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Record of Decision:

PACIFIC SOUND RESOURCES
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OU 02
SEATTLE, WA
09/30/1999

Pacific Sound Resources (PSR)
Superfund Site
Seattle, Washington

Record of Decision

September 30, 1999

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LIST OF ACRONYMS AND ABBREVIATIONS

ACL	Alternate Concentration Limit
AET	Apparent Effects Threshold
ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criteria
B(a)P	Benzo(a)pyrene
CAD	Confined Aquatic Disposal
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulation
CMS	Crowley Marine Services
CND	Confined Nearshore Disposal
COC	Chemical of Concern
CSF	Cancer Slope Factor
CSL	Cleanup Screening Level
CSO	Combined Sewer Overflow
CWA	Clean Water Act
cy	cubic yards
DMMP	Dredged Material Management Program
DNAPL	Dense Non-Aqueous Phase Liquid
DNR	Washington State Department of Natural Resources
DRET	Dredge Elutriate Test
Ecology	Washington State Department of Ecology
EP	Eddy Pump
EPA	U.S. Environmental Protection Agency
ETI	Environmental Toxicology International
FS	Feasibility Study
HI	Hazard Index
HPAH	High Molecular Weight Polycyclic Aromatic Hydrocarbon
HQ	Hazard Quotient
I&M	Inspection and Maintenance
IRIS	Integrated Risk Information System
LAET	Lowest Apparent Effects Threshold
2LAET	Second-Lowest Apparent Effects Threshold
LNAPL	Light Non-Aqueous Phase Liquid

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

LPAH	Low Molecular Weight Polycyclic Aromatic Hydrocarbon
MCL	Maximum Contaminant Level
MCUL	Minimum Cleanup Standard
MET	Modified Elutriate Test
MLLW	Mean Lower Low Water
MTCA	Model Toxics Control Act
NAPL	Non-Aqueous Phase Liquid
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
O&M	Operation and Maintenance
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCP	Pentachlorophenol
PSDDA	Puget Sound Dredged Disposal Analysis
PSR	Pacific Sound Resources
PSR MSU	Pacific Sound Resources Marine Sediments Unit
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RETEC	Remediation Technologies, Inc.
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximally Exposed
ROD	Record of Decision
ROV	Remotely Operated Vehicle
SMS	Sediment Management Standards
SQS	Sediment Quality Standard
SVPS	Sediment Vertical Profiling System
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCDF	2,3,7,8-tetrachlorodibenzo-furan
TEF	Toxicity Equivalency Factor
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TSDF	Treatment, Storage, and Disposal Facility

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

USGS	U.S. Geological Survey
WES	Waterway Experiment Station

PART 1: THE DECLARATION

Site Name and Location

The Pacific Sound Resources (PSR) facility, formerly known as the Wyckoff West Seattle Wood Treating facility, was located on the south shore of Elliott Bay in Puget Sound at 2801 S.W. Florida Street, Seattle, Washington. The Environmental Protection Agency (EPA) identification number is WAD009248287.

The site was divided into two operable units for investigation purposes; the Upland Unit and the Marine Sediments Unit. This Record of Decision (ROD) addresses both Units.

The upland property was purchased by the Port of Seattle (Port) and included in their redevelopment and expansion of an intermodal container terminal facility. The early actions conducted under removal authority were implemented to control the site and prepare it for reuse. The upland site is currently being utilized as part of the Port's intermodal yard.

Statement of Basis and Purpose

This decision document presents the Selected Remedy for the PSR site, which was chosen in accordance with Comprehensive Environmental Response Compensation and Liability Act (CERCLA), as amended, and to the extent practicable, the National Contingency Plan (NCP). This decision is based on the Administrative Record file for this site.

The State of Washington Department of Ecology concurs with the Selected Remedy.

Assessment of Site

The response action selected in this ROD is necessary to protect the public health and welfare, and the environment from imminent and substantial endangerment from actual or threatened releases of hazardous substances into the environment.

Description of Selected Remedy

Upland Unit

The cleanup actions that have been completed to date include demolition of all on-site structures, source material removal (highly contaminated soil and sludge), non-aqueous phase liquid (NAPL) collection and disposal, and isolation of remaining contaminated soil and groundwater with a low-permeability surface cap and subsurface slurry wall. These cleanup actions have addressed the contaminated soil and on-going sources to the off-shore marine environment. What was selected as early action is final action with the addition of the following:

- Inspection and Maintenance (I&M) of the surface cap
- Monitoring groundwater and collection of NAPL
- Institutional controls for prohibiting groundwater use and restricting land use

Marine Sediments Unit

The Selected Remedy for the Marine Sediments Unit is:

- Confinement through capping of contaminated marine sediments
- Five feet of clean cap material will be placed in the intertidal area
- Dredging of approximately 3,500 cubic yards of contaminated sediment to maintain navigational access
- Unused pilings will be removed
- Institutional controls to prohibit large anchor use in capped area
- Monitoring cap placement and cap performance

Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, and is cost-effective. Treatment was evaluated for sediment cleanup, however was not considered further for the following reasons: 1) there are currently no effective in situ treatments (i.e., treating in place) for sediments covering a large area and subjected to significant flushing, and 2) any ex situ treatment would require significant material handling (excavation, dewatering, transport, and processing) and extreme cost (estimated at $40 million excluding material handling). Thus, the Selected Remedy does not satisfy the statutory preference for treatment as a principal element. Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a review will be conducted within five years after initiation of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

Data Certification Checklist

The following information is included in the *Decision Summary* section of this ROD. Additional information can be found in the Administrative Record file for this site.

- Chemicals of concern and their respective concentrations (see Tables 7 and 8)
- Baseline risk represented by the chemicals of concern (see Section 7.2.4, Human Health Risk Characterization)
- Cleanup levels established for chemicals of concern and basis for the levels (see Table 5)

- How source materials constituting principal threats are addressed (see Section 9.1.1, Completed Early Actions)

- Current and reasonable anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD (see Section 6, Current and Potential Future Site and Resource Uses)

- Potential land and groundwater use that will be available at the site as a result of the Selected Remedy (see Section 11.1, Upland Unit Selected Remedy)

- Estimated capital, annual operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (see Tables 28 and 29)

- Key factors that led to selecting the remedy (see Section 10, Comparative Analysis of Alternatives)

Authorizing Signature

Chuck Clarke
Regional Administrator

9/30/99
Date

PART 2: THE DECISION SUMMARY

1. SITE NAME, LOCATION, AND BRIEF DESCRIPTION

The Pacific Sound Resources (PSR) facility, formerly known as the Wyckoff West Seattle Wood Treating facility, was located on the south shore of Elliott Bay in Puget Sound at 2801 S.W. Florida Street, Seattle, Washington (see Figure 1). Wood-treating operations were conducted at the site from 1909 to 1994. The wood-treating facility occupied approximately 25 upland acres. The southern portion of the facility (10 acres) was used primarily for treated wood storage, and the northern portion of the facility (15 acres) was used for processing. All retorts, product storage tanks and piping were located on the northern portion of the facility. The wood-treating chemicals used at the PSR site included creosote, pentachlorophenol, and various metals-based solutions. Soil, groundwater and off-shore marine sediments have all been impacted by the facility's operation.

EPA is the lead agency for this site and the Washington State Department of Ecology (Ecology) is the support agency involved. There are two sources of funding for cleanup of this site; one is monies from a settlement involving the shareholders of the PSR Company (referred to hereafter as the Company) in which an environmental trust was created to dedicate all the assets of PSR at the time of the settlement to cleanup costs, and the other source is the Superfund.

2. SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 Site History

The wood-treating plant started as a pile-supported facility over the Duwamish River estuary. The shoreline and intertidal area was filled in at various times throughout the last 100 years, and the facility was eventually entirely located on fill material that created an upland. This in-filling resulted in the border between the upland and off-shore area being a steep riprap bank. The site is located in an industrial area on the south shore of Elliott Bay.

2.2 Actions to Date

EPA conducted two phases of early cleanup actions on the upland portion of the site. The first phase focused on site stabilization and demolition of on-site structures. The second phase focused on controlling on going sources to Elliott Bay, addressing contaminated soil, and preparing the site for reuse by the Port of Seattle (Port). During the first phase, in 1995, the entire wood treatment facility was demolished and approximately 4,000 cubic yards of highly contaminated soil and process sludge were removed from the site. During the second phase, which began in 1996, a subsurface physical containment barrier (slurry wall) was installed to prevent light non-aqueous phase liquid (LNAPL) migration to Elliott Bay, and to reduce the influence of tidal fluctuation at the site. The slurry wall is 1,200 feet in length and it extends from the ground surface to a depth that averages 40 feet below ground surface. An LNAPL recovery trench was installed in conjunction with the barrier wall to intercept any LNAPL. In addition, a low-permeability asphalt cap was constructed over a layer of clean fill placed at the site. This cap was designed to prevent direct soil exposure to on-site workers, prevent runoff of contaminated soil to Elliott Bay, and minimize infiltration of storm water to groundwater. The cap was completed in 1998.

Other early actions taken at the site include clean out of the Longfellow Creek overflow channel and marine outfall (along the western border of the site - see Figure 2), and collection and disposal of the dense non-aqueous phase liquid (DNAPL) that accumulates in on-site monitoring wells. Twenty-five cubic yards of PCB contaminated sediments were removed from the Longfellow Creek outfall area by the Port as part of their terminal development work, and approximately 1,500 gallons of DNAPL has been recovered from on-site wells and treated through incineration over the last three years.

2.3 Investigation History

Numerous investigations were conducted at this site prior to the initiation of the RI/FS. The Wyckoff Company, EPA, and Ecology all investigated various aspects of the site between 1983 and 1992 under regulatory authority other than Comprehensive Environmental Response Compensation and Liability Act (CERCLA). While work was conducted under Resource Recovery and Conservation Act (RCRA) authority, the site was not considered a treatment, storage and disposal facility (TSDF). Company relations with EPA and Ecology were contentious through the 1980s, and included a federal criminal prosecution for violations of the Clean Water Act and RCRA.

The Upland Unit RI/FS began in 1994 and focused on groundwater, including non-aqueous phase liquid (NAPL) contamination. The Marine Sediments Unit RI/FS began in 1996 and focused on marine sediment contamination. Human health and ecological risk assessments were conducted for both the upland and off-shore areas.

2.4 Enforcement History

The PSR site was added to the National Priorities List in May 1994. A settlement with the Company was embodied in a Consent Decree entered in Federal District Court in August 1994. The Decree creates the PSR Environmental Trust into which the heirs of the Wyckoff Company founders, owners and operators placed all ownership rights and shares in the Company to allow the Trust to maximize liquidation of all company assets, including nonwood-treating holdings, for the benefit of the environment. The beneficiaries of the Trust are the United States Department of Intertior, National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce, and the Suquamish and Muckleshoot Tribes, as Natural Resource Trustees, as well as EPA for reimbursement of CERCLA remedial costs.

3. COMMUNITY PARTICIPATION

EPA, Ecology, and the Port have kept the public aware and updated with respect to cleanup and redevelopment progress at the site. Community participation in this process has included personal interviews, public signs, fact sheets, newspaper notices, and pubic comment on previous cleanup actions. In addition, the Port has worked extensively with the local community regarding its redevelopment project to address traffic, lighting, noise, and public access concerns.

The RI/FS reports and Proposed Plan for the PSR site were made available to the public in April 1999. They can be found in the Administrative Record file that is maintained at the U.S. EPA Records Center on the seventh floor of 1200 Sixth Avenue in Seattle. The notice of the availability of these two documents was published in the Seattle Times on April 21, 1999. A public comment period was held from April 15 to May 15, 1999. EPA's response to comments received during this period is included in the Responsiveness Summary, which is part of this Record of Decision (ROD).

4. SCOPE AND ROLE OF RESPONSE ACTION

The cleanup actions previously completed at this site removed the ongoing source of subsurface contamination and the highly contaminated material (soil and sludge) above the water table that was the source of increasing contaminant volume in the subsurface and the primary driver for contaminant migration. These actions also eliminated the threat of contact with contaminated soil through construction of a barrier, and reduced contaminated groundwater impacts to Elliott Bay through placement of a subsurface wall. While contamination will remain on-site, its potential to adversely impact human health and the environment has been mitigated by isolating it and stopping its continued migration.

The PSR facility did not identify itself as a Treatment, Storage and Disposal Facility (TSDF) pursuant to the RCRA procedures while it was operating. No determination was made through a compliance action that the wood-treating operation was a TSDF. As such, the facility was not subject to RCRA storage closure requirements. However, the facility was identified as a hazardous waste generator (Resource Conservation and Recovery Identification System number WAD009248287), and wastes taken from the site as part of the removal actions were sent to a RCRA-permitted land disposal facility. The Land Disposal Restriction treatment standards had not been established for wood-treating waste at the time the removal actions were conducted.

The groundwater investigation indicates that groundwater does contain site-related contaminants, however the concentration in groundwater at the point where it enters Elliott Bay (the sediment/surface water interface or "mudline") is so low that it is not a source of contamination to either the bay (surface water) or the marine sediment. While this ROD requires ongoing monitoring of groundwater, inspection and maintenance of the upland cap, and institutional controls for the Upland Unit to assure the efficacy and integrity of previously implemented removals, the Selected Remedy contained herein focuses on contaminated marine sediment.

The Marine Sediments Unit encompasses both intertidal and subtidal areas. The intertidal area is approximately two acres in size and is only emergent during lower tides. Specifically, the subtidal area consists of two beach areas that emerge between the piers. These small beaches are referred to as pocket beaches. In addition, the intertidal area includes a thin beach along the toe of the riprap bank at extremely low tides. The subtidal area ranges in depth from intertidal to greater than 200 feet, with approximately 35 percent of the area having a slope of 18 to 21 percent.

This ROD contains the final cleanup actions for this site.

5. SITE CHARACTERISTICS

This section summarizes information obtained as part of RI/FS activities at the site. It includes a description of the conceptual site model on which all investigations, the risk assessment, and response actions are based. In addition, this section presents sources of contamination, subsequent sampling strategies, and documented types of contamination and affected media. The conceptual site model is presented for the entire site; all other information is presented by operable unit. Figure 2 depicts current site features.

5.1 Conceptual Site Model

The Conceptual Site Model depicting contaminant migration for the Upland Unit and Marine Sediments Unit of the PSR site is presented in Figure 3. The primary source of contamination in the Upland Unit (soil and groundwater) was the daily operation of the wood-treating facility including spills, leaks and storage of wood-treatment products. Based on soil borings taken from the Upland Unit, it appears that releases of wood-treatment products occurred throughout the facility's lifetime. Borings reveal layers of contamination that indicate releases occurred both before and after the various filling episodes that turned the originally pile-supported facility into an upland area. Due to the nature of the material (primarily creosote and an oil carrier containing other wood-treatment chemicals), the volume of released material increased with time and seeped down into the soil, encountered groundwater, and separated into a light and dense phase. The lighter phase floats on the groundwater and the denser (or heavier) phase sinks through the soil formation. The floating material is referred to as light non-aqueous phase liquid (LNAPL) and the sinking material is referred to as dense non-aqueous phase liquid (DNAPL). The NAPL associated with the PSR site is detected in the environment as polycyclic aromatic hydrocarbons (PAHs). Creosote is primarily made up of PAHs.

The LNAPL followed the flow pathway of the groundwater (i.e., discharged to Elliott Bay). Prior to the placement of the slurry wall, LNAPL was seen as oily seepage at the shoreline of the facility. DNAPL followed the path of least resistance (which is downward, due to gravity; however, the path has a lateral component due to grain size variation). Free-phase NAPL (both light or dense) is mobile and able to flow. Residual NAPL is the material that is left behind after the free-phase NAPL (either light or dense) has moved through (i.e., NAPL caught in the soil pore spaces). NAPL stringers result when the majority of the mass of NAPL had been spent and the remainder continues to "trickle" through the formation. Residual NAPL will often be detected in the form of stingers, indicating that a larger NAPL mass exists in the area. Consequently, in addition to the layers of contamination created by releases to the soil surface both before and after the filling in of the upland area, upland soil bofings indicate NAPL contamination as deep as the deepest borings taken (100 feet below ground surface).

Passive NAPL collection trials were conducted during the Upland Unit RI and determined that free-phase NAPL recharge volumes (i.e., how much material flowed back into a well after collection) decreased at all collection locations over time. Since the collection locations were chosen based on soil borings and subsurface detection methods indicating higher concentrations of NAPL, it is determined that free-phase NAPL exists in thin layers or stringers at this site, rather than pools.

Of primary concern when initiating the RI/FS for this site, was whether the contamination associated with the upland facility was the source of the contamination in the marine sediment. Specifically, if the upland facility were the primary source, eliminating or controlling that source would be necessary prior to active sediment remediation. As the RI results indicated and Figure 3 depicts, the source of contamination to the marine sediment is not the upland NAPL, rather it was surface releases of wood-treatment contaminants to the off-shore environment. Off-shore sediment borings indicate a clear demarcation between native material (i.e., a clean estuarine formation) and the contaminated material above it. To distinguish between the native and contaminated material, the contaminated material is referred to as the Marine Sediments Unit Fill Area throughout this ROD. While the borings reveal a surface source of contamination to the Marine Sediments Unit rather than a lateral source, they also reveal stringers of NAPL far below the sediment surface.

Current sediment contamination is the primary result of the following historical releases:

- Releases of used or waste creosote and associated wood preservative carrier oil to surface water from the wood-treatment operations. This release pathway contaminated sediments in the southwestern portion of Elliott Bay and represents the primary source of contamination to the Marine Sediments Unit.

- Releases of process wastewater and contaminated stormwater from the Upland Unit to Elliott Bay. These releases contributed to sediment contamination as a result of the partitioning of dissolved contaminants to sediment.

- Erosion of contaminated soil by surface water runoff to Elliott Bay. This pathway contributed minor amounts of contamination to the marine sediments.

- Historical downward and lateral migration of free-phase creosote and oil via preferential flow pathways (e.g., sand layers in subsurface sediment) towards Elliott Bay. While NAPL migration has been effectively stopped through implementation of early actions, the NAPL that remains in place continues to dissolve into groundwater.

Transport of contaminated groundwater from the Upland Unit to Elliott Bay is an ongoing process, however the concentration of contaminants in groundwater is not resulting in injury to Elliott Bay (i.e., surface water is not being impacted). Installation of the slurry wall near the shoreline has nearly eliminated migration of contaminated shallow groundwater (less than 40 feet below ground surface) to Elliott Bay and completely stopped LNAPL seepage at the shoreline. However, modeling suggests that deeper groundwater may contribute to sediment contamination via dissolved contaminant advection and dispersion (i.e., the slow dissolution of NAPL into groundwater and the consequent movement of groundwater to the sediments of Elliott Bay). Based on modeling results, this could result in recontamination in a specific area of the Marine Sediments Unit referred to as the Intermediate Groundwater Discharge Zone (see Figure 4). It is important to note that this potential for recontamination is based on modeling that used conservative assumptions and overestimates the amount of contamination that would dissolve in groundwater and later be bound to sediments.

The conceptual site model is primarily based on the interaction of wood-treatment chemicals in the environment. However, the Marine Sediments Unit RI also found PCB contamination from and in the local vicinity of the Longfellow Creek outfall (not from the PSR site). Historically, Longfellow Creek flowed along the western boundary of the site, but was rerouted to discharge to the West Waterway of the Duwamish River. The original creek bed was piped and serves as a stormwater and creek overflow channel. The Longfellow Creek overflow discharges just west of the Upland Unit into the Marine Sediments Unit.

5.2 Upland Unit

5.2.1 Upland Overview

The Upland Unit, consisting of the former wood-treating facility, occupies approximately 25 acres. The Upland Unit is bounded to the north by Elliott Bay and by the Port of Seattle's newly constructed intermodal rail yard and container shipping terminal on all other sides. The West Waterway of the Duwamish River, which discharges to Elliott Bay, borders the terminal to the east. An active bulk materials shipping facility [Crowley Marine Services (CMS)], lies directly west of the container terminal (and the former PSR Upland Unit).

The wood-treating plant evolved over time from a pile-supported facility over water to a facility constructed on fill. The upland site is currently situated on approximately 20 to 45 feet of fill material that was intermittently placed over a 50-year span on what was the Duwamish River estuary. Fill materials generally consist of dredged sediments or excavated soils, sawdust, and construction debris. Wood and concrete bulkheads constructed to contain the fill material, as well as control erosion and protect equipment from marine tides, are still buried beneath the site. No surface water bodies are located within the Upland Unit, although localized flooding had been documented during periods of heavy rainfall at the wood-treating facility.

Currently, the Upland Unit is covered with a low-permeability asphalt cap that includes an underground storm drainage and utility system, railroad tracks, and a maintenance and repair building associated with the intermodal rail yard. The northern-most shoreline was developed as a public viewing area and consists of lawns, landscaping, playscapes, concrete pathways, public rest rooms and outdoor showers, a viewing tower and public access pier. Fencing and fishing exclusion screens border the shoreline and pier and restrict access to the intertidal area..

5.2.2 Upland Sources of Contamination

Early actions at the site removed much of the process-related source materials including leaking storage tanks and 3,840 tons of process sludges and creosote-saturated soils. Material remaining on-site includes contaminated soil and groundwater, limited LNAPL, and widespread DNAPL Additional actions at the site have contained the majority of the on-site contaminated media. DNAPL occurs on the site in both free (i.e., mobile) and residual phases. The free-phase DNAPL appears to be distributed throughout the site rather than in discreet accumulations or pools.

Some DNAPL has been measured in the shoreline wells on the western portion of the site. However, continued monitoring of those wells and pumping of all on-site wells containing measurable quantities of NAPL has reduced the occurrence and volume of DNAPL in these wells. DNAPL was also detected at some of the deepest stations sampled under the upland process area (i.e., 100 feet below ground surface) and extends as stringers downward and toward Elliott Bay.

Evaluations made during the RI concluded that the stringers of creosote extending underneath Elliott Bay (approximately 80 feet below the sediment surface) are highly unlikely to seep up and out of the sediment and into Elliott Bay. This conclusion was based, in part, on the characteristics of the underlying stratigraphy (layers of estuarine sediment parallel the sloping bottom surface), and continued gravitational pull (DNAPL does not flow uphill). However, the residual or free-phase DNAPL will contribute to dissolved groundwater contamination as groundwater moves past the DNAPL mass.

The majority of the contamination associated with the Upland Unit has been contained behind and below the barrier wall and cap. The relatively small percentage of NAPL that has not been isolated by the wall and cap can act as a source to groundwater contamination.

5.2.3 Upland Sampling Strategy

The Upland Unit RI/FS began in 1994 and focused on establishing the nature and extent of soil and groundwater contamination and the distribution of non-aqueous phase liquids (NAPLs). Evidence of staining and chemical analyses of soil from over 215 borings were used to establish the extent of contamination in soil and confirm the presence of NAPLs. Numerous groundwater samples were analyzed for chemicals of concern and measurements of NAPL thickness and recovery were made in all affected wells. Tidal studies were conducted to examine the effectiveness of the subsurface wall in minimizing the influence marine water of Elliott Bay on groundwater flows at the site. Geological investigations examined the subsurface stratigraphy and a laser-induced fluorescence sampling device was used to establish areas of free-phase or recoverable DNAPL in the northern portion of the site.

Based on the results of subsurface investigations, recovery wells were installed in the areas of free-phase NAPL accumulations. A test was conducted to determine how much NAPL could be collected by encouraging flow into on-site wells through varying the interval between collection events. *In situ* flushing and biological treatability studies for groundwater were also conducted to determine their effectiveness at the PSR site. In addition, the upland investigation included an assessment of the performance of the barrier wall.

5.2.4 Upland Nature and Extent of Contamination

As stated previously, wood-treating chemicals used at the facility included creosote (primarily composed of PAHs), pentachlorophenol (PCP), and various metal (arsenic, chromium, copper and zinc)-based solutions. Facility operations, including spills, leaks, and storage of wood-treatment products, were primarily responsible for upland soil and groundwater contamination. Based on work prior to the RI **(RETEC et al., 1994, Current Conditions Report)**, it was established that the majority of the contamination occurred in the northern portion of the site in areas associated with the wood-processing and treated wood storage areas.

During the RI and prior to placement of the subsurface wall, PAHs were detected in the majority of the wells sampled, including shoreline wells. DNAPLs were found in several wells, including two shoreline well clusters along the western shoreline. The mass of NAPL that may be present beneath the site in both soils and groundwater is estimated at over 12.2 million pounds. About 550,000 lbs. is estimated to be present as free-phase NAPL; the remainder exists as residual NAPL. The majority of the NAPLs occur at depths greater than 8 ft below ground surface (where the groundwater table occurs). The Upland RI/FS estimates that 96 percent of the NAPL associated with the PSR site is either behind or below the subsurface slurry wall.

Groundwater Contamination

The hydrogeology of the Upland Unit is characterized by a single unconfined shallow aquifer within the fill and alluvium. This aquifer, which is contaminated by significant concentrations of creosote constituents in both dissolved and DNAPL forms, has been determined to be non-potable by the Washington State Department of Ecology. EPA's groundwater classification evaluation has resulted in this aquifer being classified as both Class IIb and Class III (see following discussion under Key Applicable or Relevant and Appropriate Requirements).

Groundwater recharge in the area occurs as a result of stormwater infiltration from the site, as well as from upland areas to the south. However, onsite stormwater infiltration has been precluded by the construction of the asphalt cap covering the upland site. Groundwater below the Upland Unit is influenced by infiltration and tidal fluctuation of estuarine waters from Elliott Bay, but these influences have been significantly reduced by the slurry wall.

The overall movement of groundwater in the vicinity of the site is in a northerly direction toward Elliott Bay. Groundwater discharge to the bay occurs via shoreline diffuse flow through nearshore sediments. To evaluate the potential impact of groundwater transport on sediment quality in the Marine Sediments Unit, groundwater fate and transport modeling was conducted as part of both the Upland and Marine Sediments Unit remedial investigations. The results of the upland modeling effort, which focused on water quality at the potential point of discharge, indicates that groundwater meets cleanup goals at the mudline (i.e., the point where groundwater enters Elliott Bay).

For the Marine Sediments Unit modeling effort, BIOSCREEN (an EPA fate and transport model) was used to determine whether the existing groundwater quality conditions have the potential to contaminate a clean sediment cap following site remediation (i.e., following placement of a 3-foot thick cap over existing contaminated sediment). The BIOSCREEN model results predicted that sediment concentrations for two individual PAHs would exceed 2LAET values after 10 years in the intermediate groundwater discharge zone (-25 to -50 feet MLLW along the west-central shoreline). It was determined that this potential for sediment recontamination is primarily associated with groundwater flowing from the west-central portion of the upland site. However, assumptions used in the model were very conservative and did not account for any natural attenuation that may occur and assumed 100 percent of the contaminant mass transported by groundwater would be retained in the sediments.

5.3 Marine Sediments Unit

5.3.1 Marine Sediments Unit Overview

The investigation of the Marine Sediments Unit encompassed approximately 200 acres of Elliott Bay and 1,600 feet of shoreline adjacent to and offshore of the Upland Unit. The shoreline consists primarily of rock and riprap. Three wooden piers, which form the Main and West slips, extend into the central and western portions of the Marine Sediments Unit. As part of the Port's redevelopment of the site, the western-most pier has been repaired for use as a public viewing platform. The two remaining piers will be removed to facilitate cleanup of the Marine Sediments Unit. Two small pocket beaches exist between the piers and adjacent to Crowley Marine Services; a thin band of a muddy sand beach forms along the toe of the riprapped banks on more extreme tides.

Bottom depths within the Marine Sediments Unit vary from intertidal to over 200 feet deep, with a generally steeply sloped configuration ranging from 6 to 20 (or greater) percent slope. The steepest slopes are nearshore, and slopes gradually decrease with increasing distance offshore.

5.3.2 Marine Sediments Unit Sources of Contamination

Sediment contamination in the Marine Sediments Unit is the result of releases of wood-treating preservatives during the treatment and storage process, or release of process wastewater, from the Upland Unit to Elliott Bay. Downward and lateral migration of free-phase NAPLs, transport of contaminated groundwater, and erosion of contaminated soils by stormwater runoff from the Upland Unit represent other historical sources and transport pathways to the Marine Sediments Unit. In addition, the Longfellow Creek outfall contributed PCB contamination to the Marine Sediments Unit, and mercury contamination appears to have migrated from a source to the east of the site.

As a result of cleanup actions in the Upland Unit, there are only three likely contaminant migration pathways remaining: transport of dissolved contaminants via groundwater with subsequent partitioning to sediment, dissolution of sediment-bound contaminants to the waters of Elliott Bay, and longshore or downslope migration of contaminated surface sediment in the Marine Sediments Unit. The transport of free- and dissolved-phase NAPL in shallow groundwater to Elliott Bay has been inhibited by the slurry wall and LNAPL recovery trench that were constructed as part of the upland source control activities. However, some DNAPL is present seaward of and deeper than the slurry wall, constituting an ongoing, however minor source to the bay. Modeling conducted as part of the Manine Sediments Unit RI suggested that deep groundwater discharging from the western portion of the site may have the potential to recontaminate sediment in the intermediate groundwater discharge zone offshore of Crowley Marine Services. However, assumptions used in the model were very conservative, did not account for any natural attenuation that may occur, and assumed 100 percent of the contaminant mass transported by groundwater would be retained in the sediments.

5.3.3 Marine Sediments Unit Sampling Strategy

The RI sampling activities in the Marine Sediments Unit were conducted in three phases that extended from April 1996 to July 1997 and included the following:

- Subtidal surface and subsurface sediment sampling and chemical and physical analysis to determine the nature and extent of contamination. A limited number of subsurface samples were also analyzed for various engineering parameters to support future design evaluations.
- Fish and shellfish tissue sampling and chemical and physical analysis to evaluate biological uptake and potential fish and human health risks.
- Laboratory bioassays to evaluate potential acute biological effects of the observed contamination on marine invertebrates.
- Benthic community evaluations to assess potential chronic biological effects

The RI surface (0 to 10 cm) sediment sampling was conducted during three phases from April 1996 to July 1997. Each successive phase was required to fully delineate the outermost boundaries of Marine Sediments Unit surface sediment contamination. In addition to submitting samples for laboratory chemical and physical analyses, field immunoassays and visual observations were conducted at selected locations to assist in the delineation of contaminant extent. In total, 109 of 161 stations sampled are represented by laboratory data, which were subsequently compared with the sediment effects-based (or background) screening values. Figure 5 depicts the surface sediment sampling locations and Table 1 summarizes the sample analyses.

Subsurface sediment sampling was conducted during the second phase of the RI sampling activities, from September through November 1996. Shallow subsurface (0 to 20 feet below mudline) sediment cores were collected from 17 stations and generally composited in 4-foot intervals. Of the 77 resulting core samples (including duplicates), 65 were submitted for physical and chemical analyses, including PAHs. Select shallow core intervals were also composited and submitted for modified elutriate testing (MET) and dredge elutriate testing (DRET), to initially determine remedial design options. The deep subsurface (0 to 96 feet below mudline) sediment cores were collected from three locations and were continuously sampled for stratigraphic interpretations at 2-foot intervals. Select intervals were also subjected to field analyses, which including long-wave UV screening and immunoassays, or were submitted for laboratory physical testing (e.g., engineering parameters). Figure 6 depicts the subsurface sediment sampling locations and tables 2 and 3 summarize the shallow and deep-core sample analyses, respectively.

The biological sampling conducted in support of the human health and ecological risk assessments occurred during the second phase of the RI. Surface sediment from nine Marine Sediments Unit and two Elliott Bay background stations were collected for laboratory acute bioassays (using amphipods and sand dollar larvae), benthic community enumeration and identification, a laboratory bloaccumulation test (using the clam *Macoma nasuta*), and chemical and physical analyses (see Figures 5 and 7). In addition, fish (English sole) tissues were sampled from two transects offshore of the MSU and two background transects in Elliott Bay (see Figure 8). The clam tissues were analyzed for bioaccumulative Chemicals of Concern (COCs), including PAHs and dioxins and furans. The fish tissues were also analyzed for these contaminants, with the exception of PAHs, which are readily metabolized by these receptors and were thus not likely to be detected. Table 4 provides a summary of the clam and fish tissue sample analyses.

5.3.4 Marine Sediments Unit Nature and Extent of Contamination

Sediment Contamination

Sediment problem areas and chemicals were determined based on exceedances of available effects-based screening values, or, where not available, Elliott Bay background concentrations established as part of the RI sampling program. Specifically, sediment chemical data were compared with effects-based Washington State Sediment Management Standards (SMS; WAC 173-204) or Puget Sound Apparent Effects Threshold (AET) values (see Table 5).

The Washington State Sediment Management Standards provides two sets of effects-based chemical criteria for Puget Sound sediment. Sediment Quality Standards (SQS), established as long-term cleanup goals, correspond to a sediment quality below which no adverse effects on biological resources will result. Cleanup Screening Levels (CSL) are less stringent standards that correspond to minor adverse effects thresholds for biological resources; they are typically used to determine if remediation is required in a specific area. Sediment chemical data were compared to both of these criteria.

For comparisons to the SMS, all nonionic/nonpolar organic chemicals were normalized to percent total organic carbon (TOC) content. However, if station-specific TOC content was outside of the range considered appropriate for normalization, (i.e., less than 0.5 or greater that 4.0 percent), then the nonionic/nonpolar organics chemical results were compared with Puget Sound AETs. The AETs represent the chemical concentrations above which deleterious biological effects have been demonstrated to always occur. The lowest AET (LAET) was used as the equivalent of the SQS, and the second-lowest AET (2LAET) was used in place of the CSL where TOC exceeded Ecology guidelines.

Because no sediment criteria for the protection of human health have been promulgated to date, delineation of those areas of concern for human health was based on the SMS chemical criteria. Within those areas defined by the SQS or CSL, standard risk assessment techniques were used to evaluate threats to people eating seafood caught from the site (see Section 7, Summary of Site Risks).

In addition, regulatory sediment effects-based screening values were not available for dioxins and furans. The extent of contamination by these compounds was therefore evaluated by comparison to Elliott Bay background concentrations that were established as part of the RI sampling program (see Table 6).

Chemicals found to exceed effects-based or background screening values in surface and subsurface sediment included low molecular weight PAHs (LPAHs), high molecular weight PAHs (HPAHs), phenolic compounds, dibenzofuran, dioxins and furans, PCBs, and mercury. Tables 7 and 8 summarize the frequency of detection, minimum and maximum values and number of exceedances of criteria for surface and subsurface samples. Of the chemicals exceeding screening values, PAHs were identified as of primary concern, based on their widespread distribution and magnitude of exceedance. Of the more than 100 samples analyzed, concentrations of total LPAHs exceeded SQS or LAET screening values in nearly 60 percent of the surface samples and approximately half of the subsurface samples. The CSL or 2LAET screening criteria for total LPAHs were also exceeded in nearly one-third of the surface samples and nearly 40 percent of the subsurface samples. Two individual LPAHs, acenaphthene and fluorene, exceeded their respective criteria even more frequently in both surface and subsurface samples. Concentrations of individual HPAHs and total HPAHs were typically lower than LPAHs, relative to their respective screening criteria (i.e., fewer HPAH screening criteria exceedances were observed, compared to the LPAHs). In general, concentrations of PAHs tended to decrease with distance offshore of the Upland Unit.

The depth of contamination is not homogeneous in the Marine Sediments Unit. PAHs tended to have a subsurface maxima within the top 4 feet of sediment, although concentrations in excess of screening criteria were found up to 20 ft below mudline. A study of substrate characteristics conducted by the U.S. Geological Survey (USGS) mapped areas of significant accumulation of non-native sediment or fill materials using side-scan sonar techniques. These fill areas correlated well with occurrences of subsurface contamination measured during the RI. According to the USGS, these fill materials range from about 20 feet thick near the shoreline to about 3 feet thick at the furthest boundary of the fill footprint (approximately 700 feet north of the main pier). However, the depth of contamination is not well correlated with distance from shore, possibly reflecting separate release events from the facility.

Other contaminants of concern, including phenolic compounds, dibenzofuran, and dioxins and furans, tended to occur with PAHs and were similarly present at highest concentrations at nearshore locations. Elevated concentrations of mercury and PCBs (relative to SMS screening criteria) appeared to be more localized and not related to sources from the Upland Unit, as they occurred primarily east (mercury) and west (PCBs) of the Upland Unit.

Because PAHs represent the primary contaminant of concern in the surface sediment, the results of the comparisons of these surface sediment data with SMS and AET screening values were used to define the areal extent of contamination in the Marine Sediments Unit (see Figure 9). Overall, approximately 100 acres and 1,000,000 cubic yards of sediment are contaminated with PAHs at concentrations in excess of the lower (SQS/LAET) sediment screening values. When compared with the upper sediment screening value (CSL/2LAET), this area is reduced to approximately 50 acres and 500,000 cubic yards of contaminated material.

The results of the laboratory toxicity tests and the benthic community evaluations are discussed in Section 7 of this ROD under Ecological Risk Assessment, while the fish and clam tissue results are discussed in Section 7 under Human Health Risk Assessment.

6. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

6.1 Land Use

The current and future land use associated with the upland portion of the site is use as part of the Port of Seattle's intermodal terminal. As such, the site will primarily be used as an industrial property. The Port has leased the property to a container transport company (a 30-year lease), and it is anticipated this property will continue to be used for container storage and transfer into the foreseeable future. The property located to the south and east of the site is also part of the intermodal yard. The property to the west of the PSR site is utilized as a barge transport facility for bulk materials, and the site is bordered to the north by Elliott Bay. A small portion of the upland area of the site immediately adjacent to the shoreline has been developed for public use, which includes an observation tower and a scenic public walkway. Access to the shoreline itself has been prohibited and is physically inaccessible from the Upland Unit through the use of fencing.

6.2 Groundwater Use

The groundwater associated with this site is not currently being utilized, nor should it be utilized for any purpose in the future. The State Department of Ecology has made a determination that groundwater beneath the PSR site is not suitable as a potable water supply, and no wells will be permitted. EPA’s groundwater classification evaluation concurs with this determination. Further, EPA has determined that the groundwater associated with PSR meets the criteria necessary to set alternate concentration limits for the site-related contaminants of concern.

6.3 Surface Water Use

The PSR site is located in the southwestern portion of Elliott Bay, a deep, cold-water embayment located in east-central Puget Sound. Elliott Bay has been extensively developed for urban, port, and industrial land uses. While the intertidal/shoreline area is not accessible from the PSR site, there are a couple of beach areas exposed during low tides, and include mud- and sand-flats, as well as pilings and riprap. The Marine Sediments Unit is located in a transition zone between the estuarine environment of the Duwamish River and marine environment of Elliott Bay; the substrates and waters adjacent to the site contain habitat characteristics common to both environments. Currently, the usual and accustomed fishing grounds of the Suquamish and Muckleshoot Tribes include the site and adjacent areas, and impacts to potential tribal shellfish collection from the beach areas must be minimized to the greatest extent practicable.

7. SUMMARY OF SITE RISKS

Human health and ecological risk assessments were conducted for both the Upland Unit and the Marine Sediments Unit to evaluate the potential for current and future impacts of site-related contaminants on receptors inhabiting or visiting the PSR site. *The references cited in the following section are listed at the end of the Section.*

7.1 Upland Unit Human Health Risks

In 1990, Environmental Toxicology International (ETI) evaluated the potential risks to the health of aquatic and human receptors. Only those chemicals associated with wood preservatives and representing the greatest risk were evaluated and included selected PAH and metals, PCP and dioxins and furans. This risk assessment was designed to support interim response actions and determine the need for further investigations. Only limited data were available for the evaluation of Upland Unit site risks.

Several human health risk scenarios were examined based on future land use options. Risks of an industrial worker getting cancer from ingestion of soil and inhalation of vapors ranged as high as 1 in a 100 (1E-02), primarily from high molecular weight PAHs, arsenic, dioxins and furans. Cancer risks under a residential scenario were higher (1 in 10 to 1 in a 100; 1E-01 to 1E-02), using only a soil ingestion pathway. Risks of contracting cancer for a recreational user of the site were one to two orders of magnitude lower (1 in a hundred to 1 in 10,000; 1E-02 to 1E-04). All of these risks are greater than the acceptable risk ranges established by the NCP and the Washington State Model Toxics Control Act (MTCA) and establish the need for further action.

Early actions performed in the Upland Unit eliminated the risks associated with site exposure associated with current and expected future land use. Specifically, capping the upland area eliminated any risk associated with direct contact with contaminated soil, and because groundwater in the immediate vicinity of the Upland Unit is saline and not considered potable, no risks to upland receptors based on exposure to contaminated groundwater exist. Groundwater monitoring data and modeling results indicate that groundwater is currently meeting regulatory requirements at the point of discharge to Elliott Bay. The excess lifetime risk associated with the upland portion of the site (i.e., soil and groundwater) has been addressed. Furthermore, the current and long-term use of the upland property as an intermodal rail yard and container storage eliminates any future risks to human health or the environment associated with the Upland Unit. Given that the only remaining risks at the PSR site are associated with the Marine Sediments Unit, only those risks are described in detail in this ROD.

7.2 Marine Sediments Unit Human Health Risks

The human health risk assessment evaluated potential cancer and non-cancer risks to subsistence fishers, as represented by tribal fishers, who may consume above-average amounts of fish and shellfish from the site. Two types of risk were assessed: residual risks, or the risks remaining after a given area of the contaminated sediment is remediated; and baseline risks, or those risks that currently exist at the Marine Sediments Unit. The former type of risk was calculated to determine reductions in risk for several cleanup scenarios.

7.2.1 Identification of Chemicals of Concern

Contaminants evaluated in the human health risk assessment included those chemicals that exceeded SMS criteria, were known to bioaccumulate, were widespread throughout the site, exceeded risk-based screening values or exceeded Elliott Bay background concentrations, if screening values were not available. Overall, individual PAHs, PCBs, and dioxins and furans were retained for the risk assessment. Mercury was initially evaluated, but was not detected in fish or shellfish tissue, and was eliminated from further study.

7.2.2 Exposure Assessment

The objective of the exposure assessment was to identify potential exposure scenarios by which contaminants of concern in site media could contact humans and to quantify the intensity and extent of that exposure. The conceptual site model depicting potential receptors and exposure pathways were presented in Section 5 (see Figure 3).

The exposure assessment focused on exposure of tribal fishers to site contaminants through consumption of fish and shellfish from the Marine Sediments Unit. Fish were chosen as a medium of concern because they were found to contain contaminants that were also detected in sediment collected from the Marine Sediments Unit which were associated with historical site activities. English sole were used as surrogate species to represent bottom fish because of their abundance at the site, extensive contact with sediment, and limited home range. Shellfish were also evaluated because edible shellfish (primarily crab and shrimp) are found in the Marine Sediments Unit. Clams were used as a surrogate species for all shellfish because of their close association with sediment and potential for human consumption. However, most shellfish consumption related to the Marine Sediments Unit is expected to come from shrimp and crab because of the limited intertidal habitat available for clamming and restricted access to the shoreline. Tables 9 and 10 identify the fish and shellfish exposure point concentrations for the chemicals of concern.

Both an average tribal fisher scenario and a reasonably maximally exposed (RME) tribal fisher scenario were evaluated to show the range of potential risks at the site. Consumption rates for fish and shellfish, as presented in a seafood consumption survey of the Tulalip and Squaxin Island Tribes of Puget Sound (**Toy et al. 1996**), were used as the data representing Native American fish and shellfish consumption patterns specific to the Puget Sound area. Data from this study, as well as **Liao and Polissar (1996)**, which provided a more detailed analysis of the **Toy et al. (1996)** shellfish consumption data, were also used to modify the portions of consumed fish and shellfish that were considered likely to come from the MSU. Exposure point concentrations for consumers of fish and shellfish under current conditions and various cleanup scenarios were determined using a linear sediment to biota transfer model because fish tissue data were limited.

7.2.3 Toxicity Assessment

The human health toxicity assessment quantified the relationship between estimated exposure (dose) to a contaminants of concern and the increased likelihood of adverse effects. Risks of contracting cancer due to site exposure are evaluated based on toxicity factors (cancer slope factors or CSFs) promulgated by EPA (see Table 11). Quantification of non-cancer injuries relies on published reference doses (RfDs) (see Table 12).

CSFs are used to estimate the probability that a person would develop cancer given exposure to site-specific contaminants. This site-specific risk is in addition to the risk of developing cancer due to other causes over a lifetime. Consequently, the risk estimates generated in risk assessments are frequently referred to as "incremental" or "excess lifetime" cancer risks.

RfDs represent a daily contaminant intake below which no adverse human health effects are expected to occur. To evaluate noncarcinogenic health effects, the human health impact of contaminants is approximated using a hazard quotient (HQ). Hazard quotients are calculated by comparing the estimates of site-specific human exposure doses with RfDs. Values greater than 1.0 are considered to represent a potential risk.

Of the site-related contaminants of concern in fish and shellfish that potentially impact human health, only dioxins and some PAHs, are considered to be carcinogenic. The potential cancer risks posed by these compounds were evaluated using EPA's toxicity equivalency factor (TEF) approach.

For PAHs, this approach assigned toxicity potency factors to carcinogenic PAHs relative to the toxicity of benzo(a)pyrene [B(a)P]. A total B(a)P equivalent concentration was derived by multiplying each individual carcinogenic PAH concentration by its equivalency factor and summing the results. Carcinogenic PAHs were combined and referred to as total B(a)P equivalents. Carcinogenicity from B(a)P equivalents was evaluated using the CSF for benzo(a)pyrene identified in the Integrated Risk Information System (IRIS; **EPA 1997**) (see Table 11).

Dioxin and furan compounds were also evaluated using a TEF approach, by which 2,3,7,8-TCDD equivalents were derived by multiplying each individual dioxin and furan congener by its equivalency factor and summing the results. A CSF for dioxin from the Health Effects Assessment Summary Tables was used (see Table 11).

A non-cancer RfD was identified for only one non-carcinogenic PAH (pyrene; see Table 12). No RfDs were available for dioxin, benzo(a)pyrene or its equivalents, or benzo(g,h,i)perylene or phenanthrene.

7.2.4 Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. This "excess lifetime cancer risk" is calculated from the following equation:

Risk = CDI x CSF

where: risk = a unitless probability (e.g., 2×10^{-5} or 2E-5) of an individual's developing cancer

CDI = chronic daily intake averaged over 70 years (mg/kg-day)

CSF = slope factor, expressed as (mg/kg-day)-1.

(See Table 13 for a summary of the input parameters used in risk calculations.)

Risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6} or 1E-6). An excess lifetime cancer risk of 1E-6 indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an excess lifetime cancer risk because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as 1 in 3. EPA's generally acceptable risk range for site-related exposures is 1E-4 to 1E-6. Washington State Model Toxics Control Act (MTCA) rule is similar, but with the acceptable lower risk range of 1E-5.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with an RfD derived for a similar exposure period. An RfD represents the level that an individual may be exposed to a given chemical that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ less than 1 indicates that an individual's dose of a single contaminant is less than the RfD, and that toxic effects from the chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemicals of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI less than 1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI greater than 1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD

where:

CDI = Chronic daily intake

RfD = reference dose.

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

7.2.5 Cancer Risks

The results of the human health risk characterization indicated that cancer risks to subsistence fishers are the primary concern under current conditions. Cancer risks represent an individual's chance of developing cancer due to ingestion of seafood from the Marine Sediments Unit, over and above those exposures associated with general activities in a lifetime. Under current conditions, total cancer risks for the RME individual (high-end tribal fisher) are 5.2 in 10,000 (5E-4), when both PAHs and PCBs are considered (see Table 14). Given the uncertainties associated with estimating risks, this probability is considered accurate within an order of magnitude. Thus site risks under current conditions exceed the NCP risk ranges of 1E-6 to 1E-4. MTCA risk ranges do not apply directly to sediment; however, MTCA risk ranges would also be exceeded under current conditions.

7.2.6 Non-Cancer Risks

Under current conditions, non-cancer hazard indices to RME individuals based on exposure to PAHs are less than 1.0, indicating that non-cancer effects for these chemicals are likely minimal for the site. Inclusion of PCBs in the non-cancer risk assessment suggests that significant impacts to human health may occur from eating contaminated seafood (HI = 4) (see Table 15).

7.2.7 Discussion of Residual Risk Calculations

Residual risks (i.e., risk remaining after cleanup) for human consumers of seafood were calculated to allow comparisons among the alternatives. Individual sample data collected as part of the RI were replaced with the SQS, CSL or background chemical concentrations, depending on the configuration of the remedy. It was assumed that dredging would achieve the selected standard (either the SQS or CSQ, while capping would achieve the Elliott Bay background concentration. Once the sample concentrations were replaced with the post-remedial action predicted sediment concentrations for the chemicals of concern, clam and fish tissue concentrations were estimated using a biota-sediment accumulation factor for each sample location. The 90^{th} percentile of the resulting tissue concentrations was then used as the exposure point concentration in the human health risk assessment. The calculated residual risk for each alternative is listed in the Description of Alternatives Section.

7.2.8 Uncertainties

Risks to human health may be over- or underestimated based on the appropriateness of the assumptions regarding exposure, the availability and assumptions associated with the derivation of toxicity factors, and the use of a bloaccumulation model to represent exposure point concentrations. These inherent uncertainties were accounted for by making assumptions that tended to overestimate risk. For example, when calculating residual risk for a capping scenario, it is understood that some volume of capping material will be deposited in non-target areas (i.e., areas not in exceedance of the cleanup goals). The residual risk calculations do not reflect this additional risk reduction. However, the uncertainties in any risk assessment affect the estimations of risk such that EPA believes that the estimates are only accurate to within an order of magnitude.

7.3 Marine Sediments Unit Ecological Risks

The ecological risk assessment evaluated the health of benthic invertebrate communities and bottom fish populations. The benthic community evaluation was based on multiple effects measures, including sediment toxicity bioassays, *in situ* benthic community structure, and clam tissue bioaccumulation data. The bottom fish evaluation was based on fish tissue bioaccumulation data and the use of a simple linear model to estimate the transfer of bioaccumulative contaminants from a fish to its eggs.

7.3.1 Identification of Chemicals of Concern

Similar to the human health risk assessment approach, contaminants evaluated in the ecological risk assessment included those chemicals that exceeded SMS criteria, were known to bioaccumulate, were widespread throughout the site, and exceeded Elliott Bay background concentrations. Overall, individual PAHs, PCB, and dioxins and furans were retained for the risk assessment. Mercury was not evaluated because it was not detected in fish or shellfish tissue.

7.3.2 Exposure Assessment

Ecological Setting

The Marine Sediments Unit consists primarily of deep subtidal habitat, as nearly all intertidal wetlands and shallow subtidal aquatic habitats in the vicinity have been eliminated as a result of urban development. Intertidal habitat does exists within the Marine Sediments Unit, but is limited to two pocket beaches at the head of the West and Main Slips and as thin bands of muddy sand beach along the toe of the riprapped banks. Because the Marine Sediments Unit is located in a transition zone between the estuarine environment of the Duwamish River and the marine environment of Elliott Bay, the substrates and waters adjacent to the site contain habitat characteristics common to both environments.

Biota utilizing the habitat within the Marine Sediments Unit include a variety of marine invertebrates, estuarine and marine fishes (including salmonids), birds, and marine mammals. Some of these species have been classified by the State of Washington and federal government as species of special concern (i.e., requiring protective measures for their perpetuation due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance). Table 16 presents the ecological receptors and exposure pathways of concern for the site. In addition, Chinook salmon and Bull trout have been listed on the federal Endangered Species List.

Exposure Point Concentrations

Exposure point concentrations were derived for sediment, benthic infauna, clams, fish, and fish eggs. Contaminant-specific exposure point concentrations for surface sediment were represented on a station-by-station basis (rather than combined for the area) because the receptors within the benthic community are expected to have limited movement and are more likely to spend their entire lives at single, defined locations within the sediment environment. Sediment exposure point concentrations were represented by the laboratory results for PAHs and dioxins and furans, with TOC normalization of PAHs (where appropriate) and conversion of dioxin and furan congener-specific data to 2,3,7,8-TCDD equivalents (see Table 17).

Benthic exposures were also evaluated on a station-by-station basis and were represented by measures (averages) of major taxonomic group (i.e., crustacean, mollusc, and polychaete) and species-level abundance and richness. The average values for these endpoints were calculated from the replicate samples collected at each station.

Contaminant exposure to clams inhabiting the Marine Sediments Unit was estimated by directly measuring the concentrations of contaminants of concern in unpurged, whole body bent-nose clam (*Macoma nasuta*) tissues exposed to site sediments in a laboratory test (see Table 18). Similarly, contaminant exposure based on bioaccumulation in English sole was estimated by directly measuring 2,3,7,8-TCDD in whole body adult tissues of fish collected from the site (see Table 19). A maternal-egg transfer approach was used to model 2,3,7,8-TCDD exposures to fish eggs. Studies from **Nimi (1983**) and **EPA (1993)** were used as the basis for assessing the maternal transfer of TCDD.

73.3 Ecological Effects Assessment

Several different criteria were used to evaluate potential toxicity to a range of ecological receptors at the site. Effects-based criteria (i.e., SMS and AET chemical screening values) were used to evaluate toxicity to benthic organisms exposed to contaminated sediment. These criteria represent chemical-specific threshold concentrations above which adverse ecological impacts to the benthic community would be expected. Site-specific toxicological impacts from combined chemical contamination were also evaluated by comparing growth and mortality responses of organisms exposed to sediment collected from the site to responses of organisms in clean control sediments. These toxicological tests included amphipod, echinoderm embryo, and clam bioassays and comparisons with SMS biological criteria (or criteria modeled after SMS). Site-specific toxicological impacts from combined chemical contamination were also evaluated by comparing site-collected benthic infaunal community data, including measures of abundance and diversity, to similar samples collected from Elliott Bay (background).

Chemical-specific toxicity evaluations were conducted for measured concentrations of Contaminant of concern in fish collected from the site and in clams exposed to site-collected sediment. Estimates of fish egg concentrations were made based on a simple maternal transfer model. Toxicity to fish and eggs was also evaluated using literature-based effects concentrations of chemicals in fish tissues and background concentrations of chemicals in clam tissue.

7.3.4 Risk Characterization

Results of the ecological risk assessment showed that existing sediment contamination has low to moderate impacts on benthic invertebrate communities residing in the Marine

Sediments Unit. No risks were calculated for clams because of a lack of effects data in the literature. However, clams are exposed to site-related contaminants at levels exceeding Elliott Bay background concentrations, indicating the possibility that deleterious impacts could occur to this receptor. No risks to fish or fish eggs based on exposure to bioaccumulative contaminants in sediment were identified for the existing conditions in the Marine Sediments Unit. However, risks to fish from PAH exposures were not evaluated because tissue concentrations were considered a poor representation of exposure and potential effects, due to the metabolic breakdown of PAHs in vertebrates. As part of the review of the Feasibility Study, CERCLA Natural Resource Trustees (NOAA, Interior, Ecology, and the Suquamish and Muckleshoot Tribes) provided EPA with a restoration goal for the site, based on effects to flatfish. The restoration goal is 2,000 µg/kg (measured on a dry weight basis) total PAHs in sediments and is based on a sum of the concentrations of selected PAHs. Elliott Bay background concentrations currently exceed the restoration goal, as does the site, indicating that flatfish populations may be at risk throughout Elliott Bay.

7.3.5 Uncertainties

Risks to ecological receptors may be over- or underestimated based on the appropriateness of the background benthic area selected for comparison with Marine Sediments Unit data, the accuracy of the laboratory bioassays in predicting impacts to *in situ* receptors, the assumptions regarding the site-specific bioavailability of contaminants, the accuracy of the predictions of exposure to clams and fish that were based on average tissue concentrations and chemical detection limits, the use of a model to predict chemical concentrations in fish eggs, and the assumptions associated with effects levels for fish. However, similar to the approach used for conducting the human health risk assessment, these inherent uncertainties were accounted for by making assumptions that generally overestimate risk. The exception to the general overestimation is associated with the impact of PAHs on flatfish, as there is no standard methodology to evaluate this pathway.

7.4 Basis for Response Action

Contaminated sediment in the Marine Sediments Unit represents a threat to aquatic receptors (primarily fish and higher order receptors) and people consuming seafood from the site. The response action selected in this ROD is necessary to protect the public health and welfare and the environment from hazardous substances that occur in the surface sediments of the Marine Sediments Unit.

Wood-processing and related industrial chemicals released from the PSR Upland Unit or discharged from the Longfellow Creek overflow channel have been retained in the sediments composing the PSR Marine Sediments Unit. The chance of a tribal fisher developing cancer or other non-carcinogenic effects related to consumption of site-contaminated seafood exceeds the acceptable risk range identified in the NCP.

Aquatic invertebrates may be harmed by ingestion or exposure to contaminated sediments, depending on the sensitivity to PAHs exhibited by a species (i.e., not all species may be affected). However, recent work by the National Marine Fisheries Service (Horness et al.

1998) suggests that flatfish (or other fish in direct contact with sediments) may be at risk for impaired growth or reproduction or suppressed immune responses, not only at the site but throughout Elliott Bay.

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8. REMEDIATION OBJECTIVES

8.1 Upland Unit

The remedial action objectives for the groundwater pathway are: 1) Protection of aquatic life in surface water and sediments form exposure to contaminants of concern above protective levels, and 2) protection of humans from exposure to groundwater containing contaminants of concern above protective levels. These objectives are currently being met through the implementation of the early actions. Additional remedial measures will ensure that the early actions remain protective.

8.2 Marine Sediments Unit

The remedial action objectives for sediments associated with this site are: 1) to minimize human exposure through seafood consumption and 2) minimize benthic community exposure to site contaminants. These objectives will be met through remediation of the sediments exceeding the following State standards: 1) the minimum cleanup standard (CSL) under the State Sediment Management Standards for sediments contaminated with PAHs (creosote related contamination), and 2) the State's sediment quality standard (SQS) for sediments contaminated with PCBs in the near shore environment. PCB cleanup can be easily addressed during PAH cleanup and may increase the overall health of Elliott Bay. A more stringent cleanup goal was chosen for PCBs due to their potential for bioaccumulation in the food chain. These cleanup levels will result in approximately 50 acres of contaminated sediments being actively remediated. Human exposure to contaminated seafood and benthic exposure to contaminated sediment associated with this site will be nearly eliminated in the capped areas, as the fish, shellfish, and benthic community will no longer be exposed to the contaminated sediment. Rather they will exposed to the clean sediment imported for capping material.

8.3 Key Applicable or Relevant and Appropriate Requirements

The key Applicable or Relevant and Appropriate Requirements (ARARs) for PSR include the Alternative Cleanup Levels (ACLs) and the State Model Toxics Control Act (MTCA) for groundwater, and the Washington Sediment Management standards for the marine sediments, as described below.

8.3.1 Upland Unit

Alternate Concentration Limits for Groundwater

Usable groundwater should be returned to beneficial uses wherever practicable within a reasonable restoration time frame (40 CFR 300.430(a)(iii)(F)). If groundwater is a current or potential future source of drinking water, remedial actions must reduce contaminant concentrations to or below nonzero maximum contaminant level goals (MCLGs) or maximum contaminant levels (MCLs) established under Safe Drinking Water Act regulations (40CFR 300.430(e)(i)(B). However, under the following circumstances, alternate concentration limits (ACLs) in accordance with CERCLA Section 121(d)(2)(B)(ii) may be used (40 CFR 300.430(e)(i)(F):

- The groundwater must have a known or projected point of entry to surface water

- Measurements or projections must show that there is or will be no statistically significant increase of such constituents in the surface water at the point of entry or at any point where accumulation of constituents may occur downstream

- The remedial action must include enforceable measures that will preclude human exposure to the contaminated groundwater at any point between the facility boundary and all known and projected points of groundwater entry into surface water

MTCA (WAC 173-340-720(1)(c)) lists parallel requirements, and the PSR site meets the criteria as follows:

- Groundwater from the PSR site discharges directly into Elliott Bay at known or projected points (see Figure 10).

- Uplands RI/FS calculations of constituent concentrations from shoreline monitoring well data project that there will be no statistically significant increase in contaminants in Elliott Bay, after groundwater contaminant concentrations are attenuated between the shoreline wells and the marine water/sediment interface (i.e., the mudline). Under the MTCA, the shoreline wells would be considered an alternate point of compliance, as they will be used to predict the contaminant concentration at the mudline.

- Enforceable institutional controls outlined in this ROD will preclude human exposure to on-site groundwater and any groundwater between the site and Elliott Bay.

Both Class II and Class III groundwater exist at PSR (see Figure 10). Class III groundwater occurs where saltwater intrusion (i.e., the saltwater wedge) raises total dissolved solids concentrations above 10,000 mg/L. Class II groundwater occurs above and upgradient of the 10,000 mg/L boundary. The assignment of Class II to this groundwater is consistent with EPA's definition of a potential source of drinking water (i.e., one available in sufficient quantity to meet the needs of an average household.)

Restoration of Class II groundwater at PSR is impracticable. DNAPL at PSR represents a long-term continuing source of contamination to groundwater. The DNAPL is widespread and the distribution is complex as a result of the interbedding of coarse and fine-grained soil layers in the aquifer (Sections 4.2.2, 4.2.3 and 9.1.4 of the Upland RI/FS). Currently available remedial technologies cannot restore the aquifer to drinking water standards.

Based on the groundwater classification at PSR, the impracticability of restoration, and the impracticability of the site meeting the statutory requirements, use of ACLs at PSR is appropriate. The ACLs for the PSR site are the maximum allowable source concentrations. A fate and transport analysis was conducted using the Domenico Solution to determine allowable source concentrations at shoreline monitoring wells that ensure protection of receptors at the mudline. The mechanisms modeled between the shoreline wells and the mudline were dispersion, sorption, diffusion and tidal dilution. The contribution of biodegradation was not included due to a lack of site-specific degradation data.

Alternate concentration limits were calculated for each of the shoreline well-sets that span shallow (9 to -6 feet MLLW), intermediate (-20 to -40 feet MLLW) and deep (-75 to -85 feet MLLW) screen intervals. For each set, the maximum allowable source concentrations are based on the minimum estimated travel distance between the well-screen and the mudline. As shown in Table 20, many of the calculated ACLs exceeded individual compound solubilities which are the maximum dissolved concentrations possible at equilibrium (i.e., compound is not predicted to dissolve at a high enough rate to exceed the ACL). Compliance with ACLs will be confirmed by groundwater monitoring in shoreline wells.

8.3.2 Marine Sediments Unit

Washington Sediment Management Standards (WAC 173-204)

The Washington Sediment Management Standards (SMS) have been identified as one key ARAR for all Marine Sediments Unit actions. The SMS establish a narrative standard with specific biological effects criteria and numerical chemical concentrations for Puget Sound sediment. Under the SMS, the cleanup of a site should result in the elimination of adverse effects on biological resources and health threats to humans. The Sediment Quality Standards

(SQS) correspond to this narrative goal for ecological effects. Site-specific cleanup standards are established from a range of concentrations; they are to be as close as practicable to the SQS and no greater than the minimum cleanup levels (MCUL; equivalent to the CSL), based on environmental effects, feasibility, and cost.

Given site-specific factors, the CSL for PAHs has been selected as the trigger for active remediation of sediments throughout the PSR Marine Sediments Unit and the SQS for PCBs has been selected as the trigger for active remediation of sediments in the nearshore environment (i.e., sediments shallower than - 10 feet MLLW). Table 20 summarizes these values.

The justification for the selection of the CSL for PAHs is as follows:

- The CSL is protective of benthic communities (as determined by biological sampling).
- Human health risks fall within the risk range required by the NCP.
- Cleanup costs to achieve the SQS across the entire site were greater than 190 percent of the cost to achieve CSLs (greater than 110 percent is considered significant under the SMS guidance).
- Cleanup to the CSL addresses the areas of contaminated sediment accumulations, which contain the greatest mass of contaminants.
- The majority of the unremediated sediments that will remain following cleanup are in deep (greater than 100 feet) water, providing minimal exposure potential to fishers and recreational users of the bay.

The justification for the selection of the SQS for PCBs in the nearshore environment is as follows:

- The nearshore environment provides critical habitat for juvenile salmonids and their prey.
- The CSL for PCBs does not provide the same degree of protection as other chemicals because it does not address bioaccumulative effects.
- Cleanup of PCBs to SQS ensures that the Trustees' restoration goal for PAHs is met in the shallow, nearshore critical habitat area (some nearshore areas were PCBs exceed the SQS also include PAH contamination that exceeds the SQS).

9. DESCRIPTION OF ALTERNATIVES

The Upland Unit and Marine Sediments Unit remedial alternative descriptions are presented separately. The completed and on-going Upland Unit actions and the selected Marine Sediments Unit alternative, in combination, constitute the PSR site-wide remedy.

9.1 Upland Unit

9.1.1 Completed Early Actions

Early cleanup actions were completed to address threats posed by contaminated soil and groundwater and shallow NAPL in the Upland Unit. Included in these actions were the installation of a subsurface containment wall and LNAPL collection trench along the northern site perimeter and the placement of a low-permeability surface cap over the Upland Unit. The subsurface slurry wall was designed to minimize flow of contaminated groundwater and LNAPL to Elliott Bay and reduce tidal influence on contaminant movement below ground surface. The selection of this particular containment option is discussed below. The purpose of the cap was to isolate contaminated soil and reduce groundwater recharge (and associated contaminant mobilization). Early actions were completed prior to the RI/FS process.

Two general response actions were considered for subsurface containment: hydraulic containment and physical containment. Physical containment was selected primarily because LNAPL seeps to Elliott Bay could be prevented. Three types of physical containment technologies were evaluated: sheetpiles, slurry walls, and grout curtains. Grout curtains were eliminated based on technical feasibility concerns; the integrity of curtains in heterogeneous fill conditions and high groundwater tables is uncertain. Slurry wall technology was selected rather than sheet pile technology due to its lower cost. The final remedial action selected was the implementation of an upland hanging slurry wall.

PSR groundwater meets cleanup requirements under the NCP and threshold requirements for cleanup actions under MTCA without implementation of additional engineered remedial measures. What was selected as an early action is the final action, and the development and detailed evaluation of a series of cleanup alternatives was not required for the Upland Unit.

9.1.2 Requirements to Ensure Upland Unit Actions Remain Protective

Engineering Controls

A Inspection and Maintenance (I&M) program was developed to ensure the long-term structural integrity of the cap installed over the Upland Unit. The program consists of scheduled visual cap inspections and specific repair and maintenance protocols. Additionally, every five years the Port will evaluate the need to resurface the upper two inches of the asphalt and determine if reapplication of the cap seal coat is warranted.

Institutional Controls

Institutional controls are the use of legal or administrative systems to reduce the potential for human exposure to contaminated soil and groundwater in the Upland Unit. As described in Section 6, the current and projected future land use of the Upland Unit is primarily industrial (i.e., use as a paved intermodal rail yard) and the groundwater beneath the PSR site will not be used as a potable water supply. The institutional controls necessary to ensure the continued protection provided by the early actions are actions that will assure the current land use is maintained and the aquifer remains unused.

Monitoring

Confirmational monitoring is a routine requirement under CERCLA, as well as one of the threshold requirements for cleanup actions under MTCA and is the central purpose of the plan. Monitoring is intended to confirm the long-term effectiveness of the early actions.

Monitoring of the Upland Unit will consist of two components. The first component is the monitoring of groundwater quality to ensure compliance levels continue to be met (i.e., concentrations of contaminants of concern do not exceed cleanup levels at the mudline). Because the direct measurement of water quality at the mudline is impracticable, monitoring wells located in the shoreline area are utilized to evaluate compliance. These wells allow for monitoring of groundwater quality at two depths outside the containment wall and along the shoreline.

The second component is designed to monitor DNAPL attenuation. This monitoring is required to confirm the conclusion in the RI that the volume of mobile, free-phase DNAPL beneath the site is very limited, and to provide a warning in the case of an unexpected change in conditions. This component consists of gauging DNAPL thickness in wells and removing DNAPL from wells.

9.2 Marine Sediments Unit

Six candidate alternatives were identified in the Marine Sediments Unit FS:

1. No Action
2. Removal (via dredging and disposal) of sediment exceeding the CSL
3a. Capping of sediment exceeding SQS
3b. Capping of sediment exceeding CSL
4a. Fill Area Removal (via dredging and disposal) of sediment exceeding the SQS and then capping the remaining non-Fill Area sediment exceeding SQS
4b. Fill Area Removal (via dredging and disposal) of sediment exceeding the CSL and then capping the remaining non-Fill Area sediment exceeding CSL.

9.2.1 Estimated Cleanup Areas and Volumes

The numeric cleanup goals to attain the Marine Sediments Unit Remedial Action Objectives (RAOs) are the SMS criteria. The PSR cleanup levels are CSLs for PAHs (throughout the Marine Sediments Unit) and SQS for PCBs (in less the -10 feet MLLW). See Table 5 for a summary of these levels. The areas with surface sediment exceeding SQS or CSL criteria for PAHs are depicted in Figure 9. The SQS exceedance area represents about 96 acres and 970,000 cubic yards of contaminated material; within that area, 47 acres or approximately 470,000 cubic yards of sediment also exceed CSLs. Nearly all sediment volume exceeding CSL and SQS criteria (90 and 85 percent, respectively) is located at depths of less than -200 feet MLLW.

The majority of the contaminant mass exists in the Fill Area. The Fill Area sediment contains approximately 96 percent of the mass of contaminants exceeding the SQS criteria, while comprising only 39 percent of the total volume of SQS-contaminated sediment, and contains approximately 98 percent of the mass of contaminants exceeding the CSL criteria, while comprising only 70 percent of the total volume of CSL-contaminated sediment.

9.2.2 Common Components of Alternatives

With the exception of the No Action alternative, each of the sediment remedial alternatives for Marine Sediments Unit share certain components, such as institutional controls and short- and long-term monitoring. For dredging and disposal, additional common elements include methods of sediment removal and transport, and potential disposal site options. For capping, additional common components include cap material availability, methods of material transport and placement, and navigational constraints. Table 21 provides a summary of Marine Sediments Unit remedial alternatives and summarizes which common elements are associated with each alternative. Brief discussions of the common alternative components are provided below.

Another common element to the Marine Sediments Unit remedial alternatives is that they all include the requirements to ensure the Upland Unit actions remain protective (described in Section 9.1.2) to comprise the site-wide remedial alternative for PSR.

Institutional Controls

Currently, the Upland Unit shoreline is fenced to prevent access to the shoreline (by land) and fishing exclusion devices are installed along the viewing pier.

For alternatives with capping components, institutional controls to maintain cap performance will be required. These controls will include administrative measures or regulatory actions to prevent maintenance dredging and large ship anchorage in capped areas. A no-anchor zone is proposed for all alternatives in areas that would be capped. The extent of the zone would depend upon the size of the area capped for the alternative (see Table 21). For the alternatives consisting primarily of capping (Alternatives 3a and 3b), the no-anchor zone would be approximately 96 or 47 acres in size, respectively, representing about 4 or 2 percent of the total anchorage area available in Elliott Bay (approximately 2,000 acres are designated for anchorage within Elliott Bay). This institutional control is included to prevent damage to the cap from commercial vessels using large whale-type anchors. Currently, the Marine Sediments Unit is used only for barge moorage at fixed anchor buoys. This type of moorage will not be restricted. In addition, this restriction would not affect net fishers because small boat anchors and net lead-lines would not damage the cap.

Monitoring

Site monitoring will be conducted for all alternatives. Although specific monitoring requirements vary depending upon the alternative, it is assumed that three types of monitoring will be carried out. Short-term monitoring will be performed during remedial action implementation to ensure compliance with water quality requirements, confirmational monitoring will be implemented immediately following the action to ensure the actions was implemented as designed, and long-term monitoring will be performed to ensure the performance of the remedy. Specific monitoring programs will be developed for the site during remedial design.

Dredging and Transport

Two general types of dredges, clamshell (or bucket) and hydraulic, were evaluated during the FS as applicable to potential sediment removal actions. The dredging-specific methods evaluated were closed clamshell dredge, cutterhead section dredge, high-energy vortex dredge, and a limited-access hydraulic dredge, which represent the most widely used classes of dredges available. Each of these dredges has different attributes with respect to excavation capacity, depth limitations, sediment loss or expansion (bulking), and production rates of dredge material (see Table 22). Comparisons among these dredges indicated that the majority of the sediments from the Marine Sediments Unit could be removed using either a clamshell dredge or large hydraulic dredge. For the purposes of the cost estimates, it was generally assumed that a clamshell dredge would be used in nearshore areas and the high-energy vortex dredge in deeper, offshore areas.

Two methods are used to transport dredged material: pipeline and barge. The actual sediment transport method selected depends primarily on the dredging method and the distance to the disposal site. Pipeline transport was generally assumed for cost estimate purposes, based on the selected dredging method. However, final transport methods would be determined during remedial design when the final dredge equipment and disposal sites are selected.

Crowley Marine Terminal Dredging

All alternatives include dredging in the area of the Crowley Marine Services (CMS) terminal, a barge terminal at Pier 2 (just west of PSR) in order to maintain adequate depths for maneuvering and moorage of barges. Dredging is employed to remove contaminated sediments from the pier area, while maintaining current depths (to accommodate vessel depth requirements) after capping. The disposal method for dredged material varies, depending on the alternative.

Capping

Capping as a remedial technology involves placement of clean substrate (typically sand) to some specified depth over the contaminated sediments. Typical placement methods includes controlled dumping from a split-hulled barge, hydraulic washing of capping material off a flat-decked barge, distribution via a submerged diffuser, and clamshell placement. Requirements for capping material depend upon site-specific characteristics, including water depth, bathymetry, currents, and chemical and physical characteristics of the area to be capped, and are typically determined during design. Site-specific physical constraints that affect capping include currents, wave action, propeller wash, slope, and depth.

For the purposes of evaluating the capping alternatives and estimating costs in the FS, a 3-foot layer of silty sand was assumed to chemically and physically confine the majority of the Marine Sediments Unit sediments exceeding SQS or CSL criteria. Actual cap thickness requirements are determined during design. As the accuracy of cap placement and the capability of monitoring cap thickness is reduced with increasing water depth, it was further assumed that an average cap thickness of 5 feet would be needed to ensure a minimum cap thickness of 3 feet at depths greater than -200 feet MLLW. Because of the potential for resuspension of fine-grained contaminated sediment during cap placement, it was assumed that less dynamic or disruptive methods of sediment placement would be used in the offshore area, such as hydraulic washing. Nearshore area placement techniques were assumed to rely on clamshell placement to obtain desired placement accuracy.

The source of capping material was assumed to be from maintenance dredging projects performed for navigational purposes by the U.S. Army Corps of Engineers (Corps). Table 23 presents the capping material source locations and projected availability schedules. Information provided by the Corps indicates that the two largest sources of sediment suitable for capping are the Snohomish and Duwamish rivers. Dredged material from these projects is anticipated to be predominantly sand materials. Given the demands for capping material throughout Puget Sound, coordination with the Puget Sound Dredge Materials Management Program to develop priorities and schedules for the beneficial reuse of clean dredge material will be needed.

In addition to navigational dredging projects, the dredging of clean sediments in other areas was considered as an alternative capping material source and deemed inappropriate. The mining of clean sediment could have a deleterious effect on the benthos if large areas were mined in order to get the quantity of sediment needed quickly and is difficult to get permitted. In addition, capping the sediment over several years (as necessitated by the projected availability capping material from maintenance dredging projects) will allow the benthic community to reestablish itself between capping events such that a large area is not disrupted at one time. Another benefit of capping over several years is that it allows the effectiveness of capping at depth and over steep slopes to be better established through monitoring to perfect the operation from one year to the next.

Groundwater Discharge Zone Capping

The intermediate groundwater discharge zone, located in the west-central portion of the Marine Sediments Unit, has been identified as an area susceptible to recontamination (due to predicted groundwater contaminant transport in this area). To achieve cleanup goals and long-term protectiveness, a three-foot cap would be placed in the intermediate groundwater discharge zone for all alternatives. In alternatives where dredging is performed first, capping would follow.

9.2.3 Disposal Sites

Disposal options for contaminated dredged sediment consist of confined nearshore disposal (CND), confined aquatic disposal (CAD), or upland disposal. During the FS, the CND option was identified at preferable for alternatives involving the disposal of relatively large volumes of dredged sediment (i.e., Alternative 2, 4a, and 4b).

Confined Nearshore Disposal

A CND facility is typically constructed adjacent to an upland area such that the site can be used as an extension of the upland when the site is filled with sediment. Potential nearshore disposal sites were identified based on several selection criteria. To qualify as a potential nearshore disposal site, the area had to be located in Elliott Bay. In addition, the geomorphology of the site had to be stable enough to allow the construction of a retaining berm. Location of nearshore disposal facilities could not conflict with current land or shoreline uses or tribal fishing activities. The site could not be located in high-value aquatic habitat areas or habitat restoration or enhancement areas. Ten sites were evaluated according to these criteria. Of the 10 sites evaluated, only the nearshore areas associated with PSR and the former Lockheed Shipyard #2 which is adjacent to PSR, is currently available for use as a disposal site for dredged material from PSR. In general, CND facilities can be constructed as an extension to the upland, or at intertidal and/or subtidal elevations. Although evaluated, an intertidal CND site was not selected for further consideration due to inadequate capacity.

The construction of a CND site has been proposed for the above-mentioned Lockheed facility by Ecology. The CND facility is proposed to be constructed off the north shore of the Lockheed site extending eastward from the PSR site to the West Waterway. The facility consists predominantly of an intertidal disposal area supported by a constructed subtidal area. Site capacity would be filled by the Lockheed site cleanup in the current site configuration. However, if the CND at Lockheed was reconfigured to result in a final elevation equivalent to the current upland, the facility could accommodate PSR sediments. Integration of the PSR nearshore disposal site with the Lockheed intertidal disposal site would consist of constructing the Lockheed site such that it abuts the east side of the PSR disposal site and the utilization of the east side of the PSR berm for confinement. Two nearshore disposal site configurations were retained as CND facility options with capacities of 350,000 cubic yards to 480,000 cubic yards.

The CND facility berm could consist of riprap with sand infill to act as a barrier to sediment migration through any gaps in the riprap. Dredge water from inside the disposal area could be released through a notch in the top of the berm. Modified elutriate tests (METs) were performed to predict the effluent quality from nearshore dewatering operations. The test results indicate that the discharge of separable dredge water could result in exceedances of federal marine acute ambient water quality criteria (AWQC) for two LPAHs (phenanthrene and naphthalene). To protect water quality during the dewatering of dredged sediment, the separable dredge water would be detained using an oil boom and/or activated carbon filter and treated prior to discharge. Water quality sampling would be performed to ensure contaminant levels were acceptable.

To maintain slope stability, dredging of contaminated sediments would not be conducted adjacent to the riprap containment berm. Capping of the sediments adjacent to the CND would be the preferred option.

For cost estimation purposes, it was assumed that vortex hydraulic dredging would be used to minimize solids resuspension, and the hydraulically dredged solids would be pumped via floating pipeline. The area within the berm would be filled with contaminated sediment to an elevation of approximately 10 feet MLLW to ensure that the sediments remain saturated. The remaining three to five feet would be filled with clean material to serve as a cap.

To incorporate habitat into the PSR nearshore disposal facility design, the outer perimeter of the berm should be covered with fine substrate conducive to benthic habitat. This would create a 5-acre intertidal area extending outward from the top of the berm to a distance of approximately 150 feet at a 3:1 slope. It would range in elevation from -35 feet MLLW to 15 feet MLLW.

Confined Aquatic Disposal

A CAD facility would consist of consolidating the contaminated dredged sediment on a minimally sloping section of Elliott Bay and covering it with clean sand. Potential CAD sites were identified based on several criteria, including proximity to PSR, physical dimensions of the site, neighboring activities, and ecological importance of the site. Specifically, only sites located in Elliott Bay were considered. In addition, sites had to be located at depths between -80 and -200 feet MLLW and have a slope of 6 percent or less. The final consideration was that the site could not be located in high-value aquatic habitat areas or designated mitigation areas. Based on these criteria, two potential CAD sites were identified.

CAD Site 1 is located approximately 0.5 miles northeast of the PSR upland site and lies adjacent the PSDDA disposal site boundary. CAD Site 2 is located in the northwest portion of Elliott Bay near Terminal 91 and the Elliott Bay Marina. This site is approximately 3 miles north-northeast of the PSR upland site.

To minimize water quality impacts at the CAD disposal site, contaminated sediments should have high density for faster settling and less spreading upon placement into the CAD. Therefore, to implement the CAD disposal option, it would be necessary to dredge Marine Sediments Unit sediments with a closed clamshell dredge to maintain greater than 60 percent of the *in situ* sediment density. (Note: descriptions and evaluations of alternatives assume the use of a vortex hydraulic dredge).

The native sediments in the area of the CAD sites would be dredged to form a depression in which to place the contaminated sediment. This depression, in conjunction with capping, would confine the contaminated sediment. The clean dredged material could be temporarily placed adjacent to the selected CAD site for capping material. Alternately, a berm could be constructed and the dredged sediment placed within this bermed area. The estimated capacity of each site assumes the site is dredged 15 feet deep with side slopes of 10H: 1V.

The volume of clean material required to cap the CAD site was determined using a target thickness of 6 feet (5 feet plus 20 percent material loss) to ensure a 3-foot minimum thickness was achieved over the dredged material. The capping material should be composed primarily of sand to minimize material losses of finer-grained materials.

Upland Disposal

Upland disposal consist of dewatering sediment and disposing of the dewatered sediment in an existing landfill or a newly constructed upland facility. Based on the maximum concentration of contaminants reported in the RI, it is assumed that the sediments would not be considered a Dangerous Waste as defined in Washington State Regulation, and could be disposed of as a solid waste. In addition, pursuant to RCRA (40 CFR Part 261.4(g)), because this dredged material will be subject to the requirements of Section 404 of the Clean Water Act, this material is not a RCRA hazardous waste.

Twelve areas were recommended by the Corps as potential sites for the construction of new upland disposal facility. These sites were evaluated based on current land use and site characteristics. Ten sites were eliminated from further consideration based on current land use (i.e., golf course, park, or watershed buffer zone). Of the two remaining sites, the first is owned by the City of Kent and consists of approximately 152 acres zoned for industrial use. This undeveloped property is located south of South 212th Street and east of the Green River. The eastern portion of the site (approximately 30 acres) is located within the 100-year floodplain. The site is flat and the depth to groundwater is approximately 10 to 15 feet bgs. This site is located approximately 18 miles (via Interstate 5) from PSR. The second site is owned by the City of Renton and consists of approximately 73 acres zoned for industrial use. This undeveloped property is located south of Southwest 27th Street, and east and west of Long Acres Parkway, within 0.5 mile (east) of the Green River. The site is flat and the depth to groundwater is approximately 10 to 15 feet bgs. This site is located approximately 16 miles from PSR via Interstate 5 and SR-405.

For the remedial alternatives it is assumed that vortex hydraulic dredging would be used to remove the contaminated sediments from the Marine Sediments Unit. The hydraulically dredged sediments would be transported to a dewatering system consisting of two 2-to 3-acre dewatering cells (site is currently undetermined, but would need to be in close proximity). After dewatering, the sediments would be transported to the upland disposal site via trucks (rail access is not available for either of the two potential disposal sites).

Construction of a lined landfill would be needed to contain the dredged sediments. Washington State Code requires at least 10 feet between the bottom of a landfill and the seasonal high water elevation; therefore, the landfill would need to be constructed above the ground surface. Assuming the dredged material was placed with a 10-foot average fill thickness, a minimum of 35 acres would be needed to contain 480,000 cubic yards (Alternatives 2 and 4a), and a minimum of 25 acres would be needed to contain the 315,000 cubic yards (Alternative 4b) of dredged material. Due to shallow groundwater at the potential disposal sites, sufficient capping material may not be available from landfill construction. Capping material would need to be imported or obtained from other portions of these sites not used for the landfill.

Alternatively, an established landfill could be used. Sediment dewatering could be performed using dewatering cells near the point of dredging (as suggested above). The sediment may also require stabilization to ensure no free water was present prior to transport, potentially necessitating the addition of 10 to 50 percent stabilizing agent by volume. Alternatively, sediment could be pumped to intermodal containers (if rail cars are to be used for transport) and dewatered in place using a vacuum system. The dewatered sediment could be loaded into trucks or transported by rail to an appropriate existing landfill.

9.2.4 Description of the Alternatives

Each candidate alternative represents a combination of the major elements described above. This section presents summarized alternative descriptions. Detailed descriptions are presented in the Marine Sediments Unit FS; however, several modifications have been made to the alternatives since the FS report. These changes include: 1) capping the nearshore areas with 5 feet of material, rather than 3 feet of material, to preserve tribal fishing rights, 2) disposing of sediment dredged at the CMS Terminal in an existing upland disposal facility, rather than placing it off-shore under a cap, and 3) implementing mitigation actions with nearshore sediment disposal. Therefore, alternative costs and capping material volumes presented herein differ slightly from those provided in the FS.

Alternative 1 - No Action

The No Action alternative represents a baseline against which the effectiveness of other sediment remedial alternatives can be compared. Under the No Action alternative, no removal or isolation of the contaminated sediment would occur, and no engineering or administrative controls would be implemented to prevent exposure of contaminants to human or ecological receptors. Potential impacts of the No Action alternative include the following:

- Continued potential for human health effects associated with consumption of contaminated fish and shellfish
- Continued bioaccumulation of chemicals of concern in the aquatic food chain
- Continued low- to moderate-level impacts to the benthic communities (reducing the value of contaminated areas as habitat for fishery resources)
- Continued loss of contaminants to the water column (i.e., via dissolution)
- Continued acute and chronic toxicity to marine organisms associated with Marine Sediments Unit sediment
- Potential off-site transport of contaminated sediments to other areas within Elliott Bay

Under the No Action alternative, the human health risks associated with site-related contaminants would remain at their current level of approximately 5 in 10,000 with a non-cancer Hazard Index of 4.

Alternative 2 - Removal to the CSL

Alternative 2 consists of dredging the majority of sediments from the Marine Sediments Unit that exceed CSL criteria, disposing of the dredged sediment in a nearshore disposal site, and capping isolated areas for which dredging is not a feasible alternative due to concerns regarding slope stability, recontamination, or dredging impracticability. Dredging and disposal of all sediment that exceeds SQS criteria was not considered for detailed evaluation under this alternative for several reasons. First, it would be technically very difficult, as removal would be required beyond the practical depth limitations for dredging of 200 feet. Second, no local disposal sites were identified that could accommodate 970,000 cubic yards of dredge material, thereby limiting sediment disposal options. Finally, it was determined that other, less-expensive technologies (e.g., capping) could provide the same level of protectiveness at a cost substantially less than the $60 million estimated for nearshore disposal of sediment dredged to the SQS.

Dredging of sediment exceeding CSL criteria would be conducted from the nearshore area to a maximum depth of -200 feet MLLW (the assumed practical limits for dredging). Approximately 33 acres of the Marine Sediments Unit would be dredged to depths ranging from approximately 4 to 16 feet below mudline, resulting in the removal of approximately 372,000 cubic yards of sediment. Dredged sediments would be transported directly to a CND site. Assuming a 15 percent bulking factor, the disposal facility would require a storage capacity of approximately 428,000 cubic yards. If a CND site is not feasible, the dredged sediment would be disposed in a CAD facility or dewatered and placed in a newly constructed upland disposal facility.

Under this alternative, capping would also be conducted in three areas: along the shoreline, within the intermediate groundwater discharge zone west of the Main Slip, and in offshore areas with CSL exceedances that are at depths greater than -200 feet MLLW. Sediment in these areas would be isolated by 3-foot caps (excluding intertidal areas which are covered with a 5-foot cap) requiring a total volume of approximately 115,000 cubic yards of clean sediment and covering a total estimated area of 14.3 acres. This alternative requires an implementation period of approximately 2.7 years, depending upon the availability of capping material.

Under this alternative, the residual human health risks associated with site-related contaminants left in place would be approximately 1 in 10,000. The resulting non-cancer Hazard Index associated with the site would be less than 1.0.

The total cost of this alternative is approximately $22,388,000 using the nearshore disposal option, $13,714,000 using the CAD disposal option, and $25,270,000 using a newly constructed upland disposal facility option. The following cost table summarizes the dredging costs (see Table 26 for cost estimation assumptions):

Capitol Cost	Annual O&M	Total Present Worth
$4,806,000	$79,860	$6,010,000

The estimated cost of Alternative 2 is as follows:

Total Present Worth:	6,010,000
+ CND Disposal:	11,128,000
+ Mitigation:	5,250,000
= Total Cost:	**$22,388,000**

Alternative 3a – Capping to SQS

Alternative 3a consists of capping all sediments that exceed the SQS except where capping would interfere with navigation at the CMS terminal. In this area, limited dredging would be performed prior to capping. Approximately 3,500 cubic yards of sediment would be dredged from this area (to a depth of approximately 3 feet below mudline), dewatered and placed in an existing upland disposal facility.

Placement of a 3-foot cap over all sediments contaminated with PAHs at concentrations greater than SQS criteria and placement of 5 feet of material in the intertidal areas would require a total of approximately 786,000 cubic yards of sediment, isolating an estimated 96 acres of offshore, shoreline, and groundwater discharge zone contaminated sediments. Based on the limited annual availability of capping material, the cap would be constructed in stages over a five-year span.

Residual human health risks associated with site-related contaminants would be approximately 3 in 100,000. The resulting non-cancer Hazard Index associated with the site would be less than 1.

The total cost of this alternative is approximately $13,139,000, including the costs for the disposal of dredged sediment in an existing upland facility. The following table summarizes the capping costs (see Table 27 for cost estimation assumptions):

Capitol Cost	Annual O&M	Total Present Worth
$9,613,000	$191,400	$12,520,000

The estimated cost of Alternative 3a is as follows:

Total Present Worth:	12,520,000
+ Existing Upland Disposal:	619,000
+ Mitigation:	N/A
= Total Cost:	**$13,139,000**

Alternative 3b – Capping to CSL

Alternative 3b consists of capping all sediment that exceeds the CSL -based cleanup goals for PAHs and those nearshore areas (less than -10 feet MLLW) that exceed the SQS for PCBs. In addition, the shoreline area will be capped with five feet of material. Like Alternative 3a, limited dredging would be performed prior to capping at the CMS terminal and the dredged sediment would be dewatered and placed in an existing upland disposal facility.

Placement of a 3-foot cap over all sediments contaminated with PAHs at concentrations greater than CSL criteria, and placement of 5 feet of material in the intertidal areas would require a total of approximately 371,000 cubic yards of sediment, isolating an estimated 47 acres of offshore, nearshore, and groundwater discharge zone contaminated sediments. As with Alternative 3b, capping would be conducted in stages over an approximate 4-year span based on the availability of Puget Sound maintenance dredge material.

Residual human health risks associated with site-related contaminants after capping to CSLs would be approximately 4 in 100,000. The resulting non-cancer Hazard Index associated with the site would be less than 1.

The total cost of this alternative is approximately $7,059,000, including the costs for the disposal of dredged sediment in an existing upland facility. The following table summarizes capping costs (see Table 28 for cost estimation assumptions):

Capitol Cost	Annual O&M	Total Present Worth
$4,930,000	$105,285	$6,440,000

The estimated cost of Alternative 3b is as follows:

Total Present Worth:	6,440,000
+ Existing Upland Disposal:	619,000
+ Mitigation:	N/A
= Total Cost:	**$7,059,000**

Alternative 4a – Fill Area Removal to SQS and Capping

Alternative 4a consists of dredging the fill area to depths that achieve SQS criteria (thereby removing 96 percent of the mass of contaminants exceeding SQS criteria) and capping all remaining sediment (outside of the fill area) that exceeds these criteria. In addition, similar to Alternatives 2, 3a and 3b, limited dredging would be performed at the CMS terminal prior to capping.

A total of approximately 381,500 cubic yards of material would be dredged from the 24-acre Fill Area, the 4-acre groundwater discharge zone, and the 4-acre CMS Terminal area.

Sediment removed from the CMS Terminal would be placed outward of the CMS where capping would occur in conjunction with the rest of the Marine Sediments Unit. The remaining dredged sediments would require disposal in a facility with a storage capacity of approximately 439,000 cubic yards (assuming a 15 percent bulking factor). Dredged sediments would be transported directly to a CND site: If a CND site is not feasible, the dredged sediment would be disposed in a CAD facility or dewatered and placed in a newly constructed upland disposal facility. This decision would be made during remedial design.

A 3-foot cap would be placed over the remaining 70 acres of sediment exceeding SQS chemical criteria, extending from near the shoreline to a depth of approximately -240 feet MLLW. Approximately 577,000 cubic yards of capping material would be required to ensure adequate containment. An additional 8,000 cubic yards of sediment would be required to establish a 5-foot cap over the intertidal areas. As with Alternatives 3a and 3b, capping would be done in stages over an approximate 5-year span based on the availability of clean, Puget Sound maintenance dredge material.

For fill removal and capping to SQS, the residual human health risks associated with the remediated site would be approximately 7 in 100,000. The resulting non-cancer Hazard Index associated with the site would be less than 1.

The total cost of this alternative is approximately $29,094,000 using the nearshore disposal option, $20,332,000 using the CAD disposal option, and $32,185,000 using a newly constructed upland disposal facility option. The following cost table summarizes the dredging and capping costs (see Table 30 for cost estimation assumptions):

Capitol Cost	Annual O&M	Total Present Worth
$10,024,000	$159,200	$12,430,000

The estimated cost of Alternative 4a is as follows:

Total Present Worth:	12,430,000
+CND Disposal:	11,414,000
+ Mitigation:	5,250,000
= Total Cost:	**$29,094,000**

Alternative 4b – Fill Area Removal to CSL and Capping

Alternative 4b consists of dredging the fill area to depths that achieve CSL criteria (thereby removing 98 percent of the mass of contaminants exceeding CSL criteria) and capping all remaining sediment (outside of the fill area) that exceeds these criteria. As with Alternative 4a, limited dredging would also be performed in the groundwater discharge zone and at the CMS terminal prior to capping.

A total of approximately 273,500 cubic yards of material would be dredged from the fill area and the CMS terminal area. Dredged sediments would be transported directly to a confined nearshore disposal (CND) site. If a CND site is not feasible, the dredged sediment would be disposed in a CAD facility or dewatered and placed in a newly constructed upland disposal facility. This decision would be made during remedial design.

A 3-foot cap would be placed over the approximately 24 acres of sediment exceeding CSL chemical criteria, requiring approximately 154,000 cubic yards of capping material. An additional 8,000 cubic yards of sediment would be required to establish a 5-foot cap over the intertidal areas. As with Alternatives 3a and 3b, capping would be done in stages over an approximate 3-year span based on the availability of clean, Puget Sound maintenance dredge material.

For fill area removal and capping to CSLs, the residual human health risks associated with the remediated site would be approximately in 2 in 10,000. The resulting non-cancer Hazard Index associated with the site would be 4.

The total cost of this alternative is approximately $18,040,000 using the nearshore disposal option, $11,170,000 using the CAD disposal option, and $19,675,000 using a newly constructed upland disposal facility option. The following cost table summarizes the dredging and capping costs (see Table 31 for cost estimation assumptions):

Capitol Cost	Annual O&M	Total Present Worth
$4,585,000	$60,870	$5,500,000

The estimated cost of Alternative 4b is as follows:

Total Present Worth:	5,500,000
+ CND Disposal:	8,190,000
+ Mitigation:	4,350,000
= Total Cost:	**$18,040,000**

10. COMPARATIVE ANALYSIS OF ALTERNATIVES

This analysis addresses the Marine Sediments Unit alternatives.

10.1 Overall Protection of Human Health and the Environment

This criterion evaluates whether an alternative achieves and maintains adequate protection of human health and the environment. All of the alternatives except the “No Action” alternative would provide adequate protection by eliminating, reducing, or controlling risk through removal or containment, or a combination of the two. The relative degree of protectiveness has been determined by how clean the remaining surface sediment will be following cleanup. The assumption that lower contaminant concentrations result in higher sediment quality was used to rank the alternatives for overall protection. The lowest degree of remaining surficial sediment contamination would be achieved through capping because clean sediment would be used. While dredging would remove any sediment that exceeded the cleanup goal, it would not remove all contaminated sediment down to the "native" or background level (i.e., the remaining sediment would not be as clean as what would be brought in for capping). The highest degree of protectiveness is provided by capping the contaminated sediment with clean sediment.

10.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

This criterion evaluates how each alternative complies with Federal and State statutes and regulations that pertain to the site. All alternatives, with the exception of the "No Action" alternative, comply with ARARs.

10.3 Long-Term Effectiveness and Permanence

This criterion evaluates the ability of an alternative to maintain Protection of human health and the environment over time. Long-term effectiveness factors in the reliability of the remediation alternative and the degree of monitoring and maintenance that will be required. While all remediation alternatives, except the "No Action" alternative, provide long-term effectiveness and permanence (assuming current conditions), removing contaminated sediment and consolidating it in a disposal facility is more reliable than capping in place because removal and placement results in a smaller and more controlled area of contaminated sediment. In addition, an engineered disposal facility (specifically a nearshore fill or upland disposal site) is easier to inspect, monitor and maintain than a larger capped area in the aquatic environment. Alternatives with comparatively more dredging than capping rate higher under this criterion.

10.4 Reduction in Toxicity, Mobility and Volume Through Treatment

This criterion evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present. None of the alternatives reduce toxicity, mobility or volume through treatment. Treatment was evaluated for sediment cleanup, however was screened out of further consideration for the following reasons: 1) there are currently no effective *in situ* treatments (i.e., treating in place) for sediments covering a large area or subjected to significant flushing, and 2) any *ex situ* treatment would require significant material handling (excavation, de-watering, transport, and processing) and extreme cost (estimated at $40 million excluding material handling).

10.5 Short-term Effectiveness

This criterion evaluates the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation. Short-term environmental impacts include water quality impacts, biota exposure and habitat loss (i.e., fisheries impacts) during the implementation of the remedial alternative. Dredging alternatives would result in 1) greater water quality and fisheries impacts due to the disturbing and suspending of contaminated sediment, 2) greater worker exposure to contaminants due to the comparatively greater contaminated material handling, and 3) a slightly greater potential for worker injury resulting from the use of dredging machinery (more mechanically complex than capping equipment). Capping alternatives that would result in short-term loss of aquatic habitat due to covering the existing benthic community. Capping may also suspend contaminated sediment. It is important to note that much of the short-term risk associated with both dredging and capping can be significantly reduced by carefully choosing methodology and monitoring techniques. The duration of these short-term effects is generally proportional to an alternative's implementation period, including disruption of fisheries activities or other water-dependent uses. Capping generally has greater short-term effectiveness than dredging because it can be implemented more quickly. Alternative 3b for example, which is primarily capping, has an in-water implementation period of 11 months Alternative 4b, which combines more dredging with capping has an in-water implementation period of 15 months. And, Alternative 2, which is primarily dredging has an in-water implementation period of 14 months. The time required to site and build a disposal facility to accommodate the larger volumes of dredge material is not included in the in-water estimates.

10.6 Implementability

This criterion evaluates the technical and administrative feasibility of implementing the alternative. Implementability includes the ease of construction, the availability and capacity of materials and/or facilities, and logistical and/or administrative practicability. Ease of construction is similar for dredging and capping. There are uncertainties associated with both technologies (i.e., for capping; material placement difficulties on slopes and at depth, and for dredging; material control concerns regarding dewatering and resuspension). Capping requires a volume of material that won't be available immediately and will require several years of maintenance dredging to procure. Similarly, dredging requires that a disposal facility be sited, which is a time-consuming and politically very difficult process. Placement of a cap would require moorage restrictions to ensure that anchors do not harm the cap and expose/distribute contaminated sediment. Due to the historically extreme difficulty in siting a disposal facility, the capping alternatives have an ultimately higher degree of implementability than dredging alternatives.

10.7 Cost

This criterion includes estimated capital and operation and maintenance costs as well as present worth costs. Cost estimates are expected to be accurate within a range of +50 to -30 percent. Current estimates indicate that capping is the least costly alternative, and dredging with its associated disposal costs is the most costly. See Table 25 for a summary of all the alternative's costs.

10.8 State Acceptance

This criterion evaluates whether the State of Washington agrees with the US. EPA's analyses and recommendations of the RI/FS and the Proposed Plan. The Washington State Department of Ecology concurs with EPA's Selected Remedy.

10.9 Community Acceptance

This criterion evaluates whether the local community agrees with U.S. EPA's analyses and preferred alternative. One phone call was received regarding the Proposed Plan for the PSR site. The caller left a message in support of the Preferred Alternative (and now the Selected Remedy). Many comments were received from State and Federal departments and agencies. Those conunent and EPA's responses are included as Part 3, the Responsiveness Summary of this ROD.

11. SELECTED REMEDY

The Selected Remedy for the PSR site addresses both the Upland Unit and Marine Sediments Unit.

11.1 Upland Unit

Early cleanup actions were cbmpleted to address threats posed by contaminated soil and groundwater and shallow NAPL in the Upland Unit. Included in these actions were the installation of a subsurface containment wall and placement of a low-permeability surface cap over the Upland Unit. The early actions for soils and groundwater removed the most contaminated source material, eliminated direct contact with soils, eliminated soil transport to Elliott Bay, eliminated leaching of surface soil contaminants to groundwater, minimized potential future direct contact with subsurface soils, eliminated LNAPL discharges to Elliott Bay, minimized discharge of contaminated groundwater and DNAPL to Elliott Bay and significantly reduced the influence of tidal fluctuations at the site. The risk posed by exposure to contaminated soil has been eliminated, and groundwater meets cleanup requirements under the NCP and threshold requirements for cleanup actions under MTCA without implementation of additional engineered remedial measures. What was implemented as early action is final action for the Upland Unit. The Selected Remedy for the Upland Unit is:

- Inspection and Maintenance (I&M) of the surface cap; on both the Port of Seattle's intermodal yard working surface and the public access area. These actions will be in accordance with the I&M plans established during the early actions and contained in the Administrative Record.

- Monitoring groundwater contaminant concentrations and DNAPL volume trends. Alternate concentration limits have been established for PSR groundwater. These limits apply at the shoreline monitoring wells (see Table 20 for list of PSR ACLs). Groundwater will not impact Elliott Bay waters or sediment as long as these limits are met. EPA will evaluate additional remedial measures if groundwater monitoring trend analysis indicates these limits are being or will be exceeded. In addition, NAPL will continue to be collected from on-site wells and disposed of in accordance with the RCRA Land Disposal Restriction treatment standards (i.e., incineration). A groundwater monitoring plan will be created and available for review prior to implementation. The estimated costs for Upland groundwater monitoring and NAPL collection are listed in Table 32.

- Institutional Controls for prohibiting groundwater use and restricting land use. The early actions will remain protective as long as the I&M plans are implemented and land and groundwater use are unchanged. Current land use is industrial with some controlled public access, and groundwater is not used at all. Record notification of these restrictions will be recorded against the property deed, and restrictive covenants ensuring conforming use will be required of any subsequent purchasers. The State has declared the groundwater to be non-potable; no drinking water wells will be permitted.

11.2 Marine Sediments Unit

The Selected Remedy for the Marine Sediments Unit is:

- Confinement (through capping) of contaminated marine sediments that exceed the CSL for PAHs or the SQS for PCBs (criteria are listed in Table 5). The SQS for PCB will be used to trigger cleanup for sediment at depths equal to or shallower than -10 feet MLLW. The capped area will encompass approximately 50 acres of contaminated sediment. The cap will physically isolate the contaminated marine sediment from the biological receptors (i.e., the benthic community, fish and humans), stabilize the sediment within the capped area to the extent practicable, and ensure that contaminant migration through the cap is effectively eliminated.

- The thickness of the cap will be determined through design studies (see following design discussion), however no less than 5 feet of clean material will be placed over the intertidal area.

- Dredging of approximately 3,500 cubic yards of contaminated sediment from the area to the north of Crowley Marine Services. The purpose of dredging this material is to maintain current navigational depths and access to Crowley Marine Services. The dredged material will be disposed of in an established upland solid waste landfill.

- Unused pilings throughout the Marine Sediments Unit will be removed prior to capping. The pilings will be cut at the mudline and clean cap material placed over the portion remaining in the sediment.

- The clean capping material used will be at least as clean or cleaner than the SQS and will be obtained from routine maintenance dredge projects in local rivers. In addition, capping material will be selected and placed in such a way as to provide appropriate habitat for the marine organisms natural to this area.

- Cap placement techniques will be determined during design (see following design discussion).

- The entire capped area will be designated as a “no-anchor” zone. The no-anchor designation will apply to commercial vessels using the large “whale-tail” type anchors that have the capacity to break through the cap and expose contaminated sediment. This institutional control will be implemented through Federal rule-making by the U.S. Coast Guard and the Corps in consultation with the State Department of Natural Resources. The rule-making will be subject to public comment. MTCA Institutional Controls requirements will be met.

- Both a short- and long-term monitoring or management plan will be developed to ensure that the cap is placed as intended and is performing the basic confinement functions. Specific monitoring requirements will be included to address the intermediate groundwater discharge zone. The durations of the specific monitoring requirements will be addressed in the monitoring plan. In addition, this plan will address the monitoring approach to be implemented following any unusually significant seismic or storm event in the Elliott Bay area. The monitoring/management plan will also address data management, and contingency plans in the event the cap is not meeting the remedial objectives. These monitoring plans will be available for Natural Resource Agency's review prior to implementation.

11.3 Issues to be Addressed During the Design Phase of the Selected Remedy

As discussed above, several elements of the remedy will be evaluated during design:

- Cap thickness will be designed to physically isolate, stabilize and chemically isolate the contaminated marine sediments. This will be completed in accordance with the *Guidance for In Situ Subaqueous Capping of Contaminated Sediments* (EPA 905-B96-004). In addition, a determination will be made regarding whether additional engineered features are necessary to maintain the thicker cap in the nearshore area. If it is determined to be necessary, the remedial design will include these features.

- Cap placement techniques will be evaluated (and pilot test(s) conducted) to determine an optimized construction procedure (i.e., most efficient and least environmentally impacting) for placing clean material over the contaminated marine sediment to achieve the basic functions. The optimized construction procedure will take into account the geotechnical properties of both the *in situ* sediment and capping material, as well as the bathymetric configuration of the contaminated sediment (i.e., slope).

Figure 11 depicts the proposed marine sediments capping area, and capping cost estimation details are listed in tables 28 and 29.

The Total Present Worth Cost of the Selected Remedy is $7,600,000.00. (This cost includes upland monitoring and marine capping. It does not include Upland I&M because those costs are anticipated to be borne by the Port of Seattle as part of their ongoing operation of the intermodal facility.)

The Selected Remedy will meet environmental and human heath protection goals through controlled containment (i.e., capping) while leaving contamination in place. The decision to cap contaminated marine sediment is based in significant part on a cap's ability to meet the remedial action objectives at a lower cost than dredging and disposal alternatives. While capping will raise short-term water quality concerns, the potential for impacts is much lower than for alternatives that involve dredging large volumes of contaminated material. Another significant factor against dredging large volumes of contaminated material is the historically extremely controversial and time-consuming process of siting an aquatic or nearshore disposal facility. The selected alternative does include dredging a small volume of contaminated sediment in order to maintain navigation, however this material can be disposed of in an established upland solid waste landfill. While the volume of material necessary to cap the contaminated sediment in the Marine Sediments Unit will not be available to allow the action to be completed in one season, this is less of a detriment than it might seem. Working with smaller portions of capping material over time will allow for trials of various placement techniques including an evaluation of comparative capping efficacy and durability.

11.4 Estimated Outcomes of the Selected Remedy

The Selected Remedy will greatly reduce the environmental impacts associated with the current sediment contamination because the material used for capping will have contaminant concentrations equivalent to or lower than background Elliott Bay concentrations. Human health risk will be reduced by an order of magnitude. This alternative has relatively minimal impacts to fisheries and other water-dependant industries because it can be completed without extended periods of in water work, and without reduction of the fishery area. The implementation period for this alternative is nearly 4 years due to limited capping material available each year, however the short-term impacts are minimal and do not persist through the entire period (i.e., only during intermittent capping phases).

12. STATUTORY DETERMINATIONS

Based on information currently available, EPA and Ecology believe the Selected Remedy provides the best balance of tradeoffs among the alternatives with respect to the evaluation criteria. The EPA expects the Preferred Alternative to satisfy the statutory requirement in CERCLA section 121 (b) to: 1) be protective of human health and the environment; 2) comply with ARARs; 3) be cost-effective; 4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and 5) satisfy the preference for treatment as a principal element.

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements, are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility or hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

12.1 Protection of Human Health and the Environment:

The Selected Remedy will be protective of human health and the environment. Implementation of the I&M plans, monitoring plans and institutional controls for the Upland Unit will ensure that the protection provided by the early actions is maintained. Placement of clean cap material over the contaminated sediments will isolate the contaminants from the environment. The benthic community will have clean substrate to colonize, and fish and shellfish (the route to human exposure) will no longer be subjected to contaminated sediment in the area of the cap. In addition, bottom fish and anadromous fish will benefit from improved habitat in the nearshore area. Human health risk will be reduced by an order of magnitude (from 4.5E-04 to 4.2E-05 for the reasonable maximally exposed individual). The background risk calculated for Elliott Bay is 2.9E-05, so the Selected Remedy will reduce the risk associated with the site to essentially urban background levels. Implementation of this remedy may create some short-term risk to the environment through resuspension of contaminated sediment, however design studies as well as practice with various placement techniques will be utilized to minimize any short term impacts.

12.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

The Selected Remedy will comply with all applicable or relevant and appropriate requirements as follows:

12.2.1 Upland Unit ARARs

State Model Toxics Control Act

(WAC 173-340-720(l)(C))	This is applicable to establishing cleanup levels for groundwater.
(WAC 173-340-440)	This is applicable to establishing institutional controls.
(WAC 173-340-730(3))	This is applicable to establishing cleanup standards for surface water. (These standards are currently being met.)
(WAC 173-340-360(4),(6))	This is applicable to cleanup technologies and restoration timeframes.
(WAC 173-340-704 -706)	This is applicable to the use of Method A, B, and C.

12.2.2 Marine Sediments Unit ARARs

State Model Toxics Control Act

(WAC 173-340-440)	This is applicable to establishing institutional controls.

Federal Water Pollution Control Act/Clean Water Act (33 USC 1251-1376; 40 CFR 100-149)

Acute marine criteria are anticipated to be relevant and appropriate requirements for discharge to marine surface water during cap placement and sediment dredging.

Washington State Water Quality Standards for Surface Waters (WAC 173-201A)

Standards for the protection of surface water quality have been established in Washington state. The standards for marine waters will be applicable to discharges to surface water during cap placement and sediment dredging.

Washington Sediment Management Standards (WAC 173-204)

Chemical concentration and biological effects criteria are established for Puget Sound sediment and are applicable to PSR sediment cleanup. Sediment cleanup standards are established on a site-specific basis from a range of concentrations.

State Water Pollution Control Act (RCW 90.48)/Water Resources Act (RCW 90.54)

Requirements for the use of all known, available and reasonable technologies for treating wastewater prior to discharge to state waters are applicable to any dewatering of marine sediment prior to upland disposal. Section 401 requires certification for activities conducted under 404 authorities. The substantive requirements of a certification determination are applicable.

Construction in State Waters, Hydraulic Code Rules (RCW 75.20; WAC 220-110)

Hydraulic project approval and associated requirements for construction projects in state waters have been established for the protection of fish and shellfish. Substantive permit requirements are applicable to cap placement. The technical provisions and timing restrictions of the Hydraulic Code Rules are applicable to cap placement and dredging.

State Discharge Permit Program/NPDES Program (WAC 173-216, -220)

The Washington state NPDES program provides conditions for authorizing direct discharges to surface waters and specifies point source standards for such discharges. These standards are applicable to discharges to surface waters resulting from sediment dewatering operations during dredging/disposal work.

Federal Clean Water Act Dredge and Fill Requirements; Sections 401 and 404 (33 USC 401 et seq. 33 USC 1251-1316; 33 USC 1413; 40 CFR 230, 231; 33 CFR 320-330)

These regulations provide requirements for the discharge of dredged or fill material to waters of the U.S. and are applicable to any in-water work. The 404 evaluation is complete and is included in the Administrative Record for the PSR site. The Finding was that this project complies with the requirements.

Federal Endangered Species Act of 1973 (16 USC 1531 et seq., 50 CFR Part 200, 402)

This regulation is applicable to any remedial actions performed at this site as this area is potential habitat for threatened and/or endangered species.

Rivers and Harbors Appropriations Act (33 USC 403, 33 CFR 322)

Section 10 of this act establishes permit requirements for activities that may obstruct or alter a navigable waterway; activities that could impede navigation and commerce are prohibited. These substantive permit requirements are anticipated to be applicable to remedial actions, such as dredging and capping, which may affect the navigable portions of the harbor.

U.S. Fish and Wildlife Coordination Act (16 USC 661 et seq.)

Elliott Bay shorelines provide potential habitat for bald eagles and other avian species, and Marine Sediments Unit surface water is used as a salmonid migratory route. This act prohibits water pollution with any substance deleterious to fish, plant life, or bird life, and requires consultation with the U.S. Fish and Wildlife Service and appropriate state agencies. Criteria are established regarding site selection, navigational impacts, and habitat remediation. The act also requires that fill material on aquatic lands be stabilized to prevent washout. These requirements are anticipated to be relevant and appropriate for remedial activities on the site.

Resource Conservation and Recovery Act (40CFR Part 261.4(g)

This regulation is an exemption determining dredged contaminated sediments that are subject to the requirements of Section 404 of the Clean Water Act are not RCRA hazardous waste.

Shoreline Management Act (RCW 90.58, WAC 173-14); Coastal Zone Management Act (16 USC 1451 et seq., 15 CFR 923)

This statute is relevant and appropriate for capping activities in the shoreline area..

State Aquatic Lands Management Laws (RCW 79.90-79.96, WAC 332-30)

The final remedy must be consistent with state laws that promote environmental protection, public access, water dependent uses, and uses of renewable resources and that generate revenue to the state in a manner consistent with these management goals.

To Be Considered (TBCs)

TBC items are state and local ordinances, advisories, guidance documents or other requirements that, although not ARARs, may be used in determining the appropriate extent and manner of cleanup. Generally, TBC requirements are used when no federal or state requirements exist for a particular situation. A list of TBCs for PSR Marine Sediments Unit remediation is presented in Table 24.

12.3 Cost-Effectiveness

In EPA’s judgment, the Selected Remedy is cost effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness". (NCP 300.430(f)(ii)(D)). Alternative 3 provides greater protection of human health and the environment than the other alternatives that meet the same cleanup goal, at a lower cost. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence this alternative represents a reasonable value for the money to be spent.

12.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

EPA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at this site. The Selected Remedy treats the upland source materials constituting principal threats at the site, achieving reduction in NAPL volume in soil and groundwater. NAPL will be targeted for collection as a component of the on-going monitoring of this site. All NAPL collected will be incinerated. Approximately 1,500 gallons of NAPL has been collected and incinerated to date.

12.5 Preference for Treatment as a Principal Element

Treatment of contaminated sediment to reduce toxicity or mobility of contaminants is not considered feasible. As stated previously, treatment was evaluated for sediment cleanup, however was not considered further for the following reasons: 1) there are currently no effective in situ treatments (i.e., treating in place) for sediments covering a large area and subjected to significant flushing, and 2) any ex situ treatment would require significant material handling (excavation, de-watering, transport, and processing) and extreme cost (estimated at $40 million excluding material handling).

12.6 Five-Year Review Requirements

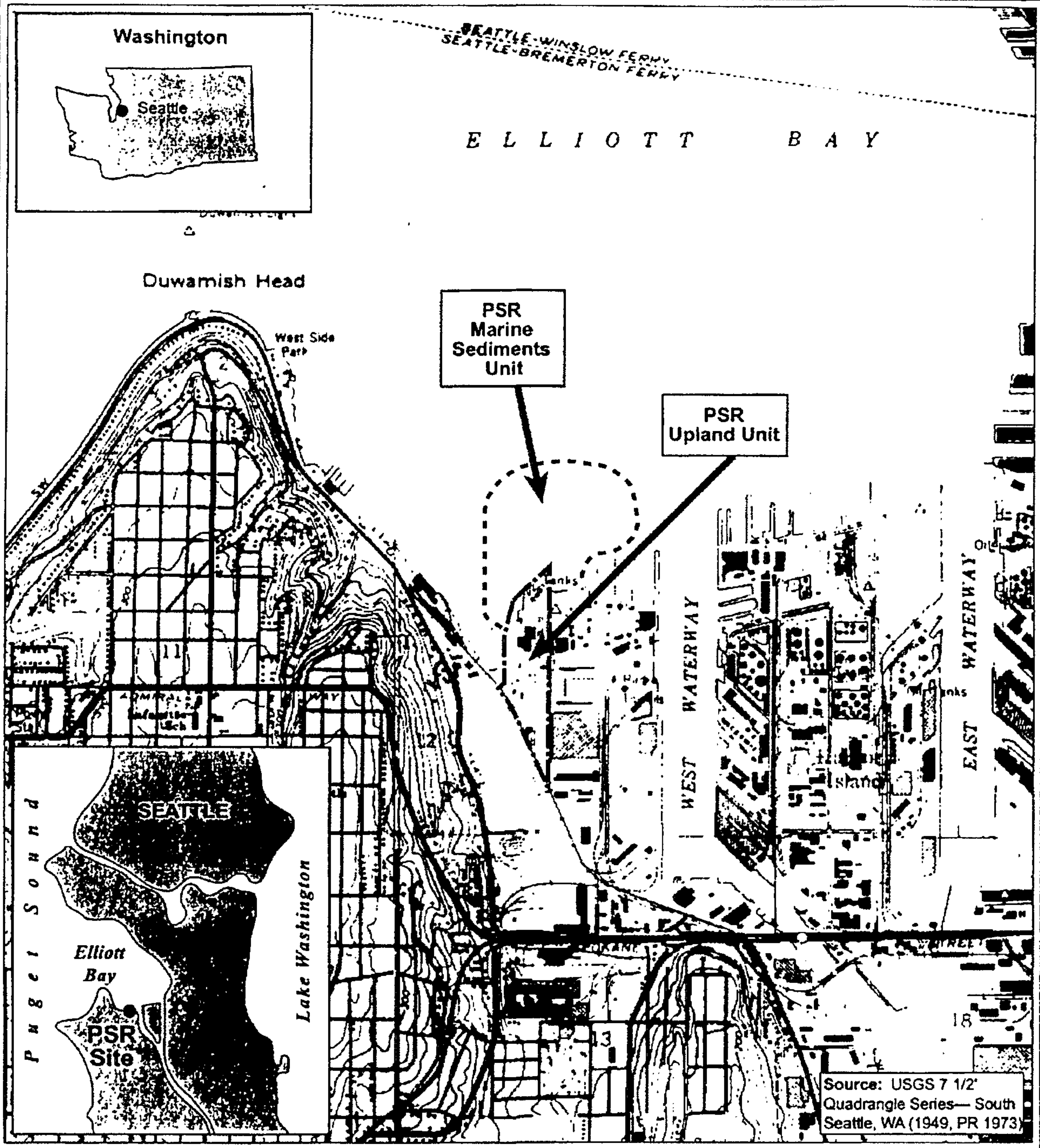
Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

12.7 Documentation of Significant Changes from Preferred Alternative of Proposed Plan

The Proposed Plan was released for public comment in April 1999. It identified Alternative 3b, placement of a marine cap, as the Preferred Alternative for sediment remediation. The Preferred Alternative specified that a small volume of material would be dredged to allow for continued navigational access to Crowley Marine Services, and the dredged material would be placed within the area to be capped, then capped with the rest of the contaminated sediment. Comment was received urging the use of an upland disposal site rather than replacement of the dredged material back into the marine environment. EPA made this change in the Selected Remedy. In addition, the Preferred Remedy as described in the Proposed Plan specified that institutional controls would be implemented in the nearshore area to restrict shellfish harvesting. The beach area that could be utilized for shellfish harvest is only available about 70 days of the year (i.e. at low tides) and access to the beach is very limited (its only accessible by boat). Public comment indicated that institutional controls of this nature would impact tribal treaty rights. EPA has revised the Selected Remedy to include placement of additional clean material in the nearshore area (no less than 5 feet) which will allow for unrestricted harvest of shellfish.

These changes could have been reasonably anticipated based on the information in the Proposed Plan. Therefore, the procedural requirement is met by discussing these changes in this ROD.

FIGURES



N

0 1000 2000

Scale in Feet

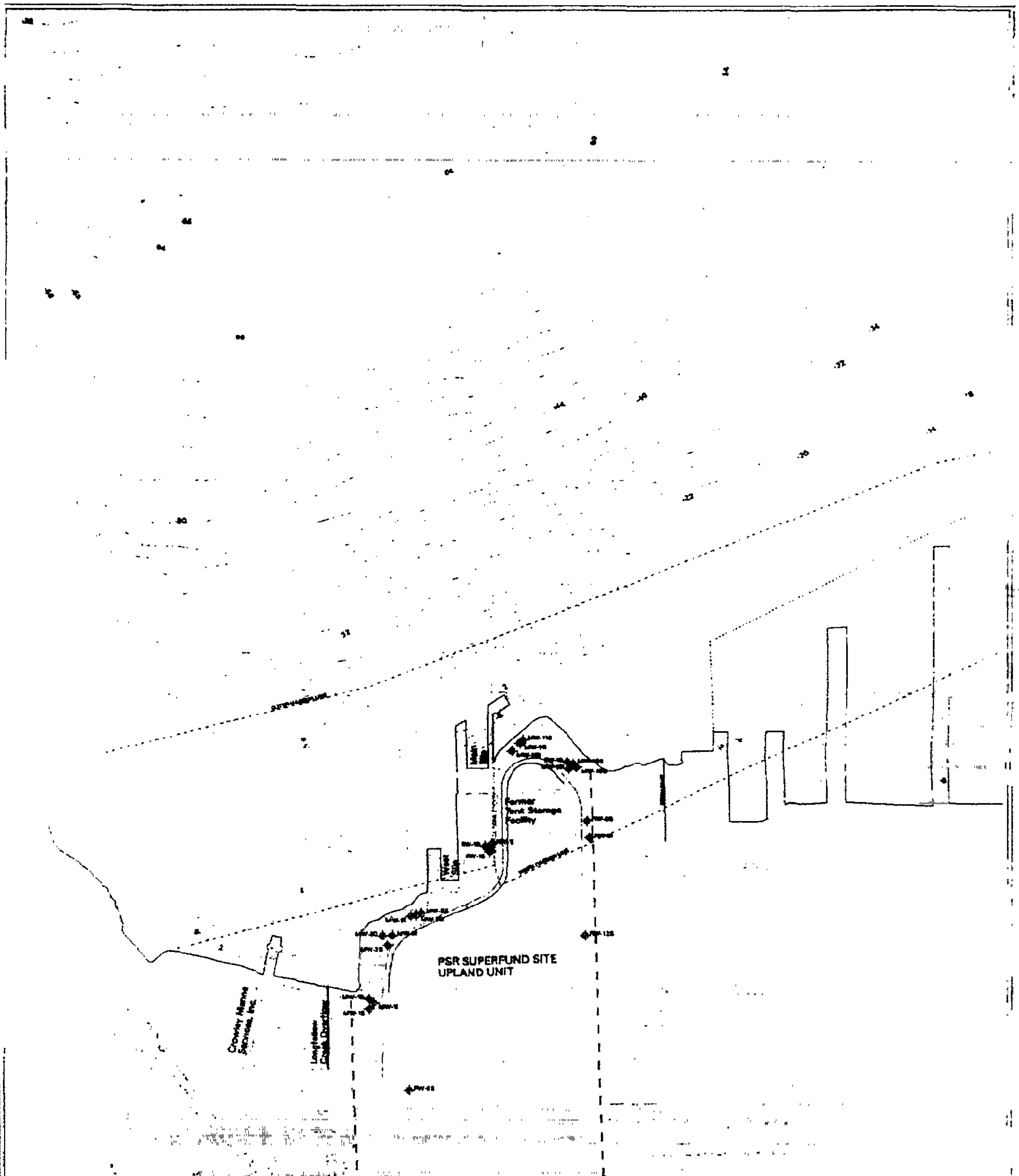
PSR Upland and Marine Sediments Unit Location Map

WESTON

Figure

1

99-0391 Fig1 fh8

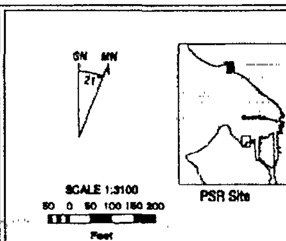


BASEMAP EXPLANATION

- Upland Feature
- Shoreline
- Upland Unit Property Boundary
- Bathymetry
- Drain
- Harbor Line
- Slurry Wall
- LNAPL Recovery Trench
- Lockheed cleanup action plan boundary

SYMBOL EXPLANATION

- Upland groundwater monitoring well
- Capped Area (See also Note 4)



NOTES

1) Vertical datum is: Meters
Mean Lower Low Water (MLLW).
2) Bathymetric data source: NOAA, 1970 & 1995.
3) Locations of slurry wall, LNAPL trench, and monitoring wells approx. (RETEC, 1996a, 1996b)
4) Areas not capped with asphalt will be covered with clean fill and landscaping.
5) Intertidal area (pocket beaches) defined by -1 m MLLW contour (not shown).

WESTON

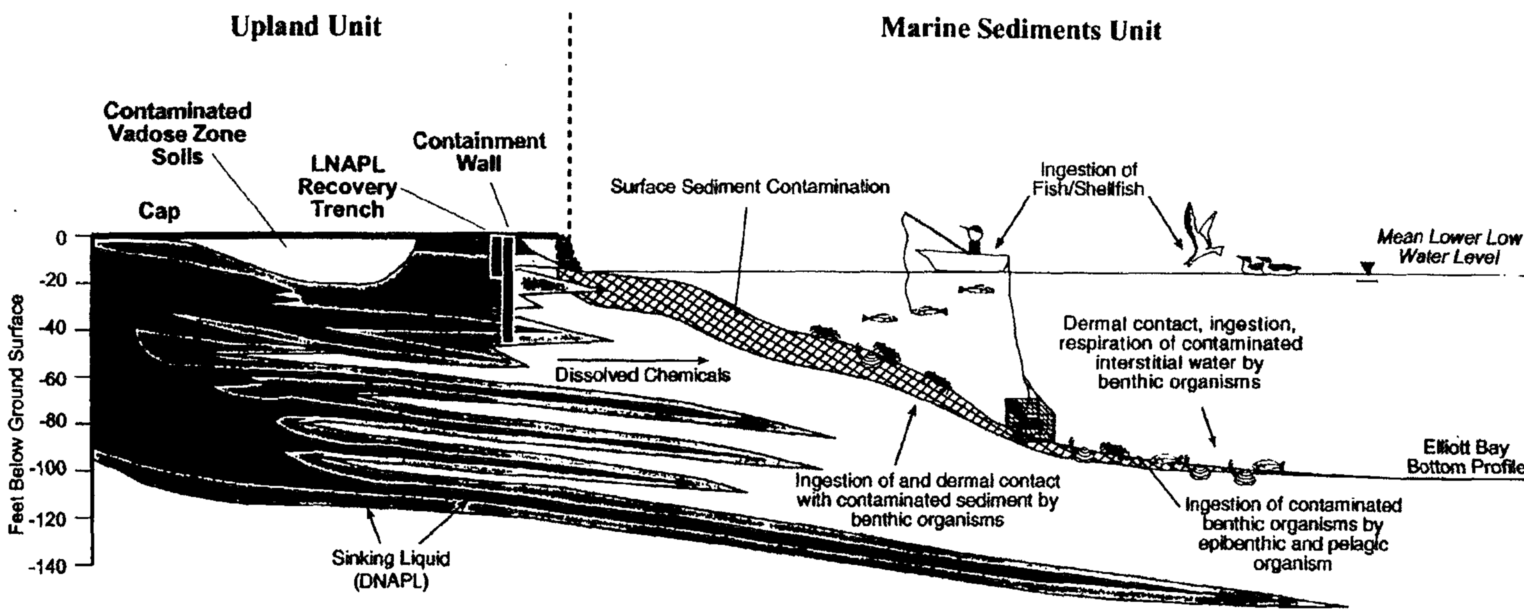
DATE: September 27, 1996 9:04 AM
JOB NUMBER: 12240-043-001-0134
VIEW FILE: basemap.view

CHECKED BY: ____________

APPROVED BY: ____________

PSR Upland and Marine Sediments Unit Site Features

Figure 2



EXPLANATION

Residual NAPL

Dissolved Phase NAPL

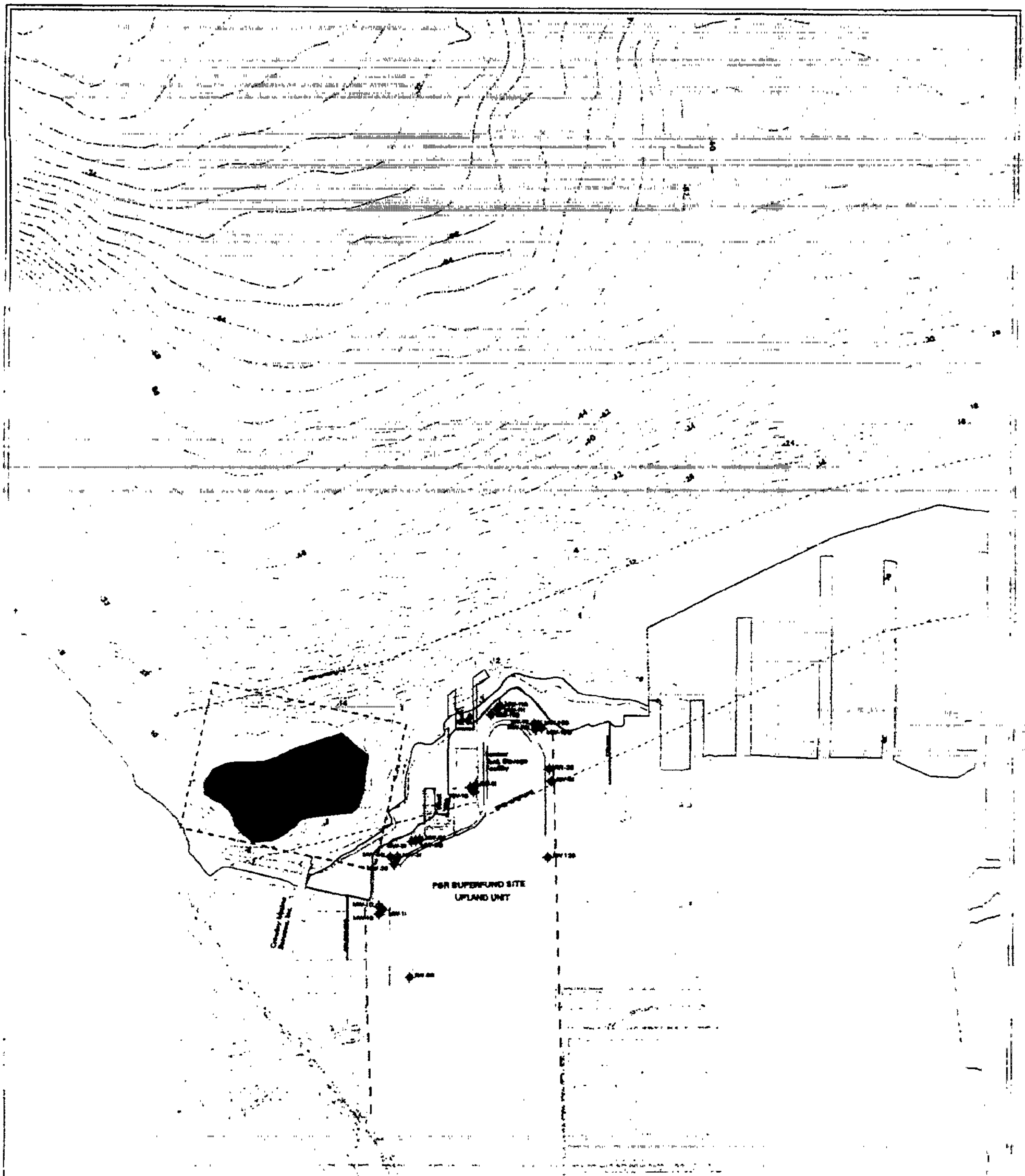
Fill Area

WESTON

PSR Conceptual Site Model of Receptors and Exposure Pathways in the Marine Sediments Unit Post-Upland Cleanup

Figure 3

99-0391 Fig3 fhl



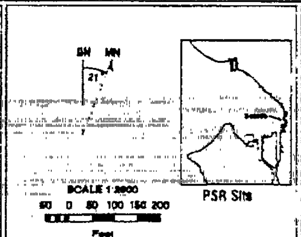
EXPLANATION

Intermediate groundwater discharge zone associated with west-central shoreline wells containing DNAPL.

Crowley Marine barge moorage area.

Area where additional cap material is required to support shell fishing.

NOTES



WESTON

DATE: March 06, 1:44 PM
JOB NUMBER: 99-0382
VIEW FILE:
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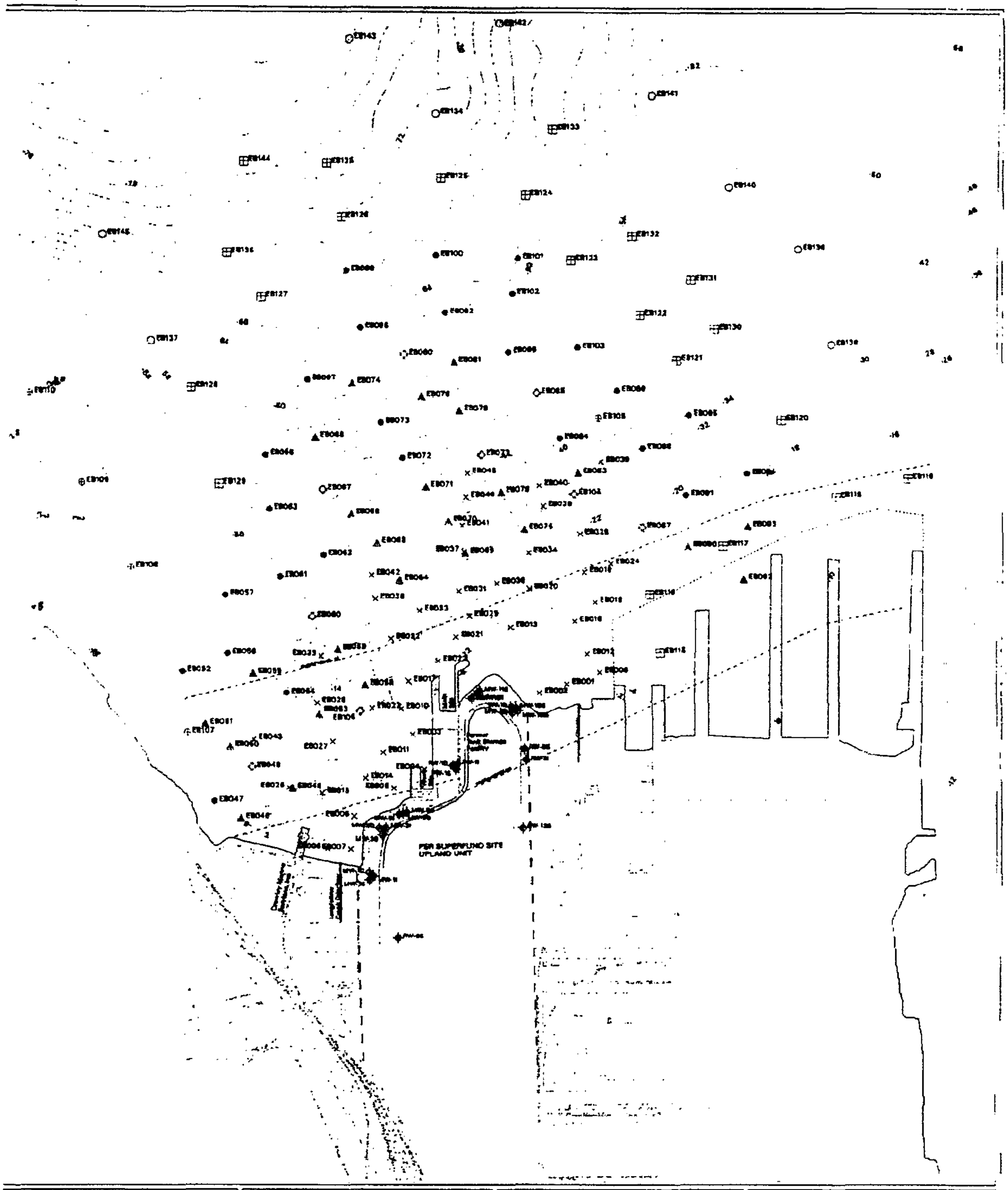
APPROVED BY: ____________

PSR Marine Sediments Unit
Shoreline Cap Area

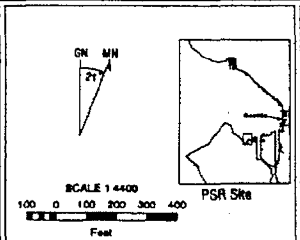
FIGURE 4

99-0391 Fig4 fh8



SYMBOL EXPLANATION

- ⌗ Phase 3 Surface (0 - 10 cm) Sediment Collected for Analysis (n = 22)
- ○ Phase 3 Surface Sediment Collected for Archival (n = 9)
- Phase 2 Surface (0 to 10 cm) Sediment Station - Chemistry Only (n = 7)
- Phase 2 Sediment Triad Station - Bioassays, Benthos, Surface (0 to 10 cm) Chemistry (n = 9)
- ● Phase 2 Surface (0 to 10 cm) Sediment Station - Chemistry and/or Field Immunoassays (n = 26)
- ▲ Phase 2 Surface (0 to 10 cm) Sediment Station - Field Immunoassay Only (n = 25)
- × Phase 1 Surface (0 to 10 cm) Sediment Sample - Chemistry Only (n = 45)



NOTES

1) See Figure 2 for site feature notes and global symbols.
2) Phase 2 Recon. stations EB111 and EB112 are located northwest of EB110.
3) Stations EB115 and EB092 located within the Lockheed cleanup action plan boundary

WESTON

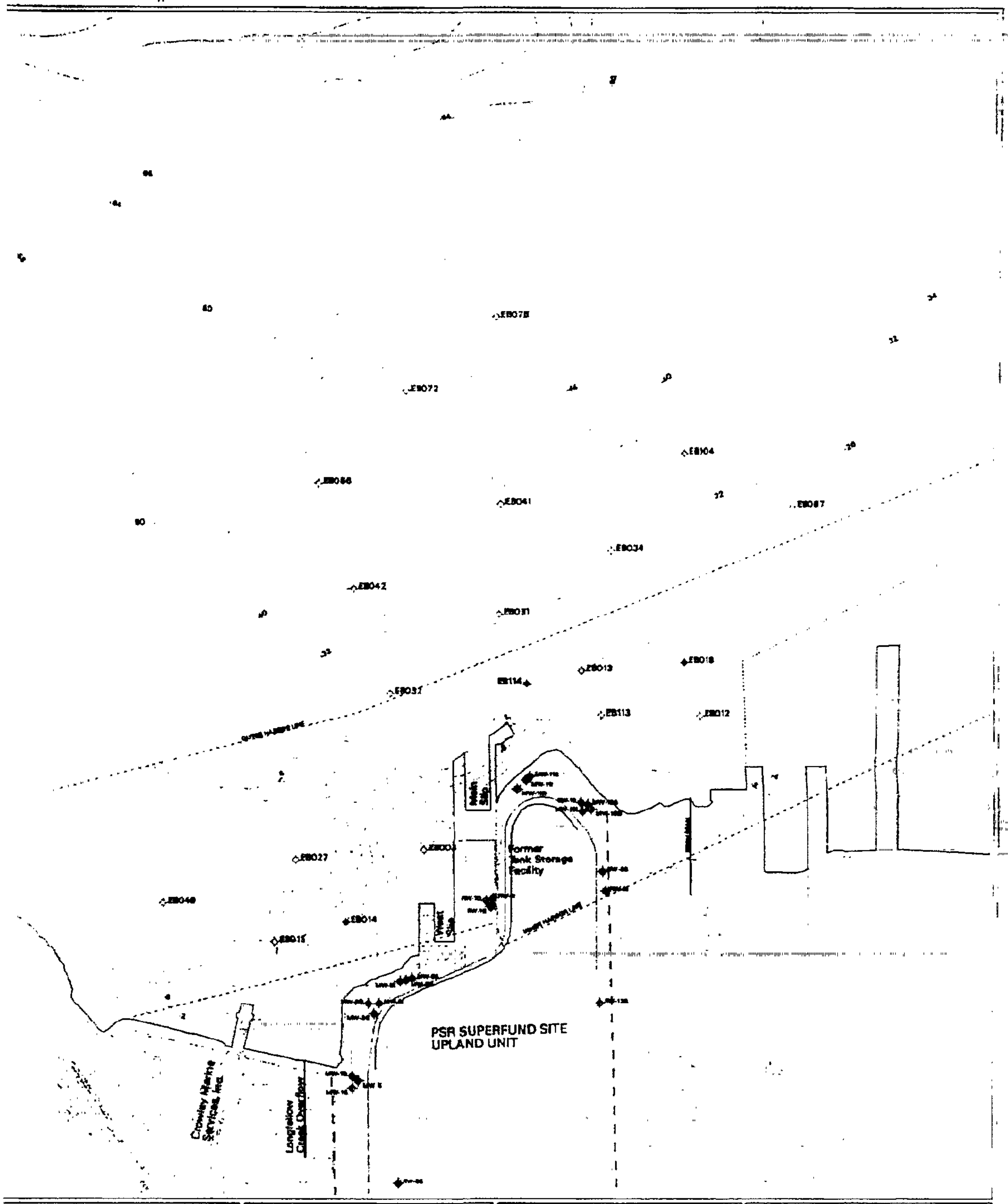
DATE: September 28, 1999 3:22 PM
JOB NUMBER: 12240-043-001-0134
VIEW FILE: [illegible].view

CHECKED BY: ____________

APPROVED BY: ____________

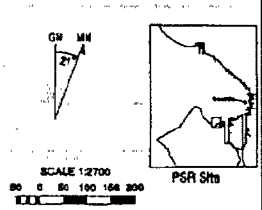
PSR Marine Sediments Unit Phase 1, 2, and 3 Surface Sediment Chemical and Biological Sampling Locations

Figure 5



SYMBOL EXPLANATION

- ◇ Shallow (0 to 20 ft) Subsurface Sediment Core (n = 17)
- ◆ Deep (0 to 96 ft) Subsurface Sediment Core (n = 3)



NOTES

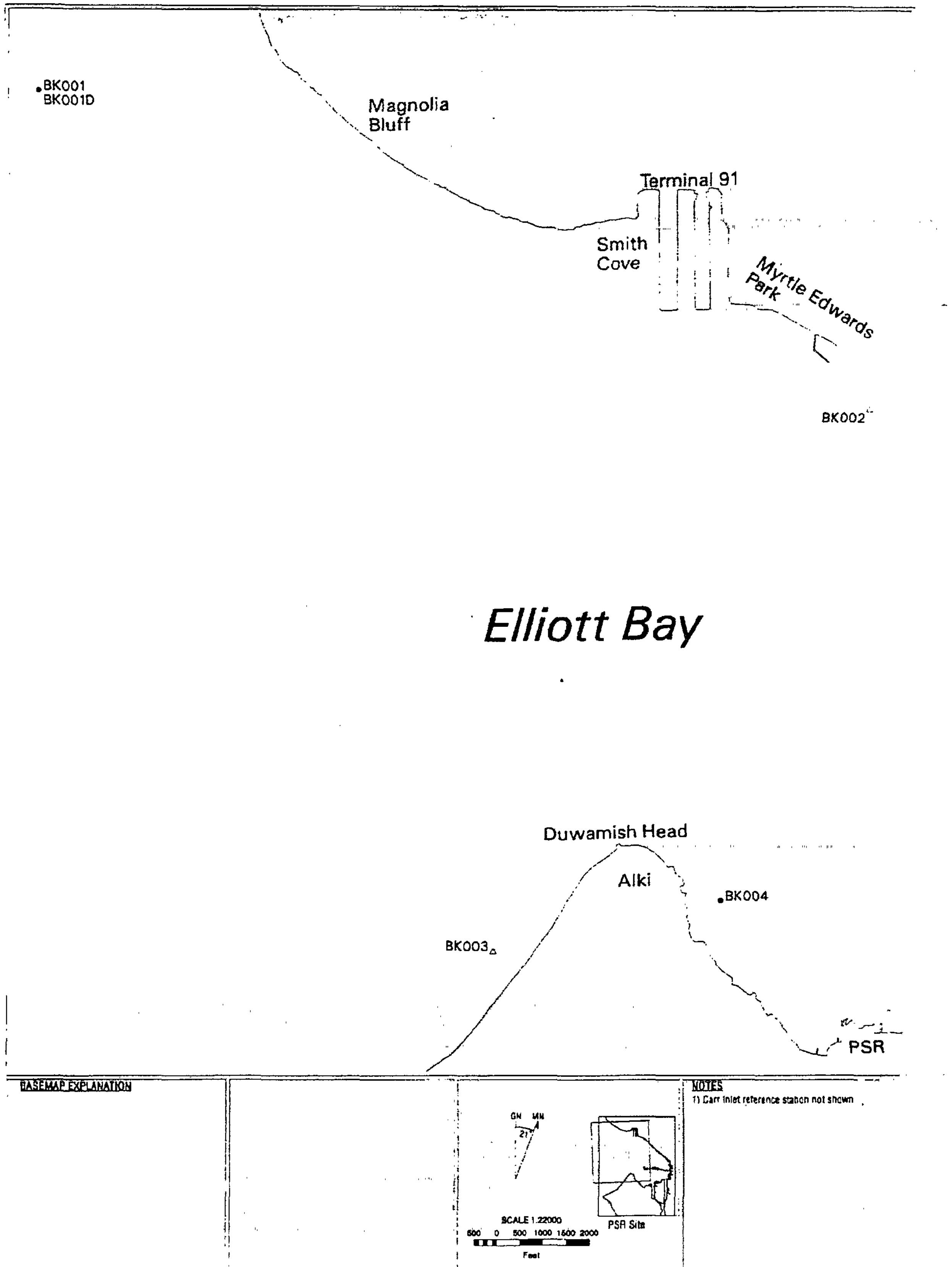
1) See Figure 2 for site feature notes and global symbols
2) Refusal encountered at four stations as follows:
   - EB012: 12 ft below mudline
   - EB042: 8 ft below mudline
   - EB072: 19 ft below mudline
   - EB113: 7 ft below mudline

WESTON

DATE: September 29, 1999 3:28 PM
JOB NUMBER: 12240-043-001-0134
VIEW FILE: subsurface.view
CHECKED BY: ____________
APPROVED BY: ____________

PSR Marine Sediments Unit Phase 2 Subsurface Sediment Sampling Locations

Figure 6

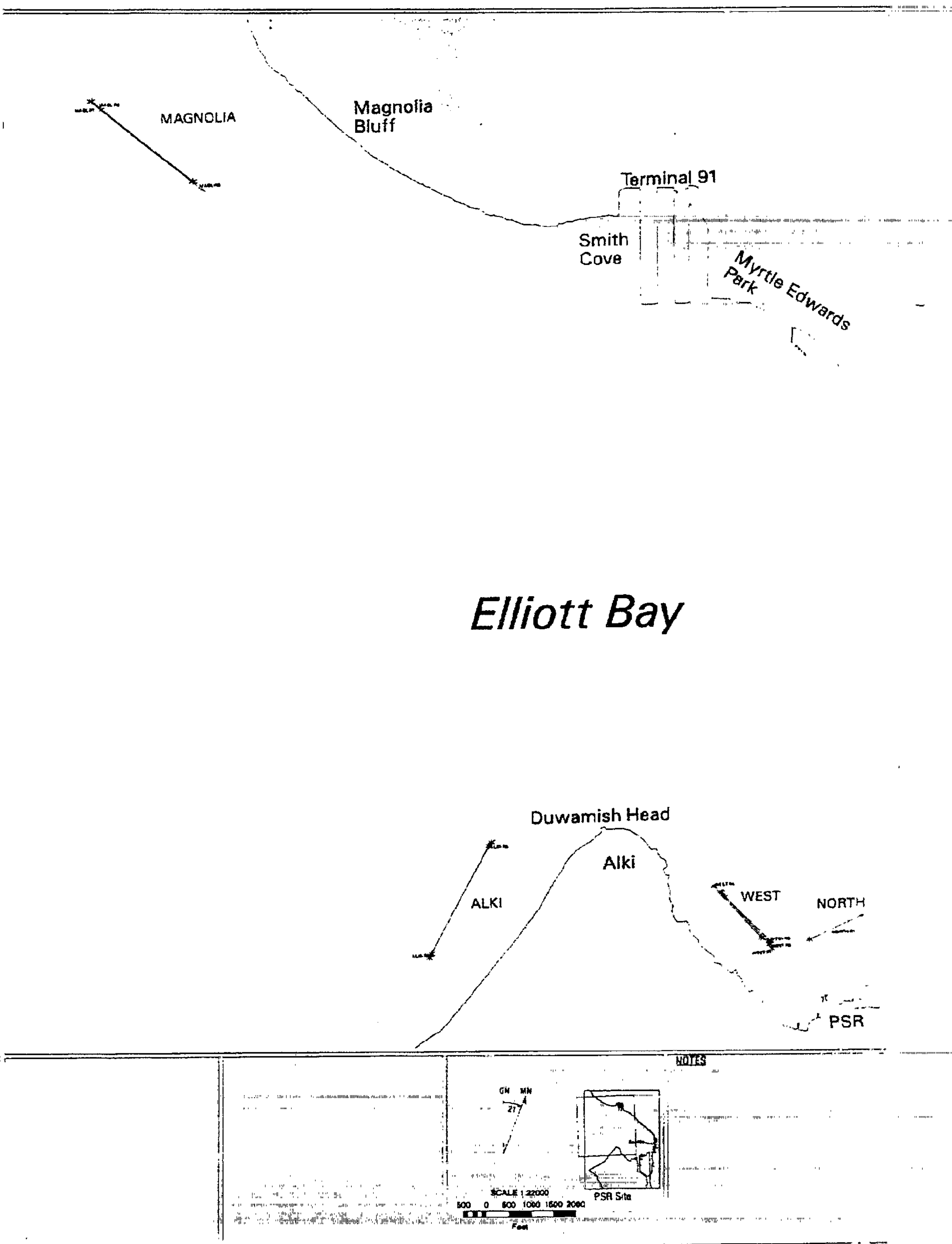


WESTON

DATE: September 26, 1996 3:25 PM
JOB NUMBER: 12240-043-001-0134
VIEW FILE: bkgrdstncls.view
CHECKED BY ____________
APPROVED BY ____________

PSR Marine Sediments Unit Surface Sediment Background Chemical and Triad Sampling Locations

Figure 7

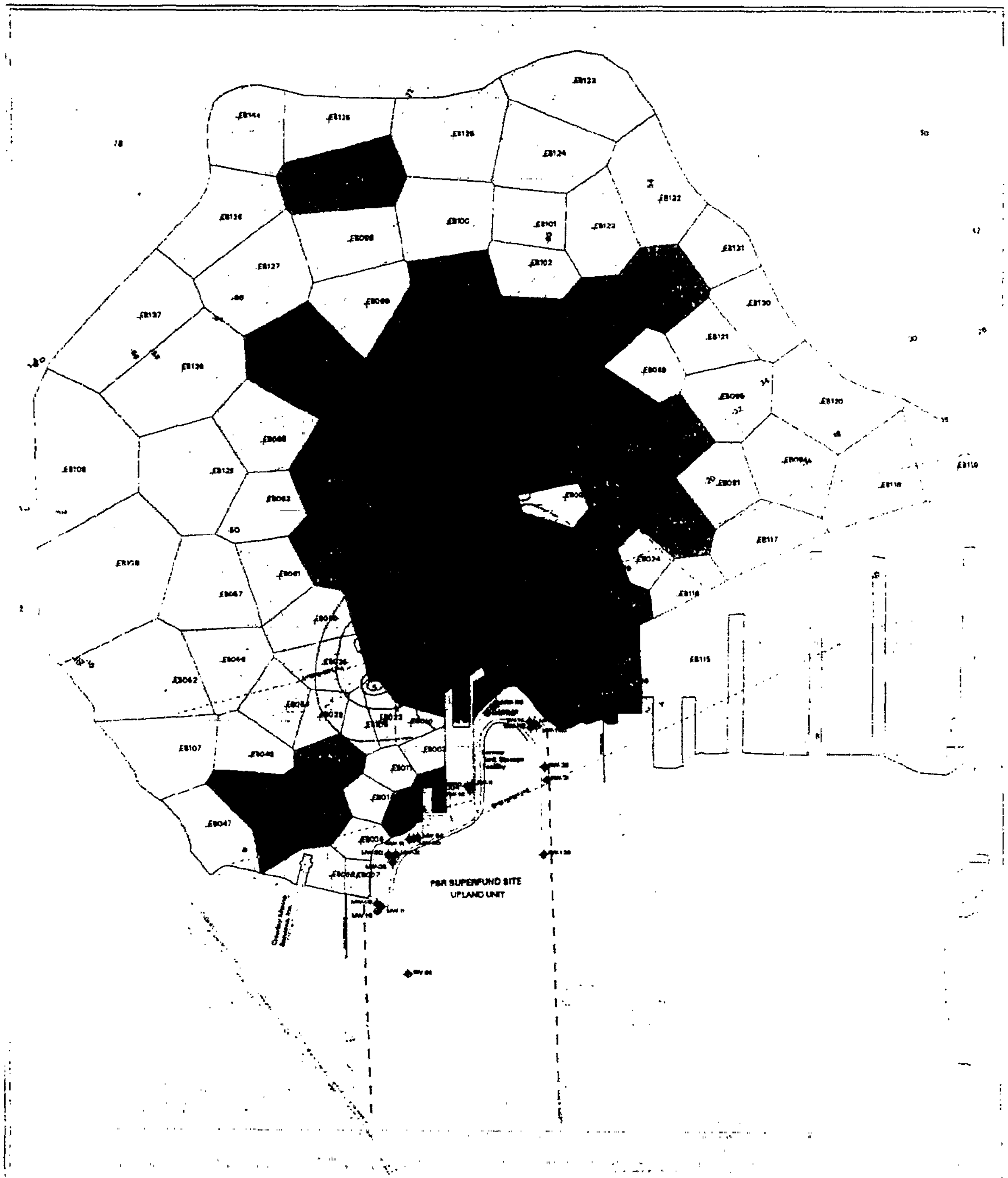


WESTON

DATE September 28, 1999 3 26 PM
JOB NUMBER 12240-043-001-0134
VIEW FILE bkgrdtrans.view
CHECKED BY: ____________
APPROVED BY: ____________

PSR Marine Sediments Unit Site and Background Fish Sampling Transects

Figure 8

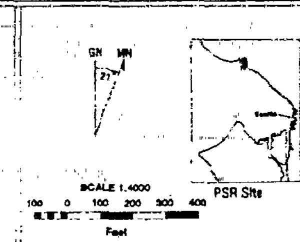


Potential Fill Thickness in Meters

Extrapolated Fill Boundary

SYMBOL EXPLANATION

- Below TOCN SQS or LAET
- Above TOCN SQS or LAET
- Above TOCN CSL or 2LAET
- Impermeable Cap



NOTES

See Figure 2 for site feature notes and global symbols

1) Exceedances based on individual or group totals for PAHs.

2) fill contours from USGS sub-bottom profiling data (1996)

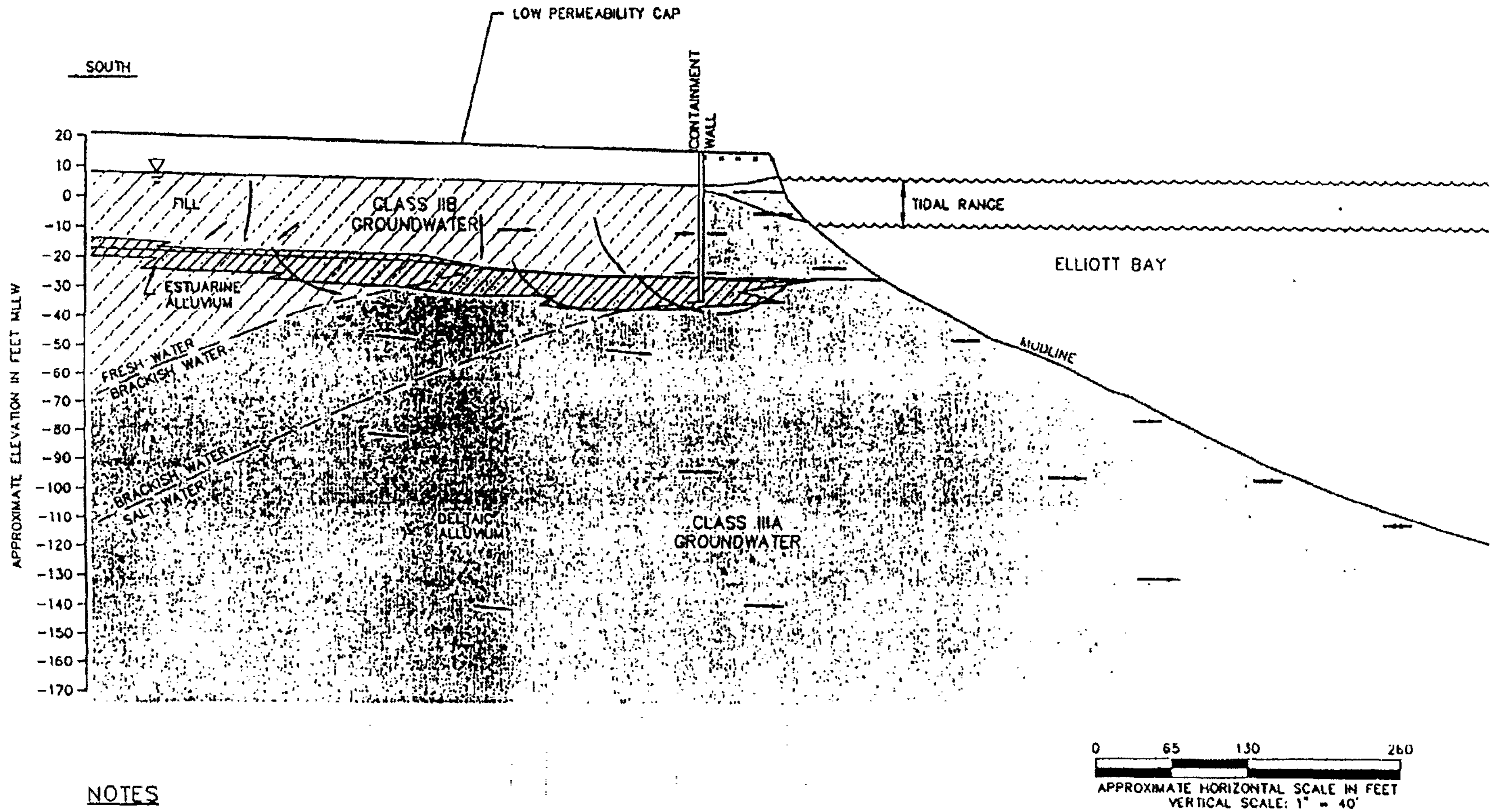
PSR Marine Sediment Unit Surface Sediment PAH Exceedance[1] Areas and Fill Contours[2]

WESTON

DATE: September 22 1998 2:01 PM
JOB NUMBER:
VIEW FILE: allpah.view
CHECKED BY: ____________
APPROVED BY: ____________

Figure 9

98-0301 Fig9.ai



NOTES

1. SCALE AND ELEVATIONS ARE APPROXIMATE. HIGH AND LOW TIDE LEVELS AND SURFACE RELIEF ARE ESTIMATED.
2. OUTSIDE THE CONTAINMENT WALL, SALT WATER IS EXPECTED DUE TO TIDAL FLUCTUATIONS THAT WILL OVERWHELM ANY FRESHWATER FLOW.

LEGEND

—	GROUNDWATER FLOW DIRECTION
MLLW	MEAN LOWER LOW WATER

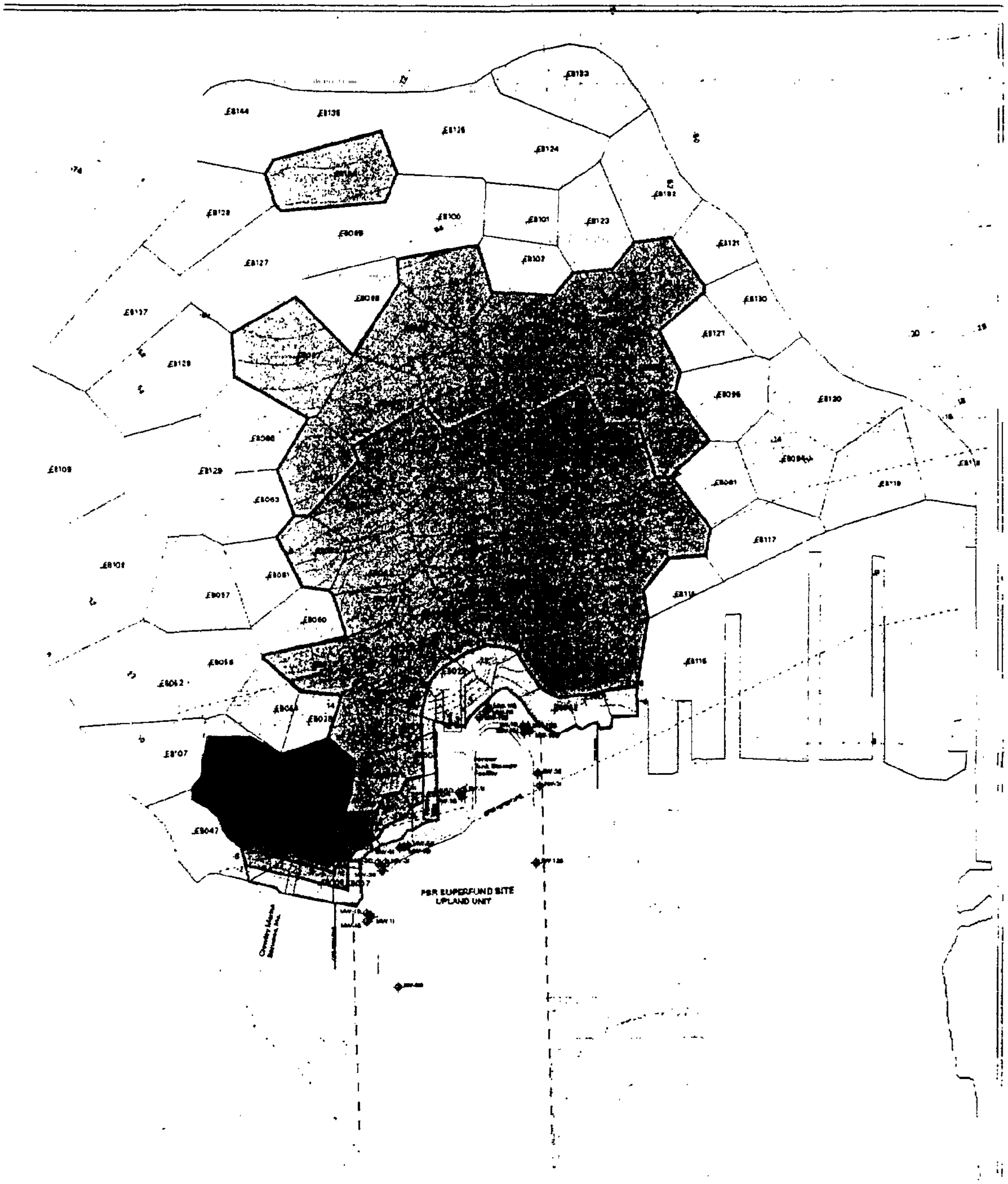
Source: Port of Seattle Pacific Sound Resources ·HA4SWHP (3-1335-564)

WESTON

Approximate Location of Saltwater-Freshwater Interface
Pacific Sound Resources-Superfund Site

Figure 10

99-0391 Fig10.ai



BASEMAP EXPLANATION

SYMBOL EXPLANATION

- Shoreline Cap
- Cap
- Dredge and Cap Crowley Marine
- Cap - Intermediate groundwater discharge zone associated with west-central shoreline wells containing DNAPL

SCALE 1:2000

50 0 50 100 150 200

Feet

PSR Site

NOTES

See Figure 2 for site features notes.

WESTON

DATE: August 27, 1998
JOB NUMBER: 98-0361
VIEW FILE:

CHECKED BY: ________

APPROVED BY: ________

PSR Marine Sediments Unit Modified Alternative 3b—Capping to CSLs

Figure 11

TABLES

Pacific Sound Resources Record of Decision-Marine Sediments Unit
Table 1-Summary of Surface Sediment Chemical and Biological Analyses

Sample Number		Field Analysis[a]	Physical and Chemical Analysis[b]							Biological Analysis[C]		
Western ID	EPA ID	Immunoassay	TOC	Grain Size	% Moisture	PAHs[d]	PCBs[e]	PCDD/PCDF	Metals[f]	Bioassays[g]	Bioaccum	Benthos
PSR Marine Sediments Units												
SD1-EB01-0000	96162600	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB02-0000	96162601	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB03-0000	96162602	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB04-0000	96162603	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB05-0000	96162604	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB06-0000	96162605	- -	X	X	X	X	X	- -	X	- -	- -	- -
SD1-EB07-0000	96162606	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB08-0000	96162607	- -	X	X	X	X	X	- -	X	- -	- -	- -
SD1-EB09-0000	96162608	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB10-0000	96162609	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB11-0000	96162610	- -	X	X	X	X	X	- -	X	- -	- -	- -
SD1-EB12-0000	96162611	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB13-0000	96162612	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB14-0000	96162613	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB15-0000	96162614	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB16-0000	96162615	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB17-0000	96162616	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB18-0000	96162617	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB19-0000	96162618	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB20-0000	96162619	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB20-1000	96162620	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB21-0000	96162621	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB22-0000	96162622	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB23-0000	96162623	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB24-0000	96162624	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB25-0000	96162625	- -	X	X	X	X	- -	- -	X	- -	- -	- -
SD1-EB26-0000	96162626	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB27-0000	96162627	- -	X	X	X	X	X	NA	X	- -	- -	- -
SD1-EB28-0000	96162628	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB29-0000	96162629	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB30-0000	96162630	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB31-0000	96162631	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB32-0000	96162632	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB33-0000	96162633	- -	X	X	X	X	X	X	X	- -	- -	- -

Pacific Sound Resources Record of Decision-Marine Sediments Unit
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Sample Number		Field Analysis[a]	Physical and Chemical Analysis[b]							Biological Analysis[c]		
Western ID	EPA ID	Immunoassay	TOC	Grain Size	% Moisture	PAHs[d]	PCBs[e]	PCDD/PCDF	Metals[f]	Bioassays[g]	Bioaccum	Benthos
SD1-EB34-0000	96162634	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB35-0000	96162635	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB36-0000	96162636	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB37-0000	96162637	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB38-0000	96162638	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB39-0000	96162639	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB39-1000	96162640	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB40-0000	96162641	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB41-0000	96162642	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB42-0000	96162643	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB43-0000	96162648	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB44-0000	96162649	- -	A	A	A	A	A	A	A	- -	- -	- -
SD1-EB45-0000	96162650	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-EB46-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD1-EB47-0000	96382524	X	X	X	- -	X	- -	- -	- -	- -	- -	- -
SD1-EB48-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD1-EB49-0000	96382526	X	X	X	- -	X	X	X	X[h]	X	X	X
SD1-EB50-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD1-EB51-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD1-EB52-0000	96364550	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
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SD1-EB62-0000	96392702	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD1-EB63-0000	96382530	X	X	X	- -	X	- -	- -	- -	- -	- -	- -
SD1-EB64-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
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SD1-EB66-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

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SD2-EB67-0000	96382531	X	X	X	- -	X	X	X	X[h] - -	X	X	X
SD2-EB68-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB69-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB70-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB71-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB72-0000	96382532	X	X	X	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB73-0000	96392703	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB74-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB75-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB76-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB77-0000	96382533	X	X	X	- -	X	X	X	X[h]	X	X	X
SD2-EB78-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB79-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB80-0000	96382534	X	X	X	- -	X	X	X	X[h]	X	X	X
SD2-EB81-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB82-0000	96392704	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB83-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
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SD2-EB86-0000	96382536	X	X	X	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB87-0000	96382537	X	X	X	- -	X	X	X	X[h]	X	X	X
SD2-EB88-0000	96392706	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB89-0000	96364552	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB90-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB91-0000	96382538	X	X	X	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB92-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB93-0000	- -	X	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SD2-EB94-0000	96364554	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB95-0000	96364553	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB96-0000	96374565	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB97-0000	96382539	X	X	X	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB98-0000	96374566	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB99-0000	96374567	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB100-0000	96382540	X	X	X	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB101-0000	96374568	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -

Sample Number		Field Analysis[a]	Physical and Chemical Analysis[b]							Biological Analysis[c]		
Western ID	EPA ID	Immunoassay	TOC	Grain Size	% Moisture	PAHs[d]	PCBs[e]	PCDD/PCDF	Metals[f]	Bioassays[g]	Bioaccum	Benthos
SD2-EB102-0000	96374569	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB103-0000	96374570	X	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB104-0000	96382541	- -	X	X	- -	X	X	X	X[h]	X	X	X
SD2-EB105-0000	96382542	- -	X	X	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB106-0000	96382543	- -	X	X	- -	X	X	X	X[h]	X	X	X
SD2-EB107-0000	96382544	- -	X	X	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB108-0000	96382547	- -	X	X	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB109-0000	96382548	- -	X	X	- -	X	- -	- -	- -	- -	- -	- -
SD2-EB110-0000	96382549	- -	X	A	- -	A	- -	- -	- -	- -	- -	- -
SD2-EB111-0000	96382550	- -	X	A	- -	A	- -	- -	- -	- -	- -	- -
SD3-EB112-0000	96382551	- -	X	A	- -	A	- -	- -	- -	- -	- -	- -
SD3-EB115-0000	97312350	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB116-0000	97312351	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB117-0000	97312352	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB118-0000	97312353	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB119-0000	97312354	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB120-0000	97312355	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB121-0000	97312356	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB122-0000	97312357	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB123-0000	97312358	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB124-0000	97312359	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB125-0000	97312360	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB126-0000	97312361	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB127-0000	97312362	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB128-0000	97312363	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB129-0000	97312364	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB130-000	97312365	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB131-0000	97312366	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB132-0000	97312367	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB133-0000	97312368	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB134-0000	97312369	- -	A	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB135-0000	97312370	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB136-0000	97312371	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB137-0000	97312372	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB138-0000	97312373	- -	A	- -	- -	X	- -	- -	- -	- -	- -	- -

Pacific Sound Resources Record of Decision-Marine Sediments Unit
Table 1-Summary of Surface Sediment Chemical and Biological Analyses

Sample Number		Field Analysis[a]	Physical and Chemical Analysis[b]							Biological Analysis[c]		
Western ID	EPA ID	Immunoassay	TOC	Grain Size	% Moisture	PAHs[d]	PCBs[e]	PCDD/PCDF	Metals[f]	Bioassays[g]	Bioaccum	Benthos
SD3-EB139-0000	97312374	- -	A	- -	- -	A	- -	- -	- -	- -	- -	- -
SD3-EB140-0000	97312375	- -	A	- -	- -	A	- -	- -	- -	- -	- -	- -
SD3-EB141-0000	97312376	- -	A	- -	- -	A	- -	- -	- -	- -	- -	- -
SD3-EB142-0000	97312377	- -	A	- -	- -	A	- -	- -	- -	- -	- -	- -
SD3-EB143-0000	97312378	- -	A	- -	- -	A	- -	- -	- -	- -	- -	- -
SD3-EB144-0000	97312379	- -	X	- -	- -	X	- -	- -	- -	- -	- -	- -
SD3-EB145-0000	97312380	- -	A	- -	- -	A	- -	- -	- -	- -	- -	- -
Background Areas												
SD1-BK01-0000	96162644	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-BK01D-0000	96162645	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-BK02-0000	96162646	- -	X	X	X	X	X	X	X	- -	- -	- -
SD1-BK03-0000	96162647	- -	X	X	X	X	X	X	X	- -	- -	- -
SD2-BK01-0000	96382545	- -	X	X	- -	X	X	X	X[h]	X	X	X
SD2-BK04-0000	96382546	- -	X	X	- -	X	X	X	X[h]	X	X	X
SD2-CARR-0000	- -	- -	- -	X[i]	- -	- -	- -	- -	- -	X	- -	- -

[a]Rapid immunoassay methods for carcinogenic PAHs were specified In the Draft Phase 2 SAP Addendum (WESTON, 1996c); sediment collected at each of the immunoassay stations was also archived for potential future laboratory analyses.

[b]Analytical methods were specified in Section 6 of the Phase 1 SAP (WESTON, 1996b).

[c]Biological testing methods were specified in the Phase 2 SAP Addendum (WESTON, 1996c, 1996d).

[d]AII Phase 1samples (indicated by WESTON Sample ID prefix “SD1") also analyzed for phenolic compounds and dibenzofuran.

[e]Aroclors only.

[f]Metals analyses were limited to aluminum, arsenic, cadmium, copper, Iron, lead, mercury, nickel, and zinc.

[g]Amphipod (*Ampelisca abdita*) and echinoderm (*Dendraster excentricus*) acute toxicity tests.

[h]Mercury only.

[i]Grain size data consist only of a field screening measurement (of 49% fines).

X: Analyzed.

- - : Not analyzed.

A: Sample archived and not analyzed for the RI.

NA: Apparent gross contamination; sample not analyzed for the RI based on assumption that PAH contamination would drive cleanup.

Metal, PAH, and PCB analyses performed by EPA Manchester Lab.

PCDD/PCDF analyses performed by Maxim Technologies, Inc.

TOC analyses performed by ARI, Inc.

Grain Size analyses performed by Soil Technology.

Bioassays conducted by Parametrix, Inc.

Benthic enumeration and taxonomic identification performed by Marine Taxonomic Services.

Pacific Sound Resources Record of Decision-Marine Sediments Unit
Table 2—Summary of Shallow Subsurface Sediment
Compositing Scheme and Chemical Analyses

Station	Depth Interval (ft bgs)		WESTON Sample Number	EPA Sample Number	Analysis[a]								
	Proposed	Actual			PAHs	Phenols	Dibenzofuran	Metals	PCBs	TOC	Grain Size	DRET	MET
EB03	0 - 4	0 - 4	SD2-EB03-0000A	96392707	X	- -	- -	- -	- -	X	- -	- -	- -
	0 - 4	0 - 4	SD2-EB03-1000A	96392708	X	- -	- -	- -	- -	X	- -	- -	- -
	4 - 8	4 - 8	SD2-EB03-0040	96392709	X	- -	- -	- -	- -	X	- -	- -	- -
	4 - 8	4 - 8	SD2-EB03-1040	96392710	X	- -	- -	- -	- -	X	- -	- -	- -
	8 - 12	8 - 12	SD2-EB03-0080	96392711	X	- -	- -	- -	- -	X	- -	- -	- -
	8 - 12	8 - 12	SD2-EB03-1080	96392712	X	- -	- -	- -	- -	X	- -	- -	- -
	12 - 16	12 - 16	SD2-EB03-0120	96392719	X	- -	- -	- -	- -	X	- -	- -	- -
	12 - 16	12 - 16	SD2-EB03-1120	96392720	X	- -	- -	- -	- -	X	- -	- -	- -
	16 - 20	16 - 20	SD2-EB03-0160	96392721	X	- -	- -	- -	- -	X	- -	- -	- -
	16 - 20	16 - 20	SD2-EB03-1160	96392722	X	- -	- -	- -	- -	X	- -	- -	- -
EB12	0 - 4	0 - 4	SD2-EB12-0000A	96404900	X	- -	- -	- -	- -	X	- -	- -	- -
	4 - 8	4 - 8	SD2-EB12-0040	96404901	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	8 - 12	8 - 12	SD2-EB12-0080	96404902	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	12 - 16	NR	NR	NR	NR	- -	- -	- -	- -	NR	- -	- -	- -
	16 - 20	NR	NR	NR	NR	- -	- -	- -	- -	NR	- -	- -	- -
EB13	0 - 4	0 - 4	SD2-EB13-0000A	96404905	X	X	X	X	X	X	X	- -	- -
	4 - 8	4 - 8	SD2-EB13-0040	96404906	X	X	X	X	X	X	X	[X(G2)]	[X(G2)]
	8 - 12	8 - 12	SD2-EB13-0080	96404907	X	X	X	X	X	X	X	[X(G2)]	[X(G2)]
	12 - 16	12 - 16	SD2-EB13-0120	96404908	X	X	X	X	X	X	X	- -	- -
	16 - 20	16 - 20	SD2-EB13-0160	96404909	X	X	X	X	X	X	X	- -	- -
EB15	0 - 4	0 - 4	SD2-EB15-0000A	96392723	X	- -	- -	- -	- -	X	- -	- -	- -
	4 - 8	4 - 8	SD2-EB15-0040	96392724	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	8 - 12	8 - 12	SD2-EB15-0080	96392725	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	12 - 16	12 - 11`6	SD2-EB15-0120	96392726	X	- -	- -	- -	- -	X	- -	- -	- -
	16 - 20	16 - 20	SD2-EB15-0160	96392727	X	- -	- -	- -	- -	X	- -	- -	- -
EB27	0 - 4	0 - 4	SD2-EB27-0000A	96392734	X	- -	- -	- -	- -	X	- -	- -	- -
	4 - 8	4 - 8	SD2-EB27-0040	96392735	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	8 - 12	8 - 12	SD2-EB27-0080	96392736	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	12 - 16	12 - 16	SD2-EB27-0120	96392737	X	- -	- -	- -	- -	X	- -	- -	- -
	16 - 20	16 - 20	SD2-EB27-0160	96392738	X	- -	- -	- -	- -	X	- -	- -	- -
EB31	0 - 4	0 - 4	SD2-EB31-0000A	96404910	X	- -	- -	- -	- -	X	- -	- -	- -
	4 - 8	4 - 8	SD2-EB31-0040	96404911	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	8 - 12	8 - 12	SD2-EB31-0080	96404912	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	12 - 16	12 - 16	SD2-EB31-0120	96404913	X	- -	- -	- -	- -	X	- -	- -	- -
	16 - 20	16 - 20	SD2-EB31-0160	96404914	X	- -	- -	- -	- -	X	- -	- -	- -
EB32	0 - 4	0 - 4	SD2-EB32-0000A	96404915	X	- -	- -	- -	- -	X	- -	- -	- -
	4 - 8	4 - 8	SD2-EB32-0040	96404916	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	8 - 12	8 - 12	SD2-EB32-0080	96404917	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	12 - 16	12 - 16	SD2-EB32-0120	96404918	X	- -	- -	- -	- -	X	- -	- -	- -
	16 - 20	16 - 20	SD2-EB32-0160	96404919	X	- -	- -	- -	- -	X	- -	- -	- -
EB34	0 - 4	0 - 4	SD2-EB34-0000A	96404920	X	- -	- -	- -	- -	X	- -	- -	- -
	4 - 8	4 - 8	SD2-EB34-0040	96404921	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	8 - 12	8 - 12	SD2-EB34-0080	96404922	X	- -	- -	- -	- -	X	- -	[X(G2)]	[X(G2)]
	12 - 16	12 - 16	SD2-EB34-0120	96404923	X	- -	- -	- -	- -	X	- -	- -	- -
	16 - 20	16 - 20	SD2-EB34-0160	96404924	X	- -	- -	- -	- -	X	- -	- -	- -
EB41	0 - 4	0 - 4	SD2-EB41-0000A	96404925	X	X	X	X	X	X	X	- -	- -
	4 - 8	4 - 8	SD2-EB41-0040	96404926	X	X	X	X	X	X	X	[X(G2)]	[X(G2)]
	8 - 12	8 - 12	SD2-EB41-0080	96404927	X	X	X	X	X	X	X	[X(G2)]	[X(G2)]
	12 - 16	12 - 16	SD2-EB41-0120	96404928	X	X	X	X	X	X	X	- -	- -
	16 - 20	16 - 20	SD2-EB41-0160	96404929	X	X	X	X	X	X	X	- -	- -

Pacific Sound Resources Record of Decision-Marine Sediments Unit
Table 2—Summary of Shallow Subsurface Sediment Compositing Scheme and Chemical Analyses

Station			WESTON Sample Number	EPA Sample Number	Analysis[a]								
	Proposed	Actual			PAHs	Phenols	Dibenzofuran	Metals	PCBs	TOC	Grain Size	DRET	MET
EB42	0 - 4	0 - 4	SD2-EB42-0000A	96404930	X	–	–	–	–	X	–	–	–
	4 - 8	4 - 8	SD2-EB42-0040	96404931	X	–	–	–	–	X	–	[X (G2)]	[X (G2)]
	8 - 12	NR	NR	NR	NR	–	–	–	–	NR	–	–	–
	12 - 16	NR	NR	NR	NR	–	–	–	–	NR	–	–	–
	16 - 20	NR	NR	NR	NR	–	–	–	–	NR	–	–	–
EB49	0 - 4	0 - 4	SD2-EB49-0000A	96392728	X	–	–	–	–	X	–	–	–
	4 - 8	4 - 8	SD2-EB49-0040	96392729	X	–	–	–	–	X	–	[X (G1)]	[X (G1)]
	8 - 12	8 - 12	SD2-EB49-0080	96392731	X	–	–	–	–	X	–	[X (G1)]	[X (G1)]
	12 - 16	12 - 16	SD2-EB49-0120	96392732	X	–	–	–	–	X	–	–	–
	16 - 20	16 - 20	SD2-EB49-0160	96392733	X	–	–	–	–	X	–	–	–
EB66	0 - 4	0 - 4	SD2-EB66-0000A	96044935	X	–	–	–	–	X	–	–	–
	4 - 8	4 - 8	SD2-EB66-0040	96404936	X	–	–	–	–	X	–	[X (G2)]	[X (G2)]
	8 - 12	8 - 12	SD2-EB66-0080	96404937	X	–	–	–	–	X	–	[X (G2)]	[X (G2)]
	12 - 16	12 - 16	SD2-EB66-0120	96404938	X	–	–	–	–	X	–	–	–
	16 - 20	16 - 20	SD2-EB66-0160	96404939	X	–	–	–	–	X	–	–	–
EB72	0 - 4	0 - 4	SD2-EB72-0000A	96404940	X	–	–	–	–	X	–	–	–
	4 - 8	4 - 8	SD2-EB72-0040	96404941	X	–	–	–	–	X	–	[X (G2)]	[X (G2)]
	8 - 12	8 - 12	SD2-EB72-0080	96404942	X	–	–	–	–	X	–	[X (G2)]	[X (G2)]
	12 - 16	12 - 16	SD2-EB72-0120	96404943	A	–	–	–	–	A	–	–	–
	16 - 20	16 -18.7	SD2-EB72-0160	96494944	A	–	–	–	–	A	–	–	–
EB78	0 - 4	0 - 4	SD2-EB78-0000A	96404945	X	–	–	–	–	X	–	–	–
	4 - 8	4 - 8	SD2-EB78-0040	96404946	X	–	–	–	–	X	–	[X (G2)]	[X (G2)]
	8 - 12	8 - 12	SD2-EB78-0080	96404947	A	–	–	–	–	A	–	[X (G2)]	[X (G2)]
	12 - 16	12 - 16	SD2-EB78-0120	96404948	A	–	–	–	–	A	–	–	–
	16 - 20	16 - 20	SD2-EB78-0160	96404949	A	–	–	–	–	A	–	–	–
EB87	0 - 4	0 - 4	SD2-EB87-0000A	96404950	X	–	–	–	–	X	–	–	–
	4 - 8	4 - 8	SD2-EB87-0040	96404951	X	–	–	–	–	X	–	[X (G2)]	[X (G2)]
	8 - 12	8 - 12	SD2-EB87-0080	96404952	X	–	–	–	–	X	–	[X (G2)]	[X (G2)]
	12 - 16	12 - 16	SDS-EB87-0120	96404953	X	–	–	–	–	X	–	–	–
	16 - 20	16 - 20	SD2-EB87-0160	96404954	A	–	–	–	–	A	–	–	–
EB104	0 - 4	0 - 4	SD2-EB104-0000A	96404955	X	–	–	–	–	X	–	–	–
	4 - 8	4 - 8	SD2-EB104-0040	96404956	X	–	–	–	–	X	–	[X (G2)]	[X (G2)]
	8 - 12	8 - 12	SD2-EB104-0080	96404957	A	–	–	–	–	A	–	[X (G2)]	[X (G2)]
	12 - 16	12 - 16	SD2-EB107-0120	96404958	A	–	–	–	–	A	–	–	–
	16 - 20	16 - 20	SD2-EB104-0160	96404959	A	–	–	–	–	A	–	–	–
EB113	0 - 4	0 - 4	SD2-EB113-0000A	96404960	X	–	–	–	–	X	–	–	–
	4 - 8	4 - 7	SD2-EB113-0040	96404961	X	–	–	–	–	X	–	[X (G2)]	[X (G2)]
	8 - 12	NR	NR	NR	NR	–	–	–	–	NR	–	–	–
	12 - 16	NR	NR	NR	NR	–	–	–	–	NR	–	–	–
	16 - 20	NR	NR	NR	NR	–	–	–	–	NR	–	–	–
Group 1	4 - 8	4 - 8	SD2-EBC01-0040	96392739	–	–	–	–	–	–	–	X	X
	8 - 12	8 - 12	SD2-EBC01-0080	96404965	–	–	–	–	–	–	–	X	X
Group 2	4 - 8	4 - 8	SD2-EBC02-0040	96404966	–	–	–	–	–	–	–	X	X
	8 - 12	8 - 12	SD2-EBC02-0080	96404967	–	–	–	–	–	–	–	X	X

[a]Analytical methods were specified in the Phase 1 SAP (WESTON), 1996b) and Draft Phase 2 SAP Addendum (WESTON, 1996c)
[b]Metal analyses limites to arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc.
X: Analyzed
A: Sample archived and not analyzed for the RI
NR: No recovery or refusal encountered; no analysis possible
– Not analyzed
G1 Composited as part of Group 1 (EBC01), which included Stations EB15, EB27, and EB49
G2 Composited as part of Group 2 (EBC02), which included Stations EB12, EB13, EB31, EB32, EB34, EB41, EB42, EB66, EB72, EB78, EB104, and EB113

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 3—Summary of Deep Subsurface Sediment Field and Laboratory Analyses

Station	Depth Interval (ft bgs)	WESTON Sample Number	EPA Sample Number	Field Analysis[a]		Laboratory Analysis[b]			
				UV	Immuno-assay	Eng. Param.[c]	PAHs	TOC	Grain Size
EB14	0 - 3	SDEB14-0000	–	–	–	X	–	–	–
	3 - 6	SDEB14-0030	–	–	–	X	–	–	–
	8 - 10	SD2-EB14-0080	–	–	–	–	–	A	A
	12 - 14	SD2-EB14-0120	–	–	–	–	–	A	A
	20 - 22	SD2-EB14-0200	–	X	–	–	A	–	–
	22 - 24	SD2-EB14-0220	–	–	–	–	A	–	–
	24 - 26	SD2-EB14-0240	–	X	–	–	A	–	–
	26 - 28	SD2-EB14-0260	–	–	–	–	A	A	A
	28 - 30	SD2-EB14-0280	–	X	–	–	A	–	–
	30 - 32	SD2-EB14-0300	–	–	X	–	A	–	–
	32 - 34	SD2-EB14-0320	96464640	X	–	–	A	X	X
	42 - 44	SD2-EB14-0420	–	–	–	–	–	A	A
	60 - 62	SD2-EB14-0600	–	X	–	–	A	–	–
	62 - 64	SD2-EB14-0620	–	–	–	–	A	–	–
	64 - 66	SD2-EB14-0640	–	X	X	–	A	–	–
	66 - 68	SD2-EB14-0660	–	–	X	–	–	A	A
	68 - 70	SD2-EB14-0680	–	X	X	–	A	–	–
	70 - 72	SD2-EB14-0700	96464641	–	X	–	A	X	X
	72 - 74	SD2-EB14-0720	–	X	X	–	A	–	–
	74 - 76	SD2-EB14-0740	–	–	X	–	A	A	A
	76 - 78	SD2-EB14-0760	–	X	–	–	A	–	–
	78 - 80	SD2-EB14-0780	–	–	–	–	A	–	–
	80 - 82	SD2-EB14-0800	–	X	–	–	A	–	–
	82 - 84	SD2-EB14-0820	–	–	–	–	A	–	–
	84 - 85	SD2-EB14-0840	–	–	–	–	A	A	A
EB16	0 - 3	SDEB16-0000	–	–	–	X	–	–	–
	3 - 6	SDEB16-0030	–	–	–	X	–	–	–
	12 - 14	SD2-EB16-0120	–	–	–	–	A	A	A
	20 - 22	SD2-EB16-0200	–	X	–	–	A	–	–
	22 - 24	SD2-EB16-0220	–	X	–	–	A	–	–
	24 - 26	SD2-EB16-0240	–	–	–	–	A	–	–
	26 - 28	SD2-EB16-0260	–	X	–	–	A	–	–
	28 - 30	SD2-EB16-0280	–	–	–	–	A	A	A
	30 - 32	SD2-EB16-0300	–	X	–	–	–	–	–
	32 - 34	SD2-EB16-0320	96464647	–	X	–	–	X	X
	52 - 54	SD2-EB16-0520	–	–	–	–	–	A	A
	60 - 62	SD2-EB16-0600	–	X	X	–	A	–	–
	62 - 64	SD2-EB16-0620	–	–	X	–	A	A	A
	64 - 66	SD2-EB16-0640	–	X	X	–	A	–	–
	66 - 68	SD2-EB16-0660	–	–	X	–	A	–	–
	68 - 70	SD2-EB16-0680	–	X	X	–	A	–	–
	70 - 72	SD2-EB16-0700	–	–	X	–	A	–	–
	72 - 74	SD2-EB16-0720	9644648	X	X	–	A	X	X
	74 - 76	SD2-EB16-0740	–	–	X	–	A	–	–
	76 - 78	SD2-EB16-0760	–	X	X	–	A	–	–
	78 - 80	SD2-EB16-0780	–	–	X	–	A	–	–
	80 - 82	SD2-EB16-0800	–	–	X	–	A	–	–
	82 - 84	SD2-EB16-0820	–	–	X	–	A	–	–
	84 - 85	SD2-EB16-0840	–	–	X	–	A	–	–

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 3—Summary of Deep Subsurface Sediment Field and Laboratory Analyses

Station	Depth Interval (ft bgs)	WESTON Sample Number	EPA Sample Number	Field Analysis[a]		Laboratory Analysis[b]			
				UV	Immuno-assay	Eng. Param.[c]	PAHs	TOC	Grain Size
EB114	0 - 3	SDEB114-0000	–	–	–	X	–	–	–
	3 - 6	SDEB114-0030	–	–	–	X	–	–	–
	8 - 10	SD2-EB114-0080	–	–	–	–	–	A	A
	12 - 14	SD2-EB114-0120	–	–	–	–	–	A	A
	20 - 22	SD2-EB114-0200	–	X	–	–	A	–	–
	22 - 24	SD2-EB114-0220	–	–	–	–	A	–	–
	24 - 26	SD2-EB114-0240	–	X	–	–	A	–	–
	26 - 28	SD2-EB114-0260	–	–	–	–	A	–	–
	28 - 30	SD2-EB114-0280	–	X	X	–	A	–	–
	30 - 32	SD2-EB114-0300	96464642	X	X	–	A	X	X
	34 - 36	SD2-EB114-0340	–	–	X	–	A	–	–
	38 - 40	SD2-EB114-0380	96464644	–	–	–	–	X	X
	56 - 58	SD2-EB114-0560	96464644	–	–	–	–	X	X
	60 - 62	SD2-EB114-0600	–	X	X	–	A	–	–
	62 - 64	SD2-EB114-0620	–	–	X	–	A	–	–
	64 - 66	SD2-EB114-0640	96464645	X	X	–	A	X	X
	66 - 68	SD2-EB114-0660	–	–	X	–	A	–	–
	68 - 70	SD2-EB114-0680	–	X	–	–	A	–	–
	70 - 72	SD2-EB114-0700	–	–	–	–	A	–	–
	72 - 74	SD2-EB114-0720	–	X	–	–	A	–	–
	74 - 76	SD2-EB114-0740	–	–	–	–	A	–	–
	76 - 78	SD2-EB114-0760	–	X	–	–	A	A	A
	80 - 82	SD2-EB114-0800	–	X	–	–	A	–	–
	82 - 84	SD2-EB114-0820	–	–	–	–	A	–	–
	84 - 86	SD2-EB114-0840	–	X	X	–	A	–	–
	86 - 88	SD2-EB114-0860	–	–	X	–	A	–	–
	88 - 90	SD2-EB114-0880	–	X	X	–	A	–	–
	90 - 92	SD2-EB114-0900	–	–	X	–	A	–	–
	92 - 94	SD2-EB114-0920	96464646	X	X	–	A	X	X
	94 - 96	SD2-EB114-0940	–	–	X	–	A	–	–

[a]Analytical methods were discussed in the revised Phase 2 SAP Addendum (WESTON, 1996d).
[b]Analytical methods were specified in the Phase 1 SAP (WESTON, 1996b).
[c]Engineering parameters consisted of Atterburg limits, engineering classification, specific gravity, grain size, percent moisture, triaxial shear (consolidated and unconsolidated), consolidation tests, and unconfined compressive strength.
X: Analyzed.
–: Not analyzed.
A: Archived; not analyzed for the RI.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 4—Summary of Clam anf Dish Tissue Chemical Analyses

Sample Number		Media	Chemical Analysis[a]				
WESTON ID	EPA ID		Lipid	PAHs	PCBs[b]	Doix/Fur	Mercury
PSR Marine Sediments Unit							
CTI-EB49-0000	96454330	Clam Whole Body[c]	X	X	X	X	X
CTI-EB60-0000	96454332	Clam Whole Body[c]	X	X	X	X	X
CTI-EB67-0000	96454333	Clam Whole Body[c]	X	X	X	X	X
CTI-EB77-0000	96454334	Clam Whole Body[c]	X	X	X	X	X
CTI-EB80-0000	96454335	Clam Whole Body[c]	X	X	X	X	X
CTI-EB85-0000	96454336	Clam Whole Body[c]	X	X	X	X	X
CTI-EB87-0000	96454337	Clam Whole Body[c]	X	X	X	X	X
CTI-EB104-0000	96454338	Clam Whole Body[c]	X	X	X	X	X
CTI-EB106-0000	96454339	Clam Whole Body[c]	X	X	X	X	X
FT2-WEST-ES-WB-R2	96382503	Fish Whole Body[d]	X	–	X	X	X
FT2-WEST-ES-WB-R4	96382504	Fish Whole Body[d]	X	–	X	X	X
FT2-WEST-ES-WB-R5	96382505	Fish Whole Body[d]	X	–	X	X	X
FT2-NORTH-ES-WB-R1	96382509	Fish Whole Body[d]	X	–	X	X	X
FT2-NORTH-ES-WB-R2	96382510	Fish Whole Body[d]	X	–	X	X	X
FT2-NORTH-ES-WB-R3	96382511	Fish Whole Body[d]	X	–	X	X	X
FT2-WEST-ES-FT-R1	96382500	Fish Fillet[d]	X	–	X	X	X
FT2-WEST-ES-FT-R3	96382501	Fish Fillet[d]	X	–	X	X	X
FT2-WEST-ES-FT-R4	96382502	Fish Fillet[d]	X	–	X	X	X
FT2-NORTH-ES-FT-R1	96382506	Fish Fillet[d]	X	–	X	X	X
FT2-NORTH-ES-FT-R2	96382507	Fish Fillet[d]	X	–	X	X	X
FT2-NORTH-ES-FT-R3	96382508	Fish Fillet[d]	X	–	X	X	X
Background Areas							
CTI-BK01-0000	96454340	Clam Whole Body[c]	X	X	X	X	X
CTI-BK04-0000	96454341	Clam Whole Body[c]	X	X	X	X	X
FT2-ALKI-ES-WB-R1	96382521	Fish Whole Body[d]	X	–	X	X	X
FT2-ALKI-ES-WB-R2	96382522	Fish Whole Body[d]	X	–	X	X	X
FT2-ALKI-ES-WB-R3	96382523	Fish Whole Body[d]	X	–	X	X	X
FT2-MAGL-ES-WB-R1	96382515	Fish Whole Body[d]	X	–	X	X	X
FT2-MAGL-ES-WB-R2	96382516	Fish Whole Body[d]	X	–	X	X	X
FT2-MAGL-ES-WB-R3	96382517	Fish Whole Body[d]	X	–	X	X	X
FT2-ALKI-ES-FT-R1	96382518	Fish Fillet[d]	X	–	X	X	X
FT2-ALKI-ES-FT-R2	96382519	Fish Fillet[d]	X	–	X	X	X
FT2-ALKI-ES-FT-R3	96382520	Fish Fillet[d]	X	–	X	X	X
FT2-MAGL-ES-FT-R1	96382512	Fish Fillet[d]	X	–	X	X	X
FT2-MAGL-ES-FT-R2	96382513	Fish Fillet[d]	X	–	X	X	X
FT2-MAGL-ES-FT-R3	96382514	Fish Fillet[d]	X	–	X	X	X

[a]Analytical methods were specified in the Phase 1 SAP (WESTON), 1996b) and Draft Phase 2 SAP Addendum (WESTON, 1996c)
[b]Arochlors only.
[C]*Macoma nasuta* exposed in laboratory to site-collected sediment.
[d]English sole collected from the site.

X: Analyzed.
–: Not analyzed.

Lipid, PAH, PCB, and Mercury analyses performed by EPA Manchester Lab.
Dioxin/Furan analyses performed by Maxim Technologies, Inc.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 5—SMS and AET Chemical Screening Criteria for Sediment COCs

Chemical	Sediment Management Standards[a]		Apparent Effects Threshold[k]	
	SQS[b]	CSL/MCUL[c]	LAET[i]	2LAET[j]
Organics (ug/kg)				
Acenaphthylene	66,000[e]	66,000[e]	1,300[h]	1,300[h]
Acenaphthene	16,000[e]	57,000[e]	500[h]	730[h]
Anthracene	220,000[e]	1,200,000[e]	960[h]	4,400[h]
Benz(a)anthracene	110,000[e]	270,000[e]	1,300[h]	1,600[h]
Benzo(a)pyrene	99,000[e]	210,000[e]	1,600[h]	3,000[h]
Total Benzofluoranthenes[g]	230,000[e]	450,000[e]	3,200[h]	3,600[h]
Benzo(g,h,i)perylene	31,000[e]	78,000[e]	670[h]	720[h]
Chrysene	110,000[e]	460,000[e]	1,400[h]	2,800[h]
Dibenz(a,h)anthracene	12,000[e]	33,000[e]	230[h]	540[h]
Dibenzofuran	15,000[e]	58,000[e]	540[h]	700[h]
2,4-Dimethylphenol	29[h]	29[h]	29[h]	72[h]
Fluoranthene	160,000[e]	1,200,000[e]	1,700[h]	2,500[h]
Fluorene	23,000[e]	79,000[e]	540[h]	1,000[h]
Total HPAH	960,000[e,f]	5,300,000[e,f]	12,000[h]	17,000[h]
Indeno(1,2,3-cd)pyrene	34,000[e]	88,000[e]	600[h]	690[h]
Total LPAH	370,000[d,e]	780,000[d,e]	5,200[h]	13,000[h]
2-Methylnaphthalene	38,000[e]	64,000[e]	670[h]	1,400[h]
2-Methylphenol	63[h]	63[h]	63[h]	72[h]
4-Methylphenol	670[h]	670[h]	670[h]	1,800[h]
Naphthalene	99,000[e]	170,000[e]	2,100[h]	2,400[h]
Total PCBs[l]	12,000[e]	65,000[e]	130[h]	1,000[h]
Pentachlorophenol	630[h]	690[h]	360[h]	690[h]
Phenanthrene	100,000[e]	480,000[e]	1,500[h]	5,400[h]
Phenol	420[h]	1,200[h]	420[h]	1,200[h]
Pyrene	1,000,000[e]	1,400,000[e]	2,600[h]	3,300[h]
Inorganics (mg/kg)				
Arsenic	57[h]	93[h]	57[h]	93[h]
Cadmium	5.1[h]	6.7[h]	5.1[h]	6.7[h]
Chromium (total)	270[h]	260[h]	260[h]	270[h]
Copper	390[h]	390[h]	390[h]	530[h]

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 5—SMS and AET Chemical Screening Criteria for Sediment COCs

Chemical	Sediment Management Standards[a]		Apparent Effects Threshold[k]	
	SQS[b]	CSL/MCUL[c]	LAET[i]	2LAET[j]
Lead	450[h]	530[h]	450[h]	530[h]
Mercury	0.41[h]	0.59[h]	0.41[h]	0.59[h]
Zinc	410[h]	960[h]	410[h]	960[h]

[a]Chapter 173-204 WAC.
[b]sediment Quality Standards.
[c]cleanup Screening Levels and Minimum Cleanup Levels.
[d]This value represents the sum of the following compounds: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene; the LPAH criteriondoes not represent the sum of the criteria values for the individual compounds.
[e]Normalized to total organic carbon content.
[f]This value represents the sum of the following compounds: fluoranthene, pyrene, benz(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3 cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene; the HPAH criterion does not represent the sum of the criteria values for the idvividual compounds.
[g]Sum of the concnetrations of the "b," "j," and "k" isomers.
[h]Dry-weight basis.
[l]lowest Apparent Effects Threshold.
[j]Second-lowest Apparent Effects Threshold.
[k]Barrick et al., 1988
[l]This value represents the sum of detected Arochlors.

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Table 6—Surface Sediment Background Concentrations for Selected Contaminants[a]

Compound	Concentration						
	Phase 1				Phase 2		
	BK01	BK01[b]	BK02	BK03	BK01	BK04	Average
2,3,7,8-TCDD Equiv. (Ng/kg DW)	0.619	0.518	4.029	0.184	0.290	0.670	1.052
2,3,7,8-TCDD Equiv. (Ng/kg TOCN)	82.5	55.1	366.3	NA	12.100	95.700	122.340
Total LPAHs (ug/kg DW)	3,463	1,008	286	36	847	644	1,044
Total LPAHs (ug/kg TOCN	461,733	107,191	25,991	--	35,292	91,957	144,433
Total HPAHs (ug/kg DW	14,969	3,173	1,528	38	3,608	1,331	4,104
Total HPAHs (ug/kg TOCN)	1,995,867	337,511	138,891	--	150,312	190,114	562,539
Total PAHs (ug/kg DW)	15,007	3,485	1,252	38	3,554	1,714	1,052
Total PCBs (ug.kg DW)	5.8	10.7	50.0	2.3	23 U	199.0	46
Total PCBs (ug/kg TOCN)	773	1,138	4,454	--	23 U	28,429	6,979

See Figure 7 for background locations.
[a]Method used for deriving and summing 2,3,7,8-TCDD equivalents are described in **RI Appendix F** (WESTON 1998).
[b]Field replicate at Station BK01.
DW: Dry-weight
TOCN: Normalized to total organic carbon (TOC) content.
NA: Normalization not appropriate; TOC content less than 0.5 percent.

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Table 7—Summary Statistics for Surface Sediments COCs

Constituent	# of Stations Analyzed	# of Detected Values	Frequency of Detection (%)	Detected Concentrations						# of Stations Exceeding Screening Criteria		Frequency of Exceedance of Screening Criteria (%)[b]		Average CSL/2LAEL
				Dry-Weight			TOC-Normalized							
				Minimum	Maximum	Location of Maximum	Minimum	Maximum	Location of Maximum	SQS/LAET[b]	CSL/2LAET[c]	SQS/LAET	CSL/2LAET	
PAHs (µg/kg)														
Naphtalene	106	104	98	38	85,700	EB09	3,324	2,818,162	EB05	59	38	56	36	3.55
Acenaphthylene	106	106	100	10	8,380	EB13	676	82,174	EB27	4	4	4	4	1.18
Acenaphthene	106	105	99	20	397,000	EB13	1,448	766,234	EB05	83	46	78	43	3.81
Fluorene	106	106	100	21	218,000	EB13	2,133	760,000	EB19	74	36	70	34	3.04
Phenanthrene	106	106	100	96	549,000	EB13	9,857	3,468,750	EB02	64	17	60	16	2.49
Anthracene	106	106	100	42	1,750,000	EB13	4,552	1,900,000	EB02	17	5	16	5	1.39
Total LPAH	106	106	100	248	2,948,080	EB13	21,990	6,988,052	EB05	59	36	56	34	2.74
Fluoranthene	106	106	100	164	2,060,000	EB13	19,095	8,695,652	EB27	57	13	54	12	2.99
Pyrene	106	106	100	187	1,140,000	EB13	16,048	6,956,522	EB27	17	14	16	13	2.59
Benzo(a)anthracene	106	106	100	61	382,000	EB13	11,714	1,891,304	EB27	26	12	25	11	2.56
Chrysene	106	106	100	100	526,000	EB13	16,238	1,860,870	EB27	44	10	42	9	2.24
Total Benzofluoranthenes	106	106	100	177	302,900	EB13	27,333	1,743,478	EB27	32	16	30	15	1.56
Benzo(a)pyrene	106	106	100	84	114,000	EB13	12,857	726,087	EB27	29	11	27	10	1.62
Indeno(1,2,3-cd)pyrene	106	106	100	45	34,400	EB13	6,190	215,652	EB27	41	9	39	8	1.50
Dibenz(a,h)anthracene	106	99	100	4.2	10,700	EB13	1,029	79,130	EB27	30	7	28	7	1.49
Benzo(g,h,i)perylene	106	106	100	46	26,600	EB13	5,238	177,826	EB27	41	7	39	7	1.61
Total HPAH	106	106	100	869	4,596,600	EB13	117,257	22,346,522	EB27	48	11	45	10	2.03
2-Methylnaphthalene	106	105	99	15	26,000	EB13	1,119	648,753	EB05	42	31	40	29	2.26
OTHER SVOCs (µg/kg)														
2,4-Dimethylphenol	44	26	59	21	1,310	EB09	–	–	–	23	23	52	52	
2-Methylphenol	44	31	70	7.2	601	EB09	–	–	–	6	6	14	14	
4-Methylphenol	44	43	98	17	6,770	EB02	–	–	–	4	4	9	9	
Pentachlorophenol	44	8	18	158	380	EB24	–	–	–	1	0	2	0	
Phenol	44	30	68	22	3,980	EB02	–	–	–	3	1	7	2	
Dibenzofuran	67	67	100	40	62,800	EB13	1,985	800,000	EB19	54	29	81	43	3.53
2-Chloronaphthalene	51	0	0	<3.5	<149	–	–	–	–	–	–	–	–	–
Carbazole	51	46	90	13	3,090	EB87	–	–	–	–	–	–	–	–
1-Methylnaphthalene	28	28	100	31	4,570	EB87	–	–	–	–	–	–	–	–
Retene	28	28	100	115	635	EB87	–	–	–	–	–	–	–	–
PCS (µg/kg)														
Total PCBs	42	42	100	24	1,340	EB06	3,923	78,182	EB08	25	2	60	5	1.14
DIOXINS/FURANS (ng/kg)														
2,3,7,8-TCDD (Equiv)	38	38	100	1.97	156	EB26	102	11,817	EB05	–	–	–	–	–

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 7—Summary Statistics for Surface Sediments COCs

Constituent	# of Stations Analyzed	# of Detected Values	Frequency of Detection (%)	Detected Concentrations: Dry-Weight Minimum	Dry-Weight Maximum	Dry-Weight Location of Maximum	TOC-Normalized Minimum	TOC-Normalized Maximum	TOC-Normalized Location of Maximum	# of Stations Exceeding Screening Criteria: SQS/LAET[b]	CSL/2LAET[c]	Frequency of Exceedance of Screening Criteria (%)[b]: SQS/LAET	CSL/2LAET	Average CSL/2LAEL ER[a]
INORGANICS (mg/kg)														
Arsenic	44	39	89	4.7	24	EB13	–	–	–	0	0	0	0	–
Cadmium	44	37	84	0.38	3	EB08	–	–	–	0	0	0	0	–
Chromium	44	44	100	9.2	251	EB09	–	–	–	0	0	0	0	–
Copper	44	44	100	12	410	EB01	–	–	–	1	1	2	2	1.05
Lead	44	44	100	6.7	192	EB09	–	–	–	0	0	0	0	–
Mercury	53	53	100	0.02	4	EB12	–	–	–	19	11	36	21	1.98
Zinc	44	44	100	35	639	EB27	–	–	–	3	0	7	0	–

[a]Average Ers calculated using only those individual Ers > 1.0 and excluding stations EB09 and EB13; these two stations were consistently characterized by chemical concentrations orders of magnitude above 2LAET screening values, which subsequently scewed the average values and effectively masked any apparent differences or trends in contaminant distribution.
[b]Frequencies based on total number of stations analyzed.
[c]The nonionic/nonpolar organic chemical for the following stations were compared with AETs based on TOC content outside the range determined to be appropriate for normalization: EB04, EB09, EB13, EB28, EB34, EB37, EB94.
–: Not appliacble.
<: Not detected at dry-weight detection limit shown.
ER = Exceedance Ration. Ers are calculated by dividing the sample concentration for a given analyte by its screening criterion.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 8—Summary Statistics for Shallow Subsurface (0 to 20 feet bgs) Sediment COCs

Constituent	# of Core Intervals Analyzed	# of Detected Values	Frequency of Detection (%)	Detected Concentrations: Dry-Weight Minimum	Dry-Weight Maximum	Dry-Weight Location of Maximum	TOC-Normalized Minimum	TOC-Normalized Maximum	TOC-Normalized Location of Maximum	# of Core Intervals Exceeding Screening Criteria: SQS/LAET[b]	CSL/2LAET[c]	Frequency of Exceedance of Screening Criteria (%)[b]: SQS/LAET	CSL/2LAET	Average CSL/2LAEL ER[a]
PAHs (ug/kg)														
Naphthalene	65	56	88	4.0	3,310,000	EB13-0000A	588	91,142,857	EB27-0080	29	26	45	40	98.23
Acenaphthylene	65	39	60	1.4	33,800	EB27-0080	240	965,714	EB27-0080	9	9	14	14	4.20
Acenaphthene	65	54	83	2.1	1,490,000	EB27-0080	339	42,571,429	EB27-0080	36	30	55	46	131.79
Fluorene	65	51	78	5.0	1,490,000	EB27-0080	806	42,571,429	EB27-0080	34	29	52	45	80.15
Phenanthrene	65	60	92	4.2	3,750,000	EB27-0080	1,069	107,142,857	EB27-0080	32	21	49	32	61.89
Anthracene	65	61	94	1.2	1,950,000	EB13-0000A	271	11,600,000	EB27-0080	18	11	28	17	59.05
Total LPAH	65	63	97	1.2	10,359,800	EB27-0080	291	295,994,288	EB27-0080	32	25	49	38	73.11
Fluoranthene	65	57	88	7.8	1,530,000	EB27-0080	1,300	43,714,286	EB27-0080	28	18	43	28	56.49
Pyrene	65	62	95	4.0	933,000	EB27-0080	909	26,657,143	EB27-0080	19	16	29	25	27.95
Benzo(a)anthracene	65	45	69	4.7	221,000	EB27-0080	1,784	6,314,286	EB27-0080	20	16	31	25	16.04
Chrysene	65	49	75	2.6	201,000	EB27-0080	371	5,742,857	EB27-0080	21	14	32	22	10.69
Total Benzofluoranthenes	65	51	78	3.6	147,900	EB27-0080	1,055	4,225,714	EB27-0080	19	14	29	22	5.32
Benzo(a)pyrene	65	40	62	6.1	61,700	EB27-0080	813	1,762,857	EB27-0080	20	13	31	20	3.38
Indeno(1,2,3-cd)pyrene	65	43	66	2.7	17,700	EB27-0080	397	505,714	EB27-0080	20	7	31	11	5.38
Dibenz(a,h)anthracene	65	34	52	1.7	6,210	EB27-0080	304	177,429	EB27-0080	18	8	28	12	3.22
Benzo(g,h,i)perylene	65	42	65	2.9	14,400	EB27-0080	426	411,429	EB27-0080	20	8	31	12	3.70
Total HPAH	65	62	95	4.0	3,132,910	EB27-0080	909	89,511,714	EB27-0080	26	15	40	23	20.80
2-Methylnaphthalene	65	61	94	1.2	1,570,000	EB27-0080	200	44,857,143	EB27-0080	28	25	43	38	75.81
OTHER SVOCs (µg/kh)														
2,4-Dimethylphenol	10	2	20	316	3,680	EB13-0000A	–	–	–	2	2	20	20	68.69
2-Methylphenol	10	0	0	<9.1	<335	–	–	–	–	0	0	0	0	–
4-Methylphenol	10	3	30	107	2,026	EB13-0000A	–	–	–	1	1	10	10	3.07
Pentachlorophenol	10	0	0	<18	<670	–	–	–	–	0	0	0	0	–
Phenol	10	0	0	<9.1	<335	–	–	–	–	0	0	0	0	–
Dibenzofuran	10	8	80	27	612,000	EB13-0000A	15,778	3,013,158	EB13-0080	6	5	60	50	198.13
2-Chloronaphthalene	49	1	2	10,600	10,600	EB72-0000A	–	–	–	–	–	–	–	–
Carbazole	49	30	61	0.003	95,400	EB27-0080A	–	–	–	–	–	–	–	–
1-Methylnaphthalene	59	57	97	1.2	897,000	EB27-0080	–	–	–	–	–	–	–	–
Retene	49	49	100	12	83,300	EB113-0040	–	–	–	–	–	–	–	–
PCBs (µg/kg)														
Total PCBs	10	1	10	291	291	EB13-0000A	–	–	–	1	0	10	0	–

Pacific Sound Resources Record of Decision-Marine Sediments Unit
Table 8-Summary Statistics for Shallow Subsurface (0 to 20 feet bgs) Sediment COCs

Constituent	# of Core Intervals Analyzed	# of Detected Values	Frequency of Detection (%)	Detected Concentrations						# of Core Intervals Exceeding Screening Criteria		Frequency of Exceedance of Screening Criteria (%)[b]		Average CSL/2LAE1 ER [a]
				Dry-Weight			TOC-Normalized							
				Minimum	Maximum	Location of Maximum	Minimum	Maximum	Location of Maximum	SQS/LAET[c]	CSL/2LAE[C]	SQS/LAET	CSL/2LAET	
INORGANIC (mg/kg)														
Arsenic	10	7	70	4.5	11.0	EB13-0000A	—	—	—	0	0	0	0	—
Cadmium	10	2	20	0.34	1.6	EB13-0000A	—	—	—	0	0	0	0	—
Chromium	10	10	100	10	67	EB13-0000A	—	—	—	0	0	0	0	—
Copper	10	10	100	7.6	62	EB13-0000A	—	—	—	0	0	0	0	—
Lead	10	10	100	3.0	102.0	EB410000A	—	—	—	0	0	0	0	—
Mercury	10	9	90	0.023	0.71	EB13-0000A	—	—	—	1	1	10	10	1.20
Nickel	10	10	100	6.6	26	EB13-0000A	—	—	—	0	0	0	0	—
Zinc	10	10	100	20	252	EB13-0000A	—	—	—	0	0	0	0	—

[a] Average ERs calculated using only those individuals ERs > 1.0.
[b] Frequencies based on total number of stations analyzed.
[c] The nonionic/nonpolar or organic chemical data for several core intervals were compared with AETs based on TOC content outside the range determined to be appropriate for normalization.
— Not applicable: Constituent not detected, screening criteria based on dry-weight data or not available, or TOC content outside range for normalization.
> Not detected at dry-weight detection limit shown.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 9 —Summary of Human Health Chemicals of Concern and Fish Tissue Exposure Point Concentrations

Scenario Timeframe: Current (Baseline)
Medium: Fish Tissue
Exposure Medium: Fish Fillet Tissue

Exposure Point	**Chemical of Concern**	Concentration Detected[D]		Units	Frequency of Detection	Exposure Point Concentration[D]	Exposure Point Concentration Units	Statistical Measure
		Minimum	Maximum					
Ingestion of Fish Fellets	Aroclor 1242	13	52	ug/kg-WW	3/6	553	ug/kg-WW	90th Percentuile
	Aroclor 1254	54	330	ug/kg-WW	6/6	672	ug/kg-WW	90th Percentuile
	Aroclor 1260	51	140	ug/kg-WW	6/6	297	ug/kg-WW	90th Percentuile
	Total PCB	105	492	ug/kg-WW	6/6	1329	ug/kg-WW	90th Percentuile
	Total 2,3,7,8-TCDD (Equiv.)	0.00007	0.00031	ug/kg-WW	2/3	0.0521	ug/kg-WW	90th Percentuile

[B] Based on 6 composite fish samples collected from the site.
[D] Site-wide exposure concentration estimated from surface sediment concentration using a biota-sediment accumulation factor.
WW: Wet-weight.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 10—Summary of Human Health Chemicals of Concern and Shellfish Tissue Exposure Point Concentrations

Scenario Timeframe: Current (Baseline)
Medium: Shellfish
Exposure Medium: Clam Whole Body Tissue

Exposure Point	Chemical of Concern	Concentration Detected[B]		Units	Frequency of Detection	Exposure Point Concentration[D]	Exposure Point Concentration Units	Statistical Measure
		Minimum	Maximum					
Ingestion of Shellfish	Naphthalene	6.7	15	ug/kg-WW	3/9	760	ug/kg-WW	90th Percentile
	Acenaphthylene	2.4	4.8	ug/kg-WW	7/9	54	ug/kg-WW	90th Percentile
	Acenaphthene	3.6	5.2	ug/kg-WW	3/9	409	ug/kg-WW	90th Percentile
	Fluorene	5.3	47	ug/kg-WW	4/9	332	ug/kg-WW	90th Percentile
	Phenanthrene	11	100	ug/kg-WW	9/9	933	ug/kg-WW	90th Percentile
	Anthracene	15	1520	ug/kg-WW	9/9	398	ug/kg-WW	90th Percentile
	Total LPAH	28	1690	ug/kg-WW	9/9	3075	ug/kg-WW	90th Percentile
	Fluoranthene	27	911	ug/kg-WW	9/9	1720	ug/kg-WW	90th Percentile
	Pyrene	118	1180	ug/kg-WW	9/9	2674	ug/kg-WW	90th Percentile
	Benzo(a)anthracene	26	246	ug/kg-WW	8/9	495	ug/kg-WW	90th Percentile
	Chrysene	35	284	ug/kg-WW	9/9	572	ug/kg-WW	90th Percentile
	Benzo(b)fluoranthene	108	450	ug/kg-WW	9/9	659	ug/kg-WW	90th Percentile
	Benzo(k)fluoranthene	44	170	ug/kg-WW	9/9	211	ug/kg-WW	90th Percentile
	Total Benzofluoranthenes	152	620	ug/kg-WW	9/9	696	ug/kg-WW	90th Percentile
	Benzo(a)pyrene	69	254	ug/kg-WW	9/9	307	ug/kg-WW	90th Percentile
	Indeno(1,2,3-cd)pyrene	20	62	ug/kg-WW	9/9	92	ug/kg-WW	90th Percentile
	Dibenz(a,h)anthracene	4.4	18	ug/kg-WW	9/9	25	ug/kg-WW	90th Percentile
	Benzog(g,h,i)perylene	20	55	ug/kg-WW	9/9	75	ug/kg-WW	90th Percentile
	Total HPAH	500	3399	ug/kg-WW	9/9	6316	ug/kg-WW	90th Percentile
	Total BaP Equivalent	90	350	ug/kg-WW	9/9	432	ug/kg-WW	90th Percentile
	Aroclor 1016	ND	ND	ug/kg-WW	0/9	43	ug/kg-WW	90th Percentile
	Aroclor 1221	ND	ND	ug/kg-WW	0/9	43	ug/kg-WW	90th Percentile
	Aroclor 1232	ND	ND	ug/kg-WW	0/9	43	ug/kg-WW	90th Percentile
	Aroclor 1242	ND	ND	ug/kg-WW	0/9	86	ug/kg-WW	90th Percentile
	Aroclor 1248	ND	ND	ug/kg-WW	0/9	43	ug/kg-WW	90th Percentile
	Aroclor 1254	13	44	ug/kg-WW	8/9	104	ug/kg-WW	90th Percentile
	Aroclor 1260	14	14	ug/kg-WW	1/9	45	ug/kg-WW	90th Percentile
	Total PCB	13	58	ug/kg-WW	8/9	205	ug/kg-WW	90th Percentile
	Total 2,3,7,8-TCDD (Equiv.)	0.00016	0.00053	ug/kg-WW	9/9	0.00825	ug/kg-WW	90th Percentile

[a] Based on 9 composite clam samples from laboratory bioaccumulation study.
[D] Site-wide exposure concentration estimated from surface sediment concentrations using biota-sediment accumulation factor.
WW: Wet-weight.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 11—Human Health Cancer Toxicity Data Summary

Pathway: Ingestion of Fish and/or Shellfish

Chemical of Concern	Oral Cancer Slope Factor	Slope Factor Units	Weight of Evidence/ Cancer Guideline Description	Source	Date
Carbazole	2.00E-02	(mg/kg)/day	B2	HEAST	1997
Total cPAHs (BaP equiv.)	7.30E+00	(mg/kg)/day	B2	IRIS	1997
Total PCBs	2.00E+00	(mg/kg)/day	B2	IRIS	1997
2,3,7,8-TCDD (Equiv.)	1.56E+05	(mg/kg)/day	B2	HEAST	1995

IRIS: Integrated Risk Information System, U.S. EPA.
HEAST: Health Effects Assessment Summary Tables.
B2: Probable human carcinogen - Indicates sufficient evidence in animals and inadequate or no evidence in humans.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 12—Human Health Cancer Toxicity Data Summary

Pathway: Ingestion of Fish and/or Shellfish

Chemical of Concern	Chronic/ Subchronic	Oral RID Value	Oral RID Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RID: Target Organ	Dates of RID: Target Organ
Acenaphthene	Chronic	6.00E-02	(mg/kg)/day	Liver	3000 [a]	IRIS	1999
Anthracene	Chronic	3.00E-01	(mg/kg)/day	NOEL	3000 [a]	IRIS	1999
Fluoranthene	Chronic	4.00E-02	(mg/kg)/day	Kidney, Liver, Blood	3000 [a]	IRIS	1999
Fluorene	Chronic	4.00E-02	(mg/kg)/day	Blood	3000 [a]	IRIS	1999
Naphthalene	Chronic	4.00E-02	(mg/kg)/day	Not Applicable	Not Applicable	Surrogate [D]	Not Applicable
Pyrene	Chronic	3.00E-02	(mg/kg)/day	Kidney	3000 [a]	IRIS	1997
Total PCBs	Chronic	2.00E-05	(mg/kg)/day	Eye, Impaired Growth, Immune System	3000 [a]	IRIS	1997

[a] Uncertainty factor; Modifying factor = None; Confidence in value = Low.
[D] Fluoranthene and fluorene used as surrogate for naphthalene.
IRIS: Integrated Risk Information System, U.S. EPA.

Table 13—Risk Parameters

Fish and Shellfish Consumption Exposure Scenario Parameters

Parameter	Parameter Description	Exposure via Fish Consumption				Exposure via Shellfish Consumption			
		Adult RME	Adult CTE	Child RME	Child CTE	Adult RME	Adult CTE	Child RME	Child CTE
c(fish)	concentration of contaminant in fish (ug/kg)	Chemical Specific							
IR	human daily ingestion rate of fish (g/day)	15.96	1.05	0.485	0.485	91.58	8.05	8.61	0.18
EF	human exposure frequency to scenario involving consumption of fish (days/yr)	175	175	175	175	175	175	175	175
ED	human exposure duration to scenario involving consumption of fish (years)	24	24	6	6	24	25	6	6
f(PS)	fraction of fish consumed that are obtained from Puget Sound (unitless)	0.21	0.21	0.21	0.21	0.67	0.67	0.67	0.67
f(species)	fraction of types fish/shellfish species consumed that are available at the site (unitless)	1	1	1	1	0.49	0.34	0.49	0.34
f(utilization)	Fraction the site represents of total sites utilized by individuals in Puget Sound to harvest fish/shellfish (unitless)	1	1	1	1	1	1	1	1
BW	body weight of person (kg)	70	70	15	15	70	70	15	15
ATcancer	averaging time over which carcinogenic exposure should be considered-usually considered as a lifetime (years)	70	70	NA	NA	70	70	NA	NA
ATnoncancer	averaging time over which noncarcinogenic exposure should be considered-usually considered as equal to the exposure duration (years)	24	24	6	6	24	24	6	6
RfDo	oral noncancer reference dose considered an exposure threshold (mg/kg-day)	Chemical Specific							
CSFo	oral cancer slope factor expressing carcinogenic toxicity of contaminant (kg-day/mg)	Chemical Specific							
HQ	hazard quotient expressing a ratio of exposure to the reference dose (unitless)	Chemical Specific							
CR	incremental cancer risk expressing probability of developing cancer over a lifetime from given exposure (unitless)	Chemical Specific							
THQ	target hazard quotient-predetermined value not to be exceeded (unitless)	1	1	1	1	1	1	1	1
TCR	target cancer risk-predetermined value not to be exceeded (unitless)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
Cf1	converts chem conc in fish from up to mg (mg/ug)	1.00E-03	1.00E-03	1.00E-03	1.00E-03	0.001	0.001	0.001	0.001
Cf2	converts ingestion rate from g to (kg/g)	1.00E-03	1.00E-03	1.00E-03	1.00E-03	0.001	0.001	0.001	0.001
Cf3	converts avg time from years to days (days/yr)	365	365	365	365	365	365	365	365

Sediment/Tissue Concentration Parameters

Parameter	Parameter Description	Fish Value	Shellfish Value
c(sediment)	concentration of contaminant in sediment (ug/kg-DW)	chem spec	chem spec
c(fish)	concentration of contaminant in fish (ug/kg)	chem spec	chem spec
f(lipid)	fraction of lipid in fish (unitless)	0.017	0.0026
BSAF	biota sediment accumulation factor [(ug-contam/g-lipid)(ug-contam/g-OC) for transfer of contaminant from sediment to fish	chem spec	chem spec
foc	fraction of organic carbon in the sediment (unitless)	0.0183	0.0183

Table 13—Risk Parameters

Equations for calculating risk

$$HQ = \frac{c(fish) \times IR \times EF \times ED \times f(PS) \times f(species) \times f(utliz) \times CF1 \times CF2}{BW \times ATnoncancer \times CF3 \times RfDo}$$

$$CR = \frac{c(fish) \times IRtwa \times EF \times (EDa+EDc) \times f(PS) \times f(species) \times f(utliz) \times CF1 \times CF2 \times CSFo}{BWtwa \times ATcancer \times CF3}$$

$$c(fish) = \frac{c(sed) \times f(lipid) \times BSAF}{foc}$$

Equations for calculating risk-based concentrations

$$RBC(fish) = \frac{THQ \times BW \times ATnoncancer \times CF3 \times RfDo}{IR \times EF \times ED \times f(PS) \times f(species) \times f(utliz) \times CF1 \times CF2}$$

$$RBC(fish) = \frac{TCR \times BWtwa \times ATcancer \times CF3}{IRtwa \times EF \times (EDc+EDa) \times f(PS) \times f(species) \times f(utliz) \times CF1 \times CF2 \times CSFo}$$

$$RBC(sed) = \frac{foc \times RBC(fish)}{f(lipid) \times BSAF}$$

Time-weighted average values over total exposure duration

$$IRtwa = \frac{(IRadult \times EDadult) + (IRchild \times EDchild)}{(EDchild + EDadult)}$$

$$BWtwa = \frac{(BWadult \times EDadult) + (BWchild \times EDchild)}{(EDchild + EDadult)}$$

SUMMARY INTAKE FACTORS						
	Fish			Shellfish		
	Cancer	Adult Noncancer	Child Noncancer	Cancer	Adult Noncancer	Child Noncancer
RME	9.41E-09	2.30E-08	3.12E-09	8.57E-08	2.06E-07	9.03E-08
CTE	6.82E-10	1.51E-09	3.12E-09	5.32E-09	1.31E-08	1.31E-09

NOTE: *HQ=(c(fish)*SIF)/RfDo* *RBC(fish)=(THQ*RfDo)/SIF*
*CR=c(fish)*SIF*CSFo* *RBC(fish)=TCR/(SIF*CSFo)*

INVERSE SUMMARY INTAKE FACTORS						
	Fish			Shellfish		
	Cancer	Adult Noncancer	Child Noncancer	Cancer	Adult Noncancer	Child Noncancer
RME	1.06E+08	4.36E+07	3.20E+08	1.17E+07	4.86E+06	1.11E+07
CTE	1.47E+09	6.62E+08	3.20E+08	1.88E+08	7.64E+07	7.63E+08

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 14-Human Health Risk Characterization Summary - Carcinogens

Scenario Timeframe: Current (Baseline)
Receptor Population: Tribal Fisher (RME)

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Lifetime Carcinogenic Risk from Ingestion
Fish	Fish Fillet	Ingestion	Benzo(g,h,i)perylene	NA
			Phenanthrene	NA
			Pyrene	NA
			Total (BaP) Equivalent	NA
			Benzo(a)anthracene	NA
			Chrysene	NA
			Benzo(b)fluoranthene	NA
			Benzo(k)fluoranthene	NA
			Benzo(a)pyrene	NA
			Indeno(1,2,3-cd)pyrene	NA
			Dibenz(a,h)anthracene	NA
			Total PCBs	2.5E-05
			Total 2,3,7,8-TCDD (Equiv.)	7.6E-05
Shellfish	Clam Whole Body	Ingestion	Benzo(g,h,i)perylene	NA
			Phenanthrene	NA
			Pyrene	NA
			Total (BaP) Equivalent	2.7E-04
			Benzo(a)anthracene	3.1E-05
			Chrysene	3.6E-07
			Benzo(b)fluoranthene	4.1E-05
			Benzo(k)fluoranthene	1.3E-06
			Benzo(a)pyrene	1.9E-04
			Indeno(1,2,3-cd)pyrene	5.8E-06
			Dibenz(a,h)anthracene	1.6E-05
			Total PCBs	3.5E-05
			Total 2,3,7,8-TCDD (Equiv.)	1.1E-04
Fish & Shellfish	Fish Fillet & Clam Whole Body	Ingestion	Benzo(g,h,i)perylene	NA
			Phenanthrene	NA
			Pyrene	NA
			Total (BaP) Equivalent	2.7E-04
			Benzo(a)anthracene	3.1E-05
			Chrysene	3.6E-07
			Benzo(b)fluoranthene	4.1E-05
			Benzo(k)fluoranthene	1.3E-06
			Benzo(a)pyrene	1.9E-04
			Indeno(1,2,3-cd)pyrene	5.8E-06
			Dibenz(a,h)anthracene	1.6E-05
			Total PCBs	6.0E-05
			Total 2,3,7,8-TCDD (Equiv.)	1.9E-04
			Total Risk [a]	5E-04

[a] includes PCBs.
NA: Not available.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 15—Human Health Risk Characterization Summary - Non-Carcinogens

Scenario Timeframe: Current (Baseline)
Receptor Population: Tribal Fisher
Receptor Age: Adult and Child

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient	
					Adult	Child
Fish	Fish Fillet	Ingestion	Benzo(g,h,i)perylene		NA	NA
			Phenanthrene		NA	NA
			Pyrene	Kidney	NA	NA
			Total (BaP) Equivalent		NA	NA
			Benzo(a)anthracene		NA	NA
			Chrysene		NA	NA
			Benzo(b)fluoranthene		NA	NA
			Benzo(k)fluoranthene		NA	NA
			Benzo(a)pyrene		NA	NA
			Indeno(1,2,3-cd)pyrene		NA	NA
			Dibenz(a,h)anthracene		NA	NA
			Total PCBs		1.5	0.2
			Total 2,3,7,8-TCDD (Equiv.)		NA	NA
				Fish Total Risks	2	0
Shellfish	Clam Whole Body	Ingestion	Benzo(g,h,i)perylene		NA	NA
			Phenanthrene		NA	NA
			Pyrene	Kidney	0.0	0.0
			Total (BaP) Equivalent		NA	NA
			Benzo(a)anthracene		NA	NA
			Chrysene		NA	NA
			Benzo(b)fluoranthene		NA	NA
			Benzo(k)fluoranthene		NA	NA
			Benzo(a)pyrene		NA	NA
			Indeno(1,2,3-cd)pyrene		NA	NA
			Dibenz(a,h)anthracene		NA	NA
			Total PCBs		2.1	0.9
			Total 2,3,7,8-TCDD (Equiv.)		NA	NA
				Shellfish Total Risks	2	1
Fish & Shellfish	Fish Fillet & Clam Whole Body	Ingestion	Benzo(g,h,i)perylene		NA	NA
			Phenanthrene		NA	NA
			Pyrene	Kidney	0.0	0.0
			Total (BaP) Equivalent		NA	NA
			Benzo(a)anthracene		NA	NA
			Chrysene		NA	NA
			Benzo(b)fluoranthene		NA	NA
			Benzo(k)fluoranthene		NA	NA
			Benzo(a)pyrene		NA	NA
			Indeno(1,2,3-cd)pyrene		NA	NA
			Dibenz(a,h)anthracene		NA	NA
			Total PCBs		3.6	1.1
			Total 2,3,7,8-TCDD (Equiv.)		NA	NA
				Fish and Shellfish Total Risks	4	1

NA: Not available.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 16—Ecological Exposure Pathways of Concern

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Endangered/ Threatened Species Flag (Y or N)	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Sediment	N	Benthic Organisms	N	Sediment ingestion, respiration, direct contact with chemicals in sediment	Benthic invertebrate health	- Abundance and richness of individual species, major taxonomic groups (crustaceans, mollusca, polychaetes), and total organisms - Community structure evaluation - Swartz's Domininance Index - Toxicity of sediment to amphipods (*Ampelisca abdita*) - Toxicity of sediment to echinoderm embryos (*Dendraster excentricus*)
		Shellfish	N	Ingestion of contaminated sediment and prey, respiration, direct contact with chemicals in sediment	Shellfish population health	- Toxicity of sediment to clams (*Macoma nasuta*) - Chemical concentrations of bioaccumulative COCs in whole body clam tissues
		Flat Fish	N	Ingestion of contaminated sediment and prey, respiration, direct contact with chemicals in sediment	Fish population health	- Chemical concentrations of bioaccumulative COCs in whole body English sole tissues - Maternal/egg TCDD transfer model

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 17—Occurrence, Distribution and Selection of Ecological Chemicals of Concern in Sediment

Exposure Medium: Sediment (Benthic Invertebrates)

Chemical of Potential Concern	Minimum Conc. (ppb)[a]	Maximum Conc. (ppb)[a]	Mean Conc. (ppb)	Background Conc. (ppb)[c]	Screening Toxicity Value (ppb)	Screening Toxicity Value Source	HQ Value[d]	COC Flag (Y or N)
2,3,7,8-TCDD (Equiv.)[b]	102	11,819	1,523	122	122	Background	96.9	Y
Acenaphthylene[b]	676	82,174	14,617	2,536	66,000	SMS SQS	1.25	Y
Acenaphthene[b]	1,448	766,234	102,255	8,966	16,000	SMS SQS	47.9	Y
Anthracene[b]	4,552	1,900,000	128,367	29,040	220,000	SMS SQS	8.64	Y
Benzo(a)anthracene[b]	11,714	1,891,304	122,502	58,274	110,000	SMS SQS	17.2	Y
Benzo(a)pyrene[b]	12,857	726,087	89,746	52,438	99,000	SMS SQS	7.33	Y
Benzo(b)fluoranthene	129	215,000	5,759	NA	NA	--	--	Y
Benzo(g,h,i)perylene[b]	5,238	177,826	31,747	25,498	31,000	SMS SQS	5.74	Y
Benzo(k)fluoranthene	48	67,900	2,144	NA	NA	--	--	Y
2-Chloronaphthalene[b]	NA	NA	NA	NA	NA	--	--	Y
Chrysene[b]	16,238	1,860,870	169,923	68,981	110,000	SMS SQS	16.9	Y
Dibenz(a,h)anthracene[b]	1,029	79,130	10,558	6,648	12,000	SMS SQS	6.59	Y
Fluoranthene[b]	19,095	8,695,652	476,699	90,845	160,000	SMS SQS	54.3	Y
Fluorene[b]	2,133	760,000	92,271	9,201	23,000	SMS SQS	33.0	Y
Indeno(1,2,3-cd)pyrene[b]	6,190	215,652	36,156	25,804	34,000	SMS SQS	6.34	Y
2-Methylnaphthalene[b]	1,119	646,753	55,424	NA	38,000	SMS SQS	17.0	Y
Naphthalene[b]	3,324	2,818,182	246,084	10,941	99,000	SMS SQS	28.5	Y
Phenanthrene[b]	9,857	3,468,750	292,003	85,936	100,000	SMS SQS	34.7	Y
Pyrene[b]	16,048	6,956,522	553,522	152,635	1,000,000	SMS SQS	6.96	Y
Total Benzofluoranthenes[b]	27,333	1,743,478	214,170	81,415	230,000	SMS SQS	7.6	Y
Total HPAH[b]	117,257	22,346,522	1,705,017	562,539	960,000	SMS SQS	23.3	Y
Total LPAH[b]	21,990	6,988,052	880,561	144,433	370,000	SMS SQS	18.9	Y
Total PCBs[b]	3,923	78,182	19,291	8,721	12,000	SMS SQS	8.96	Y
Dibenzofuran[b]	1,895	800,000	94,762	NA	15,000	SMS SQS	53.3	N
Phenolic Compounds	7.2	6,770	1,199	NA	29 - 670	SMS SQS	10.1	N
Arsenic	4,700	24,000	12,536	NA	57,000	SMS SQS	<1	N
Chromium	9,200	251,000	45,769	NA	260,000	SMS SQS	<1	N
Copper	12,000	410,000	102,116	NA	390,000	SMS SQS	1.05	N
Mercury	20	4,200	464	100	410	SMS SQS	10.2	N
Zinc	35,000	639,000	197,800	NA	410,000	SMS SQS	1.56	N

[a]Minimum/maximum detected concentration above the sample quantitation limit (SQL).
[b]Data normalized to total organic carbon (TOC) content.
[c]Based on average of detected values only.
[d]Hazard quotient (HQ) is defined as Maximum Concentration/Screening Toxicity Value.
ppb: part-per-billion (ug/kg).
NA: Not available.
SMS SQS: Sediment Management Standards Sediment Quality Standard.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 18—Occurrence, Distribution and Selection of Ecological Chemicals of Concern in Shellfish

Exposure Medium: Clam Whole Body Tissue

Chemical of Potential Concern	Minimum Conc. (ppb)[a]	Maximum Conc. (ppb)[a]	Mean Conc. (ppb)	Background Conc. (ppb)[c]	Screening Toxicity Value (ppb)	Screening Toxicity Value Source	HQ Value[d]	COC Flag (Y or N)
Mercury	ND	ND	—	—	—	—	—	N
Acenaphthylene[b]	1,043	1,680	1,311	13,842	13,842	Background	<1	N
Acenaphthene[b]	1,161	2,080	1,698	13,842	13,842	Background	<1	N
Anthracene[b]	6,478	562,963	74,405	1,947	1,947	Background	289	Y
Benzo(a)anthracene[b]	9,481	79,355	34,504	13,842	13,842	Background	5.73	Y
Benzo(a)pyrene[b]	30,130	81,935	53,702	5,685	5,685	Background	14.4	Y
Benzo(b)fluoranthene[b]	46,957	147,200	90,604	7,816	7,816	Background	18.8	Y
Benzo(g,h,i)perylene[b]	8,778	17,645	12,301	3,053	3,053	Background	5.78	Y
Benzo(k)fluoranthene[b]	19,000	54,839	35,331	2,526	2,526	Background	21.7	Y
2-Chloronaphthalene[b]	ND	ND	—	—	—	Background	—	N
Chrysene[b]	15,222	96,296	41,782	4,711	4,711	Background	20.4	Y
Dibenz(a,h)anthracene[b]	1,913	5,871	3,123	13,842	13,842	Background	<1	N
Fluoranthene[b]	11,870	295,926	99,135	7,790	7,790	Background	38.0	Y
Fluorene[b]	1,710	17,370	6,314	13,842	13,842	Background	1.25	Y
Indeno(1,2,3-cd)pyrene[b]	8,696	19,935	12,717	3,000	3,000	Background	6.65	Y
2-Methylnaphthalene[b]	4,222	4,222	4,222	13,842	13,842	Background	<1	N
Naphthalene[b]	2,593	5,556	3,609	13,842	13,842	Background	<1	N
Phenanthrene[b]	4,783	37,037	10,024	3,789	3,789	Background	9.77	Y
Pyrene[b]	51,304	437,037	177,850	10,790	10,790	Background	40.5	Y
Total Benzofluoranthenes[b]	65,957	200,000	125,935	9,079	9,079	Background	22.0	Y
Total HPAH[b]	217,348	1,146,111	557,217	41,079	41,079	Background	27.9	Y
Total LPAH[b]	12,304	625,963	90,024	4,763	4,763	Background	131	Y
2,3,7,8-TCDD (Equiv.)[b]	0.00069	0.243	0.123	0.0237	0.0237	Background	10.3	Y
Total PCBs[b]	4,815	18,710	9,301	6,842	6,842	Background	2.73	Y

[a]Minimum/maximum detected concentration above the sample quantitation limit (SQL).
[b]Data normalized to lipid content.
[c]Based on average of detected values only.
[d]Hazard quotient (HQ) is defined as Maximum Concentration/Screening Toxicity Value.
ppb: part-per-billion (ug/kg).
ND: Not detected above SQL.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 19—Occurrence, Distribution and Selection of Ecological Chemicals of Concern in Fish

Exposure Medium: Fish Whole Body Tissue

Chemical of Potential Concern	Minimum Conc. (ppb)[a]	Maximum Conc. (ppb)[a]	Mean Conc. (ppb)	Background Conc. (ppb)[c]	Screening Toxicity Value (ppb)	Screening Toxicity Value Source	HQ Value[d]	COC Flag (Y or N)
Mercury	ND	ND	--	--	--	--	--	N
2,3,7,8-TCDD (Equiv.)[b]	0.00081	0.145	0.0287	0.00489	0.00489	Background	29.7	Y
Total PCBs[b]	4,407	13,136	7,230	4,173	4,173	Background	3.15	Y

[a]Minimum/maximum detected concentration above the sample quantitation limit (SQL).
[b]Data normalized to lipid content.
[c]Based on average.
[d]Hazard quotient (HQ) is defined as Maximum Concentration/Screening Toxicity Value.
ppb: part-per-billion (ug/kg).
ND: Not detected of SQL.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 20—Alternate Concentration Limits

Constituents of Concern	ACLs (µg/L) Shallow Wells 9 to -6 ft MLLW)	Intermediate Wells (-20 to -40 ft MLLW)	Deep Wells (-75 to -85 ft MLLW)
Naphthalene	>S	7,700	30,000
Acenaphthylene	3,300	700	2,700
Acenaphthene	>S	>S	>S
Fluorene	930	200	790
Phenanthrene	>S	400	1,000
Anthracene	>S	900	>S
Fluoranthene	>S	100	>S
Pyrene	>S	>S	>S
Benzo(a)anthracene	>S	3.0	>S
Chrysene	>S	3.0	>S
Benzo(b)fluoranthene	>S	>S	>S
Benzo(k)fluoranthene	14	3.0	12
Benzo(a)pyrene	>S	3.0	>S
Indeno(1,2,3-cd)pyrene	0.47	0.1	0.39
Dibenzo(a,h)anthracene	>S	>S	>S
Benzo(g,h,i)perylene	0.09	0.016	0.06
Dibenzofuran	880	190	750
Pentachlorophenol	2,300	490	1,900
Zinc	36,000	7,700	30,000

Note:
The calculated concentrations reported in the table do not result in cleanup levels being exceeded at the mudline. Values correspond to the shortest distance to the mudline for the shallow, intermediate and deep zones. “S” indicates that concentrations in excess of the individual constituent solubility level in water are required to exceed cleanup levels at the mudline.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 21—Alternative Summary

Alternative	Cleanup Goal	Institutional Controls	Monitoring	Cap Material Required[2] (cubic yards)	Capping Area (square yards	Dredged Volume (cubic yards)	Disposal Capacity Needed[1,2] (cubic yards)	Disposal Facility[2]
Alternative 1 No Action	NA	No	No	0	0	0	0	NA
Alternative 2 Dredging	CSL	Yes	Yes	Offshore: 71,000 Shoreline: 24,000 GDZ: 20,000 **Total: 115,000**	Offshore: 34,000 Shoreline: 16,000 GDZ: 20,000 **Total: 70,000**	Offshore: 313,000 CMS: 9000 GDZ: 50,000 **Total: 372,000**	428,000	Nearshore, CAD or newly constructed upland facility
Alternative 3a Capping	SQS	Yes	Yes	Offshore: 740,000 Shoreline: 26,000 GDZ: 20,000 **Total: 786,000**	Offshore: 426,000 Shoreline: 18,000 GDZ: 20,000 **Total: 464,000**	Offshore: 0 CMS: 3,500 GDZ: 0 **Total: 3,500**	4,025	Existing upland facility.
Alternative 3b Capping	CSL	Yes	Yes	Offshore: 328,000 Shoreline: 23,000 GDZ: 20,000 **Total: 371,000**	Offshore: 193,000 Shoreline: 15,000 GDZ: 20,000 **Total: 228,000**	Offshore: 0 CMS: 3,500 GDZ: 0 **Total: 3,500**	4,025	Existing upland facility.
Alternative 4a Fill Area Removal and Capping	SQS	Yes	Yes	Offshore: 531,000 Shoreline: 26,000 GDZ: 20,000 **Total: 577,000**	Offshore: 318,000 Shoreline: 18,000 GDZ: 20,000 **Total: 356,000**	Offshore: 328,000 CMS: 3,500 GDZ: 50,000 **Total: 381,500**	439,000	Nearshore, CAD or newly constructed upland facility
Alternative 4b Fill Area Removal and Capping	CSL	Yes	Yes	Offshore: 119,000 Shoreline: 23,000 GDZ: 20,000 **Total: 162,000**	Offshore: 82,000 Shoreline: 15,000 GDZ: 20,000 **Total: 117,000**	Offshore: 220,000 CMS: 3,500 GDZ: 50,000 **Total: 273,500**	315,000	Nearshore, CAD or newly constructed upland facility.

[1]155 bulking factor

[2]Disposal methods and capping volumes have been modified slightly from those provided in the FS.

NA: Not Applicable

GDZ: Groundwater Discharge Zone

CMS: Crowley Marine Services

See Figure 4 for depiction of GDZ, CMS and shoreline areas

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 22—Comparison of Dredge Equipment

Dredge Type	Depth Range (feet)	Production Rate per 24-hour day	% Solids by Weight	Resuspension Potential	Material Transport Method	Volume Increase at Disposal Point
Closed Clamshell	0 – 200	500 – 3,500 CY	>60%	Moderate to high	Barge	15 – 25%
Cutterhead Suction	3 – 90	3,000 – 15,000 CY	10 to 20%	Low to moderate	Pipeline	15 – 25%
High Energy Vortex (Eddy Pump™)	3 – 200	4,000 – 18,000 CY	50 to 60%	Low	Pipeline	15 – 25%
Limited Access Hydraulic	0 – 60	500 – 1,500	10 to 20%	Low to Moderate	Pipeline	15 – 25%

CY = Cubic Yards

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 23—Estimated Schedule of Available Capping Material

Source Location	Percent Sand	1999	2000	2001	2002	2003	2004	2005
Duwamish River: Upstream of Settling Basin	70-90%	40,000 CY	0	40,000 CY	0	40,000 CY	0	40,000 CY
Duwamish River: Lower Reach	<50%	100,000 CY	0	100,000 CY	0	100,000 CY	0	100,000 CY
Snohomish River: Upper Reach	90%	0	0	0	240,000 CY	0	0	240,000 CY
Snohomish River: Lower Reach	70%	0	0	240,000 CY	0	240,000 CY	0	240,000 CY
Everett Home Port	70% (est.)	0	150,000 CY	0	0	0	0	0
Annual Volume of Sandy Material (excludes lower Duwamish River)		40,000 CY	150,000 CY	280,000 CY	240,000 CY	280,000 CY	0	320,000CY
Annual Total Volume		140,000 CY	150,000 CY	380,000 CY	240,000 CY	380,000 CY	0	420,000 CY
Cumulative Volume of Sandy Material (excludes lower Duwamish River		40,000 CY	190,000 CY	470,000 CY	710,000 CY	890,000 CY	890,000 CY	1,210,000 CY
Cumulative Total Volume		140,000 CY	290,000 CY	670,000 CY	910,000 CY	1,290,000 CY	1,290,000 CY	1,710,000 CY

CY = Cubic Yard.
Dredge Mmaterial from Upper Snohomish River may not be available until 2002 due to existing commitments.
Available quantities are variable depending on runoff and dredging requirements.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 24—Items to be Considered—PSR Site Sediment Remediation

Federal, State, and Local Criteria, Advisories and Procedures	Comments
Guidelines developed by the Elliott Bay/Duwamish Restoration Panel	Guidelines for habitat restoration
Puget Sound Water Quality Management Plan	Defines the objectives for standards regarding the confined disposal of contaminated sediment.
Standards for Confined Disposal of Contaminated Sediments, Washington Department of Ecology (January 1990)	Guidelines for assessing the suitability of dredged material for unconfined disposal relevant to cap material specifications.
Federal and State Water Quality Guidance Documents.	Contains policy and technical data reviewed and/or used in the development of state sediment management standards
Area of Contamination Interprogram Policy, developed by Washington Department of Ecology	Guidelines for the management of dredged sediment meeting the criteria as a state dangerous waste
Sediment Cleanup Standards Users Manual, Washington State Department of Ecology (December, 1991)	Guidance for implementing the sediment cleanup decision process for contaminated sediments in Washington State
Sediment Source Control Standards Users Manual, Washington State Department of Ecology (June, 1993)	Guidance for implementing the Sediment Source Control Standards
Sediment Shoreline Master Program	Guidelines for managed development of shorelines to preserve natural resources while protecting public access and navigation.
Sediment Quality Criteria for the Protection of Human Health	Proposes draft sediment quality standards based on risks to humans

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 25—Revised Costs Summary for MSU Remedial Alternatives

Alternative	Remediation Cost	Disposal Method	Disposal Cost*	Mitigation Cost**	Revised Cost
2--Dredge to CSLs	$6,010,000	Nearshore	$11,128,000	$5,250,000	$22,338,000
	$6,010,000	CAD	$7,704,000	--	$13,714,000
	$6,010,000	Constructed Upland	$19,260,000	--	$25,270,000
3a--Cap to SQS	$12,520,000	Established Upland	$619,000	--	$13,139,000
3b--Cap to CSLs	$6,440,000	Established Upland	$619,000	--	$7,059,000
4a--Dredge/Cap to SQS	$12,430,000	Nearshore	$11,414,000	$5,250,000	$29,094,000
	$12,430,000	CAD	$7,902,000	--	$20,332,000
	$12,430,000	Constructed Upland	$19,755,000	--	$32,185,000
4b--Dredge/Cap to CSL	$5,500,000	Nearshore	$8,190,000	$4,350,000	$18,040,000
	$5,500,000	CAD	$5,670,000	--	$11,170,000
	$5,500,000	Constructed Upland	$14,175,000	--	$19,675,000

*CAD and Nearshore costs from FS. Established upland facility costs have been revised.
**Mitigation costs from PSR Responsiveness Summary. Does not include cost of DNR land use.

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 26—Cost Estimate Summary of Alternative 2 - Dredging to CSLs

Year	Capital Cost	O&M Cost			Discount Factor	Present Worth			Total Present Worth
		Cap Maintenance	Cap Monitoring	Dredge Area Monitoring	5%	Cap Maintenance	Cap Monitoring	Dredge Area Monitoring	
0	4,806,000								4,806,000
1		42,600	-		0.952	40,571	-	-	40,571
2		42,600	56,700		0.907	38,639	51,429	-	90,068
3		42,600	-		0.864	36,799	-	-	36,799
4		42,600	56,700		0.823	35,047	46,647	-	81,694
5		42,600	-	44,550	0.784	33,378	-	34,906	68,284
6		42,600	56,700		0.746	31,789	42,310	-	74,099
7		42,600	-		0.711	30,275	-	-	30,275
8		42,600	56,700		0.677	28,833	38,377	-	67,210
9		42,600	-		0.645	27,460	-	-	27,640
10		42,600	56,700	44,550	0.614	26,153	34,809	27,350	88,311
11		42,600	-		0.585	24,907	-	-	24,907
12		42,600	56,700		0.557	23,721	31,573	-	55,294
13		42,600	-		0.530	22,592	-	-	22,592
14		42,600	56,700		0.505	21,516	28,637	-	50,153
15		42,600	-	44,550	0.481	20,491	-	21,429	41,921
16		42,600	56,700		0.458	19,516	25,975	-	45,490
17		42,600	-		0.436	18,586	-	-	18,586
18		42,600	56,700		0.416	17,701	23,560	-	41,261
19		42,600	-		0.396	16,858	-	-	16,858
20		42,600	56,700	44,550	0.377	16,055	21,370	16,790	54,216
21		42,600	-		0.359	15,291	-	-	15,291
22		42,600	56,700		0.342	14,563	19,383	-	33,946
23		42,600	-		0.326	13,869	-	-	13,869
24		42,600	56,700		0.310	13,209	17,581	-	30,790
25		42,600	-	44,550	0.295	12,580	-	13,156	25,736
26		42,600	56,700		0.281	11,981	15,946	-	27,927
27		42,600	-		0.268	11,410	-	-	11,410
28		42,600	56,700		0.255	10,867	14,464	-	25,331
29		42,600	-		0.243	10,350	-	-	10,350
30		42,600	56,700	44,550	0.231	9,857	13,119	10,308	33,284
						Total Present Worth Cost			**6,010,000**

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 27—Cost Estimate Summary of Alternative 3a - Capping to SQS

Year	Capital Cost	O&M Cost		Discount Factor	Present Worth		Total Present Worth
		Cap Maintenance	Cap Monitoring	5%	Cap Maintenance	Monitoring	
0	9,613,000						9,613,000
1		87,000	-	0.952	82,857	-	82,857
2		87,000	208,000	0.907	78,912	189,388	268,299
3		87,000	-	0.864	75,154	-	75,154
4		87,000	208,000	0.823	71,575	171,780	243,355
5		87,000	-	0.784	68,167	-	68,167
6		87,000	208,000	0.746	64,921	155,810	220,731
7		87,000	-	0.711	61,829	-	61,829
8		87,000	208,000	0.677	58,885	141,324	200,209
9		87,000	-	0.645	56,081	-	56,081
10		87,000	208,000	0.614	53,410	128,185	181,596
11		87,000	-	0.585	50,867	-	50,867
12		87,000	208,000	0.557	48,445	116,268	164,713
13		87,000	-	0.530	46,138	-	46,138
14		87,000	208,000	0.505	43,941	105,458	149,399
15		87,000	-	0.481	41,848	-	41,848
16		87,000	208,000	0.458	39,856	95,654	135,509
17		87,000	-	0.436	37,958	-	37,958
18		87,000	208,000	0.416	36,150	86,761	122,911
19		87,000	-	0.396	34,429	-	34,429
20		87,000	208,000	0.377	32,789	78,695	111,484
21		87,000	-	0.359	31,228	-	31,228
22		87,000	208,000	0.342	29,741	71,378	101,119
23		87,000	-	0.326	28,325	-	28,325
24		87,000	208,000	0.310	26,976	64,742	91,718
25		87,000	-	0.295	25,691	-	25,691
26		87,000	208,000	0.281	24,468	58,723	83,191
27		87,000	-	0.268	23,303	-	23,303
28		87,000	208,000	0.255	22,193	53,264	75,457
29		87,000	-	0.243	21,136	-	21,136
30		87,000	208,000	0.231	20,130	48,312	68,441
					Total Present Worth Cost		**12,520,000**

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 28—Modified Alternative 3b - Capping to CSLs

Capital Cost

Description	Unit	Quantity	Unit Cost	Cost
1. Mobilization	LS	1	300,000.00	$300,000
2. Crowley Marine Terminal Dredging				
Dredge Mobilization	LS	1	15,000.00	$15,000
Dredging w/Clamshell	Days	10	2,500.00	$25,000
Short Term Monitoring	Days	5	2,200	$11,000
3. Groundwater Discharge Area Capping				
A. Cap				
Silty Sand	CY	20,000	3.00	$60,000
Transport and Placement	CY	20,000	4.25	$85,000
B. Short-term Monitoring - Capping				
Water Quality Monitoring	LS	1	3,720.00	$3,720
Bathymetric/Sed. Profile Surveys	LS	1	11,700.00	$11,700
4. Shoreline Area Capping				
A. Cap				
Silty Sand	CY	23,000	3.00	$69,000
Transport and Placement	CY	23,000	9.00	$207,000
B. Short-term Monitoring - Capping				
Water Quality Monitoring	LS	1	38,038.00	$38,060
Bathymetric/Sed. Profile Surveys	LS	1	11,700.00	$11,700
5. Non-shoreline Area Capping				
A. Cap				
Silty Sand	CY	328,000	3.00	$984,000
Transport and Placement	CY	328,000	4.25	$1,394,000
B. Short-term Monitoring - Capping				
Water Quality Monitoring	LS	1	61,258.00	$61,258
Bathymetric/Sed. Profile Surveys	LS	1	11,700.00	$11,700
Subtotal Capital Costs				$3,288,146
Administrative Cost	% SUBTOTAL	10*		$328,815
Engineering Expenses	% SUBTOTAL	15*		$493,222
Contingency Allowances	% SUBTOTAL	25*		%822,037
Total Capital Costs				**$4,930,000**

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 29—Cost Estimate Summary of Alternative 3b - Capping to CSLs

Year	Capital Cost	O&M Cost		Discount Factor	Present Worth		Total Present Worth
		Cap Maintenance	Cap Monitoring	5%	Cap Maintenance	Monitoring	
0	4,930,000						4,930,000
1		41,985	-	0.952	39,986	-	39,986
2		41,985	114,600	0.907	38,082	103,946	142,027
3		41,985	-	0.864	36,268	-	36,268
4		41,985	114,600	0.823	34,541	94,282	128,823
5		41,985	-	0.784	32,896	-	32,896
6		41,985	114,600	0.746	31,330	85,516	116,846
7		41,985	-	0.711	29,838	-	29,838
8		41,985	114,600	0.677	28,417	77,566	105,983
9		41,985	-	0.645	27,064	-	27,064
10		41,985	114,600	0.614	25,772	70,354	96,130
11		41,985	-	0.585	24,548	-	24,548
12		41,985	114,600	0.557	23,379	63,814	87,192
13		41,985	-	0.530	22,266	-	22,266
14		41,985	114,600	0.505	21,205	57,881	79,086
15		41,985	-	0.481	20,196	-	20,196
16		41,985	114,600	0.458	19,234	52,500	71,733
17		41,985	-	0.436	18,318	-	18,318
18		41,985	114,600	0.416	17,446	47,619	65,064
19		41,985	-	0.396	16,615	-	16,615
20		41,985	114,600	0.377	15,824	43,192	59,015
21		41,985	-	0.359	15,070	-	15,070
22		41,985	114,600	0.342	14,353	39,176	53,529
23		41,985	-	0.326	13,669	-	13,669
24		41,985	114,600	0.310	13,018	35,534	48,552
25		41,985	-	0.295	12,398	-	12,398
26		41,985	114,600	0.281	11,808	32,230	44,038
27		41,985	-	0.268	11,246	-	11,246
28		41,985	114,600	0.255	10,710	29,234	39,944
29		41,985	-	0.243	10,200	-	10,200
30		41,985	114,600	0.231	9,714	26,516	36,230
					Total Present Worth Cost		**6,440,000**

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 30—Cost Estimate Summary of Alternative 4a - Fill Removal to SQS and Cap

Year	Capital Cost	O&M Cost			Discount Factor	Present Worth			Total Present Worth
		Cap Maintenance	Cap Monitoring	Dredge Area Monitoring	5%	Cap Maintenance	Cap Monitoring	Dredge Area Monitoring	
0	10,024,000								10,024,000
1		64,600	-		0.952	61,524	-	-	61,524
2		64,600	174,000		0.907	58,594	157,823	-	246,417
3		64,600	-		0.864	55,804	-	-	55,804
4		64,600	174,000		0.823	53,147	143,150	-	196,297
5		64,600	-	38,000	0.784	50,616	-	29,774	80,390
6		64,600	174,000		0.746	48,206	129,841	-	178,047
7		64,600	-		0.711	45,910	-	-	45,910
8		64,600	174,000		0.677	43,724	117,770	-	161,494
9		64,600	-		0.645	41,642	-	-	41,642
10		64,600	174,000	38,000	0.614	39,659	106,821	23,329	169,808
11		64,600	-		0.585	37,770	-	-	37,770
12		64,600	174,000		0.557	35,972	96,890	-	132,861
13		64,600	-		0.530	34,259	-	-	34,259
14		64,600	174,000		0.505	32,627	87,882	-	120,509
15		64,600	-	38,000	0.481	31,074	-	18,279	49,352
16		64,600	174,000		0.458	29,594	79,711	-	109,305
17		64,600	-		0.436	28,185	-	-	28,185
18		64,600	174,000		0.416	26,843	72,301	-	99,143
19		64,600	-		0.396	25,564	-	-	25,564
20		64,600	174,000	38,000	0.377	24,347	65,579	14,322	104,248
21		64,600	-		0.359	23,188	-	-	23,188
22		64,600	174,000		0.342	22,084	59,482	-	81,565
23		64,600	-		0.326	21,032	-	-	21,032
24		64,600	174,000		0.310	20,030	53,952	-	73,982
25		64,600	-	38,000	0.295	19,077	-	11,222	30,298
26		64,600	174,000		0.281	18,168	48,936	-	67,104
27		64,600	-		0.268	17,303	-	-	17,303
28		64,600	174,000		0.255	16,479	44,386	-	60,865
29		64,600	-		0.243	15,694	-	-	15,694
30		64,600	174,000	38,000	0.231	14,947	40,260	8,792	63,999
						Total Present Worth Cost			**12,430,000**

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Table 31—Cost Estimate Summary of Alternative 4b - Fill Removal to CSLs and Cap

Year	Capital Cost	O&M Cost			Discount Factor	Present Worth			Total Present Worth
		Cap Maintenance	Cap Monitoring	Dredge Area Monitoring	5%	Cap Maintenance	Cap Monitoring	Dredge Area Monitoring	
0	4,585,000								4,585,000
1		19,300	-		0.952	18,381	-	-	18,381
2		19,300	67,500		0.907	17,506	61,224	-	78,730
3		19,300	-		0.864	16,672	-	-	16,672
4		19,300	67,500		0.823	15,878	55,532	-	71,411
5		19,300	-	39,100	0.784	15,122	-	30,636	45,758
6		19,300	67,500		0.746	14,402	50,370	-	64,771
7		19,300	-		0.711	13,716	-	-	13,716
8		19,300	67,500		0.677	13,063	45,687	-	58,750
9		19,300	-		0.645	12,441	-	-	12,441
10		19,300	67,500	39,100	0.614	11,849	41,439	24,004	77,292
11		19,300	-		0.585	11,284	-	-	11,284
12		19,300	67,500		0.557	10,747	37,587	-	48,333
13		19,300	-		0.530	10,235	-	-	10,235
14		19,300	67,500		0.505	9,748	34,092	-	43,840
15		19,300	-	39,100	0.481	9,284	-	18,808	28,091
16		19,300	67,500		0.458	8,842	30,923	-	39,764
17		19,300	-		0.436	8,421	-	-	8,421
18		19,300	67,500		0.416	8,020	28,048	-	36,067
19		19,300	-		0.396	7,638	-	-	7,638
20		19,300	67,500	39,100	0.377	7,274	25,440	14,736	47,450
21		19,300	-		0.359	6,928	-	-	6,928
22		19,300	67,500		0.342	6,598	23,075	-	29,673
23		19,300	-		0.326	6,284	-	-	6,284
24		19,300	67,500		0.310	5,984	20,930	-	26,914
25		19,300	-	39,100	0.295	5,699	-	11,546	17,246
26		19,300	67,500		0.281	5,428	18,984	-	24,412
27		19,300	-		0.268	5,169	-	-	5,169
28		19,300	67,500		0.255	4,923	17,219	-	22,142
29		19,300	-		0.243	4,689	-	-	4,689
30		19,300	67,500	39,100	0.231	4,466	15,618	9,047	29,130
						Total Present Worth Cost			**5,500,000**

Table 32: Cost Estimation for Groundwater Monitoring and DNAPL Collection
(Pacific Sound Resources: Record of Decsion)

Item	Description	Quantity	Units	Unit Cost ($)	Total Cost
Capital Costs					
Recovery Well Upgrades	new monuments for 7 wells (installed	7	each	1,000	$7,000
Monitoring Well Construction	MW-16S; 2"- SS casing with sump	22	foot	100	$2,200
	MW-16I; 2"-SS casing with sump	54	foot	100	$54,00
	MW-112; 2"-SS casing with sump	54	foot	100	$54,00
Equipment Shed	Metal shed on concrete slab w/ garage doors, heating, ventilation, lighting	500	square foot	40	$20,000
Service Vehicle	3/4-ton pick-up with end lift	1	lump sum	15,000	$15,000
Miscellaneous Equipment	pumps, secondary containment, tools health and safety, decontamination, etc.	1	lump sum	10,000	$10,000
Subtotal Capital Cost					$65,000
Engineering design, overhead and administration		1	lump sum	500000	$50,000
Deed restrictions	attorney's fees	1	lump sum	5,000	$5,000
Total Capital Cost					$115,000
Annual Operation and Maintenance Cost					
Groundwater Monitoring - Analytical Costs (12-well network + 20% for QA/QC)					
Annual costs years 1–5 (quarterly)	subcontract laboratory	58	each	300 [1]	$17,400
Annual costs years 6–10 (semiannually)	subcontract laboratory	29	each	300 [1]	$8,700
Annual costs years 11–30 (annually)	subcontract laboratory	15	each	300 [1]	$4,500
Groundwater Monitoring - Labor Costs					
Annual costs years 1–5 (quarterly)	sampling and reporting	1	lump sum	24,000 [2]	$24,000
Annual costs years 6–10 (semiannually)	sampling and reporting	1	lump sum	12,000 [2]	$12,000
Annual costs years 11–30 (annually)	sampling and reporting	1	lump sum	6,000 [2]	$6,000
Expandible Materials and Fuel	PPE, sampling, decontamination	1	lump sum	1,500	$1,500
Well. Equipment and Facility Maintenance		1	lump sum	5,000	$5,000
DNAPL-to-Energy Recovery Facility	manifesting, shipping and disposal	1	lump sum	4,000	$4,000
PPE and Miscellaneous Waste Disposal	manifesting, shipping and disposal	1	lump sum	2,000	$2,000
Present Worth of O&M Cost	8% discount rate				$370,000
General Project Administration and Overhead (5% of subtotal)					$18,000
Contingency (10% of subtotal)					$37,000
Total Present Worth Cost					$541,000

NOTES:

[1]Unit costs for PAR and dibenzofuran by EPA Method 8310 is $200.
Unit costs for PCP by EPA Method 8040 is $100.

[2]Labor costs for a single sampling round are as follows:

Field Technician	24	hours	45	$1,080
Chemist (data QA/QC)	8	hours	58	$464
Staff Hydrogeologist	60	hours	58	$3,480
CAD Operator	6	hours	45	$270
Supervisor	8	hours	88	$704
			Total	$6,000

PACIFIC SOUND RESOURCES (PSR) SUPERFUND SITE SEATTLE, WASHINGTON

RECORD OF DECISION:

PART 3: RESPONSIVE SUMMARY

September 1999

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RECORD OF DECISION:

RESPONSIVENESS SUMMARY

This is the Responsiveness Summary for comments received regarding the draft Upland Groundwater Remedial Investigation/Feasibility Study, the draft Marine Sediments Unit Feasibility Study and the Proposed Plan for cleanup of the Pacific Sound Resources Superfund site. The first two sections of this Responsiveness Summary address the comments received regarding the draft Marine Sediments Unit Feasibility Study and the Proposed Plan. Several reviewers provided similar comments on these documents; responses and discussions are organized by general topic and EPA's responses are presented in the first section of this Responsiveness Summary. The second section includes a copy of all original comments received on the Marine Sediments Unit Feasibility Study and Proposed Plan and responds to issues that were not addressed in the first section. The third section of this Responsiveness Summary presents the comments received, and EPA's responses to the draft Upland Groundwater RI/FS.

1. POTENTIAL IMPACTS TO TREATY RIGHTS

The primary concern raised by the tribes focused on the impact of the selected remedy relative to treaty-protected rights of net fishing and shellfish gathering in Elliott Bay. More specifically, reviewers were concerned that disposal options or institutional controls may preclude these activities. In addition, the tribes have requested that any aspect of a cleanup that would impact tribal activities should be coordinated with the Tribes.

EPA has modified the Proposed Plan such that treaty rights will not be impacted. The cleanup alternative selected by EPA for the PSR Marine Sediments Unit is a modification of Alternative 3b that was presented in the Feasibility Study Report (WESTON 1998). This remedy relies primarily upon capping (a small area will be dredged near Crowley Marine to maintain navigational depths) to confine contaminated sediments. The alternative was modified to include additional capping in the nearshore and intertidal environments to protect human health and natural resources that may be impacted by contaminants (specifically PCBs) that were released from the old Seattle Landfill and were discharged to Elliott Bay via Longfellow Creek overflow.

Currently, small pocket beaches exist on either side of the peninsula that now contains the public viewing lower; these beaches are connected by a strip of beach that formed at the toe of the riprap bank. The total area is about 2 acres and is exposed during daylight hours between 0 (the approximate toe of the constructed bank) and -4 MLLW for approximately 72 days per year for an average of 2.6 hours a day (assuming at least an hour would be required to harvest shellfish).

This area can only be reached by boat, as the beaches are not accessible by land due to fencing along the shoreline.

Restrictions on shellfish gathering (i.e., institutional controls) were proposed for the minimal intertidal area that is available in order to maximize the protectiveness of the remedy. A 3-foot cap was proposed in the intertidal areas and it was assumed that institutional controls would be necessary because a cap this thick could potentially be penetrated while digging for shellfish. In response to Tribal concerns, EPA will place a thicker cap (5-foot deep) cap along the shoreline and intertidal areas that will allow for unrestricted harvesting of shellfish (i.e., no institutional controls regarding shellfish gathering will be included in the ROD).

The present shoreline capping approach was reviewed to determine how the thicker cap would affect the present cap layout. In order to place additional cap material, it was determined the thicker cap would need to be expanded out to a depth of approximately -8.0 MLLW (100 to 150 feet offshore) in the shoreline southeast of the piers. The remaining shoreline could accommodate additional capping material within the existing footprint of the shoreline cap. The thicker shoreline cap footprint is shown in Figure 4 of the Record of Decision.

Placement of additional cap material to support shellfishing in the intertidal areas of the site is estimated to require an additional 8,000 cubic yards of cap material. This additional material is estimated to cost $144,000 to obtain, transport, and place. However, the nearshore area (depths to about - 10 feet MLLW) represents a potentially higher energy environment. During design, the need for additional engineered features to maintain a thicker cap in the shoreline will be evaluated.

A no-anchor zone over the cap is also proposed as part of this remedy. This institutional control is included to prevent damage to the cap from commercial vessels using large whale-tail type anchors. This restriction will not affect net fishers in that small boat anchors and net lead-lines would not damage the cap. A no-anchor zone must be implemented by a Rule-making through the Coast Guard and the U.S. Army Corps of Engineers, in consultation with the Department of Natural Resources. The Rule-making would be subject to public review.

Finally, it is important to note that EPA has consistently coordinated with the Muckleshoot and Suquamish tribe throughout the cleanup process at the PSR site and will continue to do so. Specifically, comments were solicited from the tribes as part of the technical review of the remedial investigation scoping memorandum and work plan, the sampling and analysis plan, Phase 1 and Phase 2 RI Data Report, the human health and ecological risk assessment, the draft remedial investigation report, the feasibility study technical memoranda, and the draft FS report. Several stakeholder meetings were held to receive input and inform Trustees and regulators of the status of the project during the RI scoping phase, at the conclusion of the RI field sampling phases, and during the development of the alternatives to be evaluated in the FS.

2. POTENTIAL IMPACTS TO LAND USE

Because capping is the remedy proposed for the site, a number of reviewers expressed a concern that capping would impact future use within the Harbor Area, particularly if deepening in the nearshore would be a component of future use. A second concern was that the associated no-anchor zone over the cap would limit navigation and other marine activities such as laying cable in and around the Harbor Area.

The selected remedy (modified Alternative 3b) for the site relies upon a cap to confine contaminated sediments. A small area will be dredged near Crowley Marine prior to capping to maintain current navigational depths. The Port of Seattle does not have a need for deep-draft capabilities in this area of the harbor, at this time (Doug Hotchkiss, pers. comm). Other development plans for areas adjacent to the site may also affect future development as a deep draft facility. Ecology has proposed construction of a nearshore CAD facility as part of the remediation of the adjacent Lockheed Shipyard. The eastern portion of the PSR MSU has also been considered as an expansion site if the Lockheed nearshore CAD were to be developed as a Multi-User Disposal Site. If the use of the PSR MSU should change in the future, additional dredging could be performed but would require disposal or treatment of contaminated sediments that would be removed.

A no-anchor zone over the cap is also proposed as part of this remedy. The no-anchor zone would be approximately 47 acres in size and would represent about 2 percent of the total anchorage area available in Elliott Bay (approximately 2,000 acres are designated for anchorage within Elliott Bay). This institutional control was included to prevent damage to the cap from commercial vessels using large whale-tail type anchors. Currently, this area is used only for barge moorage at fixed anchor buoys. This type of moorage is not expected to be restricted. Other marine activities, such as cable laying, would have to be evaluated on a case-by-case basis. Large marine cable is typically buried a meter below the mudline (or has the capacity to self-bury to that depth); smaller cables cause less disturbance of the bottom.

Accidental damage to the cap would be assessed as part of the long-term operations and maintenance plan for the remedy.

3. RISK

Multiple issues were raised by reviewers regarding the assessment of risk associated with the remedy. Many reviewers felt that the proposed remedy did not fall within the MTCA risk range and would not be as protective as a cleanup under the State's process. Reviewers took specific exception to the use of the Sediment Management Standards for evaluating bioaccumulative contaminants, interpretation of the risk calculations, and development and use of background contaminant levels.

EPA believes that the risks remaining following cleanup will be protective of human health and ecological receptors. Ecological risks were evaluated for bioaccumulative contaminants as part of the original risk assessment. The risk evaluation indicated that protecting human health *would also protect ecological receptors because (for the endpoints evaluated) the human health response was more sensitive to the contaminants associated with this site; therefore, all risk evaluations during the FS were based on human health. As part of the modifications to Alternative 3b, EPA re-evaluated the residual risks to human receptors under a post-cleanup scenario. As part of this re-evaluation, post-cleanup risks were recalculated by assuming that all nearshore areas (less than -10 ft MLLW) were capped along with all other areas with PAHs greater than the CSL. The resulting post-cleanup risks to human healthfall within the range of 1 in 100,000 (IE-5). Residual risks for consumption of fish and mobile shellfish (i.e., shrimp and crab) from the site over a lifetime for the RME receptor was 4.2E-5. The uncertainties in any risk assessment affect the estimations of risk such that the estimates are only accurate to within an order of magnitude, thus 4.2E-05 represents a risk of the same order of magnitude as IE-05. Revised risk calculations are provided in Attachment 1.*

The proposed remedy for the Marine Sediments Unit relies upon capping to confine the contaminated sediments and prevent exposure of human and ecological receptors. Although the area to be capped is primarily defined by the SMS CSL, the resulting sediment quality within the capped area will be at least as clean as the SQS (a requirement for selection of capping material). In calculating the risks remaining following cleanup, average background concentrations from Elliott Bay were used to estimate sediment quality in areas to be capped (i.e., background values were substituted for those samples representing the area to be capped). Use of background concentrations to estimate surface sediment concentrations on the cap was considered reasonable because sediments would tend to equilibrate with the existing conditions over time. Average background concentrations (based on RI samples) fall below the SMS sediment quality standards and fall within the MTCA risk range of IE-05. Because Elliott Bay background samples tended to have chemical concentrations less than the SQS, risks are lower under a capping scenario compared to dredging to the standard.

4. ARARs

Several reviewers felt that the alternatives evaluated in the FS did not meet risk ARARs; specifically, it was thought that several alternatives (including the proposed remedy) did not comply with MTCA risk ranges.

The Model Toxics Control Act does not address acceptable risk ranges associated with cleanup of sediments; MTCA references the Sediment Management Standards. The SMS do not have a numeric risk goal for the protection of human health. MTCA is not an ARAR for sediment cleanups. Nevertheless, the alternative proposed for implementation at the site (cap with limited dredging to maintain navigational depths) will result in a risk equivalent to 1 in 100,000 and thus would meet MTCA risk goals.

The Corps suggested that additional ARARs be considered; the Washington Hydraulic Code, Tribal Government to Government Presidential Memorandum, and the National Historic Preservation Act.

The Washington Hydraulic Code is included as an ARAR for the site. The cited Presidential Memorandum does not include specific substantive environmental or facility siting requirements and as such is not an ARAR. The Port of Seattle addressed the National Historic Preservation Act as part of the Southwest Harbor Project EIS. Therefore, no modifications will be made to the evaluation of ARARs, based on these comments.

5. CLEANUP LEVEL SELECTION

Several reviewers are concerned that selection of the CSLs as the cleanup level for PAHs is not protective of human or ecological health.

As part of the initial risk assessment, preliminary remediation goals were calculated separately for human and several ecological receptors. Human cancer risk was shown to be the most sensitive endpoint and was used as a surrogate for all other receptors. Human health effects were used to identify the areas of highest risk at the site, which were coincident with the CSL boundary. As discussed in Section 3 of these responses, the resulting sediment quality following cleanup of the area defined by CSL exceedances will be protective of human health in that risks fall within the range of 1 in 100,000. The CSL boundary also encompasses the area identified by the subbottom profiling and subsurface sampling data as potential fill north of the upland facility and a secondary discharge/disposal area north of Crowley Marine Services (i.e., this is the area where there are significant accumulations of contamination up to 96 percent of the total contaminant mass).

Under the Sediment Management Standards, the cleanup of a site should result in an elimination of adverse effects on biological resources and significant health threats to humans. The SQS are considered the numerical values that correspond to the narrative goal. A site-specific cleanup standard is to be as close as practicable to the SQS, given consideration of environmental effects, feasibility and cost. Given site-specific factors, the minimum cleanup standard (MCUL) for PAHs has been selected as the trigger for active remediation of sediments within the PSR MSU because this level represents the minor adverse effects threshold for benthic organisms. In addition, capping in the CSL exceedance area results in a significant reduction in risks to human health such that the NCP requirements regarding risks are met (the MTCA risk ranges that apply to soil and groundwater would also be met). An exception to the use of the minimum cleanup level (MCUL; equivalent to the CSL) is in the cleanup of PCBs in the nearshore environment. At those locations, PCB sediment concentrations exceeding the Sediment Quality Standard (SQS) will be included in the area to be remediated.

The justification for selection of the MCUL for PAHs is as follows:

- *the MCUL is protective of benthic communities at this site. No benthic failures occurred at the biological sampling stations within the MCUL boundary. Bioassay failures were noted, but were generally in the minor adverse effects range. Given that minor adverse impacts occurred in samples collected from the MCUL/CSL exceedance area where more severe effects were anticipated, based on chemical concentrations, only minor to minimal adverse impacts would be predicted in remaining areas with sediment concentrations between the SQS and the MCUL/CSL.*

- *human health risks fall with the risk range required by the NCP (and would also meet MTCA ranges).*

- *cleanup costs to achieve the SQS across the entire site were greater than 190 percent of the costs to achieve CSL (greater than 110 percent is considered significant under the SMS guidance)*

- *cleanup to the MCUL/CSL addresses the areas of contaminated sediment accumulation, which contains the greatest mass of contaminants*

- *the majority of the sediments that exceed the SQS and will remain following cleanup are in deep (> 100 ft) water, and provide minimal exposure potential to fishers and recreational users of the bay. Achieving cap performance goals in deeper areas is less certain and would require significant additional capping material, possibly greater engineering of the cap, and longer duration of the cleanup.*

Justification for selection of the SQS for PCBs in the nearshore environment is:

- *the nearshore environment provides critical habitat for juvenile salmonids and their prey.*

- *the MCUL for PCBs does not provide the same degree of protection as other chemicals because it does not address bioaccumulative effects (invertebrates are relatively insensitive to bioaccumulative chemicals because they are short-lived and lack some of the key enzyme systems that contribute to the production of cancer).*

- *ensures that the Trustees restoration goal for PAHs is met in the shallow, nearshore critical habitat area.*

Confinement through capping provides additional protection of resources (including fish) in that capping material must meet the SQS. Thus 47 acres of the site will be at or below the SQS and the remaining area will be between the SQS and the CSL. It is likely that there will be additional benefit from capping in the SQS exceedance areas as cap material is lost during placement in deeper water or material migrates from the CSL boundary areas (see Sections 9 and 13 of these responses for further discussion).

6. DESIGN ISSUES

Reviewers raised a number of issues relative to the design of the remedy. Design issues and discussions are presented by subtopic below.

6.1 Capping at Depth

Reviewers had conflicting comments regarding the feasibility of placing a cap at depths greater than 200 feet and ensuring the performance criterion of obtaining a minimum 3-foot thickness. The Corps felt that capping at depth was feasible based on a recent demonstration capping project at the PSDDA site in Elliott Bay. Ecology felt that the issue still needed further investigation during the design phase.

Achieving Cap Thickness Performance Criterion—*Achieving the required thickness of the placed material could be accomplished in a manner similar to that used at Eagle Harbor. Monitoring the volume of material being placed and accurately recording the placement locations would allow the average cap thickness to be indirectly calculated as the project proceeded. However, precisely controlling the placement of material in water depths of 30 feet to 200 feet probably isn't warranted. Controlling the placement of material in a marine environment presents additional challenges, not generally encountered in placing a layer of asphalt on a road or covering a landfill. There is no method to "grade" the finished surface to the tolerances usually associated with terrestrial construction (0.1 ft), nor is there any way to directly inspect the completed project to assure that the design tolerances have been met. The inability to "see or feel " the capping site directly introduces an-additional uncertainty into the design. Adjusting construction methods and tolerances to meet the design objectives in the most economical manner possible is often the best way to accommodate this uncertainty. A large tolerance in cap thickness would allow the use of readily available construction equipment, and uncomplicated placement methods. For this reason, a relatively simple placement design that requires a large volume of capping material may be less costly than a complicated design that requires the precise placement of a minimum volume of capping material.*

Significant variations in the cap thickness should be anticipated in the design of the project. A design thickness of 5 feet to 6 feet may be required to assure that a minimum cap thickness of 3 feet has been achieved. A 15 percent contingency for loss during placement may be appropriate for estimating capping material with a very low percent of fines, but sufficient quantities of this type of dredged material may not be readily available. Estimating capping material needs based on loss of 25 percent or higher would allow for the placement of dredged material from a wider range of sources. Assuming an average cap thickness of 5 feet and loss of 25 percent at all water depths results in a capping volume of about 500,000 cubic yards (cy). This estimate assumes 25 percent of the capping material is fine-grained (clay and silt) that settles so slowly that it will be carried off site regardless of the water depth. This estimate differs from that presented in the FS (363,000 cy), because the estimate in the FS assumed only material sufficient for a 3-foot cap with a potential loss of 15 percent would occur when capping in water depths less than 60 feet. Assumptions when estimating the volume required for capping at greater than 60 feet were the same as presented here. The target cap thickness of 5 feet is a conservative "first cut " and represents an average thickness that should assure a minimum thickness of 3 feet has been achieved throughout the cleanup area. And from another perspective, any "loss "from the target area (i.e., CSL exceedance area) will likely contribute to enhanced natural recovery in the SQS exceedance area.

Monitoring Cap Thickness—*Measuring the cap thickness directly will be difficult. The expected accuracy for bathymetric surveys is about I to 2 percent of the water depth. In 200 feet of water this is 2 to 4 feet, assuming a flat bottom surface. The steep bottom slope at the PSR site will compromise the survey data even further, so using standard bathymetric surveying techniques would not be an effective tool to measure cap performance (i.e., assuring a cap thickness of 3 feet).*

However, Sediment Vertical Profiling System (SVPS) photos could accurately establish the placement boundary, and direct observations by a Remotely Operated Vehicle (ROV) should *provide assurance that a relatively uniform layer of material has been placed. The remotely-operated SVPS drives a prism into the bottom and takes a photograph of up to a 20-cm-high cross section of the sediment-water interface, depending on sediment characteristics. Where the cap thickness becomes less than approximately 20 cm, a distinct layer of capping material overlying the native sediment is visible. The sampling locations where the cap thickness is found to be less than 20 cm could serve to delineate the cap boundary. The SVPS was used successfully to monitor the extent of newly placed material at PSDDA disposal sites at Port Gardner and Elliott Bay, and at the Superfund site in Eagle Harbor. An ROV was used in Eagle Harbor to provide video coverage of large areas of the site to visually confirm that the newly placed material was not being recontaminated by creosote seeping out of bottom sediments. In addition, the ROV was used to monitoring the cap during construction to detect any problems in the placement process (such as the disposal of large individual mounds of capping material or debris). A ROV could be used in a similar manner at the PSR site. Sediment cores and subbottom profiling can also be used to provide additional information.*

The best assurance that an adequate cap thickness can be obtained is the fact that there is an ongoing supply of nearby capping material from the federal channel in the Duwamish River. After an initial cap is laid down, it may be possible to achieve additional cap thickness by allowing disposal of PSDDA materials by bottom dump barge over time. Since the haul distance to the PSR site appears to be essentially the same as to the PSDDA site, the additional "capping" could be accomplished at no additional cost (over that of maintenance dredging), and could continue until all parties were satisfied with the results. However, it should be noted that this clean material may be needed for beneficial reuse at other contaminated sites and its use would be prioritized based on a number of considerations, including the potential benefits to the environment at potentially competing locations.

Monitoring Cap Effectiveness—*Monitoring of capping projects has included various techniques, some of which are described in this paragraph. Bathymetric surveys are used to determine cap thickness as well as changes in thickness. Sub-bottom profilers have been used to determine the extent to which compaction and subsidence contribute to apparent loss of material from the cap. These profilers have also been used to assist in evaluating biological activity such as epifauna in the image area, organism tube density and types, thickness of fecal pellets, and successional stages (recolonization). Sediment cores obtained through the cap have been used for a variety of purposes such as determining cap thickness, contaminant migration into the cap, and depth of biological activity.*

Most monitoring has been conducted at capping sites in less than 40 meters of water. Chemical analyses of sediment cores obtained from sites in Puget Sound and New England have not shown chemical migration into the cap material. The longest monitoring in Puget Sound has been 11 years at the US. Army Corps of Engineers (USACE) West Waterway CAD site. The interface between contaminated material disposed at the site and capping sand remained a sharp interface after 11 years with no indication of contaminants moving into the cap. This same observation has been made at the St. Paul cap, a shallow water, higher energy site near the Puyallup River in Commencement Bay, where monitoring has been conducted over the last 10 years. The USACE New England Division has about 19 Years of monitoring data of capped contaminated material. Results of this monitoring data have shown sharp concentration shifts at the interface *between the caps and contaminated layers, strongly suggesting minimal long-term transport of contaminants into the caps. However, possible surface contamination of the Eagle Harbor cap in Puget Sound has recently been identified. To determine whether recontamination is from surface sources or from the capped contaminated sediments, chemical evaluation of core sediments is currently being conducted. Monitoring results following a hurricane at a capped site in the Northeast showed that some erosion of the cap material had occurred. Based on these monitoring data, additional capping material was placed at the site as a precaution even though contaminated sediments were not exposed on the surface. This experience demonstrates the importance of monitoring and managing capped sites.*

Recently, contaminated sediment was successfully capped in 74 meters of water. The tools described above were effectively employed at this site to determine that a cap of the required thickness was placed over the entire site. Long-term monitoring data have not been obtained because of the relatively recent establishment of this cap. However, there is every reason to assume that a cap at this depth, once successfully placed, would be as effective in isolating contaminated sediments as caps placed in shallower water.

Although steep slopes have not been a factor, PSDDA site monitoring has demonstrated successful prediction of the bottom footprint for disposal of material in greater than 200 feet of water. The Corps has experimented with capping contaminated material in 200 feet of water in Elliott Bay at an old (1976) Waterways Experiment Station site. The site was used to dispose of PCB-contaminated sediments to monitor open water disposal. The site was capped with approximately a dozen bargeloads of Upper Duwamish River sand in two cycles of maintenance dredging (2 dozen loads). Between the first and second cycle, surface grab samples were collected and evaluated for chemistry. The samples indicated contaminants were below state clean-up standards (SQS). There are plans to take SVPS photographs during the next Elliott Bay PSDDA site monitoring (the site is located partially within the PSDDA site bottom boundary). This will provide information on the mixing and spread of capping sand being dumped in 200 feet of water. Short-term fate modeling indicated little off-site movement would occur and the SVPS data will be used to confirm that prediction.

6.2 Geotechnical

Reviewers were primarily concerned that the potential for failure of a cap has not be adequately evaluated in the FS. There was a specific concern that the conditions assumed in the FS stability analysis did not account for more catastrophic ground motion. Several agency reviewers were concerned about the ability to cap on steep slopes or in sloped areas with a finer substrate and requested that a slope stability analysis or more detailed field investigation of the potential for cap failure on a slope be performed during the design phase.

Seismic Considerations in Cap Design—*Seismic considerations can be factored into the slope stability programs to produce projected seismic/stability conditions at the site. Any significant seismic event would tend to flatten the existing slopes to a more stable condition. As a result, localized areas could experience sloughing and/or thinning of the cap materials. To remedy the conditions, additional capping materials would need to be deposited at these localized areas. At a minimum, periodic monitoring of the site would be required with additional monitoring after* *any significant seismic event. Rehabilitation of the site would require placement of additional capping materials. Any design cannot protect totally from seismic events, the solution is to try to minimize the effects and maintain containment.*

Two possible solutions to minimizing the effects of seismic events pertaining to cover and containment would be to flatten slopes to maintain integrity and to build containment dikes to prevent migration of materials. However, the latter method would also be subject to the seismic events and thus would need to be designed accordingly (i.e., overbuild dike heights to absorb seismic forces).

It would be very difficult to predict the potential sloughing and/or thinning of the cap materials based on some unknown future seismic event. Further sampling and testing of the sediments and cap materials would need to be performed to determine engineering properties for design. After any significant seismic event, monitoring of the cap for thickness and to determine any movement of materials will be recommended in the operation and maintenance plan for this site.

Capping on Steep (>18 %) Slopes to Ensure Stability—*The site shall be evaluated during design for slope stability for both existing in-situ conditions and the cap design. Characteristic parameters for the materials of both the contaminated soils and the capping soils will need to be obtained for slope stability analysis. Soils parameters can be obtained by several methods such as historical data, performance data at other sites/projects, and exploration at the site. In general, based on past experience at other disposal/capping sites, soils such as sands are stable at slopes of IV to 4H (25 percent slope). The flatter the slopes the more stable they become.*

Limited data regarding engineering soil parameters are currently available for the site. Sampling data contained in the RI consists of surface (0-4 inches), shallow subsurface (0-20 feet) for physical and chemical analyses, and deep subsurface (0- 96 feet) for physical testing. Additional surface sediment samples were collected for laboratory toxicity testing, benthic enumeration and identification, and a clam laboratory bioaccumulation study. Limited engineering information on the subsurface materials were obtained in the three deep subsurface borings at depths below 6 feet (visual soil classification, standard penetration testing). Additional engineering parameter including triaxial shear, consolidation, Atterberg Limits, water content, void ratios, density, and particle size distribution were collected at depths up to 6 feet below mudline at these same locations. Preliminary data (Attachment 2) indicate the site characteristics are highly variable. At two locations, surface sediments are likely to deform or undergo lateral flow; at one location sediments appear capable of supporting a cap. The variability in the geotechnical properties suggest that further exploration may need to be conducted during design to obtain the soil parameters to identify the more problematic areas with respect to capping and finalize design.

Additional capping materials at the localized displaced areas may be required based on design phase testing. Monitoring will be conducted in the short term to evaluate the effectiveness of the capping operation and to determine the extent of any downslope migration of materials.

6.3 Cap Thickness

Several reviewers questioned how cap thickness will be determined given the need for chemical isolation of creosote-contaminated sediments with a potential groundwater transport pathway and the potential for bioturbation.

Cap Design Considerations to Achieve Physical, Chemical, and Biological Isolation and Containment*—The 3-foot cap thickness utilized in the FS is based on a screening analysis in the RI Report. The total flux into offshore surficial sediments was calculated, assuming that all contaminant mass was retained in a hypothetical 1-meter sediment thickness, with no discharge of contaminants into the Sound, and no degradation of contaminants in the top layer of surface sediments (i.e., upper 10-15 cm). This approach identified critical COC's and sediment zones for recontamination by groundwater, but found that the groundwater contribution is minor compared to the existing mass in sediments. No assumptions of grain-size or TOC were required because of the conservative assumption that all contamination would be retained in the cap material.*

During Remedial Design, the cap thickness will be evaluated by methods consistent with guidance in EPA 905-B96-004, Guidance for In-Situ Subaqueous Capping of Contaminated Sediments. This manual recommends that recontamination by three primary groundwater mechanisms be addressed:

A. *Expressed porewater from consolidation of underlying contaminated sediments.*

B. *Diffusion of contaminants from underlying contaminated sediments (for projects without active groundwater discharge).*

C. *Discharge of contaminated groundwater through the cap. The contaminated groundwater may originate from:*

    1) *Dissolved flux from contaminated upland areas.*

    2) *Partitioning from underlying sediments into discharging groundwater.*

For Mechanism A, two processes are at work: 1) the cap materials consolidate to express porewater and 2) the underlying sediments/soils consolidate from the weight of the cap materials and thus express porewater along with any contamination associated with it. Expression of porewater is dependent on the porosity of the materials and the consolidation of the materials in both the cap materials and the underlying sediments. Basic soil testing (consolidation and porosity/permeability) as well as computer modeling can be used to evaluate expressed porewater during consolidation. Samples of both the cap materials and the sediments are obtained to conduct this type of testing. If the information is not available, then additional sampling and testing would be required Sampling and testing in the RI does not address these issues and therefore there is not enough information to begin to evaluate whether porewater can and will be expressed both through the capping materials and the underlying sediments. Further studies/sampling and testing will be conducted during design to evaluate this potentiality.

Mechanism B can be ignored, since diffusion will be negligible compared to advective transport associated with groundwater discharge.

According to the EPA guidance, Mechanism C should be evaluated by an analytical one-dimensional transport model, to estimate breakthrough times for different cap materials and thicknesses, based on advection of discharging groundwater with longitudinal dispersion and partitioning in the cap. The model can also be made to incorporate reasonable decay in the upper, aerobic portion of the cap. Analytical solutions provided by Ogata and Banks (1961) or Van Genuchten and Alves (1982) may be used; both are available in EXCEL or MathCAD format. Mechanisms C.1 and C.2 both need to be examined by this procedure, because the sediments underlying the cap may actually release porewater concentrations higher than groundwater concentrations originating in the uplands OU.

The analytical transport model described above would simulate only the cap material, and would be in addition to modeling already performed at the PSR site. The BIOSCREEN model described in the RI Report can be used to provide groundwater discharge rates and concentrations for input to the sediment cap model. Input data required for the sediment cap model is shown in Table 1.

Table 1—Sediment Cap Input Data

Model Input Data	***Data Source***
Cap material gradation	***Test data from anticipated sources***
Cap material TOC	***Test data from anticipated sources***
Cap material density	***Test data from anticipated sources***
Cap material porosity	***Test data from anticipated sources***
Groundwater discharge rates	***BIOSCREEN model***
Groundwater contaminant concentrations	***BIOSCREEN model***
Sediment contaminant concentrations	***RI Report***
Sediment Kd's	***RI Report***
Contaminant Koc's	***RI Report***
Contaminant solubilities	***RI Report***
Contaminant decay (degradation) rates	***Published data***

The sediment cap design thickness will be adjusted to ensure that contaminant breakthrough does not occur within the specified service lifetime of the cap. Conservative results may be obtained by neglecting contaminant degradation in the cap; however, some representative degradation rates may be obtained from literature sources, or from studies at other projects such as Eagle Harbor.

Subtidal benthic communities inhabiting Elliott Bay exhibit higher abundance and species richness in shallower environments. Word et. al. 1984[1]*, in a study in Elliott Bay found a decrease in numbers and abundance of benthic taxa with increasing depth. Therefore cap thickness in the shallower nearshore areas (< 100 feet), should provide a thickness sufficient to provide a chemical and biological barrier to recolonizing benthos (3 feet), including bioturbating species such as Molpadia intermedia (infaunal holothurian) and Callianassa spp. (burrowing shrimp) known to inhabit Elliott Bay. The Denny Way CSO capping project documented Callianassa spp. densities of 8-10/m^2 within six months of capping and densities of 38-66/m^2 within eighteen months of capping in water depths from 20 to 60 feet. Densities of Callianassa spp. observed at eighteen months at the Denny Way CSO are capable of effectively turning over up to 1.2 - 5.4 kg/m^2/day*[2] *of sediment. Other taxa such as Molpadia spp. can also cause significant biogenesis and vertical transport of sediment (as a conveyor belt species) through their feeding activities (Rhoads and Young 1971*[3]*; Lee and Swarz 1980)*[4]*.*

6.4 Cap Source Material

Reviewers raised several pertinent issues regarding the source of the capping material and the timing of the placement. Most reviewers were looking for options that minimized the material costs by timing the cleanup to coincide with the availability of maintenance dredged materials.

The proximity of the Federal project in the Duwamish River makes Corps[1] *maintenance dredging material the most logical source of capping material. If cap placement methods utilized readily available dredging equipment, (similar to the placement methods used in Eagle Harbor), only minor modifications to routine maintenance dredging contracts would be required, and capping cost would be minimal. The PSR Superfund Project would have to pick up only the incremental increase in the disposal cost over open water disposal at the Elliott Bay PSDDA site. For this reason, every effort should be made to adjust the "estimated time to cleanup" to the Duwamish maintenance dredging volumes and schedule.*

Maintenance dredged material from the Federal channel in the Snohomish River is an alternative source of capping material, but at an increased cost. Obtaining capping material from a marine borrow source is not recommended due to adverse environmental impacts. A

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[1]*Word, J. Q., et. Al., 1984. Subtidal Benthic Ecology. Final Report Vol. V, Section 6. In: Q.J. Stober and K. K. Chew,Principal Investigators. Renton Sewage Treatment Plan Project: Seahurst Baseline Study. University of Washington Fisheries Research Institute.*

[2]*Lee* and *Swarz* (1980) *estimated Callianassa californients* can individually rework sediment at a rate of 33 to 82.5 g/individual/day down to a sediment depth of 76 cm (see citation below at 4).

[3]*Rhoads, D.C. and D.K. Young 1971. Animal-sediment relations in Cape Cod Bay, Massachusetts. II. Reworking by Molpadia oolíticia (Holothuroidea). Marine Biology. 11: 255-261.*

[4]*Lee, H and R.C. Swarz. 1980. Chapter 29. Biological process affecting the distribution of pollutants in marine sediments. Part II. Biodeposition and Bioturbation. In: Contaminants and Sediments. Volume 2, edited R.A. Baker. Pp. 555-606.*

viable borrow source probably would have to be located in water depths of -20 to -40 feet MLLW. Assuming a borrow volume of 850, 000 cubic yards and a dredge cut of 10 feet, the borrow site would remove all benthic organisms from approximately 52 acres of bottom lands between -20 to -40 feet MLLW.

The use of an upland source for capping material would increase capping costs by more than an order of magnitude, clearly less desirable from an economic standpoint. In 1994, the Corps of Engineers estimated the cost of placing additional capping material at Eagle Harbor. The cost for sand, obtained from an upland source, and placed hydraulically, was $11/cubic yard. In November 1994, the Corps placed approximately 5,000 cubic yards of sand and gravel at Seattle's Lincoln Park as part of a beach nourishment project. This material cost $24/cubic yard. The cost for the initial placement of the capping material (by washoff) at Eagle Harbor was $2.42/cubic yard, including a 60-mile round trip haul from the Snohomish River. The cost of capping with material obtained from an upland source appears to be between 4.5 to 10 times the cost of material obtained from maintenance dredging.

6.5 Cap Placement

Reviewers provided technical information about possible methods of cap placement that need to be further evaluated during design. Some methods will require field tests prior to selection which would need to be incorporated into the design schedule.

Placing a cap of clean material over contaminated bottom sediments at the PSR Superfund site does not appear to be technically difficult. Placement methods previously utilized in Puget Sound, (Denny Way CSO and Eagle Harbor) have demonstrated that a relatively uniform layer of dredged material can be gently placed overlarge areas of contaminated sediments. While the PSR site is in much deeper water, 200 feet versus 30 to 60 feet, the quiet, low energy nature of the PSR site should result in only an extended settling time for the capping material. The greatest challenge may be in developing a placement plan that most economically utilizes the available capping resources.

Hydraulic placement methods could be used to gently place a layer of dredged material in a relatively shallow portion of the area to be capped. This area could then serve as a disposal site within which the standard bottom dump barge disposal method is utilized. Material placed by this method would flow down the steep bottom slope and cover the deeper contaminated sediments. Since the haul distance to the PSR site and the existing PSDDA site are essentially the same, the construction cost for a significant portion of the PSR capping project could potentially be eliminated.

A numerical model developed at the Waterways Experiment Station, STFATE, is used to predict the short-term fate of dredged material disposed in open water. This model does have the capability to represent the effects of the bottom slope. It may be possible to "verify " the model by comparing model results with monitoring data from the Elliott Bay PSDDA site. However, a pilot test is probably the only "sure " way to determine if standard the bottom dump procedure will produce satisfactory results.

The following Elliott Bay capping projects have successfully placed material on slopes by slowly releasing (sprinkling) from bottom dump barges at about 27 cubic yards/minute.

Project	*Average Slope*	*Maximum Slope*
Denny Way CSO	*13%*	*29%*
Piers 53-55 Cap	*15%*	*33%*
Pier 64 Cap	*20%*	*50%*

By comparison, the PSR MSU has an average slope of 5.1 percent, with a maximum slope of 21 percent.

6.6 Life/Duration

Several reviewers were concerned that the design life evaluated in the FS didn't realistically address the actual longevity needed for the remedy.

While the FS utilized 30 years for cost evaluation and alternative comparison purposes, the actual life of a sediment cap can be indefinite if properly designed and managed The following bullets discuss some of the major elements of a long-term site management program.

- *Development of an effective monitoring program. Implementation of monitoring during and after construction to insure that the cap is placed as intended and that the cap is performing the basic functions (physical isolation, sediment stabilization, and chemical isolation) as required to meet the remedial objectives. It is important to insure implementation of the monitoring program after major events such as unusually strong storms and earthquakes.*

- *Long-term management of data with reporting of conditions and results. This is crucial since the site manager may change over an extended period of time.*

- *Designation of contingency plans if monitoring indicates that the cap is not meeting the remedial objectives. These may include, but not be limited to, placement of additional capping material or modifications to the cap design including placement techniques.*

- *Identification of additional capping material source(s). Coordination between the site manager and the source of cap material should also be conducted.*

6.7 General Issues

Reviewers raised a number of other issues that may affect the design of the remedy. Issues included the need to confirm the potential contaminant mounds on the bottom and incorporation of that information in the design of the cap, capping in the higher energy nearshore areas, impacts of capping on local current movement and sediment transport, capping phasing and duration, compatibility of the grainsize of the capping material with underlying sediments or as benthic habitat, evaluation of innovative engineering techniques for construction of a cap on a slope, and effectiveness of new dredging technologies.

EPA recognizes that more information will be needed to design and implement the remedy at the site and anticipates an additional data gathering or testing phase at the beginning of the design process. EPA believes that there are adequate data available to provide reasonable confidence that a cap will be effective in addressing site risks. However, as with all technologies, there are uncertainties associated with certain performance functions of the cap. EPA will evaluate the need for a capping test prior to design to provide data to resolve the uncertainties with a proposed cap.

7. COST EFFECTIVENESS

Reviewers questioned how costs were integrated into the selection of the proposed remedy. In addition, questions were raised regarding how costs were compared among the alternatives. There was also some confusion because cleanup and disposal costs were presented separately.

Cost information in the FS is used as one criterion in selecting the preferred alternative. Cost is factored into the alternative evaluation with the other evaluation parameters as set forth in the NCP. Overall Protection of Human Health and the Environment and Compliance with ARARs must be met; all other criteria (including Cost) are balancing criteria, after the first two are achieved. In the FS, each alternative was ranked based on a cumulative ranking of 7 of the 9 CERCLA criteria (State and Public Acceptance were not considered), in order to frame how the criteria may affect a remedy. No single criterion was used to select the preferred alternative.

Generally, an alternative is cost effective if it provides a similar or greater level of protection as other alternatives at a similar or lower cost. Additionally, an alternative is cost effective if an increase in cost returns an equal or greater increase in benefit compared to the other alternatives.

There are no specific criteria under CERCLA that indicate when an alternative is not cost effective. Ecology's cleanup guidance suggests that costs that deviate more than 10 percent are significant. Costs for the proposed cleanup alternatives ranged from $5.5 to $12.4 million; with disposal (assuming construction of a nearshore disposal facility) costs ranging from $8.2 to $11.4 million. These costs are within the range of cleanup costs at other sites within Puget Sound; all alternatives considered for detailed evaluation in the FS have some degree of cost effectiveness.

Costs for removal or capping were considered separately in the FS because of the difficulty in siting an in-water disposal facility or upland dewatering facility. However, all information was presented such that different cleanup alternatives could be considered with each disposal option.

8. SOURCE CONTROL AND POTENTIAL FOR RECONTAMINATION

Overall, reviewers were concerned that all source control measures are in place prior to implementation of the remedy. Specifically, they were interested in what source control actions will address the potential releases from Longfellow Creek, the uplands, the groundwater discharge zone, and the Lockheed and Crowley Marine Services facilities. Reviewers also requested clarification of the contingency planning process if recontamination does occur.

Source control has been accomplished to the extent practicable for this site. Numerous actions have been taken to control releases from the Upland Unit of the site. The wood treating facility has been demolished and source material (sludge and highly contaminated soil) has been removed. A subsurface wall around the north end of the Upland Unit prevents the migration of shallow (less than 45 ft below ground surface) groundwater, DNAPL and LNAPL to Elliott Bay. DNAPL has been pumped from all wells where it has been detected and has shown a significant reduction in volume over time. An impermeable cap is in place over the entire 25 acre site. In addition, the Port of Seattle cleaned out the Longfellow Creek overflow pipe and dredged a small volume of sediment at the mouth of the outfall to remove contaminated sediments.

The MSU RI evaluated the potential for groundwater to transport dissolved constituents from NAPL in the Upland Unit to the sediments. The model indicated that an area near Crowley Marine has the potential to be recontaminated at low levels over time for selected PAH's. However, the model assumptions used were very conservative and did not account for all processes that could serve to retain or degrade PAHs in groundwater prior to reaching surface sediments. While the potential for recontamination of a clean cap in that area from groundwater discharged to the marine environment is unlikely, it cannot be ruled out entirely. Long-term monitoring will be designed to detect recontamination, if it should occur. If the remedy for any reason, should prove deficient, action plans will be developed with input from the trustees and agencies to remedy any such contingency.

9. NATURAL RECOVERY

Several reviewers felt that natural recovery should be evaluated as part of the remedy. Specifically, they were interested in whether the areas currently above the SQS would fall below the SQS within a 10-year time frame.

EPA completed a preliminary evaluation of the potential for natural recovery of the PSR MSU based on data collected as part of the Harbor Island Remedial Investigation, and the Seattle Waterfront Recontamination Study. Sedimentation rates in the Southwestern portion of Elliott Bay are unlikely to be sufficient to achieve natural recovery at the site. Accordingly, active remediation rather than natural recovery is the main component of the proposed remedy. EPA has discussed the potential for enhanced natural recovery in the areas bordering the cap area with a number of Trustee and regulatory reviewers. It is anticipated that there will be some amount of transport of capping materials to non-target areas due to the inaccuracies inherent in cap placement at depth or on steep slopes. It is difficult to estimate the amount of area that may undergo "enhanced natural recovery " via this process.

10. RAOs/EVALUATION CRITERIA

The primary concern expressed by the reviewers was whether the RAOs selected for the MSU were sufficiently protective of human and fish health. Another concern raised was how the site-specific criteria were incorporated in the evaluation of the alternatives and how alternatives were ranked.

The RAOs developed for the MSU do address human health risk. The FS lists the human health risk guidelines outlined in the NCP as the RAOs for this site. EPA believes these RAOs also comply with the requirements of the SMS.

In addition, although the SMS are not based on human health exposure pathways, human health risks can be calculated based on the constituent concentrations equivalent to the SMS. This evaluation is what was done in the FS. The residual human health risks were determined based on the residual contaminant concentrations expected to remain once remediation is completed. Within the level of accuracy of the risk calculation, the residual risk falls within the risk range of 1 in 100,000, which meets both the NCP and MTCA human health risk guidance.

RAOs describe what the outcome of a cleanup should be. By definition in EPA guidance documents, RAOs specify the contaminants or contaminated media, exposure routes and receptors and an acceptable target contaminant level for each exposure route. This is the definition that was used when deriving the RAOs for PSR. In addition to these objectives (which are primarily concerned with receptors, exposure pathways and cleanup levels), there are also functionality requirements that each alternative should strive to meet. These functionality requirements are the site-specific criteria also listed in the FS. These criteria are additional desirable aspects over and above what are included in the RAOs.

The site-specific criteria were used in selecting and designing the components of each alternative. Each alternative was designed to accommodate the site-specific criteria to the extent practicable. These site-specific criteria were also used in evaluating each alternative along with the 7 required NCP criteria. This evaluation was accomplished by addressing the site-specific criteria as components of the first 7 NCP evaluation criteria. The following is the list of site-specific criteria and the criterion (in parentheses) under which it was evaluated.

- *minimize impacts to tribal, recreational, and commercial fisheries (Implementability)*
- *minimize impacts to current water-dependent industries (Implementability)*
- *complete actions within an acceptable time-frame (Short-term Effectiveness, Implementability)*
- *prevent injury to threatened or endangered species (Overall Protection of Human Health and the Environment, Short-Term Effectiveness)*
- *provide a minimum design life of 30 years (Long-term Effectiveness)*
- *maintain geotechnical stability of shoreline (Long-term Effectiveness and Permanence and Implementability)*
- *minimize impacts to water quality during the remedial action (Overall Protection of Human Health and the Environment and Short-Term Effectiveness)*
- *maintain the physical integrity of in-water constructed features (Long-term Effectiveness and Permanence and Implementability)*

- *result in a human health excess cancer risk of less than 1 in 10,000 and a noncancer hazard index of less than 1.0 (Overall Protection of Human Health and the Environment, Compliance with ARARs)*

A numerical ranking was used to summarize the evaluation of the alternatives. This approach allows for a less subjective understanding of how one alternative compares to another. The evaluation text alone is adequate for selection of an alternative, however, EPA felt it would be beneficial to provide the numerical ranking to let the reader know how each compared to the others. Overall Protection of Human Health and the Environment and Compliance with ARARs are two criteria that must be met; all other criteria are considered balancing criteria, when the first two are achieved. In the FS, each alternative was ranked based on a cumulative rank of 7 of the 9 criteria (State and Public Acceptance were not considered). Rankings were assigned a value of 1 through 5 (there were five alternatives evaluated other than No Action). An alternative was ranked based on the information provided in the text (if one alternative better met the criterion under evaluation, it was given a higher rank; those with similar effectiveness shared ranks). See Appendix G of the FS for specific rankings.

11. MONITORING

Reviewers were concerned that the monitoring cost estimates were not reasonable for a site this deep. This concern was raised in part based on the Corps' experience with the Eagle Harbor capping project. Most reviewers also felt that a greater level of effort and longer duration would be required for the actual long-term monitoring program.

EPA believes that FS monitoring costs are adequate for the purpose of proposing a remedy. The estimate based on the monitoring scheme presented in the FS was not intended to serve as the final monitoring plan for the site. Rather, the monitoring scheme was intended to provide some basic monitoring elements to allow comparisons among alternatives. The actual monitoring program will be developed during design and will be available for review prior to implementation. It is likely that actual long-term monitoring will occur on a more frequent basis or with greater level of effort per event, depending on the final characteristics of the remedy and monitoring techniques that will be most effective.

EPA understands that the cap or disposal site may need monitoring beyond a period of 30 years. However, EPA guidance recommends use of 30 years for comparative purposes.

If costs were modified to address reviewers comments (see example below), the impacts to costs across alternatives would be similar (i.e., relationships among alternatives would stay the same). The following assumptions were used to create the recosted example.

- *Monitoring occurs for 100 years on the following years: 1, 2, 3, 5, 7, 10, and every 5 years thereafter out to 100 years.*

- *The cost for a single monitoring event is double that in the FS. The following table shows the recalculated monitoring cost versus the FS cost.*

Table 2-Modified Costs Incorporating Revised Assumptions for Long-term Monitoring

Alternative	FS Monitoring Cost ($)	Recalculated Cost ($)
3a Cap to SQS	1,040,000	1,960,000
3b Cap to CSL	573,000	1,070,000
4a Dredge and Cap to SQS	940,000	1,990,000
4b Dredge and cap to CSL	410,000	999,000

12. DISPOSAL/SITING

The main concern of the reviewers was that issues associated with disposal had not been adequately addressed for each alternative; however, there were widely differing views as to the acceptability of some disposal options. Reviewers requested that additional combinations of alternatives be evaluated, including disposal and treatment. Others wanted disposal to be combined with other cleanup actions within Elliott Bay. Tribal reviewers specifically stated that nearshore disposal was unacceptable due to impacts to treaty-protected fish and shellfish harvesting, while Ecology wanted further consideration of a nearshore CAD that could combine habitat restoration opportunities.

A screening of various technologies was conducted as part of the FS and resulted in retention of several confinement options for evaluation in the FS (e.g., treatment was screened out due to cost and the lack of available land to process sediments). Various configurations for cleanup and disposal were developed for the FS, however, removal and disposal were not specifically included in the same alternative because of the large number of combinations that could be evaluated. Rather, removal and disposal were evaluated separately, although the FS provided adequate information to evaluate cleanup and disposal together based on the cleanup goal selected and the subsequent volumes requiring disposal.

The FS evaluated several types of disposal options (confined aquatic, confined nearshore, and upland) in order to comply with the requirements of EPA guidance documents and CWA 404 regulations. Based on this evaluation, it was determined that confinement in place (i.e., capping) was the best remedy for the MSU. The opportunity to combine disposal of MSU sediments with other projects in Elliott Bay was evaluated; currently no opportunities exist. The nearshore CAD (proposed by Ecology at the Lockheed site) did not have sufficient excess capacity to include PSR sediments.

13. RESTORATION GOALS

The primary concern raised by reviewers was that the selected remedy (capping areas exceeding the CSL for PAHs over the entire site and SQS for PCBs in the nearshore area) was not protective of fish. As part of their comments on the FS, the natural resource trustees provided documentation of their restoration goals for the PSR MSU. Specifically, they provided a chemical threshold for total PAHs (2,000 µg/kg dry weight) that they felt would provide sufficient protection of fish resources. During a subsequent meeting with EPA, the Trustees further clarified that this goal applied to any depth (i.e., not just the nearshore) and should be met on a point-by-point basis, as opposed to an area weighted average. In addition, their goals included removal of all pilings from the nearshore area and no net loss of habitat.

EPA has evaluated how to achieve the Trustee PAH restoration goal for the PSR MSU. Immediately following capping, total PAHs will likely be at or below the restoration goal over 47 acres of the site. Additional areas near the boundary of the capped area may also meet the goal due to loss (estimated 25% of total cap volume) and migration of clean capping material during placement in deep water or along steep slopes. Modeling can be performed during the design phase to estimate which areas may be positively affected; however, this benefit cannot be confirmed until post-remediation monitoring takes place. Areas outside of the capped area will likely have total PAH concentrations above the restoration goal but below the CSL for individual PAHs based on current conditions (see Figure 1).

With respect to the remaining restorations goals, the proposed remedy will not result in loss of any aquatic habitat, and all pilings that are not in use will be removed from the marine environment.

14. EDITORIAL COMMENTS

The following editorial comments were provided to EPA; however, the Feasibility Study and the Proposed Plan documents will not be revised. The Record of Decision and responsiveness summary will incorporate editorial comments, where specific materials (tables, figures or appendices) are included.

D3a. DNR would like to request that the products being offered for public review and comment clearly identify the public-aquatic lands within the site boundaries. It is critical for the public to understand that the decisions being made at the site have specific implications for the citizens of this state.

A2. Suggest removing any “recommendations” that specify and/or constrain the methods of sediment cap placement sequencing or details of construction methods, unless they have a sound engineering or environmental basis. See related specific comments below.

A3. Suggest that a list of all the acronyms appearing in this document be prepared and placed in the front, following the table of contents.

A50. **Page 1-1, second paragraph, first sentence.** “The purpose of this report is to provide EPA, other interested agencies....” The FS should be by EPA, not directed to EPA. WESTON may have prepared it, but under the direction of EPA, making it EPA’s report.

T6. **Page 1-2, first paragraph.** The phrase “to the extent practicable” should be changed to “to the maximum extent practicable” to conform to the Model Toxics Control Act (MTCA) cleanup regulation *language (Chapter 173-340, WAC).*

A52. **Page 1-3, Section 1.3, first paragraph, numerous citations of WESTON documents.** Are these EPA documents or WESTON documents? If they are WESTON documents, what role does WESTON play in the decision making process? Likewise, all of the RETEC citations should be 'Port of Seattle.' It is my understanding that all of these reports were prepared for and under the control of a government entity. It is the government entity that takes responsibility for the report, and therefore, should be listed as the source of the report.

T8. **Page 1-4, Section 1.3.2, third paragraph.** Please change the phrase "treaty rights to gather shellfish" to "treaty rights to gather other fish and shellfish." Also, please delete the last sentence in the paragraph, and the associated Figures 1-7 and 1-8. The figures are inaccurate and the previous sentences in the paragraph adequately state that the Tribes fish in the area.

T10. **Page 1-8, Section 1.4.6, second paragraph, fourth line.** Please change the first word in this line from "estuary" to "Waterway."

A53. **Page 1-12, Section 1.5.2 (Biota), first paragraph, second sentence.** 'Some of these species....' EPA should provide a list or a table of those species of concern and their status (Federal or State listings).

M19. **Page 1-12, last paragraph.** Chinook have now been listed, and various references to it throughout the report should be updated.

T13. **Page 2-2, first full paragraph.** This paragraph should clearly state that the SQS and CSLs are Washington State-derived numbers. The term "biological resources" should also be replaced with "benthic infauna."

E15. **Page 2-2 Section 2.2.1.1, second paragraph.** Insert as second sentence "However, the SMS does have a narrative standard for human health of no significant health risk to humans."

T14. **Page 2-2, Section 2.2.1.1, second paragraph.** Insert the following as a second sentence: "However, the SMS does have a narrative standard for human health of no significant health risk to humans."

E16. **Page 2-2 Section 2.2.1.1, third paragraph.** The wording discussing the difference between CSL and AETs is too confusing. Simply put, the only difference is that SQS and CSL are TOC normalized, AETs are dry weight normalized.

A7. **Page 2-4, Section 2.3.1, last paragraph, third sentence.** Data generated from the clam bioaccumulation and fish tissue study used to support the human health risk assessment should be summarized and provided in an appendix to this report.

A55. **Page 2-10, Section 2.4.3.1.** Change the last sentence to read 'EPA consults with Department of Interior on remedial actions to assure appropnate consideration of threatened and endangered species.'

T18. **Page 2-10, Section 2.4.3.1, last sentence.** Please replace the phrase "from the Department of the Interior" to "from the Department of Interior and/or the Department of Commerce, acting through the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, respectively."

T19. **Page 2-10, Section 2.4.3.3, Title.** Please remove "U.S." from Fish and Wildlife Coordination Act.

A57. **Page 2-12, Section 2.6, last paragraph.** Change 1st sentence reference from 'WESTON' to 'EPA.'

M27. **Page 3-1, bullet.** This paragraph should be rephrased so that it does not state that "no action/institutional controls" will meet the project RAOs.

A8. **Page 3-3, first paragraph, fourth sentence.** Strike "on" between "CAD sites" and "with greater.. *in situ.*"

T21. **Page 3-3, first paragraph, fifth line.** Please change the sentence that starts with "Some CAD sites on with" to "Some CAD sites with."

A9. **Page 3-4, fifth paragraph, first sentence.** "Institutional Contracts" should be changed to "Institutional Controls".

A58. **Page 3-4, Section 3.2.3.** This appears to be an alternative, not a technology. I would be careful here to not start mixing a technology evaluation with an alternatives analysis. I recommend moving this entire section to Section 5.

A12. **Page 3-7, paragraph 3.3.3.2, next to last sentence.** Figure 4-12 should be referenced in text to denote location of two CAD sites.

A59. **Pages 4-1, Section 4.1.1.** This is good detail on dredging but we believe a summary would work fine in this section, with the details put into an appendix (Sections 4.1.1 to 4.1.1.5). This would make the document a bit more readable by the general public.

A14. **Page 4-2, third paragraph.** In the last sentence, should replace "a barge" with "one or more barges".

M28. **Page 4-5, first paragraph.** The prevailing winds may be from the southwest, but the winter storms that generate the most wave action are typically from the north.

T22. **Page 4-5, Section 4.1.2. second paragraph, last sentence.** Due to the explanation immediately preceding this sentence, the last sentence should read "Most slopes within the MSU..."

A21. **Page 4-6, Section 4.1.2.2, last two sentences.** The basis for these statements is unclear. I believe that specifying and/or constraining the sequence or details of the method of placement may be premature. I suggest that these two sentences be removed.

A24. **Page 4-7, last paragraph, first sentence.** I suggest that this sentence be revised from .....shoreline would require.... to read ....shoreline may require.....

A28. **Page 4-8, first paragraph.** See Comment A21 above.

A61. **Page 4-8, Section 4.1.2.3 (Capping Summary), second paragraph, second sentence.** Change dredge spoils to dredge materials.

T24. **Page 4-11, Section 4.1.5.1, last paragraph.** On the second line, please change the beginning of the third sentence to "If conditions allow, sampling frequency would then be decreased..."

A32. **Page 4-13, last paragraph, last sentence**: I believe that specifying and/or constraining the sequence or details of the method of placement may be premature. I suggest this sentence be removed. See General Comment A2.

T26a. **Page 4-17, Section 4.2, second paragraph.** Remove sentence four, since it is debatable that "other less-expensive technologies would provide the same level of protectiveness..." (emphasis added).

T27. **Page 4-18, Section 4.2.2, third sentence.** Include a statement that allows for dredging of shoreline or areas close to shore in which shore protectiveness and slope instability are not issues.

A37. **Page 4-20 to 4-22.** Figures 4-7, 4-8, and 4-10 do not clearly elucidate the demarcations for the capping sequences. The line symbols used (at least in my copy) were indistinguishable between phase 1 and phase 2.

A38. **Page 4-22, third paragraph, last sentence.** Add "foot depths" between "150" and "offshore".

A45. **Figure 4-12** should also note the location of the WES experimental dump site relative to the PSDDA site and potential CAD site 1 boundaries.

A63. **Page 5-1, Section 5.** I recommend using the language directly from 40 CFR 300 to present the purpose of the alternative analysis. For example:

> 'This section contains a detailed analysis of viable approaches (as identified in Section 4) to the remedial action at the PSR MSU. The detailed analysis consists of an assessment of individual alternatives against each of the nine evaluation criteria (listed below) and a comparative analysis that focuses upon the relative performance of each alternative against those criteria.'

A65. **Page 5-1, Section 5.2 (Analysis Criteria).** I recommend changing this to 'Evaluation Criteria' to be consistent with the 40 CFR 300.

A66. **Page 5-1, Section 5.2.** I recommend explaining all nine criteria, then note that EPA will evaluate the last two upon their selection of the preferred alternative. I also recommend a short paragraph on how EPA considers the nine criteria (threshold, balancing, modifying).

A41. **Page 5-12, Section 5.3.3.5.** Discuss seismic failure risk further in this section.

T39. **Page 5-14, Section 5.3.4.2, first paragraph, fourth line.** Please change "CLS" to "CSL." (typographical error).

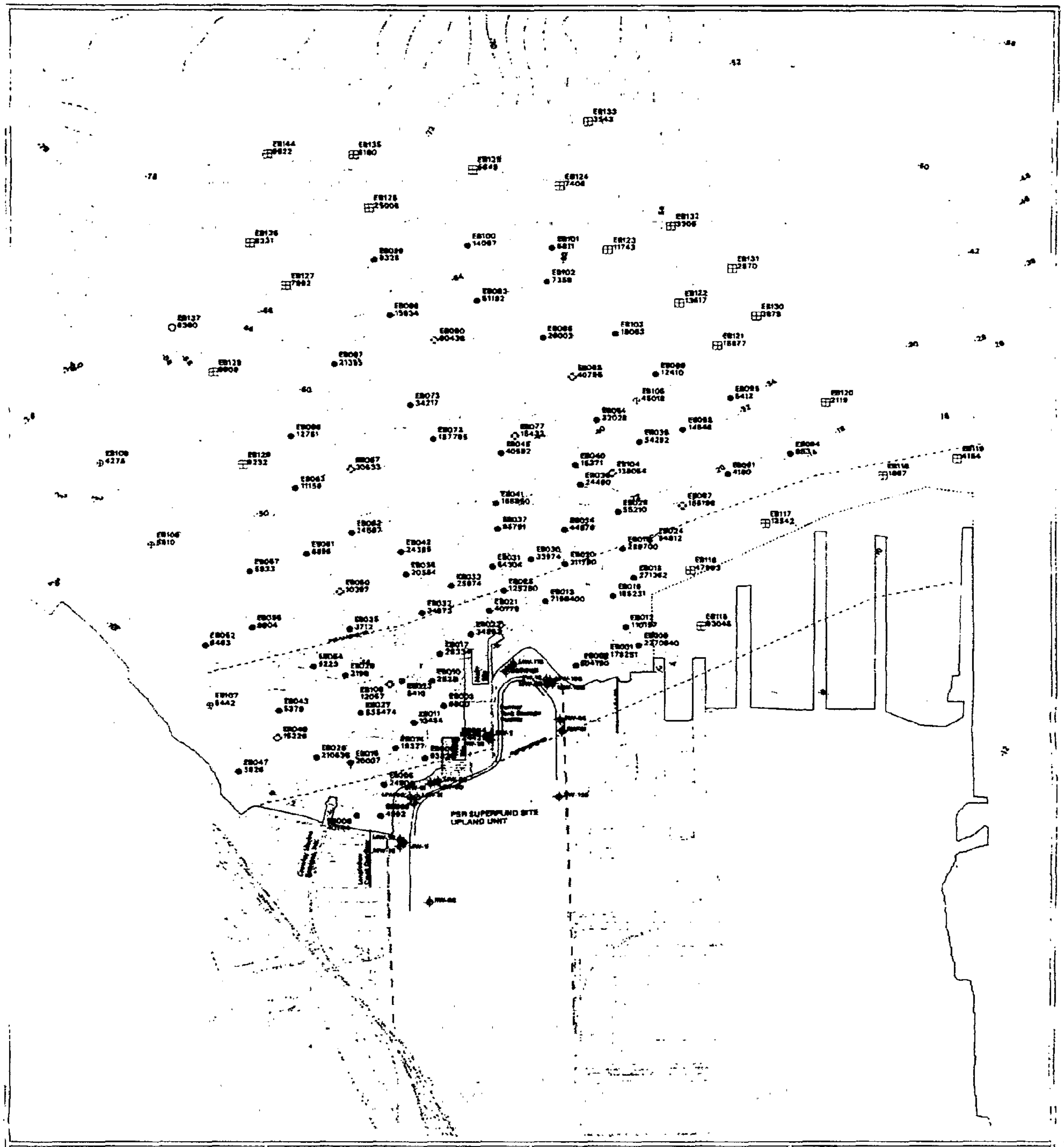
A84. **Page 5-18 through 5-29, Section 5.4.** I believe that it confuses the record to treat these as actual separate alternatives (See Comment A71). Instead of providing a page by page review of these alternatives, I believe all of the detailed comments for the previous alternatives are applicable to these sections.

T40. **Page 5-23, first paragraph.** The Trustees suggest deleting the sentence that states, "The area lost, however, is currently highly contaminated, providing low-quality habitat for fish." This sentence is not needed in the paragraph, and is not necessarily accurate. This paragraph should also note that habitat mitigation would likely be a requirement of this disposal alternative.

T41. **Page 5-25, first full paragraph.** The Trustees suggest deleting the following from the paragraph: "that now provide low quality habitat for native marine communities. The present ecological values of these sites are limited by existing contamination." See the explanation in the previous comment.

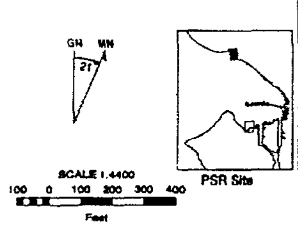
T42. **Page 5-25, Section 5.4.2.6, third paragraph, sixth line.** Please delete the following: "The area lost, however, is currently contaminated and provides low-quality habitat for fish. In addition,". See the explanation in the two previous comments.

FIGURES



SYMBOL EXPLANATION

- ⊟ Phase 3 Surface (0 - 10 cm) Sediment Collected for Analysis (n = 22)
- ○ Phase 3 Surface Sediment Collected for Archival (n = 9)
- ⊕ Phase 2 Surface (0 to 10 cm) Sediment Station - Chemistry Only (n = 7)
- ◇ Phase 2 Sediment Triad Station - Bioassays, Benthos, Surface (0 to 10 cm) Chemistry (n = 9)
- ● Phase 2 Surface (0 to 10 cm) Sediment Station - Chemistry and/or Field Immunoassays (n = 26)
- ▲ Phase 2 Surface (0 to 10 cm) Sediment Station - Field Immunoassay Only (n = 25)
- × Phase 1 Surface (0 to 10 cm) Sediment Sample - Chemistry Only (n = 45)



NOTES

1) Concentrations posted as dry weight.
2) Surface Sediment

WESTON

DATE: September 28, 1999 3:20 PM
JOB NUMBER: 12240-043-001-0134
VIEW FILE: allstns.view

CHECKED BY: ____________

APPROVED BY: ____________

PSR Marine Sediments Unit
NOAA Total PAH

Figure 1

RESPONSES TO SPECIFIC COMMENTS ON THE PSR MARINE SEDIMENTS UNIT FS, AND PROPOSED PLAN

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

May 13, 1999

Environmental Management Branch

Ms. Sally Thomas
U.S. EPA, Region 10
1200 Sixth Avenue
Seattle, Washington 98101

SUBJECT: Review Comments for Draft Feasibility Study (Nov 98) and Proposed Plan (Apr 99), Pacific Sound Resources Superfund Site, Elliot Bay, Washington

Dear Ms. Thomas:

Submitted with this letter are the Seattle District, U.S. Army Corps of Engineers comments on the Draft Feasibility Study (November 1998) and the Proposed Plan (April 1999). The comments were focused on identifying issues related to: 1) Alternatives Analysis and Clean Water Act Section 404(b)(1) Evaluation and 2) Engineering considerations for future remedial design/remedial action (RD/RA). I look forward to meeting with you to discuss these comments.

If you have any questions, please call me at telephone (206) 764-6682.

Sincerely,

Ralph J. Totorica
Project Manager

Enclosure

U.S. Army Corps of Engineers Comments
Draft Feasibility Study (November 1998)
Pacific Sound Resources Marine Sediment Unit

I. Engineering Considerations for RD/RA:

General Comments:

A1. The following general comments are submitted regarding the cap thickness and recontamination issues discussed on p.4-15. This may not require resolution for the FS, but is worth bringing up for consideration by EPA:

The 3-foot cap assumption is probably good for the purposes of the FS alternative evaluation, however the actual thickness should be evaluated during the design analysis per guidance in EPA 905-B96-004. This manual recommends that recontamination by 3 primary groundwater mechanisms be addressed:

1. Expressed porewater from consolidation of underlying contaminated sediments.

2. Diffusion of contaminants from underlying contaminated sediments (for projects without active groundwater discharge).

3. Discharge of contaminated groundwater through the cap. The contaminated groundwater may originate from:

   a) Dissolved flux from contaminated upland areas.

   b) Partitioning from underlying sediments into discharging groundwater.

Modeling in the RI appears to addresses only mechanism 3b). The total flux into offshore surficial sediments was calculated, assuming that all contaminant mass was retained in a hypothetical 1-meter sediment thickness, with no discharge of contaminants into the Sound, and no degradation of contaminants in the top layer of surface sediments (i.e. upper 10-15 cm). This approach identified critical COC's and sediment zones for recontamination by groundwater, but noted that the groundwater contribution is minor compared to the existing mass in sediments.

According to the EPA guidance, mechanism 3) should be evaluated by an analytical 1D transport model, which would estimate breakthrough times for different cap materials and thicknesses, based on advection of discharging groundwater, with longitudinal dispersion and partitioning into the cap. The model can also be made to incorporate reasonable decay in the upper, aerobic portion of the cap. Both 3a) and 3b) need to be looked at by this procedure, because the sediments underlying the cap may actually release porewater concentrations higher than groundwater concentrations originating in the uplands OU.

The results of analyses for 3a) and 3b) will determine cap thickness required to prevent recontamination.

See Section 6.3 (Design Issues—Cap Thickness) of the Responsiveness Summary.

A2. Suggest removing any “recommendations” that specify and/or constrain the methods of sediment cap placement sequencing or details of construction methods, unless they have a sound engineering or environmental basis. See related specific comments below.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A3. Suggest that a list of all the acronyms appearing in this document be prepared and placed in the front, following the table of contents.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A4. The FS lacks a discussion of natural recovery processes as they might attenuate sediments in SQS contaminated areas, which are outside the proposed active remediation footprints for alternatives 2, 3b, and 4b. The FS should summarize the results of a “natural recovery” analysis (e.g., “WASP” modeling) relative to achieving natural attenuation (sedimentation) of PAH contaminated sediments below SQS levels and the potential timeline for achieving SQS. For the “no action alternative, the FS text @ page 5-4 (last sentence) and top of page 5-5, acknowledges that natural recovery processes are possible, but does not quantify how effective this process may be as an adjunct to active remediation of the CSL contaminated sediments (e.g., alternatives 2, 3b, and 4b) to achieve the ultimate cleanup goal of SQS. Also, explicit monitoring of the SQS contaminated areas needs to be part of the long term monitoring plan to monitor the natural attenuation progress following cap placement.

See Section 9 (Natural Recovery) of the Responsiveness Summary.

A5. Monitoring costs for the cap appear to be low for a site this deep. For example, monitoring of the Eagle Harbor cap, at a depth of 40 feet, is estimated to cost 1.5 million dollars over a ten year period. In addition, extensive monitoring was required during cap placement. Since PSR is much deeper, monitoring is more difficult and expensive. Monitoring data and cost data are available concerning the Elliott Bay PSDDA site which is 300 ft. In fact, data from the PSDDA site could provide valuable information concerning the behavior of dredged material at deep sites.

See Section 11 (Monitoring) of the Responsiveness Summary.

A6. The New England District of the Corps of Engineers recently conducted a capping demonstration at a 200 ft site. The project included the formation of a mound using fine grained material and capping the mound with coarse material. They have been monitoring the site since the disposal activity. Results demonstrate that a successful cap was placed over the fine grained material. Extensive monitoring including bathymetry, side-scan sonar, sediment profiling camera, as well as grab and core sampling was conducted. This project would be an excellent source of information relevant to the PSR project.

See Sections 6.2 (Design Issues—Geotechnical) and 63 (Design Issues—Cap Thickness) of the Responsiveness Summary.

<u>Specific Comments:</u>

A7. Page 2-4, paragraph 2.3.1, last paragraph, third sentence. Data generated from the clam bioaccumulation and fish tissue study used to support the human health risk assessment should be summarized and provided in an appendix to this report.

Clam and fish tissue data were provided as part ofAppendix K in the RI report.

A8. Page 3-3, first paragraph, fourth sentence. Strike “on” between “CAD sites” and “with greater.. in situ.”

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A9. Page 3-4, fifth paragraph, first sentence. “Institutional Contracts” should be changed to “Institutional Controls”.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

Al0. Page 3-6, third paragraph. More information should be provided on the Eddie Pump™ high energy Vortex dredge, which should include a schematic or figure showing what it looks like in an appendix to assist the reader in evaluating this particular type of dredge, particularly since there is a lack of experience in the use of this dredge in the northwest and its use to dredge deeper than 50 feet MLLW (historical dredging depth limit) down to 200 feet MLLW.

See Attachment 3 and response to Comment A18.

Al1. Page 3-6, 3rd Paragraph. it is stated that the Eddie Pump™ can be equipped to dredge at depths of 150 to 200 feet. Please indicate where it has been demonstrated successful at these depths.

See Attachment 3 and response to Comment A18.

A12. Page 3-7, paragraph 3.3.3.2, next to last sentence. Figure 4-12 should be referenced in text to denote location of two CAD sites.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A13. Page 3-8, first paragraph, last sentence. The $110 per cubic yard cost quoted for Roosevelt Landfill seems way out of line, especially since the Bellingham Pilot Study team got a quote in the neighborhood of $30 per cubic yard from the same place. This quote should be re-evaluated.

This estimate is an all inclusive estimate that includes dewatering, handling, shipping and disposal. It is correct that the disposal cost alone is approximately $30 to $60 per cubic yard. However, for the PSR site, the sediment would need to be removed, dewatered in a storage cell, stabilized, loaded into trucks and shipped to Roosevelt Landfill and offloaded 411 these costs are included in the $110 per cubic yard estimate.

A14. Page 4-2, 3rd Paragraph. In the last sentence, should replace “a barge” with “one or more barges”.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A15. Page 4-2, 4th Paragraph. It should be noted that rinsing the clamshell bucket prior to reentry significantly slows production. Has this been factored into the analysis?

See Section 6.7 (Design Issues—General Issues) of the Responsiveness Summary.

A16. Page 4-2, 1st Paragraph. Differential global positioning system (DGPS) units are normally mounted on the top of the crane boom. Have to mark cables or provide other transducers (pressure, position) to monitor bucket depth.

See Section 6.7 (Design Issues—General Issues) of the Responsiveness Summary.

A17. Pages 4-2 and 4-3, Section 4.1.1.2. Stated that hydraulic dredges available in Puget Sound typically operate in 90 feet of water. We are not aware of any dredging performed this deep. Please provide examples or clarify. Also, factor of nine increase in sediment volume appears high. Generally can pump up to 20% solids.

The comment is correct. The depth of hydraulic dredges in Puget Sound are typically less than 60feet with most work done around 30feet. The factor of 9 was used as a conservative assumption of the likely volume of slurry to be dealt with assuming a 1:9 solids/water (10% v/v solids) ratio. The volume of solids:water can vary depending upon the type of material dredged and the type of the edge.

A18. Page 4-3, Section 4.1.1.3. None of the performance data for the vortex dredge has been substantiated according to Jim Clausner of WES. Jim was involved with determining appropriate dredges for remediation of the Palos Verdes shelf in southern California. The Palos Verdes project involves depths and slopes similar to PSR. Jim has been trying to evaluate the vortex dredge for several years. He has not been able to get field data to evaluate the dredge from the manufacturer. Jim specifically questions the upper production rate claims as well as maintaining the in-situ solids content while dredging. From the Corps' perspective, this is an unevaluated dredging technique. However, Jim recommends evaluating a bottom crawling dredge used in deep sea mining but equipped with an environmental disk cutter.

Performance data from a recent small test dredge is provided in Attachment 3.

Operation of the EDDY PUMP dredge at depths off 200 feet has not been demonstrated. However, because the EDDY PUMP is suspended on the end of a cable, it has much deeper capabilities compared to ladder type cutter head dredges. Factors limiting the depth of the EDDY PUMP dredge are the length of the cable and the pumping capabilities of the pump. The manufacturer has indicated that their pumps can produce up to 400feet of head which would allow dredging at depths of 200 feet. A booster pump may be needed to pump the sediment once it reaches the surface to the disposal site.

Steve Scott at WES just witnessed a test dredge with the EDDY PUMP. Steve indicated that he thinks the pump will pump up to 40% solids. He feels the EDDY PUMP has a lot of potential but has not seen any pump curves or other documentation that shows the pump has enough head to move the material from a depth of 100 to 200 feet to a distant disposal site. He also said he believes the output of the pump may be a little exaggerated He did say however, that the setup of the EDDY PUMP has no depth limitations assuming there is adequate head to move the dredged material. That is, it's only depth limitation is the length of cable on the dredge crane.

See Section 6.7 (Design Issues—General Issues) of the Responsiveness Summary.

A19. Page 4-5, third paragraph. The text should also note that additional cover in nearshore areas out to 100 foot depths will be needed to insure a final cap thickness of 3 feet, and not just in proposed capping areas deeper than 100 feet. Concerns about bioturbation by deep burrowing organisms are generally more significant in the shallower areas less than 100 feet, where contamination levels are greater and natural resource concentrations are generally higher.

See Sections 6.2 (Design Issues—Geotechnical) and 63 (Design Issues—Cap Thickness) of the Responsiveness Summary.

A20. Page 4-5, Section 4.1.2.1. It should be noted that the Snohomish and Duwamish sources have been successfully used in the past and provide controllable sand gradations.

See Section 6.4 (Design Issues—Cap Source Material) of the Responsiveness Summary.

A21. Pg. 4-6, para. 4.1.2.2, last two sentences: The basis for these statements is unclear. I believe that specifying and/or constraining the sequence or details of the method of placement may be premature. I suggest that these two sentences be removed.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A22. Page 4-6, Section 4.1.2.2, Cap Placement. Since the sediment cap should be placed in layers, may want to consider placing material from upslope to down slope in lanes parallel to shore so that material tending to spread laterally downslope will cover the down slope areas and not be wasted. If a current exists, you want to place material up current.

See Section 6.5 (Design Issues—Cap Placement) of the Responsiveness Summary.

A23. Page 4-6, Section 4.1.2.2, Cap Placement. Snohomish and Duwamish bedload have approximately the same gradation and have worked well for placement in the past. Other sources, if finer-grained, may not work as well. If major changes are proposed from historic placements, suggest a placement test be required.

See Section 6.5 (Design Issues—Cap Placement) of the Responsiveness Summary.

A24. Pg. 4-7, last paragraph, first sentence: I suggest that this sentence be revised from..... shoreline would require.....to read.....shoreline may require.....

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A25. Page 4-7, 2nd Paragraph. Submerged discharge methods require field trials for effective placement without displacement. A field demonstration should be required as a material placement variation can give different results.

See Section 6.5 (Design Issues—Cap Placement) of the Responsiveness Summary.

A26. Page 4-7, 4th Paragraph. A suspended deflector plate may be used on bottom for energy dissipation. This method requires field testing. Method has been used at Ross Island, Portland with difficulty.

See Section 65 (Design Issues—Cap Placement) of the Responsiveness Summary.

A27. Page 4-7, last Paragraph. It should be noted that capping under the piers and adjacent to the shoreline would likely require coarser gradations to protect against wave and boat wake erosion.

See Sections 6.2 (Design Issues—Geotechnical) and 6.3 (Design Issues—Cap Thickness) of the Responsiveness Summary.

A28. Page 4-8, first paragraph. See comment A21 above.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A29. Page 4-11, paragraph 4.1.5.2. An additional monitoring and mapping tool, the Sediment Vertical Profile Survey (SVPS) camera system, should be considered for use in monitoring the cap placement and as a tool for postremediation long term monitoring. This technology has been shown to be valuable in mapping the capping area (e.g., Eagle Harbor EOU), and can be used at the capping periphery to measure cap thicknesses less than 20 cm (the profile depth of the camera).

See Section 6.1 (Design Issues—Capping at Depth) and Section 11 (Monitoring) of the Responsiveness Summary.

A30. Page 4-13, Section 4.1.6. How vulnerable is the proposed cap to a modest seismic event in this relatively steep area? A seismic evaluation should be performed for this site. The proposed cap sands are uniformly graded. Is liquefaction a concern?

See Section 6.2 (Design Issues-Geotechnical) of the Responsiveness Summary.

A31. Page 4-13, Section 4.1.6.1, 3rd Paragraph. It should be noted that the capping sands will not settle much as they are uniformly graded. Only in situ material will settle.

See Section 6.2 (Design Issues-Geotechnical) of the Responsiveness Summary.

A32. Page 4-13, last paragraph, last sentence: I believe that specifying and/or constraining the sequence or details of the method of placement may be premature. I suggest this sentence be removed. See General Comment A2.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A33. Page 4-17, Section 4.2. Do the areas of SQS exceedance (96 acres) and CSL exceedance (47 acres) take into consideration the slope? If not, volume adjustments may be necessary to account for the slope. This comment applies to area and volume estimates throughout the report.

Yes, the areas calculated accounted for slope.

A34. Page 4-19, Section 4.2.2.2. As a critical element of this alternative, disposal of dredged material should be discussed in this section.

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

A35. Page 4-19, Section 4.2.2.3. Do the volume estimates for capping material reflect the fact that approximately 5 feet of capping material will be required to end up with a final cap thickness of 3 feet? This comment applies to volume estimates for capping material throughout the report.

In the calculation of capping volumes, the additional material that was necessary to provide for inaccuracies of cap thickness and losses was accounted for. Generally speaking, a 5 foot equivalent thickness plus losses of 25% was used to determine the potential volume of sand needed for the deeper (>100feet) capping areas.

A36. Page 4-20, last Paragraph. This section describes capping the nearshore area first. This appears to be in conflict with Section 4.1.2.2, which discusses beginning the capping at the bottom of the slope and working towards shore.

See Sections 6.2 (Design Issues—Geotechnical) and 6.3 (Design Issues—Cap Thickness) of the Responsiveness Summary.

A37. Page 4-20 to 4-22. Figures 4-7, 4-8, and 4-10 do not clearly elucidate the demarcations for the capping sequences. The line symbols used (at least in my copy) were indistinguishable between phase 1 and phase 2.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A38. Page 4-22, third paragraph, last sentence. Add "foot depths" between "150" and "offshore".

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A39. Page 4-25, next to last paragraph, second sentence. The mechanics of how the native sediments would be dredged and stockpiled adjacent to the CAD sites needs more detail. CAD Site 1 is immediately adjacent to an old Waterways Experiment Station (USCOE) experimental PCB dump site and the lateral extent of the PCB contamination within the proposed CAD site would need to be established before the dredging at this location is accomplished. Also, as noted in appendix A (sheet 2 of 3) barge disposal in 200 feet of water would likely result in displacement of contaminated material outside the CAD depression. The mechanics of how the contaminated sediments could be placed in the CAD depression needs more discussion. Use of geotextile fabric bags, which are capable of holding up to 400-800 metric meters of dredged material, for disposal would be one means of potentially minimizing water column impacts and the bottom footprint of the contaminated material (see EPA Contaminated Sediments News, Number 22, Fall 1998, page 2).

See Section 6 7 (Design Issues—General Issues) of the Responsiveness Summary.

A40. Page 5-12, third paragraph. Given that 28 % of the SQS contaminated sediments and 35% of the CSL contaminated sediments are on slopes of 18 to 21 %, a "slope stability analysis" should be conducted as part of the preremedial design for the selected capping alternative.

See Section 6.2 (Design Issues—Geotechnical) of the Responsiveness Summary.

A41. Page 5-1, Section 5.3.3.5. Discuss seismic failure risk further in this section.

See Section 6.2 (Design Issues—Geotechnical) of the Responsiveness Summary.

A42. Page 5-18, fourth paragraph, last sentence. The frequency of environmental monitoring of the cap after placement should be greater at the front end out to five years. If the monitoring confirms cap integrity (evaluating cap stability in high slope areas, bioturbation, etc.), the monitoring frequency may then be reduced out to 30 years (e.g., years 1, 2, 3, 5, 7, 10, 15, 20, 25, 30).

See Section 11 (Monitoring) of the Responsiveness Summary.

A43. Page 5-20, second paragraph. As noted in comment A39 above, the potential use of geotextile fabric bags as a method of placing the contaminated sediments in the dredged depressions at CAD sites 1 and 2 should also be considered/assessed. This method could significantly reduce water column impacts and also minimize the contaminated sediments footprint on the bottom.

See Section 6.7 (Design Issues—General Issues) of the Responsiveness Summary.

A44. Page 5-22, fourth paragraph. Monitoring at a CAD site should also consider the use of the SVPS camera, as noted previously in comment A29 above.

See Section 6.1 (Design Issues—Capping at Depth) and Section 11(Monitoring) of the Responsiveness Summary.

A45. Figure 4-12 should also note the location of the WES experimental dump site relative to the PSDDA site and potential CAD site 1 boundaries.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A46. Appendix C. More discussion of risk and modes of failure needed, particularly risk of cap loss in seismic event due to steep slopes. Risk assessment should be performed.

See Section 6.2 (Design Issues—Geotechnical) of the Responsiveness Summary.

II. Alternatives Analysis and Section 404(b)(1) Evaluation:

General Comments:

A47. There appears to be no purpose for the development of the site-specific criteria in Section 1.2. I believe it would have been effective for EPA to incorporate the criteria as specific elements to determine compliance with the 9 CERCLA criteria. Although I believe the site-specific criteria give important information regarding EPA's decision making process, they are only referred to again in the discussion under the preferred alternative. I also believe that they could be used effectively within this document, but it would take some effort to re-write many of the sections. Unless EPA can clearly define the use and intent of these specific criteria, I recommend that they be removed from the document.

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A48. I recommend that the dredging alternatives include all of the disposal options (i.e., Alternatives 2a, 2b, 2c). This is because the biggest problem with the dredging alternatives is finding a disposal site that is available, cost effective and environmentally acceptable. However, the document provides a favorable analysis of, for example, Alternative 2 without mentioning that there will likely be a major problem finding a suitable disposal site. This concept needs more development or discussion so that the reader understands that the dredging alternatives must be evaluated in light of the disposal options.

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

A49. The document's reference to the CERCLA criteria "Reduction of Toxicity, Mobility, and Volume" is very confusing. I understand this to be an evaluation of the efficacy of treatment alternatives. However, the way it is used in this document makes it redundant with CERCLA criterion 1 (overall protection....). I betieve the correct interpretation is eventually discussed in Section 6 (there are no treatment altematives at PSR MSU). Unfortunately, the Section 5 interpretation is not consistent with how EPA discusses the criterion in Section 4. This should be clarified or corrected throughout the document.

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

Specific Comments:

A50. Page 1-1. Second Paragraph, 1st sentence. "The purpose of this report is to provide EPA, other interested agencies...." The FS should be by EPA, not directed to EPA. Weston may have prepared it, but under the direction of EPA, making it EPA's report.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A51. Page 1-2. Last paragraph (criteria bullets); I like the criteria, but EPA may want to reconsider the 'complete actions within an acceptable time frame (less than 3 years).' This may unduly restrict the evaluation of potential disposal options. I recommend that EPA drop the modifier of 'less than 3 years' and let the design details determine what is an 'acceptable' time frame.

EPA used a target time frame for which the alternatives could be evaluated. For the purpose of this FS, EPA chose 3 years. An alternative that requires longer than 3 years would not necessarily be eliminated; however, the additional duration would be factored into the cost and implementability evaluation of the alternative.

A52. Page 1-3, Section 1.3, 1ST paragraph, numerous citations of Weston documents. Are these EPA documents or Weston documents? If they are Weston documents, what role does Weston play in the decision making process? Likewise, all of the RETEC citations should be 'Port of Seattle.' It is my understanding that all of these reports were prepared for and under the control of a government entity. It is the government entity that takes responsibility for the report, and therefore, should be listed as the source of the report.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A53. Page 1-12, Section 1.5.2 (Biota), 1st paragraph, 2nd sentence - 'Some of these species....' EPA should provide a list or a table of those species of concern and their status (Federal or State listings).

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A54. Page 2-1. Section 2. EPA should explain how the RAOs and the site-specific criteria listed in Section 1.2 relate. It appears that the RAOs are the human and environmental health criteria for the alternatives analysis. Indeed, the first RAO in Section 2.5 says the same thing as the last site-specific criteria. If that is the case, then I think that both of the RAOs should be listed as site-specific criteria.

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A55. Page 2-10. 2.4.3.1. Change the last sentence to read 'EPA consults with Department of Interior on remedial actions to assure appropriate consideration of threatened and endangered species.'

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A56. Page 2-10. 2.4.3. Location-Specific ARARS. Also include the following as ARARs:

a. Washington State Hydraulic Code (RCW 75.20.100-160). The Hydraulic Code regulates construction and other work that uses, diverts, obstructs, or changes the natural flow or bed of fresh or salt waters of the state through the issuance of a Hydraulic Project Approval (HPA). Although an HPA will not be issued for this project, the Hydraulic Code requirements are potentially relevant and appropriate for dredging and capping activities.

b. Tribal Government to Government Presidential Memorandum of April 29, 1994. This Order requires consultation with tribal governments on Federal actions that may affect their lands, interests, and/or resources.

See Section 4 (ARARs) of the Responsiveness Summary.

A57. Page 2-12, Section 2.6, last paragraph. Change 1st sentence reference from 'WESTON' to 'EPA.'

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A58. Page 3-4, Section 3.2.3. This appears to be an alternative, not a technology. I would be careful here to not start mixing a technology evaluation with an alternatives analysis. I recommend moving this entire section to Section 5.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A59. Pages 4-1, Section 4.1.1. This is good detail on dredging but we believe a summary would work fine in this section, with the details put into an appendix (Sections 4.1.1 to 4.1.1.5). This would make the document a bit more readable by the general public.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A60. Page 4-5, Section 4.1.2.1, second paragraph, last sentence ('Mining/borrowing of marine sediments ....). I recommend this sentence be deleted or contain a warning. Sediment mining would be highly controversial, involve a extended review process, and require multiple permits.

See Section 6 4 (Design Issues—Cap Source Material) of the Responsiveness Summary.

A61. Page 4-8, Section 4.1.2.3 (Capping Summary), paragraph 2, second sentence. Change dredge spoils to dredge materials.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A62. Page 4-8, Section 4.1.2.3. I would also include a short discussion on the availability of dredged materials - that is, the entire amount may not be available at the time of construction. This is likely to be a major issue in design, so it is worth putting forward for discussion here.

Proposed navigational dredging projects and the availability of capping material was presented in Table 4-2 and discussed in Section 4.1.2.1 of the FS.

A63. Page 5-1, Section 5. I recommend using the language directly from 40 CFR 300 to present the purpose of the alternative analysis. For example:

> ‘This section contains a detailed analysis of viable approaches (as identified in Section 4) to the remedial action at the PSR MSU. The detailed analysis consists of an assessment of individual alternatives against each of the nine evaluation criteria (listed below) and a comparative analysis that focuses upon the relative performance of each alternative against those criteria.’

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A64. Page 5-1, Section 5. There is no mention regarding the site-specific criteria developed in Section 1.2. How do they relate to the CERCLA criteria, in what capacity are they intended to be used, how does this all relate to the RAOs?

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A65. Page 5-1, Section 5.2 (Analysis Criteria). I recommend changing this to ‘Evaluation Criteria’ to be consistent with the 40 CFR 300.

A66. Page 5-1, Section 5.2. I recommend explaining all nine criteria, then note that EPA will evaluate the last two upon their selection of the preferred alternative. I also recommend a short paragraph on how EPA considers the nine criteria (threshold, balancing, modifying).

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A67. Page 5-1, Section 5.2.1. Overall Protection of Human Health and the Environment. I recommend that this paragraph include some specific standards or concepts that EPA used to determine a given alternative performance ***for this site*** under this criterion. Is there any standard or level of protection that an alternative must reach to be considered by EPA to be suitable for consideration at PSR (what is the bottom line?)? Is this where EPA uses the RAOs to determine overall protection?

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A68. Page 5-1, Section 5.2.2. (Compliance with ARARs), 2nd paragraph. This paragraph seems out of context. It is not clear how residual human health risks are associated with ARARs. This paragraph may be more appropriate for Section 5.2.1.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A69. Page 5-1, Section 5.2.3 (Reduction of Toxicity, Mobility or Volume). This criterion, as written, appears to be redundant with Section 5.2.1. The regulations (40 CFR 300) call this ‘Reduction.... *through treatment*.’ I may be misunderstanding the terminology, but the range of alternatives for PSR do not include treatment. Rather, they are removal or isolation technologies. There should be some connection made with the actual Superfund criterion in the regulations.

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A70. Page 5-2, Section 5.2.7. It is not clear as to how EPA actually uses the cost information in the CERCLA decision making process. A "cost effectiveness" discussion would indeed be helpful here to clarify how each alternative "ranks" relative to others in terms of effectiveness. For example, EPA may find that a given alternative provides only a minimal increased level of protection at an order of magnitude greater cost than another alternative. EPA may determine that the benefits accrued from the more protective alternative do not warrant the exceptionally higher costs. This type of discussion would help the reader (and decision maker) to understand the tradeoffs.

See Section 7 (Cost Effectiveness) of the Responsiveness Summary.

A71. Page 5-5, Section 5.3.2 (Alternative 2). Alternative 2 cannot stand alone in evaluation because a critical factor for this alternative is the ability to dispose of 372,000 cubic yards of contaminated materials. For example, I am not sure dredging with nearshore disposal would meet the ARARs because of substantial and irreversible impacts to aquatic resources. Recommend that this section be rewritten to include all of the disposal options (Alternatives 2a, 2b, and 2c) and their evaluation under the criteria.

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

A72. Page 5-5, Section 5.3.2.1. This is where is would be helpful to the reader if EPA discussed the merits of 'overall protection' of Alternative 2 compared to some standard that EPA is trying to achieve. The significance of 3rd and 4th sentences of paragraph 2 is not clear. Is this an acceptable reduction of risk and the hazard index? Does Alternative 2 meet the first threshold criterion?

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A73. Page 5-5, Section 5.3.2.2. Recommend that this section be re-written as follows:

For the purposes of this review, EPA believes that Alternative 2 can meet the substantive requirements of the applicable ARARs. EPA will complete an in-depth ARAR evaluation upon determination of the preferred alternative[1].

ARARs would include:

a. Substantive compliance with Washington State Sediment Management Standards.

b. Substantive compliance with Washington State Water Quality Standards both during and post project construction (Section 401 of the Clean Water Act)

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[1] If Alternative 2 is changed to reflect comments under Page 5-5, Section 5.3.2, then I would modify this statement to include a qualifying statement about dredging with nearshore disposal. This disposal option may not be able to meet the substantive requirements of the Clean Water Act and the coordination objectives of the Endangered Species Act. If EPA determined that this was the appropriate remedial action to take at this site, then EPA would need to demonstrate that compliance would result in greater risk to human health and the environment.

c. Substantive compliance with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act.

d. Substantive compliance with Washington State Hydraulic Code.

e. Substantive compliance with Washington State Shorelines Management Act (and Coastal Zone Management Act).

f. Coordination with National Marine Fisheries Service and the U.S. Fish and Wildlife Service consistent with Section 7 of the Endangered Species Act.

g. Consultation with the Muckleshoot Indian Tribe and the Suquamish Indian Tribe.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A74. Page 5-6, Section 5.3.2.3. See Comment A69.

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A75. Page 5-9, Section 5.3.3.1. See Comment A72. What is the significance of the risk reduction estimates? Do both 3a and 3b meet this threshold criterion?

See Section 3 (Risk) and Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A76. Page 5-10, Section 5.3.3.2. See Comment A73. It is inappropriate at this level of review to determine ARAR compliance. However, it is appropriate to point out where there may be difficulty achieving compliance (for example, see Footnote 1).

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A77. Page 5-10, Section 5.3.3.3. See Comment A69.

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A78. Page 5-13, Section 5.3.3.7 (Cost). See Comment A70. This would be a good place to discuss the relative merits (if there are any) of the substantially higher costs of alternative 3a. In other words, is alternative 3a a cost-effective alternative?

See Section 7 (Cost Effectiveness) of the Responsiveness Summary.

A79. Page 5-14, Section 5.3.4 (Alternative 4). As with Alternative 2, Alternatives 4a and 4b have a significant disposal problem that should be evaluated as a complete alternative (see Comment A71).

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

A80. Page 5-14, Section 5.3.4.1. See Comment A72. What is the significance of the risk reduction estimates? Do both 4a and 4b meet this threshold criterion?

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A81. Page 5-14, Section 5.3.4.2. See Comment A73. It is inappropriate at this level of review to determine ARAR compliance. However, it is appropriate to point out where there may be difficulty achieving compliance (for example, see Footnote 1).

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A82. Page 5-15, Section 5.3.4.3. See Comment A69.

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A83. Page 5-18, Section 5.3.4.7. See Comment A70.

See Section 7 (Cost Effectiveness) of the Responsiveness Summary.

A84. Page 5-18 through 5-29, Section 5.4. I believe that it confuses the record to treat these as actual separate alternatives (See Comment A71). Instead of providing a page by page review of these alternatives, I believe all of the detailed comments for the previous alternatives are applicable to these sections.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A85. Page 5-30, Section 5-5. I do not understand the purpose of the numerical ranking and how they may have been used to select the preferred alternative. EPA should provide an explanation how this process was used for their decision.

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A86. Page 5-30, Section 5.5.1. Do all of the Alternatives meet this threshold criterion?

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

A87. Page 5-30, Section 5.5.2. The analysis of compliance with ARARs is currently incomplete. Some of the alternatives may not be in compliance with ARARs. I would modify this statement to say that EPA believes that Alternatives 3a and 3b may be in compliance with ARARs. Alternatives (the alternatives with nearshore fill and CAD) would require fairly extensive documentation to determine compliance. Alternative I is not in compliance with the ARARs.

See Section 10 (RAOs / Evaluation. Criteria) of the Responsiveness Summary.

A88. Page 5-31, Section 5.5.3. This is not what was presented for review in the alternatives analysis. I think this is the correct statement for all of the alternatives, but it is not what is presented in the discussion on alternatives (see Comment A69).

See Section 10 (RAOs /Evaluation Criteria) of the Responsiveness Summary.

A89. Page 5-33, Section 5.5.7 (Cost). Are all of these costs considered cost effective (acceptable) for this project purpose (see Comment A70)?

See Section 7 (Cost Effectiveness) of the Responsiveness Summary.

A90. Page 5-34, Section 5.6.2. This is not what is said in the ranking analysis, which stated that all alternatives complied with ARARs. I agree with this statement and would add that the nearshore and deeper CAD alternatives are likely to have an extremely hard time passing the various ESA and 404 criteria and coming into compliance with both sets of regulations.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

A91. Page 5-34, Section 5.6.3. See comment for Page 5-31, Section 5.5.3.

See Section 10 (RA Os / Evaluation Criteria) of the Responsiveness Summary.

A92. Section 5-37, Section 5.7. How do the numerical rankings relate to the criterion? How do they relate to the RAOs? Are all of the alternatives equally viable? Do any of the alternatives fail to meet the threshold Criteria (the nearshore/CAD disposal alternatives are somewhat up in the air for ARAR compliance)? I would add some discussion regarding what EPA thinks about the results of the numerical rankings and their interpretation of compliance with the Criteria. This would make a better introduction to the selection of the preferred alternative.

See Section 10 (RAOs /Evaluation Criteria) of the Responsiveness Summary.

A93. Page 6-2, Section 6.3.1 recommend that EPA explain the performance criteria and their purpose at this stage of the document. What would have happened if the preferred alternative failed any of the performance criteria? They seem unnecessary and redundant at this stage. My recommendation is to incorporate the performance criteria into the Superfund criteria for the alternatives analysis. They could be considered site specific considerations for the evaluation of the threshold and balancing criteria. A suggested format is as follows:

a. The project must provide for the overall protection of human health and the environment.

1) The project must result in a human health excess cancer risk of less than 1 in 10,000 and a non-cancerous hazard index of less than 1.0.

2) The project must prevent marine organisms from contacting sediments that exceed the SMS chemical criteria to reduce potential unacceptable impacts to the benthic community.

b) Compliance with ARARs

1) The project must minimize impacts to aquatic habitat to the maximum extent practicable.

2) The project cannot jeopardize threatened or endangered species (proposed or listed)

3) more?

c) Reduction of toxicity, mobility or volume through treatment.

1) N/A (no treatment)

d) Short term effectiveness

1) must minimize human and environmental health risks from exposure to contaminated sediments

2) minimize risks to worker safety during implementation

3) minimize impacts to current water dependent industries

4) minimize impacts to tribal, recreational, and/or commercial fisheries.

5) maintain the physical integrity of in-water constructed features

e) Long-term effectiveness

1) The project must provide a minimum design life of 30 years (for engineered components)

2) The project must maintain geotechnical stability of shoreline

f) Implementability

1) The project must be constructible at this site.

2) The project must be technically feasible for this site.

3) The project actions must be completed within an acceptable time-frame.

g) Cost

1) must provide tangible benefits for money spent.

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

U.S. Army Corps of Engineers Comments
Proposed Plan (April 1999)
Pacific Sound Resources Superfund Site

I. Engineering Considerations for RD/RA:

<u>General Comments:</u>

A94. The proximity of the Federal project in the Duwamish River makes Corps' maintenance dredging material the most logical source of capping material. If cap placement methods utilized readily available dredging equipment, (similar to the placement methods used in Eagle Harbor), only minor modifications to routine maintenance dredging contracts would be required, and capping cost would be minimal. The PSR Superfund Project would have to pick up only the incremental increase in the disposal cost over open water disposal at the Elliott Bay PSDDA site. For this reason, every effort should be made to adjust the "estimated time to cleanup" to the Duwamish maintenance dredging volumes and schedule.

See Section 6.4 (Design Issues—Cap Source Material) of the Responsiveness Summary.

A95. The combination of readily available maintenance dredged material and the steep bottom slopes of the PSR site may offer a particularly attractive option for construction of the Alternative 3 cap. Hydraulic placement methods could be used to gently place a layer of dredged material in a relatively shallow portion of the area to be capped. This area could then serve as a disposal site within which the standard bottom dump barge disposal method was allowed. Material placed by this method would flow down the steep bottom slope and cover the deeper contaminated sediments. Since the haul distance to the PSR site and the existing PSDDA site are essentially the same, the construction cost for a significant portion of the PSR capping project could conceivably be eliminated.

See Section 6.5 (Design Issues—Cap Placement) of the Responsiveness Summary.

A96. Maintenance dredged material from the Federal channel in the Snohomish River is an alternative source of capping material, but at an increased cost. Obtaining capping material from a marine borrow source is so unlikely that it should be dismissed outright due to adverse environmental impacts. The use of an upland source for capping material would increase capping costs by more than an order of magnitude and does not make sense from an economic standpoint.

See Section 6.4 (Design Issues—Cap Source Material) of the Responsiveness Summary.

A97. See FS General Comment A4 above regarding discussion of natural recovery processes as they might attenuate sediments in SQS contaminated areas.

See Section 9 (Natural Recovery) of the Responsiveness Summary.

Specific Comments:

A98. Pg. 9, Alternative 2 and Alternative 3. Can the dredging and capping costs be broken out as separate items?

The requested information is provided below:

Alternative 2:

- *Dredging costs are $3,248,000*
- *Cappings costs are $1,413,000*

Alternative 3

- *Dredging costs are $585,000*
- *Capping costs are $4,261,000*

A99. Page 2, fourth paragraph. A slope stability analysis should be accomplished during pre-remedial design to assess the stability of capping on slopes ranging from 18 to 21%.

See Section 6.2 (Design Issues—Geotechnical) of the Responsiveness Summary.

WASHINGTON STATE DEPARTMENT OF
NATURAL RESOURCES

May 14, 1999

Ms. Sally Thomas, Project Manager
Office of Environmental Cleanup
US EPA Region 10
1200 Sixth Avenue, MS ECL-111
Seattle, WA 98101

Subject: Comments on the *Pacitic Sound Resources Superfund Site Proposed Plan,* April 1999 and the *Draft Feasibility Study, Pacific Sound Resources, Marine Sediments Unit, Seattle, Washington,* November 1998

Dear Ms. Thomas:

Enclosed please find comments regarding the aforementioned documents. The comments have been prepared on behalf of the Washington State Department of Natural Resources (DNR) and are based on summary reviews of the documents. DNR review and comments concentrate on the marine sediment unit at the site. The information discussed herein represents DNR's comments on the specific documents noted and should not necessarily be viewed as DNR's final determinations for this site.

As land manager for the state-owned aquatic lands at the site, DNR is concerned about cleanup, appropriate land use, and risk and responsibility management. As natural resource trustee, DNR seeks to protect, restore and sustain natural resources. In general, DNR finds the analysis for the PSR site inadequate to fully evaluate a preferred alternative for the marine sediment unit. DNR therefore believes that additional analysis is necessary before limiting options for the site. The following discussion identifies a number of issues that DNR believes require additional consideration.

Dla. <u>Baywide Context</u>

Throughout much of the proceeding discussion, a number of issues will be discussed that relate to the concept of scale in decision-making. As DNR has stated during review of Feasibility Study (FS) technical memoranda, storage of contaminated sediment on state-owned aquatic lands must be based on a baywide planning effort that shows this use to be in the best interest of the resources and the public. Such a context will facilitate decisions that help return resource function and ensure resource protection and sustainability for the long-term benefit of the resources and the public. Evaluation points associated with these decisions include: 1. Consistency with the department's state land use plans; 2. A clear net gain inhabitat area and function; 3. Protection and creation of critical habitats for listed or candidate threatened or endangered species; 4. Efficient use of state-owned aquatic land material for beneficial uses as defined in the Puget Sound Dredged Disposal Analysis guidelines; 5. Disposal alternatives that prepare for rebuilding large blocks of habitat areas; 6. Disposal alternatives that provide for acquisition and/or development of strategic habitat areas; 7. Avoidance and minimization of impacts and compensatory mitigation measures; and 8. The best rate of return on the investment of state natural resources.

It is EPA's understanding, based on discussions with DNR staff, that the baywide context being referred to would require preparation of some type of management plan for Elliott Bay. Currently this does not exist and delay of the cleanup to accommodate development and adoption of such a plan would be inappropriate.

Dlb. In addition, from a cleanup perspective, site-specific decisions that do not adequately consider cleanup issues at adjoining or area-wide sites may result in options being precluded for a number of these sites and potential efficiencies being lost.

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

Dlc. DNR would like to encourage EPA to pursue decision-making from a baywide scale. This approach is being utilized at other cleanup sites in Puget Sound and is consistent with a number of initiatives, including EPA's Aquatic Ecosystem Protection, Achieving Environmental Results in EPA Region 10, three year action plan.

Please see response to Dla.

D2. <u>Protectiveness</u>

DNR does not believe that capping to cleanup screening levels is protective of natural resources. It also is inconsistent with prioritization of restoration at this site. The Proposed Plan states that EPA has considered in its decision the recent information provided by the National Oceanographic and Atmospheric Administrationdemonstrating adverse effects to bottom fish at polycyclic aromatic hydrocarbons (PAH) concentrations much lower than current regulatory levels of concern. However, it is unclear how the analysis summarized in the Proposed Plan includes consideration of this new information. Also, although the draft is preliminary, it is important to note that the proposed changes to a number of the chemical criteria for PAHs in the Washington State Sediment Management Standards reflect adverse effects at much lower concentrations.

See Section 13 (Restoration Goals) of the Responsiveness Summary.

D3. Site Identification and Description

D3a. DNR would like to request that the products being offered for public review and comment clearly identify the public-aquatic lands within the site boundaries. It is critical for the public to understand that the decisions being made at the site have specific implications for the citizens of this state.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

D3b. In a related matter, DNR would like to suggest that in the FS, the applicable or relevant and appropriate requirements discussion regarding the State Aquatic Lands Management Laws and Public Trust Doctrine be revised because both are inaccurately summarized. The statutes constituting the Aquatic Lands Acts are RCW 79.90 through 79.96. Of particular importance are the statutes on Harbor Areas (RCW 79.92) and Bedlands (RCW 79.95). These, as well as Aquatic Land Management, Chapter 332-30 WAC, should be appropriately summarized.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

D3c. The Public Trust Doctrine should be summarized separately from the State Aquatic Lands Act and related WACs. The clear purpose of the public trust doctrine as held by the US Supreme Court is to preserve and continuously assure the public's ability to fully use and enjoy public trust lands, waters, and resources for certain public uses (Slade et. al., Putting the Public Trust Doctrine to Work, Second Edition, June 1997, Page 3).

See Section 4 (ARARs) of the Responsiveness Summary.

D4. Land Use

D4a. A number of land use issues need additional consideration. Many are associated with the fact that the marine sediment unit is within a state Harbor Area that is reserved to facilitate land-water transfer of goods. The Harbor Area will be significantly and permanently altered under the preferred alternative, and there is no contingency for future land use decisions beyond the statement in the Proposed Plan that the State and/or the Port may want to alter the depth at some future time which EPA believes can be accommodated without compromise to the proposed remedy. It is unclear what analysis was completed by EPA to reach such a conclusion, and it appears as though the lost navigational capacity in the state Harbor Area may represent a permanent loss of water dependent commerce potential. In analyzing the appropriateness of fill in a harbor area, the facilitation of land-water transfer must be considered. For example, from a harbor area land use perspective, a fill for 62 acres of container storage is less problematic than a 62 acre fill for contaminant containment or habitat restoration.

The Port of Seattle and DNR may need to develop recommendations to the Harbor Line Commission on the reconfiguration of the Harbor Area. All such recommendations must be consistent with: 1. maintaining or enhancing the type and amount of harbor area needed to meet long-term needs of water dependent commerce; 2. maintaining adequate space for navigation beyond the outer harbor line; and 3. any other relevant harbor area studies, regulations, or policies.

Please see Section 2 (Potential Impacts to Land Use) of the Responsiveness Summary.

D4b. Also, the institutional controls mentioned in the documents are not sufficiently defined to evaluate the impacts of a navigational encumbrance. It is unclear if EPA is proposing a no-anchor zone/regulated navigation area that will prohibit cap disturbance from activities such as anchoring, prop wash, or laying cable. Any no anchor zone/regulated navigation area will have additional navigational impacts throughout the Harbor Area. And, finally, it is not clear if EPA has made provisions for vessel loss of control and emergency anchoring adjacent to the federal navigation channel.

Please see Section 2 (Potential Impacts to Land Use) of the Responsiveness Summary.

D4c. In a related matter, given that this is a federally funded and federally approved project, it is unclear if a Section 106, National Historic Preservation Act evaluation has been or needs to be completed at the site.

See Section 4 (ARARs) of the Responsiveness Summary.

D5. <u>Source Control</u>

DNR believes that additional clarification of source control information is necessary, both for on-site and off-site sources.

D5a. *On-site*

DNR is concerned about the potential for recontamination in the intermediate groundwater discharge zone and generally does not support cleanup without source control first being completely addressed. It is also unclear if all other mechanisms for transport from the upland portion of the site to the offshore have been controlled. For example, the FS states that the Longfellow Creek overflow potentially receives groundwater from the site.

See Section 8 (Source Control and Potential for Recontamination) of the Responsiveness Summary.

D5b. *Off-Site*

There is preliminary discussion of other potential off-site sources provided in the documents. However, it is unclear if a thorough analysis has been completed to evaluate the potential for these off-site sources to impact the site and the proposed remedy. For example, although it is noted that the stormwater discharge from the Longfellow Creek overflow is permitted, information regarding the potential for the discharge to impact the cap is not provided. Transport of material from the Lockheed site and sources associated with operations at Crowley Marine Services are also uncertain.

See Section 8 (Source Control and Potential for Recontamination) of the Responsiveness Summary.

D5c. *Sediment Total Maximum Daily Load (TMDL)*

It is unclear if the proposed cleanup constitutes an EPA-approved sediment TMDL. However, the apparent lack of clarity in source analysis, as well as a number of other factors, seems to suggest it does not.

The Proposed Plan and the Record of Decision do not constitute a TMDL for Elliott Bay.

D6. Preliminary Cap Design

DNR is concerned about the placement and long-term stability of a cap because of the significant slopes at the site, the characteristics of the contaminated sediments, and the uneven distribution of the contaminated materials (i.e., the mounds of contaminated materials). EPA recognizes that it has similar concerns but, through consultation with the US Army Corps of Engineers, has determined that these issues can be adequately addressed during the design and placement of the cap. This discussion needs to be significantly substantiated. Without substantiation, it is unclear if the proposed remedy meets the selection criteria.

DNR is also concerned about the proposed depth of the cap. The cap needs to effectively isolate and provide unimpacted sediment of appropriate characteristics to achieve sustainable biological function. Finally, the analysis of potential disturbances to the cap, especially in the vicinity of Crowley Marine Services and in other nearshore areas, seems too cursory in both documents.

See Sections 6.2 (Design Issues—Geotechnical) and 6.3 (Design Issues—Cap Thickness) of the Responsiveness Summary.

D7. Slope Stability Earthquake Issues

D7a. A significant issue not explicitly addressed in the FS is the true lifetime of this proposed remedy. It appears as though the design life for the engineered contaminant isolation (capping, nearshore containment facility, or deep-water confined aquatic disposal) is 30 years and that long-term effectiveness is measured by the facility performance during this 30 design life.

See Section 6.6 (Design Issues—Life/Duration) of the Responsiveness Summary.

D7b. The concept of a 30 year project lifetime is a guiding principal in the slope stability evaluation documented in Appendix C of the FS. The seismic stability analyses presented in this appendix are predicated on earthquake ground motions having a dynamic acceleration of 0.1 g. This level of ground motion has a 10% chance of being equaled or exceeded in 30 years using the results of the U.S. Geological Survey probabilistic ground motion mapping for areas encompassing the Port of Seattle. Statewide code presently requires that new buildings be designed to a 10% in 50 years ground motion; this design level is used by the Washington State Department of Transporation for new highway construction. All municipal solid waste landfills are required by both EPA and the Washington State Department of Ecology regulations to be designed for ground motions corresponding to a 10% in 250 year chance of exceedance. The evaluation presented in Appendix C concludes:

> "The potential for damage to the berm exists if subjected to dynamic accelerations greater than 0.1 g (see attached geotechnical slope stability analysis). Collateral damage from liquefaction could be expected to affect facility integrity under higher accelerations."

The 30 year design lifetime that is proposed for any of the engineered contaminant isolation methods does not consider the actual lifetime of these facilities, which will undoubtedly be much longer. Consequently, the rankings based on long-term performance (measured over a 30 year time period) consider only "sub-catastrophic" conditions (pg. C.1-1). A longer, and more realistic, project lifetime would require design to higher levels of seismic ground motions.

See Section 6.6 (Design Issues—Life/Duration) of the Responsiveness Summary.

D7c. It is not clear that any or all of the proposed contaminant isolation methods will provide adequate long-term performance when more realistic earthquake ground motions are considered. The following is a partial list of issues related to earthquake design that have not been adequately addressed in the draft FS.

1) Section 4.1.7.2 suggests that dredging to a 3:1 slope (slope angle of 18º) will remain stable. On page 4-5, the angle of repose of sand used in capping is estimated at 20º, and is the maximum slope on which capping can occur. Consequently, capping on any slope dredged to 3:1 will be marginally stable and would undoubtedly be unstable under reasonable seismic loading. The likelihood of instability will be greatly increased if the capping material is liquefiable and can fail as a flow slide. Liquefaction-induced flow slides of capping material placed on shallower slopes has also not been evaluated for realistic earthquake ground motions. Consequently, long term performance of this contaminant isolation action is uncertain and may in fact not be feasible for certain areas of the marine sediment unit.

2) Stability analyses presented in Appendix C for the nearshore containment berm evaluate conditions for a very low level of earthquake ground motion. The evaluations presented in this appendix ignore soil liquefaction and its potential impact on the foundation conditions of the containment berm. Likewise, the potential for a global slope instability (one that encompasses the entire delta slope) is not considered in Appendix C. Consequently, long-term performance of this contaminant isolation action is uncertain, and may in fact not be a feasible option.

See Section 6.2 (Design Issues—Geotechnical) of the Responsiveness Summary.

D7d. EPA provides a preferred alternative for cleanup of the marine sediment unit that is based in part on ranking of the long-term effectiveness of the various mitigation options. The present FS fails to adequately evaluate the potential impact of realistic earthquake ground motion on long-term performance of the various options. As a result, EPA is not certain that the preferred alternative can be implemented. This uncertainty is addressed in section 4.1.6 with the closing statement:

> "If an alternative is selected that includes capping or a nearshore disposal facility, the supporting geotechnical analysis necessary to implement this approach would be performed during remedial design."

This statement makes the presumption that the supporting geotechnical analysis will demonstrate the feasibility of implementation of the chosen alternatives. The FS should outline the actions that would be taken if the supporting geotechnical analysis demonstrates that the chosen alternative is not feasible.

If during the design process, the proposed alternative is shown to be infeasible, EPA will evaluate other alternatives.

D8. Long-term Evaluation

As discussed in the preceding section in relation to stability/earthquake issues, the evaluation of long-term implications associated with the proposed remedy is inadequate. The design life of 30 years does not represent the life of the containment facility on state-owned aquatic lands, and it does not represent a timeframe for long-term trust management at the site. For these reasons, the analysis provided does not adequately address long-term risks and responsibilitiesthat will fall to the citizens of the State after 30 years. There is also uncertainty regarding the long-term risks and responsibility for the groundwater contamination and its potential impact to the offshore, as well as for assuring the long-term viability of the slurry wall. The completed remedial actions on the uplands and the proposed remedy for the marine sediment unit are not permanent solutions, and limiting the analysis to a 30-year timeframe does not provide an adequate basis for decision-making. At a minimum, a discussion should be provided regarding projected contaminant levels at the end of the design life.

See Section 6.6 (Design Issues—Life/Duration) of the Responsiveness Summary.

D9. Cost Analysis

DNR appreciates the inclusion inthe Proposed Plan of valuation issues associated with the use of state-owned aquatic lands and will be sending within the next several weeks updated informationregarding the valuation of state-owned aquatic lands. However, the cost analysis provided appears to exclude a number of cost considerations in addition to the recognized valuation issues. For example, potential restoration and mitigation costs are not included. Also, there appears to be uncertainty in some of the cost estimates used in the analysis. For example, the cost of $110 per cubic yard for disposal at an existing upland landfill does not appear to be consistent with the cost range provided in the Draft Puget Sound Confined Disposal Site Study, Programmatic Environmental Impact Statement, February 1999. And, finally, the decision process for eliminating potential remedies based primarily on cost-effectiveness needs to be better defined throughout the documents (i.e., the factors evaluated in determining cost-effectiveness).

Please see responses to Comments Trustees-3, Army Corps of Engineers-13, and Section 7—Cost Effectiveness.

D10a. <u>Other Initiatives</u>

DNR would like to encourage EPA to evaluate its analysis of a preferred alternative in the context of other applicable initiatives such as EPA's Aquatic Ecosystem Protection, Achieving Environmental Results in EPA Region 10 and EPA's Contaminated Sediment Management Strategy. The principals and goals provided in these documents should be used in evaluating approaches for this site (e.g., watershed context, reduction in volume of existing contaminated sediment, and development of scientifically sound sediment management tools).

The approach used to define the problem and select a remedy for the PSR MSU is in keeping with EPA's Contaminated Sediment Management Strategy. Scientific methodologies developed under the Puget Sound Estuaries Program and updated as part of the SMS and the DMMP were employed on this project. Extensive coordination with and review by regulatory and Trustee agencies further refined the decision-making process implemented at this site.

D10b. Also, because of the number of difficult technical issues at this site, DNR would like to encourage EPA to continue to evaluate innovative technologies as potential components of a solution for the marine sediment unit (e.g., it has been suggested that geotextile tubes be used as containment for the contaminated sediment and that the filled tubes be used as stabilizing devices in the offshore).

See Sections 6.2 (Design Issues—Geotechnical) and 6.3 (Design Issues—Cap Thickness) of the Responsiveness Summary.

DNR looks forward to continuing discussions regarding these issues and would like to suggest that a meeting be scheduled. Please contact me at 360-902-1068 or at tamara.allen@wadnr.gov with information regarding the possibility of a meeting or with any questions you might have. Thank you for the opportunity to provide input.

Sincerely,

Tamara Allen, Environmental Specialist
Aquatic Resources Division
PO Box 47027
Olympia, WA 98504-7027

c: Paul Silver, Deputy Supervisor, DNR
Craig Partridge, DNR

Maria Victoria Peeler, Division Manager, DNR Aquatics
Mike Palko, ADM, DNR Aquatics
Tim Goodman, DNR Aquatics
Carol Lee Roalkvam, DNR Aquatics
Don Olmsted, DNR Aquatics
Bill Graeber, DNR Aquatics
Cathy Carruthers, DNR Aquatics
Steve Palmer, DNR Geology
Christa Thompson, AGO
Michelle Wilcox, Ecology, SMU
Pete Adolphson, Ecology, TCP NWRO

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Northwest Regional Office, 3190 - 160th Ave S.E. – Bellevue, Washington 98008-5452 – (425) 649-7000

May 14, 1999

Ms. Sally Thomas
EPA Region 10 - Superfund
1200 Sixth Avenue ECL-111
Seattle, WA 98101

RE: Proposed Plan for Cleanup of the Pacific Sound Resources (PSR) Superfund Site (EPA dated April 1999)

Dear Sally:

The Department of Ecology received the above document on April 15, 1999, and have completed our review. The attached comments; mostly focus on the Draft Feasibility Study for the Offshore Unit, since agency comments were to be formally submitted during the comment period for the Proposed Plan. The comments were prepared by Glynis Carrosino, Ecology Project Manager, and Peter Adolphson, Ecology Sediment Cleanup Specialist.

The Proposed Plan identifies the Preferred Cleanup Alternative for addressing soil, groundwater and marine sediments at the PSR site. The focus of this Proposal is on the contaminated sediments associated with the marine sediment unit, as EPA believes that the risks due to soil contamination have been controlled through early actions. The Preferred Alternative presented in this Plan proposes leaving contamination in place and meeting environmental and human health protection goals through controlled containment (capping in place). At this point in time, Ecology is supportive of the proposed remedy, though we do have critical opinions on the Feasibility Study and have identified issues we expect to be addressed during design, prior to cap placement. Ecology would expect other cleanup options to be considered, should predesign not support the cap alternative and Ecology's concerns (re attached comments).

EPA, in consultation with the Washington State Department of Ecology, will select a final remedy for the site after reviewing and considering all information submitted during the 30-day public comment period on this Proposed Plan. We look forward to upcoming project discussions.

If you should have any questions regarding these comments, please contact me at 425-649-7263, or Peter Adolphson at 425-649-7257.

Sincerely,

Glynis A. Carrosino, Project Manager
Toxics Cleanup Program

cc: Peter Adolphson, Ecology NWRO
Steve Alexander, Ecology NWRO
Kathy Gerla, Office of the Attorney General

May 14, 1999

Ecology Comments re Pacific Sound Resources Draft FS/Proposed Cleanup Plan:

Glynis Carrosino (WA Dept. of Ecology - NWRO)
Peter Adolphson (WA Dept. of Ecology - NWRO)

General Comments:

E1. The Preferred Alternative selected from the Draft Feasibility Study and presented in the Proposed Plan proposes leaving contamination in place and meeting environmental and human health protection goals through controlled containment (capping in place). The preference for capping contaminated marine sediments at PSR is primarily based on difficulties associated with other alternatives. Also, reflective of the specific issues associated with this site was that the human health risk goal also had to account for background levels already present in Elliott Bay.

E1a. Ecology continues to have concerns about placement of a cap where the slope has been documented as being very steep (up to 21 percent). A cap placed on an area with a steep slope has the potential for slump and containment failure. The sediments in this unit are also soft and highly contaminated, and placement of capping material onto the soft sediment has the potential to resuspend the contaminated sediment into the water column.

See Section 6.2 (Design Issues—Geotechnical) of the Responsiveness Summary.

E1b. Depth is also an issue (the deep area has been documented to be greater than 200 feet) to ensure the minimum 3 foot capping thickness can be maintained. These issues must be addressed during design, prior to cap placement.

See Section 6.1 (Design Issues—Capping at Depth) of the Responsiveness Summary.

E2. There are significant misinterpretations throughout the Draft Feasibility Study Report with respect to the risk calculations. Section 4 contains values which are clearly above the NCP risk value 1.0E-4 (e.g. 1.3E-4). This interpretive error is presented consistently throughout the report and will have a significant impact upon selection of preferred alternatives. Similar misinterpretation also exists with respect to these values (e.g. Section 5.3.4.1 designates 5.7E-05 as equivalent to 1: 100,000. The value 5.7E-05 is equivalent to 1: 17,544. See also 5.5.3.1 etc. The values calculated above and those cited in the proposed plan exceed Ecology's acceptable risk values for significant human health effects. There appears to be confusion with respect to interpretation of risk values throughout the report as well as the proposed plan.

See Section 3 (Risk) of the Responsiveness Summary.

E3. Comments submitted to EPA by Ecology, 11/3/97, (Teresa Michelsen, Laura Weiss) concerning cleanup areas also referenced Ecology ARARs: "Since this site will require state concurrence, please recognize and discuss the MTCA risk ranges that will need to be adhered to ($<1X10^{-4}$ for individual chemical and $<1X10^{-5}$ for overall).” “Given the requirement for State concurrence at this site, and for Superfund to meet State ARARs, it would seem appropriate for the risk assessment results to be reviewed in light of MTCA acceptable risk ranges, as well as EPA's risk management range. It is inexplicable to Ecology why we have to keep making this basic request at site after site.” “Application of quartile approach is inappropriate for areas exceeding ARARs (CSLs or $lx10^{5}$ risk), as any such are must be actively remediated.”

See Section 4 (ARARs) of the Responsiveness Summary.

Specific Comments:

E4. **2.3.1**: Reference to data and methods for Ecological risk and Human health risk including the Elliot Bay Background cancer risk level section should be cited.

The risk assessment approach was detailed in the Section 4.5.4 of the RI work plan (WESTON 1996). Data were presented and evaluated (with a further discussion of guidance used) in Appendix K of the RI report (WESTON 1998)

E5. **pg. 3-5**: Please include the citations for the conclusion that in areas that are thin-layer capped bioturbation will result in a reduction of the sediment contaminant concentrations by 50%.

This estimate was based on an assumption that if thin layer clean cap material was placed at a thickness of half the bioturbation zone (5 cm), complete mixing within the bioturbation zone would result in the cap material having half the concentration of the underlying chemicals. If bioturbation is incomplete, then the long-term cap concentrations would be significantly less than the original sediment contaminant concentrations.

E6. For purposes of cap placement on slopes exceeding 15%, how is “base” of slope defined?

The slopes were determined using the distances where the rate of decrease in elevation was the greatest. The base of the slope did not include the distance where a slope “runs out “ to avoid obtaining less of a slope than really exists.

E7a. **4.1.2.3**: Please cite the data (e.g. in situ pre-tests) which support the conclusion that a 3-foot layer of silty sand will chemically and physically confine sediments exceeding the CSL and SQS, especially in areas of greater than 15% slope. What specific grain size, TOC and other sediment parameters were assumed in reaching these conclusions. Were the sediment resuspension calculations cited in (Parametrix 1990) performed using a 15% or greater slope?

No pilot tests have been completed for the PSR site using sediment from likely borrow areas. Cap thickness, based on the capping material to be used and the specific site characteristics, will be determined in design.

E7b. Seismic considerations remain largely unaddressed with respect to the proposed plan, particularly in areas with slopes greater than 15%. And these areas constitute approximately 35% of the CSL area and significant SQS contaminated areas as well.

See Section 6.2 (Design Issues—Geotechnical) of the Responsiveness Summary.

E8. **pg. 4-8**: The proposed plan requires capping of CSL areas only. Due to depth, slope and fine-grained unconsolidated nature of these contaminated sediments, a significant amount of sediment resuspension and migration can be expected resulting in potential expansion of the CSL areas currently categorized as SQS. How will potentially recontaminated areas be addressed in this scenario?

See Section 11 (Monitoring) of the Responsiveness Summary.

E9. **4.3.2**: The text states that one criteria for siting a CND was that it could not be located in habitat restoration or enhancement areas. It appears that this criteria automatically precludes combined CND habitat enhancement areas, however one usage does not necessarily preclude the other. Siting criteria may need modification.

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

El0. **5.2.7**: Cost: It does not appear that costs for the implementation of the preferred alternative of leaving contaminated sediment on state lands and implementing capping were included in cost estimates. Does EPA have any current information from DNR?

There is currently no agreement with respect to costs associated with capping of state owned aquatic lands.

E11. Has a model been performed which predicts recovery of the areas currently above SQS to levels not exceeding the SQS if the CSL areas are capped?

See Section 9 (Natural Recovery) of the Responsiveness Summary.

E12. **Pg. 6.3**: The Human Health risk presented in the text of 6.6E-05 does not meet Ecology's “no significant human health risk” criteria of 1.0E-05 to 1.0E-06.

See Section 3 (Risk) of the Responsiveness Summary.

E13. In areas which remain uncapped, will the biologically active zone fall below SQS within the specified 10 year recovery period?

See Section 9 (Natural Recovery) of the Responsiveness Summary.

E 14. **pg. 1-15**: Ecology has discussed with EPA contingency plans and actions to respond and meet original cleanup goals should recontamination occur at the site.

Yes. EPA will continue to coordinate with Ecology throughout design and implementation of the remedy. In addition, Ecology will be the key reviewer of the long-term operations and maintenance plan, where the contingency planning process will be defined.

E15. **pg. 2-2 section 2.2.1.1**: second paragraph Insert as second sentence "However, the SMS does have a narrative standard for human health of no significant health risk to humans."

See Section 14 (Editorial Comments) of the Responsiveness Summary.

E16. **pg. 2-2 section 2.2.1.1**: third paragraph The wording discussing the difference between CSL and AETs is too confusing. Simply put, the only difference is that SQS and CSL are TOC normalized, AETs are dry weight normalized.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

Predesign/Contingency Considerations:

E17. There are several "combination" alternatives (i.e. decontamination technologies, partial removal of CSL/CND with habitat development, capping to SQS) which have not been proposed or investigated for this site. Integration of adjacent NPL sites (Harbor Island) should also be investigated when discussing a potential MUDs facility. This may significantly reduce cost and implementability especially considering potential Lockheed involvement/at both sites.

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

E18. Additional geological data maybe necessary to establish potential volume and/or construction design modification for a CND facility. This would likely affect cost and therefore consideration of alternative ranking.

See Section 6.7 (Design Issues—General Issues) of the Responsiveness Summary.

E19. As identified in previous discussions between Ecology and EPA, a pilot scale cap should be implemented prior to final alternative selection in order to determine if a cap alternative is viable and to determine potential final costs of this preferred alternative.

See Section 6.7 (Design Issues—General Issues) of the Responsiveness Summary.

E20. It is also imperative to perform highly detailed investigation of the slope and slump potential. In areas of soft highly contaminated substrate, is a 20 percent slope a conservative number of slump/containment failure or is this slope based upon "moderate" substrate material?

See Section 6.2 (Design Issues—Geotechnical) of the Responsiveness Summary.

E21. The rationale for removal of intertidal CND as a possible alternative were 1) "...it would be difficult to construct a facility using dredged sediment of the type and contaminant level this is characteristic of the PSR sediment." and 2)"An intertidal disposal site may lack capacity to accommodate both PSR and the Lockheed sediment." Additional data, and/or rationale which substantially supports this conclusion should be presented. It can be argued that with potential modification in construction and design this alternative is still viable. In addition, potential solutions to the potential individual hurdles (e.g, settling rates/consolidation/dewatering) to this alternative should be presented for further consideration.

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

E22. A significant degree of speculation has been offered with respect to water quality impacts, settling, dredged sediment behavioral characteristics, consolidation periods etc. Without further investigation, data, and potential modeling based upon this data, an intertidal CND alternative should not be dismissed as a potential preferred remedy.

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

E23. Alternative construction techniques should also be explored which will allow efficient dewatering to occur. This could potentially include increased berm elevation, alternative construction material, and tide gates to prevent excessive tidal influence. Potential alternative construction options should also be explored such as extending the eastern and western berm sides, in order to maximize capacity.

See Section 6.7 (Design Issues—General Issues) of the Responsiveness Summary.

E24. It is unclear how contaminated "mound" areas will be addressed in the capping alternative.

See Sections 61 (Design Issues—Capping at Depth), 62 (Design Issues—Geotechnical), and 6.3 (Design Issues—Cap Thickness) of the Responsiveness Summary.

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THE SUQUAMISH TRIBE

P.O. Box 498 Suquamish, Washington 98392

May 14,1999

Sally Thomas
Project Manager
1200 6th Avenue ECL-111
Seattle, WA 98101

Re: Pacific Sound Resources Superfund Site Proposed Plan

Dear Ms. Thomas:

S1. Elliot Bay lies within the Suquamish Tribe's treaty defined Usual and Accustomed Hunting and Fishing Area (U&A). Within this area, the Tribe holds treaty rights to natural resources that are impacted by contamination from this and other sites. The Tribe is an active participant in the Elliot Bay/Duwamish Natural Resource Trustee group, and incorporates by reference the detailed comments and restoration goals submitted by the trustees. The Tribe advocates a long-term solution to contaminated marine sediments throughout the U&A. For this site, EPA's preferred alternative is capping the existing contaminated marine sediment in place to prevent human and ecological contact. Since this action does not eliminate existing contamination, the proposed plan is not a permanent solution. In addition, the proposed plan does not adequately address Treaty fishing access issues and human health concerns.

See Section 1 (Potential Impacts to Treaty Rights) and Section 13 (Restoration Goals) of the Responsiveness Summary.

S2. The Suquamish Tribe supports permanent clean up of contaminated sites that will protect and support harvestable treaty-reserved resources for future generations. In the evaluation of alternatives, the proposed plan states "the least degree of long-term effectiveness is provided by capping due to more complex monitoring requirements." If capping is implemented as proposed, it must be done with the understanding that permanent removal of contaminants may be necessary in the future. The Tribe encourages serious consideration of other alternatives that will achieve long-term effectiveness and permanence.

See Sections 6.6 (Design Issues—Life/Duration) and 11 (Monitoring) of the Responsiveness Summary.

S3. The plan states that if dredging is chosen as the preferred cleanup alternative, nearshore disposal would be the preferred disposal option. The Tribe does not consider nearshore disposal an acceptable alternative. Upland disposal is the only method currently being considered that would minimize adverse impacts to treaty-reserved resources. The cumulative impact of shoreline development has resulted in a significant loss of nearshore habitat in Puget Sound. Further fill and subsequent development of nearshore areas would continue to erode the quantity and quality of these habitats and the species they support.

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

S4. The proposed plan states that Crowley Marine Services will require dredging of 3,500 cubic yards prior to cap placement. The preferred alternative proposes to move this contaminated dredged material deeper within the off-shore contaminated area prior to capping. The Tribe recommends that this limited amount of dredged material be disposed upland or treated prior to replacing it in the aquatic environment.

EPA agrees that upland disposal of the material to be dredged off of Crowley Marine Services will be included in the final design. However, there is limited land available for dewatering this material. Assuming clamshell dredging, dewatering in 25-cubic-yard containers that can be transported via truck to a non-hazardous waste landfill will add $688,000 in cleanup costs to the remedy. Different methods for dewatering (e.g., barge, railcar) will be evaluated prior to final design.

S5. Treaty fishing access issues and human health concerns are not adequately addressed in the proposed plan. At a minimum, the Suquamish Tribe believes that EPA should observe MTCA standards for the protection of human health.

See Sections 3 (Risk) and 4 (ARARs) of the Responsiveness Summary.

S6. The proposed plan indicates that all alternatives would entail the establishment of a no shellfishing zone through shoreline restrictions for “intrusive recreational activities, such as clamdigging . . . ” Benefits cited in the text of the draft feasibility study include minimizing the potential for human dermal contact and ingestion of sediments and reducing the potential for disturbance and resuspension of contaminated sediments. However, the impact on Tribal treaty fishing rights is not addressed, and the text implies an indefinite foreclosing of shellfishing opportunities.

See Section 1 (Potential Impacts to Treaty Rights) of the Responsiveness Summary.

S7. The proposed plan refers to a “no anchor zone” without specifying location and duration, and remains silent concerning potential impacts on Tribal treaty fishing activities. This issue must be addressed in detail so that the potential impact can be determined by the affected Tribes.

See Section 1 (Potential Impacts to Treaty Rights) of the Responsiveness Summary.

S8. The clean-up time in the proposed alternative totals 11 months of in-water time over four years due to using clean sediment obtained through routine dredging for navigational purposes. Not only does this alternative entail four years of potential disruption and lost fishing opportunity in terms of treaty fishing, it also prolongs injury to trust resources along with continued adverse human health impacts. We maintain that the emphasis should be on restoration and clean-up, and that costs entailed in securing clean sediment from other than the Duwamish River must be calculated and incorporated into the final clean-up plan.

The duration estimated in the FS is based on the assumption that capping material will be derived from navigational dredging projects throughout Puget Sound, not just the Duwamish River. Other sources were considered such as dredging clean sediments in other areas. However, mining of clean sediment is extremely difficult to get permitted and could also have a deleterious effect on the benthos if large areas were mined in order to get the quantity of sediment needed quickly. In addition, capping the sediment over several years will allow the benthic community to re-establish itself between capping events such that a large area is not disrupted at one time. Another benefit of capping over several years is that it allows the effectiveness of capping at depth and over steep slopes to be better established through monitoring to perfect the operation from one year to the next.

The Suquamish Tribe looks forward to further dialogue concerning habitat and treaty fishing access issues as EPA works toward the development of a final plan and Record of Decision.

Sincerely,

Randy Hatch
Fisheries Director

MUCKLESHOOT INDIAN TRIBE

FISHERIES DEPARTMENT

12 May 1999

Ms. Sally Thomas
Remedial Project Manager
U.S. EPA - Superfund
1200 Sixth Ave., HW-113
Seattle, WA 98101

Re: Comments on the following two reports:

1) Pacific Sound Resources Superfund Site Proposed Plan (April 1999);
2) Draft Feasibility Study, Pacific Sound Resource Marine Sediments Unit, Seattle, Washington (November 1998).

Dear Ms. Thomas,

The Environmental Division of the Muckleshoot Indian Tribe's Fisheries Department has reviewed the above-referenced documents. As you are aware, the aquatic area that comprises the PSR Marine Sediments Unit is a very important portion of the Tribe's Usual and Accustomed Fishing Area. Hence, this area is a location where the Tribe exercises its federally-adjudicated fishing rights. Adequate cleanup of this area is a necessary step for the protection of the health of tribal fishers exercising their treaty rights in this area and for the protection of the aquatic ecosystem which contributes to the health of the fishery itself.

Attached is a summary of general and page-specific comments on the above-referenced documents. You will find from these comments that the Tribe has substantial concerns about the adequacy of the cleanup proposed to protect either human health or fish. The Tribe reserves the right to comment on additional environmental or human health concerns about this cleanup in the future.

Thank you for the opportunity to comment on this very important activity. Please feel free to contact me at (253) 931-0652, extension 130, with any questions or concerns.

Sincerely,

Glen R. St. Amant
Senior Sediment Specialist

Cc: Elliott Bay Natural Resource Trustees
John Malek, EPA

Comments on:
Pacific Sound Resources Superfund Site Proposed Plan

General Comments-

M1a. The preferred alternative, identified as capping to CSL, is neither protective of human health nor protective of impacts to fish from polycyclic aromatic hydrocarbons (PAHs). Alternative 2 should be screened out by EPA during threshold evaluation, since risks to human health exceeding $1x10^{-4}$ would remain. As you are aware, this risk level is clearly inconsistent with EPA's site-specific criteria, remedial action objectives for PSR, CERCLA guidance, the acceptable risk range identified in MTCA (an ARAR), and the human health protection afforded by the Washington State Sediment Management Standards (another ARAR).

See Section 3 (Risk) of the Responsiveness Summary.

M1b. In addition, cleanup of only CSL contaminated sediments at the site does not adequately protect fish and potentially other aquatic organisms which must rely on this area as habitat. EPA has received information from the Elliott Bay Natural Resource Trustees on a PAH level that should be used to define and cleanup the site for restoration purposes. The level proposed is based upon information about impacts to fish and other aquatic resources riot addressed in your ecological risk assessment.

See Section 13 (Restoration Goals) of the Responsiveness Summary.

M2. The preferred alternative must be designed in such a way as to allow tribal fishing and shellfishingactivities once the area has been remediated. No institutional controls should be implementedthat would interfere with such activities, as these are protected treaty rights of the Tribe.

See Section 1 (Potential Impacts to Treaty Rights) of the Responsiveness Summary.

Page-Specific Comments-

M3. **Page 1, bullets.** These bullets give the public the mistaken impression that EPA is proposing to cap all offshore areas that present a risk to human health and the environment. The first bullet should be rewritten to indicate that the preferred alternative proposes to cap less than half the area that presents a risk to human health and fish.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

M4. Page 6, last paragraph. This paragraph also gives the mistaken impression that all migration from uplands has been eliminated, yet the paragraph above acknowledges that there is one area where migration from uplands continues to impact sediments and the aquatic environment. Potential source controls for this area should be included and evaluated in the Feasibility Study and included in the Proposed Plan.

See Section 8 (Source Control and Potential for Recontamination) of the Responsiveness Summary.

M5. **Page 7, last paragraph.** There is no evidence whatsoever that EPA considered the information provided by NOAA on potential risks to fish. The issue is neither discussed in the risk assessments (except for a sentence or two in the final summary) nor incorporated into the feasibility study, and apparently had no effect on selection of the remediation area boundaries. It is not accurate to state that risks to fish from PAHs cannot be quantified simply because PAHs are metabolized. Other methods of assessing risks and establishing safe concentrations are available that do not depend on fish tissue concentrations, and have been provided to EPA by the Elliott Bay Natural Resource Trustees.

See Section 13 (Restoration Goals) of the Responsiveness Summary.

M6. **Page 8, Remediation Objectives.** The remediation objectives for human health should be clearly identified here, as they are in the FS. It should also be stated that the preferred alternative does not meet EPA's stated human health risk objectives (1x10^{4}).

See Section 3 (Risk) of the Responsiveness Summary.

M7. **Page 8, Summary of Alternatives.** This section again fails to acknowledge the source area that is affecting sediments west of the former process area.

See Section 8 (Source Control and Potential for Recontamination) of the Responsiveness Summary.

M8. **Page 12, Evaluation of Cleanup Alternatives.** Please see detailed comments on the Feasibility Study.

Comments on:
Draft Feasibility Study
Pacific Sound Resources, Marine Sediments Unit
Seattle, Washington

General Comments-

M9. Human Health. According to the FS, none of the alternatives meets state standards for protection of human health. In addition, Alternative 2 exceeds even EPA's risk range, and for this reason should be immediately screened out from consideration. Yet the feasibility study repeatedly states that all alternatives (except no action) comply with ARARs.

See Section 4 (ARARs) of the Responsiveness Summary.

M10. **Protection of Fish.** The remedial action objectives are not protective of the possible effects of PAHs on fish, which should bea key consideration at this site. There is no consideration given to this issue in the FS and very little in the supporting risk assessments. However, it is stated that the levels that would be protective of fish would be lower than any of the existing alternatives supports.

See Section 13 (Restoration Goals) of the Responsiveness Summary.

M11. **Adequacy of Alternatives.** The remedial action objectives should be revised downward, and additional alternatives should be developed to protect human health and fish, as discussed above.

See Section 5 (Cleanup Level Selection) and Section 13 (Restoration Goals) of the Responsiveness Summary.

M12. **Interference with Tribal Fishing and Shellfish Collection.** The submerged nearshore disposal facility contemplated in the Lockheed FS has been elevated to upland fill in this FS, and it is not clear that this is necessary to meet project objectives. Such a design would clearly have the potential to impact tribal treaty fishing access. In addition, all alternatives state that no shellfish collection and no anchoring of vessels would be allowed along the shorelines, to protect the integrity of the cap. The cap and fill designs should be modified to allow Tribal collection of fish and shellfish in the area, once restored, since this should be one of the primary objectives of the cleanup.

See Section 1 (Potential Impacts to Treaty Rights) of the Responsiveness Summary.

M13. **Bathymetric Modifications.** Some of the alternatives involving dredging result in unrealistic modificationsto bottom depths, including 20-foot discontinuities where capping and dredging areas meet. There is no discussion of the potential slope stability problems or habitat alterations that these modifications might create. These alternatives should be redesigned in a more realistic manner.

No bathymetric discontinuities would be allowed in the project design. The FS alternatives were conceptual in nature and were only intended to be sufficient to select a preferred alternative.

M14. **Design Life.** The engineering design life of the alternatives is only 30 years, hardly sufficient to be protective over the long-term. The design life should be increased to a much longer timeframe, and provisions made for monitoring and maintenance of any in-water engineered structures in perpetuity.

See Section 6.6 (Design Issues—Life/Duration) of the Responsiveness Summary.

M15. **Comparative Evaluation of Alternatives.** The comparative evaluation of the alternatives overstates feasibility issues of large caps (especially if thin-layer caps are considered), and downplays much more significant issues associated with dredging and confined disposal facilities. In addition, it does not give enough emphasis to the lack of protectiveness and effectiveness of the CSL alternatives over large areas of the site. As threshold criteria, protection of human health and the environment and compliance with ARARs should be given more weight than the balancing criteria, and any alternatives not meeting these thresholds should be screened out altogether.

Under CERCLA, threshold criteria are given more weight in that they must be met for an alternative to be considered EPA believes that all alternatives evaluated met the threshold criteria of Overall Protection of Human Health and the Environment and Compliance wit ARARs.

Page-Specific Comments-

M16. **Page 1-2, last bullet.** The design life is too short. Engineered components of the remedy should be designed to be as permanent as possible. To be protective of human health and the environment for as long as possible, and to be in better conformance with State land management planning horizons, a design life of 100-200 years would seem more appropriate. This is particularly important for engineered facilities such as nearshore confined disposal, where failure could result in catastrophic contamination of large areas.

See Section 6.6 (Design Issues—Life/Duration) of the Responsiveness Summary.

M17. **Page 1-3, last bullet.** The paragraph on the previous page states that remedial action goals were developed in consultation with the Washington Department of Ecology, yet the remedial action goal in this bullet calls for a level of protection of human health of only 1 in 10,000. This is higher than the maximum legally allowable under the Washington Model Toxics Control Act, which is 1 in 1,000,000 for individual chemicals and 1 in 100,000 for cumulative risks. These are numeric ARARs that must be met under Superfund. Information in the Feasibility Study and its appendices does not support the claim that the risk level or the preferred alternative is in compliance with applicable laws. If the EPA continues to make such claims, the Tribe requests a detailed explanation on how all aspects of MTCA and SMS are addressed by the proposed approach.

See Section 4 (ARARs) of the Responsiveness Summary.

M18. **Page 1-7, third paragraph.** The text states that no seepage of oil has been observed along the shoreline since the slurry wall was installed, but does not describe whether or how often the shoreline has been monitored for seepage, and whether the monitoring included very low tides when such seepage would be most likely to be evident.

These observations are based on casual observations made during other work in the shoreline (including low tide period) (Brian Stone, pers. com. with Larry Vanselow-WESTON 8/2/99). Currently, no formal inspection of the shoreline is included in the Upland Unit long-term monitoring plan. See response to T-9.

M19. **Page 1-12, last paragraph.** Chinook have now been listed, and various references to it throughout the report should be updated.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

M20. **Page 2-2, Chemical Screening Criteria.** The phrase “biological resources” in the first paragraph should be replaced by "benthic infauna". The SMS chemical criteria are designed to be protective only of benthic organisms and do not necessarily provide protection of fish, shellfish, birds, mammals, or other biological resources in Elliott Bay. In the second paragraph, SMS chemical criteria cannot be used to assess protection of human health. Ecology and the PSDDA agencies (including EPA Region 10) have been very clear that this in an inappropriate use of AETs. In human health guidance documents published by Ecology and WDOH (1995, 1996), it was established that protective sediment concentrations for some of the bioaccumulative contaminants at the site (e.g., PCBs, dioxins/furans) would be lower than values protective of benthic organisms (in part because benthic organisms lack the receptors that mediate toxicity of these compounds).

Separate screening values should be developed for each of these other types of receptors using appropriate risk- or effects-based values provided in the literature and/or developed for other sites.

See Section 5 (Cleanup Level Selection) of the Responsiveness Summary.

M21. **Page 2-2, last paragraph.** Background concentrations should be taken from approved Puget Sound reference areas; such values for bioaccumulative compounds can be found in DOH (1995), Appendix A, and PSEP (1991a,b). Elliott Bay concentrations should be considered “ambient” or some other phrase that does not imply a lack of contamination. Station BK02 is suspect, as its concentration was markedly higher than other stations in Elliott Bay. If these values are used for screening dioxin/furan concentrations, BK02 should be removed as an outlier and the remaining stations averaged, as inclusion of this station is currently resulting in an “average” concentration well above that in most areas of Elliott Bay.

Background sample locations (i.e., Duwamish Head, Magnolia Bluff, and Myrtle Edwards Park) were selected to represent conditions in Elliott Bay outside the influence of PSR. Data from these locations were used in their entirety; however, comparisons to background were not used *to establish risks. Rather body burdens associated with deleterious effects (derived from the literature) were used as the comparison endpoint to quantify ecological risks. See also Section 3 (Risk) of the Responsiveness Summary.*

M22a. Page 2-5, last paragraph, and page 2-6. It is not acceptable to ignore potential effects to fish from PAHs at the site, since PAHs are the primary contaminant of concern, fish listed under ESA are present at the site, and the literature that is available on effects of PAHs to fish is specific to fish that are abundant near the site (English sole). The ESA listing necessitates an approach somewhat more protective than might otherwise be employed at a Superfund site. This characterization of the results of the ecological risk assessment is incomplete and leaves out one of its key conclusions, as stated in the executive summary to Appendix K of the RI Report: "... significant deleterious impacts can occur at PAH concentrations several times to an order of magnitude lower than the concentrations that cause effects in benthic invertebrates. Given that this range of concentrations is similar to the levels in sediment that would be protective of people eating shellfish, cleanup decisions based on human health issues will likely protect fish."

See Section 5 (Cleanup Level Selection) and Section 13 (Restoration Goals) of the Responsiveness Summary.

M22b. No remedial action objectives have been proposed that are protective of either human health or fish at the site, and no remedial alternatives have been developed that would reduce these risks to acceptable levels. Protectiveness of the remedy to fish, shellfish, and tribal members fishing for and consuming these resources is of primary concern to the Tribe, and the FS should rewritten to include and evaluate alternatives that are protective of these resources, in conformance with federal and state law.

See Section 4 (ARARs) of the Responsiveness Summary.

M23. Page 2-7, 2.4.1.2 Washington State Water Quality Standards The water quality standards also include other requirements, such as no visible sheen, that are likely to be applicable to this site both during and after active remediation. In addition, the water quality standards set out specific characteristic uses for each water body that must be maintained, including protection of fish and shellfish, and fisheries based on these resources The remedial action objectives should be designed to ensure that these uses of the water body are protected.

See Section 10 (RAOs /Evaluation Criteria) of the Responsiveness Summary.

M24. Page 2-7, 2.4.1.2 Washington Sediment Management Standards This section misinterprets the narrative definitions within the SMS. Again, "biological resources" should be replaced with "benthic organisms". The definition of SQS provided in WAC 173-204-100 is a narrative definition of the SQS, intended to guide site-specific development of numeric RAOs. It is not meant to imply that the numeric criteria that have been promulgated for the protection of benthic organisms are also protective of human health or other higher trophic level receptors. Numeric criteria protective of human health have been reserved, and site managers are expected to develop such criteria on a site-specific basis (WAC 173-204-320(4)). Ecology and DOH guidance (DOH, 1995) on the protection of human health clearly indicates that there are a number of bioaccumulative chemicals for which the benthic criteria will not be protective of human health (or other higher trophic, level receptors). A maximum cumulative risk level of 1×10^{-5} has been selected by Ecology as corresponding to the CSL, while a cumulative risk level of 1×10^{-6} has been selected as a human health risk level corresponding to the SQS (see draft rule language). These risk levels are consistent with MTCA.

See Section 3 (Risk) of the Responsiveness Summary.

M25**.** **Page 2-7, Section 2.4.1.4.** The numeric human health risk levels included in MTCA should be referenced, as they are ARARs applicable to Superfund sites.

See Section 4 (ARARs) of the Responsiveness Summary.

M26a. **Page 2-12, bullets**. Neither of these RAOs is adequate to protect human health and the environment at the site. The human health risk level does not comply with MTCA risk levels or draft SMS human health risk levels. The SQS/CSL chemical criteria are as much as an order of magnitude higher than levels protective of impacts to fish from PAHs present at the site.

See Section 4 (ARARs) of the Responsiveness Summary.

M26b Alternative RAOs should be developed that better reflect state and federal regulations and risks to humans and fisheries resources, and the areas and volumes used to design the remedial alternatives should be adjusted accordingly. Regardless of the remedial action ultimately selected, the FS should be more forthright about the risks that are present and the areas that exceed these risks.

See Section 10 (RAOs / Evaluation Criteria) of the Responsiveness Summary.

M27. **Page 3-1, bullet.** This paragraph should be rephrased so that it does not state that “no action/institutional controls” will meet the project RAOs.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

M28 **Page 4-5, first paragraph.** The prevailing winds may be from the southwest, but the winter storms that generate the most wave action are typically from the north.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

M29. **Page 4-5, Capping Material Availability.** It would be easier to put this discussion in context if it was stated how much capping material was projected to be needed for the various alternatives.

The alternatives with a significant capping element as part of the remedial approach would require between 363, 000 to 778, 000 cubic yards of capping material depending on which alternative was selected.

M30. **Page 4-6, first full paragraph.** Rejection of the lower Duwamish material because it is siltier does not make sense - earlier in the test it stated that siltier material would be better at containing contaminants. Because of its higher organic matter content, it typically also provides a better substrate for recolonization by benthic organisms. Clean, silty sands may therefore be a better capping material than sand alone. However, a good reason to reject lower Duwamish material would be if it had higher levels of contamination than other sources of capping material.

See Section 6 .4 (Design Issues—Cap Source Material) of the Responsiveness Summary.

M31. **Page 4-6, Cap Placement.** There's no particular reason why capping could not be considered for areas > 200 ft. deep—a demonstration capping project was recently completed on the margins of the PSDDA site in Elliott Bay, which is substantially deeper than 200 ft. In particular, thin-layer capping could be conducted in almost any depth of water, since it does not require that an evenly thick cap be placed.

See Section 6.1 (Design Issues—Capping at Depth) of the Responsiveness Summary.

M32. **Page 4-10, Institutional Controls** Any caps along the shoreline should be sufficiently adequate to allow tribal collection of shellfish resources, including clams, once the site is cleaned up, since one of the primary reasons to conduct the cleanup is to protect and restore fisheries resources and better support Tribal treaty rights to gather fish and shellfish in the area. Cleanup should also be adequate to support the use of the area as a Tribal net fishery, which could include use of anchors with nets

See Section 1 (Potential Impacts to Treaty Rights) of the Responsiveness Summary.

M33. **Page 4-12, Long-Term Capped Area Monitoring.** The cap should maintain its integrity for more than 30 years. Provisions should be made for inspections and cap maintenance over the long term. If, during the first 30 years, any problems are identified with cap integrity, a more permanent solution or an ongoing (permanent) maintenance program should be established.

See Sections 6.6 (Design Issues—Life/Duration) and 11 (Monitoring) of the Responsiveness Summary.

M34. **Page 4-13, first full paragraph** The ability of the cap to withstand storms and waves may depend on whether the elevation of the bottom is being changed. Placement of the cap in a manner that increases bottom elevations may make it more exposed to wind waves, wakes, and storm events.

See Section 6.5 (Design Issues—Cap Placement) of the Responsiveness Summary.

M35. **Page 4-15, Potential for Recontamination** It is really not clear that the measures proposed will prevent eventual recontamination of this area. The design modification of using a sandy cap is particularly troubling because it implies that, rather than allowing the PAHs to sorb onto the cap materials, they will be allowed to pass through and be released into the water column. It does not seem like this approach would reduce exposure to the receptors of concern (e.g., English sole and juvenile salmonids). Source control is generally considered a more appropriate and effective approach to recontamination concerns than engineering modifications to the receiving environment. To ensure that the potential for recontamination is minimized, source removal, DNAPL pumping, and/or further migration barriers along the shoreline should be considered as part of the cleanup alternatives.

See Section 8 (Source Control and Potential for Recontamination) of the Responsiveness Summary.

M36. **Page 4-18, Removal to CSL**. This alternative would raise the elevation in intertidal areas by as much as three feet, while dredging in adjacent nearshore areas to as much as 16 feet. Since no backfill of dredged areas are proposed, a bathymetric discontinuity of up to 20 feet could be created. The slopes in this area are already steep. The engineering feasibility of this approach should be discussed, and provision made for a method to leave a reasonable slope in this area. For this and all alternatives that change bottom elevations in nearshore areas, the impact of these changes on habitat and fisheries resources should be discussed.

The alternatives presented in FS were conceptual and were not intended in include the level of detail discussed in this comment. No bathymetric discontinuities would be allowed in the actual design.

M37. **Page 4-20, Capping to SQS.** All other constituents in the capping material should also be less than the SQS (not just PAHs).

Chemical concentrations in potential capping material must meet the SMS for all constituents for which there are standards.

M38. **Page 5-5, Compliance with ARARs** Alternative 2 does not comply with ARARs, particularly SMS human health guidance or promulgated MTCA human health risk limits, both of which require that cumulative human health risks be reduced below 1×10^{-5} The residual risks of this alternative are even above EPA's acceptable risk range (upper limit of $1x10^{-4}$). Alternative 2 entails substantial modification of bathymetric contours in shallow subtidal areas if no clean backfill is proposed, which may or may not comply with the Washington Hydraulics Code.

See Section 4 (ARARs) of the Responsiveness Summary.

M39. **Page 5-10, Compliance with ARARs.**Alternative 3a begins to get close to SMS/MTCA required risk ranges, but Alternative 3b is well above the acceptable risk limit. It is not clear why Alternative 3b is expected to have lower risks than Alternative 2, when both address the same area (sediments > CSL). The same comments apply to Alternatives 4a and 4b, on Page 5-14.

See Section 3 (Risk) of the Responsiveness Summary.

M40a. **Page 5-18, fourth paragraph.** Here and in other places throughout the FS, a better explanation should be provided of why it would be so difficult to inspect and monitor the cap or CAD site. The PSDDA site is in deeper water and it has been very effectively monitored over the years, for relatively low cost.

See Section 11 (Monitoring) of the Responsiveness Summary.

M40b. **Page 5-18, fourth paragraph** How likely is anchor drag or other damage to the CAD surface in these relatively deep waters?

See Section 6.3 (Design Issues—Cap Thickness) of the Responsiveness Summary.

M41. **Page 5-20, second paragraph** A tremie pipe could be used to place these contaminated sediments in deep water, limiting losses to the water column and allowing better placement of materials.

See Section 6.5 (Design Issues—Cap Placement) of the Responsiveness Summary.

M42. **Page 5-30, last paragraph** As noted above, none of the existing alternatives meets State ARARs for protection of human health.

See Section 4 (ARARs) of the Responsiveness Summary.

M43. **Page 5-32, Long-Term Effectiveness and Permanence.** For the same reason that the no-action alternative provides the least long-term effectiveness, alternatives that clean up only to the CSL will have lower long-term effectiveness than those that clean up to the SQS, since CSL alternatives take no action over large areas that exceed risk levels for human health and the environment.

See Section 3 (Risk) of the Responsiveness Summary.

M44. **Table 5-6**. Because none of the alternatives is fully protective of human health or meets State ARARs, the alternatives should receive different scores for this criterion based on whether they come close to achieving the human health ARAR or not. On this basis, Alternatives 3a and 4a would receive higher scores than the others. Similarly, these alternatives should receive a higher score in reduction of mobility, since they will effectively contain a much larger percentage of the sediments that pose a risk to human health and fish.

EPA believes that all alternatives evaluated meet ARARs with respect to protection of human health. Please see EPA's responses to Section 3—Risk. Reduction in contaminant mobility is evaluated for treatment options only and does not apply to remedies based on confinement.

References

Ecology. 1997. Developing Health-Based Sediment Quality Criteria for Cleanup Sites: A Case Study Report. Washington Department of Ecology, Olympia, WA.

EPA. 1993. Interim Report on Data and Methods for Assessment of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Risks to Aquatic Life and Associated Wildlife. Office of Research and Development, Washington DC. EPA/600/R-93/055.

Horness, BH, DP Lomax, LL Johnson, MS Myers, SM Pierce, and TK Collier. 1998. Sediment Quality Thresholds: Estimates from Hockey Stick Regression of Liver Lesion Prevalence in English Sole. *Environmental Toxicology and Chemistry* 17(5):872-882.

PSEP. 1991a. Pollutants of Concern in Puget Sound. Puget Sound Estuary Program. EPA 910/9-91-003,

PSEP. 1991b. Reference Area Performance Standards for Puget Sound. Puget Sound Estuary Program. EPA 910/9-91-041.

WDOH. 1995. Tier I Report, Development of Sediment Quality Criteria for the Protection of Human Health. Washington Department of Health, Olympia, WA.

WDOH. 1996. Tier II Report, Development of Sediment Quality Criteria for the Protection of Human Health. Washington Department of Health, Olympia, WA.

MUCKLESHOOT INDIAN TRIBE
FISHERIES DEPARTMENT

13 May 1999

Ms. Sally Thomas
Remedial Project Manager
U.S. EPA – Superfund
1200 Sixth Ave., HW-113
Seattle, WA 98101

Re: 1) Elliott Bay/Duwamish River Natural Resource Trustee joint comments on the PSR draft Feasibility Study and Proposed Plan.

2) Transmission of Trustee Restoration Goals for the PSR Site.

Dear Ms. Thomas,

On behalf of the Elliott Bay/Duwamish River Natural Resource Trustees (Trustees), please find the attached joint comments on the draft Feasibility Study and the Trustee Restoration Goals for the PSR Site. As warranted, individual Trustees will be corresponding with you directly with any additional comments they may wish to provide you on the PSR reports. The Trustees have not provided separate joint comments on EPA's Proposed Plan for the PSR Site, although comments on the draft Feasibility Study should be addressed in the Proposed Plan, as appropriate. The Restoration Goals are provided to EPA to better ensure that the selection and design of remedial actions at the PSR site are consistent with these goals.

Thank you for the opportunity to comment and coordinate on this very important activity. Please feel free to contact me at (253) 931-0652, extension 130, with any questions or concerns.

Sincerely,

Glen R. St. Amant
Senior Sediment Specialist

Cc: Elliott Bay/Duwamish River Natural Resource Trustees

August 4, 1999

General Comments on the Draft Feasibility Report-

T1. The Trustees do not agree that the proposed preferred alternative, capping to the Cleanup

Screening Level (CSL), should be selected for the PSR site. The Trustees believe that cleanup at the site should incorporate the attached Restoration Goals, including the identified sediment cleanup goal of 2,000 parts per billion dry weight for total polycyclic aromatic hydrocarbons.

See Section 13 (Restoration Goals) of the Responsiveness Summary.

T2. Long-term effectiveness of the proposed remedy is very important. Source control must be implemented concurrent to remediation to better assure the long-term success of cleanup. The draft Feasibility Study predicts recontamination of a portion of the capped sediments within 10 years, due to uncontrolled migration of contaminants through groundwater. This is inconsistent with the Sediment Management Standards ARAR (WAC 173-204-570) and permissible cleanup standards. The Trustees do not consider reducing the organic carbon content of the cap material to be an appropriate measure for addressing this problem. Other measures to prevent recontamination should be identified, and the ROD should include a specific commitment to address the recontamination of sediments should it occur.

See Section 8 (Source Control and Potential for Recontamination) of the Responsiveness Summary.

T3. The cost analysis of the proposed remedial and disposal options (Section 5) are currently misleading and should include estimates for mitigation and/or access and easement costs when applicable. These additional estimates would allow a more readily comparable cost-benefit ratio of the proposed cleanup and disposal alternatives.

The estimates have been revised to include mitigation. No estimate of DNR land use costs can be made at this time. The revised estimate for each of the alternatives are provided below. The first table gives the costs for habitat mitigation, based on mitigation cost estimates from Commencement Bay projects. Because the nearshore disposal sites are predominantly subtidal, a habitat mitigation ration of 1:1 was used. No mitigation was assumed to be necessary for a CAD; capping was assumed to be "self-mitigating." The second table provides the cost of all the alternatives including habitat mitigation costs.

Mitigation Cost Estimates

Alternative	Disposal Method	Land Use (Acres)	DNR Use Cost per Acre	Land Use Cost	Mitigation Area (Acres)	Mitigation Cost per Acre	Mitigation cost ($)
2 - Dredge to CSLs	CAD	16	Unknown	Unknown	N/A	-	-
2 - Dredge to CSLs	Nearshore	17.5	Unknown	Unknown	17.5	300,000	5,250,000
3a - Cap to SQS	Cap	96	Unknown	Unknown	N/A	-	-
3b - Cap to CSLs	Cap	47	Unknown	Unknown	N/A	-	-
4a - Dredge/Cap to SQS	CAD	16	Unknown	Unknown	N/A	-	-
4a - Dredge/Cap to SQS	Nearshore	17.5	Unknown	Unknown	17.5	300,000	5,250,000
4b -Dredge/Cap to CSLs	CAD	12.5	Unknown	Unknown	NIA	-	-
4b Dredge/Cap to CSLs	Nearshore	14.5	Unknown	Unknown	14.5	300,000	4,350,000

Alternative Estimates (includes mitigation costs)

Alternative	Disposal Method	Remediation Cost	CAD Disposal Cost ($)	Nearshore Disposal Cost ($)	Upland Disposal Cost ($)	Habitat Mitigation Cost ($)	Total Cost ($)
2 - Dredge to CSLs	CAD	6,010,000	7,704,000	-		-	13.714,000
2 - Dredge to CSLs	Nearshore	6,010,000	-	11,128,000		5.250.000	22,388,000
2 - Dredge to CSLs	Constructed Upland	6,010,000	-		19,260,000		25.270,000
3a - Cap to SQS	Established Upland	12,520,000	-		619,000	-	13,139,000
3b - Cap to CSLs	Established Upland	6,440.000	-		619,000	-	7,059,000
4a - Dredge/Cap to SQS	CAD	12,430,000	7,902,000	-		-	20,332,000
4a - Dredge/Cap to SQS	Nearshore	12,430,000	-	11,414,000		5,250,000	29,094,000
4a - Dredge/Cap to SQS	Constructed Upland	12,430,000	-		19,755.000		32,185,000
4b - Dredge/Cap to CSLs	CAD	5,500,000	5,670,000	-		-	11.170,000
4b - Dredge/Cap to CSLs	Nearshore	5,500,000	-	8,190,000		4,350,000	18,040,000
4b - Dredge/Cap to CSLs	Constructed Upland	5,500.000	-		14,175,000		19,675,000

T4a. Several aspects of the capping scenarios discussed for the site need clarification and additional discussion. Portions of the site with very steep slopes (i.e., greater than 18 to 20%) present serious challenges for proper cap placement and cap stability. More thorough discussion of the feasibility of placing and maintaining a cap in these areas is warranted.

*See Section 6.2 (Design Issues***SS***Geotechnical) of the Responsiveness Summary.*

T4b. In addition, statements are made about the selection of the proper capping material grain size and coarseness for maintenance of cap integrity. Cap design should also address the potential to integrate similar grain size fractions to the existing bottom, to help promote biological colonization and recolonization of species that will be displaced by the cap.

*See Sections 6.1 (Design Issues***SS***Capping at Depth) and 6.3 (Design Issues***SS***Cap Thickness) of the Responsiveness Summary.*

T4c. Finally, any discussion of cap design should also address the following functions: physical isolation, stabilization of sediment, and reduction in flux (i.e., chemical isolation).

*See Section 6.3 (Design Issues***SS***Cap Thickness) of the Responsiveness Summary.*

T5. The Trustees are interested in participating in the remedial design process that evaluates and selects the specific remediation activities ultimately employed at the site. For example, issues such as the type of dredge bucket selected and timing of the proposed action may have important recontamination or other environmental implications. At the time that these issues are being discussed, please notify the Trustees, in advance, so that we may be able to coordinate with EPA on these issues.

During design, EPA will provide design documents and monitoring plans to the Trustee and regulatory agencies. As with the RI/FS process, EPA may hold technical meetings in advance of the preparation of deliverables to solicit ideas from reviewing agencies to assure that issues have been identified and discussed early on.

Page-Specific Comments on the Draft Feasibility Report-

T6. ***Page 1-2, First Paragraph***. The phrase “to the extent practicable” should be changed to “to the maximum extent practicable” to conform to the Model Toxics Control Act (MTCA) cleanup regulation language (Chapter 173-340, WAC).

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T7. ***Page 1-3, Fourth Bullet***. The PSR Site Criteria of a human health excess cancer risk of less than 1 in 10,000 is inappropriate. ARARs for the site include MTCA and the Washington State Sediment Quality Standards. MTCA allows for a maximum of 1 x 10^{-5} cancer risk for multiple chemical exposure (MTCA Cleanup Regulation, WAC 172-340-708). This comment significantly affects other sections of the document, which should be revised accordingly.

See Section 4 (ARARs) of the Responsiveness Summary.

T8. ***Page 1-4, Section 1.3.2, Third Paragraph*** Please change the phrase “treaty rights to gather shellfish” to “treaty rights to gather other fish and shellfish.” Also, please delete the last sentence in the paragraph, and the associated Figures 1-7 and 1-8. The figures are inaccurate and the previous sentences in the paragraph adequately state that the Tribes fish in the area.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T9. ***Page 1-4, Section 1.3.3.1, Last Paragraph*** Please explain why no LNAPL has been collected in the recovery trench. Is this expected or is the product migrating somewhere else?

During the remedial investigation of the Upland Unit, LNAPL was found to be very localized and occurrence was sporadic. However, there was some uncertainty regarding the volume of LNAPL that may be present, so a collection trench was added on the upgradient side of the wall to collect any LNAPL that may befloating on groundwater towards Elliott Bay. Since completion of the wall and trench, no LNAPL has been observed, confirming the suspicion that LNAPL was minimal at the site. The lack of LNAPL may be due, in part, to the limited use of pentachlorophenol (PCP) as a wood preservative at the PSR site. LNAPLs at this site would primarily be generated from the carrier oils used to apply PCP.

T10. ***Page 1-8, Section 1.4.6, Second Paragraph, Fourth Line*** Please change the first word in this tine from “estuary” to “Waterway.”

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T 11. ***Page 1-13, First Full Paragraph*** Some mention should be given to include the pocket beaches at or near the site as additional habitat potentially used by the great blue heron.

It is recognized that piscivorous birds may utilize the site. It should be also noted that exposed beach is limited to 72 days per year and provides only a fraction of the total fishing area that may be utilized by a heron.

T12. ***Pages 1-14 and 1-15***. This paragraph mentions the potential recontamination of a portion of the MSU by naphthalene and fluorene. How does EPA plan to handle cleanup situations where recontamination does occur? EPA should elaborate on further actions or contingency plans for handling ongoing sources of DNAPL as well as deep groundwater contamination in this section and throughout the document.

See Section 8 (Source Control and Potential for Recontamination) of the Responsiveness Summary.

T 13. ***Page 2-2, First Full Paragraph*** This paragraph should clearly state that the SQSs and CSLs are Washington State-derived numbers. The term “biological resources” should also be replaced with “benthic infauna.”

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T14. ***Page 2-2, Section 2.2.1.1, Second Paragraph*** Insert the following as a second sentence: "However, the SMS does have a narrative standard for human health of no significant health risk to humans."

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T15. ***Page 2-3, Section 2.2.1.2, Second to the last sentence*** Please explain why only detected values were used to calculate 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) equivalents as opposed to also utilizing some value for the samples that were below detection limits.

This method of summing dioxins is similar to the method used under the SMS for creating composite chemical concentrations (e.g., total benzofluoranthenes, total LPAHs, total PCBs, etc). This approach was considered reasonable by WESTON's risk assessors and was used for the PSR MSU evaluations.

T16. ***Page 2-3, Section 2.2.2, Second Paragraph*** Please specify types (i.e., congener-specific or total families) of compounds found to exceed screening levels. For example, dibenzofuran is a specific type of furan, so "total" dioxins/furans were found, as well as the specific furan, to exceed screening levels. Also, when referring to PCBs, please state "total" PCBs, if that is what is meant here and throughout the document.

Individual congeners were analyzed; a total TCDD/TCDF concentration was created by applying toxicity equivalency factors to each group and then summing. Please see the RI risk assessment for further details regarding treatment of dioxins and furans. Total PCBs refers to the sum of detected Aroclors reported for each sample.

T17. ***Page 2-7, Section 2.4.1.3, Second Paragraph*** This paragraph is an inaccurate interpretation of the SMS rule. The SQS numeric criteria do not necessarily protect human health. They are developed by the State to protect the benthic community. The level of protection needed to meet the SQS narrative standard for human health must be determined on a site-specific basis.

See Section 3 (Risk) of the Responsiveness Summary.

T18. ***Page 2-M, Section 2.4.3.1, Last Sentence*** Please replace the phrase "from the Department of the Interior" to "from the Department of Interior and/or the Department of Commerce, acting through the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, respectively."

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T19. ***Page 2-10, Section 2.4.3.3, Title*** Please remove "U.S." from Fish and Wildlife Coordination Act.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T20. ***Page 2-12, First Bullet***. A risk level of less than 1 in 10,000 does not comply with your listed ARARs. Please revise. Please refer to comments on pages 1-3 and 2-7 for more details.

See Section 4 (ARARs) of the Responsiveness Summary.

T21. ***Page 3-3, First Paragraph, Fifth Line***. Please change the sentence that starts with "Some CAD sites on with" to "Some CAD sites with."

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T22. ***Page 4-5, Section 4.1.2 Second Paragraph, Last Sentence***. Due to the explanation immediately preceding this sentence, the last sentence should read "Most slopes within the MSU..."

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T23. ***Pages 4-11 and 4-12***. The dredged area monitoring and capped area monitoring assume sampling densities (e.g., one sample per two, three, or six acres) inadequate to determine the long-term success of the remedial actions. Also, reference is made that only PAHs would be included for analysis. EPA should include a normal suite of analytes, especially PCBs, in the monitoring program to determine the short-term and long-term efficacy of the remedial action. For example, recontamination could occur from off-site, potentially resulting in non-PAH recontamination of the PSR MSU. All future PCB analysis should be congener-based, rather than Aroclor-based, for better interpretation of toxicological significance.

See Section 11 (Monitoring) of the Responsiveness Summary.

T24. ***Page 4-11, Section 4.1.5.1, Last Paragraph***. On the second line, please change the beginning of the third sentence to "If conditions allow, sampling frequency would then be decreased..."

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T25. ***Page 4-15, Section 4.1.7.1, Third Paragraph***. Source control is a major concern at this site (see General Comments Section and Trustee Restoration Goals). The argument and example given in this paragraph is compelling evidence that source control needs to be attained concurrent to remedial action.

See Section 8 (Source Control and Potentialfor Recontamination) of the Responsiveness Summary.

T26a. ***Page 4-17, Section 4.2, Second Paragraph***. Remove sentence four, since it is debatable that "other less-expensive technologies would provide the <u>same level of protectiveness</u>..." (emphasis added).

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T26b. Also, the Trustees believe that alternatives such as dredging to SQS or dredging to CSL and then capping to SQS as well as other cleansing/bioremedial technologies need to be reexamined at this point in the feasibility study.

A number of alternatives were screened as part of the FS process and were summarized in the FS report; the screening technical memorandum was reviewed by Trustee and regulatory agencies. Dredging to the SQS was not considered feasible due to the technical difficulties associated with dredging at depths greater than -200 feet MLLW, volumes generated (970,000 cubic yards) and the resulting cost of disposal ($60,000,000, assuming construction of a nearshore disposal facility) and was therefore not carried forward in the FS. Various treatment technologies were evaluated during the screening process. None are currently available as a cost-effective remedy at this time. Should a long-term, regional facility be developed, treatment may become a viable remedial technology for the Puget Sound region. The Superfund process recognizes that new, more cost-effective technologies may be developed over time. This is one of the reasons remedies are only costed for a 30-year life.

T27. ***Page 4-18, Section 4.2.2, Third Sentence.*** Include a statement that allows for dredging of shoreline or areas close to shore in which shore protectiveness and slope instability are not issues.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T29. ***Page 4-18, Section 4.2.2.2, Second Paragraph, Last Sentence.*** Since PCBs are also of concern in certain areas of the site, include a statement which encompasses the idea that PCBs will also be dredged to appropriate levels in those areas.

See Section 5 (Cleanup Level Selection) of the Responsiveness Summary.

T29. ***Pages 4-20 through 4-22, Section 4.2.3.*** Add a discussion in this section to address hydrology and changes in hydrology to the area after placement of a large cap (i.e., explain how wave, currents, and wind impacts will change). Also, add a discussion section on any alternatives that could be employed to complete capping over a faster duration than proposed.

See Sections 6.2 (Design IssuesSSGeotechnical) and 63 (Design IssuesSSCap Thickness) of the Responsiveness Summary.

T30. ***Page 4-20, Section 4.2.3.1, First Paragraph, Last Sentence.*** Please revise the PAH chemical concentration of the capping material to be consistent with the Trustees' primary restoration goal of less than or equal to 2,000 parts per billion dry weight.

See Section 3 (Risk) and Section 13 (Restoration Goals) of the Responsiveness Summary.

T31. ***Page 4-20, Section 4.2.3.1, Third Paragraph*** Is wave or wind energy a concern for the stability of the shoreline cap? Please explain. This comment also applies to Section 4.2.3.2, Second Paragraph.

*See Sections 6.2 (Design Issues***SS***Geotechnical) and 6.3 (Design Issues***SS***Cap Thickness) of the Responsiveness Summary.*

T32. ***Page 4-26, Section 4.3.2, First and Second Paragraphs*** The first paragraph states that CND sites cannot conflict with tribal fishing activities. However, the nearshore areas retained for consideration are within Tribal fishing areas. These two statements contradict one another and should be rewritten.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T33. ***Page 5-5, Section 5.3.2.2, First Paragraph*** The risk levels obtained by this alternative are not consistent with ARARs. Please refer to comments on pages 1-3 and 2-7.

See Section 4 (ARARs) of the Responsiveness Summary.

T34. ***Page 5-6, Section 5.3.2.2, First Paragraph*** This paragraph mentions that the alternative would comply with all appropriate dredge requirements under the Clean Water Act. However, no mention is made of the ultimate disposal method being proposed for the dredged material. Please discuss the proposed disposal method, location, and any associated environmental impact issues.

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

T35. ***Page 5-9, Section 5.3.2.7, Last Sentence*** It seems that some form of cost estimate for disposal should be applied in this section, since the alternative could not be accomplished without disposal.

See Section 12 (Disposal/Siting) of the Responsiveness Summary.

T36. ***Page 5-10, Section 3.3.2, First Paragraph*** The risk levels associated with Alternative 3b are not consistent with ARARs. Please refer to comments on pages 1-3 and 2-7.

See Section 4 (ARARs) of the Responsiveness Summary.

T37. ***Page 5-11, Section 5.3.3.4, Third Paragraph, Last Sentence*** The Trustees encourage EPA to evaluate the upland disposal of the 3,500 cubic yards of dredged materials, since upland disposal would lessen the environmental impacts associated with moving them to another location in deeper water at a minimal cost.

The ROD will include upland disposal of the material dredged near Crowley-Marine at a cost of $688,000.

T38. ***Page 5-13. Fourth Full Paragraph, Second Sentence*.** In circumstances where remedial activities may impact Tribal fishing, EPA should coordinate directly with the Tribes. This comment applies to all areas in the report that discuss potential impacts to Tribal fishing.

See Section 1 (Potential Impacts to Treaty Rights) of the Responsiveness Summary.

T39. ***Page 5-14, Section 5.3.4.2, First Paragraph, Fourth Line*** Please change "CLS" to "CSL" (typographical error).

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T40. ***Page 5-23, First Paragraph*.** The Trustees suggest deleting the sentence that states, "The area lost, however, is currently highly contaminated, providing low-quality habitat for fish." This sentence is not needed in the paragraph, and is not necessarily accurate. This paragraph should also note that habitat mitigation would likely be a requirement of this disposal alternative.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T41. ***Page 5-25, First Full Paragraph*.** The Trustees suggest deleting the following from the paragraph: "that now provide low quality habitat for native marine communities. The present ecological values of these sites are limited by existing contamination." See the explanation in the previous comment.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T42. ***Page 5-25, Section 5.4.2.6, Third Paragraph, Sixth Line*** Please delete the following: "The area lost, however, is currently contaminated and provides low-quality habitat for fish. In addition,". See the explanation in the two previous comments.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T43. ***Page 5-25, Section 5.4.2.6, Fourth Paragraph*.** This paragraph states that the CND would hame no long-ranging impacts on water-dependent industries. However, this CND eliminates an area used for Tribal Fishing. Please rewrite.

See Section 14 (Editorial Comments) of the Responsiveness Summary.

T44. ***Page 5-26, Section 5.4.2.7*.** The cost estimate for this alternative does not include habitat mitigation costs. These costs should be included, since they could be significant, and since habitat mitigation will likely be required. This cost estimate should also be included in section 5.6.7.

The estimates will be revised to include habitat mitigation costs. Please see response to comment T3, above.

T45. ***Page 6-2, Section 6.2, Second Paragraph*** This paragraph states that, "With appropriate monitoring and maintenance, capping provides long-term isolation of contaminants." Before it can be concluded that the preferred alternatives meets the SARA mandate for permanence, the Trustees believe that specific commitments to address predicted recontamination of the cap need to be included, above and beyond standard provisions for long-term monitoring and maintenance.

See Section 11 (Monitoring) of the Responsiveness Summary.

T46. ***Page 6-3, Section 6.4, Last Paragraph*** This paragraph states that the long-term effectiveness of the cap is "uncertain due to static stability issues." This section should be expanded to address the potential of recontamination through groundwater migration. According to the model results presented on page 1- 15, the capped sediment areas are predicted to exceed the 2LAET after 10 years. Does the long-term monitoring and maintenance envisioned for the preferred alternative include a requirement that recontaminated areas be remediated again? If so, how? Are there no other source control activities envisioned that would reduce the likelihood of recontamination?

See Section 8 (Source Control and Potential for Recontamination) of the Responsiveness Summary.

T47. ***Table 2-2. Footnote a*** Correct the reference to Appendix F. Appendix F does not include TEQ information.

TEQ information is presented in Appendix K of the RI report.

RESPONSES TO THE PSR UPLAND GROUNDWATER RI/FS

ADDENDUM TO THE PSR UPLAND GROUNDWATER RI/FS
RESPONSES TO COMMENTS

This addendum to the PSR *Upland Groundwater Remedial Investigation and Feasibility Study Report* (RI/FS) presents comments on the draft RI/FS that were received from the U.S. Army Corps of Engineers, the Washington Department of Natural Resources, and the Washington Department of Ecology. EPA responses are also included. Agency comments are provided in a regular typeface and EPA's responses to those comments are presented in an *italicized* typeface. The text of the RI/FS was modified in response to the comments.

U.S. Army Corps of Engineers, Seattle District Comments

In summary, the report concludes the following:

- DNAPL at the site has spread laterally along numerous thin coarse-grained soil layers. Relative saturations have reached residual levels at most locations; therefore most of the DNAPL migration has already occurred and the remaining DNAPL is mostly immobile (p.5-9).
- Sandy beds, 2 to 3 inches thick, are saturated with DNAPL as far as 200 feet seaward of the shoreline, but it is not known if the DNAPL layers extend to the mudline (p.5-9).
- Shoreline NAPL seeps have been detected in the Central Shoreline Area and Tank Area 1. Buried riprap could act as a preferential migration pathway (p.4-9).
- Groundwater modeling indicates that groundwater exiting the site into Elliott bay will be protective of water quality (p.9-15). The model did not incorporate biodegradation. Localized groundwater impacts occur near the thin DNAPL layers (p.9-6).
- The slurry wall prevents migration of LNAPL to Elliott Bay, prevents migration of DNAPL to Elliott Bay above -25 feet MLLW, and substantially decreases flow of contaminated groundwater to Elliott Bay above -25 feet MLLW (p.10-2).

These findings support the comments submitted by this office on the PSR Offshore Unit Phase 2 Technical Memorandum, May 23, 1997:

A1 • Remediation of offshore sediments could be hampered by seepage of NAPL or contaminated groundwater into the bay. Although the slurry wall should prevent further NAPL migration above -25 MLLW, some NAPL probably remains between the wall and the shoreline, and seepage above -25 MLLW could continue for perhaps several years. Thin layers of DNAPL intersecting the shoreline and bay floor below -25 MLLW could also recontaminate remediated sediments.

Response*. As mentioned in the Corp's comment, the slurry wall prevents NAPL migration above -25 MLLW from sources upland of the wall. In addition, the wall has eliminated the main driving force for DNAPL between the wall and the shoreline. In other words, gravitational* *forces associated with the thickness of the DNAPL source body caused seaward migration of DNAPL in more permeable layers extending from the source area. The slurry wall isolated the material seaward of the wall from the source area that drove its migration. Without connection to the source mass, continued migration of stringers located seaward of the slurry wall is unlikely.*

EPA acknowledges that some DNAPL exists between the wall and the shoreline and that there is some potential for direct impact to sediments from this material. It is important to note that no NAPL sheens have been observed along the shoreline since construction of the wall. Further, free-phase DNAPL diminished from 1.8 feet in MW-5S to an unmeasurable thickness the first year after the containment wall was installed. These observations support EPA's position that the driving force for migration has been eliminated, that existing NAPL contamination of sediments is historic, and that any further migration is likely to be very localized and limited in extent. Monitoring, and maintenance and inspection is required as a part of remedial actions at the site to ensure that site conditions do not change.

The potential for continued direct NAPL impacts to sediments generally diminishes with depth as the travel distance between the upland and mudline increases. Again, although the potential for recontamination of remediated sediments cannot be fully discounted, evidence collected during the uplands and sediment RI's indicate that direct DNAPL impacts are likely to be very localized and limited in extent.

A2 • Additional work is needed to establish continuity of geology and extent of contamination between the Offshore and the Uplands Units. The RI/FS report contains sufficient uplands boring data to allow construction of geologic sections through each of the three offshore deep-core borings, showing geologic correlations and possible offshore migration paths.

***Response*.** Please see response to the third comment, below.

A3 • As discussed in our comments on May 23, 1997, additional offshore borings are necessary to allow extension of geologic sections under Elliott Bay. In addition, alternative methods for locating offshore seepage and evaluating offshore contaminant flux rates need to be evaluated before proceeding with the RI.

***Response*.** *The idea of developing geologic correlations and possible offshore migration paths, although ideal, is improbable at this site given the complex stratigraphy described in Section 3 of the Upland Unit RI/FS. The available data suggest that narrow fingers (or stringers) of DNAPL are dispersed within the interbedded sand and sandy gravel lenses. The geologic and DNAPL distribution data, as presented in the site conceptual model (Section 9), do not support the idea of finding large preferential path ways through which DNAPL migrates to sediments and on which remedial actions and be focused.*

Washington State Department of Natural Resources (DNR) Comments

B-1 **Section 1.3.1, Wood Treating Operation, Page 1-5**. The ownership of the site as presented in this text section and summarized in Table 1-2 needs clarification. Although the majority of state-owned aquatic lands associated with the site are being addressed in the offshore unit investigations, the filled tidelands in the harbor area which have been included in the upland investigations are state-owned. This portion of the upland site has been managed by DNR in the past and is part of the area that will be managed by the Port of Seattle upon completion of negotiations associated with its port management agreement.

Response. *Figure 1-6, Table 1-2, and thefirst paragraph of Section 1.3.1 were modified to highlight the fact of DNR ownership for filled tidelands seaward of the Inner Harbor Line.*

B-2 **Section 4.2.3, DNAPL Distribution and Sources, Seaward Locations, Page 4-6**. The discussion is confusing. Characterizations of several different depths, as well as presentation of different hypotheses regarding contributing activities, are unclearly intermingled. It may be more effective to discuss each depth and associated hypotheses to completion before addressing other depths.

Response: *This paragraph was reorganized to improve clarity.*

B-3 **Other Areas, Page 4-7**. The discussion of the origin of DNAPL in the final paragraph is unclear. The points of consideration associated with each alternative should be more separate and distinct.

Response: *This paragraph was split into two separate paragraphs and edited to improve clarity.*

B-4 **DNAPL distribution in the Vicinity of Elliott Bay, Page 4-8**. The text statement regarding the removal of substantially all unsaturated-zone source material in the vicinity of Tank Area 1 does not seem to be consistent with Tank Area 1 as it is illustrated in Figures 4-3 and others; the graphics show residual NAPL at the surface in this area. To the extent practicable, removal of residual product from the unsaturated zone on state-owned land would have been preferential to DNR.

Response: *Deposits of DNAPL-saturated material were excavated from Tank Area 1 as part of the Early Actions. Some residual DNAPL-impacted soil remains in this area. Shading in Figure 4-3 is meant to refiect this condition.*

B-5 **Figure 5-3, Potential Migration Pathways**. I found this diagram confusing and difficult to interpret.

Response: *The figure is based on an ASTM standard and is commonly used in describing site impacts. The figure was modified slightly to add product storage and piping1distribution of primary sources.*

B-6 **Section 7.1, Media of Concern, Page 7-1**. It would be more accurate to state that no further action, beyond cap maintenance, is expected with respect to contaminated soil.

Response*: The narrative was modified as suggested.*

B-7 **Section 8.4.4, Location-Specific ARARs, Page 8-5**. The state aquatic land management laws (RCW 79.90-79.96 and 332-30 WAC) have been cited as potential location-specific ARARs for the offshore unit at the PSR site (reference DNR comments on the Draft RI/FS Study Work Plan and SAP for the PSR Sediment Unit, February 1996). Given that a part of the uplands addressed in this RI/FS are within a harbor area and are therefore state-owned, some of these laws, especially those specific to harbor areas, may be potential location specific ARARs.

Response*. Table 8-2 was modified to cite WAC 332-30 as a potential location-specific ARAR.*

B-8 **Table 8-1, Potential Chemical-Specific ARARs at the PSR Site, Page 8-9**. The final entry in the Comments column should read: "Groundwater cleanup levels that protect sediments are reported in Table 8-5," rather than Table 8-2.

Response*: The reference was changed from Table 8-2 to Table 8-5.*

B-9 **Section 10.1.4, Conformational Monitoring Plan, Page 10-5**. DNR would like to continue to evaluate potential impacts to state-owned lands at the site by reviewing the conformational monitoring information as it becomes available. In addition, if other issues regarding sources to the marine environment are identified during the offshore investigations, we would like the opportunity to evaluate this new information.

Response: *EPA will make the results of confirmational monitoring available to DNR and other interested parties.*

State of Washington Department of Ecology, Northwest Regional Office Comments

General Comments

1. The most significant comment is that the mixing (tidal dilution) predicted by the model does not appear to actually occur, based on groundwater monitoring results for DO and salinity in shallow shoreline wells. Because the determination of whether groundwater discharges meet surface water ARARs depends heavily on this assumption, a final decision regarding the adequacy of existing source control measures cannot be made until these discrepancies are resolved.

Response*: The text was revised to provide additional clarity on these issues. See responses to the relevant specific comments below.*

2. It also appears that NAPL migration and groundwater impacts may be greater along the western shoreline (RW-1 to MW-3) than in the areas to the north (where most of the modeling effort and text discussion is focused). The potential for surface water impacts from NAPL and dissolved groundwater constituents in this area needs to be more clearly and directly discussed. The model needs to be adjusted to place the source term at the shoreline in areas with residual NAPL saturation (e.g., areas where seeps have been observed). Ecology will withhold judgement on the need for further source control in these shoreline areas until these comments and modifications have been addressed.

***Response**. The text was revised to provide additional clarity on these issues. See responses to the relevant specific comments below.*

Specific Comments

C-1 Page 2-17, first paragraph. How was it determined that 50 percent fluorescence intensity corresponds to free-phase DNAPL? Especially since free NAPL samples and not soil samples were used to calibrate the method. Ecology does not have a copy of the completion report to review the referenced discussion.

***Response**: A copy of the referenced Completion report was submitted to Ecology and other relevant agencies. The assumption of 50 percent fluorescence intensity as an indicator of free phase DNAPL is based on the technology supplier's experience. Recovery well data showed that 50 percent intensity is a conservative assumption of free-phase DNAPL (i.e., 50 percent intensity did not result in significant DNAPL collection).*

C-2 **Page 2-17, fourth paragraph**. Why was DNAPL not recovered from RW-1D, in which 10 to 15 feet of product accumulated? Since this is a shoreline well, this would seem to be an area of concern. Same question on page 2-19, Analysis of DNAPL Samples, second paragraph.

***Response**: Monitoring Well RW-1D was installed at the site in August of 1996 The DNAPL recovery testing described on page 2-17 occurred during the first half of 1996 (i.e., before installation of RW-1D). Well RW-1D was one of several wells from which routine DNAPL removal began in August of 1996 and is ongoing. Refer to Section 4.3.1 for updated removal volumes and other relevant information.*

C-3 **Page 3-17, second paragraph**. The hypotheses that DO is low in shoreline wells due to biodegradation seems less likely to Teresa Michelsen than other alternatives. If complete mixing were occurring between surface water and shallow groundwater twice daily, it does not seem possible that biodegradation alone could reduce the DO from 7 to less than 2. DO may be low in shoreline wells due to original concentrations of DO in groundwater and lack of mixing with seawater. This possibility seems borne out by the discussion of salinity for Round 3 data, showing that salinity (and DO) in shoreline wells was still similar to that in inland wells. These data strongly suggest that, prior to wall installation, there was not significant mixing between migrating groundwater and surface waters in the shallow nearshore areas of the site. Conditions predicted by the model for post-wall installation will need to be verified by an increase in DO and salinity in the final round of groundwater monitoring.

Response: *The concept offical mixing and the effects of such mixing on groundwater chemistry are central to the subsequent fate and transport modeling presented later in the report (Section 9). Therefore, a clear and thorough treatment of tidal mixing, which was absent from the original narrative, is needed in the latter portion of Section 3. Section 3.4.7 is now divided into two subsections entitled " Groundwater Flow" and "Tidal Mixing," the latter of which is new material.*

The conceptual model of tidal mixing at PSR is not inconsistent with the salinity and DO data presented earlier in Section 3. The zone where most of the tidal mixing occurs is very close to the mudline and is difficult to measure. The shoreline monitoring wells are, for the most part, completed further upland where most of the mixing is due to dispersion of marine water into the aquifer This is a slow process and changes towards a new geochemical distribution will occur slowly over time in response to construction of the containment wall. Consequently, existing data on DO, salinity and other parameters, obtained from the shoreline wells are not good indicators of the effects of tidal mixing.

C-4 **Page 3-24, last paragraph**. It is not clear to Ecology that all of the water flowing in during a tidal cycle actually mixes with the groundwater flowing out (the surface water may simply "bank" above the groundwater table and flow out again on a low tide). If full mixing occurred, the DO and salinity anomalies identified in the previous comment would not exist. If complete mixing were occurring every tidal cycle, 6 months should have been plenty of time for the surface water outside the wall to equilibrate. Furthermore, there should have been just as much mixing previous to installation of the wall, and there should not have been a need for "equilibration;" the water in the surface wells would already have been similar to marine water (especially at 12,000:1 dilution).

The model used may predict changes in head very accurately without indicating whether mixing is actually occurring. The model should determine the values of salinity and DO that would be expected as a result of such mixing and, if not verified by site monitoring data, the mixing predicted by the model should be adjusted accordingly. Since this is the least well-understood process modeled, only mixing that can actually be verified based on site data should be used in predicting groundwater concentrations at the point of discharge. A final round of monitoring results should be conducted well after installation of the site cap to accurately reflect post-upland cleanup conditions and conduct the final evaluation of source control.

Response. *Please see response to comment on Page 3-17, second paragraph, above.*

C-5 **Page 44, DNAPL occurrence**. The text minimizes the estimate that there is over 500 tons of DNAPL outside the containment wall in the shallow soil layers (an unknown amount of which is mobile). Plans should be developed to manage, pump, or contain this DNAPL, particularly along the central (western) shoreline near the old process area, and possibly in other areas (north-northwest of Tank Farm 1).

***Response**. The text of this and subsequent portions of Section 4 describe estimated volumes and the distribution of DNAPL at the site based on interpretation of soil boring data, ROST data, and DNAPL observations in completed wells. These interpretations and the subsequent estimates are subject to uncertainy**SS**a common feature of such estimates at all DNAPL sites.*

The comment that "...plans should be developed to manage, pump or contain DNAPL near the shoreline..." is acknowledged by EPA as an appropriate consideration for any DNAPL site. However, Section 4 is devoted to presentation of the nature and extent of contamination. Discussion of remedial objectives, a site conceptual model, and cleanup options are covered in Sections 8, 9 and 10 of the report. In particular, Section 10 describes DNAPL monitoring and removal as an element of compliance monitoring.

C-6 **Figure 4-6**. Since there are no data waterward of the impacted wells along the shoreline, there is no evidence one way or the other whether free-phase NAPL is reaching the water in this western shoreline area. Question marks or some other method of noting uncertainties in the shoreward boundaries should be added to the figure. The proximity of impacted wells to the shoreline in this area suggests it is highly likely that impacts are reaching surface water.

***Response**: The figure was revised. Impacts to surface water are addressed in Section 9.*

C-7 **Figure 4-12**. It seems unlikely that the outmost contours would parallel the western shoreline at 60 to 100 feet in depth. Where there is no available data to predict the actual extent of contamination, use questions marks or other notation to show uncertainty in the boundaries.

***Response**: The figure was revised.*

C-8 **Page 5-8, last paragraph**. The statement earlier on this page that "there are no pools of DNAPL" may not be true in the vicinity of RW-1, based on the accumulation of DNAPL seen in that well. The occurrence of the sandy/gravelly lenses in this area, and along the western shoreline in general, needs to be better discussed, since it appears this is the one potential for DNAPL to be reaching the shoreline in quantity. This should also be highlighted in Section 5.4.2.

***Response**: Page 4-7 in Section 4.2.3 contains a detailed discussion of subsurface conditions and release scenarios that could explain DNAPL accumulations at depth in the west-central shoreline area (i.e., near RW- 1D). Reference to the discussion of DNAPL presence at depth near RW-1 was added to the last paragraph of page 5-8.*

C-9 **Page 5-10, second paragraph**. Based on the comments above regarding tidal mixing, we suggest deleting the fifth sentence until it can be confirmed by groundwater monitoring results.

***Response**: Clarifications to the tidal mixing discussion in Section 3.4.7 describe the nature of mixing (both bulk and dispersive) that occurs as a result of tidal cycling. The groundwater modeling and conceptual hydrodynamic modeling support the conclusion that dissolved-phase contamination in groundwater strongly attenuates on approach to the shoreline. No change was made to the text in Section 5.*

C-10 **Page 5-10, last paragraph**. Along the western shoreline near the process area, it appears that there is sufficient free-phase and residual NAPL in soils right at the shoreline that little attenuation, retardation, or degradation would occur before groundwater reaches surface water.

***Response**: EPA acknowledges the western shoreline near the former process area poses the greatest potential risk of DNAPL impacts to sediment, groundwater, and surface water quality. The presence and possible remedial measures for any DNAPL located at the mudline is inherently a sediment issue, whereas the DNAPL source and any consideration of source control measures is an uplands issue. EPA contends that the likelihood of significant continued DNAPL movement towards the mudline is slim and that aggressive source removal measures near the former process area are not beneficial. Note: this is referred to in the Marine Sediments Unit RI as the intermediate groundwater discharge zone, and will be monitored carefully after remediation to ensure the remedy remains protective.*

C-11 **Page 7-1, second paragraph**. Based on the conceptual site model shown in Figure 5-3 and data presented in the RI, the possibility exists that DNAPL along the western shoreline is reaching surface waters, and the possibility also exists that DNAPL in soils outside the containment wall is affecting groundwater quality near the shoreline. The medium of concern is stated as "groundwater," however, it should be clarified that NAPL is included.

***Response**: EPA contends that DNAPL and DNAPL-impacted soil are sources of contamination to groundwater and that it is confusing to consider DNAPL as a medium of concern. Measures for DNAPL and groundwater control must nevertheless be considered in the context of meeting the remedial action objectives set forth in Section 7.2. The first sentence of this paragraph now reads, "Groundwater is the medium of concern addressed in this FS and DNAPL is the primary source of contamination to groundwater"*

C-12 **Page 8-1, bullets**. Zinc levels are also quite high in wells along the western shoreline, and should be included in the ARARs analysis and in Table 8-5.

***Response**. Section 8 was revised to include zinc as a constituent of concern. Specifically, a bullet for zinc was added to the list in Section 8.2, numeric cleanup levels for zinc were added to Table 8-5, and supporting narrative was added to Section 8.5.*

C-13 **Page 8-6, Cleanup Levels and Points of Compliance**. In addition to numeric cleanup levels, the state and federal requirement of "no visible sheen" is also an important ARAR for this site.

***Response**: A note was added to Section 8.5 identifying the requirement for "no visible sheen" on surface water.*

C-14 **Page 8-7, partitioning equation**. Pentachlorophenol is ionizable in water, and its sediment cleanup standards are not organic-carbon normalized, nor is its partitioning expected to be dominated by organic carbon (and hence, K_{oc}. Please explain how the water values for pentachlorophenol were derived and/or revise them if they were based on incorrect assumptions.

***Response**: Ecology was concerned with the method used to calculate PCP partitioning to sediments in the RI/FS. Specifically, the concern related to the validity of using a K_{oc} value for predicting aqueous PCP concentrations at the higher pH and ionization strengths of marine water. In addition, Ecology pointed out that Sediment Management Standard cleanup levels for PCP are not organic carbon normalized as reported in Table 8-6 of the FS.*

EPA contends that using a K_{oc} value to predict aqueous PCP concentrations in marine waters is appropriate as long as pH and solution ionic strength effects are taken into consideration. The use of K_{oc} for conditions found at PSR is supported by the literature (Lee et al., 1990). Lee reported that a modified partitioning relationship to account for pH effects adequately described the sorption of PCP to soil. In addition, Lee reported that the degree to which PCP sorbs to solid matrices increases with increasing solution ionic strength. For pH greater than 7, PCP sorption to soil increased by a factor of 6 when the ionic strength of a solution varied two orders of magnitude from 0.01 to 1.4 (seawater has an ionic strength ofopproximately 0.7).

The K_{oc} value used in the original FS calculations did not account for the elevated pH and ionic strength of seawater. The EPA has published K_{oc} values for ionizing organics as a function of pH in the document entitled "Soil Screening Guidance: User's Guide" (EPA/540/R-96/018). The reported valuefor PCP in a solution of pH 8.0, the approximate pH of seawater is 410 (L/kg). Using a K_{oc} of 410 L/kg and a sediment organic carbon content of 1 percent results in calculated pore-water concentrations for protection of sediments at 88 µg/L and 168 µg/L for the Sediment Quality Standards and Screening Levels, respectively. Reducing these concentrations by a factor of 6 to account for the effects of solution ionic strength still results in concentrations below the selected PCP cleanup level of 4.9 µg/L (MTCA Method B Surface Water Standards). Therefore, the conclusions of the RI/FS with respect to PCP do not change based on the above calculations.

Tables 8-5 and 8-6 and the narrative of Section 8.5 were modified per the above discussion. Table 8-6 was revised to show PCP cleanup levels with the appropriate units (i.e., µg/kg dry weight of sediment).

C-15 **Page 9S4, equations**. Again, it is not clear that actual dilution occurs in either zone, to the extent implied by these equations. Site monitoring data do not support this conclusion. This whole section needs to be revised accordingly.

***Response**: The revised conceptual model language for tidal mixing presented in Section 3.4.7 makes clear the nature of both the bulk and dispersive mixing occurring at the site. The equations, as presented, on page 9-4, are basic mass balance equations and are essentially* *independent of the mixing mechanisms involved. EPA believes that existing site monitoring data do not conflict with the conceptual model of groundwater movement and tidal mixing.*

C-16 **Page 9-5, third paragraph**. The extensive accumulation of NAPL in RW-1I and RW- 1D should be discussed somewhere in this section. Various figures on this page are inconsistent with those presented earlier in the chapter. Here it is stated that 200 tons of NAPL are present in Zone A; Figure 4-3 shows 514 tons. 514 tons of DNAPL times 3% mobile DNAPL is still over 15 tons of free-phase creosote right along the shoreline. This is not insignificant, though the text uses words such as "minimal" to describe it. The next paragraph says that free-phase DNAPL is an average of 6% of the total, yet, in Chapter 4, a figure of 4% was used. Which is correct?

***Response**: EPA agrees that some of the narrative in this section of the report was confusing. This is particularly true of the DNAPL percentages cited for the various zones of contamination. The figures were not in error but were difficult to reconcile with information presented in Figure 9-1 and other portions of the report.*

DNAPL masses and percentages cited on Page 9-5 are now more clearly stated and are readily matched with information presented in Figure 9-1. Figures on dissolved-phase PAH masses were removed from Figure 9-1 to focus the discussion on DNAPL as was originally intended. Similar changes were made to Figure 4-3 and page 4-4.

A reference to an earlier section of the report (Section 4.3. 1) was added to the narrative on page 9-5. The referenced section describes DNAPL accumulation and removal information for wells RW-1I, RW-1D, and MW-5I.

C-17 **Page 9-6, third paragraph**. Here, and in many other places in the report, PCP is referred to as a "DNAPL constituent." It is not. It is another wood treating chemical, and its presence with creosote is largely coincidental. It ionizes in groundwater, and thus would not behave much of anything like a heavy DNAPL constituent PAH compound.

***Response**: EPA recognizes that PCP is not a constituent of creosote, the source of DNAPL at the site. The first sentence of this paragraph now reads, "Other constituents of concern, such as dibenzofuran (Figure 4-13) and PCP (Figure 4-14) ..." A similar change was made to other portions of the document where reference is made to PCP as a DNAPL constituent.*

C-18 **Page 9-6, fourth paragraph**. This description of DNAPL outside the wall is occurring largely in thin stringers is descriptive primarily of the northern areas, and is not really a good description of what is going on to the west of the process area.

***Response**: EPA believes that the conceptual model set forth for DNAPL occurrence at the site is accurate. At the same time, EPA acknowledges that the density or concentration of DNAPL varies near the shoreline depending on the original source volume and location, distance to the shoreline, and structure of the complexly interbedded deposits described in Section 3.3.2.*

The greatest potential for source material to occur near the mudline is in the shallow west-central shoreline area as discussed in Section 4.2.3. Here, buried riprap may have acted as a preferential DNAPL migration pathway at shallow depths. Further, any spills from former product off-loading in this area would have resulted in a concentrated source of DNAPL very close to the shoreline.

The RI revealed no evidence of large amounts of free-phase DNAPL in the shallow nearshore areas of the west-central shoreline. Only modest amounts of DNAPL were removed from MW-5I and DNAPL removal from MW-5I was negligible. Currently, sheens are not observed at the shoreline. Therefore, while there are indications of NAPL occurrence, there is also evidence that the NAPL mass is immobile and limited in volume.

The last sentence of the paragraph was modified and additional language included as follows. "...These fingers produce small, localized impacts to groundwater because the volume of free-phase DNAPL contributing to these fingers is small and because the fingers are limited spatially. This model of DNAPL contributions to groundwater contamination may not fully explain conditions along the west-central shoreline. Here, historic spills from product off-loading operations could have produced direct nearshore impacts. In addition, a former riprap shoreline that is upland of the existing shoreline could be a preferential route for DNAPL movement. Currently, there are no product sheens along the shoreline and very limited amounts of DNAPL have been removed from shallow nearshore wells."

C-19 **Page 9-7, last full paragraph.** This may not be a conservative approach in areas where the bulk of DNAPL transport is though to have occurred in gravelly tenses with higher hydraulic conductivity than the average aquifer (e.g., west of the process areas).

Response: *Data collected during the RI do not suggest the presence of large, continuous gravelly-sand lenses at PSR. Instead, the evidence suggests that gravelly-sand layers are infrequent, discontinuous and unlikely to represent significant preferential migration pathways.*

C-20 **Page 9-10, Distance to Receptor.** As noted above, in some areas DNAPL (both residual and free) may extend beyond the shoreline monitoring wells to the shoreline. Any areas where seeps were previously observed will certainly have at least residual saturation of NAPL that can act as a source to the groundwater, and some free NAPL is predicted by the report (15+ tons) in these shoreline areas. Anywhere where residual saturation extends to the shoreline (or where the extent of NAPL has not been fully defined by the soil/groundwater samples), the source term should be placed at the shoreline (distance =0), rather than set back the distance from the nearest well to the shoreline. In addition, the distance to the shoreline should be the shortest distance from a given well to the shoreline, not the average distance. The point of compliance is the entire mudline, including those shallower points closest to the well. Seeps have been observed well in-shore of the point of compliance shown on Figure 9-5, highlighting the need for this requirement.

Response: *EPA believes that the fate and transport analysis, including estimates of distance to receptors, is generally representative o site conditions. Simultaneously, EPA recognizes that there is some potential for residual DNAPL existing at locations seaward of the shoreline wells.*

The greatest risk for such an occurrence is at shallow depths (i.e., Zone A) along the west-central shoreline area between boring BH-4 and Wells RW-1. Treating operations were closest to the shoreline in this area and NAPL sheens were observed on surface water before the containment wall was installed. No sheens were observed after wall construction.

The sensitivity of the fate and transport assessment to the possibility of nearshore source material was evaluated for this revision of the RI/FS. New material describing the sensitivity evaluation was added to Section 9.2.3. In general, compliance with cleanup levels is still predicted for most COCs even if NAPL exists at or very close to the mudline. The calculations assumed the conservative tidal mixing factor of 100. Near the water surface, groundwater modeling predicts that tidal mixing factors are several fold higher

The assumed travel distances for the base-case fate and transport modeling were not adjusted as recommended in Ecology's comment. EPA believes that a 10- to 100-fold increase in the assumed tidal mixing factor of 100 would be necessary if the shortest distance between shoreline wells and the mudline were selected as the travel distance. These changes would neither add value to the overall fate and transport assessment nor change the ultimate conclusions.

C-21 **Page 9-13, last paragraph.** There are various statements in this section about how long it would take certain chemicals to migrate to the shoreline. These statements assume that there is no NAPL shoreward of the monitoring wells that could act as a closer source of these chemicals to surface water, which is unlikely to be true in some areas.

Response: *References to constituent travel times add little value to the discussion of predicted groundwater quality at the point of compliance. These references were removed from the narrative and from Tables 9-1, 9-2, and 9-3.*

C-22 **Page 9-15, last paragraph.** These findings need to be reevaluated in light of the above comments on dilution and on location of the source term. It seems likely that the analysis holds for most areas. However, in certain areas where DNAPL (free or residual) extends to the shoreline, or may extend to the shoreline, but existing data are inadequate to determine this (west of the process area), the model may need to be modified. The dilution term also needs to be field-tested or verified in some way with site-specific data, since it drives the outcome of the model. Ecology will withhold judgement on the need for further source control in these shoreline areas until these comments and modifications have been addressed.

Response: *As discussed abovefor the comment on Page 9-10, the sensitivity of the fate and transport assessment to the possibility of nearshore source material was evaluated for this revision of the RI/FS. New material describing the sensitivity evaluation was added to Section 9.2.3.*

The tidal mixing factors presented in this section of the RI/FS were derived from modeling that was calibrated with site-specific data. As such, EPA does not believe that further verification or field-testing of tidal mixing is necessary.

C-23 **Chapter 10.** Comments will be provided on this chapter following modifications to address the above comments.

Response: *Comment noted*

ATTACHMENT 1

REVISED RISK CALCULATIONS

Pacific Sound Resources Record of Decision—Marine Sediments Unit
Residual Risks from Reasonable Maximum Exposure Fish and Shellfish Consumption

			Residential risk following cleanup										
			Residential Concentrations (ug/fg)		Fish			Shellfish			Total (Fish and Shellfish)		
					Lifetime	Adult	Child	Lifetime	Adult	Child	Lifetime	Adult	Child
Chemical	RfDo (mg/kg- day)	CSFo (kg-day/mg)	Fish Tissue	Shellfish Tissue	CR	HQ	HQ	CR	HQ	HQ	CR	HQ	HQ
Polycyclic Aromatic Hydrocarbons													
Benzo(g.h.i)perylene			#N/A	18	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene			#N/A	66	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	3 00E-02		#NA	143	NA	NA	NA	NA	0.0	0.0	NA	0.0	0.0
Total B(a)P equivalent		7.30E-00	#NA	53	NA	NA	NA	3 3E-05	NA	NA	3.3E-05	NA	NA
Benzo(a)anthracene		*7.30E-01*	#NA	30	*NA*	*NA*	*NA*	*1.9E-06*	*NA*	*NA*	*1.9E-06*	*NA*	*NA*
Chrysene		*7.30E-03*	#NA	46	*NA*	*NA*	*NA*	*2.9E-08*	*NA*	*NA*	*2.9E-08*	*NA*	*NA*
Benzo(b)fluoranthene		*7.30E-01*	#NA	60	*NA*	*NA*	*NA*	*3.8E-06*	*NA*	*NA*	*3.8E-06*	*NA*	*NA*
Benzo(k)fluoranthene		*7.30E-02*	#N/A	20	*NA*	*NA*	*NA*	*1.3E-07*	*NA*	*NA*	*1.3E-07*	*NA*	*NA*
Benzo(a)pyrene		*7.30E+00*	#NA	38	*NA*	*NA*	*NA*	*2.4E-05*	*NA*	*NA*	*2.4E-05*	*NA*	*NA*
Indeno(1,2,3-cd)pyrene		*7.30E-01*	#NA	19	*NA*	*NA*	*NA*	*1.2E-06*	*NA*	*NA*	*1.2E-06*	*NA*	*NA*
Dibenz(a,h)anthracene		*7.30E+00*	#NA	5	*NA*	*NA*	*NA*	*3.1E-06*	*NA*	*NA*	*3.1E-06*	*NA*	*NA*
Polychlorinated Biphenyls													
Total PCB	2.00E-05	2.00E+00	122	19	2.3E-06	0.1	0.0	3.2E-06	0.2	0.1	5.5E-06	0.3	01
Dioxins/Furans													
Total 2,3,7,8-TCDD (Equiv)		1.56E+05	0.00	0.0001	1.5E-06	NA	NA	2.0E-06	NA	NA	3.4E-06	NA	NA
TOTAL PAH RISKS					*0.0E+00*	*0*	*0*	*3.3E-05*	*0*	*0*	*3.3E-05*	*0*	*0*
TOTAL PCB RISKS					*2.3E-06*	*0*	*0*	*3.2E-06*	*0*	*0*	*5.5E-06*	*0*	*0*
TOTAL DIOXINS RISKS					*1.5E-06*	*NA*	*NA*	*2.0E-06*	*NA*	*NA*	*3.4E-06*	*NA*	*NA*
TOTAL RISKS					3.7E-06	0	0	3.5E-05	0	0	4.2E-05	0	0
TOTAL RISKS W/OUT PCBS					1.5E-06	0	0	3.5E-05	0	0	3.7E-05	0	0

ATTACHMENT 2

GEOTECHNICAL DATA FROM THREE BORINGS

EB-14

EB-16

EB-114

SOIL
TECHNOLOGY, INC.
SPECIALIZING IN PHYSICAL SOIL TESTING

TO: **Roy F. Weston, Inc.**
700 Fifth Avenue, Suite 5700
Seattle. WA 98104

Date: January 27, 1997
Job No.: J-1014

ATTENTION: **Larry Vanslow**

SUBJECT: **PSR**
Lab Servies Agreement No. LL-2373-G6
Work Order No. 04000-027-001-2031-01

RE: **Sample ID No.'s E1344, EB-1 14 and EBI 6**

We are sending the following items:

Date	Copies	Description
1-20-97	2	Triaxial Shear: UU, CU and QU (Figures 1 through 16) w/summary tables
1-20-97	2	Consolidation (4 Plots)
1-20-97	2	Atterberg Limits (1 Plasticity Chart)
1-20-97	2	Particle Size Distributions (6 Plots)
1-20-97	2	Case Narrative
1-20-97	1	Copy of Invoice No. 1409

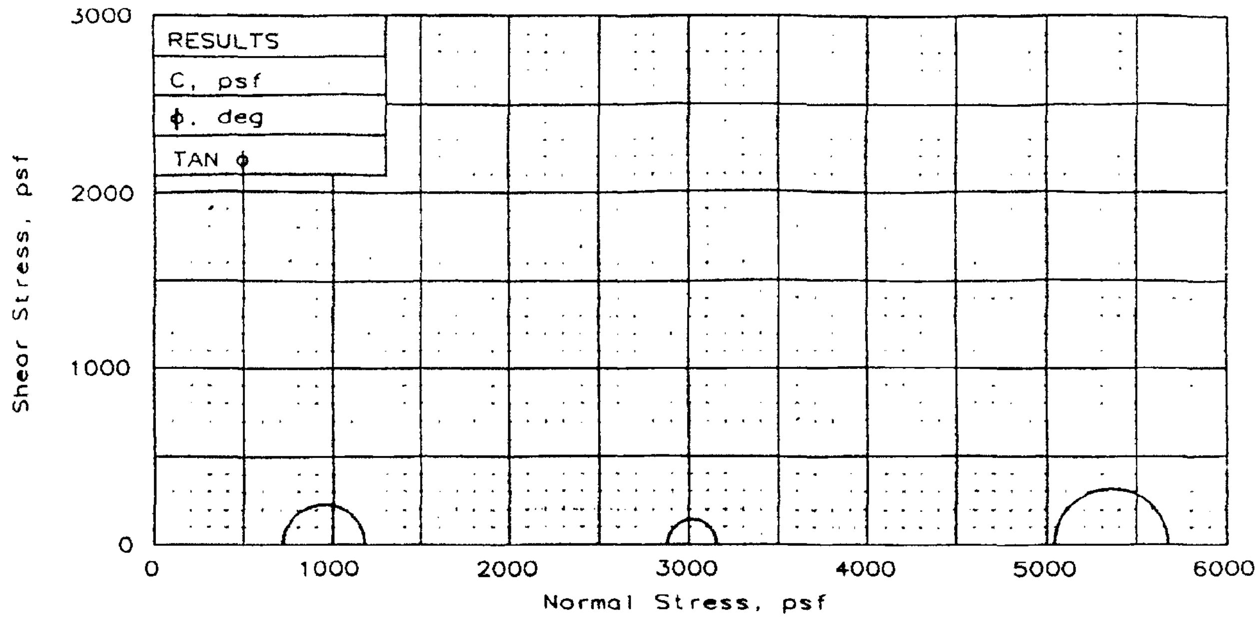
These are transmitted for your use.

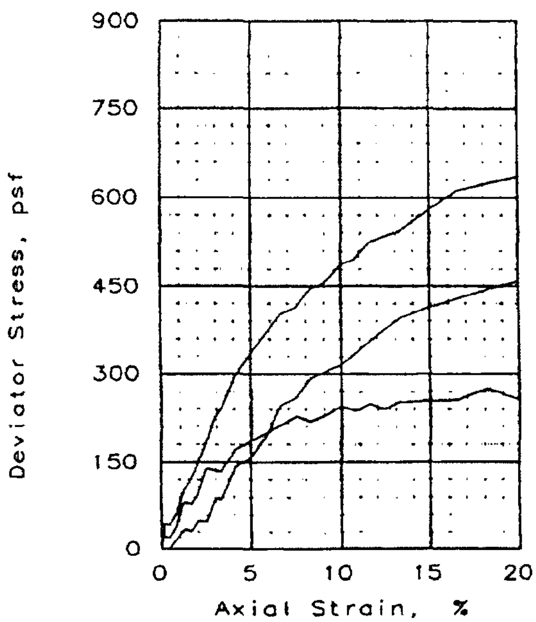
Remarks: Samples were tested in general accordance with ASTM D-422, D-4318, D-854, D2850, D-4767, 0-2166, D-2974, D-2453 and general laboratory procedures. Please call if you have any questions regarding this submittal or presentation of the data. Thank you.

Best Regards,
SOIL TECHNOLOGY, INC.

Richard G. Sheets,
Vice President

RECEIVED
JAN 29 1997
ROY F. WESTON, INC.
SEATTLE OPERATIONS





SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	49.9	46.2	40.4
	DRY DENSITY, pcf	69.8	73.7	78.2
	SATURATION, %	95.7	97.4	94.6
	VOID RATIO	1.404	1.278	1.149
	DIAMETER, in	2.83	2.88	2.84
	HEIGHT, in	6.05	6.03	6.03
AT TEST	WATER CONTENT, %	48.8	45.1	40.0
	DRY DENSITY, pcf	69.8	73.7	78.2
	SATURATION, %	93.5	95.0	93.6
	VOID RATIO	1.404	1.278	1.149
	DIAMETER, in	2.83	2.88	2.84
	HEIGHT, in	6.05	6.03	6.03
Strain rate, in/min		0.0600	0.0600	0.0600
BACK PRESSURE, psf		0	0	0
CELL PRESSURE, psf		2880	720	5040
FAIL. STRESS, psf		275	458	635
ULT. STRESS, psf		275	458	635
σ_1 FAILURE, psf		3155	1178	5675
σ_3 FAILURE, psf		2880	720	5040

TYPE OF TEST:
Unconsolidated Undrained
SAMPLE TYPE: Shelby Tube
DESCRIPTION: Silt at top, then sandy silt, then silt bottom

SPECIFIC GRAVITY= 2.69
REMARKS: Sample 1 0.2-0.7'
Sample 2 0.8-1.3'
Sample 3 2.5-3.0'

Fig No.: 1

CLIENT: Roy F. Weston

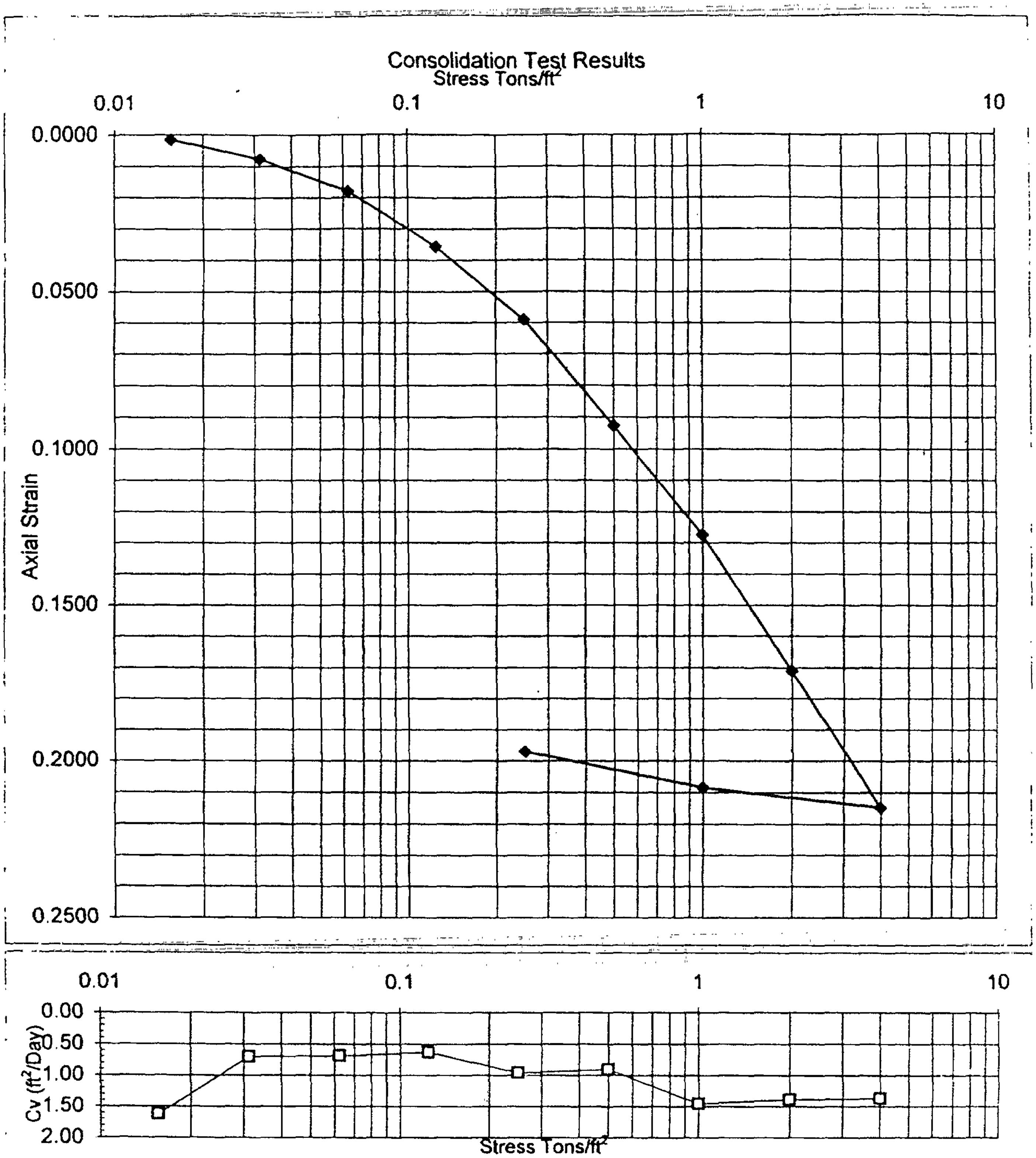
PROJECT: Puget Sound Resources

SAMPLE LOCATION: EB-14 0-3'

PROJ. NO. J-1014 DATE: 1/7/97

TRIAXIAL SHEAR TEST REPORT

SOIL TECHNOLOGY, INC.



Exploration Number	Sample Number	Depth ft	Moisture Content %		Atterberg Limits			Wet Density pcf	Description
			Before	After	LL	PL	PI		
EB-14	0-3'	1.3-1.5'	57	48	33	31	2	101	Sandy Silt

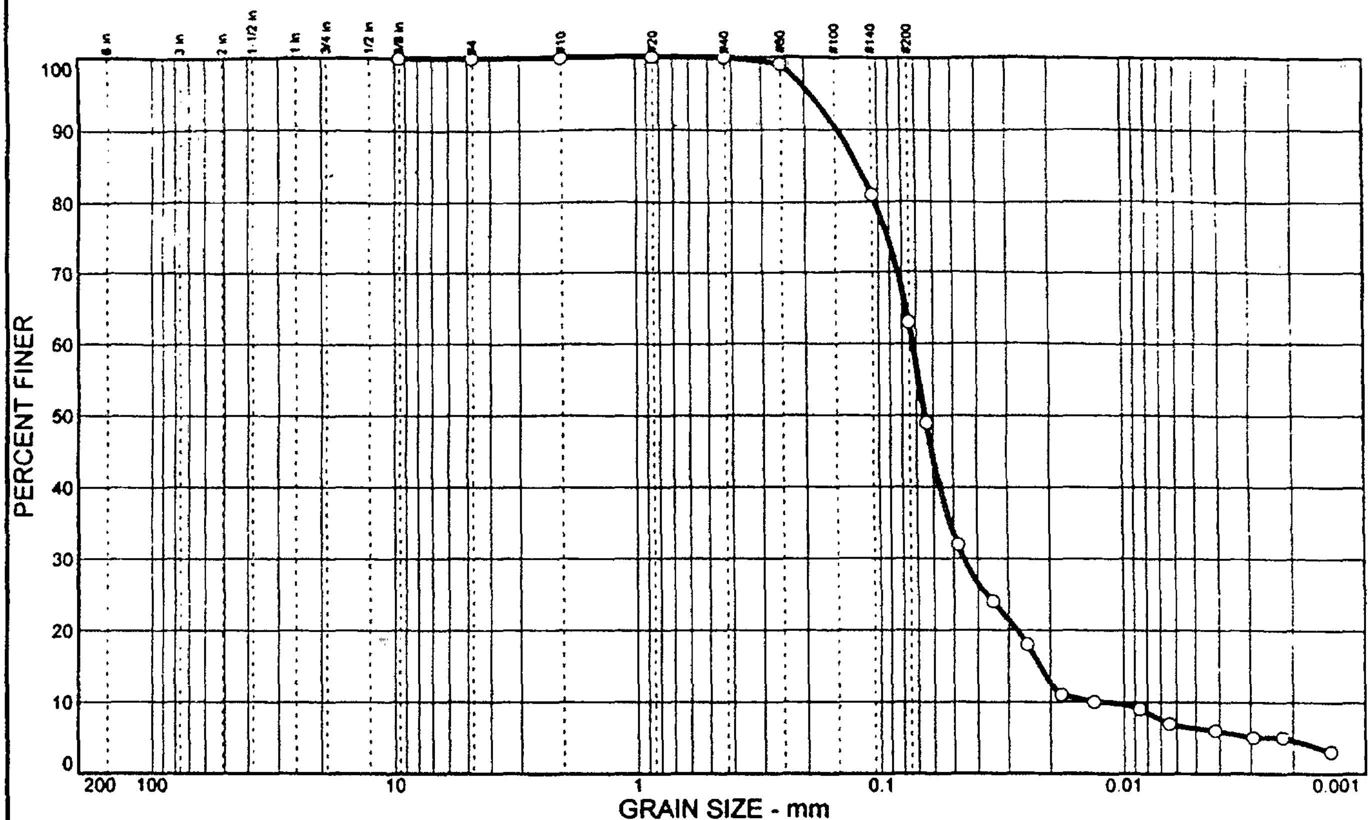
Roy F. Weston
Puget Sound Resources
Consol Summary

		d0	d90	d100	df	t90	T	Cv ft^2/day	Load tsf	Strain Ratio
Job #	J-1014	2	13	14.2	16	1.3	9991.0	1.63	0.0156	0.0016
Exploration #	EB-14	20	70	75.6	77	3	9951.5	0.70	0.03125	0.0077
Sample ID #	0-3'	81	170	179.9	180	3	9869.5	0.69	0.0625	0.0180
Sample Depth (ft)	1.3-1.5'	190.0	336.0	352.2	357.0	3.2	9726.5	0.63	0.125	0.0357
Type of Test	CONSOL	364.0	563.0	585.1	590.0	2	9523.0	0.96	0.25	0.0590
Date	1/7/97	602.0	880.0	910.9	927.0	2	9235.5	0.90	0.5	0.0927
Test by	HB	945.0	1230.0	1261.7	1275.0	1.15	8890.0	1.46	1	0.1275
Initial Length (in x 10^4)	10000	1340.0	1660.0	1695.6	1710.0	1.1	8475.0	1.38	2	0.1710
Area (ft**2)	0.03409	1780.0	2102.0	2137.8	2148.0	1	8036.0	1.37	4	0.2148
		2118.0	2090.0	2086.9	2085.0	0.5	7898.5	2.65	1	0.2085
		2068.0	1990.0	1981.0	1970.0	0.8	7981.0	1.69	0.25	0.1970
		1960.0	1820.0	1804.4	1802.0	4	8119.0	0.35	0.0625	0.1802

Soil Technology, Inc.

J-1014

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
O			37	57	6	ML		31	33

SIEVE inches size	PERCENT FINER O		
3/8"	100		
	GRAIN SIZE		
D_{60}	0.0724		
D_{30}	0.0454		
D_{10}	0.0133		
	COEFFICIENTS		
C_c	2.15		
C_u	5.46		

SIEVE number size	PERCENT FINER O		
#4	100		
#10	100		
#20	100		
#40	100		
#60	99		
#140	81		
#200	63		

SOIL DESCRIPTION

O Sandy silt

REMARKS

O

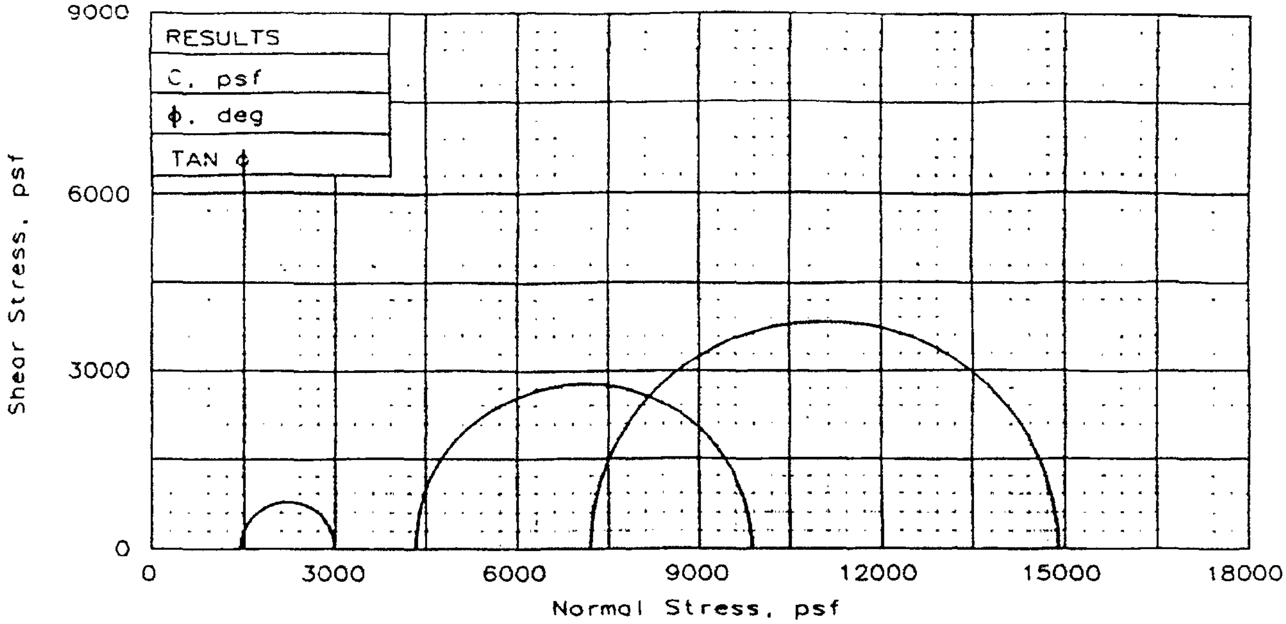
O Source: EB14 0-3' Sample No.: 0.8-1.3' Elev./Depth:

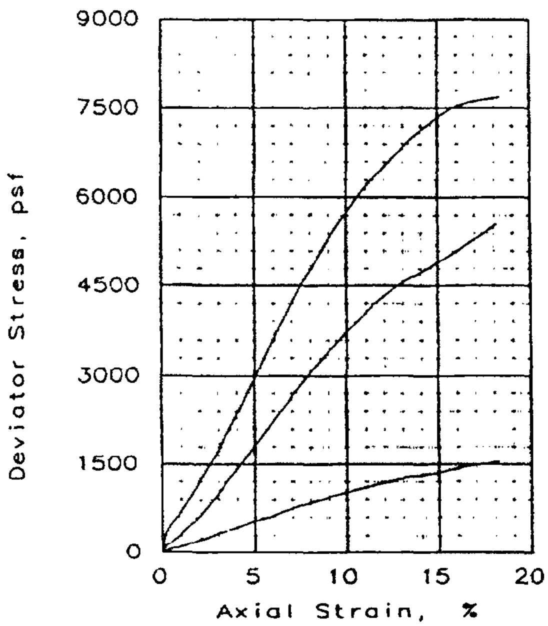
SOIL TECHNOLOGY, INC.

Client Roy F. Weston

Project Puget Sound Resources

Project No J-1014 Plate 1





SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	35.5	33.6	31.9
	DRY DENSITY, pcf	84.9	86.8	89.6
	SATURATION, %	99.7	98.5	100.3
	VOID RATIO	0.940	0.900	0.839
	DIAMETER, in	2.86	2.84	2.80
	HEIGHT, in	6.04	6.04	5.99
AT TEST	WATER CONTENT, %	34.8	32.8	31.6
	DRY DENSITY, pcf	84.9	86.8	89.6
	SATURATION, %	97.6	96.3	99.3
	VOID RATIO	0.940	0.900	0.839
	DIAMETER, in	2.86	2.84	2.80
	HEIGHT, in	6.04	6.04	5.99
Strain rate, in/min		0.0600	0.0600	0.0600
BACK PRESSURE, psf		0	0	0
CELL PRESSURE, psf		1440	4320	7200
FAIL. STRESS, psf		1551	5554	7693
ULT. STRESS, psf		1551	5554	7693
σ_1 FAILURE, psf		2991	9874	14893
σ_3 FAILURE, psf		1440	4320	7200

TYPE OF TEST:
Unconsolidated Undrained
SAMPLE TYPE: Shelby Tube
DESCRIPTION: Gray silty sand

SPECIFIC GRAVITY= 2.64
REMARKS: Sample 1 4.3-4.8'
Sample 2 4.8-5.3'
Sample 3 5.5-6.0'

CLIENT: Roy F. Weston

PROJECT: Puget Sound Resources

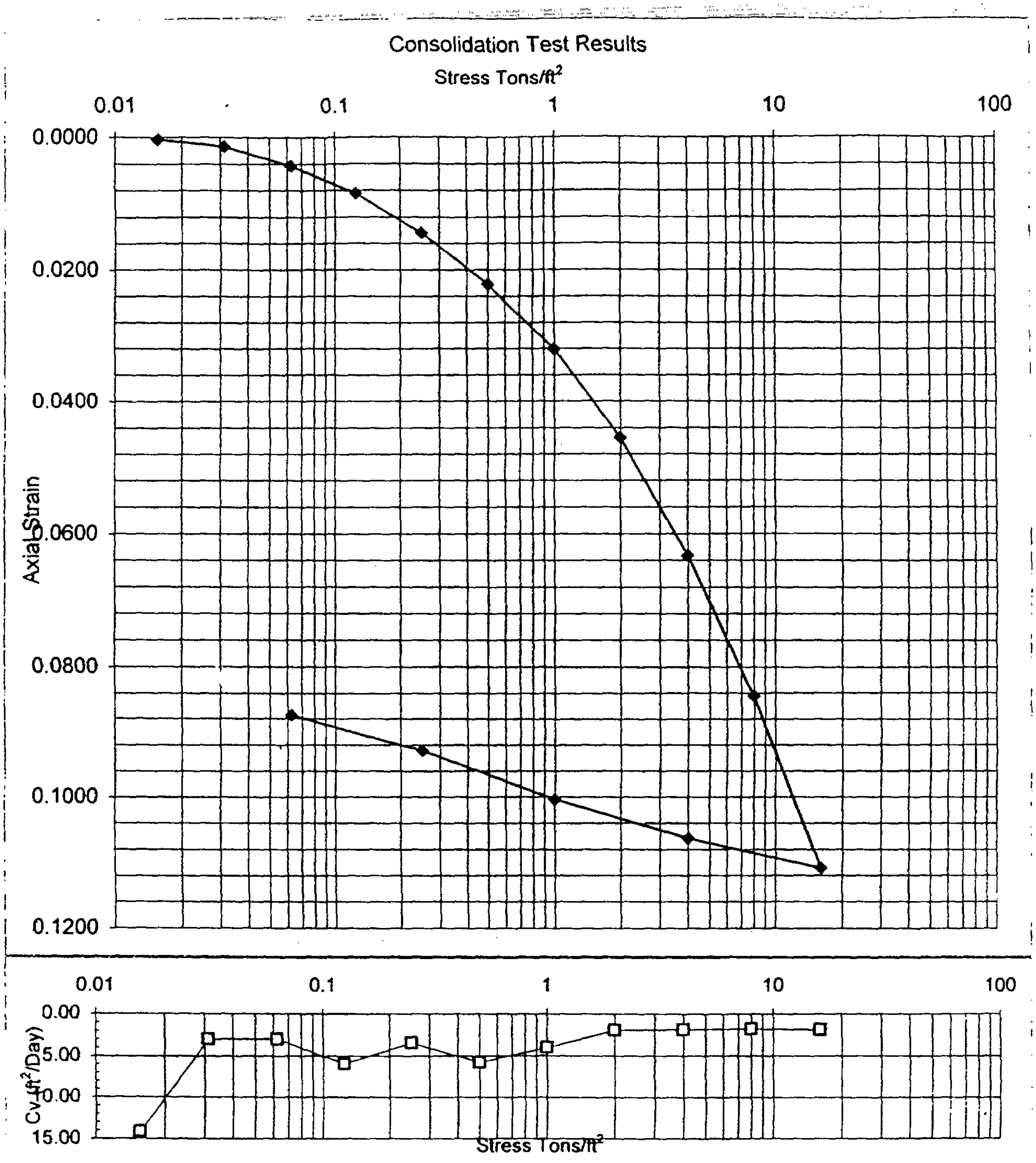
SAMPLE LOCATION: EB-14 3.0-6.0

PROJ. NO.: J-1014 DATE: 1/8/97

TRIAXIAL SHEAR TEST REPORT

SOIL TECHNOLOGY, INC.

Fig No 2



Exploration Number	Sample Number	Depth ft	Moisture Content %		Atterberg Limits			Wet Density pcf	Description
			Before	After	LL	PL	PI		
EB-14	3-6'	5.3-5.5	33	44	GNP			114	Silty Sand

Roy F. Weston
Puget Sound Resources
Consol Summary

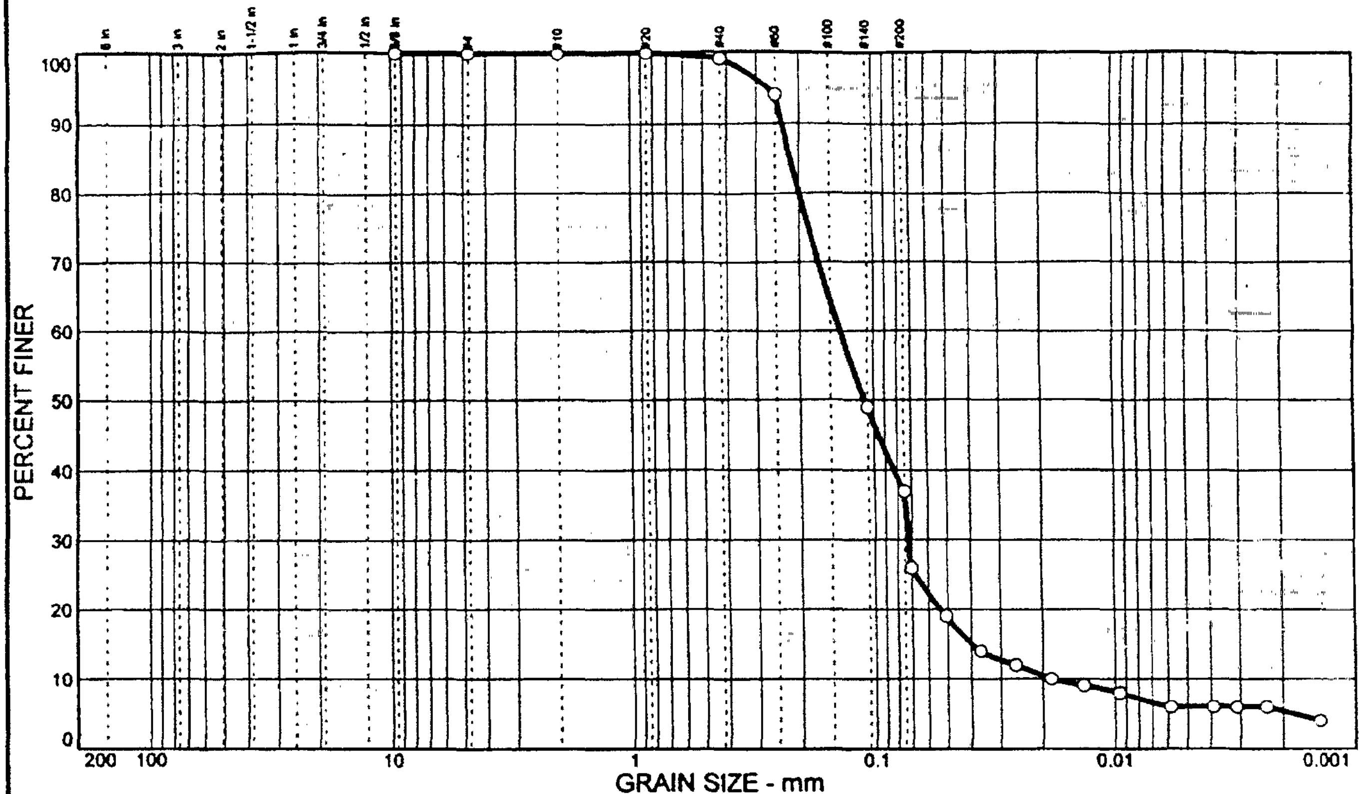
		d0	d90	d100	df	t90	T	Cv ft^2/day	Load tsf	Strain Ratio
Job #	J-1014	3	39	43.0	44	27	9976.5	0.08	0.01563	0.0022
Exploration #	EB-114	45	108	115.0	115	23	9920.0	0.09	0.03125	0.0083
Sample ID #	0-3'	114	254	269.6	270	23	9808.0	0.09	0.0625	0.0227
Sample Depth (ft)	1.8-2.0'	275.0	425.0	441.7	470.0	12.5	9627.5	0.16	0.125	0.0414
Type of Test	CONSOL	470.0	859.0	902.2	903.0	20	9313.5	0.09	0.25	0.0836
Date	1/8/97	907.0	1280.5	1322.0	1330.0	15	8881.5	0.11	0.5	0.1249
Test by	HB/RS	1335.0	1697.5	1737.8	1740.0	8	8462.5	0.19	1	0.1641
Initial Length (in x 10^4)	10000	1740.0	2156.0	2202.2	2205.0	6	8027.5	0.23	2	0.2081
Area (ft**2)	0.03409	2205.0	2563.0	2602.8	2633.0	3	7581.0	0.41	4	0.2534
		2626.5	2607.5	2605.4	2601.0	0.6	7386.3	1.93	1	0.2520
		2592.0	2518.0	2509.8	2500.0	3.5	7454.0	0.34	0.25	0.2434
		2496.0	2402.0	2391.6	2390.0	14	7557.0	0.09	0.0625	0.2390

Soil Technology, Inc.
J-1014

Roy F. Weston
Puget Sound Resources
Consol Summary

		d0	d90	d100	df	t90	T	Cv ft^2/day	Load tsf	Strain Ratio
Job #	J-1014	0	3	3.3	4	0.15	9998.0	14.13	0.015625	0.0004
Exploration #	EB-14	11	13	13.2	14	0.7	9987.5	3.02	0.03125	0.0014
Sample ID #	3-6'	33	40	40.8	43	0.7	9962.0	3.01	0.0625	0.0043
Sample Depth (ft)	5.3-5.5'	73.0	79.0	79.7	85.0	0.35	9921.0	5.96	0.125	0.0085
Type of Test	CONSOL	130.0	140.0	141.1	144.0	0.6	9863.0	3.44	0.25	0.0144
Date	1/8/97	202.0	216.0	217.6	222.0	0.35	9788.0	5.80	0.5	0.0222
Test by	HB	298.0	316.0	318.0	321.0	0.5	9690.5	3.98	1	0.0321
Initial Length (in x 10^4)	10000	425.0	450.0	452.8	455.0	1	9560.0	1.94	.2	0.0455
Area (ft**2)	0.03409	583.0	621.0	625.2	633.0	1	9392.0	1.87	4	0.0633
		780.0	837.0	843.3	845.0	1	9187.5	1.79	8	0.0845
		1042.0	1093.0	1098.7	1109.0	0.9	8924.5	1.88	16	0.1109
		1067.5	1065.0	1064.7	1063.0	0.35	8934.8	4.84	4	0.1063
		1013	1004	1003.0	1004.0	1	8991.5	1.71	1	0.1004
		954	933	930.7	929.0	2	9058.5	0.87	0.25	0.0929
		905	885	882.8	875.0	0.7	9110.0	2.51	0.0625	0.0875

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
O			63	31	6	SM			

SIEVE inches size	PERCENT FINER O		
3/8"	100		

	GRAIN SIZE		
D_{60}	0.136		
D_{30}	0.0722		
D_{10}	0.0184		

	COEFFICIENTS		
C_c	2.07		
C_u	7.40		

SIEVE number size	PERCENT FINER O		
#4	100		
#10	100		
#20	100		
#40	99		
#60	94		
#140	49		
#200	37		

SOIL DESCRIPTION

O Silty sand

REMARKS:

O Atterberg Limit, Granular Non-Plastic

O Source: EB14 3-6'

Sample No.: 4.2-4.3'

Elev./Depth:

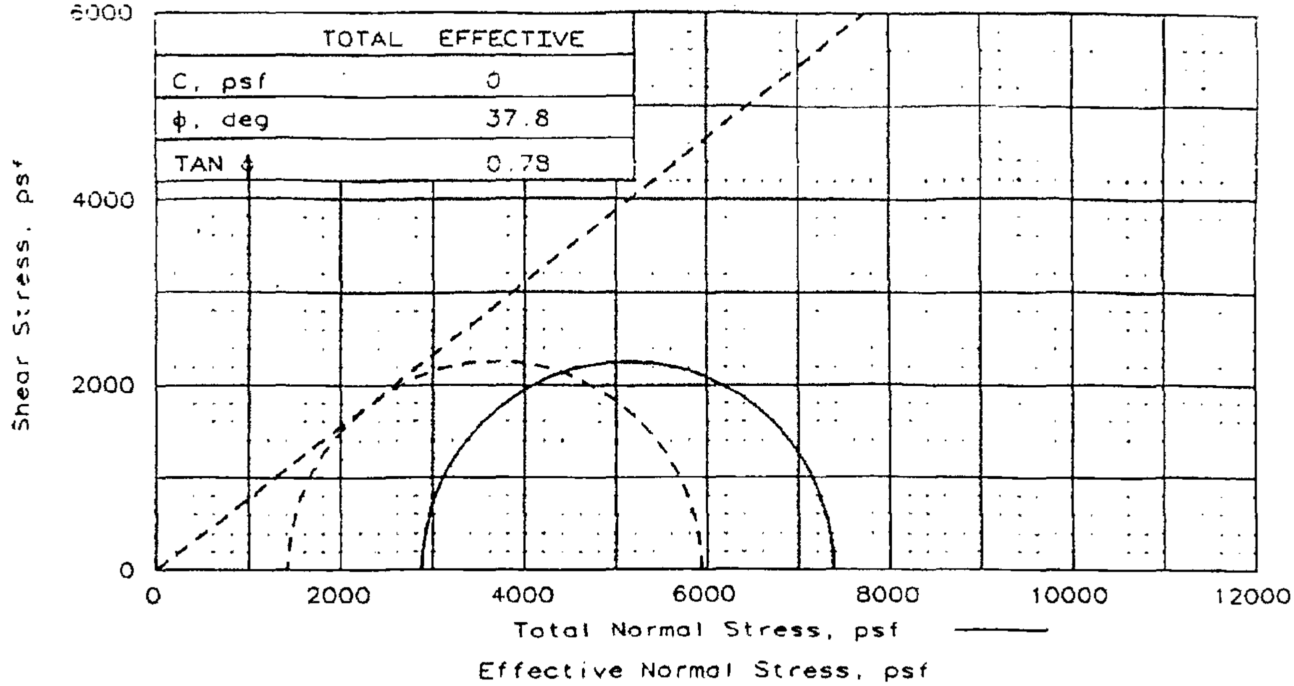
SOIL TECHNOLOGY, INC.

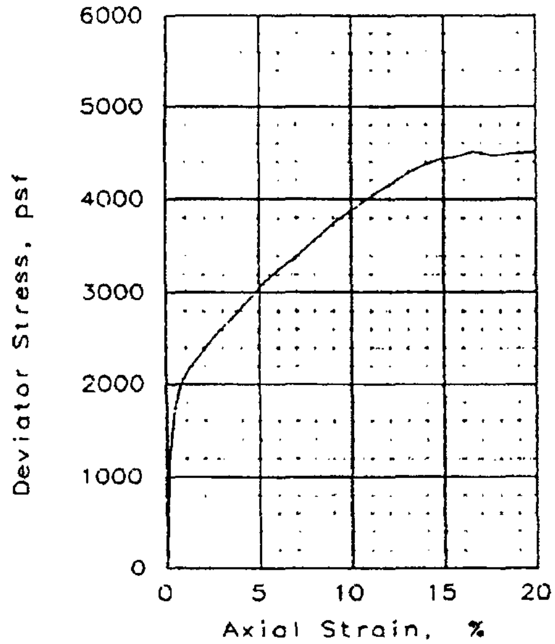
Client: Roy F. Weston

Project: Puget Sound Resources

Project No. J-1014

Plate 2





SAMPLE NO..		1
INITIAL	WATER CONTENT, %	48.3
	DRY DENSITY, pcf	73.7
	SATURATION, %	102.5
	VOID RATIO	1.253
	DIAMETER, in	2.83
	HEIGHT, in	5.95
AT TEST	WATER CONTENT, %	38.5
	DRY DENSITY, pcf	85.7
	SATURATION, %	109.3
	VOID RATIO	0.937
	DIAMETER, in	2.67
	HEIGHT, in	5.76
Strain rate, in/min		0.0030
BACK PRESSURE, psf		7200
CELL PRESSURE, psf		10080
FAIL. STRESS, psf		4511
TOTAL PORE PR., psf		8654
ULT. STRESS, psf		4511
TOTAL PORE PR., psf		8654
$\bar{\sigma}_1$ FAILURE, psf		5937
$\bar{\sigma}_3$ FAILURE, psf		1426

TYPE OF TEST:
CU with Pore Pressures

SAMPLE TYPE: Shelby Tube

DESCRIPTION: Silt with sand

LL= 36 PL= 34 PI= 2

SPECIFIC GRAVITY= 2.66

REMARKS: Sample Depth 0.8-1.3'

CLIENT: Roy F Weston

PROJECT: Puget Sound Resources

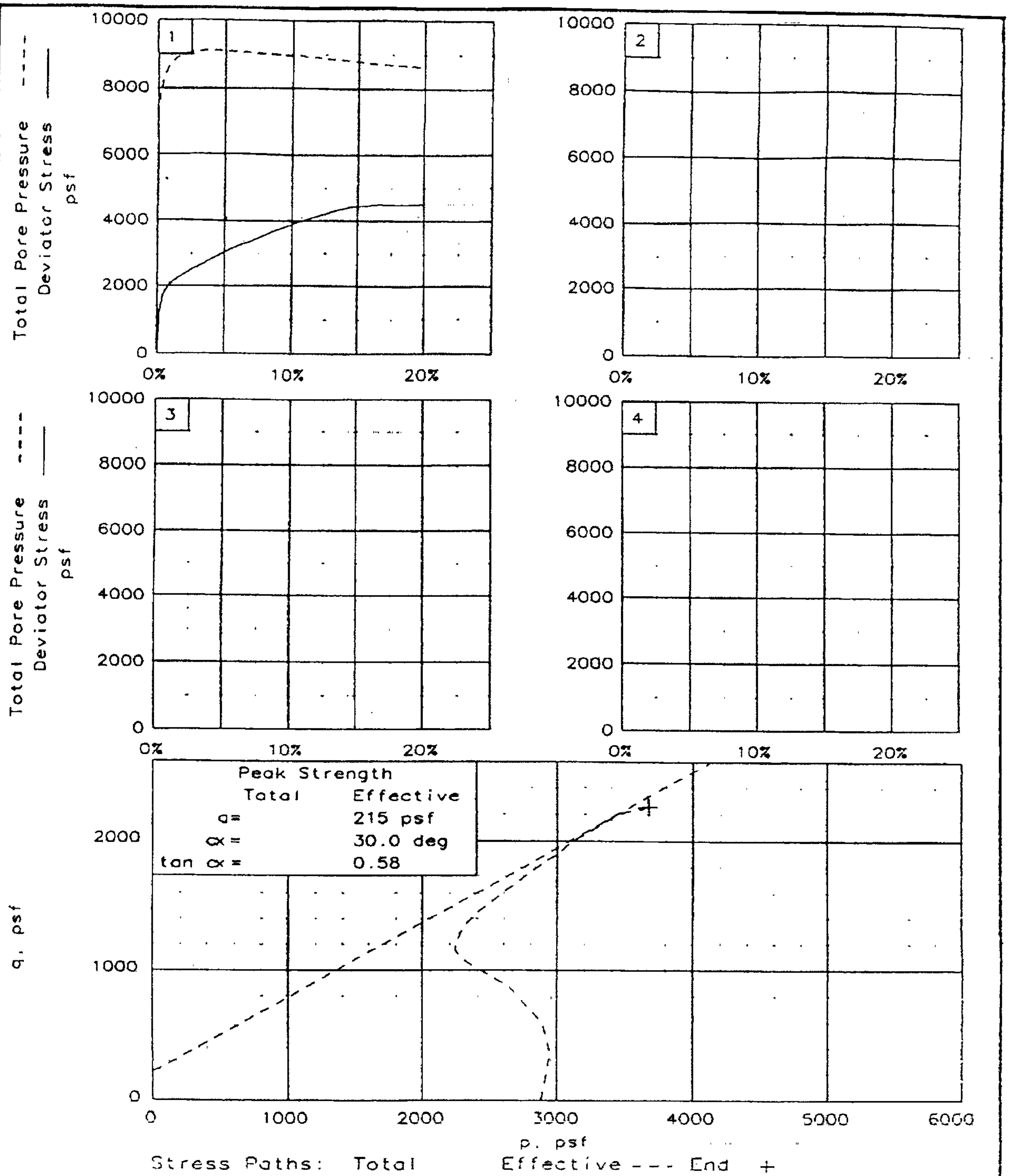
SAMPLE LOCATION: EB-16 .0-3'

PROJ. NO. J-1014 DATE: 12/18/96

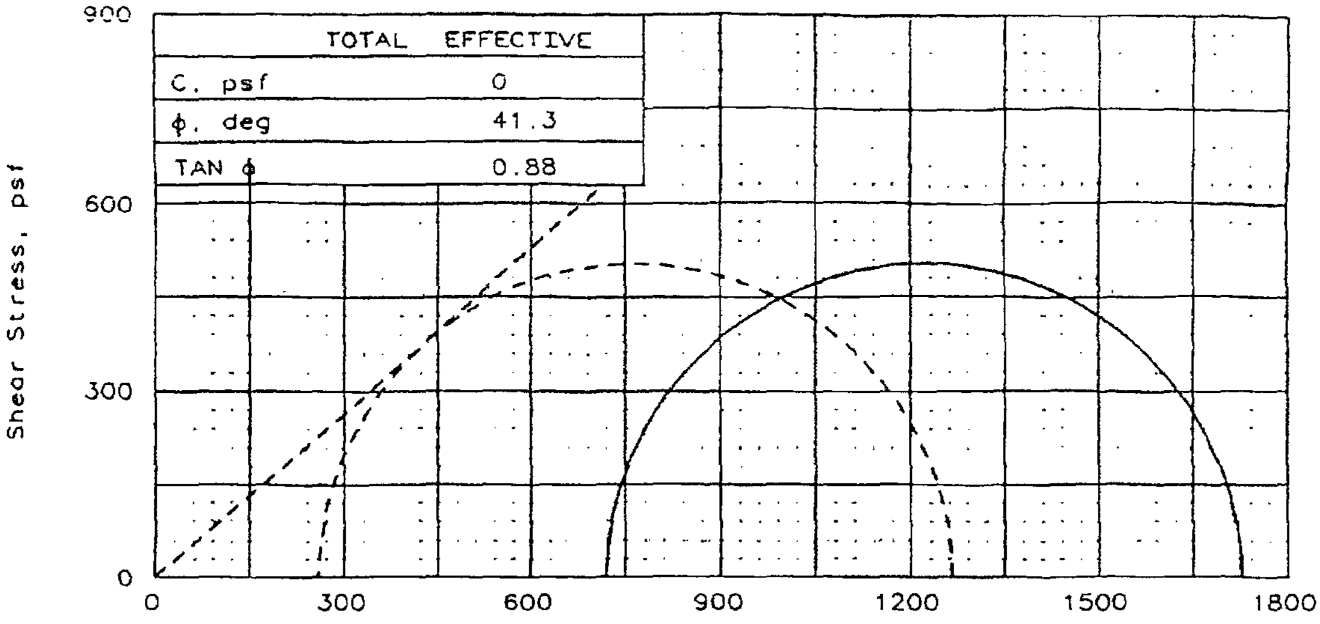
TRIAXIAL SHEAR TEST REPORT

SOIL TECHNOLOGY, INC.

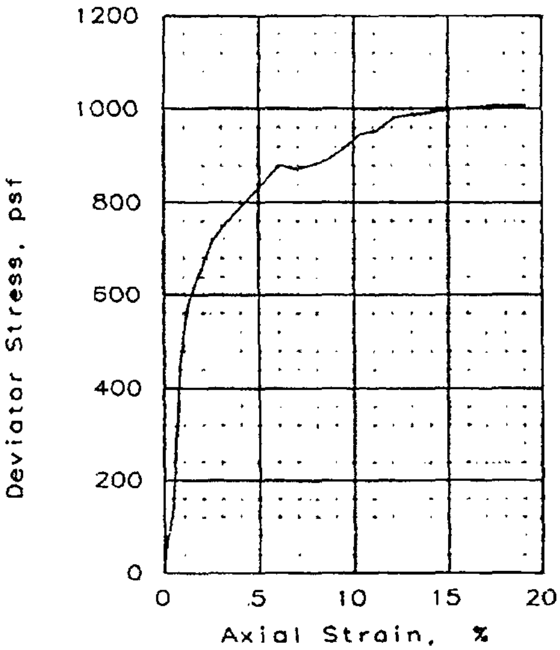
Fig No 3



Client. Roy F. Weston
Project: Puget Sound Resources
Location. EB-16 0-3'
File EB1608 Project No : J-1014 Fig. No. 4



	TOTAL	EFFECTIVE
C, psf		0
φ, deg		41.3
TAN φ		0.88



SAMPLE NO.:		1
INITIAL	WATER CONTENT, %	111.5
	DRY DENSITY, pcf	42.9
	SATURATION, %	105.4
	VOID RATIO	2.656
	DIAMETER, in	2.88
	HEIGHT, in	6.14
AT TEST	WATER CONTENT, %	89.6
	DRY DENSITY, pcf	50.7
	SATURATION, %	107.4
	VOID RATIO	2.093
	DIAMETER, in	2.73
	HEIGHT, in	5.79
Strain rate, in/min		0.0030
BACK PRESSURE, psf		5760
CELL PRESSURE, psf		6480
FAIL. STRESS, psf		1007
TOTAL PORE PR., psf		6221
ULT. STRESS, psf		1007
TOTAL PORE PR., psf		6221
$\bar{\sigma}_1$ FAILURE, psf		1266
$\bar{\sigma}_3$ FAILURE, psf		259

TYPE OF TEST:
CU with Pore Pressures

SAMPLE TYPE. Shelby Tube

DESCRIPTION. Silt with sand

LL= 42 PL= 32 PI= 10

SPECIFIC GRAVITY= 2.51

REMARKS. Sample Depth 1.3-1.8'

CLIENT: Roy F. Weston

PROJECT: Puget Sound Resources

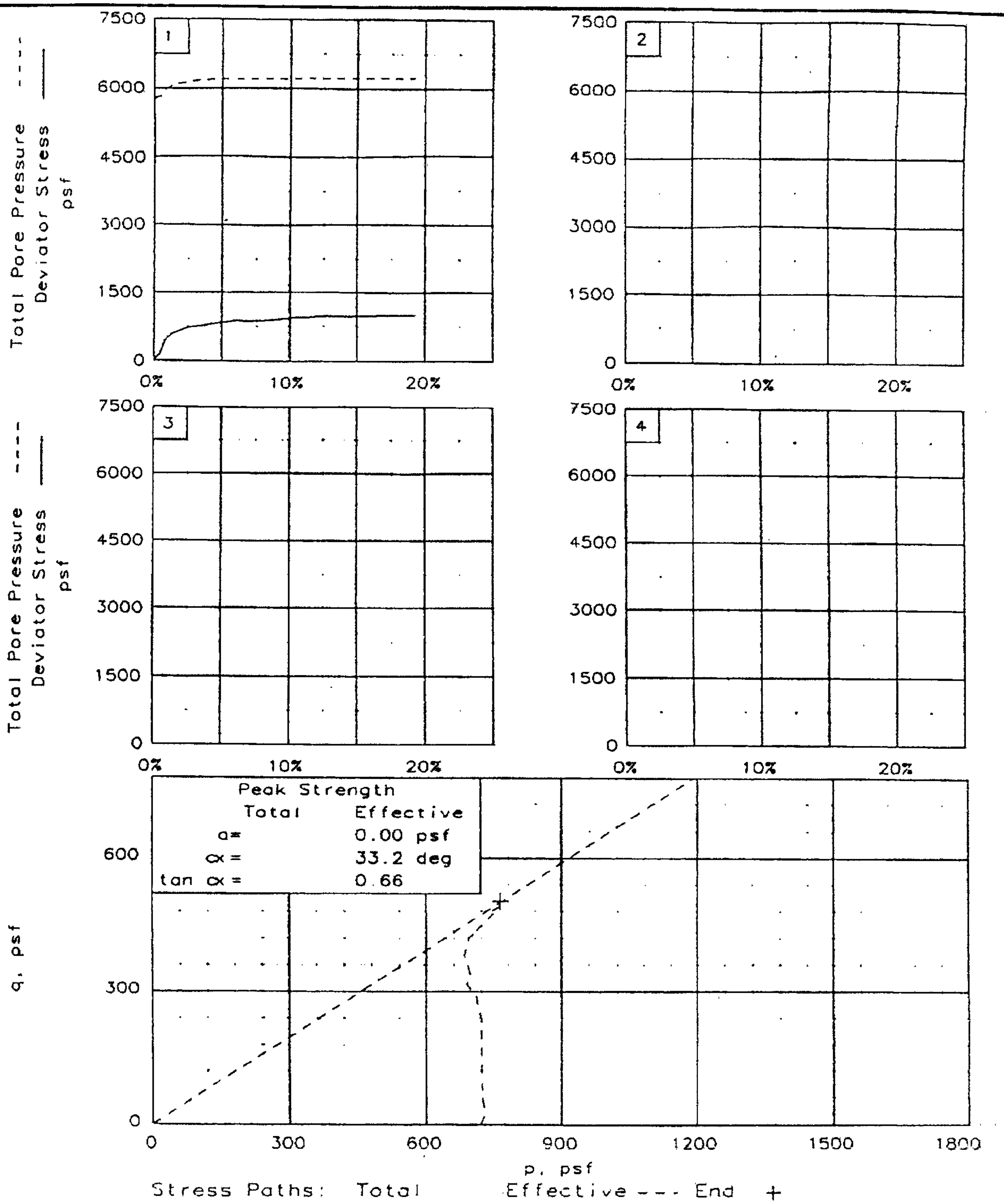
SAMPLE LOCATION: EB-16 0-3'

PROJ. NO.: J-1014 DATE: 12/18/96

TRIAXIAL SHEAR TEST REPORT

SOIL TECHNOLOGY, INC.

Fig No 5



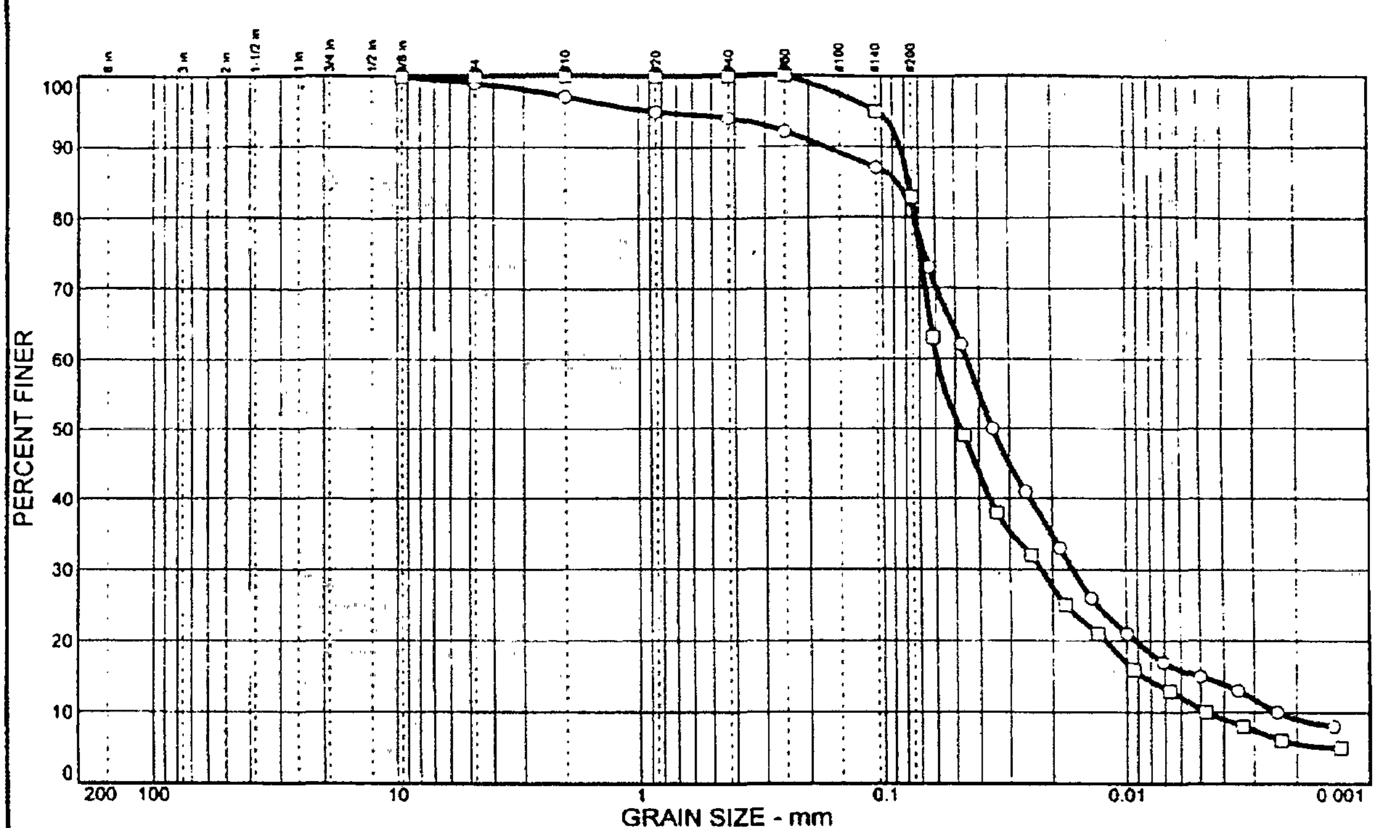
Client. Roy F. Weston

Project: Puget Sound Resources

Location. EB-16 0-3

File EB1613 Project No. J-1014 Fig No. 6

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		1	18	66	15	OL		32	42
□			17	73	10	ML		34	36

SIEVE inches size	PERCENT FINER ○	□	
3/8"	100	100	
	GRAIN SIZE		
D_{60}	0.0449	0.0593	
D_{30}	0.0165	0.0222	
D_{10}	0.0024	0.0048	
	COEFFICIENTS		
C_c	2.50	1.75	
C_u	18.56	12.48	

SIEVE number size	PERCENT FINER ○	□	
#4	99	100	
#10	97	100	
#20	95	100	
#40	94	100	
#60	92	100	
#140	87	95	
#200	81	83	

SOIL DESCRIPTION

○ Silt with sand

□ Silt with sand

REMARKS

○

□

○ Source: EB16 0-3' Sample No.: 1.3-1.8' Elev./Depth:

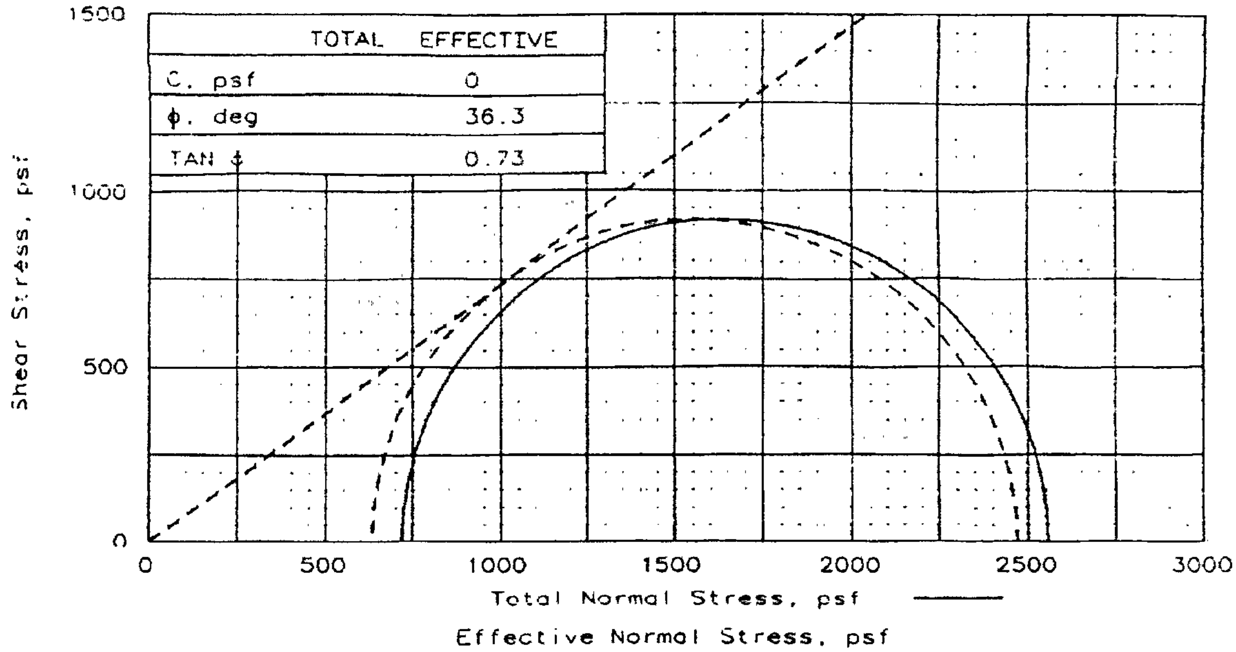
□ Source: EB16 0-3' Sample No.: 0.8-1.3' Elev./Depth:

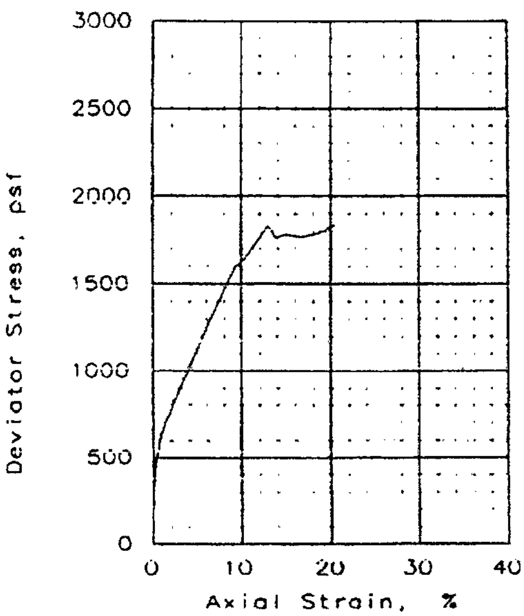
SOIL TECHNOLOGY, INC.

Client Roy F. Weston

Project Puget Sound Resources

Project No J-1014 Plate 3





SAMPLE NO.:		1
INITIAL	WATER CONTENT, %	51.0
	DRY DENSITY, pcf	70.2
	SATURATION, %	97.8
	VOID RATIO	1.420
	DIAMETER, in	2.85
	HEIGHT, in	5.50
AT TEST	WATER CONTENT, %	41.2
	DRY DENSITY, pcf	79.0
	SATURATION, %	97.5
	VOID RATIO	1.149
	DIAMETER, in	2.72
	HEIGHT, in	5.38
Strain rate, in/min		0.0030
BACK PRESSURE, psf		5760
CELL PRESSURE, psf		6480
FAIL. STRESS, psf		1837
TOTAL PORE PR., psf		5846
ULT. STRESS, psf		1792
TOTAL PORE PR., psf		5861
$\bar{\sigma}_1$ FAILURE, psf		2470
$\bar{\sigma}_3$ FAILURE, psf		634

TYPE OF TEST:
CU with Pore Pressures
SAMPLE TYPE: Shelby Tube
DESCRIPTION: Silt

LL= 41 PL= 31 PI= 10
SPECIFIC GRAVITY= 2.72
REMARKS: Sample Depth 5.0-5.5'

CLIENT: Roy F. Weston

PROJECT: Puget Sound Resources

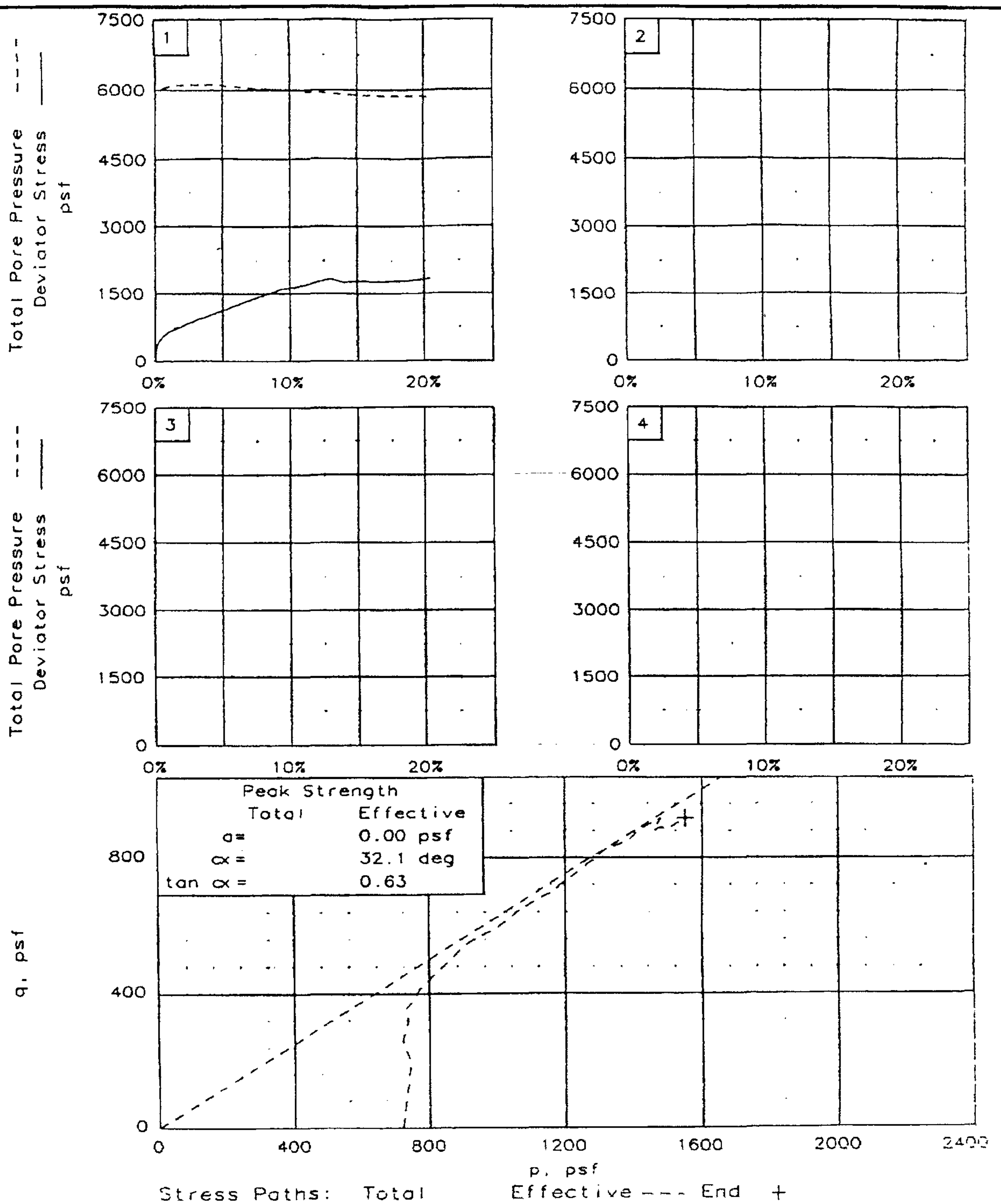
SAMPLE LOCATION: EB-16 3-6'

PROJ. NO.: J-1014 DATE: 11/26/96

TRIAXIAL SHEAR TEST REPORT

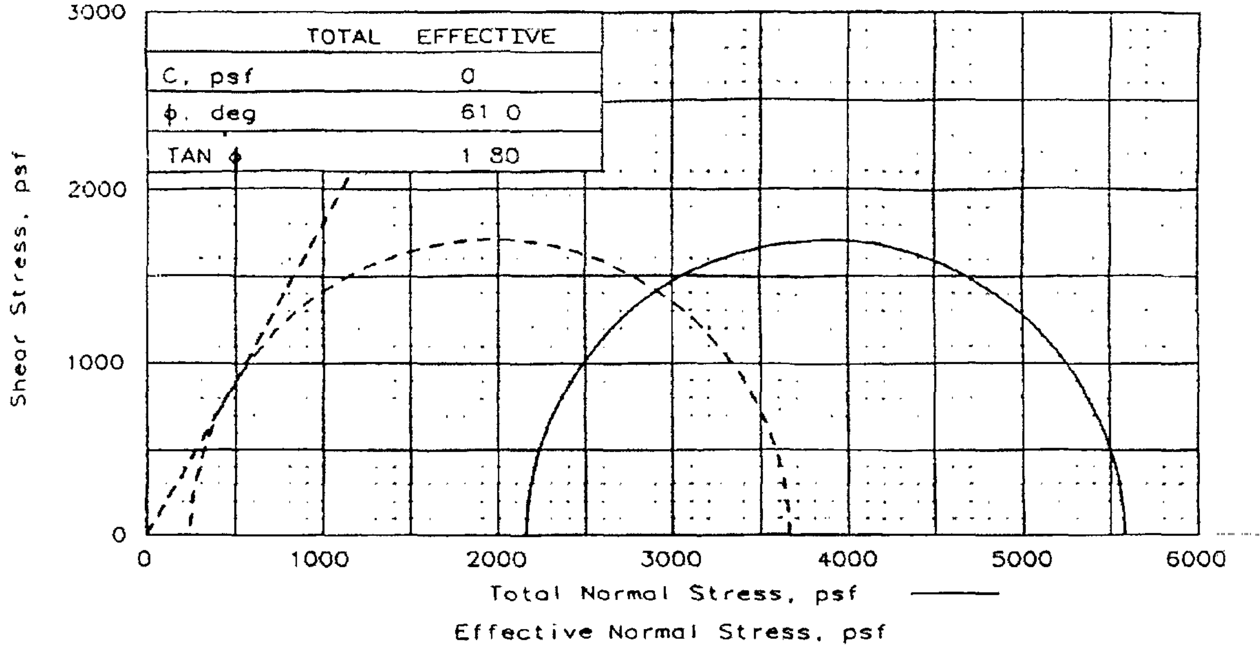
SOIL TECHNOLOGY, INC.

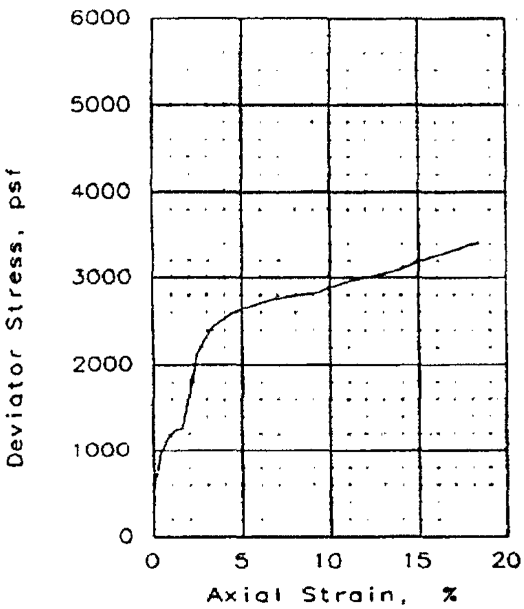
Fig No. 7



Client: Roy F. Weston
Project: Puget Sound Resources
Location: EB-16 3-6'
File EB16CU50 Project No J-1014 Fig No.: 8

	TOTAL	EFFECTIVE
C, psf		0
ϕ, deg		61.0
TAN ϕ		1.80





SAMPLE NO.:		1
INITIAL	WATER CONTENT, %	164.6
	DRY DENSITY, pcf	28.2
	SATURATION, %	89.2
	VOID RATIO	4.981
	DIAMETER, in	2.86
	HEIGHT, in	6.08
AT TEST	WATER CONTENT, %	112.2
	DRY DENSITY, pcf	38.5
	SATURATION, %	89.8
	VOID RATIO	3.373
	DIAMETER, in	2.45
	HEIGHT, in	6.07
Strain rate, in/min		0.0020
BACK PRESSURE, psf		7200
CELL PRESSURE, psf		9360
FAIL. STRESS, psf		3418
TOTAL PORE PR., psf		9115
ULT. STRESS, psf		3418
TOTAL PORE PR., psf		9115
$\bar{\sigma}_1$ FAILURE, psf		3663
$\bar{\sigma}_3$ FAILURE, psf		245

TYPE OF TEST:
CU with Pore Pressures

SAMPLE TYPE: Shelby Tube

DESCRIPTION:

SPECIFIC GRAVITY= 2.7

REMARKS Sample Depth 5.5-6.0'

CLIENT: Roy F. Weston

PROJECT: Puget Sound Resources

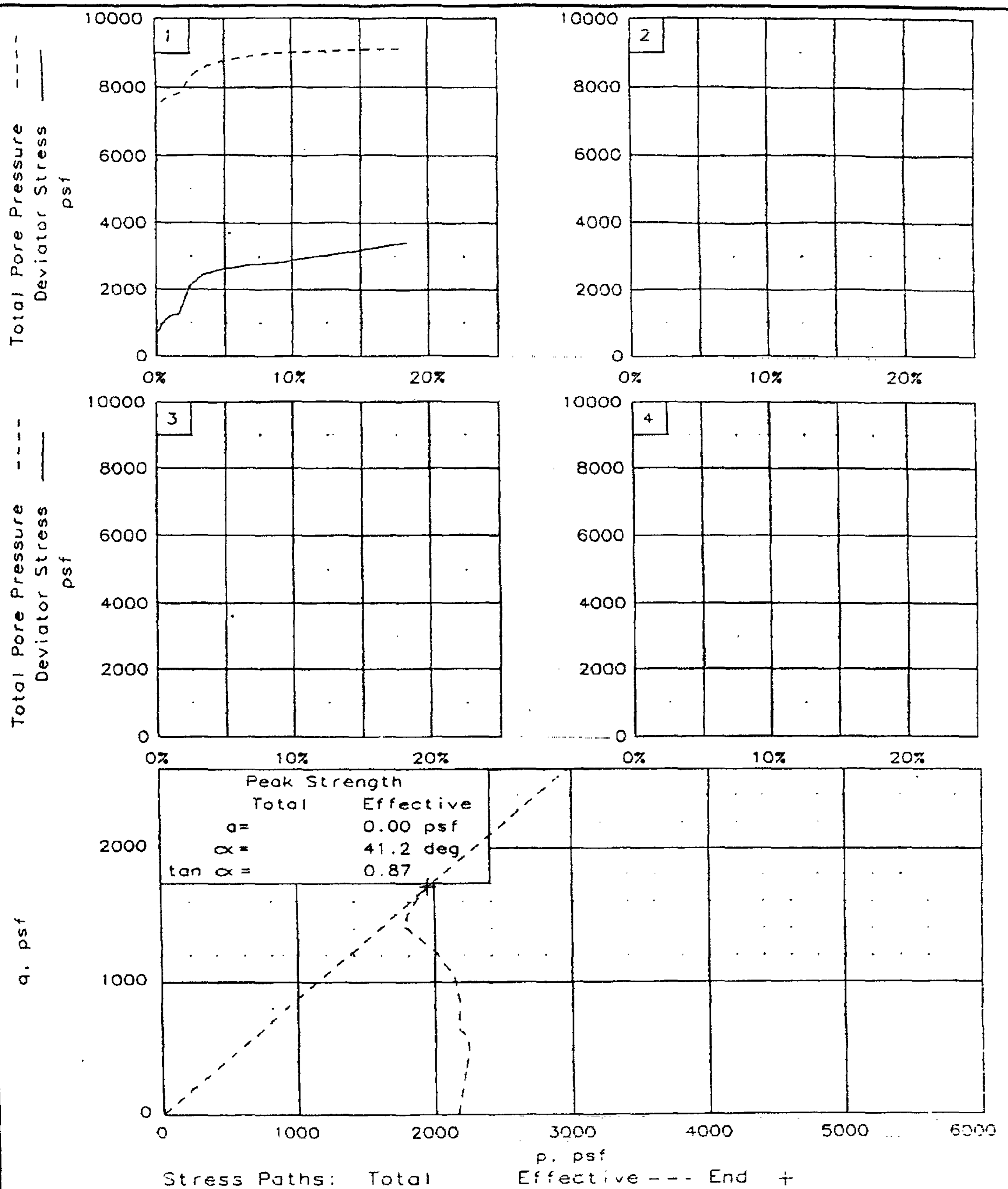
SAMPLE LOCATION: EB-16 3-6'

PROJ. NO.: J-1014 DATE: 11/26/96

TRIAXIAL SHEAR TEST REPORT

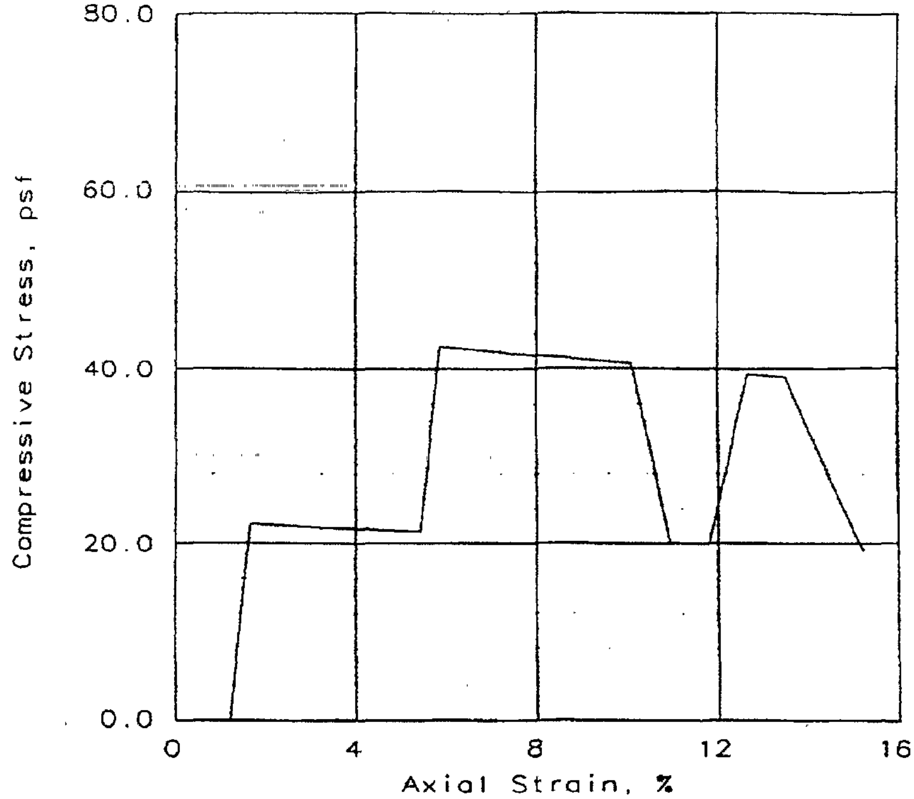
SOIL TECHNOLOGY, INC.

Fig No 9



Client: Roy F. Weston
Project: Puget Sound Resources
Location: EB-16 3-6
File: EB1655 Project No J-1014 Fig No 10

UNCONFINED COMPRESSION TEST



SAMPLE NO.:	1			
Unconfined strength, psf	42.5			
Undrained shear strength, psf	21.3			
Failure strain, %	5.9			
Strain rate, in/min	0.0600			
Water content, %	120.2			
Wet density, pcf	79.4			
Dry density, pcf	36.0			
Saturation, %	88.3			
Void ratio	3.6763			
Specimen diameter, in	2.85			
Specimen height, in	5.89			
Height/diameter ratio	2.07			

Description:

GS= 2.7 | Type: Shelby Tube

Project No.: J-1014
Date: 11/26/96
Remarks:
Sample Depth 4.0-4.5'

Client: Roy F. Weston

Project: Puset Sound Resources

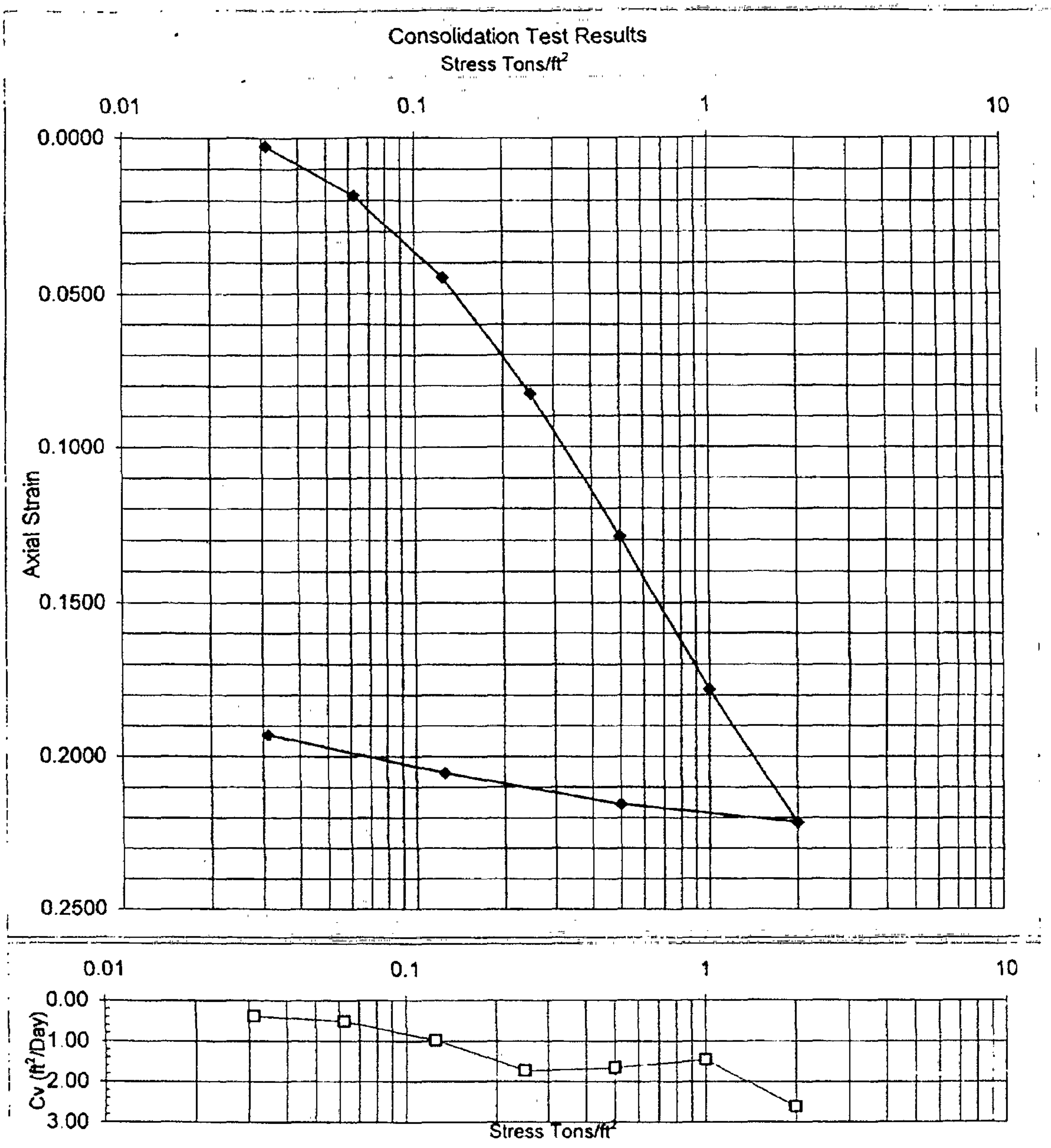
Location: EB16 3-6

UNCONFINED COMPPESSION TEST

SOIL TECHNOLOGY, INC.

Fig. No.: 11

Roy F. Weston
Puget Sound Resources



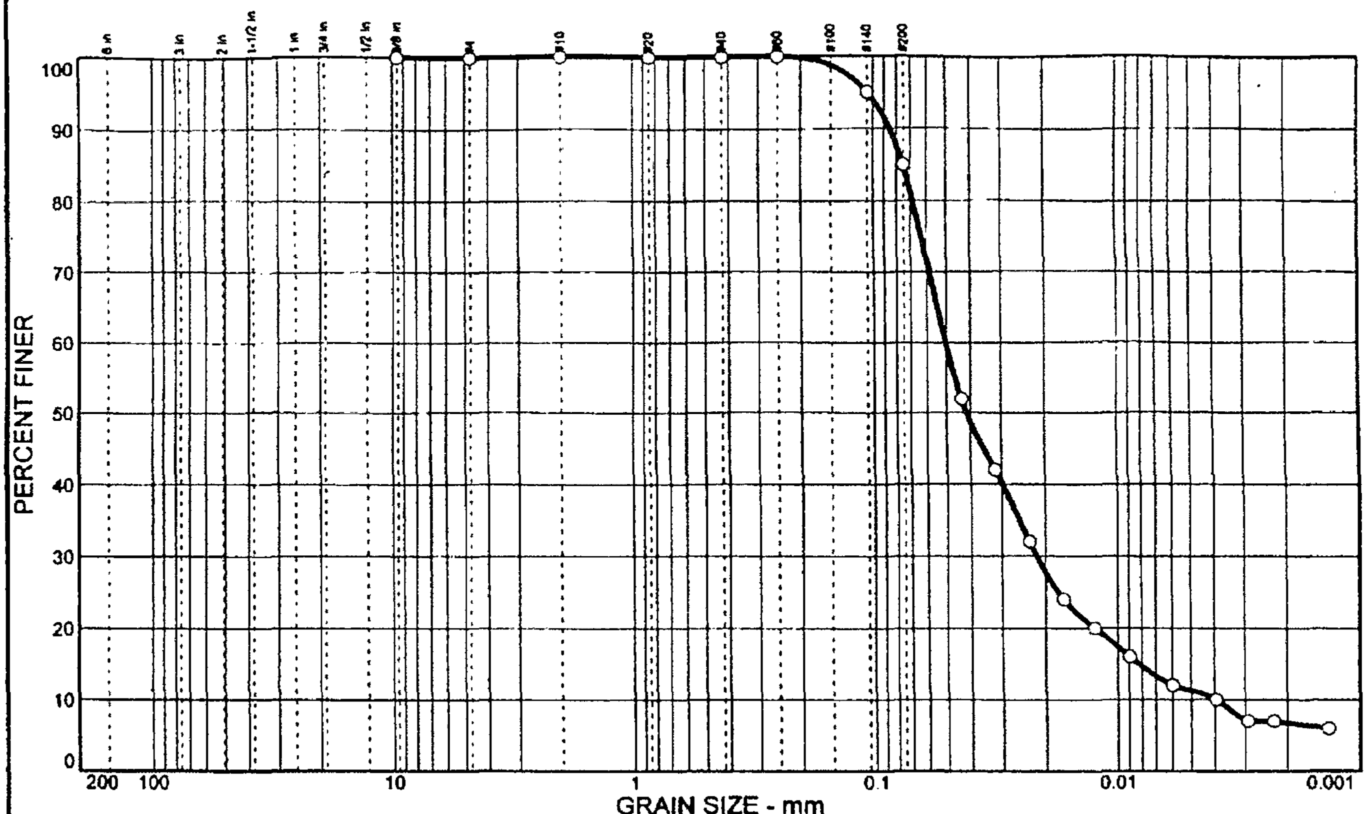
Exploration Number	Sample Number	Depth ft	Moisture Content %		Atterberg Limits			Wet Density pcf	Description
			Before	After	LL	PL	PI		
EB-16	3-6'	4.6-4.8	171	75	41	31	10	86	Silt

Soil Technology, Inc.
J-1014

Roy F. Weston
Puget Sound Resources
Consol Summary

		d0	d90	d100	df	t90	T	Cv ft^2/day	Load tsf	Strain Ratio
Job #	J-1014	3	46	50.8	50	5.5	9973.5	0.38	0.03125	0.0028
Exploration #	EB-16	82	202	215.3	217	4	9850.5	0.51	0.0625	0.0185
Sample ID #	3-6'	290	464	483.3	490	2	9610.0	0.98	0.125	0.0447
Sample Depth (ft)	4.6-4.8	570.0	840.0	870.0	883.0	1.05	9273.5	1.74	0.25	0.0827
Type of Test	CONSOL	960.0	1295.0	1332.2	1355.0	1	8842.5	1.66	0.5	0.1288
Date	11/26/96	1480.0	1816.0	1853.3	1863.0	1	8328.5	1.47	1	0.1782
Test by	HB	1985.0	2265.0	2296.1	2314.0	0.5	7850.5	2.61	2	0.2215
Initial Length (in x 10^4)	10000	2308.0	2285.0	2282.4	2280.0	0.5	7706.0	2.52	0.5	0.2156
Area (ft**2)	0.03409	2252.0	2168.0	2158.7	2154.0	1	7797.0	1.29	0.125	0.2055
		2146.0	2033.0	2020.4	2012.0	2	7921.0	0.67	0.03125	0.1931

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
O			15	74	11	ML		31	41

SIEVE inches size	PERCENT FINER O		
3/8"	100		
	GRAIN SIZE		
D_{60}	0.0501		
D_{30}	0.0217		
D_{10}	0.0040		
	COEFFICIENTS		
C_c	2.38		
C_u	12.66		

SIEVE number size	PERCENT FINER O		
#4	100		
#10	100		
#20	100		
#40	100		
#60	100		
#140	95		
#200	85		

SOIL DESCRIPTION

O Silt

REMARKS:

O

O Source: EB16 3-6' Sample No.: 5.0-5.5' Elev./Depth:

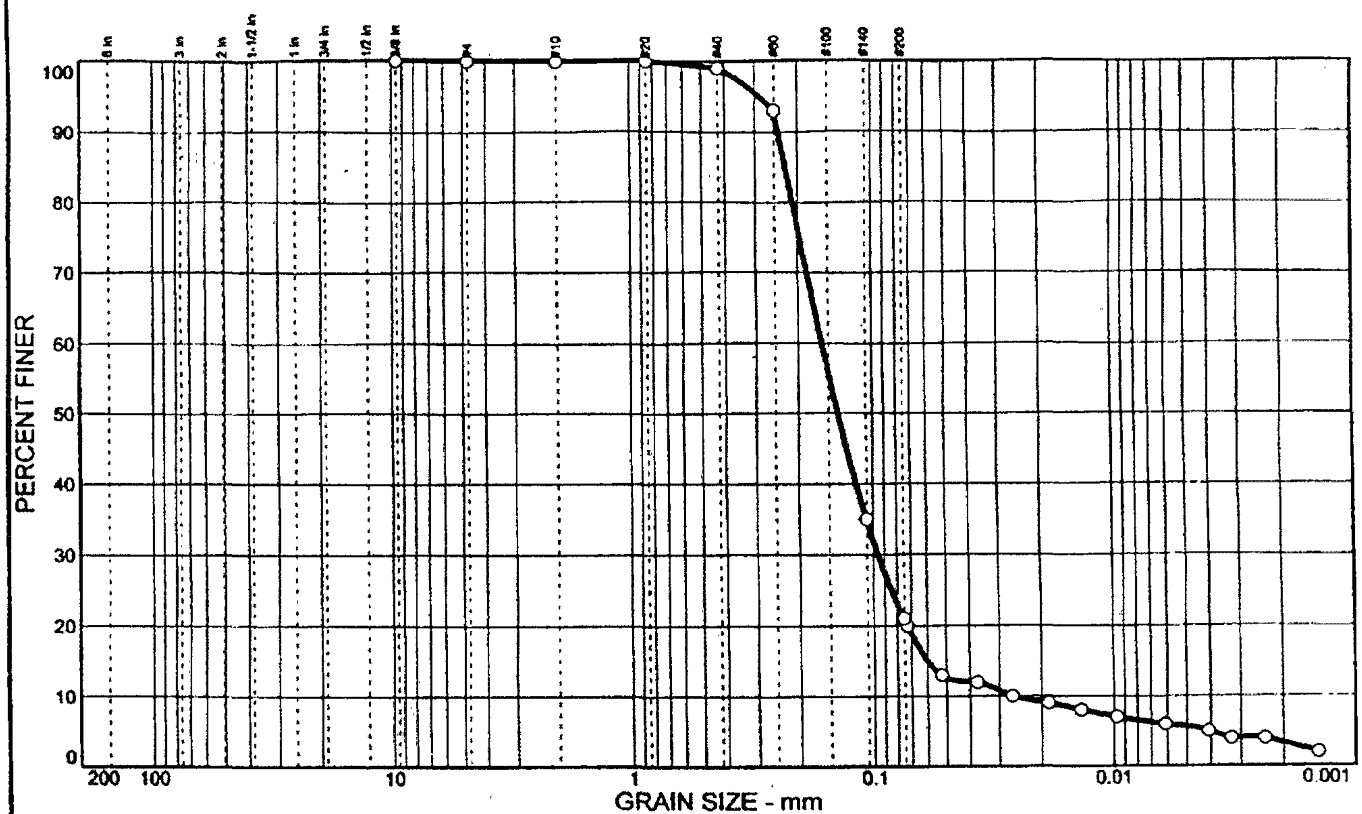
SOIL TECHNOLOGY, INC.

Client Roy F. Weston

Project. Puget Sound Resources

Project No. J-1014 Plate 4

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
O			79	15	6	SM			

SIEVE inches size	PERCENT FINER O		
3/8"	100		
	GRAIN SIZE		
D_{60}	0.159		
D_{30}	0.0953		
D_{10}	0.0264		
	COEFFICIENTS		
C_c	2.17		
C_u	6.03		

SIEVE number size	PERCENT FINER O		
#4	100		
#10	100		
#20	100		
#40	99		
#60	93		
#140	35		
#200	21		

SOIL DESCRIPTION

O Silty sand

REMARKS

O

O Source: EB114 0-3'

Sample No.: 2.5-3.0

Elev./Depth:

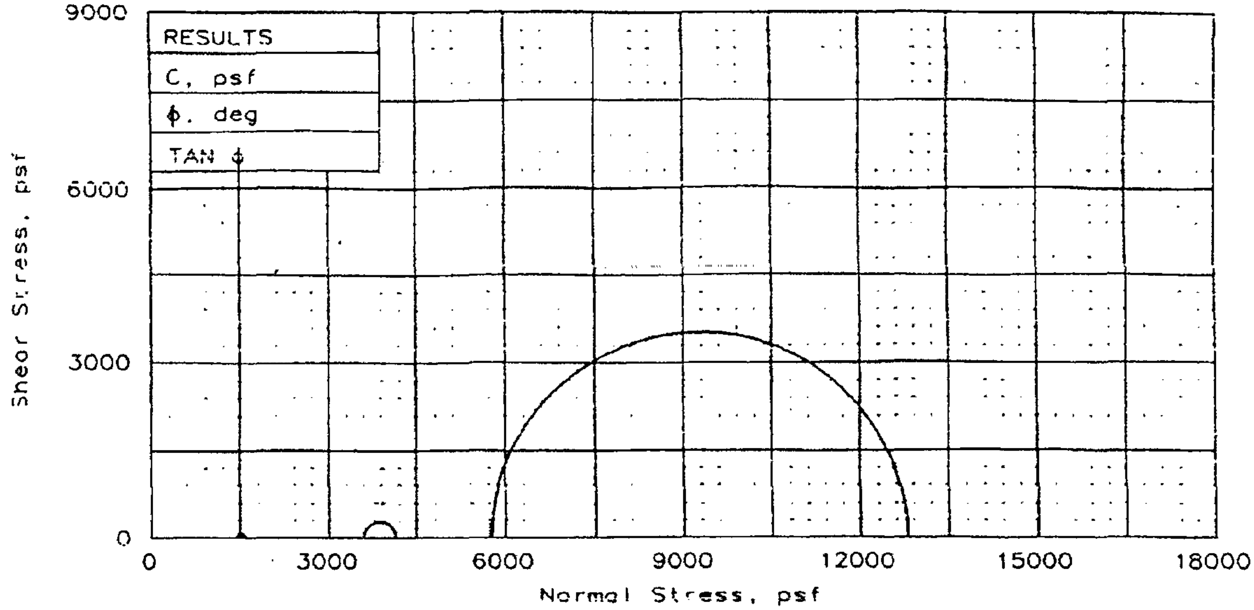
SOIL TECHNOLOGY, INC.

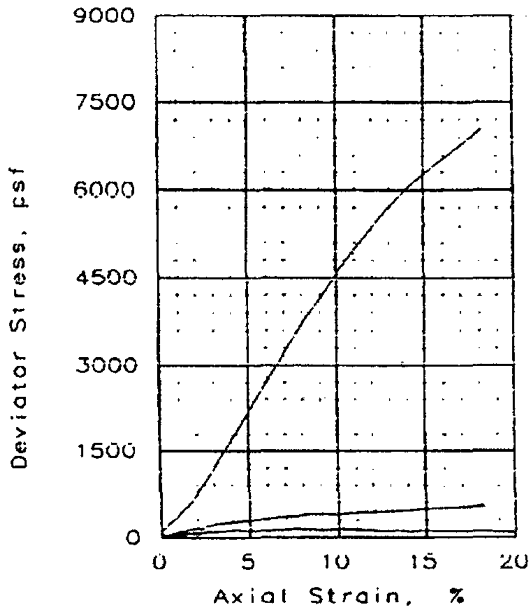
Client: Roy F. Weston

Project: P [illegible] nd Resources

Project No. J-1014

Plate 5





SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	86.2	44.6	32.0
	DRY DENSITY, pcf	49.4	77.2	90.8
	SATURATION, %	97.9	104.8	105.3
	VOID RATIO	2.298	1.111	0 794
	DIAMETER, in	2.82	2.81	2.80
	HEIGHT, in	6.05	6.04	6.05
AT TEST	WATER CONTENT, %	85.6	43.9	31.6
	DRY DENSITY, pcf	49.4	77.2	90.8
	SATURATION, %	97 3	103.1	104.0
	VOID RATIO	2.298	1.111	0.794
	DIAMETER, in	2.82	2.81	2.80
	HEIGHT, in	6.05	6.04	6.05
Strain rate, in/min		0.0600	0.0600	0.0600
BACK PRESSURE, psf		0	0	0
CELL PRESSURE, psf		1440	3600	5760
FAIL. STRESS, psf		143	547	7044
ULT. STRESS, psf		143	547	7044
σ_1 FAILURE, psf		1583	4147	12804
σ_3 FAILURE, psf		1440	3600	5760

TYPE OF TEST.
Unconsolidated Undrained

SAMPLE TYPE: Shelby Tube

DESCRIPTION: Top-Clay w/organic ,at approx 2.2' becomes sand

SPECIFIC GRAVITY= 2.61

REMARKS: Sample 1 1.3-1 8'
Sample 2 2 0 2 5'
Sample 3 2.5-3.0'

Fig No · 12

CLIENT. Roy F. Weston

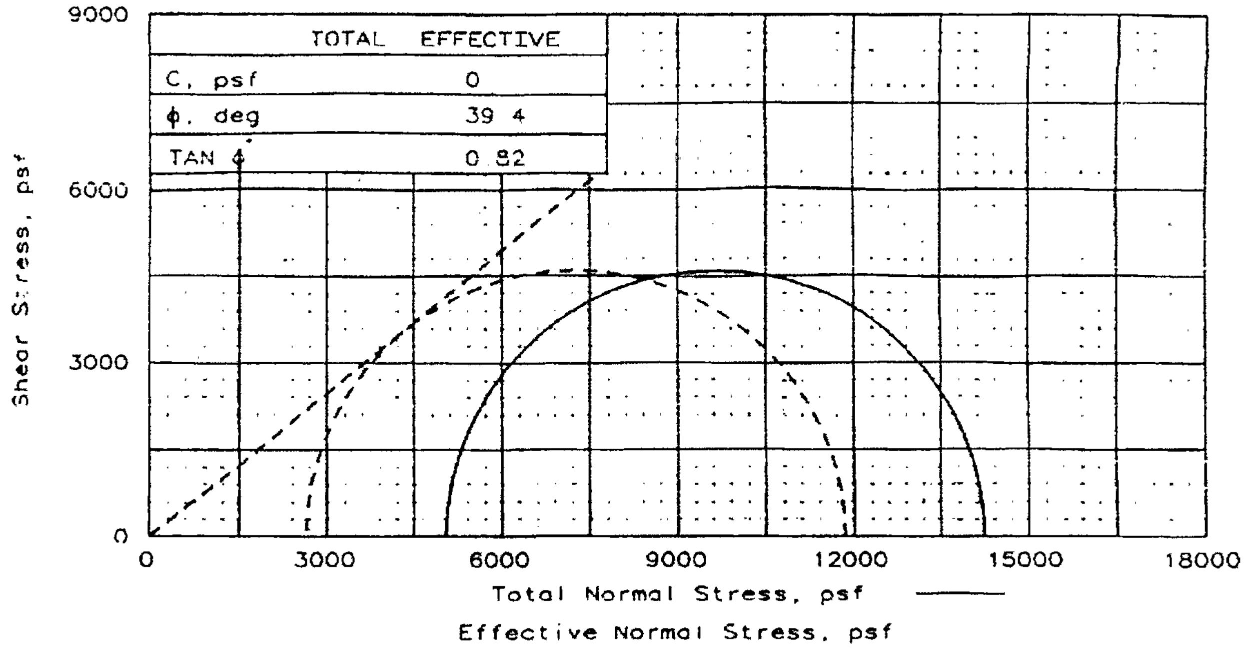
PROJECT. Puget Sound Resources

SAMPLE LOCATION. EB-114 0.0-3.0'

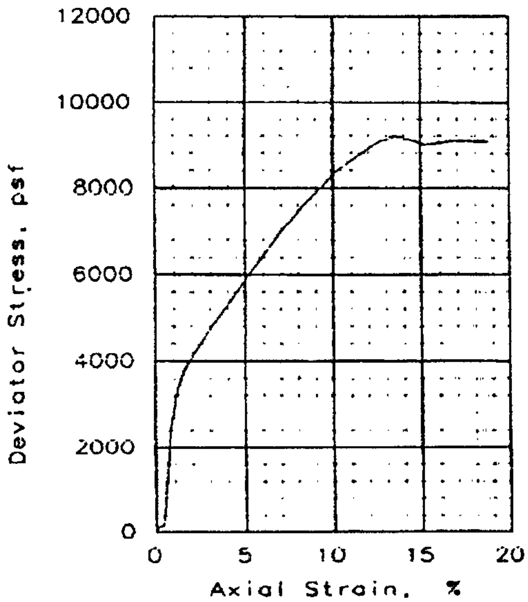
PROJ. NO.: J-1014 DATE. 1/9/97

TRIAXIAL SHEAR TEST REPORT

SOIL TECHNOLOGY, INC.



	TOTAL	EFFECTIVE
C, psf		0
φ, deg		39 4
TAN φ		0 82



SAMPLE NO.:		1
INITIAL	WATER CONTENT, %	43.3
	DRY DENSITY, pcf	76.9
	SATURATION, %	98.0
	VOID RATIO	1.193
	DIAMETER, in	2.82
	HEIGHT, in	6.10
AT TEST	WATER CONTENT, %	32.4
	DRY DENSITY, pcf	92.7
	SATURATION, %	107.1
	VOID RATIO	0.818
	DIAMETER, in	2.60
	HEIGHT, in	5.92
	Strain rate, in/min	0.0040
	BACK PRESSURE, psf	5760
	CELL PRESSURE, psf	10800
	FAIL. STRESS, psf	9197
	TOTAL PORE PR., psf	8150
	ULT. STRESS, psf	9197
	TOTAL PORE PR., psf	8150
	$\bar{\sigma}_1$ FAILURE, psf	11847
	$\bar{\sigma}_3$ FAILURE, psf	2650

TYPE OF TEST.
CU with Pore Pressures

SAMPLE TYPE: Shelby Tube

DESCRIPTION: Silty sand

LL= 43 PL= 31 PI= 12

SPECIFIC GRAVITY= 2.7

REMARKS. Sample Depth 4.9-5.4'

Fig No. 13

CLIENT: Roy F. Weston

PROJECT: Puget Sound Resources

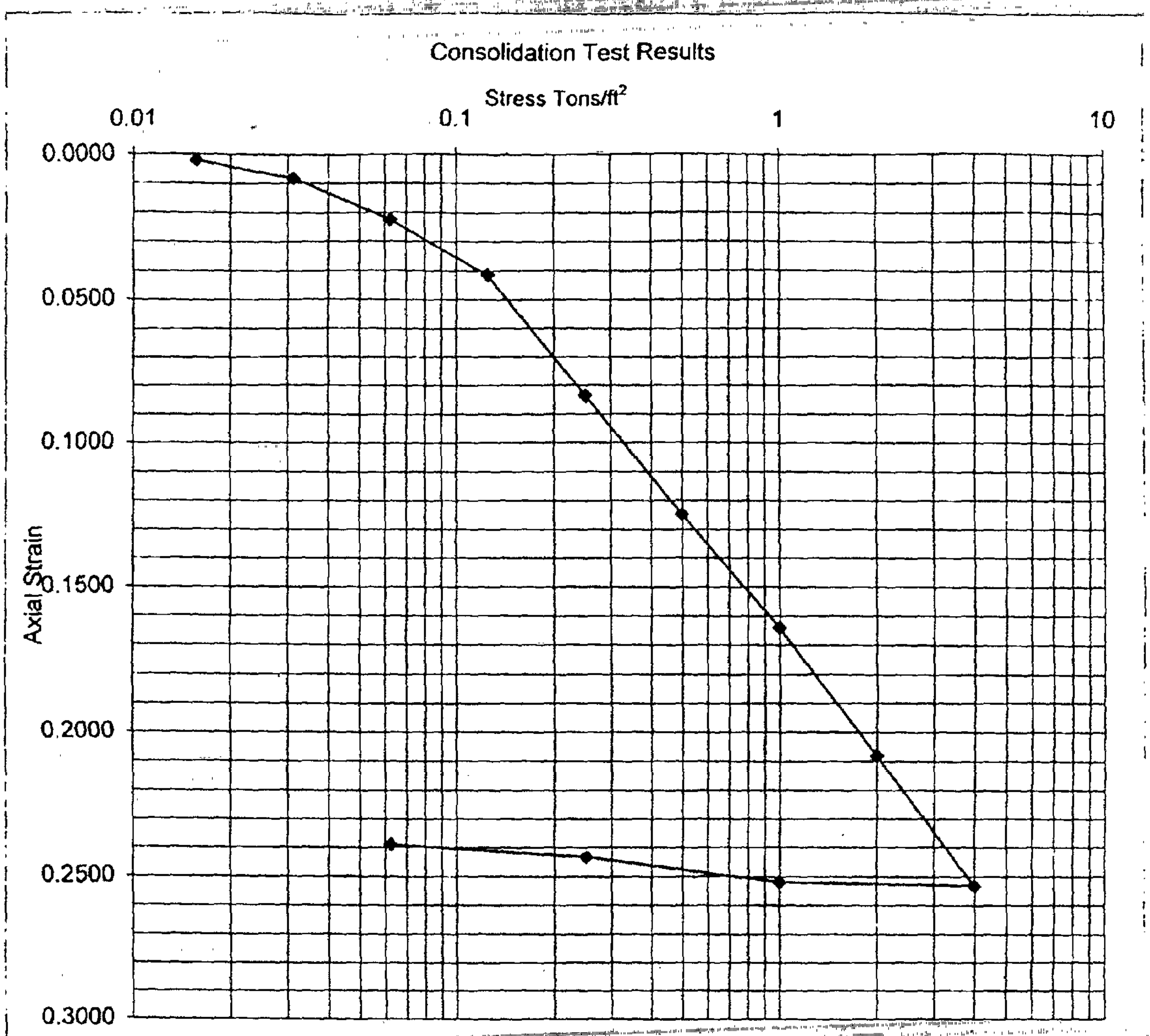
SAMPLE LOCATION. EB-114 3-6'

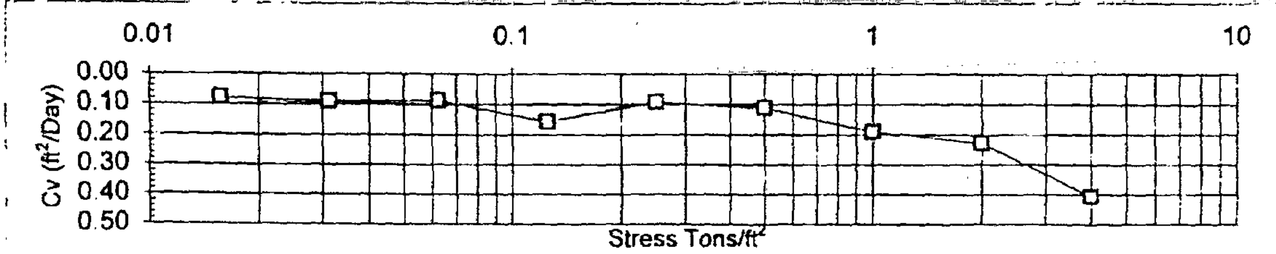
PROJ. NO.: J-1014 DATE: 11/26/96

TRIAXIAL SHEAR TEST REPORT

SOIL TECHNOLOGY, INC.

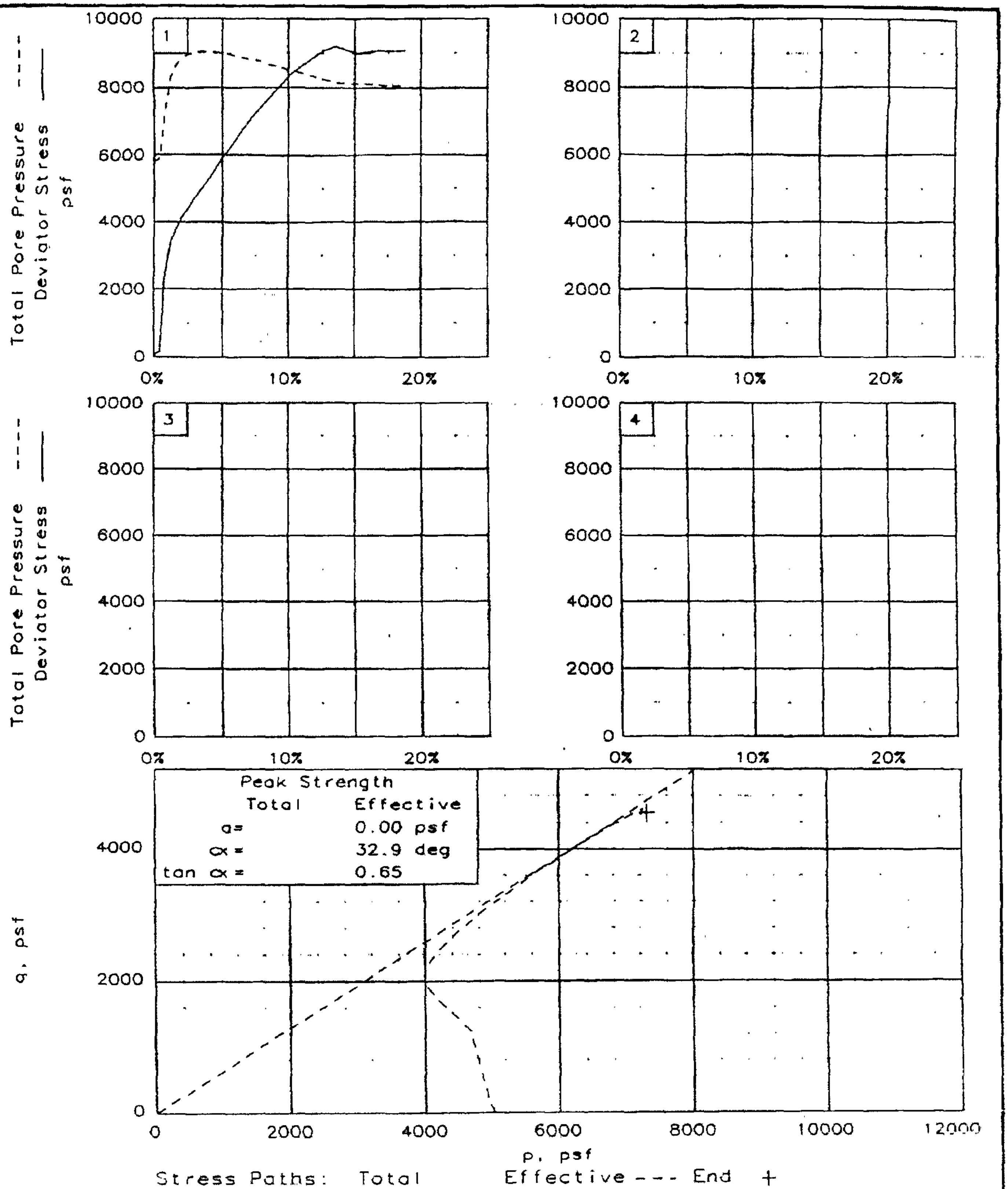
Roy F. Weston
Puget Sound Resources



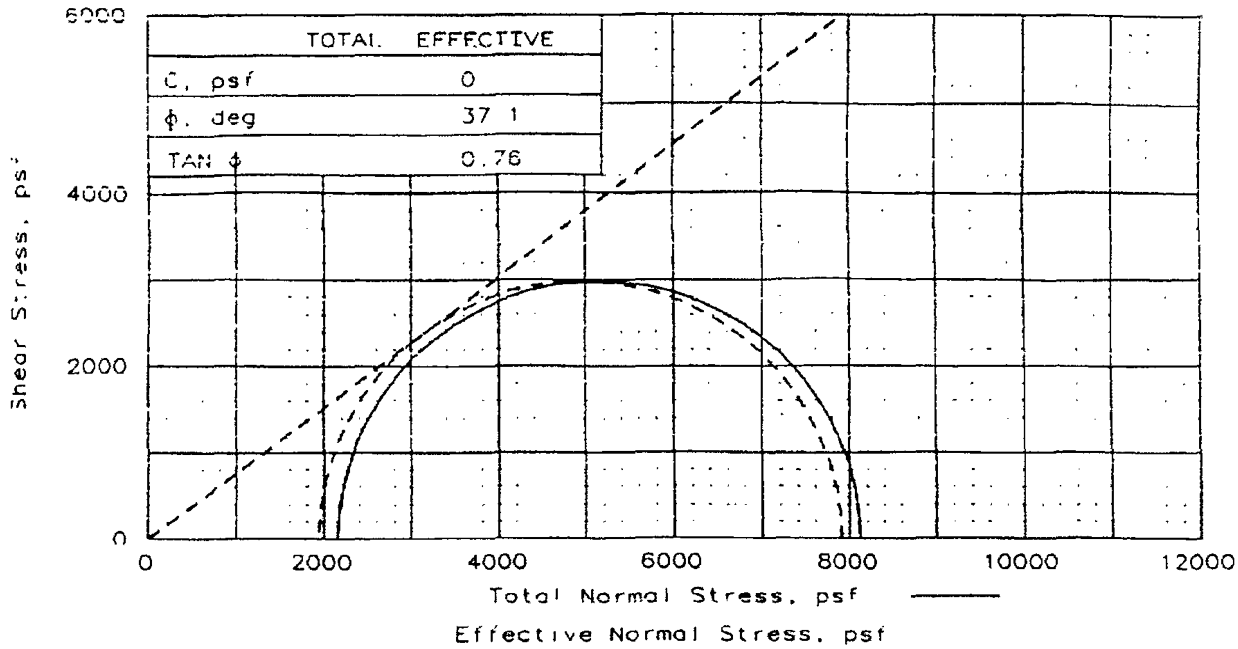


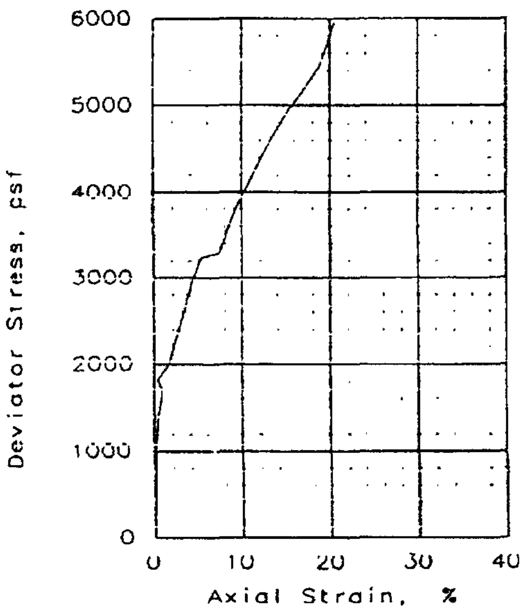
Exploration Number	Sample Number	Depth ft	Moisture Content %		Atterberg Limits			Wet Density pcf	Description
			Before	After	LL	PL	PI		
EB-114	0-3'	1.8-2.0'	67	40	59	30	29	103	Clay

Soil Technology
J-1014



Client: Roy F. Weston
Project: Puget Sound Resources
Location: EB-114 3-6
File: EB11449 Project No.: J-1014 Fig. No.: 14





SAMPLE NO.:		1
INITIAL	WATER CONTENT, %	36.9
	DRY DENSITY, pcf	81.2
	SATURATION, %	93.7
	VOID RATIO	1.052
	DIAMETER, in	2.89
	HEIGHT, in	6.07
AT TEST	WATER CONTENT, %	29.9
	DRY DENSITY, pcf	91.0
	SATURATION, %	95.8
	VOID RATIO	0.833
	DIAMETER, in	2.75
	HEIGHT, in	5.97
Strain rate, in/min		0.0040
BACK PRESSURE, psf		7200
CELL PRESSURE, psf		9360
FAIL. STRESS, psf		5969
TOTAL PORE PR., psf		7416
ULT. STRESS, psf		5969
TOTAL PORE PR., psf		7416
$\bar{\sigma}_1$ FAILURE, psf		7913
$\bar{\sigma}_3$ FAILURE, psf		1944

TYPE OF TEST:
Cu with Pore Pressures

SAMPLE TYPE: Shelby Tube

DESCRIPTION: Silty sand

LL= 39 PL= 30 PI= 9

SPECIFIC GRAVITY= 2.67

REMARKS: Sample Depth 5.5-6.0'

CLIENT: Roy F. Weston

PROJECT: Puget Sound Resources

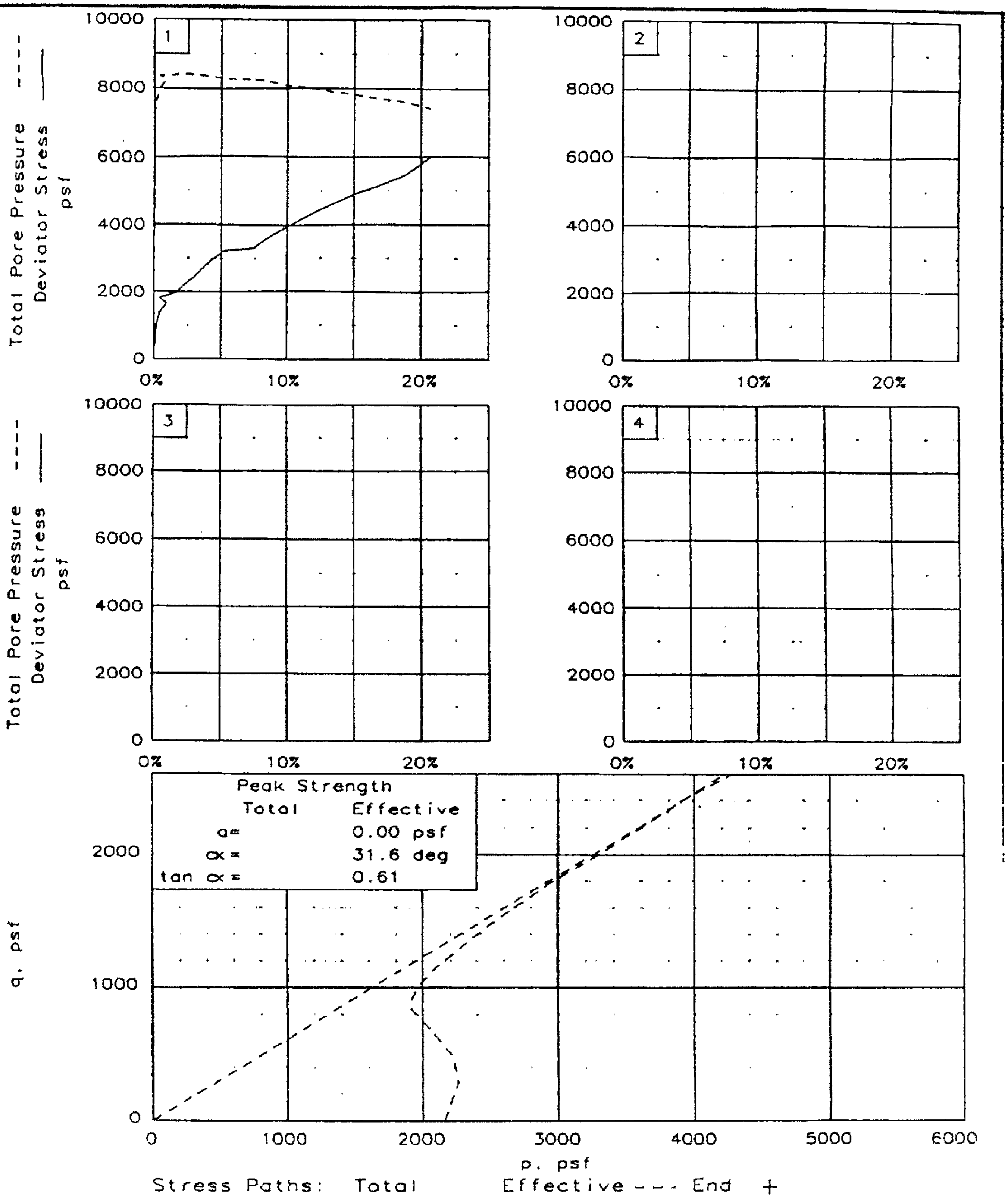
SAMPLE LOCATION: EB-114 3-6'

PROJ. NO. J-1014 DATE: 11/26/96

TRIAXIAL SHEAR TEST REPORT

SOIL TECHNOLOGY, INC.

Fig. No. 15



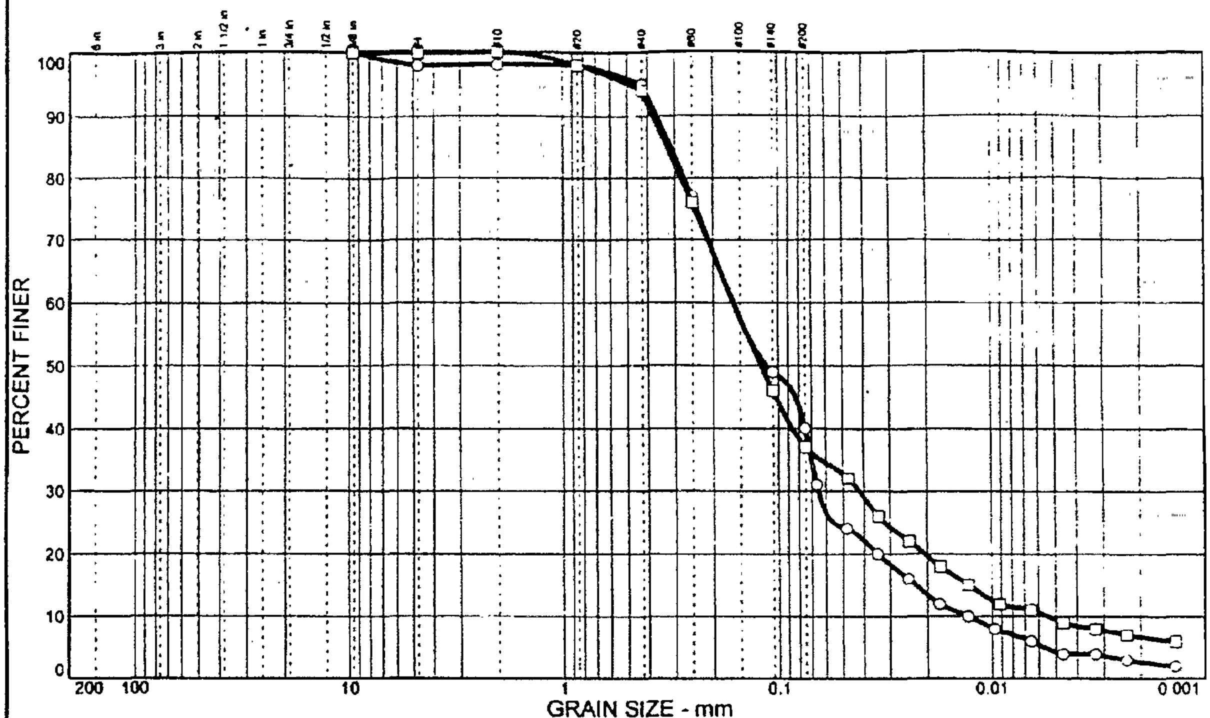
Client. Roy F. Weston

Project: Puget Sound Resources

Location: EB-114 3-6'

File EB11455 Project No. J-1014 Fig No 16

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		2	58	36	4	SM		31	43
□			63	28	9	SM		30	39

SIEVE inches size	PERCENT FINER ○	□	
3/8"	100	100	
	GRAIN SIZE		
D_{60}	0.161	0.160	
D_{30}	0.0652	0.0421	
D_{10}	0.0129	0.0055	
	COEFFICIENTS		
C_c	2.03	2.03	
C_u	12.47	29.35	

SIEVE number size	PERCENT FINER ○	□	
#4	98	100	
#10	98	100	
#20	98	98	
#40	95	94	
#60	77	76	
#140	49	46	
#200	40	37	

SOIL DESCRIPTION

○ Silty sand

□ Silty sand

REMARKS

○

□

○ Source: EB114 3-6' Sample No.: 4.9-5.4' Elev./Depth:

□ Source: EB114 3-6' Sample No.: 5.5-6.0' Elev./Depth:

SOIL TECHNOLOGY, INC.

Client Roy F. Weston

Project Puget Sound Resources

Project No J-1014 Plate

Roy F. Weston
Puget Sound Resources

Table 1: Soil Parameters

Boring Number	Boring Depth feet	Sample Depth feet	Specific Gravity[1]	Total Volatile Solids[2] %
EB 14	0 - 3	0.2 - 0.7	2.69	2.8
EB 14	3 - 6	4.3 - 4.8	2.64	2.5
EB 16	0 - 3	0.8 - 1.3	2.66	4.0
EB 16	0 - 3	1.3 - 1.8	2.51	20.3
EB 16	3 - 6	4.0 - 4.5	NA	39.9
EB 16	3 - 6	5.0 - 5.5	2.72	NA
EB 114	0 - 3	1.8 -2.0	2.61	5.1
EB 114	3 - 6	4.9 - 5.4	2.70	3.8
EB 114	3 - 6	5.5 - 6.0	2.67	2.4

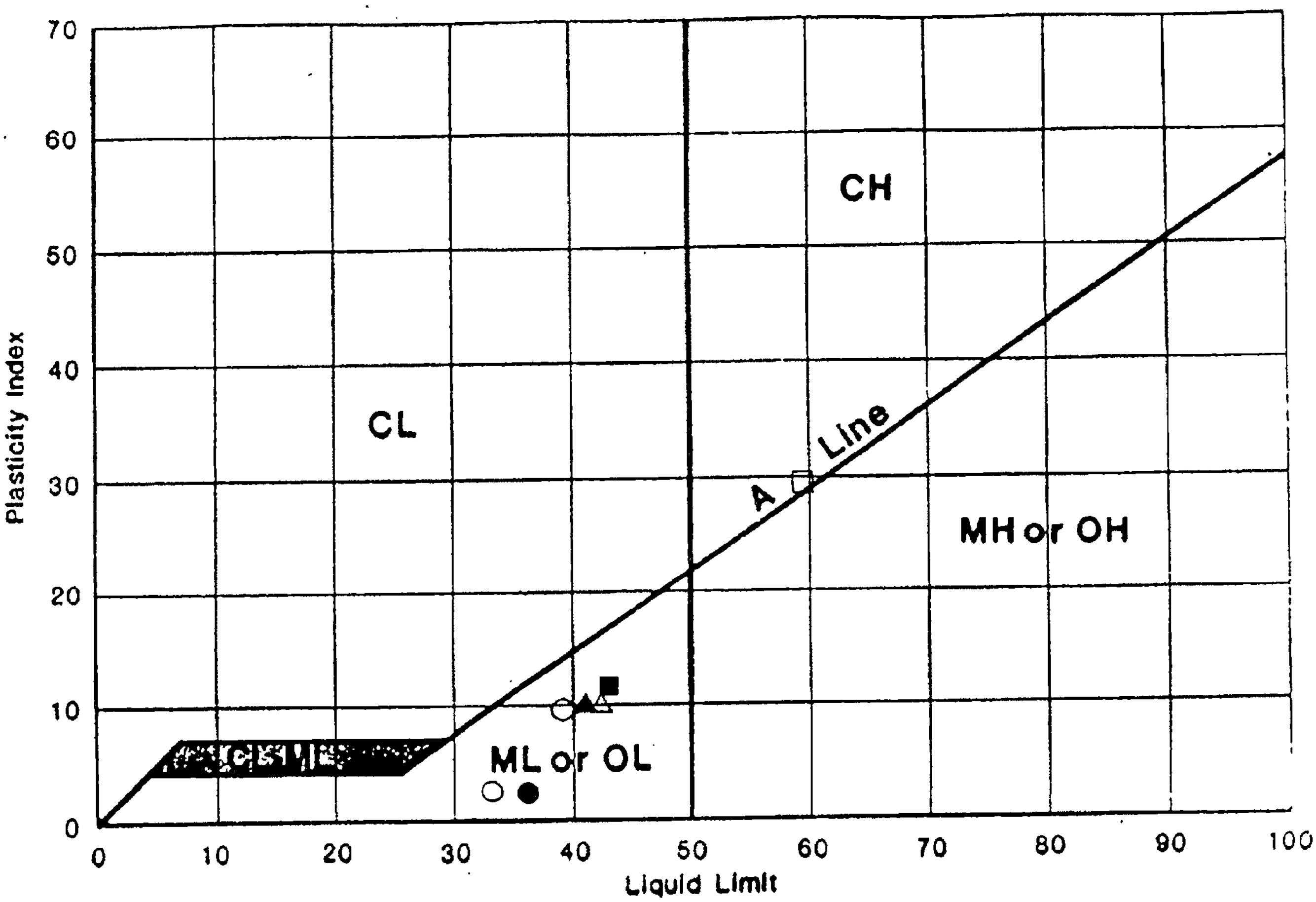
[1] Specific Gravity determined following ASTM D–854 methodology.

[2] Total Volatile Solids determined following ASTM D-2974 Method C.

NA = Not analyzed.

Plasticity Chart

Roy F. Weston
Puget Sound Resources



Symbol	Boring Number	Boring Depth ft	Sample Depth ft	Water Content in Percent Nat.	L.L.	P.L.	P.I.	Classification
○	EB 14	0 - 3	0.2 - 0.7	50	33	31	2	ML
	EB 14	3 - 6	4.2 - 4.3	36	Granular Non-Plastic			SM
●	EB 16	0 - 3	0.8 - 1.3	48	36	34	2	ML
△	EB 16	0 - 3	1.3 - 1.8	111	42	32	10	OL
▲	EB 16	3 - 6	5.0 - 5.5	51	41	31	10	ML
□	EB 114	0 - 3	1.8 - 2.0	67	59	30	29	CH*
■	EB 114	3 - 6	4.9 - 5.4	43	43	31	12	SM
⬡	EB 114	3 - 6	5.5 - 6.0	37	39	30	9	SM

Nat. Natural
L.L. Liquid Limit
P.L. Plastic Limit
P.I. Plasticity Index

*Classification based on Atterberg Limits only; no grain size performed.

Soil Technology, Inc.
J-1014

Roy F. Weston
Puget Sound Resources

Case Narrative

When interpreting results it is necessary to give careful attention to the depths of each sample taken from within the shelby tube. In some instances the sample type within a tube varied significantly from the top to the bottom. When Atterberg Limits, specific gravity, grain size and total volatile solids are not reported for each individual sample, that indicates that the material changed type within the tube and that data was not generated for each sample type.

ATTACHMENT 3

EDDIE PUMP^{TM} DEMONSTRATION PERFORMANCE DATA

RESULTS FROM THE EDDY PUMP DEMONSTRATION AT SANTEE CALIFORNIA JUNE 21 - JUNE 24,1999

US ACOE WATERWAYS EXPERIMENT STATION
STEVE SCOTT

BACKGROUND

The Eddy Pump dredge was demonstrated in Santee California during the week of June 21, 1999, at an abandoned 19-acre gravel pit. The dredge pumping plant consists of a 10-inch Eddy Pump powered by a 400-horsepower motor. The pump is attached to the dredge frame by a steel ladder, with the discharge line running along the ladder, under the dredge frame, and out the back of the dredge. The dredge is designed to operate as either a stationary platform or advance through a cut much like a conventional cutterhead dredge. A spud carriage is used to advance the dredge forward through the cut. A traditional dredge ladder is rotated through the cut radius using winches. The Eddy Pump dredge utilizes powered wheels attached to the pump infrastructure which are assisted by water pump thrusters to swing the ladder and pump.

SITE CONDITIONS

The sediments in the abandoned gravel pit consisted of a layer of fine silt overlaying sand. Sediment analysis at the Engineering Research and Design Center (ERDC) indicated that the sand is a narrowly graded medium sand with a median particle size of about 0.45 mm and an in-place saturated density of 1.89 g/cm^3. The pit also contained large rocks and scrap metal.

ACQUIRED DATA

During the tests, the following data were logged: pump discharge pressure, flowrate, percent solids by *in situ* volume, electric motor amperage, spud advance, depth, turbidity, and heading. Data were acquired every five seconds.

RESULTS

Data were acquired while the dredge advanced through a cut. The data were analyzed for dredge productivity and pump efficiency. Figures 1 - 5 depict the slurry velocity, slurry specific gravity, pump efficiency, dredge production, and turbidity generated for a 27-minute test. The pump ingested a large piece of scrap metal which locked up the pump, therefore further testing was halted.

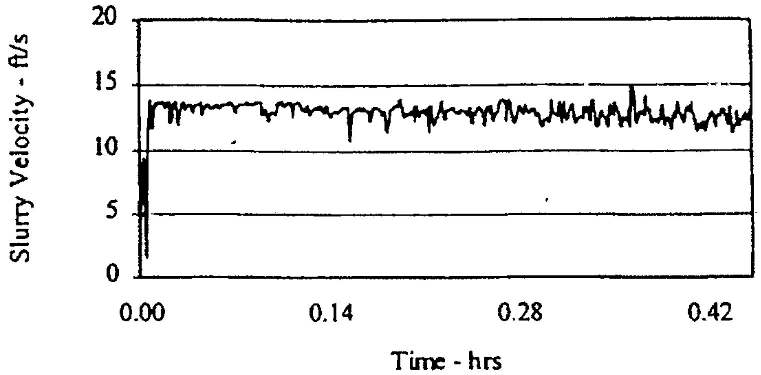


Figure 1. Slurry Velocity in the 10 inch pipeline

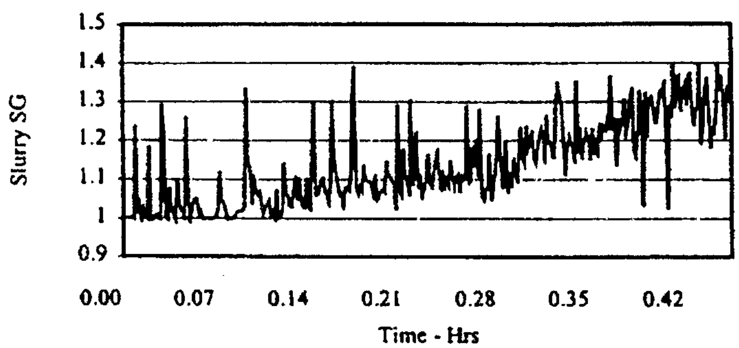


Figure 2. Slurry specific gravity in the 10 inch pipeline

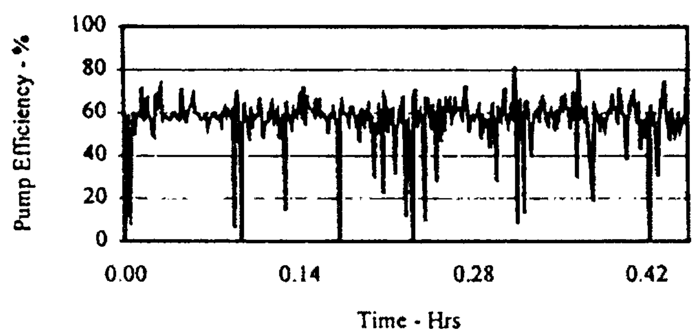


Figure 3. Eddy Pump efficiency

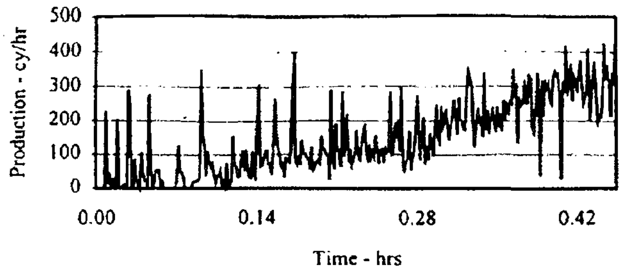


Figure 4. Eddy Pump dredge production

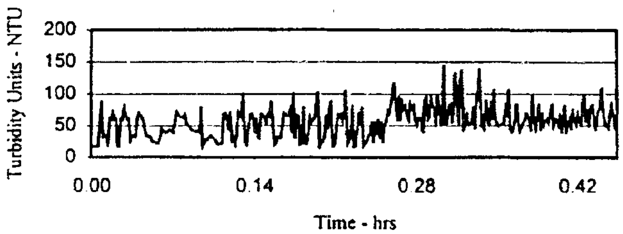


Figure 5. Turbidity measured just above the pump

During the test, the pump speed was a constant 1200 revolutions per minute. The discharge pipeline consisted of 55 feet of 10 inch pipe, 320 feet of 8 inch plastic pipe, and a 28 foot piece of 8 inch pipe used as a discharge manifold for evenly distributing the slurry in the disposal pit. The digging depth ranged from 20 to 30 feet. The flow rate at 1200 rpm ranged from approximately 3300 gallons per minute (gpm) when pumping water to approximately 3100 gpm when loaded with slurry. This represents a velocity range of approximately 13.5 - 12.5 feet per second in the 10 inch pipeline (Figure 1). The critical carrying velocity for a medium sand in the 10 inch pipeline is approximately 10 feet per second. The discharge pressure head ranged from 45 to 50 psi (104 - 116 feet of fresh water) during the test.

The density data (Figure 2) was characteristic of data from nuclear density gauges. It consists of data spikes that result from slugs of sediment passing through the gauge measurement field. The average of the data represents the solids delivery to the disposal site. Because the data record is so short, and the dredge did not advance, the data will not be analyzed for cycle efficiency or average interval productivity. The average specific gravity delivered to disposal was approximately 1.15, which represents 17 percent of insitu solids, or 21 percent solids by weight. The maximum average specific attained during the test was approximately 1.3, which represents 34 percent of insitu solids, or 37 percent solids by weight. This record occurred during the last 2 - 5 minutes of the test. Appendix A contains formulas for computing the percent solids by insitu volume, percent solids by true volume. and percent solids by weight.

The average dredge production over the test was approximately 159 cubic yards per hour. The maximum production was approximately 306 cubic yards per hour. The average pump efficiency over the test duration was approximately 60 percent.

The turbidity measurement was made just above the pump. The measurements were in units of Nephelometric Turbidity Units (NTU), which are a measurement of the scattering of light passing through a column of water. This scattering effect increases as the particle concentration increases in the water column. This is a qualitative rather than quantitative method of describing turbidity due to suspended solids. Figure 5 presents the turbidity data. The data indicates that when the dredge had not fully engaged the material (0 - 0.23 hour of the data record), the turbidity was on the average 44 NTU. When the suction head was engaging the material, the turbidity measurement increase to an average of 66 NTU (0.23 - 0.45 hour of the data record). This represents an increase of approximately 50 percent. As you can see from Figure 5, the turbidity scale begins at about 15 NTU, so it is questionable whether the sensor was calibrated before the test. Regardless of the calibration, the 50 percent increase in turbidity due to the Eddy Pump engaging the material is representative. I attribute the turbidity to the very fine layer of sediments on the gravel pit bed. This can better be quantified in the future if suspended sediment samples are taken along with the turbidity measurements.

DISCUSSION

The test was of too short duration to draw any conclusions about overall dredge performance. Data should be taken over numerous dredge advance cycles to evaluate cycle efficiency as well as dredge productivity. The productivity of an advancing dredge such as a conventional cutterhead dredge or the Eddy Pump dredge design is dependent on the solids available to the suction line, not pump performance. Both the Eddy Pump dredge and a conventional dredge can pump the solids if they are available. The maximum concentration of saturated sand that can be pumped over a sustained interval is approximately 50 percent of insitu solids volume (53 percent solids by weight), assuming a saturated sand density of 2.0 g/cm^3. Concentrations as high as 60 percent of insitu volume (60 percent solids by weight) have been pumped, but not over any appreciable length of time because of the possibility of plugging the pipe. Attached are density and production records from submersible centrifugal pumps that were used in sand bypassing tests (Appendix B). The pumps are manufactured by Toyo and H&H, with discharge pipe diameters of 10.0 and 8.0 inches respectively. The slurry specific gravity was measured by both a differential pressure gauge and a density gauge for comparison purposes. The production and percent solids by weight data are for the density gauge record. The pumps achieved up to 50 percent solids by weight, but could not sustain it because of pipe plugging. No hydraulic pumping system can pump saturated sands at insitu densities (70-80 percent solids by weight).

The cut face that the dredge is working in limits the amount of solids that can be entrained as well as the method of dredge advance. The lower the cut face, the more water that will be entrained into the suction line. The spud carriage is the most efficient method of advance. Conventional spuds on which the dredge pivots during the advance keep the dredge in the material approximately 50 percent of the time. The spud carriage, because of its forward movement, is more efficient, and can raise the cycle efficiency to 75 percent. These are only approximate cycle efficiencies, and may vary substantially due to operator expertise. Therefore, the solids delivered to disposal are dependent on cutface height and on the advance (cycle) efficiency. For example, if the cut face is substantial (the suction line buried in the material), the maximum average slurry specific gravity pumped could be 1.4. The slurry specific gravity delivered to disposal is reduced because of the advance efficiency. Assuming a 75 percent cycle efficiency results in a slurry specific gravity delivered to disposal of 1+(.75*.4) = 1.3. Very rarely is there sufficient material to obtain the maximum solids flow rate. The cut face height and terrain will vary, as well as the operator expertise. The suction head will not remain buried in the sediment 100% of the time. Therefore, the average solids pumped while the head is engaging sediment will be lower than the maximum possible. The cycle efficiency will also vary substantially due to operator expertise.

The efficiency of the 10 inch Eddy Pump was only evaluated at one speed (1200 RPM), and resistance (pressure head condition). The efficiency will change as a function of rotor size, rotor speed, and resistance.

CONCLUSIONS

The productivity of the Eddy Pump dredge can only be properly evaluated over a lengthy dredging project. Based on my observations, and experience in evaluating hydraulic dredging production data, I believe that the Eddy Pump dredge can pick up and transport an average slurry specific gravity of approximately 1.3 (30 percent insitu solids, 40 percent solids by weight) when engaging the cutface. This is assuming an insitu sand density of 2.0 g/cm^3 and the dredge is maintenance dredging (going through the advance and swing cycle). Assuming a 75 percent cycle efficiency, the slurry specific gravity delivered to disposal will be further reduced to 1+(.75*.30) = 1.22. This represents 22 percent insitu solids or approximately 29 percent solids by weight. The production at a 1.22 specific gravity and a nominal flow rate of 12.0 ft/s in the 10 inch pipeline would be 192 cubic yards per hour. This assumes an experienced operator. The productivity can be higher or lower depending on conditions, but overall, I feel that this is what can be expected in normal maintenance dredging conditions. For hard packed sediments, the Eddy Pump dredge may not be effective in entraining solids unless some method is used to break up the sediment.

The solids content of the slurry will vary with the insitu density. Assuming that the dredge will entrain, on the average, 30 percent of the insitu solids, Table1 presented below presents estimated slurry concentrations for sand, silty sand, and silt sediments. Table 2 presents the amount of water that must be transported to the disposal site per yard of insitu sediment and per yard of solids only

Table 1. Estimated delivered slurry specific gravity for sand, silty sand, and silt

Sediment	Insitu SG	Cutface SG	Delivered SG	% Insitu Vol	% Solids Wt
Sand	2.0	1.30	1.22	22	29
Silty Sand	1.7	1.21	1.16	22	22
Silt	1.4	1.12	1.09	22	13

Table 2. Water delivered to disposal per yard of sediment dredged

Sediment	Delivered SG	Yards of Water Per Insitu Yard	Yards of Water Per Yard of Solids Only
Sand	1.22	3.5	6.5
Silty Sand	1.16	3.5	9.0
Silt	1.09	3.5	18.0

Test data for two other Eddy Pump Demonstrations were examined. The Eddy Pump was used to dredge sands at Cresta Reservoir in California and silty sands for Fina Oil in Texas. For the Cresta reservoir work, it was reported by Harrison and Weinrib that a 10.0 inch diameter Eddy Pump averaged approximately 300 cubic yards per hour. This represents a slurry specific gravity of approximately 1.34 at a velocity of approximately 12.0 ft/s. At the Fina Oil demonstration site, the Eddy Pump was working in silty sands. The average specific gravity pumped was 1.16, with an estimated insitu sediment specific gravity of 1.6. The scaled slurry density for sand sediments with an insitu. specific gravity of 2.0 g/cm^3 for the Fina test would be approximately 1.27. Table 3 compares the estimated slurry solids transport to that measured during the Fina and Cresta Reservoir tests.

Table 3. Estimated and measured average sand slurry solids concentrations

Source	Avg Delivered SG	% By Insitu Volume	% By Weight
Estimated	1.22	22.0	29.0
Cresta Reservoir	1.34	34.0	41.0
Fina Oil	1.27	27.0	34.0

Because the three dredge designs that were used for the Santee, Cresta Reservoir, and Fina Oil demonstrations were different, the method of advance probably varied, thus the ability of the pump to pick up and transport the solids may have affected the pump performance.

In a static application, where advance is not a concern, and the suction line of the pump can be totally embedded in the sediments, the pump can potentially maximize production (approach 50 percent sand insitu solids) only if the pump can provide the necessary power to overcome friction losses in the line, and sustain the critical flow velocity so the solids do not settle out and plug the pipe. Because pump curves are not available for the Eddy Pump, this capability cannot be confirmed at this time.

For static applications in viscous materials such as sludges, the Eddy Pump may be effective. Sludges containing sewage wastes and fine clays can have very high viscosities and yield stress when found in high concentrations. The yield stress results from chemical and electrical forces that bind the particles together. When subjected to agitation, or shearing action, the bonds are broken, and the material becomes easy to pump. These materials are referred to as shear thinning. The effect of the Eddy Pump vortex impinging on the material would tend to agitate the surface, breaking the particle attractions, and thus entraining the sediments. Once subjected to the agitation of the rotor, and pumped in turbulent flow, the friction losses of these materials becomes approximately that of water only in the pipe. Additionally, because the fine particles commonly found in sludges have very low settling velocities, the critical settling velocity is not a concern, therefore these materials can be pumped significant distances with low power requirements.

APPENDIX A

SLURRY CONCENTRATION CALCULATIONS

Percent Solids By True Volume: This represents the percent solids by volume in the slurry. This is the solids volume without the pore volume

$$Cvt = ((SGs - SGw)/(SGm - SGw)) * 100$$

With SGs = The slurry specific gravity (measured by the density gauge)
SGw = The water specific gravity (1.0 for fresh water, 1.025 for salt water)
SGm = The mineral specific gravity (~2.65 for quartz)

Percent Solids By Insitu Volume: This represents the percent solids by insitu volume in the slurry. This is the volume of solids plus the pore volume between the sediment grains.

$$Cvi = ((SGs - SGw) / (SGi - SGw)) * 100$$

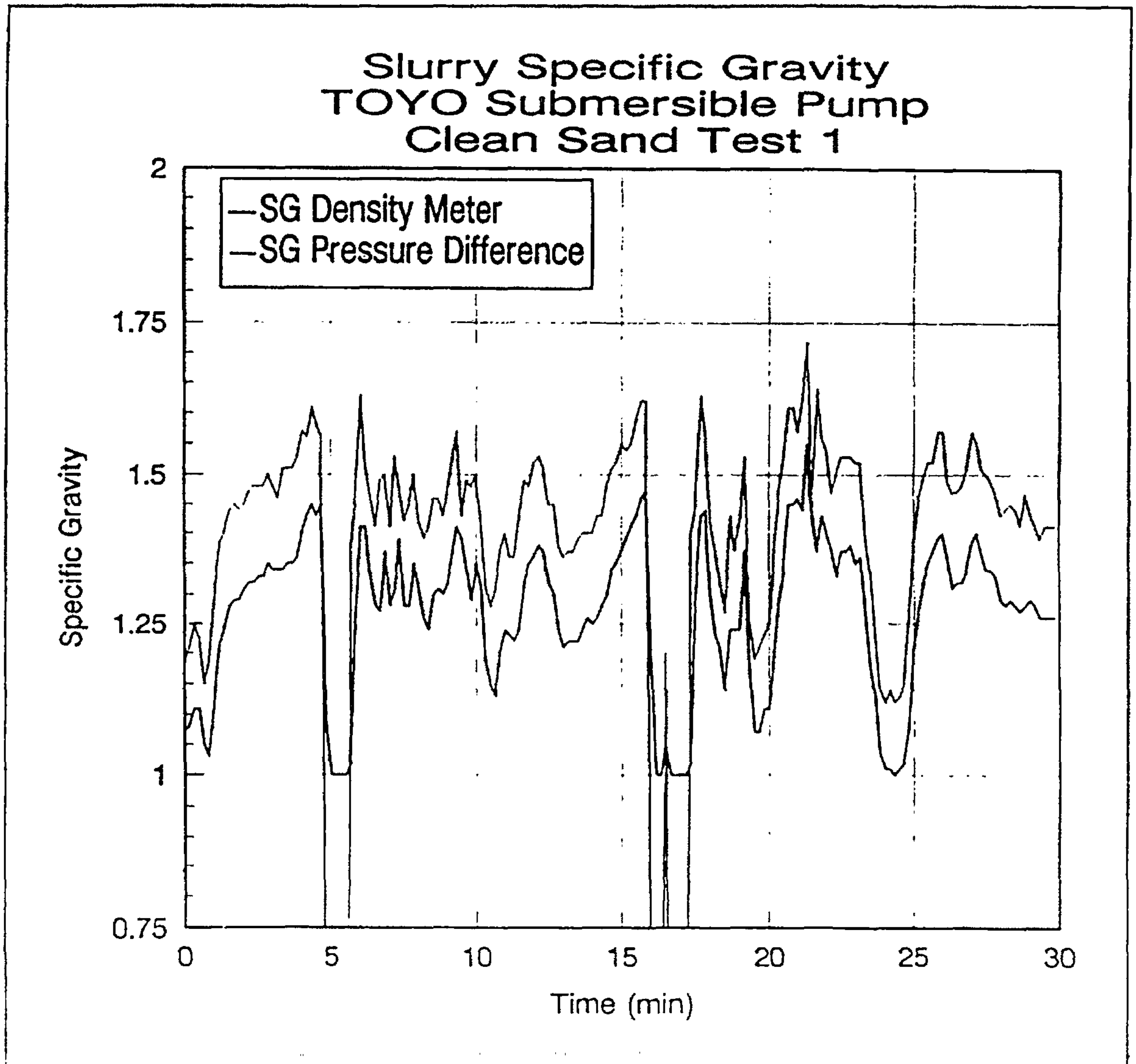
With SGi = The insitu sediment specific gravity (~2.0 for sand)

Percent Solids By Weight: This represents the percent solids in the slurry by weight.

$$Cw = ((Cvt*SGm)/(l+((SGm-1)*Cvt)))*100$$

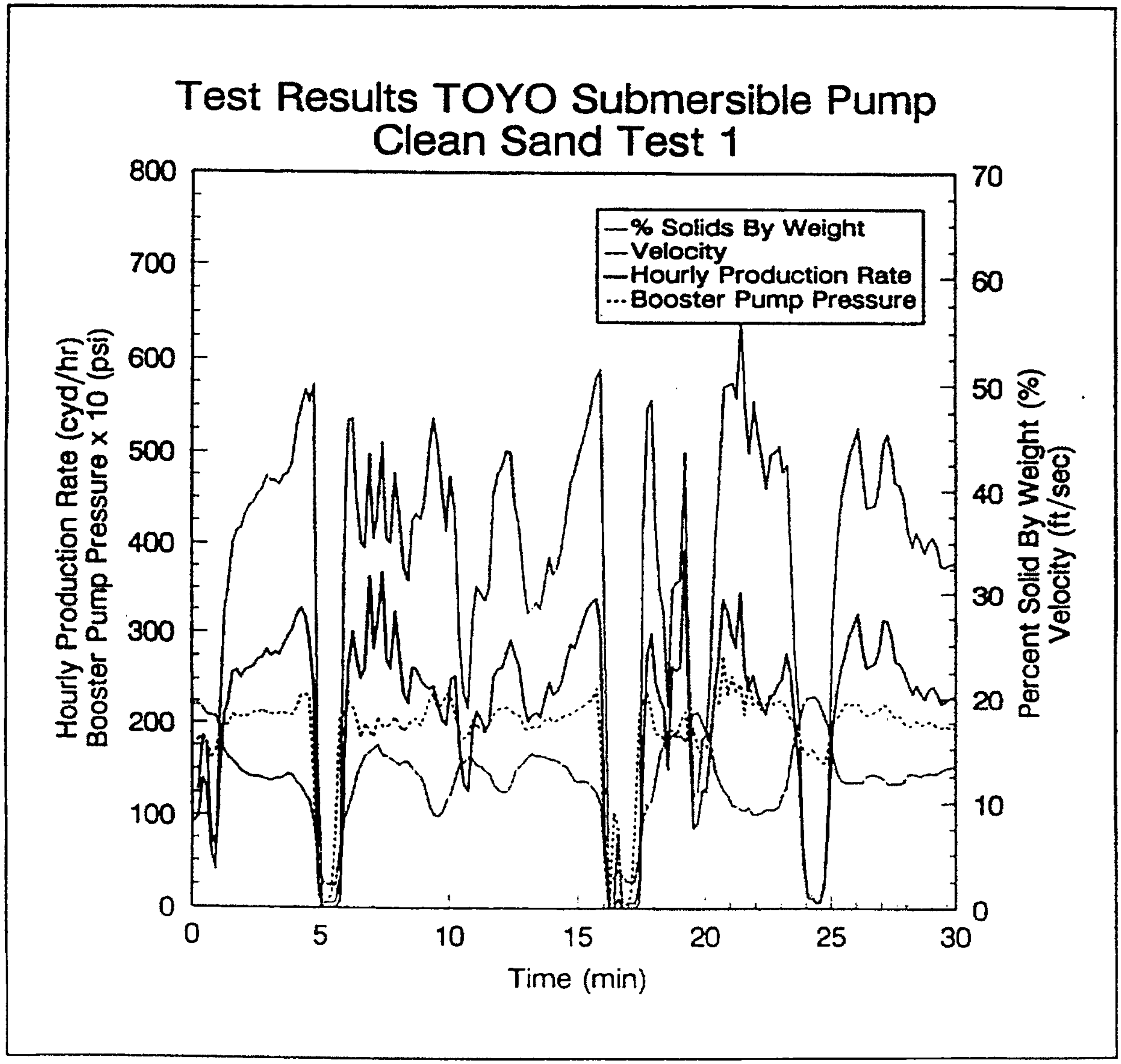
APPENDIX B

RESULTS FROM THE TOYO AND H&H SUBMERSIBLE PUMPS



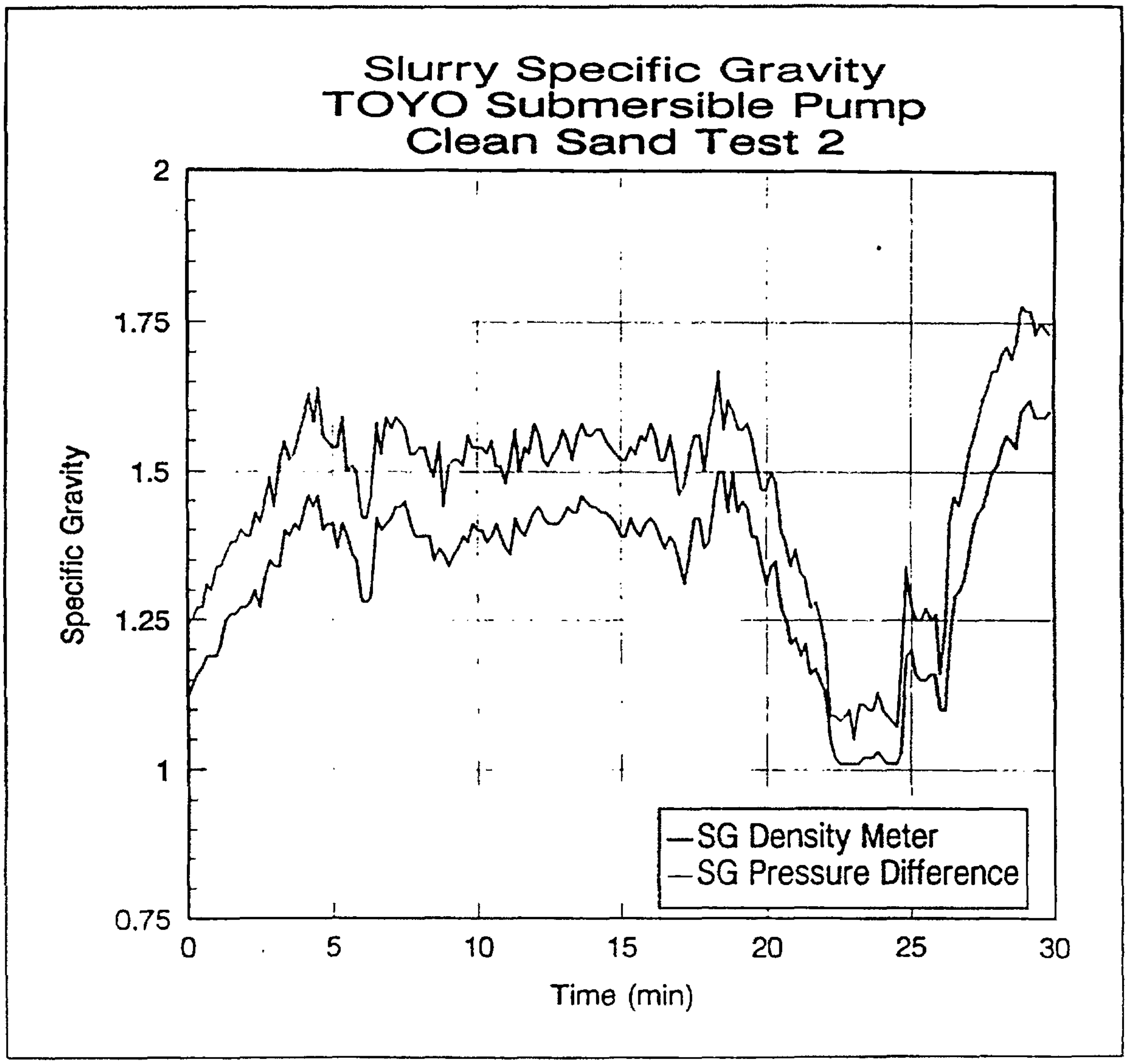
Slurry Specific Gravity
TOYO Submersible Pump
Clean Sand Test 1
—SG Density Meter
—SG Pressure Difference
Specific Gravity
2
1.75
1.5
1.25
1
0.75
0
5
10
15
20
25
30
Time (min)

Plate B71



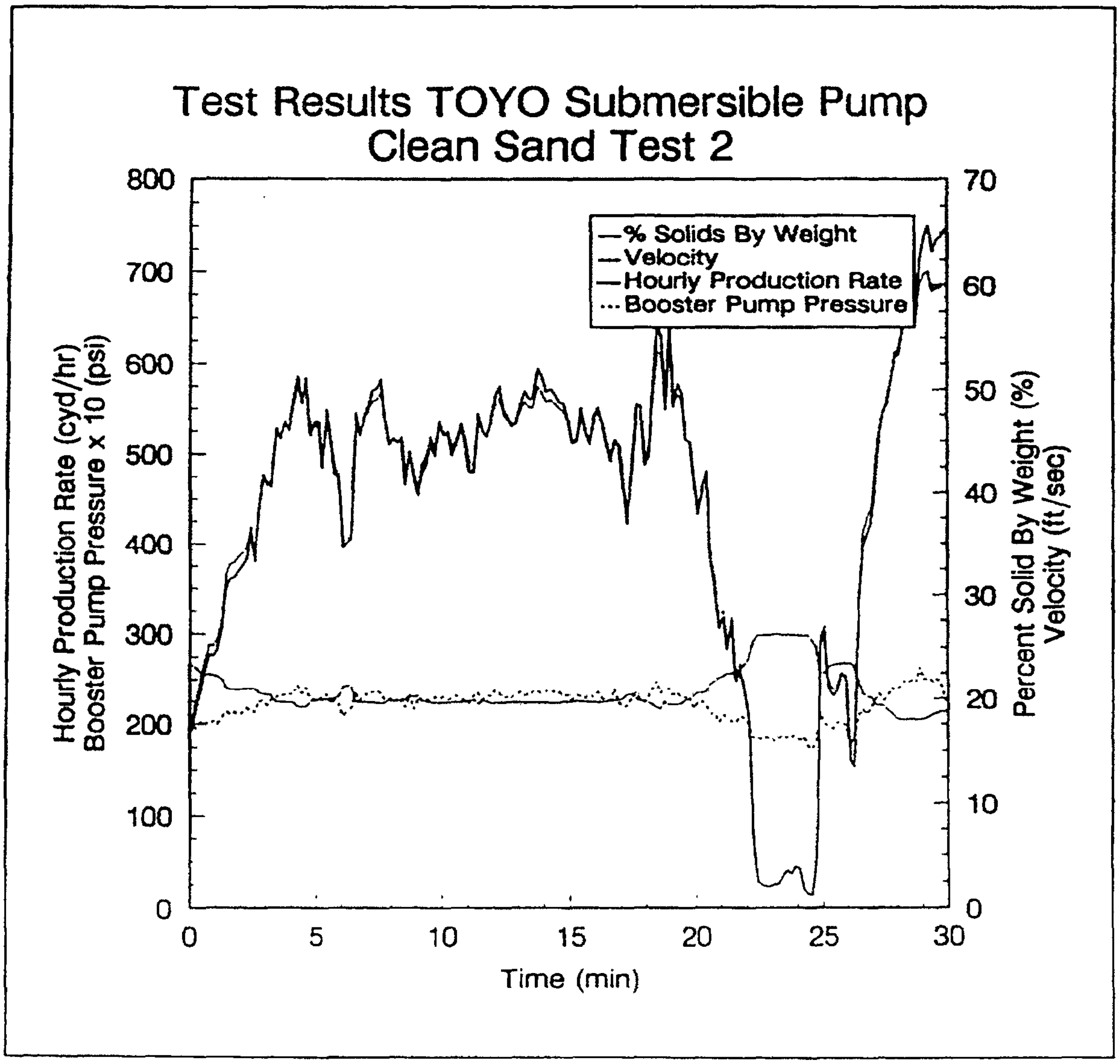
Test Results TOYO Submersible Pump
Clean Sand Test 1
% Solids By Weight
Velocity
Hourly Production Rate
Booster Pump Pressure
Hourly Production Rate (cyd/hr)
Booster Pump Pressure x 10 (psi)
Percent Solid By Weight (%)
Velocity (ft/sec)
Time (min)
0
100
200
300
400
500
600
700
800
10
20
30
40
50
60
70
5
15
25

Plate B39



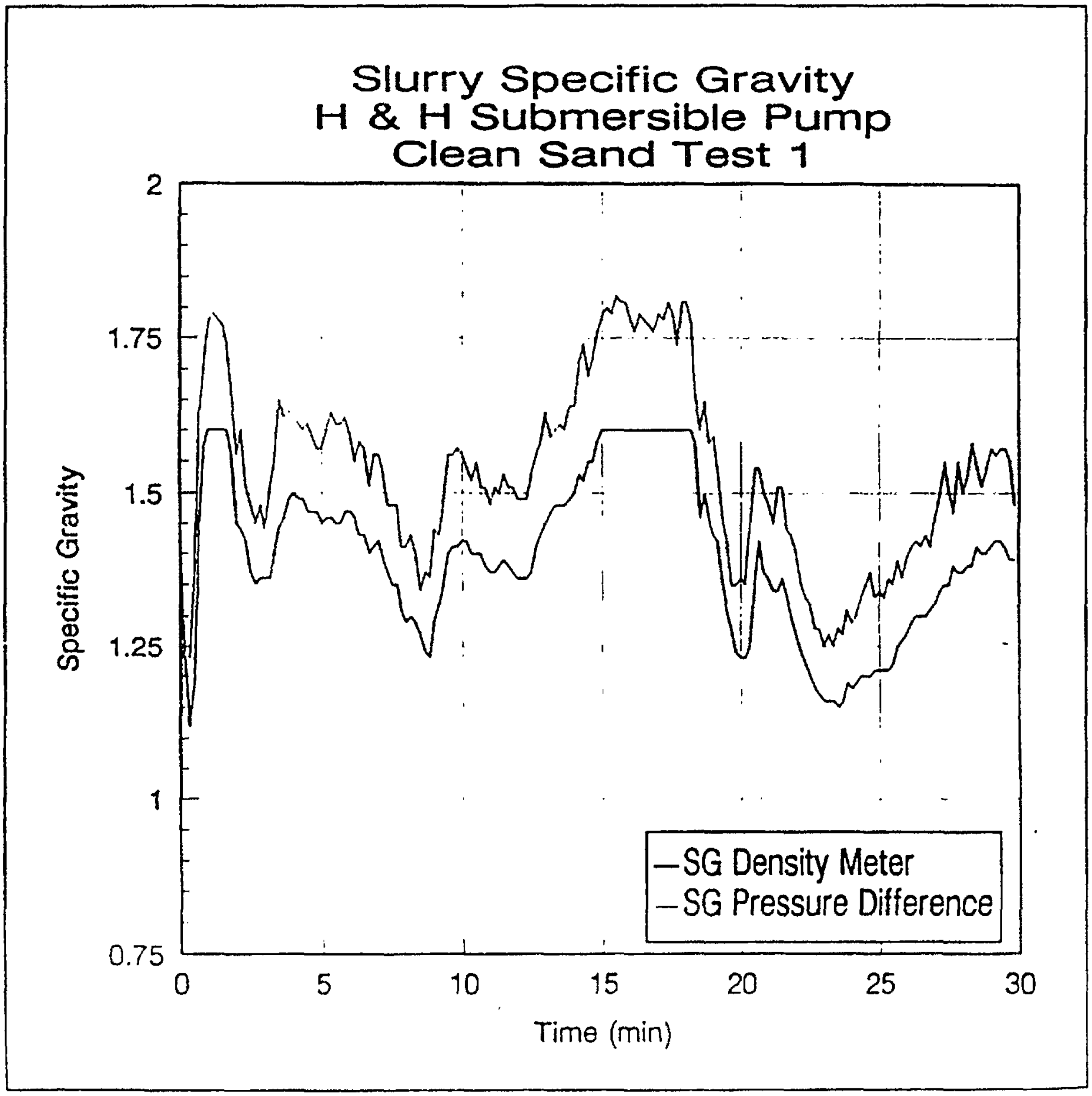
Slurry Specific Gravity
TOYO Submersible Pump
Clean Sand Test 2
Specific Gravity
2
1.75
1.5
1.25
1
0.75
0
5
10
15
20
25
30
Time (min)
—SG Density Meter
—SG Pressure Difference

Plate B73



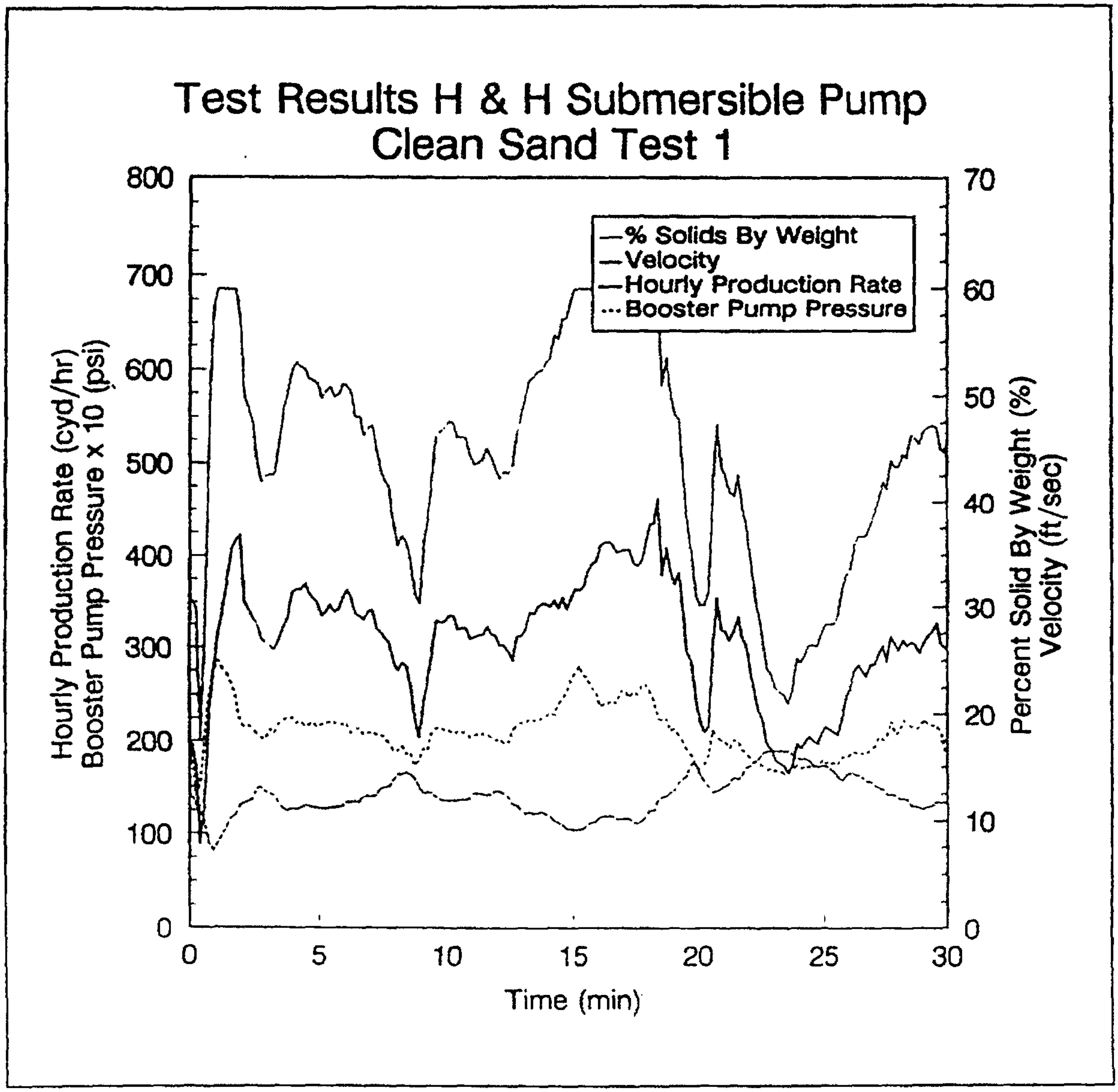
Test Results TOYO Submersible Pump
Clean Sand Test 2
% Solids By Weight
Velocity
Hourly Production Rate
Booster Pump Pressure
Hourly Production Rate (cyd/hr)
Booster Pump Pressure x 10 (psi)
Percent Solid By Weight (%)
Velocity (ft/sec)
Time (min)
0
100
200
300
400
500
600
700
800
10
20
30
40
50
60
70
5
15
25

Plate B40



Slurry Specific Gravity
H & H Submersible Pump
Clean Sand Test 1
Specific Gravity
2
1.75
1.5
1.25
1
0.75
0
5
10
15
20
25
30
Time (min)
—SG Density Meter
—SG Pressure Difference

Plate B64



Test Results H & H Submersible Pump
Clean Sand Test 1
% Solids By Weight
Velocity
Hourly Production Rate
Booster Pump Pressure
Hourly Production Rate (cyd/hr)
Booster Pump Pressure x 10 (psi)
Percent Solid By Weight (%)
Velocity (ft/sec)
Time (min)
0
100
200
300
400
500
600
700
800
0
10
20
30
40
50
60
70
0
5
10
15
20
25
30

Plate B31

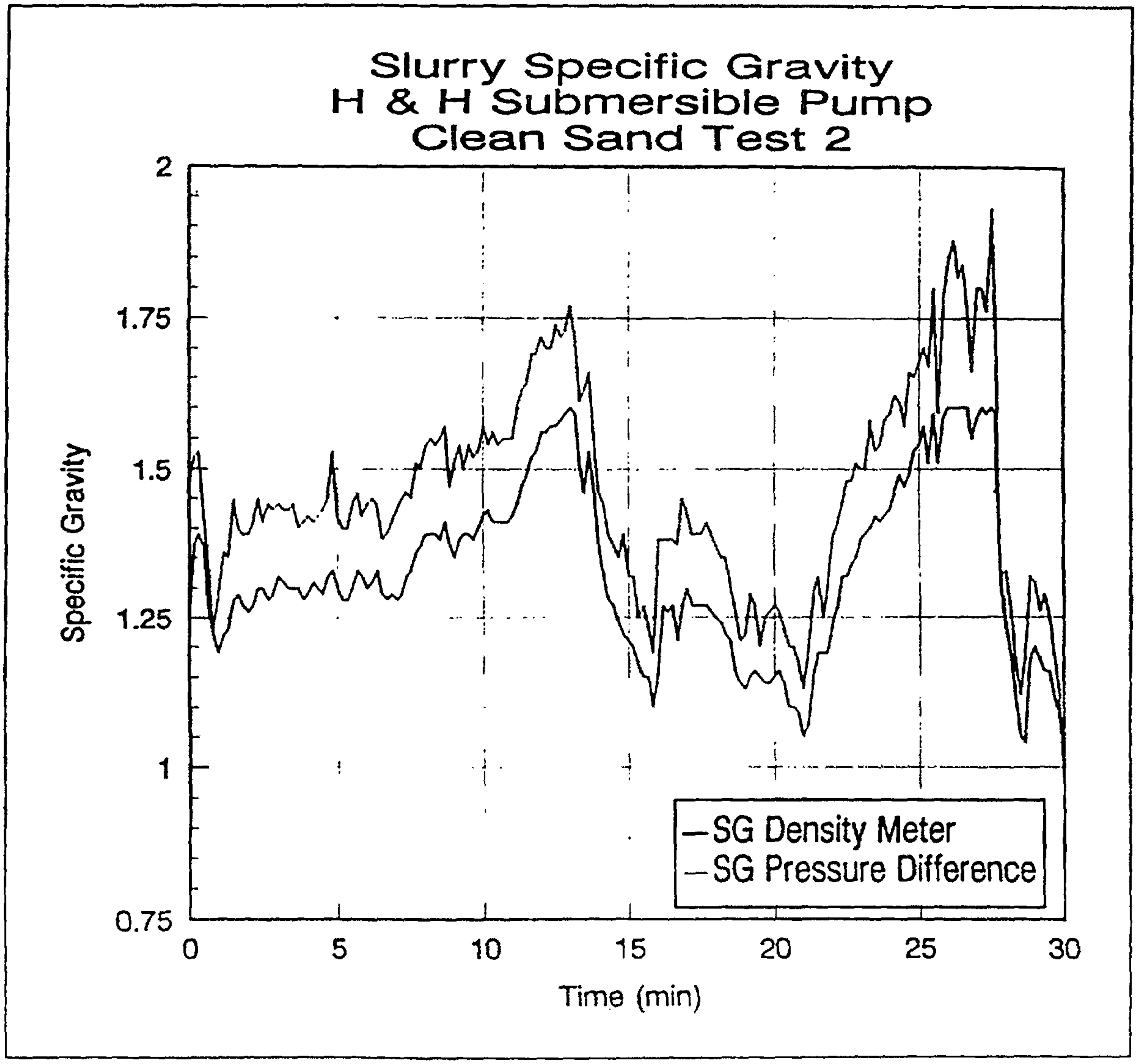
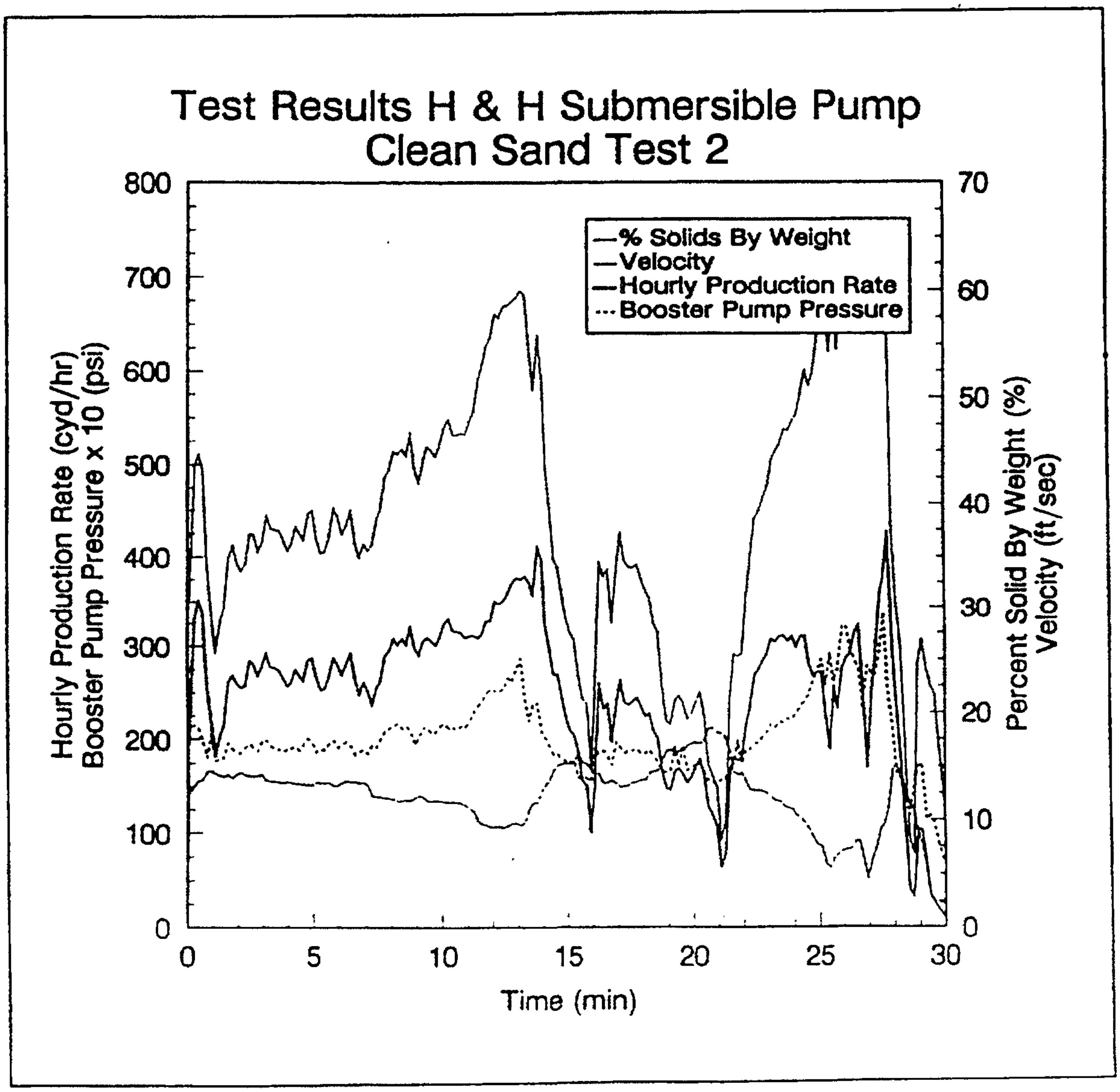

Slurry Specific Gravity
H & H Submersible Pump
Clean Sand Test 2
Specific Gravity
2
1.75
1.5
1.25
1
0.75
0
5
10
15
20
25
30
Time (min)
SG Density Meter
SG Pressure Difference

Plate B65



Test Results H & H Submersible Pump
Clean Sand Test 2
Hourly Production Rate (cyd/hr)
Booster Pump Pressure x 10 (psi)
Percent Solid By Weight (%)
Velocity (ft/sec)
Time (min)
% Solids By Weight
Velocity
Hourly Production Rate
Booster Pump Pressure
800
700
600
500
400
300
200
100
0
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30

Plate B32