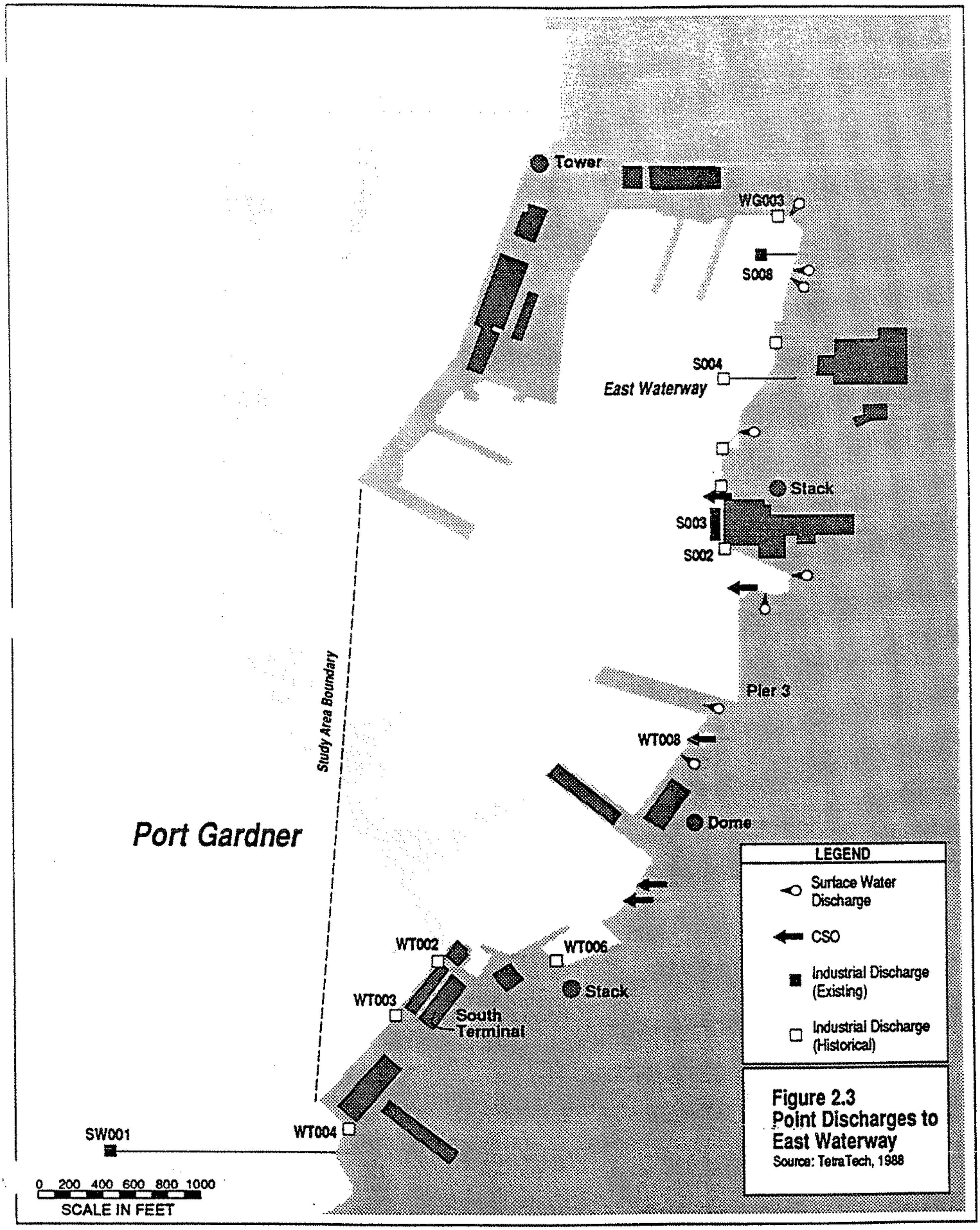

Figure 2.3
Point Discharges to East Waterway
Source: TetraTech, 1988

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Attachment B

PRESENT OWNERSHIP OF PARCELS ADJACENT TO EAST WATERWAY

TABLE 2-1
PRESENT OWNERSHIPS OF PARCELS ADJACENT TO
THE EAST WATERWAY AND ASSOCIATED LAND USE

OWNER/ADDRESS	GENERAL LOCATION [1]	PARCEL NUMBER [2]	ASSOCIATED LAND USE
U. S. Navy PO Box 2366 Silverdale, WA 98383	North end and western side of East Waterway	192905-2-003 192905-2-014	Naval Station Puget Sound (under construction)
U. S. Navy PO Box 727 San Bruno, CA 94066	East side of East Waterway	192905-2-008	Naval Reserve Center
Scott Paper Company, 2600 Federal Avenue Everett, WA 98201	East side of East Waterway	192905-2-009, 2-010, 2-013, 2-015; 192905-3-001, 3-002	Pulp and paper manufacturing
Port of Everett PO Box 538, Everett, WA 98201	East side south of mouth of the East Waterway. Includes Hewitt Avenue and South Terminals, and Piers 1 and 3	192905-3-010, 3-012, 3-013, 3-016, 3-17; 302905-2-015, 2-016, 2-017, 2-018	Log transportation (Dunlap Towing Company), log handling and shipping [TAT(USA) Corporation], bauxite storage (Columbia Falls Aluminum Company), port offices, bulk handling facilities
City of Everett City Hall Everett, WA 98201	Extension of Hewitt Avenue	192905-3-012	Log handling by Port of Everett

Notes:

1 See Figure 2-1.
2 Based on maps and records available in the Snohomish County Office of the Assessor.

Attachment C

CONTAMINANTS OF CONCERN

Table 3-1. Contaminants of Concern Observed in the East Waterway of Everett Harbor.

Substance	Maximum Concen.	EAR	Ref.
LPAH (ug/kg)	100,000	**310[a]**	1,2
naphthalene	17,000		1
acenaphthylene	800		1
acenaphthene	5,200		1
fluorene	4,300		1
phenanthrene	8,100		1
anthracene	6,100		1
HPAH (ug/kg)	200,000	**90**	1,2
fluoranthene	3,700		1
pyrene	5,500		1
benz(a)anthracene	3,200		1
chrysene	3,200		1
benzofluoranthenes	4,100		1
benzo(a)pyrene	1,700		1
indeno(1,2,3-c,d)pyrene	730		1
dibenzo(a,h)anthracene	270		1
benzo(g,h,i)perylene	550		1
Total PCBs (ug/kg)	9,600	1,600	1
Resin Acids (ug/kg)			
abietic acid	98,000	**120**	1
dehydroabietic acid	83,000	**310**	1
isopimaric acid	11,000		1
neoabietic acid	14,000		1
sandaracopimaric acid	14,000		1
12-chlorodehydroabietic acid	11,000		1
14-chlorodehydroabietic acid	3,400		1
dichlorodehydroabietic acid	3,400		1
Phenols and Guaiacols (ug/kg)			
phenol	2,900	**40**	1
2-methyphenol	1,200		1
4-methyphenol	98,000	**1900**	1
2,4-dimethyphenol	520		1
2-chlorophenol	160	**30**	1
2,4-dichlorophenol	320		1
2,4,6-trichlorophenol	290		1
2,4,5-trichlorophenol	120		1
2,3,4,6-tetrachlorophenol	120		1
pentachlorophenol	460		1

3,4,5-trichloroguaiacol	110		1
4,5,6-trichloroguaiacol	48		1
tetrachloroguaiacol	50		1
Chlorinated Benzenes (ug/kg)			
1,2-dichlorobenzene	96	27	1
Phthalate Esters (ug/kg)			
butyl benzyl phthalate	70	4	1
bis(2-ethylhexyl)phthalate	930	55	1
Metals (mg/kg)			
antimony	203	**88(288)**	1
arsenic	685	**4(90)**	1
cadmium	7.9	**2(3)**	1
copper	1,010	**9(43)**	1
lead	517	**5(110)**	1
mercury	3.5	**6**	3
zinc	5,910	**9(26)**	1

a Bold EAR values are the means for the East Waterway. For some substances, no mean value could be calculated due to the limited number of times the substance was detected. The metals were detected in the sediments of the East Waterway at relatively low concentrations at all stations but one the Tetra Tech study. The EAR values are presented both without and with (in parentheses) the high value.

b Reference 1. PTI Environmental Services and Tetra Tech, Inc. 1988. Everett Harbor Action Program: Analysis of Toxic Problem Areas. for U.S. Environmental Protection Agency, Regions X, Office of Puget Sound, Seattle, WA.
Reference 2. Storer, R.A., and P.M. Arsenault. 1987. City of Everett CSO Study, Phase II, Task 7 - Water Quality (Sediment Sampling). Technical Memorandum. Ott Water Engineers, Inc., Seattle, WA.
Reference 3. Anderson, J.W., and E.A. Crecelius. 1985. Analysis of sediments and soils for chemical contamination for the design of U.S. Navy Homeport facilities at East Waterway of Everett Harbor, Washington. Final Report. Battelle Northwest Laboratory, Sequim, WA.

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Appendix Q

EAST WATERWAY, EVERETT, WASHINGTON
TECHNICAL DOCUMENT REVIEW

Review of:

United States Army Corps of Engineers, 1985, Final Report, U.S. Navy Homeport Facility at East Waterway, Everett Harbor, Washington: Biological and Chemical Analyses of Sediments, United States Army Corps of Engineers, Seattle, Washington, 15 pp. and appendices.

Contract No. C0089007

Document Control No. WD4030.1.0-Q

January 1991

Prepared For:

WASHINGTON STATE DEPARTMENT OF ECOLOGY
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EAST WATERWAY TECHNICAL DOCUMENT REVIEW

TABLE OF CONTENTS CHECKLIST

ATTACHMENTS

Attachment A - Maps
Attachment B - Bioaccumulation Chemistry Data Summaries
Attachment C - Amphipod Bioassay Data Summary

1.0 INTRODUCTION AND CHRONOLOGY OF EVENTS

The document reviewed serves as the final report by the United States Corps of Engineers (COE) that summarizes the results of biological testing conducted on East Waterway native sediments and on sediments from potential disposal sites located in Port Gardner. The document uses some verbatim text from the Anderson (1985) report entitled Biological and Chemical Analysis of Sediments for the Design and Construction of the U.S. Navy Homeport Facility at East Waterway, Everett Harbor, Washington. The Anderson (1985) report is also attached to the COE report as Appendix B and reportedly serves as the basis for evaluations by the COE. Appendix A is a presentation of oversize drawings from the COE Foundations and Materials Branch, but it was not present in the review copy of the report.

These studies were initiated by the United States Navy (Navy) to provide information about the various aquatic and nearshore areas of Port Gardner which could receive contaminated sediments from the dredging of East Waterway for the Navy's proposed Homeport facility. Studies were conducted by Battelle Pacific Northwest Laboratory at the request of the Seattle District Office of the United States COE. A February 1985 COE report, titled Analysis of Sediments and Soils for Chemical Contamination for the Design and Construction of U.S. Navy Homeport Facility at East Waterway of Everett Harbor, Washington recommended a comprehensive, detailed testing program for contaminated, organic sediments and biological testing of native sediments from East Waterway, Everett. Thus, acting upon the recommendations of the February 1985 COE report, the present studies were initiated.

The report begins by describing two distinct layers of marine sediments present in the East Waterway. These layers occur in areas proposed for dredging by the Navy for construction of the Homeport facility. The overlying organically rich, contaminated layer comprises 800,000 cubic yards of material shown to contain significantly elevated levels of chemical contaminants that were determined to be unacceptable for unconfined disposal in open water. Approximately 40,000 cubic yards of this material is said to lie outside the Navy's proposed dredging depth. The native material underlying the contaminated sediments is said to comprise approximately 500,000 cubic yards of material that the Navy is also proposing to dredge. (Citations are not provided for the volume calculations of contaminated and uncontaminated sediments presented.) This material is said to contain levels of specific metals and organics slightly elevated over Puget Sound background. Because no previous biological testing had been conducted on this material, the acceptability of this material for unconfined, open water disposal had not yet been determined.

Generally, the report summarizes the results and findings of the Anderson (1985) report but with a COE interpretation of the findings. In addition, a description of each potential dredge disposal site is included in the report.

- o The Army COE requested that Battelle, Pacific Northwest Laboratory (PNL) assist the COE with sampling and testing of East Waterway Everett Sediments.
- o Sediment samples collected between February 19 and 23, 1985 from Everett East Waterway and surrounding areas.
- o Physical, chemical, and biological testing conducted by Battelle PNL at Sequim, Washington.
- o Report of findings produced by Jack W. Anderson in May 1985.
- o May 3, 1985 the COE produces final report with Anderson study as an appendix.

2.0 LEGAL AND REGULATORY ISSUES

The report reviewed indirectly addresses those legal and regulatory issues related to the dredge and disposal of contaminated sediments from the East Waterway. A total of eight potential dredge disposal sites were evaluated through the sampling of 11 sediment stations located in and around the East Waterway (Attachment A). Alternative disposal sites were evaluated through the physical and chemical testing of sediments collected from these sites. While the potential disposal sites are evaluated for their potential to receive contaminated sediments, allowable levels of contamination are not discussed nor are specific regulatory and legal issues that would govern the disposal of contaminated sediments at these sites.

3.0 DEMOGRAPHICS AND LAND USE

N/A

4.0 POTENTIALLY LIABLE PERSONS

N/A

5.0 IDENTIFICATION OF POLLUTION POINT SOURCES

N/A

6.0 IDENTIFICATION OF POLLUTION NON-POINT SOURCES

N/A

7.0 CHEMICAL DATA

Presentation of chemical data is limited to summary statements of sediment quality at the potential disposal sites and to tissue chemistry results for bioaccumulation studies conducted previously by Anderson (1985). (The reader is directed to the Anderson report for the presentation of detailed data).

Bioaccumulation Chemistry

Uptake of metals or polychlorinated biphenyls (PCBs) by mussels and clams exposed to contaminated sediments of the East Waterway for 13 days was said not to be significant when compared to uptake by control organisms. (It should be noted that although only Aroclor 1254 was analyzed, it is not mentioned in the report.) Uptake of polynuclear aromatic hydrocarbons (PAHs) was noted but was said to be "particularly high" at only one station in the East Waterway (E-15-T). The report goes on to state that "the data suggest that the contaminated sediments in East Waterway may constitute an environmental problem in place, and that removal of the contaminated sediments may reduce potential adverse effects on marine biota."

Very high concentrations of PAH (255 ppm) in clam tissue at EEW-1 were said to be caused by interference, and cleanup steps suggested by the lab "would be expected to reduce this value significantly." (Cleanup of the sample extract would not necessarily be expected to reduce the values of PAH observed.)

The statements above tend to discount the bioaccumulation of metals and organics by mussels and clams from East Waterway sediments. In fact, PAHs and metals were strongly accumulated by these organisms after exposures of 13 and 21 days (see Tables 9, 10, and 11 provided in Attachment B).

Port Gardner Disposal Site Characterization

The site characterizations presented are only summaries of data presented elsewhere, the sources of which were not described in the report.

The Snohomish Channel (Scott-Crowley) Site (EDS-1 and 2) was said to have a silty-sand substrate at EDS-1 grading to sandy-silt at EDS-2. The substrate is also heavily littered with wood chips, bark, and other organic debris. Chemical analysis indicates that sediments at the site are moderately contaminated with High Molecular Weight PAHs (HPAHs). Except for lead at EDS-1, metals are at or below Puget Sound background levels. (Supporting documentation is not presented.) Contamination levels are higher at the southern end of the site (EDS-1) than at the north (EDS-2).

Weyerhaeuser Mill Site (EDS-3 and 4) was said to have substrate similar to the rest of East Waterway, with an organic layer of wood debris overlying native sediments. The overlying organic layer is contaminated with metals and organics although the levels present are not as high as those in East Waterway. Contamination is less in the northern end (EDS-3) than the southern (EDS-4), particularly for PAHs.

Port Gardner Open-Water Disposal Site (EDS-5) is a deep-water site with sand and sandy-silt substrate. Chemical analysis indicates that the site is less contaminated than Puget Sound background sediments.

Deep Delta Site (EDS-6 and 7) is a deep water site with primarily sand (EDS-6) and silty sand (EDS-7) substrate. Significant wood debris was present at both stations. Chemical analysis indicates that these sediments are cleaner than Puget Sound background.

South Jetty Island Site (EDS-8) has a sand substrate with an organic layer overlying Snohomish River sediments deposited during construction and maintenance of the navigation channel. Chemical analysis indicates that PAH levels are slightly above Puget Sound background while metals and PCB levels are below Puget Sound background.

Snohomish River Delta Site (EDS-9 and 10) is composed of sand substrate at both stations. Chemical analysis of sediments "indicates the area to be very clean."

The discussion/conclusions section of the report notes the following:

1. Downward migration of PAHs into the top of native sediment is suggested by the data of Anderson (1985). Higher sediment chemistry values obtained during the Anderson study (compared to previous sediment characterization) were said to result from a shallower sampling depth in the Anderson work. The level of sediment contamination in East Waterway appears to decrease with depth with the bulk of the contamination being associated with the top portion of native material closest to the overlying, organic layer.

2. Three of the composited native sediments, EEW-1, -2 and -6, contain levels of Low Molecular Weight PAHs (LPAHs) that exceed Four Mile Rock disposal criteria. "As a conservative measure, the top meter of native sediment for the area associated with EEW-2 and EEW-6 should be dredged and disposed of with the upper, organic fraction."

3. Contaminant mobility testing (not yet conducted at the time of the report) was expected to greatly assist in final selection and design of the selected dredge disposal site.

4. Recognition and endorsement is made of the need for more comprehensive analyses of tissue and sediment samples to determine the relationship between the presence of contaminants and their possible effect(s).

8.0 BIOLOGICAL DATA (FLORA/FAUNA)

The biological data presented contains a summary of the data compiled by Anderson (1985). The Anderson report is included as an appendix and is cited frequently.

Amphipod Bioassays

The amphipod bioassay results indicated significant toxicity for four of six East Waterway composite sediment samples when compared to native control sediments (see Table 2 in Attachment C). However, when compared to Sequim Bay sediments, only one East Waterway station (EEW-5) was said to show significant toxicity to amphipods. Thus, the report concludes that "the East Waterway native sediments do not exhibit significant toxicity that should preclude unconfined, open water disposal of the material."

Bioaccumulation

Bioaccumulation testing of mussels and clams exposed to East Waterway sediments for 13 days was said to show no significant uptake of metals or PCBs. Uptake of PAHs by clams was noted for only one sediment sample (E-15-T).

Bioaccumulation by mussels and clams exposed to contaminated sediments of East Waterway for 21 days was said to be difficult to summarize because "tissue concentrations did not always follow the pattern of sediment concentrations." (Exactly what is meant by this statement is not clear.) The uptake of metals was said not to appear significant. More accumulation of organics did take place at 21 days than for the 13-day exposure period.

As noted previously, the statements presented regarding the test data obtained from the Anderson (1985) study tend to discount the bioaccumulation of metals and organics by mussels and clams from East Waterway sediments. In fact, PAHs and metals were strongly accumulated by these organisms after exposures of 13 and 21 days (see Tables 9, 10, and 11 in Attachment B).

Biological Characterization of Potential Disposal Sites

Snohomish Channel (Scott-Crowley) Site: Because of the past use of the site to raft logs, the infaunal abundance and diversity is the lowest of those stations analyzed. The site is located on the migration route of juvenile and adult salmonids. Wintering waterfowl and shorebirds also use the site. Marine mammals have been observed resting on the log rafts present. A decrease in the use of the area for log rafting is expected to improve the productivity of the site.

Weyerhaeuser Mill Site: Infaunal species abundance and diversity are moderately depressed. This site is also located on the migration route of juvenile salmonids and returning adult salmon. Dungeness crab and marine fishes also utilize the site. The site also provides shelter for bird species.

Port Gardner Open-Water Disposal Site: Underwater video survey of the site in 1984 revealed the presence of 14 species of fish as well as a number of invertebrate species including Dungeness crab, small shrimp, sea pens, and similar deep water organisms. Deposit feeders, scavengers, or predators were the predominant invertebrates observed with few suspension feeders present due to the low current velocities. Though abundant algal debris was present, no attached algae were observed. Infaunal abundance and diversity were the second highest of the stations sampled.

Deep Delta Site: The report states that "marine resources at the site would be similar to those encountered at the Port Gardner Open Water Site (EDS-5)." Infaunal species abundance and diversity were said to be similar at both sites and ranked moderate to all other stations sampled.

South Jetty Island Site: The site is stated to be a highly visible and valuable habitat area. Disposal of dredge material at the site for the purpose of maintaining and expanding wildlife values of the island has been conceptually approved under a document stated to have been adopted in 1977 entitled Consensus Guidelines, Future Development of the Port of Everett - Citizen's Planning/Mediation Committee (Consensus Guidelines). Because of muds present, the extensive eelgrass beds present farther north and west of Jetty Island (in the delta area) are absent. Abandoned barges at the site have attracted heavy use as haul-out areas by marine mammals. The area is also used by shorebirds and waterfowl. Infaunal species diversity and abundance are low to moderate.

Snohomish River Delta Site(s): The area provides exceptional quality and varied habitat for all manner of fish and wildlife species. Infaunal species diversity and abundance are low which is likely the result of shifting substrate and rapidly changing salinity.

Port Gardner Deepwater/Slope Site: The report states that "Biological resources associated with this area would be similar to the Port Gardner open water site." Infaunal species diversity and abundance were highest at this site.

9.0 DATA QUALITY

Because much of the reviewed report summarizes the data of Anderson (1985), the quality of the data is dependent upon that report. Other summary information presented is not verifiable, and no citations or documentation is presented to back-up many of the statements made.

10.0 HYDROLOGIC AND HYDRODYNAMIC INFORMATION

N/A

11.0 DREDGING AND DISPOSAL ISSUES AND DATA

Dredging and disposal issues are addressed with regard to the potential Port Gardner disposal sites investigated as part of the Anderson (1985) study. This information, as it relates to issues of dredging and disposal, are presented below:

Snohomish Channel (Scott-Crowley) Site: This 180-acre, nearshore, intertidal site is located along the left side of the Snohomish River. Ownership is mixed. If completely filled to elevation +19 feet Mean Lower Low Water (MLLW), the site has a capacity of approximately 5.7 million cubic yards of material.

Weyerhaeuser Mill Site: The 69-acre, nearshore site, of which 18 acres is subtidal, is owned by the Port of Everett. Average ground elevation is +18 feet MLLW, and average in-water elevation is approximately -14 feet MLLW. The site has been identified as a preferred development site by the Port.

Port Gardner Open-Water Disposal Site: The site is managed by the Washington State Department of Natural Resources (DNR) for disposal of dredged material. The DNR reports that although the site is infrequently used, approximately 375,000 cubic yards of material have been disposed there since formal designation in 1970. Approximately 225,000 cubic yards of sand from the Snohomish River were disposed of in 1984 by the COE.

Deep Delta Site: The deep water site is characterized as a relatively broad, sloping shelf located west of the mouth of the Snohomish River and at the southern edge of the Snohomish River delta. Depths vary between 100 and 200 feet before dropping off sharply to the deeper waters (+350 feet) of Port Gardner. Capacity of the site for dredged material disposal has not been determined.

South Jetty Island Site: The 150-acre, nearshore site is located at the southern end of Jetty Island and is completely intertidal. The site is owned by the Port of Everett and has been designated as a disposal area for the Port's maintenance dredge material, subject to conditions of the Consensus Guidelines. The site (+3 feet MLLW average elevation) is bisected throughout by tidal channels. Disposal capacity is limited to approximately 1 million cubic yards.

Snohomish River Delta Site: The delta is primarily shallow, subtidal, and intertidal. Capacity is virtually unlimited although design objectives would provide limitations.

Port Gardner Deepwater/Slope Site: This deep water site is expected to have a large capacity to accept dredged disposal materials. Because of the slope present, disposal is likely feasible only where the slope flattens at the bottom of Port Gardner.

Nearshore Disposal Site Feasibility

The three nearshore sites (Snohomish Channel, Weyerhaeuser Mill, and South Jetty Island) would require extensive diking and perhaps construction of a special liner to contain leachate and runoff from contaminated dredge materials. Because mobility of the contaminants to be contained had not yet been defined, the report states that nearshore confinement "cannot be categorically endorsed or rejected." Economic comparisons between the sites were not made because costs associated with diking or transportation of dredged materials were not developed.

Of the three nearshore sites, the Weyerhaeuser and South Jetty Island are the closest to the dredging site. The Weyerhaeuser site lacks adequate capacity to contain all the material planned for dredging by the Navy and the Port of Everett. The South Jetty Site has adequate capacity and a conceptual mitigation plan in place, but it would require the most extensive diking. Because it is shallow, it would place more material in the hydraulically and geochemically active zone. The Snohomish Channel site has adequate capacity and offers the greatest flexibility in site design, but its value as wildlife habitat would require mitigation. An unknown factor is the influence of the Snohomish River on contaminant mobility.

Aquatic Disposal Site Feasibility

Of the Port Gardner, Deep Delta, Snohomish River Delta, and Port Gardner Deepwater/Slope sites, all but the Snohomish River Delta site lie in less active zones and would be amenable to either mounding or confinement aquatic disposal techniques. The Snohomish River Delta would likely require diking, but the resulting island would create upland and intertidal habitat similar to those present at Jetty Island. The design for this site would likely be quite expensive and would require extensive coordination with federal and state resource agencies.

Slope stability and bathymetry at the Deep Delta site are unknown and require further research. The shallower depth here may make the site more accessible to present disposal technology. The Port Gardner open water site and Port Gardner deep water/slope sites also involve issues and concerns related to slope stability although less so than the Deep Delta site. Accurate placement of the contaminated dredge material and capping materials are a major engineering concern for the deep water disposal sites. The report also notes that "additional testing of the contaminated sediments, evaluation of the availability of equipment, and more detailed site characterization (including current studies and stratification of the water column) must be completed" before selection of a preferred dredge disposal site.

12.0 ENVIRONMENTAL IMPACTS

Environmental impacts of the proposed dredge disposal sites are only indirectly addressed. As noted above in Section 9.0, existing site conditions are only briefly summarized.

One of the major concerns raised is the impact of return water and/or leachate from contaminated sediments. If this return water/ leachate is not easily controlled and is significantly contaminated, it could pose a risk to aquatic organisms and human health. A study of contaminant mobility was underway by the COE Waterways Experiment Station at the time this report was prepared.

13.0 INTERIM MEASURES/SPILL AND POLLUTION PREVENTION MEASURES

N/A

14.0 COMMUNITY RELATIONS INFORMATION

The only reference to any community relations is in regard to the Consensus Guidelines. This document reportedly provides for the disposal of materials dredged from the Port of Everett as part of regular maintenance. In addition, it also provides conceptual approval for the disposal of dredge material at Jetty Island with the apparent intent of extending and maintaining the wildlife values of the island.

15.0 RECOMMENDATIONS

This review should be read along with the review of the Anderson (1985) report titled Biological and Chemical Analysis of Sediments for the Design and Construction of the U.S. Navy Homeport Facility at East Waterway - Everett Harbor, Washington, which served as Appendix B to the report reviewed.

This report summarizes the initial Port Gardner dredge disposal sites selected and evaluated by the COE. It does not provide references or documentation for many of the statements made regarding the physical and biological attributes of the alternative disposal sites and therefore is somewhat limiting. Later documents should be consulted to ascertain the results of contaminant mobility testing and more detailed site characterizations.

16.0 FINAL COMMENTS

N/A

Attachment A

MAPS

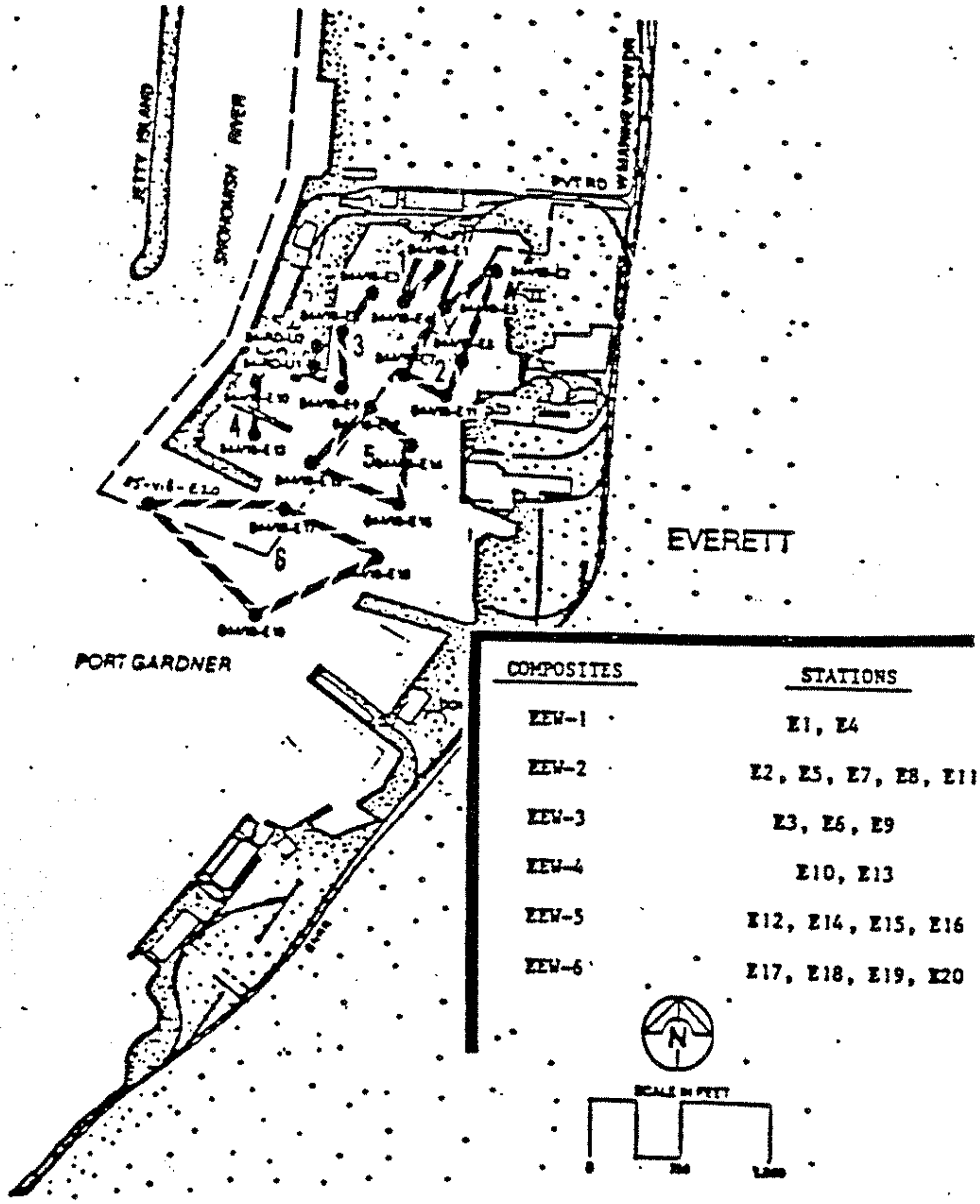

FIGURE 1. Sediment Sampling Locations in the East Waterway

NPSEN-PL-ER
SUBJECT: U.S. Navy Homeport Facility at East Waterway, Everett Harbor, Washington: Biological and Chemical Analyses of Sediments. May 3, 1985

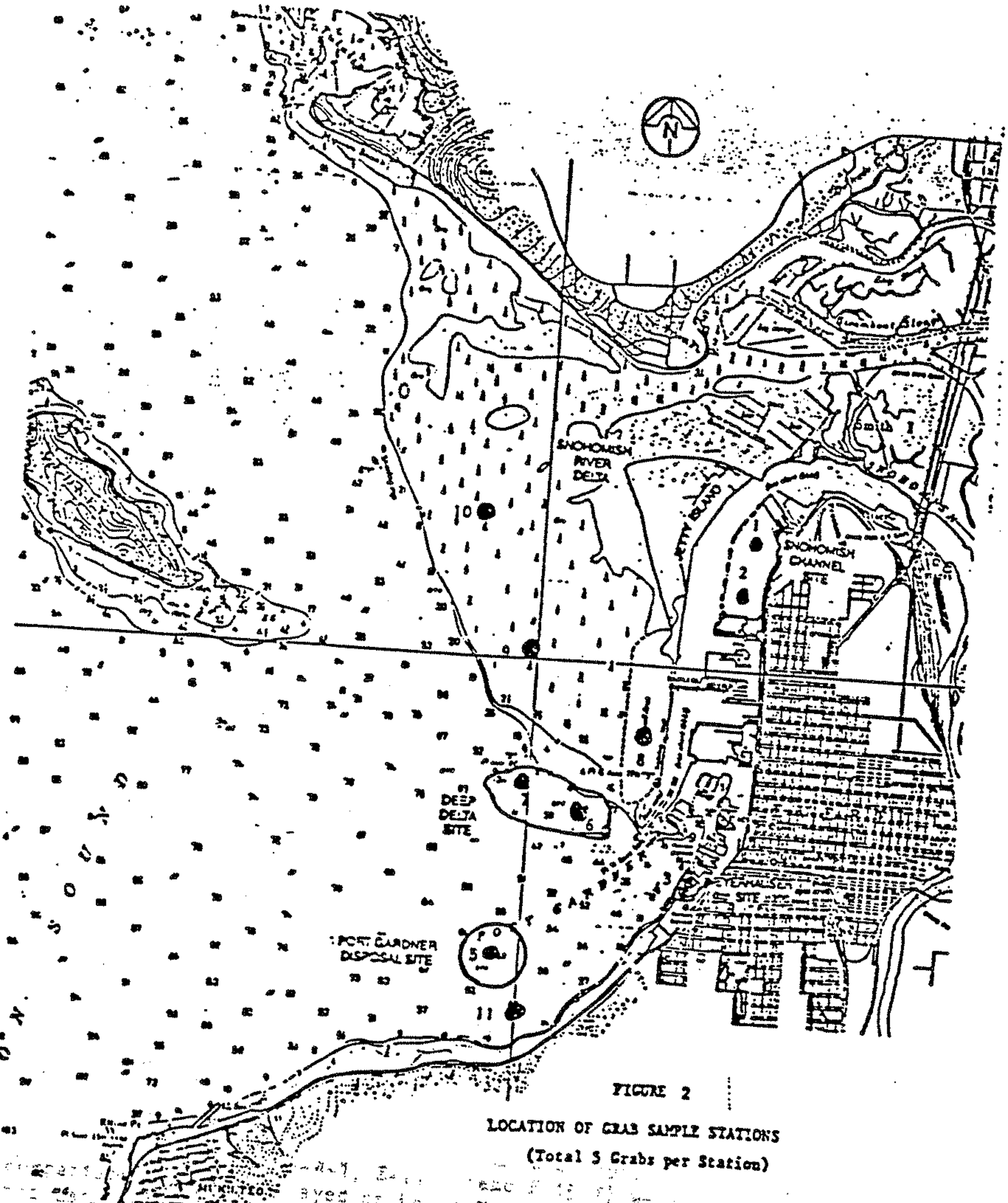

FIGURE 2

LOCATION OF GRAB SAMPLE STATIONS

(Total 5 Grabs per Station)

Attachment B

BIOACCUMULATION CHEMISTRY DATA SUMMARIES

9. Analyses of Trace Metals and PAH in Clams and Mussels Exposed to Everett East Waterway Sediments in Aug., 1984. Values are in mg/Kg dry weight (ppm).

	PCB (1254)	TOTAL PAH	Cu	Zn	Pb	As	Hg	Cd
MACOMA								
Sequim Bay								
Control	1.02	2.74	33.8	337	3.23	13.27	0.21	1.07
E-1-B	0.72	5.11	21.2	340	<1.7	13.48	0.13	1.13
E-4-T	0.0	3.39	27.3	357	4.71	12.11	0.16	1.97
E-4-B	0.71	2.28	22.7	291	2.27	12.46	0.17	0.96
E-15-T	0.0	36.61	R1 21.1	312	4.17	12.08	0.13	1.07
			R2 22.3	301	4.22	11.96	0.12	0.96
			R3 22.6	307	3.78	11.71	0.13	1.07
E-18-T*	0.55	0.80	17.5	358	<1.7	13.73	0.15	1.13
MYTILUS								
Sequim Bay								
Control	0.93	6.02	8.18	169	<1.7	10.58	0.22	3.21
E-1-B	0.30	0.82	7.32	158	<1.9	11.58	0.16	3.72
E-4-T	0.80	6.22	7.60	146	191	5.90	0.13	4.11
E-4-B	0.51	15.50	7.69	177	<1.7	12.90	0.15	3.72
E-11-T	0.78	10.45	7.09	245	332	<3.1	0.12	3.49
E-15-T	R1 1.04	1.23						
	R2 0.73	1.47	7.21	192	<1.9	11.53	0.13	3.55
E-18-T*	0.68	2.75	6.92	118	<1.8	8.53	0.12	4.00

*Since surface layer was very thin this is essentially a bottom sediment

TABLE 10. Total PAH and PCB Concentrations (mg/kg dry) in Bivalves Exposed to Everett East Waterway Native Sediments for 21 Days

	Sediment		Macoma		Mytilus	
	PAH	PCB	PAH	PCB	PAH	PCB
Initial Samples	--	-	2.18	**	5.50	**
Sequim Bay Controls	0.20	*	16.13	**	4.43	**
Composite 1	7.00	*	254.80	**	20.74	1.41
Composite 2	3.57	*	2.90	**	16.91	1.42
Composite 3	3.94	*	1.66	**	2.40	0.47
Composite 4	2.02	0.012	5.01	**	20.83	0.70
Composite 5	5.89	0.012	36.09	**	4.71	1.80
Composite 6	5.86	0.009	19.54	1.23	87.95	1.49

* <1 µg/kg.

** <10µg/kg.

TABLE 11. Metal Concentrations in Bivalves Exposed for 21 Days to Everett Harbor Native Sediments

Station Composites	Sample Type	Dry Weight %	Hg ppm	Cd ppm	Cu ppm	Zn ppm	Pb ppm	As ppm
EEW-1	Mytilus	7.11	0.342	2.63	8.7	168.7	8.2	7.3
	Macoma	10.45	0.202	1.10	12.2	245.0	<4.5	13.0
EEW-2	Mytilus	7.09	0.295	2.85	8.7	194.0	5.7	10.7
	Macoma	9.85	0.193	1.41	11.2	266.0	<4.1	14.2
EEW-3	Mytilus	14.82	0.321	3.00	7.2	159.4	<5.4	9.6
	Macoma	10.91	0.188	1.30	11.3	212.0	<4.3	15.6
EEW-4	Mytilus	7.07	0.278	3.58	7.5	182.9	5.8	10.6
	Macoma	10.76	0.197	1.87	12.3	326.0	<4.1	16.0
EEW-5	Mytilus	7.58	0.182	3.18	8.2	199.0	<5.0	9.0
	Macoma	10.82	0.141	1.42	14.4	326.0	4.1	12.8
EEW-6	Mytilus	9.04	0.220	3.10	7.2	196.0	<4.5	9.9
	Macoma	8.10	0.196	1.43	17.2	231.0	<3.7	17.7
Sequim Bay Control	Mytilus	8.64	0.215	3.44	11.5	136.4	8.5	11.1
	Macoma	11.16	0.161	1.19	35.6	247.0	<4.5	20.4
Initial Samples	Mytilus	8.48	0.106	3.00	7.7	156.1	5.5	12.8
	Macoma	12.40	0.107	1.12	9.6	237.0	<3.6	13.7

Attachment C

AMPHIPOD BIOASSAY DATA SUMMARY

NPSEN-PL-ER May 3, 1985
SUBJECT: U.S. Navy Homeport Facility at East Waterway, Everett Harbor, Washington: Biological and Chemical Analyses of Sediments.

TABLE 2

Summary of Results of Amphipod Bioassays of Everett East Waterway Native Sediments.

Sediment	Rep	Survivors (20 max)	Mean & SD Survival	%Mortality	# Reburied After 1 hr	% Reburial
Sequim Bay	1	15	16.5(1.9)	25	15	100
	2	15		25	15	100
	3	17		15	17	100
	4	19		5	19	100
Sequim Bay (repeat)	1	13	12.6(1.1)	35	11	85
	2	12		40	12	100
	3	14		30	13	93
	4	13		35	13	100
	5	11		45	11	100
Habitat Sed.	1	19	19.3(0.5)	5	19	100
	2	19		5	18	95
	3	20		0	20	100
	4	19		5	18	95
Habitat Sed. (repeat)	1	19	19.7(0.6)	5	19	100
	2	20		0	20	100
	3	20		0	20	100
EEW-1	1	17	14.8(2.6)	15	14	82
	2	17		15	16	94
	3	12		40	10	83
	4	13		35	13	100
EEW-2	1	15	13.8(5.3)	25	14	93
	2	16		20	14	86
	3	18		10	18	100
	4	6		70	5	83
EEW-3	1	19	15.8(2.9)	5	18	95
	2	12		40	10	83
	3	16		20	13	81
	4	16		20	12	75
EEW-4	1	17	13.8(3.2)	15	17	100
	2	11		45	11	100
	3	11		45	10	91
	4	16		20	15	94
EEW-5	1	10	12.0(2.9)	50	10	100
	2	9		55	9	100
	3	14		30	14	100
	4	15		25	13	87
EEW-5 (repeat)	1	13	13.2(2.7)	35	12	92
	2	16		20	13	81
	3	15		25	15	100
	4	13		35	12	92
	5	9		55	8	89
EEW-6	1	16	16.5(2.9)	20	16	100
	2	13		35	12	92
	3	17		15	16	94
	4	20		0	20	100

Note: With 4 replicates, a difference of 3.35 in survival is needed to be 75% certain of detecting a statistically significant ($p < 0.05$) difference between conditions. Using Sequim Bay as a fine sediment control (16.50 - 3.35 = 13.15), only EEW-5 shows a significant reduction in survival. The repeat test does not show this reduction.

Appendix R

EAST WATERWAY, EVERETT, WASHINGTON
TECHNICAL DOCUMENT REVIEW

Review of:

U.S. Army Corps of Engineers, 1985b, Analysis of Sediments and Soils for Chemical Contamination for the Design and Construction of U.S. Navy Homeport Facility at East Waterway of Everett Harbor, Washington, prepared for U.S. Department of the Navy, Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Contract No. C0089007

Document Control No. WD4030.1.0-R

January 1991

Prepared For:

WASHINGTON STATE DEPARTMENT OF ECOLOGY
Toxics Cleanup Program

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EAST WATERWAY TECHNICAL DOCUMENT REVIEW

TABLE OF CONTENTS CHECKLIST

ATTACHMENTS

1.0 INTRODUCTION AND CHRONOLOGY OF EVENTS

The report reviewed was prepared to provide the United States Department of the Navy (Navy) with information needed to prepare the Environmental Impact Statement (EIS) for the proposed Homeport facility in Everett. It evaluates dredging and dredged material disposal issues using sediment chemistry data from a previous study (Anderson and Crecelius 1985). Existing sediment data were compared with the sediment quality criteria that were available at the time the report was written (i.e., Fourmile Rock open-water disposal site criteria and Puget Sound background sediment quality data) to identify sediment that would be suitable for open-water disposal. In addition, the report reviewed describes additional studies required to predict environmental impacts.

The following list summarizes the events leading to the completion of the final report:

- June 1984: Navy requests the United States Corps of Engineers (COE) assistance in developing a contaminated sediments assessment program for the proposed Homeport facility. The COE develops a sediment characterization program in conjunction with the United States Environmental Protection Agency, National Oceanic and Atmospheric Administration (NOAA), and Washington Department of Ecology (Ecology) and contracts with Battelle Pacific Northwest Laboratory to perform chemical analyses of the sediment samples.

- July 1984: Foundations and Materials Branch of the Seattle District COE office collects samples from 25 stations in the East Waterway and Port Gardner (Figure 1, Attachment A).

- November 1984: COE issues draft report providing a preliminary assessment of contaminated sediments in the project area.

- January 1985: COE issues final report incorporating comments from the Navy.

2.0 LEGAL AND REGULATORY ISSUES

The report reviewed estimates the quantity of contaminated sediments to be dredged for the construction of the Navy's Homeport facility that would not be suitable for unconfined, open-water disposal using the criteria developed for the Fourmile Rock disposal site in Elliott Bay. Although these criteria are specific to the Fourmile Rock site and are not generally applicable to the East Waterway/Port Gardner area, they are the only criteria that were available at the time this report was written. These estimates should be updated using the most current Puget Sound Dredged Disposal Analysis (PSDDA) criteria.

3.0 DEMOGRAPHICS AND LAND USE

N/A

4.0 POTENTIALLY LIABLE PERSONS

N/A

5.0 IDENTIFICATION OF POLLUTION POINT SOURCES

N/A

6.0 IDENTIFICATION OF POLLUTION NON-POINT SOURCES

N/A

7.0 CHEMICAL DATA

Although data from the sediment sampling conducted in the East Waterway and Port Gardner were used to evaluate the sediment contamination, these data are not presented in the report. The chemical analyses were conducted by Battelle Pacific Northwest Laboratory and were apparently limited to metals, polychlorinated biphenyl (PCB) Aroclor 1254, and selected polynuclear aromatic hydrocarbons (PAHs).

8.0 BIOLOGICAL DATA (FLORA/FAUNA)

N/A

9.0 DATA QUALITY

Because the report reviewed uses data from a previous study, no quality assurance/quality control (QA/QC) results are presented. The original study (Anderson and Crecelius 1985) should be consulted to ascertain the quality of the sediment chemistry data that were used in this report. (See Anderson and Crecelius 1985 review included in this compendium of reviews.) The report does, however, include a letter from NOAA (Malins 1984) describing possible problems with the sediment chemistry data. Specifically, the letter recommends that results from the New York testing laboratory be discarded and requests additional QA/QC information.

Supporting Documentation

Anderson, J.W. and E.A. Crecelius, 1985, Analysis of Sediments and Soils for Chemical Contamination for the Design of the U.S. Navy Homeport Facility at East Waterway of Everett Harbor, Washington, prepared for U.S. Army Corps of Engineers, PNL-5383, Pacific Northwest Laboratory, Richland, Washington.

Malins, D.C., 12 October 1984, Personal Communication (letter Mr. John Malek, U.S. Army Corps of Engineers, Seattle, Washington), National Oceanic and Atmospheric Administration, Seattle, Washington.

Galvin, D.V., G.P. Romberg, D.R. Houck, and J.H Lesniak, 1984, Toxicant Pretreatment Planning Study, Summary Report, Municipality of Metropolitan Seattle, Seattle, Washington.

Parametrix, 1984, Draft Environmental Impact Statement Carrier Battle Group (CVBG) Homeporting in the Puget Sound Area, Washington State, prepared for U.S. Navy, Western Division, Naval Facilities Engineering Command, Parametrix, Bellevue, Washington.

U.S. Army Corps of Engineers, 1986, Final Supplement to U.S. Navy Environmental Impact Statement Carrier Battle Group, Puget Sound Region Ship Homeporting Project, Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

10.0 HYDROLOGIC AND HYDRODYNAMIC INFORMATION

N/A

11.0 DREDGING AND DISPOSAL ISSUES AND DATA

Potential dredged material disposal impacts were evaluated based on the dredged material estimates (i.e., 3.5 million yd^3 total, with 1.0 million yd^3 of upland sediments) presented in the Navy Homeport draft EIS (Parametrix 1984). The upland area to be dredged consists of a 10-acre portion of the L-shaped mole pier located on the western edge of the East Waterway. Two cores were collected from this area. With the exception of PCB Aroclor 1254 (143 ppb) and lead (135 ppm) in the surface sample from Core U1, all contaminants analyzed were below Puget Sound background levels as described in by Galvin et al. (1984).

The sediment samples from the East Waterway exceeded background concentrations. As shown in Table 1, Attachment B, under the Navy's proposed dredging plan, the contaminated sediments at most of the stations would be removed. The report estimates that only about 40,000 yd^3 of contaminated sediments in the vicinity of Stations E1 and E4 would remain after dredging.

To identify sediments that could be disposed of in an unconfined, open-water disposal site, the available sediment chemistry data were compared with the Fourmile Rock disposal criteria (see Table 2, Attachment C). (At the time this report was written, the PSDDA criteria for open water disposal were not available.) In addition, the Fourmile Rock methodology was applied to Puget Sound background values reported by Galvin et al. 1984 (see Table 3, Attachment C).

Based on the results of the comparisons with existing criteria (Table 4, Attachment C), the report estimates that approximately 800,000 yd^3 of sediments from the East Waterway would be unsuitable for unconfined, open-water disposal. The native material underlying the contaminated sediments which accounts for about 500,000 yd^3 of the sediments to be dredged, did not exceed the Fourmile Rock sediment chemistry criteria. However, the Fourmile Rock criteria also require that biological tests be conducted before qualifying sediments for open-water disposal. Therefore, it is not certain whether these underlying sediments could be disposed of in an unconfined aquatic disposal site. (Including the 1 million yd^3 of uncontaminated upland sediments, this only accounts for 2.3 million yd^3 of the total 3.5 million yd^3 of dredged material.)

The report identifies the following three options for disposing contaminated sediments:

- o Confined aquatic disposal,
- o Nearshore fill, and
- o Upland fill.

The report reviewed recommends that additional studies be conducted to determine the most suitable disposal option. These additional tests include biological tests, evaluation of the potential for contaminant migration during dredging and disposal, physical analyses (e.g., settling tests), and water chemistry. These additional tests were eventually conducted and reported in COE 1986. (See COE 1986 review included in this compendium of reviews.)

12.0 ENVIRONMENTAL IMPACTS

N/A

13.0 INTERIM MEASURES/SPILL AND POLLUTION PREVENTION MEASURES

N/A

14.0 COMMUNITY RELATIONS INFORMATION

N/A

15.0 RECOMMENDATIONS

Sediment contamination evaluations should be updated to reflect the current PSDDA dredged material disposal criteria and the final sediment management standards recently adopted by Ecology to identify sediments that require remediation and to evaluate dredged disposal options. In addition, additional contaminants (priority pollutants as well as contaminants associated with the pulp and paper industry) should also be evaluated. This study was based on analysis of a limited number of contaminants (i.e., metals, PCB Aroclor 1254, and PAH). There also appear to be some problems with the data set used in this report. A QA review of this data set should be performed to determine whether they are acceptable for use in the Remedial Investigation/Feasiblity Study.

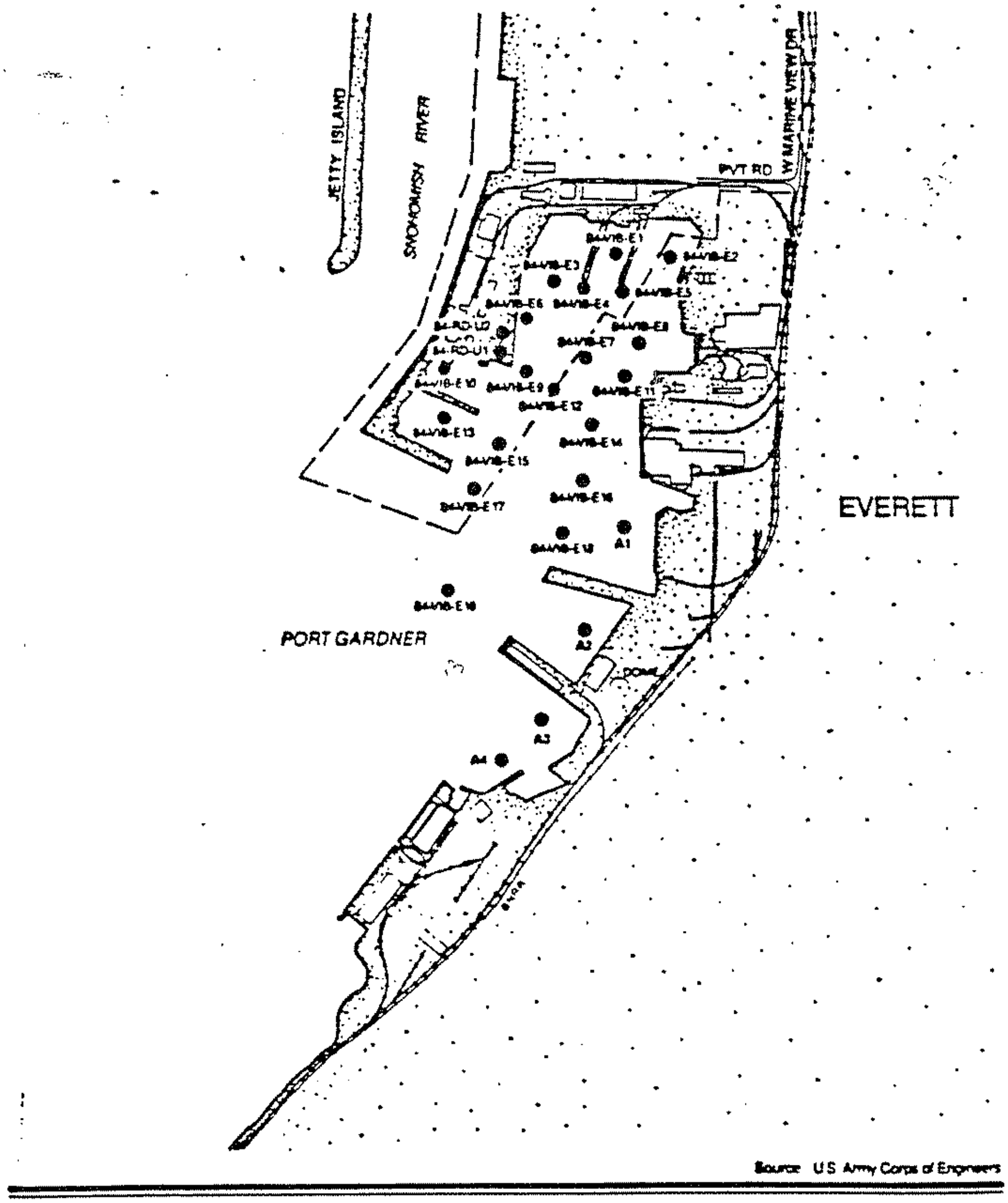
16.0 FINAL COMMENTS

This study used the best criteria that were available at the time to evaluate and quantify the volume of sediment contamination in the East Waterway and Port Gardner. Because most of these criteria are now outdated, the estimated quantities of contaminated sediments that require special disposal methods need to be revised.

Attachment A

SITE MAP

FIGURE 1



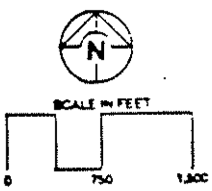


Figure 1
Sediment sampling locations in the East Waterway.

Attachment B

DREDGING AND SEDIMENT CONTAMINATION DEPTH

TABLE 1

COMPARISON OF DREDGING DEPTHS WITH DEPTH OF SEDIMENT CONTAMINANTS

Station	Current Bottom Elevation Ft. MLLW	US Navy Proposed Dredging Ft. MLLW	Sediments To Be Dredged (feet)	Contamin. Sediment Layer (feet)
E1	39.5	42	2.5	3.8
E2	28.5	42	13.5	2.5
E3	28.5	42	13.5	1.3
E4	45	42	-3	6.6
E5	33.5	42	8.5	1.4
E6	27.5	42	14.5	4
E7	36	42	6	2
E8	24.9	42	17.1	2.5
E9	28.5	42	13.5	2
E10	30.5	42	11.5	4
E11	14.8	42	27.2	3.7
E12	32.3	42	9.7	2
E13	30	42	12	6.5
E14	33.5	42	8.5	1.5
E15	33.2	42	8.8	2.8
E16	34.2	42	7.8	0.5
E17	22.2	42	19.8	1
E18	34.7	42	7.3	0
E19	40.2	47	6.8	0.5

Attachment C

SEDIMENT CRITERIA

TABLE 2

TABLE I: CHEMICAL SEDIMENT CRITERIA

Pollutant:	Column 1 Four-Mile Rock Concentration	Column 2	Column 3	Column 4
		% of 4-Mile Rock Ambient Concentration		
		125%	110-125%	110%
Metals:	(ppm)	(ppm)	(ppm)	(ppm)
Arsenic	15	19	16.5-19	16.5
Cadmium	0.7	0.9	0.75-0.9	0.75
Copper	92	115	100-115	100
Lead	126	158	140-158	140
Mercury	1.1	1.4	1.2-1.4	1.2
Zinc	359	450	395-450	395
Organics:	(ppb)	(ppb)	(ppb)	(ppb)
Polychlorinated Biphenyls (PCB) 1/	610	760	670 - 760	670
High Molecular Wt. Polynuclear Aromatic Hydrocarbons 2/	11,200	14,000	12,300-14,000	12,300
Low Molecular Wt. Polynuclear Aromatic Hydrocarbons 3/	683	855	750-855	750
DDT 4/	7	9	8 - 9	8

1/ Summation of PCB 1016, 1232, 1242, 1248, 1254, 1260

2/ Summation of Dibenzo (A-H) Anthracene, Benzo (A) Anthracene, Benzo (A) Pyrene, Benzo (B) Fluoranthene, Benzo (K) Fluoranthene, Chrysene, Fluoranthene, Indeno (1-2-3-C-D) Pyrene, Pyrene, Benzo (G-H-I) Perylene.

3/ Summation of Acenaphthene, Naphthalene, Acenaphthylene, Anthracene, Phenanthrene, Fluorene.

4/ Summation of 4-4 DDD, 4-4 DDE, and 4-4 DDT.

The chemical and biological data for each individual core sample or core section will be interpreted as follows:

A. Chemical

1. If any pollutant, or group of pollutants, listed in Table 1, is found in concentrations greater than 125% of the ambient concentrations of that pollutant at the Four-Mile Rock site (Table 1, column 2), in-water disposal will not be allowed.

2. If three or more pollutants, listed in Table 1, are found in concentrations greater than 110% of the ambient concentrations for those same pollutants at the Four-Mile Rock site (Table 1, column 4), in-water disposal will not be allowed.

3. If one or two pollutants, listed in Table 1, are found in concentrations within the range of 110 to 125% of the ambient concentrations for those same pollutants at the Four-Mile Rock site (Table 1, column 3), in-water disposal will be allowed, provided that bioassay criteria are not exceeded.

4. If all pollutants, listed in Table 1, are found at concentrations of 110% or less than the ambient concentrations for the same pollutants at the Four-Mile Rock site (Table 1, column 4), in-water disposal will be allowed, provided that bioassay criteria are not exceeded.

5. If in the best professional judgment of EPA and WDOE decision-makers, additional chemical data not listed in Table 1 indicates unacceptable sediment contamination, in-water disposal will not be allowed.

TABLE 3

CHEMICAL SEDIMENT CRITERIA 1/

Pollutant:	Puget Sound Concentration 2/	% of Ambient Concentration 110 %	125 %
Metals:	(ppm)	(ppm)	(ppm)
Arsenic (As)	10	11	12
Cadmium (Cd)	0.32	0.35	0.40
Copper (Cu)	36	40	45
Lead (Pb)	38	42	47
Mercury (Hg)	0.14	0.15	0.17
Zinc (Zn)	100	110	125.0
Organics:	(ppb)	(ppb)	(ppb)
Polychlorinated Biphenyls (PCB) 3/	125	137	156
Polynuclear Aromatic Hydrocarbons (PAH)			
High Molecular Wt. 4/	2,200	2,420	2,750
Low Molecular Wt. 5/	160	176	200
DDT 6/	1.5	1.7	1.9

1/Adapted from Chemical Sediment Criteria (table 2) for Fourmile Rock Disposal site. PRESENTED FOR ILLUSTRATION ONLY.
2/Values derived from Metro TPPS (1984) for Puget Sound Central Basin.
3/Summation of PCB 1016, 1232, 1242, 1254, & 1260.
4/Summation of Dibenzo (A-H) Anthracene, Benzo (A) Anthracene, Benzo (A) Pyrene, Benzo (B) Fluoranthene, Benzo (K) Fluoranthene, Chrysene, Fluoranthene, Indeno (1-2-3-C-D) Pyrene, Pyrene, Benzo (G-H-I) Perylene
5/Summation of Acenaphthene, Naphthalene, Acenaphthylene, Anthracene.
6/Summation of 4-4 DDD, 4-4 DDE, & 4-4 DDT.

TABLE 4

COMPARISON OF SEDIMENT CHEMISTRY WITH CRITERIA:
POLLUTANTS EXCEED CRITERIA VALUES

Station (Top)	Parameter	Fourmile Rock Site 110 %	Fourmile Rock Site 125 %	Puget Sound 1/ 110 %	Puget Sound 1/ 125 %
E1	Metals	-----	Cu,Cd	-----	Cu,Cd,Zn,Pb,Hg
	PAHs	-----	L & H	-----	L & H
	PCBs	No	No	Yes	Yes
E2	Metals	-----	Cd	-----	Cd,Cu,Pb,Hg
	PAHs	-----	No data	-----	-----
	PCBs	-----	No data	-----	-----
E3	Metals	-----	Cu,Cd	-----	Cu,Cd,Zn,Pb,Hg
	PAHs	-----	L & H	-----	L & H
	PCBs	No	No	Yes	Yes
E4 (T & M)	Metals	-----	Cu,Hg,Cd		Cu,Hg,Cd,Zn, Pb,Hg
	PAHs	-----	L & H	-----	L & H
	PCBs	No	No	Yes	Yes
E5	Metals	Cu	Cd	-----	Cd,Cu,Zn,Pb,Hg
	PAHs	-----	L & H	-----	L & H
	PCBs	Yes	No	Yes	Yes
E6	Metals	-----	Cu,Cd	-----	Cu,Cd,Zn,Pb, As,Hg
	PAHs	-----	No data	-----	-----
	PCBs	-----	No data	-----	-----
E7	Metals	Cu	Cd	-----	Cd,Cu,Pb,Zn
	PAHs	-----	L & H	-----	L & H
	PCBs	No	No	Yes	Yes
E8	Metals	-----	Cu,Cd	-----	Cd,Cu,Zn,Pb,Hg
	PAHs	-----	L & H	-----	L & H
	PCBs	No	No	Yes	Yes
E9	Metals	Cu	Cd	-----	Cd,Cu,Zn,Pb,Hg
	PAHs	-----	L & H	-----	L & H
	PCBs	No	No	Yes	Yes

TABLE 4 (con.)

E10	Metals	-----|	Cd,Zn	-----|	Cd,Zn,Cu,Pb,Hg
	PAHs	-----|	L	-----|	L & H
	PCBs	No	No		
E11	Metals	Cu	Cd	-----|	Cd,Cu,Zn,Pb,Hg
	PAHs	-----|	L	-----|	L & H
	PCBs	Yes	No	Yes	Yes
E12	Metals	Cu	Cd	-----|	Cd,Cu,Zn,Pb,Hg
	PAHs	-----|	L	-----|	L & H
	PCBs	No	No	Yes	Yes
E13 (T & M)	Metals	-----|	Cu,Cd,Hg	-----|	Cu,Cd,Hg,Zn, Pb,As
	PAHs	-----|	L & H	-----|	L & H
	PCBs	No	No	Yes	Yes
E14	Metals	-----|	Cd	-----|	Cd,Cu,Zn,Pb,Hg
	PAHs	-----|	L	-----|	L & H
	PCBs	No	No	Yes	Yes
E15	Metals	-----|	Cd	-----|	Cd,Cu,Zn,Pb,Hg
	PAHs	-----|	L & H	-----|	L & H
	PCBs	No	No	Yes	Yes
E16	Metals	No	No	-----|	Cd,Hg
	PAHs	-----	No data	------------	------------
	PCBs	-----	No data	------------	------------
E17	Metals	-----|	Cd,Zn	-----|	Cd,Zn,Cu,As
	PAHs	-----|	L	-----|	L & H
	PCBs	No	No	Yes	Yes
E18	Metals	No	No	No	No
	PAHs	No	No	No	No
	PCBs	No	No	No	No
E19	Metals	-----|	Cd	Zn	Cd,Cu,Hg
	PAHs	-----	No data	------------	------------
	PCBs	-----	No data	------------	------------

1/See Table 3.

L: Low Molecular Wt. H: High Molecular Wt.
Yes: PCBs exceed value. No: PCBs do not exceed value.

Appendix S

EAST WATERWAY, EVERETT, WASHINGTON
TECHNICAL DOCUMENT REVIEW

Review of:

United States Army Corps of Engineers, Seattle District, November 1986, Final Supplement to United States Navy Environmental Impact Statement, Carrier Battle Group, Puget Sound Region Homeporting Project, Volume 1, Chapters 1-12.

Contract No. C0089007

Document Control No. WD4030.1.0-S

January 1991

Prepared For:

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EAST WATERWAY TECHNICAL DOCUMENT REVIEW

TABLE OF CONTENTS CHECKLIST

<u>ATTACHMENTS</u>

1.0 INTRODUCTION AND CHRONOLOGY OF EVENTS

The document reviewed was an Environmental Impact Statement Supplement (EISS) prepared by the United States Army Corps of Engineers (COE), Seattle District Office, in order to provide additional information regarding environmental impacts as a result of the proposed Everett Homeport project.

The EISS is limited to the following topics listed by chapter:

1. Summary
2. Siting Analysis and Project Descriptions
3. Dredging and Dredge Disposal Analysis
4. Water Quality Impacts
5. Fisheries Resource Impacts
6. Air Quality Impacts
7. Port of Everett Impacts
8. Native American Concerns
9. Traffic and Transportation Impacts
10. Population and Housing
11. Nuclear Concerns
12. Unavoidable Impacts and Mitigation

Volume 2 of the document (not reviewed as a part of this initial review task) includes chapters 13-17:

13. Response to Comments
14. Coordination and Public Involvement
15. Revised Public Notice of Application for Permit and Revised Application Drawings
16. References
17. Authors and Principal Contributors/List of Preparers

The chronology of events leading up to the issuance of this document includes the following:

- June 1985: United States Department of the Navy, Western Division, Naval Facilities Engineering Command (Navy) issues the final Environmental Impact Statement (EIS) for the Carrier Battle Group Puget Sound Region Ship Homeporting Project.

- September 1985: Navy files a permit application with COE for constructing structures in waters, dredging, and disposing of dredged material.

- October 15, 1985: COE publishes a public notice regarding the proposed activities. Based in part on comments received from governmental agencies and the public, the COE prepares an environmental assessment of the proposed project.

- January 22, 1986: COE publishes notice in the Federal Register of intent to prepare a supplement to the Navy final EIS (FEIS).

- July 1986: Draft EISS is issued.

- August 19, 1986: Public hearing is held on the EISS.

- November 1986: Final EISS is issued.

Information and data presented in this EISS are, in most cases, derived from the other studies and are cited as such. Consequently, the data presented cannot be verified as to its quality or reliability.

2.0 LEGAL AND REGULATORY ISSUES

The following permits and approvals necessary for the proposed project are identified as follows:

Federal

- Section 10 and Section 404 permit
- Fish and Wildlife Coordination Act
- Endangered Species Act of 1973
- National Pollutant Discharge Elimination System Permit (NPDES)
- Clean Air Act

State

- State Waste Discharge Permit
- Construction of Domestic Wastewater Facilities
- Construction of Industrial Wastewater Facilities
- Notification of Dangerous Waste Activities
- Notice of Construction and Application for Approval (New Air Pollution Sources)
- Prevention of Significant Deterioration (PSD) Permit
- Construction of a Public Water System
- Coastal Zone Management Consistency Certification
- Water Quality Certification (Short-Term Exception to Water Quality Standards)
- Hydraulic Project Approval
- Archaeological Approval
- State Environmental Policy Act (SEPA)
- Open Water Disposal Site Permit

At the time this document was prepared, none of these permits or approvals had yet been issued for the project.

3.0 DEMOGRAPHICS AND LAND USE

N/A

4.0 POTENTIALLY LIABLE PERSONS

N/A

5.0 IDENTIFICATION OF POLLUTION POINT SOURCES

N/A

6.0 IDENTIFICATION OF POLLUTION NON-POINT SOURCES

N/A

7.0 CHEMICAL DATA

New data presented in this EISS includes results from physical and chemical analytical testing of sediments conducted by the Waterways Experiment Station (WES), Vicksburg, Mississippi. This testing was conducted in order to further evaluate contaminated sediments of East Waterway and to predict the stability of contaminants present during dredging, disposal, and storage at selected disposal sites. Because only summaries of data are presented in the EISS, it was not possible to evaluate testing procedures, methods, or reliability of the data presented.

Chemical Testing of Sediments

A single composite sample of contaminated East Waterway sediment and a composite of underlying native sediment were analyzed for selected chemicals by the WES laboratory. Based upon the results of these analyses (data not presented), the EISS states that a list of selected representative parameters of concern was developed. A total of 33 sediment contaminants of concern were identified. The chemical list includes the following compounds:

- Chromium (Cr)
- Copper (Cu)
- Arsenic (As)
- Cadmium (Cd)
- Selected polychlorinated biphenyls (PCBs)
- 1- and 2-Methylnaphthalene
- Nickel (Ni)
- Zinc (Zn)
- Lead (Pb)
- Mercury (Hg)
- Polynuclear aromatic hydrocarbons (PAHs)

It should be noted that not all PAHs nor all priority pollutants were tested for by the WES laboratory. Thus, the list of sediment contaminants of concern noted above should not be considered complete.

A single, near-bottom water sample also was collected within East Waterway (sample location not cited). This sample was analyzed for selected metals and organics and the results are presented in Table 3-2

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in Attachment A. All parameters were below detection limits except for Cu, Ni, Cd, Cr, and Hg. Federal water quality criteria were exceeded for Cu, Ni, and Hg.

Standard Elutriate Testing

Composite sediment samples and water from Eagle Harbor were mixed in the laboratory, and the supernatant was analyzed for selected metals and organics (i.e., those compounds identified in Table 3-2, Attachment A). The results were then used to estimate the degree of dissolved contaminant release to receiving waters at the Confined Aquatic Disposal (CAD) site. Procedures and detailed results reportedly were presented in Appendix B of the EISS. (Appendix B was neither available nor part of this review.)

Seven of 33 contaminants of concern were detected in the elutriate tests. Five exceeded background concentrations in the reference water: Ni, Cd, Pb, Cr, and PCB 1254. Pb exceeded chronic exposure levels for United States Environmental Protection Agency (EPA) water quality criteria; PCB 1254 exceeded both chronic and acute criteria; Ni was twice the chronic exposure criteria (see Table 4-1, Attachment B.

Estimated dilution factors of 1 for Pb and 13 for PCB Aroclor 1254 would be necessary to meet specific EPA water quality criteria. WES concluded that these dilutions could be achievable by dispersion and mixing within a short distance of an open-water disposal site.

Because the concentration of Ni in waters of the harbor were equal to that in the elutriate, dilution would not reduce the concentration. Therefore, the chronic criteria levels for Ni cannot be met by dilution with Everett Harbor waters.

Modified Elutriate Testing

Modified elutriate testing was conducted to evaluate the contaminant concentration in effluent discharged from a typical disposal retention pond for hydraulic pipeline dredging activities. Dissolved and particle contaminant fractions were quantified.

Five of 32 contaminants of concern were detected but only Ni and PCB Aroclor 1254 exceeded background values. Dissolved Ni exceeded the chronic exposure level. Dissolved PCB Aroclor 1254 exceeded chronic and acute exposure levels (see Table 4-2, Attachment B).

Mass release of all contaminant parameters was calculated to be less than 0.6 percent except for PCB Aroclor 1254 with a mass release of 3.2 percent (see Table 4-3, Attachment B).

Settleability Testing

Settleability testing was conducted to define sedimentation characteristics of materials to be dredged. Results indicate that "the settling behavior of East Waterway sediments at slurry concentrations expected in pipeline dredging was governed by a zone-settling process." (More specific settling data are not presented.)

Capping Effectiveness Testing

A small-scale reaction column was used by WES to predict cap thickness required to chemically isolate contaminated East Waterway sediments. Dissolved oxygen depletion rates and release rates of ammonium and orthophosphate were used as tracers. No significant difference in release rates was observed for contaminated versus native East Waterway sediments. For Everett Harbor sediments, the minimum effective cap thickness was found to be 30 cm. To prevent exposure from burrowing organisms, a safety factor was recommended for an additional 20 cm. Overall, a 1-m cap was recommended as an operational requirement to ensure at least 80 cm of cap throughout a disposal site. Actual design was said to use a safety factor of 1.4, thus resulting in a cap thickness of 1.4 m.

Surface Runoff

Surface runoff testing was conducted to evaluate contaminant losses due to rainfall at confined upland or nearshore contained dredged material disposal sites. Approximately 2,000 liters of sediment were tested in a lysimeter bed and simulated rainfall was added. Results indicate that suspended solids in surface water runoff from exposed dredged material will be high for both wet and dry material; and after dredge deposition, dissolved contaminant concentrations of Cd, Zn, and Cu, may equal or exceed EPA water quality criteria (Table 4-4, Attachment B). A dilution factor of 18 or greater is required to meet water quality criteria levels.

The preferred method of containment would include covering the dredged material with clean stable material.

Leachate Testing

The leachate generating capability of East Waterway sediments placed in confined nearshore or upland disposal sites was tested by WES. Water was passed through contaminated sediments in the laboratory. Results indicated that there is a potential for metals and organics to be mobilized, but this potential is low if conditions remain anaerobic. This is primarily related to pH; under aerobic conditions, lower pHs were observed along with high contaminant mobility. Under aerobic conditions, over 85 percent of sediment Zn, 57 percent of sediment Ni, and 49 percent of sediment Cd were mobilized (see Table 4-5, Attachment B).

The results indicate that final design of an upland disposal alternative that is subject to progressive oxidation will require site-specific evaluations of groundwater conditions and long-term leaching results.

Sediment Stabilization

Solidification/stabilization studies were conducted on East Waterway sediments by WES through the addition of setting agents. Additives included portland cement, fly ash, lime and Firmix (a commercial product). This testing reportedly showed reductions in the leachability of selected metals. (Apparently, only metals leachability was examined). The results indicate that solidified/stabilized Everett Harbor sediment does not have a significant leaching potential for metals (although no data are presented).

8.0 BIOLOGICAL DATA (FLORA/FAUNA)

Data presented in the EISS are generally in the form of summary numbers or statements regarding the various aquatic species present.

Dungeness Crabs

Alterations in the existing shoreline along the Snohomish River Channel and East Waterway would occur for the proposed project. The proposed shoreline would replace existing muddy substrate with large riprap material (Figure 5.1, Attachment C). This riprap is not expected to provide a juvenile Dungeness crab habitat that is as good as the current conditions. A reduction in survival of juvenile crabs that settle-out in East Waterway may occur.

Dredging in East Waterway was predicted to severely impact both adult males and juvenile Dungeness crabs during the 2 years of planned dredging. (Adult males are present in Everett Harbor year-round while juveniles are present during summer and early fall.) One-third of young crabs in East Waterway would be lost each year.

Following dredging, food sources for crabs were predicted to improve in East Waterway.

Disposal impacts on Dungeness crabs were evaluated for the open water and nearshore disposal sites. CAD sites (Deep Delta [DD], Southwest Delta [SW], and Revised Application [RAD]) were superimposed on crab distribution survey maps (Figures 5.2, 5.3, 5.4, and 5.5, Attachment D). Lower impacts are anticipated for the SW and RAD CAD disposal sites. Long-term impacts could occur from potential habitat changes at each of the three CAD sites.

Nearshore disposal impacts relate primarily to direct loss of habitat for juvenile and adult crabs.

Macroinvertebrates

The total area to be affected by dredging in East Waterway is 120 acres. Thus, the average biomass of 16.2 g/m^2 would be lost. Samples from East Waterway were dominated by polychaetes (75 percent of total biomass). Recolonization of the harbor should occur rapidly. Improved benthic production after dredging is predicted.

Direct loss of benthic macroinvertebrates would occur at each CAD site due to direct smothering of organisms by disposal materials. Predictions were that placement of clean capping materials would aid in recolonization of impacted areas.

Demersal Fish

Impacts on these species are not expected to be great as a result of dredge activities in East Waterway. Most species identified during baseline studies (Navy 1985) were highly mobile and are expected to avoid the area during dredging.

No significant direct losses of demersal fish were predicted as a result of dredged material disposal. If fish are attracted to the disposal area, they would be exposed to contaminated sediments for a short period of time (i.e., 35 days in 1987 and 55 days in 1988). Chronic impacts as a result of exposure during these periods were said to be speculative. Loss of food sources (macrobenthos) would occur due to smothering.

Pacific hake was considered the species at greatest risk from disposal impacts. Port Gardner is reportedly the site of a hake nursery (citations for Dinnel et al. and Appendix F are made but could not be verified).

Salmonids

No dredging is scheduled during the "window" of March 15 to June 15 as designated by the Washington State Department of Fisheries (to protect juvenile salmonids). The Navy reportedly supports ongoing research by the Tulalip Tribe to further evaluate the temporal distribution of juvenile salmonids in the project area. Preliminary results of 1986 monitoring indicate the presence of juvenile salmonids beyond June 15. Thus, fish present in Port Gardner beyond June 15, will be prone to dredging and disposal impacts.

9.0 DATA QUALITY

The EISS uses data described in previous studies to evaluate potential impacts from the proposed Navy Homeport facility. No quality assurance (QA) information for these data is presented in the report. The original reports should be reviewed to evaluate the quality of this data. Most of the data on sediment characterization for dredge disposal appears to be presented in the report titled Sediment Testing and Disposal Alternatives Evaluation (U.S. Army Corps of Engineers 1986a, 1986b).

Supporting Documentation

Anderson, J.W., E.A. Crecelius, and J.Q. Word, 1986, Biological and Chemical Analysis of Sediments for the Design and Construction of the U.S. Navy Homeport facility at East Waterway - Everett Harbor, Washington, Phase III, prepared for U.S. Army Corps of Engineers, Seattle, Washington, Pacific Northwest Laboratory, Richland, Washington.

Crecelius, E.A. and J.W. Anderson, 1986, Biological and Chemical Analysis of Sediments for the Design and Construction of the U.S. Navy Homeport facility at East Waterway - Everett Harbor, Washington, Phase III, prepared for U.S. Army Corps of Engineers, Seattle, Washington, Pacific Northwest Laboratory, Richland, Washington.

Lee, C.R., R.K. Peddicord, M.R. Palermo, and N.R. Francingues, 1985, Decision Making Framework for Management of Dredged Material: Application to Commencement Bay, Washington, draft miscellaneous paper, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Parametrix, 1985, Final Environmental Impact Statement, Carrier Battle Group, Puget Sound Region Ship Homeporting Project, prepared for U.S. Navy, Western Division, Naval Facilities Engineering Command, San Bruno, California, Parametrix.

United States Army Corps of Engineers, Seattle District, 1986a, Sediment Testing and Disposal Alternatives Evaluation, prepared for Department of Navy, Western Division, Naval Facilities Engineering Command, San Bruno, California.

United States Army Corps of Engineers, Seattle District, 1986b, Technical Supplement to Sediment Testing and Disposal Alternatives Evaluation, prepared for Department of Navy, Western Division, Naval Facilities Engineering Command, San Bruno, California.

10.0 HYDROLOGIC AND HYDRODYNAMIC INFORMATION

N/A

11.0 DREDGING AND DISPOSAL ISSUES AND DATA

Dredging Plan

The project dredging plan is shown in Figure 2-4, Attachment C. Dredging was proposed to be conducted in a phased approach beginning in 1987 and ending in 1988. Total estimated quantities of dredged materials are summarized below:

Project Number	In situ (1) Contaminated	Dredge Contaminated	Dredge Clean	Dredge TOTAL
P-111	65,800	97,000	739,000	836,000
P-905	197,300	224,500	1,140,000	1,364,500
P-112	223,800	552,000	498,000	1,050,000
		54,500 (2)		54,500
	486,900	928,000	2,377,000	3,305,000

(1) Overdepth included in dredge contaminated.
(2) Contaminated sediment below project depth in P-112.

Impacts from dredging operations are summarized in Sections 8.0 and 12.0.

Dredge Disposal

Alternative disposal sites and alternative disposal methods were evaluated in terms of environmental impacts, engineering feasibility (e.g., depositional zone, geotechnical stability, site configuration, site size), and cost. The alternative disposal sites that were considered are shown in Figure 3-8, Attachment C. Alternative disposal methods and the corresponding disposal sites are described in Table 3-6, Attachment E.

CAD Sites. Much of the study area was considered unsuitable for a CAD site because of steep slopes or evidence of unstable geotechnical conditions. Two of the five sites (Port Gardner and Puget Sound Dredged Disposal Analysis [PSDDA]) evaluated were eliminated from further consideration. Disposal criteria for the Port Gardner site precluded disposal of contaminated sediments. Because the PSDDA site was already under consideration for disposing uncontaminated dredged material, it was considered undesirable due to the potential for future disposal operations to disturb the CAD cap.

The remaining three (DD, SW, and RAD CAD sites) were evaluated in detail. All three are located in the same area, with portions of each site overlapping. The primary difference is the depth at which each site is located:

DD: 240-320 ft
SW: 300-370 ft
RAD: 310-430 ft

Two methods of placing dredged material at these depths were evaluated: vertical downpipe or bottom dump barge. The bottom dump barge method was identified as the preferred placement method. Modeling conducted by WES indicated that 98 percent of the dredged material would reach the bottom within one hour and minimal impacts on water column turbidity were predicted.

Due to differences in depth, it was determined that the CAD sites would have different potential impacts on Dungeness crab populations, particularly female crabs (see Figures 5.2-5.3, Attachment D). It is expected that the DD site would have the greatest impact on crabs.

Estimated disposal costs for the three CAD sites are summarized below:

DD:	$18,800,000
SD:	$16,500,000
RAD:	$17,500,000

Unconfined Open Water Disposal. The existing Port Gardner site (Figure 3-8, Attachment C) was the only site evaluated for unconfined openwater disposal of uncontaminated sediments.

Nearshore Disposal. The following two nearshore disposal sites were evaluated (Figure 3-8, Attachment C):

- o Snohomish channel intertidal site
- o East Waterway site

The 180-acre Snohomish channel site is located in intertidal mud-flats along the east shoreline of East Waterway. Adjacent lands have been filled for industrial use. The intertidal areas are used for log storage. Dikes would be constructed to contain the contaminated dredged material in the fill area. The fill material is expected to settle as much as 5 feet during the first 5 years. The cost to dispose all dredged material at the Snohomish channel site is estimated at $24,101,000 (includes land acquisition cost). If only the contaminated sediments were disposed in the Snohomish channel and the contaminated sediments were disposed at the CAD site or Port Gardner, the estimated costs are $18,890,000 and $20,823,000, respectively.

The East Waterway site, located at the northern and eastern edges of East Waterway, was considered for disposal of debris and contaminated dredged material. Containment dikes with a retaining wall would be required. The fill is expected to settle 8 to 12 feet, with as much as 2 feet occurring before construction is complete. The estimated cost of this disposal site is $35,919,000 (includes relocation of the Scott Paper Company outfall and disposal of uncontaminated sediments at Port Gardner).

Upland Disposal. The EISS evaluated several upland sites on Smith Island and one located north of Smith Island on the Tulalip Indian Tribe property. Based on size, distance from dredging, and existing use, only two sites (Sites 2 and 4) on Smith Island were considered feasible (see Figure 3-8, Attachment C).

The following two disposal options were evaluated:

- Excavated disposal: Contaminated dredged material is placed in a cell excavated below existing groundwater level and, therefore, sediments would remain saturated and anaerobic. Approximately 1,330,000 yd3 of material would have to be excavated to construct the cell. This material would have to be disposed of, thus creating additional disposal costs. Potential disposal sites that were considered include Weyerhaeuser property on Smith Island, Department of Natural Resources, Dagmars Landing, Biringer property on east side of Union Slough, and Weyerhaeuser property on south bank of the Snohomish River. Estimated cost for this option is $33,357,000 (includes land acquisition for Smith Island disposal site only). If additional land is purchased to dispose excavated material, the estimated cost is $38,857,000.

- Elevated disposal: Contaminated dredged material is placed above existing ground. Because sediments may eventually dry and oxidize, a disposal site liner and leachate collection system would be required to contain leachate. The cost estimate for this option is $54,750,000.

The options for dredged disposal were evaluated based on the following criteria:

- Contaminant availability,
- Potential contaminant availability,
- Site environmental considerations,
- Erosion potential,
- Institutional constraints,
- Site capacity,
- Relative cost, and
- Adequate capping materials.

The results of the evaluations are presented in Tables 3-9 and 3-10, Attachment F.

Characterization of Contaminated Sediments

Phase I studies of sediments in East Waterway were completed in February 1985 (no citation given, but assumed to be Battelle studies of Anderson 1985). Phase II biological testing of sediments was completed in May 1985 (Crecelius and Anderson 1986). Phase III sediment studies involved chemical testing of sediment elutriates and testing procedures indentified in the document Decision Making Framework for Management of Dredged Material (Lee et al. 1985). The Phase II studies were conducted by the Waterways Experiment Station in Vicksburg, Mississippi.

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12.0 ENVIRONMENTAL IMPACTS

In addition to the impacts to water quality identified in Section 7.0 Chemical Data, the EISS also evaluates potential operational impacts of the proposed Homeport facility. These include impacts of graywater discharges and tributyl tin (TBT) paints. Oil spill impacts are discussed in Section 13.0. Construction-related impacts also are discussed.

Operational Impacts

The impact(s) of graywater (wastewater from ships that originates from showers and sinks, laundry and food preparation areas) on waters of Everett Harbor were identified. The total graywater discharge was estimated at 185,000 gallons/year for all ships to be berthed at the Homeport facility. To meet EPA water quality criteria, dilution of a continuous discharge would have to be 57 for copper, 8 for zinc, and 2 for lead.

TBT paints are used on ship hulls as an antifoulant similar to copper-based paints. The high toxicity of low levels of this material argues for caution in its use. Projected mass loadings of TBT to East Waterway from berthing of Navy ships was estimated at 138 g/day. Steady state concentrations were estimated at 0.04 µg/L. (Since this EISS, the State of Washington and EPA have banned the use of TBT paints.)

Potential oil spill impacts related to the project also were evaluated. Based upon the Navy's oil spill model, a conservative estimate is that sensitive shoreline areas identified in the FEIS (not described) would be covered with jet fuel or diesel fuel and would cause severe impairment and/or death to the associated biota of those areas. Habitat restoration would probably be required. The Navy FEIS (Parametrix 1985) is referenced for information on this topic.

Possible oil spills combined with TBT and copper (from graywater) may act synergistically to yield water quality impacts greater than those predicted.

Removal of contaminated sediments from East Waterway is expected to improve the existing habitat. However, ongoing point sources adjacent to East Waterway may recontaminate the site.

Construction Impacts

The majority of the environmental impacts from construction of the proposed project are associated with dredging and disposal activities.

Because the project would displace Port of Everett facilities, relocation to and dredging of the Hewitt Avenue and Weyerhaeuser Company (WEYCO) areas would be necessary. The volume of material to be dredged from this area was estimated at 235,000 cubic yards. These sediments are reported to be less contaminated than East Waterway sediments (Anderson and Crecelius 1985) with 51,500 cubic yards reportedly contaminated, 13,500 cubic yards of debris, and 170,000 cubic yards of relatively clean material. Because this material would be combined with overall dredge activities proposed for East Waterway, this would increase total contaminated dredged material volumes by 6 percent.

Mass release of particulates from all dredging activities for the project was estimated to be 0.3 percent and 2.9 percent of the total non-point source impact to Puget Sound for 1987 and 1988, respectively (the years for which dredging and disposal were planned).

Short-term adverse water quality conditions were predicted to occur as a result of the proposed dredging and disposal operations, but within a short distance dilution is expected to reduce contaminant concentrations to concentrations below water quality criteria levels. Bioaccumulation was not expected to result in measurable impairment to the aquatic food chain as a result of the proposed project.

Air Quality

Air emissions resulting from construction activities at the site are identified in Tables 6-1, 6-2, and 6-3, Attachment G.

Dredging of the inner and outer harbor were shown to have the greatest emissions for five air pollutants of concern; non-methane hydrocarbons (ROC), sulfur dioxide (SO2), carbon monoxide (CO), oxides of nitrogen (NOx), and particulate matter (PM). The main sources of these emissions are the clamshell dredge and debris haul trucks. Breakwater construction is the activity that produces the second greatest amount of air emissions.

Atmospheric dispersion modeling was conducted in response to comments regarding the FEIS air quality impact analysis. Modeling of ship and onshore construction emission sources was conducted and was said to be consistent with EPA recommendations set forth in a July 19, 1985 letter and subsequent February 10, 1986 project meeting (no citations presented). SO_2 and total suspended particulates (TSP) project impacts were below EPA-designated significance levels. Maximum annual NO2 concentrations were predicted to be greater than EPA-designated significance level of 1 µg/m3 (Figure 6-1, Attachment G).

Traffic and Transportation

An updated (1986) report by the Puget Sound Council of Governments (PSCOG) documents potential impacts for a 13 ship battle group rather than a 15 ship battle group as previously analyzed.

Key findings of the PSCOG report are:

- Background traffic growth for 1990 (without Homeport) is expected to vary from modest on Everett arterials serving primarily local traffic to intermediate on arterials to relatively high (16 to 25 percent) on regional highways.

- Generally, the Everett arterial system can accommodate the projected 1990 growth levels except on Broadway where loss of service would occur during peak evening hours.

- Under conservative conditions, 21,800 vehicle trips/day would be generated by the proposed Homeport. Eleven percent of this increase would occur during peak evening hours.

- Sixteen percent of the daily traffic generated would use the north access corridor and 84 percent would use the south access corridor.

- Traffic on Marine View Drive could increase by 100 percent.

- A reduction in level of service would occur at all primary route intersections.

- Additional lanes or configurations would be required at five major intersections.

13.0 INTERIM MEASURES/SPILL AND POLLUTION PREVENTION MEASURES

Spills related to fuel storage and delivery were discussed in the EISS. The Everett Homeport would function only as a "topping off" facility to maintain ships at the required fuel levels (i.e., 85 percent of storage capacity). Fuel would be delivered to the Homeport site via barge from the Manchester fueling station. Fuel would be offloaded to a shore-based tank farm from the existing Norton Terminal Wharf. The tank farm facility would be "enclosed within an impermeable diked containment area capable of handling all of the tank's contents should a major leak occur". Spill containment equipment would be deployed during all fuel barge off-load operations. When not in use, the containment equipment would be stored on-site.

Potential impacts from oil spills were described in the Navy FEIS (Parametrix 1985). The Navy modeled impacts from diesel and jet fuel spills and concluded that sensitive shoreline areas would be covered with jet fuel or diesel fuel, causing severe impairment and/or death, and requiring extensive cleanup to restore the damaged habitat and organisms.

14.0 COMMUNITY RELATIONS INFORMATION

Additional information and analysis is provided beyond that discussed in the Navy draft EIS and FEIS (Parametrix 1985) for Native American concerns regarding the project.

The primary tribes in the area of the proposed Homeport are the Tulalip Tribes, the Stillaguamish Tribe, the Lummi Tribe, the Muckelshoro Tribe, the Suquamish Tribe, and the Swinomish Tribal Community. The Tulalip Tribes are the primary and dominant tribe in the vicinity of the proposed Homeport facility.

The potential impacts discussed were 1) reduction in fishable area within usual and accustomed fishing grounds resulting from Homeport pier construction, 2) increased potential for damage of fishing gear and/or reduction of fishing time as a result of ship traffic, and 3) potential degradation/alternation of salmonid and Dungeness crab habitat and water quality associated with construction and operation of the proposed facility.

It is recognized that the proposed project would affect treaty rights adversely (discussed in the Navy FEIS [Parametrix 1985]). Fishing rights are the main issue but also of concern to the tribes are land use, economics, demographics, housing, and environmental impacts.

Although negotiations have been ongoing, as of the date of the EISS, no agreement was reached between the Navy and Tulalip Tribes regarding Homeport-related tribal impacts.

15.0 RECOMMENDATIONS

The original reports detailing the field and analytical methods used to generate the data that was used in the EISS should be reviewed to verify data quality. Most of the sediment data used to evaluate disposal options (i.e., elutriate tests, leachate tests, settleability tests, surface runoff analyses) are described in a COE report (1986b) and Appendix B of the EISS (these reports have not been reviewed).

The estimated quantities of contaminated sediments present in East Waterway should be revised based on Ecology's new Sediment Management Standards. The disposal options also should be reevaluated based on the PSDDA criteria. Finally, this information should be used to update the cost estimates for the various disposal options.

16.0 FINAL COMMENTS

The EISS never identifies a preferred alternative for disposing contaminated sediments from the Navy's proposed Homeport facility. However, it appears to be weighted towards the CAD sites because it presents more detailed information for these sites. Other remediation options (e.g., stabilization and treatment) will have to be evaluated for the Remedial Investigation/Feasibility Study.

Attachment A

WATER CHEMISTRY

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Table 3-2. Everett Harbor Site Water Chemistry[1]

Parameter	Concentration ppm
Arsenic	<0.005
Copper	0.007
Nickel	0.007
Cadmium	0.0006
Lead	<0.001
Zinc	<0.030
Chromium	0.004
Mercury	0.0067
PCB-1016	<0.0002
PCB-1221	<0.0002
PCB-1248	<0.0002
PCB-1232	<0.0002
PCB-1254	<0.0002
PCB-1242	<0.0002
PCB-1260	<0.0002
Acenaphthylene	<0.005
Naphthalene	<0.005
Acenaphthene	<0.005
Fluorene	<0.005
Fluoranthene	<0.005
Phenanthrene	<0.005
Pyrene	<0.005
Benzo (B) Fluoranthene	<0.005
Anthracene	<0.005
Chrysene	<0.005
Benzo (K) Fluoranthene	<0.005
Benzo (A) Pyrene	<0.005
Benzo (G H I) Perylene	<0.005
1-Methylnaphthalene	<0.005
Indeno (1 2 3-C D) Pyrene	<0.005
2-Methylnaphthalene	<0.005
Dibenzo (A H) Anthracene	<0.005

Note: Concentrations of this Everett Harbor site water sample were specified by the Seattle District for use as Port Gardner background or reference.

1. From: U.S. Army Corps of Engineers, 1986a. Dredging and Disposal Design Requirements Report

Attachment B

SEDIMENT CHARACTERIZATION

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Table 4-1. Summary of Dissolved Concentrations for Standard Elutriate Tests and Criteria (Source; Palermo et al. 1986)

Parameter	Dissolved Concentration ppm	Site Water Concentration ppm	Federal WQ Criteria ppm chronic	Federal WQ Criteria ppm acute	Remarks
Copper	.007	.007	.004	.023	Test < background
Nickel	.015	.007	.007	.140	Test < acute background
Cadmium	.003	.0006	.0045	.059	Test < chronic background
Lead	.020	<.001	.025	.660	Test > background
Chromium	.008	.004	.010	1.2	Test < chronic background
Mercury	.0066	.0067	.000025	.0037	Test < background
PCB-1254	.0004	<.0002	.00003	.00003	Dilution factor = 13

Table 4-2. Summary of Dissolved Concentrations for Modified Elutriate Tests and Criteria (Source; Palermo et al., 1986)

Parameter	Dissolved Concentration ppm	Site Water Concentration ppm	Federal WQ Criteria ppm chronic	Federal WQ Criteria ppm acute	Remarks
Copper	.006	.007	.004	.023	Test < background
Nickel	.018	.007	.007	.140	Test < acute criteria
Cadmium	.0002	.0006	.0045	.059	Test < background
Chromium	.003	.004	.018	1.2	Test < background
PCB-1254	.0004	<.0002	.00003	.00003	Dilution factor = 13

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Table 4-3. Summary of Total Concentration and Mass Release for Modified Elutriate Tests, Snohomish Channel (100 Acres)

Mass Release Parameter	Bulk Sediment mg/kg	Inflow[1] mg/l	Dissolved Modified Elutriate mg/l	Total[2] Modified Elutriate mg/l	Effluent[3] Concentration mg/l	%
Copper 0.05	73.4	11.01	0.006	0.003	0.006	
Nickel	21.4	3.21	0.018	0.017	0.018	0.6
Cadmium 0.04	3.3	0.50	0.0002	0.0002	0.0002	
Chromium 0.59	39.7	5.96	0.003	0.008	0.035	
PCB-1254	0.25	0.0375	0.0004	0.0006	0.0017	4.5

1 Based on an inflow concentration of 150 g/l.

2 Samples containing a mean suspended solids concentration of 29 mg/l.

3 Based on settling analysis for a 100 acre site, 26" dredge, resulting in effluent suspended solids concentration of 185 mg/l.

Table 4-4. Contaminant Loads in Surface Runoff from Wet, Oxidized Sediment During a 5 cm/hr, 30 min. Storm Event, (Runoff Volume = 187 liters). Source; Appendix D of the DEISS)

Parameter	Filt. Conc. (mg/l)	Load (mg)	Load (mg/Ha)	EPA Maximum Criteria (mg/l) (US EPA 1981)
PAH	0.0004	0.075	134	N
Cd	0.0002	0.037	67.1	0.0015-0.0063
Cu	0.005	0.935	1677	0.012 -0.043
Pb	0.004	0.748	1342	0.074 -0.400
SS	6900	1.29kg	2315 kg/Ha	N

N: No Values Available

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Table 4-5. Results of leaching studies conducted on contaminated East Waterway sediments (U.S. Army Corps of Engineers, 1986b). Concentrations of various contaminants are presented in mg/L.

Contaminant	Anaerobic	Aerobic	Federal/State Drinking Water Standards
As	.039	0.005	0.05
Cd	.010	0.034	0.010
Cr	.080	2.27	0.05
Cu	.096	0.023	1.0

Table 4-5 (Continued)

Contaminant	Anaerobic	Aerobic	Federal/State Drinking Water Standards
Ni	.052	0.449	NA
Pb	.058	0.210	0.05
Zn	.181	3.5	5.0
PCB	.00036	0.00176	NA

NA: Not available.

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Attachment C

SITE MAPS

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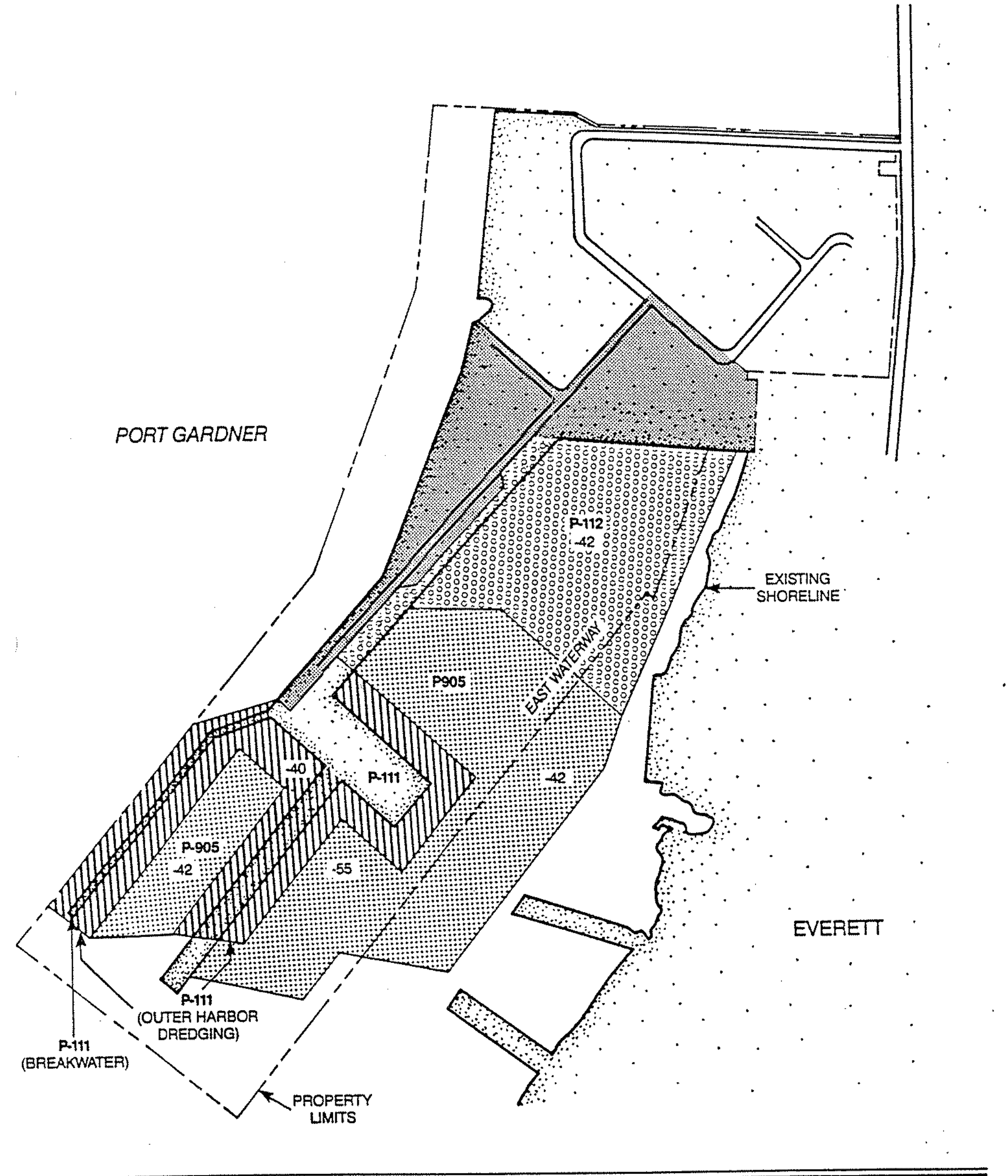


FY87 Projects

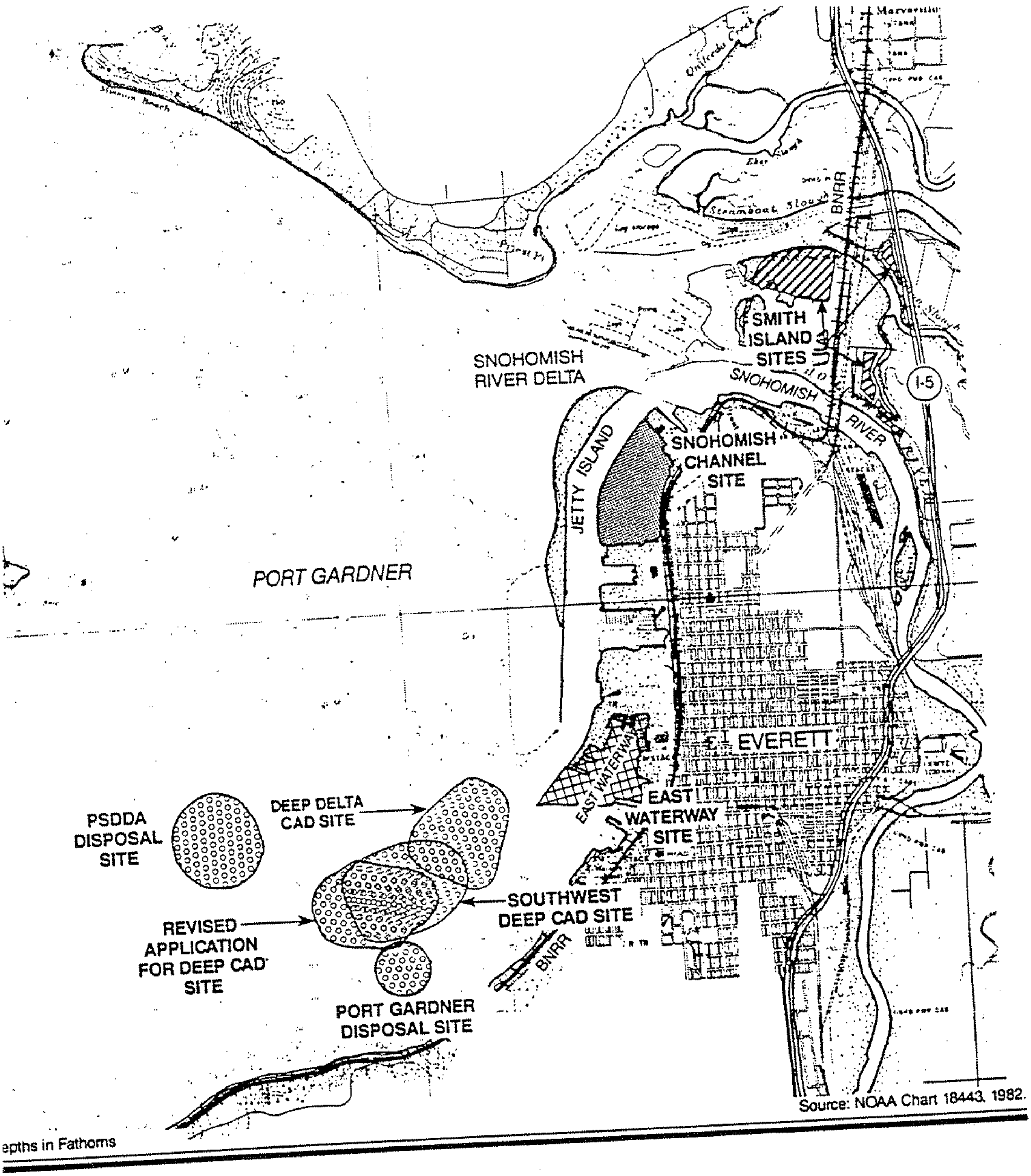
P-111 Outer Harbor Dredging, Breakwater, and Mole

FY88 Projects

P-112 Dredging Inner Harbor

P-905 Dredging Outer Harbor

Figure 2-4.
Project Dredging plan.



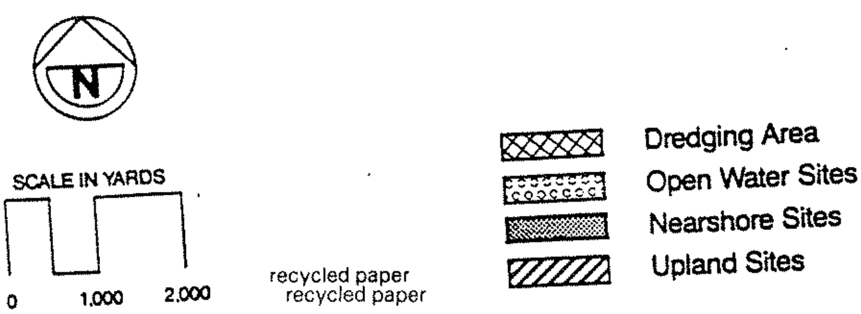


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Figure 3-8. Location Map of Dredging Area and Alternative Disposal Sites.

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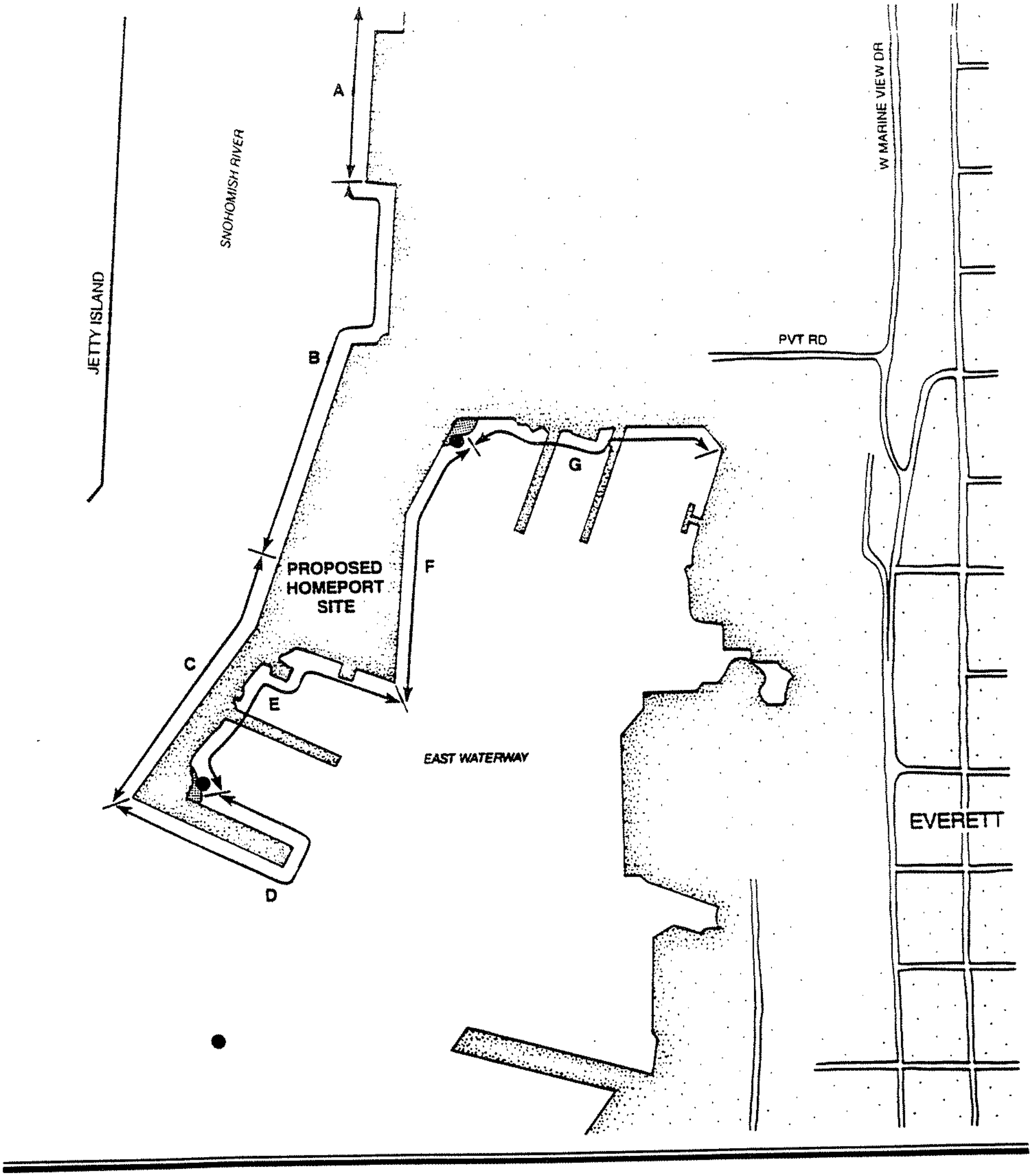

Figure 5.1
Segments within Homeport Site having uniform slopes and substrate type.

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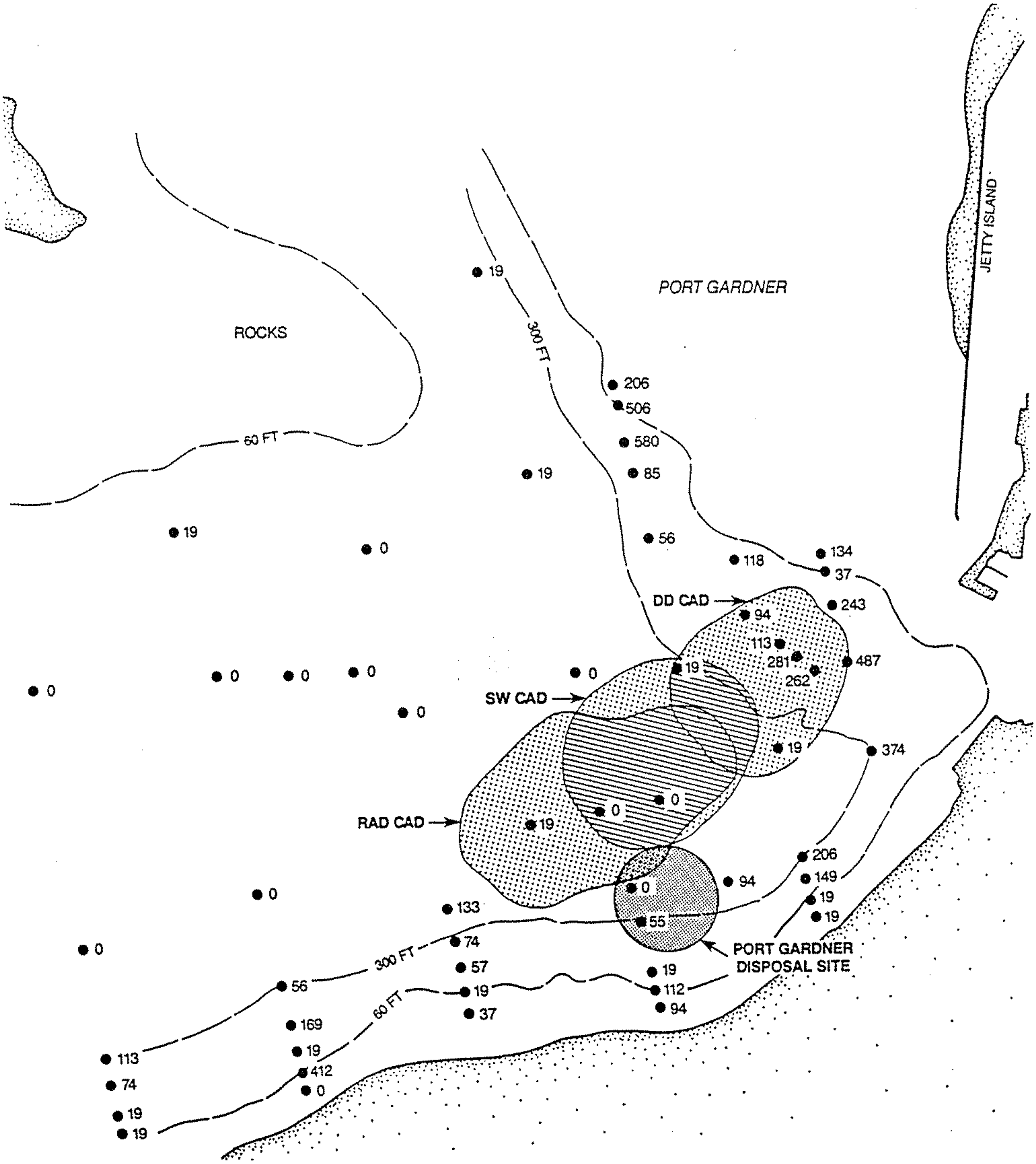
Attachment D

DISTRIBUTION OF DUNGENESS CRABS



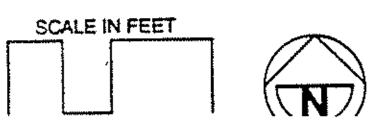


Figure 5.2
Distribution of female Dungeness crab (number/10,000m^2) in the Port Gardner vicinity, February, 1986 cruise (from

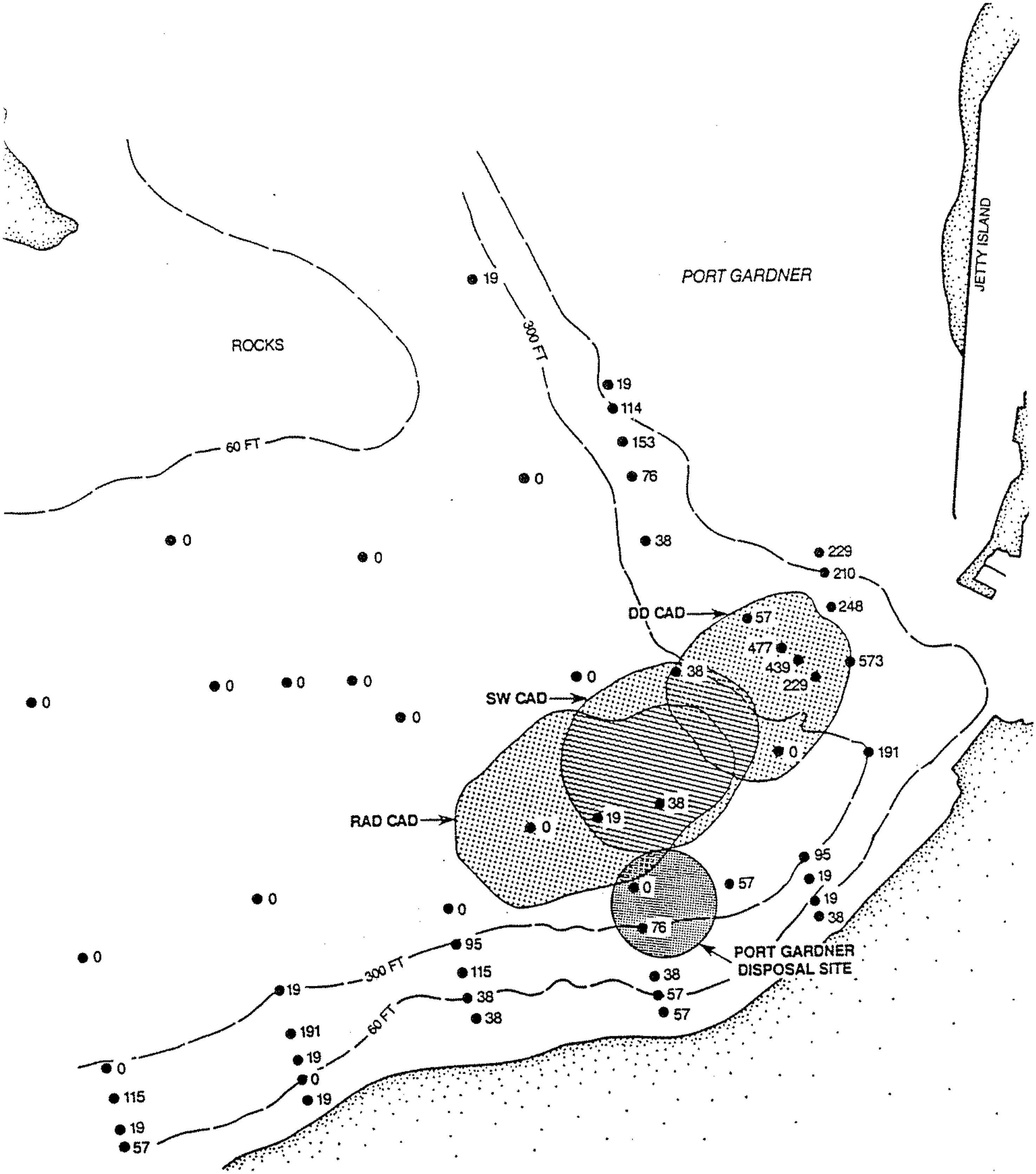


Figure 5.3
Distribution of female Dungeness crab (number/10,000m²) in the Port Gardner vicinity, April, 1986 cruise (from Dinnel et al. 1986b).

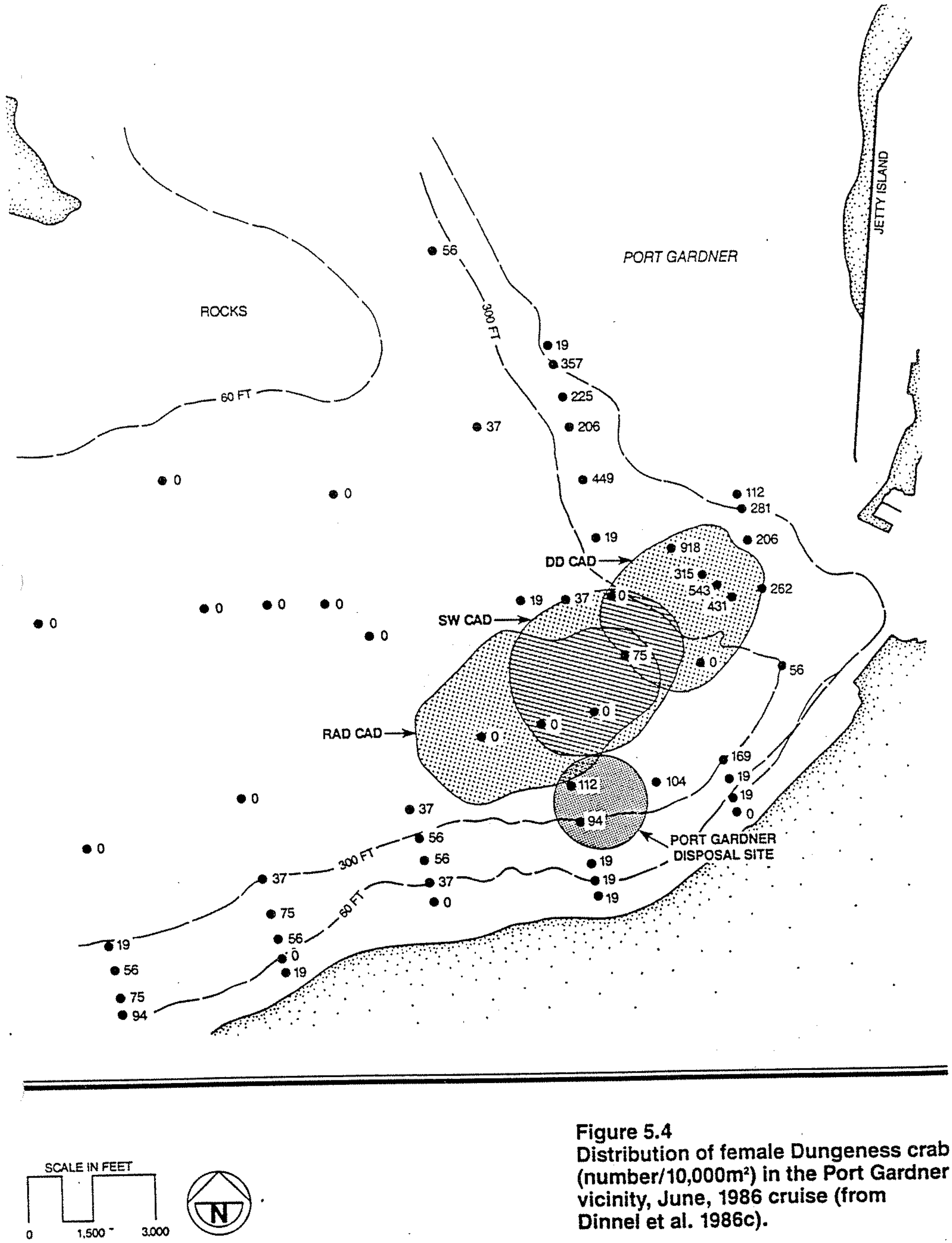


Figure 5.4
Distribution of female Dungeness crab (number/10,000m²) in the Port Gardner vicinity, June, 1986 cruise (from Dinnel et al. 1986c).

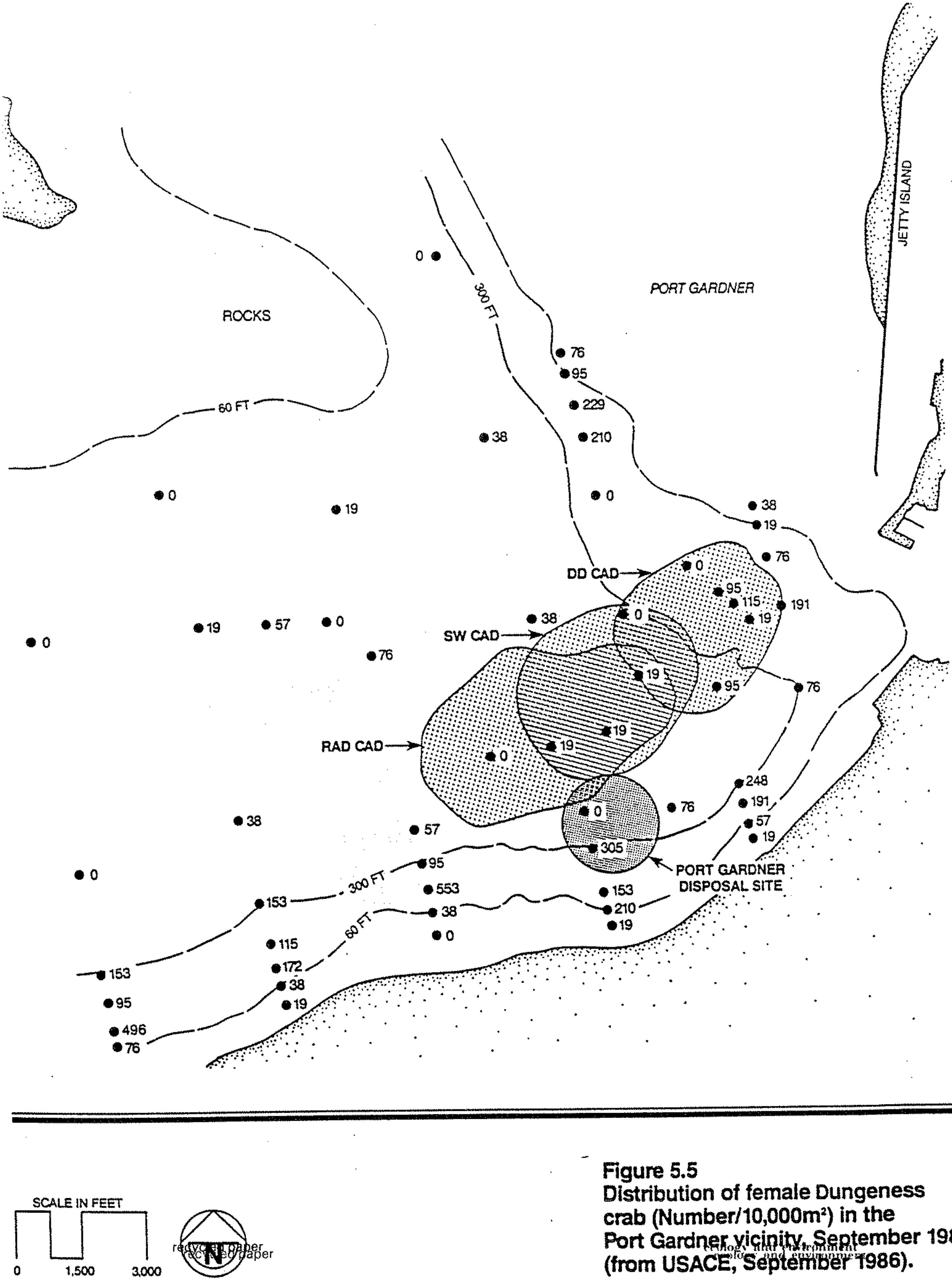


Figure 5.5
Distribution of female Dungeness crab (Number/10,000m²) in the Port Gardner vicinity, September 1986 (from USACE, September 1986).

Attachment E

ALTERNATIVE DREDGE AND DISPOSAL SITES

Table 3-6 Alternative Dredge and Disposal Sites Considered in the EISS.

Dredging Method	Disposal Method	Disposal Site
Clamshell & Bottom Dump	Open Water	Port Gardner
Clamshell & Bottom Dump of Contaminated sediments Pipeline dredge uncontaminated sediments	Open Water Capped	Deep Delta CAD Southwest Deep CAD RAD CAD
Clamshell & rehandle all sediments to downpipe with berm construction	Open Water Capped	Deep Delta CAD
Pipeline all sediments to diked site, sediments remain saturated	Nearshore	Snohomish River
Pipeline contaminated to saturated diked site, uncontaminated to CAD	Nearshore/ Open Water	East Waterway/ CAD
Pipeline contaminated to saturated diked site, uncontaminated to CAD	Nearshore/ Open Water	Smith Island/ CAD
Pipeline all sediments to diked site	Upland	Smith Island
Clamshell & Bottom Dump haul to Ocean	Ocean	Contiguous Zone

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Attachment F

DISPOSAL SITE EVALUATION MATRICES

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Table 3-9. Rating Matrix of Alternative Disposal Sites for Contaminated Sediments

	Contaminant Availability	Potential Contaminant Mobility	Site Environmental Considerations	Erosion Potential	Institutional Constraints	Site Capacity	Relative Cost	Monitoring Capability
Port Gardner Uncontaminated Only	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CAD Deep Delta Downpipe & Berms	1	1	3	1	2	1	2	2
CAD Deep Delta Barge & Pipe-line only	1	1	3	1	2	1	1	2
Snohomish Channel Nearshore All Sediments	1	1	3	1	2	1	2	1
Snohomish Channel Nearshore	1	1	3	1	2	1	2	1
East Waterway Nearshore	1	1	2	1	1	3	3	1
Smith Island Excavated	1	1	2	1	2	3	2	1
Smith Island Elevated	1	1	2	1	3	3	3	1
Ocean	3	1	3	1	3	1	2	3

Table 3-9. Rating Matrix of Alternative Disposal Sites for Contaminated Sediments
Continued ...

	Contaminant Availability	Potential Contaminant Mobility	Site Environmental Considerations	Erosion Potential	Institutional Constraints	Site Capacity	Relative Cost	Monitoring Capability
Southwest Deep CAD Barge & Pipe-line Only	1	1	3	1	2	1	2	2
Revised Application Deep CAD	1	1	2	1	2	1	2	2

1: Minor or no adverse effects
2: Moderate adverse effects
3: Significant adverse effects

Table 3-10. Rating Matrix of Alternative Disposal Sites for Clean Sediments

	Site Environmental Considerations	Availability for Capping	Institutional Constraints	Site Capacity	Relative Cost
Port Gardner Uncontaminated Only	2	2	3	1	1
CAD Deep Delta Downpipe & Berms	3	1	1	1	2
CAD Deep Delta Barge & Pipe-line Only	3	1	1	1	1
Snohomish Channel Nearshore All Sediments	3	1	1	1	2
Snohomish Channel Nearshore	3	1	1	2	2
East Waterway Nearshore	2	1	1	3	3
Smith Island Upland Excavated	1	1	2	2	2
Smith Island Upland Elevated	1	1	3	2	3

Table 3-10. Rating Matrix of Alternative Disposal Sites for Clean Sediments (cont.)
Continued ...

	Site Environmental Considerations	Availability for Capping	Institutional Constraints	Site Capacity	Relative Cost
Southwest Deep CAD Barge & Pipeline Only	3	1	1	1	2
Revised Application Deep CAD	2	1	1	1	2

1: Minor or no adverse effects
2: Moderate adverse effects
3: Significant adverse effects

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Attachment G

AIR QUALITY

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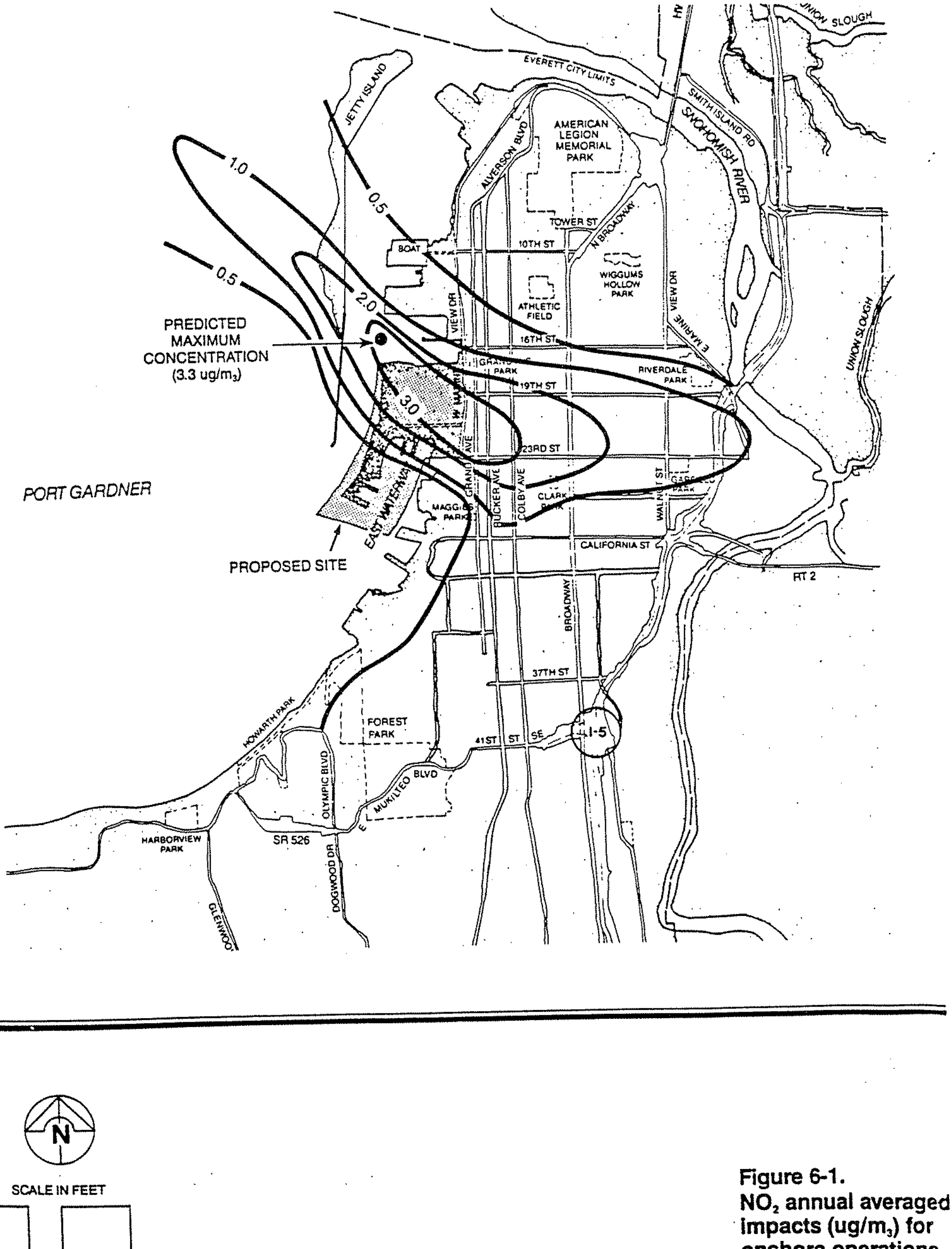

Figure 6-1.
NO_2 annual averaged impacts (ug/m$_3$) for onshore operations.

Table 6-1. Total Construction Air Emissions (per activity). Proposed U.S. Navy Homeport - Everett, Washington.

Activity	Pollutant/Emissions(tons)				
	ROC	NOx	SO2	CO	PM
Carrier Pier/Breakwater Dredging	0.61	8.56	0.84	2.31	0.73
Carrier Pier Pile Driving/Breakwater Construction	3.69	73.73	5.65	15.05	5.05
Structure and Pier Demolition	4.14	41.55	4.63	12.65	3.43
Outer/Inner Harbor Dredging	7.85	90.16	10.16	27.11	8.14
Slope Protection and Stabilization	1.89	31.92	2.52	6.42	2.23
Pier/Wharf Completion	3.84	55.64	4.70	13.99	4.39
Norton Terminal Fill and Excavation	4.04	35.55	4.56	14.02	3.43
Central and South Wharf Sitework	0.89	11.40	1.22	3.50	0.89
Norton Terminal Building Construction	5.73	63.78	5.18	22.25	5.03
Total Construction Emissions:	32.67	412.29	39.47	117.30	33.33

Table 6-2. Average Daily Construction Emissions (per activity). Proposed U.S. Navy Homeport - Everett, Washington.

Activity	Pollutant/Emissions(lbs./day)				
	ROC	NOx	SO2	CO	PM
Carrier Pier/Breakwater Dredging	9.24	129.71	12.72	34.95	11.11
Carrier Pier Pile Driving/Breakwater Construction	21.63	432.42	33.13	88.29	29.63
Structure and Pier Demolition	41.78	419.71	46.77	127.77	34.69
Outer/Inner Harbor Dredging	39.64	455.34	51.31	136.92	41.11
Slope Protection and Stabilization	28.68	483.67	38.22	97.23	33.78
Pier/Wharf Completion	20.56	297.53	25.13	74.78	23.46
Norton Terminal Fill and Excavation	30.60	269.30	34.57	106.23	25.95
Central and South Wharf Sitework	6.71	26.36	9.25	26.52	6.78
Norton Terminal Building Construction	14.46	161.07	13.09	56.20	12.71

Table 6-3. Proposed Homeport Construction Emissions. U. S. Navy Proposed Homeport Construction Emissions (per activity/source).

1. Carrier Pier/Breakwater Dredging

Basis: Hours/day = 24

Mode	Equipment/source	#	ROC	NOx	SO2	CO	PM
			Emissions (tons)				
Dredging	Clamshell Dredge/Prime Mover		0.110	4.125	0.481	1.100	0.413
	Barge Anchor Winch		0.010	0.119	0.008	0.023	0.009
	Auxiliary Generator (250 KW)		0.108	1.345	0.089	0.291	0.096
Disposal	Dump Scow Tug - idle		0.204	0.292	0.046	0.393	0.040
	- cruise/maneuver		0.128	2.290	0.159	0.368	0.140
	Dump Scow		0.004	0.050	0.003	0.011	0.004
Debris Removal	Loader						
	Haul Trucks - haul		0.045	0.336	0.052	0.114	0.032
	- idle		0.002	0.003	0.000	0.004	0.000
		Total:	0.610	8.561	0.340	2.307	0.733
		Average lb/day:	9.24	129.71	12.72	34.95	11.11