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ENGINEERING EVALUATION/ COST ANALYSIS REPORT

Area 5106 Removal Action
Former OCC Tacoma Facility
Tacoma, Washington

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EXECUTIVE SUMMARY

Background

On September 29, 1989, a Record of Decision (ROD) was issued by the United States Environmental Protection Agency (USEPA) for the Commencement Bay Nearshore/Tideflats (CB/NT) Superfund Site, which includes the Hylebos Waterway. As required by the ROD, the Hylebos Cleanup Committee (HCC) conducted a Hylebos Waterway Pre-Remedial Design (PRD) Study to provide additional information for implementation of the ROD. The PRD Study included the collection and analysis of sediment samples from the Hylebos Waterway in 1994, including one sample from a location identified as Station 5106. This location is downstream from the 11th Street bridge, in the area known as the mouth of the Hylebos Waterway, and about 100 feet into the Hylebos Waterway from the bank of the former OCC Tacoma, Inc. (OCCT) Facility located at 605 Alexander Avenue in Tacoma, Washington (currently know as the Pioneer Facility). The analytical results from the Station 5106 sample showed elevated levels of chlorinated organics solvents, specifically tetrachloroethene (PCE) and trichloroethene (TCE). Additional samples taken in the vicinity of Station 5106 confirmed the earlier sample results. The test results indicated that the sediments in the vicinity of Station 5106 may not be appropriate for disposal with the remainder of the Hylebos Waterway sediments under any of the disposal options being considered in the PRD Study and, therefore, needed to be addressed independently.

In November 1997, the USEPA and OCCT voluntarily entered into an Administrative Order on Consent (AOC) (Docket No. 10-97-0011-Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]) to address the sediments in the vicinity of Station 5106, hereafter referred to as Area 5106 Sediment, as a non-time-critical removal action under the CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The AOC also addresses the embankments of the properties at 605 and 709 Alexander Avenue, referred to as the Embankment Area. However, the embankment chemistry and concentrations, the recommended removal action, and its implementation schedule are substantially different from that outlined for the Area 5106 Removal Action. Therefore, the Embankment Area Removal Action will be addressed in a separate Engineering Evaluation/Cost Analysis (EE/CA).

As required by the NCP, an EE/CA must be completed for all non-time-critical removal actions. The goals of the EE/CA are to identify the objectives of the removal action and to analyze in terms of cost, effectiveness, and implementability the various alternatives that may be used to satisfy the objectives. This report presents the EE/CA for the

Area 5106 Sediment, and concludes with a recommended removal action alternative, which is consistent with the Hylebos Waterway remedial action.

The scope of the removal action is to address contaminated sediment with different chemical constituents and concentrations than those found in surrounding Hylebos Waterway sediment and that, if removed, would require treatment prior to disposal. As such, the criteria for the removal action are not established by Sediment Management Standards (SMSs) or Sediment Quality Objectives (SQOs). Sediment, that remains following the Area 5106 Removal Action, which exceeds SQOs but does not require treatment, will be addressed in accordance with the ROD as part of the Hylebos Waterway remedial action.

Site Characterization

Area 5106 Sediment is defined as those sediments which, if placed in a disposal site with dredged Hylebos sediment, without treatment, could cause the disposal site to fail relevant marine Water Quality Criteria (WQC)[1] at the regulatory point of compliance. Conversely, if sediment is determined to be acceptable for placement in the disposal site, that sediment is considered boundary sediment and not Area 5106 Sediment.

An investigation was performed to characterize the source, nature, and extent of the chemicals in and near Area 5106. Initially, the investigation focused on historical operations and waste management practices at the former OCCT Facility. Based on the available information, it was determined that the chemicals present within Area 5106 resulted from historical operations which no longer exist. These operations included:

i) a chlorinated solvents process which produced TCE and PCE from 1947 to 1973;

ii) shipbuilding activities from World War I through 1946; and

iii) shipyard and ship demolition activities from 1946 to the mid 1980s.

Once the probable source of the chemistry was determined, the limits of the Area 5106 Sediment was established based upon an extensive program of sampling, analysis, and evaluation. Consistent with the above definition of Area 5106 Sediment, the

[1] Marine Water Quality Criteria for compounds detected in the Area 5106 Sediment are presented in Table 2.6. To the extent available, the criteria are referenced from "National Recommended Water Quality Criteria: (EPA 822-2-99-001, April 1999) and from "Water Quality Standards for Surface Waters on the State of Washington: (Chapter 173-201A WAC, last updated 11/18/97). For chemicals with no promulgated standard, the marine WQC is based on the Lowest Observed Effect Level (LOEL) obtained from various references.

methodology utilized to determine the boundary of Area 5106 Sediment was based on the criteria for disposal of dredged sediments into a nearshore confined disposal facility (CDF). Discharges from a CDF are regulated under the Clean Water Act (CWA) and must not result in exceedance of marine WQC at the point of discharge into the receiving water (i.e., in seeps that discharge through the CDF berm). Acceptability of a dredged sediment for placement in a CDF is determined using a combination of laboratory tests (column leach tests [CLTs]) and groundwater flow and contaminant transport modeling. The CLTs simulate the salt washout effects and chemical mobility of the dredged sediments once placed in a CDF influenced by upland groundwater. The groundwater flow and transport model simulates the various attenuation processes (such as tidal dispersion, biodegradation, and sorption) which occur within the CDF and predicts the chemical concentrations at the point of compliance. Comparison of the predicted water quality with relevant marine WQC determines whether the sediment represented by the CLT is acceptable for placement within the CDF without treatment.

The boundary of Area 5106 was determined utilizing the following methodology:

i) three potential horizontal boundaries were estimated based on the concentrations of PCE, TCE, ethylbenzene, and hexachlorobutadiene (HCBD) in porewater extracted from sediment samples (see Figure 3.1);

ii) one potential vertical boundary was estimated based on the concentrations of PCE, TCE, ethylbenzene, and HCBD in leachate obtained from native sand sediments utilizing the Synthetic Precipitation Leaching Procedure (SPLP) (porewater could not be extracted from the native sand sediments);

ii) CLTs were performed on composite samples collected from each of the four estimated boundaries. Each CLT was representative of the sediment just outside the estimated boundary; and

iv) the leachate concentrations from the CLTs were utilized in the groundwater flow and contaminant transport model to predict the long-term quality of the water that may ultimately discharge from the disposal site to the adjacent surface waters.

The disposal site analysis predicts that seepage concentrations from the CDF will be significantly below the relevant marine WQC and will present no long-term water quality concerns for the boundary sediment represented by all four CLTs. Therefore, the boundary sediments represented by all four CLTs were determined to be acceptable for placement within the CDF without treatment, thereby confirming the boundary of the Area 5106 Sediment.

Based upon the confirmed horizontal and vertical boundaries, Area 5106 Sediment includes an estimated in situ volume of 22,300 cubic yards (c.y.) and covers approximately 2.15 acres (see Figure 7.3 for limits of Area 5106 Sediment).

Following the boundary confirmation, the chemical and physical characteristics of the Area 5106 Sediment were determined through sampling, analysis, and testing of collected Area 5106 Sediment:

i) the stratigraphy within the Area 5106 Study Area generally consists of fill, recent fine grained sediment, visual 5106-like material, and native sandy sediment. The visual 5106-like material includes both Area 5106 Sediment and material that has the same physical properties but not the chemical properties;

ii) surface sediment concentrations exceed (SQOs but are significantly lower than subsurface sediment concentrations; and

iii) the primary organic chemicals present in the Area 5106 Sediment are PCE, TCE, dichloroethene (DCE), vinyl chloride (VC), hexachlorobenzene (HCB), and HCBD.

Scope of Removal Action

The scope of the removal action is to address contaminated sediment with different chemical constituents and concentrations than those found in surrounding Hylebos Waterway sediment and that, if removed, require treatment prior to disposal. The removal action will contribute to the efficient implementation of the Hylebos Waterway remedial action by addressing the Area 5106 Sediments so that the surrounding sediment may be remediated and monitored in accordance with the ROD.

Removal Action Objectives

The goal of the non-time critical removal action for Area 5106 Sediment is to reduce the potential exposure to Area 5106 Sediment in such a way as to be protective of human health and the environment, and to the extent practicable considering the exigencies of the situation, attain Applicable or Relevant and Appropriate Requirements (ARARs).

Specific removal action objectives for Area 5106 Sediment include the following:

i) reduce the availability of impacted sediments (both surface and subsurface) to the waterway and marine ecosystem in order to mitigate impacts to the environment;

ii) reduce the migration of impacted sediments from Area 5106 Sediment to mitigate impacts on the environment beyond Area 5106 Sediment;

iii) reduce the potential future exposure of the marine ecosystem and/or human receptors resulting from ongoing industrial/shipping activities, maintenance dredging, and future accidents/catastrophes (of natural or human origin) which may exacerbate release of and exposure to contaminants; and

iv) ensure that porewater within 0 to 10 cm of the sediment surface meets relevant marine WQC.

Development of Removal Action Alternatives

Following the site characterization, potentially applicable removal action technologies for the containment, removal, treatment, and disposal of the Area 5106 Sediment were identified. The technologies were initially screened based on implementability for the site conditions and sediment characteristics. Those technologies which were not technically feasible to implement or whose effectiveness would be less than another comparable technology were eliminated from further consideration. The retained technologies were evaluated based on effectiveness, implementability, and cost considerations. The strengths and limitations of each retained technology were evaluated in order to facilitate the combination of technologies into removal action alternatives.

Preliminary removal action alternatives were developed from the retained technologies in order to evaluate how the technologies must interact to achieve a successful removal response. Twelve preliminary removal action alternatives were identified and assessed based on relative effectiveness, implementability, and costs (see Table 5.15). In conjunction with the alternative assessment, preliminary technology modeling and testing were performed to evaluate the potential of a technology to meet the removal action objectives.

Based on the preliminary technology evaluation, the alternative assessments, and the preliminary model/testing, the most promising containment, removal, treatment, and disposal technologies were identified for additional study and evaluation. The additional technology evaluations included:

i) Bench Scale Treatability Study - Bench scale treatability tests were performed in the laboratory to assess the effectiveness of the Slurry Aeration treatment process;

ii) Dredging Controls - Potential engineering controls to limit impacts to water quality during dredging were evaluated;

iii) Water Quality Test - A limited dredging test was performed in the Hylebos to measure the water quality resulting from dredging operation and to collect material for the treatability study; and

iv) Disposal Site Analysis - Additional disposal site modeling was performed to determine the practicable level of treatment required for the disposal of treated Area 5106 Sediment in a CDF to be constructed at the Port of Tacoma Slip 1.

Based on the technology evaluations, the following removal action alternatives were developed for detailed evaluation and analysis in the EE/CA:

i) Alternative A - No Action (Natural Recovery):

- no removal action would be performed,
- long-term annual inspection, sampling, and analysis would be performed to monitor the rate of natural recovery;

ii) Alternative B - Containment (see Figure 7.1):

- containment would be achieved utilizing an armored sand cap,
- institutional controls would be implemented to restrict future dredging and ship anchoring in the vicinity of the cap,
- long-term inspection and monitoring would be performed to ensure the caps continued effectiveness;

iii) Alternative C - Removal/Treatment/Disposal (see Figure 7.3):

- Area 5106 Sediment would be removed utilizing a combination of TOYO pump (refer to Appendix G, Page G-5, for a discussion of TOYO Pump) and mechanical dredging,
- the removed sediment would be treated using the Slurry Aeration treatment process, and
- the treated sediment would be transported to the Slip 1 CDF for disposal; and

iv) Alternative D - Combined Containment and Removal (see Figure 7.7):

- the portion of Area 5106 Sediment located on Pioneer property would be capped including the Area 5106 Sediment located under Pioneer Dock No. 1, and
- the portion of Area 5106 Sediment from the face of the docks into the Hylebos would be removed, treated, and disposed as described in Alternative C.

Evaluation

Each of the Alternatives were evaluated against short- and long-term aspects of the broad CERCLA criteria: effectiveness, implementability, and costs. A comparative analysis (ranking) of the four removal action alternatives, performed as part of the evaluation, is summarized below (1=best, 4=worst).

	Removal Action Alternatives			
	A No Action (Natural Recovery)	*B Containment*	*C Removal/ Treatment/ Disposal*	*D Combined Containment and Removal*
Effectiveness:				
• Overall Protection of Public Health and the Environment	4	2	1	2
• Compliance with ARARs	4	1	2	3
• Long-Term Effectiveness and Permanence	4	2	1	2
• Reduction of Toxicity, Mobility, or Volume	4	3	1	2
• Short-Term Effectiveness	1	2	4	3
Implementability:				
• Technical Feasibility	2	1	3	3
• Availability	NA	1	1	1
• Administrative Feasibility	3	4	1	2
Cost:	$0.85 MM	$3.26 MM	$11.05 MM	$9.27 MM

When properly designed and implemented, Alternatives B, C, and D all meet the removal action objectives. Each alternative is consistent with the ROD and complies with the substantive requirements of the ARARs. Selection of the removal action alternative for the Area 5106 Removal Action, however, was based on a balancing of short-term and long-term environmental risk, technical feasibility, and cost of each alternative.

Alternative B is clearly the least costly removal action. A well designed, properly constructed, armored sand cap over the Area 5106 Sediment would provide effective protection of human health and the environment if properly and regularly maintained for the life of the cap. Implementation of institutional controls and long-term monitoring and maintenance would be required to assure the continued effectiveness over time. The required institutional controls may be difficult to implement. While short-term environment risks are expected to be lower than both Alternatives C and D, there are long-term environmental risks associated with leaving Area 5106 Sediment in place.

Alternative C meets the USEPA preference for removal and treatment, and provides the highest level of overall protection of human health and the environment. Alternative C, however, is the highest cost alternative and there are short-term environmental risk related to the water quality impacts during dredging of the Area 5106 Sediment. The long-term environmental risk associated with Alternative C is relatively low following removal of the Area 5106 Sediment from the Waterway and subsequent treatment prior to disposal in the Slip 1 CDF.

Alternative D combines the environmental risk and feasibilities of both Alternatives B and C. While the cost of Alternative D is lower than that of Alternative C, the difference does not justify the long-term risk associated with leaving a portion of Area 5106 Sediment in place. Once a treatment facility is designed and constructed, the remainder of the Area 5106 Sediment from beneath the docks can be removed, treated, and disposed of at a reasonable marginal cost.

Recommendations

Alternative C is selected as the recommended removal action alternative. After weighing the short-term and long-term risks, technical feasibility, and relative cost, the long-term effectiveness of removal of Area 5106 Sediment under Alternative C outweighs the lower short-term risks and cost associated with Alternative B.

The selection of Alternative C is based upon the scope and assumptions outlined in this EE/CA Report. If changes are required that fundamentally alter the scope, cost or performance of the removal action, selection of Alternative C may be reconsidered.

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GLOSSARY

ASIL	Acceptable Source Impact Levels
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirement
BA	Biological Assessment
Boundary Sediments	Those sediments surrounding Area 5106 Sediment that are acceptable for disposal in Slip 1 without treatment
CAD	Confined Aquatic Disposal; the subquatic disposal of dredged sediment and capping with appropriate material
CAMU	Corrective Action Management Unit
CAPP	Confined Alternative Assessment Procedure
CB/NT	Commencement Bay Nearshore/Tideflats
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	Cubic Feet Per Minute
CHCC	Visual Horizontal Boundary Composite
CLT	Column Leach Test
CST	Column Settling Test
CWA	Clean Water Act
DRET	Dredging Elutriate Test
EE/CA	Engineering Evaluation/Cost Analysis
ESA	Endangered Species Act
Facility	The Former OCCT Facility at 605 Alexander Avenue, Tacoma
GPS	Global Positioning System
HASP	Health and Safety Plan
HCC	Hylebos Cleanup Committee
HCBD	Hexachlorobutadiene
HSA	Hollow-Stem Auger
H:V	Horizontal Value
IHBC	Inner Horizontal Boundary Composite
LTTD	Low Temperature Thermal Desorption
MCL	Maximum Contaminant Level
MET	Modified Dredging Elutriate Test
MLLW	Mean Lower Low Water

GLOSSARY

MWQ	Marine Water Quality
NCP	National Oil and Hazardous Substances Contingency Plan
Nearshore Disposal	Confined disposal of dredged sediments in a nearshore environment that utilizes shoreline as part of containment structure for disposal site
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
O&M	Operation and Maintenance
OCCT	OCC Tacoma, Inc.
OCCT Property	The property at 709 Alexander Avenue, Tacoma, previously owned by PRI Northwest and now owned by OCCT, Inc.
OHBC	Outer Horizontal Boundary Composite
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethene
Pioneer	Pioneer Chlor Alkali Company, Inc.
POT	Port of Tacoma
PRD	Pre-Remedial Design
PTTE	Preliminary Treatment Technology Evaluation
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SMS	Sediment Management Standards
SPLP	Synthetic Precipitation Leaching Procedure
SQO	Sediment Quality Objective
SVOC	Semi-Volatile Organic Compound
TCBD	Tetrachlorobutadiene
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TIC	Tentatively Identified Compound
Tremie	Placement of materials under water using pipes or tubes to reach the bottom
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers

GLOSSARY

USC	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fisheries and Wildlife Service
VBC	Vertical Boundary Composite
VOC	Volatile Organic Compound
WES	USACE Waterway Experiment Station
WMU	Waste Management Unit
WQC	Water Quality Criteria

1.0 INTRODUCTION

The United States Environmental Protection Agency (USEPA) and OCC Tacoma, Inc. (OCCT) voluntarily entered into an Administrative Order on Consent (AOC) (Docket No. 10-97-0011- Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]) in November 1997. The AOC concerned the implementation of Removal Response Activities in the area of the Hylebos Waterway referred to as Area 5106 and the Embankment Areas of the properties located at 605 and 709 Alexander Avenue, Tacoma, Washington. The property at 605 Alexander Avenue, formerly owned and operated by OCCT, is currently owned by Pioneer Chlor Alkali Company (Pioneer). OCCT currently retains ownership of the former PRI property at 709 Alexander Avenue.

The AOC required completion of an Engineering Evaluation/Cost Analysis (EE/CA) of removal action alternatives for Area 5106 Sediment. The work performed as part of the Area 5106 Sediment EE/CA included:

i) an Area 5106 Background Data Report;

ii) an Area 5106 Sediment Characterization Report;

iii) a Column Leach Test (CLT) Evaluation Report;

iv) a Preliminary Treatment Technology Evaluation (PTTE) Report;

v) a Evaluation of Dredging Controls Report;

vi) a Water Quality Test Report;

vii) a Bench Scale Treatability Study Report; and

viii) Treatment Criteria - Slurry Aeration Treatment.

The above reports are referenced in this report.

This EE/CA Report summarizes the activities conducted during the above-referenced evaluations and recommends an Area 5016 removal action alternative. This EE/CA Report follows the approach recommended in the "Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA" (USEPA Publications 9360.0-32, August 1993) (EE/CA Guidance), and is organized as follows:

Section 1.0 - Introduction

Section 2.0 - Site Background including Site description and background; surrounding land use; ecological conditions; and summaries of previous and recent investigations

Section 3.0 - Site Characterization including chemical and physical characterization and streamlined risk evaluation

Section 4.0 - Identification of Removal Action Goals and Objectives

Section 5.0 - Identification and Analysis of Removal Action Technologies

Section 6.0 - Water Quality Assessments

Section 7.0 - Identification of Removal Action Alternatives

Section 8.0 - Analysis of Removal Action Alternatives

Section 9.0 - Comparative Analysis of Removal Action Alternatives

Section 10.0 - Recommendation

Section 11.0 - Schedule

Section 12.0 - References

2.0 SITE BACKGROUND

2.1 BACKGROUND

On September 29, 1989, a Record of Decision (ROD) was issued by USEPA for the Commencement Bay Nearshore/Tideflats (CB/NT) Superfund Site, which includes the Hylebos Waterway. The remedy established cleanup standards called Sediment Quality Objectives (SQOs) and selected containment of contaminated sediments which consisted of four options. These included in-place capping and three disposal options following sediment dredging: confined aquatic disposal (CAD), nearshore disposal, and upland disposal.

As required by the ROD, the Hylebos Cleanup Committee (HCC) conducted a Hylebos Waterway Pre-Remedial Design (PRD) Study to provide additional information for implementation of the ROD. The PRD Study included the collection and analysis of sediment samples from the Hylebos Waterway in 1994, including one sample from a location identified as Station 5106. This location is downstream from the 11th Street bridge, in the area known as the mouth of the Hylebos Waterway, and about 100 feet into the Hylebos Waterway from the bank of the former OCCT facility. The analytical results from the Station 5106 sample showed elevated levels of chlorinated organic solvents, specifically tetrachloroethene (PCE) and trichloroethene (TCE). Subsequently, additional samples taken in the vicinity of Station 5106 confirmed the earlier sample results. The test results indicated that the sediments in the vicinity of Station 5106 may not be appropriate for disposal with the remainder of the Hylebos Waterway sediments under any of the disposal options being considered in the PRD Study and, therefore, need to be addressed independently. OCCT and USEPA entered into the 1997 AOC to address these sediments, hereafter referred to as Area 5106 Sediment. Area 5106 Sediment includes those sediments which, if placed without appropriate treatment in a disposal site with dredged Hylebos Waterway sediment, could cause the disposal site to fail relevant marine Water Quality Criteria (WQC)[1] at the regulatory point of compliance.

The location of the Area 5106 Sediment is referred to in this report as Area 5106 or the Site.

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1 Marine Water Quality Criteria for compounds detected in the Area 5106 Sediment are presented in Table 2.6. To the extent available, the criteria are referenced from "National Recommended Water Quality Criteria: (EPA 822-2-99-001, April 1999) and from "Water Quality Standards for Surface Waters on the State of Washington: (Chapter 173-201A WAC, last updated 11/18/97). For chemicals with no promulgated standard, the marine WQC is based on the Lowest Observed Effect Level (LOEL) obtained from various references.

2.2 SITE LOCATION AND DESCRIPTION

The former OCCT Facility (Facility) is located at 605 Alexander Avenue in Tacoma, Washington. The Facility is approximately 33 acres in size. The Facility is bounded on the northwest by the Port of Tacoma (POT) property, on the southwest by Alexander Avenue, on the northeast by the Hylebos Waterway, and on the southeast by an OCCT property formerly owned by PRI. Figure 2.1 is a Site location map for Area 5106 (Site). Figure 2.2 presents a Site Plan showing Area 5106 in relation to adjoining properties. From hereon, north will be considered to be true northwest, that is, parallel to the Hylebos Waterway and toward the mouth.

Area 5106 Sediment is located in the Hylebos Waterway, one of eight waterways within Commencement Bay, Tacoma, Washington. The Hylebos Waterway is approximately 2.5 miles long. The former OCCT Facility is located approximately 0.75 miles south of the mouth of the Hylebos Waterway. A 200-foot wide shipping channel exists within the Hylebos Waterway and is maintained by the U.S. Army Corps of Engineers (USACE) to a minimum depth of 30 feet below mean lower low water (MLLW). The Site encompasses the Area 5106 Sediment, which extends into the Hylebos Waterway and beneath two active docks (Pioneer Dock No. 1 and a portion of the POT Pier 25) adjacent to Station 5106. The west shipping channel line of the Hylebos Waterway is located 100 feet east and parallel to the face of Dock No. 1. Area 5106 Sediment extends from 0-foot MLLW along portions of the Pioneer and POT embankment of the Hylebos Waterway east into the shipping channel. The general dimensions of Area 5106 Sediment are 800 feet in length and 100 to 150 feet in width (see Figure 2.2). The Hylebos Waterway from the face of the docks and into the shipping channel is owned by the POT, and therefore the Area 5106 Sediment is located on property owned by Pioneer and the POT. Portions of POT Pier 25 are currently leased and operated by Trident Seafoods.

2.3 SITE OPERATION

The Facility began operating in 1929, producing chlorine and caustic soda by the electrolysis of sodium chloride brine. Those products were produced by OCCT at the Facility until June 17, 1997, when OCCT sold the Facility to Pioneer. Other products manufactured at the Facility from time to time included hydrogen, muriatic acid, hydrogenated fish oils, ammonia, ammonium hydroxide, sodium aluminate, calcium

hydroxide solution, calcium chloride solution, sodium hypochlorite solution, and oxygen. During World War II, the Defense Plant Corporation, at that time an agency of the United States Government, constructed a plant at the Facility for the production of aluminum chloride.

The northern section of the Facility, adjacent to Area 5016, was acquired by OCCT from Todd Shipyards in 1937. A series of aerial photographs covering the period from 1936 to 1980 were included in the Area 5106 Background Data Report submitted to USEPA in November 1997. These aerial photographs and historical drawings confirm that the area was the site of heavy industrial activities (especially shipbuilding), most likely during World War I and subsequent years. In aerial photographs from 1936, extensive ground discoloration in the area reveals the location of numerous buildings that had been demolished. Between 1941 and 1946, the area was leased for war-related shipyard activities undertaken by the United States Navy and Todd Shipyards (Navy/Todd). Those activities included the use of the Embankment Area for waste incineration and disposal. According to Navy maps and historical photographs, an incinerator and landfill were located near the shoreline. Historical aerial photographs provide "before and after" views of the Navy/Todd dump site, showing the landfilling of waste that expanded the embankment area into the Hylebos Waterway. The final alignment of the shoreline adjacent to Area 5106 was essentially complete by the time the Navy and Todd Shipyards ceased activities in 1946. However, the property north of the Facility, now known as the Port Industrial Yard at 401 Alexander Avenue, was owned and operated by the Navy as a Naval Station from 1946 to 1960. Tacoma Naval Station was the site for vessel storage, maintenance, and demolition. Thereafter, until the mid-1980s, Zidell Dismantling leased that property from the POT and demolished additional Navy vessels and other equipment. AKWA Shipbuilding also engaged in ship repairs and conversions at the Port Industrial Yard. Recent inspection and sampling events conducted on the Facility's Embankment Area confirm the presence of shipyard and demolition waste.

From 1947 to 1973, a chlorinated solvents process, producing TCE and PCE, was in operated on the northern section of the Facility proximate to Area 5106. During the first year of production, effluent from the process was discharged directly to the Hylebos Waterway. That effluent consisted of an aqueous slurry composed of byproduct calcium chloride, lime, and traces of chlorinated organics. From approximately 1949 to 1952, and again in 1972 to 1973, the process effluent was passed through one of a series of upland ponds where the solids settled out, and the supernatant was discharged to the Hylebos Waterway. During the period from 1952 to 1972, the effluent was discharged to a barge berthed alongside the present northern walking pier (Pioneer Dock No. 1, proximate to

Area 5106). The solids settled in the barge, and the supernatant was discharged to the Hylebos Waterway. The solids in the barge were taken to a deep water disposal site. Solids that overflowed the barge were dredged for deep water disposal pursuant to permits. Between 1949 and 1971, a small landfill adjacent to the Hylebos Waterway was used for the disposal of spent lime and calcium chloride from the chlorinated solvents process.

Based upon currently available information, the chemicals detected in and near Area 5106 resulted from historical operations that no longer exist--the chlorinated solvents process, shipyard activities, and ship/equipment demolition.

2.4 WASTE MANAGEMENT PRACTICES

An investigation into past and current Waste Management Unit (WMUs) for the Facility was performed in preparation for OCCT's Resource Conservation and Recovery Act (RCRA) Part B Permit application of October 1985, revised in December 1986. Aerial photographs of the former OCCT Facility have also been studied to identify and confirm the locations of possible landfills along the Facility embankment proximate to Area 5106. These landfill areas are of interest because of potential impacts on the surrounding area. The identified WMUs are shown on Figure 2.3.

The settling ponds (1949 to 1952), the landfill (1949 to 1971), the Navy dump, and the lime barge (1952 to 1972) are discussed in Section 2.3 on Site operations.

In 1981, the upland ponds and impacted soils were excavated for off-Site disposal. The Embankment Area, including the Navy/Todd disposal site and the 1949 to 1971 landfill, is being characterized and remediated by OCCT pursuant to the AOC, as a separate activity.

The groundwater at the Facility has been impacted by the release of VOCs from the former chlorinated solvents process. As part of the Joint Permit for the Storage of Dangerous Waste (Permit No. WAD009242314) (Permit), OCCT agreed to implement a Corrective Action Plan which included the design, construction, operation and maintenance of a groundwater extraction, treatment, and injection system and the subsequent monitoring of the system's performance.

The extraction system consists of 23 extraction wells located to contain and recover impacted groundwater. The recovered groundwater is pumped to a treatment facility

and the treated water is then injected into the aquifer through 20 injection wells located along the Hylebos Waterway. The impacted groundwater provides an hydraulic barrier which prevents impacted groundwater from discharging to the Hylebos Waterway.

The system was started up in 1996 and has effectively contained the impacted groundwater. The performance of the system continues to be monitored on a quarterly basis.

2.5 EXISTING SITE CONDITIONS

2.5.1 STRUCTURES

Pioneer's Dock No. 1 and POT's Pier 25 extend over portions of the Area 5106 Sediment. Details about the docks include the following:

i) Pioneer's Dock No. 1 was constructed in the late 1920s or early 1930s and was later expanded in the 1950s;

ii) Pier 25 was constructed in 1941;

iii) the docks are supported on wooden piles driven into the native soils to elevations of up to 60 feet below MLLW;

iv) typical spacing between piles at Dock No. 1 is 10 feet;

v) typical spacing between piles at Pier 25 is 5 to 10 feet; and

vi) maintenance work was performed on Dock No. 1 in 1994.

2.5.2 EMBANKMENTS

The embankment areas adjacent to the Site consist mostly of fill materials (concrete rubble or debris (as described in Section 2.0 of the Embankment Area EE/CA) or rip rap (large rocks) placed at a slope that varies from 1:1 to 2:1 (horizontal value [H:V]). The Pioneer embankment (above 0-foot MLLW) is subject to a separate removal action under the OCCT AOC.

The POT has completed a PRD Study of the embankment beneath Pier 25.

2.5.3 SHIPPING

The Hylebos Waterway shipping channel is approximately 200 feet wide and is maintained by the USACE for use by the industrial businesses located along the Waterway. These industries include chemical manufacturers, scrap metal reclamation, some boat building, and various other small businesses. The authorized depth of the channel is 30 feet below MLLW. The average elevation of the shipping channel is 30 to 35 feet below MLLW. At the face of Dock No. 1 and POT Pier 25, the Hylebos Waterway depth decreases to less than 30 feet below MLLW. Dock No. 1 is used primarily to dock salt ships required for Pioneer's operations. The southern portion of Pier 25 is used by Trident Foods to dock fishing ships. Both the Pioneer salt ships and Trident Food fishing ships dock directly above Area 5106 Sediment.

2.5.4 METEOROLOGICAL CONDITIONS

The Seattle-Tacoma area receives annual average precipitation of approximately 38 inches. Over 28 inches of this precipitation typically falls in the six months from October through March. The average annual mean temperature is approximately 53 degrees Fahrenheit (°F), ranging from a mean of 41°F in January to a mean of 66°F in July (data from Seattle-Tacoma International Airport).

2.5.5 BATHYMETRIC PLAN

The existing bathymetry of Area 5106 is shown on Figure 2.4. The bathymetry has been developed from data from several sources. These sources include:

i) topographic surveys of the Facility and POT Pier 25 embankments;

ii) Area 5106 characterization sample point elevations; and

iii) existing charts of the Hylebos Waterway.

The embankment adjacent to Area 5106 slopes steeply from a ground elevation of approximately 18 feet MLLW to elevations of approximately -20 feet MLLW at the face of the dock and -35 feet MLLW in the shipping channel. The average slope from the top of the bank to elevation -30 feet MLLW is approximately 2 feet horizontal to 1-foot vertical. Below elevation -30 feet MLLW the slope to the shipping channel is generally flatter. Figures 3.2 and 3.3 show the typical slopes of the embankment adjacent to Area 5106.

2.6 SURROUNDING LAND USE/POPULATION

2.6.1 LAND USE

Land use in the Site area is primarily industrial and commercial. Numerous production facilities and commercial establishments that utilize the Hylebos Waterway for shipping are located near the Site. As mentioned in Section 2.2, the POT is directly adjacent to the former OCCT Facility.

2.6.2 EXPOSURE PATHWAYS

The potential receptors of chemistry from impacted Area 5106 Sediment are various species of marine life in the waterway and humans through consumption of marine life. The main exposure pathway is expected to be the release of volatile organic compounds/semi-volatile organic compounds (VOCs/SVOCs) from Area 5106 Sediment porewater to the Hylebos Waterway as a mass flux. Mass flux of chemicals is the transportation of dissolved chemicals in water, caused by the movement of water through interstitial pore spaces (a function of permeability and hydraulic gradient) and by diffusion of chemicals from areas of high concentration (i.e., Area 5106 Sediment porewater) to areas of lower concentration (i.e., recent sediment porewater), and then into the water column. Benthic and burrowing organisms in the various sediment layers could also be exposed to the chemical mass flux.

In addition, dermal exposure at low tide could be an exposure pathway.

2.6.3 DRINKING WATER SOURCES

Drinking water for the properties within the Site area is supplied by the City of Tacoma public water supply. A 1992 survey response from over 100 property owners within a 1-mile radius of the Facility, indicated that there were no potable groundwater wells in use. In addition, there is no current or potential future use of the groundwater.

The Hylebos Waterway is not a source of drinking water. It is classified as a Class B marine surface water (WAC 173-201A-140).

2.7 ECOLOGICAL CONDITIONS

2.7.1 EXISTING HABITAT

As described in the PRD Report, existing subtidal (below -10 feet MLLW) habitat in Area 5016 is largely comprised of fine muds that currently exceed SQOs, and which provide low feeding and rearing functional value to juvenile salmonids, crab, flatfish, and waterfowl.

Existing intertidal/shallow subtidal (0 to -10 feet MLLW) habitat present near the edge of Area 5106, adjacent to the Embankment Area, is a mixture of relatively steep (typically 1H:1V to 2H:1V) rip rap, artificial substrate (metal, concrete, wooden bulkhead), gravel, and mixed fines. Due to the steep slopes and predominately rip rap substrate, this part of Area 5106, which is expected to recover more slowly due to low net sedimentation rates, also currently provides only minimal feeding and rearing habitat functions.

2.7.2 HYLEBOS WATERWAY BIOLOGICAL ENVIRONMENT

Use of the Hylebos Waterway by salmonids and invertebrates is documented in numerous reports. Juvenile chinook, chum, and pink salmon use the shoreline and open water habitats in the Hylebos Waterway, whereas, juvenile steelhead trout, cutthroat trout, and coho salmon would be expected to occur only in open water areas.

The benthic infauna community in the lower portions of the Hylebos Waterway is similar to that in much of Commencement Bay with a dominance of the polychaetes *Tharyx multifilis* and *Axinopsida serricata* (Tetra Tech 1985). The mollusk *Psephidia lordi* and the polychaetes *Lumbrineris* spp. are also well represented. The diversity and abundance of crustaceans is generally limited, with *Euphilomedes* spp. being the most abundant.

Crab numbers appear to be generally low in the waterways of Commencement Bay (Tetra Tech 1985). Eaton and Dinnel (1993) sampled in the mouth of the Hylebos Waterway and found higher abundances of Dungeness crabs than in other portions of the waterways.

Various other shorebirds and waterfowl utilize the Hylebos Waterway for feeding and refuge.

2.7.3 ENDANGERED SPECIES

Threatened and endangered species identified in the vicinity of the Hylebos Waterway include Puget Sound chinook salmon, the Stellar sea lion, the humpback whale, and the leatherback sea turtle. Puget Sound coho salmon, a candidate species, could occur in the area. The bull trout is a proposed species that may occur in the vicinity of the project. These species are briefly discussed below:

i) juvenile chinook salmon use the shoreline and open water habitat in and near the Hylebos Waterway. Coho salmon are present but juvenile fish rapidly migrate away from the shoreline. Because of their larger size, when entering salt water, coho are generally considered less dependent on estuarine rearing than chinook salmon;

ii) bull trout - very small numbers of bull trout may use the shoreline and open water habitats in and near the Hylebos Waterway;

iii) Stellar sea lions do not breed in Puget Sound, are rarely found south of Admiralty Inlet, and are unlikely to be present in or near the Hylebos Waterway;

iv) humpback whales utilize the Washington coast as a corridor for their annual migration north to feeding grounds and south to breeding grounds. Inside Admiralty Inlet, sightings of humpback whales are uncommon, and they are not expected to use or occur in the Hylebos Waterway; and

v) leatherback sea turtles are typically found in off shore locations and there are no documented sightings within Puget Sound. Leatherback sea turtles are not expected to use or occur in the Hylebos Waterway, and no critical habitat is present.

The selected removal action alternative must address Endangered Species Act (ESA) requirements, particularly the listing of Puget Sound chinook, and will include consultation with National Marine Fisheries Service (NMFS) and United States Fisheries and Wildlife Service (USFWS). A Site-wide Commencement Bay Biological Assessment (BA) is being prepared which addresses the Area 5106 Removal Action. The BA will be submitted to NMFS and USFWS to begin the consultation process to resolve potential conflicts.

2.7.4 PUGET SOUND FISH WINDOW

There are prohibitions on dredging and other in-water work in Puget Sound and Commencement Bay from March 15 to June 15. This is the time when juvenile salmon are most abundant. The fish window is expected to be extended from February 15 to August 15 in the near future.

2.8 PREVIOUS INVESTIGATIONS

Prior to the 1997 AOC, several investigations related to the Area 5106 Study Area were performed. These investigations, performed between 1979 and 1995, are summarized in Table 2.1. A complete compilation of the chemical data from each of these previous investigations is contained in the Area 5106 Background Data Report submitted to USEPA in November 1997.

In June and July 1994, a sediment sampling program was performed in the Waterway by the HCC as part of the PRD Study. That sampling event is referred to as Event 1A and 1B. Sampling of Station 5106 and the surrounding area was included in that program. The data collected during Event 1A and 1B showed elevated concentrations of VOCs in samples collected from Station 5106. The sampling stations nearest 5106 (5105, 5108, and 5109), did not exhibit the same magnitude of concentrations of VOCs. A summary of the compounds detected in samples from Stations 5105, 5106, 5108, and 5109 is presented in Table 2.2.

Additional sampling around Station 5106 (Event 1C) was conducted by the HCC in November 1995 to provide data to assess the nature and extent of the sediments containing the high VOC concentrations.

The samples collected and analyzed during Event 1C included recent sediment, anthropogenic material, and native sediment. These materials are referred to in the Event 1C Report as Materials A, B, and C, respectively. Discrete samples of each type of material were analyzed for VOCs, pH, and calcium. In addition, two composite samples of anthropogenic material were analyzed using the Toxicity Characteristic Leaching Procedure (TCLP); one of these samples was analyzed for the standard TCLP compound list and the other for VOCs only. Results of the TCLP analysis from the PRD Study are presented in Table 2.3.

The results of the Event 1C analyses were used to develop a TCLP surrogate and predict the concentrations of TCE and PCE in TCLP leachate from each of the Event 1C samples. The evaluation of the Event 1C data and predicted TCLP concentrations showed that the material which had the potential to exceed the TCLP disposal criteria was essentially limited to the anthropogenic material. There were no predicted TCLP exceedances in the native material (Material C) and only one in recent sediment (Material A).

In 1996, OCCT conducted supplemental sampling to characterize the materials in the Embankment Area of the Facility. OCCT sampled and analyzed intertidal sediments at the base of the embankment fill adjacent to Area 5106. Three composite samples were prepared and analyzed for selected VOCs, including TCE and PCE, selected SVOCs, pesticides, polychlorinated biphenyls (PCBs), selected metals, gasoline and diesel range hydrocarbons, total petroleum hydrocarbons, and general parameters. A summary of the compounds detected in these samples is presented in Table 2.4. These data were used in conjunction with other historic data to develop the initial estimation of the boundary of the Area 5106 Sediment.

2.9 RECENT INVESTIGATIONS

Subsequent to the 1997 AOC, field activities for the Area 5106 Sediment Characterization were conducted to obtain chemical and physical data for characterization of the sediment for completion of the EE/CA.

The field activities were conducted during the period of February to June 1998 in accordance with the "Sampling and Analysis Plan, Area 5106 Sediment Characterization" (SAP) as modified in May 1998 (see letter from J. Singer [Glenn Springs Holdings, Inc.] to K. Marcy [USEPA] dated May 28, 1998) and SAP Amendment No. 1 dated February 27, 1998, and as described in the following sections. Additional field activities not described in the SAP also were conducted to gather supplemental characterization data and information for use in the treatment technology evaluation, as presented in the Preliminary Treatment Technology Evaluation (PTTE) Report.

The stratigraphy within the Area 5106 Study Area was developed based upon chemical and physical testing sample logs and the geotechnical borehole logs presented as Appendix A. In general, four material matrices are typically present in the Area 5106 Study Area as follows:

i) Fill - Also referred to as Material A, the fill varies in composition and includes rip rap, slag, concrete, shingles, wood brick, glass, brown sludge, sand, and gravel;

ii) Recent Sediment - Also referred to as Material A, the recent sediment consists of natural deposited silt and clay with no visual evidence of 5106-like material;

iii) Visual 5106-Like Material - Also referred to as Material B, this material is tan to gray, silt with clay, generally present below the recent sediment and/or fill; and

iv) Native Sediment - Also referred to as Material C, the native sediment consists of sand with trace silt or clay to sand and silt, and is black, and compact to very dense.

The following subsections, 2.9.1 and 2.9.2, outline the field and laboratory activities performed during the 1998 Investigation. The results of these activities are discussed in Section 3.0 as part of the Site characterization presentation.

2.9.1 CHEMICAL SAMPLING AND ANALYSIS

Samples of sediment within and around Area 5106 were collected and analyzed for boundary definition, sediment characterization, and sediment chemical profiling. All samples for chemical analyses were collected as described in the SAP using one or the other of two types of sampling equipment:

i) a Mudmole™ vibratory corer with which continuous core samples of various lengths were collected for boundary estimation, boundary confirmation, and sediment characterization; and

ii) a split-spoon sampler advanced through hollow-stem augers (HSA) for collection of 12 boundary estimation samples.

2.9.1.1 HORIZONTAL BOUNDARY ESTIMATION

Cores were obtained from 120 locations for horizontal boundary estimation. Analytical samples were collected from the cores, prepared, shipped, and analyzed as described in the SAP. In general, the analytical samples were collected from each distinct sediment matrix observed within an individual core. At approximately 25 of the locations, however, the matrix referred to as "Visual 5106-Like Material" was observed to be thinly layered with recent sediment. At these locations, it was not possible to collect samples from distinct matrices and a composite of the two matrices was collected.

2.9.1.2 VERTICAL BOUNDARY ESTIMATION

Approximately 75 locations were sampled for vertical boundary estimation and the samples were prepared, shipped, and analyzed as described in the SAP and SAP Addendum No. 1. The SAP required porewater extraction for the vertical boundary estimation as well as for the horizontal boundary estimation. The vertical boundary estimation samples typically consisted of native sand from which sufficient porewater for analyses could not be extracted. Therefore, leachate from the vertical boundary estimation samples was prepared using the Synthetic Precipitation Leaching Procedure (SPLP) (SW-846 Method 1312) and analyzed for the estimation of the vertical boundary. This modification of the SAP procedure was described in detail in SAP Addendum No. 1.

2.9.1.3 BOUNDARY CONFIRMATION

Seventeen sediment samples were collected from 15 locations for Area 5106 Sediment boundary confirmation. The boundary confirmation sample locations are shown on Figure 2.5. All samples were collected, prepared, shipped, and analyzed as described in the modified SAP.

The following modifications to the Area 5106 Sediment boundary confirmation procedures were implemented:

i) a composite sample consisting of aliquots from the five locations at the boundary of the visual 5106-like material was collected for an additional column test at the request of the HCC as a potential horizontal boundary outside the estimated horizontal boundary of the Area 5106 Sediment;

ii) the composite sample and column test from locations 20 feet outside the estimated Area 5106 Sediment horizontal boundary were deleted from the program since another outside test was being conducted (see item i) above);

iii) an additional composite sample consisting of aliquots from four locations inside the estimated horizontal boundary of Area 5106 Sediment was prepared and tested. This sample represents the estimated boundary of marine WQC exceedances of the Area 5106 Sediment VOC indicator parameters (ethylbenzene, PCE, and TCE);

iv) core samples were processed at the testing laboratory using precooled equipment and containers. Ice was used to keep samples cool whenever they were outside the storage cooler; and

v) based upon the sediment analyses, the porewater and CLT analytical parameter list was modified to delete phenanthrene and chloroform and add 1,2,4-trichlorobenzene (1,2,4-TCB). At the request of the HCC, 4,4'-DDD and 4,4'-DDE were added to the parameter list and other chlorinated butadienes were reported as Tentatively Identified Compounds (TICs)[2].

2.9.1.4 SEDIMENT CHARACTERIZATION

Ten discrete random samples were collected for the chemical characterization of the Area 5106 Sediment. The samples were prepared, shipped, and analyzed as described in the SAP. The locations of the chemical characterization samples are shown on Figure 2.5.

2.9.1.5 CHEMICAL PROFILING

In addition to the chemical characterization required by the SAP, cores were collected at two locations to prepare chemical profiles of the Area 5106 Sediment and the associated porewater. The chemical profiles provide an estimate of the distribution of chemistry through the depth of Area 5106 Sediment, and particularly at the surface.

Six sediment samples were collected from each core for analysis of sediment and/or porewater. All samples were collected, prepared, and analyzed in accordance with the SAP procedures.

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2 Tentatively Identified Compounds (TICs) are compounds present in the sample(s) but the analytical system has not been calibrated for those particular compounds. Tentative identification of the compound is based on the comparison of the unknown spectra with a reference spectra obtained from a Mass Spectral Library. An estimated concentration is calculated by comparing the total peak area (height) for the TIC to the total peak area (height) of the closest internal standards, of which the concentration is known.

2.9.2 PHYSICAL SAMPLING AND TESTING

Physical testing data were collected during the Area 5106 Sediment Characterization program to gather data for use in the evaluation of removal action alternatives.

Samples for physical testing were collected and the testing was performed as described in the SAP. A summary of the physical testing performed is presented in Table 2.5. After the presence of asbestos was identified in the initial samples tested or handled, determinations of grain size and Atterberg limits were not performed on remaining samples.

3.0 SITE CHARACTERIZATION

The primary sources of contaminated sediments at the Site are waste management practices and operational methods associated with a chlorinated solvents plant that operated at the Facility from 1947 to 1973 (see Sections 2.3 and 2.4).

The extent of contamination at the Site was determined as outlined in the Area 5106 Sediment Characterization Report approved by USEPA. The extent was confirmed based upon the sampling, analysis, and evaluations presented in the CLT Evaluation Report. The extent of contamination is the boundary of Area 5106 Sediment as discussed in the following subsections.

3.1 BOUNDARY ESTIMATION

The Area 5106 Sediment boundary estimation was based upon the concentrations of Area 5106 Sediment indicator parameters (PCE, TCE, ethylbenzene, and hexachlorobutadiene [HCBD]) in porewater and Synthetic Precipitation Leaching Procedure (SPLP) leachate. The sample grid and individual sample locations are shown on Figure 3.1. The boundary estimation analytical data are presented in Tables 3.1 and 3.2.

OCCT began implementation of the SAP in February 1998. Three estimated horizontal boundaries, shown on Figure 3.1, were identified based on the results of the porewater analysis performed as part of the SAP. The estimated horizontal boundaries and the criteria for establishing each boundary are as follows:

i) **Inner Horizontal Boundary** - Porewater from samples taken at or outside this boundary contain concentrations which were below the marine WQC for the three volatile screening parameters of TCE, PCE, and ethylbenzene;

ii) **Outer Horizontal Boundary** - Porewater from samples taken at or outside this boundary contain concentrations which were below the marine WQC for HCBD in addition to the three volatile screening parameters identified in i) above; and

iii) **Visual Horizontal Boundary** - This boundary corresponds to the limits of the visual Area 5106-like materials.

The estimated Vertical Boundary of the Area 5106 Sediment is generally at the top of the native sand sediments. The estimated Vertical Boundary (top of native sand) is shown

in cross-sections on Figures 3.3 and 3.4. The locations of the cross-sections are shown on Figure 3.2. The Vertical Boundary was estimated based on the analysis of leachate obtained from native sediments utilizing the SPLP. Leachate from samples collected at or below the estimated vertical boundary contained concentrations of TCE, PCE, ethylbenzene, and HCBD that were below their respective marine WQC.

3.2 BOUNDARY CONFIRMATION

The boundary of the Area 5106 Sediment was confirmed based on the results of the four thin-layer CLTs. The CLTs were performed on composite samples collected from each of the four estimated boundaries (three horizontal and one vertical). The locations of the confirmation samples are shown on Figure 3.1.

Each composite boundary confirmation sample was divided into three portions (aliquots) for chemical analysis and testing. The sample aliquots, analyses, and use of the analytical data are as follows:

i) a bulk sediment sample was removed from each composite and analyzed for the parameters listed in Table 3.3. The resultant data were used to finalize the analytical parameter list for the CLTs;

ii) a porewater sample was extracted from an aliquot from each horizontal boundary confirmation sample and an SPLP leachate sample was prepared from an aliquot of sediment from the vertical boundary estimation sample. These samples were analyzed for the parameters listed in Table 3.3. The resultant data were used as a preliminary indicator of the concentrations of compounds which might be detected in the CLT samples; and

iii) an aliquot of each composite sample was used for the CLT.

The analyte lists for the porewater, SPLP, and CLT samples include the analytes approved by USEPA for the definition of the boundary of the Area 5106 Sediment and additional analytes requested by the HCC for use in the evaluation of remedial alternatives for sediment outside Area 5106.

The analytical data for the porewater, SPLP, and bulk analyses are presented in Tables 3.4 and 3.5.

The four CLTs were initiated in June 1998. Each CLT continued for a minimum of 15

pore volumes or until a constant or downward concentration trend was observed for all analyzed chemical parameters.

Each CLT was representative of one of the four estimated boundaries and were designated as follows:

i) **IHBC** - CLT for the Inner Horizontal Boundary Composite. IHBC is considered representative of the sediment between the Inner Horizontal Boundary and the Outer Horizontal Boundary, and above the Vertical Boundary;

ii) **OHBC** - CLT for the Outer Horizontal Boundary Composite. OHBC is considered representative of the sediment between the Outer Horizontal Boundary and the Visual Horizontal Boundary, and above the native sediment;

iii) **CHCC** - CLT for the Visual Horizontal Boundary. CHCC is considered representative of the sediment immediately outside the Visual Horizontal Boundary and above the native sediment; and

iv) **VBC** - CLT for the Vertical Boundary Composite. VBC is considered representative of the sediment within the Outer Horizontal Boundary and immediately below the top of the native sediments.

The thin layer CLT simulates the salt washout effects and contaminate mobility to be expected in a confined disposal facility (CDF [nearshore fill, or confined aquatic disposal facility]), influenced by upland groundwater. Consequently, the leachate concentrations from the CLTs are utilized in a contaminant transport (migration and attenuation) analysis to predict long-term water quality of water that may ultimately discharge (e.g., seep) from the disposal site to adjacent surface waters (regulatory point of compliance). Comparison of the predicted water quantity with relevant marine WQC determines whether the sediment represented by the CLT is acceptable for placement within the CDF without treatment.

Appendix A, extracted from the CLT Evaluation Report, presents the results and evaluation of the CLTs. The CLT Evaluation included disposal site modeling/analysis to determine whether sediment represented by each CLT was acceptable for placement in the Slip 1 CDF without treatment. If acceptable, the sediment is considered boundary sediment and not Area 5106 Sediment.

As presented in Appendix A, the disposal site analysis predicts that seepage concentrations from the CDF will be significantly below the relevant marine WQC and will present no long-term water quality concerns for the boundary sediments

represented by all four CLTs. Therefore, the boundary sediments representing all four CLTs are acceptable for placement within the CDF without treatment. Consequently, the boundary of Area 5106 Sediment was confirmed to be the Inner Horizontal Boundary and the Vertical Boundary.

Based on the confirmed boundary, Area 5106 Sediment includes an estimated in situ volume of 22,300 cubic yards (c.y.) and covers approximately 2.15 acres.

3.3 CHEMICAL CHARACTERIZATION

The chemical characterization of the Area 5106 Sediment has been determined through the analysis of sediment and porewater samples collected at locations within the estimated boundaries of the Area 5106 Sediment. The sample locations for the chemical characterization are shown on Figure 2.5. The analytical data used for the chemical characterization includes:

1. Sediment Characterization Samples - Ten discrete random samples were collected as described in Section 3.1.3 of the Area 5106 Characterization Report. Data from these analyses are presented in Table 3.6.

   Eight of these samples were collected from within the Area 5106 Sediment, while two of the samples were collected from the overlying recent sediment. Since the Area 5106 Sediment Characterization was used to evaluate removal, treatment, and disposal alternatives, only the eight samples from within Area 5106 Sediment were included in the chemical characterization. Further, under a removal alternative the quantity of overlying, relatively clean, recent sediment would be a small proportion of the total removed sediment, and should not influence the treatment process design requirements.

   Table 3.9 presents a statistical summary of the eight Area 5106 Sediment samples including the range of concentrations, the average concentrations, and number of detections for each analyzed parameter. For the purpose of the Area 5106 Sediment Characterization and the evaluation of removal, treatment, and disposal alternatives, the average concentration of each analyte was considered representative of the mass of Area 5106 Sediment.

2. Chemical Profile Samples: Twelve sediment samples and 10 porewater samples were collected from two cores as described in Section 3.1.4 of the Area 5106 Sediment Characterization Report. Data from the sediment and porewater analysis are presented in Tables 3.7 and 3.8, respectively. The chemical profile

data provide an estimate of the distribution of chemistry through the depth of Area 5106 Sediment which is useful for the evaluation of natural recovery and containment alternatives.

Of the 10 porewater samples, four were extracted from Area 5106 Sediment. Table 3.9 presents a statistical summary of these four porewater samples.

3. Boundary Estimation Samples: The porewater and SPLP analyses from the Boundary Estimation samples were also considered in the chemical characterization of Area 5106 Sediment.

4. Previous Investigations: Analytical data from previous investigations were reviewed and considered in the chemical characterization of the Area 5106 Sediment.

3.3.1 ORGANIC CHEMICAL DATA

The primary organic chemical compounds present in the Area 5106 Sediment are PCE, TCE, 1,2-dichloroethene (DCE), vinyl chloride (VC), hexachlorobenzene (HCB), HCBD, and polynuclear aromatic hydrocarbons (PAHs). The ranges of concentrations of these compounds are broad, generally being from one to four orders of magnitude.

While all the analytical data are considered in the various evaluations performed for the EE/CA, PCE, TCE, and VC are indicators of Area 5106 Sediment and are used to illustrate the distribution of chemistry in the Area 5106 Sediment. The array of the chemical characterization and profiling samples and concentrations of the indicator compounds in the samples are shown on Figures 3.5 and 3.6.

Review of the Area 5106 Sediment chemical data shows that the concentrations of the indicator compounds are elevated in the Area 5106 Sediment and decrease sharply at both the recent sediment and native sediment interfaces. The concentrations of the indicator parameters in the recent sediment are generally less than 10 percent of the concentrations in the Area 5106 Sediment and, with four exceptions (locations 31-07R, 32-06R, 34-08, and 35-04), the porewater concentrations in the native sediment do not exceed the marine WQC.

The concentrations of the indicator compounds are elevated in the approximate center of the estimated Area 5106, along grid lines 01 and 08 between Sections 30+00 and 34+00. The concentrations of each parameter generally decrease moving outward in each direction toward the estimated Area 5106 Sediment boundary.

The other organic chemical compounds detected in the Area 5106 Sediment and their ranges of concentration are shown in Table 3.9.

Total organic carbon (TOC) concentrations were determined at selected depths from the geotechnical boreholes and dredging sample locations. The results are tabulated in Table 3.10. TOC concentrations were found to range between 9,300 and 21,000 milligrams per kilogram (mg/kg) in the recent sediment, 5,800 and 21,000 mg/kg in the visual 5106-like material, 10,000 and 16,000 mg/kg in precipitant, and 960 and 1,500 mg/kg in the native sediment.

TCLP analyses were not performed on Area 5106 Sediment samples. However, to conservatively estimate TCLP concentrations the "1:20 Rule" can be applied to the characterization data. The application of the 1:20 rule is based upon the following:

i) it is assumed that 100 percent of the concentration of each compound present in the sediment is leachable; and

ii) to arrive at an estimated TCLP concentration, the average concentration of each compound present, which is representative of the concentration in the mass of Area 5106 Sediment, is divided by 20 to adjust for the dilution which is part of the TCLP analytical procedure.

The average concentrations of each compound detected in Area 5106 Sediment, the estimated TCLP concentrations, and the TCLP criteria are presented in Table 3.11.

The porewater data from discrete samples can be used to estimate the quality of leachate from the Area 5106 Sediment if it were placed untreated into an aquatic disposal cell. The average concentrations of each compound detected in the Area 5106 Sediment porewater and the marine WQC are presented in Table 3.12. Based upon the average porewater data, the Area 5106 Sediment leachate would likely contain the following compounds at concentrations which exceed the marine WQC for: TCE, PCE, HCBD, sulfide, and ammonia.

3.3.2 METALS

Based upon the eight discrete samples collected from within the boundary of the Area 5106 Sediment, the Area 5106 Sediment contains detectable concentrations of all of

the metal analytes except silver. The ranges of concentrations of the metals are all within an order of magnitude.

The estimated TCLP concentrations of the metals are shown in Table 3.11 (see Section 3.3.1).

3.3.3 ASBESTOS

Testing of the 10 chemical characterization samples identified asbestos in all samples. Asbestos concentrations ranged from 0.38 to 2.3 percent by weight as shown in Table 3.6. Fibrous material was visually identified in samples of fill and visual 5106-like material collected at the locations indicated in Table 3.13.

Asbestos also was identified during the Embankment Area Characterization Program in selected samples from boreholes at the base of the bank. The asbestos concentrations in the embankment borehole samples ranged from 0 to 80 percent by volume. The asbestos type was identified as chrysotile.

3.3.4 ELUTRIATE TESTS

Dredging elutriate tests (DRETs) and modified dredging elutriate tests (METs) were performed using samples which were composites of recent sediment and Area 5106 Sediment. The analytical data from the elutriate tests are presented in Tables 3.14 and 3.15 and are discussed in the following subsections.

3.3.4.1 DREDGING ELUTRIATE TESTS

Two DRETs were performed on sediment samples representing composites of recent sediments and Area 5106 Sediment. One sample represented a "worst case" sediment in terms of chemical concentration, and the second sample represented an "average" to "higher than average case". The "worst case" sample was a composite of material collected at sample locations 30.5-07 and 32.5-08, and the "average case" sample was collected at sample locations 28.5-08 and 34.5-08.

The dredging elutriate test is designed to model potential short-term water quality impacts in the water column during dredging. Data from these tests show that the marine WQC were exceeded for copper, mercury, nickel, and silver.

3.3.4.2 MODIFIED ELUTRIATE TEST

Two METs were performed on sediment samples made up of a composite of Recent Sediment and Area 5106 Sediment. One sample was collected from location 30-06 and represented a "worst case" in terms of chemical concentration. The second sample was collected from location 34-07 and represented an "average case".

The MET is designed to model the concentration of chemicals in the dredge water during hydraulic dredging for placement at a disposal site. The tests indicated that dredge water would be expected to exceed marine WQC for TCE, PCE, phenanthrene, arsenic, mercury, and nickel.

3.3.5 CHEMICAL MOBILITY CHARACTERISTICS

Analysis of Area 5106 Sediment samples performed during the investigations indicate that the highest concentrations of chemicals are present at depths between 24 and 80 cm below the present mudline (sediment surface). The Area 5106 Sediment at these depths contain bulk sediment concentrations of key Site compounds (HCBD, PCE, and TCE) that are approximately 200 to 6,000 times higher than surface (0 to 10 centimeters [cm]) concentrations. These results indicate that the surface sediments which still exceeded SQOs are significantly less contaminated than subsurface sediments.

Site-specific partitioning coefficients (K_{oc}) were calculated from the sediment and porewater analysis as part of the Area 5106 Sediment Characterization. The analysis and calculated K_{oc} values are presented in Appendix B.

3.4 PHYSICAL CHARACTERIZATION

The physical characterization of the Area 5106 Study Area and the Area 5106 Sediment has been developed based upon the information collected during survey and sampling activities and from in situ and laboratory geotechnical testing. The following

subsections present the physical characterization of the Area 5106 Study Area and the Area 5106 Sediment.

3.4.1 STRATIGRAPHY AND PHYSICAL CHARACTERIZATIONS

The stratigraphy in the Area 5106 Study Area has been developed based upon the following sources of information:

i) chemical and physical testing sample logs;

ii) geotechnical borehole logs;

iii) geotechnical testing data; and

iv) embankment characterization data.

The logs of items i) and ii) are contained in Appendix C. The soils testing laboratory reports are contained in Appendix C of the Area 5106 Sediment Characterization Report. Summaries of the physical testing data are presented in Tables 3.16 through 3.18. The embankment characterization data have been presented previously in the "Embankment Area Characterization Report, Former OCC Tacoma Facility"; approved by USEPA.

The stratigraphy within the Area 5106 Study Area generally consists of fill, recent naturally deposited fine-grained sediment, visual 5106-like material, and native sandy sediment. The four units are typically found in this order, from top to bottom, although the first three units are also interlayered and reversed at some locations. The visual 5106-like material includes both Area 5106 Sediment, which is defined based upon exceedances of marine WQC in porewater or leachate, and material which has the same physical properties but not the chemical presence which defines Area 5106 Sediment.

A brief description of each unit, in the order of deposition described above, is as follows:

i) Fill - The fill varies in composition and includes such materials as rip rap, slag, concrete, shingles, wood, brick, glass, brown sludge, sand, and gravel. The fill types are frequently intermixed. Fill thickness and properties vary significantly between locations;

ii) Recent Sediment - The recent sediment consists of naturally deposited silt and clay found either directly below the fill where fill is present, or at the mudline.

The thickness of recent sediment is typically between 1 and 3 feet. The recent sediment is dark brown to black and very soft;

iii) Visual 5106-Like Material - This material is tan to gray, of low to medium plasticity, and very soft. The visual 5106-like material includes both the Area 5106 Sediment and material that has the same physical properties but not the chemical presence that defines Area 5106 Sediment; and

iv) Native Sediment - The native sediment ranges from sand with traces of silt and clay to sand and silt, and is black, compact, to every dense.

The borehole sample locations are shown on Figure 3.2. Stratigraphic cross-sections are shown on Figures 3.3 and 3.4.

3.4.3 CONSOLIDATION TESTING AND ANALYSES

Consolidation testing was performed on 10 samples: three samples of recent sediment; one sample of brown sludge; three samples of Area 5106 Sediment; two composite samples of Recent and Area 5106 Sediment; and one sample of native sediment, The testing indicated that the brown sludge, recent sediment, and Area 5106 Sediment will settle 0.03 to 0.09 feet in 0.16 to 13.7 days assuming a 2-foot thickness of sediment, and 0.18 to 0.36 feet in 2.9 to 218 days assuming an 8-foot thickness of sediment. The settlement rates for the majority of samples and stress ranges, however, would be less than 10 to 30 days. The results of the testing are summarized in Table 3.19.

Using the settlement information, the stratigraphy at sample locations 30-08 and 33-08 was evaluated to determine the potential for redistribution of porewater during consolidation under a 2-foot thick sand and gravel cap. The results of this evaluation are shown on Figure 3.7. The figure indicates that porewater from the sediment will advance a maximum of 0.31 feet into a sand/rip rap cover assuming the cover is 2 feet thick.

3.4.4 COLUMN SETTLING TESTS

Column Settling Tests (CSTs) were performed on samples collected from locations 30-06 and 34-07. Location 30-06 is considered to have sediments representing "worst case" conditions in terms of contaminant loading, whereas location 34-07 is considered to represent an "average case". The stratigraphic profile at location 30-06 includes 1 foot of

recent sediment and 4.1 feet of Area 5106 Sediment above the native fine sand. At location 34-07, sampling identified 0.4 feet of recent sediment, 9.7 feet of precipitant-like material, above the native fine sand. Each of the two samples was composited to represent the sediment from the mudline to 2 feet below the surface of the native sediment.

The laboratory data are presented in Appendix D of the Area 5106 Characterization Report and are summarized in the following paragraph.

The sample from location 30-06 settled rapidly when placed in the CST column. Total Suspended Solids (TSS) and turbidity were less than 28 milligrams per liter (mg/L) and 19 nephelometric turbidity units (NTUs), respectively, within 1 hour of the start of the test, and the water was described as clear. A TSS of 28 mg/L is less than 0.05 percent of the TSS at the start of the CST. The sample from 34-07 settled less rapidly. The TSS and turbidity were 270 mg/L and 81 NTU within 1 hour of the test commencement, and the water had an amber color. A TSS of 270 mg/L is 0.27 percent of the original TSS. Within 24 hours the TSS was less than 34 mg/L, 0.034 percent of the original concentration.

The results of both tests are considered to represent rapid settlement of solids from dredge water.

3.5 STREAMLINED RISK EVALUATION

The EE/CA Guidance requests that a streamlined risk assessment be performed. A streamlined risk assessment is intended to be intermediate in scope and detail between the limited risk evaluations associated with emergency removal actions and traditional baseline risk assessments. The intent of a streamlined risk assessment is to "help EPA decide whether to take a cleanup action at the site". In addition, the streamline risk assessment is performed "in some cases, to define appropriate cleanup levels". However, for the Area 5106 EE/CA, the objectives of a streamlined risk assessment were met during earlier phases of the project. Human health and environmental risk assessments were completed as part of the remedial investigation phase of the CB/NT Superfund project. The findings of these risk assessments were described in the ROD. The results presented rationale for the decision to remediate the Site and also formed the basis for the risk-based cleanup goals (SQOs and marine WQC). Therefore, a streamlined risk assessment is not necessary for this removal action.

4.0 IDENTIFICATION OF REMOVAL ACTION GOALS AND OBJECTIVES

Removal action goals and objectives were developed in the PTTE Report, July 1999, and are summarized in the following subsections.

4.1 SCOPE OF REMOVAL ACTION

The scope of the removal action is to address sediment with different chemical constituents and concentrations than those found in surrounding Hylebos Waterway sediment and that, if removed, require treatment prior to disposal. The removal action will contribute to the efficient implementation of the Hylebos Waterway remedial action by addressing the Area 5106 Sediment so that the surrounding sediment may be remediated and monitored in accordance with the ROD.

4.2 REMOVAL ACTION GOAL

The goal of the non-time critical removal action for Area 5106 Sediment is to reduce the potential exposure to Area 5106 Sediment in such a way as to be protective of human health and the environment, and, to the extent practicable considering the exigencies of the situation, attain Applicable or Relevant and Appropriate Requirement (ARARs).

Compliance with ARARs to the extent practicable given the scope and purpose of the removal action and its role in the Hylebos Waterway remedial action is one of the effectiveness criteria against which the various removal action alternatives will be analyzed. The following list of ARARs, wherein items i) through iv) are primary ARARs, has been developed for the Area 5106 removal action alternative evaluations:

i) Clean Water Act (CWA) Section 401 - Section 401 of the CWA requires that both dredging and dredged material disposal operations shall not violate applicable effluent standards or water quality standards. This determination may allow for the designation of mixing zones within which standards may be exceeded, but beyond which all applicable standards must be met. While dredging operations conducted as part of a remedial action within a CB/NT problem area do not require following the procedures for a formal Section 401 water quality certification, the dredging operations must comply with the substantive requirements of such certification;

ii) CWA Section 404 and 404(b)(1) Guidelines (40 CFR Part 230) - Section 404 of the CWA regulates the discharge of dredged or fill material into waters of the United States. Section 404(b)(1) instructs USEPA to promulgate guidelines for evaluating proposed projects involving such discharges. These guidelines (the "404(b)(1) Guidelines") are published in 40 CFR Part 230. Under the Section 404(b)(1) Guidelines, discharges of dredged or fill material may be permitted if there is no practicable alternative to the proposed discharges that would have a less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. The term "practicable" is defined in CWA regulations as "available and capable of being done after taking into consideration cost, existing technology, and logistics, in light of overall project purposes". Section 404(b)(1) Guidelines require demonstration that the proposed discharge of dredged or fill material will not:

a) cause or contribute, after consideration of disposal site dilution and dispersion, to violations of any applicable State water quality standard,

b) violate any applicable toxic effluent standard or prohibition under Section 307 of the CWA,

c) jeopardize the continued existence of any endangered or threatened species or contribute to the destructive or modification of any critical habitat for such species, and

d) contribute to significant degradation of the waters of the United States.

The proposed discharge of dredged or fill material must avoid to the fullest extent practicable adverse effects on human health, aquatic ecosystems, and recreational, aesthetic, and economic values. Section 404 also maintains that degradation or destruction of special aquatic sites such as wetlands represents an irreversible loss of valuable aquatic resources that should be avoided. Unavoidable impacts must be minimized. Dredged material disposal conducted as part of a remedial action within a CB/NT problem area must comply with the substantive requirements of the 404(b)(1) Guidelines;

iii) Rivers and Harbor Act (Act) (33 CFR Parts 320, 322) - Prohibits unauthorized activities that obstruct or alter a navigable waterway. In particular, Section 10 of the Act applies to any dredging and/or disposal activity in navigable waters of the United States. Authorization of such activities follows a public interest review of the proposed activity. This review is based on an evaluation of probable impacts (including cumulative impacts), which is in turn based on a balancing of the benefits of the proposal against its reasonably foreseeable detriments. The parameters on which this decision is based are outlined in

40 CFR Part 320.4. They include effects on wetlands; fish and wildlife; historic, cultural, scenic, and recreational values; coastal zones; marine sanctuaries; other Federal, State, and local requirements; navigation; environmental benefits; economics; as well as mitigation to minimize adverse project impacts;

iv) Endangered Species Act - The ESA provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The USFWS of the Department of the Interior maintains the list of 632 endangered species (326 plants) and 190 threatened species (78 are plants).

Species include birds, insects, fish, reptiles, mammals, crustaceans, flowers, grasses, and trees. The act prohibits any action, administrative or real, that results in a "taking" of a listed species, or adversely affects habitat.

Section 7(a) of the ESA grants authority to and imposes requirements upon Federal agencies regarding endangered or threatened species of fish, wildlife, or plants ("listed species") and habitat of such species that has been designated as critical. Section 7 generally provides that Federal agencies must assess the impacts that may result from any action, and confer with the NMFS on any action that is likely to jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of any critical habitat important to the proposed species. The conference/consultation process is directed at making a biological opinion regarding the proposed action. The opinion evaluates whether or not the action will jeopardize the continued existence of a species, or result in the destruction or adverse modification of critical habitat; and may include modification to the action that would avoid the likelihood of adverse effects to listed species or their critical habitat;

v) Clean Water Act (CWA), 33 United States Code (USC) 1251 *et seq*

a) Section 304 of the CWA (33 USC 1314) requires USEPA to publish WQC for the protection of human health and aquatic life, and

b) Sections 301, 302, and 303 of the CWA (33 USC 1311, 1312, and 1313), and 40 CFR Part 131, require states to develop water quality standards. Washington Water Quality Standards are promulgated under the Washington Water Pollution Control Act (Chapter 90.48 Revised Code of Washington [RCW], Chapter 173-201 WAC);

vi) Section 402 of the CWA (33 USC 1342) and 40 CFR Parts 122 and 125 - Establish the National Pollutant Discharge Elimination System (NPDES) which provides for the issuance of permits for direct discharges to navigable waters. The State of Washington has been authorized to implement this program and they do so under Chapter 173-220 WAC. Section 402 of the CWA does not apply to

discharges to navigable waters that are authorized under Section 404 of the CWA;

vii) Puyallup Tribe Water Quality Program (Puyallup Tribal Council Resolution No. 151288C) - Establishes interim tribal water quality standards by adopting Washington Water Quality Standards;

viii) Safe Drinking Water Act (SDWA - 42 USC 300f et seq; 40 CFR Parts 141 and 143) - Establishes standards designed to protect human health from the potential adverse effects of drinking water contaminants. Maximum Contaminant Levels (MCLs) are relevant and appropriate for surface water or groundwater that is a current or potential source of drinking water;

ix) Puyallup Tribe of Indians Settlement Act of 1989 (PL 101-41, 103 Stat. 83) - Establishes environmental standards and requirements for fishery enhancement and protection, and provides for cultural and religious preservation for activities affecting tribal interests;

x) Washington Solid Waste Management Act (Chapter 0.95 RCW) and Solid Waste Regulations (WAC 173-304) - Establishes siting requirements for solid waste disposal facilities and State minimum functional performance standards for handling of solid waste;

xi) Water Pollution Control Act (Chapter 90.48 RCW) - Establishes permitting requirements for point source discharges to surface waters of Washington State;

xii) Coastal Zone Management Act (16 USC 1451 et. seq.); Washington Shoreline Management Act (Chapter 90.58 RCW; Chapter 173-14 WAC); City of Tacoma Shoreline Ordinance (Chapter 13.10) - The Washington Shoreline Management Act, authorized under the Federal Coastal Zone Management Act, establishes requirements for substantial development occurring within waters of the State or within 200 feet of a shoreline;

xiii) Resource Conservation and Recovery Act (RCRA; 42 USC 6901 *et. seq.*) - Regulates the handling, storage, treatment, and disposal of hazardous and non-hazardous solid waste;

xiv) Washington Hazardous Waste Management Act (Chapter 70.105 RCW; Chapter 173-303 WAC) - State requirements for designating solid wastes to determine whether they are "dangerous waste" or "extremely hazardous waste" ,and for handling such waste;

xv) Washington Hydraulics Code (Chapter 75.20 RCW; Chapter 220-100 WAC) - Establishes requirements for performing work that would use, divert, obstruct, or change the natural flow or bed of any salt or fresh waters; and

xvi) Clean Air Act (40 CFR Part 50) - Establishes ambient air quality standards for chemicals and particulates.

The following "to be considered" criteria are other advisories, criteria or guidance to be considered in the implementation of the selected remedy.

i) US Fish and Wildlife Mitigation Policy (45 FR 7644) - Establishes guidance for the US Fish and Wildlife Service recommendations to protect and conserve fish and wildlife resources;

ii) Memorandum of Agreement between USEPA and the COE (Mitigation Under CWA 404(b)(1)) - Sets forth policy and procedures for developing mitigation for compliance under CWA, Section 404. These guidelines for mitigation include, in order of importance: avoidance; minimization; and compensatory mitigation;

iii) Puget Sound Water Quality Act (Chapter 90.70.011 RCW) - Authorizes the Puget Sound Water Quality Authority to develop a comprehensive plan for water quality protection in Puget Sound;

iv) Washington Sediment Management Standards (WAC 173-204) - Establishes numerical limits for chemical constituents in sediments. These requirements were promulgated after the CB/NT ROD was issued;

v) Sediment Cleanup Standards User's Manual (Ecology, 1991 and Subsequent Revisions) - Provides guidance for the implementation of Section 5, Sediment Cleanup Standards, of the Sediment Management Standards (Chapter 173-204 WA);

vi) Washington Standards for Confined Disposal of Contaminated Sediments (Ecology, 1990) - Establishes the Confined Alternative Assessment Procedure (CAPP) to evaluate confinement alternatives;

vii) Washington Department of Fisheries Habitat Management Policy (POL-410) - Calls for no net loss of productive capacity of the habitat of food and shellfish resources, restoration of the productive capacity of habitats that have been damaged or degraded, improvement of the productive capacity of existing habitats, and the creation of new habitats;

viii) Executive Order 11988 (40 CFR 6 Appendix A) - Establishes requirements for actions occurring within a floodplain;

ix) Executive Order 11990 (40 CFR 6 Appendix A) - Establishes requirements for actions within wetlands;

x) Water Resources Act (Chapter 90.54 RCW) - Establishes fundamental water resource policies for preservation of Washington State water resources;

xi) Washington Model Toxics Control Act (Chapter 70.105D RCW) and Hazardous Waste Cleanup Regulations (WAC 173-340) - Establishes Washington State cleanup requirements for State hazardous waste sites;

xii) Puget Sound Air Pollution Control Agency Guidelines - Provides air pollution control guidelines for acceptable ambient levels; and

xiii) Puget Sound Dredged Disposal Analysis (PSDDA 1988) - Establishes chemical and biological criteria for dredged material disposal in Puget Sound.

4.3 REMOVAL ACTION OBJECTIVES

Specific removal action objectives for Area 5106 Sediment include the following:

i) reduce the availability of impacted sediments (both surface and subsurface) to the waterway and marine ecosystem in order to mitigate impacts to the environment;

ii) reduce the migration of impacted sediments from Area 5106 Sediment to mitigate impacts on the environment beyond Area 5106 Sediment;

iii) reduce the potential future exposure of the marine ecosystem and/or human receptors resulting from ongoing industrial/shipping activities, maintenance dredging, and future accidents/catastrophes (of natural or human origin) which may exacerbate release of and exposure to contaminants; and

iv) ensure that porewater within 0 to 10 cm of the sediment surface meets relevant marine WQC.

5.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION TECHNOLOGIES

The PTTE Report identified general response actions that satisfy the removal action objectives for Area 5106 Sediment and porewater (response actions that address Area 5106 Sediment also address the Area 5106 Sediment porewater and the resultant impacts to human health and the environment). The response actions include:

i) no action;

ii) source containment;

iii) sediment removal;

iv) sediment treatment;

v) sediment disposal; and

vi) institutional controls.

5.1 INITIAL SCREENING OF TECHNOLOGIES

The PTTE Report also identified the following potentially applicable removal action technologies based upon the identified response actions:

i) containment technologies presented in Table 5.1;

ii) removal technologies presented in Table 5.2;

iii) treatment technologies presented in Tables 5.3 and 5.4; and

iv) disposal technologies presented in Table 5.5.

The potentially applicable technologies presented above were screened based on implementability for the Site conditions and sediment characteristics. Those technologies which were not technically feasible to implement or whose effectiveness would be less than another comparable technology were eliminated from further consideration.

Containment technologies were eliminated from further evaluation if they were difficult or expensive to implement relative to technology that would be equally effective. The eliminated containment technologies and the reasons for their elimination are presented in Table 5.6.

Removal technologies were eliminated from further evaluation if the sediments were deeper than the technical capabilities of the technologies if the operation of the technology would create unacceptable levels of resuspended solids compared to another removal technology that would be equally effective and/or if the required equipment was not readily available. The eliminated removal technologies and the reasons for their elimination are presented in Table 5.7.

Treatment technologies were eliminated from further evaluation if they were difficult or expensive to implement relative to another technology that would be equally effective and/or on the basis of obvious performance deficiencies. The eliminated treatment technologies and the reasons for their elimination are presented in Table 5.8.

Disposal technologies were eliminated from further evaluation if they were not feasible due to space limitations, regulatory restrictions, worker risks, or disposal criteria concerns. The eliminated disposal technologies and the reasons for their elimination are presented in Table 5.9.

5.2 PRELIMINARY TECHNOLOGY EVALUATION

The initial screening provided the technologies in Table 5.10 which were retained for further evaluation in the PTTE Report approved by USEPA. The retained technologies were evaluated based upon the following criteria:

i) effectiveness considerations:

- protectiveness of the technology, including potential impacts to human health and the environment during the construction and implementation phase,
- potential effectiveness of the technology in handling the estimated areas or volumes of media,
- ability to achieve removal objectives, and
- magnitude of residual risks;
- implementability considerations: technical feasibility of the technology:
  - a) ability to design, construct, and operate,
  - b) reliability, and
  - c) scheduling considerations,
- administrative feasibility of the technology:

a) coordination with agencies (permits, institutional controls), and

b) impact on adjoining property, and

- availability of necessary equipment and materials to implement the technology:

a) treatment, storage, and disposal services, and

b) equipment and skilled personnel; and

iii) cost considerations:

- cost evaluations were based on classification of capital and operation and maintenance (O&M) costs as high, moderate, or low, relative to other options in the same technology category, and
- cost had a limited role in the evaluation process compared to effectiveness and implementability.

The strengths and limitations of each retained technology were evaluated in order to facilitate the combination of technologies into removal action alternatives and to determine the testing/modeling that was necessary to fully evaluate the most promising technologies. The containment, removal, treatment, and disposal technology evaluations are presented in Tables 5.11 through 5.14.

5.3 PRELIMINARY REMOVAL ACTION ALTERNATIVE ASSESSMENTS

Following the evaluations of the retained technologies, preliminary removal action alternatives were developed in the PTTE Report. Alternative development, which involved combining multiple technologies (e.g., removal, treatment, and disposal) was useful in establishing and evaluating how the technologies must interact to achieve a successful removal action. For example: a specific treatment technology might not be feasible to consider if upstream requirements for dredging or dewatering cannot be achieved.

Twelve preliminary removal action alternatives were identified to satisfy a single general response action or several general response actions utilizing the technologies evaluated in Section 5.2. Alternatives were grouped into five response action categories as follows:

i) Alternative A - Natural Recovery (No Action);

ii) Alternative B - Source Containment;

iii) Alternative C - Sediment Removal/Treatment/Disposal;

iv) Alternative D – Sediment Removal/Treatment/Disposal with Containment Under Docks; and

v) Alternative E - Combined Embankment and Area 5106 Sediment Containment.

The preliminary removal action alternatives included only one technology, such as containment, or included multiple technologies to satisfy a general response action. The containment alternative(s) were illustrated with figures. The removal, treatment, and disposal alternatives were depicted in flow charts. Removal and treatment rates were estimated for evaluation purposes based on technology constraints and the estimated volume of Area 5106 Sediment. Each of four removal/treatment/disposal alternatives was based on two removal options (hydraulic or mechanical removal) that impact the treatment technology process requirements. Multiple disposal technologies were shown for most of the removal/treatment alternatives.

The descriptions, detailed figures, and flowsheets for each preliminary removal action alternative are presented in Appendix D.

The preliminary removal action alternatives were assessed based on the following criteria:

i) effectiveness:
   - short-term (environmental and human health), and
   - long-term (removal action objectives);

ii) implementability:
   - regulatory acceptance,
   - constructability (size and configuration of equipment, containment structures, material staging and handling requirements, disposal requirements including distances, transportation methods, and sediment characteristics), and
   - schedule (time frame to achieve removal action goals); and

iii) relative costs (capital and O&M).

The assessment of the preliminary removal action alternatives is presented in Table 5.15.

5.4 PRELIMINARY TECHNOLOGY TESTING AND MODELING

Preliminary technology modeling and/or limited testing were performed in conjunction with the assessment of preliminary removal action alternatives discussed in Section 5.3. The objective of these studies was to evaluate the potential of the selected technologies to meet the removal action objectives.

These programs are described in the PTTE Report and included the following:

i) preliminary modeling of Area 5106 Sediment and water quality;

ii) consolidation analyses of Area 5106 Sediment, fill material, recent sediment, and native sediment;

iii) bench scale aeration tests on 20 percent sediment slurry prepared from Area 5106 Sediment and Hylebos Waterway water;

iv) Hazelton Soil Washing Pilot Scale Testing; and

v) bench scale dewatering.

The results of the technology modeling and testing are presented in Appendix E.

5.5 SELECTION OF MOST PROMISING TECHNOLOGIES

Based on the technology evaluations, the alternative assessments, and evaluation of the preliminary modeling/testing, the most promising containment, removal, treatment, and disposal technologies were identified and are summarized in Table 5.16.

5.6 TECHNOLOGY SELECTION

Additional studies and evaluations of several of the most promising treatment, removal, and disposal technologies, presented in Table 5.16, were performed. The purpose of the studies and evaluations was to:

i) determine which of the most promising technologies should be combined for the EE/CA removal action alternatives analyses; and

ii) provide more detailed information for the actual alternatives analyses.

Summaries of the additional technology evaluations are presented in the following subsections. The selection of technologies for EE/CA alternatives analyses is presented following each summary.

5.6.1 SEDIMENT TREATMENT TECHNOLOGIES

There were four treatment technologies listed among the most-promising technologies:

i) Hazelton Maxi-Clone Soil Washing;

ii) Low Temperature Thermal Desorption (LTTD);

iii) Incineration; and

iv) Slurry Aeration/Oxidation.

A pilot-scale Hazelton Soil Washing batch test was conducted for the PTTE Report. That test provided sufficient data to evaluate the Hazelton treatment technology for potential inclusion as an EE/CA alternative. No bench- or pilot-scale tests were performed for the LTTD or incineration treatment operations. These technologies are well established and sufficient information was available to evaluate them for potential inclusion as an EE/CA alternative.

However, the PTTE Report identified slurry aeration and chemical oxidation as technologies requiring further evaluation. Accordingly, a bench scale treatability study was performed during September-October 1999 to assess whether volatilization alone or in conjunction with chemical oxidation could effectively treat the Area 5106 Sediment.

The main objectives of the treatability study were to:

i) determine the effects of various airflow rates on the volatilization process;

ii) determine the effects of temperature on the volatilization process;

iii) determine the effect of chemical oxidation on enhancing the removal of SVOCs; and

iv) determine which sediment/water mixtures, or slurries, would allow for the most effective sediment treatment.

The results of the treatability study were presented in the Bench Scale Treatability Study, Slurry Aeration of Area 5106 Sediment Report, approved by USEPA and attached as Appendix F. Conclusions from the Bench Scale Treatability Study include:

i) slurry aeration can effectively treat Area 5106 Sediment to chemical levels acceptable for disposal in the Slip 1 CDF;

ii) the slurry aeration was determined to be most effective under the following treatment conditions:

- slurry content of 10 to 15 percent solids by weight,
- treatment temperature of 45°C,
- treatment airflow of 1000 cfm (scaled up from 480 liters/hour in lab), and

iii) air dispersion agitation; and

iv) the effectiveness of chemical oxidation was inconclusive, showing no perceptible improvement over treatment by slurry aeration alone. As such, in agreement with USEPA, chemical oxidation was eliminated from further consideration as a treatment enhancement.

5.6.1.1 SELECTION OF TREATMENT TECHNOLOGY FOR EE/CA ALTERNATIVE ANALYSES

Based upon the results of pilot/bench scale studies and on knowledge of the technologies, slurry aeration was selected as the treatment technology for EE/CA removal action alternative evaluation.

Slurry aeration was selected over the Hazelton Maxi-Clone soil washing for the following reasons:

i) based on the pilot and treatability tests, slurry aeration was determined to be the more effective treatment technology for Area 5106 Sediment;

ii) slurry aeration is a proven, existing technology, whereas the Hazelton system has not been used in large-scale applications; and

iii) slurry aeration can be performed on sediment with 10 to 15 percent solids by weight, whereas the Hazelton system is limited to less than 5 percent solids by weight.

Incineration and LTTD were eliminated because of the extensive handling requirements of untreated sediments, such as dewatering, prior to treatment. Air emissions and worker protection issues associated with handling the untreated sediments make incineration and LTTD less desirable technologies than either slurry aeration or the Hazelton Maxi-Clone. In addition, both technologies were significantly more costly to implement and were only marginally more effective.

5.6.2 SEDIMENT REMOVAL TECHNOLOGIES

A more detailed evaluation of the most promising dredging technologies outlined in the PTTE Report was performed which included:

i) mechanical dredging;
   - standard clamshell bucket;
   - enclosed (environmental) clamshell bucket;

ii) hydraulic cutterhead dredge; and

iii) specialty dredging:
   - Eddy pump,
   - TOYO pump,
   - Pneuma dredge, and
   - DRE Dry-Dredge.

Table 5.17 presents a summary of the dredging technology evaluation. The dredging technologies were evaluated against the parameters of performance, production, resuspension characteristics, cost, and availability. A discussion of each dredging technology is included in Appendix G.

5.6.2.1 SELECTION OF REMOVAL TECHNOLOGIES FOR EE/CA ALTERNATIVE EVALUATIONS

Based on the detailed analysis of the sediment removal technologies, a combination of the TOYO pump and mechanical dredging was selected as the preferred removal option. The two technologies, while quite different, complement each other when used in combination for the removal of Area 5106 Sediment.

Mechanical dredging:

i) provides the highest dredged material solids content (40 to 70 percent by volume), thereby minimizing the amount of water collected;

ii) is the dredging technology most compatible with the selected treatment technology;

iii) can dredge on sloping surfaces;

iv) is able to sustain production rates of 50 to 200 c.y./hr.; and

v) based on the Water Quality Test (see Section 6.3), the chemical concentrations within the initial mixing zone for mechanical dredging appear to be equal to or less than those predicted by the WES model for hydraulic dredging.

Of the hydraulic dredging technologies evaluated (hydraulic cutterhead, Eddy pump, TOYO pump, and pneuma pump), the TOYO pump would provide the best performance in Area 5106 Sediment for the following reasons:

i) provide a lower resuspension than anticipated for mechanical dredging;

ii) it is capable of providing up to 70 percent dredged solids concentrations (by weight);

iii) it is readily available on a commercial basis in a number of different sizes; and

iv) neither the Eddy pump nor the pnuema pump have demonstrated large-scale experience.

However, the TOYO pump is not capable of dredging in stiff or dense materials, such as a clay or compacted sand layer. In addition, the TOYO pump is designed to dredge bulk materials. Dredging to specific lines and grades as required for the Area 5106 Sediment removal would be difficult utilizing the TOYO pump.

Standard hydraulic cutterhead dredging substantially increases the amount of water collected during dredging. Even at relatively low production rates, the amount of slurry (water) becomes unmanageable at the Site. The resulting low solids slurry (average 2 to 5 percent by weight) would extend the dredging and treatment schedule by three to five times that estimated for mechanical dredging. Therefore, hydraulic dredging activities in the Hylebos Waterway would occur over a longer period time, thereby increasing the potential environmental impacts of dredging.

Under normal dredging operations, hydraulic dredging results in lower suspended solids than mechanical dredging, thereby minimizing impacts to water quality.

However, at the low production rates anticipated for removal of Area 5106 Sediment, solids resuspension from mechanical dredging will be minimized. Consequently, water quality impacts from mechanical dredging are not expected to differ significantly from those expected from standard hydraulic dredging. Costs would increase significantly using hydraulic dredging, with no significant improvement in short-term water quality.

Considering the above analysis, the selected removal technology will consist of a combination of the TOYO pump and mechanical dredging. The dredging technique will consist of initially utilizing a TOYO pump to remove Area 5106 Sediment. The TOYO pump will be used as long as the solids content of the dredged sediment is greater than 20 percent by weight. When the sediment content in the dredged slurry drops below 20 percent by weight the TOYO pump will be moved to another location. Mechanical dredging will follow the TOYO pump and will be used to remove the remaining Area 5106 Sediment.

Use of a hydraulic dredging technology to a greater extent than described above would be incompatible with the selected treatment process. Cost would increase significantly and the in water schedule could increase by more than 23 weeks.

The Dredging Controls Report (see Section 6.2) concluded that production rate reduction and timing of dredging are the only practicable engineering controls which could be implemented in the event that significant water quality exceedances occur outside the mixing zone on a regular basis during dredging of the Area 5106 Sediment. Therefore, the dredging engineering controls for the removal action alternatives will be limited to modifying the production rate and timing of the dredging. The controls, if required, would be implemented to the extent practicable solely to limit the extent of water quality impacts to within the mixing zone.

5.6.3 DISPOSAL TECHNOLOGIES

The following treated sediment disposal technologies were evaluated based upon preliminary assessments performed as part of the PTTE Report:

i) HCC Nearshore Fill - This option would consist of treated sediment disposal with the rest of the dredged Hylebos Waterway sediment in the Slip 1 CDF. The location of the Slip 1 CDF is shown on Figure 5.1. The preliminary design concept is presented on Figures 5.2 and 5.3;

ii) OCCT Property (former PRI property) - This option would consist of treated sediment disposal as fill on the OCCT property or in a landfill constructed at the property. Disposal on OCCT property would be allowed through the establishment of a Corrective Action Management Unit (CAMU). Placement of remediation residues in a CAMU is not considered "land disposal" and provisions of the CWA would apply. The location of the OCCT CAMU is shown on Figure 5.1. The preliminary design concept is presented on Figures 5.4 and 5.5; and

iii) Subtitle D/Upland Disposal - Disposal of treated sediment would be in a Subtitle D Facility.

5.6.3.1 SELECTION OF DISPOSAL TECHNOLOGY FOR EE/CA ALTERNATIVES ANALYSES

Based on the disposal technology evaluation presented in Table 5.14, the results of pilot/bench scale treatment studies, the treatment technology selected for the EE/CA alternative analysis (slurry aeration), and on knowledge of the treatment ability of the selected technology, disposal of treated sediment in the HCC nearshore fill site (Slip 1 CDF) was selected as the disposal technology for the EE/CA removal action alternative analyses.

Slip 1 disposal was selected over OCCT property disposal and Subtitle D disposal for the following reasons:

i) Slip 1 is a USEPA-preferred disposal site for Hylebos sediment. Disposal of dredged sediments is regulated under CWA, Section 404;

ii) disposal of treated Area 5106 Sediment would be with sediment from other Hylebos dredging activities;

iii) the selected treatment technology (slurry aeration) achieves levels of treatment well beyond those required for disposal in the Slip 1 CDF (refer to the treatment criteria analysis presented as Appendix H). Modeling of the Slip 1 CDF, performed as part of the CLT Evaluation Report and presented as a portion of Appendix A, demonstrates that the worst case seepage concentrations resulting from the placement of treated Area 5106 Sediment within the Slip 1 CDF are well below the acute or chronic marine WQC at the regulatory point of compliance (i.e., at the seaward face of the berm);

iv) the level of treatment achieved by the slurry aeration process may not meet Subtitle D disposal requirements (see Table 3.11 for the estimated TCLP concentrations for metals); and

v) disposal of treated sediments on the OCCT property or in a Subtitle D site would be considerably more costly than Slip 1 CDF disposal with no greater protection to human health and the environment.

6.0 WATER QUALITY ASSESSMENTS

Following the selection of the most promising technologies in the PTTE Report, several models, tests, and reports were conducted to assess the impacts on water quality in the Hylebos Waterway during sediment removal processes. The water quality impacts of sediment disposal in the Slip 1 CDF were also evaluated.

6.1 USEPA WATER QUALITY MODELING

As part of the PTTE Report, OCCT performed preliminary modeling to assess the water quality that may be expected during the dredging of the Area 5106 Sediment. The preliminary modeling indicated that exceedances of relevant acute and chronic marine WQC may be expected well beyond the mixing zones established in the Washington State surface water quality standards (WAC 173-201A-100). Consequently, OCCT recommended further modeling to more fully assess the impacts dredging of the Area 5106 Sediment may have on the water quality in the Hylebos Waterway.

Subsequently, under the direction of USEPA, the USACE Waterways Experiment Station (WES) performed additional screening level modeling to predict the water quality impacts from dredging. WES utilized the DREDGE model to estimate the mixing zones required to meet relevant WQC.

Based on the results of the WES Modeling, USEPA has determined that:

i) the acute marine WQC will serve as the performance criteria for the established mixing zone; and

ii) an approximately 300 feet extent estimates the necessary mixing zone dimensions.

Based on the USEPA model, acute marine WQC may be exceeded beyond 300 feet from the point of dredging. Furthermore, chemical concentrations within the mixing zone could have impacts to marine life. Figure 6.1 illustrates the limits of the USEPA 300-foot mixing zone in the Hylebos Waterway.

6.2 DREDGING CONTROLS REPORT

Subsequent to the modeling discussed in Section 6.1, USEPA requested that OCCT evaluate dredging controls to limit temporary water impacts to water quality. The following barrier-type controls and dredging equipment design/operational controls were evaluated:

i) cofferdam containment;

ii) sheet piling containment;

iii) silt curtain containment;

iv) semi-pervious barriers;

v) plume entrainment structure;

vi) treatment wall;

vii) timing of dredging;

viii) production rate;

ix) dredgehead hood; and

x) mechanical dredge.

Each of the control measures were evaluated with respect to effectiveness, implementability, schedule, and costs. Whenever possible, the effectiveness of the control measure was evaluated using the USEPA model.

The Evaluation of Dredging Controls Report concluded that, in theory, the following engineering controls could be implemented during dredging to limit the water quality impacts to the established mixing zone:

i) production rate (rate at which the sediment is removed);

ii) timing of dredging (relative to tidal movements);

iii) silt curtains containment;

iv) semi-pervious barrier; and

v) plume containment structure.

However, items iii), iv), and v) above are unproven controls for the water quality impacts resulting from releases of VOCs and SVOCs. Implementation of these controls would significantly increase the cost of the removal action substantially with no

assurance or expectation of effectiveness. Consequently, production rates and timing of dredging are considered the only practicable engineering controls which could be implemented in the event that significant water quality exceedances occur outside the mixing zone on a regular basis during dredging of the Area 5106 Sediment.

6.3 WATER QUALITY TEST - DREDGING IMPACTS

In order to further evaluate the water quality impacts of dredging, water quality monitoring was performed during the collection of Area 5106 Sediment for the Bench Scale Treatability Study. The purpose of the water quality test was:

i) to measure the mass flux of chemicals in to the water column from combined sediment resuspension and cut face release processes resulting from dredging operations;

ii) to verify or correlate the field monitoring results with the assumptions made in the WES Modeling; and

iii) to evaluate the water quality impacts associated with mechanical dredging of Area 5106 Sediment.

The results of the water quality monitoring are presented in the Draft Water Quality Test Report.

6.4 DISPOSAL SITE ANALYSIS

Groundwater flow and transport modeling of the Slip 1 CDF was performed in order to assess the potential water quality impacts of placing the Area 5106 boundary sediments in the Slip 1 CDF. The disposal site analysis predicted that seepage concentrations from the Slip 1 CDF will be significantly below the relevant marine WQC and will present no long-term water quality concerns. Consequently, the Area 5106 boundary sediments are acceptable for placement within the Slip 1 CDF without treatment. The results of methodology and the modeling are presented in Appendix E.

The results of the modeling and subsequent sensitivity analyses were also utilized to estimate the practicable treatment criteria for the disposal of treated Area 5106 Sediment in the Slip 1 CDF.

7.0 IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

A total of four removal action alternatives have been developed for analysis against the criteria of effectiveness, implementability, and cost. The selection of the alternatives was based upon the Site characterization, the nature and extent of contamination, the removal action goals and objectives, and the analysis of removal action technologies.

7.1 ALTERNATIVE A - NO ACTION (NATURAL ATTENUATION)

The No Action Alternative supplies a baseline against which other removal action alternatives can be compared. Under the No Action Alternative, no removal actions would be performed and the Site would be left largely unchanged. However, some degree of sediment natural recovery will occur over time, as presented in the PTTE Report.

Long-term annual inspection, sampling, and analysis would be performed to monitor the rate of sediment natural recovery.

7.2 ALTERNATIVE B - CONTAINMENT

In situ sediment capping is a source containment alternative that would isolate the Area 5106 Sediment. Capping would be designed to ensure the mass flux of chemicals from Area 5106 Sediment would not cause exceedances of SQOs or the relevant marine WQC within 10 cm of the surface of the cap.

Alternative B consists of an armored sand cap. The cap would cover the limits of the Area 5106 Sediment as presented on Figure 7.1. The western boundary would be the 0-foot MLLW at the Hylebos Waterway embankment, and the eastern boundary would be the western edge of the shipping channel. The southern limit would be approximately 50 feet south of Pioneer's Dock No. 1 and the northern limit would be approximately 200 feet north of Pioneer's northern property line.

Initially, approximately 2,000 c.y. of Area 5106 Sediment would be removed from the shipping channel and placed within the main body of the Area 5106 Sediment to allow future dredging of the navigation channel. Since it is anticipated that capping would occur prior to dredging of the Hylebos, a berm of hydraulically placed sand would then

be placed around the perimeter of the Area 5106 Sediment at the elevation of the proposed Hylebos dredging (see Figure 7.2). A geotextile fabric would then be placed over the Area 5106 Sediment to separate it from the cap materials. Clean sand would then be hydraulically placed over the geotextile fabric to contain the sediment and reduce the mass flux of chemicals from the sediment. Gravel or light, loose rip rap would be placed over the sand layer as armoring to protect the sand from propeller wash and other scouring effects. The rip rap armor layer would be covered with sand and gravel "fish mix" to fill voids and improve habitat feeding and rearing functions for juvenile salmonids and other resources. The finer grained components of the fish mix would provide habitat conducive to supporting epibenthic organisms that serve as prey items for out-migrating juvenile salmonids.

The sand thickness, rip rap gradation and thickness, placement methodologies, and the "fish mix" thickness, would be determined during final design based upon design criteria developed to meet the removal action objectives. The ability of the Area 5106 Sediment to support a cap and the resulting settlements were discussed in Section 6.1.2 of the PTTE Report (see Appendix D). Installation of a cap would cause minimal settlement of the existing sediments. Engineered structural support may be necessary on sloping surfaces to provide increased long-term slope stability.

Following construction of the cap, institutional controls would be implemented to restrict future dredging and ship anchoring in the vicinity of the cap. In addition, long-term inspection and monitoring would be performed to ensure the continued effectiveness of the containment alternative.

7.3 ALTERNATIVE C - REMOVAL/TREATMENT/DISPOSAL

Alternative C consists of sediment removal by dredging, treatment by slurry aeration, and disposal of treated sediment in the Slip 1 CDF. The basis for selection of the specific sediment removal, treatment, and disposal technologies is presented in Section 5.6.

Removal of Area 5106 Sediment would be performed utilizing a combination of TOYO pump and mechanical dredging to limit the amount of sediment resuspension to the extent practicable. The dredging technique would consist of initially utilizing a TOYO pump to remove Area 5106 Sediment. The TOYO pump would be used as long as the solids content of the dredged sediment is greater than 20 percent by weight. The percent solids achieved by the TOYO pump will be monitored on a regular basis during dredging to optimize performance. The specific monitoring methodology will be

developed during final design. When the solids content falls below the target 20 percent, the TOYO pump will be moved to another location. Mechanical dredging would follow the TOYO pump and remove the remaining Area 5106 Sediment, if any, which cannot be removed at greater than 20 percent solids with the TOYO pump. A standard clamshell bucket or hydraulic excavator would be used for mechanical dredging. Environmental buckets would not be utilized since they do not work effectively on the granular materials expected to be encountered at the vertical limit of the Area 5106 Sediment where the mechanical dredging would occur.

A minimum 300-foot mixing zone would be established to meet relevant acute marine WQC during dredging activities. In the event that relevant acute marine WQC are exceeded beyond the limits of the mixing zone during dredge, the need for dredging engineering controls will be evaluated. The dredging engineering controls will be limited to modifying the production rate and/or the timing of the dredging. These controls, if required, would be implemented to the extent practicable solely to limit the water quality impacts to within the mixing zone.

The limits of dredging would be the lines and grades of Area 5106 Sediment determined by the boundary estimation investigation. Since the sediment at these limits were determined not to be Area 5106 Sediment, removal to these limits is conservative. The removal will be confirmed during dredging utilizing GPS or other appropriate survey methodologies. Following removal of the Area 5106 Sediment, the boundary sediments will be addressed as part of the Hylebos Mouth Cleanup. A dredging plan for Alternative C is presented on Figure 7.3. Typical dredging sections are presented on Figures 7.4 and 7.5.

The dredged portion of the embankment slope will be backfilled with sand to mitigate the effects of dredging within the critical habitat zone (elevation 0 feet MLLW to -10 feet MLLW). The fill will be incorporated as part of the cap proposed for the Embankment Area removal action.

The process for treating Area 5106 Sediment is presented on the Process Flow Diagram shown on Figure 7.6. The treatment facility would be located on the OCCT property (formerly PRI). Following removal, the dredged sediments would be pumped to an upland covered storage tank where the dredged sediments would be stored until processed for treatment. For mechanical dredging, a covered processing unit with vapor collection and carbon treatment would be placed on a barge to receive the dredged sediment and produce a slurry that would be pumpable to the storage tank. Tankage on the barge would be limited to the slurry processing unit. The storage tank would have

the capacity to store approximately 1.5 days of treatment capacity. The dredged sediments would be pumped from the storage tank to an agitated, covered, equalization tank where a high solids slurry would be formed and preheated. Three 20,000 gallon covered tanks would be utilized for treatment. Each treatment tank would be equipped with an agitator, air dispersion impeller, air diffusers, internal baffles, and steam inlet nozzles.

The slurry from the equalization tank would be mixed with Hylebos seawater in each treatment tank to form a slurry consisting of 10 to 15 percent solids by weight. The mixing slurry would be heated with steam and maintained at a temperature of 45 degrees Celsius (°C). Simultaneously, air would be added at the bottom of the tank at a rate of approximately 1000 cubic feet per minute (cfm). Target VOCs/SVOCs in the vapor stream would be removed through vapor carbon beds. Air monitoring would be performed to assure compliance to the substantive requirements of the Clean Air Act and the Acceptable Source Impact Level (ASIL) established by the Puget Sound Clean Air Agency, Regulation III, Appendix A. The Area 5106 Sediment would be treated to meet the treatment criteria presented in Appendix H.

The treated slurry would be pumped to barges moored along the embankment for settling and dewatering. Alternatively, settling ponds would be used for dewatering. The decant water would be pumped to a storage tank for recycle into the treatment process. Excess decant water would be pumped from the storage tank and discharged to the Hylebos Waterway. Based on the results of the Treatability Study, the decant water is expected to meet the relevant acute marine WQC without further treatment. Decant water which does not meet discharge criteria will be recycled to the treatment process for further aeration and heating. Following settling and dewatering, the treated sediment would be transported to the Slip 1 CDF for disposal.

7.4 ALTERNATIVE D - COMBINED CONTAINMENT AND REMOVAL

Alternative D consists of a combination of Alternatives B and C, as shown on Figures 7.7 through 7.9. The portion of Area 5106 Sediment situated between 0 foot MLLW and the face of the dock on Pioneer's property would be capped in situ as described in Section 7.2. The rip rap armor layer in the capped areas would be covered with sand and gravel "fish mix" to fill voids and improve habitat feeding and rearing functions for juvenile salmonids and other resources. The finer grained components of the fish mix would provide habitat conducive to supporting epibenthic organisms that serve as prey

items for out-migrating juvenile salmonids. The methodology for capping under the dock would be determined during final design. The methodology could include: dock removal, mechanical placement, tremie placement, etc., or a combination of methods.

Area 5106 Sediment from the face of the docks into the Hylebos Waterway would be removed with a combination of TOYO pump and mechanical dredge as described in Section 7.3. The small amount of Area 5106 Sediment under the POT dock would be also removed by dredging.

Sheet piling would be permanently installed at the east face of the Pioneer dock and along a straight line from the southern end of the POT dock to the southern end of Pioneer Dock 1. The sheet piling would provide structural slope stability where the sediment is dredged from the waterway side of the dock line. The height of the sheet piling is shown conceptually on Figures 7.8 and 7.9. The final height and depth of piling would be determined during final design.

Treatment of dredged sediment would be conducted using slurry aeration as described in Alternative C. The treated sediment would be disposed of in the Slip 1 CDF.

8.0 ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The EE/CA Guidance requires an evaluation of each removal action alternative against the short- and long-term aspects of the broad criteria: effectiveness, implementability, and cost. Effectiveness refers to the ability of an alternative to meet the objective within the scope of the removal action. Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. Costs for each removal action alternative considers both the initial project capital cost of the removal action, and the long-term O&M cost associated with the alternative. The following subsections contain the analyses of the four identified alternatives.

8.1 ALTERNATIVE A - NO ACTION (NATURAL RECOVERY)

8.1.1 EFFECTIVENESS

Overall Protection of Public Health and the Environment - Although natural recovery is occurring within the boundary of the Area 5106 Sediment, there will continue to be potential impacts to aquatic life under the No Action Alternative until recovery is complete. The occurrence of natural recovery is based on testing and modeling performed as part of the PTTE Report and presented in Appendix E. Marine life would continue to be impacted by contamination present in the sediments and benthic communities would continue to be depressed, thereby reducing the value of contaminated areas as habitat. Human health effects associated with consumption of contaminated fish and shellfish would continue to exist.

Compliance with ARARs - Preliminary modeling of the sediment surface (0 to 10 cm) indicates that portions of Area 5106 surface sediments may achieve SQOs within the 10 years following the completion of the Hylebos Waterway remedial action. Several propeller wash zones within the Area 5106 Sediment boundary, however, are not predicted to fully recover and may not meet SQOs without further controls (e.g., capping). Therefore, the No Action Alternative does not meet the removal action objectives.

Long-Term Effectiveness and Permanence - The No Action Alternative does not involve removal of contaminated sediments, therefore, the inherent risk from the sediments will remain for the long-term.

Reduction of Toxicity, Mobility, or Volume Through Treatment - The No Action Alternative does not involve treatment of sediment, therefore, only natural biodegradation processes will contribute to the reduction of toxicity and mobility in contaminated sediments.

Short-Term Effectiveness - There are no active implementation steps (capping and/or sediment removal and treatment) under Alternative A. Therefore, the short-term effectiveness criterion evaluates the effects of the alternative until natural recovery is complete:

i) Protection of the Community - As discussed above, there could be human health effects associated with the consumption of contaminated fish and shellfish that have come in contact with Area 5106 Sediment;

ii) Protection of the Workers - Since there are no active implementation steps, there are no worker impacts;

iii) Environmental Impacts - As discussed above, aquatic life would continue to be impacted by contamination present in the sediments, and benthic communities would continue to be depressed; and

iv) Time until Response Objectives are Achieved - Surface sediments are not expected to meet SQOs in the short term.

8.1.2 IMPLEMENTABILITY

Technical Feasibility - The No Action Alternative does not involve implementation of remedial activities other than periodic monitoring. Therefore, there are no technical issues to evaluate.

Availability - Since there are no remedial activities to be implemented, availability is not an issue.

Administrative Feasibility - There will be no required permits, easements, or right-of-ways required for the No Action Alternative. However, future use of the property could be impacted as institutional controls would be required to restrict dredging and anchoring of ships in this area of the Hylebos Waterway.

State and community acceptance of this alternative will be fully evaluated during the public comment period of this EE/CA.

8.1.3 COST

The estimated cost of Alternative A is $851,000. Details of the cost estimate are presented in Table 8.1.

8.2 ALTERNATIVE B - CONTAINMENT

8.2.1 EFFECTIVENESS

Overall Protection of Public Health and the Environment - With properly implemented institutional controls, the armored sand cap would meet the remedial removal action objectives for Area 5106 Sediment. However, there are long-term environmental risks associated with leaving Area 5106 Sediment in place. A properly designed cap would satisfy SQOs by providing a 10 cm surface layer consisting of sand and gravel "fish mix" to improve habitat feeding and rearing functions for juvenile salmonids and other resources. The finer grained components of the fish mix would provide habitat conducive to supporting epibenthic organisms that serve as prey items for out-migrating juvenile salmonids.

Consolidation analysis performed for the PTTE Report shows that a 2-foot cap would result in minimum consolidation of the Area 5106 Sediment, hence the upward movement of porewater would affect only the lower portion of the cap (approximately 3 inches into the sand layer). Preliminary modeling (presented in Appendix E) indicates that a 1-foot cap may be adequate to satisfy remedial removal action objectives.

Compliance with ARARs - Page 2 of the CB/NT ROD declares that the selected remedy, which included capping outside of the navigation channel, complies with Federal, State, and tribal requirements that are applicable, or relevant and appropriate, for the remedial removal action. The alternative is consistent with the ROD and therefore complies with the ARARs, as summarized below.

CWA Section 401 - The PTTE Report shows that water above the surface of the cap will meet marine WQC, and therefore the alternative complies with the substantive requirements of Section 401 of the CWA.

Rivers and Harbors Act - Alternative B involves a small amount of dredging in the navigation channel of the Hylebos Waterway. The alternative complies with the substantive requirements of the Rivers and Harbors Act. However, institution controls required to assure the long-term effectiveness of cap may infringe upon navigable waters of the Hylebos Waterway.

CWA Section 404 - Alternative B involves the placement of a clean cap and no dredging and disposal (except for the small amount in the navigation channel, which will be placed beneath the cap). Capping is expected to result in short term increases in suspended particulates and turbidity, but any increase is expected to be small due to the relatively coarse materials used in cap construction. Short-term release of chemistry may also occur within an appropriate mixing zone. The alternative would therefore not cause or contribute to violations of any applicable State water quality standard; violate any applicable toxic standard or prohibition under Section 307 of the CWA; jeopardize the continued existence of any endangered species or threatened species or contribute to the destruction of any critical habitat for such species; or contribute to significant degradation of the waters of the United States. The alternative would therefore satisfy the substantive requirements of Section 404 of the CWA. Capping, however, would modify the elevation of intertidal habitat.

Endangered Species Act - Impacts to endangered species will be minimized by performing all in-water work outside the designated fish window. The conceptual design of Alternative B includes a nominal 2-foot thick sand bedding layer, overlain as necessary with armor to maintain slope stability. The entire surface of the Alternative B cap, including voids in the armor layer, would be covered with sand and gravel "fish mix" to improve habitat feeding and rearing functions for juvenile salmonids and other resources. Previous experience with fish mix placed in similar settings in Commencement Bay, including at the Slip 1 Mitigation Beach in the adjacent Blair Waterway (FishPro 1990), has demonstrated that such designs lead to rapid and substantial development of feeding and rearing junctions for juvenile salmonids. Habitat functions provided by Area 5106 immediately following construction of Alternative B are expected to be substantially improved relative to existing conditions. This improvement is due to both enhanced physical conditions (gentler slopes and more fine-grained substrate materials) and to the removal of exposure to existing contaminated sediments.

<u>Long-Term Effectiveness and Permanence</u> - In situ capping is a proven technology that has been used extensively in Puget Sound sites since 1984. Ongoing monitoring of these projects has demonstrated the long-term integrity and effectiveness of caps placed to a

thickness greater than 1-foot, even when constructed within navigation channels. Armoring with gravel and/or rip rap provides additional protection from propeller wash.

Preliminary analysis indicates that the upward movement of porewater due to material placement would only affect the lower portion (approximately 3 inches) of the cap. SQOs would be satisfied for the 10 cm surface layer, which would support benthic life.

There are long-term environmental risks associated with leaving Area 5106 Sediment in place. Effectively enforced, institutional controls would be required for the life of the cap to restrict dredging and anchoring of ships within the capping area. Dredging restrictions would prevent damage to the cap surface.

Reduction of Toxicity, Mobility, or Volume Through Treatment - The in situ capping alternative does not immediately reduce toxicity or volume of Area 5106 Sediment, although natural biodegradation processes would continue to occur. The mobility of the sediment chemistry would be reduced by the cap. The contaminated sediments would be contained and the upward migration of porewater would not extend beyond the lower portion of the sand layer.

Short-Term Effectiveness:

i) Protection of the Community - The implementation of Alternative B would not pose any significant risk to the community because it is an in situ action;

ii) Protection of the Workers - Cap placement would be done solely with equipment on barges or on land. Therefore, the workers installing the cap would not be subject to contact with potentially contaminated sediments. The minimal release of chemistry during placement of the cap is not expected to require protection of workers;

iii) Environmental Impacts - The in situ capping is expected to result in short-term increases in suspended particulate and turbidity but impacts are expected to be minor due to the relatively coarse materials used in cap construction. Short-term release of chemistry may also occur within an appropriate mixing zone during placement of the cap. Short-term, temporary, water quality impacts are also expected during the removal of the small amount of Area 5106 Sediment located within the shipping channel; and

iv) Time Until Response Objectives Are Achieved - The in situ cap would be completed within 8 months of USEPA approval of the recommended alternative.

8.2.2 IMPLEMENTABILITY

Technical Feasibility:

i) Construction and Operational Considerations - Capping is a proven technology that has been utilized in the Puget Sound area for approximately 15 years. Placement of the in situ cap would use standard equipment and techniques to be determined during final design. Under-dock areas are slightly more difficult to cap but sand and rip rap can be placed using long-arm or telescoping equipment. Once placed, there are long-term operational considerations for the cap including enforcement of institutional controls, and regular maintenance and monitoring;

ii) Demonstrated Performance/Useful Life - As discussed above, in situ capping in marine environments is a proven technology with demonstrated long-term integrity and effectiveness. However, institutional controls and regular maintenance and monitoring would be required for the life of the cap; and

iii) Adaptability to Environmental Conditions - Placement of a cap would meet the removal action objectives if institutional controls are implemented and well enforced. Placement of clean cap material would provide sediment surface environments conducive for benthic development and would greatly reduce the migration of impacted sediment. The cap would be regularly monitored with contingencies in place to ensure the long-term effectiveness of the cap.

Availability: An in situ cap would be constructed using standard equipment and no availability problems are anticipated for equipment, personnel, and related services.

Administrative Feasibility:

i) Permits Required - In accordance with the AOC, no local, State, or Federal permits would be required for any portion of the on Site removal action activities. The removal action, however, to the extent practicable, would attain ARARs under Federal an State environmental laws;

ii) Easements and Right-of-Way Required - The POT and Pioneer own the area impacted by Area 5106 Sediment. Formal agreements with these two parties would be necessary in order to proceed with the in situ cap;

iii) Impact on Adjoining Property - The installation of a 2-foot thick cap could impact future use of the property. For example, the available draft at both the POT's and Pioneer's docks could impact the ability of ships to berth at these two areas. Further, construction of the cap would impact ongoing

loading/unloading and activities at both the POT and Pioneer. These issues would have to be resolved during easement/right-of-way discussions;

iv) Ability to Impose Institutional Controls - Institutional controls to restrict dredging and anchor ships within the cap area would be required to assure the continued effectiveness of the alternative over time. Resolving this issue would be part of the formal agreement with POT and Pioneer. Institutional controls, once implemented, are sometimes difficult to effectively maintain over the long-term; and

v) State and Community Acceptance - State and community acceptance of this alternative will be fully evaluated during the public comment period for this EE/CA.

8.2.3 COST

The estimated cost of Alternative B is $3,260,000. Details of the cost estimate are presented in Table 8.2.

8.3 ALTERNATIVE C - REMOVAL/TREATMENT/DISPOSAL

8.3.1 EFFECTIVENESS

Overall Protection of Public Health and the Environment - Removal, treatment, and disposal of Area 5106 Sediment would meet the removal action objectives for the Area 5106 Sediment by removing the sediments that require treatment prior to disposal and would therefore contribute to the efficient implementation of the Hylebos Waterway remedial action. The boundary sediments would be removed as part of the Hylebos Waterway remedial action to meet the SQOs.

Compliance with ARARs - Alternative C involves the dredging and treatment of contaminated sediments and the disposal of those treated sediments within the navigable waters of the United States in a Nearshore Contained Disposal Facility. Under the dredged sediment exclusion rule (CFR 261.4(g)), promulgated by USEPA on November 30, 1998, and effective in non-RCRA delegated states on June 1, 1999, such sediments are excluded from regulation under RCRA's Hazardous Waste Regulation and are subject to regulation under CWA 404(b)(1). Washington State adopted CFR 261.4(g) on June 10, 2000.

CWA Section 401 - As discussed in Section 6.0, the acute marine WQC will serve as the performance criteria for the established mixing zone. In addition, chemical concentrations within the mixing zone could have impacts to marine life. Alternative C is therefore expected to comply with the substantive requirements of Section 401 of the CWA, only as long as a mixing zone of at least the 92 meters (300 feet) estimated by USEPA is utilized for the alternative.

Rivers and Harbors Act - Alternative C involves dredging in the Waterway. The ROD determined that the cumulative negative effects of dredging in the channel, when balanced against the benefits of a substantial reduction in risk to human health and the environment, were in the public interest. The alternative therefore complies with the substantive requirements of the Rivers and Harbors Act.

CWA Section 404 - Dredging of Area 5106 Sediment may impact the physical, chemical, and biological environment within the mixing zone during the removal action. Short-term water quality may be temporarily degraded during dredging to where chemical concentrations within the mixing zone are above the acute marine WQC.

The PRD Evaluation Report discusses potential effects of the nearshore CDF in the Slip 1 CDF on the physical and chemical environment, the biological environment, special aquatic sites and human use characteristics. The discussion concludes that the effects would be negligible to minor, and that any minor effects could be eliminated or controlled. The PRD Evaluation Report does not specifically address the potential impact due to the presence of the treated Area 5106 Sediment in the CDF. Based on the disposal site modeling, however, the discussion and the conclusions are applicable to the disposal of treated Area 5106 Sediment in the Slip 1 CDF.

Endangered Species Act - Impacts to endangered species will be minimized by performing all in-water work outside the designated fish window. The conceptual design of Alternative C includes placement of sand bedding and armor layers (as necessary) over the excavated portion of the nearshore, shallow subtidal (0 to -10 feet MLLW) slope area. The surface of the Alternative C backfill, including voids in the armor layer, would be covered with sand and gravel "fish mix" to improve habitat feeding and rearing functions for juvenile salmonids and other resources. Previous experience with fish mix placed in similar settings in Commencement Bay, including at the Slip 1 Mitigation Beach in the adjacent Blair Waterway (FishPro 1990), has demonstrated that such designs lead to rapid and substantial development of feeding and rearing functions for juvenile salmonids. As such, habitat functions in the vicinity of Area 5106 are expected

to be substantially improved relative to existing conditions immediately following completion of Alternative C.

The slurry aeration treatment system is described in Section 7.3. The treatment system itself will be designed in substantive compliance with the Coastal Zone Management Act and the Washington Shoreline Management Act.

The vapor stream from the treatment system would contain VOCs/SVOCs which would be removed through vapor carbon beds. The carbon beds would be designed so that their emissions to the atmosphere meet the substantive requirements of the Clean Air Act and the ASIL established by the Puget Sound Clean Air Agency, Regulation III, Appendix A.

The Hylebos water used to make the slurry for treatment would also be treated during the slurry aeration process. To the extent practicable, the water would be recycled to the treatment process. However, treated water may be discharged to the Hylebos. The treated water would meet the substantive requirements of the Washington State Water Quality Standards for Surface Water (Chapter 173-201A WAC). Due to the temporary nature of the project and intermittent discharges, compliance would be based on acute marine WQC. A 20-foot mixing zone, measured from the discharge point, would be established to meet the relevant acute marine WQC (from Table 3.9).

The treated sediment from the system would be disposed of in the Slip 1 CDF and, as discussed above, this sediment would be regulated by the substantive requirements of CWA 404(b)(1).

The above discussion shows that Alternative C meets the substantive requirements of the ARARs.

Long-Term Effectiveness and Permanence - Removal of Area 5106 Sediment by dredging would be highly effective and permanent. There would be an extremely low level of residual risk at the Site due to the completeness of the removal activity. Treatment of dredged sediments would be to levels acceptable for inclusion with dredged Hylebos Waterway sediments in the Slip 1 CDF. Modeling has indicated that the treated sediment would not cause exceedance of relevant marine WQC at the regulatory point of compliance of the Slip 1 CDF.

Reduction of Toxicity, Mobility, or Volume Through Treatment - Alternative C reduces the toxicity, mobility, and volume of contaminants through treatment. The dredged sediments would be treated to the treatment criteria presented in Appendix H.

Based upon the average mass and in situ sediment concentrations, the proposed treatment process would remove greater than 97 percent (approximately 16,600 kg) of the organic chemical mass.

Short-Term Effectiveness:

i) Protection of the Community - The potential risks to the community due to implementation of Alternative C would be addressed in a Site-specific Health and Safety Plan (HASP) for the project.

   The HASP would address issues such as perimeter air monitoring (VOCs and particulates), emergency response planning (including coordination with local emergency response officials), and planning of off-Site truck routes (for transportation of any hazardous materials).

   Community risks are expected to be relatively minor as the public would not be allowed access to the dredging area and treatment would be performed in a secure area on private property;

ii) Protection of Workers - The Site-specific HASP would address potential risks to workers involved with the implementation of Alternative C. Contact with contaminated sediments would be expected to be very limited, and personal protective equipment would be required for workers in close proximity to the sediment treatment areas;

iii) Environmental Impacts - As described in Section 6.1, there are short-term water quality impacts associated with sediment dredging operations. Chemical concentrations within the mixing zone could result in temporary impacts to marine life. Based on the water quality achieved during the Bench Scale Treatability Study, short-term water quality impacts would be expected to be minimal during the disposal of the treated sediment within the Slip 1 CDF; and

iv) Time Until Response Objectives Are Achieved - Alternative C would be completed within 12 months of USEPA approval of the recommended alternative.

8.3.2 IMPLEMENTABILITY

Technical Feasibility:

i) Constructability and Operational Considerations - Sediment removal consists of dredging with a combination of a TOYO pump and a mechanical dredge. Both of these technologies are proven and are readily implementable. Removal of sediment under the dock areas can be done using standard construction equipment but the removal rate could be significantly slower than in open areas.

The exact methodology and equipment would be determined during final design. The methodology may include partial dock removal, TOYO pump, clamshell or hydraulic excavator, etc., or a combination of methods.

The treatment operation would utilize standard equipment and is readily constructable. Bench scale treatability tests performed for the slurry aeration process would form the basis of the full-scale operations.

There are no significant construction or operational concerns associated with the disposal of treated sediment in the Slip 1 CDF;

ii) Demonstrated Performance/Useful Life - As discussed above, bench scale treatability tests of the slurry aeration treatment process have demonstrated the performance of the treatment technology at removing chemistry from impacted sediments. Full-scale performance has not yet been demonstrated; and

iii) Adaptability to Environmental Conditions - Dredging of impacted sediments is a proven technology and has been used on numerous occasions in similar applications in Puget Sound. Dredging with either a TOYO pump or a mechanical dredge poses no foreseeable adaptability issues.

Availability:

i) Equipment, Personnel, and Services - The Alternative C removal, treatment, and disposal technologies utilize standard construction equipment and no availability problems are anticipated; and

ii) Off-Site Treatment, Storage, and Disposal - Disposal of treated sediment would be in the Slip 1 CDF. Sufficient volume is available in Slip 1 to accommodate the treated Area 5106 Sediment.

Administrative Feasibility:

i) Permits Required - In accordance with the AOC, no local, State, or Federal permits would be required for any portion of the on-site removal action

activities. The removal action, however, to the extent practicable, would attain ARARs under federal and state environmental laws;

ii) Easements and Right-of-Way Required - The POT and Pioneer own the area impacted by Area 5106 Sediment. Formal agreements with these two parties would be necessary in order to proceed with Alternative C;

iii) Impact on Adjoining Property - Dredging Area 5106 Sediment adjacent to the POT and Pioneer dock areas would cause temporary disruptions in ongoing loading/unloading activities while the removal action is being implemented. The removal work would be scheduled around these activities as much as possible. The details of these issues would need to be resolved during easement/right-of-way discussions.

There would also be temporary impacts on ship traffic in the Hylebos Waterway channel during dredging operations.

Treatment operations would be performed on the adjacent OCCT property (formerly PRI) and/or on Pioneer property;

iv) Ability to Impose Institutional Controls - Since Alternative C involves complete removal of Area 5106 Sediment, no institutional controls are anticipated for the post-removal phase; and

v) State and Community Acceptance - Will be fully evaluated during the public comment period of this EE/CA.

8.3.3 COST

The estimated cost of Alternative C is $11,050,000. Details of the cost estimate are presented in Table 8.3.

8.4 ALTERNATIVE D - COMBINED CAPPING AND REMOVAL

8.4.1 EFFECTIVENESS

Overall Protection of Public Health and the Environment - As discussed in Sections 8.2 and 8.3, both an in situ cap and sediment removal, treatment, and disposal satisfy the removal action objectives for Area 5106 Sediment. The boundary sediments would be removed as part of the Hylebos cleanup to meet the SQOs.

Compliance with ARARs - Alternative D includes capping as in Alternative B, and dredging, treatment and disposal as in Alternative C. Except as related to the habitat discussion below, conclusions in Sections 8.2.1 and 8.3.1 also apply to this alternative.

Similar to the cap design described in Section 7.2, the Alternative D cap section on slope areas (i.e., to the face of the dock) includes a nominal 2-foot thick sand cap, overlain as necessary with rip rap armor to maintain slope stability. The entire surface of the Alternative D cap, including voids in the rip rap armor layer, would be covered with sand and gravel "fish mix" to improve habitat feeding and rearing functions for juvenile salmonids and other resources. Capping, however, would modify the elevation of the intertidal habitat. The exposed vertical face of the subtidal sheet piling, present at depths ranging from approximately -20 to -40 feet MLLW, results in a loss of subtidal habitat. The presence of the sheet piling, however, does result in a relatively flat, fine grained substrate adjacent to the base of the piling.

Alternative D meets the substantive requirements of the ARARs, with the possible exception of CWA 401, CWA 404, and the ESA.

Long-Term Effectiveness and Permanence - See discussions in Sections 8.2.1 and 8.3.1 relative to the capping and removal portions of this alternative.

Reduction of Toxicity, Mobility, or Volume Through Treatment - See discussions in Sections 8.2.1 and 8.3.1 relative to the capping and removal portions of this alternative.

Short-Term Effectiveness - See discussions in Sections 8.2.1 and 8.3.1 relative to the capping and removal portions of this alternative.

i) Time Until Response Objectives Are Achieved - Alternative D would be completed within 12 months of USEPA approval of the recommended alternative.

8.4.2 IMPLEMENTABILITY

Technical Feasibility - See discussions in Sections 8.2.2 and 8.3.2 relative to capping and removal portions of this alternative.

Availability - See discussions in Sections 8.2.2 and 8.3.2 relative to capping and removal portions of this alternative.

Administrative Feasibility - See discussions in Sections 8.2.2 and 8.3.2 relative to capping and removal portions of this alternative.

8.4.3 COST

The estimated cost of Alternative D is $9,270,000. Details of the cost estimate are presented in Table 8.4.

9.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section performs a comparative analysis of the four removal action alternatives using the CERCLA criteria: effectiveness, implementability, and cost. Table 9.1 presents a comparative ranking of each alternative for the CERCLA criteria.

9.1 EFFECTIVENESS

Overall Protection of Public Health and the Environment: The highest potential impacts to aquatic life would continue to exist under Alternative A since no action is taken to mitigate exposure to contaminated sediments. Alternatives B, C, and D are more protective of the environment than Alternative A. While Alternatives B, C, and D would all meet the removal action objectives and satisfy the SQOs, Alternative C would provide the greatest overall protection to public health and the environment.

Compliance with ARARs: Alternative A is the only removal action for which primary ARARs (e.g., SQOs) may not be met for Area 5106 Sediment within 10 years of completion of the Hylebos Waterway remedial action. Alternatives B, C, and D would satisfy the substantial requirements of the ARARs. Alternative D also results in a loss of subtidal habitat from the vertical sheet piling.

Long-Term Effectiveness and Permanence: Long-term inherent risk remains under Alternatives A although portions would be expected to meet SQOs within 10 years after completion of remediation. Alternatives B, C, and D are all proven to be effective and permanent long-term alternatives. The long-term risk associated with Alternative C, however, is reduced through the removal and treatment of the Area 5106 Sediment. Alternatives B and D require effectively enforced institutional controls and regular maintenance and monitoring for the life of the capped areas to assure continued effectiveness over time.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Alternative A does not involve removal and treatment so there is no reduction of toxicity, mobility, or volume of impacted sediment. Only natural biodegradation processes will contribute to reduction in toxicity and mobility. Alternative B achieves minimal reduction in toxicity through natural biodegradation processes. Mobility would be reduced by the presence of the cap. Alternative C achieves the greatest reduction in toxicity, mobility, and volume is achieved through removal and treatment. Alternative D achieves a reduction

in toxicity and volume to the extent that a portion of the Area 5106 Sediment is removed and treated. Mobility would be reduced under the capped portion.

Short-Term Effectiveness: Alternative A is not expected to achieve SQOs in the near term. Alternative B provides the lowest short-term environmental risk of the alternatives as water quality impacts during the placement of the cap are expected to be lower than Alternative C. There are short-term environmental risks (water quality impacts with the mixing zone) associated with the removal of Area 5106 Sediment under Alternatives C and D.

9.2 IMPLEMENTABILITY

Technical Feasibility: There are no technical feasibility issues with Alternative A. The capping under Alternatives B and D is a proven technology that is implemented using standard equipment and techniques. Similarly, the removal of Area 5106 Sediment under Alternatives C and D utilizes proven technologies which are readily implementable using standard equipment and techniques. The performance of the treatment process, however, has not been proven on a full-scale basis, thereby increasing the technical risk of Alternatives C and D.

Availability: There are no availability issues with Alternative A. There are no expected availability concerns with Alternatives B, C, and D. These alternatives use readily available equipment.

Administrative Feasibility: All four alternatives have administrative feasibility issues associated with their implementation. Alternatives A, B, and D impact the future use of property owned by POT and Pioneer. Effectively enforced institutional controls would be required for the life of the capped areas to assure the continued effectiveness of these alternatives over time. Alternative C impacts the POT and Pioneer properties in the short-term during its implementation. Once completed, these impacts no longer exist.

9.3 COST

Alternative A has the least cost of the four alternatives, followed by Alternatives B and D. Alternative C is the most costly of the four alternatives.

10.0 RECOMMENDATION

Alternative C is selected as the recommended removal action alternative.

When properly designed and implemented, Alternatives B, C, and D all meet the removal action objectives presented in Section 3.2. Each alternative would contribute to the efficient implementation of the ROD and complies with the substantive requirements of the ARARs to the extent practicable. Selection of the removal action alternative for the Area 5106 Removal Action, however, was based on a balancing of short-term and long-term environment risk, technical feasibility, and cost of each alternative.

Alternative B is clearly the least costly removal action. A well designed, properly constructed armored sand cap over the Area 5106 Sediment would provide effective protection of human health and the environment if properly and regularly maintained for the life of the cap. Implementation of institutional controls and long-term monitoring and maintenance would be required to assure the continued effectiveness over time. The required institutional controls may be difficult to implement. While short-term environment risks are expected to be lower than both Alternatives C and D, there are long-term environmental risks associated with leaving Area 5106 in place.

Alternative C meets the USEPA preference for removal and treatment and provides the highest level of overall protection of human health and the environment. Alternative C, however, is the highest cost alternative and there are short-term environmental risk related to the marine water quality during dredging of the Area 5106 Sediment. The long-term environmental risk associated with Alternative C is relatively low following removal of the Area 5106 Sediment from the Waterway and subsequent treatment prior to disposal in the Slip 1 CDF.

Alternative D combines the environmental risk and feasibilities of both Alternatives B and C. While the cost of Alternative D is lower than that of Alternative C, the difference does not justify the long-term risk associated with leaving a portion of Area 5106 Sediment in place. Once a treatment facility is designed and constructed, the remainder of the Area 5106 Sediment can be removed, treated, and disposed of at a reasonable marginal cost.

After weighing the short-term and long-term risks, technical feasibility, and relative cost based upon the analysis, the long-term benefits of removal of Area 5106 Sediment under Alternative C outweigh the lower short-term risks and cost associated with

Alternative B. Consequently, Alternative C is selected as the recommended removal action alternative.

A BA is being prepared to determine whether the selected removal action meets the requirements of the ESA. The BA will be submitted to NMFS and USFWS for consultation.

The selection of Alternative C is based upon the scope and assumptions outlined in this EE/CA Report. If changes are required that fundamentally alter the scope, cost, or performance of the removal action, selection of Alternative C may be reconsidered.

11.0 SCHEDULE

The project schedule for Alternative C is presented on Figure 11.1. The proposed schedule is based on beginning dredging activities on August 16, 2001, following the 2001 fish window. The schedule, however, assumes NMFS approval to perform in water construction of docks and mooring facilities along the OCCT property, beginning June 15, 2001. As indicated, the schedule also requires:

i) timely approval of the EE/CA and the subsequent Consent Decree;

ii) construction of the Slip 1 berm and the availability of the Slip 1 CDF for disposal by August 16, 2001; and

iii) a single design submittal (95 percent) with timely review and approval by USEPA.

The schedule is also based on paragraph 60 of the AOC (USEPA Docket No. 10-97-0011-CERCLA) which states that no local, State, or Federal permits will be required for any portion of any activity pursuant to the AOC.

12.0 REFERENCES

CRA Reports prepared for OCCT:

Area 5106 Background Data Report, Engineering Evaluation/Cost Analysis. CRA. November 1997. Approved by USEPA September 1999.

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Column Leach Test Evaluation Report; Area 5106 Removal Action. CRA. December 14, 1999.

Evaluation of Dredging Controls; Area 5106 Sediment. CRA. November 22, 1999.

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Pre-Remedial Design Evaluation Report. November 1999.

Tetra Tech 1985. *Commencement Bay/Nearshore Tideflats Remedial Investigation; Final Report TC-3752.* Prepared for EPA Region 10 and Washington State Department of Ecology. Tetra Tech, Bellevue, WA. 1985

FIGURES

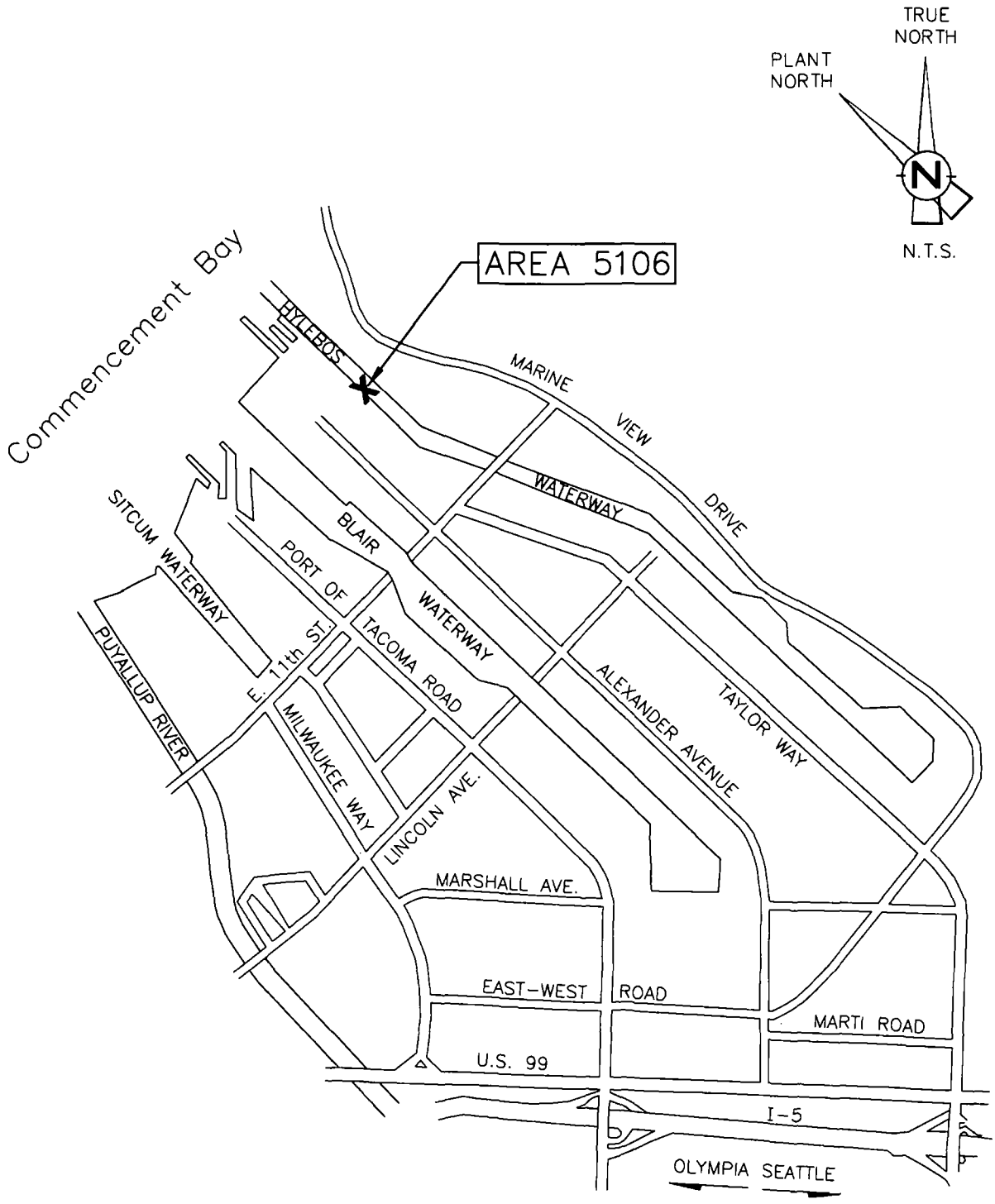


figure 2.1
SITE LOCATION MAP
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF001 JUL 07/2000

19.3.4.6.2
137633 FIGURES 1

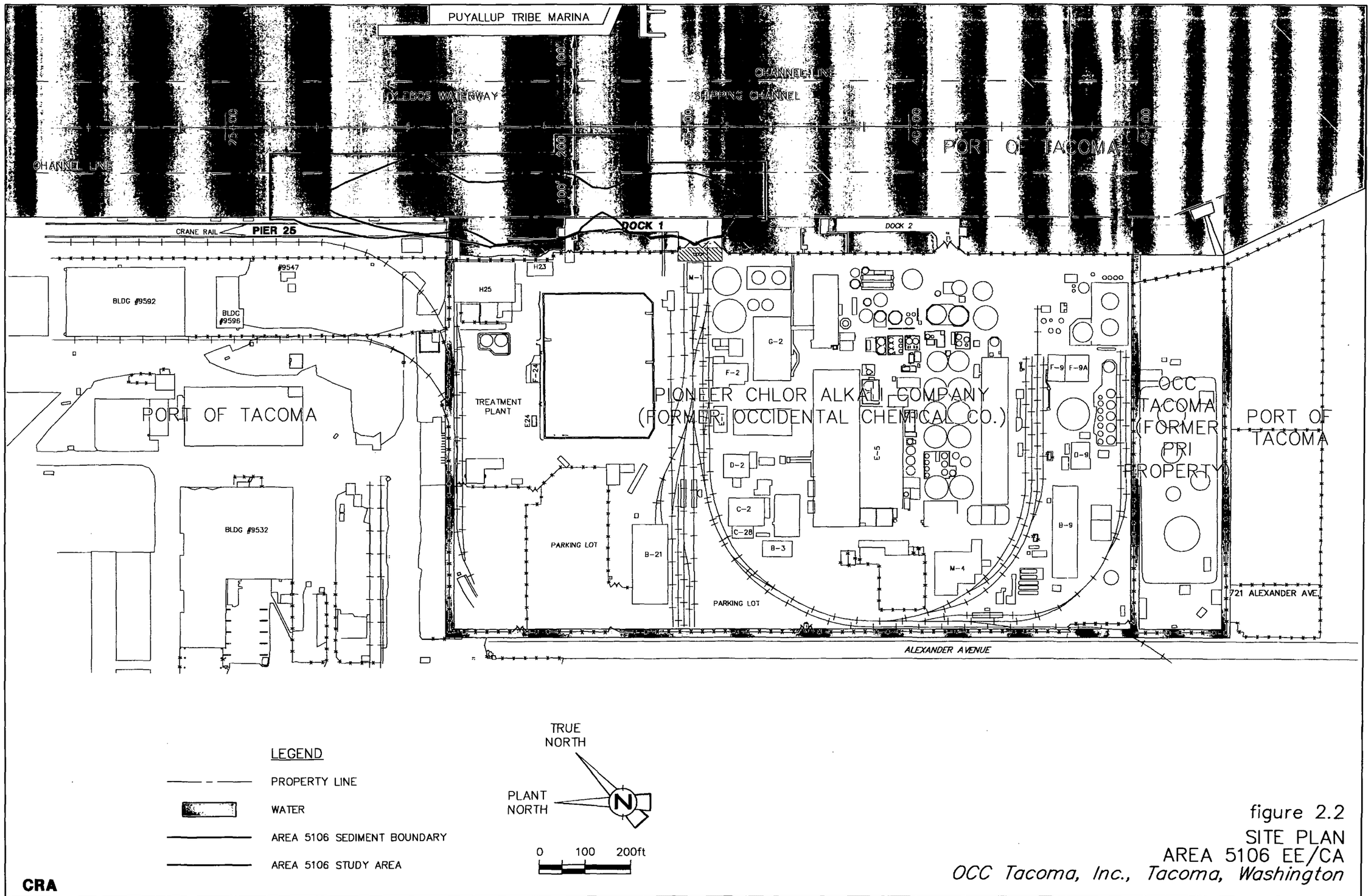


figure 2.2
SITE PLAN
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

07431-65(015)GN-NF002 JUL 07/2000

19.34.6.2
137633

2

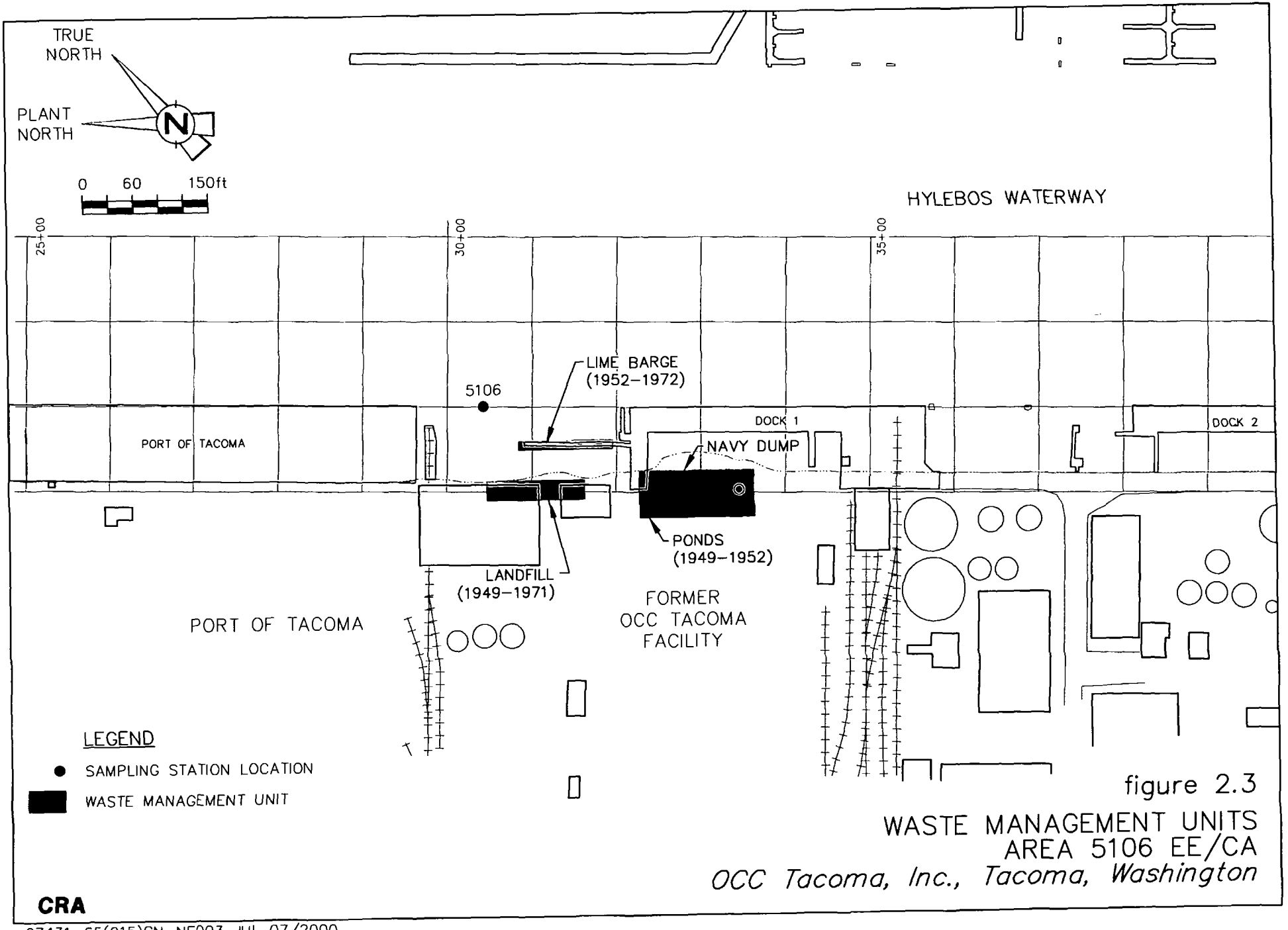
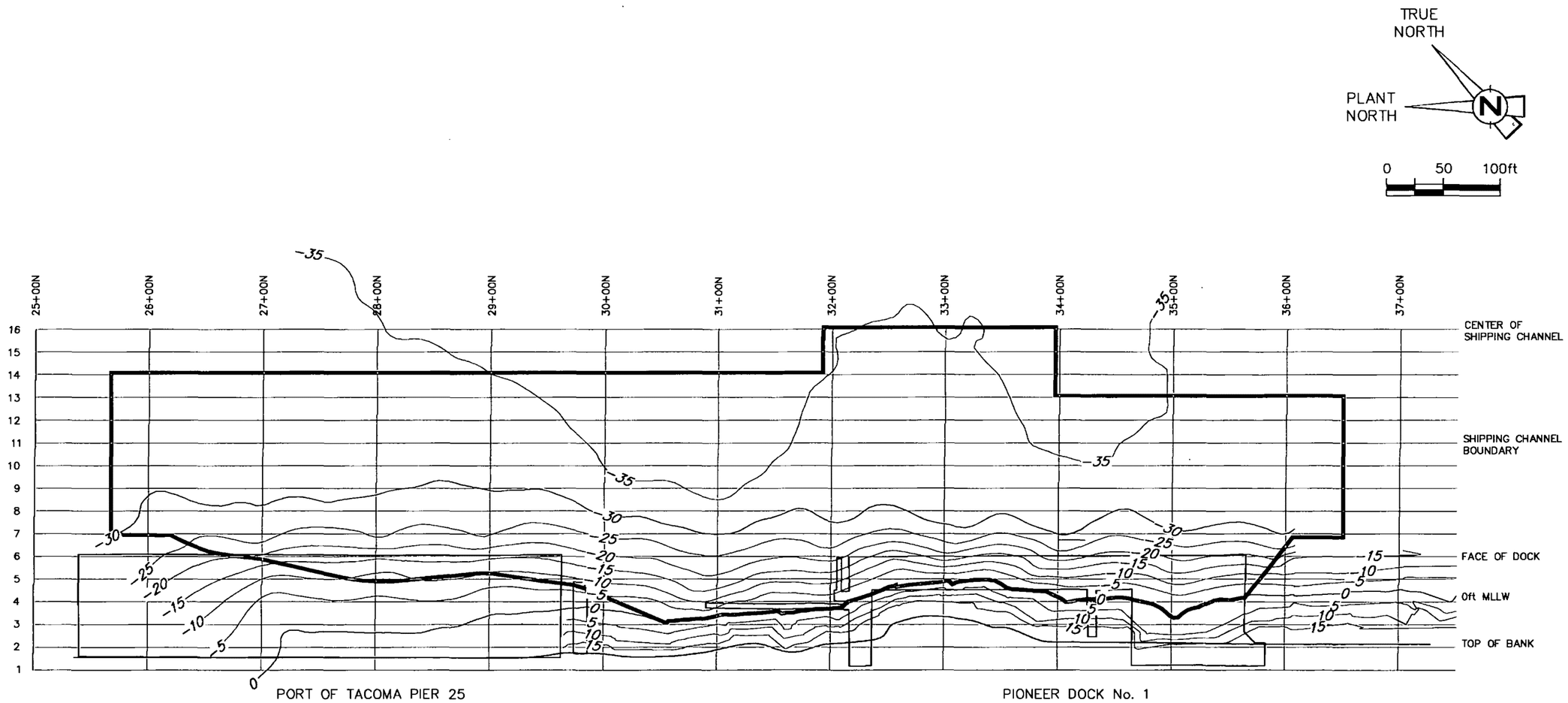


figure 2.3

WASTE MANAGEMENT UNITS
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431–65(015)GN–NF003 JUL 07/2000



LEGEND

EXISTING CONTOUR (FEET MLLW)

LIMITS OF AREA 5106 STUDY AREA

NOTE:

BASED ON RCA SURVEY, JOB 3-96129, JUNE 1996, AND CRA SAMPLING PROGRAM, JUNE 1998.

figure 2.4

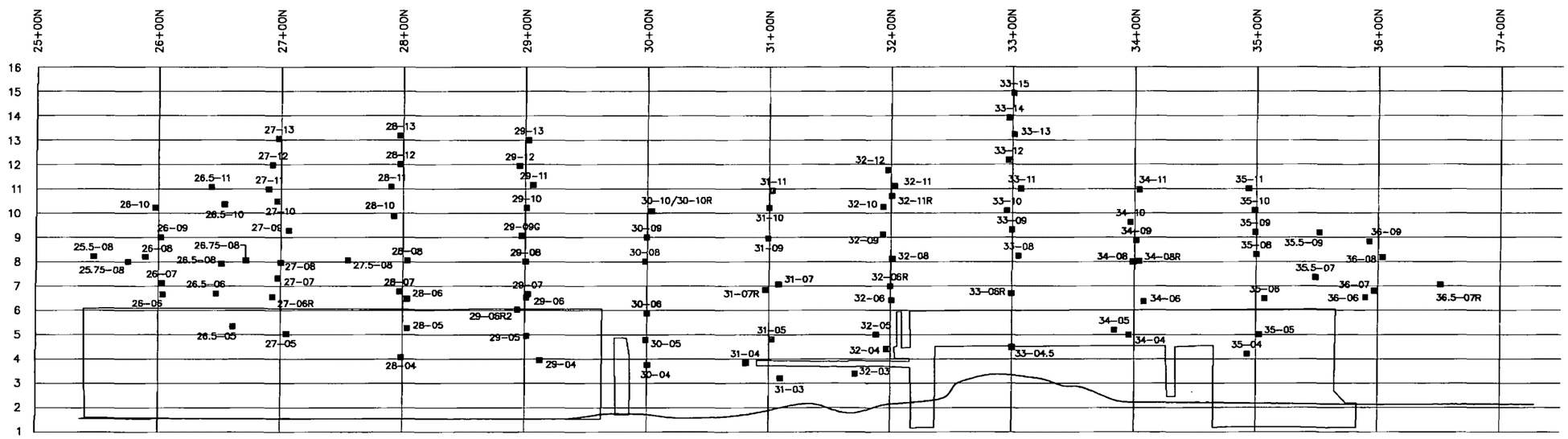
EXISTING BATHYMETRY
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF004 JUL 07/2000

19.3.4.6.2
137633

4



LEGEND

30–06 BOREHOLE LOCATION

■ 30–06 BOUNDARY ESTIMATION SAMPLE LOCATION

■ 30–06 COMBINATION – BOUNDARY ESTIMATION AND SEDIMENT CHARACTERIZATION SAMPLE LOCATION

■ 30–06 COMBINATION – BOUNDARY ESTIMATION AND PROFILE SAMPLE LOCATION

■ 30–06 COMBINATION – BOUNDARY ESTIMATION, SEDIMENT CHARACTERIZATION AND PROFILE SAMPLE LOCATION

figure 2.5

SAMPLE LOCATIONS
BOUNDARY ESTIMATION AND CHEMICAL CHARACTERIZATION
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

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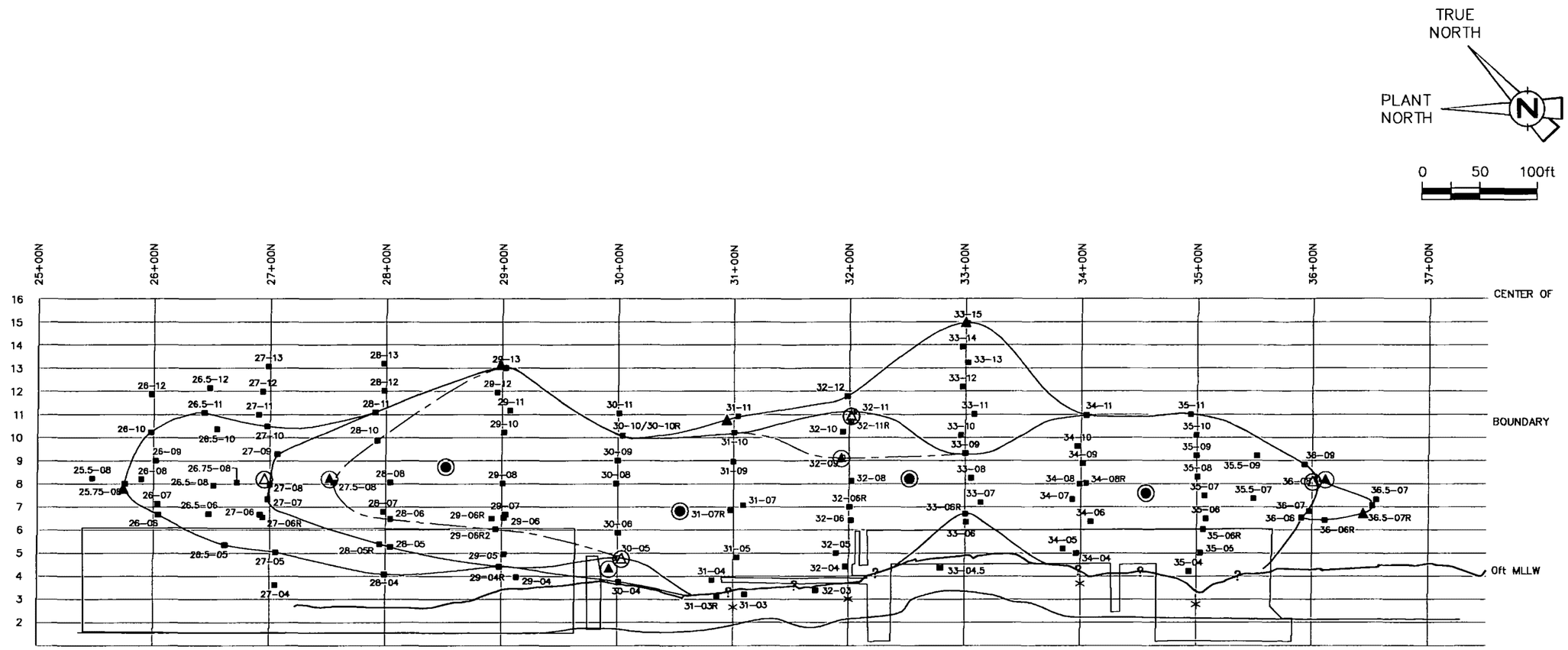
19.3.4.6.2
137633



LEGEND

——— ESTIMATED VISUAL HORIZONTAL BOUNDARY

——— ESTIMATED OUTER HORIZONTAL BOUNDARY

— - — ESTIMATED INNER HORIZONTAL BOUNDARY

30-06 BOREHOLE LOCATION

* NO FURTHER BOUNDARY ESTIMATION SAMPLE OBTAINABLE

▪ VISUAL 5106-LIKE MATERIAL PRESENT

▪ VISUAL 5106-LIKE MATERIAL NOT PRESENT

▲ CHCC BOUNDARY CONFIRMATION SAMPLE LOCATION (ONE COMPOSITE OF 5 LOCATIONS)

◬ OHBC CONFIRMATION SAMPLE LOCATION (ONE COMPOSITE OF 4 LOCATIONS)

◭ IHBC BOUNDARY CONFIRMATION SAMPLE LOCATION (ONE COMPOSITE OF 4 LOCATIONS)

◉ VBC VERTICAL BOUNDARY CONFIRMATION SAMPLE LOCATION (ONE COMPOSITE OF 4 LOCATIONS)

figure 3.1

ESTIMATED HORIZONTAL BOUNDARIES AND BOUNDARY CONFIRMATION SAMPLE LOCATIONS
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF005 JUL 07/2000

19.3.4.6.2
137633

6

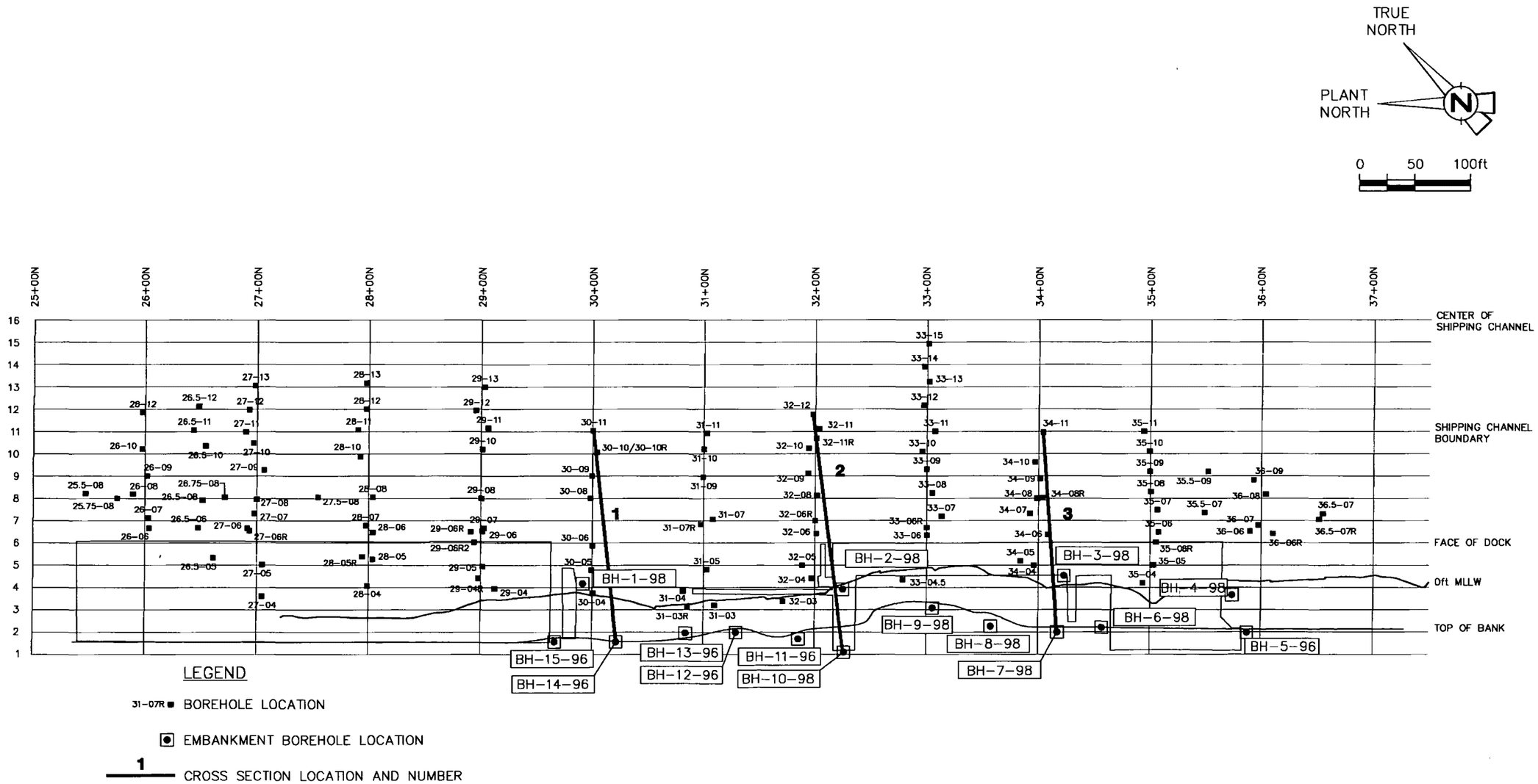


figure 3.2

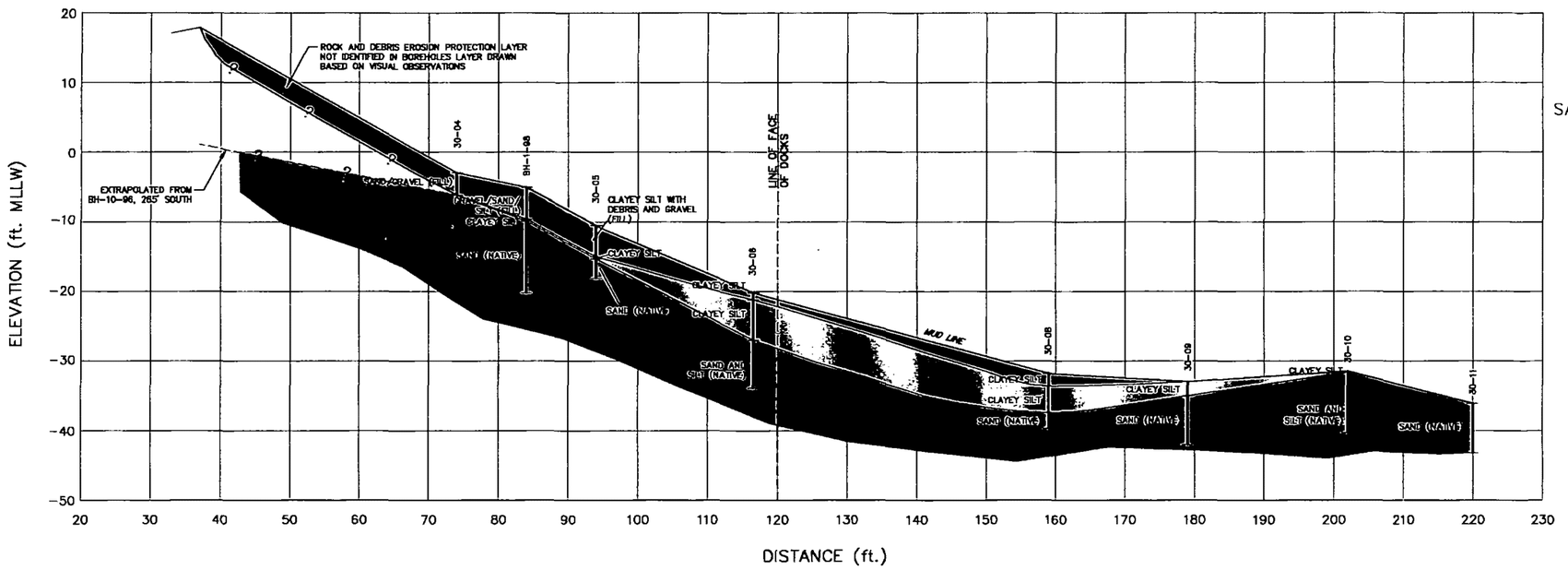
BOREHOLE AND CROSS-SECTION LOCATIONS
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF023 JUL 07/2000

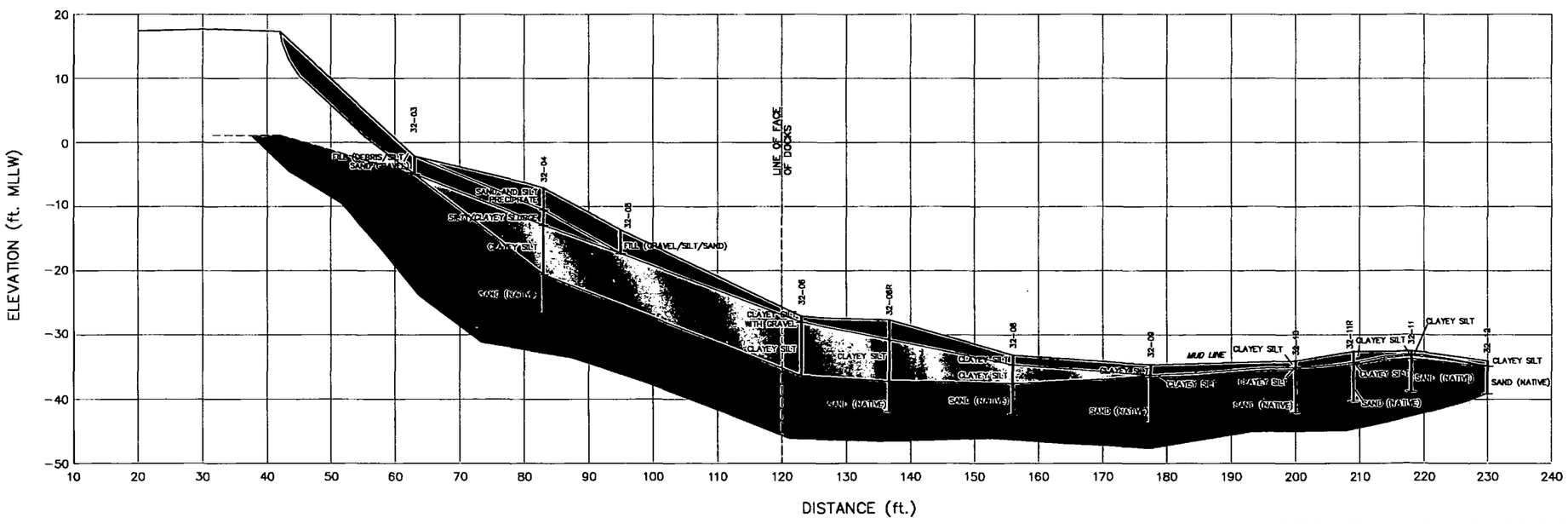
19.3.4.6.2
137633

7



CROSS SECTION 1

SCALES: HORIZ. 1"=20'
VERT. 1"=20'



CROSS SECTION 2

SCALES: HORIZ. 1"=20'
VERT. 1"=20'

LEGEND

SAND (FILL)
SAND (NATIVE)

- BOREHOLE LOCATION (30-06)
- UNIT INTERFACE
- STRATIGRAPHIC UNIT
- RECENT SEDIMENT/FILL (MATERIAL A)
- VISUAL AREA 5106-LIKE MATERIAL (MATERIAL B)
- NATIVE SEDIMENT (MATERIAL C)

figure 3.3

STRATIGRAPHIC CROSS-SECTIONS 1 AND 2
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF024 JUL 07/2000

19.3.4.6.2
137633

8

LEGEND

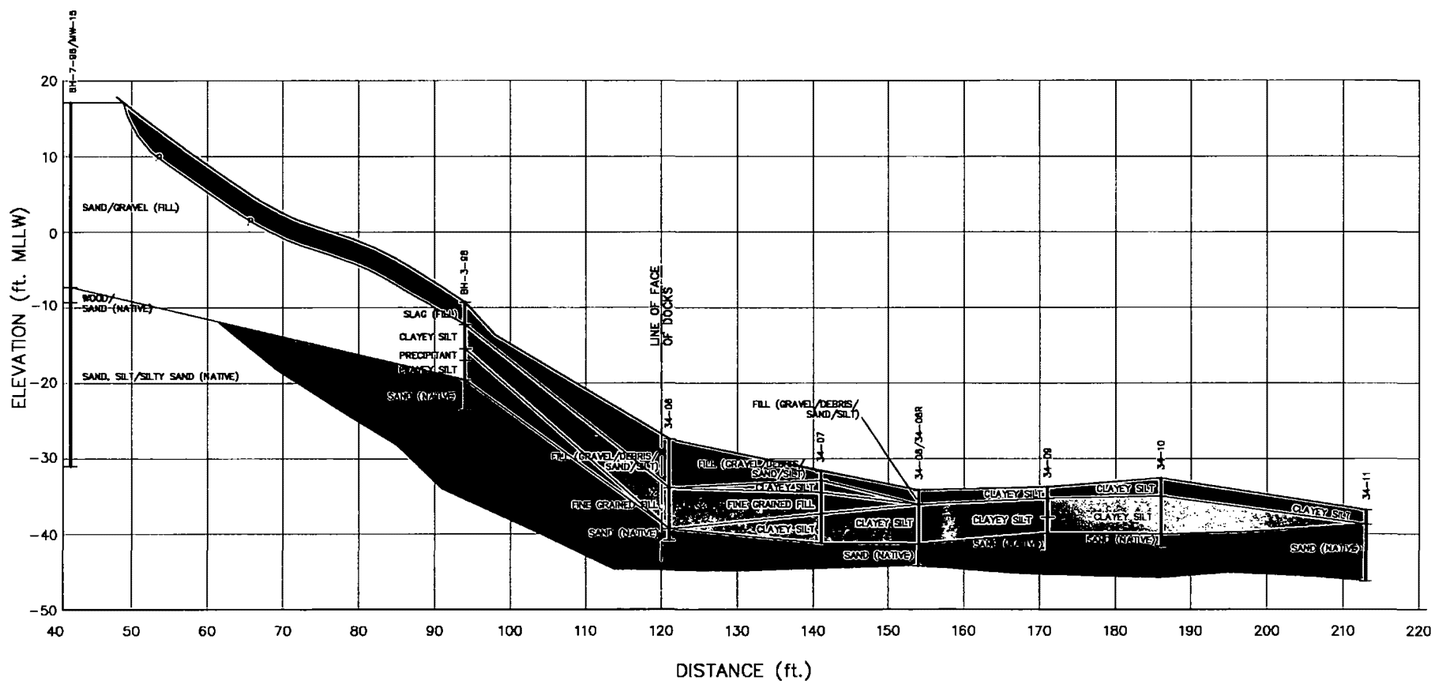
SAND (FILL)
SAND (NATIVE)

BOREHOLE LOCATION (30-06)
UNIT INTERFACE
STRATIGRAPHIC UNIT:

RECENT SEDIMENT/FILL (MATERIAL A)

VISUAL AREA 5106-LIKE MATERIAL (MATERIAL B)

NATIVE SEDIMENT (MATERIAL C)



CROSS SECTION 3

SCALES: HORIZ. 1"=20'
VERT. 1"=20'

figure 3.4

STATIGRAPHIC CROSS-SECTION 3
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF025 JUL 07/2000

19.3.4.6.2
137633

9

LEGEND

- MUDLINE
- RECENT SEDIMENT/FILL (MATERIAL A)
- VISUAL 5106-LIKE MATERIAL (MATERIAL B)
- *1200/58J/ND9.9* (PCE/TCE/VC) mg/Kg SEDIMENT
- *ND* NOT DETECTED AT SPECIFIED VALUE
- *J* ESTIMATED VALUE
- (0–5.0) SAMPLE INTERVAL, FEET ABOVE NATIVE SAND

REFERENCE

FROM AREA 5106 SEDIMENT CHARACTERIZATION REPORT:
TABLE 3.3 FOR SAMPLE COLLECTION SUMMARY AND
TABLE 5.1 FOR ANALYTICAL DATA FOR THE TEN DISCRETE SAMPLES.

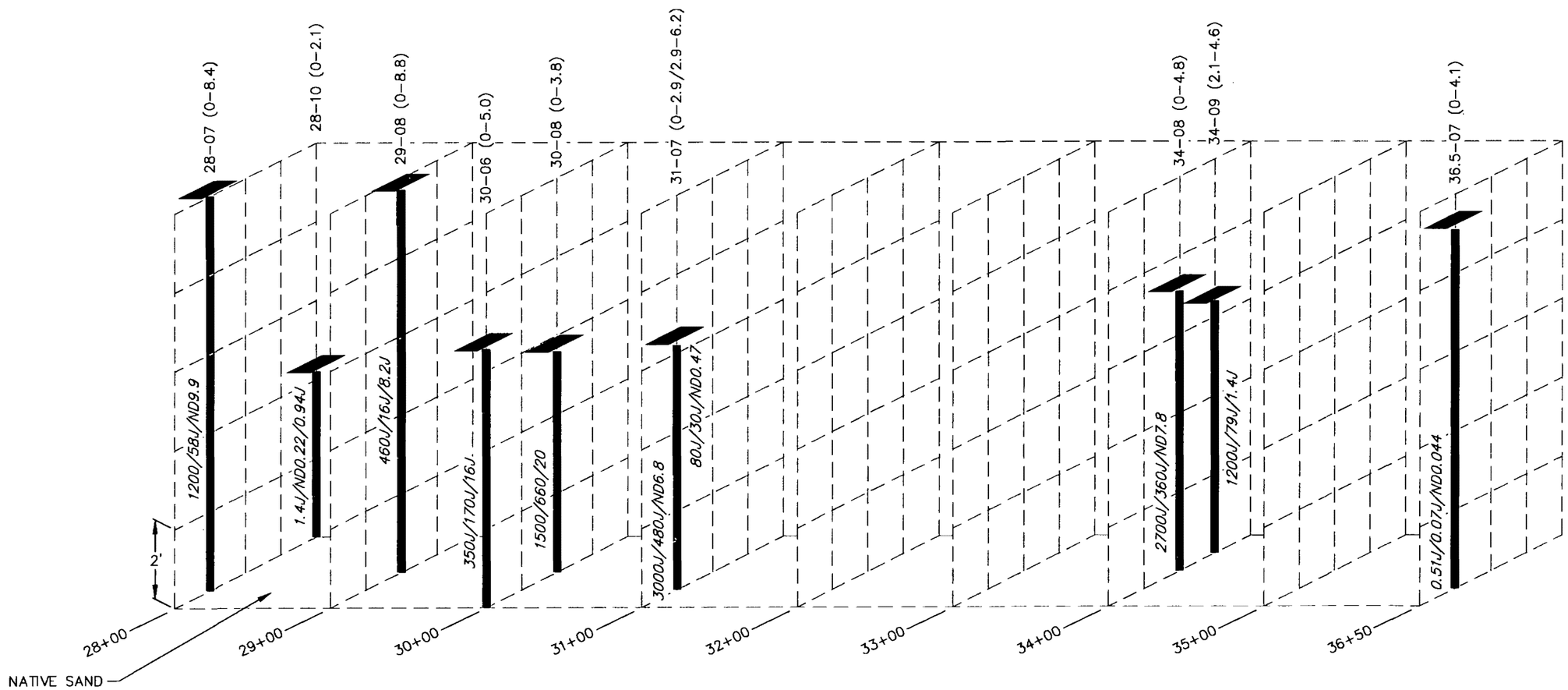


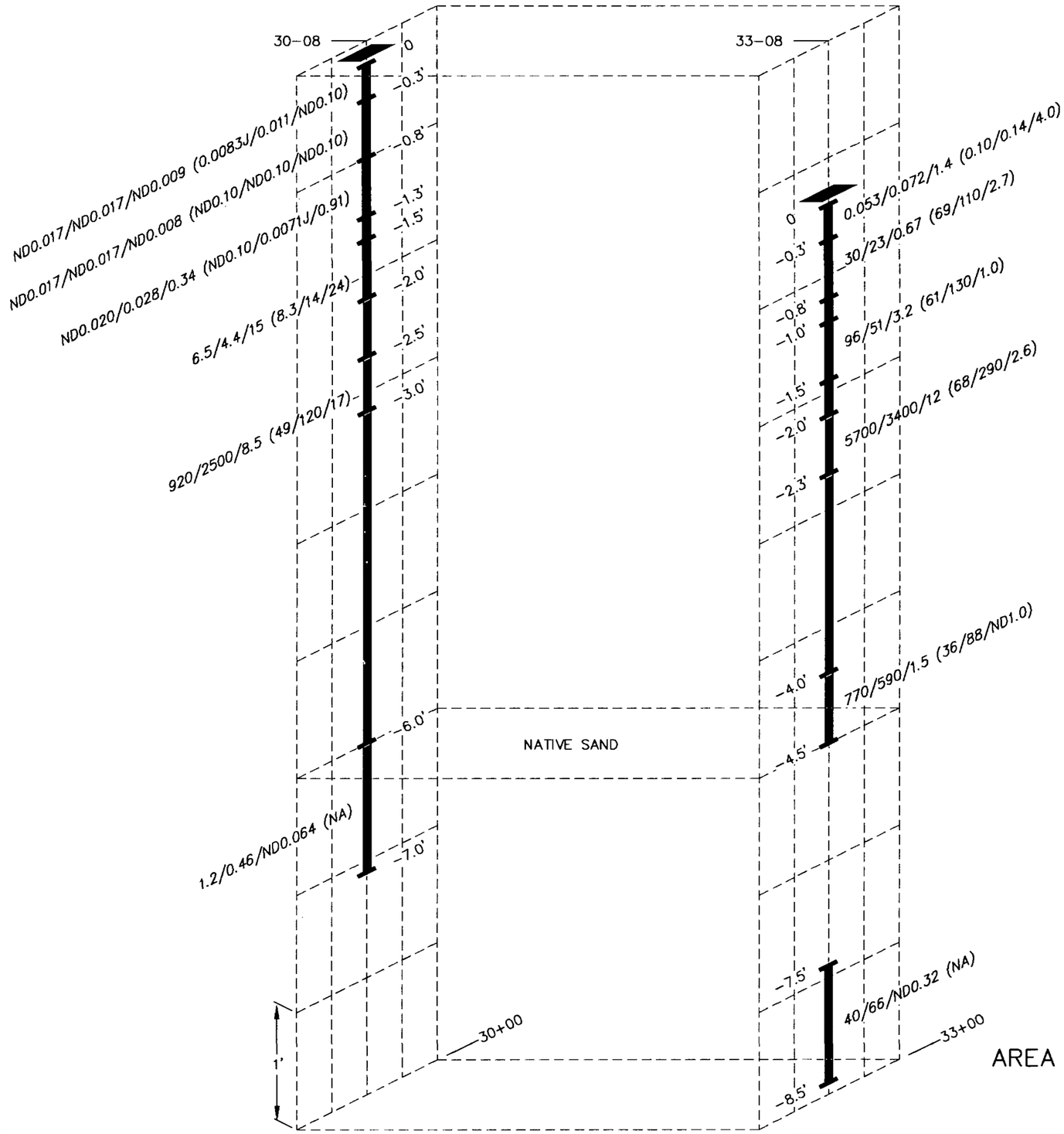
figure 3.5
DISTRIBUTION OF AREA 5106 SEDIMENT INDICATOR CHEMICALS
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF026 JUL 07/2000

19.3.4.6.2
137633

10



LEGEND

	MUDLINE
	RECENT SEDIMENT/FILL (MATERIAL A)
	VISUAL 5106-LIKE MATERIAL (MATERIAL B)
	NATIVE SEDIMENTS (MATERIAL C)
1200/58J/ND9.9	PCE/TCE/VC mg/Kg SEDIMENT
(10/20/30)	PCE/TCE/VC mg/L POREWATER
NA	NOT ANALYZED
ND	NOT DETECTED AT SPECIFIED VALUE
J	ESTIMATED VALUE
-0.5'	DEPTH BELOW MUDLINE (FEET)

REFERENCE

FROM AREA 5106 SEDIMENT CHARACTERIZATION REPORT:

TABLE 3.4 FOR SAMPLE COLLECTION SUMMARY AND TABLES 5.2 AND 5.3 FOR ANALYTICAL DATA.

figure 3.6

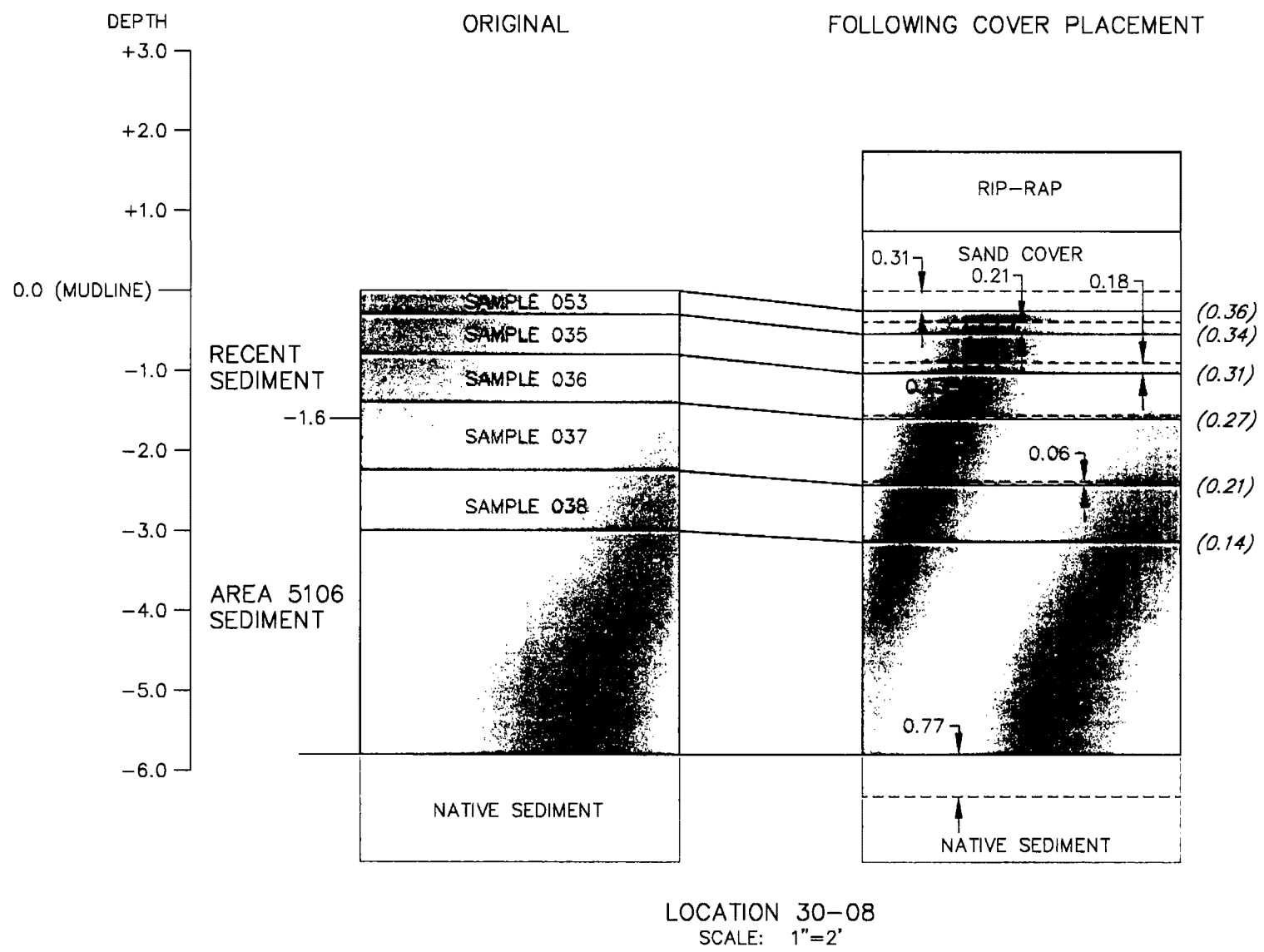
AREA 5106 SEDIMENT INDICATOR CHEMICAL PROFILE
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

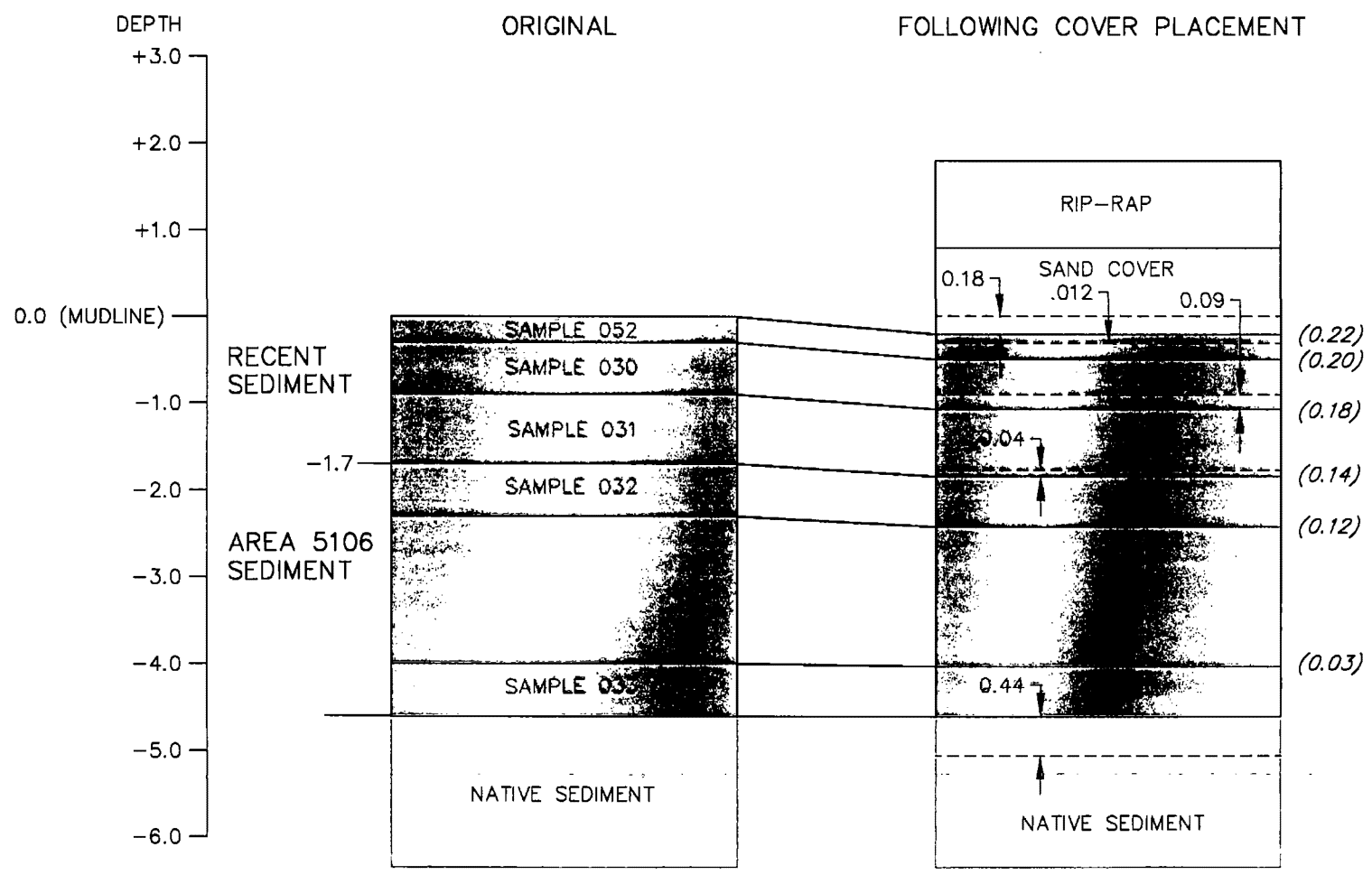
07431-65(015)GN-NF027 JUL 07/2000

19.3.4.6.2
137633

11



LOCATION 30-08
SCALE: 1"=2'



LOCATION 33-08
SCALE: 1"=2'

LEGEND

0.23 — ADVANCEMENT OF POREWATER FRONT ABOVE SAMPLE INTERVAL (FEET)

(0.25) — SETTLEMENT (FEET)

SAMPLE 053 — SAMPLE NUMBER AS SHOWN IN LOG FOR PROFILE SAMPLE AT 30-08

19.3.4.6.2
137633

figure 3.7
REDISTRIBUTION OF POREWATER
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF028 JUL 07/2000

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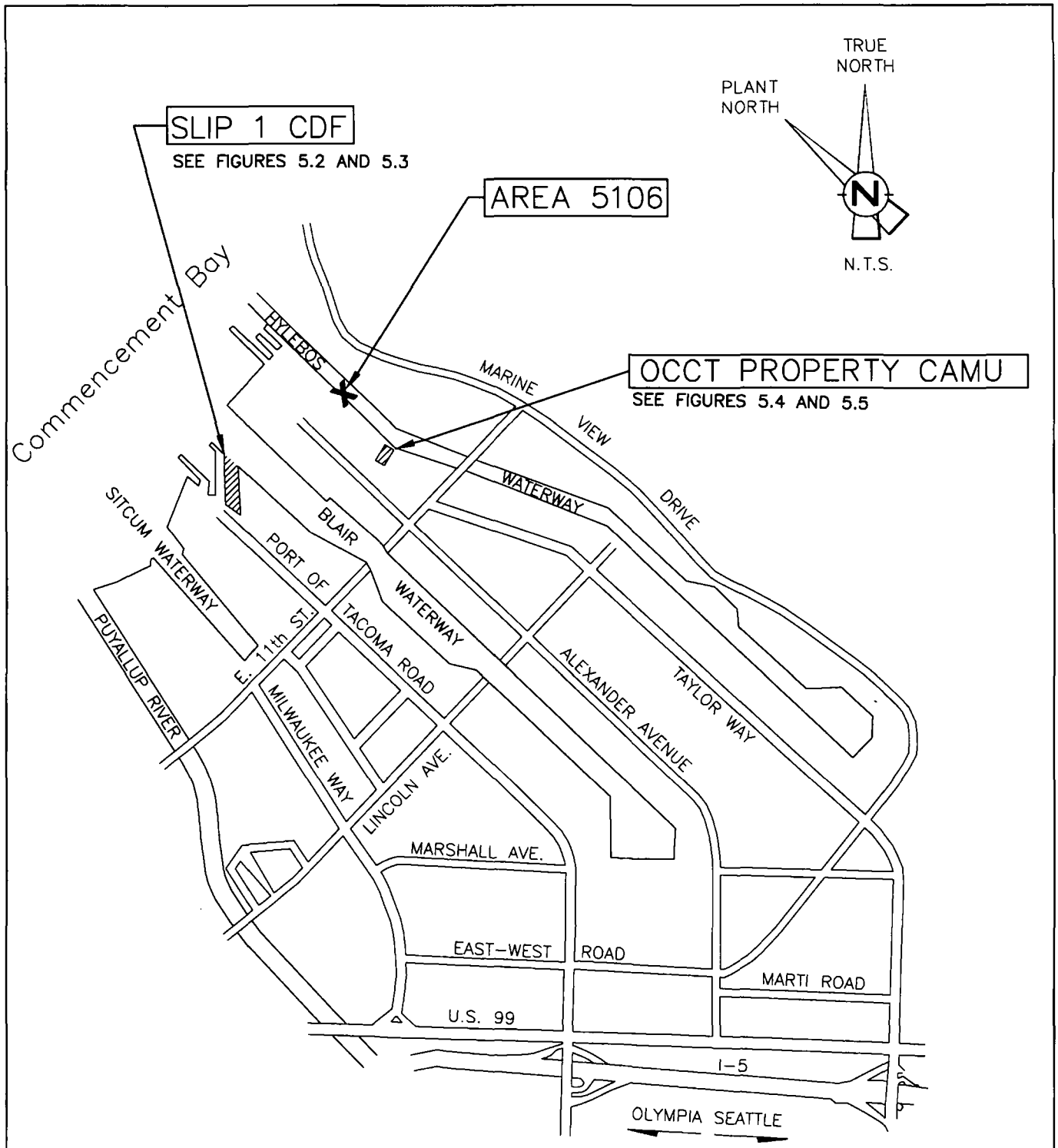
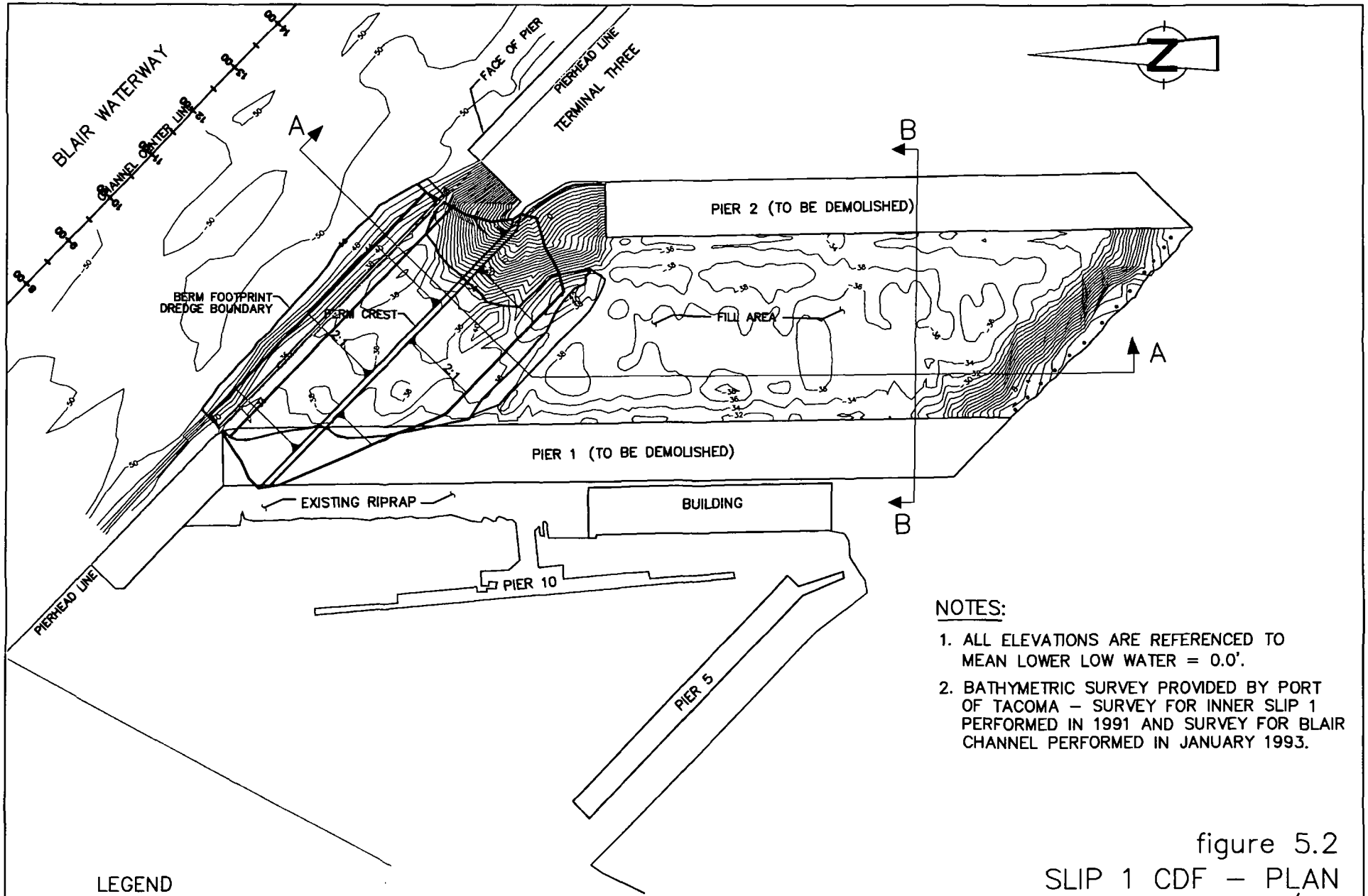


figure 5.1
DISPOSAL SITE LOCATION MAP
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF018 JUL 07/2000

19.3.4.6.2
137633



NOTES:

1. ALL ELEVATIONS ARE REFERENCED TO MEAN LOWER LOW WATER = 0.0'.
2. BATHYMETRIC SURVEY PROVIDED BY PORT OF TACOMA – SURVEY FOR INNER SLIP 1 PERFORMED IN 1991 AND SURVEY FOR BLAIR CHANNEL PERFORMED IN JANUARY 1993.

LEGEND

2:1 SLOPE ANGLE– REPRESENTS RATIO OF HORIZONTAL DISTANCE TO VERTICAL DISTANCE.

figure 5.2
SLIP 1 CDF – PLAN
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF020 JUL 07/2000

19.3.4.6.2
137633

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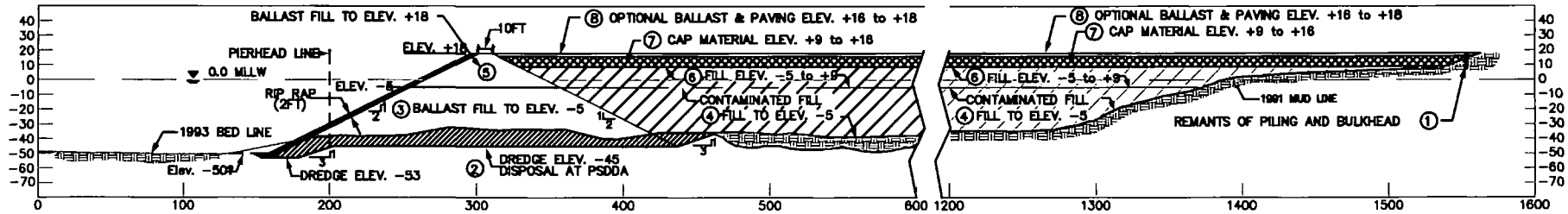
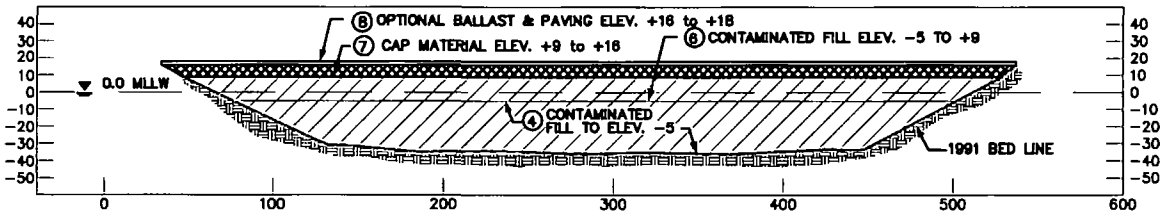
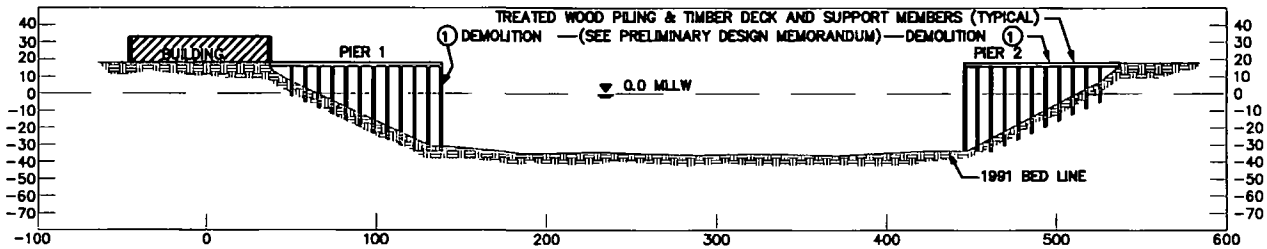


TYPICAL SECTION A–A



FILL – TYPICAL SECTION B–B



DEMOLITION – TYPICAL SECTION B–B

NOTES:

1. ALL ELEVATIONS ARE REFERENCED TO MEAN LOWER LOW WATER = 0.0'.
2. BATHYMETRIC SURVEY PROVIDED BY PORT OF TACOMA – SURVEY FOR INNER SLIP 1 PERFORMED IN 1991 AND SURVEY FOR BLAIR CHANNEL PERFORMED IN JANUARY 1993.
3. ① FOR DESCRIPTION OF DREDGING AND AND FILLING SEQUENCE, SEE PRELIMINARY DESIGN MEMO.

figure 5.3

SLIP 1 CDF – SECTIONS
AREA 5106 EE/CA

OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF021 JUL 07/2000

15

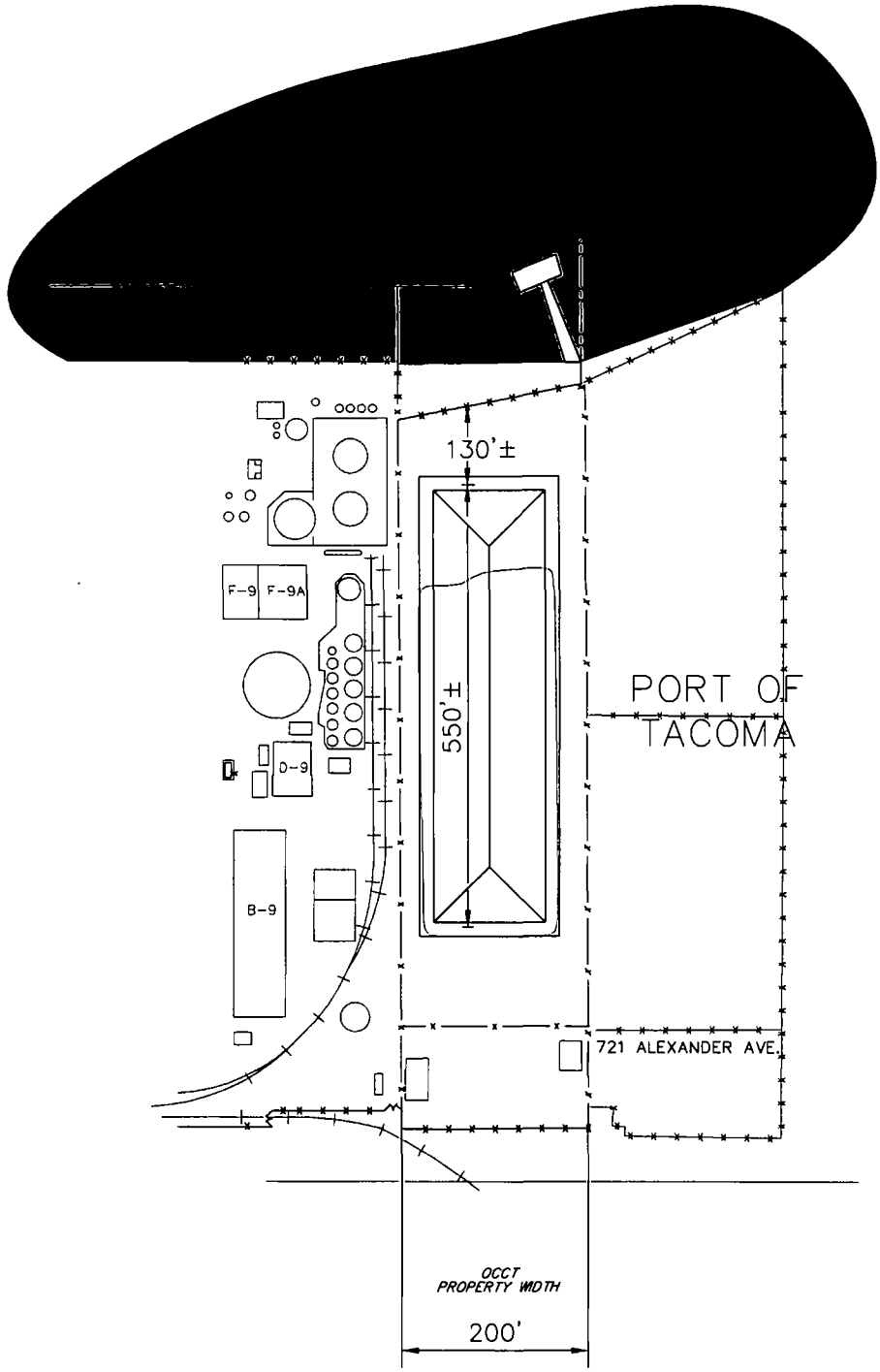


figure 5.4

OCCT PROPERTY CAMU-PLAN
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF022 JUL 07/2000

19.3.4.6.2
137633

16

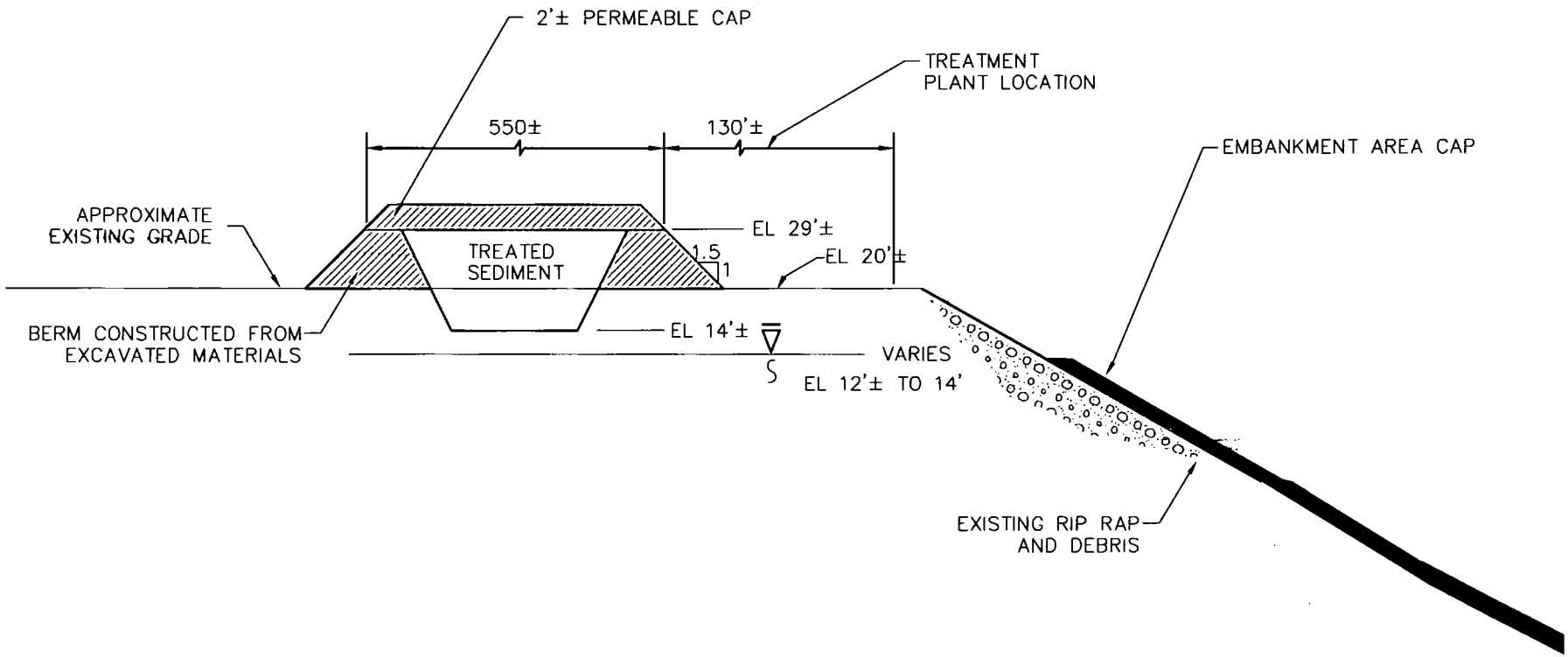


figure 5.5

OCC PROPERTY CAMU–SECTION
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431–65(015)GN–NF019 JUL 07/2000

19.3.4.6.2
137633

17

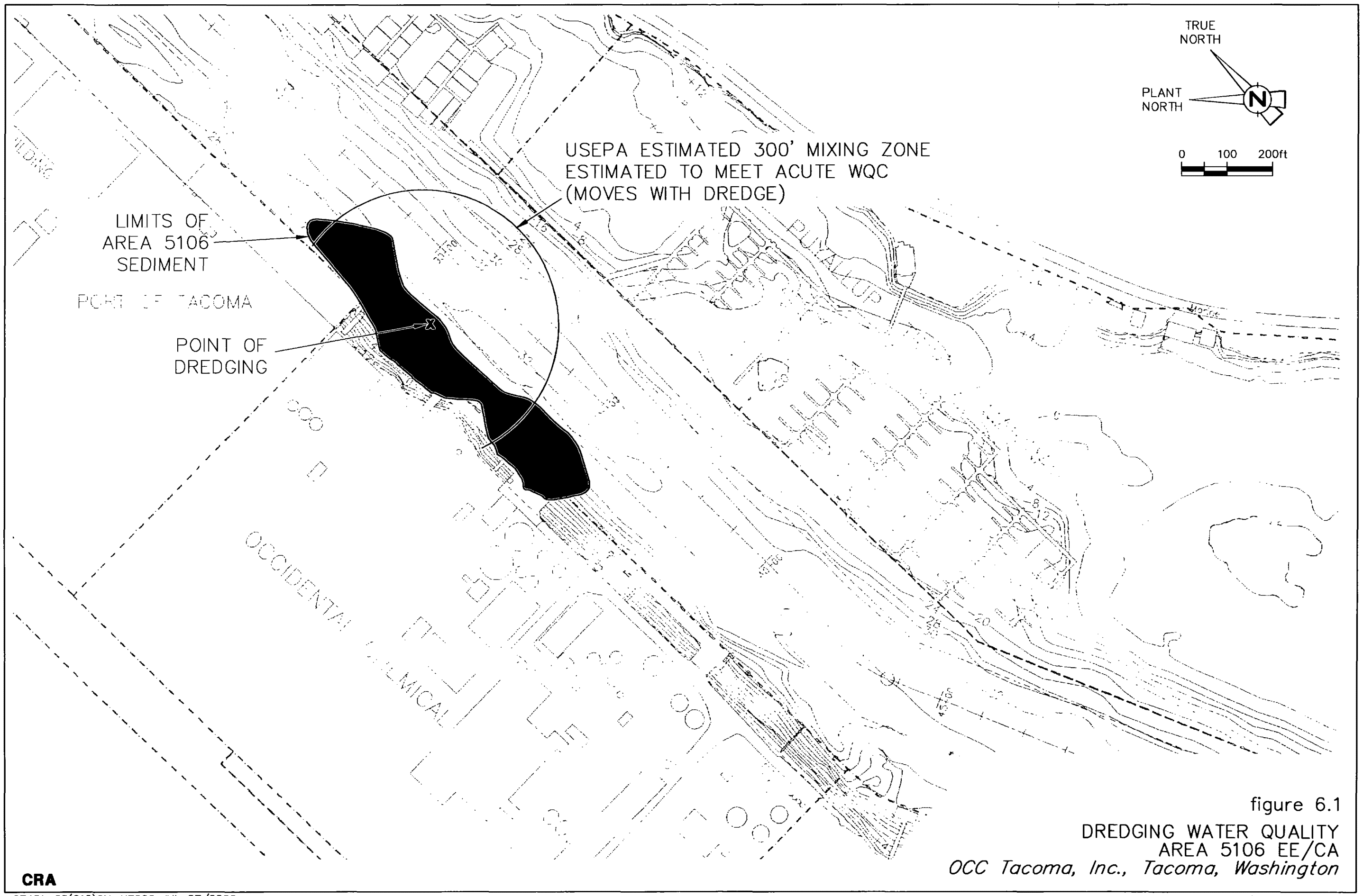
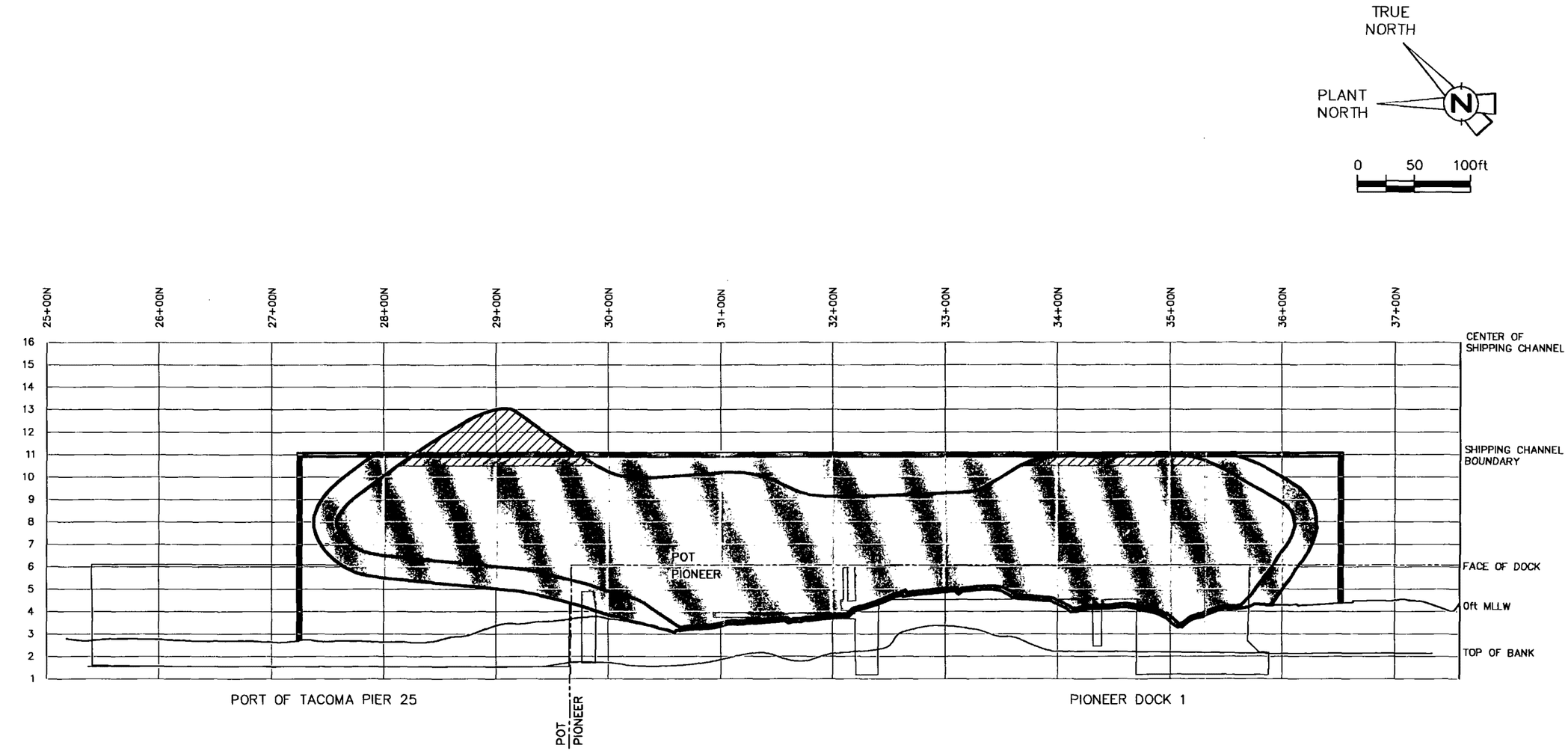


figure 6.1
DREDGING WATER QUALITY
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF006 JUL 07/2000

19.3.4.6.2
137633



LEGEND

- LIMITS OF AREA 5106 SEDIMENT
- LIMITS OF CAP
- LIMITS OF RESTRICTED DREDGING ZONE (BASED ON MAXIMUM DREDGE ELEVATION OF −35 MLLW)
- REMOVED AREA 5106 SEDIMENT
- SAND/GRAVEL CAP
- POT / PIONEER — PROPERTY BOUNDARY

figure 7.1

ALTERNATIVE B – CONTAINMENT CAPPING PLAN
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431–65(015)GN–NF007 JUL 07/2000

19.3.4.6.2
137633

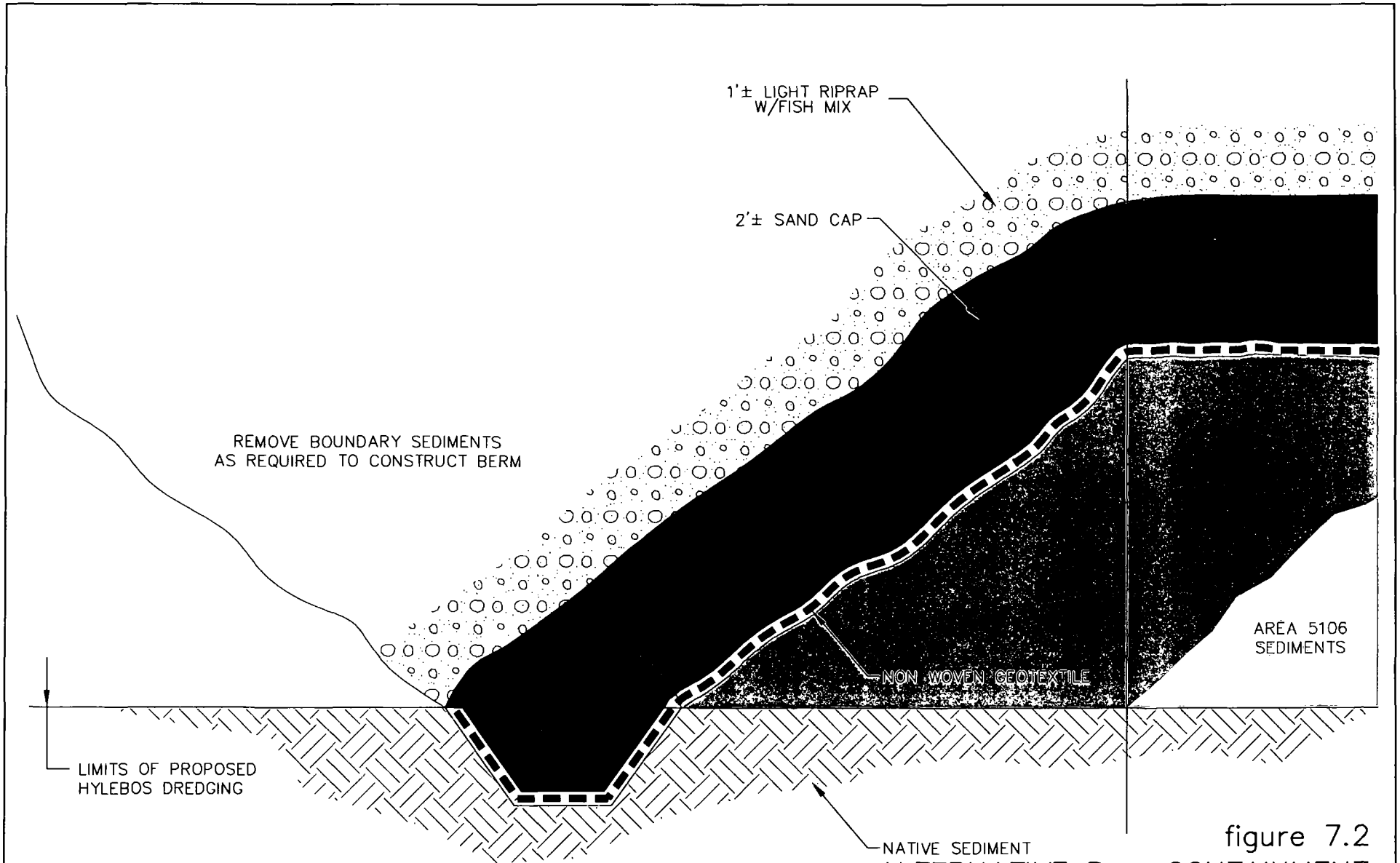


figure 7.2
ALTERNATIVE B – CONTAINMENT
TYPICAL CAPPING SECTION
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(015)GN-NF008 JUL 07/2000

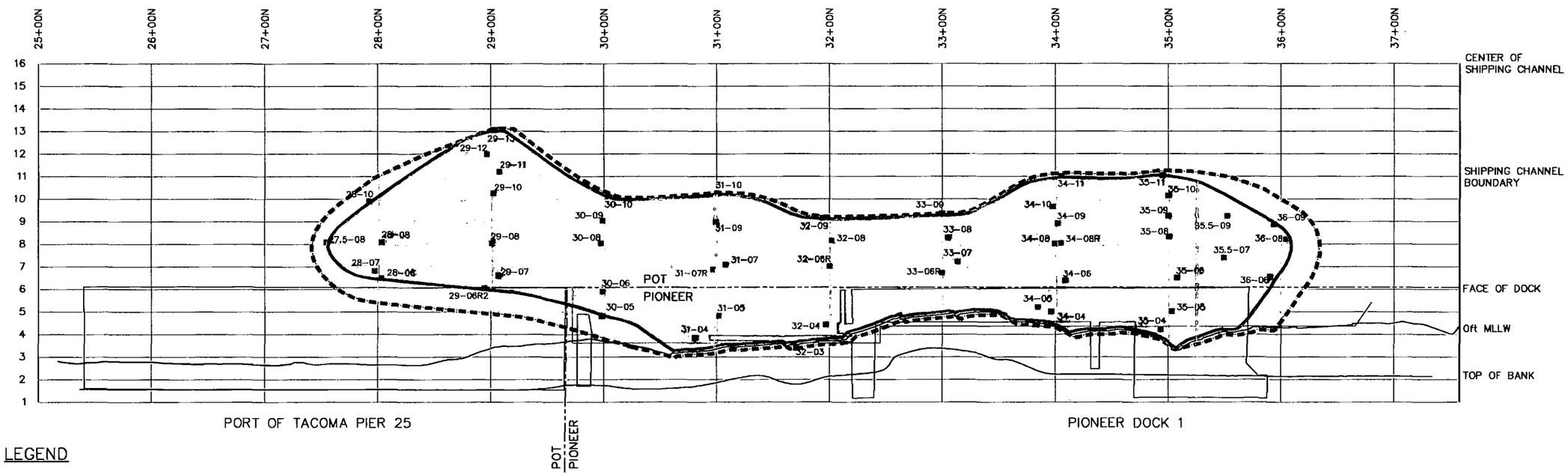
19.3.4.6.2
137633

20

SAMPLE LOCATION	EASTING	NORTHING	VERTICAL LIMIT OF AREA 5106 SEDIMENT (MLLW)	DEPTH OF REQUIRED DREDGING (FEET)
27.5 – 08	1167337.6500	716327.8040	−36.0	6.4
28 – 06	1167350.7503	716271.0334	−35.6	12.0
28 – 07	1167350.7559	716279.7934	−35.9	10.0
28 – 08	1167373.0182	716293.8441	−38.2	9.4
28 – 10	1167390.1536	716327.6761	−36.5	4.8
29 – 06R2	1167410.1408	716201.6223	−26.6	9.6
29 – 07	1167425.3227	716204.7491	−29.9	5.7
29 – 08	1167442.3954	716225.7010	−38.7	9.7
29 – 10	1167473.9317	716256.7892	−36.8	5.6
29 – 11	1167490.9494	716266.7288	−35.9	3.3
29 – 12	1167493.9458	716285.7053	−35.5	2.1
29 – 13	1167514.1286	716295.8987	−36.3	1.8
30 – 05	1167468.8947	716110.5830	−17.1	6.6
30 – 06	1167484.8348	716125.8217	−27.0	6.8
30 – 08	1167513.2573	716157.7293	−37.4	5.6
30 – 09	1167528.2295	716171.0161	−35.0	2.0
30 – 10	1167546.2680	716183.5945	−35.3	0.1
31 – 04	1167514.9386	716039.8565	−18.1	5.8

SAMPLE LOCATION	EASTING	NORTHING	VERTICAL LIMIT OF AREA 5106 SEDIMENT (MLLW)	DEPTH OF REQUIRED DREDGING (FEET)
31 – 05	1167544.2083	716038.8216	−22.0	3.6
31 – 07	1167579.7926	716067.6402	−37.3	6.2
31 – 07R	1167568.4928	716072.2730	–	7.1
31 – 09	1167599.8575	716100.9337	−38.6	2.3
31 – 10	1167617.8468	716118.5158	−38.5	1.8
32 – 03	1167573.7669	715970.9533	−5.0	2.8
32 – 04	1167606.8238	715967.7000	−20.6	13.5
32 – 06R	1167645.2075	716002.7576	−41.2	13.5
32 – 08	1167662.2778	716017.7623	−37.6	4.4
32 – 09	1167670.5952	716037.5815	−36.3	1.6
33 – 06R	1167713.4487	715928.9201	−37.8	5.8
33 – 07	1167730.1021	715926.8331	−38.5	7.6
33 – 08	1167738.8462	715947.7597	−37.5	3.2
33 – 09	1167749.9577	715966.7464	−36.6	1.8
34 – 04	1167759.2182	715837.5518	−17.0	7.7
34 – 05	1167753.3983	715848.6183	−23.5	9.8
34 – 06	1167787.2466	715848.7674	−39.3	11.9

SAMPLE LOCATION	EASTING	NORTHING	VERTICAL LIMIT OF AREA 5106 SEDIMENT (MLLW)	DEPTH OF REQUIRED DREDGING (FEET)
34 – 08	1167803.2623	715878.7878	−42.7	8.5
34 – 08R	1167807.5656	715875.4858	−42.3	9.8
34 – 09	1167817.5784	715889.6616	−39.9	6.1
34 – 10	1167824.6308	715903.6372	−40.0	7.4
34 – 11	1167848.6625	715917.8285	−38.7	1.9
35 – 04	1167818.6649	715758.6886	−11.5	8.8
35 – 05	1167836.8476	715763.4888	−21.4	7.3
35 – 06	1167860.9486	715781.6525	−38.3	12.3
35 – 08	1167881.1068	715812.5980	−41.0	6.8
35 – 09	1167893.2451	715826.3928	−39.8	5.6
35 – 10	1167905.5391	715839.4849	−39.0	5.8
35 – 11	1167914.3975	715855.9683	−36.1	2.1
35.5 – 07	1167903.3550	715765.0045	−38.5	9.0
35.5 – 09	1167931.3637	715789.6074	−37.6	5.0
36 – 06	1167921.3335	715724.7329	−34.4	10.7
36 – 08	1167954.5917	715738.8170	−39.3	6.6
36 – 09	1167955.7361	715755.6141	−40.6	6.0



LEGEND

- HORIZONTAL LIMIT OF AREA 5106 SEDIMENT
- ESTIMATED LIMITS OF POTENTIAL BOUNDARY SEDIMENT SLOUGHING
- AREA 5106 SEDIMENT DREDGING
- POT / PIONEER — PROPERTY BOUNDARY
- SAMPLE LOCATION
- AREA OF POTENTIAL BOUNDARY SEDIMENT SLOUGHING

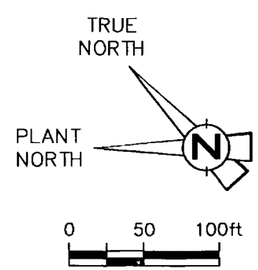
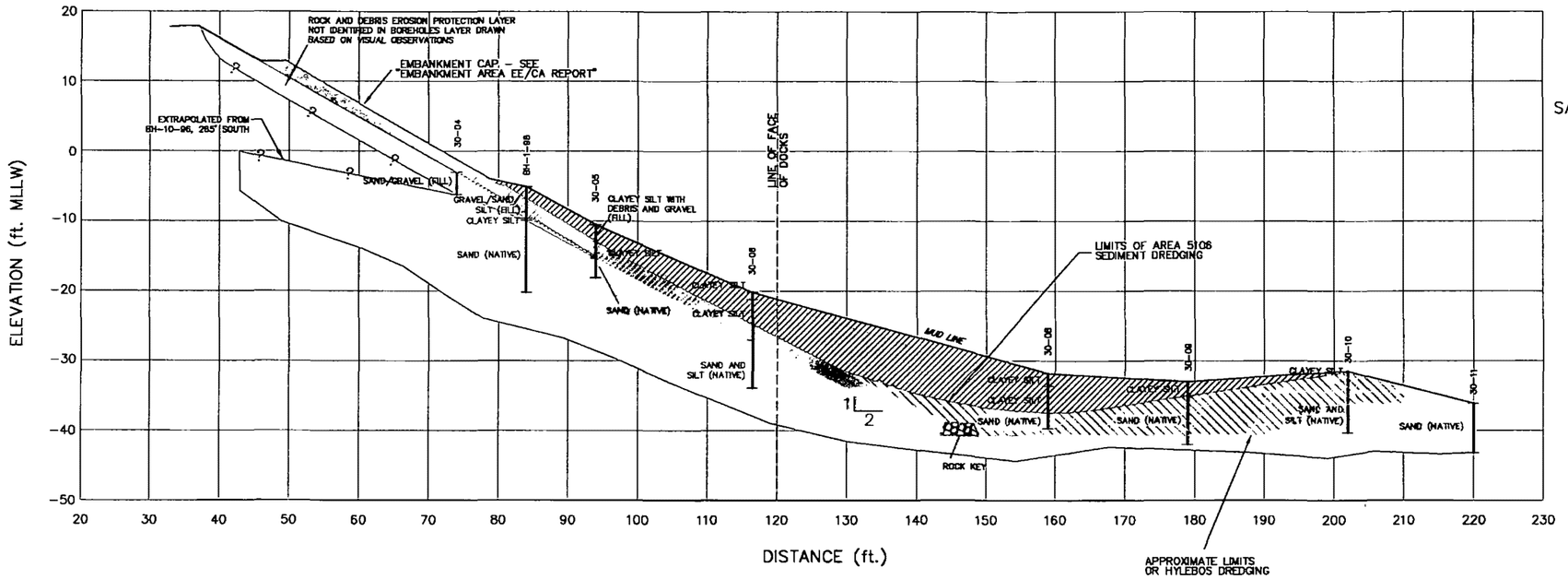


figure 7.3
ALTERNATIVE C – REMOVAL/TREATMENT/DISPOSAL
LIMITS OF AREA 5106 SEDIMENT TO BE REMOVED
AREA 5106 EE/CA
OCC Tacoma Inc., Tacoma, Washington

CRA

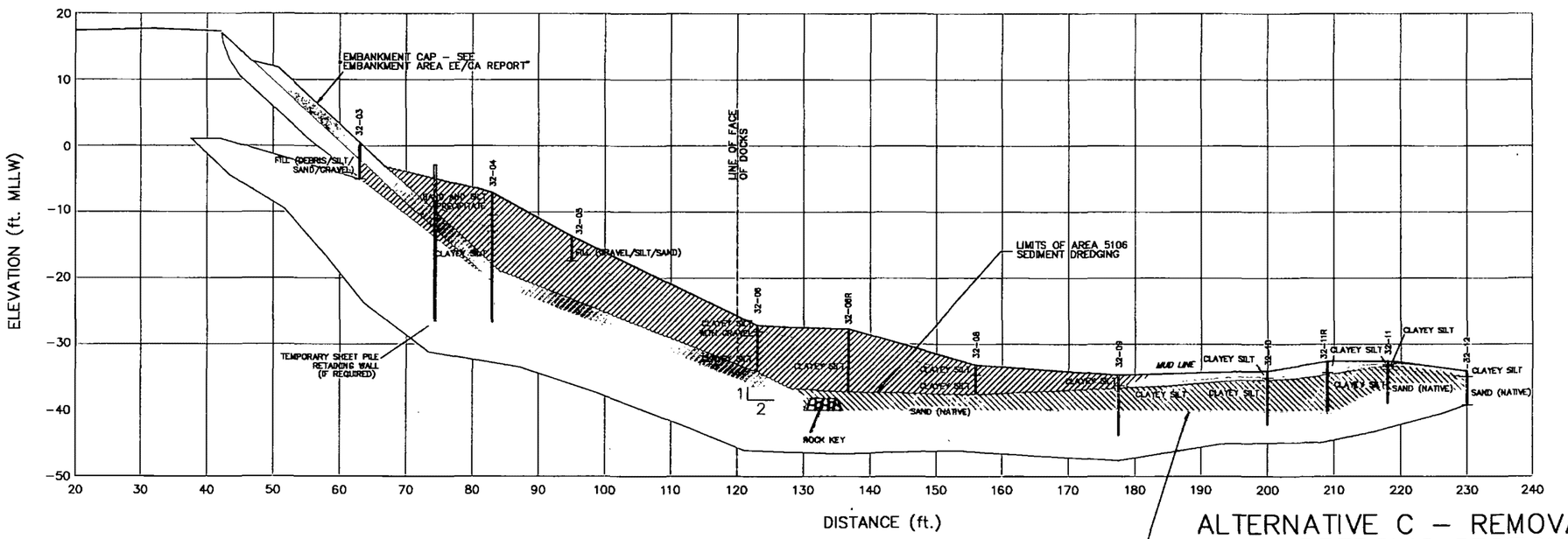
07431–65(015)GN–NF010 JUL 07/2000

19.3.4.6.2
137633



CROSS SECTION AT GRID 30+00

SCALES: HORIZ. 1"=20'
VERT. 1"=20'



CROSS SECTION AT GRID 32+00

SCALES: HORIZ. 1"=20'
VERT. 1"=20'

LEGEND

- BOREHOLE LOCATION (30-06)
- SAND (FILL) / SAND (NATIVE) — UNIT INTERFACE
- STRATIGRAPHIC UNIT
- RECENT SEDIMENT/FILL (MATERIAL A)
- VISUAL AREA 5106-LIKE MATERIAL (MATERIAL B)
- NATIVE SEDIMENT (MATERIAL C)
- AREA 5106 SEDIMENT TO BE DREDGED
- EMBANKMENT CAP
- HYLEBOS DREDGING

figure 7.4

ALTERNATIVE C – REMOVAL/TREATMENT/DISPOSAL DREDGING SECTIONS AT 30+00 AND 32+00
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

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19.3.4.6.2
137633

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LEGEND

SAND (FILL)
SAND (NATIVE)

BOREHOLE LOCATION (30-06)

UNIT INTERFACE

STRATIGRAPHIC UNIT:

RECENT SEDIMENT/FILL (MATERIAL A)

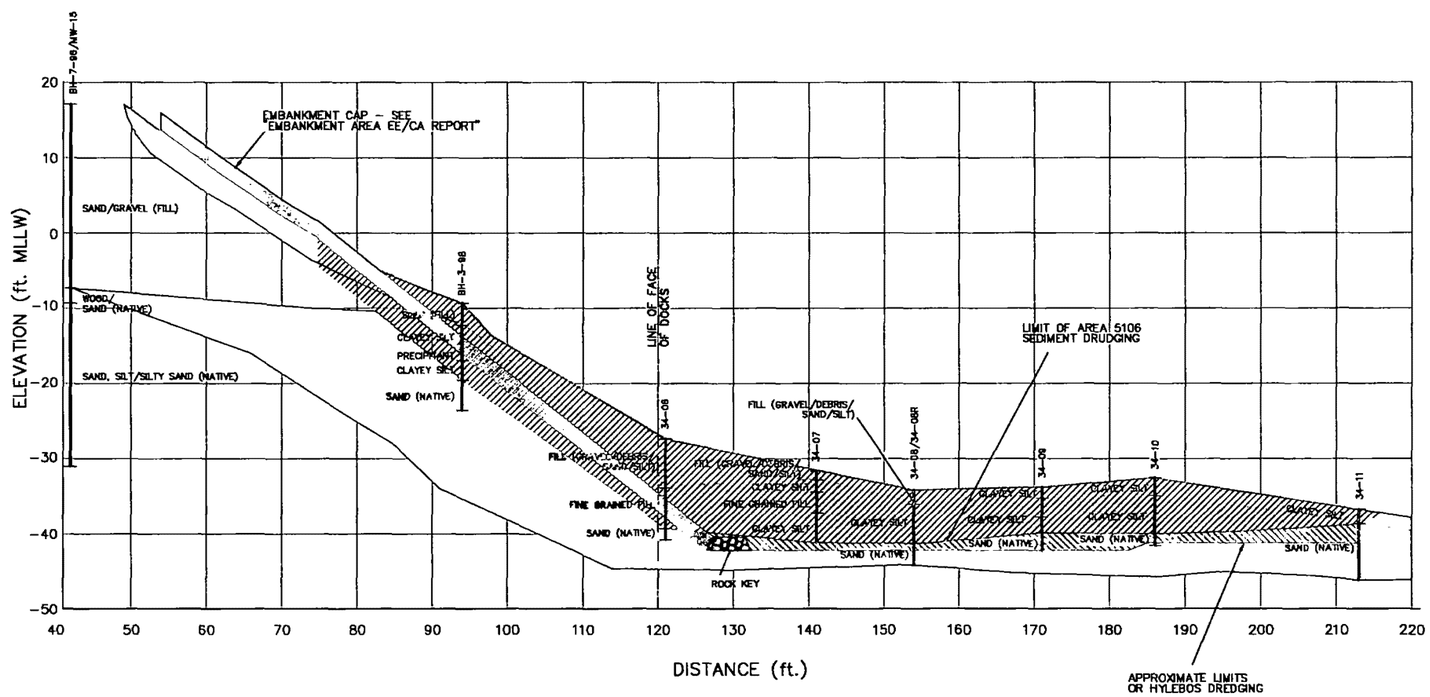
VISUAL AREA 5106-LIKE MATERIAL (MATERIAL B)

NATIVE SEDIMENT (MATERIAL C)

AREA 5106 SEDIMENT TO BE DREDGED

EMBANKMENT CAP

HYLEBOS DRUDGING



CROSS SECTION AT GRID 34+00

SCALES: HORIZ. 1"=20'
VERT. 1"=20'

figure 7.5

ALTERNATIVE C – REMOVAL/TREATMENT/DISPOSAL
DREDGING SECTION AT 34+00
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

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19.3.4.6.2
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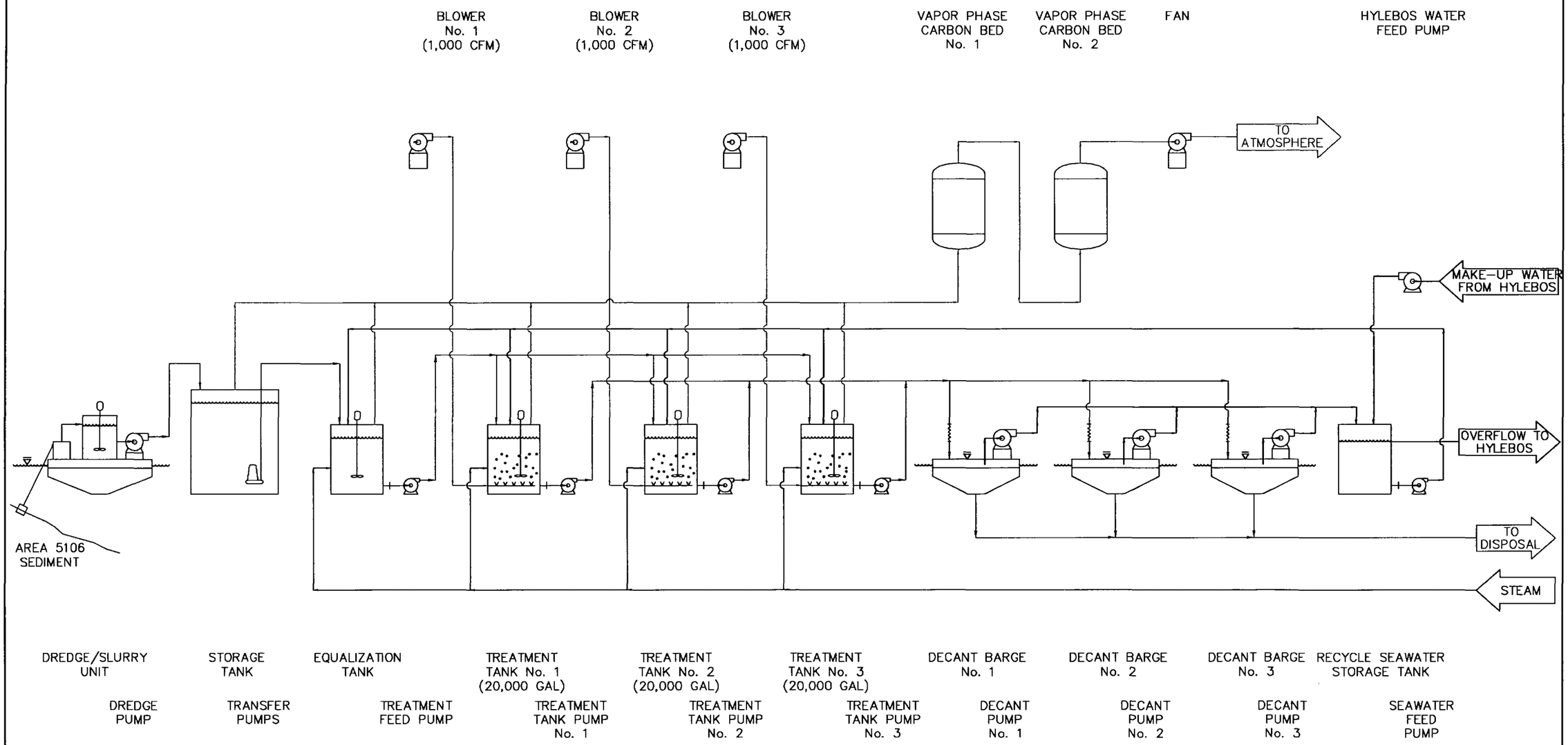

figure 7.6

ALTERNATIVE C – REMOVAL/TREATMENT/DISPOSAL
PROCESS FLOW DIAGRAM
SLURRY AERATION TREATMENT
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

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19.3.4.6.2
137633

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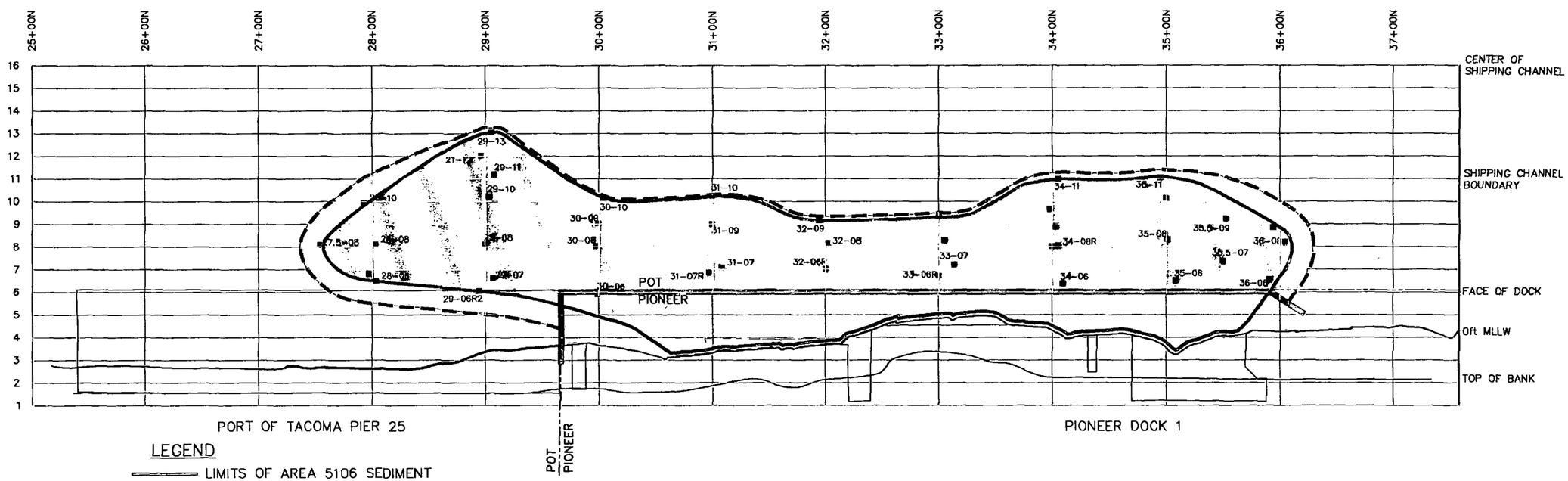
SAMPLE LOCATION	EASTING	NORTHING	VERTICAL LIMIT OF AREA 5106 SEDIMENT (MLLW)	DEPTH OF REQUIRED DREDGING (FEET)
27.5 – 08	1167337.6500	716327.8040	–36.0	6.4
28 – 06	1167350.7503	716271.0334	–35.6	12.0
28 – 07	1167350.7559	716279.7934	–35.9	10.0
28 – 08	1167373.0182	716293.8441	–38.2	9.4
28 – 10	1167390.1536	716327.6761	–36.5	4.8
29 – 06R2	1167410.1408	716201.6223	–26.6	9.6
29 – 07	1167425.3227	716204.7491	–29.9	5.7
29 – 08	1167442.3954	716225.7010	–38.7	9.7
29 – 10	1167473.9317	716256.7892	–36.8	5.6
29 – 11	1167490.9494	716266.7288	–35.9	3.3
29 – 12	1167493.9458	716285.7053	–35.5	2.1
29 – 13	1167514.1286	716295.8987	–36.3	1.8
30 – 08	1167513.2573	716157.7293	–37.4	5.6
30 – 09	1167528.2295	716171.0161	–35.0	2.0
30 – 10	1167546.2680	716183.5945	–35.3	0.1

SAMPLE LOCATION	EASTING	NORTHING	VERTICAL LIMIT OF AREA 5106 SEDIMENT (MLLW)	DEPTH OF REQUIRED DREDGING (FEET)
31 – 07	1167579.7926	716067.6402	–37.3	6.2
31 – 07R	1167568.4928	716072.2730	–	7.1
31 – 09	1167599.8575	716100.9337	–38.6	2.3
31 – 10	1167617.8468	716118.5158	–38.5	1.8
32 – 06R	1167645.2075	716002.7576	–41.2	13.5
32 – 08	1167662.2778	716017.7623	–37.6	4.4
32 – 09	1167670.5952	716037.5815	–36.3	1.6
33 – 06R	1167713.4487	715928.9201	–37.8	5.8
33 – 07	1167730.1021	715926.8331	–38.5	7.6
33 – 08	1167738.8462	715947.7597	–37.5	3.2
33 – 09	1167749.9577	715966.7464	–36.6	1.8
34 – 06	1167787.2466	715848.7674	–39.3	11.9

SAMPLE LOCATION	EASTING	NORTHING	VERTICAL LIMIT OF AREA 5106 SEDIMENT (MLLW)	DEPTH OF REQUIRED DREDGING (FEET)
34 – 08	1167803.2623	715878.7878	–42.7	8.5
34 – 08R	1167807.5656	715875.4858	–42.3	9.8
34 – 09	1167817.5784	715889.6616	–39.9	6.1
34 – 10	1167824.6308	715903.6372	–40.0	7.4
34 – 11	1167848.6625	715917.8285	–38.7	1.9
35 – 06	1167860.9486	715781.6525	–38.3	12.3
35 – 08	1167881.1068	715812.5980	–41.0	6.8
35 – 09	1167893.2451	715826.3928	–39.8	5.6
35 – 10	1167905.5391	715839.4849	–39.0	5.8
35 – 11	1167914.3975	715855.9683	–36.1	2.1
35.5 – 07	1167903.3550	715765.0045	–38.5	9.0
35.5 – 09	1167931.3637	715789.6074	–37.6	5.0
36 – 06	1167921.3335	715724.7329	–34.4	10.7
36 – 08	1167954.5917	715738.8170	–39.3	6.6
36 – 09	1167955.7361	715755.6141	–40.6	6.0



LEGEND

- LIMITS OF AREA 5106 SEDIMENT
- ESTIMATED LIMITS OF POTENTIAL BOUNDARY SEDIMENT SLOUGHING
- PERMANENT SHEET PILE WALL
- AREA 5106 SEDIMENT DREDGING
- AREA OF POTENTIAL BOUNDARY SEDIMENT SLOUGHING
- AREA TO BE CAPPED
- POT / PIONEER PROPERTY BOUNDARY

figure 7.7

ALTERNATIVE D – COMBINED CONTAINMENT/REMOVAL DREDGING/CAPPING PLAN
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

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19.3.4.6.2
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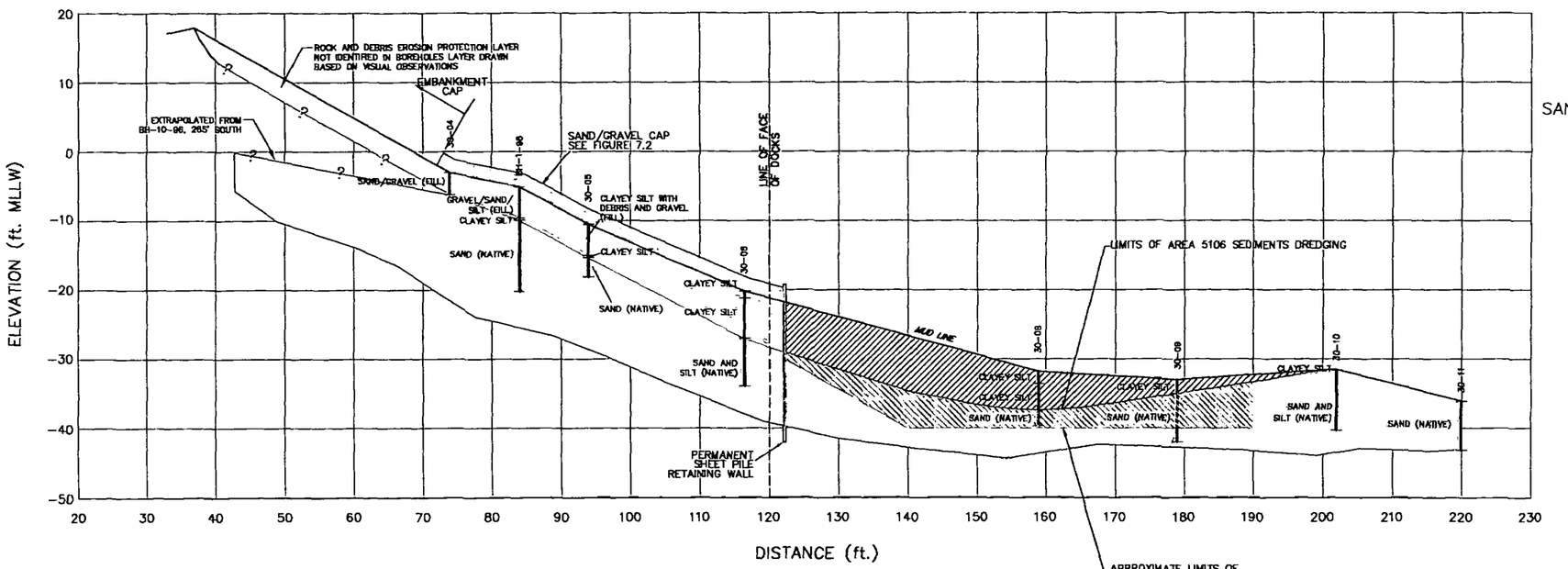
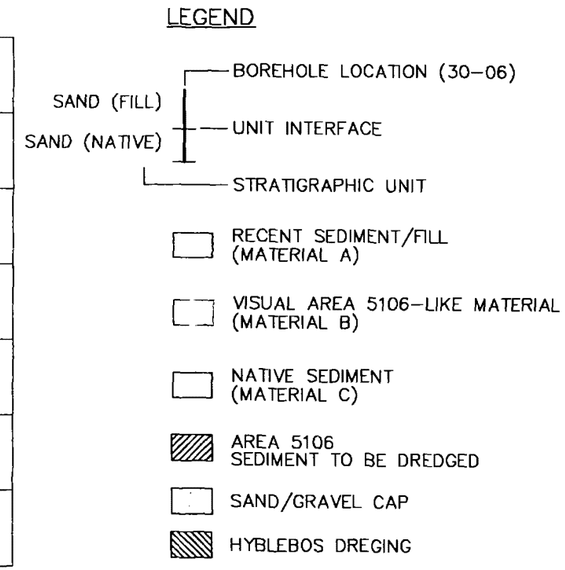
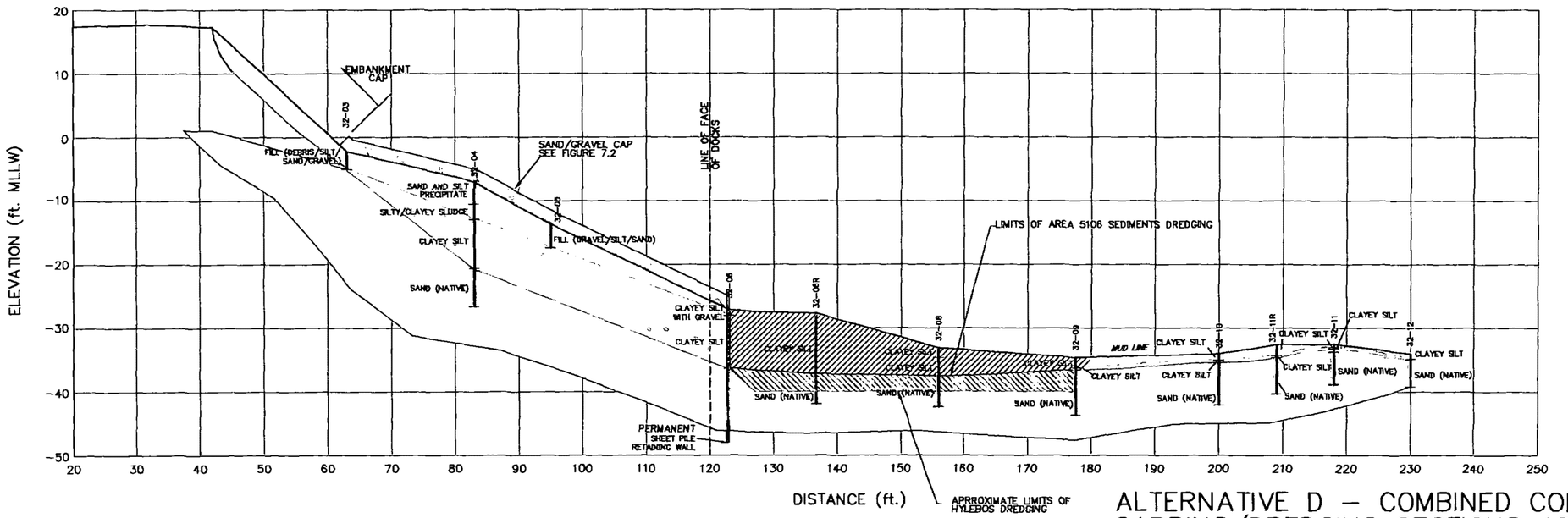
25



CROSS SECTION AT GRID 30+00

SCALES: HORIZ. 1"=20'
VERT. 1"=20'





CROSS SECTION AT GRID 32+00

SCALES: HORIZ. 1"=20'
VERT. 1"=20'

figure 7.8

ALTERNATIVE D – COMBINED CONTAINMENT/REMOVAL CAPPING/DREDGING SECTIONS AT 30+00 AND 32+00
AREA 5106 EE/CA

OCC Tacoma, Inc., Tacoma, Washington

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19.3.4.6.2
137633

26

LEGEND

SAND (FILL)
SAND (NATIVE)

BOREHOLE LOCATION (30-06)

UNIT INTERFACE

STRATIGRAPHIC UNIT:

RECENT SEDIMENT/FILL (MATERIAL A)

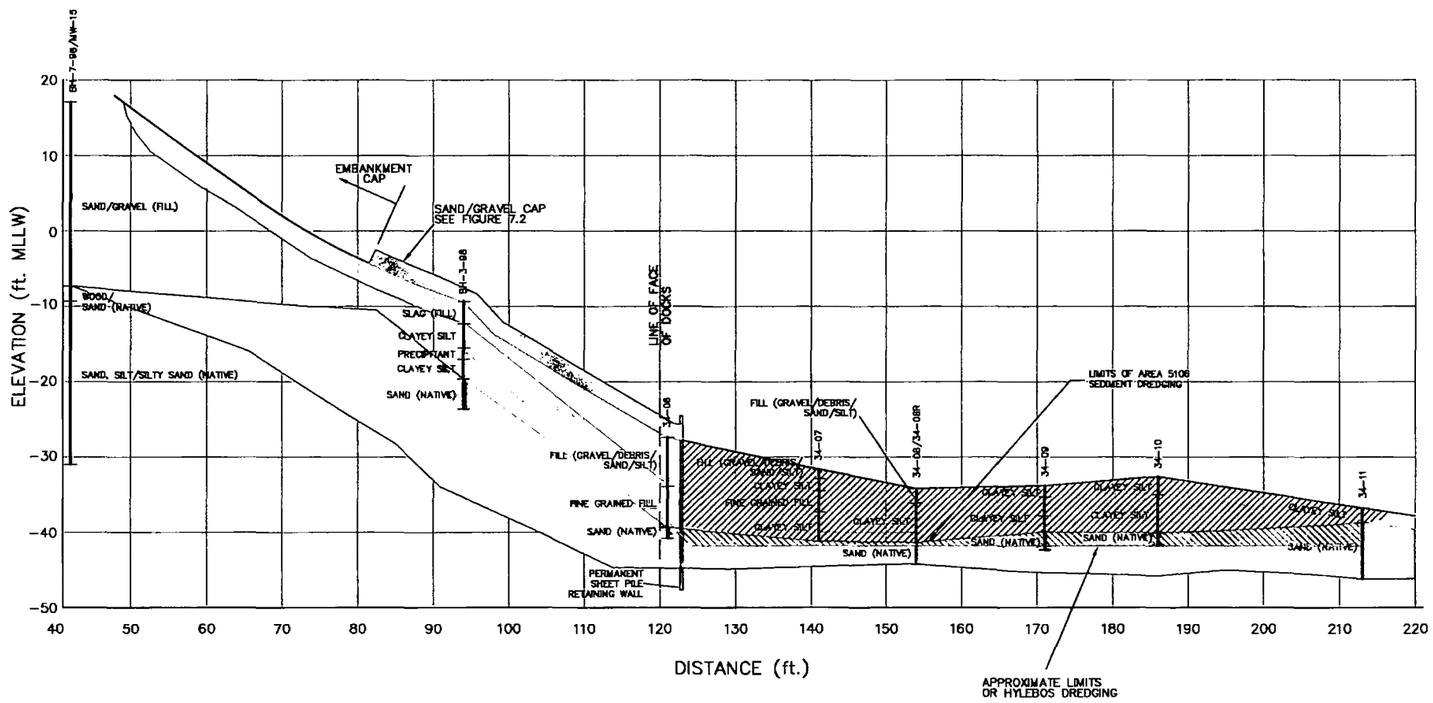
VISUAL AREA 5106-LIKE MATERIAL (MATERIAL B)

NATIVE SEDIMENT (MATERIAL C)

AREA 5106 SEDIMENT TO BE DREDGED

SAND/GRAVEL CAP

HYLEBOS DREDGING



CROSS SECTION AT GRID 34+00

SCALES: HORIZ. 1"=20'
VERT. 1"=20'

figure 7.9

ALTERNATIVE D – COMBINED CONTAINMENT/REMOVAL
CAPPING/DREDGING SECTIONS AT 34+00
AREA 5106 EE/CA
OCC Tacoma, Inc., Tacoma, Washington

CRA

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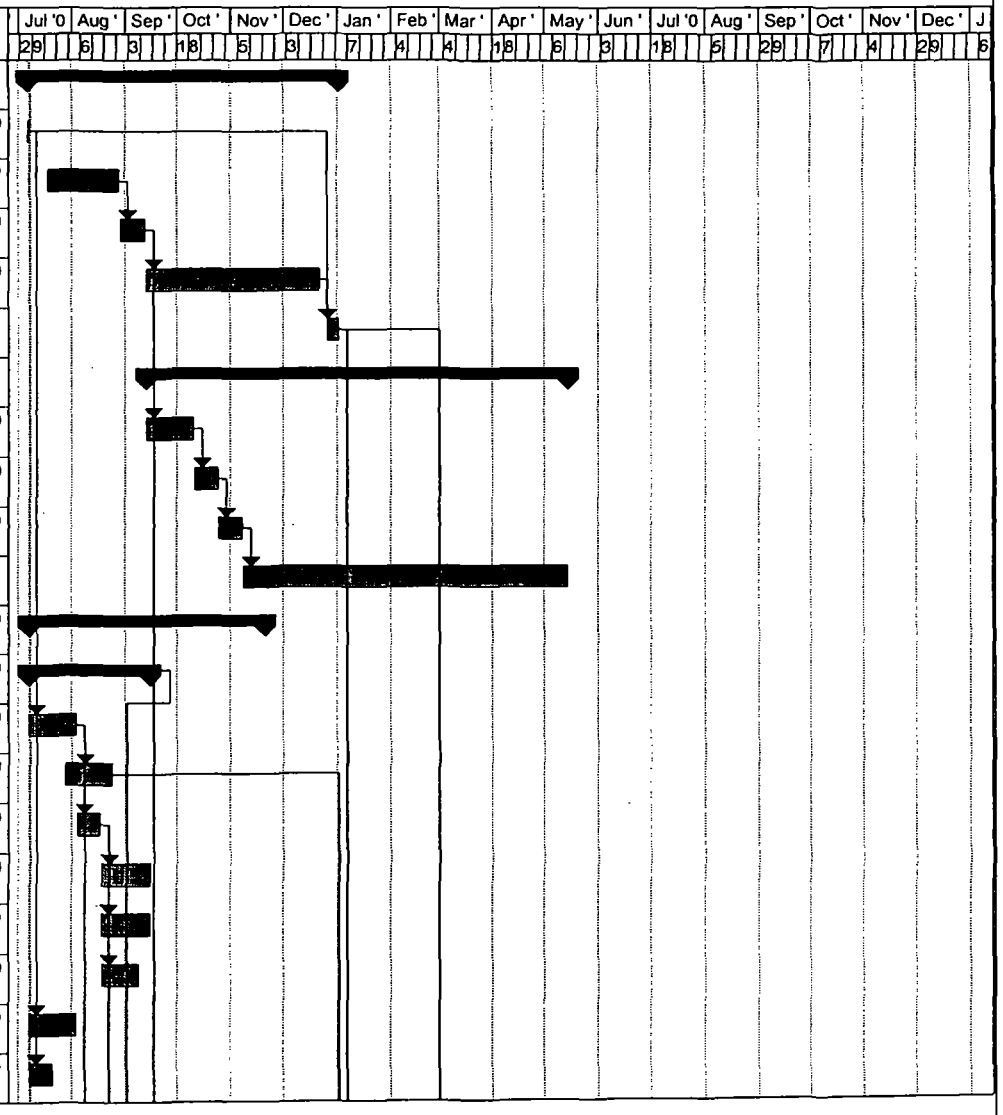
19.3.4.6.2
137633

27

figure 11.1

PROJECT SCHEDULE
AREA 5106 REMOVAL ACTION

ID		Task Name	Duration	Start	Finish
1		**Administrative Tasks**	**123 days**	**Thu 7/6/00**	**Mon 1/1/01**
2		USEPA Approval of EE/CA	1 day	Thu 7/6/00	Thu 7/6/00
3		Public Comment Period	30 days	Tue 7/18/00	Mon 8/28/00
4		Finalize EE/CA	2 wks	Tue 8/29/00	Tue 9/12/00
5		Negotiate Consent Decree	14 wks	Wed 9/13/00	Thu 12/21/00
6		Finalize Consent Decree	1 wk	Tue 12/26/00	Mon 1/1/01
7		**Biological Assessment for ESA**	**170 days**	**Wed 9/13/00**	**Mon 5/14/01**
8		Prepare Biological Assessment	4 wks	Wed 9/13/00	Tue 10/10/00
9		USEPA Review of BA	2 wks	Wed 10/11/00	Tue 10/24/00
10		Finalize BA	2 wks	Wed 10/25/00	Tue 11/7/00
11		Consultation Period	26 wks	Wed 11/8/00	Mon 5/14/01
12		**Design**	**96 days**	**Fri 7/7/00**	**Mon 11/20/00**
13		Prepare Design Report	50 days	Fri 7/7/00	Fri 9/15/00
14		Process Flow Diagram / P&IDs	4 wks	Fri 7/7/00	Thu 8/3/00
15		Equipment Specifications	4 wks	Fri 7/28/00	Thu 8/24/00
16		Mechanical Layout	2 wks	Fri 8/4/00	Thu 8/17/00
17		Piping D&D	4 wks	Fri 8/18/00	Fri 9/15/00
18		Electrical D&D	4 wks	Fri 8/18/00	Fri 9/15/00
19		Civil D&D	3 wks	Fri 8/18/00	Fri 9/8/00
20		Dredging Plan	4 wks	Fri 7/7/00	Thu 8/3/00
21		Disposal Plan	2 wks	Fri 7/7/00	Thu 7/20/00



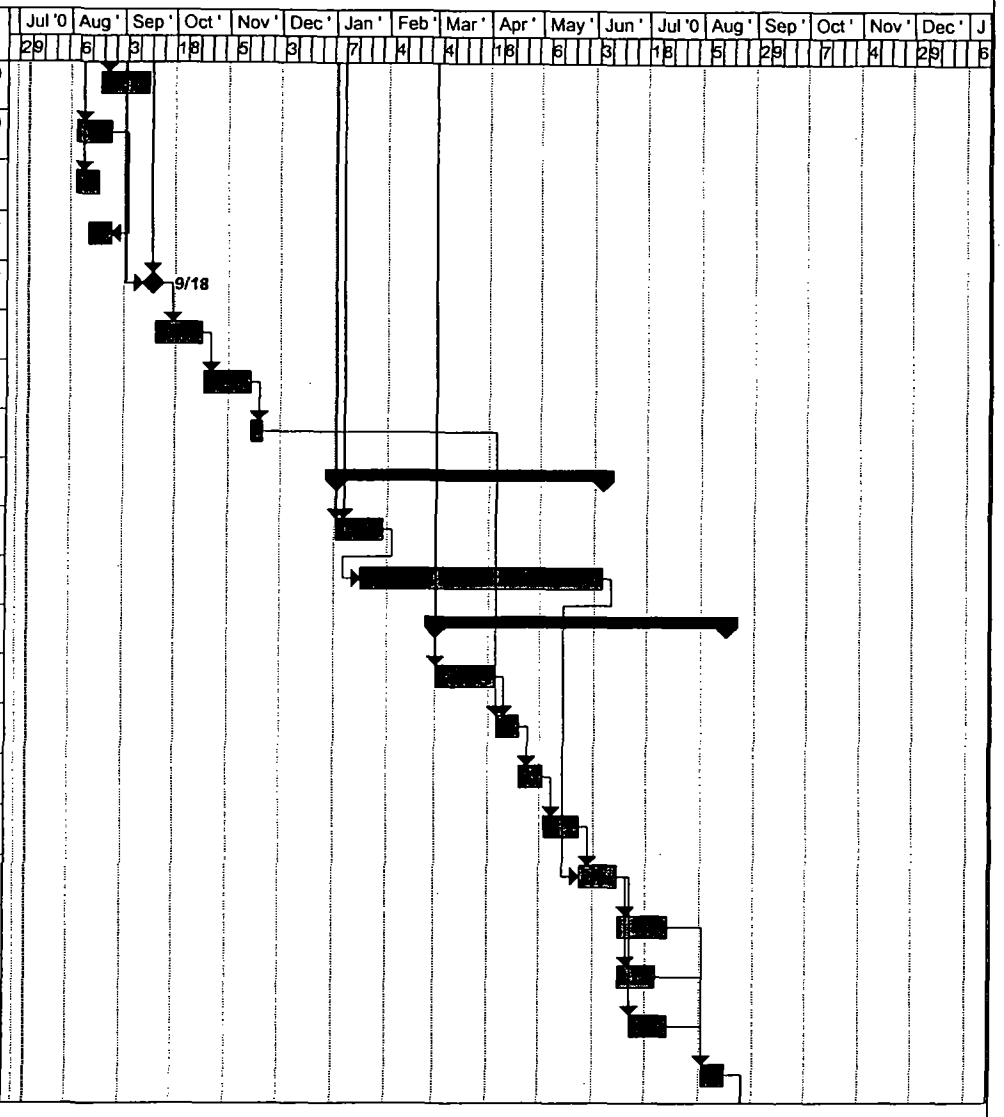
Project: Area 5106
Date: Fri 7/7/00

Task		Milestone		Rolled Up Split		External Tasks	
Split		Summary		Rolled Up Milestone		Project Summary	
Progress		Rolled Up Task		Rolled Up Progress			

figure 11.1

PROJECT SCHEDULE
AREA 5106 REMOVAL ACTION

ID		Task Name	Duration	Start	Finish
22		Scope of Work and Specifications	4 wks	Fri 8/18/00	Fri 9/15/00
23		Compliance Monitoring Plan	3 wks	Fri 8/4/00	Thu 8/24/00
24		Health and Safety Plan	2 wks	Fri 8/4/00	Thu 8/17/00
25		QA/QC Plan	2 wks	Fri 8/11/00	Thu 8/24/00
26		Submit Design Report to USEPA	1 day	Mon 9/18/00	Mon 9/18/00
27		USEPA Review	4 wks	Tue 9/19/00	Mon 10/16/00
28		Finalize Design Report	4 wks	Tue 10/17/00	Mon 11/13/00
29		USEPA Approval	1 wk	Tue 11/14/00	Mon 11/20/00
30		**Equipment Procurement**	**110 days**	**Tue 1/2/01**	**Tue 6/5/01**
31		Equipment Procurement	4 wks	Tue 1/2/01	Mon 1/29/01
32		Equipment Fabrication / Delivery	20 wks	Tue 1/16/01	Tue 6/5/01
33		**Treatment Plant Construction**	**118 days**	**Thu 3/1/01**	**Wed 8/15/01**
34		Construction Bids	5 wks	Thu 3/1/01	Wed 4/4/01
35		Contractor Selections	2 wks	Thu 4/5/01	Wed 4/18/01
36		Contractor Mobilization	2 wks	Thu 4/19/01	Wed 5/2/01
37		Site Work / Install Foundations	3 wks	Thu 5/3/01	Wed 5/23/01
38		Equipment Installations	3 wks	Thu 5/24/01	Thu 6/14/01
39		Piping Installation	4 wks	Fri 6/15/01	Fri 7/13/01
40		Electrical Installation	3 wks	Fri 6/15/01	Fri 7/6/01
41		Process Control Installation	3 wks	Fri 6/22/01	Fri 7/13/01
42		Checkout / Startup	2 wks	Thu 8/2/01	Wed 8/15/01



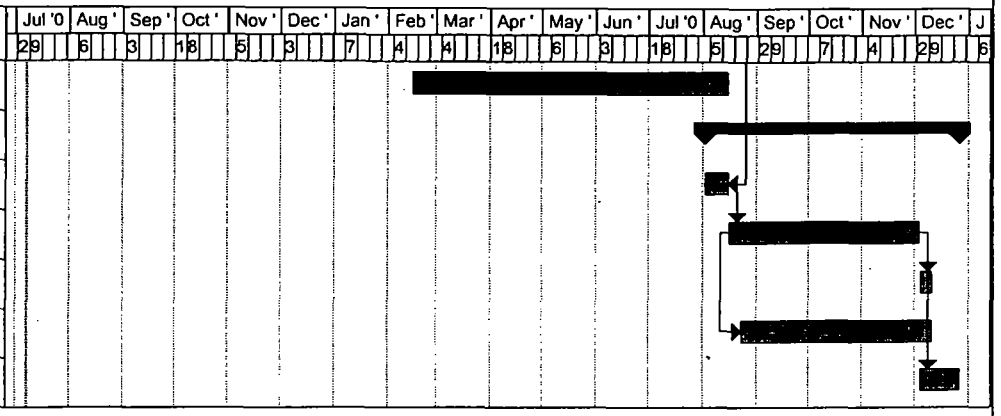
Project: Area 5106
Date: Fri 7/7/00

Task		Milestone		Rolled Up Split		External Tasks	
Split		Summary		Rolled Up Milestone		Project Summary	
Progress		Rolled Up Task		Rolled Up Progress			

figure 11.1

PROJECT SCHEDULE
AREA 5106 REMOVAL ACTION

ID		Task Name	Duration	Start	Finish
43		**Hylebos Fish Window**	**128 days**	**Thu 2/15/01**	**Wed 8/15/01**
44		**Treatment Plant Operation**	**100 days**	**Thu 8/2/01**	**Wed 12/26/01**
45		Dredge Mobilization	2 wks	Thu 8/2/01	Wed 8/15/01
46		Dredge / Treatment Operation	15 wks	Thu 8/16/01	Mon 12/3/01
47		Dredge Demobilization	1 wk	Tue 12/4/01	Mon 12/10/01
48		Disposal	15 wks	Thu 8/23/01	Mon 12/10/01
49		Treatment Plant Dismantlement	3 wks	Tue 12/4/01	Wed 12/26/01



Project: Area 5106
Date: Fri 7/7/00

Task		Milestone		Rolled Up Split		External Tasks	
Split		Summary		Rolled Up Milestone		Project Summary	
Progress		Rolled Up Task		Rolled Up Progress			

30

TABLES

TABLE 2.1

SUMMARY OF PREVIOUS CHEMICAL INVESTIGATIONS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Date of Investigation	*Conducted By*	*Sample Type*	*No. of Samples*	*Analyses Conducted*
1979	National Marine Fisheries	Surface Sediment	1	Metals, Volatiles, Semi-Volatiles, PCBs
1980	National Marine Fisheries	Surface Sediment	2	Metals, Volatiles, Semi-Volatiles, PCBs
Dec. 1980	Batelle Northwest	Subsurface Sediment	9	Volatiles, Semi-Volatiles, PCBs
July-Aug. 1981	Washington DOE	Surface Sediment	8	Metals, Volatiles, Semi-Volatiles, PCBs
Jan. 1984	Tetra Tech	Surface Sediment	2	Conventional Variables, Grain Size, Metals, Volatiles, Semi-Volatiles, Pesticides, PCBs, Miscellaneous Chemicals
March 1984	Tetra Tech	Surface Sediment	13	Conventional Variables, Grain Size, Metals, Volatiles, Semi-Volatiles, Pesticides, PCBs, Miscellaneous Chemicals
April 1984	Washington DOE	Surface Sediment	3	Metals, Volatiles, Semi-Volatiles, PCBs
May 1984	Tetra Tech	Subsurface Sediment	13	Conventional Variables, Grain Size, Metals, Volatiles, Semi-Volatiles, Pesticides, PCBs, Miscellaneous Chemicals
1983/1984	OCC	Surface Sediment	4	Conventional Variables, Grain Size, Metals, Volatiles, Semi-Volatiles
1984/1985	OCC	Subsurface Sediment	45	Metals, Volatiles, Semi-Volatiles
1981-1986	OCC	Water (3 Depths)	10	Volatiles

TABLE 2.1

SUMMARY OF PREVIOUS CHEMICAL INVESTIGATIONS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Date of Investigation	*Conducted By*	*Sample Type*	*No. of Samples*	*Analyses Conducted*
1989	OCC	Surface and Subsurface Sediment	35	Conventional Variables, Grain Size, Metals, Volatiles, Semi-Volatiles
1994	HCC (Striplin Events 1A and 1B)	Sediments	281	Conventional Variables, Metals, Volatiles, Pesticides, PCBs
1995	HCC (Striplin Event 1C)	Sediments	52	Conventional Parameters, Volatiles, Semi-Voaltiles, Calcium, PCBs

Notes:
HCC Hylebos Cleanup Committee.
OCC Occidental Chemical Corporation.
PCBs Polychlorinated Biphenyls.

TABLE 2.2

SUMMARY OF COMPOUNDS DETECTED IN THE PRD STUDY
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:	*5105*			*5106*				*5108*			*5109*		
Matrix:	*Surface*	*Recent*	*Native*	*Surface*	*Recent*	*Recent*	*Native*	*Surface*	*Recent*	*Native*	*Surface*	*Recent*	*Native*
Depth Below Mudline:	*0 to 10 cm*	*0 to 1 ft.*	*3 to 5 ft.*	*0 to 10 cm*	*0 to 4 ft.*	*4 to 8 ft.*	*9.5 to 11 ft.*	*0 to 10 cm*	*0 to 4 ft.*	*5.5 to 7.5 ft.*	*0 to 10 cm*	*0 to 3 ft.*	*4 to 6 ft.*
Parameter													
Volatiles (ug/kg)													
Trichloroethene	1.7	2.9	ND 1.1	9.3	13000J	1600000	28000	15.0	3.6J	ND 2	2.7	32.0	ND 1
Tetrachloroethene	ND 1.3	ND 1.3	ND 1.1	19	110000J	3200000	27000	ND 8.5	3.2J	ND 1	ND 1.8	32.0	ND 1
Ethylbenzene	ND 1.3	ND 1.3	ND 1.1	ND 1.5	9.9	ND 9400.0	ND 1.0	ND 8.5	ND 1.3	ND 1	ND 1.8	ND 1.7	ND 1
Total Xylenes	ND 2.5	ND 2.6	ND 2.3	ND 3.0	35.0	ND 19000.0	4.5J	ND 17.0	ND 2.6	ND 2	ND 3.6	5.8	ND 2.1
Semi-Volatiles (ug/kg)													
1,4-Dichlorobenzene	12J	ND 15	ND 13	ND 18	ND 20	ND 260	ND 1.0	ND 18	ND 10	ND 12	ND 17	45	ND 12
2-Methylphenol	ND 16	ND 15	ND 13	ND 18	ND 20	ND 260	ND 13	ND 18	ND 39	27	ND 17	78	25
4-Methylphenol	ND 16	ND 15	ND 13	ND 18	100	ND 260	38J	ND 18	ND 47	66	11J	170	67
Hexachloroethane	ND 31	ND 29	ND 26	4500	ND 39	ND 520	ND 51	ND 37	ND 20	ND 25	62	ND 49	ND 25
2,4-Dimethylphenol	ND 16	ND 15	ND 13	ND 18	ND 20	ND 23000	44J	ND 4	ND 20	ND 12	ND 10	120	91
1,2,4-Trichlorobenzene	ND 6.3	ND 6.4	ND 5.7	9J	45J	200J	13J	63	ND 6.5	ND 12	ND 9.1	27J	ND 12
Naphthalene	24J	76	ND 13	72	520	12000	1200	130	190	ND 12	64	130	12J
Hexachlorobutadiene	46J	35	ND 5.7	180	6300	44000J	650	410	4200	ND 5.1	160	150	ND 5.2
2-Methylnaphthalene	ND 16	40	ND 13	25J	81	3900	270	94	100	ND 12	20J	94	9J.
Dimethylphthalate	ND 16	ND 15	ND 13	10J	ND 20	ND 260	ND 25	ND 18	ND 39	ND 12	10J	ND 25	ND 12
Acenaphthylene	ND 16	19J	ND 13	22J	17J	ND 260	ND 25	ND 18	ND 39	ND 12	18J	ND 25	ND 12
Acenaphthene	ND 16	25J	ND 13	47	150	5200	350	150	130	ND 12	41	120	7J
Dibenzofuran	16J	37	ND 13	48	130	3800	300	76	98	ND 12	44	93	10J
Fluorene	19J	35	ND 13	71	160	5400	340	100	130	ND 12	56	140	11J
Hexachlorobenzene	19J	24	ND 0.67	54	920	4600	18J	260	550	ND 0.62	140	440	2.6
Pentachlorophenol	ND 78	ND 73	ND 67	ND 91	140J	ND 1300	ND 70	ND 130	ND 200	ND 62	42J	ND 120	ND 62
Phenanthrene	81	140	18	310	810	19000	1200	530	510	15J	270	520	35
Anthracene	48	89	ND 13	270	270	3200	160	49	140	ND 12	130	110	14J
Di-n-butylphthalate	ND 16	ND 15	ND 13	ND 18	ND 20	ND 260	ND 25	ND 18	ND 39	ND 12	13J	ND 25	ND 12
Fluoranthene	160	220	ND 13	960	1200	20000	680	450	800	16J	560	560	39
Pyrene	190	300	16	870	1100	12000	370	400	710	16J	550	460	88
Butylbenzylphthalate	ND 16	ND 15	ND 13	29N	ND 20	ND 260	ND 25	86	ND 39	ND 12	20N	ND 25	ND 12
Benzo(a)anthracene	83	88	ND 13	360	480	4500	97	200	210	ND 12	230	180	16J
bis(2-Ethylhexyl)phthalate	74	27J	ND 13	280	350	680	ND 25	180	80	18J	230	150	ND 8
Chrysene	160	160	ND 13	660	730	4600	86	240	420	ND 12	420	300	26
Benzo(b)fluoranthene	140	150	ND 13	430	570	3400	68	200	280	ND 12	350	160	22J
Benzo(k)fluoranthene	100	97	ND 13	290	460	3400	51	140	240	ND 12	200	150	20J
Benzo(a)pyrene	84	110	ND 13	300	360	2400	40J	120	190	ND 12	200	120	19J
Indeno(1,2,3-cd)pyrene	38	62	ND 13	160	230	1200	ND 25	62	84	ND 12	130	60	ND 10
Dibenz(a,h)anthracene	ND 16	19J	ND 13	60N	100	410	ND 25	24J	ND 39	ND 12	37N	24J	ND 12
Benzo(g,h,i,)perlyene	.16	56	ND 13	120	98	790	ND 25	47	73J	ND 12	88	48	ND 10

TABLE 2.2

SUMMARY OF COMPOUNDS DETECTED IN THE PRD STUDY
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:	*5105*			*5106*				*5108*			*5109*		
Matrix:	*Surface*	*Recent*	*Native*	*Surface*	*Recent*	*Recent*	*Native*	*Surface*	*Recent*	*Native*	*Surface*	*Recent*	*Native*
Depth Below Mudline:	*0 to 10 cm*	*0 to 1 ft.*	*3 to 5 ft.*	*0 to 10 cm*	*0 to 4 ft.*	*4 to 8 ft.*	*9.5 to 11 ft.*	*0 to 10 cm*	*0 to 4 ft.*	*5.5 to 7.5 ft.*	*0 to 10 cm*	*0 to 3 ft.*	*4 to 6 ft.*
Parameter													
Pesticides/PCBs (ug/kg)													
Heptachlor	ND 2.90	1.40	ND 0.67	2.80	ND 0.98	ND 1.30	ND 1.10	ND 6.40	ND 11.00	ND 0.62	8.00	ND 1.20	ND 0.62
Dieldrin	ND 6.10	ND 2.60	ND 1.30	ND 5.80	22.00	ND 2.60	ND 1.30	ND 6.80	ND 12.00	ND 1.20	ND 8.20	ND 4.60	ND 1.20
gamma-Chlordane	ND 6.60	2.40	ND 0.67	ND 4.00	18.00	ND 1.30	ND 0.63	ND 9.80	ND 17.00	ND 0.62	ND 1.70	ND 1.20	ND 0.62
Aroclor-1254	130	ND 49	ND 13	90	ND 390	ND 2600	ND 38	230	ND 390	ND 12	480	ND 180	ND 12
Aroclor-1260	210	ND 37	ND 13	220	170J	ND 1300	ND 25	300	220J	ND 12	440	ND 120	ND 12
Metals (mg/kg)													
Antimony	2.70J	3.20J	ND 3.31	ND 2.71	5.90J	7.00J	ND 3.04	ND 3.28	4.00J	ND 3.08	4.90J	4.80J	4.00J
Arsenic	11.00	9.20	2.00	13.80	25.70	25.90	1.70	20.50	21.60	1.20	15.00	11.60	1.60
Cadmium	0.35	ND 0.31	ND 0.35	0.64	1.10	1.60	ND 0.32	0.86	1.00	ND 0.33	0.71	0.93	ND 0.34
Chromium	20.00	21.50	18.60	24.50	29.50	30.50	14.50	27.00	24.60	13.50	27.50	28.40	18.00
Copper	49.50	40.60	18.50	85.00	83.60	61.10	13.60	80.80	60.20	9.40	94.40	70.20	13.60
Lead	35.90	33.10	ND 3.74	67.90	139.00	121.00	ND 3.44	133.00	86.90	3.70	106.00	245.00	6.60
Mercury	0.16	0.24	ND 0.06	0.39	0.25	0.48	ND 0.05	0.44	0.32	ND 0.06	0.18	0.31	ND 0.04
Nickel	16.60	17.20	10.50	19.20	27.60	46.40	9.00	31.90	35.00	9.10	21.00	47.20	8.90
Silver	ND 0.07	0.15	ND 0.07	ND 0.11	0.51	0.29	ND 0.06	ND 0.13	0.27	ND 0.06	ND 0.12	0.30	ND 0.06
Zinc	59.3	51.4	25.7	104.0	109.0J	190.0J	21.9	109.0	88.1	19.9	108.0	83.1J	21.8J

Notes:
J Estimated.
NDx Not detected at or above x.
PCBs Polychlorinated Biphenyls.

TABLE 2.3

SUMMARY OF TCLP ANALYSIS FROM PRD STUDY [1]
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Parameters	Composite C-1		Composite C-2	
	Bulk (µg/kg)	TCLP Extract (µg/L)	Bulk (µg/kg)	TCLP Extract (µg/L)
Volatile Organics				
Vinyl chloride	3400J	440J	16000J	2900J
1,1-Dichloroethene	ND 400	14	ND 350	ND 10
Chloroform	ND 400	ND 10	ND 350	ND 10
1,2-Dichloroethane	ND 400	ND 50	ND 1700	ND 50
2-Butanone	ND 2000	ND 50	ND 1700	ND 50
Carbon Tetrachloride	ND 400	ND 10	ND 350	ND 10
Trichloroethene	46000	1000	650000	20000J
Tetrachloroethene	320000	5200J	2600000	26000J
Benzene	ND 400	ND 10	ND 350	ND 10
Chlorobenzene	ND 400	ND 10	ND 350	ND 10
Extractable Organics				
g-BHC	120	ND 0.5	-	-
Heptachlor	150	ND 0.5	-	-
g-Chlordane	120	ND 0.5	-	-
a-Chlordane	120	ND 0.5	-	-
Heptachlorepoxide	120	ND 0.5	-	-
Endrin	250	ND 1	-	-
Methoxychlor	1200	ND 5	-	-
Toxaphene	12000	ND 50	-	-
2,4,5-TP (Silvex)	26	ND 1.2	-	-
2,4-D	100	ND 5	-	-
1,4-Dichlorobenzene	620	ND 10	-	-
2-Methylphenol	620	ND 20	-	-
4-Methylphenol	620	ND 10	-	-
Hexchloroethane	620	ND 20	-	-
Nitrobenzene	620	ND 20	-	-
2,4,6-Trichlorophenol	3100	ND 50	-	-
2,4,5-Trichlorophenol	3100	ND 50	-	-
2,4-Dinitrotoluene	3100	ND 50	-	-
Pyridine	1200	ND 20	-	-
Hexachlorobutadiene	41000	22	-	-
Hexachlorobenzene	2100	ND 10	-	-
Pentachlorophenol	3100	ND 50	-	-

TABLE 2.3

SUMMARY OF TCLP ANALYSIS FROM PRD STUDY [1]
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Parameters	*Composite C-1*		*Composite C-2*	
	Bulk (mg/kg)	*TCLP Extract (mg/L)*	*Bulk (mg/kg)*	*TCLP Extract (mg/L)*
Metals				
Calcium	53300		-	-
Arsenic	ND 10	ND 0.1	-	-
Barium	56.9	0.503	-	-
Cadmium	0.5	0.004	-	-
Chromium	24	ND 0.01	-	-
Lead	91	0.07	-	-
Mercury	0.21	ND 0.0001	-	-
Selenium	ND 10	ND 0.1	-	-
Silver	ND 0.8	ND 0.006	-	-

Notes:

(1) Reference: Striplin Environmental Associates, Inc., Hylebos Waterway Pre-Remedial Design Round 1 Data Report.

[ ] Exceeds TCLP disposal criteria.

J Associated value is estimated.

NDx Not detected at or above x.

TCLP Toxicity Characteristic Leaching Procedures.

TABLE 2.4

SUMMARY OF COMPOUNDS DETECTED IN INTERTIDAL SEDIMENT
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:	*Area 7 Sediment*	*Area 8 Sediment*	*Area 9 Sediment*
Sample Collection Date:	*04/05/96*	*04/05/96*	*04/05/96*
Parameter			
Volatiles (ug/kg)			
Trichloroethene	ND 1.1	3.0	29
Tetrachloroethene	3.6	29	170
Semi-Volatiles (ug/kg)			
Phenol	ND 26	19	79
Hexachloroethane	1200	ND 19	4400
Naphthalene	110	26	25
Hexachlorobutadiene	290	37	470
2-Methylnaphthalene	53	23	ND 20
Acenaphthene	82	71	32
Dibenzofuran	96	64	33
Fluorene	170	140	69
Hexachlorobenzene	580	50	57
Pentachlorophenol	220	ND 95	ND 98
Phenanthrene	1300	670	430
Anthracene	440	650	190
Fluoranthene	1800	1300	670
Pyrene	2500	1400	360
Benzo(a)anthracene	1200	530	290
bis(2-Ethylhexyl)phthalate	210	1800	290
Chrysene	1600	980	490
Benzo(b)fluoranthene	1000	310	440
Benzo(k)fluoranthene	1100	640	330
Benzo(a)pyrene	960	340	340
Indeno(1,2,3-cd)pyrene	690	160	390
Dibenz(a,h)anthracene	220	44J	85
Benzo(g,h,i,)perlyene	690	150	370
Pesticides/PCBs (ug/kg)			
Dieldrin	ND 510	ND 110	3.8
4,4'-DDE	ND 510	ND 110	3.5
4,4'-DDT	ND 510	ND 110	3.4
gamma-Chlordane	310	ND 54	5.1
alpha-Chlordane	ND 260	ND 54	4.7
Aroclor-1248	ND 50	250	310
Aroclor-1254	ND 50	4200	ND 50
Aroclor-1260	160	1800	120
Diesel Range Hydrocarbons (mg/kg)	230	100	99
Total Petroleum Hydrocarbons (mg/kg)	530J	200J	250J

TABLE 2.4

SUMMARY OF COMPOUNDS DETECTED IN INTERTIDAL SEDIMENT
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:	*Area 7 Sediment*	*Area 8 Sediment*	*Area 9 Sediment*
Sample Collection Date:	*04/05/96*	*04/05/96*	*04/05/96*
Parameter			
Metals (mg/kg)			
Antimony	12J	40J	9J
Arsenic	73	50	32
Cadmium	1.1	3.6	0.5
Chromium	61	160	64
Copper	250	980	110
Lead	45000J	1200J	520J
Mercury	0.31	0.55	1.4
Nickel	150J	290J	44J
Silver	0.8	1.6	0.4
Zinc	380	1500	210
General Chemistry			
pH (SU)	7.8	7.8	7.8
Percent Solids (%)	76.1	69.7	74.0
Total Volatile Solids (mg/kg)	37000	40000	34000
N-Ammonia (mg/kg)	1.4	2.4	3.4
Total Organic Carbon (%)	1.9	3.0	1.9

Notes:

J	Estimated.
NDx	Not detected at or above x.
PCBs	Polychlorinated Biphenyls.
S.U.	Standard Units.

TABLE 2.5

PHYSICAL PROPERTIES TESTING PROGRAM
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

	Media	*Sample/Test Location*	*Sample/Test Depth (ft below mudline)*
1. In Situ Tests			
a) **Standard Penetration Test**	NS	29-09	6-8.1
		29-09	8.1-12
		31-07	4-5
		31-07	5-8.1
		31-07	8.1-13
		33-07	8-14
		34-06	5.5-10
b) **Vane Shear Strength** [1]	RS	29-09	1.5
		29-09	3
		29-09	4.5
		29-09	6
		31-07	1.5
		31-07	3
		33-07	1.5
		33-07	3
		33-07	4.5
		33-07	6
		33-07	7.5
		34-06	1.5
		34-06	3
		34-06	5
2. Laboratory Testing			
a) **Index Tests:**			
i) Grain Size	RS/NS	none	-
ii) Atterberg Limits	RS	31-07	4.3-4.6
		31-07	1.5-2.0
		31-07	3.4-3.7

TABLE 2.5

PHYSICAL PROPERTIES TESTING PROGRAM
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

	Media	*Sample/Test Location*	*Sample/Test Depth (ft below mudline)*
iii) Water Content	RS/NS	31-07	1.0-1.5
		33-07	1.2-1.5
		33-07	1.75-1.9
		33-07	4.6-5.0
		33-07	5.0-5.2
		33-07	2.8-3.3
		33-07	3.3-3.6
		31-07	4.3-4.6
		34-06	4.7-4.9
		34-06	5.1-5.5
		34-06	0.9-1.4
		34-06	1.6-2.0
		33-07	2.2-2.4
		33-07	5.4-5.9
		29-09	0.6-0.7
		31-07	0.9-1.4
		29-09	1.5-2.0
		31-07	2.5-3.0
		31-07	3.2-3.4
		31-07	3.4-3.7
		31-07	5.1-5.6
		29-09	5.2-5.4
		29-09	5.5-5.8
		31-07	6.5-7.0
		31-07	7.15-7.3
		30-06	composite (2)
		34-07	composite (2)
iv) Specific Gravity	RS	31-07	0.6-0.7
		31-07	6.5-7.0
v) In Situ Unit Weight	RS	33-07	1.2-1.5
		33-07	4.6-5.0
		33-07	2.8-3.3
		34-06	5.1-5.5
		34-06	0.9-1.4
		33-07	2.2-2.4
		33-07	5.4-5.9
		29-09	0.9-1.4
		31-07	2.5-3.0
		31-07	5.1-5.6
		29-09	5.5-5.8
		31-07	6.5-7.0
		31-07	7.15-7.3
		30-06	composite (2)
		34-07	composite (2)

TABLE 2.5

PHYSICAL PROPERTIES TESTING PROGRAM
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

	Media	*Sample/Test Location*	*Sample/Test Depth (ft below mudline)*
vi) Total Organic Carbon	RS/NS	29-09	0.8-0.9
		31-07	2.4-2.5
		31-07	5.6-5.7
		31-07	6.4-6.5
		30-06	0-2
		30-06	2-4
		30-06	4-6
		30-06	6-8
		34-07	0-2
		34-07	2-4
		34-07	4-6
		34-07	6-8
		34-07	8-10
		34-07	10-12
b) **Engineering Test:**			
vii) Hydraulic Conductivity	RS	33-07	1.2-1.5
		33-07	4.6-5.0
		33-07	2.8-3.3
		34-06	5.1-5.5
		34-06	0.9-1.4
		29-09	0.9-1.4
		31-07	2.5-3.0
		31-07	5.1-5.6
		31-07	7.15-7.3
viii) Consolidation Test	RS	29-09	1.6-1.7
		31-07	1.0-1.5
		31-07	1.5-2.0
		31-07	3.2-3.3
		31-07	4.3-4.6
		33-07	1.75-1.9
		33-07	3.3-3.6
		33-07	5.0-5.2
		34-06	4.7-4.9
ix) Reconsolidation Test	RS	30-06	composite (2)
		34-07	composite (2)
c) **Dredging Tests:**			
x) Dredging Elutriate Test (DRET)	RS	30.5-07/32.5-08	composite (2)
		28.5-08/34.5-08	composite (2)
xi) Column Settling Test and Modified Elutriate Test	RS	30-06/34-07	composite (2)

Notes:

(1) Vane depths are for vane tip

(2) Mixture of sediment from all depths from the mudline to the native sediment

NS Native Sediment

RS Recent Sediment

TABLE 2.6

MARINE WATER QUALITY CRITERIA AND SEDIMENT QUALITY OBJECTIVES FOR DETECTED COMPOUNDS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Compounds Detected	*Sediment Quality Objective (mg/kg)*	*Marine WQC*		*References*
		Acute (mg/L)	*Chronic (mg/L)*	
Volatile Organic Compounds				
Trichloroethene	NV	2.0	NV	(3)
Tetrachloroethene	0.057	10.2	0.45	(3)
1,1-Dichloroethene	NV	224	NV	(3)
cis-1,2-Dichloroethene	NV	224	NV	(3)
Ethylbenzene	0.010	0.43	NV	(3)
m,p-Xylene	0.040	NV	NV	
trans-1,2-Dichloroethene	NV	224	NV	(3)
Vinyl chloride	NV	NV	NV	
Semi-Volatile Organic Compounds				
Hexachlorobenzene	0.022	0.16	0.129	(3)
Hexachlorobutadiene	0.011	0.032	NV	(3)
Acenaphthene	0.50	0.97	0.71	(3)
Chrysene	2.8	0.3	NV	(3)
Fluoranthene	2.50	0.04	0.016	(3)
Naphthalene	2.1	2.35	NV	(3)
Phenanthrene	1.5	0.0077	0.0046	(3)
Pyrene	3.3	0.3	NV	(3)
1,2,4-Trichlorobenzene	0.051	0.16	0.129	(3)
1,4-Dichlorobenzene	0.11	1.97	NV	(3)
2,4-Dimethylphenol	0.029	NV	NV	
2-Methylnaphthalene	0.67	2.35	NV	(3)
2-Methylphenol	0.063	NV	NV	
4-Methylphenol	0.063	NV	NV	
Acenaphthylene	1.3	NV	NV	
Anthracene	0.96	NV	NV	
benzo(a)Anthracene	1.6	0.3	NV	(3)
benzo(a)Pyrene	1.6	0.3	NV	(3)
benzo(b)Fluoranthene	3.6	0.3	NV	(3)
benzo(g,h,i)Perylene	0.72	NV	NV	
benzo(k)Fluoranthene	3.6	0.3	NV	(3)
bis(2-Ethylhexyl) phthalate	1.3	NV	NV	
Carbazole	NV	NV	NV	
dibenz(a,h)Anthracene	0.23	0.3	NV	(3)
Dibenzofuran	0.54	NV	NV	
Fluorene	0.54	0.3	NV	(3)
indeno(1,2,3-cd)Pyrene	0.69	0.3	NV	(3)
Pentachlorophenol	0.36	0.013	0.0079	(1) (2)
Phenol	0.42	5.8	NV	(3)
PCBs				
Aroclor 1254	0.15	0.010	0.00003	(1) (2)
Aroclor 1260		0.010	0.00003	(1) (2)

TABLE 2.6

MARINE WATER QUALITY CRITERIA AND SEDIMENT QUALITY OBJECTIVES FOR DETECTED COMPOUNDS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Compounds Detected	*Sediment Quality Objective (mg/kg)*	*Marine WQC*		*References*
		Acute (mg/L)	*Chronic (mg/L)*	
Tentatively Identified Compounds				
Dichlorobutadiene	NV	NV	NV	
Trichlorobutadiene	NV	NV	NV	
Tetrachlorobutadiene	NV	NV	NV	
Pentachlorobutadiene	NV	NV	NV	
Metals				
Aluminum	NV	NV	NV	
Arsenic	57	0.069	0.036	(1) (2)
Barium	NV	NV	NV	
Beryllium	NV	0.0053	NV	(3)
Cadmium	5.1	0.042	0.0093	(1) (2)
Calcium	NV	NV	NV	
Chromium (Hex)	NV	1.1	0.05	(1) (2)
Cobalt	NV	NV	NV	
Copper	390	0.0048	0.0031	(1) (2)
Iron	NV	1.0	NV	
Lead	450	0.21	0.0081	(1) (2)
Magnesium	NV	NV	NV	
Manganese	NV	NV	NV	
Mercury	0.59	0.0018	0.00094/0.000025	(1) (2)
Nickel	<140	0.074	0.0082	(1) (2)
Potassium	NV	NV	NV	
Selenium	NV	0.29	0.071	(1) (2)
Silver	6.1	0.0019	NV	(1) (2)
Sodium	NV	NV	NV	
Thallium	NV	2.13	NV	(3)
Vanadium	NV	NV	NV	
Zinc	410	0.090	0.081	(1) (2)

Notes:

(1) Marine Water Quality Criteria as referenced from "National Recommended Water Quality Criteria", EPA 822-Z-99-001, Corrected April 1999.

(2) Marine Water Quality Criteria as referenced from Water Quality Standards for Surface Waters of the State of Washington. Chapter 173-201A WAC, last updated 11/18/97.

(3) Various references. Marine Water Quality Criteria is based on the Lowest Observed Effect Level (LOEL).

NV No Value.

PCBs Polychlorinated Biphenyls.

WQC Water Quality Criteria.

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			25.5-08-A1	25.5-08-A2	25.75-08-A	25.75-08-A	25.75-08-A	26-06-A1	26-06-A2
Feet Above Native:			5.0 to 6.8	0 to 5.0	0 to 5.2	0 to 5.2	0 to 5.2	5.0 to 9.1	0 to 5.0
Feet Below Mudline:			0 to 1.8	1.8 to 6.8	0 to 5.2	0 to 5.2	0 to 5.2	0 to 4.1	4.1 to 9.1
Sample Id:			PW-030398-STI-010	PW-030398-STI-011	PW-030498-STI-002	PW-031098-STI-012	PW-031098-STI-016	PW-030398-STI-007	PW-030298-STI-004
Sample Date:			03/02/1998	03/02/1998	03/03/1998	03/03/1998	03/03/1998	03/01/1998	03/01/1998
							Dupl.		
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	ND 5.0	ND 5.0	--	--	ND 5.0	ND 5.0
Tetrachloroethene	ug/l	450	ND 5.0	ND 5.0	ND 5.0	--	--	ND 5.0	ND 5.0
Trichloroethene	ug/l	2000	ND 5.0	ND 5.0	ND 5.0	--	--	ND 5.0	ND 5.0
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	ND 25	ND 25	--	--	ND 25	ND 25
Hexachlorobutadiene	ug/l	32	--	--	--	R	R	R	R

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			26-06-A2	26-07-B1	26-07-B1	26-07-B1	26-07-B2	26-07-B2	26-07-B2
Feet Above Native:			0 to 5.0	5.0 to 6.4	5.0 to 6.4	5.0 to 6.4	0 to 5.0	0 to 5.0	0 to 5.0
Feet Below Mudline:			4.1 to 9.1	1.7 to 3.1	1.7 to 3.1	1.7 to 3.1	3.1 to 8.1	3.1 to 8.1	3.1 to 8.1
Sample Id:			PW-030398-STI-008	PW-030398-STI-001	PW-030998-STI-008	PW-030998-STI-009	PW-030398-STI-002	PW-031098-STI-001	PW-030398-STI-012
Sample Date:			03/01/1998	03/02/1998	03/02/1998	03/02/1998	03/02/1998	03/02/1998	03/02/1998
			Dupl.			Dupl.			Dupl.
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	ND 9.0	--	--	ND 9.0	--	ND 9.0
Tetrachloroethene	ug/l	450	ND 5.0	ND 9.0	--	--	ND 9.0	--	ND 9.0
Trichloroethene	ug/l	2000	ND 5.0	ND 9.0	--	--	34	--	32
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	ND 45	--	--	ND 45	--	ND 45
Hexachlorobutadiene	ug/l	32	--	--	R	R	--	0.26 J	--

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			26-08-B	26-09-B	26-09-B	26-10-A	26-10-A	26.5-05-A1	26.5-05-A1
Feet Above Native:			0 to 4.2	0 to 5.6	0 to 5.6	0 to 2.6	0 to 2.6	3.5 to 4.9	3.5 to 4.9
Feet Below Mudline:			0.8 to 5.0	0.8 to 6.4	0.8 to 6.4	0 to 2.6	0 to 2.6	0 to 1.4	0 to 1.4
Sample Id:			PW-030298-STI-005	PW-030398-STI-004	PW-031098-STI-002	PW-030398-STI-009	PW-031098-STI-007	PW-031198-STI-006	PW-031798-STI-006
Sample Date:			03/01/1998	03/02/1998	03/02/1998	03/02/1998	03/02/1998	03/10/1998	03/10/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	ND 5.0	--	ND 5.0	--	ND 5.0	--
Tetrachloroethene	ug/l	450	ND 5.0	ND 5.0	--	ND 5.0	--	ND 5.0	--
Trichloroethene	ug/l	2000	ND 5.0	ND 5.0	--	ND 5.0	--	ND 5.0	--
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	ND 25	--	ND 25	--	ND 25	--
Hexachlorobutadiene	ug/l	32	R	--	R	--	R	--	R

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			26.5-05-A2	26.5-05-A2	26.5-06-B1	26.5-06-B1	26.5-06-B2	26.5-08-B	26.5-08-B
Feet Above Native:			0 to 3.5	0 to 3.5	5.0 to 7.6	5.0 to 7.6	0 to 5.0	0 to 4.1	0 to 4.1
Feet Below Mudline:			1.4 to 4.9	1.4 to 4.9	2.6 to 5.2	2.6 to 5.2	5.2 to 10.2	0.9 to 5.0	0.9 to 5.0'
Sample Id:			PW-031198-STI-007	PW-031798-STI-007	PW-030698-STI-008	PW-031298-STI-001	PW-030298-STI-006	PW-030398-STI-005	PW-031098-STI-003
Sample Date:			03/10/1998	03/10/1998	03/01/1998	03/01/1998	03/01/1998	03/02/1998	03/02/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	--	7.8	--	ND 5.0	ND 5.0	--
Tetrachloroethene	ug/l	450	ND 5.0	--	ND 5.0	--	ND 5.0	ND 5.0	--
Trichloroethene	ug/l	2000	ND 5.0	--	ND 5.0	--	ND 5.0	ND 5.0	--
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	--	ND 25	--	ND 25	ND 25	--
Hexachlorobutadiene	ug/l	32	--	R	--	5.6 J	R	--	R

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			26.5-10-B	26.5-10-B	26.5-11-A	26.5-11-A	26.75-08-B	27-05-A	27-05-A
Feet Above Native:			0 to 3.9	0 to 3.9	0 to 2.6	0 to 2.6	0 to 5.0	0 to 2.5	0 to 2.5
Feet Below Mudline:			2.2 to 6.1	2.2 to 6.1	0 to 2.6	0 to 2.6	1.1 to 6.1	0 to 2.5	0 to 2.5
Sample Id:			PW-030398-STI-006	PW-031098-STI-004	PW-030498-STI-001	PW-031098-STI-011	PW-030298-STI-007	PW-031198-STI-001	PW-031798-STI-001
Sample Date:			03/02/1998	03/02/1998	03/03/1998	03/03/1998	03/01/1998	03/09/1998	03/09/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	--	ND 5.0	--	ND 5.0	ND 5.0	--
Tetrachloroethene	ug/l	450	ND 5.0	--	ND 5.0	--	ND 5.0	ND 5.0	--
Trichloroethene	ug/l	2000	ND 5.0	--	ND 5.0	--	ND 5.0	ND 5.0	--
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	--	ND 25	--	ND 25	ND 25	--
Hexachlorobutadiene	ug/l	32	--	8.2 J	--	R	0.34 J	--	R

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			27-05-A	27-06R-B1	27-06R-B1	27-06R-B2	27-07-A1	27-07-A2	27-08-A1
Feet Above Native:			0 to 2.5	5.0 to 9.0	5.0 to 9.0	0 to 5.0	0 to 5.0	5.0 to 6.8	0 to 5.0
Feet Below Mudline:			0 to 2.5	2.5 to 6.5	2.5 to 6.5	6.5 to 11.5	0 to 1.8	1.8 to 6.8	2.0 to 7.0
Sample Id:			PW-031198-STI-009	PW-030698-STI-009	PW-031298-STI-002	PW-030298-STI-008	PW-021998-STI-001	PW-021998-STI-002	PW-021998-STI-003
Sample Date:			03/09/1998	03/01/1998	03/01/1998	03/01/1998	02/18/1998	02/18/1998	02/18/1998
			Dupl.						
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	ND 5.0	--	ND 5.0	ND 5.0	ND 5.0	5.3
Tetrachloroethene	ug/l	450	ND 5.0	ND 5.0	--	34	ND 5.0	ND 5.0	4.6 J
Trichloroethene	ug/l	2000	ND 5.0	ND 5.0	--	ND 5.0	ND 5.0	ND 5.0	11
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	ND 25	--	ND 25	ND 25	ND 25	17 J
Hexachlorobutadiene	ug/l	32	--	--	R	R	R	R	7.6 J

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			27-08-A2	27-08-C1	27-09-A	27-10-A1	27-10-A1	27-10-A2	27-11-A
Feet Above Native:			5.0 to 7.0	0 to -0.5	0 to 5.0	--	--	--	0 to 2.8
Feet Below Mudline:			0 to 2.0	7.0 to 7.5	0 to 5.0	--	--	--	0 to 2.8
Sample Id:			PW-021998-STI-004	PW-021998-STI-008	PW-022698-STI-001	PW-022398-STI-001	PW-022398-STI-002	PW-022398-STI-003	PW-022098-STI-013
Sample Date:			02/18/1998	02/18/1998	02/25/1998	02/20/1998	02/20/1998	02/20/1998	02/19/1998
							Dupl.		
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	ND 1.0	ND 5.0	ND 1.0	ND 1.0	ND 5.0	ND 1.0
Tetrachloroethene	ug/l	450	ND 5.0	ND 1.0	ND 5.0	ND 1.0	ND 1.0	ND 5.0	ND 1.0
Trichloroethene	ug/l	2000	ND 5.0	ND 1.0	ND 5.0	ND 1.0	ND 1.0	ND 5.0	ND 1.0
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	ND 5.0	ND 25	ND 5.0	ND 5.0	ND 25	ND 5.0
Hexachlorobutadiene	ug/l	32	0.32 J	--	R	R	R	R	R

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			27-12-A	27-13-A	27.5-08-A	27.5-08-B1	27.5-08-B1	27.5-08-B2	28-05-B
Feet Above Native:			0 to 1.2	0 to 1.2	5.6 to 6.4	5.0 to 5.6	5.0 to 5.6	0 to 5.0	--
Feet Below Mudline:			0 to 1.2	0 to 1.2	0 to 0.8	0.8 to 1.4	0.8 to 1.4	1.4 to 6.4	0.4 to 5.6
Sample Id:			PW-022098-STI-009	PW-021998-STI-005	PW-030698-STI-010	PW-030698-STI-011	PW-031298-STI-004	PW-030298-STI-009	PW-031198-STI-002
Sample Date:			02/19/1998	02/18/1998	03/01/1998	03/01/1998	03/01/1998	03/01/1998	03/09/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 1.0	ND 9.0	ND 5.0	ND 5.0	--	6.1	11
Tetrachloroethene	ug/l	450	ND 1.0	ND 9.0	ND 5.0	ND 5.0	--	170	11
Trichloroethene	ug/l	2000	ND 1.0	ND 9.0	ND 5.0	ND 5.0	--	43	13
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 5.0	ND 45	ND 25	ND 25	--	ND 25	ND 50
Hexachlorobutadiene	ug/l	32	R	R	R	--	R	40 J	--

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			28-05-B	28-05-B2	28-06-A	28-06-A	28-06-B1	28-06-B1	28-06-B2
Feet Above Native:			--	0 to 3.5	0 to 1.7	0 to 1.7	5.0 to 10.3	5.0 to 10.3	0 to 5.0
Feet Below Mudline:			0.4 to 5.6	4.2 to 7.7	10.3 to 12.0	10.3 to 12.0	1.7 to 7.0	1.7 to 7.0	7.0 to 12.0
Sample Id:			PW-031798-STI-003	PW-040298-STI-002	PW-030698-STI-013	PW-031298-STI-005	PW-030698-STI-012	PW-031298-STI-007	PW-030298-STI-010
Sample Date:			03/09/1998	03/31/1998	03/01/1998	03/01/1998	03/01/1998	03/01/1998	03/01/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	--	24	ND 5.0	--	ND 5.0	--	ND 5.0
Tetrachloroethene	ug/l	450	--	ND 10	ND 5.0	--	130	--	140
Trichloroethene	ug/l	2000	--	ND 10	ND 5.0	--	22	--	330
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	--	ND 50	ND 25	--	44	--	ND 25
Hexachlorobutadiene	ug/l	32	0.66 J	--	--	R	--	49 J	59 J

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			28-07-B1	28-07-B2	28-10-A	28-10-A	28-10-B	28-11-A	28-12-A
Feet Above Native:			--	--	2.1 to 4.8	2.1 to 4.8	0 to 2.1	0 to 3.5	0 to 1.2
Feet Below Mudline:			6.7 to 10.0	1.6 to 6.7	0 to 2.7	0 to 2.7	2.7 to 4.8	0 to 3.5	0 to 1.2
Sample Id:			PW-022098-STI-010	PW-022098-STI-011	PW-022398-STI-005	PW-022398-STI-008	PW-022398-STI-009	PW-022398-STI-006	PW-022498-STI-001
Sample Date:			02/19/1998	02/19/1998	02/22/1998	02/22/1998	02/22/1998	02/22/1998	02/20/1998
						Dupl.			
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	6.0	ND 5.0	5.3	8.8	ND 5.0	ND 5.0
Tetrachloroethene	ug/l	450	140	10000	ND 5.0	ND 5.0	90	ND 5.0	ND 5.0
Trichloroethene	ug/l	2000	64	9800	ND 5.0	ND 5.0	18	ND 5.0	ND 5.0
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	33	31	ND 25	ND 25	33	ND 25	ND 25
Hexachlorobutadiene	ug/l	32	--	--	R	--	34 J	R	R

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			28-13-A	29-04-B	29-05-A	29-05-A	29-05-B1	29-05-B1	29-05-B2
Feet Above Native:			0 to 0.7	0 to 4.7	--	--	--	--	--
Feet Below Mudline:			0 to 0.7	0 to 4.7	0 to 1.0	0 to 1.0	1.0 to 4.8	1.0 to 4.8	4.8 to 9.0
Sample Id:			PW-022098-STI-012	PW-040298-STI-001	PW-031898-STI-001	PW-032098-STI-002	PW-031198-STI-003	PW-031798-STI-004	PW-031198-STI-004
Sample Date:			02/19/1998	03/31/1998	03/09/1998	03/09/1998	03/09/1998	03/09/1998	03/09/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 1.0	ND 50	ND 5.0	--	ND 75	--	ND 45
Tetrachloroethene	ug/l	450	54	ND 50	ND 5.0	--	ND 75	--	ND 45
Trichloroethene	ug/l	2000	16	170	ND 5.0	--	ND 75	--	ND 45
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 5.0	ND 250	ND 25	--	ND 370	--	ND 230
Hexachlorobutadiene	ug/l	32	--	--	--	R	--	45 J	--

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			29-05-B2	29-06-B	29-07-B1	29-07-B2	29-11-A	29-12-AB	29-13-A
Feet Above Native:			--	0 to 5.0	--	--	0 to 3.3	0 to 2.1	0 to 1.8
Feet Below Mudline:			4.8 to 9.0	1.9 to 6.9	0.7 to 5.7	5.7 to 8.6	0 to 3.3	0 to 2.1	0 to 1.8
Sample Id:			PW-031798-STI-005	PW-022098-STI-014	PW-022698-STI-002	PW-022698-STI-003	PW-022398-STI-007	PW-022598-STI-002	PW-022698-STI-004
Sample Date:			03/09/1998	02/19/1998	02/25/1998	02/25/1998	02/22/1998	02/24/1998	02/25/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	--	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 10	ND 5.0
Tetrachloroethene	ug/l	450	--	340	550	200	940	1500	ND 5.0
Trichloroethene	ug/l	2000	--	510	2800	380	1200	260	6.4
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	--	ND 25	39	ND 25	ND 25	51	ND 25
Hexachlorobutadiene	ug/l	32	R	96 J	--	--	--	--	R

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			30-04-A	30-05-AB1	30-05-AB2	30-05-AB2	30-06-B	30-06-B	30-08-A
Feet Above Native:			0 to 3.2	5.0 to 6.6	0 to 5.0	0 to 5.0	0 to 5.0	0 to 5.0	3.8 to 5.6
Feet Below Mudline:			0 to 3.2	0 to 1.6	1.6 to 6.6	1.6 to 6.6	1.8 to 6.8	1.8 to 6.8	0 to 1.8
Sample Id:			PW-022698-STI-005	PW-022798-STI-002	PW-022798-STI-003	PW-030398-STI-014	PW-030598-STI-004	PW-030598-STI-006	PW-022498-STI-003
Sample Date:			02/25/1998	02/26/1998	02/26/1998	02/26/1998	03/03/1998	03/03/1998	02/22/1998
						Dupl.		Dupl.	
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	ND 30	ND 5.0	--	750	770	ND 5.0
Tetrachloroethene	ug/l	450	ND 5.0	190	ND 5.0	--	21000	19000	54
Trichloroethene	ug/l	2000	10	99	ND 5.0	--	35000	34000	90
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	ND 150	ND 25	--	54	62	ND 25
Hexachlorobutadiene	ug/l	32	--	1.3 J	R	R	--	--	--

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			30-09-B	30-10-AC	30-10-AC	31-03-B	31-04-B	31-07-A	31-09-A
Feet Above Native:			0 to 2.0	0 to -2.0	0 to -2.0	--	--	2.9 to 6.2	0 to 2.3
Feet Below Mudline:			0 to 2.0	0 to 2.0	0 to 2.0	0 to 4.0	--	0 to 3.3	0 to 2.3
Sample Id:			PW-022398-STI-010	PW-022798-STI-001	SE-022498-ILM-052	PW-022698-STI-006	PW-032698-STI-001	PW-022098-STI-015	PW-022398-STI-011
Sample Date:			02/22/1998	02/24/1998	02/24/1998	02/25/1998	03/24/1998	02/19/1998	02/22/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	ND 5.0	--	ND 5.0	9.6	ND 5.0	ND 5.0
Tetrachloroethene	ug/l	450	33000	ND 5.0	--	ND 5.0	11000	8600	900
Trichloroethene	ug/l	2000	76000	ND 5.0	--	ND 5.0	10000	9100	1500
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	33 J	ND 25	--	ND 25	110	ND 25	61
Hexachlorobutadiene	ug/l	32	R	--	ND 5.0	--	--	--	--

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			31-10-A	31-11-A	32-03-B	32-05-B	32-08-B	32-09-A	32-09-A
Feet Above Native:			0 to 1.8	0 to 0.7	--	--	0 to 2.9	0 to 1.6	0 to 1.6
Feet Below Mudline:			0 to 1.8	0 to 0.7	0 to 2.8	0 to 3.7	1.5 to 4.4	0 to 1.6	0 to 1.6
Sample Id:			PW-022398-STI-012	PW-022598-STI-003	PW-022698-STI-007	PW-030498-STI-003	PW-030598-STI-001	PW-030598-STI-003	PW-031898-STI-002
Sample Date:			02/22/1998	02/24/1998	02/25/1998	03/03/1998	03/04/1998	03/04/1998	03/04/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	--
Tetrachloroethene	ug/l	450	350	ND 5.0	910	2300	23000	34	--
Trichloroethene	ug/l	2000	130	ND 5.0	250	5100	39000	32	--
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	ND 25	ND 25	160	32	ND 25	--
Hexachlorobutadiene	ug/l	32	0.61 J	R	--	--	--	--	R

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			32-10-A	32-11-A	32-12-A	32-12-A	33-06R-A	33-06R-AB	33-08-B
Feet Above Native:			0 to 2.0	0 to 1.2	0 to 0.8	0 to 0.8	0 to 1.8	1.8 to 5.8	0 to 1.9
Feet Below Mudline:			0 to 2.0	0 to 1.2	0 to 0.8	0 to 0.8	4.0 to 5.8	0 to 4.0	1.3 to 3.2
Sample Id:			PW-022498-STI-002	PW-022598-STI-004	PW-030998-STI-003	PW-031398-STI-001	PW-032098-STI-001	PW-032398-STI-001	PW-022498-STI-008
Sample Date:			02/22/1998	02/24/1998	03/03/1998	03/03/1998	03/18/1998	03/18/1998	02/23/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	ND 5.0	ND 5.0	--	ND 45	ND 45	ND 50
Tetrachloroethene	ug/l	450	310	170	ND 5.0	--	200	60 J	11000
Trichloroethene	ug/l	2000	170	62	ND 5.0	--	1600	900 J	130000
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	27	ND 25	--	ND 230	ND 230	270
Hexachlorobutadiene	ug/l	32	42 J	--	--	R	--	--	--

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			33-09-A	33-10-A	33-11-A	33-12-AB	33-13-AB	33-13-AB	33-14-AB
Feet Above Native:			0 to 1.8	0 to 2.0	0 to 3.3	0 to 1.2	0 to 1.6	0 to 1.6	0 to 1.1
Feet Below Mudline:			0 to 1.8	0 to 2.0	0 to 3.3	0 to 1.2	0 to 1.6	0 to 1.6	0 to 1.1
Sample Id:			PW-022498-STI-007	PW-022498-STI-004	PW-022598-STI-005	PW-022798-STI-005	PW-030498-STI-004	PW-031098-STI-014	PW-030498-STI-005
Sample Date:			02/23/1998	02/23/1998	02/24/1998	02/26/1998	03/03/1998	03/03/1998	03/03/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 10	ND 10	ND 5.0	ND 5.0	ND 5.0	--	ND 5.0
Tetrachloroethene	ug/l	450	ND 10	ND 10	6.7	ND 5.0	ND 5.0	--	ND 5.0
Trichloroethene	ug/l	2000	ND 10	ND 10	12	6.6	6.8	--	ND 5.0
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	660	ND 50	ND 25	58	88	--	ND 25
Hexachlorobutadiene	ug/l	32	9.8 J	0.67 J	26 J	18 J	--	11 J	--

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			33-14-AB	33-15-A	33-15-A	34-04-B1	34-04-B1	34-05-B3	34-06-B1
Feet Above Native:			0 to 1.1	0 to 3.8	0 to 3.8	7.3 to 10.3	7.3 to 10.3	--	10.4 to 11.9
Feet Below Mudline:			0 to 1.1	0 to 3.8	0 to 3.8	0 to 3.0	0 to 3.0	5.9 to 7.9	0 to 1.5
Sample Id:			PW-031098-STI-015	PW-030598-STI-002	PW-031798-STI-008	PW-033198-STI-002	PW-033198-STI-003	PW-031198-STI-005	PW-030698-STI-005
Sample Date:			03/03/1998	03/04/1998	03/04/1998	03/30/1998	03/30/1998	03/06/1998	03/05/1998
							Dupl.		
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	--	ND 5.0	--	ND 500	ND 500	ND 75	ND 5.0
Tetrachloroethene	ug/l	450	--	17 J	--	100000 J	100000 J	5100	100
Trichloroethene	ug/l	2000	--	14 J	--	30000	30000	1100	120
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	--	ND 25	--	ND 2500	ND 2500	ND 370	ND 25
Hexachlorobutadiene	ug/l	32	0.65 J	--	R	--	--	--	--

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			34-06-B2	34-06-B3	34-10-B	34-11-A	35-04-A	35-05-A	35-05-B
Feet Above Native:			5.4 to 10.4	0 to 5.4	0 to 5.0	0 to 1.9	1.6 to 6.8	3.0 to 7.3	0 to 3.0
Feet Below Mudline:			1.5 to 6.5	6.5 to 11.9	2.4 to 7.4	0 to 1.9	0 to 5.2	0 to 4.3	4.3 to 7.3
Sample Id:			PW-030698-STI-006	PW-030698-STI-007	PW-022498-STI-010	PW-022498-STI-005	PW-033198-STI-001	PW-031398-STI-002	PW-031398-STI-003
Sample Date:			03/05/1998	03/05/1998	02/23/1998	02/23/1998	03/30/1998	03/06/1998	03/06/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 10	ND 50	ND 10	ND 5.0	12 J	ND 5.0	ND 9.0
Tetrachloroethene	ug/l	450	4500	69	15000	ND 5.0	1200 J	44 J	1600 J
Trichloroethene	ug/l	2000	3300	8500	15000	35	140	14	170
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 50	ND 250	72	ND 25	ND 45	ND 25	ND 45
Hexachlorobutadiene	ug/l	32	--	--	--	R	--	--	--

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			35-06-B1	35-06-B2	35-06-B3	35-09-A	35-09-B	35-10-A2	35-11-A
Feet Above Native:			--	--	--	0 to 1.8	1.8 to 5.6	0 to 3.9	0 to 2.1
Feet Below Mudline:			0 to 1.6	1.6 to 6.6	6.6 to 11.6	3.8 to 5.6	0 to 3.8	1.9 to 5.8	0 to 2.1
Sample Id:			PW-030998-STI-004	PW-030998-STI-005	PW-030998-STI-006	PW-022498-STI-006	PW-022598-STI-007	PW-022598-STI-006	PW-030298-STI-003
Sample Date:			03/04/1998	03/04/1998	03/04/1998	02/23/1998	02/23/1998	02/24/1998	02/26/1998
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	6.9	ND 5.0	6.8	ND 5	ND 150	ND 10	ND 5.0
Tetrachloroethene	ug/l	450	410	640	600	300	12000	770	ND 5.0
Trichloroethene	ug/l	2000	140	200	200	1000	21000	14000	85
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	ND 25	ND 25	ND 25	ND 750	ND 50	ND 25
Hexachlorobutadiene	ug/l	32	--	--	--	--	--	--	R

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			35-11-A	35.5-07-B1	35.5-07-B2	35.5-09-A	35.5-09-B	36-06-A1	36-06-A1
Feet Above Native:			0 to 2.1	3.3 to 6.8	0 to 3.3	1.8 to 5.0	0 to 1.8	--	--
Feet Below Mudline:			0 to 2.1	2.2 to 5.7	5.7 to 9.0	0 to 3.2	3.2 to 5.0	3.2 to 5.8	3.2 to 5.8
Sample Id:			PW-030798-STI-001	PW-032698-STI-002	PW-032698-STI-003	PW-033098-STI-001	PW-033098-STI-003	PW-022698-STI-008	PW-022698-STI-009
Sample Date:			02/26/1998	03/25/1998	03/25/1998	03/26/1998	03/26/1998	02/24/1998	02/24/1998
			Dupl.						Dupl.
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	--	6.9	5.2	ND 90	ND 300	ND 5.0	ND 5.0
Tetrachloroethene	ug/l	450	--	12000	8300	330	7800	ND 22	ND 21
Trichloroethene	ug/l	2000	--	3900	11000	9800	55000	34	34
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	--	ND 25	ND 25	ND 450	ND 1500	ND 25	ND 25
Hexachlorobutadiene	ug/l	32	R	--	--	--	--	R	--

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			36-06-A2	36-07-A	36-07-A	36-07-B	36-07-B	36-08-A1	36-08-A2
Feet Above Native:			--	--	--	--	--	0 to 5.0	5.0 to 6.6
Feet Below Mudline:			5.8 to 8.0	0 to 3.6	0 to 3.6	3.6 to 9.5	3.6 to 9.5	0 to 1.6	1.6 to 6.6
Sample Id:			PW-022598-STI-009	PW-030698-STI-014	PW-031298-STI-006	PW-030298-STI-001	PW-030298-STI-002	PW-022598-STI-008	PW-030998-STI-007
Sample Date:			02/24/1998	02/23/1998	02/23/1998	02/23/1998	02/23/1998	02/24/1998	02/24/1998
							Dupl.		
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	ND 5.0	--	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Tetrachloroethene	ug/l	450	32	14	--	30	31	160	8.4
Trichloroethene	ug/l	2000	29	24	--	19	20	160	5.5
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	ND 25	--	ND 25	ND 25	ND 25	ND 25
Hexachlorobutadiene	ug/l	32	0.28 J	--	R	0.58 J	--	0.58 J	R

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			36-09-A1	36-09-A2	36.5-07R-A	36.5-07R-B1	36.5-07R-B1	36.5-07R-B1	36.5-07R-B2
Feet Above Native:			1.0 to 6.0	0 to 5.0	6.0 to 6.4	6.4 to 9.1	6.4 to 9.1	6.4 to 9.1	5.0 to 6.0
Feet Below Mudline:			5.0 to 6.0	0 to 1.0	2.7 to 3.1	0 to 2.7	0 to 2.7	0 to 2.7	3.1 to 4.1
Sample Id:			PW-022598-STI-010	PW-022598-STI-011	PW-031398-STI-004	PW-030698-STI-004	PW-031798-STI-009	PW-031798-STI-012	PW-030698-STI-001
Sample Date:			02/24/1998	02/24/1998	03/05/1998	03/05/1998	03/05/1998	03/05/1998	03/05/1998
								Dupl.	
Parameters	Units	MWQ							
Volatile Organics									
Ethylbenzene	ug/l	430	ND 5.0	ND 5.0	ND 5.0	ND 5.0	--	--	ND 5.0
Tetrachloroethene	ug/l	450	ND 5.0	30	14	11	--	--	12
Trichloroethene	ug/l	2000	110	110	6.1	9.8	--	--	8.4
Semi-Volatiles									
Hexachlorobutadiene (EST)	ug/l	32	ND 25	ND 25	ND 25	ND 25	--	--	ND 25
Hexachlorobutadiene	ug/l	32	0.32 J	5.5 J	--	--	R	R	--

TABLE 3.1

AREA 5106 SEDIMENT HORIZONTAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			36.5-07R-B2	36.5-07R-B3	36.5-07R-B3
Feet Above Native:			5.0 to 6.0	0 to 5.0	0 to 5.0
Feet Below Mudline:			3.1 to 4.1	4.1 to 9.1	4.1 to 9.1
Sample Id:			PW-031798-STI-010	PW-030698-STI-002	PW-031798-STI-011
Sample Date:			03/05/1998	03/05/1998	03/05/1998
Parameters	Units	MWQ			
Volatile Organics					
Ethylbenzene	ug/l	430	--	ND 5.0	--
Tetrachloroethene	ug/l	450	--	82	--
Trichloroethene	ug/l	2000	--	17	--
Semi-Volatiles					
Hexachlorobutadiene (EST)	ug/l	32	--	ND 25	--
Hexachlorobutadiene	ug/l	32	R	--	1.3 J

Notes:

(1) *Sample location ID xx-yy-za defined as follows:*
xx - north-south grid location (see Figure 3.1)
yy - east-west grid location (see Figure 3.1)
z - material designation (for sampling purposes only) where:
A = recent sediment, sand, or gravel
B = visual 5106-like material or anthropogenic fill material
C = native sediment
a - sample number within material designation

J Estimated.
R Rejected.
NDx Non-detect at or above x.

TABLE 3.2

AREA 5106 SEDIMENT VERTICAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		25.75-08-C1	26-06-C1	26-08-C1	26-10-C	26.5-05-C1	26.5-11-C	27-05-C	27-07-C
Feet Above Native:		0 to -2.0	0 to -2.0	0 to -2.0	0 to -0.6	0 to -2.0	0 to -2.0	0 to -1.1	0 to -2.0
Feet Below Mudline:		5.2 to 7.2	9.1 to 11.1	5.0 to 7.0	2.6 to 3.2	4.9 to 6.9	2.6 to 4.6	2.5 to 3.6	6.8 to 10.1
Sample ID:		SE-030398-ST1-032	SE-030198-ILM-028	SE-030198-ILM-027	SE-030298-ILM-029	SE-031098-ASF-055	SE-030398-ST1-031	SE-030998-ILM-053	SE-021898-ILM-003
Sample Date:		03/03/1998	03/01/1998	03/01/1998	03/02/1998	03/10/1998	03/03/1998	03/09/1998	02/18/1998
Parameters	Units								
Volatile Organics									
Ethylbenzene	ug/l	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10
Tetrachloroethene	ug/l	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10
Trichloroethene	ug/l	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10
Semi-Volatiles									
Hexachlorobutadiene	ug/l	ND 5.0	ND 5.0	ND 5.0	ND 5.0	3.8 J	ND 5.0	ND 5.0	ND 5.0

TABLE 3.2

AREA 5106 SEDIMENT VERTICAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		27-08-C1	27-09-C	27-10-C	27.5-08-C1	28-04-B2	28-05-C1	28-06-C	28-08-C1
Feet Above Native:		0 to -0.5	0 to -2.2	0 to -2.2	0 to -2.0	0 to 5.7	0 to -2.0	0 to 0.3	0 to -2.0
Feet Below Mudline:		7.0 to 7.5	5.0 to 7.2	4.5 to 8.9	6.4 to 8.4	6.8 to 12.5	7.7 to 9.7	12.0 to 12.3	9.4 to 11.4
Sample ID:		SE-021898-CRA-001	SE-022598-ILM-002	SE-022098-ILM-030	SE-030198-ILM-047	SE-033198-ASF-071	SE-033198-ASF-070	SE-030198-ILM-048	SE-022698-ILM-011
Sample Date:		02/18/1998	02/25/1998	02/20/1998	03/01/1998	03/31/1998	03/31/1998	03/01/1998	02/26/1998
Parameters	Units								
Volatile Organics									
Ethylbenzene	ug/l	ND 5.0	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10
Tetrachloroethene	ug/l	ND 5.0	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10
Trichloroethene	ug/l	ND 5.0	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10
Semi-Volatiles									
Hexachlorobutadiene	ug/l	R	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	2.1 J	ND 5.0

TABLE 3.2

AREA 5106 SEDIMENT VERTICAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		28-10-C	28-11-C	29-04-B	29-04-C1	29-06R2-C1	29-08-C1	29-10-C	29-12-C1
Feet Above Native:		0 to -2.0	0 to -2.0	0 to 4.7	0 to -2.0	0 to -2.0	0 to -2.0	0 to -2.0	0 to -2.0
Feet Below Mudline:		4.8 to 6.8	3.5 to 5.5	0 to 4.7	4.7 to 6.7	9.6 to 11.6	9.7 to 11.7	5.6 to 7.6	2.1 to 4.1
Sample ID:		SE-022298-ILM-005	SE-022298-ILM-004	SE-033198-ASF-072	SE-033198-ASF-069	SE-033198-ASF-068	SE-022698-ILM-009	SE-022298-ILM-008	SE-022498-ILM-007
Sample Date:		02/22/1998	02/22/1998	03/31/1998	03/31/1998	03/31/1998	02/26/1998	02/22/1998	02/24/1998
Parameters	Units								
Volatile Organics									
Ethylbenzene	ug/l	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10
Tetrachloroethene	ug/l	ND 10	ND 10	6.5 J	ND 10	ND 10	ND 10	ND 10	ND 10
Trichloroethene	ug/l	ND 10	ND 10	9.3 J	5.7 J	ND 10	ND 10	ND 10	ND 10
Semi-Volatiles									
Hexachlorobutadiene	ug/l	ND 5.0	ND 5.0	ND 5.0	ND 5.0	0.86 J	ND 5.0	ND 5.0	0.55 J

TABLE 3.2

AREA 5106 SEDIMENT VERTICAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		29-13-C	30-05-C	30-06-C1	30-08-C	30-09-C1	30-09-C2	30-10-C	31-05-C1
Feet Above Native:		0 to -2.0	0 to -1.0	0 to -2.0	0 to -2.3	0 to -2.0	-2.0 to -4.0	-2.0 to -4.0	0 to -2.0
Feet Below Mudline:		1.8 to 3.8	6.6 to 7.6	6.8 to 8.8	5.6 to 7.9	2.0 to 4.0	4.0 to 6.0	2.0 to 4.0	3.6 to 5.6
Sample ID:		SE-022598-ILM-006	SE-022698-STI-033	SE-030398-STI-034	SE-022298-STI-035	SE-022298-ILM-010	SE-022298-ILM-026	SE-022298-ILM-013	SE-030398-STI-036
Sample Date:		02/25/1998	02/26/1998	03/03/1998	02/22/1998	02/22/1998	02/22/1998	02/22/1998	03/03/1998
Parameters	Units								
Volatile Organics									
Ethylbenzene	ug/l	ND 10	ND 10	ND 10	ND 10	ND 10	ND 100	ND 10	ND 10
Tetrachloroethene	ug/l	ND 10	ND 10	ND 10	ND 10	27	280	ND 10	ND 10
Trichloroethene	ug/l	ND 10	ND 10	ND 10	ND 10	17	950	ND 10	ND 10
Semi-Volatiles									
Hexachlorobutadiene	ug/l	ND 5.0	ND 5.0	ND 5.0	ND 5.0	0.86 J	ND 5.0	ND 5.0	3.5 J

TABLE 3.2

AREA 5106 SEDIMENT VERTICAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		31-07-C	31-07R-C1	31-07R-C2	31-09-C1	31-10-C	31-10-C	31-11-C	32-04-C1
Feet Above Native:		0 to -1.8	-1.0 to -2.0	-2.0 to -3.0	0 to -2.0	0 to -2.0	0 to -2.0	0 to -2.0	0 to -2.0
Feet Below Mudline:		6.2 to 8.0	--	--	2.3 to 4.3	1.8 to 3.8	1.8 to 3.8	0.7 to 2.7	13.5 to 15.5
Sample ID:		SE-021998-ILM-014	SE-032698-ASF-060	SE-032698-ASF-074	SE-022298-ILM-024	SE-022298-ILM-012	SE-022298-ILM-023	SE-022498-ILM-025	SE-032498-ASF-059
Sample Date:		02/19/1998	03/26/1998	03/26/1998	02/22/1998	02/22/1998	02/22/1998	02/24/1998	03/24/1998
							Dupl.		
Parameters	Units								
Volatile Organics									
Ethylbenzene	ug/l	ND 200	ND 200	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10
Tetrachloroethene	ug/l	900	3300	200	6.4 J	ND 10	ND 10	ND 10	5.0 J
Trichloroethene	ug/l	1200	760	38	5.0 J	ND 10	ND 10	ND 10	20
Semi-Volatiles									
Hexachlorobutadiene	ug/l	11 J	77 J	11 J	5.5 J	ND 5.0	ND 5.0	ND 5.0	ND 5.0

TABLE 3.2

AREA 5106 SEDIMENT VERTICAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		32-06R-C1	32-06R-C3	32-06-C4	32-06-C5	32-08-C1	32-09-C1	32-09-C1	32-11R-C1
Feet Above Native:		0 to -1.0	-1.0 to -2.0	-2.0 to -3.0	-3.0 to -4.0	0 to -2.0	0 to -2.0	0 to -2.0	0 to -2.0
Feet Below Mudline:		9.5 to 10.5	10.5 to 11.5	11.5 to 12.5	12.5 to 13.5	4.4 to 6.4	1.6 to 3.6	1.6 to 3.6	2.0 to 4.0
Sample ID:		SE-032698-ASF-061	SE-032698-ASF-073	SE-032698-ASF-075	SE-032698-ASF-076	SE-030498-ILM-045	SE-030498-ILM-040	SE-030498-ILM-044	SE-041598-JJW-050
Sample Date:		03/26/1998	03/26/1998	03/26/1998	03/26/1998	03/04/1998	03/04/1998	03/04/1998	04/15/1998
								Dupl.	
Parameters	Units								
Volatile Organics									
Ethylbenzene	ug/l	ND 100	ND 1000	ND 500	ND 500	ND 10	ND 10	ND 10	ND 10
Tetrachloroethene	ug/l	680	13000	7400	2500	82	ND 10	ND 10	ND 10
Trichloroethene	ug/l	160	6200	880	2100	25	ND 10	ND 10	ND 10
Semi-Volatiles									
Hexachlorobutadiene	ug/l	19 J	95 J	--	--	ND 5.0	ND 5.0	ND 5.0	ND 5.0

TABLE 3.2

AREA 5106 SEDIMENT VERTICAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		32-11R-C2	32-12-C1	33-06R-C1	33-08-C1	33-09-C	33-10-C1	33-12-C1	33-14-C1
Feet Above Native:		-2.0 to -4.0	0 to -2.0	0 to -2.0	0 to -2.0	0 to -2.0	0 to -2.0	0 to -2.0	0 to -2.0
Feet Below Mudline:		4.0 to 6.0	0.8 to 2.8	5.8 to 7.8	3.2 to 5.2	1.8 to 3.8	2.0 to 4.0	1.2 to 3.2	1.1 to 3.1
Sample ID:		SE-041598-JJW-051	SE-030998-ILM-049	SE-031898-ASF-058	SE-022398-ILM-043	SE-022398-ILM-016	SE-022398-ILM-015	SE-022698-STI-037	SE-030398-STI-038
Sample Date:		04/15/1998	03/09/1998	03/18/1998	02/23/1998	02/23/1998	02/23/1998	02/26/1998	03/03/1998
Parameters	Units								
Volatile Organics									
Ethylbenzene	ug/l	ND 10	ND 10	ND 10	ND 20	ND 10	ND 10	ND 10	ND 10
Tetrachloroethene	ug/l	ND 10	ND 10	7.0 J	260	ND 10	ND 10	ND 10	ND 10
Trichloroethene	ug/l	ND 10	ND 10	10	180	ND 10	ND 10	ND 10	ND 10
Semi-Volatiles									
Hexachlorobutadiene	ug/l	ND 5.0	ND 5.0	3.5 J	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0

TABLE 3.2

AREA 5106 SEDIMENT VERTICAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		33-15-C1	34-04-C1	34-05-B4	34-06-C	34-08-C	34-08R-C1	34-09-C	34-11-C
Feet Above Native:		0 to -2.0	0 to -2.0	--	0 to -1.5	0 to -1.4	-1.0 to -2.0	0 to -2.4	0 to -2.0
Feet Below Mudline:		3.8 to 5.8	10.3 to 12.3	7.9 to 9.8	11.9 to 13.4	7.1 to 8.5	9.8 to 10.8	6.1 to 8.5	1.9 to 3.9
Sample ID:		SE-030498-ILM-041	SE-033098-ASF-067	SE-030698-ASF-056	SE-030998-ILM-050	SE-030498-ILM-042	SE-032698-ASF-062	SE-022398-ILM-017	SE-022398-ILM-018
Sample Date:		03/04/1998	03/30/1998	03/06/1998	03/05/1998	03/04/1998	03/26/1998	02/23/1998	02/23/1998
Parameters	Units								
Volatile Organics									
Ethylbenzene	ug/l	ND 10	ND 10	ND 10	ND 10	ND 100	ND 10	ND 10	ND 10
Tetrachloroethene	ug/l	6.8 J	300	2500	ND 10	1700	37	35 J	ND 10
Trichloroethene	ug/l	ND 10	39	130	16	520	22	ND 10	7.7 J
Semi-Volatiles									
Hexachlorobutadiene	ug/l	ND 5.0	2.2 J	--	ND 5.0	4.8 J	4.2 J	ND 5.0	ND 5.0

TABLE 3.2

AREA 5106 SEDIMENT VERTICAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		35-04-B	35-04-C1	35-04-C2	35-05-C	35-08-C	35-10-C	35-11-C1	35.5-09-C1
Feet Above Native:		0 to 1.6	0 to -2.0	-2.0 to -4.0	0 to -1.4	0 to -2.7	0 to -2.7	0 to -2.0	0 to -2.0
Feet Below Mudline:		5.2 to 6.8	6.8 to 8.8	8.8 to 10.8	7.3 to 8.7	6.8 to 9.5	5.8 to 8.5	2.1 to 4.1	5.0 to 7.0
Sample ID:		SE-033098-ASF-065	SE-033098-ASF-066	SE-033098-ASF-077	SE-030698-ASF-057	SE-022398-ILM-021	SE-022498-ILM-019	SE-022698-ILM-020	SE-032698-ASF-063
Sample Date:		03/30/1998	03/30/1998	03/30/1998	03/06/1998	02/23/1998	02/24/1998	02/26/1998	03/26/1998
Parameters	Units								
Volatile Organics									
Ethylbenzene	ug/l	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10	ND 10
Tetrachloroethene	ug/l	100	150	180	410	89	90	ND 10	190
Trichloroethene	ug/l	ND 10	ND 10	ND 10	8.4 J	41	170	11	96
Semi-Volatiles									
Hexachlorobutadiene	ug/l	41 J	42 J	21 J	20 J	ND 5.0	ND 5.0	ND 5.0	ND 5.0

TABLE 3.2

AREA 5106 SEDIMENT VERTICAL BOUNDARY ESTIMATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		36-06R-C1	36-08-C	36.5-07R-C1
Feet Above Native:		0 to -2.0	0 to -3.4	0 to -2.0
Feet Below Mudline:		10.7 to 12.7	6.6 to 10.0	9.1 to 11.1
Sample ID:		SE-032598-ASF-064	SE-022498-ILM-022	SE-030598-ILM-046
Sample Date:		03/25/1998	02/24/1998	03/05/1998
Parameters	Units			
Volatile Organics				
Ethylbenzene	ug/l	ND 10	ND 10	ND 10
Tetrachloroethene	ug/l	ND 10	9.2 J	ND 10
Trichloroethene	ug/l	ND 10	7.0 J	ND 10
Semi-Volatiles				
Hexachlorobutadiene	ug/l	ND 5.0	ND 5.0	ND 5.0

Notes:

(1) Sample location ID xx-yy-za defined as follows:
xx - north-south grid location (see Figure 3.1)
yy - east-west grid location (see Figure 3.1)
z - material designation (for sampling purposes only) where:
A = recent sediment, sand, or gravel
B = visual 5106-like material or anthropogenic fill material
C = native sediment
a - sample number within material designation

\- Not applicable.
J Estimated.
R Rejected.
NDx Non-detect at or above x.

TABLE 3.3

BOUNDARY CONFIRMATION ANALYTICAL PARAMETER LISTS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Parameter	*CAS Number*	*Bulk*	*Porewater and SPLP*	*Column Leach Tests*
Volatiles				
Trichloroethene	79-01-6	x	x	x (1)
Tetrachloroethene	127-18-4	x	x	x (1)
Ethylbenzene	100-41-4	x	x	
Total Xylenes	1330-20-7	x	x	
trans-1,2-Dichloroethene	540-89-0	x	x	x (1)
Chloroform	66-66-3	x		
Vinyl chloride	75-01-4	x	x	x (1)
Toluene			x	
Semi-Volatiles				
Phenol	108-95-2	x		
1,3-Dichlorobenzene	541-73-1	x		
1,4-Dichlorobenzene	106-46-7	x		
1,2-Dichlorobenzene	95-50-1	x		
2-Methylphenol	95-48-7	x		
4-Methylphenol	106-44-5	x		
Hexachloroethane	67-72-1	x		
2,4-Dimethylphenol	105-67-9	x		
1,2,4-Trichlorobenzene	120-82-1	x	x	x
Naphthalene	91-20-3	x		
Hexachlorobutadiene	87-68-3	x	x	x
2-Methylnaphthalene	91-57-6	x		
Dimethylphthalate	131-11-3	x		
Acenaphthylene	208-96-8	x		
Acenaphthene	83-32-9	x		
Dibenzofuran	132-64-9	x		
Diethylphthalate	84-66-2	x		
Fluorene	86-73-7	x		
n-Nitrosodiphenylamine	86-30-6	x		
Hexachlorobenzene	118-74-1	x		
Pentachlorophenol	87-86-5	x		
Phenanthrene	85-01-8	x	x	
Anthracene	120-12-7	x		
Di-n-butylphthalate	84-74-2	x		
Fluoranthene	206-44-0	x		
Pyrene	129-00-0	x		
Butyl benzyl phthalate	85-68-7	x		
Benzo(a)anthracene	56-55-3	x		
Chrysene	218-01-9	x		
bis(2-Ethylhexyl)phthalate	117-81-7	x		
Di-n-octyl phthalate	117-84-0	x		
Benzo(b)fluoranthene	205-99-2	x		
Benzo(k)fluoranthene	207-08-9	x		

TABLE 3.3

BOUNDARY CONFIRMATION ANALYTICAL PARAMETER LISTS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Parameter	*CAS Number*	*Bulk*	*Porewater and SPLP*	*Column Leach Tests*
Semi-Volatiles (Cont'd.)				
Benzo(a)pyrene	50-32-8	x		
Indeno(1,2,3-cd)pyrene	193-39-5	x		
Dibenz(a,h)anthracene	53-70-3	x		
Benzo(g,h,i,)perylene	191-24-2	x	x	x
PCBs as Aroclor	1336-33-3			
Pesticides				
4,4'-DDD			x	x (1)
4,4'-DDE			x	x (1)
Tentative Identified Compounds				
Chlorobutadiene		x	x	x (1)
Dichlorobutadiene		x	x	x (1)
Trichlorobutadiene		x	x	x (1)
Tetrachlorochlobutadiene	-	x	x	x
Pentachlorobutadiene		x	x	x (1)

Notes:

(1) Data collected at request of Hylebos Cleanup Committee (HCC).

NV No Value. Data for these compounds will be evaluated qualitatively by OCCT, HCC, and USEPA.

OCCT OCC Tacoma.

PCBs Polychlorinated Biphenyls.

SPLP Synthetic Precipitation Leaching Procedure.

SQO Sediment Quality Objective.

USEPA United States Environmental Protection Agency.

TABLE 3.4

BOUNDARY CONFIRMATION POREWATER AND SPLP ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		25.75-08/29-13/ 31-11/33-15/36.5-07R	27-08/30-05/32-11/ 36-08	27.5-08/30-05/ 32-09/36-08	28.5-08/30.5-07/ 32.5-08/34.5-08
Sample Id:		CHCC-061398-STI-002	OHBC-061398-STI-002	IHBC-061498-STI-001	VBC-061298-STI-001*
Sample Date:		06/13/1998	06/13/1998	06/14/1998	06/12/1998
Parameters	Units				
Volatile Organics					
Chloroform	ug/l	ND 5.0	6.3	4.6 J	ND 5.0
Ethylbenzene	ug/l	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Tetrachloroethene	ug/l	ND 5.0	1000	710	6.6
Toluene	ug/l	ND 5.0	ND 5.0	ND 5.0	4.2 J
trans-1,2-Dichloroethene	ug/l	ND 5.0	54	41	ND 5.0
Trichloroethene	ug/l	ND 5.0	190	170	47
Vinyl chloride	ug/l	ND 5.0	7800	8500	15
Xylenes	ug/l	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Semi-Volatiles					
1,2,4-Trichlorobenzene	ug/l	ND 5.0	8.0	7.6	ND 5.0
Hexachlorobenzene	ug/l	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Hexachlorobutadiene	ug/l	ND 5.0	49 J	37 J	2.7 J
Phenanthrene	ug/l	ND 5	ND 5	ND 5	--
Pesticides					
4,4'-DDD	ug/l	ND 0.20	ND 0.20	ND 0.20	ND 0.20
4,4'-DDE	ug/l	ND 0.20	ND 0.20	ND 0.20	ND 0.20
PCBs					
Aroclor 1016	ug/l	ND 2.0	ND 2.0	ND 2.0	ND 0.08
Aroclor 1221	ug/l	ND 2.0	ND 2.0	ND 2.0	ND 0.08
Aroclor 1232	ug/l	ND 2.0	ND 2.0	ND 2.0	ND 0.08
Aroclor 1242	ug/l	ND 2.0	ND 2.0	ND 2.0	ND 0.08
Aroclor 1248	ug/l	ND 2.0	ND 2.0	ND 2.0	ND 0.08
Aroclor 1254	ug/l	ND 2.0	ND 2.0	ND 2.0	ND 0.08
Aroclor 1260	ug/l	ND 0.03	ND 0.03	ND 0.03	ND 0.08
Tentatively Identified - VOCs					
Chlorobutadiene	ug/l	ND	ND	ND	--
Dichlorobutadiene	ug/l	6 J	160 J	180 J	--
Trichlorobutadiene	ug/l	54 J	1300 J	1200 J	--

TABLE 3.4

BOUNDARY CONFIRMATION POREWATER AND SPLP ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		25.75-08/29-13/ 31-11/33-15/36.5-07R	27-08/30-05/32-11/ 36-08	27.5-08/30-05/ 32-09/36-08	28.5-08/30.5-07/ 32.5-08/34.5-08
Sample Id:		CHCC-061398-STI-002	OHBC-061398-STI-002	IHBC-061498-STI-001	VBC-061298-STI-001*
Sample Date:		06/13/1998	06/13/1998	06/14/1998	06/12/1998
Parameters	Units				
Tentatively Identified - VOCs (Cont'd)					
Tetrachlorobutadiene	ug/l	ND	2100 J	1400 J	--
Pentachlorobutadiene	ug/l	ND	120 J	87 J	--

Notes

J - Estimated.
NDx - Non-detect at or above x.
* - Analyses were performed on SPLP extract.

TABLE 3.5

BOUNDARY CONFIRMATION BULK SEDIMENT ANALYTICAL DATA(1)
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		25.75-08/29-13/ 31-11/33-15/36.5-07R	27-08/30-05/32-11/ 36-08	27.5-08/30-05/ 32-09/36-08	28.5-08/30.5-07/ 32.5-08/34.5-08
Sample Id:		CHCC-061398-STI-002	OHBC-061398-STI-002	IHBC-061498-STI-001	VBC-061298-STI-001
Sample Date:		06/13/1998	06/13/1998	06/14/1998	06/12/1998
Parameters	Units				
Volatile Organics					
Chloroform	ug/kg	ND 10	ND 120	ND 100	33
Ethylbenzene	ug/kg	ND 10	ND 120	ND 100	ND 31
Tetrachloroethene	ug/kg	ND 10	6200 J	2900 J	200
trans-1,2-Dichloroethene	ug/kg	ND 10	88 J	66 J	31
Trichloroethene	ug/kg	7.9 J	820 J	580 J	1000
Vinyl chloride	ug/kg	8.5 J	9000 J	7800 J	460
Xylenes	ug/kg	ND 10	ND 120	ND 100	ND 31
Semi-Volatiles					
1,2,4-Trichlorobenzene	ug/kg	ND 40	520 J	230 J	ND 25
1,2-Dichlorobenzene	ug/kg	ND 40	ND 50	ND 41	ND 25
1,3-Dichlorobenzene	ug/kg	ND 40	ND 50	ND 41	ND 25
1,4-Dichlorobenzene	ug/kg	ND 40	ND 50	ND 41	ND 25
2,4-Dimethylphenol	ug/kg	ND 40	ND 50	ND 41	ND 25
2-Methylnaphthalene	ug/kg	140 J	300 J	160 J	ND 25
2-Methylphenol	ug/kg	ND 40	ND 50	ND 41	ND 25
4-Methylphenol	ug/kg	ND 40	ND 50	ND 41	ND 25
Acenaphthene	ug/kg	220 J	500 J	270 J	ND 25
Acenaphthylene	ug/kg	ND 40	ND 50	29 J	ND 25
Anthracene	ug/kg	120 J	250 J	160 J	ND 25
benzo(a)Anthracene	ug/kg	150 J	350 J	290 J	ND 25
benzo(a)Pyrene	ug/kg	110 J	420 J	230 J	ND 25
benzo(b)Fluoranthene	ug/kg	140 J	1000 J	530 J	ND 25
benzo(g,h,i)Perylene	ug/kg	49 J	160 J	72 J	ND 25
benzo(k)Fluoranthene	ug/kg	110 J	680 J	370 J	ND 25
bis(2-ethylhexyl)Phthalate	ug/kg	ND 200	ND 320	ND 290	ND 25
Butylbenzylphthalate	ug/kg	ND 40	ND 50	ND 41	ND 25
Chrysene	ug/kg	220 J	680 J	490 J	ND 25
di-N-Butylphthalate	ug/kg	20 J	ND 50	31 J	ND 25
di-N-Octylphthalate	ug/kg	ND 40	R	R	ND 25
dibenz(a,h)Anthracene	ug/kg	ND 40	ND 50	ND 41	ND 25
Dibenzofuran	ug/kg	110 J	210 J	120 J	ND 25
Diethylphthalate	ug/kg	ND 40	ND 50	ND 41	ND 25
Dimethylphthalate	ug/kg	ND 40	ND 50	ND 41	ND 25
Fluoranthene	ug/kg	490 J	1600 J	ND 41	ND 25

TABLE 3.5

BOUNDARY CONFIRMATION BULK SEDIMENT ANALYTICAL DATA(1)
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		25.75-08/29-13/ 31-11/33-15/36.5-07R	27-08/30-05/32-11/ 36-08	27.5-08/30-05/ 32-09/36-08	28.5-08/30.5-07/ 32.5-08/34.5-08
Sample Id:		CHCC-061398-STI-002	OHBC-061398-STI-002	IHBC-061498-STI-001	VBC-061298-STI-001
Sample Date:		06/13/1998	06/13/1998	06/14/1998	06/12/1998
Parameters	Units				
Semi-Volatiles (Cont'd)					
Fluorene	ug/kg	170 J	380 J	210 J	ND 25
Hexachlorobenzene	ug/kg	240 J	800 J	1300 J	24
Hexachlorobutadiene	ug/kg	400 J	14000 J	6000 J	330
Hexachloroethane	ug/kg	ND 40	ND 50	ND 41	ND 25
indeno(1,2,3-cd)Pyrene	ug/kg	ND 40	150 J	78 J	ND 25
N-Nitrosodiphenylamine	ug/kg	ND 40	ND 50	ND 41	ND 25
Naphthalene	ug/kg	470 J	600 J	230 J	120
Pentachlorophenol	ug/kg	ND 160	ND 200	ND 160	ND 100
Phenanthrene	ug/kg	570 J	1600 J	1200 J	ND 25
Phenol	ug/kg	ND 40	ND 50	ND 41	ND 25
Pyrene	ug/kg	400 J	1500 J	1400 J	ND 25
PCBs					
Aroclor 1016	ug/kg	ND 400	ND 750	ND 620	ND 130
Aroclor 1221	ug/kg	ND 510	ND 1200	ND 1000	ND 130
Aroclor 1232	ug/kg	ND 400	ND 7500	ND 620	ND 130
Aroclor 1242	ug/kg	ND 400	ND 750	ND 620	ND 130
Aroclor 1248	ug/kg	ND 400	ND 750	ND 620	ND 130
Aroclor 1254	ug/kg	ND 200	ND 250	ND 210	ND 130
Aroclor 1260	ug/kg	340 J	1200 J	930 J	ND 130
Tentatively Identified - VOCs					
Chlorobutadiene	ug/kg	ND	ND	ND	ND
Dichlorobutadiene	ug/kg	ND	4000 J	3100 J	240 J
Trichlorobutadiene	ug/kg	510 J	23000 J	19000 J	770 J
Tetrachlorobutadiene	ug/kg	85 J	92000 J	64000 J	4000 J
Pentachlorobutadiene	ug/kg	ND	7500 J	53000 J	440 J

J - Estimated.
NDx - Non-detect at or above x.
(1) - Results are reported on a dry weight basis.
R - Rejected.

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		28-07-B	28-10-B	29-08-B	30-06-B	30-08-B	31-07-A	31-07-A	31-07-B
Feet Above Native:		--	0 to 2.1	0 to 8.8	0 to 5.0	0 to 3.8	2.9 to 6.2	2.9 to 6.2	0 to 2.9
Feet Below Mudline:		1.6 to 10.0	2.7 to 4.8	0.9 to 9.7	1.8 to 6.8	1.8 to 5.6	0 to 3.3	0 to 3.3	3.3 to 6.2
Sample ID:		SE-021998-JJW-003	SE-022298-JJW-004	SE-022698-JJW-010	SE-030398-JJW-011	SE-022298-JJW-007	SE-021998-JJW-001	SE-021998-JJW-002	SE-021998-JJW-001
Sample Date:		02/19/1998	02/22/1998	02/26/1998	03/03/1998	02/22/1998	02/19/1998	02/19/1998	02/19/1998
							Dilution		
Parameters	Units								
Volatile Organics									
1,1,1-Trichloroethane	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
1,1,2,2-Tetrachloroethane	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
1,1,2-Trichloroethane	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
1,1-Dichloroethane	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
1,1-Dichloroethene	ug/kg	ND 5000	ND 220	380 J	ND 5300	3600 J	--	ND 230	ND 3400
1,2-Dichloroethane	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
1,2-Dichloropropane	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
2-Butanone	ug/kg	ND 25000	ND 1100	ND 1300	ND 26000	ND 1400	--	ND 1200	ND 17000
2-Hexanone	ug/kg	ND 25000	ND 1100	ND 1300	ND 26000	ND 1400	--	ND 1200	ND 17000
4-Methyl-2-pentanone (MIBK)	ug/kg	ND 25000	ND 1100	ND 1300	ND 26000	ND 1400	--	ND 1200	ND 17000
Acetone	ug/kg	ND 35000	ND 1100	ND 1300	ND 26000	ND 1400	--	ND 1600	ND 17000
Benzene	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Bromodichloromethane	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Bromoform	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Bromomethane	ug/kg	ND 9900	ND 440	ND 530	ND 11000	ND 540	--	ND 470	ND 6800
Carbon disulfide	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Carbon tetrachloride	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Chlorobenzene	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Chloroethane	ug/kg	ND 9900	ND 440	ND 530	ND 11000	ND 540	--	ND 470	ND 6800
Chloroform	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Chloromethane	ug/kg	ND 9900	ND 440	ND 530	ND 11000	ND 540	--	ND 470	ND 6800
cis-1,2-Dichloroethene	ug/kg	75000 J	1300 J	140000 J	380000 J	290000 J	--	4200 J	7200 J
cis-1,3-Dichloropropene	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Dibromochloromethane	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Ethylbenzene	ug/kg	ND 5000	ND 220	ND 270	13000 J	ND 270	--	ND 230	ND 3400
m,p-Xylene	ug/kg	ND 9900	ND 440	ND 530	14000 J	ND 540	--	ND 470	ND 6800
Methylene chloride	ug/kg	ND 20000	ND 440	ND 530	ND 11000	ND 1400	--	ND 870	ND 14000
o-Xylene	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Styrene	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Tetrachloroethene	ug/kg	1200000	1400 J	460000 J	350000 J	1500000 J	--	80000 J	3000000 J
Toluene	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
trans-1,2-Dichloroethene	ug/kg	ND 5000	ND 220	ND 270	ND 5300	1400 J	--	ND 230	ND 3400
trans-1,3-Dichloropropene	ug/kg	ND 5000	ND 220	ND 270	ND 5300	ND 270	--	ND 230	ND 3400
Trichloroethene	ug/kg	58000 J	ND 220	16000 J	170000 J	660000 J	--	30000 J	480000 J

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		28-07-B	28-10-B	29-08-B	30-06-B	30-08-B	31-07-A	31-07-A	31-07-B
Feet Above Native:		--	0 to 2.1	0 to 8.8	0 to 5.0	0 to 3.8	2.9 to 6.2	2.9 to 6.2	0 to 2.9
Feet Below Mudline:		1.6 to 10.0	2.7 to 4.8	0.9 to 9.7	1.8 to 6.8	1.8 to 5.6	0 to 3.3	0 to 3.3	3.3 to 6.2
Sample ID:		SE-021998-JJW-003	SE-022298-JJW-004	SE-022698-JJW-010	SE-030398-JJW-011	SE-022298-JJW-007	SE-021998-JJW-001	SE-021998-JJW-002	SE-021998-JJW-001
Sample Date:		02/19/1998	02/22/1998	02/26/1998	03/03/1998	02/22/1998	02/19/1998	02/19/1998	02/19/1998
							Dilution		
Parameters	Units								
Volatile Organics (Cont'd)									
Vinyl chloride	ug/kg	ND 9900	940 J	8200 J	16000 J	20000 J	--	ND 470	ND 6800
Semi-Volatiles									
1,2,4-Trichlorobenzene	ug/kg	ND 280	42 J	ND 98	ND 300	ND 200	--	ND 38	ND 200
1,2-Dichlorobenzene	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
1,3-Dichlorobenzene	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
1,4-Dichlorobenzene	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
2,2'-Oxybis(1-chloropropane)	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
2,4,5-Trichlorophenol	ug/kg	ND 1400	ND 99	ND 490	ND 1500	ND 1000	--	ND 190	ND 990
2,4,6-Trichlorophenol	ug/kg	ND 1400	ND 99	ND 490	ND 1500	ND 1000	--	ND 190	ND 990
2,4-Dichlorophenol	ug/kg	ND 840	ND 60	ND 290	ND 890	ND 600	--	ND 110	ND 590
2,4-Dimethylphenol	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
2,4-Dinitrophenol	ug/kg	ND 2800	ND 200	ND 980	ND 3000	ND 2000	--	ND 380	ND 2000
2,4-Dinitrotoluene	ug/kg	ND 1400	ND 99	ND 490	ND 1500	ND 1000	--	ND 190	ND 990
2,6-Dinitrotoluene	ug/kg	ND 1400	ND 99	ND 490	ND 1500	ND 1000	--	ND 190	ND 990
2-Chloronaphthalene	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
2-Chlorophenol	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
2-Methylnaphthalene	ug/kg	2800 J	450 J	640 J	960 J	1300 J	--	100 J	1200 J
2-Methylphenol	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
2-Nitroaniline	ug/kg	ND 1400	ND 99	ND 490	ND 1500	ND 1000	--	ND 190	ND 990
2-Nitrophenol	ug/kg	ND 1400	ND 99	ND 490	ND 1500	ND 1000	--	ND 190	ND 990
3,3'-Dichlorobenzidine	ug/kg	ND 1400	R	ND 490	ND 1500	ND 1000	--	ND 190	ND 990
3-Nitroaniline	ug/kg	ND 1700	R	ND 590	ND 1800	ND 1200	--	ND 230	ND 1200
4,6-Dinitro-2-methylphenol	ug/kg	ND 2800	ND 200	ND 980	ND 3000	ND 2000	--	ND 380	ND 2000
4-Bromophenyl-phenylether	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
4-Chloro-3-methylphenol	ug/kg	ND 560	ND 40	ND 200	ND 600	ND 400	--	ND 76	ND 400
4-Chloroaniline	ug/kg	ND 840	R	ND 290	ND 890	ND 600	--	ND 110	ND 590
4-Chlorophenyl-phenylether	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
4-Methylphenol	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
4-Nitroaniline	ug/kg	ND 1400	ND 99	ND 490	ND 1500	ND 1000	--	ND 190	ND 990
4-Nitrophenol	ug/kg	ND 1400	ND 99	ND 490	ND 1500	ND 1000	--	ND 190	ND 990
Acenaphthene	ug/kg	2400 J	410 J	420 J	1100 J	980 J	--	200 J	820 J
Acenaphthylene	ug/kg	ND 280	25 J	ND 98	ND 300	ND 200	--	42 J	ND 200

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		28-07-B	28-10-B	29-08-B	30-06-B	30-08-B	31-07-A	31-07-A	31-07-B
Feet Above Native:		--	0 to 2.1	0 to 8.8	0 to 5.0	0 to 3.8	2.9 to 6.2	2.9 to 6.2	0 to 2.9
Feet Below Mudline:		1.6 to 10.0	2.7 to 4.8	0.9 to 9.7	1.8 to 6.8	1.8 to 5.6	0 to 3.3	0 to 3.3	3.3 to 6.2
Sample ID:		SE-021998-JJW-003	SE-022298-JJW-004	SE-022698-JJW-010	SE-030398-JJW-011	SE-022298-JJW-007	SE-021998-JJW-001	SE-021998-JJW-002	SE-021998-JJW-001
Sample Date:		02/19/1998	02/22/1998	02/26/1998	03/03/1998	02/22/1998	02/19/1998	02/19/1998	02/19/1998
							Dilution		
Parameters	Units								
Semi-Volatiles (Cont'd)									
Anthracene	ug/kg	480 J	260 J	120 J	400 J	610 J	--	480 J	300 J
benzo(a)Anthracene	ug/kg	650 J	360 J	230 J	610 J	1100 J	--	450 J	570 J
benzo(a)Pyrene	ug/kg	430 J	270 J	180 J	460 J	590 J	--	410 J	240 J
benzo(b)Fluoranthene	ug/kg	640 J	470 J	290 J	710 J	1100 J	--	540 J	430 J
benzo(g,h,i)Perylene	ug/kg	ND 280	160 J	88 J	320 J	270 J	--	140 J	ND 200
benzo(k)Fluoranthene	ug/kg	600 J	210 J	160 J	690 J	890 J	--	540 J	410 J
bis(2-chloroethoxy)Methane	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
bis(2-ethylhexyl)Phthalate	ug/kg	970 J	220 J	170 J	890 J	290 J	--	440 J	2300 J
bis-(2-chloroethyl) Ether	ug/kg	ND 560	ND 40	ND 200	ND 600	ND 400	--	ND 76	ND 400
Butylbenzylphthalate	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
Carbazole	ug/kg	560 J	120 J	ND 98	ND 300	ND 200	--	110 J	ND 200
Chrysene	ug/kg	1100 J	540 J	490 J	1100 J	1300 J	--	890 J	750 J
di-N-Butylphthalate	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
di-N-Octylphthalate	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
dibenz(a,h)Anthracene	ug/kg	ND 280	69 J	ND 98	ND 300	ND 200	--	50 J	ND 200
Dibenzofuran	ug/kg	1300 J	270 J	250 J	690 J	690 J	--	130 J	510 J
Diethylphthalate	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
Dimethylphthalate	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
Fluoranthene	ug/kg	2800 J	1200 J	840 J	3900 J	5000 J	--	1800 J	2400 J
Fluorene	ug/kg	2000 J	400 J	340 J	1100 J	1100 J	--	230 J	830 J
Hexachlorobenzene	ug/kg	4600 J	5300 J	2000 J	7200 J	5600 J	--	200 J	5200 J
Hexachlorobutadiene	ug/kg	38000 J	6500 J	22000 J	130000 J	53000 J	--	360 J	180000 J
Hexachlorocyclopentadiene	ug/kg	ND 1400	R	ND 490	ND 1500	ND 1000	--	ND 190	ND 990
Hexachloroethane	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
indeno(1,2,3-cd)Pyrene	ug/kg	ND 280	180 J	91 J	350 J	330 J	--	160 J	ND 200
Isophorone	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
N-Nitroso-di-N-propylamine	ug/kg	ND 560	ND 40	ND 200	ND 600	ND 400	--	ND 76	ND 400
N-Nitrosodiphenylamine	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
Naphthalene	ug/kg	8800 J	810 J	1500 J	1700 J	5800 J	--	190 J	1400 J
Nitrobenzene	ug/kg	ND 280	ND 20	ND 98	ND 300	ND 200	--	ND 38	ND 200
Pentachlorophenol	ug/kg	ND 1400	ND 99	ND 490	ND 1500	ND 1000	--	ND 190	ND 990
Phenanthrene	ug/kg	4500 J	1500 J	1400 J	4700 J	5300 J	--	840 J	2900 J
Phenol	ug/kg	400 J	ND 20	670 J	ND 300	250 J	--	210 J	ND 200
Pyrene	ug/kg	2400 J	1500 J	690 J	2600 J	4200 J	--	1800 J	1800 J

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		28-07-B	28-10-B	29-08-B	30-06-B	30-08-B	31-07-A	31-07-A	31-07-B
Feet Above Native:		--	0 to 2.1	0 to 8.8	0 to 5.0	0 to 3.8	2.9 to 6.2	2.9 to 6.2	0 to 2.9
Feet Below Mudline:		1.6 to 10.0	2.7 to 4.8	0.9 to 9.7	1.8 to 6.8	1.8 to 5.6	0 to 3.3	0 to 3.3	3.3 to 6.2
Sample ID:		SE-021998-JJW-003	SE-022298-JJW-004	SE-022698-JJW-010	SE-030398-JJW-011	SE-022298-JJW-007	SE-021998-JJW-001	SE-021998-JJW-002	SE-021998-JJW-001
Sample Date:		02/19/1998	02/22/1998	02/26/1998	03/03/1998	02/22/1998	02/19/1998	02/19/1998	02/19/1998
							Dilution		
Parameters	Units								
Pesticides									
4,4'-DDD	ug/kg	ND 48	ND 19	ND 9.5	ND 360	ND 55	--	ND 1.8	ND 20
4,4'-DDE	ug/kg	ND 140	ND 110	ND 82	ND 360	ND 55	--	ND 5.6	ND 20
4,4'-DDT	ug/kg	ND 48	ND 10	ND 9.5	ND 360	ND 55	--	ND 5.5	ND 20
Aldrin	ug/kg	ND 440	ND 93	ND 410	ND 190	ND 300	--	ND 5.6	ND 37
alpha-BHC	ug/kg	ND 24	ND 23	ND 4.7	ND 180	ND 36	--	ND 3.5	ND 37
alpha-Chlordane	ug/kg	ND 24	ND 9.6	ND 4.7	ND 180	ND 28	--	ND 0.91	ND 9.9
beta-BHC	ug/kg	ND 67	ND 65	ND 40	ND 180	ND 45	--	ND 19	ND 38
delta-BHC	ug/kg	ND 24	ND 19	ND 13	ND 180	ND 28	--	ND 4.0	ND 9.9
Dieldrin	ug/kg	ND 48	ND 19	ND 9.5	ND 360	ND 55	--	ND 1.8	ND 20
Endosulfan I	ug/kg	R	R	R	R	R	--	R	R
Endosulfan II	ug/kg	ND 48	ND 19	ND 9.5	ND 360	ND 55	--	ND 3.3	ND 20
Endosulfan sulfate	ug/kg	ND 48	ND 12	ND 9.5	ND 360	ND 55	--	ND 1.8	ND 20
Endrin	ug/kg	ND 61	ND 24	ND 29	ND 360	ND 67	--	ND 13	ND 74
Endrin aldehyde	ug/kg	ND 48	ND 19	ND 9.5	R	ND 55	--	ND 1.8	ND 20
Endrin ketone	ug/kg	ND 48	ND 19	ND 26	ND 360	ND 55	--	ND 1.8	ND 49
gamma-BHC (lindane)	ug/kg	ND 42	ND 18	ND 23	ND 180	ND 28	--	ND 1.6	ND 190
gamma-Chlordane	ug/kg	ND 24	ND 9.6	ND 4.7	ND 180	ND 28	--	ND 7.7	ND 82
Heptachlor	ug/kg	ND 100	ND 42	ND 55	ND 180	ND 94	--	ND 3.2	ND 83
Heptachlor epoxide	ug/kg	ND 140	ND 72	ND 71	ND 180	ND 130	--	ND 6.0	ND 96
Methoxychlor	ug/kg	ND 240	ND 170	ND 62	ND 1800	ND 280	--	ND 34	ND 200
Toxaphene	ug/kg	ND 2400	ND 960	ND 470	ND 18000	ND 2800	--	ND 91	ND 990
PCBs									
Aroclor 1016	ug/kg	ND 480	ND 190	ND 660	ND 3600	ND 1100	--	ND 18	ND 200
Aroclor 1221	ug/kg	ND 950	ND 1200	ND 190	ND 7100	ND 1100	--	ND 36	ND 400
Aroclor 1232	ug/kg	ND 480	ND 190	ND 95	ND 3600	ND 550	--	ND 18	ND 200
Aroclor 1242	ug/kg	ND 9500	ND 190	ND 850	ND 3600	ND 1100	--	ND 18	ND 5300
Aroclor 1248	ug/kg	ND 9500	ND 190	ND 95	ND 3600	ND 1100	--	ND 18	ND 4000
Aroclor 1254	ug/kg	ND 950	ND 760	ND 570	ND 3600	ND 1600	--	130 J	ND 850
Aroclor 1260	ug/kg	ND 480	ND 290	ND 310	ND 3600	ND 940	--	180 J	ND 200

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		28-07-B	28-10-B	29-08-B	30-06-B	30-08-B	31-07-A	31-07-A	31-07-B
Feet Above Native:		--	0 to 2.1	0 to 8.8	0 to 5.0	0 to 3.8	2.9 to 6.2	2.9 to 6.2	0 to 2.9
Feet Below Mudline:		1.6 to 10.0	2.7 to 4.8	0.9 to 9.7	1.8 to 6.8	1.8 to 5.6	0 to 3.3	0 to 3.3	3.3 to 6.2
Sample ID:		SE-021998-JJW-003	SE-022298-JJW-004	SE-022698-JJW-010	SE-030398-JJW-011	SE-022298-JJW-007	SE-021998-JJW-001	SE-021998-JJW-002	SE-021998-JJW-001
Sample Date:		02/19/1998	02/22/1998	02/26/1998	03/03/1998	02/22/1998	02/19/1998	02/19/1998	02/19/1998
							Dilution		
Parameters	Units								
Tentatively Identified - VOCs									
Chlorobutadiene	ug/kg	ND	ND	ND	ND	ND	--	ND	ND
Dichlorobutadiene	ug/kg	81000 J	6900 J	ND	ND	ND	--	ND	ND
Trichlorobutadiene	ug/kg	120000 J	29000 J	26000 J	ND	33000 J	--	ND	26000 J
Tetrachlorobutadiene	ug/kg	4400000 J	120000 J	1100000 J	450000 J	1600000 J	--	11000 J	3200000 J
Pentachlorobutadiene	ug/kg	880000 J	27000 J	200000 J	140000 J	310000 J	--	ND	640000 J
Metals									
Aluminum	mg/kg	18000 J	9400 J	14000 J	17000 J	12000 J	16000 J	17000 J	11000 J
Antimony	mg/kg	R	R	ND 20	ND 20	R	ND 10	R	R
Arsenic	mg/kg	30 J	22 J	20 J	30 J	ND 9	10 J	10 J	ND 10
Barium	mg/kg	58 J	63 J	40 J	72 J	40 J	40 J	42 J	43 J
Beryllium	mg/kg	1.1 J	0.2 J	0.4 J	0.8 J	0.3 J	0.3 J	0.3 J	0.7 J
Cadmium	mg/kg	1.0 J	0.4 J	ND 0.6	ND 0.6	ND 0.4	0.5 J	0.5 J	ND 0.6
Calcium	mg/kg	76000 J	31000 J	34000 J	86000 J	29000 J	13000 J	13000 J	47000 J
Chromium	mg/kg	37 J	22 J	22 J	49 J	19 J	26 J	26 J	17 J
Cobalt	mg/kg	10 J	6.4 J	4.2 J	9.2 J	5.2 J	6.7 J	6.9 J	14 J
Copper	mg/kg	74 J	62 J	44 J	68 J	32 J	86 J	83 J	34 J
Iron	mg/kg	19000 J	22000 J	13000 J	22000 J	13000 J	20000 J	19000 J	8200 J
Lead	mg/kg	160 J	180 J	59 J	200 J	64 J	94 J	98 J	150 J
Magnesium	mg/kg	70000 J	42000 J	86000 J	59000 J	36000 J	14000 J	14000 J	55000 J
Manganese	mg/kg	300 J	140 J	140 J	370 J	180 J	180 J	190 J	120 J
Mercury	mg/kg	0.4 J	0.31 J	0.2 J	0.3 J	0.13 J	0.3 J	0.3 J	0.2 J
Nickel	mg/kg	90 J	43 J	31 J	43 J	23 J	21 J	20 J	28 J
Potassium	mg/kg	1900 J	810 J	1500 J	1600 J	890 J	1800 J	1900 J	1000 J
Selenium	mg/kg	20 J	13 J	30 J	ND 20	10 J	ND 10	ND 10	20 J
Silver	mg/kg	ND 1	ND 0.5	ND 0.9	ND 1.0	ND 0.6	ND 0.6	ND 0.6	ND 0.9
Sodium	mg/kg	29000 J	13000 J	23000 J	37000 J	14000 J	46000 J	46000 J	96000 J
Thallium	mg/kg	ND 20	12 J	30 J	ND 20	ND 9	ND 10	ND 10	ND 10
Vanadium	mg/kg	120 J	29 J	38 J	49 J	49 J	52 J	53 J	32 J
Zinc	mg/kg	180 J	240 J	100 J	230 J	69 J	110 J	120 J	59 J

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		28-07-B	28-10-B	29-08-B	30-06-B	30-08-B	31-07-A	31-07-A	31-07-B
Feet Above Native:		--	0 to 2.1	0 to 8.8	0 to 5.0	0 to 3.8	2.9 to 6.2	2.9 to 6.2	0 to 2.9
Feet Below Mudline:		1.6 to 10.0	2.7 to 4.8	0.9 to 9.7	1.8 to 6.8	1.8 to 5.6	0 to 3.3	0 to 3.3	3.3 to 6.2
Sample ID:		SE-021998-JJW-003	SE-022298-JJW-004	SE-022698-JJW-010	SE-030398-JJW-011	SE-022298-JJW-007	SE-021998-JJW-001	SE-021998-JJW-002	SE-021998-JJW-001
Sample Date:		02/19/1998	02/22/1998	02/26/1998	03/03/1998	02/22/1998	02/19/1998	02/19/1998	02/19/1998
							Dilution		
Parameters	Units								
General Chemistry									
pH	s.u.	8.9	8.8	9.0	8.8	9.0	--	11	11
Total cyanide	mg/kg	1.4 J	1.6 J	1.4 J	0.54 J	ND 0.59	--	0.48 J	0.60 J
Total oil & grease	mg/kg	3000 J	2900 J	2500 J	5700 J	1600 J	--	1600 J	ND 460
Total solids	%	33	33	28	33	31	--	50	44
Miscellaneous									
Asbestos	weight %	2.3	0.86	0.50	1.3	0.86	--	0.84	0.38

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		34-08-B2	34-09-B	36.5-07R-B3
Feet Above Native:		0 to 4.8	2.1 to 4.6	0 to 5.0
Feet Below Mudline:		2.3 to 7.1	1.5 to 4.0	4.1 to 9.1
Sample ID:		SE-030498-JJW-012	SE-022398-JJW-009	SE-030598-JJW-013
Sample Date:		03/04/1998	02/23/1998	03/05/1998
Parameters	Units			
Volatile Organics				
1,1,1-Trichloroethane	ug/kg	ND 3900	ND 440	ND 22
1,1,2,2-Tetrachloroethane	ug/kg	ND 3900	ND 440	ND 22
1,1,2-Trichloroethane	ug/kg	ND 3900	ND 440	ND 22
1,1-Dichloroethane	ug/kg	ND 3900	ND 440	ND 22
1,1-Dichloroethene	ug/kg	ND 3900	ND 440	ND 22
1,2-Dichloroethane	ug/kg	ND 3900	ND 440	ND 22
1,2-Dichloropropane	ug/kg	ND 3900	ND 440	ND 22
2-Butanone	ug/kg	ND 20000	ND 2200	ND 110
2-Hexanone	ug/kg	ND 20000	ND 2200	ND 110
4-Methyl-2-pentanone (MIBK)	ug/kg	ND 20000	ND 2200	ND 110
Acetone	ug/kg	ND 20000	ND 2200	ND 460
Benzene	ug/kg	ND 3900	ND 440	ND 22
Bromodichloromethane	ug/kg	ND 3900	ND 440	ND 22
Bromoform	ug/kg	ND 3900	ND 440	ND 22
Bromomethane	ug/kg	ND 7800	ND 880	ND 44
Carbon disulfide	ug/kg	ND 3900	ND 440	ND 22
Carbon tetrachloride	ug/kg	ND 3900	ND 440	ND 22
Chlorobenzene	ug/kg	ND 3900	ND 440	ND 22
Chloroethane	ug/kg	ND 7800	ND 880	ND 44
Chloroform	ug/kg	ND 3900	ND 440	ND 22
Chloromethane	ug/kg	ND 7800	ND 880	ND 44
cis-1,2-Dichloroethene	ug/kg	73000 J	55000 J	66 J
cis-1,3-Dichloropropene	ug/kg	ND 3900	ND 440	ND 22
Dibromochloromethane	ug/kg	ND 3900	ND 440	ND 22
Ethylbenzene	ug/kg	ND 3900	ND 440	ND 22
m,p-Xylene	ug/kg	ND 7800	ND 880	ND 44
Methylene chloride	ug/kg	ND 7800	ND 880	ND 44
o-Xylene	ug/kg	ND 3900	ND 440	ND 22
Styrene	ug/kg	ND 3900	ND 440	ND 22
Tetrachloroethene	ug/kg	2700000 J	1200000 J	510 J
Toluene	ug/kg	ND 3900	ND 440	ND 22
trans-1,2-Dichloroethene	ug/kg	ND 3900	ND 440	ND 22
trans-1,3-Dichloropropene	ug/kg	ND 3900	ND 440	ND 22
Trichloroethene	ug/kg	360000 J	79000 J	69 J

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		34-08-B2	34-09-B	36.5-07R-B3
Feet Above Native:		0 to 4.8	2.1 to 4.6	0 to 5.0
Feet Below Mudline:		2.3 to 7.1	1.5 to 4.0	4.1 to 9.1
Sample ID:		SE-030498-JJW-012	SE-022398-JJW-009	SE-030598-JJW-013
Sample Date:		03/04/1998	02/23/1998	03/05/1998
Parameters	Units			
Volatile Organics (Cont'd)				
Vinyl chloride	ug/kg	ND 7800	1400 J	ND 44
Semi-Volatiles				
1,2,4-Trichlorobenzene	ug/kg	ND 250	ND 25	ND 29
1,2-Dichlorobenzene	ug/kg	ND 250	ND 25	ND 29
1,3-Dichlorobenzene	ug/kg	ND 250	ND 25	ND 29
1,4-Dichlorobenzene	ug/kg	ND 250	ND 25	50 J
2,2'-Oxybis(1-chloropropane)	ug/kg	ND 250	ND 25	ND 29
2,4,5-Trichlorophenol	ug/kg	ND 1300	ND 130	ND 150
2,4,6-Trichlorophenol	ug/kg	ND 1300	ND 130	ND 150
2,4-Dichlorophenol	ug/kg	ND 760	ND 75	ND 87
2,4-Dimethylphenol	ug/kg	1200 J	830 J	110 J
2,4-Dinitrophenol	ug/kg	R	ND 250	ND 290
2,4-Dinitrotoluene	ug/kg	ND 1300	ND 130	ND 150
2,6-Dinitrotoluene	ug/kg	ND 1300	ND 130	ND 150
2-Chloronaphthalene	ug/kg	ND 250	ND 25	ND 29
2-Chlorophenol	ug/kg	ND 250	ND 25	ND 29
2-Methylnaphthalene	ug/kg	980 J	210 J	200 J
2-Methylphenol	ug/kg	ND 250	290 J	37 J
2-Nitroaniline	ug/kg	ND 1300	ND 130	ND 150
2-Nitrophenol	ug/kg	ND 1300	ND 130	ND 150
3,3'-Dichlorobenzidine	ug/kg	R	ND 130	ND 150
3-Nitroaniline	ug/kg	R	ND 150	ND 170
4,6-Dinitro-2-methylphenol	ug/kg	R	ND 250	ND 290
4-Bromophenyl-phenylether	ug/kg	ND 250	ND 25	ND 29
4-Chloro-3-methylphenol	ug/kg	ND 510	ND 50	ND 58
4-Chloroaniline	ug/kg	R	ND 75	ND 87
4-Chlorophenyl-phenylether	ug/kg	ND 250	ND 25	ND 29
4-Methylphenol	ug/kg	870 J	680 J	120 J
4-Nitroaniline	ug/kg	ND 1300	ND 130	ND 150
4-Nitrophenol	ug/kg	ND 1300	ND 130	ND 150
Acenaphthene	ug/kg	1200 J	240 J	260 J
Acenaphthylene	ug/kg	ND 250	ND 25	ND 29

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		34-08-B2	34-09-B	36.5-07R-B3
Feet Above Native:		0 to 4.8	2.1 to 4.6	0 to 5.0
Feet Below Mudline:		2.3 to 7.1	1.5 to 4.0	4.1 to 9.1
Sample ID:		SE-030498-JJW-012	SE-022398-JJW-009	SE-030598-JJW-013
Sample Date:		03/04/1998	02/23/1998	03/05/1998
Parameters	Units			
Semi-Volatiles (Cont'd)				
Anthracene	ug/kg	400 J	140 J	170 J
benzo(a)Anthracene	ug/kg	540 J	220 J	240 J
benzo(a)Pyrene	ug/kg	260 J	140 J	170 J
benzo(b)Fluoranthene	ug/kg	460 J	270 J	260 J
benzo(g,h,i)Perylene	ug/kg	ND 250	69 J	92 J
benzo(k)Fluoranthene	ug/kg	360 J	210 J	180 J
bis(2-chloroethoxy)Methane	ug/kg	ND 250	ND 25	ND 29
bis(2-ethylhexyl)Phthalate	ug/kg	750 J	280 J	99 J
bis-(2-chloroethyl) Ether	ug/kg	ND 510	ND 50	ND 58
Butylbenzylphthalate	ug/kg	ND 250	ND 25	ND 29
Carbazole	ug/kg	ND 250	56 J	82 J
Chrysene	ug/kg	820 J	380 J	360 J
di-N-Butylphthalate	ug/kg	ND 250	ND 25	ND 29
di-N-Octylphthalate	ug/kg	ND 250	ND 25	ND 29
dibenz(a,h)Anthracene	ug/kg	ND 250	ND 25	28 J
Dibenzofuran	ug/kg	910 J	190 J	160 J
Diethylphthalate	ug/kg	ND 250	ND 25	ND 29
Dimethylphthalate	ug/kg	ND 250	ND 25	ND 29
Fluoranthene	ug/kg	3000 J	780 J	890 J
Fluorene	ug/kg	1300 J	250 J	260 J
Hexachlorobenzene	ug/kg	10000 J	6100 J	1000 J
Hexachlorobutadiene	ug/kg	58000 J	14000 J	180 J
Hexachlorocyclopentadiene	ug/kg	R	ND 130	ND 150
Hexachloroethane	ug/kg	ND 250	ND 25	ND 29
indeno(1,2,3-cd)Pyrene	ug/kg	ND 250	75 J	89 J
Isophorone	ug/kg	ND 250	ND 25	ND 29
N-Nitroso-di-N-propylamine	ug/kg	ND 510	ND 50	ND 58
N-Nitrosodiphenylamine	ug/kg	ND 250	ND 25	ND 29
Naphthalene	ug/kg	1600 J	380 J	640 J
Nitrobenzene	ug/kg	ND 250	ND 25	ND 29
Pentachlorophenol	ug/kg	ND 1300	330 J	ND 150
Phenanthrene	ug/kg	4300 J	1100 J	1000 J
Phenol	ug/kg	2900 J	1700 J	780 J
Pyrene	ug/kg	2200 J	740 J	760 J

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		34-08-B2	34-09-B	36.5-07R-B3
Feet Above Native:		0 to 4.8	2.1 to 4.6	0 to 5.0
Feet Below Mudline:		2.3 to 7.1	1.5 to 4.0	4.1 to 9.1
Sample ID:		SE-030498-JJW-012	SE-022398-JJW-009	SE-030598-JJW-013
Sample Date:		03/04/1998	02/23/1998	03/05/1998
Parameters	Units			
Pesticides				
4,4'-DDD	ug/kg	ND 310	ND 2.0	ND 1.9
4,4'-DDE	ug/kg	ND 310	ND 2.0	ND 2.3
4,4'-DDT	ug/kg	ND 310	ND 9.8	ND 6.7
Aldrin	ug/kg	ND 150	ND 55	ND 3.1
alpha-BHC	ug/kg	ND 150	ND 19	ND 3.0
alpha-Chlordane	ug/kg	ND 150	ND 6.2	ND 0.96
beta-BHC	ug/kg	ND 150	ND 42	ND 23
delta-BHC	ug/kg	ND 150	ND 19	ND 2.9
Dieldrin	ug/kg	ND 310	ND 2.0	ND 1.9
Endosulfan I	ug/kg	R	R	R
Endosulfan II	ug/kg	ND 310	ND 5.1	ND 4.3
Endosulfan sulfate	ug/kg	ND 310	ND 2.0	ND 1.9
Endrin	ug/kg	ND 310	ND 20	ND 7.7
Endrin aldehyde	ug/kg	R	ND 2.0	R
Endrin ketone	ug/kg	ND 310	ND 13	ND 1.9
gamma-BHC (lindane)	ug/kg	ND 150	ND 0.99	ND 1.6
gamma-Chlordane	ug/kg	ND 150	ND 10	ND 6.8
Heptachlor	ug/kg	ND 150	ND 8.6	ND 2.9
Heptachlor epoxide	ug/kg	ND 150	ND 16	ND 0.96
Methoxychlor	ug/kg	ND 1500	ND 38	ND 27
Toxaphene	ug/kg	ND 15000	ND 99	ND 96
PCBs				
Aroclor 1016	ug/kg	ND 3100	ND 20	ND 19
Aroclor 1221	ug/kg	ND 6100	ND 40	ND 38
Aroclor 1232	ug/kg	ND 3100	ND 20	ND 19
Aroclor 1242	ug/kg	ND 3100	ND 20	ND 19
Aroclor 1248	ug/kg	ND 3100	ND 20	ND 19
Aroclor 1254	ug/kg	ND 3100	ND 20	120 J
Aroclor 1260	ug/kg	950 J	240 J	130 J

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		34-08-B2	34-09-B	36.5-07R-B3
Feet Above Native:		0 to 4.8	2.1 to 4.6	0 to 5.0
Feet Below Mudline:		2.3 to 7.1	1.5 to 4.0	4.1 to 9.1
Sample ID:		SE-030498-JJW-012	SE-022398-JJW-009	SE-030598-JJW-013
Sample Date:		03/04/1998	02/23/1998	03/05/1998
Parameters	Units			
Tentatively Identified - VOCs				
Chlorobutadiene	ug/kg	ND	ND	ND
Dichlorobutadiene	ug/kg	ND	ND	ND
Trichlorobutadiene	ug/kg	ND	ND	ND
Tetrachlorobutadiene	ug/kg	160000 J	320000 J	720 J
Pentachlorobutadiene	ug/kg	ND	15000 J	ND
Metals				
Aluminum	mg/kg	15000 J	14000 J	8500 J
Antimony	mg/kg	ND 20	R	ND 20
Arsenic	mg/kg	ND 20	ND 20	ND 20
Barium	mg/kg	52 J	42 J	32 J
Beryllium	mg/kg	0.5 J	0.7 J	ND 0.4
Cadmium	mg/kg	ND 0.7	ND 0.8	ND 0.7
Calcium	mg/kg	66000 J	51000 J	23000 J
Chromium	mg/kg	27 J	21 J	13 J
Cobalt	mg/kg	13 J	7 J	48 J
Copper	mg/kg	62 J	56 J	38 J
Iron	mg/kg	12000 J	10000 J	8600 J
Lead	mg/kg	180 J	110 J	180 J
Magnesium	mg/kg	47000 J	45000 J	63000 J
Manganese	mg/kg	210 J	160 J	130 J
Mercury	mg/kg	0.3 J	ND 0.2	ND 0.2
Nickel	mg/kg	41 J	26 J	19 J
Potassium	mg/kg	2300 J	3800 J	5600 J
Selenium	mg/kg	20 J	20 J	ND 20
Silver	mg/kg	ND 1.0	ND 1	ND 1
Sodium	mg/kg	54000 J	82000 J	96000 J
Thallium	mg/kg	ND 20	ND 20	20 J
Vanadium	mg/kg	53 J	50 J	38 J
Zinc	mg/kg	100 J	85 J	63 J

TABLE 3.7

AREA 5106 SEDIMENT CHEMICAL PROFILE ANALYTICAL DATA (1)
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		30-08	30-08	30-08	30-08	30-08	30-08	33-08	33-08
Feet Below Mudline:		0-0.3	0.3-0.8	0.8-1.3	1.5-2.0	2.5-3.0	5.9-6.9	0-0.3	0.3-0.8
Sample Id:		SE-041598-JJW-053	SE-041598-JJW-035	SE-041598-JJW-036	SE-041598-JJW-037	SE-041598-JJW-038	SE-041598-JJW-039	SE-041598-JJW-052	SE-041498-JJW-030
Sample Date:		04/15/1998	04/15/1998	04/15/1998	04/15/1998	04/15/1998	04/15/1998	04/15/1998	04/14/1998
Parameters	Units								
Volatile Organics									
Chloroethane	ug/kg	ND 17	ND 17	ND 20	ND 230	ND 850	ND 64	ND 85	ND 440
Chloroform	ug/kg	ND 17	ND 17	ND 20	ND 230	ND 850	ND 64	61 J	ND 440
Ethane	ug/kg	ND 0.00047	ND 0.00022	0.28	3.3	7.0	0.0016	0.60	ND 0.00062
Ethanol	ug/kg	R	R	R	R	R	R	R	R
Tetrachloroethene	ug/kg	ND 17	ND 17	ND 20	6500	920000	1200	97	30000
trans-1,2-Dichloroethene	ug/kg	ND 17	ND 17	ND 20	290	990	ND 64	53 J	ND 440
Trichloroethene	ug/kg	ND 17	ND 17	28	4400	2500000	460	72 J	23000
Vinyl chloride	ug/kg	ND 8.6	ND 8.4	340	15000	8500	ND 64	1400	670
Semi-Volatiles									
Hexachlorobenzene	ug/kg	120	42 J	110	2500	7500	ND 42	61	100
Hexachlorobutadiene	ug/kg	110	65	280	12000	58000	84	270	210
Phenanthrene	ug/kg	220	250	340	ND 1500	2700	ND 130	1400	800
Tentatively Identified - VOCs									
Tetrachlorobutadiene	ug/kg	2100 J	1700 J	3400 J	21000 J	220000 J	2600 J	1900 J	ND
Metals									
Phosphosus (P)	mg/kg	790	670	710	640	770	510	860	720
General Chemistry									
Chemical oxygen demand	mg/kg	480	340	340	600	650	200	2600	10000
Total kjeldahl nitrogen	mg/kg	1200	1100	1300	1400	1200	320	1300	1100
Total organic carbon	mg/kg	14000	12000	14000	8200	26000	1100	9400	20000

TABLE 3.6

AREA 5106 SEDIMENT CHARACTERIZATION ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		34-08-B2	34-09-B	36.5-07R-B3
Feet Above Native:		0 to 4.8	2.1 to 4.6	0 to 5.0
Feet Below Mudline:		2.3 to 7.1	1.5 to 4.0	4.1 to 9.1
Sample ID:		SE-030498-JJW-012	SE-022398-JJW-009	SE-030598-JJW-013
Sample Date:		03/04/1998	02/23/1998	03/05/1998
Parameters	Units			
General Chemistry				
pH	s.u.	11	11	12
Total cyanide	mg/kg	0.63 J	ND 0.81	ND 0.54
Total oil & grease	mg/kg	5000 J	2100 J	3800 J
Total solids	%	26	25	24
Miscellaneous				
Asbestos	weight %	1.6	0.55	0.79

Notes

J	-	Estimated
R	-	Rejected
NDx	-	Non-detect at or above x
s.u.	-	Standard units

TABLE 3.7

AREA 5106 SEDIMENT CHEMICAL PROFILE ANALYTICAL DATA (1)
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		33-08	33-08	33-08	33-08
Feet Below Mudline:		1.0-1.5	1.8-2.3	4.0-4.5	7.5-8.5
Sample Id:		SE-041498-JJW-031	SE-041498-JJW-032	SE-041498-JJW-033	SE-041498-JJW-034
Sample Date:		04/14/1998	04/14/1998	04/14/1998	04/14/1998
Parameters	Units				
Volatile Organics					
Chloroethane	ug/kg	ND 450	ND 1900	ND 370	ND 320
Chloroform	ug/kg	ND 450	ND 1900	ND 370	ND 320
Ethane	ug/kg	ND 0.00040	0.085	0.024	0.0054
Ethanol	ug/kg	R	R	R	R
Tetrachloroethene	ug/kg	96000	5700000	770000	40000
trans-1,2-Dichloroethene	ug/kg	230 J	ND 1900	ND 370	ND 320
Trichloroethene	ug/kg	51000	3400000	590000	66000
Vinyl chloride	ug/kg	3200	12000	1500	ND 320
Semi-Volatiles					
Hexachlorobenzene	ug/kg	150	26000	920	ND 43
Hexachlorobutadiene	ug/kg	54 J	140000	4400	59
Phenanthrene	ug/kg	430	2900	300 J	ND 130
Tentatively Identified - VOCs					
Tetrachlorobutadiene	ug/kg	ND	90000 J	12000 J	590 J
Metals					
Phosphosus (P)	mg/kg	680	800	550	550
General Chemistry					
Chemical oxygen demand	mg/kg	9600	8700	3200	2200
Total kjeldahl nitrogen	mg/kg	730	1600	560	240
Total organic carbon	mg/kg	13000	60000	9800	920

Notes

J	-	Estimated
NDx	-	Non-detect at or above x.
(1)	-	Results are reported on a dry weight basis.
R	-	Rejected

TABLE 3.8

POREWATER CHEMICAL PROFILE ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		30-08	30-08	30-08	30-08	30-08	33-08	33-08	33-08
Feet Below Mudline:		0-0.3	0.3-0.8	0.8-1.3	1.5-2.0	2.5-3.0	0-0.3	0.3-0.8	1.0-1.5
Sample Id:		PP-042098-STI-002	PP-041698-STI-005	PP-041698-STI-006	PP-041698-STI-007	PP-041698-STI-008	PP-042098-STI-001	PP-041698-STI-001	PP-041698-STI-002
Sample Date:		04/20/1998	04/16/1998	04/16/1998	04/16/1998	04/16/1998	04/20/1998	04/16/1998	04/16/1998
Parameters	Units								
Volatile Organics									
Chloroethane	ug/l	ND 10	ND 10	ND 10	ND 50	ND 5000	ND 10	ND 1000	ND 1000
Chloroform	ug/l	ND 10	ND 10	ND 10	ND 50	ND 5000	ND 10	ND 1000	ND 1000
Tetrachloroethene	ug/l	ND 10	ND 10	ND 10	8300	49000	ND 100	69000	61000
trans-1,2-Dichloroethene	ug/l	ND 10	ND 10	ND 10	480	ND 5000	58	ND 1000	ND 1000
Trichloroethene	ug/l	ND 11	ND 10	ND 10	14000	120000	ND 140	110000	130000
Vinyl chloride	ug/l	ND 10	ND 10	910	24000	17000	4000	2700	1000
Semi-Volatiles									
Hexachlorobenzene	ug/l	ND 5.0	ND 5.0	ND 5.0	ND 10	ND 5.0	ND 5.0	ND 5.0	5.7
Hexachlorobutadiene	ug/l	ND 5.0	ND 5.0	ND 5.0	190	86	ND 5.0	21 J	53
Tentatively Identified - VOCs									
Tetrachlorobutadiene	ug/l	ND	ND	ND	860 J	1800 J	ND	130 J	ND
General Chemistry									
Ammonia as N	mg/l	10	ND 0.5	3.8	9.9	10	ND 0.5	44	16
Nitrate as N	mg/l	ND 0.10	ND 0.10	ND 0.10	ND 0.10	ND 0.10	ND 0.10	0.16	ND 0.10
Nitrite as N	mg/l	ND 0.10	ND 0.10	ND 0.10	ND 0.10	ND 0.10	ND 0.10	0.91	0.76
Sulfate	mg/l	1600	2200	2000	1700	1500	ND 20	700	540
Sulfide	mg/l	ND 4	ND 4	ND 4	ND 4	ND 4	ND 4	44	83

TABLE 3.8

POREWATER CHEMICAL PROFILE ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:		33-08	33-08
Feet Below Mudline:		1.8-2.3	4.0-4.5
Sample Id:		PP-041698-ST1-003	PP-041698-ST1-004
Sample Date:		04/16/1998	04/16/1998
Parameters	Units		
Volatile Organics			
Chloroethane	ug/l	ND 5000	ND 1000
Chloroform	ug/l	ND 5000	ND 1000
Tetrachloroethene	ug/l	68000	36000
trans-1,2-Dichloroethene	ug/l	ND 5000	ND 1000
Trichloroethene	ug/l	290000	88000
Vinyl chloride	ug/l	2600 J	ND 1000
Semi-Volatiles			
Hexachlorobenzene	ug/l	9.7	33
Hexachlorobutadiene	ug/l	120	450
Tentatively Identified - VOCs			
Tetrachlorobutadiene	ug/l	120 J	ND
General Chemistry			
Ammonia as N	mg/l	38	38
Nitrate as N	mg/l	ND 0.10	--
Nitrite as N	mg/l	0.65	--
Sulfate	mg/l	650	--
Sulfide	mg/l	72	11

Notes

J - Estimated

NDx - Non-detect at or above x.

-- - No results available, insufficient sample volume.

TABLE 3.9

STATISTICAL SUMMARY OF CHEMICAL CHARACTERIZATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Compounds Detected	SQOs (mg/kg)	Sediment Characterization Samples: Number of Detections	Maximum Detection (mg/kg)	Minimum Detection (mg/kg)	Average[1] (mg/kg)	Porewater Profile Samples: Number of Detections	Maximum Detection (mg/L)	Minimum Detection (mg/L)	Average (mg/L)	Marine WQC: Acute (mg/L)	Chronic (mg/L)
Volatile Organic Compounds											
Trichloroethene	NV	8/8	660	ND (0.22)	228	4/4	290	14	128	2.0	NV
Tetrachloroethene	0.057	8/8	3000	1.4	1301	4/4	68	8.3	40	10.2	0.45
1,1-Dichloroethene	NV	2/8	3.6	ND (0.22)	1.6	NA	-	-	-	224	NV
cis-1,2-Dichloroethene	NV	8/8	380	1.3	128	NA	-	-	-	224	NV
Ethylbenzene	0.010	1/8	13	ND (0.22)	2.5	NA	-	-	-	0.43	NV
m,p-Xylene	0.040	1/8	14	ND (0.44)	3.4	NA	-	-	-	NV	NV
trans-1,2-Dichloroethene	NV	1/8	1.4	ND (0.22)	1.3	1/4	ND (5.0)	0.48	1.5	224	NV
Vinyl chloride	NV	5/8	20	0.94	7.3	3/4	24	ND (1.0)	11	NV	NV
Semi-Volatile Organic Compounds											
Hexachlorobenzene	0.022	8/8	10	2	5.8	2/4	33	ND (0.0050)	0.013	0.16	0.129
Hexachlorobutadiene	0.011	8/8	180	6.5	63	4/4	0.45	0.086	0.21	0.032	NV
Acenaphthene	0.50	8/8	2.4	0.24	0.95	NA	-	-	-	0.97	0.71
Chrysene	2.8	8/8	1.3	0.38	0.81	NA	-	-	-	0.3	NV
Fluoranthene	2.50	8/8	5	0.78	2.5	NA	-	-	-	0.04	0.016
Naphthalene	2.1	8/8	8.8	0.38	2.7	NA	-	-	-	2.35	NV
Phenanthrene	1.5	8/8	5.3	1.1	3.2	NA	-	-	-	0.0077	0.0046
Pyrene	3.3	8/8	4.2	0.69	2	NA	-	-	-	0.3	NV
1,2,4-Trichlorobenzene	0.051	1/8	0.042	ND (0.025)	0.09	NA	-	-	-	0.16	0.129
1,4-Dichlorobenzene	0.11	0/8	ND (0.30)	ND (0.020)	-	NA	-	-	-	1.97	NV
2,4-Dimethylphenol	0.029	2/8	1.2	ND (0.020)	0.32	NA	-	-	-	NV	NV
2-Methylnaphthalene	0.67	8/8	2.8	0.21	1.1	NA	-	-	-	2.35	NV
2-Methylphenol	0.063	1/8	0.29	ND (0.020)	0.12	NA	-	-	-	NV	NV
4-Methylphenol	0.063	2/8	0.87	ND (0.020)	0.26	NA	-	-	-	NV	NV
Acenaphthylene	1.3	1/8	0.025	ND (0.025)	0.088	NA	-	-	-	NV	NV
Anthracene	0.96	8/8	0.61	0.12	0.34	NA	-	-	-	NV	NV
benzo(a)Anthracene	1.6	8/8	1.1	0.22	0.54	NA	-	-	-	0.3	NV
benzo(a)Pyrene	1.6	8/8	0.59	0.14	0.32	NA	-	-	-	0.3	NV
benzo(b)Fluoranthene	3.6	8/8	1.1	0.27	0.55	NA	-	-	-	0.3	NV
benzo(g,h,i)Perylene	0.72	5/8	0.32	0.069	0.16	NA	-	-	-	NV	NV
benzo(k)Fluoranthene	3.6	8/8	0.89	0.16	0.44	NA	-	-	-	0.3	NV
bis(2-Ethylhexyl) phthalate	1.3	8/8	2.3	0.17	0.73	NA	-	-	-	NV	NV

TABLE 3.9

STATISTICAL SUMMARY OF CHEMICAL CHARACTERIZATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

		Sediment Characterization Samples				*Porewater Profile Samples*				*Marine WQC*	
Compounds Detected	*SQOs (mg/kg)*	*Number of Detections*	*Maximum Detection (mg/kg)*	*Minimum Detection (mg/kg)*	*Average[1] (mg/kg)*	*Number of Detections*	*Maximum Detection (mg/L)*	*Minimum Detection (mg/L)*	*Average (mg/L)*	*Acute (mg/L)*	*Chronic (mg/L)*
Semi-Volatile Organic Compounds (Cont'd)											
Carbazole	NV	3/8	0.56	0.056	0.16	NA	-	-	-	NV	NV
dibenz(a,h)Anthracene	0.23	1/8	0.069	ND (0.025)	0.093	NA	-	-	-	0.3	NV
Dibenzofuran	0.54	8/8	1.3	0.19	0.6	NA	-	-	-	NV	NV
Fluorene	0.54	8/8	2	0.25	0.92	NA	-	-	-	0.3	NV
indeno(1,2,3-cd)Pyrene	0.69	5/8	0.35	0.075	0.17	NA	-	-	-	0.3	NV
Pentachlorophenol	0.36	1/8	0.33	ND (0.099)	0.46	NA	-	-	-	0.013	0.0079
Phenol	0.42	5/8	2.9	ND (0.020)	0.77	NA	-	-	-	5.8	NV
PCBs											
Aroclor 1254	0.15	0/8	ND (3.6)	ND (0.020)	-	NA	-	-	-	0.010	0.00003
Aroclor 1260	0.15	2/8	0.95	ND (0.20)	0.51	NA	-	-	-	0.010	0.00003
Tentatively Identified Compounds											
Dichlorobutadiene	NV	2/8	81J	7J	11J	-	-	-	-	NV	NV
Trichlorobutadiene	NV	5/8	120J	26J	30J	-	-	-	-	NV	NV
Tetrachlorobutadiene[2]	NV	8/8	1600J	30J	427J	3/4	1.8J	0.12J	0.86J	NV	NV
Pentachlorobutadiene	NV	7/8	880J	15	276J	-	-	-	-	NV	NV
Metals											
Aluminum	NV	8/8	18000	9400	13800	NA	-	-	-	NV	NV
Arsenic	57	4/8	30	ND (9)	16	NA	-	-	-	0.069	0.036
Barium	NV	8/8	72	40	51	NA	-	-	-	NV	NV
Beryllium	NV	8/8	1.1	0.2	0.59	NA	-	-	-	0.0053	NV
Cadmium	5.1	2/8	1	0.4	0.41	NA	-	-	-	0.042	0.0093
Calcium	NV	8/8	86000	29000	52500	NA	-	-	-	NV	NV
Chromium	NV	8/8	49	17	27	NA	-	-	-	1.1	0.05
Cobalt	NV	8/8	14	4.2	8.6	NA	-	-	-	NV	NV
Copper	390	8/8	74	32	54	NA	-	-	-	0.0048	0.0031
Iron	NV	8/8	22000	8200	14900	NA	-	-	-	1.0	NV
Lead	450	8/8	200	59	138	NA	-	-	-	0.21	0.0081
Magnesium	NV	8/8	86000	36000	55000	NA	-	-	-	NV	NV

TABLE 3.9

STATISTICAL SUMMARY OF CHEMICAL CHARACTERIZATION DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

		Sediment Characterization Samples				*Porewater Profile Samples*				*Marine WQC*	
Compounds Detected	*SQOs (mg/kg)*	*Number of Detections*	*Maximum Detection (mg/kg)*	*Minimum Detection (mg/kg)*	*Average[1] (mg/kg)*	*Number of Detections*	*Maximum Detection (mg/L)*	*Minimum Detection (mg/L)*	*Average (mg/L)*	*Acute (mg/L)*	*Chronic (mg/L)*
Metals (Cont'd)											
Manganese	NV	8/8	370	120	203	NA	-	-	-	NV	NV
Mercury	0.59	7/8	0.4	0.13	0.24	NA	-	-	-	0.0018	0.00094
Nickel	<140	8/8	90	23	41	NA	-	-	-	0.074	0.0082/0.000025
Potassium	NV	8/8	3800	810	1725	NA	-	-	-	NV	NV
Selenium	NV	7/8	30	10	18	NA	-	-	-	0.29	0.071
Silver	6.1	0/8	ND (1.0)	ND (0.5)	-	NA	-	-	-	0.0019	NV
Sodium	NV	8/8	96000	13000	43500	NA	-	-	-	NV	NV
Thallium	NV	2/8	30	ND (9)	11	NA	-	-	-	2.13	NV
Vanadium	NV	8/8	120	29	53	NA	-	-	-	NV	NV
Zinc	410	8/8	240	59	133	NA	-	-	-	0.090	0.081
General Chemistry											
pH (s.u.)		8/8	11	8.8	9.7	NA	-	-	-		
Total Cyanide (mg/kg)		6/8	1.6	0.54	0.86	NA	-	-	-		
Total Oil & Grease (mg/kg)		7/8	5,700	ND (460)	2,879	NA	-	-	-		
Total Solids (%)		8/8	33	25	32	NA	-	-	-		
Ammonia as N (mg/L)		NA	-	-	-	4/4	38	9.9	24		
Nitrate as N (mg/L)		NA	-	-	-	0/3	ND (0.10)	ND (0.10)	-		
Nitrite as N (mg/L)		NA	-	-	-	1/3	0.65	ND (0.10)	0.25		
Sulfate (mg/L)		NA	-	-	-	3/3	1,700	650	1,283		
Sulfide (mg/L)		NA	-	-	-	2/4	72	ND (4.0)	22		
Miscellaneous											
Asbestos (weight %)		8/8	2.3	0.38	1.04	NA	-	-	-		

Notes:
(1) All non-detect results, except TICs, were averaged at half the detection limit. Averages were calculated using data presented in Table 5.1
(2) Sediment concentrations were recalculated based on a TCBD internal standard analyzed several months after the samples were analyzed.
- Not applicable.
J Associated value is estimated.
NA Not analyzed.
ND Non-detect at associated value.
NV No Value.
PCBs Polychlorinated Biphenyls.
SQOs Sediment Quality Objectives.
s.u. Standard Units.
TICs Tentatively Identified Compounds.
WQC Water Quality Criteria.

TABLE 3.10

TOTAL ORGANIC CARBON
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Location	*Depth (Ft. BML)*	*Matrix*	*Total Organic Carbon (mg/kg)*
29-09	0.8-0.9	A	14,000
31-07	2.4-2.5	A	9,300
31-07	5.6-5.7	B	10,000
31-07	6.4-6.5	C	960
30-06	0-2	A/B	21,000
30-06	2-4	B	7,700
30-06	4-6	B	5,800
30-06	6-8	C	1,500
34-07	0-2	A/Precipitant	8,600
34-07	2-4	Precipitant	13,000
34-07	4-6	Precipitant	10,000
34-07	6-8	Precipitant	14,000
34-07	8-10	Precipitant	16,000
34-07	10-12	C	1,400

Notes:
A Recent natural sediment.
B Visual Area 5106-like material.
C Native sediment.
BML Below Mudline.

TABLE 3:11
ESTMATED TCLP CONCENTRATIONS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Compounds Detected	*Average Sediment Concentration (mg/kg)*	*Estimated TCLP* Concentration (mg/L)*	*TCLP Disposal Criteria (mg/L)*
Volatile Organic Compounds			
Trichloroethene	228	11.4	0.5
Tetrachloroethene	1301	65.05	0.7
1,1-Dichloroethene	1.6	0.08	0.7
cis-1,2-Dichloroethene	128	6.4	NS
Ethylbenzene	2.5	0.125	NS
m,p-Xylene	3.4	0.17	NS
trans-1,2-Dichloroethene	1.3	0.065	NS
Vinyl chloride	7.3	0.365	0.2
Semi-Volatile Organic Compounds			
Hexachlorobenzene	5.8	0.29	0.13
Hexachlorobutadiene	63	3.15	0.5
Acenaphthene	0.95	0.0475	NS
Chrysene	0.81	0.0405	NS
Fluoranthene	2.5	0.125	NS
Naphthalene	2.7	0.135	NS
Phenanthrene	3.2	0.16	NS
Pyrene	2	0.1	NS
1,2,4-Trichlorobenzene	0.09	0.0045	NS
2,4-Dimethylphenol	0.32	0.016	NS
2-Methylnaphthalene	1.1	0.055	NS
2-Methylphenol	0.12	0.006	NS
4-Methylphenol	0.26	0.013	NS
Acenaphthylene	0.088	0.0044	NS
Anthracene	0.34	0.017	NS
benzo(a)Anthracene	0.54	0.027	NS
benzo(a)Pyrene	0.32	0.016	NS
benzo(b)Fluoranthene	0.55	0.0275	NS
benzo(g,h,i)Perylene	0.16	0.008	NS
benzo(k)Fluoranthene	0.44	0.022	NS
bis(2-Ethylhexyl) phthalate	0.73	0.0365	NS
Carbazole	0.16	0.008	NS
dibenz(a,h)Anthracene	0.093	0.008	NS
Dibenzofuran	0.6	0.00465	NS
Fluorene	0.92	0.03	NS
indeno(1,2,3-cd)Pyrene	0.17	0.0085	NS
Pentachlorophenol	0.46	0.023	100.0
Phenol	0.77	0.0385	NS
PCBs			
Aroclor 1260	0.51	0.0255	NS

TABLE 3:11
ESTMATED TCLP CONCENTRATIONS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Compounds Detected	*Average Sediment Concentration (mg/kg)*	*Estimated TCLP* Concentration (mg/L)*	*TCLP Disposal Criteria (mg/L)*
Metals			
Aluminum	13800	690	NS
Arsenic	16	0.8	5.0
Barium	51	2.55	100.0
Beryllium	0.59	0.0295	NS
Cadmium	0.41	0.0205	1.0
Calcium	52500	2625	NS
Chromium	27	1.35	5.0
Cobalt	8.6	0.43	NS
Copper	54	2.7	NS
Iron	14900	745	NS
Lead	138	6.9	5.0
Magnesium	55000	2750	NS
Manganese	203	10.15	NS
Mercury	0.24	0.012	0.2
Nickel	41	2.05	NS
Potassium	1725	86.25	NS
Selenium	18	0.9	1.0
Sodium	43500	2175	NS
Thallium	11	0.55	NS
Vanadium	53	2.65	NS
Zinc	133	6.65	NS
General Chemistry			
pH (s.u.)	9.7	0.485	NS
Total Cyanide (mg/kg)	0.86	0.043	NS
Total Oil & Grease (mg/kg)	2879	144	NS
Total Solids (%)	32	1.6	NS
Miscellaneous			
Asbestos (weight %)	1.04	0.052	NS

Notes:

*	(Average concentration)/20
NA	Not applicable
NS	No standard
PCBs	Polychlorinated Biphenyls
s.u.	Standard Units
TCLP	Toxicity Characteristic Leaching Procedure
[ ]	Potential exceedance of TCLP Disposal Criteria

TABLE 3.12

POREWATER CONCENTRATIONS VERSUS MWQ CRITERIA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Compounds Detected	*Average Porewater Concentration (mg/L)*	*Marine WQC (mg/L)*
Volatile Organic Compounds		
Trichloroethene	128	2.0 (1)
Tetrachloroethene	40	0.45 (1)
trans-1,2-Dichloroethene	1.5	224 (1)
Vinyl chloride	11	NS
Semi-Volatile Organic Compounds		
Hexachlorobenzene	0.013	0.129 (3)
Hexachlorobutadiene	0.21	0.032 (1)
Tetrachlorobutadiene	0.86	NS
General Chemistry		
Ammonia as N (mg/L)	24	3.9 (2)
Nitrite as N (mg/L)	0.25	NS
Sulfate (mg/L)	1,283	NS
Sulfide (mg/L)	22	0.002 (2)

Notes:

(1) USEPA Quality Criteria for Water, EPA-440/5-86-001, May 1986, 51 FR 43665.

(2) USEPA National Toxic Rule (NTR), 51 FR 60848, Dec. 22, 1992. (Note: Metals criteria are expressed as total recoverable.)

(3) Lowest Observed Effect Level (LOEL).

[ ] Exceedance of relevant MWQ criteria.

N Nitrogen.

ND Non-detect at associated value.

NS No standard.

WQC Chronic Marine Water Quality Criteria Protective of Salt Water. Acute criteria where there is no chronic.

TABLE 3.13

LOCATIONS WHERE FIBROUS MATERIAL OBSERVED
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Fill	*Visual Area 5106-Like Material*
35.5 - 07	29 - 12
36 - 06	31 - 05
36.5 - 07	31 - 07
	31 - 09
	31 - 10
	32 - 06
	32 - 08
	32 - 11
	33 - 10
	33 - 14
	34 - 04
	35 - 08
	36 - 07

TABLE 3.14

DREDGING ELUTRIATE TEST ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			28.5-08/34.5-08	30.5-08/32.5-08
Sample Id:			DRET-062698-STI-002	DRET-062698-STI-001
Sample Date:			06/09/1998	06/09/1998
Parameters	Units	MWQ		
Volatile Organics				
1,1,1-Trichloroethane	ug/l	31200	ND 5.0	ND 5.0
1,1,2,2-Tetrachloroethane	ug/l	9020	ND 5.0	ND 5.0
1,1,2-Trichloroethane	ug/l	9400	ND 5.0	ND 5.0
1,1-Dichloroethane	ug/l	--	ND 5.0	ND 5.0
1,1-Dichloroethene	ug/l	224000	ND 5.0	ND 5.0
1,2-Dichloroethane	ug/l	113000	ND 5.0	ND 5.0
1,2-Dichloroethene (Total)	ug/l	224000	ND 5.0	ND 5.0
1,2-Dichloropropane	ug/l	3040	ND 5.0	ND 5.0
2-Butanone	ug/l	--	4.3 J	3.6 J
2-Hexanone	ug/l	--	ND 5.0	ND 5.0
4-Methyl-2-pentanone (MIBK)	ug/l	--	ND 5.0	ND 5.0
Acetone	ug/l	--	ND 10	ND 10
Benzene	ug/l	700	ND 5.0	ND 5.0
Bromodichloromethane	ug/l	6400	ND 5.0	ND 5.0
Bromoform	ug/l	6400	ND 5.0	ND 5.0
Bromomethane	ug/l	6400	ND 5.0	ND 5.0
Carbon disulfide	ug/l	--	ND 5.0	ND 5.0
Carbon tetrachloride	ug/l	50000	ND 5.0	ND 5.0
Chlorobenzene	ug/l	129	ND 5.0	ND 5.0
Chloroethane	ug/l	--	ND 5.0	ND 5.0
Chloroform	ug/l	--	ND 5.0	ND 5.0
Chloromethane	ug/l	--	ND 5.0	ND 5.0
cis-1,3-Dichloropropene	ug/l	3040	ND 5.0	ND 5.0
Dibromochloromethane	ug/l	--	ND 5.0	ND 5.0
Ethylbenzene	ug/l	430	ND 5.0	ND 5.0
Methylene chloride	ug/l	6400	ND 10	ND 10
Styrene	ug/l	--	ND 5.0	ND 5.0
Tetrachloroethene	ug/l	450	ND 5.0	5.5
Toluene	ug/l	5000	ND 5.0	ND 5.0
trans-1,3-Dichloropropene	ug/l	--	ND 5.0	ND 5.0
Trichloroethene	ug/l	2000	ND 5.0	4.8 J
Vinyl chloride	ug/l	--	ND 5.0	ND 5.0
Xylenes	ug/l	--	ND 5.0	ND 5.0
Semi-Volatiles				
1,2,4-Trichlorobenzene	ug/l	129	ND 10	ND 10

TABLE 3.14

DREDGING ELUTRIATE TEST ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			28.5-08/34.5-08	30.5-08/32.5-08
Sample Id:			DRET-062698-STI-002	DRET-062698-STI-001
Sample Date:			06/09/1998	06/09/1998
Parameters	Units	MWQ		
Semi-Volatiles (Cont'd)				
1,2-Dichlorobenzene	ug/l	1970	ND 10	ND 10
1,3-Dichlorobenzene	ug/l	1970	ND 10	ND 10
1,4-Dichlorobenzene	ug/l	1970	ND 10	ND 10
2,2'-Oxybis(1-chloropropane)	ug/l	--	ND 10	ND 10
2,4,5-Trichlorophenol	ug/l	--	ND 10	ND 10
2,4,6-Trichlorophenol	ug/l	--	ND 10	ND 10
2,4-Dichlorophenol	ug/l	--	ND 10	ND 10
2,4-Dimethylphenol	ug/l	2120	5.7 J	ND 10
2,4-Dinitrophenol	ug/l	--	ND 50	ND 50
2,4-Dinitrotoluene	ug/l	370	ND 10	ND 10
2,6-Dinitrotoluene	ug/l	370	ND 10	ND 10
2-Chloronaphthalene	ug/l	7.5	ND 10	ND 10
2-Chlorophenol	ug/l	--	ND 10	ND 10
2-Methylnaphthalene	ug/l	--	ND 10	7.8 J
2-Methylphenol	ug/l	--	ND 10	ND 10
2-Nitroaniline	ug/l	--	ND 50	ND 50
2-Nitrophenol	ug/l	4850	ND 10	ND 10
3,3'-Dichlorobenzidine	ug/l	--	ND 20	ND 20
3-Nitroaniline	ug/l	--	ND 50	ND 50
4,6-Dinitro-2-methylphenol	ug/l	--	ND 50	ND 50
4-Bromophenyl-phenylether	ug/l	--	ND 10	ND 10
4-Chloro-3-methylphenol	ug/l	--	ND 20	ND 20
4-Chloroaniline	ug/l	--	ND 20	ND 20
4-Chlorophenyl-phenylether	ug/l	--	ND 10	ND 10
4-Methylphenol	ug/l	--	5.7 J	6.7 J
4-Nitroaniline	ug/l	--	ND 50	ND 50
4-Nitrophenol	ug/l	4850	ND 50	ND 50
Acenaphthene	ug/l	710	ND 10	8.3 J
Acenaphthylene	ug/l	300	ND 10	ND 10
Anthracene	ug/l	--	ND 10	ND 10
benzo(a)Anthracene	ug/l	300	ND 10	ND 10
benzo(a)Pyrene	ug/l	300	ND 10	ND 10
benzo(b)Fluoranthene	ug/l	300	ND 10	ND 10
benzo(g,h,i)Perylene	ug/l	--	ND 10	ND 10
benzo(k)Fluoranthene	ug/l	300	ND 10	ND 10
bis(2-chloroethoxy)Methane	ug/l	6400	ND 10	ND 10
bis(2-ethylhexyl)Phthalate	ug/l	360	ND 10	ND 10

TABLE 3.14

DREDGING ELUTRIATE TEST ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			28.5-08/34.5-08	30.5-08/32.5-08
Sample Id:			DRET-062698-STI-002	DRET-062698-STI-001
Sample Date:			06/09/1998	06/09/1998
Parameters	Units	MWQ		
Semi-Volatiles (Cont'd)				
bis-(2-chloroethyl) Ether	ug/l	--	ND 10	ND 10
Butylbenzylphthalate	ug/l	3.4	ND 10	ND 10
Carbazole	ug/l	--	ND 10	ND 10
Chrysene	ug/l	300	ND 10	ND 10
di-N-Butylphthalate	ug/l	3.4	ND 10	ND 10
di-N-Octylphthalate	ug/l	360	ND 10	ND 10
dibenz(a,h)Anthracene	ug/l	300	ND 10	ND 10
Dibenzofuran	ug/l	--	ND 10	ND 10
Diethylphthalate	ug/l	3.4	ND 10	ND 10
Dimethylphthalate	ug/l	3.4	ND 10	ND 10
Fluoranthene	ug/l	16	ND 10	ND 10
Fluorene	ug/l	300	ND 10	ND 10
Hexachlorobenzene	ug/l	129	ND 10	ND 10
Hexachlorobutadiene	ug/l	32	ND 10	7.0 J
Hexachlorocyclopentadiene	ug/l	--	ND 10	ND 10
Hexachloroethane	ug/l	940	ND 10	ND 10
indeno(1,2,3-cd)Pyrene	ug/l	300	ND 10	ND 10
Isophorone	ug/l	12900	ND 10	ND 10
N-Nitroso-di-N-propylamine	ug/l	3300000	ND 10	ND 10
N-Nitrosodiphenylamine	ug/l	3300000	ND 10	ND 10
Naphthalene	ug/l	2350	ND 10	89
Nitrobenzene	ug/l	6680	ND 10	ND 10
Pentachlorophenol	ug/l	7.9	ND 50	ND 50
Phenanthrene	ug/l	4.6	ND 10	ND 10
Phenol	ug/l	5800	11	ND 10
Pyrene	ug/l	300	ND 10	ND 10
Pesticides				
4,4'-DDD	ug/l	3.6	ND 0.05	ND 0.05
4,4'-DDE	ug/l	14	ND 0.05	ND 0.05
4,4'-DDT	ug/l	0.001	ND 0.05	ND 0.05
Aldrin	ug/l	1.3	ND 0.05	ND 0.05
alpha-BHC	ug/l	0.34	ND 0.05	ND 0.05
beta-BHC	ug/l	0.34	ND 0.05	ND 0.05
Chlordane	ug/l	--	ND 0.05	ND 0.05
delta-BHC	ug/l	0.34	ND 0.05	ND 0.05

TABLE 3.14

DREDGING ELUTRIATE TEST ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			28.5-08/34.5-08	30.5-08/32.5-08
Sample Id:			DRET-062698-STI-002	DRET-062698-STI-001
Sample Date:			06/09/1998	06/09/1998
Parameters	Units	MWQ		
Pesticides (Cont'd)				
Dieldrin	ug/l	0.0019	ND 0.05	ND 0.05
Endosulfan I	ug/l	0.0087	ND 0.05	ND 0.05
Endosulfan II	ug/l	0.0087	ND 0.05	ND 0.05
Endosulfan sulfate	ug/l	--	ND 0.05	ND 0.05
Endrin	ug/l	0.0023	ND 0.05	ND 0.05
Endrin aldehyde	ug/l	--	ND 0.05	ND 0.05
Endrin ketone	ug/l	--	ND 0.05	ND 0.05
gamma-BHC (lindane)	ug/l	0.16	ND 0.05	ND 0.05
Heptachlor	ug/l	0.0036	ND 0.05	ND 0.05
Heptachlor epoxide	ug/l	0.0036	ND 0.05	ND 0.05
Methoxychlor	ug/l	0.03	ND 0.05	ND 0.05
Toxaphene	ug/l	0.0002	ND 1.0	ND 1.0
PCBs				
Aroclor 1016	ug/l	0.03	ND 1.0	ND 1.0
Aroclor 1221	ug/l	0.03	ND 1.0	ND 1.0
Aroclor 1232	ug/l	0.03	ND 1.0	ND 1.0
Aroclor 1242	ug/l	0.03	ND 1.0	ND 1.0
Aroclor 1248	ug/l	0.03	ND 1.0	ND 1.0
Aroclor 1254	ug/l	0.03	ND 1.0	ND 1.0
Aroclor 1260	ug/l	0.03	ND 1.0	ND 1.0
Tentatively Identified - VOCs				
Pentachlorobutadiene	ug/l	--	ND	5.8 J
Tetrachlorobutadiene	ug/l	--	ND	440
Metals				
Aluminum	ug/l	--	116	ND 100
Antimony	ug/l	500	11.3	ND 5
Arsenic	ug/l	36	22.4	7.6
Barium	ug/l	--	30.8	19.2
Beryllium	ug/l	--	ND 2	ND 2
Cadmium	ug/l	9.3	ND 5	ND 5
Calcium	ug/l	--	268000	280000

TABLE 3.14

DREDGING ELUTRIATE TEST ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			28.5-08/34.5-08	30.5-08/32.5-08
Sample Id:			DRET-062698-STI-002	DRET-062698-STI-001
Sample Date:			06/09/1998	06/09/1998
Parameters	Units	MWQ		
Metals (Cont'd)				
Chromium	ug/l	50	ND 5	ND 5
Cobalt	ug/l	--	ND 5	ND 5
Copper	ug/l	2.9	ND 5	8.2
Iron	ug/l	--	ND 50	51.3
Lead	ug/l	8.1	ND 3	ND 3
Magnesium	ug/l	--	913000	938000
Manganese	ug/l	--	8.2	21.8
Mercury	ug/l	0.025	ND 0.2	0.2
Nickel	ug/l	8.3	11.5	ND 5
Potassium	ug/l	--	326000	311000
Selenium	ug/l	71	ND 5	ND 5
Silver	ug/l	0.92	1.6	ND 1
Sodium	ug/l	--	8940000	9300000
Thallium	ug/l	2130	ND 5	ND 5
Vanadium	ug/l	--	7.1	ND 5
Zinc	ug/l	86	ND 50	50.5
General Chemistry				
Oil & Grease	mg/l	--	ND 4.5	ND 6.9
Total cyanide	ug/l	1.0	ND 10	ND 10

TABLE 3.15

MODIFIED ELUTRIATE TEST ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			30-06	30-06	34-07	34-07
Sample Id:			MED-050198-KVE-002	MET-050198-KVE-002	MED-043098-KVE-001	MET-043098-KVE-001
Sample Date:			05/01/1998	05/01/1998	04/30/1998	04/30/1998
Parameters	Units	MWQ				
Volatile Organics						
1,1,1-Trichloroethane	ug/l	31200	ND 5.0	ND 5.0	ND 5.0	ND 5.0
1,1,2,2-Tetrachloroethane	ug/l	9020	ND 5.0	ND 5.0	ND 5.0	ND 5.0
1,1,2-Trichloroethane	ug/l	9400	ND 5.0	ND 5.0	ND 5.0	ND 5.0
1,1-Dichloroethane	ug/l	--	ND 5.0	ND 5.0	ND 5.0	ND 5.0
1,1-Dichloroethene	ug/l	224000	9.9	9.4	ND 5.0	ND 5.0
1,2-Dichloroethane	ug/l	113000	ND 5.0	ND 5.0	ND 5.0	ND 5.0
1,2-Dichloroethene (Total)	ug/l	224000	1600	1400	26	28
1,2-Dichloropropane	ug/l	3040	ND 5.0	ND 5.0	ND 5.0	ND 5.0
2-Butanone	ug/l	--	7.3	ND 5.0	ND 5.0	4.1 J
2-Hexanone	ug/l	--	ND 5.0	ND 5.0	ND 5.0	ND 5.0
4-Methyl-2-pentanone (MIBK)	ug/l	--	4.3 J	4.2 J	ND 5.0	ND 5.0
Acetone	ug/l	--	15	14	19	19
Benzene	ug/l	700	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Bromodichloromethane	ug/l	6400	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Bromoform	ug/l	6400	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Bromomethane	ug/l	6400	ND 10	ND 10	ND 10	ND 10
Carbon disulfide	ug/l	--	6.5	3.8 J	31	6.3
Carbon tetrachloride	ug/l	50000	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Chlorobenzene	ug/l	129	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Chloroethane	ug/l	--	ND 10	ND 10	ND 10	ND 10
Chloroform	ug/l	--	6.6	6.4	ND 5.0	ND 5.0
Chloromethane	ug/l	--	ND 10	ND 10	ND 10	ND 10
cis-1,3-Dichloropropene	ug/l	3040	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Dibromochloromethane	ug/l	--	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Ethylbenzene	ug/l	430	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Methylene chloride	ug/l	6400	36	33	ND 10	ND 10
Styrene	ug/l	--	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Tetrachloroethene	ug/l	450	2700	2600	300	300
Toluene	ug/l	5000	ND 5.0	ND 5.0	ND 5.0	ND 5.0
trans-1,3-Dichloropropene	ug/l	--	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Trichloroethene	ug/l	2000	3100	2800	140	150
Vinyl chloride	ug/l	--	30	27	ND 5.0	ND 5.0
Xylenes	ug/l	--	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Semi-Volatiles						
1,2,4-Trichlorobenzene	ug/l	129	ND 10	ND 10	ND 10	ND 10

TABLE 3.15

MODIFIED ELUTRIATE TEST ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			30-06	30-06	34-07	34-07
Sample Id:			MED-050198-KVE-002	MET-050198-KVE-002	MED-043098-KVE-001	MET-043098-KVE-001
Sample Date:			05/01/1998	05/01/1998	04/30/1998	04/30/1998
Parameters	Units	MWQ				
Semi-Volatiles (Cont'd)						
1,2-Dichlorobenzene	ug/l	1970	ND 10	ND 10	ND 10	ND 10
1,3-Dichlorobenzene	ug/l	1970	ND 10	ND 10	ND 10	ND 10
1,4-Dichlorobenzene	ug/l	1970	ND 10	ND 10	ND 10	ND 10
2,2'-Oxybis(1-chloropropane)	ug/l	--	ND 10	ND 10	ND 10	ND 10
2,4,5-Trichlorophenol	ug/l	--	ND 10	ND 10	ND 10	ND 10
2,4,6-Trichlorophenol	ug/l	--	ND 10	ND 10	ND 10	ND 10
2,4-Dichlorophenol	ug/l	--	ND 10	ND 10	ND 10	ND 10
2,4-Dimethylphenol	ug/l	2120	ND 10	ND 10	20	21
2,4-Dinitrophenol	ug/l	--	ND 50	ND 50	ND 50	ND 50
2,4-Dinitrotoluene	ug/l	370	ND 10	ND 10	ND 10	ND 10
2,6-Dinitrotoluene	ug/l	370	ND 10	ND 10	ND 10	ND 10
2-Chloronaphthalene	ug/l	7.5	ND 10	ND 10	ND 10	ND 10
2-Chlorophenol	ug/l	--	ND 10	ND 10	ND 10	ND 10
2-Methylnaphthalene	ug/l	--	ND 10	ND 10	5.5 J	5.4 J
2-Methylphenol	ug/l	--	ND 10	ND 10	6.2 J	6.1 J
2-Nitroaniline	ug/l	--	ND 50	ND 50	ND 50	ND 50
2-Nitrophenol	ug/l	4850	ND 10	ND 10	ND 10	ND 10
3,3'-Dichlorobenzidine	ug/l	--	ND 20	ND 20	ND 20	ND 20
3-Nitroaniline	ug/l	--	ND 50	ND 50	ND 50	ND 50
4,6-Dinitro-2-methylphenol	ug/l	--	ND 50	ND 50	ND 50	ND 50
4-Bromophenyl-phenylether	ug/l	--	ND 10	ND 10	ND 10	ND 10
4-Chloro-3-methylphenol	ug/l	--	ND 20	ND 20	ND 20	ND 20
4-Chloroaniline	ug/l	--	ND 20	ND 20	ND 20	ND 20
4-Chlorophenyl-phenylether	ug/l	--	ND 10	ND 10	ND 10	ND 10
4-Methylphenol	ug/l	--	ND 10	ND 10	15	15
4-Nitroaniline	ug/l	--	ND 50	ND 50	ND 50	ND 50
4-Nitrophenol	ug/l	4850	ND 50	ND 50	ND 50	ND 50
Acenaphthene	ug/l	710	ND 10	ND 10	5.4 J	5.2 J
Acenaphthylene	ug/l	300	ND 10	ND 10	ND 10	ND 10
Anthracene	ug/l	--	ND 10	ND 10	ND 10	ND 10
benzo(a)Anthracene	ug/l	300	ND 10	ND 10	ND 10	ND 10
benzo(a)Pyrene	ug/l	300	ND 10	ND 10	ND 10	ND 10
benzo(b)Fluoranthene	ug/l	300	ND 10	ND 10	ND 10	ND 10
benzo(g,h,i)Perylene	ug/l	--	ND 10	ND 10	ND 10	ND 10
benzo(k)Fluoranthene	ug/l	300	ND 10	ND 10	ND 10	ND 10
bis(2-chloroethoxy)Methane	ug/l	6400	ND 10	ND 10	ND 10	ND 10
bis(2-ethylhexyl)Phthalate	ug/l	360	ND 10	ND 10	ND 10	ND 10

TABLE 3.15

MODIFIED ELUTRIATE TEST ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			30-06	30-06	34-07	34-07
Sample Id:			MED-050198-KVE-002	MET-050198-KVE-002	MED-043098-KVE-001	MET-043098-KVE-001
Sample Date:			05/01/1998	05/01/1998	04/30/1998	04/30/1998
Parameters	Units	MWQ				
Semi-Volatiles (Cont'd)						
bis-(2-chloroethyl) Ether	ug/l	--	ND 10	ND 10	ND 10	ND 10
Butylbenzylphthalate	ug/l	3.4	ND 10	ND 10	ND 10	ND 10
Carbazole	ug/l	--	ND 10	ND 10	ND 10	ND 10
Chrysene	ug/l	300	ND 10	ND 10	ND 10	ND 10
di-N-Butylphthalate	ug/l	3.4	ND 10	ND 10	ND 10	ND 10
di-N-Octylphthalate	ug/l	360	ND 10	ND 10	ND 10	ND 10
dibenz(a,h)Anthracene	ug/l	300	ND 10	ND 10	ND 10	ND 10
Dibenzofuran	ug/l	--	ND 10	ND 10	ND 10	ND 10
Diethylphthalate	ug/l	3.4	ND 10	ND 10	ND 10	ND 10
Dimethylphthalate	ug/l	3.4	ND 10	ND 10	ND 10	ND 10
Fluoranthene	ug/l	16	ND 10	ND 10	ND 10	ND 10
Fluorene	ug/l	300	ND 10	ND 10	ND 10	ND 10
Hexachlorobenzene	ug/l	129	ND 10	ND 10	ND 10	ND 10
Hexachlorobutadiene	ug/l	32	15	21	ND 10	ND 10
Hexachlorocyclopentadiene	ug/l	--	ND 10	ND 10	ND 10	ND 10
Hexachloroethane	ug/l	940	ND 10	ND 10	ND 10	ND 10
indeno(1,2,3-cd)Pyrene	ug/l	300	ND 10	ND 10	ND 10	ND 10
Isophorone	ug/l	12900	ND 10	ND 10	ND 10	ND 10
N-Nitroso-di-N-propylamine	ug/l	3300000	ND 10	ND 10	ND 10	ND 10
N-Nitrosodiphenylamine	ug/l	3300000	ND 10	ND 10	ND 10	ND 10
Naphthalene	ug/l	2350	11	12	45	42
Nitrobenzene	ug/l	6680	ND 10	ND 10	ND 10	ND 10
Pentachlorophenol	ug/l	7.9	ND 50	ND 50	ND 50	ND 50
Phenanthrene	ug/l	4.6	ND 10	ND 10	6.4 J	5.9 J
Phenol	ug/l	5800	5.9 J	5.7 J	47	46
Pyrene	ug/l	300	ND 10	ND 10	ND 10	ND 10
Pesticides						
4,4'-DDD	ug/l	3.6	ND 0.05	ND 0.05	ND 0.05	ND 0.05
4,4'-DDE	ug/l	14	ND 0.05	ND 0.05	ND 0.05	ND 0.05
4,4'-DDT	ug/l	0.001	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Aldrin	ug/l	1.3	ND 0.05	ND 0.05	ND 0.05	ND 0.05
alpha-BHC	ug/l	0.34	ND 0.05	ND 0.05	ND 0.05	ND 0.05
beta-BHC	ug/l	0.34	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Chlordane	ug/l	--	ND 0.05	ND 0.05	ND 0.05	ND 0.05
delta-BHC	ug/l	0.34	ND 0.05	ND 0.05	ND 0.05	ND 0.05

TABLE 3.15

MODIFIED ELUTRIATE TEST ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			30-06	30-06	34-07	34-07
Sample Id:			MED-050198-KVE-002	MET-050198-KVE-002	MED-043098-KVE-001	MET-043098-KVE-001
Sample Date:			05/01/1998	05/01/1998	04/30/1998	04/30/1998
Parameters	Units	MWQ				
Pesticides (Cont'd)						
Dieldrin	ug/l	0.0019	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Endosulfan I	ug/l	0.0087	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Endosulfan II	ug/l	0.0087	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Endosulfan sulfate	ug/l	--	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Endrin	ug/l	0.0023	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Endrin aldehyde	ug/l	--	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Endrin ketone	ug/l	--	ND 0.05	ND 0.05	ND 0.05	ND 0.05
gamma-BHC (lindane)	ug/l	0.16	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Heptachlor	ug/l	0.0036	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Heptachlor epoxide	ug/l	0.0036	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Methoxychlor	ug/l	0.03	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Toxaphene	ug/l	0.0002	ND 2.0	ND 5.0	ND 2.0	ND 5.0
PCBs						
Aroclor 1016	ug/l	0.03	ND 2.0	ND 5.0	ND 2.0	ND 5.0
Aroclor 1221	ug/l	0.03	ND 2.0	ND 5.0	ND 2.0	ND 5.0
Aroclor 1232	ug/l	0.03	ND 2.0	ND 5.0	ND 2.0	ND 5.0
Aroclor 1242	ug/l	0.03	ND 2.0	ND 5.0	ND 2.0	ND 5.0
Aroclor 1248	ug/l	0.03	ND 1.0	ND 1.0	ND 1.0	ND 1.0
Aroclor 1254	ug/l	0.03	ND 1.0	ND 1.0	ND 1.0	ND 1.0
Aroclor 1260	ug/l	0.03	ND 1.0	ND 1.0	ND 1.0	ND 1.0
Metals						
Aluminum	ug/l	--	--	ND 100	--	398
Aluminum, dissolved	ug/l	--	ND 100	--	ND 100	--
Antimony	ug/l	500	--	5.1	--	8.2
Antimony, dissolved	ug/l	500	5.7	--	8.2	--
Arsenic	ug/l	36	--	7.5	--	71.3
Arsenic, dissolved	ug/l	36	7.1	--	71.0	--
Barium	ug/l	--	--	29.5	--	29.3
Barium, dissolved	ug/l	--	29.6	--	27.7	--
Beryllium	ug/l	--	--	ND 2.0	--	ND 2.0
Beryllium, dissolved	ug/l	--	ND 2.0	--	ND 2.0	--
Cadmium	ug/l	9.3	--	ND 5.0	--	ND 5.0
Cadmium, dissolved	ug/l	9.3	ND 5.0	--	ND 5.0	--

TABLE 3.15

MODIFIED ELUTRIATE TEST ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			30-06	30-06	34-07	34-07
Sample Id:			MED-050198-KVE-002	MET-050198-KVE-002	MED-043098-KVE-001	MET-043098-KVE-001
Sample Date:			05/01/1998	05/01/1998	04/30/1998	04/30/1998
Parameters	Units	MWQ				
Metals (Cont'd)						
Calcium	ug/l	--	--	346000	--	81400
Calcium, dissolved	ug/l	--	348000	--	83800	--
Chromium	ug/l	50	--	ND 5.0	--	15.7
Chromium, dissolved	ug/l	50	ND 5.0	--	15.1	--
Cobalt	ug/l	--	--	ND 5.0	--	ND 5.0
Cobalt, dissolved	ug/l	--	ND 5.0	--	ND 5.0	--
Copper	ug/l	2.9	--	ND 8.8	--	ND 19.1
Copper, dissolved	ug/l	2.9	ND 8.7	--	ND 13.8	--
Iron	ug/l	--	--	92.3	--	590
Iron, dissolved	ug/l	--	ND 50	--	93.0	--
Lead	ug/l	8.1	--	ND 3.0	--	5.8
Lead, dissolved	ug/l	8.1	ND 3.0	--	ND 3.0	--
Magnesium	ug/l	--	--	917000	--	87400
Magnesium, dissolved	ug/l	--	921000	--	89700	--
Manganese	ug/l	--	--	13.9	--	10.1
Manganese, dissolved	ug/l	--	16.2	--	ND 5.0	--
Mercury	ug/l	0.025	--	ND 0.20	--	0.20
Mercury, dissolved	ug/l	0.025	ND 0.20	--	ND 0.20	--
Nickel	ug/l	8.3	--	ND 5.0	--	10.6
Nickel, dissolved	ug/l	8.3	ND 5.0	--	9.8	--
Potassium	ug/l	--	--	329000	--	353000
Potassium, dissolved	ug/l	--	304000	--	338000	--
Selenium	ug/l	71	--	ND 5.0	--	ND 5.0
Selenium, dissolved	ug/l	71	ND 5.0	--	ND 5.0	--
Silver	ug/l	0.92	--	ND 1.0	--	ND 1.0
Silver, dissolved	ug/l	0.92	ND 1.0	--	ND 1.0	--
Sodium	ug/l	--	--	25000000	--	24900000
Sodium, dissolved	ug/l	--	14600000	--	19900000	--
Thallium	ug/l	2130	--	ND 5.0	--	ND 5.0
Thallium, dissolved	ug/l	2130	ND 5.0	--	ND 5.0	--
Vanadium	ug/l	--	--	ND 5.0	--	272
Vanadium, dissolved	ug/l	--	ND 5.0	--	283	--
Zinc	ug/l	86	--	ND 50	--	ND 50
Zinc, dissolved	ug/l	86	ND 50	--	ND 50	--

TABLE 3.15

MODIFIED ELUTRIATE TEST ANALYTICAL DATA
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Sample Location:			30-06	30-06	34-07	34-07
Sample Id:			MED-050198-KVE-002	MET-050198-KVE-002	MED-043098-KVE-001	MET-043098-KVE-001
Sample Date:			05/01/1998	05/01/1998	04/30/1998	04/30/1998
Parameters	Units	MWQ				
General Chemistry						
Oil & Grease	mg/l	--	1300 J	58 J	47	2900
Total cyanide	ug/l	1.0	ND 10	ND 10	ND 10	ND 10

TABLE 3.16

GEOTECHNICAL PROPERTIES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Location	Shelby Tube Depth (Ft. BML)	Laboratory Sample Depth (Ft. BML)	Matrix	Water Content (Percent)	Atterberg Limit LL (Percent)[1]	Atterberg Limit PL (Percent)[1]	Atterberg Limit PI (Percent)[1]	Specific Gravity	Hydraulic Conductivity (cm/s)	Wet Density (pcf)	Dry Density (pcf)	Void Ratio[2]	Porosity[2]
31-07	0 - 2	1.0 - 1.5	Recent Sediment	127	ND	ND	ND	ND	ND	ND	ND	3.493	0.777
33-07	0 - 2	1.2 - 1.5	Recent Sediment	127	ND	ND	ND	ND	9.0E-06	85	37	3.493	0.777
33-07	0 - 2	1.75 - 1.9	Recent Sediment	235.4	ND	ND	ND	ND	ND	ND	ND	6.474	0.866
33-07	4 - 6	4.6 - 5.0	Recent Sediment	74	ND	ND	ND	ND	5.0E-06	98	56	ND	ND
33-07	4 - 6	5.0 - 5.2	Recent Sediment	107.3	ND	ND	ND	ND	ND	ND	ND	2.951	0.747
33-07	2 - 4	2.8 - 3.3	Recent Sediment/Fill	252	ND	ND	ND	ND	4.0E-06	79	22	ND	ND
33-07	2 - 4	3.3 - 3.6	Recent Sediment/Visual 5106-like Material	201.1	ND	ND	ND	ND	ND	ND	ND	5.530	0.847
31-07	4 - 6	4.3 - 4.6	Recent Sediment/Visual 5106-like Material	170	141	65	76	ND	ND	ND	ND	4.675	0.824
34-06	4 - 6	4.7 - 4.9	Recent Sediment/Visual 5106-like Material	349.1	ND	ND	ND	ND	ND	ND	ND	9.600	0.906
34-06	4 - 6	5.1 - 5.5	Recent Sediment/Visual 5106-like Material	318	ND	ND	ND	ND	8.0E-06	74	18	8.745	0.897
34-06	0 - 2	0.9 - 1.4	Brown sludge	170	ND	ND	ND	ND	1.0E-05	84	31	4.675	0.824
34-06	0 - 2	1.6 - 2.0	Brown sludge	126	ND	ND	ND	ND	ND	85	ND	3.465	0.776
33-07	2 - 4	2.2 - 2.4	Fill sand	110	ND	ND	ND	ND	ND	91	37	3.025	0.752
33-07	4 - 6	5.4 - 5.9	Fill sand	42	ND	ND	ND	ND	ND	118	83	1.155	0.536
31-07	0 - 2	0.6 - 0.7	Visual 5106-like Material	-	ND	ND	ND	2.80	ND	ND	ND	ND	ND
29-09	0 - 2	0.9 - 1.4	Visual 5106-like Material	288	ND	ND	ND	ND	2.0E-06	74	19	7.920	0.888
31-07	0 - 2	1.5 - 2.0	Visual 5106-like Material	211	80	63	17	ND	ND	ND	ND	5.803	0.853
29-09	0 - 2	1.6 - 1.7	Visual 5106-like Material	280	ND	ND	ND	ND	ND	ND	ND	7.700	0.885
31-07	2 - 4	2.5 - 3.0	Visual 5106-like Material	202	ND	ND	ND	ND	7.0E-06	83	27	5.555	0.847
31-07	2 - 4	3.2 - 3.4	Visual 5106-like Material	257	ND	ND	ND	ND	ND	ND	ND	7.068	0.876
31-07	2 - 4	3.4 - 3.7	Visual 5106-like Material	201	150	80	70	ND	ND	ND	ND	5.528	0.847
31-07	4 - 6	5.1 - 5.6	Visual 5106-like Material	199	ND	ND	ND	ND	5.0E-06	82	27	5.473	0.846
29-09	4 - 6	5.2 - 5.4	Native sediment	25	ND	ND	ND	ND	ND	ND	ND	0.688	0.407
29-09	4 - 6	5.5 - 5.8	Native sediment	25	ND	ND	ND	ND	ND	126	100	0.688	0.407
31-07	6 - 8	6.5 - 7.0	Native sediment	33	ND	ND	ND	2.71	ND	120	90	0.908	0.476
31-07	6 - 8	7.0 - 7.15	Native sediment	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
31-07	6 - 8	7.15 - 7.3	Native sediment	29	ND	ND	ND	ND	6.0E-04	122	95	ND	ND
30-06	composite	—		196.5	ND	ND	ND	ND	ND	ND	27	5.404	0.844
34-07	composite	—		181	ND	ND	ND	ND	ND	ND	29	4.978	0.833

Notes:
(1) Ratio of mass of water to mass of dry solids, multiplied by 100.
(2) Calculated assuming specific gravity of 2.75.
BML Below Mudline.
ND Not Determined.
psf Pounds Per Square Foot.

TABLE 3.17

SOIL SHEAR STRENGTH DATA SUMMARY
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Borehole	*Depth of Vane Tip (Ft. BML)*	*Matrix*	*Undrained Shear Strength* [1] *(psf)*	*Strength Description*	*Remoulded Undrained Shear Strength* [1] *(psf)*
29-09	1.5	Visual 5106-like Material	43	Very Soft	17
	3	Visual 5106-like Material	32	Very Soft	11
	4.5	Visual 5106-like Material	63	Very Soft	32
	6	Visual 5106-like Material	97	Very Soft	23
31-07	1.5	Recent Sediment	86	Very Soft	29
	3	Recent Sediment	86	Very Soft	14
33-07	1.5	Sand Fill	329	Soft	29
	3	Visual 5106-like Material	229	Very Soft	43
	4.5	Visual 5106-like Material	69	Very Soft	17
	6	Visual 5106-like Material	69	Very Soft	40
	7.5	Visual 5106-like Material	86	Very Soft	29
34-06	1.5	Recent Sediment	29	Very Soft	29
	3	Recent Sediment	<3	Very Soft	<3
	5	Recent Sediment	86	Very Soft	14

Notes:
(1) Determined using in situ vane, ASTM D2573.
BML Below Mudline.
psf Pounds Per Square Foot.

TABLE 3.18

COMPRESSION CHARACTERISTICS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Location	*Matrix*	*Shelby Tube Depth* (Ft. BML)	*Lab Depth* (Ft. BML)	*Applied Pressure* (tsf)	*Initial Stress* (tsf)	*Final Stress* (tsf)	*Cumulative Strain* (%)	*Moisture Content* (%)	*Initial Void Ratio*	*Final Void Ratio*	*Coefficient of Consolidation* (C_v) (Ft^2/day)	*Volume Compressibility* (m_v)	*Hydraulic Conductivity* (k) (cm/sec)
29-09PS	Visual 5106-like Material	0 - 2	1.6 - 1.7	0.03	0	0.03	0.7	288	7.92	7.858	0.6	0.233	1.540E-06
				0.04	0.03	0.04	1		7.858	7.769	0.64	1.000	7.042E-06
				0.05	0.04	0.05	1.5		7.769	7.637	0.49	1.500	8.087E-06
				0.08	0.05	0.08	3.5		7.637	7.335	0.32	1.167	4.108E-06
				0.15	0.08	0.15	8.3		7.335	6.643	0.22	1.186	2.870E-06
				0.27	0.15	0.27	18.8		6.643	5.206	0.13	1.567	2.241E-06
				0.52	0.27	0.52	29.2		5.206	3.394	0.11	1.168	1.414E-06
				1.02	0.52	1.02	42		3.394	1.549	0.08	0.840	7.394E-07
				0.27	1.02	0.27	42.2		1.549	0.473	0.44	-0.563	-2.724E-06
				0.08	0.27	0.08	41		0.473	-0.131	0.29	-2.158	-6.886E-06
31-07PS	Recent Sediment	0 - 2	1.0 - 1.5	0.03	0	0.03	3	127	3.4925	3.358	0.27	1.000	2.971E-06
				0.04	0.03	0.04	5.4		3.358	3.122	0.06	5.400	3.565E-06
				0.05	0.04	0.05	5.8		3.122	2.883	0.15	5.800	9.573E-06
				0.08	0.05	0.08	7.7		2.883	2.584	0.08	2.567	2.259E-06
				0.15	0.08	0.15	9.7		2.584	2.237	0.11	1.386	1.677E-06
				0.27	0.15	0.27	11.2		2.237	1.874	0.66	0.933	6.778E-06
				0.52	0.27	0.52	14.3		1.874	1.463	0.34	0.572	2.140E-06
				1.02	0.52	1.02	18.1		1.463	1.017	0.36	0.362	1.434E-06
				0.27	1.02	0.27	19.1		1.017	0.632	1.92	-0.255	-5.380E-06
				0.08	0.27	0.08	18.5		0.632	0.330	0.09	-0.974	-9.642E-07
31-07PS	Visual 5106-like Material	0 - 2	1.5 - 2.0	0.03	0	0.03	1.5	211	5.8025	5.700	0.58	0.500	3.191E-06
				0.04	0.03	0.04	2.5		5.700	5.533	1.35	2.500	3.714E-05
				0.05	0.04	0.05	3.6		5.533	5.298	0.38	3.600	1.505E-05
				0.08	0.05	0.08	5.7		5.298	4.939	0.78	1.900	1.631E-05
				0.15	0.08	0.15	8.3		4.939	4.446	0.81	1.186	1.057E-05
				0.27	0.15	0.27	11.5		4.446	3.820	1.58	0.958	1.666E-05
				0.52	0.27	0.52	15.2		3.820	3.087	1.44	0.608	9.633E-06
				1.02	0.52	1.02	20		3.087	2.270	1.39	0.400	6.118E-06
				0.27	1.02	0.27	19.8		2.270	1.622	1.18	-0.264	-3.428E-06
				0.08	0.27	0.08	19.3		1.622	1.116	0.78	-1.016	-8.718E-06

TABLE 3.18

COMPRESSION CHARACTERISTICS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Location	*Matrix*	*Shelby Tube Depth* (Ft. BML)	*Lab Depth* (Ft. BML)	*Applied Pressure* (tsf)	*Initial Stress* (tsf)	*Final Stress* (tsf)	*Cumulative Strain* (%)	*Moisture Content* (%)	*Initial Void Ratio*	*Final Void Ratio*	*Coefficient of Consolidation* (C_v) (Ft^2/day)	*Volume Compressibility* (m_v)	*Hydraulic Conductivity* (k) (cm/sec)
31-07PS	Visual 5106-like Material	2 - 4	3.2 - 3.4	0.04	0	0.04	0.1	257	7.0675	7.059	1.91	0.025	5.254E-07
				0.05	0.04	0.05	0.2		7.059	7.043	4.49	0.200	9.881E-06
				0.8	0.05	0.8	0.5		7.043	7.003	0.79	0.007	5.795E-08
				0.15	0.8	0.15	0.9		7.003	6.931	1	-0.014	-1.524E-07
				0.27	0.15	0.27	1.5		6.931	6.812	1.26	0.125	1.733E-06
				0.52	0.27	0.52	3		6.812	6.578	1.32	0.120	1.743E-06
				1.02	0.52	1.02	6.7		6.578	6.070	1.19	0.134	1.755E-06
				2.02	1.02	2.02	15		6.070	5.010	1.1	0.150	1.816E-06
				4.02	2.02	4.02	26.4		5.010	3.423	0.78	0.132	1.133E-06
				1.02	4.02	1.02	25.5		3.423	2.295	1.43	-0.085	-1.337E-06
				0.27	1.02	0.27	24.3		2.295	1.494	0.3	-0.324	-1.070E-06
				0.08	0.27	0.08	23.7		1.494	0.903	0.07	-1.247	-9.607E-07
31-07PS	Recent Sediment/ Visual 5106-like Material	4 - 6	4.3 - 4.6	0.04	0	0.04	0.1	170	4.675	4.669	1.33	0.025	3.659E-07
				0.05	0.04	0.05	0.4		4.669	4.647	1.02	0.400	4.489E-06
				0.08	0.05	0.08	0.9		4.647	4.596	1.27	0.300	4.192E-06
				0.15	0.08	0.15	2.8		4.596	4.439	0.61	0.400	2.685E-06
				0.27	0.15	0.27	6.3		4.439	4.096	1.19	0.525	6.874E-06
				0.52	0.27	0.52	11.8		4.096	3.495	1.15	0.472	5.973E-06
				1.02	0.52	1.02	17.7		3.495	2.699	0.89	0.354	3.467E-06
				0.27	1.02	0.27	17.2		2.699	2.063	1.85	-0.229	-4.668E-06
				0.08	0.27	0.08	16.4		2.063	1.561	0.34	-0.863	-3.229E-06
33-07PS	Recent Sediment	0 - 2	1.75 - 1.9	0.04	0	0.04	0.2	235	6.4625	6.448	0.4	0.050	2.201E-07
				0.05	0.04	0.05	0.4		6.448	6.418	0.84	0.400	3.697E-06
				0.08	0.05	0.08	0.9		6.418	6.351	1.18	0.300	3.895E-06
				0.15	0.08	0.15	2.2		6.351	6.189	1.02	0.314	3.527E-06
				0.27	0.15	0.27	5.9		6.189	5.765	1.97	0.492	1.066E-05
				0.52	0.27	0.52	9.4		5.765	5.129	1.25	0.376	5.171E-06
				1.02	0.52	1.02	15.5		5.129	4.179	2.26	0.310	7.709E-06
				0.52	1.02	0.52	17.2		4.179	3.288	1.93	-0.344	-7.305E-06
				0.27	0.52	0.27	16.8		3.288	2.568	3.44	-0.672	-2.544E-05
				0.05	0.27	0.05	16		2.568	1.997	2.31	-0.727	-1.849E-05

TABLE 3.18

COMPRESSION CHARACTERISTICS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Location	*Matrix*	*Shelby Tube Depth* (Ft. BML)	*Lab Depth* (Ft. BML)	*Applied Pressure* (tsf)	*Initial Stress* (tsf)	*Final Stress* (tsf)	*Cumulative Strain* (%)	*Moisture Content* (%)	*Initial Void Ratio*	*Final Void Ratio*	*Coefficient of Consolidation* (C_v) (Ft^2/day)	*Volume Compressibility* (m_v)	*Hydraulic Conductivity* (k) (cm/sec)
33-07PS	Recent Sediment/ Visual 5106-like Material	2 - 4	3.3 - 3.6	0.04	0	0.04	0.05	201	5.5275	5.524	4.97	0.013	6.836E-07
				0.05	0.04	0.05	0.2		5.524	5.511	4.96	0.200	1.092E-05
				0.08	0.05	0.08	0.5		5.511	5.479	2.09	0.167	3.833E-06
				0.15	0.08	0.15	1.5		5.479	5.381	2.11	0.214	4.975E-06
				0.27	0.15	0.27	3.6		5.381	5.152	1.14	0.300	3.763E-06
				0.52	0.27	0.52	8.3		5.152	4.641	0.96	0.332	3.507E-06
				1.02	0.52	1.02	15		4.641	3.795	0.94	0.300	3.103E-06
				2.02	1.02	2.02	22.3		3.795	2.726	0.91	0.223	2.233E-06
				0.52	2.02	0.52	23.1		2.726	1.865	1.61	-0.154	-2.728E-06
				0.15	0.52	0.15	22.2		1.865	1.229	0.62	-0.600	-4.093E-06
33-07PS	Recent Sediment	4 - 6	5.0 - 5.2	0.04	0	0.04	0.6	107	2.9425	2.919	2.6	0.150	4.291E-06
				0.05	0.04	0.05	0.75		2.919	2.889	0.75	0.750	6.189E-06
				0.15	0.05	0.15	7.4		2.889	2.602	0.11	0.740	8.957E-07
				0.27	0.15	0.27	10.33		2.602	2.230	0.76	0.861	7.199E-06
				0.52	0.27	0.52	12.5		2.230	1.826	0.84	0.500	4.621E-06
				1.02	0.52	1.02	15.1		1.826	1.399	1.39	0.302	4.619E-06
				0.27	1.02	0.27	15.5		1.399	1.027	1.73	-0.207	-3.934E-06
				0.08	0.27	0.08	15		1.027	0.723	0.87	-0.789	-7.557E-06
34-06PS	Recent Sediment/ Visual 5106-like Material	4 - 6	4.7 - 4.9	0.03	0	0.03	0.33	349	9.5975	9.563	1.4	0.110	1.694E-06
				0.04	0.03	0.04	0.5		9.563	9.510	1.19	0.500	6.547E-06
				0.05	0.04	0.05	0.75		9.510	9.431	2.86	0.750	2.360E-05
				0.08	0.05	0.08	2.4		9.431	9.181	2.16	0.800	1.901E-05
				0.15	0.08	0.15	3.5		9.181	8.824	1.36	0.500	7.482E-06
				0.27	0.15	0.27	8.4		8.824	7.999	1.05	0.700	8.087E-06
				0.52	0.27	0.52	17.5		7.999	6.424	0.94	0.700	7.240E-06
				1.02	0.52	1.02	29.4		6.424	4.241	0.78	0.588	5.046E-06
				0.27	1.02	0.27	30		4.241	2.669	0.7	-0.400	-3.081E-06
				0.05	0.27	0.05	29		2.669	1.605	0.47	-1.318	-6.817E-06

TABLE 3.18

COMPRESSION CHARACTERISTICS
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Location	*Matrix*	*Shelby Tube Depth* (Ft. BML)	*Lab Depth* (Ft. BML)	*Applied Pressure* (tsf)	*Initial Stress* (tsf)	*Final Stress* (tsf)	*Cumulative Strain* (%)	*Moisture Content* (%)	*Initial Void Ratio*	*Final Void Ratio*	*Coefficient of Consolidation* (C_v) (Ft^2/day)	*Volume Compressibility* (m_v)	*Hydraulic Conductivity* (k) (cm/sec)
30-06D	Recent Sediment/ Visual 5106-like Material	composite	—	0.04	0	0.04	7.5	197	5.40375	4.923	1.23	1.875	2.538E-05
				0.05	0.04	0.05	11.7		4.923	4.230	0.13	11.700	1.674E-05
				0.08	0.05	0.08	14.5		4.230	3.472	0.34	4.833	1.808E-05
				0.15	0.08	0.15	19		3.472	2.622	0.43	2.714	1.284E-05
				0.27	0.15	0.27	24.7		2.622	1.728	0.31	2.058	7.021E-06
				0.52	0.27	0.52	30.5		1.728	0.896	0.35	1.220	4.698E-06
				1.02	0.52	1.02	36.5		0.896	0.204	0.3	0.730	2.410E-06
				0.27	1.02	0.27	37		0.204	-0.242	1.16	-0.493	-6.297E-06
				0.08	0.27	0.08	36.5		-0.242	-0.518	0.63	-1.921	-1.332E-05
34-07	Recent Sediment/ Visual 5106-like Material	composite	—	0.05	0	0.05	7	197	5.40375	4.955	0.31	1.400	4.775E-06
				0.08	0.05	0.08	7.8		4.955	4.491	1.36	2.600	3.891E-05
				0.15	0.08	0.15	10.2		4.491	3.931	0.93	1.457	1.491E-05
				0.27	0.15	0.27	12.7		3.931	3.305	2	1.058	2.329E-05
				0.52	0.27	0.52	15.7		3.305	2.629	1.71	0.628	1.182E-05
				1.02	0.52	1.02	20.3		2.629	1.892	0.84	0.406	3.753E-06
				0.27	1.02	0.27	21.1		1.892	1.282	1.47	-0.281	-4.550E-06
				0.08	0.27	0.08	20.5		1.282	0.814	0.15	-1.079	-1.781E-06

Notes:
BML Below Mudline.
tsf Tons per Square Foot.

TABLE 3.19

SUMMARY OF CONSOLIDATION ANALYSES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

	Average Total Consolidation [1] (Feet)	
	2 Ft. Sediment Thickness	*8 Ft. Sediment Thickness*
Recent Sediment	0.08	0.026
Visual 5106-like Material	0.06	0.32
Recent Sediment/Visual 5106-like Material	0.02	0.08
Fill	0.02	0.10
Native Sediment	0.007	0.008

Note:
(1) Average total consolidation based upon placement of a 2-foot thick cap over the indicated sediment thickness. At some locations, compression may be twice the tabulated values.

TABLE 5.1

SUMMARY POTENTIALLY APPLICABLE CONTAINMENT TECHNOLOGIES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Description*	*Examples*
Sand/Sediment	Placement of clean sand or sediment over an existing impacted sediments bottom, effectively sealing impacted sediments.	• Eagle Harbor, Washington • St. Paul Waterway, Washington • Hiroshima Harbor, Japan
Armored Sand	Use of varying thickness of sand layers to physically isolate impacted sediments. Cap armoring is the inclusion of gravel or light riprap to prevent erosion in high energy environments.	• North Hollywood Dump, Memphis, Tennessee • Pier 53, Washington • Hamilton Harbor, Ontario
Armored Sand over Flexible Membrane Liner	Use of sand over a flexible membrane liner to physically isolate impacted sediments. Protected by armoring.	• Sheboygan Falls, Wisconsin • Manastique Harbor, Michigan • St. Lawrence River, Massena, New York • Convair Lagoon, California
Armored Flexible Membrane Liner	Use of a flexible membrane liner to physically isolate impacted sediments. Protected by armoring.	
Armored Sediment/ Clay Cap over Flexible Membrane Liner	Use of dredged fine grained sediments or commercially obtained clay materials to physically isolate impacted sediments. Protected by armoring.	• Rotterdam, Netherlands
Armored Composite Cap with Additives	Incorporate materials such as activated granular carbon or iron filings into the cap layer to provide chemical binding of chemicals migrating in porewater.	• Manastique Harbor, Michigan
Bentonite-Filled Bag/Flexible Membrane Liner	Use of bentonite filled bags as a cap along with a flexible membrane liner to physically isolate impacted sediments.	
Bolted Steel Plate over Flexible Membrane Liner	Use of steel plates over flexible membrane liner to physically isolate impacted sediments.	

TABLE 5.2

SUMMARY OF POTENTIALLY APPLICABLE SEDIMENT REMOVAL TECHNOLOGIES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Description*
Mechanical Dredging	
Clamshell Dredges	The clamshell, or grab dredge, consists of a barge-mounted floating crane that maneuvers a cable-suspended dredging bucket. The bucket is lowered into the sediment, and when withdrawn the cable closes the jaws of the bucket, retaining dredged material.
Watertight Clamshell Bucket	Essentially a conventional clamshell bucket, modified to minimize or eliminate water loss (hence sediment resuspension) during dredging operations. Has top seals to prevent overflow and overlapping cutting edges.
Cable Arm Bucket	A specialized clamshell that offers the advantage of a large, level cut footprint, capability to remove even layers of sediments, and reduced resuspension losses to the water column.
Excavators	
Bonacavor	Bean Dredging Corp's hydraulic excavator with open grab. High precision and minimal resuspension. Places dredged materials into a patented screened hopper system which automatically adjusts water content for end-use treatment and pumps through pipeline as slurry to treatment or disposal.
DRE Dry-Dredge	Fully enclosed grab bucket closed by hydraulic cylinders. Operated from rigid retractable boom. Clammed materials screened to open hopper and transported in pipeline by positive displacement pump. High accuracy, low resuspension.
Visor Grab	Grab bucket with revolving visor flap closure operated by hydraulic cylinders. Has been used on sediment and wood waste. Operated from hydraulic excavator.
Hydraulic Dredging	
Matchbox Dredge	A plain suction dredgehead enclosed in a housing resembling a matchbox. The housing collects escaping gases, and valved openings on each side of the suction head allow the leeward opening on each swing to be closed to avoid influx of water.
Open Suction Dredge	A common hydraulic dredge, consisting of an open-end suction pipe connected to a centrifugal pump. As these dredges are not equipped with any kind of cutting device, they produce very little resuspension of solids during dredging.

TABLE 5.2

SUMMARY OF POTENTIALLY APPLICABLE SEDIMENT REMOVAL TECHNOLOGIES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Description*
Refresher Dredge	A modified cutterhead, the Refresher system uses a helical-shaped head to feed the sediments into the suction pipe. A cover over the head reduces resuspension.
Viscous Excavator	A newly patented dredge "cutterhead" consisting of an open 3-bladed screw with cupped blades that loosens and moves high viscosity sediment mixtures into the suction mouth of the hydraulic dredge pump. Interchangeable with standard dredge cutterheads.
Hydraulic Dredging (Cont'd.)	
Cutterhead Dredge (6- to 8-inch)	A rotating cutterhead loosens sediment at the suction mouth, where a centrifugal pump draws the sediment/water slurry through the pipeline. Performs efficiently in most sediments. Resuspension losses can be minimized by operational controls.
Mudcat Horizontal Auger	The Mudcat is one of a variety of portable shrouded horizontal-auger dredges which loosen and move sediment laterally to the center of the rotating auger to be picked up by the suction. Advances forward into the cut, removing a flat layer up to 8 feet wide.
Diver-Articulated Hydraulic Dredge	A small suction dredge operated by tethered or SCUBA-supported diver. Especially effective for dredging under docks, or hard to approach areas. While diver-operated dredging is thought to minimize suspended sediments by careful control, efficiencies of operation have led to the abandonment of several such operations in the Great Lakes.
Specialized Dredging	
Oozer Dredge	Similar to the Pneuma dredge, but creates an external suction vacuum in the head chamber, and can be equipped with special suction and/or cutterheads depending upon the type of material being dredged.
Cleanup Dredge	The Cleanup head consists of a shielded auger that collects and guides sediment into the suction of a submerged centrifugal pump as the dredge head advances. Movable shutters limit resuspension as the dredge swings back and forth across the cut.
Airlift Dredge	Uses buoyancy of compressed air rising and expanding in the submerged pipeline to create water flow in the suction pipe. Can be equipped with rotating cutterhead.
Eddy Pump	Essentially a hydraulic dredge that creates a swirling eddy current to agitate and withdraw impacted sediments. A rotor set deep into the dredge head creates a high speed vortex, lifting the sediment into the head with little sediment resuspension.

TABLE 5.2

SUMMARY OF POTENTIALLY APPLICABLE SEDIMENT REMOVAL TECHNOLOGIES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Description*
Pneuma Dredge	Uses compressed air to pump slurry through a pipeline. Sediment removal is via a set of submerged pressure chambers and valving, using the static head (depth) at the bottom to force sediment into the evacuated chambers for pumping.
Toyo Pump	A proprietary electrically-driven compact submerged pump assembly. Maneuvered into the dredging cut by suspension from a derrick barge. Capable of high solids production in uncohesive sediment. Can be equipped with rotating cutter or jet-ring to loosen sediment. Typical: 6- to 12-inch diameter discharge pipe. Can also be used to offload barged dredged materials.
Excavation	
Sheet Pile and Backhoe	This removal option erects sheetpiles or a coffer dam around the impacted sediments followed by dewatering of the site. Removal would then involve conventional excavation (backhoe) equipment.

TABLE 5.3

POTENTIALLY APPLICABLE EX SITU SEDIMENT TREATMENT TECHNOLOGIES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Description*
Landfarming/ Composting	Sediment is mixed with amendments and placed on a treatment area that typically includes leachate collection. The soil and amendments are mixed using a windrow composter, conventional tilling equipment, or other means to provide aeration. Moisture, heat, nutrients, oxygen, and pH can be controlled to enhance biodegradation. Other organic amendments such as wood chips, potato waste, or alfalfa are added to composting systems. Emission control is required if VOCs or SVOCs are present.
Stabilization	Stabilizing agents are added to induce reactions between the agent and chemical to reduce chemical mobility. Fly ash, lime, and Portland cement are common stabilizing agents. May also be effective for SVOCs and pesticides.
Vitrification	Uses an electric current to melt soil or other earthen materials at extremely high temperatures (2,900 to 3,650°F). Inorganic compounds are incorporated into the vitrified glass and crystalline mass and organic compounds are destroyed by pyrolysis. Off-gas collection and treatment are required.
Solvent Extraction	Similar to soil washing but uses a solvent rather than water-based wash solution. May also extract organically bound metals.
Base Catalyzed Decomposition Process	Dehalogenation process in which sediment is screened, processed with a crusher and pug mill, and mixed with sodium bicarbonate. The mixture is heated to above 630°F in a rotary reactor to decompose and volatilize contaminants. Process produces biphenyls, olefins, and sodium chloride. Solids content above 80% is preferred.
Wet Air Oxidation	Continuous feed exothermic liquid phase process that operates at temperatures up to 250°C and pressures up to 110 psig. Oxidation is sustained by the injection of oxygen, usually as air. Oxidizes a broad range of organics. Total organic load is reduced by up to 90% while select compounds may be reduced more completely. Effluents usually require polishing and off-gas requires treatment.
Soil Pile Aeration	Sediment is placed in a lined and covered pile that contains a piping network for vapor extraction. May also include an air supply blower and an irrigation system
Pyrolysis	The chemical decomposition of organic materials by heat in the absence of oxygen. Some oxidation and thermal desorption will occur due to the presence of oxygen. Sediment must be dried to reduce the moisture content to below 1%. Pyrolysis typically occurs under pressure at an operating temperature above 800°F. Off-gas will require treatment and a solid residue is produced consisting of fixed carbon and ash. Volatile metals may be removed.
High Temperature Thermal Desorption	Commercially available technology that heats sediment to 600 to 1,000°F to volatilize water and organic compounds. Typically a vacuum system collects the off-gas and the off-gas is oxidized. Volatile metals may also be removed by these systems. High water content and fine-grained sediment content increase reaction time and energy

TABLE 5.3

POTENTIALLY APPLICABLE EX SITU SEDIMENT TREATMENT TECHNOLOGIES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Description*
	requirements.
Dehalogenation (Glycolate)	Dehalogenation occurs by adding an alkaline polyethylene glycol to the sediment and mixing and heating in a treatment vessel. Typically, potassium polyethylene glycol is used although other reagents have been tested. Solids content above 80% is preferred.
Radiolytic Dechlorination	Sediment is placed in alkaline isopropanol solution and gamma irradiated to a dose of <10 (~1% solution). Products of this dechlorination process are biphenyl, acetone, and inorganic chloride. Process must be carried out under inert atmosphere and has only been tested on PCBs.
Dry Rotary Air Stripping	Sediment is placed in a rotary drum (similar to LTTD) or trommel screen and aggressively agitated to remove VOCs. Vapors are collected and treated.
Soil Micronization/Air Stripping Process	Sediment is loaded into a helical mixer/conveyer where partial dewatering takes place. The sediment is then fed into a proprietary air stripping mill where it is pulverized and passed through a cyclone system to remove volatiles.
Anaerobic/ Aerobic Sequential Slurry Treatment	Anaerobic slurry treatment dechlorinates the organic compounds, while aerobic treatment is used to more rapidly degrade anaerobic byproducts. Anaerobic retention times up to 45 days and aerobic retention times are up to 10 days.
Ultraviolet Irradiation/ Oxidation	A commercially available water treatment process that uses ultraviolet light with ozone or peroxide to generate the hydroxyl radical to oxidize organics.
Hazleton Maxi-Clone/Maxi-Strip Air Stripping	Hydraulically dredged material is screened to 1/2 inch then passed through a series of Maxi-Clones. Volatiles are stripped from the slurry and sediment in each Maxi-Clone. Treatment may be enhanced by the addition of oxidizing agents such as ozone or peroxide.
Slurry Aeration/ Oxidation	Dredged sediment is placed in aeration tanks at about 10 to 20% solids and treated in batch, semi-continuous, or continuous mode. Treatment may be enhanced by the addition of oxidizing agents such as ozone or peroxide. Ambient air is injected to strip VOCs and a mixer is used to keep solids in suspension. Vapors are collected and treated.
Incineration	High temperatures (1,400 to 2,200°F) are used to volatilize and combust refractory organics. Commercial incinerator designs are rotary kilns equipped with an afterburner, a quench, and an air pollution control system.
Low Temperature Thermal Desorption	Commercially available technology that heats sediment to 200 to 600°F to volatilize water and organic compounds. Typically a vacuum system collects the off-gas and the off-gas is oxidized.

TABLE 5.4

SUMMARY OF POTENTIALLY APPLICABLE IN SITU SEDIMENT TREATMENT TECHNOLOGIES
AREA 5106 SEDIMENT
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION REPORT
HYLEBOS WATERWAY
TACOMA, WASHINGTON

Technology	*Description*
Vitrification	Uses an electric current to melt soil or other earthen materials at extremely high temperatures (2,900 to 3,650°F). Inorganic compounds are incorporated into the vitrified glass and crystalline mass and organic compounds are destroyed by pyrolysis. Off-gas collection and treatment are required.
Biodegradation	Anaerobic or aerobic degradation of organic compounds with indigenous or exogenous microorganisms. Oxygen levels, nutrients, and pH are controlled to enhance degradation. Not recommended for use in clay and high levels of chlorinated organics may be toxic.
Soil Flushing	Water or other aqueous solution is circulated through impacted sediment. An injection or infiltration process introduces the solution to the impacted area and the solution is later extracted along with dissolved chemicals. Extraction fluid must be treated and is often recycled.
SVE/Thermally Enhanced SVE /Bioventing	An array of extraction and injection wells is used to physically strip volatile compounds or to stimulate biodegradation in unsaturated sediment. Off-gas treatment is required for vapor extraction. Oxygen levels, nutrients, and pH can be controlled in bioventing applications. Removal may be enhanced by heating the system.
Stabilization	Cement is mixed with sediments in-situ to bind chemicals and reduce mobility.
Ground Freezing	An array of pipes is placed in the ground and brine at a temperature of -20 to -40°C is circulated to freeze soil. Is only recommended for short duration applications (up to 15 years) and to assist with excavation.
Air Sparging/ Steam Stripping	An array of extraction and injection wells is used to physically strip volatile contaminants or to stimulate biodegradation in saturated sediment. Off-gas treatment is required for vapor extraction. Oxygen levels, nutrients, and pH can be controlled in bioventing applications. Removal may be enhanced by heating the system.
Oxidation (Fenton's Reagent)	Place steel sheet pile containment wall around impacted sediment area with a cover for vapor collection. Place an air injection system to 10 feet below the maximum depth of impacted sediment and inject a combination of ferric sulfate and hydrogen peroxide to oxidize organics.
Aqua MecTool™ Oxidation	A caisson (18 feet x 18 feet) is driven into the sediment and a mixing/injection blade is used to strip VOCs. A rotary blade can be used to mix sediment and add oxidizing agents such as peroxide and ozone. A bladder is placed in the caisson to reduce TSS in the surface water and the vapors are collected at the surface and treated.

TABLE 5.5

SUMMARY OF POTENTIALLY APPLICABLE DISPOSAL TECHNOLOGIES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Disposal Technology	*Description*
Subtitle C	Commercial disposal facilities for hazardous solid waste. Sediment must not be above LDR restrictions.
Subtitle D	Commercial disposal facilities for solid waste. Sediment must not be hazardous waste or dangerous waste (DW).
Confined Aquatic Disposal	The placement of treated sediment within some form of a lateral containment structure (e.g., bottom depression or subaqueous berm) and capping with clean sediments.
HCC Nearshore CDF	Place treated sediment with the Hylebos Sediment in the HCC CDF.
OCCT Nearshore CDF (with in-place treatment)	Place untreated sediment behind containment wall/berm just offshore of the former OCCT Tacoma property. Provide in situ treatment such as air sparging.
OCCT Nearshore CDF	Placed treated sediment behind containment wall/berm just offshore of the former OCCT Tacoma property.
OCCT Embankment Fill	Place treated sediment as backfill for the embankment area. Treated sediments would be capped with clean fill and rip rap.
PRI Upland Confined Fill (with in-place treatment)	Place untreated sediment in a containment cell on the former PRI property. Treat in-place with vapor extraction/passive venting.
PRI Upland Confined Fill Subtitle D Disposal	Place treated sediment in lined and capped containment cell on the former PRI property. No further treatment of materials.
PRI Upland Confined Fill Non Subtitle D Disposal	Place treated, clean fill without a liner on the former PRI property. Sediments would be capped with impermeable material.
Upland Confined Fill with Vapor Extraction	Place untreated sediment on an industrial property, capped and out of contact with groundwater. Collect off-gas from the sediment and allow for beneficial use of the property (i.e., parking lot, warehouse).
Residential/Clean Fill	Treat sediment to MTCA Method B 100 x GW criteria and use at an upland site. No institutional controls will be required.

TABLE 5.6

CONTAINMENT TECHNOLOGIES ELIMINATED FROM CONSIDERATION
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Reason for Elimination*
Sand/Sediment Cap	Cap material would be subject to prop wash, currents, and dissipate with time.
Armored Flexible Membrane Liner	Performance relative to other capping alternatives is potentially not as good. The lack of a cover such as sand would preclude a habitat for marine micro organisms.
Armored Sediment/Clay Cap Over FML	Performance relative to sand in a marine environment is not significantly better and clay would be more difficult to place than sand.
Armored Composite Cap with Additives	Performance relative to sand in a marine environment is not significantly better and composite would be more difficult to place than sand.
Bentonite-Filled Bag/Flexible Membrane Liner	Performance relative to sand is not significantly better, placement under the docks would be difficult and the bags would not provide a suitable marine habitat for microorganisms.
Bolted Steel Plate over Flexible Membrane Liner	Performance relative to sand is not significantly better, placement under the docks would be difficult and the plates would not provide a suitable marine habitat for microorganisms.

TABLE 5.7

REMOVAL TECHNOLOGIES ELIMINATED FROM CONSIDERATION
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Reason for Elimination*
Excavators	
Bonacavor	Tacoma
Visor Grab	No demonstrated field efforts
Hydraulic Dredging	
Matchbox	Low slurry density, coupled with high water treatment costs.
Open Suction	Unacceptable high levels of resuspended solids. Subject to clogging.
Refresher Dredge	U.S.
Viscous Excavator	Not available for work in U.S.
Mudcat Horizontal Auger	Sediments are deeper than the 20 feet operation limit of the dredge. High levels of suspended solids.
Suspended Dredging	
Oozer Dredge	Japanese dredge not available for work in U.S.
Cleanup Dredge	Japanese dredge not available for work in U.S.
Airlift Dredge	Some of the Area 5106 Sediment is in less than 20 feet of water and would not satisfy the minimum operating depth requirements.
Excavation	
Sheet Pile and Backhoe	Difficult and expensive to implement under tidal conditions.

TABLE 5.8

TREATMENT TECHNOLOGIES ELIMINATED FROM CONSIDERATION
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Ex Situ Sediment Treatment Technologies	
Landfarming/ Composting	• Uncontrolled vapor emissions • Compounds not amenable to aerobic degradation
Stabilization	• Halogenated VOCs hinder cement hydration process
Vitrification	• Requires less than 60% water content • Expensive ($700 per ton) • Would volatilize the constituents at the expense of heating soil to 3,000 °F
Solvent Extraction	• Expensive ($100 to $400 per ton) • Generates liquid that requires disposal or treatment
Base Catalyzed Decomposition Process	• Generates secondary waste streams of air, water, sludge • Similar to low temperature thermal desorption (LTTD) but more expensive ($245 per ton)
Wet Air Oxidation	• Halogenated VOCs may be resistant to process • Predominantly for aqueous phase compounds
Soil Pile Aeration	• Excessive sediment preparation and risk to workers and public with little or no treatment effectiveness • Insufficient area on the former PRI property for treatment equipment and disposal
Pyrolysis	• Expensive ($300 per ton) • VOCs are not a target compound
High Temperature Thermal Desorption	• Target compound boiling temperatures are within range of low temperature thermal desorption • More expensive than low temperature thermal desorption
Dehalogenation (Glycolate)	• Expensive ($200 to $500 per ton) • Not recommended for halogenated VOCs • Not recommended for soil with over 20% moisture
Radiolytic Dechlorination	• Expensive ($1,500 plus per ton)
Dry Rotary Air Stripping	• Similar to LTTD and requires drying capability of LTTD
Soil Micronization/Air Stripping Process	• Listed in the SEDTEC database, but vendor can't be located.
Anaerobic/Aerobic Sequential Slurry Treatment	• Long retention times (each batch would take two months of treatment) • Large vapor-tight tankage would make process expensive ($150 to $300 per cubic yard)
Ultraviolet Irradiation/Oxidation	• High turbidity of sediment slurry would prevent process from working

TABLE 5.8

TREATMENT TECHNOLOGIES ELIMINATED FROM CONSIDERATION
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

In Situ Sediment Treatment Technologies	
Vitrification	• Not well demonstrated • Expensive ($700 per ton) • Would volatilize the constituents of concern
Biodegradation	• Process very slow at high concentrations • More toxic degradation products may be produced during anaerobic degradation
Soil Flushing	• Not applicable to sediment remediation
SVE/Thermally Enhanced SVE/Bioventing	• Not applicable in saturated environment
Stabilization	• Halogenated VOCs hinder cement hydration process
In Situ Sediment Treatment Technologies (Cont'd.)	
Ground Freezing	• Expensive ($7M capital plus $2.7M annually)
Air Sparging/Steam Stripping	• Vapor collection not practical over entire area of concern
Oxidation (Fenton's Reagent)	• Vapor collection not practical over entire area of concern

TABLE 5.9

DISPOSAL TECHNOLOGIES ELIMINATED FROM CONSIDERATION
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Reason for Elimination*
PRI Upland Confined Fill (with in-place treatment)	Excessive sediment preparation and risk to workers and public with little or no ultimate treatment effectiveness and potential problems with exceedences of disposal criteria.
PRI Upland Confined Fill Subtitle D or Non Subtitle D	Insufficient area on the former PRI property for treatment equipment and disposal.
OCCT Nearshore CDF (with in-place treatment)	Excessive sediment preparation and risk to workers and public with questionable treatment effectiveness and potential problems with exceedences of disposal criteria.
Residential/Clean Fill	Too restrictive.

TABLE 5.10

TECHNOLOGIES RETAINED FOR FURTHER EVALUATION IN PTTE REPORT
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

CONTAINMENT TECHNOLOGIES

IN SITU SEDIMENT CAPPING
- Armored Sand
- Armored Sand Over Flexible Membrane Liner

REMOVAL TECHNOLOGIES

MECHANICAL DREDGING
- Watertight Clamshell Bucket
- Clamshall Dredge
- Cable Arm Bucket

EXCAVATORS
- DRE Dry-Dredge

HYDRAULIC DREDGING
- Cutterhead Dredge
- Diver Articulated Dredge

OTHER DREDGING
- Eddy Pump
- Pneuma Dredge
- Toyo Dredge

TREATMENT TECHNOLOGIES

EX SITU SEDIMENT TREATMENT
- Hazelton Maxi-Clone/Maxi-Strip
- Slurry Aeration/Oxidation
- Incineration
- Low-Temperature Thermal Desorption

IN SITU SEDIMENT TREATMENT
- Aqua MecTool™ Oxidation

DISPOSAL TECHNOLOGIES

UPLAND DISPOSAL
- Subtitle C
- Subtitle D

AQUATIC DISPOSAL
- Confined Aquatic Disposal (CAD)
- HCC Nearshore CDF
- OCCT Nearshore CDF
- OCCT Embankment Fill

TABLE 5.11
SEDIMENT CONTAINMENT TECHNOLOGY EVALUATION
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Technology Information*		*Effectiveness*						*Implementability*										
			Protectiveness				*Ability to Achieve Removal Objectives*		*Technical Feasibility*				*Availability*	*Administrative Feasibility*				*Cost*	
	Description	*Limitations*	*Protective of Human Health & Community*	*Protective of Workers During Implementation*	*Protective of the Environment*	*Complies with ARARs*	*Level of Treatment/ Containment Expected*	*Residual Effect Concerns*	*Construction & Operational Considerations*	*Demonstrated Performance/Useful Life*	*Adaptable to Environmental Conditions*	*Schedule*	*Equipment*	*Permits Required*	*Easements of Right-of-Ways Required*	*Impact on Adjoining Property*	*Ability to Impose Institutional Controls*	*Capital*	*O&M*
Armored Sand	Gravel or light riprap over hydraulically placed sand and geotextile	None	No exposure to contaminated sediment or water	No exposure to contaminated sediment or water	Sediment not available to Waterway. Flux to Waterway less than MWQ criteria. Constituents continual.	Complies with ARARs.	Mass flux to Waterway less than MWQ criteria	Constituents will remain.	Uses standard equipment and techniques.	Demonstrated at other Puget Sound remedial sites	Yes	Construction in 3 months.	To be constructed using standard equipment.	USACE Permit	Port of Tacoma and Pioneer Chlor Alkali	Reduces available draft at docks	Yes. Institutional controls will be required on Pioneer and POT owned aquatic lands	*Low*	Bathymetric surveys, chemical monitoring, and habitat surveys
Armored Sand Over Flexible Membrane Liner	Gravel or light riprap over hydraulically placed sand, flexible membrane liner, drainage net (optional), drain pipe (optional), and woven geotextile	Installation of FML under dock is difficult	No exposure to contaminated sediment or water	No exposure to contaminated sediment or water	Sediment not available to Waterway. Flux to Waterway less than MWQ criteria. Constituents continual.	Complies with ARARs.	Mass flux to Waterway less than MWQ criteria	Constituents will remain.	Uses standard equipment and techniques.	Demonstrated at other Puget Sound remedial sites	Yes	Construction in 6 months.	To be constructed using standard equipment.	USACE Permit	Port of Tacoma and Pioneer Chlor Alkali	Reduces available draft at docks	Yes. Institutional controls will be required on Pioneer and POT owned aquatic lands	Moderate	Bathymetric surveys, chemical monitoring, and habitat surveys

TABLE 5.12
SEDIMENT REMOVAL DETAILED TECHNOLOGY EVALUATION MATRIX
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Technology Description*	*Effectiveness*						*Implementability*			
		Dredging Accuracy		*Production Rate*	*Sediment Density*	*Resuspension*	*Technical Limits*	*Dredge Availability*	*Debris*	*Agency Acceptance*	*Cost*
		Vertical (feet)	*Horizontal (feet)*	*(cubic yards/hour)*	*(% solids content)*	*(TSS - mg/L)*					
Mechanical Dredging											
Cable Arm Bucket	A specialized clamshell that offers the advantage of a large, level cut footprint, capability to remove even layers of sediments, and reduced resuspension losses to the water column.	0.5	1	33.2	Near *in situ*	<32	Light/fluffy sediment less than 30% solids. Soft sediment only.	Two Cable Arms now in Washington. Two more available on West Coast.	+	Moderate	Moderate
Clamshell Dredges	The clamshell, or grab dredge, consists of a barge-mounted floating crane that maneuvers a cable-suspended dredging bucket. The bucket is lowered into the sediment, and when withdrawn the cable closes the jaws of the bucket, retaining dredged material.	0.5	1	20-30	Near *in situ*	High	Conventional clamshell dredges will result in high levels of resuspended sediments leading to water quality problems.	Numerous buckets available in Washington		Moderate	Moderate
Watertight Clamshell Bucket	Essentially a conventional clamshell bucket, modified to minimize or eliminate water loss (hence sediment resuspension) during dredging operations. Has top seals to prevent overflow and overlapping cutting edges.	0.5	1	20-30	Near *in situ*	Moderate	Vessel draft of the clamshell precludes operations in water with depths less than 6 feet.	Available.		Moderate	Moderate to High
Excavators											
DRE Dry-Dredge	Fully enclosed grab bucket closed by hydraulic cylinders. Operated from rigid retractable boom. Clammed materials screened to open hopper and transported in pipeline by positive displacement pump. High accuracy, low resuspension.	0.5	1	20-30	Near *in situ*	Low to Moderate	DRE Dry-Dredge has demonstrated experience in operating under docks, delivering high solids with low resuspension. However, it is limited to less than -17 feet of water. Company plans larger unit with 25 feet capacity.	Smaller units are currently available and could be trucked to Tacoma.	+	Moderate	Moderate to High
Hydraulic Dredging											
Cutterhead (6- to 8-inch diameter)	A rotating cutterhead loosens sediment at the suction mouth, where a centrifugal pump draws the sediment/water slurry through the pipeline. Performs efficiently in most sediments. Resuspension losses can be minimized by operational controls.	1	3.3	20-50	10-20	82	Low slurry density, result in higher water treatment costs.	Numerous cutterheads available on the West Coast.	+	Moderate	Low
Diver-Articulated Dredge	A small suction dredged operated by tethered or SCUBA-supported diver. Especially effective for dredging under docks, or hard to approach areas.	0.5	1	10-20	1-10	low	Diver working time limited at depths over 30 feet. Requires underwater visibility (low turbidity) and positioning system (e.g., gridding) to assure complete coverage. Low average solids content, requires handling and treatment of return flow. Cannot dredge debris/trash. Safety is high consideration. While diver-operated dredging is thought to minimize suspended sediments by careful control, efficiencies of operation have led to the abandonment of several such operations in the Great Lakes.	Numerous qualified commercial diving firms in Puget Sound area.	-	High	Very High
Specialized Dredging											
Pneuma Dredge	Uses compressed air to pump slurry through a pipeline. Sediment removal is via a set of submerged pressure chambers and valving, using the static head (depth) at the bottom to force sediment into the evacuated chambers for pumping.	1	1	35-230	25-40	2-128 (surface) 2-509 (bottom)	Pneuma Pump has demonstrated experience in both Puget Sound and in the Great Lakes program. Requires softer sediments; there is no cutting head associated with this type of dredge.	Pumps are available in the U.S., but would have to be shipped to Tacoma.	-	High	Moderate
Eddy Pump	A hydraulic dredge that creates a swirling eddy current to agitate and withdraw contaminated sediments. A rotor set deep into the dredge head creates a high speed vortex, lifting the sediment into the head with little sediment resuspension.	1	2	310	70	low	Recent field trials have not shown the Eddy Pump to meet expectations for efficiency, delivery rates, and resuspended sediments.	Available.	-	High	Moderate
Toyo Pump	A proprietary electrically-driven compact submerged pump assembly. Maneuvered into the dredging cut by suspension from a derrick barge. Capable of high solids production in uncohesive sediment. Can be equipped with rotating cutter or jet-ring to loosen sediment. Typical: 6- to 12-inch-diameter discharge pipe. Can also be used to offload barged dredged materials.	1	2	50-400 (6- to 12-inch-diameter discharge range)	20-50	moderate	Will not handle trash/debris. Lower head pump; therefore may require booster pump for long discharge pipeline distances. Requires electric power source.	At least one available in the Seattle area.	-	High	Moderate

TABLE 5.13

SEDIMENT TREATMENT DETAILED TECHNOLOGY EVALUATION MATRIX

AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS

OCC TACOMA, INC.

TACOMA, WASHINGTON

Technology	Technology Information												Effectiveness						Implementability									Relative Cost Capital
				Cleanup Levels Achievable									Protectiveness				Ability to Achieve Removal Objectives		Technical Feasibility				Availability	Administrative Feasibility				
	Description	Limitations	Target Compounds	UTS	DW	100x AWQC	SQS	ADR (3)	MTCA C Soil	MTCA B 100x GW	Removal or Feed Rate	Byproducts	Stage	Protective of Public Health & Community	Protective of Workers During Implementation	Protective of the Environment	Complies with ARARs	Level of Treatment/ Containment Expected	Residual Effect Concerns	Construction & Operational Considerations	Demonstrated Performance/Useful Life	Adaptable to Environmental Conditions	Schedule	Equipment	Permits Required	Easements of Right-of-Ways Required	Impact on Adjoining Property	Ability to Impose Institutional Controls	
Ex-situ Sediment Treatment																												
Hazleton Maxi-Clone/Maxi-Strip	Hydraulically dredged material is screened to 1/2" then passed through a series of Maxi-Clones. Volatiles are stripped from sediment and water in each Maxi-Clone. Treatment may be enhanced by the addition of oxidizing agents such as ozone or peroxide.	Requires pilot testing to determine suitability for Site VOCs and and Maxi-Strip SVOCs that are adsorbed to sediments. May not adequately oxidize target compounds due to interference. Sediments >1/2" have to be treated separately.	VOCs, light-end SVOCs	√	√		√ oxidation	√	√		Designed to keep up with hydraulic dredging (450 gpm)	Vapor emissions require treatment	Pilot commercial	No vapor emissions if hydraulically dredged directly into tanks.	No uncontrolled vapor emissions.	Sediment removed from Waterway. Constituents destroyed by treatment.	Complies with ARARs.	95% removal of VOCs and >50% removal of SVOCs.	Inorganics and non-volatile organics will remain.	Uses standard equipment and techniques.	No demonstrated performance although principles are well understood.	Performance will be reduced in colder weather.	System will be designed to keep up with dredging rate (3 to 9 months).	To be constructed using standard equipment.	PSAPCA (Air) Shoreline Development	None	Treatment to occur on former PRI property now owned by OCCT	Depends on sediment disposition.	Moderate
Slurry Aeration/Oxidation	Dredged sediment is placed in aeration tanks at about 10 to 20% solids and treated in batch, semi-continuous, or continuous mode. Treatment may be enhanced by the addition of oxidizing agents such as ozone or peroxide. Ambient air is injected to strip VOCs and a mixer is used to keep solids in suspension. Vapors are collected and treated.	Requires pilot testing to determine suitability. May not adequately oxidize target compounds due to interference. Possible problems with adequate air distribution in large tanks and removal of VOCs/SVOCs absorbed to sediments. Sediments >1" have to be treated separately.	VOCs, light-end SVOCs	√	√		√ oxidation	√	√		Designed to keep up with hydraulic dredging	Vapor emissions require treatment	Concept based on existing technology	No vapor emissions if hydraulically dredged directly into tanks.	No vapor emissions.	Sediment removed from Waterway. Constituents destroyed by treatment.	Complies with ARARs.	90% removal of VOCs and 50% removal of SVOCs.	Inorganics and non-volatile organics will remain.	Uses standard equipment and techniques. Space availability at the former PRI property may not be adequate.	No demonstrated performance although principles are well understood. Pilot study required.	Performance will be reduced in colder weather	System will be designed to keep up with dredging rate (3 to 9 months).	To be constructed using standard equipment.	PSAPCA (Air) Fire Department Shoreline Development NPDES	None	Treatment to occur on former PRI property now owned by OCCT	Depends on sediment disposition.	Moderate
Incineration	High temperatures (1,400 to 2,200 °F) are used to volatilize and combust refractory organics in hazardous waste. Commercial incinerator designs are rotary kilns equipped with an afterburner, a quench, and an air pollution control system.	On-site incinerator would have to pass public comment. Moisture content restricted by transportation regulations.	All organics	√	√	√	√	√	√	√	Will be controlled by rate of dredging	Ash will be handled as part of the incineration fee	Full-scale commercial	Perimeter air monitoring likely required during upland sediment handling to reduce moisture content for shipping	Likely will require respiratory protection during upland sediment dewatering.	Sediment removed from Waterway. Constituents destroyed by treatment.	Stockpiling of sediment prior to loading may not comply with container requirement.	99.99+% removal of organics.	Inorganic constituents will be concentrated in ash and disposed.	Uses standard construction techniques	Performance well demonstrated.	Adaptable.	Project duration will depend on dredging rate and dewatering.	Commercially available.	Shoreline Development	None	Treatment to occur on former PRI property now owned by OCCT	None required.	Very High
Low Temperature Thermal Desorption	Commercially available technology that heats sediment to 200 to 600 °F to volatilize water and organic contaminants. Typically a vacuum system collects the off-gas and the off-gas is oxidized.	Requires 31655 drum. Costs will increase with moisture content.	VOCs, SVOCs, pesticides, PCBs	√	√			√	√	√	20 to 90 tons per hour	Air emissions will require acid scrubber	Full-scale commercial	Perimeter air monitoring required if system loaded with mechanically dredged or excavated sediment.	Likely will require respiratory protection during desorption unit loading and containment of emissions from untreated sediments.	Sediment removed from Waterway. Constituents destroyed by treatment.	Stockpiling of sediment prior to loading may not comply with container requirement.	95+% removal of VOCs and SVOCs.	Inorganics and some high boiling point organics will remain	Uses standard construction techniques.	Performance well demonstrated. Bench tests required.	Adaptable.	Project duration will depend on dredging rate and dewatering.	Commercially available.	PSAPCA (Air) Fire Department Shoreline Development	None	Treatment to occur on former PRI property now owned by OCCT	Depends on sediment disposition.	High
In-situ Sediment Treatment																												
Aqua Mecool™ Oxidation	A caisson (18' by 18') is driven into the sediment and a rotary blade is used to mix sediment and add oxidizing agents such as peroxide and ozone. A bladder is placed in the caisson to collect the vapors at the surface for treatment.	Oxidation requires pilot testing to determine that target compounds are removed. Cannot access sediment beneath docks.	All organic compounds	√	√			√	√	√	Up to 100 cubic yards per hour	Vapor emissions are treated as part of process	Full-scale commercial upland	No vapor emissions anticipated.	No vapor emissions.	Some inorganic constituents will remain in Waterway.	Complies with ARARs.	95+% removal of VOCs and SVOCs. 90+% removal of total organics.	Inorganic constituents will remain in Waterway.	Must schedule treatment around dock usage.	Some successful upland projects performed. Pilot testing recommended to verify efficiency of oxidation.	Adaptable.	Treatment in 1 to 3 months.	Commercially available.	PSAPCA (Air) Fire Department	None	Access to Port of Tacoma-owned waters is necessary.	Institutional controls may be required on Pioneer- and Port of Tacoma-owned aquatic lands.	Moderate

Notes:

1 Several changes in evaluation criteria relative to EE/CA guidance have been made as follows:

- "Can be implemented in 1 year" has been changed to "Schedule" since PRP-lead sites are not subject to the 1-year statutory restriction.
- "Availability" criteria are included in the guidance due to the 1-year statutory restriction; however, since this site is not subject to the restriction, "Availability" is not a concern. "Availability" of "Equipment" has been retained.
- "Contributes to remedial performance" since all of these removal actions are consistent with future remedial actions on the Hylebos Waterway.

2. Achievement of the SQS may be achievable through oxidation of the COEPC.

3. Aquatic Disposal Requirements.

VOCs	Volatile Organic Compounds.
SVOCs	Semi-Volatile Organic Compounds.
PCBs	Polychlorinated Biphenyls.
ARARs	Applicable or Relevant and Appropriate Requirements.
UTS	Universal Treatment Standards for primary and underlying hazardous constituents.
DW	Washington State Dangerous Waste Regulations.
AWQC	Ambient Water Quality Criteria-Chronic (1987).
MTCA	Washington State Model Toxics Control Act.

CSo Mat rds

TABLE 5.14

DISPOSAL TECHNOLOGY EVALUATION MATRIX
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

	Technology Information		Effectiveness		Implementability						Relative Costs	
					Technical Feasibility		Administrative Feasibility					
Disposal Option	*Description*	*Limitations*	*Applicable Criteria*	*Protectiveness*	*Regulatory Acceptance*	*Constructability*	*Permits*	*Easements*	*Impact on Adjoining Property*	*Ability to Impose Institutional Controls*	*Capital*	*O&M*
Subtitle "D"	Commercial disposal facilities for solid waste. Sediments must not be hazardous waste or DW.	Sediment must pass paint filter test for transport.	UTS[1] DW	Commercial permitted landfill	Preference for treatment but disposal is acceptable	N/A	Permitted by operator.	N/A	N/A	N/A	Moderate	N/A
HCC Nearshore CDF	Place treated Area Sediments with the Hylebos Sediment in the HCC CDF.	Must be included in Hylebos planning process.	AWQC in column test leachate	Sediment is treated.	Satisfies preference for treatment.	Standard construction materials and methods.	Permitted by disposal site owner.	N/A	None	Same as disposal site owner.	Low	Low
OCCT Nearshore CDF	Place treated Sediments behind containment wall just offshore of the former OCC Tacoma property.	Physical restrictions on fill placement. Coordination with Pioneer Resource agency concerns	UTS[1,2] AWQC in column test leachate	Sediment is essentially clean.	Satisfies preference for treatment.	Standard construction materials and methods	USACE	Pioneer	Pioneer Operations	Yes	Moderate	Low
OCCT Embankment Fill	Place treated Area 5106 Sediments as backfill following on the embankment area. Treated sediments would be capped with clean fill and riprap..	Physical restrictions on fill placement. Coordination with Pioneer.	UTS[1,2] SQS 100 x AWQC[3] Method C Industrial	Sediment is treated and covered with clean fill and riprap.	Satisfies preference for treatment.	Standard construction materials and methods	Standard construction materials and methods.	Pioneer	Pioneer Operations	Yes	Low	Low
Subtitle C	Commercial disposal facility for solid hazardous waste. Soil must not exceed LDR.	Sediment must pass paint filter test for transport.	LDR UTS	Commercial permitted landfill	Preference for treatment but disposal is acceptable.	N/A	Permitted by operator.	N/A	N/A	N/A	High	N/A

Notes:
1. UTS will only apply for sediment that exceeds toxicity characteristic at the point of generation. Point of generation may be negotiated so that UTS will not apply.
2. U.S. Army Corps of Engineers has previously argued that RCRA and MTCA criteria do not apply to "sediment" that is disposed in-water. As such, UTS and DW criteria may not apply to these in-water disposal alternatives.
3. 100 times AWQC criteria has been determined using an assumed dilution attenuation factor of 100 that is a standard assumption under MTCA. Site-specific dilution attenuation factors can be calculated that may be less conservative.

AWQC Ambient Water Quality Criteria - Chronic (1987)
CDF Confined Disposal Facility.
DW Washington State Dangerous Waste Regulations
HCC Hylebos Cleanup Committee.
LDR Land Disposal Restrictions.
MTCA Washington State Model Toxics Control Act
N/A Not Applicable.
OCCT OxyChem Tacoma, Inc.
SQS Washington State Sediment Quality Standards
UTS Universal Treatment Standards for primary and underlying hazardous constituents

TABLE 5.15

ASSESSMENT OF REMOVAL ACTION ALTERNATIVES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Alternative		Comments	Effectiveness: Protectiveness: Short Term	Effectiveness: Protectiveness: Long Term	Implementability: Regulatory Acceptance	Implementability: Constructability	Implementability: Schedule	Relative Costs: Capital	Relative Costs: O & M
A	Natural Recovery	Preliminary modeling indicates that net sedimentation will likely be sufficient to achieve SQOs within a 10-year time frame. Some armoring may be required to stabilize sediments.	Moderate.	High.	High. Natural recovery has been accepted at other locations in Puget Sound.	High. Uses standard techniques and equipment		Very Low	Low
B1	Armored Sand Cap	Satisfies SQOs and is cost effective.	High.	High.	High. Capping has been accepted in other locations in Puget Sound.	High. Uses standard techniques and equipment.	3 months	Low	Low
B2	Armored Sand Cap Over Flexible Membrane Liner	Satisfies SQOs but liner would be difficult to install in open areas and very difficult under the dock.	High.	High.	High.	Difficult. Under dock.	6 months	Low	Low
C1	Hazelton Maxi-Clone/Maxi-Strip (High Solids/Low Solids)	Initial pilot testing was promising. Equipment compatible for low or high solids removal although limited to 10 percent solids by volume. Low solids removal may be more favorable for performance of Hazelton system and also to minimize space requirements. Target disposal would be HCC Nearshore CDF with	Low. Additional pilot testing required. Potential impact to Waterway during dredging. Air emissions require control.	High.	Unknown.	High with standard equipment.	6 to 12 months	Moderate	N/A
C2	Slurry Aeration/Oxidation (High Solids/Low Solids)	Initial bench testing was not promising for SVOC removal. Equipment space requirement may exceed the space available on the Former PRI property. Low solids removal may be more favorable for performance of Aeration system and also to minimize space requirements. Air emission control system would be extensive. Target disposal would be LPF with Hylebos. Target disposal would be NCC Nearshore CDF with Hylebos Sediment.	Low. Potential impact to Waterway during dredging. Air emissions require control.	High.	Unknown.	Moderate. Extensive piping and ducts for batch tanks.	6 to 12 months	Moderate	N/A
C3	Low Temperature Thermal Desorption (Mechanical/High Solids)	Effective for VOCs/SVOCs but expensive compared to capping and slurry treatment alternative. Handling of untreated sediments required prior to treatment. Air emissions would be contained. Mechanical removal would be favored to reduce dewatering. Target disposal would be HCC Nearshore CDF with Hylebos Sediment.	Low. Worker exposure to untreated sediments has to be controlled. Air emissions a concern during handling. Potential impact to Waterway during dredging.	High.	High.	High but many controls required to stage sediments and monitor emissions.	6 to 12 months	High	N/A
C4	Incineration (Mechanical/High Solids)	Very effective but very expensive. Handling of untreated sediments required prior to treatment. Air emissions would be contained. Mechanical removal would be favored to reduce dewatering.	Low. Worker exposure to untreated sediments has to be controlled. Air emissions a concern during handling. Potential impact to Waterway during dredging.	High.	High.	Moderate but many controls required to stage sediments and monitor emissions.	6 to 12 months	Very High	N/A
C5	Aqua Mectool™/Oxidization (Under Dock Capping or Under Dock Dredging)	In situ treatment eliminates removal requirements. The technology has been used for dry land applications but is unproven for underwater applications. Distribution of the sediments and impact to the Waterway is a concern.	Moderate. Potential impact to Waterway. Sedimentation control required.	Ability to achieve treatment uniformly is moderate.	Unknown.	Low to Moderate	3 to 6 months	Low to Moderate	Low
D	Sediment Removal/Treatment/ Disposal With Containment Under	Capping under the dock may be easier than dredging under the dock. Treatment (see above alternatives) could be structured for open water dredging to reduce time and equipment requirements.	As per previous evaluation.	High.	Unknown.	Moderate to High	6 to 12 months	Moderate	Low
E	Combined Embankment and Area 5106 Sediment Containment	Satisfies SQOs and is cost effective. Suitability for the embankment has not been determined. Available ship draft at the face of dock would be decreased significantly.	High.	High.	High. Capping has been accepted in other locations in Puget Sound.	Moderate. Embankment stability needs to be evaluated.	3 to 6 months	Low	Low

Notes:
CDF Confined Disposal Facility.
HCC Hylebos Cleanup Committee.
SQOs Sediment Quality Objective.
SVOCs Semi-Volatile Organic Compunds.
VOCs Volatile Organic Compounds.

TABLE 5.16

SUMMARY OF MOST PROMISING TREATMENT TECHNOLOGIES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Technology	*Preliminary Evaluation/Testing Performed*				*Issues*
	Study	*Modeling*	*Bench*	*Pilot*	
Containment					
1. Natural Attenuation	X	X			erosion
2. Armored Sand Cap	X	X			none
Removal					
1. High Solids Dredge	X	X			treatment compatibility, production rates, reliability, environmental impacts
2. Low Solids Dredge	X	X			treatment compatibility, production rates, reliability, environmental impacts
3. Mechanical Dredge	X	X			treatment compatibility, production rates, reliability, environmental impacts
4. Diver Dredge	X	X			treatment compatibility, production rates, reliability, environmental impacts
Treatment					
1. Hazelton Maxi-Clone	X			X	metals, dewater, SVOC removal, production rates, particle size
2. Slurry Aeration/Oxidation	X		X		metals, dewater, SVOC removal, production rates, particle size
3. Low Temperature Thermal Desorption	X				metals, dewater, air quality, production rates
4. Incineration	X				none
Disposal					
1. HCC Nearshore CDF	X				approval of disposal site owner, acceptability of treated sediments
2. Subtitle D	X				metals, dewater
3. OCCT Embankment Fill	X				criteria for placing, compatibility with embankment removal action

Notes:
CDF Confined Disposal Facility.
HCC Hylebos Cleanup Committee.
OCCT OxyChem Tacoma, Inc.
SVOC Semi-Volatile Organic Compound.

TABLE 5.17
DREDGING TECHNOLOGY - ADDITIONAL EVALUATION
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

	Type of Dredge		
Evaluation Parameters	*Hydraulic Cutterhead Dredge 12-Inch*	*Mechanical Clamshell Dredge with Standard Digging Bucket*	*Mechanical Clamshell Dredge with Environmental Bucket*
System and Performance			
Dredge Type	Hydraulic cutterhead, 12-inch pump discharge	Derrick barge w/clamshell bucket	Derrick barge with clamshell bucket
Material Transport Type	12-inch Floating pipeline	Mechanical rehandling into flat-deck/dump barge	Mechanical rehandling into flat-deck/dump barge
Max. Digging Depth	30 ft. w/Standard ladder, 50 ft. w/extended ladder	Up to 100 feet	Up to 100 feet
Dredge Advance Mechanism	Walking spuds or wires	Tug assist, spuds for fixed positioning, bucket	Tug assist, spuds for fixed positioning, bucket
Performance Effectiveness	A 12 to 16-inch hydraulic dredge would be suitable for the Area 5106 dredging project. Operational controls could be instituted to minimize resuspension. Water content will be highest of dredges evaluated. Production rates will also be relatively high, unless operational controls are instituted.	A 4 to 10 c.y. clamshell bucket would be suitable for the Area 5106 dredging project. Operational controls could be instituted to minimize resuspension. Offers mid-range required water quantities of technologies evaluated. Dredge production rates will be high relative to environmental bucket and other specialty dredges.	A 4 to 10 c.y. environmental clamshell bucket would be suitable for the Area 5106 dredging project. The environmental bucket is capable of dredging at high solids concentrations with reduced sediment resuspension, relative to a standard digging bucket. The environmental bucket is generally only suited for looser silty material, and does not perform well in consolidated stiffer material, or material with a significant amount of debris.
Dredging Accuracy	+/-0.5 ft. horizontal, +/-2.0 ft. vertical, w/GPS	+/-0.5 ft. horizontal, +/-1 ft. vertical, w/ GPS	+/-0.5 ft. horizontal, +/-1 ft. vertical, w/GPS
Production			
Estimated Hourly Dredge Production* (assumes production limit at point of dredging)	100 to 300 c.y./hour	100 to 200 c.y./hour, assumes 6 c.y. bucket	100 to 150 c.y./hour, assumes 6 c.y. bucket
Ability to Dredge in Stiff (Clay)/Dense (Sand)	Good	Good, with heavy duty bucket	Poor
Debris Handling	Debris to approximately 6-inch OK; large debris may be caught	Standard digging bucket has good debris handling qualities	Debris can impact bucket closure, and water minimization
Slope Dredging	Slope dredging is possible, production impacted	Slope dredging is possible, production impacted	Limited slope dredging capability, production impacted
Dredged Material Solids Concentration (by weight)	1 Percent to 5 Percent	30 Percent to 40 Percent	30 Percent to 40 Percent
Estimated Water Volume (gallons)	104,000,000	4,100,000	2,700,000
Resuspension Characteristics			
Potential Sources of Resuspension	Cutterhead, 2 stern spuds, anchors and wires (or 2 additional traveling spuds), discharge line, service vessel/ anchor barge, crew vessel, debris barge	Dredge bucket, 2 stern spuds, traveling spuds tug, debris barge	Dredge bucket, 2 stern spuds, traveling spuds tug, debris barge
Range of Resuspension Operational Controls	Reduce advance/swing speed, cutterhead rotation, optimize pump speed, silt curtain, no teeth cutter, maintain cut depth less than cutter diameter, swing in only one direction	Reduce rate of bucket deployment, closure, and retrieval. Drain free water at water surface prior to swinging.	Bucket design reduces downward pressure on in situ sediments during bucket lowering thereby reducing resuspension. Sediment washout is minimized during bucket raising due to closed bucket configuration.
Costs and Availability			
Estimated Costs Per Cubic Yard**	$20	$14	$16
Availability	Hydraulic cutterhead dredges in this size range are available in Washington and Oregon	Numerous standard clamshell dredges in this size range are available in Puget Sound region	Mechanical dredges with environmental bucket in this size range are available in Puget Sound region

* Estimated Hourly Production Rates based on advertised and recorded measurements. Actual dredge productions may vary depending upon a wide range of variables including operator skills, operational controls, debris, etc.
** For mechanical dredges based on placement in hopper barge fleeted alongside dredge. For other dredges based on pumping dredged material into tanks on shore within 1000 ft. of point of dredging.

TABLE 5.17
DREDGING TECHNOLOGY - ADDITIONAL EVALUATION
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Evaluation Parameters	Type of Dredge: Eddy Pump	Pneuma Pump	TOYO Pump
System and Performance			
Dredge Type	Vortex slurry pump	Derrick barge w/cable-controlled Pneuma pump	Derrick barge w/TOYO pump
Material Transport Type	10-inch Floating Pipeline	6 to 8-Inch hydraulic pipeline	10-Inch hydraulic pipeline
Max. Digging Depth	100 ft.	70 Ft.	Up to 100 ft.
Dredge Advance Mechanism	Shore anchors and wires	Tug assist, anchors, and wires	Tug assist, spuds for fixed positioning
Performance Effectiveness	The EDDY pump, also called the Soli-Flo pump, appears to have accomplished relatively high solids concentration dredged material removal and transport. Production rates were reported to reach 300 c.y./hour for lighter sands and silts. The EDDY pump does not appear to be capable of working in other than calmer marine environments, as it consists of three primary pontoons. Waves and currents of any significant magnitude would impact production.	The Pneuma pump is particularly effective at removing bottom sediments in high solids concentrations. The dredge consists of 3 cylinders with no rotating parts, which provide suction and discharge pressure via sequenced piston motion. Like the EDDY pump, the vertical control of the Pneuma pump appears to be limited, and only removal of fine silts is applicable. Produces low turbidity. Can work in tight spaces.	The TOYO pump is available in a number of sizes and is used on a number of applications including dredging. The DP-50 series model, suitable for the OCCT project, offers production in the range of 100 c.y./hour at up to 70 percent solids concentration (by weight). Like the Pneuma pump, the TOYO pump can be used off a standard derrick barge. Vertical control may also be a problem, particularly when slope dredging.
Dredging Accuracy	Pump is suspended from derrick. Dredging accuracy depends on pump position and influence of pump suction. +/-0.5 ft. horizontal, +/-1.5 ft. vertical, w/GPS	Pump is suspended from derrick. Dredging accuracy depends on pump position and influence of pump suction. +/-0.5 ft. horizontal, +/- 1.5 ft. vertical, w/GPS	Pump is suspended from derrick. Dredging accuracy depends on pump position and influence of pump suction. +/-0.5 ft. horizontal, +/- 1.5 ft. vertical, w/GPS
Production			
Estimated Hourly Dredge Production* (assumes production limit at point of dredging)	100 to 300 c.y./hour	100 to 300 c.y./hour	100 to 300 c.y./hour
Ability to Dredge in Stiff (Clay)/Dense (Sand) Materia	Poor	Poor	Poor to fair
Debris Handling	Readily handles debris	Readily handles debris	Debris up to roughly 6 inches can become lodged in pump
Slope Dredging	Slope dredging is possible, but inefficient	Slope dredging is possible, but inefficient	Slope dredging is possible, but inefficient
Dredged Material Solids Concentration (by weight)	30 Percent to 40 Percent	30 Percent to 40 Percent	30 Percent to 40 Percent
Estimated Water Volume (gallons)	5,100,000	3,400,000	3,400,000
Resuspension Characteristics			
Potential Source of Resuspension	Dredge has good resuspension minimization characteristics. Anchor barge, anchor and wires, and debris barge could cause resuspension of bottom sediments.	Pump assembly, barge spuds, tugs, debris barge	Pump assembly, barge spuds, tugs, debris barge
Range of Resuspension Operational Controls	Reduce advance/swing speed, optimize pump speed	Reduce advance/swing speed, optimize pump speed	Reduce advance/swing speed, optimize pump speed
Costs and Availability			
Estimated Cost per Cubic Yard**	$22	$24	$20
Availability	EDDY pump is currently inactive. Owned by Soli-Flo, a Division of Fluor Daniel	Pneuma pump is not a standard piece of equipment and is not readily available in the Puget Sound region. Parent company is Italian.	The TOYO pump is readily available on a commercial basis.

* Estimated Hourly Production Rates based on advertised and recorded measurements. Actual dredge productions may vary depending upon a wide range of variables including operator skills, operational controls, debris, etc.

** For mechanical dredges based on placement in hopper barge fleeted alongside dredge. For other dredges based on pumping dredged material into tanks on shore within 1000 ft. of point of dredging.

TABLE 5.17
DREDGING TECHNOLOGY - ADDITIONAL EVALUATION
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Evaluation Parameters	*Type of Dredge* *Dry-Dredge*
System and Performance	
Dredge Type	Sealed bucket with positive displacement pump on barge
Material Transport Type	5 to 6-Inch discharge pipeline
Max. Digging Depth	To 30 ft.
Dredge Advance Mechanism	Walking spuds
Performance Effectiveness	The Dry-Dredge uses a sealed clamshell bucket for excavation of bottom materials. The bucket is pressed into the bottom, the bucket sealed, and brought to the surface where the material is deposited into a hopper on the dredge pontoon. Debris is removed using a grizzly, and the dredged material is transported up to 2,000 ft. away using a positive displacement pump, which requires no water for transport. High solids concentration. The dredge is limited to finer silts and currently cannot dredge below 30 feet.
Dredging Accuracy	+/-0.5 ft. horizontal, +/- 1 ft. vertical, w/ GPS
Production	
Estimated Hourly Dredge Production* (assumes production limit at point of dredging)	40 to 75 c.y./hour
Ability to Dredge in Stiff (Clay)/Dense (Sand)/Materi	Poor
Debris Handling	The Dry-Dredge production is impacted by larger debris
Slope Dredging	Slope dredging is feasible
Dredged Material Solids Concentration (by weight)	30 Percent to 40 Percent
Estimated Water Volume (gallons)	2,200,000
Resuspension Characteristics	
Potential Sources of Resuspension	Clamshell, barge spuds, tugs, debris barge
Range of Resuspension Operational Controls	Sealed bucket is placed into sediments and closed. The bucket is designed to minimize entrainment of water and material resuspension. Slow bucket deployment and retrieval will further minimize water quality impacts.
Costs and Availability	
Estimated Costs Per Cubic Yard**	$35
Availability	The Dry-Dredge is not readily available in Puget Sound but can be easily transported by flatbed truck from point of origin on the east coast.

* Estimated Hourly Production Rates based on advertised and recorded measurements. Actual dredge productions may vary depending upon a wide range of variables including operator skills, operational controls, debris, etc.
** For mechanical dredges based on placement in hopper barge fleeted alongside dredge. For other dredges based on pumping dredged material into tanks on shore within 1000 ft. of point of dredging.

TABLE 8.1

COST SUMMARY
ALTERNATIVE A - NO ACTION
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Long-Term O&M:					
Monitoring	$50,000 annual	Present value @ 8 percent, 30 years	$	607,920	
Reporting	$10,000 annual	Present value @ 8 percent, 30 years	$	121,584	
Maintenance	$10,000 annual	Present value @ 8 percent, 30 years	$	121,584	
			Long-Term O&M Costs:	$	851,088
			TOTAL ALTERNATIVE COST:	$	851,088

Note:
O&M Operation and Maintenance

TABLE 8.2

COST SUMMARY
ALTERNATIVE B - CONTAINMENT
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

		Quantity	Units	Unit Cost	Total Cost	
Sediment Dredging:						
Materials and Installation						
Dredge Mobilization		1	L.S.	$ 10,000	$ 10,000	
Dredge Demobilization		1	L.S.	$ 2,000	$ 2,000	
Tug	2 Hrs. Per Day	11	Hrs.	$ 500	$ 5,500	
		Materials and Installation Sub-Total:			**$ 17,500**	
Operation						
Boundary Sediment Dredging/Relocation		44	Hrs.	$ 1,000	$ 44,000	
Water Quality Monitoring	8 Per Day	5.5	Days	$ 3,200	$ 17,600	
Surveying		1	L.S.	$ 5,000	$ 5,000	
			Operation Sub-Total:		**$ 66,600**	
					Dredging Sub-Total:	**$ 84,100**
Capping:						
Materials and Installation						
Mobilization/Demobilization		1	L.S.	$ 20,000	$ 20,000	
Berm Construction	20 Sq. Ft. Per L.Ft.	1,481	C.Y.	$ 35	$ 51,852	
Geotextile		117,000	Sq. Ft.	$ 1.	$ 175,500	
Sand Cap	2-Ft. Thick	8,667	C.Y.	$ 30	$ 260,000	
Rip Rap	1-Ft. Thick	4,333	C.Y.	$ 50	$ 216,667	
Capping QA/QC		1	L.S.	$ 50,000	$ 50,000	
Surveying		1	L.S.	$ 25,000	$ 25,000	
Institutional Controls		1	Allowance	$ 25,000	$ 25,000	
		Materials and Installation Sub-Total:			**$ 824,019**	
					Capping Sub-Total:	**$ 824,019**
					Total Facility Cost:	$ 908,119
					Contingency (25 Percent):	$ 227,030
					Engineering (1):	$ 136,218
					Construction Oversight (2):	$ 39,000
					Total Facility Cost:	**$ 1,310,366**

Long-Term O&M:				
Monitoring	$100,000 Annual	Present Value @ 8 Percent, 30 Years	$ 1,215,841	
Reporting	$10,000 Annual	Present Value @ 8 Percent, 30 Years	$ 121,584	
Maintenance	$50,000 Annual	Present Value @ 8 Percent, 30 Years	$ 607,920	
			Long-Term O&M Cost:	**$ 1,945,345**
			TOTAL ALTERNATIVE COST:	**$ 3,255,711**

Notes:

(1) Engineering calculated as 15 percent of construction cost.

(2) Construction oversight based on construction period of 12 weeks.

C.Y. Cubic Yards.

L.S. Lump Sum.

O&M Operation and Maintenance.

QA/QC Quality Assurance/Quality Control.

Sq.Ft. Square Feet.

TABLE 8.2

COST SUMMARY
ALTERNATIVE B - CONTAINMENT
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

Estimate Assumptions:

Area 5106 Sediment in Shipping Channel	2,000 C.Y.	
Estimated Over-Dredge	200 C.Y.	6-Inch Over-Dredge
Total In Situ Sediment	2,200 C.Y.	
Dredging Rate	50 C.Y. Per Hr.	
Actual Dredging Time	44 Hrs.	
Area to be Capped	117,000 Sq. Ft.	
Length of Berm	2,000 L.Ft.	
Construction Schedule	12 Weeks	

TABLE 8.3

COST SUMMARY
ALTERNATIVE C - REMOVAL/TREATMENT/DISPOSAL
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

		Quantity	*Units*	*Unit Cost*	*Total Cost*	
Sediment Dredging:						
Equipment						
Slurry Processor Unit/Pump/Carbon		1	L.S.	$ 425,000	$ 425,000	
Dredging Barge		10.6	Wks.	$ 2,400	$ 25,389	
Processing Barge		10.6	Wks.	$ 2,400	$ 25,389	
Tug	2 Hrs. Per Day	126.9	Hrs.	$ 250	$ 31,736	
			Equipment Sub-Total:		**$ 507,514**	
Materials and Installation						
Dredge Mobilization		1	L.S.	$ 8,000	$ 8,000	
Sheet Pile Wall	750 L.Ft. @ 25 Ft. Deep	19,000	Sq. Ft.	$ 20	$ 380,000	
Dock No. 1 Removal/Replacement		1	L.S.	$ 255,885	$ 255,885	
Pier 25 Removal/Replacement		1	L.S.	$ 164,497	$ 164,497	
Relocate Seawater Pumps/Piping		1	Allowance	$ 75,000	$ 75,000	
			Materials and Installation Sub-Total:		**$ 883,382**	
Operation						
Dredging - Actual		639.8	Hrs.	$ 800	$ 511,840	
Dredging - Downtime		0.0	Hrs.	$ 800	$ -	
Slurry Unit Operation - Labor/O&M	1 Man	639.8	Hrs.	$ 60	$ 38,388	
Slurry Unit Operation - Power		2.4	Month	$ 15,000	$ 36,647	
Surveying		1	L.S.	$ 25,000	$ 25,000	
Water Quality Monitoring	8 Per Day	63.5	Days	$ 3,200	$ 203,111	
Air Quality Monitoring	2 Per Day	63.5	Days	$ 400	$ 25,389	
			Operation Sub-Total:		**$ 840,375**	
				Dredging Sub-Total:		**$ 2,231,271**
Sediment Treatment:						
Equipment						
Storage Tank	400,000 Gals.	1	Ea.	$ 240,000	$ 240,000	
Equalization Tank	75,000 Gals.	1	Ea.	$ 45,000	$ 45,000	
Treatment Tanks	20,000 Gals.	3	Ea.	$ 16,000	$ 48,000	
Seawater Recycle Tank	50,000 Gals.	1	Ea.	$ 40,000	$ 40,000	
Blowers	1,000 1000 cfm @ 12 psig/75 h	3	Ea.	$ 20,000	$ 60,000	
Carbon Beds		2	Ea.	$ 16,000	$ 32,000	
I.D. Fan	4,000 cfm @ 20-inch/40 hp	1	Ea.	$ 30,000	$ 30,000	
Boiler	Rental	13	Ea.	$ 2,300	$ 28,931	
Equalization Tank Agitator	400 hp	1	Ea.	$ 300,000	$ 300,000	
Treatment Tank Agitator	75 hp	3	Ea.	$ 60,000	$ 180,000	
Transfer Pumps	500 GPM	2	Ea.	$ 25,000	$ 50,000	
Treatment Feed Pump	1,000 GPM @15 TDH/10 hp	1	Ea.	$ 10,000	$ 10,000	
Treatment Tank Pumps	1,000 GPM/25 hp	3	Ea.	$ 10,000	$ 30,000	
Seawater Recycle Pump	1,000 GPM	1	Ea.	$ 10,000	$ 10,000	
Seawater Makeup Pump	500 GPM	1	Ea.	$ 5,000	$ 5,000	
Electrical Substation	1,500 kVA	1	Ea.	$ 135,000	$ 135,000	
Electrical MCC		2	Ea.	$ 17,000	$ 34,000	
			Equipment Sub-Total:		**$ 1,277,931**	
Materials and Installation						
Foundations						
• Treatment Area	120 ft. x 60 ft. Stone 18 in. thic	400	C.Y.	$ 20	$ 8,000	
• Pumps	Concrete Pads	6	Ea.	$ 500	$ 3,000	
• Electrical/Control Building	20 ft. x 20 ft. Concrete Slab	15	C.Y.	$ 300	$ 4,500	
• Gravel Road/Parking	21,000 Sq. Ft. / 8-inch Thick	600	C.Y.	$ 20	$ 12,000	
Mechanical Installation						
• Blowers		3	Ea.	$ 1,000	$ 3,000	
• Carbon Beds		2	Ea.	$ 1,000	$ 2,000	
• I.D. Fan		1	Ea.	$ 1,000	$ 1,000	
• Boiler		1	Ea.	$ 2,000	$ 2,000	
• Equalization Tank Agitator		1	Ea.	$ 10,000	$ 10,000	
• Treatment Tank Agitators		3	Ea.	$ 4,000	$ 12,000	
• Transfer Pumps		2	Ea.	$ 3,000	$ 6,000	
• Treatment Feed Pump		1	Ea.	$ 1,500	$ 1,500	

TABLE 8.3

COST SUMMARY
ALTERNATIVE C - REMOVAL/TREATMENT/DISPOSAL
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

		Quantity	Units	Unit Cost	Total Cost
Materials and Installation (Cont'd.)					
Mechanical Installation (Cont'd.)					
• Treatment Tank Pumps		3	Ea.	$ 1,500	$ 4,500
• Seawater Recycle Pump		1	Ea.	$ 1,500	$ 1,500
• Seawater Makeup Pump		1	Ea.	$ 1,500	$ 1,500
Piping					
• Dredged Sediment (from dredge)	12 In. to Equalization Tank	2,800	L. Ft.	$ 40	$ 112,000
• Untreated Slurry (from Equalization Tank)	8 In. to Treatment Tanks	145	L. Ft.	$ 45	$ 6,525
• Treated Slurry (from Treatment Tanks)	8 In. to Decant Barges	380	L. Ft.	$ 45	$ 16,200
• Recycle Seawater (from Recycle Tank)	12 In. to Equalization Tank	210	L. Ft.	$ 40	$ 8,400
• Recycle Seawater (from Decant Barges)	8 In. to Recycle Seawater Tank	400	L. Ft.	$ 40	$ 16,000
• Seawater Makeup (from Hylebos)	8 In. to Recycle Seawater Tank	400	L. Ft.	$ 40	$ 16,000
• Steam (from boiler)	8 In. to Treatment Tanks	110	L. Ft.	$ 45	$ 4,950
• Steam Pipe Insulation		110	L. Ft.	$ 20	$ 2,200
• Air (from blowers)	12 In. to Treatment Tanks	70	L. Ft.	$ 35	$ 2,450
• Vapor (from Treatment Tanks)	18 In. to Carbon Beds	205	L. Ft.	$ 25	$ 5,125
• Natural Gas (from Alexander)	4 In. to Boiler	600	L. Ft.	$ 24	$ 14,400
• Water (from Alexander)	2 In. to Boiler	600	L. Ft.	$ 16	$ 9,600
• Air Spargers	4 In. to Treatment Tanks	3	Ea.	$ 600	$ 1,800
Supports					
• Equalization Tank Agitator	5,700 Lbs.	1	Ea.	$ 8,550	$ 8,550
• Treatment Tank Agitator	2,100 Lbs.	3	Ea.	$ 3,150	$ 9,450
• Piping/Electrical Supports	4,810 L.Ft. of Piping	601	Ea.	$ 10	$ 6,013
Electrical					
• Substation Installation		1	Ea.	$ 12,000	$ 12,000
• MCC Installation		2	Ea.	$ 1,920	$ 3,840
• T.C.L. Service		1	L.S.	$ 10,000	$ 10,000
• Main Stream/Miscellaneous		1	L.S.	$ 35,760	$ 35,760
• Treatment Tanks		3	Ea.	$ 25,000	$ 75,000
Instrumentation					
• Main Stream		1	L.S.	$ 17,100	$ 17,100
• Treatment Tanks		3	Ea.	$ 10,000	$ 30,000
		Materials and Installation Sub-Total:			**$ 495,863**
Operation					
PLC Programming		60	Hrs.	$ 75	$ 4,500
Startup		80	Hrs.	$ 75	$ 6,000
Operators (1 per Shift)					
• Straight Time	120 Hrs. Per Week	1,269	Hrs.	$ 75	$ 95,208
• Overtime	24 Hrs. Per Week	254	Hrs.	$ 95	$ 24,119
Assistant Operators (1 per Shift)					
• Straight Time	120 Hrs. Per Week	1,269	Hrs.	$ 60	$ 76,167
• Overtime	24 Hrs. Per Week	254	Hrs.	$ 75	$ 19,042
Maintenance	8 Manhours Per Day	508	Hrs.	$ 50	$ 25,389
Steam					
• Initial Heating	10,000 Lbs. Per Batch	9,140,000	Lbs.	$ 0.01	$ 91,400
• Maintain Temperature	2,000 Lbs. Per Hour	3,046,667	Lbs.	$ 0.01	$ 30,467
Water	1,000 Gallons Per Day	63,472	Gallons		$ -
Power					
• Main Stream	8,034 Kwh Per Day	509,936	Kwh	$ 0.1	$ 76,490
• Treatment Tanks	3,040 Kwh Per Day Per Tank	578,867	Kwh	$ 0.1	$ 86,830
Carbon	12,000 Per Day	183,000	Lbs.	$ 0.7	$ 137,250
Confirmatory Analytical	1 Composite Per Barge	38.4	Samples	$ 750	$ 28,791
• Daily QA/QC	10 Percent of Batches	91	Samples	$ 750	$ 68,550
• Air Quality	1 Per 10 Batches	91	Samples	$ 200	$ 18,280
			Operation Sub-Total:		**$ 788,483**
			Treatment Sub-Total:		**$ 2,562,277**

TABLE 8.3

COST SUMMARY
ALTERNATIVE C - REMOVAL/TREATMENT/DISPOSAL
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

		Quantity	*Units*	*Unit Cost*	*Total Cost*
Disposal:					
Equipment					
Decant Barge No. 1	2,000 C.Y.	10.6	Wks.	$ 10,000	$ 105,787
Decant Barge No. 2	2,000 C.Y.	10.6	Wks.	$ 10,000	$ 105,787
Decant Barge No. 3	2,000 C.Y.	10.6	Wks.	$ 10,000	$ 1,057,887
Decant Pumps	10 hp	3	Ea.	$ 3,000	$ 9,000
Tugs	1,000 C.Y. Per Trip	38.388	Trips	$ 2,000	$ 76,776
			Equipment Sub-Total:		**$ 1,355,237**
Materials and Installation					
Barge Modifications		3	Ea.	$ 150,000	$ 450,000
Demo Treatment Facility		1	Allowance	$ 100,000	$ 100,000
			Materials and Installation Sub-Total:		**$ 550,000**
Operation					
Disposal Charges[3]	Slip 1 CDF	31,990	C.Y.	$ 50.75	$ 1,623,493
			Operation Sub-Total:		**$ 1,623,493**
				Disposal Sub-Total:	**$ 3,528,730**
				Total Facility Cost:	$ 8,522,277
				Contingency (25 Percent):	$ 2,080,569
				Engineering [1]:	$ 557,203
				Construction Oversight [2]:	$ 89,587
				TOTAL ALTERNATIVE COST:	**$ 11,049,636**

Notes:

(1)	Engineering calculated as 15 percent of construction cost.
(2)	Construction oversight based on a 12-week construction schedule plus the estimated 10.6 week dredging/treatment schedule.
(3)	Unit cost does not include financing and insurance costs.
C.Y.	Cubic Yards.
cfm	Cubic Feet Per Minute.
GPM	Gallons Per Minute.
hp	Horsepower.
Kwh	Kilowatt-hours.
L.S.	Lump Sum.
O&M	Operation and Maintenance.
QA/QC	Quality Assurance/Quality Control.
Sq.Ft.	Square Feet.

Estimate Assumptions:		*Notes*
Area 5106 Sediment Quantity	22,265 cubic yards	included sloughing volume per 6-inch over-dredge
Estimated Over-Dredge Quantity	9,725 cubic yards	
Total In Situ Sediment	31,990 cubic yards	
Treatment Slurry Content	15 Percent	
Number of Treatment Tanks	3 each	20,000 gallons each
Treatment Time	4 hours per batch	average
Batches	14.4 batches per day	includes 1 hour fill/discharge time per batch
Batch Capacity	18,500 gallons per batch	plus 1,000 gallons of steam condensate
	35 cubic yards per batch	
Treatment Rate	266,400 gallons per day	
	504 cubic yards per day	
Required Storage Tank Capacity	400,000 gallons	1.5 times the daily treatment rate
Theoretical Treatment Days	63.5 days	
	10.6 weeks	6 days per week
Theoretical Dredging Days	63.5 days	
	10.6 weeks	6 days per week
Minimum Dredge Rate	504.0 cubic yards per day	equal to Treatment Rate
Dredge Capacity	50.0 cubic yards per hour	
Minimum Dredge Operation	10.1 hours per day	
Actual Dredging Time	639.8 hours	
Chargeable Dredging Time	639.8 hours	10 hours per day

TABLE 8.4

COST SUMMARY
ALTERNATIVE D - COMBINED CONTAINMENT AND REMOVAL
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

		Quantity	Units	Unit Cost	Total Cost	
Sediment Dredging:						
Equipment						
Slurry Processor Unit/Pump/Carbon		1	L.S.	$ 425,000	$ 425,000	
Dredging Barge		5.8	Wks.	$ 2,400	$ 13,817	
Processing Barge		5.8	Wks.	$ 2,400	$ 13,817	
Tug	2 Hrs. Per Day	69.1	Hrs.	$ 250	$ 17,271	
				Equipment Sub-Total:	**$ 469,905**	
Materials and Installation						
Dredge Mobilization		1	L.S.	$ 8,000	$ 8,000	
Sheet Pile Wall	750 L.Ft. @ 40 Ft. Long	30,000	Sq. Ft.	$ 25	$ 750,000	
Pier 25 Removal/Replacement		1	L.S.	$ 164,497	$ 164,497	
				Materials and Installation Sub-Total:	**$ 922,497**	
Operation						
Dredging - Actual		348.2	Hrs.	$ 800	$ 278,544	
Dredging - Downtime		0.0	Hrs.	$ 800	$ -	
Slurry Unit Operation - Labor/O&M	1 Man	348.2	Hrs.	$ 60	$ 20,891	
Slurry Unit Operation - Power		1.3	Month	$ 15,000	$ 19,943	
Surveying		1	L.S.	$ 20,000	$ 20,000	
Water Quality Monitoring	8 Per Day	34.5	Days	$ 3,200	$ 110,533	
Air Quality Monitoring	2 Per Day	34.5	Days	$ 400	$ 13,817	
				Operation Sub-Total:	**$ 463,728**	
					Dredging Sub-Total:	**$ 1,856,130**
Sediment Treatment:						
Equipment						
Storage Tank	400,000 Gals.	1	Ea.	$ 240,000	$ 240,000	
Equalization Tank	75,000 Gals.	1	Ea.	$ 45,000	$ 45,000	
Treatment Tanks	20,000 Gals.	3	Ea.	$ 16,000	$ 48,000	
Seawater Recycle Tank	50,000 Gals.	1	Ea.	$ 40,000	$ 40,000	
Blowers	1,000 1000 cfm @ 12 psig/75 h	3	Ea.	$ 20,000	$ 60,000	
Carbon Beds		2	Ea.	$ 16,000	$ 32,000	
I.D. Fan	4,000 cfm @ 20-inch/40 hp	1	Ea.	$ 30,000	$ 30,000	
Boiler	Rental	8	Ea.	$ 2,300	$ 17,841	
Equalization Tank Agitator	400 hp	1	Ea.	$ 300,000	$ 300,000	
Treatment Tank Agitator	75 hp	3	Ea.	$ 60,000	$ 180,000	
Transfer Pumps	500 GPM	2	Ea.	$ 25,000	$ 50,000	
Treatment Feed Pump	1,000 GPM @15 Ft. TDH/10 h	1	Ea.	$ 10,000	$ 10,000	
Treatment Tank Pumps	1,000 GPM/25 hp	3	Ea.	$ 10,000	$ 30,000	
Seawater Recycle Pump	10 hp	1	Ea.	$ 10,000	$ 10,000	
Seawater Makeup Pump	10 hp	1	Ea.	$ 5,000	$ 5,000	
Electrical Substation	1,500 kVA	1	Ea.	$ 135,000	$ 135,000	
Electrical MCC		2	Ea.	$ 17,000	$ 34,000	
				Equipment Sub-Total:	**$ 1,266,841**	
Materials and Installation						
Foundations						
• Treatment Area	120 ft. x 60 ft. Stone 18 in. thic	400	C.Y.	$ 20	$ 8,000	
• Pumps	Concrete Pads	6	Ea.	$ 500	$ 3,000	
• Electrical/Control Building	20 ft. x 20 ft. Concrete Slab	15	C.Y.	$ 300	$ 4,500	
• Gravel Road/Parking	21,000 Sq. Ft. / 8-inch Thick	600	C.Y.	$ 20	$ 12,000	
Mechanical Installation						
• Blowers		3	Ea.	$ 1,000	$ 3,000	
• Carbon Beds		2	Ea.	$ 1,000	$ 2,000	
• I.D. Fan		1	Ea.	$ 1,000	$ 1,000	
• Boiler		1	Ea.	$ 2,000	$ 2,000	
• Equalization Tank Agitator		1	Ea.	$ 10,000	$ 10,000	
• Treatment Tank Agitators		3	Ea.	$ 4,000	$ 12,000	
• Transfer Pumps		2	Ea.	$ 3,000	$ 6,000	
• Treatment Feed Pump		1	Ea.	$ 1,500	$ 1,500	

TABLE 8.4

COST SUMMARY
ALTERNATIVE D - COMBINED CONTAINMENT AND REMOVAL
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

		Quantity	*Units*	*Unit Cost*	*Total Cost*
Materials and Installation (Cont'd.)					
Mechanical Installation (Cont'd.)					
• Treatment Tank Pumps		3	Ea.	$ 1,500	$ 4,500
• Seawater Recycle Pump		1	Ea.	$ 1,500	$ 1,500
• Seawater Makeup Pump		1	Ea.	$ 1,500	$ 1,500
Piping					
• Dredged Sediment (from dredge)	12 In. to Equalization Tank	2,800	L. Ft.	$ 40	$ 112,000
• Untreated Slurry (from Equalization Tank)	8 In. to Treatment Tanks	145	L. Ft.	$ 45	$ 6,525
• Treated Slurry (from Treatment Tanks)	8 In. to Decant Barges	380	L. Ft.	$ 45	$ 16,200
• Recycle Seawater (from Recycle Tank)	12 In. to Equalization Tank	210	L. Ft.	$ 40	$ 8,400
• Recycle Seawater (from Decant Barges)	8 In. to Recycle Seawater Tank	400	L. Ft.	$ 40	$ 16,000
• Seawater Makeup (from Hylebos)	8 In. to Recycle Seawater Tank	400	L. Ft.	$ 40	$ 16,000
• Steam (from boiler)	8 In. to Treatment Tanks	110	L. Ft.	$ 45	$ 4,950
• Steam Pipe Insulation		110	L. Ft.	$ 20	$ 2,200
• Air (from blowers)	12 In. to Treatment Tanks	70	L. Ft.	$ 35	$ 2,450
• Vapor (from Treatment Tanks)	18 In. to Carbon Beds	205	L. Ft.	$ 25	$ 5,125
• Natural Gas (from Alexander)	4 In. to Boiler	600	L. Ft.	$ 24	$ 14,400
• Water (from Alexander)	2 In. to Boiler	600	L. Ft.	$ 16	$ 9,600
• Air Spargers	4 In. to Treatment Tanks	3	Ea.	$ 600	$ 1,800
Supports					
• Equalization Tank Agitator	5,700 Lbs.	1	Ea.	$ 8,550	$ 8,550
• Treatment Tank Agitator	2,100 Lbs.	3	Ea.	$ 3,150	$ 9,450
• Piping/Electrical Supports	4,810 L.Ft. of Piping	601	Ea.	$ 10	$ 6,013
Electrical					
• Substation Installation		1	Ea.	$ 12,000	$ 12,000
• MCC Installation		2	Ea.	$ 1,920	$ 3,840
• T.C.L. Service		1	L.S.	$ 10,000	$ 10,000
• Main Stream/Miscellaneous		1	L.S.	$ 35,760	$ 35,760
• Treatment Tanks		3	Ea.	$ 25,000	$ 75,000
Instrumentation					
• Main Stream		1	L.S.	$ 17,100	$ 17,100
• Treatment Tanks		3	Ea.	$ 10,000	$ 30,000
		Materials and Installation Sub-Total:			**$ 495,863**
Operation					
PLC Programming		40	Hrs.	$ 75	$ 3,000
Startup		40	Hrs.	$ 75	$ 3,000
Operators (1 per Shift)					
• Straight Time	120 Hrs. Per Week	691	Hrs.	$ 75	$ 51,813
• Overtime	24 Hrs. Per Week	138	Hrs.	$ 95	$ 13,126
Assistant Operators (1 per Shift)					
• Straight Time	120 Hrs. Per Week	691	Hrs.	$ 60	$ 41,450
• Overtime	24 Hrs. Per Week	138	Hrs.	$ 75	$ 10,363
Maintenance	8 Manhours Per Day	276	Hrs.	$ 50	$ 13,817
Steam					
• Initial Heating	10,000 Lbs. Per Batch	4,974,000	Lbs.	$ 0.01	$ 49,740
• Maintain Temperature	2,000 Lbs. Per Hour	1,658,000	Lbs.	$ 0.01	$ 16,580
Water	1,000 Gallons Per Day	34,542	Gallons		$ -
Power					
• Main Stream	8,034 Kwh Per Day	277,508	Kwh	$ 0.1	$ 41,626
• Treatment Tanks	3,040 Kwh Per Day Per Tank	315,020	Kwh	$ 0.1	$ 47,253
Carbon	12,000 Per Day	414,500	Lbs.	$ 0.7	$ 310,875
Confirmatory Analytical	1 Composite Per Barge	20.9	Samples	$ 750	$ 15,668
• Daily QA/QC	10 Percent of Batches	50	Samples	$ 750	$ 37,305
• Air Quality	1 Per 10 Batches	50	Samples	$ 200	$ 9,948
			Operation Sub-Total:		**$ 665,564**
			Treatment Sub-Total:		**$ 2,428,266**

TABLE 8.4

COST SUMMARY
ALTERNATIVE D - COMBINED CONTAINMENT AND REMOVAL
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

		Quantity	Units	Unit Cost	Total Cost	
Disposal:						
Equipment						
Decant Barge No. 1	2,000 C.Y.	5.8	Wks.	$ 10,000	$ 57,569	
Decant Barge No. 2	2,000 C.Y.	5.8	Wks.	$ 10,000	$ 57,569	
Decant Barge No. 3	2,000 C.Y.	5.8	Wks.	$ 10,000	$ 57,569	
Decant Pumps	<10 HP	3	Ea.	$ 3,000	$ 9,000	
Tugs	1,000 C.Y. Per Trip	20.8808	Trips	$ 2,000	$ 41,782	
				Equipment Sub-Total:	**$ 223,489**	
Materials and Installation						
Barge Modifications		3	Ea.	$ 150,000	$ 450,000	
Demo Treatment Facility		1	Allowance	$ 100,000	$ 100,000	
				Materials and Installation Sub-Total:	**$ 550,000**	
Operation						
Disposal Charges [3]	Slip 1 CDF	17,409	C.Y.	$ 50.75	$ 883,507	
				Operation Sub-Total:	**$ 883,507**	
					Disposal Sub-Total:	**$ 1,656,996**
Capping						
Materials and Installation						
Mobilization/Demobilization		1	L.S.	$ 20,000	$ 20,000	
Berm Construction	20 Sq. Ft. Per L. Ft.	0	C.Y.	$ 40	$ -	
Geotextile		39,000	Sq. Ft.	$ 1	$ 58,500	
Sand Cap	2 Foot Thick Cap	2,889	C.Y.	$ 35	$ 101,111	
Rip Rap	1 Foot Thick	1,444	C.Y.	$ 55	$ 79,444	
Capping QA/QC		1	L.S.	$ 50,000	$ 50,000	
Surveying		1	L.S.	$ 25,000	$ 25,000	
Institutional Controls		1	L.S.	$ 25,000	$ 25,000	
				Materials and Installation Sub-Total:	**$ 359,055**	
					Capping Sub-Total:	**$ 359,055**
					Facility Sub-Total:	$ 6,300,447
					Contingency (25 Percent):	$ 1,575,112
					Engineering [1]:	$ 527,124
					Construction Oversight [2]:	$ 70,632
					TOTAL ALTERNATIVE COST:	**$ 8,473,315**
Long-Term O&M:						
Monitoring	$40,000 Annual	Present Value @ 8 Percent, 30 Years			$ 486,336	
Reporting	$5,000 Annual	Present Value @ 8 Percent, 30 Years			$ 60,792	
Maintenance	$20,000 Annual	Present Value @ 8 Percent, 30 Years			$ 243,168	
					Long-Term O&M Cost:	**$ 790,296**
					TOTAL ALTERNATIVE COST:	**$ 9,263,611**

Notes:

(1) Engineering calculated as 15 percent of construction cost.
(2) Construction oversight based on a 12-week construction schedule plus the estimated dredging/treatment schedule.
(3) Unit cost does not include financing and insurance cost.
C.Y. Cubic Yards.
cfm Cubic Feet Per Minute.
GPM Gallons Per Minute.
hp Horsepower.
Kwh Kilowatt-hours.
L.S. Lump Sum.
O&M Operation and Maintenance.
QA/QC Quality Assurance/Quality Control.
Sq.Ft. Square Feet.

TABLE 8.4

COST SUMMARY
ALTERNATIVE D - COMBINED CONTAINMENT AND REMOVAL
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

		Notes
Estimate Assumptions:		
Area 5106 Sediment Quantity	15,360 cubic yards	included sloughing volume per 6-inch over-dredge
Estimated Over-Dredge Quantity	2,049 cubic yards	
Total In Situ Sediment	17,409 cubic yards	
Treatment Slurry Content	15 Percent	
Number of Treatment Tanks	3 each	20,000 gallons each
Treatment Time	4 hours per batch	
Batches	14.4 batches per day	includes 1 hour fill/discharge time per batch
Batch Capacity	18,500 gallons per batch	plus 1,200 gallons of steam condenstate
	35 cubic yards per batch	
Treatment Rate	266,400 gallons per day	
	504 cubic yards per day	
Required Storage Tank Capacity	400,000 gallons	1.5 times the daily treatment rate
Theoretical Treatment Days	34.5 days	
	5.8 weeks	6 days per week
Theoretical Dredging Days	34.5 days	
	5.8 weeks	6 days per week
Minimum Dredge Rate	504.0 cubic yards per day	equal to Treatment Rate
Dredge Capacity	50.0 cubic yards per hour	
Minimum Dredge Operation	10.1 hours per day	
Actual Dredging Time	348.2 hours	
Chargeable Dredging Time	348.2 hours	10 hours per day
Area to be Capped	39,000 square feet	

TABLE 9.1
COMPARATIVE ANALYSIS OF ALTERNATIVES
AREA 5106 ENGINEERING EVALUATION/COST ANALYSIS
OCC TACOMA, INC.
TACOMA, WASHINGTON

	Removal Action Alternatives			
	A *No Action (Natural Recovery)*	*B* *Containment*	*C* *Removal/ Treatment/ Disposal*	*D* *Combined Containment and Removal*
Effectiveness				
• Overall Protection of Public Health and the Environment	4	2	1	2
• Compliance with ARARs	4	1	2	3
• Long-Term Effectiveness and Permanance	4	2	1	2
• Reduction of Toxicity, Mobility, or Volume Through Treatment	4	3	1	2
• Short-Term Effectiveness	1	2	4	3
Implementability				
• Technical Feasibility	2	1	3	3
• Availability	NA	1	1	1
• Administrative Feasibility	3	4	1	2
Cost	$0.85 MM	$3.26 MM	$11.05 MM	$9.27 MM

Note:
NA Not Applicable.

Rankings:
1 Best.
4 Worst.

APPENDICES

A

APPENDIX A

COLUMN LEACH TESTS AND DISPOSAL SITE ANALYSIS; SECTIONS 3.0, 4.0, AND 5.0 EXTRACTED FROM THE CLT REPORT

3.0 COLUMN LEACH TESTS

3.1 GENERAL

The CLTs were conducted on each of the four composite samples in accordance with U.S. Army Corps of Engineers (USACE), Waterways Experiment Station (WES) methodologies, modified as appropriate to perform the tests under anaerobic conditions. Procedures used for the CLTs are described in detail in the Area 5106 SAP and subsequent modifications approved by USEPA.

The CLTs were performed by Soils Technology in Bainbridge Island, Washington, utilizing groundwater from well HCC-1 as leach water. During preparation of the columns, the composited sediment samples were remolded to approximate in-place density for conducting the test. The CLTs were initiated in June 1998. Leachate sampling occurred at intervals of approximately one porewater volume. Geochemical index parameters including pH, Eh, conductivity, dissolved oxygen, turbidity, and ferrous iron were analyzed for each sample. A minimum of 10 samples from the first 15 pore volumes were submitted to APPL Laboratory in Fresno, California, for analyses of the target chemical parameters. Table 3.1 presents a summary of the samples collected and analyzed during each CLT. Each CLT continued for a minimum of 15 pore volumes or until a constant or downward concentration trend was observed for all analyzed chemical parameters.

3.2 COLUMN LEACH TEST PARAMETERS

Chemical Parameters

The chemical parameters for the CLTs, established by the SAP, initially consisted of hexachlorobutadiene, phenathrene, tetrachlorobutadiene (as a Tentatively Identified Compound [TIC]), hexachlorobenzene, and polychlorinated biphenyls (PCBs) as Aroclors. Volatile organic compounds (VOCs) considered representative of Area 5106 Sediment were specifically excluded due to sample collection limitations of the CLT setup. Subsequently, modified CLT setup and sampling procedures were developed by OCCT and Hylebos Cleanup Committee (HCC) representatives to allow for the collection of samples for VOC analysis. The modified procedures were approved by USEPA and finalized on July 13, 1998 (Ref. CRA letter from C. Dunnigan [CRA] to K. Marcy [USEPA]).

The leachates from the CLTs were analyzed for the chemical parameters listed in Table 3.2. These parameters were finalized based upon the analyses of bulk sediment samples taken from each of the composite boundary confirmation samples and

discussions with USEPA and the HCC. As noted in Table 3.2, 4,4'-DDD, 4,4'-DDE, and five chlorinated butadienes were added to the USEPA approved parameter list at the request of the HCC.

The analytical data for the bulk analysis are presented in Table 3.3. The Quality Assurance/Quality Control (QA/QC) review for these data is contained in Appendix A of the Area 5106 Sediment Characterization Report.

Geochemical Index Parameters

Geochemical index parameters were analyzed by Soils Technology to monitor test conditions and ensure the samples remained anaerobic during collection. The index parameters, including pH, Eh, conductivity, dissolved oxygen, and ferrous iron, were analyzed from an aliquot of every sample collected during the CLTs. Although geochemical conditions within the CLTs were affected by the test conditions (e.g., reduced salinity and increased oxidation-reduction potential over time), all samples remained anaerobic throughout the testing period.

Physical Parameters

Prior to initiating the CLTs, moisture content, wet density, and porosity were measured. Upon termination of each CLT, moisture content and wet density were measured on the remolded sediment. In addition, effective porosity and hydraulic conductivity were measured on unmolded sediment from column CHCC following termination. Effective porosity and hydraulic conductivity tests also were attempted on remolded sediment from column OHBC, although the results were determined to be unacceptable by Soils Technology (due to remolding uncertainties).

3.3 COLUMN LEACH TEST DATA

The chemical and geophysical analytical data for the four CLTs are presented in Tables 3.4 through 3.7. The data also are presented graphically on Figures 3.1 through 3.4. The QA/QC review for the chemical data is contained in Appendix A.

Results for moisture content, wet density, total porosity, effective porosity, and hydraulic conductivity are presented in Table 3.8.

3.4 DATA EVALUATION

Upon completion of the CLT, the peak leachate concentrations detected for each parameter initially were compared to the respective WQC for the protection of aquatic life. Chemicals with concentrations which exceeded their respective WQC were identified as "Chemicals of Potential Concern" and subjected to further evaluation, as described in Section 4.0, to determine their acceptability for placement within the CDF. Chemicals with concentrations which were below their respective WQC present no long-term water quality concerns and were determined to be acceptable for placement in the CDF without further evaluation.

While most of the CLTs exhibited clearly defined trends of increasing chemical concentrations during the early portions of the tests, followed by declining trends towards the end of the tests, some of the CLTs exhibited concentration fluctuations that were more variable (e.g., tetrachlorobutadiene in CHCC and VBC; see Figures 3.3 and 3.4, respectively). In such cases, concentration fluctuations observed towards the end of the CLTs (i.e., after 20 to 30 pore volumes) approximated steady-state conditions (i.e., no defined increasing or decreasing trends). The peak concentrations detected in such tests provide an upper-bound measure of the observed concentration fluctuations, and were used as conservative estimates of leachate concentrations that may be generated at prospective disposal sites (discussed in Section 4.0).

3.4.1 WATER QUALITY CRITERIA

Established Water Quality Criteria

Acute and chronic WQC for the CLT chemical parameters are presented in Table 3.9. These criteria represent established USEPA promulgated or recommended standards for the protection of aquatic life.

As noted in Table 3.9, several of the CLT chemical parameters have no established or recommended acute or chronic WQC. These parameters include vinyl chloride and five chlorinated butadienes which were reported as Tentatively Identified Compounds (TICs). Without established acute or chronic WQC against which to compare, long-term water quality relative to these chemicals cannot be assessed within the regulatory framework.

Estimated Water Quality Criteria

As a screening level tool, WQC were estimated for those CLT parameters without established WQC. Estimated WQC, presented in Table 3.10, were developed in conjunction with HCC representatives for the following chemicals:

1. Vinyl Chloride - A review of the literature indicates that no salt water organisms have been tested to assess the effects of their exposure to vinyl chloride. Consequently, no direct estimates can be made relative to acute or chronic toxicity. In the absence of any data relative to the protection of aquatic life, the human health criterion for vinyl chloride was selected as the best available estimate of WQC relevant to longer-term (chronic) exposure conditions.
2. Chlorinated Butadienes - With the exception of HCBD there are no data in the literature concerning the toxicity of chlorinated butadienes to aquatic organisms. Consequently, no direct estimates can be made relative to acute or chronic toxicity. In the absence of any data, the toxicities of the butadienes were estimated using the USEPA ECOSAR computer program. The ECOSAR program uses structure-activity relationships for similar classes of compounds to predict aquatic toxicity of organic chemicals based on the similarity of their structure to chemicals with known aquatic toxicity. Mr. C. Boatman of Aura Nova Consultants performed the analysis based upon the known toxicity of HCBD. A copy of Mr. Boatman's memo dated October 21, 1998, which outlines the estimation of WQC for the chlorinated butadienes, is contained in Appendix B.

3.4.2 CHEMICALS OF POTENTIAL CONCERN

The peak leachate concentrations for each parameter are compared to the established marine WQC. Based upon the comparison presented in Table 3.11, the following two chemicals exceed their established marine WQC and were identified as "Chemicals of Potential Concern" in one or more of the CLT:

Chemical of Potential Concern	*Peak Leachate Concentration (µg/L)*	*CLT With Peak Concentration*	*Marine WQC (µg/L)*
Hexachlorobutadiene	42	OHBC	32
Tetrachloroethene	700	OHBC	450

All other CLT chemicals are either below their respective marine WQC or have no established criteria against which to compare. PCBs were not detected in the leachate from any of the columns, although the highest detection limits for some Aroclors were

above the marine chronic WQC. However, detection limits for Aroclor 1260 were as low as 0.05 μg/L. Given the relative bulk concentrations of the PCB Aroclors in the sediment, and the highly insoluble nature of PCBs, the actual PCB concentrations in the column leachate are expected to be well below the chronic marine WQC of 0.03 μg/L.

Based upon the comparison of peak leachate concentrations with the established marine WQC, HCBD, and PCE were evaluated further as described in Section 4.0, to determine whether sediment with leachate concentrations of 42 μg/L for HCBD and 700 μg/L for PCE are acceptable for placement within the CDF.

3.4.3 OTHER CHEMICALS

As stated in Section 3.4.1, several CLT parameters have no established or recommended acute or chronic WQC. WQC were estimated for these parameters in order to perform a screening level evaluation of the CLT results. The peak leachate concentrations for vinyl chloride and the five chlorinated butadienes were compared to the estimated marine WQC. Based upon the comparison presented in Table 3.12, the following chemicals exceed their estimated marine WQC in one or more of the CLTs:

Chemical	*Peak Leachate Concentration (μg/L)*	*CLT With Peak Concentration*	*Estimated Marine WQC (μg/L)*
Vinyl chloride	2600	IHBC	525
Dichlorobutadiene	870J	IHBC	282
Trichlorobutadiene	870J	OHBC	192
Tetrachlorobutadiene	1500J	OHBC	121
Pentachlorobutadiene	100J	OHBC	67

While there is no regulatory basis for evaluating the CLT data against estimated WQC, the above screening level evaluation may indicate a potential ecological concern. As such, the above chemicals were evaluated further as described in Section 4.0 to determine whether sediments with these leachate concentrations do indeed present a potential long-term water quality concern for the CDF.

4.0 BOUNDARY CONFIRMATION ANALYSIS

Area 5106 Sediment is defined as those sediments which, if placed in a disposal site with the dredged Hylebos sediment, without treatment, could cause the disposal site to fail relevant WQC at the regulatory point of compliance. Conversely, if sediment represented by a CLT is determined to be acceptable for placement in the disposal site, without treatment, the sediment is considered boundary sediment and not Area 5106 Sediment.

4.1 DISPOSAL SITE ACCEPTANCE CRITERIA

The boundary sediments will be dredged and disposed of with the remainder of the dredged Hylebos sediments. Four possible disposal sites have been identified by the HCC in their Draft Pre-Remedial Design Evaluation Report, dated November 30, 1998. These sites included:

i)	Nearshore CDF Site 12	Blair Waterway Slip 1;
ii)	Aquatic CDF Site 1	Mouth of Hylebos Waterway;
iii)	Aquatic CDF Site 3	Upper Hylebos Turning Basin; and
iv)	Upland Regional Landfill	Roosevelt or Columbia Ridge.

Due to the substantially higher cost of the Upland Regional Landfill, the dredged Hylebos sediment most likely will be disposed of at the Nearshore CDF or an Aquatic CDF site.

Disposal of dredged sediments into a neashore or aquatic CDF is regulated under the Clean Water Act (CWA) and other Federal and State authorities. Discharges from a CDF site must not result in exceedance of water quality criteria at the point of discharge into the receiving water (i.e., in seeps that discharge through the berm and/or cap sections). In making this determination, the CDF designer and Agency reviewers normally use a combination of laboratory tests (CLTs) and mathematical models of the various processes involved (e.g., chemical attenuation and dispersion, see Section 4.2). The appropriate and relevant marine WQC for the Hylebos sediment disposal sites are presented in Table 3.9.

4.2 DISPOSAL SITE ANALYSIS

The data evaluation presented in Section 3.4 identified several chemicals with peak leachate concentrations from the CLTs which exceed either their marine WQC or an

estimated marine WQC. OCCT has analyzed the transport of solutes from a representative disposal site to evaluate the potential for water quality impacts at the point of discharge from the CDF into adjacent surface waters (regulatory point of compliance). The Nearshore CDF Site 12 (Slip 1) was utilized in this analysis because it is currently one of the most promising disposal sites under consideration by the HCC and USEPA, and also because the hydrogeologic system in the CDF area has generally been characterized sufficiently to support preliminary modeling. However, the results of the preliminary modeling also may be applicable to other potential CDF sites.

Model Basis

The list of potentially relevant transport processes that control chemical transport and resultant water quality at the point of discharge from the CDF include the following:

i) contaminant dissolution and colloidal release;

ii) advection (transport along with the flowing groundwater);

iii) hydrodynamic dispersion;

iv) chemical adsorption;

v) metal sulfide precipitation;

vi) ferrous iron oxidation/precipitation;

vii) organic biodegradation; and

viii) tidal dispersion.

Previous studies have shown that all of these processes have been determined to be quantitatively important in controlling water quality within Puget Sound CDFs. However, the design approach presently utilized in the Puget Sound region (and elsewhere in the U.S.) has been based on the conservative premise that only a few of the simpler physical/chemical processes listed above control chemical attenuation and resultant water quality at a CDF site. A relatively straightforward CLT and chemical transport modeling-based evaluation that focuses on these simpler processes is normally applied to evaluate water quality protection provided by regional CDFs.

For the purpose of this CLT Evaluation Report, a conservative screening level analysis was performed that considers only tidal dispersion processes. Further, the model assumes worst-case placement of all Area 5106 boundary sediment at locations very near the upland face of the CDF berm (see Figure 4.1). Peak leachate concentrations were assumed to discharge directly (and continuously) into the containment berm without the benefit of dilution or other attenuation processes that will occur with placement further inshore of the berm. As described below, other assumptions also were intentionally conservative.

The analysis considered time-varying groundwater flow under the influence of tidal oscillations in Commencement Bay. Groundwater flow and solute transport were modeled using a numerical simulation approach. Transient groundwater flow was simulated using the finite-difference code MODFLOW developed by the U.S. Geological Survey (McDonald and Harbaugh, 1988). Solute transport was simulated using the comprehensive solute transport simulator MT3DMS (Zheng, 1998). The results of the transport modeling were evaluated by comparing predicted attenuation with empirical observations of tidal dispersion and chemical transport in similar CDF berms.

The MODFLOW/MT3DMS model is based on the following key assumptions:

i) the groundwater system within the CDF is unconfined;

ii) the regional groundwater discharge is constant;

iii) water levels at the seaward face of the CDF oscillate with the tides, with corresponding flow reversals and the water levels in Commencement Bay are assumed to follow a regular tidal cycle;

iv) dredged sediments from Area 5106 are placed very near to the upland face of the CDF;

v) the dredged sediments are represented by a zone of chemical concentration that remains constant through time; and

vi) solutes leaching from the dredged sediments are assumed to be non-reactive. That is, the solutes do not undergo either sorption, or degradation reactions. In effect, the solute transport analysis considers the migration of a tracer released from the fill.

Application of Model to Slip 1

The following points describe the application of the MODFLOW/MT3DMS model to the Slip 1 disposal site:

1. The groundwater system within the CDF was represented by a vertical slice taken through the berm and fill materials. For this analysis, it was assumed that the dredged boundary sediments will be placed 20 feet inland from the face of the CDF berm. It is assumed that both the berm materials and the dredged sediments will remain saturated (e.g., placed below elevation at +6 feet mean lower low water; based on regional CDF evaluations (Ecology, 1990)). A sketch illustrating the conceptual model for the analysis is shown on Figure 4.1. The model domain, material properties, and boundary conditions for the analysis are presented on Figure 4.2.

2. The upgradient boundary of the groundwater model was assigned a constant inflow representing regional discharge to Commencement Bay. The magnitude of the inflow was specified based on previous regional-scale analyses of groundwater flow. The regional Darcy flux is defined as:

$$q = Ki$$

Assuming a regional hydraulic conductivity and regional hydraulic gradient of 6×10^{-4} centimeters per second (cm/sec) and 0.004, respectively (Port of Tacoma, 1992), the mean Darcy flux from the upland areas was estimated to be 2.4×10^{-6} cm/sec.

3. The downgradient boundary for the CDF is the outlet to Commencement Bay at the seaward face of the berm. The actual tidal fluctuations in the Commencement Bay are irregular, exhibiting seasonal variations in amplitude and period. Data collected during pilot testing of the extraction system at the former OCCT Facility in 1995 were used to derive a simplified representation of the tides. The data suggest that seasonal neap tide conditions associated with minimum tidal mixing can be approximated reasonably well by a simple sinusoidal cycle described by:

$$h(0,t) = a_o \sin\left(\frac{2\pi t}{t_o}\right)$$

A tidal amplitude a_o of 6 feet was specified; the difference between the minimum and maximum water levels in Commencement Bay is $2a_o$, or 12 feet. A tidal period t_o of 0.5 days was specified (i.e., semi-diurnal tidal fluctuation).

4. The fill placed behind the berm was assigned a uniform hydraulic conductivity of 6×10^{-4} cm/sec. This value is the same as the estimated regional scale conductivity, and is consistent with the results of lab tests on remolded Area 5106 boundary sediments (see Table 3.8) and other sediments from the Hylebos Waterway (Striplin, 1998).

5. Typically constructed of select sand and gravel materials, the CDF berm will be more permeable than either the dredged sediment fill or the sands and silts comprising the upland sediments. The measured hydraulic conductivity of similar berm materials has averaged 10^{-2} cm/sec (Port of Seattle, 1994). In the present analysis, the berm is assigned a uniform hydraulic conductivity of 3×10^{-2} cm/sec.

6. The analysis considers an upgradient boundary that remains effectively at a fixed tracer concentration. A concentration of 1.0 is assigned to the tracer. The results of the analysis can therefore be applied to particular solutes analyzed in the CLTs by scaling with respect to assumed solute concentrations in the fill. For this analysis the actual concentrations assigned to the fill are set as the peak leachate

concentration from the CLTs. This maximum source concentration is assumed constant through time.

Input Parameters

The input parameters for the MODFLOW/MT3DMS analysis are summarized below:

Parameter	*Value*
Regional hydraulic gradient, i_r	0.004
Regional hydraulic conductivity, K	$6x10^{-4}$ cm/sec
Hylebos sediment hydraulic conductivity, K	$6x10^{-4}$ cm/sec
Hylebos sediment porosity, n	0.77
Berm hydraulic conductivity, K	$3x10^{-2}$ cm/sec
Berm porosity, n	0.35
Storage coefficient (specific yield), S	0.10
Aquifer thickness, B	30 ft
Longitudinal dispersivity, α_l	1.0 m
Tidal amplitude, a_o	6.0 ft
Tidal period, t_o	0.5 day
Model length, L	505 ft
Grid spacing, Δx	1.0 ft
Flow Model Stress Period	72 min
Transport Model Time Step per Flow Model Stress Period	1 to 2

Results of Analysis

The analysis of groundwater flow predicts that water levels in the berm and a portion of the fill will oscillate in response to tidal fluctuations in Commencement Bay. A profile of predicted groundwater levels is shown on Figure 4.3. Figure 4.3 plots the envelopes of water levels. Within Commencement Bay, the envelopes fluctuate approximately 6.0 feet around the mean sea level elevation. The figure also shows that water level fluctuations are damped relatively close to the upland face of the berm. The distinct "kinks" in the water level envelopes are due to the contrast in material properties between the berm and the fill.

The discharge at the outlet to Commencement Bay over ten tidal cycles is shown on Figure 4.4. The analysis predicts that the groundwater flow between the berm and Commencement Bay also oscillates. During intervals when surface water levels exceed groundwater levels, flow is directed inward from Commencement Bay to the aquifer. In the transport analysis, it is assumed that during these intervals the concentration of the influent water is zero.

The predicted tracer concentrations at the seaward face of the berm are shown on Figure 4.5. The concentration axis was chosen deliberately to represent the full magnitude of the source concentration, in order to highlight the relatively large degree of attenuation that arises from tidal dilution. The analysis predicts that the concentrations at the outlet oscillate through time in response to the tides. Over the full range of time considered, the envelope of the concentration appears as a solid band that stabilizes after about 2000 tidal cycles (1000 days). Figure 4.6 shows the results for the interval of 998 to 1000 days re-plotted at an expanded scale, clearly illustrating the oscillatory nature of the concentration history. The peak and average tracer concentrations are identified as 0.024 and 0.017, respectively. The average concentration is very close to the arithmetic average of the maximum and minimum concentrations. In contrast, the average concentration just outside the model (in Commencement Bay) would be significantly lower, since the concentration in Commencement Bay is set to zero for a significant portion of each tidal cycle.

The solute transport predicts a stable mixing zone is established between the dredged fill and the outlet to Commencement Bay. The concentration profile is shown on Figure 4.7.

The transport analysis was developed for a non-reactive tracer with a source concentration of 1.0. Therefore, the tidal dispersion factors (TDFs) can be estimated directly from:

$$TDF_{peak} = \frac{1.0}{C_{peak}}$$

and

$$TDF_{avg} = \frac{1.0}{C_{avg}}$$

The resulting tidal dispersion factors were estimated to be:

$TDF_{peak} = 42$; and

$TDF_{avg} = 59$.

The results of the analysis are consistent with empirical observations of tidal dispersion reported for similar CDFs elsewhere in Puget Sound. For example, post-construction monitoring and detailed transport modeling of the T-91 CDF in Seattle concluded that total attenuation factors, including tidal dispersion and chemical absorption/decay, ranged from 20:1 to 100:1. These total attenuation factors included estimated tidal

dispersion factors of 17:1 to 20:1, which corresponds to the predicted average tidal dispersion factor of 15 (with a zero buffer zone) for Slip 1.

The analysis assumes that the dredged boundary sediment is placed 20 feet from the berm. Figure 4.8 presents the results of a sensitivity analysis of the length of the buffer zone between the berm and the dredged boundary sediments. The results suggest that the degree of attenuation (of peak and average concentrations) can be controlled effectively by varying the length of the buffer zone. The degree of attenuation increases rapidly as the length of the buffer zone is increased beyond 10 feet.

Once the tidal dispersion factors were determined, the predicted peak and average seepage concentrations that may discharge from the seaward face of the berm were calculated for each chemical using the following relation:

$$C_{peak} = \frac{C_{max}}{TDF_{peak}}; \text{ and}$$

$$C_{avg} = \frac{C_{max}}{TDF_{avg}}$$

where C_{max} was set as the peak leachate concentration of selected chemicals monitored in the CLTs.

The predicted peak and average seepage discharge concentrations are presented in Table 4.1 and compared against their respective acute and chronic marine WQC or estimated WQC. The disposal site analysis demonstrates that worst-case seepage concentrations resulting from the placement of Area 5106 boundary sediments within the Slip 1 CDF will not exceed acute or chronic marine WQC at the seaward face of the berm.

The analysis developed herein is for screening-level estimates, and is based on highly conservative assumptions. Consequently, actual chemical concentrations at the seepage discharge point of compliance will be far lower than the predicted values presented in Table 4.1. The conservative nature of the predicted concentration estimates is emphasized by recalling two of the key assumptions of the analysis:

1. The analysis assumes that tidal dispersion within the CDF berm is the only attenuation mechanism.

   In reality, the leachate will undergo biodegradation, sorption, and other significant contaminant attenuation mechanisms that will substantially reduce the predicted long-term leachate concentrations.

For example, at the Terminal 91 CDF in Seattle, a variety of chemical and biological attenuation reactions occurring within the containment berm (i.e., beyond tidal dispersion) contribute to the high degree of efficiency of that tidally-influenced berm to significantly inhibit contaminant mobility and transport to the receiving water (Boatman and Hotchkiss, 1997). Similar modeling-based results have been reported at other regional CDFs (e.g., Port of Tacoma, 1992; Port of Seattle, 1994), and suggest that standard CDF designs (those providing structural integrity and seismic protection) also provide considerable water quality protection through biological and geochemical attenuation. None of these attenuation processes have been assumed in this screening-level analysis.

In addition, analyses for other sites have suggested that solutes may undergo substantial vapor-phase VOC attenuation during tidally-influenced transport (Hart Crowser 1993). Furthermore, although it is assumed that solutes do not undergo transformation reactions (e.g., biodegradation), the Area 5106 chemicals of potential concern such as PCE, TCE, and HCBD have reported biodegradation half-lives in water that range from less than 1 to 5 years (Howard et. al., 1991; Weidemeier et. al., 1996).

2. The analysis assumes that source concentrations are effectively constant through time, at a level corresponding to the peak concentrations measured during the CLTs.

   These initial concentrations, however, will decline over time, as the groundwater flows through the dredged boundary sediment, thereby significantly reducing the predicted long-term seepage concentrations.

Given the conservative approach utilized for the Slip 1 analysis and the resulting low predicted seepage concentration, a more detailed assessment of the disposal site is not required for the analysis of Area 5106 boundary sediments. In addition, since the design and hydrogeologic characteristics are likely to be similar, the results from the Slip 1 analysis would be representative of other prospective regional CDF sites.

5.0 CONCLUSIONS

The disposal site analysis predicts that seepage concentrations from the CDF will be significantly below the relevant marine WQC and will present no long-term water quality concerns. Therefore, the boundary sediments representing all four CLTs are acceptable for placement within the CDF without treatment. Consequently, the boundary of Area 5106 Sediment is confirmed to be the Inner Horizontal Boundary and the Vertical Boundary.

Based on the confirmed boundary, Area 5106 Sediment includes an estimated in situ volume of 21,500 cubic yards and covers approximately 2.15 acres.

6.0 REFERENCES

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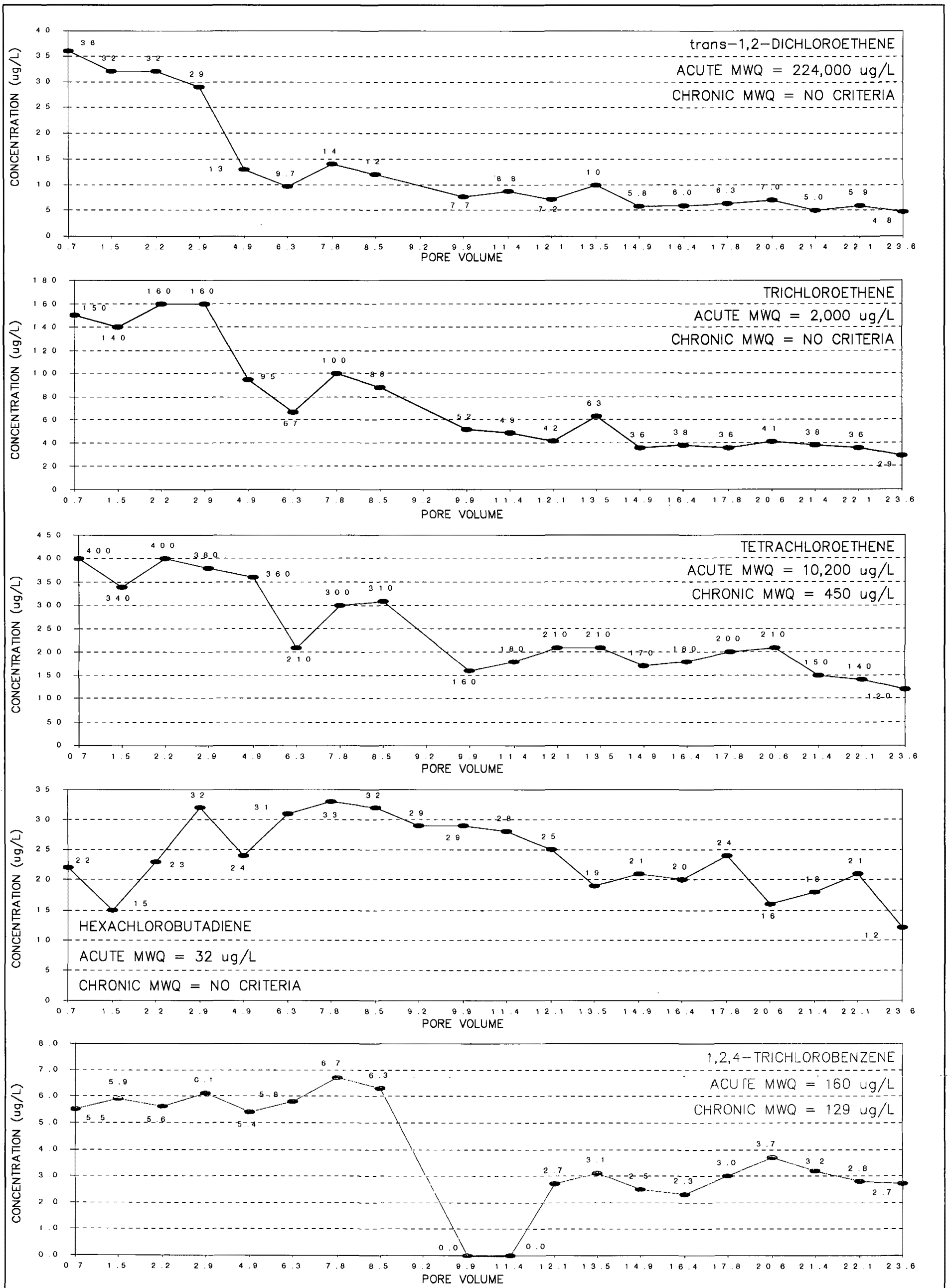


NOTE:

THE FOLLOWING CLT CHEMICAL PARAMETERS WERE NOT DETECTED IN THE LEACHATE FROM COLUMN IHBC:
- HEXACHLOROBENZENE
- 4,4'-DDD
- 4,4'-DDE
- PCB AROCLORS
- CHLOROBUTADIENE

figure 3.1 (SHEET 1 OF 3)

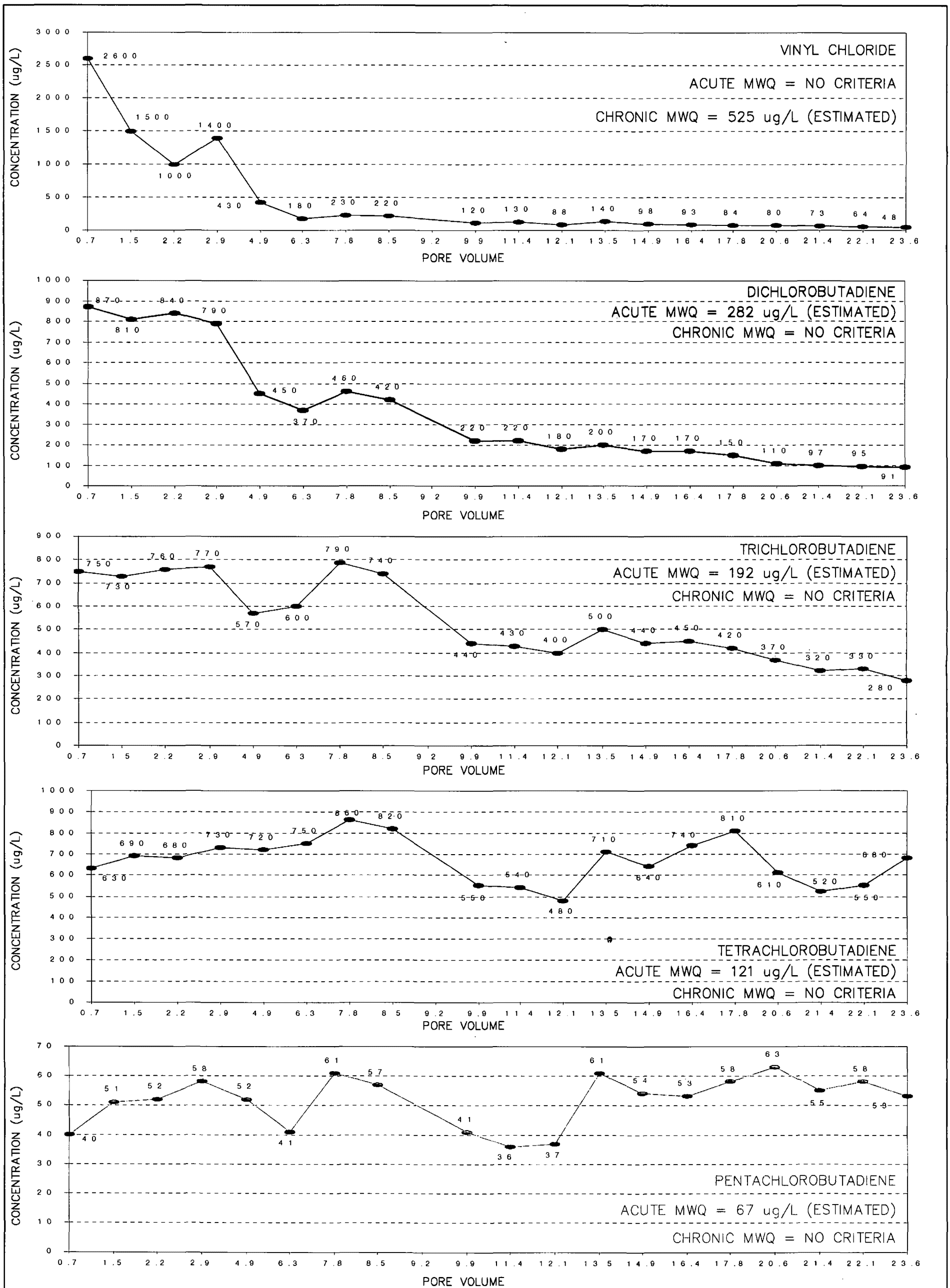
CLT ANALYTICAL RESULTS – IHBC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

CRA

07431-65(010)EX-NF001 DEC 08/1999

19.3.4.6.2
137633
AP.A

1



NOTE:

THE FOLLOWING CLT CHEMICAL PARAMETERS WERE NOT DETECTED IN THE LEACHATE FROM COLUMN IHBC:
- HEXACHLOROBENZENE
- 4,4'-DDD
- 4,4'-DDE
- PCB AROCLORS
- CHLOROBUTADIENE

figure 3.1 (SHEET 2 OF 3)

CLT ANALYTICAL RESULTS – IHBC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

CRA

07431-65(010)EX-NF002 DEC 08/1999

19.3.4.6.2
137633
Ap. A

2

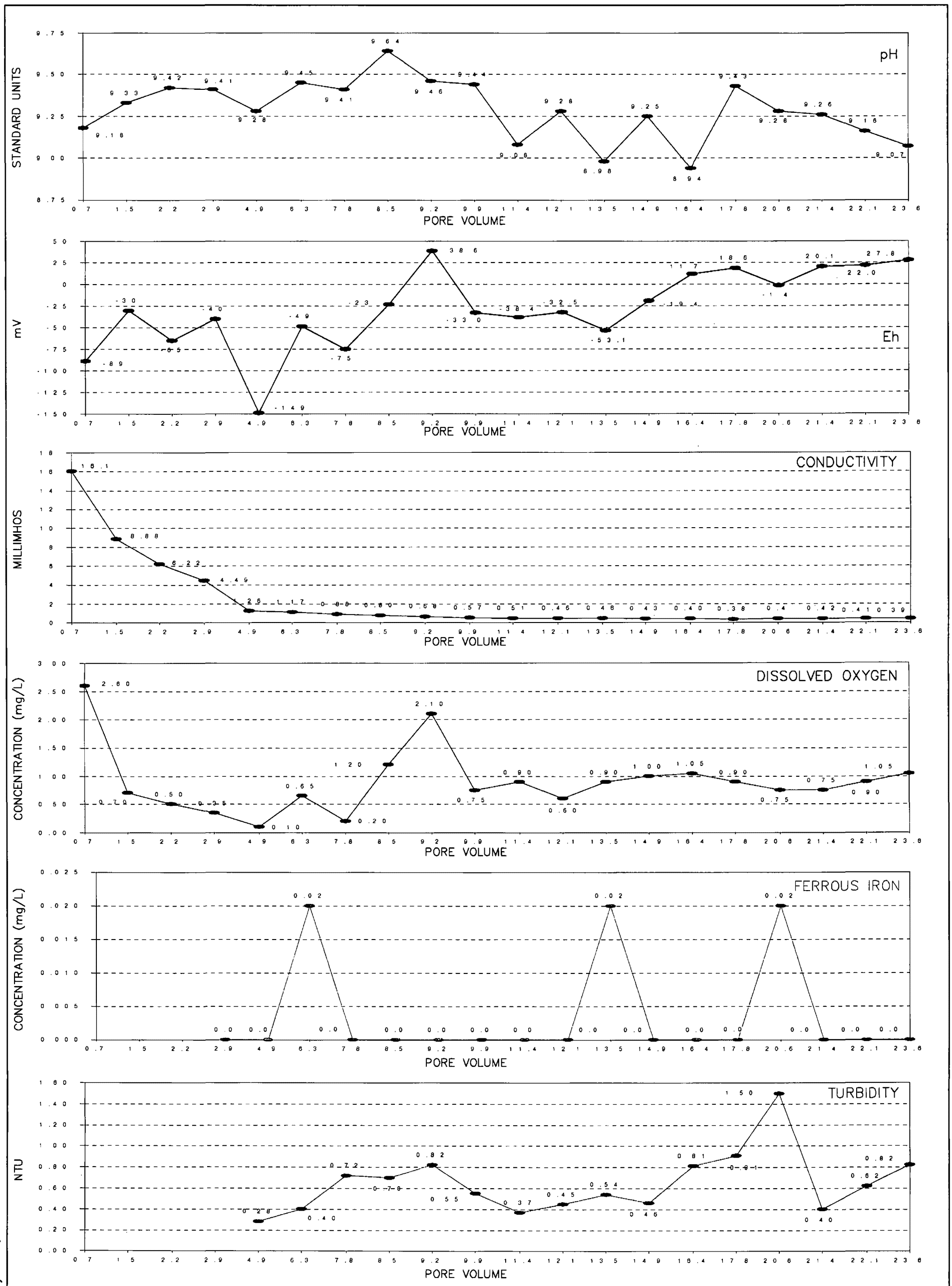


figure 3.1 (SHEET 3 OF 3)

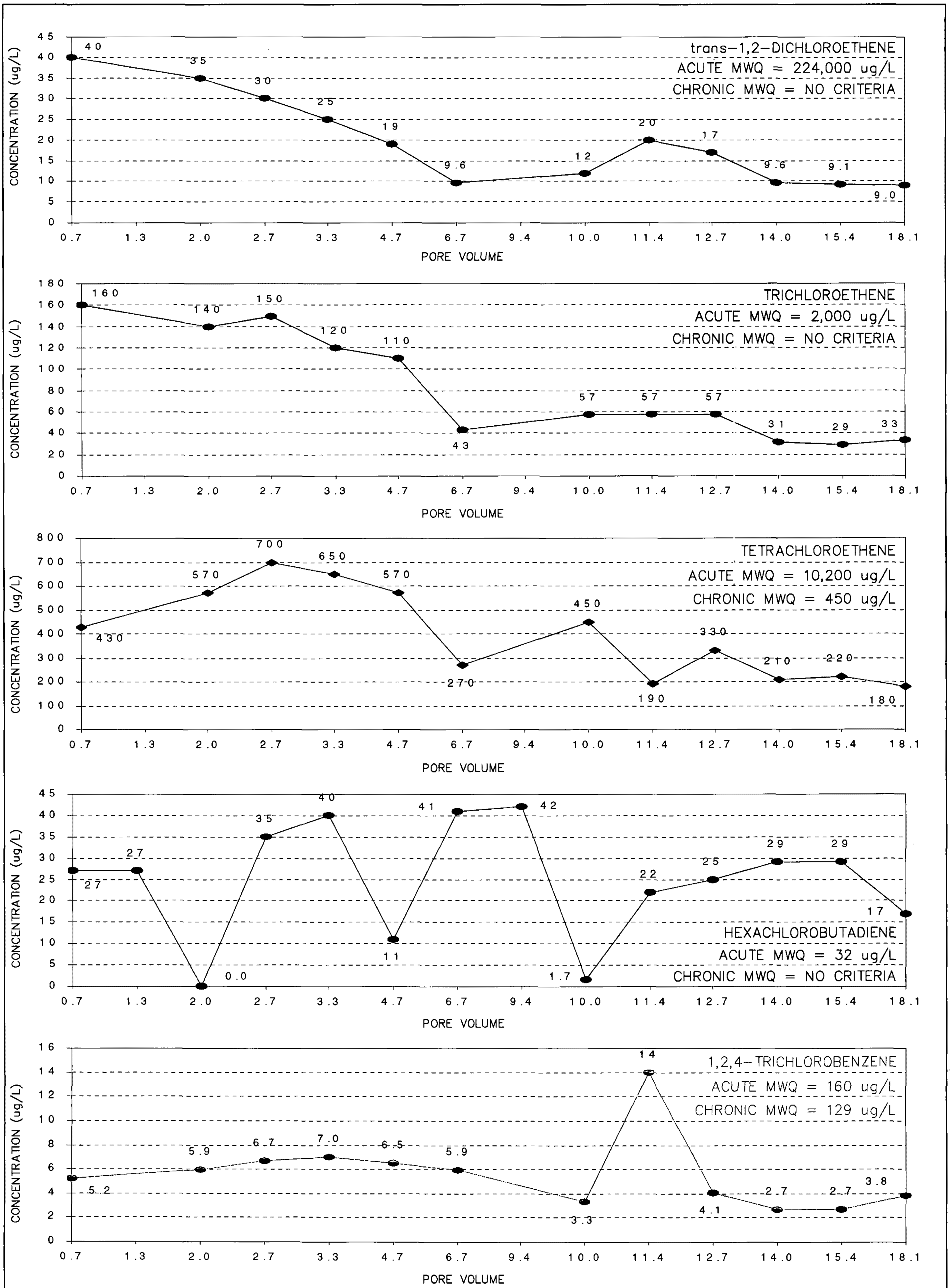
CLT ANALYTICAL RESULTS – IHBC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

CRA

07431-65(010)EX-NF003 DEC 08/1999

19.3.4.6.2
137633

3



NOTE:

THE FOLLOWING CLT CHEMICAL PARAMETERS WERE NOT DETECTED IN THE LEACHATE FROM COLUMN OHBC:
- HEXACHLOROBENZENE
- 4,4'-DDD
- 4,4'-DDE
- PCB AROCLORS
- CHLOROBUTADIENE

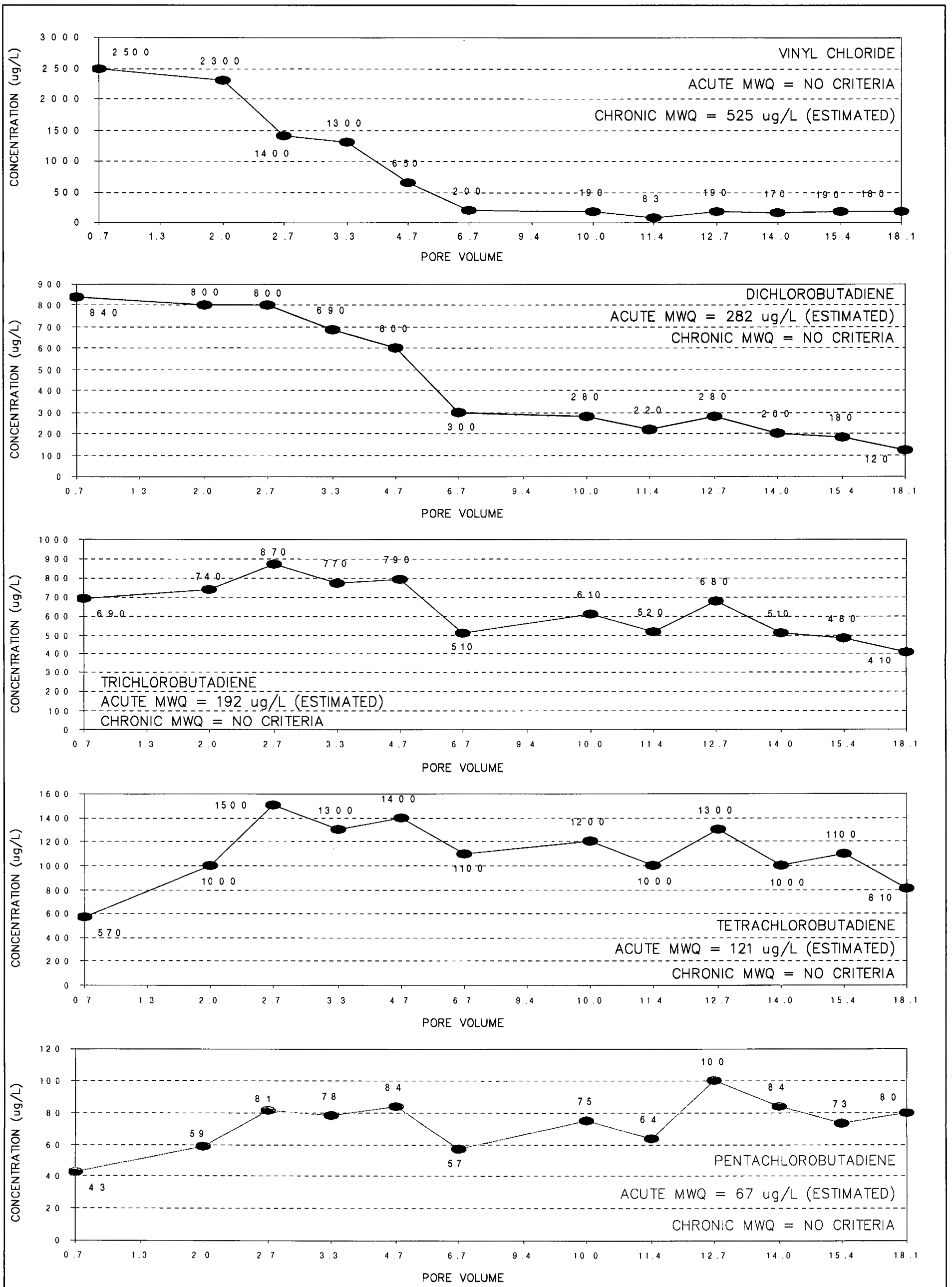
figure 3.2 (SHEET 1 OF 3)
CLT ANALYTICAL RESULTS – OHBC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

CRA

07431-65(010)EX-NF004 DEC 08/1999

19.3.4.6.2
137633
Ap.A

4



NOTE:

THE FOLLOWING CLT CHEMICAL PARAMETERS WERE NOT DETECTED IN THE LEACHATE FROM COLUMN OHBC:
- HEXACHLOROBENZENE
- 4,4'-DDD
- 4,4'-DDE
- PCB AROCLORS
- CHLOROBUTADIENE

figure 3.2 (SHEET 2 OF 3)

CLT ANALYTICAL RESULTS – OHBC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

CRA

07431-65(010)EX-NF005 DEC 08/1999

19.3.4.6.2
137633
Ap. A

5

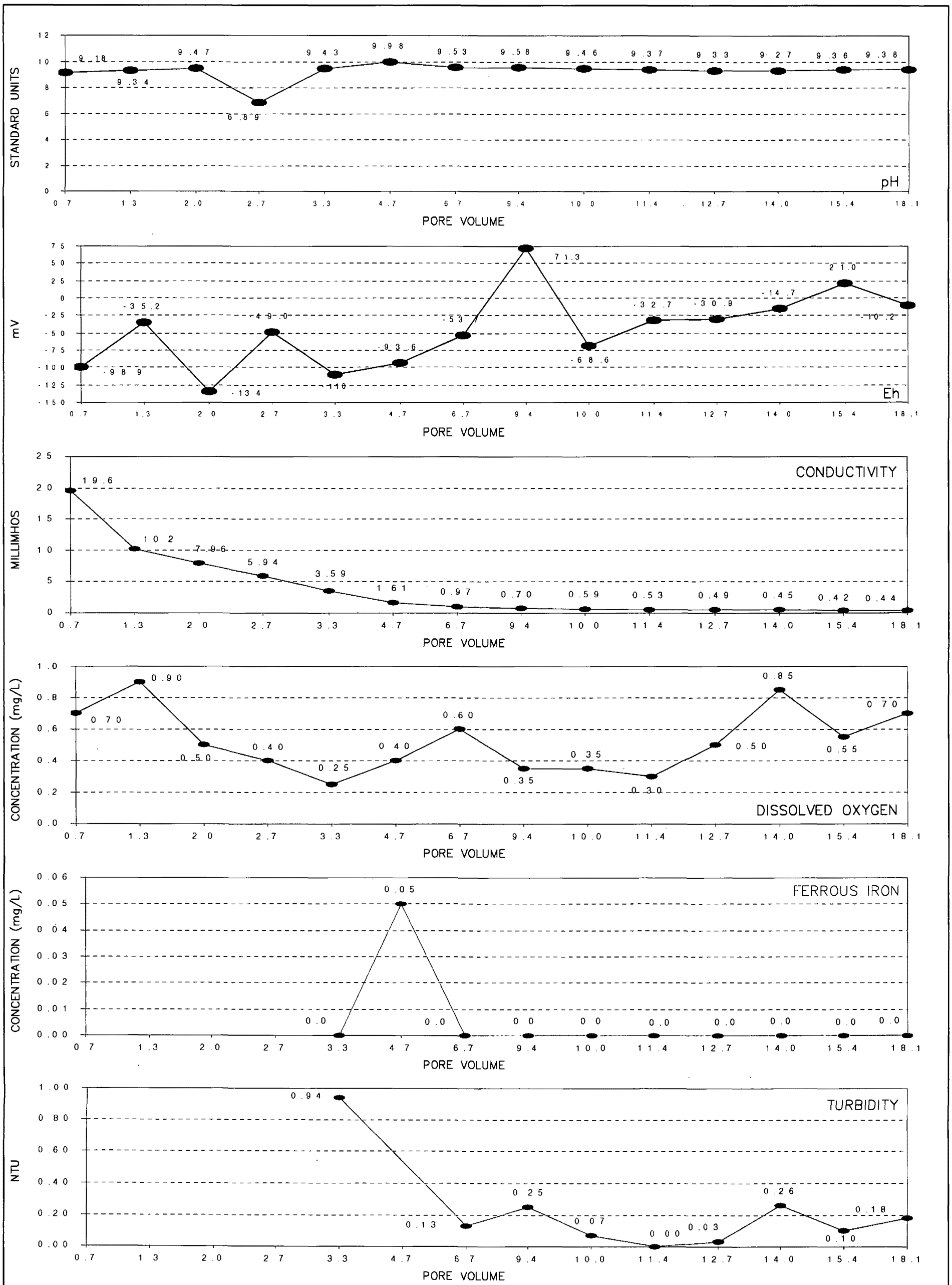


figure 3.2 (SHEET 3 OF 3)

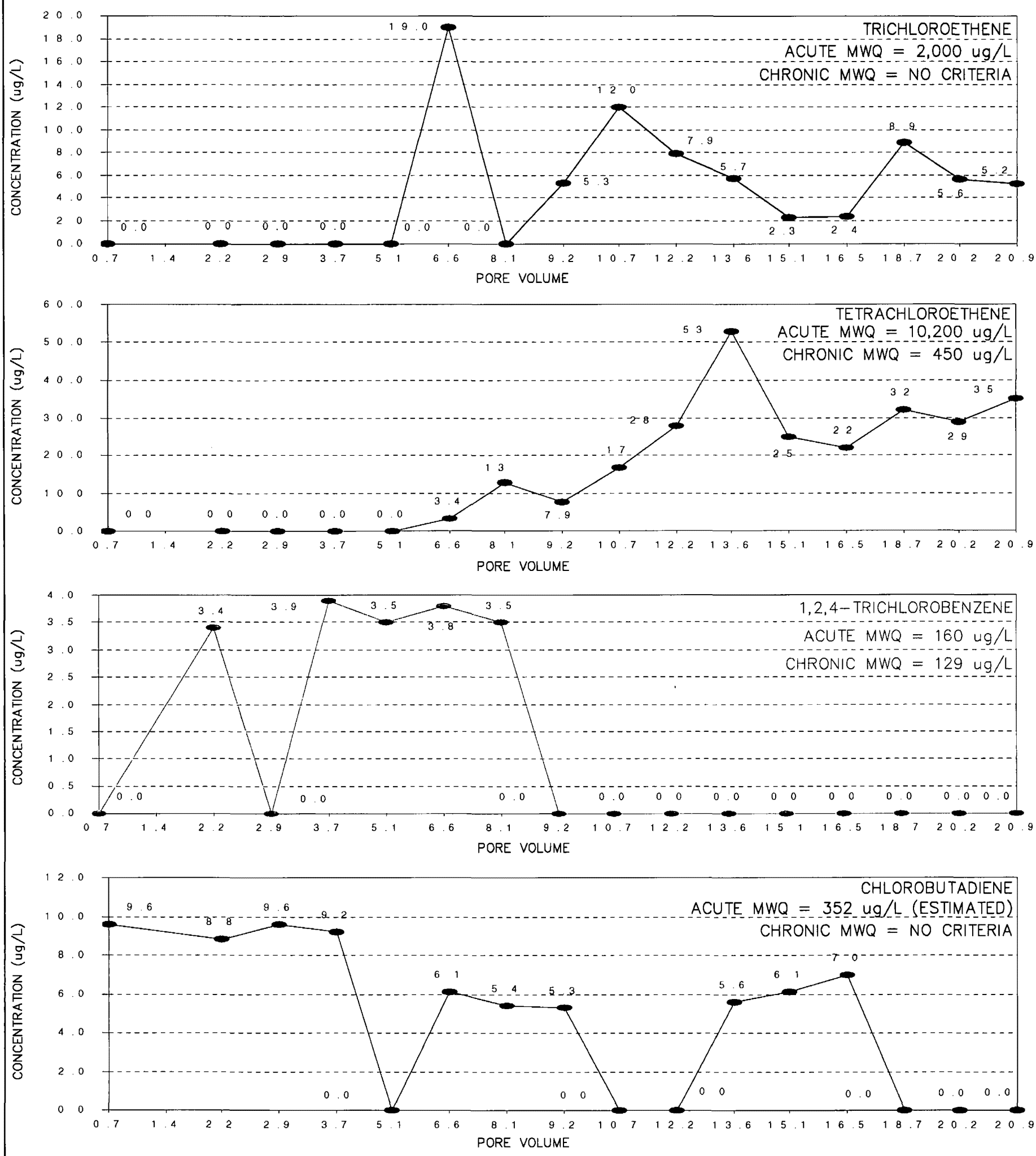
CLT ANALYTICAL RESULTS – OHBC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

CRA

07431-65(010)EX-NF006 DEC 08/1999

19.3.4.6.2
137633
Ap. A

6



NOTE:

THE FOLLOWING CLT CHEMICAL PARAMETERS WERE NOT DETECTED IN THE LEACHATE FROM COLUMN CHCC:
- TRANS-1,2-DICHLOROETHENE
- HEXACHLOROBUTADIENE
- HEXACHLOROBENZENE
- 4,4'-DDD
- 4,4'-DDE
- PCB AROCLORS

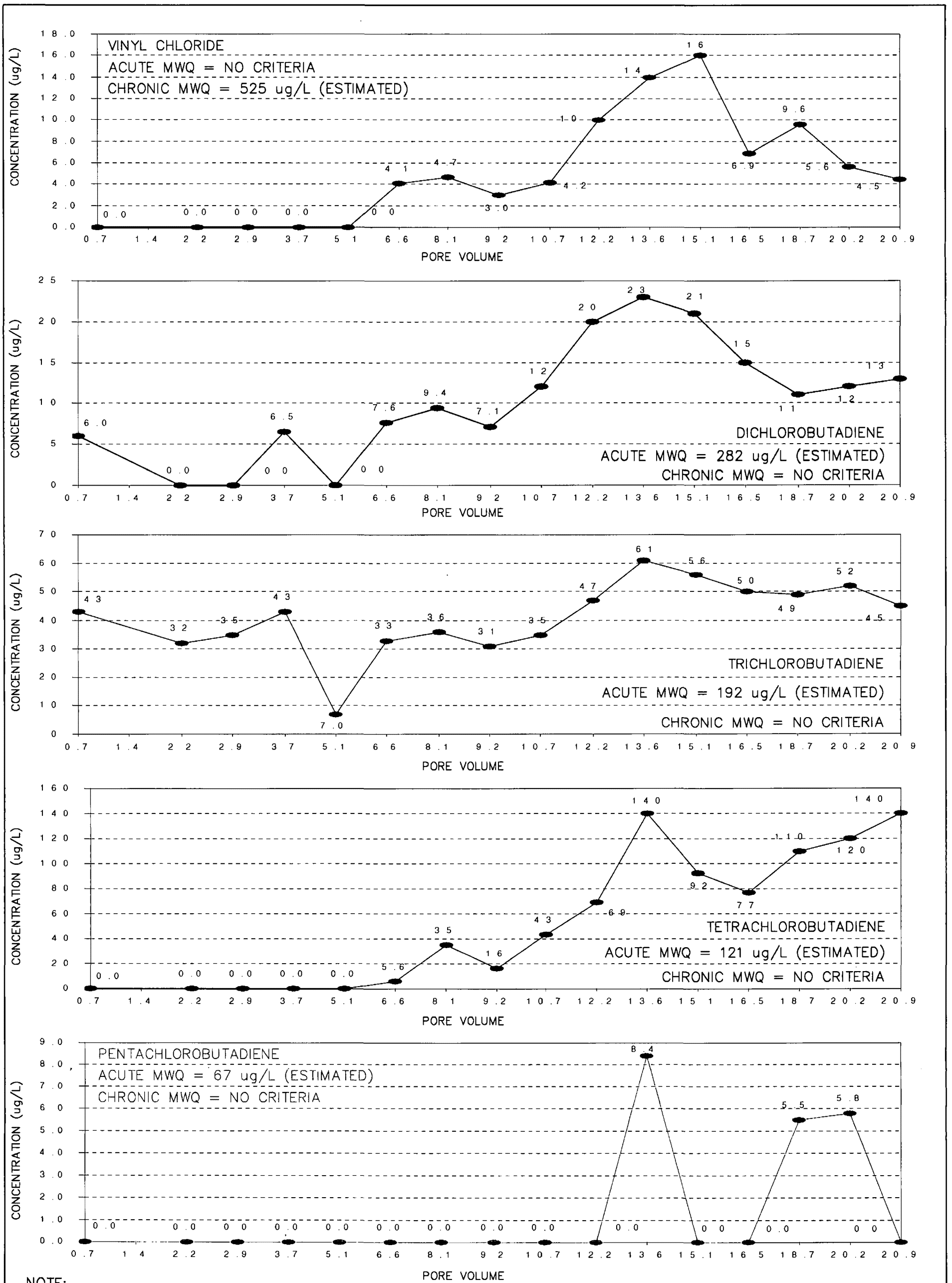
figure 3.3 (SHEET 1 OF 3)
CLT ANALYTICAL RESULTS – CHCC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

CRA

07431-65(010)EX-NF007 DEC 08/1999

19.3.4.6.2
137633
App. A

7



NOTE:

THE FOLLOWING CLT CHEMICAL PARAMETERS WERE NOT DETECTED IN THE LEACHATE FROM COLUMN CHCC:

- TRANS-1,2-DICHLOROETHENE
- HEXACHLOROBUTADIENE
- HEXACHLOROBENZENE
- 4,4'-DDD
- 4,4'-DDE
- PCB AROCLORS

figure 3.3 (SHEET 2 OF 3)

CLT ANALYTICAL RESULTS – CHCC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

CRA

07431-65(010)EX-NF008 DEC 08/1999

19.3.4.6.2
137633
Ap. A

8

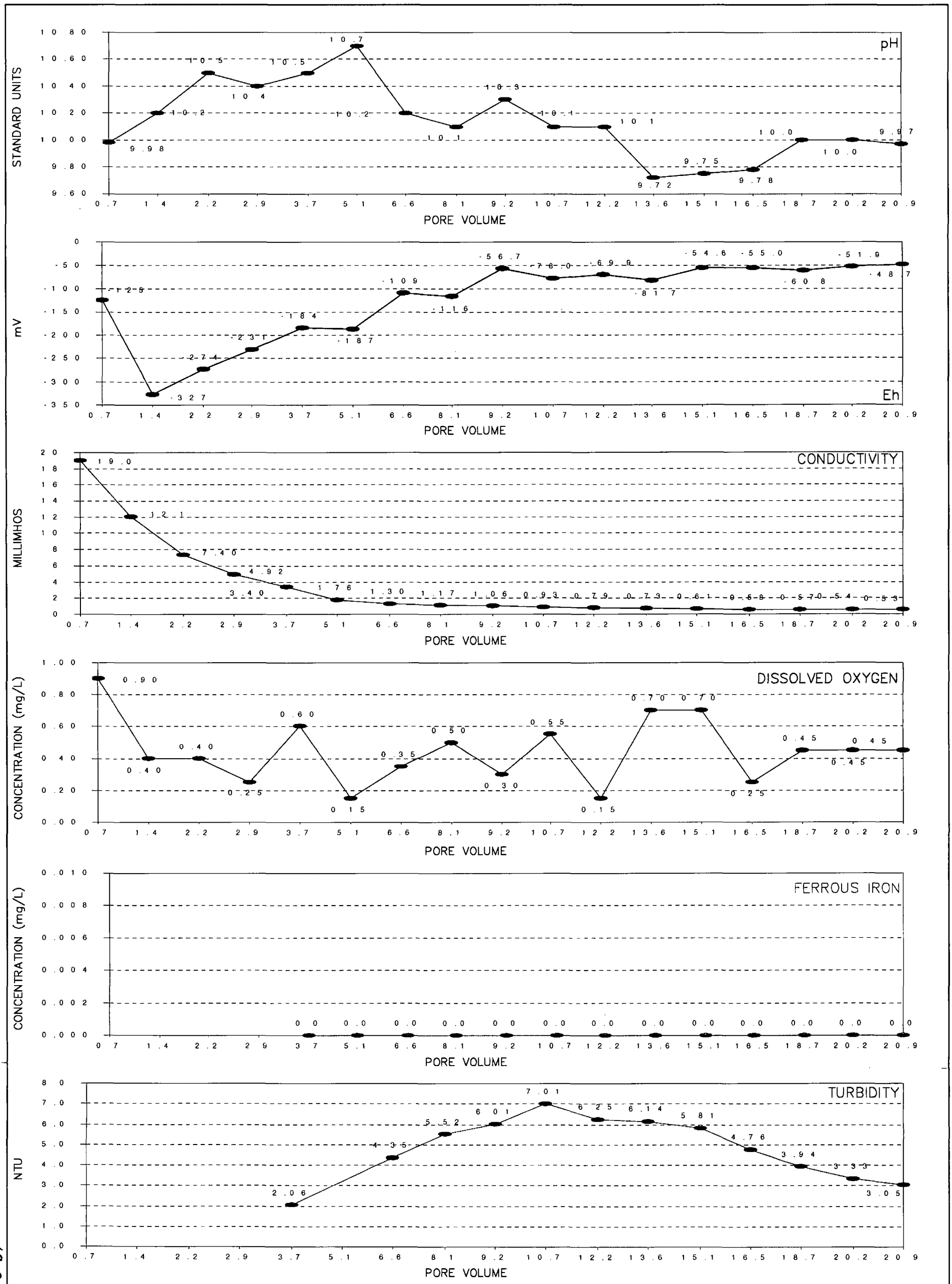


figure 3.3 (SHEET 3 OF 3)

CLT ANALYTICAL RESULTS – CHCC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

CRA

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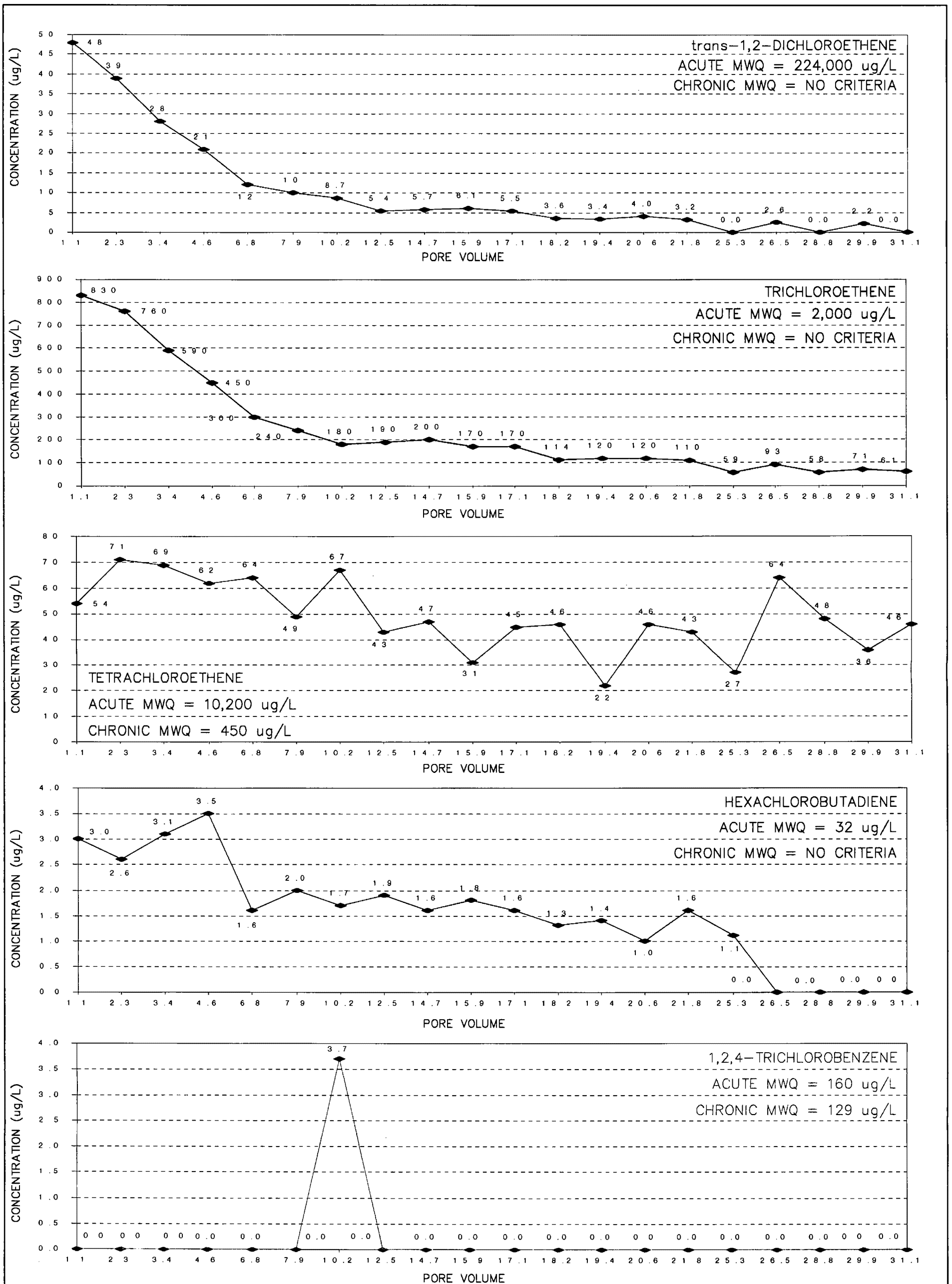
19.3.4.6.2
137633
App. A



NOTE:

THE FOLLOWING CLT CHEMICAL PARAMETERS WERE NOT DETECTED IN THE LEACHATE FROM COLUMN VBC:
- HEXACHLOROBENZENE
- 4,4'-DDD
- 4,4'-DDE
- PCB AROCLORS
- CHLOROBUTADIENE

figure 3.4 (SHEET 1 OF 3)

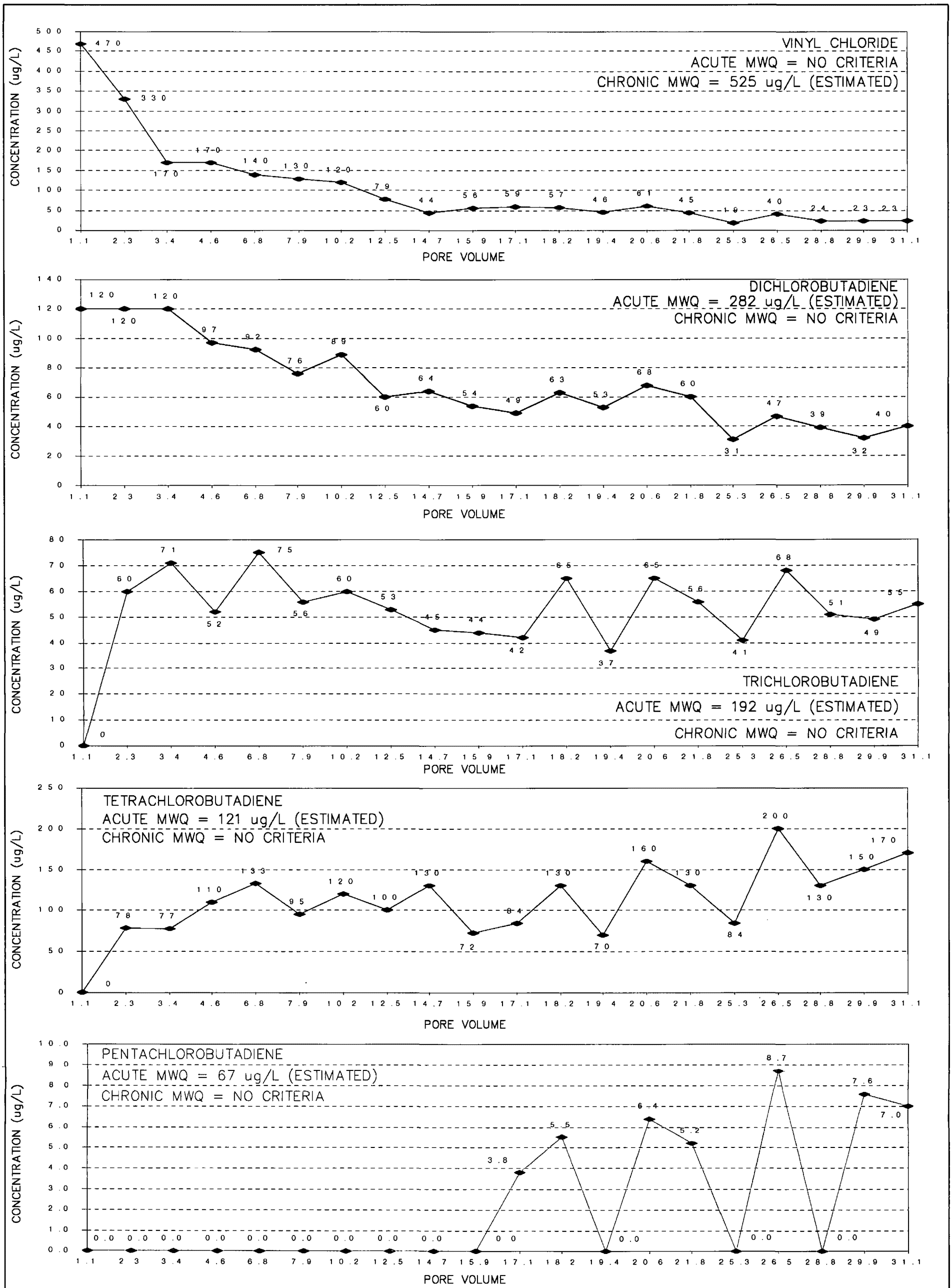
CLT ANALYTICAL RESULTS – VBC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

CRA

07431-65(010)EX-NF010 DEC 08/1999

19.3.4.6.2
137633
Ap. A

10



NOTE:

THE FOLLOWING CLT CHEMICAL PARAMETERS WERE NOT DETECTED IN THE LEACHATE FROM COLUMN VBC:
- HEXACHLOROBENZENE
- 4,4'-DDD
- 4,4'-DDE
- PCB AROCLORS
- CHLOROBUTADIENE

figure 3.4 (SHEET 2 OF 3)

CLT ANALYTICAL RESULTS – VBC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

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19.3.4.6.2
137633
App A

11

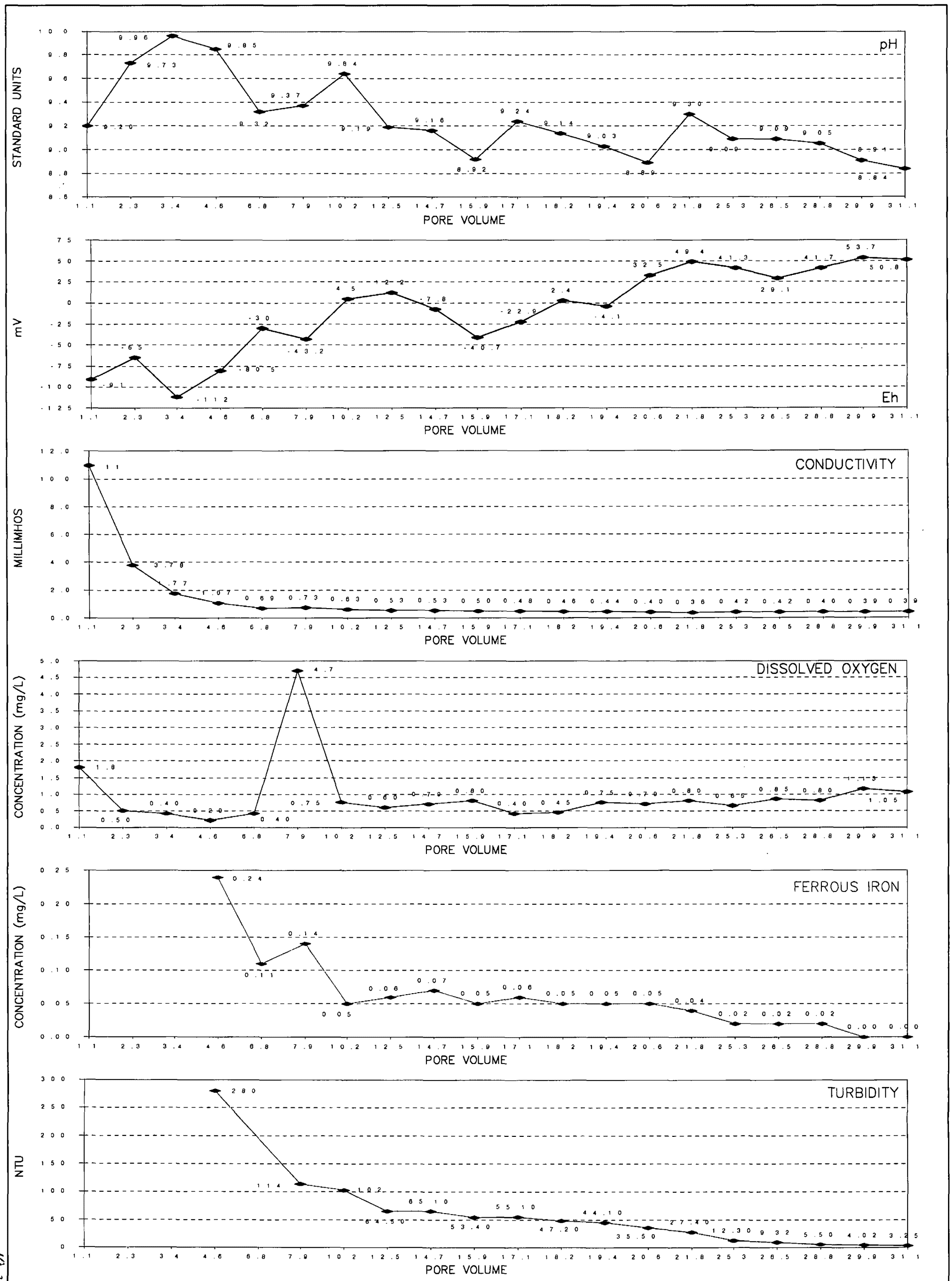

figure 3.4 (SHEET 3 OF 3)

CLT ANALYTICAL RESULTS – VBC
CLT EVALUATION
OCC TACOMA
Tacoma, Washington

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07431-65(010)EX-NF012 DEC 08/1999

19.3.4.6.2
137633
Ap.A

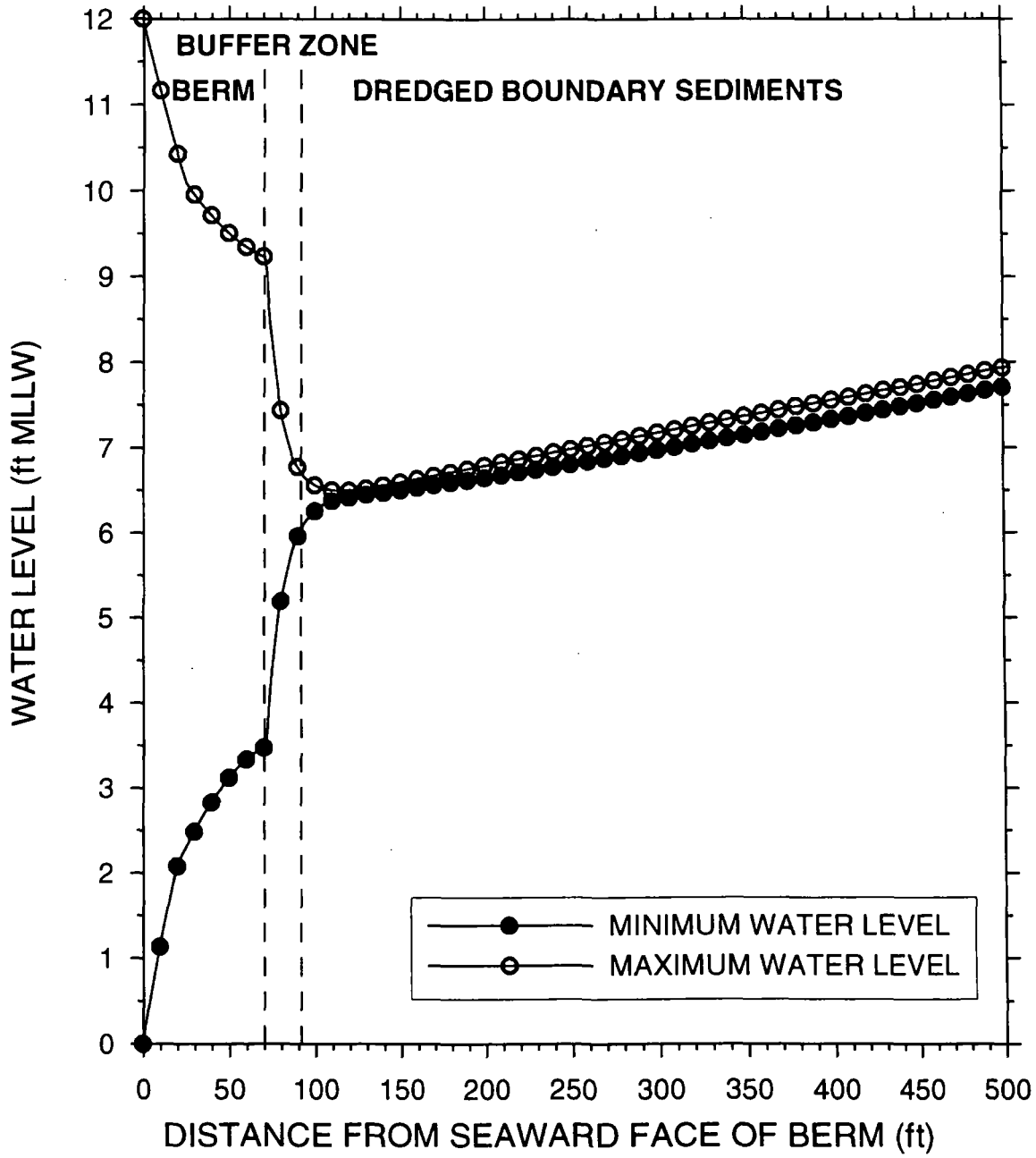

figure 4.3

PREDICTED TIDE INDUCED WATER LEVEL FLUCTUATIONS
CDF MODELING
OCC TACOMA
Tacoma, Washington

CRA

07431-00(010) WA-HYD (N:\HEG\7431\cdf\model6\r8_1\figure42.grf) DEC 8/99

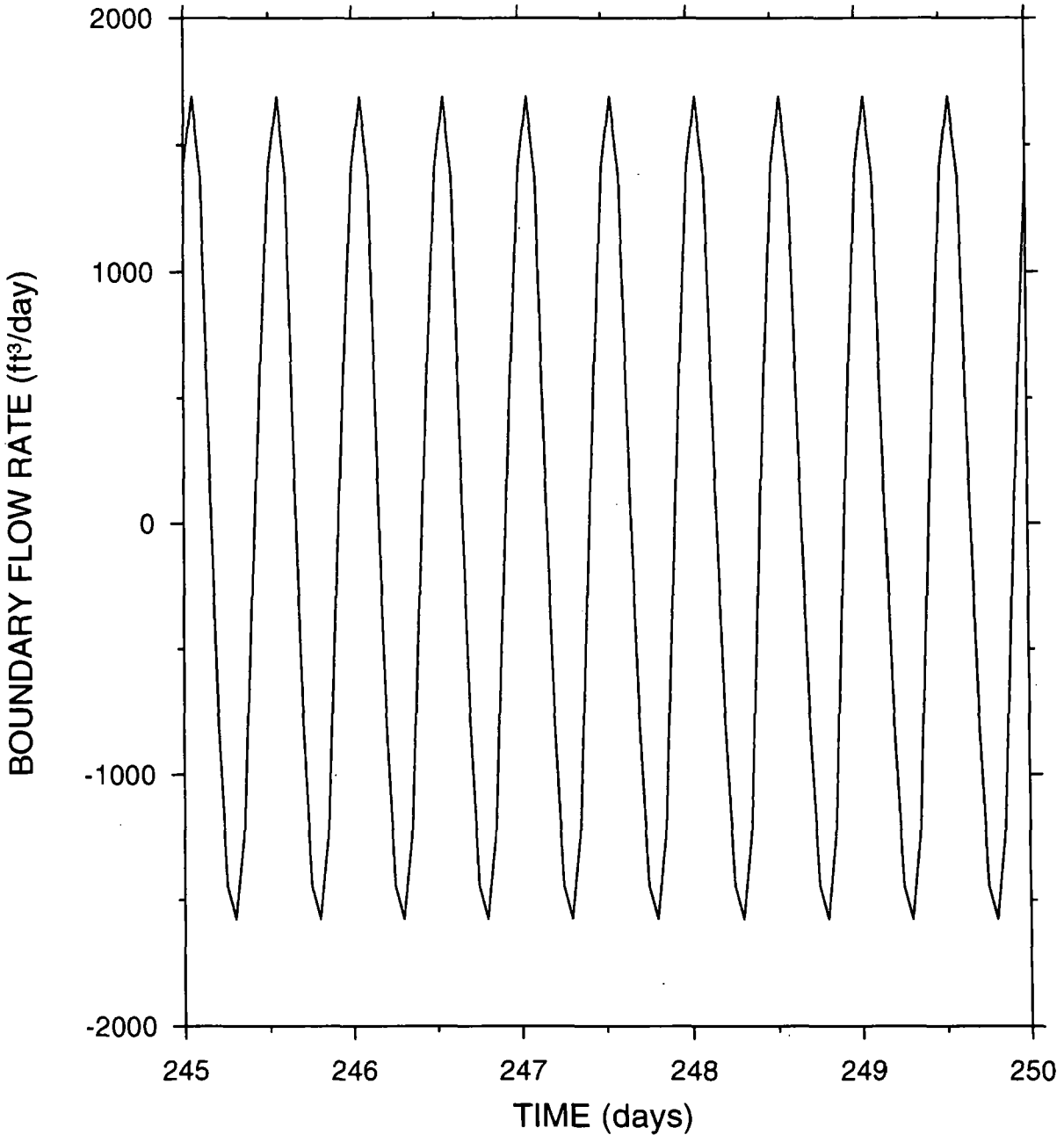

figure 4.4
FLOW RATE AT BOUNDARY
CDF MODELING
OCC TACOMA
Tacoma, Washington

CRA

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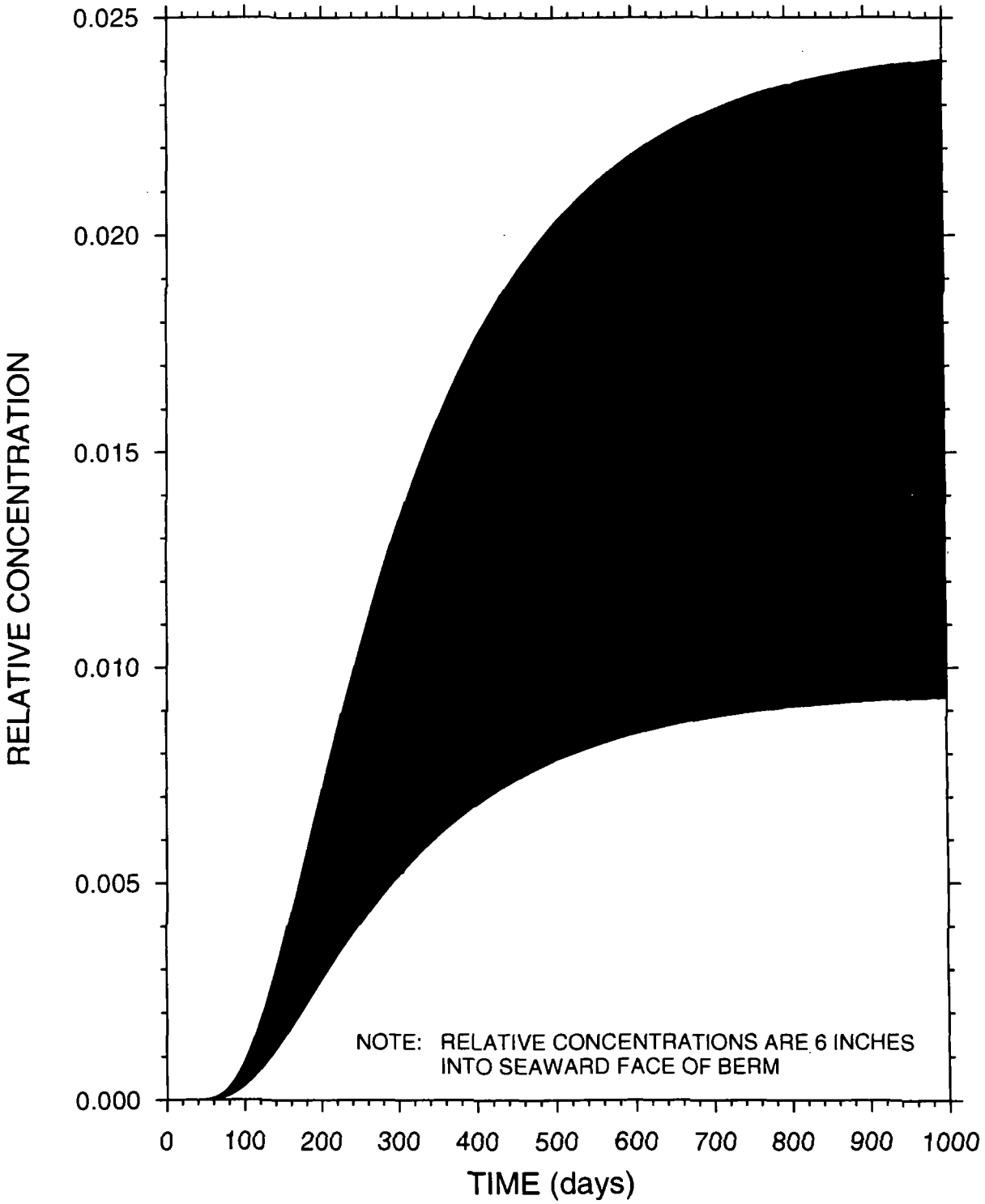

figure 4.5

PREDICTED CONCENTRATION AT SEAWARD FACE OF BERM

CDF MODELING

OCC TACOMA

Tacoma, Washington

CRA

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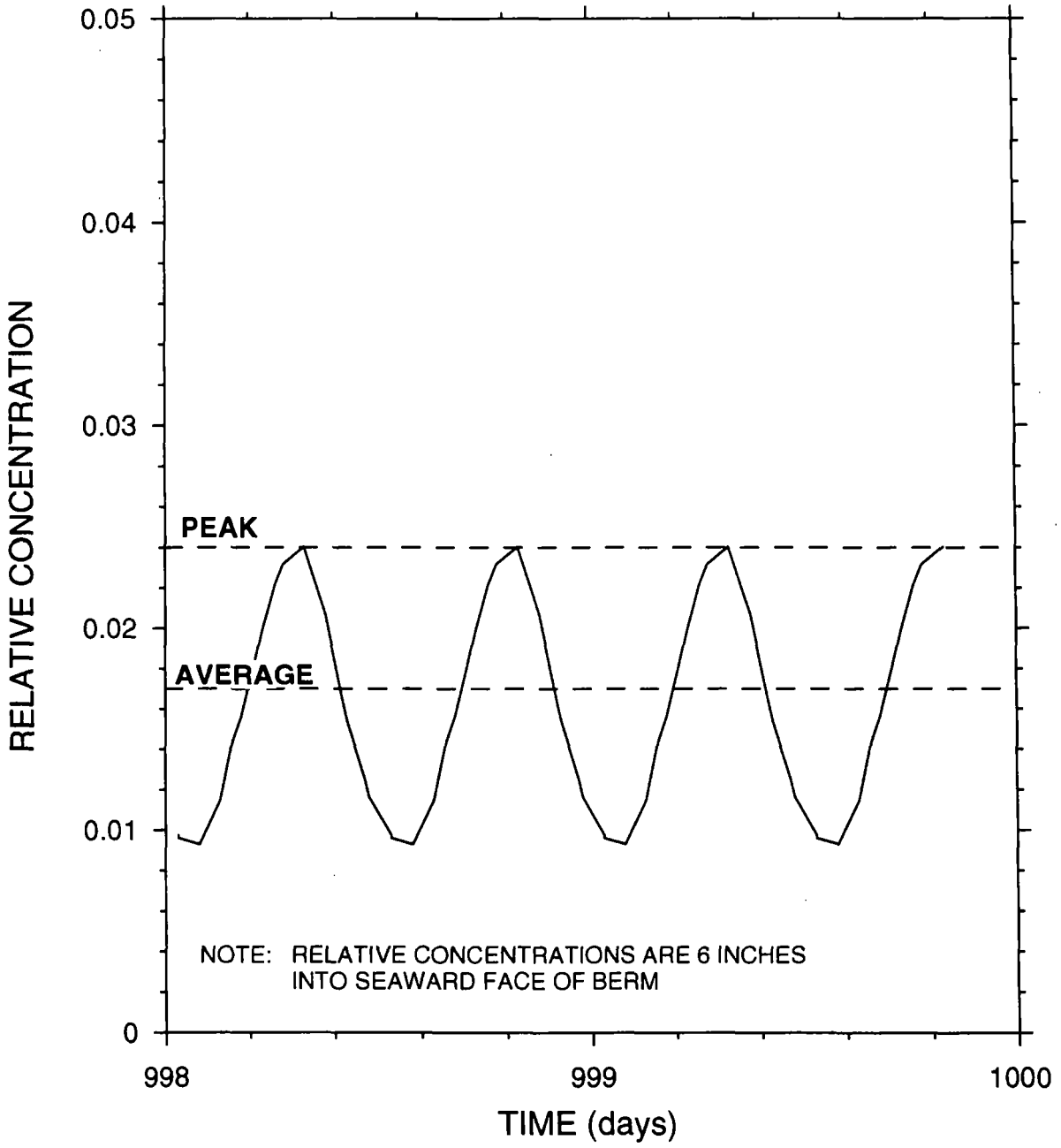

figure 4.6

CONCENTRATION AT SEAWARD FACE (EXPANDED SCALE)

CDF MODELING

OCC TACOMA

Tacoma, Washington

CRA

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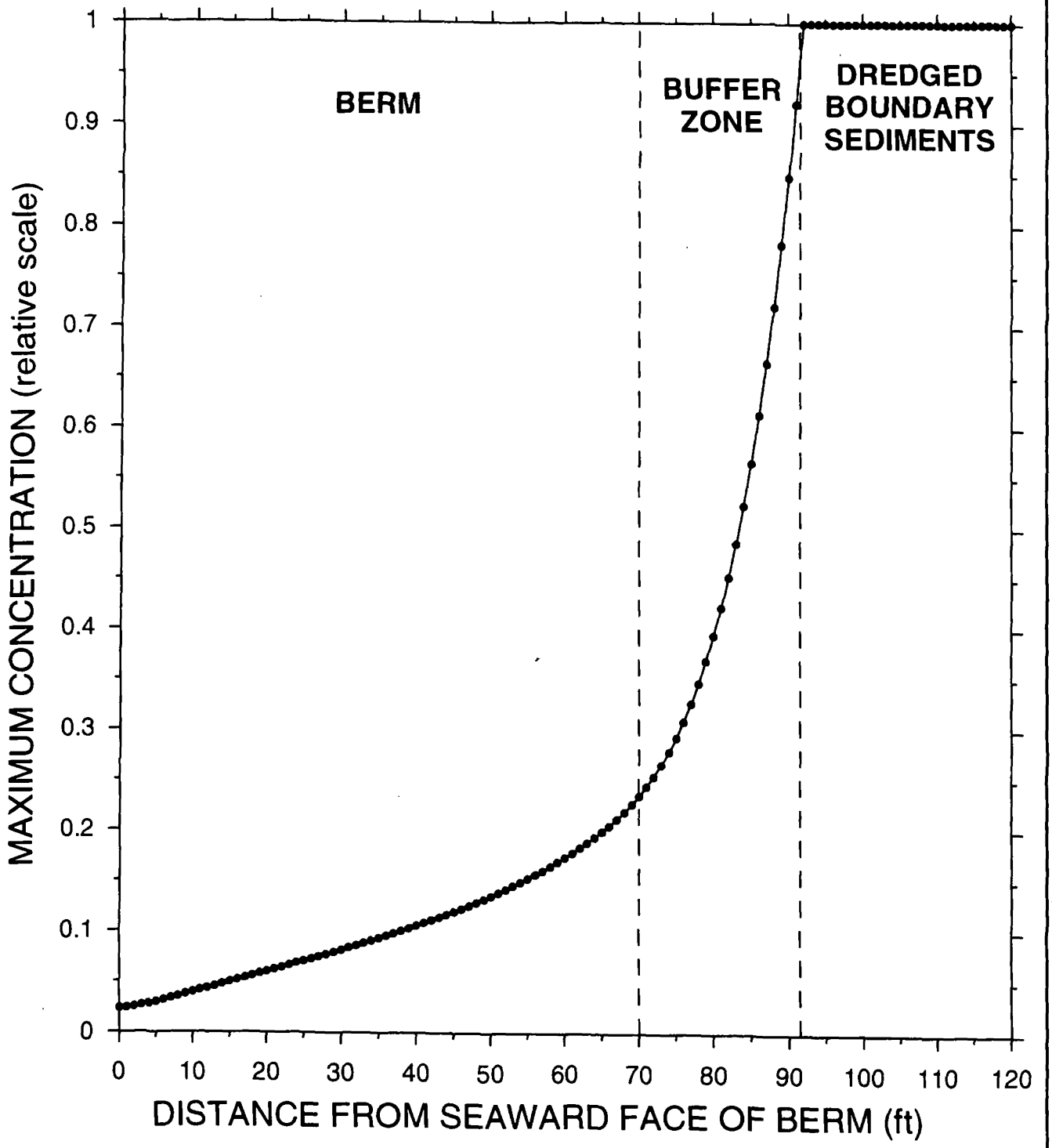

figure 4.7
CONCENTRATION PROFILE AFTER 1000 DAYS
CDF MODELING
OCC TACOMA
Tacoma, Washington

CRA

07431-00(010) WA-HYD (N:\HEG\7431\cdf\model6\r8_1\figure46.grf) DEC 8/99

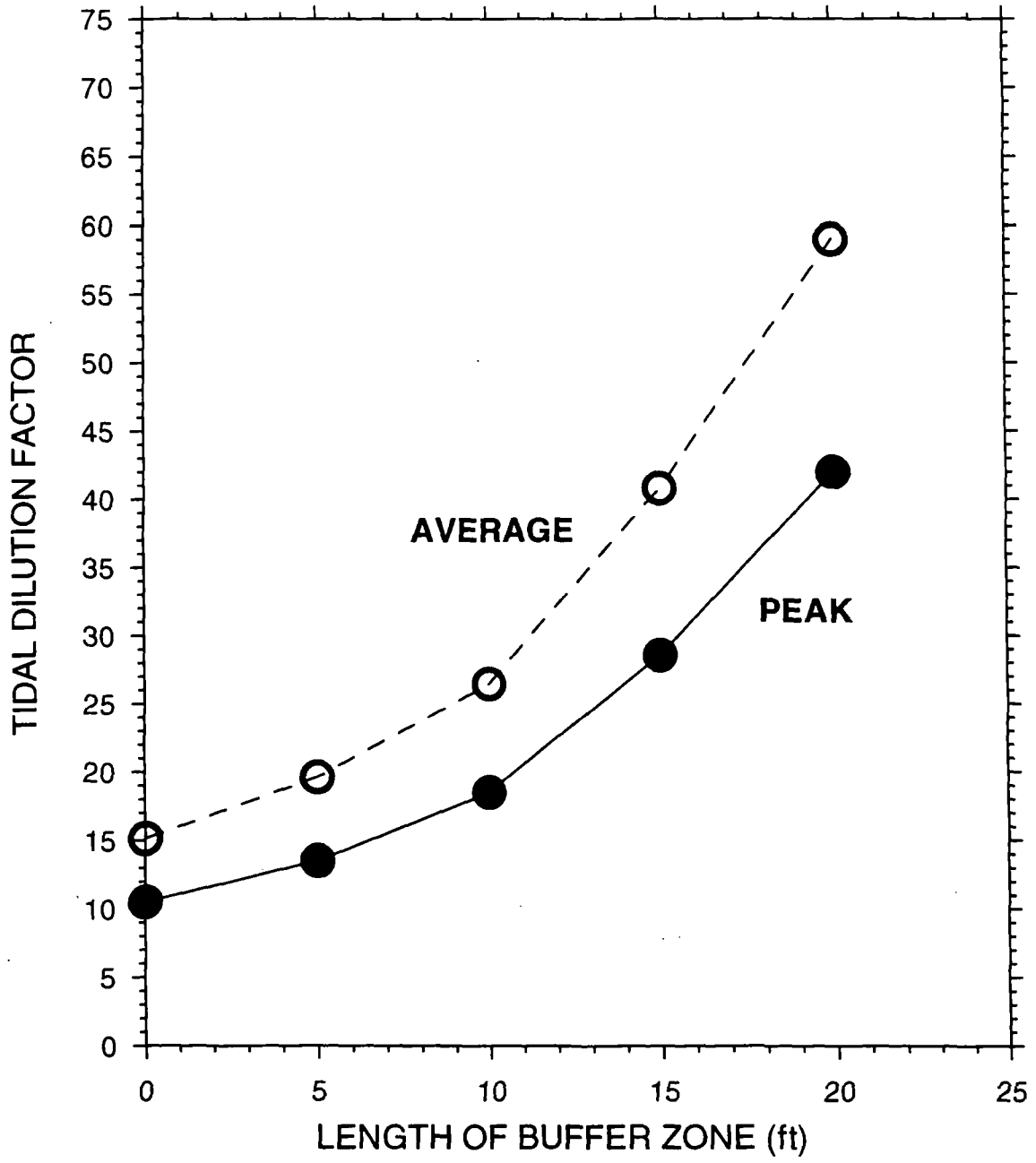

figure 4.8
TIDAL DILUTION FACTORS
CDF MODELING
OCC TACOMA
Tacoma, Washington

CRA

07431-00(010) WA-HYD (N:\HEG\7431\cdf\model6\r8_1\figure47.grf) DEC 8/99

TABLE 3.1

SUMMARY OF COLLECTED LEACHATE SAMPLES
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

IHBC			OHBC			CHCC			VBC		
Collection Date	*Pore Volume Interval*	*Analysis*	*Collection Date*	*Pore Volume Interval*	*Analysis*	*Collection Date*	*Pore Volume Interval*	*Analysis*	*Collection Date*	*Pore Volume Interval*	*Analysis*
07/05/98	0.7	8260/8081/8082	07/05/98	0.68	8260/8081/8082	07/05/98	0.7	8260/8081/8082	07/04/98	1.1	8260/8081/8082
07/10/98	1.5	8260/8081/8082	07/09/98	1.3	8260/8081/8082	07/08/98	1.4	8260/8081/8082	07/10/98	2.3	8260/8081/8082
07/14/98	2.2	8260/8081/8082	07/13/98	2.0	8260/8081/8082	07/12/98	2.2	8260/8081/8082	07/14/98	3.4	8260/8081/8082
07/17/98	2.9	8260/8081/8082	07/17/98	2.7	8260/8081/8082	07/15/98	2.9	8260/8081/8082	07/19/98	4.6	8260/8081/8082
07/21/98	3.5	None	07/21/98	3.3	8260/8081/8082	07/19/98	3.7	8260/8081/8082	07/23/98	5.8	None
07/26/98	4.3	None	07/25/98	4.0	None	07/23/98	4.4	None	07/30/98	6.8	8260/8081/8082
07/30/98	4.9	8260/8081/8082	07/28/98	4.7	8260/8081/8082	07/27/98	5.1	8260/8081/8082	08/04/98	7.9	8260/8081/8082
08/04/98	5.6	None	07/31/98	5.4	None	08/02/98	5.9	None	08/10/98	9.1	None
08/09/98	6.3	8260/8081/8082	08/04/98	6.1	None	08/07/98	6.6	8260/8081/8082	08/15/98	10.2	8260/8081/8082
08/15/98	7.0	None	08/08/98	6.7	8260/8081/8082	08/12/98	7.4	None	08/19/98	11.4	None
08/19/98	7.8	8260/8081/8082	08/13/98	7.4	None	08/17/98	8.1	8260/8081/8082	08/25/98	12.5	8260/8081/8082
08/25/98	8.5	8260/8081/8082	08/19/98	8.1	None	08/22/98	8.5	None	08/31/98	13.6	None
08/31/98	9.2	8081/8082	08/24/98	8.8	None	08/27/98	9.2	8260/8081/8082	09/07/98	14.7	8260/8081/8082
09/04/98	9.9	8260/8081/8082	08/31/98	9.4	8081/8082	08/31/98	10	None	09/14/98	15.9	8260/8081/8082
09/08/98	10.6	None	09/04/98	10.0	8260/8081/8082	09/05/98	10.7	8260/8081/8082	09/22/98	17.1	8260/8081/8082
09/12/98	11.4	8260/8081/8082	09/09/98	10.7	None	09/10/98	11.4	None	09/29/98	18.2	8260/8081/8082
09/16/98	12.1	8260/8081/8082	09/14/98	11.4	8260/8081/8082	09/14/98	12.2	8260/8081/8082	10/05/98	19.4	8260/8081/8082
09/20/98	12.8	None	09/20/98	12.1	None	09/19/98	12.9	None	10/11/98	20.6	8260/8081/8082
09/24/98	13.5	8260/8081/8082	09/25/98	12.7	8260/8081/8082	09/24/98	13.6	8260/8081/8082	10/18/98	21.8	8260/8081/8082
09/29/98	14.2	None	09/30/98	13.4	None	09/28/98	14.4	None	10/23/98	23.0	None
10/03/98	14.9	8260/8081/8082	10/05/98	14.0	8260/8081/8082	10/03/98	15.1	8260/8081/8082	10/28/98	24.2	None
10/07/98	15.6	None	10/10/98	14.7	None	10/08/98	15.8	None	11/01/98	25.3	8260/8081/8082
10/12/98	16.4	8260/8081/8082	10/15/98	15.4	8260/8081/8082	10/12/98	16.5	8260/8081/8082	11/07/98	26.5	8260/8081/8082
10/16/98	17.1	None	10/20/98	16.1	None	10/16/98	17.2	None	11/12/98	27.6	None
10/21/98	17.8	8260/8081/8082	10/25/98	16.7	None	10/31/98	17.9	None	11/17/98	28.8	8260/8081/8082
10/26/98	18.5	None	10/30/98	17.4	None	11/05/98	18.7	8260/8081/8082	11/23/98	29.9	8260/8081/8082
11/02/98	19.3	None	11/04/98	18.1	8260/8081/8082	11/09/98	19.4	None	11/28/98	31.1	8260/8081/8082
11/05/98	20.0	8260/8081/8082	11/10/98	18.8	None	11/14/98	20.2	8260/8081/8082	12/04/98	32.2	None
11/10/98	20.7	None	11/14/98	19.4	None	11/19/98	20.9	8260/8081/8082	12/15/98	Test Terminated	
11/15/98	21.4	8260/8081/8082	11/18/98	20.1	None	11/24/98	21.6	None			
11/20/98	22.1	8260/8081/8082	11/23/98	Test Terminated		11/29/98	22.4	None			
11/24/98	22.8	None				12/04/98	23.1	None			
11/29/98	23.6	8260/8081/8082				12/07/98	Test Terminated				
12/04/98	24.3	None									
12/15/98	Test Terminated										

Notes:
OHBC CLT for the Outer Horizontal Boundary Composite.
IHBC CLT for the Inner Horizontal Boundary Composite.
CHCC CLT for the Visual Horizontal Composite.
VBC CLT for the Vertical Boundary Composite.
Method 8260 Vinyl chloride, trans-1,2-dichloroethene, trichloroethene, tetrachloroethene, 1,2,4-trichlorobenzene, mono- through pentachlorobutadiene.
8081 Hexachlorobenzene, hexachlorobutadiene, 4,4'-DDD, 4,4'-DDE.
8082 Polychlorinated biphenyls.

CRA 7431 (15) APPA from
CRA 7431 (10)

TABLE 3.2

COLUMN LEACH TEST CHEMICAL PARAMETERS
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

Volatiles
Vinyl chloride
trans-1,2-Dichloroethene
Trichloroethene
Tetrachloroethene

Semi-Volatiles
1,2,4-Trichlorobenzene
Hexachlorobutadiene
Hexachlorobenzene

Pesticides/PCBs
4,4'-DDD [(1)]
4,4'-DDE [(1)]
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1248
Aroclor 1254
Aroclor 1260

TICs
Chlorobutadiene [(1)]
Dichlorobutadiene [(1)]
Trichlorobutadiene [(1)]
Tetrachlorobutadiene [(1)]
Pentachlorobutadiene [(1)]

Noes:

(1)	Chemical parameters added at the request of the Hylebos Cleanup Committee (HCC).
CLT	Column Leach Test.
PCBs	Polychlorinated Biphenyls.
TICs	Tentatively Identified Compounds.

TABLE 3.3

BOUNDARY CONFIRMATION BULK SEDIMENT ANALYTICAL DATA(1)
CLT EVALUATION
AREA 5106 REMOVAL ACTION

Sample Location:			25.75-08/29-13/ 31-11/33-15/36.5-07R	27-08/30-05/32-11/ 36-08	27.5-08/30-05/ 32-09/36-08	28.5-08/30.5-07/ 32.5-08/34.5-08
Sample Id:			CHCC-061398-STI-002	OHBC-061398-STI-002	IHBC-061498-STI-001	VBC-061298-STI-001
Sample Date:			06/13/1998	06/13/1998	06/14/1998	06/12/1998
Parameters	Units	SQO's				
Volatile Organics						
Chloroform	ug/kg	--	ND 10	ND 120	ND 100	33
Ethylbenzene	ug/kg	10	ND 10	ND 120	ND 100	ND 31
Tetrachloroethene	ug/kg	57	ND 10	6200 J	2900 J	200
trans-1,2-Dichloroethene	ug/kg	--	ND 10	88 J	66 J	31
Trichloroethene	ug/kg	--	7.9 J	820 J	580 J	1000
Vinyl chloride	ug/kg	--	8.5 J	9000 J	7800 J	460
Xylenes	ug/kg	40	ND 10	ND 120	ND 100	ND 31
Semi-Volatiles						
1,2,4-Trichlorobenzene	ug/kg	51	ND 40	520 J	230 J	ND 25
1,2-Dichlorobenzene	ug/kg	50	ND 40	ND 50	ND 41	ND 25
1,3-Dichlorobenzene	ug/kg	170	ND 40	ND 50	ND 41	ND 25
1,4-Dichlorobenzene	ug/kg	110	ND 40	ND 50	ND 41	ND 25
2,4-Dimethylphenol	ug/kg	29	ND 40	ND 50	ND 41	ND 25
2-Methylnaphthalene	ug/kg	670	140 J	300 J	160 J	ND 25
2-Methylphenol	ug/kg	63	ND 40	ND 50	ND 41	ND 25
4-Methylphenol	ug/kg	670	ND 40	ND 50	ND 41	ND 25
Acenaphthene	ug/kg	500	220 J	500 J	270 J	ND 25
Acenaphthylene	ug/kg	1300	ND 40	ND 50	29 J	ND 25
Anthracene	ug/kg	960	120 J	250 J	160 J	ND 25
benzo(a)Anthracene	ug/kg	1600	150 J	350 J	290 J	ND 25
benzo(a)Pyrene	ug/kg	1600	110 J	420 J	230 J	ND 25
benzo(b)Fluoranthene	ug/kg	3600	140 J	1000 J	530 J	ND 25
benzo(g,h,i)Perylene	ug/kg	720	49 J	160 J	72 J	ND 25
benzo(k)Fluoranthene	ug/kg	3600	110 J	680 J	370 J	ND 25
bis(2-ethylhexyl)Phthalate	ug/kg	1300	ND 200	ND 320	ND 290	ND 25
Butylbenzylphthalate	ug/kg	900	ND 40	ND 50	ND 41	ND 25
Chrysene	ug/kg	2800	220 J	680 J	490 J	ND 25
di-N-Butylphthalate	ug/kg	1400	20 J	ND 50	31 J	ND 25
di-N-Octylphthalate	ug/kg	6200	ND 40	R	R	ND 25
dibenz(a,h)Anthracene	ug/kg	230	ND 40	ND 50	ND 41	ND 25
Dibenzofuran	ug/kg	540	110 J	210 J	120 J	ND 25
Diethylphthalate	ug/kg	200	ND 40	ND 50	ND 41	ND 25
Dimethylphthalate	ug/kg	160	ND 40	ND 50	ND 41	ND 25
Fluoranthene	ug/kg	2500	490 J	1600 J	ND 41	ND 25
Fluorene	ug/kg	540	170 J	380 J	210 J	ND 25
Hexachlorobenzene	ug/kg	22	240 J	800 J	1300 J	24

TABLE 3.3

BOUNDARY CONFIRMATION BULK SEDIMENT ANALYTICAL DATA(1)
CLT EVALUATION
AREA 5106 REMOVAL ACTION

Sample Location:			25.75-08/29-13/ 31-11/33-15/36.5-07R	27-08/30-05/32-11/ 36-08	27.5-08/30-05/ 32-09/36-08	28.5-08/30.5-07/ 32.5-08/34.5-08
Sample Id:			CHCC-061398-STI-002	OHBC-061398-STI-002	IHBC-061498-STI-001	VBC-061298-STI-001
Sample Date:			06/13/1998	06/13/1998	06/14/1998	06/12/1998
Parameters	Units	SQO's				
Semi-Volatiles (Cont'd)						
Hexachlorobutadiene	ug/kg	11	400 J	14000 J	6000 J	330
Hexachloroethane	ug/kg	--	ND 40	ND 50	ND 41	ND 25
indeno(1,2,3-cd)Pyrene	ug/kg	690	ND 40	150 J	78 J	ND 25
N-Nitrosodiphenylamine	ug/kg	28	ND 40	ND 50	ND 41	ND 25
Naphthalene	ug/kg	2100	470 J	600 J	230 J	120
Pentachlorophenol	ug/kg	360	ND 160	ND 200	ND 160	ND 100
Phenanthrene	ug/kg	1500	570 J	1600 J	1200 J	ND 25
Phenol	ug/kg	420	ND 40	ND 50	ND 41	ND 25
Pyrene	ug/kg	3300	400 J	1500 J	1400 J	ND 25
PCBs						
Aroclor 1016	ug/kg	--	ND 400	ND 750	ND 620	ND 130
Aroclor 1221	ug/kg	--	ND 510	ND 1200	ND 1000	ND 130
Aroclor 1232	ug/kg	--	ND 400	ND 7500	ND 620	ND 130
Aroclor 1242	ug/kg	--	ND 400	ND 750	ND 620	ND 130
Aroclor 1248	ug/kg	--	ND 400	ND 750	ND 620	ND 130
Aroclor 1254	ug/kg	--	ND 200	ND 250	ND 210	ND 130
Aroclor 1260	ug/kg	--	340 J	1200 J	930 J	ND 130
Tentatively Identified - VOCs						
Chlorobutadiene	ug/kg	--	ND	ND	ND	ND
Dichlorobutadiene	ug/kg	--	ND	4000 J	3100 J	240 J
Trichlorobutadiene	ug/kg	--	510 J	23000 J	19000 J	770 J
Tetrachlorobutadiene	ug/kg	--	85 J	92000 J	64000 J	4000 J
Pentachlorobutadiene	ug/kg	--	ND	7500 J	53000 J	440 J

Notes:

(1) Results are reported on a dry weight basis.
J Estimated
NDx Non-detect at or above x.
R Rejected.

TABLE 3.4

SUMMARY OF ANALYTICAL DATA - IHBC
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

Pore Volume Interval:	*0.7*	*1.5*	*2.2*	*2.9*	*4.9*	*6.3*	*7.8*	*8.5*	*9.2*	*9.9*	*11.4*	*12.1*	*13.5*	*14.9*	*16.4*	*17.8*	*20.6*	*21.4*	*22.1*	*23.6*
Bottle Collection Date:	*07/05/98*	*07/10/98*	*07/14/98*	*07/17/98*	*07/30/98*	*08/09/98*	*08/19/98*	*08/25/98*	*08/31/98*	*09/04/98*	*09/12/98*	*09/16/98*	*09/24/98*	*10/03/98*	*10/12/98*	*10/21/98*	*11/05/98*	*11/15/98*	*11/20/98*	*11/29/98*
Syringe Collection Date:	*07/06/98*	*07/10/98*	*07/14/98*	*07/18/98*	*07/30/98*	*08/10/98*	*08/19/98*	*08/25/98*	*08/31/98*	*09/04/98*	*09/12/98*	*09/16/98*	*09/24/98*	*10/03/98*	*10/12/98*	*10/21/98*	*11/05/98*	*11/15/98*	*11/20/98*	*11/29/98*
Volatiles (µg/L)																				
Vinyl chloride	2600J	1500J	1000J	1400J	430J	180	230	220	NA	120J	130J	88	140J	98J	93J	84J	80	73J	64J	48
trans-1,2-Dichloroethene	36	32	32	29	13J	9.7	14	12	NA	7.7	8.8J	7.2J	10	5.8	6.0	6.3	7.0	5.0	5.9	4.8J
Trichloroethene	150	140	160	160	95J	67	100	88	NA	52	49	42J	63	36	38	36	41	38	36	29
Tetrachloroethene	400	340	400	380	360J	210	300	310	NA	160	180	210J	210	170	180	200	210	150	140	120
Tetrachlorobutadiene[1]	630J	690J	680J	730J	720J	750J	860J	820J	NA	550J	540J	480J	710J	640J	740J	810J	610J	520J	550J	680J
Semi-Volatiles (µg/L)																				
1,2,4-Trichlorobenzene	5.5	5.9	5.6	6.1	5.4J	5.8	6.7	6.3	NA	ND 5.0	ND 5.0	2.7J	3.1J	2.5J	2.3J	3.0J	3.7J	3.2J	2.8J	2.7J
Hexachlorobutadiene	22	15J	23J	32	24J	31J	33	32	29	29J	28J	25J	19	21	20J	24J	16J	18	21J	12J
Hexachlorobenzene	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Pesticides/PCBs (µg/L)																				
4,4'-DDD	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
4,4'-DDE	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Aroclor-1016	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.60	ND 0.50
Aroclor-1221	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.60	ND 0.50
Aroclor-1232	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.60	ND 0.50
Aroclor-1242	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.60	ND 0.50
Aroclor-1248	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.60	ND 0.50
Aroclor-1254	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.60	ND 0.50
Aroclor-1260	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.06	ND 0.06	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.06	ND 0.05	ND 0.05	ND 0.06	ND 0.05	ND 0.06	ND 0.05
TICs (µg/L)																				
Chlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorobutadiene	870J	810J	840J	790J	450J	370J	460J	420J	NA	220J	220J	180J	200J	170J	170J	150J	110J	97J	95J	91J
Trichlorobutadiene	750J	730J	760J	770J	570J	600J	790J	740J	NA	440J	430J	400J	500J	440J	450J	420J	370J	320J	330J	280J
Pentachlorobutadiene	40J	51J	52J	58J	52J	41J	61J	57J	NA	41J	36J	37J	61J	54J	53J	58J	63J	55J	58J	53J
Geochemistry																				
pH (S.U.)	9.18	9.33	9.42	9.41	9.28	9.45	9.41	9.64	9.46	9.44	9.08	9.28	8.98	9.25	8.94	9.43	9.28	9.26	9.16	9.07
Eh (mV)	-89	-30	-65	-40	-149	-49	-75	-23	38.6	-33	-38.4	-32.5	-53.1	-19.4	11.7	18.6	-1.4	20.1	22.0	27.8
Conductivity (millimhos)	16.1	8.88	6.22	4.49	1.26	1.17	0.88	0.80	0.68	0.57	0.51	0.46	0.46	0.43	0.40	0.38	0.40	0.42	0.41	0.39
Dissolved Oxygen (mg/L)	2.60	0.70	0.50	0.35	0.10	0.65	0.20	1.20	2.10	0.75	0.90	0.60	0.90	1.0	1.05	0.90	0.75	0.75	0.90	1.05
Ferrous Iron (mg/L)	NA	NA	NA	ND 0.02	ND 0.02	0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	0.02	ND 0.02	ND 0.02	ND 0.02	0.02	ND 0.02	ND 0.02	ND 0.02
Turbidity (NTU)	NA	NA	NA	NA	0.28	0.40	0.72	0.70	0.82	0.55	0.37	0.45	0.54	0.46	0.81	0.91	1.50	0.40	0.62	0.82

Notes:

(1) Concentrations were recalculated based on a tetrachlorobutadiene (TCBD) interval standard analyzed several months after the samples were analyzed. See memo from James Singer, CRA, to Ken Marcy, USEPA, dated November 2, 1999.

J Estimated.

NA Not Analyzed.

NDx Not detected at or above x.

PCBs Polychlorinated Biphenyls.

S.U. Standard Units.

TICs Tentatively Identified Compounds.

CRA 7431 (15) APPA from
CRA 7431 (10)

TABLE 3.5

SUMMARY OF ANALYTICAL DATA - OHBC
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

Pore Volume Interval:	*0.68*	*1.3*	*2.0*	*2.7*	*3.3*	*4.7*	*6.7*	*9.4*	*10.0*	*11.4*	*12.7*	*14.0*	*15.4*	*18.1*
Bottle Collection Date:	*07/05/98*	*07/09/98*	*07/13/98*	*07/17/98*	*07/21/98*	*07/28/98*	*08/08/98*	*08/31/98*	*09/04/98*	*09/14/98*	*09/25/98*	*10/05/98*	*10/15/98*	*11/04/98*
Syringe Collection Date:	*07/07/98*	*NA*	*07/13/98*	*07/17/98*	*07/21/98*	*07/28/98*	*08/08/98*	*08/31/98*	*09/04/98*	*09/04/98*	*09/25/98*	*10/05/98*	*10/15/98*	*11/04/98*
Volatiles (µg/L)														
Vinyl chloride	2500J	NA	2300J	1400J	1300J	650J	200	NA	190	83J	190J	170J	190J	180
trans-1,2-Dichloroethene	40	NA	35	30J	25	19J	9.6	NA	12	20J	17	9.6	9.1	9.0
Trichloroethene	160	NA	140	150J	120	110J	43	NA	57	57	57	31	29	33
Tetrachloroethene	430	NA	570	700J	650	570J	270	NA	450	190	330	210	220	180
Tetrachlorobutadiene[1]	570J	NA	1000J	1500J	1300J	1400J	1100J	NA	1200J	1000J	1300J	1000J	1100J	810J
Semi-Volatiles (µg/L)														
1,2,4-Trichlorobenzene	5.2	NA	5.9	6.7J	7.0	6.5J	5.9	NA	3.3J	14	4.1J	2.7J	2.7J	3.8J
Hexachlorobutadiene	27	27J	ND 5.0	35J	40	11J	41J	42J	1.7J	22J	25	29	29J	17J
Hexachlorobenzene	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	R	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Pesticides/PCBs (µg/L)														
4,4'-DDD	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	R	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
4,4'-DDE	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	R	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Aroclor-1016	ND 0.60	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.60	R	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1221	ND 0.60	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.60	R	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1232	ND 0.60	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.60	R	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1242	ND 0.60	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.60	R	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1248	ND 0.60	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.60	R	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1254	ND 0.60	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.60	R	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1260	ND 0.06	ND 0.05	ND 0.12	ND 0.05	ND 0.05	ND 0.05	ND 0.06	ND 0.06	R	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
TICs (µg/L)														
Chlorobutadiene	ND	NA	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND
Dichlorobutadiene	840J	NA	800J	800J	690J	600J	300J	NA	280J	220J	280J	200J	180J	120J
Trichlorobutadiene	690J	NA	740J	870J	770J	790J	510J	NA	610J	520J	680J	510J	480J	410J
Pentachlorobutadiene	43J	NA	59J	81J	78J	84J	57J	NA	75J	64J	100J	84J	73J	80J
Geochemistry														
pH (S.U.)	9.18	9.34	9.47	6.89	9.43	9.98	9.53	9.58	9.46	9.37	9.33	9.27	9.36	9.38
Eh (mV)	-98.9	-35.2	-134	-49.0	-110	-93.6	-53.7	71.3	-68.6	-32.7	-30.9	-14.7	21.0	-10.2
Conductivity (millimhos)	19.6	10.2	7.96	5.94	3.59	1.61	0.97	0.70	0.59	0.53	0.49	0.45	0.42	0.44
Dissolved Oxygen (mg/L)	0.70	0.90	0.50	0.40	0.25	0.40	0.60	0.35	0.35	0.30	0.50	0.85	0.55	0.70
Ferrous Iron (mg/L)	NA	NA	NA	NA	ND 0.02	0.05	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02
Turbidity (NTU)	NA	NA	NA	NA	0.94	NA	0.13	0.25	0.07	0.00	0.03	0.26	0.10	0.18

Notes:

(1) Concentrations were recalculated based on a tetrachlorobutadiene (TCBD) interval standard analyzed several months after the samples were analyzed. See memo from James Singer, CRA, to Ken Marcy, USEPA, dated November 2, 1999.

J Estimated.
NA Not Analyzed.
NDx Not detected at or above x.
PCBs Polychlorinated Biphenyls.
R Data Rejected.
S.U. Standard Units.
TICs Tentatively Identified Compounds.

CRA 7431 (15) APPA from
CRA 7431 (10)

TABLE 3.6

SUMMARY OF ANALYTICAL DATA - CHCC
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

Pore Volume Interval:	*0.7*	*1.4*	*2.2*	*2.9*	*3.7*	*5.1*	*6.6*	*8.1*	*9.2*	*10.7*	*12.2*	*13.6*	*15.1*	*16.5*	*18.7*	*20.2*	*20.9*
Bottle Collection Date:	*07/05/98*	*07/08/98*	*07/12/98*	*07/15/98*	*07/19/98*	*07/27/98*	*08/07/98*	*08/17/98*	*08/27/98*	*09/05/98*	*09/14/98*	*09/24/98*	*10/03/98*	*10/12/98*	*11/05/98*	*11/14/98*	*11/19/98*
Syringe Collection Date:	*07/07/98*	-	*07/12/98*	*07/15/98*	*07/19/98*	*07/27/98*	*08/07/98*	*08/17/98*	*08/27/98*	*09/05/98*	*09/14/98*	*09/24/98*	*10/03/98*	*10/12/98*	*11/05/98*	*11/14/98*	*11/19/98*
Volatiles (µg/L)																	
Vinyl chloride	ND 5.0	NA	ND 5.0	ND 5.0	ND 5.0	ND 5.0	4.1J	4.7J	3.0J	4.2J	10	14J	16J	6.9J	9.6	5.6J	4.5J
trans-1,2-Dichloroethene	ND 5.0	NA	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Trichloroethene	ND 5.0	NA	ND 5.0	ND 5.0	ND 5.0	ND 5.0	19	ND 5.0	5.3	12	7.9	5.7	2.3J	2.4J	8.9	5.6	5.2
Tetrachloroethene	ND 5.0	NA	ND 5.0	ND 5.0	ND 5.0	ND 5.0	3.4J	13	7.9	17	28J	53	25	22	32	29	35
Semi-Volatiles (µg/L)																	
1,2,4-Trichlorobenzene	ND 5.0	NA	3.4J	ND 5.0	3.9J	3.5J	3.8J	3.5J	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Hexachlorobutadiene	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	R	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Hexachlorobenzene	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	0.16J	ND 5.0	ND 5.0
Pesticides/PCBs (µg/L)																	
4,4'-DDD	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
4,4'-DDE	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Aroclor-1016	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1221	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1232	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1242	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1248	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1254	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1260	ND 0.06	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.06	ND 0.05	ND 0.50	ND 0.05	ND 0.06	ND 0.05	ND 0.05	ND 0.05	ND 0.05
TICs (µg/L)																	
Chlorobutadiene	9.6J	NA	8.8J	9.6J	9.2J	ND	6.1J	5.4J	5.3J	ND	ND	5.6J	6.1J	7.0J	ND	ND	ND
Dichlorobutadiene	6.0J	NA	ND	ND	6.5J	ND	7.6J	9.4J	7.1J	12J	20J	23J	21J	15J	11J	12J	13J
Trichlorobutadiene	43J		32J	35J	43J	7.0J	33J	36J	31J	35J	47J	61J	56J	50J	49J	52J	45J
Tetrachlorobutadiene	ND	NA	ND	ND	ND	ND	5.6J	35J	16J	43J	69J	140J	92J	77J	110J	120J	140J
Pentachlorobutadiene	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.4J	ND	ND	5.5J	5.8J	ND
Geochemistry																	
pH (S.U.)	9.98	10.2	10.5	10.4	10.5	10.7	10.2	10.1	10.3	10.1	10.1	9.72	9.75	9.78	10.0	10.0	9.97
Eh (mV)	-125	-327	-274	-231	-184	-187	-109	-116	-56.7	-78.0	-69.9	-81.7	-54.6	-55.0	-60.8	-51.9	-48.7
Conductivity (millimhos)	19.0	12.1	7.40	4.92	3.40	1.76	1.30	1.17	1.06	0.93	0.79	0.73	0.61	0.58	0.57	0.54	0.53
Dissolved Oxygen (mg/L)	0.90	0.40	0.40	0.25	0.60	0.15	0.35	0.50	0.30	0.55	0.15	0.70	0.70	0.25	0.45	0.45	0.45
Ferrous Iron (mg/L)	NA	NA	NA	NA	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02	ND 0.02
Turbidity (NTU)	NA	NA	NA	NA	2.06	NA	4.35	5.52	6.01	7.01	6.25	6.14	5.81	4.76	3.94	3.33	3.05

Notes:

J Estimated.
NA Not Analyzed.
NDx Not detected at or above x.
PCBs Polychlorinated Biphenyls.
R Data Rejected.
S.U. Standard Units.
TICs Tentatively Identified Compounds.

CRA 7431 (15) APPA from
CRA 7431 (10)

TABLE 3.7

SUMMARY OF ANALYTICAL DATA - VBC
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

Pore Volume Interval:	*1.1*	*2.3*	*3.4*	*4.6*	*6.8*	*7.9*	*10.2*	*12.5*	*14.7*	*15.9*	*17.1*	*18.2*	*19.4*	*20.6*	*21.8*	*25.3*	*26.5*	*28.8*	*29.9*	*31.1*
Bottle Collection Date:	*07/04/98*	*07/10/98*	*07/14/98*	*07/19/98*	*07/30/98*	*08/04/98*	*08/15/98*	*08/25/98*	*09/07/98*	*09/14/98*	*09/22/98*	*09/29/98*	*10/05/98*	*10/11/98*	*10/18/98*	*11/01/98*	*11/07/98*	*11/17/98*	*11/23/98*	*11/28/98*
Syringe Collection Date:	*07/05/98*	*07/10/98*	*07/14/98*	*07/19/98*	*07/30/98*	*08/04/98*	*08/14/98*	*08/25/98*	*09/07/98*	*09/14/98*	*09/22/98*	*09/29/98*	*10/05/98*	*10/11/98*	*10/18/98*	*11/01/98*	*11/07/98*	*11/17/98*	*11/23/98*	*11/28/98*
Volatiles (µg/L)																				
Vinyl chloride	470J	330J	170J	170J	140	130	120	79	44	56	59J	57J	46J	61J	45J	19J	40	24J	23J	23
trans-1,2-Dichloroethene	48	39	28	21	12	10	8.7	5.4	5.7	6.1J	5.5	3.6J	3.4J	4.0J	3.2J	ND 5.0	2.6J	ND 5.0	2.2J	ND 5.0
Trichloroethene	830	760	590	450	300	240	180	190	200	170	170	114J	120	120	110	59J	93	58J	71	61
Tetrachloroethene	54	71	69	62	64	49	67	43	47	31	45	46J	22	46	43	27J	64	48J	36	46
Semi-Volatiles (µg/L)																				
1,2,4-Trichlorobenzene	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	3.7J	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Hexachlorobutadiene	3.0J	2.6J	3.1J	3.5J	1.6J	2.0J	1.7J	1.9J	1.6J	1.8J	1.6J	1.3J	1.4J	1.0J	1.6J	1.1J	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Hexachlorobenzene	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0	ND 5.0
Pesticides/PCBs (µg/L)																				
4,4'-DDD	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
4,4'-DDE	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Aroclor-1016	ND 0.60	ND 0.50	ND 0.50	ND 1.0	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1221	ND 0.60	ND 0.50	ND 0.50	ND 1.0	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1232	ND 0.60	ND 0.50	ND 0.50	ND 1.0	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1242	ND 0.60	ND 0.50	ND 0.50	ND 1.0	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1248	ND 0.60	ND 0.50	ND 0.50	ND 1.0	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1254	ND 0.60	ND 0.50	ND 0.50	ND 1.0	ND 0.60	ND 0.50	ND 0.50	ND 0.60	ND 0.60	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50	ND 0.50
Aroclor-1260	ND 0.06	ND 0.05	ND 0.05	ND 0.10	ND 0.06	ND 0.05	ND 0.50	ND 0.06	ND 0.06	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
TICs (µg/L)																				
Chlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorobutadiene	120J	120J	120J	97J	92J	76J	89J	60J	64J	54J	49J	63J	53J	68J	60J	31J	47J	39J	32J	40J
Trichlorobutadiene	ND	60J	71J	52J	75J	56J	60J	53J	45J	44J	42J	65J	37J	65J	56J	41J	68J	51J	49J	55J
Tetrachlorobutadiene	ND	78J	77J	110J	133J	95J	120J	100J	130J	72J	84J	130J	70J	160J	130J	84J	200J	130J	150J	170J
Pentachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.8J	5.5J	ND	6.4J	5.2J	ND	8.7J	ND	7.6J	7.0J
Geo-Chemistry																				
pH (S.U.)	9.20	9.73	9.96	9.85	9.32	9.37	9.64	9.19	9.16	8.92	9.24	9.14	9.03	8.89	9.30	9.09	9.09	9.05	8.91	8.84
Eh (mV)	-91.0	-65.0	-112	-80.5	-30.0	-43.2	4.5	12.2	-7.8	-40.7	-22.9	2.4	-4.1	32.5	49.4	41.3	29.1	41.7	53.7	50.8
Conductivity (millimhos)	11.0	3.78	1.77	1.07	0.69	0.73	0.63	0.53	0.53	0.50	0.48	0.46	0.44	0.40	0.36	0.42	0.42	0.40	0.39	0.39
Dissolved Oxygen (mg/L)	1.80	0.50	0.40	0.20	0.40	4.70	0.75	0.60	0.70	0.80	0.40	0.45	0.75	0.70	0.80	0.65	0.85	0.80	1.15	1.05
Ferrous Iron (mg/L)	-	-	-	0.24	0.11	0.14	0.05	0.06	0.07	0.05	0.06	0.05	0.05	0.05	0.04	0.02	0.02	0.02	ND 0.02	ND 0.02
Turbidity (NTU)	-	-	-	280	-	114	102	64.5	65.1	53.4	55.1	47.2	44.1	35.5	27.4	12.3	9.32	5.50	4.02	3.25

Notes:

J	Estimated.
NA	Not Analyzed.
NDx	Not detected at or above x.
PCBs	Polychlorinated Biphenyls.
S.U.	Standard Units.
TICs	Tentatively Identified Compounds.

CRA 7431 (15) APPA from
CRA 7431 (10)

TABLE 3.8

SUMMARY OF PHYSICAL DATA
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

CLT	Moisture Content (%)		Wet Density (pcf)		Porosity[d,e,f]		Hydraulic Conductivity (cm/sec)[c,d,f]
	Before	After[a]	Before	After[a]	Total[b]	Effective[a]	
CHCC	137	138	85	88	0.72	0.41	2×10^{-5}
OHBC	102	104	92	93	0.78	0.05q	3×10^{-3}q
IHBC	113	112	90	91	0.74	na	na
VBC	30	29	116	117	0.48	na	na

Notes:

a Measurements conducted on thin column remolded sediment after test was terminated.

b Total porosity is based on an estimated specific gravity of 2.6

c Hydraulic conductivity was measured using a constant-head test in the thin column apparatus and calculated using the following formula:

$$k = \frac{QL}{Aht}$$

Where:

k is the hydraulic conductivity in cm/sec
Q is the flow volume in mL
L is the length of sample in cm
A is the area in cm^2
h is the hydraulic head of water in cm
t is the time in seconds

d Average saturated hydraulic conductivity using fresh water corrected to 20°C.

e Effective porosity was measured by replacing leach water with a sodium chloride solution at approximately 5 millimhos electrical conductivity. Flow the tracer solution through the column was controlled with a constant head apparatus. The electrical conductivity of the effluent was recorded over time until it reached steady state (Freeze and Cherry 1979). Effective porosity was calculated using the following formula:

$$n_e = \frac{t_{ne}}{t_{(n = 100)}}$$

Where:

n_e is the effective porosity
t_{ne} is the time for the tracer solution to reach 50 percent concentration of the maximum value
$t_{n=100}$ is the time for a segment of fluid to flow through the sample.

TABLE 3.8

SUMMARY OF PHYSICAL DATA
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

f It is important to note that the effective porosity and hydraulic conductivity tests were conducted in the test apparatus specifically designed for contaminant transport testing. The thin column has limitations for measuring saturated hydraulic conductivity because of the rigid wall of the test apparatus resulting in a lack of confining stress. In addition, head losses or gradient measurement are difficult to measure in the thin column apparatus.

Contaminant transport flow for the CLT was controlled by a pump, whereas effective porosity was measured under hydraulic conductivity conditions and is therefore subject to the limitations discussed above. Other limitations include the use of electronic measurement equipment in a 4°C environment. This may cause variation in the accuracy of electrical conductivity measurements. Due to the specialized nature of the CLT, dispersion in some parts of the apparatus may interfere with measurement of the effective porosity. Based on these limitations, the effective porosity and hydraulic conductivity values should be considered only in a highly qualitative manner.

q Value was judged unacceptable by Soils Technology and should not be used.

na Not Analyzed.

TABLE 3.9

WATER QUALITY CRITERIA
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

Parameters	*Marine Water Quality Criteria*	
	Acute (*µg/L*)	*Chronic* (*µg/L*)
Volatiles		
Vinyl chloride	nc	nc
trans-1,2-Dichloroethene	224,000	nc
Trichloroethene	2,000	nc
Tetrachloroethene	10,200	450
Semi-Volatiles		
1,2,4-Trichlorobenzene	160	129
Hexachlorobutadiene	32	nc
Hexachlorobenzene	160	129
Pesticides/PCBs		
4,4'-DDD	nc	3.6
4,4'-DDE	14	nc
Aroclor 1016	nc	0.03
Aroclor 1221	nc	0.03
Aroclor 1232	nc	0.03
Aroclor 1248	nc	0.03
Aroclor 1245	nc	0.03
Aroclor 1260	nc	0.03
TICs		
Chlorobutadiene	nc	nc
Dichlorobutadiene	nc	nc
Trichlorobutadiene	nc	nc
Tetrachlorobutadiene	nc	nc
Pentachlorobutadiene	nc	nc

Notes:
nc No criteria established.
PCBs Polychlorinated Biphenyls.
TICs Tentatively Identified Compounds.

TABLE 3.10

ESTIMATED WATER QUALITY CRITERIA
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

Parameters	*Estimated Marine Water Quality Criteria*	
	Acute (*µg/L*)	*Chronic* (*µg/L*)
Volatiles		
Vinyl chloride	nc	525[1]
TICs		
Chlorobutadiene	352 [2]	nc
Dichlorobutadiene	282 [2]	nc
Trichlorobutadiene	192 [2]	nc
Tetrachlorobutadiene	121 [2]	nc
Pentachlorobutadiene	67 [2]	nc

Notes:
(1) Estimate based on human health criterion.
(2) Estimated based on USEPA ECOSAR computer program.
nc No criteria established.
TICs Tentatively Identified Compounds.

TABLE 3.11

PEAK LEACHATE CONCENTRATIONS VS. WATER QUALITY CRITERIA
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

Parameters	Marine Water Quality Criteria		Peak Leachate Concentrations (µg/L)			
	Acute (µg/L)	Chronic (µg/L)	IHBC	OHBC	CHCC	VBC
Volatiles						
Vinyl chloride	nc	nc	2600J	2500J	16J	470J
trans-1,2-Dichloroethene	224,000	nc	36	40	ND 5.0	48
Trichloroethene	2,000	nc	160	160	19	830
Tetrachloroethene	10,200	450	400	700J	53	71
Semi-Volatiles						
1,2,4-Trichlorobenzene	160	129	6.7	14	3.9J	ND 5.0
Hexachlorobutadiene	32	nc	33	42J	ND 5.0	3.5J
Hexachlorobenzene	160	129	ND 5.0	ND 5.0	0.16J	ND 5.0
Pesticides/PCBs						
4,4'-DDD	nc	3.6	ND 0.05	ND 0.05	ND 0.05	ND 0.05
4,4'-DDE	14	nc	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Aroclor 1016	nc	0.03	ND 0.60	ND 0.60	ND 0.60	ND 1.0
Aroclor 1221	nc	0.03	ND 0.60	ND 0.60	ND 0.60	ND 1.0
Aroclor 1232	nc	0.03	ND 0.60	ND 0.60	ND 0.60	ND 1.0
Aroclor 1242	nc	0.03	ND 0.60	ND 0.60	ND 0.60	ND 1.0
Aroclor 1248	nc	0.03	ND 0.60	ND 0.60	ND 0.60	ND 1.0
Aroclor 1254	nc	0.03	ND 0.60	ND 0.60	ND 0.60	ND 1.0
Aroclor 1260	nc	0.03	ND 0.06	ND 0.12	ND 0.06	ND 0.10
TICs						
Chlorobutadiene	nc	nc	ND	ND	9.6J	ND
Dichlorobutadiene	nc	nc	870J	840J	23J	120J
Trichlorobutadiene	nc	nc	790J	870J	61J	71J
Tetrachlorobutadiene	nc	nc	860J	1500J	140J	200J
Pentachlorobutadiene	nc	nc	63J	100J	8.4J	8.7J

Notes:

J Estimated.
nc No criteria established.
NDx Not detected at or above x.
PCBs Polychlorinated Biphenyls.
TICs Tentatively Identified Compounds.
Value exceeds the acute marine Water Quality Criteria.
Value exceeds the chronic marine Water Quailty Criteria.

TABLE 3.12

PEAK LEACHATE CONCENTRATIONS VS. ESTIMATED WATER QUALITY CRITERIA
CLT EVALUATION
AREA 5106 REMOVAL ACTION
FORMER OCC TACOMA FACILITY

Parameters	*Estimated Marine Water Quality Criteria*		*Peak Leachate Concentrations (µg/L)*			
	Acute (µg/L)	*Chronic (µg/L)*	*IHBC*	*OHBC*	*CHCC*	*VBC*
Volatiles						
Vinyl chloride	nc	525 (1)	2600J	2500J	16J	470J
TICs						
Chlorobutadiene	352 (2)	nc	ND	ND	9.6J	ND
Dichlorobutadiene	282 (2)	nc	870J	840J	23J	120J
Trichlorobutadiene	192 (2)	nc	790J	870J	61J	71J
Tetrachlorobutadiene	121 (2)	nc	860J	1500J	140J	200J
Pentachlorobutadiene	67 (2)	nc	63J	100J	8.4J	8.7J

Notes:

(1) Estimated based on human health criteria.

(2) Estimated based on USEPA ECOSAR computer program.

J Estimated.

nc No criteria established.

NDx Not detected at or above x.

TICs Tentatively Identified Compounds.

Value exceeds the estimated acute marine Water Quality Criteria.

Value exceeds the estimated chronic marine Water Quailty Criteria.

CRA 7431 (15) APPA from
CRA 7431 (10)

B

APPENDIX B

SITE-SPECIFIC PARTITIONING COEFFICIENTS

SITE-SPECIFIC PARTITIONING COEFFICIENTS

Sorption is the uptake by soil of dissolved chemical constituents. Sorptive mechanisms act to partition the chemical between the soil (or sediment) particles and the surrounding water matrix. K_d is the partitioning coefficient of a particular chemical constituent, which expresses the ratio of the sorbed and solution phased concentrations. The higher the vale of K_d, the more the mobility of the chemical is retarded by sorptive mechanisms.

$$K_d = \frac{C_s}{C_w}, \text{ where:}$$

K_d = partitioning coefficient of chemical compound;
C_s = concentration of chemical compound in solid phase; and
C_w = concentration of chemical compound in water phase.

K_{oc} is the partitioning coefficient normalized to the organic carbon content of the soil or sediment.

$K_{oc} = K_d/f_{oc}$, where:
K_{oc} = normalized partitioning coefficient of chemical compound;
K_d = partitioning coefficient of chemical compound; and
f_{oc} = fraction of organic carbon in sediment.

Site-specific Area 5106 K_{oc} values were calculated from sediment and porewater analyses as part of the Area 5106 Sediment Characterization Report. The methodology was as follows:

i) sediment and porewater chemistry were analyzed from the same sample;
ii) the bulk sediment concentrations were normalized with respect to the fraction of total organic carbon; and
iii) regression analyses of the bulk sediment and porewater concentrations were performed for each chemical of interest to determine K_{oc}.

K_{oc} values for six chemical compounds of interest at Area 5106 were determined to be as follows:

	K_{oc} (Liters/Kilogram [L/kg])
Vinyl Chloride (VC)	70
cis-1,2-Dichloroethene (c-DCE)	100
Trichloroethene (TCE)	190
Tetrachloroethene (PCE)	220
Hexachlorobutadiene (HCBD)	18,000
Hexachlorobenzene (HCB)	24,000

SITE-SPECIFIC PARTITIONING COEFFICIENTS

Sorption is the uptake by soil of dissolved chemical constituents. Sorptive mechanisms act to partition the chemical between the soil (or sediment) particles and the surrounding water matrix. K_d is the partitioning coefficient of a particular chemical constituent, which expresses the ratio of the sorbed and solution phased concentrations. The higher the vale of K_d, the more the mobility of the chemical is retarded by sorptive mechanisms.

$$K_d = \frac{C_s}{C_w}, \text{ where:}$$

K_d = partitioning coefficient of chemical compound;
C_s = concentration of chemical compound in solid phase; and
C_w = concentration of chemical compound in water phase.

K_{oc} is the partitioning coefficient normalized to the organic carbon content of the soil or sediment.

$K_{oc} = K_d/f_{oc}$, where:
K_{oc} = normalized partitioning coefficient of chemical compound;
K_d = partitioning coefficient of chemical compound; and
f_{oc} = fraction of organic carbon in sediment.

Site-specific Area 5106 K_{oc} values were calculated from sediment and porewater analyses as part of the Area 5106 Sediment Characterization Report. The methodology was as follows:

i) sediment and porewater chemistry were analyzed from the same sample;
ii) the bulk sediment concentrations were normalized with respect to the fraction of total organic carbon; and
iii) regression analyses of the bulk sediment and porewater concentrations were performed for each chemical of interest to determine K_{oc}.

K_{oc} values for six chemical compounds of interest at Area 5106 were determined to be as follows:

	K_{oc} (Liters/Kilogram [L/kg])
Vinyl Chloride (VC)	70
cis-1,2-Dichloroethene (c-DCE)	100
Trichloroethene (TCE)	190
Tetrachloroethene (PCE)	220
Hexachlorobutadiene (HCBD)	18,000
Hexachlorobenzene (HCB)	24,000

C

APPENDIX C

STRATIGRAPHIC LOGS EXTRACTED FROM APPENDIX B OF THE AREA 5106 SEDIMENT CHARACTERIZATION REPORT

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
25.5 - 08	-31.9	0 to 6.8	A	MH - SILT, with clay, trace vegetation	5.0 to 6.8	N
				very soft, gelatinous, low to medium plasticity, black, wet	0 to 5.0	N
		6.8 to 9.5	C	SP-SAND, fine, some silt, trace shells,	0 to -2.0	--
				dense, dark gray to black, moist	-2.0 to -2.7	--
25.75 - 08	-31.8	0 to 5.2	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 5.2	N
		5.2 to 9.4	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood, dense,	0 to -2.0	N
				dark grey to black, moist	-2.0 to -4.0	--
26 - 06	-27.0	0 to 9.1	A	MH - SILT, with clay, trace wood debris, very	5.0 to 9.1	N
				soft, gelatinous, low to medium plasticity, black, wet	0 to 5.0	N
		9.1 to 12.3	C	SP/SM - SAND, fine to medium, trace silt and clay, trace shells, dense,	0 to -2.0	N
				dark grey to black, moist	-2.0 to -3.2	--
26 - 07	-28.8	0 to 1.7	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	6.4 to 8.1	--
		1.7 to 8.1	B (2)	MH - SILT, with clay, very soft, gelatinous,	5.0 to 6.4	N
				low to medium plasticity, black with grey-tan layers 4 inches thick every 8 inches, reactive with HCL, wet	0 to 5.0	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		8.1 to 12.7	C	SP-SAND, fine, some silt, trace wood, and shells, dense, dark gray to black, moist	0 to -2.0 -2.0 to -4.0	-- --
26 - 08	-30.0	0 to 0.8	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	4.2 to 5.0	--
		0.8 to 5.0	B (2)	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black with occasional grey-tan layers 1-inch thick, reactive with HCL, wet	0 to 4.2	N
		5.0 to 11.8	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N --
26 - 09	-30.2	0 to 0.8	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	5.6 to 6.4	--
		0.8 to 6.4	B (2)	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black with occasional grey-tan layers 1-inch thick every 4", reactive with HCL, wet	0 to 5.6	N
		6.4 to 9.8	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -3.4	-- --
26 - 10	-31.8	0 to 2.6	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 2.6	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		2.6 to 3.2	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -0.6	N
26 - 12	-32.0	0 to 2.2	A	MH - SILT, with clay, some sand, very soft, gelatinous, low to medium plasticity, black, wet	0 to 2.2	--
		2.2 to 9.1	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	-- --
26.5 - 05	-13.2	0 to 4.9	A	MH - SILT, with clay, trace vegetation, wood debris, sand and gravel below 1.4 feet BML, very soft, gelatinous, low to medium plasticity, black, wet	3.5 to 4.9 0 to 3.5	N N
		4.9 to 7.6	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0	N
26.5 - 06	-24.4	0 to 2.6	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	7.6 to 10.2	--
		2.6 to 10.2	B (2)	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black with grey to grey tan layers 4 inches thick, reactive with HCL, wet	5.0 to 7.6 0 to 5.0	N N
		10.2 to 13.4	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -3.2	-- --

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
26.5 - 08	-30.3	0 to 0.9	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	4.1 to 5.0	--
		0.9 to 5.0	B (2)	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black with grey-tan layers 1-inch thick every 4 inches, reactive with HCL, wet	0 to 4.1	N
		5.0 to 12.5	C	SM - SAND AND SILT, fine, trace wood and shells, dense, dark grey, moist	0 to -2.0 -2.0 to -4.0	-- --
26.5 - 10	-31.3	0 to 2.2	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, black, wet	3.9 to 6.1	--
		2.2 to 6.1	B (2)	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black with grey-tan layers 1-inch thick every 6 inches, reactive with HCL, wet	0 to 3.9	N
		6.1 to 10.6	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	-- --
26.5 - 11	-31.8	0 to 2.6	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	0 to 2.6	N
		2.6 to 4.6	C	SM - SAND, fine, some silt, trace shells, dense, dark grey to black, wet	0 to -2.0	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
26.5 - 12	-33.0	0 to 1.5	A	MH - SILT, with clay, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	0 to 1.5	--
		1.5 to 7.3	C	SP/SM - SAND, fine to medium, trace silt and clay, trace shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	-- --
26.75 - 08	-29.5	0 to 1.1	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	5.0 to 6.1	--
		1.1 to 6.1	B (2)	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black with grey-tan layers 2 to 3 inches thick, reactive with HCL, wet	0 to 5.0	N
		6.1 to 13.5	C	SM - SAND AND SILT, fine, trace wood and shells, dense, dark grey, moist	0 to -2.0 -2.0 to -4.0	-- --
27 - 04	-1.5	0 to 1.1	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	0 to 1.1	--
		1.1 to 3.5	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist Refusal at 3.5 feet BML	0 to -2.0 -2.0 to -2.4	-- --

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
27 - 05	-9.7	0 to 2.5	A	MH - SILT, with clay, trace gravel, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	0 to 2.5	N
		2.5 to 3.6	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -1.1	N
27 - 06	-26.7	0 to 1.6	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	9.9 to 11.5	--
		1.6 to 11.5	B (2)	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black intermixed with grey-tan, reactive with HCL, wet	0 to 9.9	--
		11.5 to 13.0	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0	--
27 - 06R	-27.5	0 to 2.2	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	9.3 to 11.5	--
		2.2 to 11.5	B (2)	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black with occasional grey-tan 1 to 2 inches, 10-inch thick grey-tan layer at 4.7 to 5.5 feet BML	5.0 to 9.3 0 to 5.0	N N

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TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		11.5 to 12.3	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -0.8	--
27 - 07	-28.9	0 to 6.8	A	MH - SILT, with clay, trace crystalline and ceramic objects, very soft, gelatinous, low plasticity, black with grey mottling, wet	5.0 to 6.8 0 to 5.0	N N
		6.8 to 10.1	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -2.0	N
27 - 08	-29.8	0 to 7.0	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black with grey mottling, wet	5.0 to 7.0 0 to 5.0	N N
		7.0 to 8.5	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -0.5	N
27 - 09	-30.9	0 to 5.0	B (2)	MH - SILT, with clay, very soft, gelatinous, low plasticity, black with grey-tan layers 1 to 2.5 inches thick at 1.1, 1.5, and 2.8 feet BML, black medium sand 3.2 to 4.1 feet BML, reactive with HCL, wet	0 to 5.0	N
		5.0 to 7.2	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, wet	0 to -2.2	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
27 - 10	-30.7	0 to 4.5	A	MH - SILT, with clay, soft, low to medium plasticity, black, 1-inch layer of fine sand at 3.4 feet BML, wet	0 to 4.5	N
		4.5 to 8.9	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0	N
27 - 11	-32.0	0 to 2.8	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 2.8	N
		2.8 to 7.4	C	SP/SM - SAND, fine to medium, trace silt and clay, trace shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.6	-- --
27 - 12	-32.3	0 to 1.2	A	MH - SILT, with clay WITH SAND, firm, gelatinous, low to medium plasticity, black, wet	0 to 1.2	N
		1.2 to 7.0	C	SP/SM - SAND, fine to medium, trace silt and clay, occasional silt layer, trace wood, dense, dark grey to black, moist	0 to -2.0	--
27 - 13	-33.6	0 to 1.2	A	MH - SILT, with clay, trace vegetation, very soft, gelatinous, low to medium plasticity, black to dark grey, wet	0 to 1.2	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		1.2 to 9.2	C	SP/SM - SAND, fine to medium, trace silt and clay, occasional silt layer, shells, dense, dark grey to black, moist	0 to -2.0	--
27.5 - 08	-29.6	0 to 0.8	A	MH - SILT, with clay, trace vegetation, very soft, gelatinous, low to medium plasticity, black, wet	5.6 to 6.4	N
		0.8 to 6.4	B (2)	MH - SILT, with clay, very soft, gelatinous, low plasticity, black with occasional grey-tan layers 2 to 3 inches thick, reactive with HCL, wet	5.0 to 5.6 0 to 5.0	N N
		6.4 to 12.2	C	SP/SM - SAND, fine to medium, trace silt and clay, occasional wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N
28 - 04	8.7	2.0 to 12.5	AS	FILL - gravel, some sand and silt, some wood debris, cemented brown and black, moist	5.7 to 12.5 0 to 5.7	-- N
		12.5 to 17.0	C	SP/SM - SAND, fine to medium, trace silt and clay, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	-- --
28 - 05	-9.6	0 to 0.4	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	5.2 to 5.6 (3)	--
		0.4 to 5.6	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan with black layers in upper 2 feet, reactive with HCL, wet	0 to 5.2 (3)	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
			C	Borehole refusal prior to reaching C		
28 - 05R	-11.6	0 to 2.0	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black, wet	5.7 to 7.7	--
		2.0 to 4.2	B	MH - SILT, with clay, very soft, gelatinous, low plasticity, grey-tan, reactive with HCL, wet	3.5 to 5.7	--
		4.2 to 7.7	AS	FILL - gravel and sand, metal at 4.5 feet BML, black, wet	0 to 3.5	N
		7.7 to 12.0	C	SP/SM - SAND, fine to medium, trace silt and clay, dark grey to black, moist	-0 to -2.0 -2.0 to -4.0	N --
28 - 06	-23.6	0 to 1.7	A	MH - SILT, with clay, trace vegetation, very soft, gelatinous, low to medium plasticity, black to dark grey, wet	10.3 to 12.0	N
		1.7 to 12.0	B	MH - SILT, with clay, very soft, gelatinous, low plasticity, black mixed with grey-tan, reactive with HCL, wet	5.0 to 10.3 0 to 5.0	Y Y
		12.0 to 12.3	C	SP/SM - SAND, fine to medium, trace silt and clay, occasional silt layer shells, dense, dark grey to black, wet	0 to -0.3	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
28-07	-25.9	0 to 1.6	A	MH - SILT, with clay, trace vegetation and shells, trace sand, very soft, gelatinous, low to medium plasticity, black, wet	--	
		1.6 to 10.0	B	MH - SILT, with clay, very soft, becoming firm below 6.7 feet BML, gelatinous, low to medium plasticity, tan with grey and black mottling, wet	5.0 to 8.4 (3) 0 to 5.0 (3)	Y N
28 - 08	-28.8	0 to 1.0	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	8.4 to 9.4	--
		1.0 to 9.4	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan with black mottling, reactive with HCL, wet	0 to 8.4	--
		9.4 to 13.5	C	SM - SAND AND SILT, fine, dense, dark grey moist	0 to -2.0 -2.0 to -4.0	N
28 - 10	-31.7	0 to 2.7	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	2.1 to 4.8	N N
		2.7 to 4.8	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, tan with black mottling, reactive with HCL, wet	0 to 2.1	Y

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		4.8 to 6.8	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells dense, dark grey to black, moist	0 to -2.0	N
28 - 11	-31.9	0 to 3.5	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 3.5	N
		3.5 to 9.0	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -2.0	N
28 - 12	-33.0	0 to 1.2	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 1.2	N
		1.2 to 8.5	C	SP/SM - SAND, fine to medium, trace silt and clay, trace shells, clay layer 1.4 to 1.7 feet BML, dense, dark grey to black, moist	0 to -2.0	--
28 - 13	-34.1	0 to 0.7	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black, wet	0 to 0.7	N
		0.7 to 9.9	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, black, moist	0 to -2.0	--
29 - 04	-1.5	0 to 2.8	A	MH - SILT, with clay, trace shells, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet, refusal at 2.8 feet BML	0 to 2.8 (3)	--

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TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
29 - 04R	-3.6	0 to 4.7	AS	FILL - gravel, some sand and silt, cemented, black, moist to wet, creosote odor	0 to 4.7	N
		4.7 to 9.0	C	SP/SM - SAND, fine to medium, trace silt and clay, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N
29 - 05	-8.0	0 to 1.0	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black, wet	3.8 to 4.8 (4)	N
		1.0 to 4.8	B	MH - SILT, with clay, very soft, gelatinous, low plasticity, black with grey-tan layers, reactive with HCL, wet	0 to 3.8 (4)	Y
		4.8 to 9.0	AS	FILL - sand, fine, some silt and clay, loose, black, wet	0 to -4.2 (4)	N
29 - 06	-22.4	0 to 1.0	A	MH - SILT, with clay, trace shell, very soft, gelatinous, low to medium plasticity, black, wet	--	
		1.0 to 6.9	B	MH - SILT, with clay, very soft, gelatinous, low plasticity, black with grey-tan layers, reactive with HCL, wet	0 to 5.0 (3)	N
29 - 06R	-23.7	0 to 1.1	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	10.3 to 11.4 (3)	--

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		1.1 to 11.4	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan with some black layers, reactive with HCL, wet	0 to 10.3 (3)	--
29 - 06R2	-17.0	0 to 2.8	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	6.8 to 9.6	--
		2.8 to 7.5	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan, reactive with HCI, wet	2.1 to 6.8	--
		7.5 to 9.6	AS	FILL - gravel, sand and silt, trace wood, black, wet	0 to 2.1	--
		9.6 to 13.5	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N --
29 - 07	-24.2	0 to 0.7	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	7.9 to 8.6 (3)	--
		0.7 to 8.6	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan with some black, reactive with HCL, wet	2.9 to 7.9 (3) 0 to 2.9 (3)	Y N
			C	Not identified		
29 - 08	-29.0	0 to 0.9	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	8.8 to 9.7	--

CRA 7431 (15) APPC from
CRA 7431 (9) APPB

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		0.9 to 9.7	B	MH - SILT, with clay, very soft, gelatinous, low plasticity, black with grey-tan layers, reactive with HCL, wet	0 to 8.8	--
		9.7 to 13.4	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -3.7	N --
29 - 10	-31.2	0 to 1.1	A	MH - SILT, with clay, trace fine sand, very soft, gelatinous, low to medium plasticity, black, wet	--	--
		1.1 to 5.6	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, mottled white and tan, reactive with HCL, wet	--	--
		5.6 to 10.0	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0	N
29 - 11	-32.6	0 to 3.3	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black, wet	0 to 3.3	Y
		1.0 to 1.5	B	MH - SILT, with clay, very soft, gelatinous, low plasticity, grey and white, reactive with HCL, wet	(see above)	
		3.3 to 9.3	C	SM - SAND AND SILT, fine, 0.3 feet thick firm grey clay layer at 5.0 feet BML, dense, dark grey to black, moist	0 to -2.0	--

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
29 - 12	-33.4	0 to 0.4	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	(see below)	
		0.4 to 2.1	B	MH - SILT, with clay, trace fibrous material, very soft, gelatinous, low to medium plasticity, reactive with HCL, wet	0 to 2.1	Y
		2.1 to 8.8	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, very moist	0 to -2.0 -2.0 to -4.0	N --
29 - 13	-34.5	0 to 1.8	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 1.8	N
		1.8 to 6.3	C	SM - SAND AND SILT, fine, dense, dark grey to black, moist	0 to -2.0	N
30 - 04	-3.0	0 to 3.2	AS	FILL - sand and gravel, some shells, dense, dark grey to black, wet	0 to 3.2	N
			C	Refusal at 3.2 feet below mud line in slag		
30 - 05	-10.5	0 to 6.6	A	MH - SILT, with clay with debris and gravel, very soft, gelatinous, low to medium plasticity, black, wet	5.0 to 6.6	N
		4.5 to 4.8	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan, reactive with HCL, wet	0 to 5.0	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		6.6 to 7.6	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -1.0	N
30 - 06	-20.2	0 to 1.0	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	5.0 to 6.8	--
		1.0 to 6.8	B	MH - SILT, with clay, trace shells and wood, very soft, gelatinous, low to medium plasticity, grey-tan, reactive with HCL, wet	0 to 5.0	Y
		6.8 to 13.7	C	SM - SAND AND SILT, fine, some silt, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N --
30 - 08	-31.8	0 to 1.8	A	MH - SILT, with clay, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	3.8 to 5.6	N
		1.8 to 5.6	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan with white and black mottling, reactive with HCL, wet	--	--
		5.6 to 7.9	C	SP-SAND, fine some silt, dense, dark grey to black moist	0 to -2.3	N
30 - 09	-33.0	0 to 2.0	B	MH - SILT, with clay, very soft, gelatinous, low plasticity, grey-tan with black and white mottling, reactive with HCL, wet	0 to 2.0	Y

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		2.0 to 9.0	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N N
30 - 10	-35.2	0 to 0.1	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black, wet	(see below)	
		0.1 to 8.8	C	SP/SM - SAND AND SILT, fine, some silt, firm grey clay layer 0.3 feet thick at 4.5 feet BML, trace wood and shells, dense, dark grey to black, moist	-2.0 to -4.0	N
30 - 10R	-36.6	0 to 0.1	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black, wet	--	--
		0.1 to 8.7	C	SP/SM - SAND AND SILT, fine, some silt, firm grey clay layer 0.3 feet thick at 6.0 feet BML, trace wood and shells, dense, dark grey to black, moist	0 to -2.0	N
30 - 11	-36.1	0 to 7.1	C	SP/SM - SAND, fine to medium, trace silt and clay, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	-- --
31 - 03	-2.9	0 to 4.0 (3)	AS/AD	FILL - sand and gravel, debris, fibrous sheeting, wood, slag, black, wet	0 to 4.0 (3)	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
31 - 04	-12.3	1.5 to 2.2	AS	FILL - gravel, with sand and silt, black, wet	3.6 - 5.8	--
		2.2 to 5.8	B	MH - SILT, with clay, very soft, gelatinous, low plasticity, grey, becoming grey - tan at 3.0 ft BML, wet	0 - 3.6	Y
		5.8 to 9.9	C	SP/SM - SAND, fine to medium, trace silt and clay, trace gravel black, wet	0 to -2.0 -2.0 to -4.0	-- --
		9.9 to 10.5	C	ML - SILT, with sand and clay, grey, moist	--	--
31 - 05	-18.4	0 to 0.1	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	(see below)	
		0.1 to 3.6	B	MH - SILT, with clay, very soft, trace, grey, fibrous material, gelatinous, low to medium plasticity, tan, reactive with HCL, wet	0 to 3.5	--
		3.6 to 7.9	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N --
31 - 07	-31.1	0 to 3.3	A	MH - SILT, with clay, trace ceramic and plastic, trace wood debris, trace crystalline material, very soft, gelatinous, low to medium plasticity, black, wet	2.9 to 6.2	Y

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		3.3 to 6.2	B	MH - SILT, with clay, fibrous, soft, low to medium plasticity, tan-grey	--	--
		6.2 to 8.0	C	SP/SM - SAND AND SILT, dense, dark grey to black, moist	0 to -1.8	Y
31-07R	--	0 to 7.1	-	Not Sampled		
		7.1 to 12.0	C	SP/SM - SAND AND SILT, dense, dark grey to black, moist	-1.0 to -2.0 -2.0 to -3.0 -3.0 to -4.0	N -- --
31 - 09	-36.3	0 to 2.3	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 2.3	Y
		0.7 to 1.2	B	MH - SILT, with clay, very soft, trace fibrous material, gelatinous, low to medium plasticity, grey-tan, reactive with HCL, wet	(see above)	
		2.3 to 7.6	C	SP/SM - SAND, fine to medium, trace silt and clay, firm grey clay 0.6 feet thick at 2.8 feet BML, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N --
31 - 10	-36.7	0 to 1.8	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 1.8	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		1.2 to 1.3	B	MH - SILT, with clay, fibrous, very soft, gelatinous, low to medium plasticity, grey-tan, reactive with HCL, wet	(see above)	
		1.8 to 10.2	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood, dense, dark grey to black, moist	0 to -2.0	N
31 - 11	-37.0	0 to 0.7	A	MH - SILT, with clay, trace vegetation, very soft, gelatinous, low to medium plasticity, black, wet	0 to 0.7	N
		0.7 to 8.9	C	SP/SM - SAND, fine to medium, trace silt and clay, trace shells, dense, dark grey to black, very moist	0 to -2.0	N
32 - 03	-2.2	0 to 2.8	AD	FILL, debris, silt, sand, gravel, brick, shells, slag, dark grey to black, wet	0 to 2.8 (3)	Y
32 - 04	-7.1	0 to 0.6	AS	SM - SAND AND SILT, trace gravel, black, wet	12.9 to 13.5	--
		0.6 to 3.4	AD	PRECIPITANT - fine grained, hard, white, moist	10.1 to 12.9	--
		3.4 to 5.8	AF	SLUDGE - silty/clayey, soft, brown, black banding, wet	7.7 to 10.1	--
		5.8 to 13.5	B	MH - SILT, with clay, stiff, low to medium plasticity, grey, becoming tan brown at 6.0 ft BML, occasional white layers at 9 to 10.5 feet BML	0 to 7.7	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		13.5 to 19.5	C	SP/SM - SAND, fine to medium, trace silt and clay, dark grey to black, wet to 16.5 ft BML, moist below	0 to -2.0 -2.0 to -4.0	-- --
32 - 05	-13.6	0 to 3.7	AS	FILL, gravel, silt, sand, clay, 3 inch layer of white precipitate at top, brown to black, wet	0 to 3.7 (3)	Y
32 - 06	-27.2	0 to 0.9	A	MH - SILT, with clay and gravel, trace shells, very soft, gelatinous, low to medium plasticity, black, wet	8.3 to 9.2 (3)	--
		0.9 to 9.2	B	MH - SILT, with clay, fibrous, very soft, gelatinous, low to medium plasticity, tan, occasional layer of white precipitate reactive with HCL, wet	3.3 to 8.3 (3) 0 to 3.3 (3)	-- --
32-06R	-27.7	0 to 9.5	--	Not sampled		
		9.5 to 14.2	C	SP/SM - SAND, fine to medium, trace silt and clay and shells, dense, dark grey, moist	0 to -1.0 0 to -2.0 -1.0 to -2.0 -2.0 to -3.0 -3.0 to -4.0	Y -- Y Y Y
32 - 08	-33.2	0 to 1.5	AD	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet followed by debris, sand and gravel, some silt, black, very wet below 0.2 feet BML	2.9 to 4.4	--

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		1.5 to 4.4	B	MH - SILT, with clay with fibrous material, very soft, gelatinous, low to medium plasticity, grey-tan, reactive with HCL, wet	0 to 2.9	Y
		4.4 to 9.2	C	SP/SM - SAND, fine to medium, trace silt and clay, trace shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N
32 - 09	-34.7	0 to 1.6	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low plasticity, black, wet	0 to 1.6	N
		1.6 to 9.0	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N
32 - 10	-34.1	0 to 2.0	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 2.0	N
		1.0 to 1.3	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan, wet	(see above)	
		2.0 to 8.0	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	-- --
32 - 11	-32.6	0 to 1.2	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 1.2	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		0.5 to 0.7	B	MH - SILT, with clay, fibrous, very soft, gelatinous low to medium plasticity, grey, reactive with HCL, wet	(see above)	
		1.2 to 6.3	C	SP - SAND, fine to medium, some silt, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	-- --
32-11R	-32.6	0 to 1.7	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0.3 to 2.0	--
		1.7 to 2.0	B	MH - SILT, with clay, fibrous, very soft, gelatinous low to medium plasticity, grey, reactive with HCL, wet	0 to 0.3	--
		2.0 to -7.7	C	SP/SM - SAND, fine to medium, trace silt and clay, trace shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N N
32 - 12	-34.1	0 to 0.8	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 0.8	N
		0.8 to 5.1	C	SP/SM - SAND, fine to medium, trace silt and clay, trace shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N --
33-06	-25.8	0 to 2.2	AD/AS	FILL - debris, gravel, sand, silt, cobbles, shells, wood, grey to brown, wet	0 to 2.2	--

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
33 - 06R	-32.0	0 to 4.0	AS	FILL - silt, sand and gravel, trace wood, black, wet	1.8 to 5.8	N --
		4.0 to 5.8	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black, wet	0 to 1.8	N
		5.8 to 10.5	C	SP/SM - SAND, fine to medium, trace silt and clay, dark grey to black, wet	0 to -2.0 -2.0 to -4.0	N --
33 - 07	-30.9	0 to 2.5	AD	FILL, debris, sand, gravel, silt, brown to black, wet	5.1 to 7.6	--
		2.5 to 7.6	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan to dark green with some black, reactive with HCL, wet	0 to 5.1	--
		7.6 to 7.9	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -0.3	--
33 - 08	-34.3	0 to 1.3	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	1.9 to 3.2	--
		1.3 to 3.2	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity grey-tan reactive with HCL, wet	0 to 1.9	Y

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		3.2 to 8.2	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N --
33 - 09	-34.8	0 to 1.8	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 1.8	N
		1.8 to 9.1	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -2.0	N
33 - 10	-33.5	0 to 2.0	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 2.0	N
		1.3 to 1.6	B	MH - SILT, with clay, fibrous, very soft, gelatinous, low to medium plasticity, grey-tan, reactive with HCL, wet	(see above)	
		2.0 to 7.6	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N --
33 - 11	-33.0	0 to 3.3	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	0 to 3.3	N
		2.3 to 2.5	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey with black mottling, reactive with HCL, wet	(see above)	

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		3.3 to 6.5	C	SP/SM - SAND, fine to medium, trace silt and clay, occasional 0.1 to 0.2 foot, firm clay layers, dense, dark grey to black, moist	0 to -2.0	--
33 - 12	-32.0	0 to 1.2	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	0 to 1.2	N
		0.4 to 0.7	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan, reactive with HCL, wet	(see above)	
		1.2 to 8.5	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N --
33 - 13	-33.6	0 to 1.6	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	0 to 1.6	N
		0.7 to 0.8	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan, reactive with HCL, wet	(see above)	
		1.6 to 9.1	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	-- --
33 - 14	-33.4	0 to 1.1	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 1.1	N

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BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		0.2 to 0.3	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan, reactive with HCL, wet	(see above)	
		1.1 to 9.3	C	SM - SAND AND SILT, fine, trace wood and shells, dense, dark grey, moist	0 to -2.0 -2.0 to -4.0	N --
33 - 15	-34.8	0 to 3.8	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	0 to 3.8	N
		3.8 to 7.6	C	SP/SM - SAND, fine to medium, trace silt and clay, trace shells, dense, dark grey, moist	0 to -2.0 -2.0 to -4.0	N --
34 - 04	-9.3	0 to 3.0	AD	FILL - slag, metallic, sand to gravel size, reddish brown, moist	7.3 to 10.3	--
		3.0 to 6.2	B	MH - SILT, with clay, very soft, gelatinous, trace fibers, low to medium plasticity, reactive with HCL, wet	4.1 to 7.3	Y
		6.2 to 7.7	AP	PRECIPITANT, fine grained, firm, brown, moist to dry	2.6 to 4.1	--
		7.7 to 10.3	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black, wet	0 to 2.6	N --

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AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		10.3 to 15.0	C	SP/SM - SAND, fine to medium, trace silt and clay, compact, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N --
34 - 05	-13.7	0 to 0.8	AD	FILL-gravel, debris, sand, silt, black, wet	5.1 to 5.9 (4)	--
		0.8 to 5.9	AF	SLUDGE-brown, occasional black layers, very soft, non reactive with HCL, wet	0 to 5.1 (4)	--
		5.9 to 9.8	A	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.0 (4) -2.0 to -4.0 (4)	Y Y
34 - 06	-27.4	0 to 6.5	AD	FILL - gravel, debris, sand, silt, wood, shells, brown to black, wet	10.4 to 11.9 5.4 to 10.4	N Y
		6.5 to 11.9	AF	SLUDGE, brown to black, wet, occasional black layer	0 to 5.4	Y
		11.9 to 13.4	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -1.5	N
34 - 07	-31.7	0 to 1.2 1.2 to 2.8	AD/AS A	FILL, debris, sand, gravel, silt, wet MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	8.3 to 9.5 (3) 6.7 to 8.3 (3)	-- --

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		2.8 to 5.6	AF	SLUDGE, very soft, brown, wet, trace reaction with HCL	3.9 to 6.7 (3)	--
		5.6 to 9.5	B (2)	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black with grey-tan layers 1 inch thick every 6 inches, reactive with HCL, wet	0 to 3.9 (3)	--
34 - 08	-34.2	0 to 1.9	AD	FILL, debris, sand, gravel, silt, brown to black, wet	5.2 to 7.1	--
		1.9 to 7.1	B (2)	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, tan to brown interlayered with black, reactive with HCL, wet	4.8 to 5.2 0 to 4.8	-- --
		7.1 to 10.0	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -1.4	Y
34-08R	-32.5	0 to 8.8	-	No sample		
		8.8 to 13.3	C	SP/SM - SAND, fine to medium, trace silt and clay, trace shells and clay, cemented dark grey to black, moist	-1.0 to -2.0 -2.0 to -3.0 -3.0 to -4.0	N -- --
34 - 09	-33.8	0 to 1.5	A	MH - SILT, with clay, some gravel, trace wood, debris, very soft, gelatinous, low plasticity, black, wet	4.6 to 6.1	--

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		1.5 to 4.0	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan reactive with HCL, wet	2.1 to 4.6	--
		4.0 to 6.1	A	MH - SILT, with clay, some gravel, trace wood, debris, very soft, gelatinous, low plasticity, black, wet	0 to 2.1	--
		6.1 to 8.5	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -2.4	N
34 - 10	-32.6	0 to 2.4	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	5.0 to 7.4	--
		2.4 to 7.4	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, mottled grey, white and brown, reactive with HCL, wet	0 to 5.0	Y
		7.4 to 9.0	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -1.6	--
34 - 11	-36.8	0 to 1.9	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	0 to 1.9	N
		1.9 to 9.4	C	SP/SM - SAND, fine to medium, trace silt and clay, dense, dark grey to black, moist	0 to -2.0	N

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
35 - 04	-2.7	0 to 5.2	A	MH - SILT, with clay, very soft, gelatinous, low plastic, back and white, moist	1.6 to 6.8	Y
		5.2 to 6.8	AS	FILL - sand, yellow brown, cemented, moist	0 to 1.6	Y
		6.8 to 12.0	C	SP/SM - SAND, fine to medium, trace silt and clay, compact, grey to black, moist	0 to -2.0 -2.0 to -4.0	Y N
35 - 05	-14.1	0 to 4.3	A	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black, wet	3.0 to 7.3	N
		4.3 to 7.3	AF	SLUDGE, brown to white with thin black layers, soft, wet	0 to 3.0	Y
		7.3 to 8.7	C	SM - SAND AND SILT, some clay, few rootlets, trace wood and shells, dense, dark grey to black, moist	0 to -1.4	N
35 - 06	-26.0	0 to 1.6	AD/AS	FILL, debris, sand, gravel, silt, wood, plastics, brown to black, wet	10.7 to 12.3 (3)	N
		1.6 to 12.3	AD/AP	FILL, interlayered debris and white precipitate	5.7 to 10.7 (3) 0 to 5.7 (3)	Y Y
35 - 06R	--	0 - 3.2 3.2 - 9.3	AS/AD AF	FILL, sand and gravel, debris, trace clay and silt, trace wood, black and bro SLUDGE, trace sand and gravel, brown, white, grey, black, soft, moist	-- --	NA NA
35 - 07	-32.4	surface	A	White precipitant at surface	surface	--

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
35 - 08	-34.2	0 to 2.4	A	MH - SILT, with clay, some gravel and debris very soft, gelatinous, low to medium plasticity, black, wet	4.4 to 6.8	--
		2.4 to 6.8	B	MH - SILT, with clay, very soft gelatinous, low to medium plasticity, grey-tan with black mottling, reactive with HCL, wet	0 to 4.4	--
		6.8 to 9.5	C	SM - SAND AND SILT, fine, dense, dark grey to black moist	0 to -2.7	N
35 - 09	-34.2	0 to 1.8	A	MH - SILT, with clay with gravel and debris, very soft, gelatinous, low to medium plasticity, black, wet	3.8 to 5.6	N
		1.8 to 5.6	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan, reactive with HCL, wet	0 to 3.8	Y
		5.6 to 8.7	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist	0 to -3.1	--
35 - 10	-33.2	0 to 1.9	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	3.9 to 5.8	--
		1.9 to 5.8	B (2)	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, black with trace grey spotting, reactive with HCL, wet	0 to 3.9	Y

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		5.8 to 8.5	C	SM - SAND AND SILT, dense, dark grey to black, moist	0 to -2.7	N
35 - 11	-34.0	0 to 2.1	A	MH - SILT, with clay, debris, very soft, gelatinous, low to medium plasticity, black, wet	0 to 2.1	N
		2.1 to 9.3	C	SP/SM - SAND, fine to medium, trace silt and clay, trace wood and shells, dense, dark grey to black, moist, silt layer 4.1 to 5.6 feet BML	0 to -2.0 -2.0 to -4.0	N --
35.5 - 07	-29.5	0 to 2.2	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black, wet	6.8 to 9.0	--
		2.2 to 5.7	AP	PRECIPITANT, fine grained, very soft, brown and white, wet	3.3 to 6.8	Y
		5.7 - 9.0	AF	SLUDGE - fine grained, becoming fibrous at 8.7 feet BML, very soft, layered black and white, wet	0 to 3.3	Y
		9.0 - 13.5	C	SP/SM - SAND, fine to medium, trace silt and clay, very dense, dark grey t black, moist	0 to -2.0 -2.0 to -4.0	-- --
35.5 - 09	-32.6	0 to 3.2	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black, wet	1.8 to 5.0	Y

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		3.2 to 5.0	A	MH - SILT, with clay, very soft, low to medium plasticity, grey to black, trace white precipitant, wet	0 to 1.8	Y
		5.0 to 9.0	C	SP/SM - SAND, fine to medium, trace silt and clay, very dense, dark grey t black, moist	0 to -2.0 -2.0 to -4.0	N --
36 - 06	-27.3	0 to 3.2	AS	FILL - gravel and cobbles		
		3.2 to 5.8	AF	FILL - silt, debris, wood, gravel, reddish brown, wet	2.2 to 4.8 (3)	N
		5.8 to 8.0	A	MH - SILT, with clay, trace wood debris, very soft, stratified in 1/8 inch thick layers, reddish brown to clear, wet	0 to 2.2 (3)	N
36 - 06R	-23.7	0 to 3.0	AS	FILL - sand and gravel, with silt, loose, dark grey to black, wet		
		3.0 to 8.8	AP	PRECIPITANT - fine grained, very soft becoming firm below 4.5 feet BML, cream color, wet	1.9 to 7.7	--
		8.8 to 9.0	AD	FILL - slag, gravel size, rust red	with lower sample	
		9.0 to 10.7	A	FILL - clay fibrous, with sand, soft, reddish brown layers, moist	0 to 1.9	--

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		10.7 to 15.0	C	SP/SM - SAND, fine to medium, trace silt and clay, dark grey to black, moist	0 to -2.0 -2.0 to -4.0	N --
36 - 07	-29.7	0 to 3.6	A	MH - clay, silt, and sand, some gravel, very soft, gelatinous, low to medium plasticity, black, wet	5.9 to 9.5 (3)	N
		3.6 to 9.5	B	MH - SILT, with clay, very soft, gelatinous, low to medium plasticity, grey-tan with occasional 1/4 inch thick black seams, reactive with HCL, wet	0 to 5.9 (3)	N
36 - 08	-32.7	0 to 6.6	A	MH - SILT, with clay, trace gravel, trace wood, very soft, gelatinous, low to medium plasticity, black, wet, brown sediment layers 3.2 to 6.6 feet BML	5.0 to 6.6 0 to 5.0	N N
		6.6 to 10.0	C	SM - SAND AND SILT, fine, some silt, shells, dense, dark grey to black, moist	0 to -3.4	N
36 - 09	-34.6	0 to 6.0	A	MH - SILT, with clay, very soft, gelatinous, low plasticity, black, occasional brown spots, wet	1.0 to 6.0 0 to 1.0	N N
		6.0 to 9.0	C	SM - SAND AND SILT, fine, some silt, trace shells, dense, dark grey to black, moist	0 to -3.0	--
36.5 - 07	-30.3	0 to 1.9	AD	FILL - debris, gravel, sand, silt, brown to black, wet	8.2 to 10.1 (3)	--
		1.9 to 2.7	A	CL/CM - SILT, with clay, very soft, gelatinous, black, wet	7.4 to 8.2 (3)	--

TABLE B.1
BOUNDARY ESTIMATION SAMPLES AND BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*MWQ Exceedance (Y/N)*
		2.7 to 10.1	AP	PRECIPITANT - some debris, sand and gravel, fibrous material, tan, brown, black, wet	4.4 to 7.4 (3) 0 to 4.4 (3)	-- --
36.5 - 07R	-29.5	0 to 2.7	A	FILL, debris, gravel, sand, silt, brown to black, wet	6.4 to 9.1	N
		2.7 to 3.1	A	MH - SILT, with clay, trace vegetation, trace wood debris, very soft, gelatinous, low to medium plasticity, black, wet	6.0 to 6.4	N
		3.1 to 9.1	A	SLUDGE, pinkish tan to brown, with thin black seams, very soft, wet	5.0 to 6.0 0 to 5.0	N N
		9.1 to 12	C	SP/SM - SAND, fine to medium, trace silt and clay, shells, dense, dark grey to black, moist	0 to -2.0 -2.0 to -2.9	N --

Notes:

MLLW	Mean Lower Low Water
HCL	Hydrochloric Acid
(1)	Matrix: A: Recent natural fine grained sediment
	B: Visual Area 5106 - like material
	C: Native sediment
	AS: Sand and gravel fill
	AF: Fine grained fill
	AP: Precipitant
	AD: Debris, riprap
(2)	Contains thin layers of visual 5106 like material
(3)	'C' - Material not encountered. Depths referenced from bottom of borehole
(4)	'C' - Material not encountered. Depths referenced from lower sand layer interface
MWQ	Exceedance of Marine Water Quality based on analytical results for porewater screening.
--	Sample not submitted for analysis

TABLE B.2
PROFILE SAMPLE BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mud Line Elevation (ft. MLLW)*	*Depth (ft. below mud line)*	*Matrix (1)*	*Description*	*Sample Depth (ft. above native)*	*Sample Numbers*
30-08	-31.8	0 to 1.6	A	CL/ML - CLAYEY SILT, trace wood debris, very soft, gelatinous, low plasticity, black, wet	5.5 to 5.8 [1] 5.0 to 5.5 4.5 to 5.0	SE-7431-041598-JJW-053/PP-042098-STI-002 SE-7431-041598-JJW-035/PP-041698-STI-005 SE-7431-041598-JJW-036/PP-041698-STI-006
		1.6 to 5.8	B	CL/ML - CLAYEY SILT, very soft, trace, grey, fibrous material, gelatinous, low plasticity, tan, reactive with HCL, wet	3.8 to 4.3 [2] 2.8 to 3.3	SE-7431-041598-JJW-037/PP-041698-STI-007 SE-7431-041598-JJW-038/PP-041698-STI-008
		5.8 to 9.4	C	SP - SAND, fine, some silt, dense, dark grey to black, moist	-0.1 to -1.1	SE-7431-041598-JJW-039
33-08	-34.3	0 to 1.7	A	CL/ML - CLAYEY SILT, very soft, gelatinous, lo plasticity, black, wet	4.3 to 4.6 [1] 3.8 to 4.3 3.1 to 3.6	SE-7431-041598-JJW-052/PP-042098-STI-001 SE-7431-041498-JJW-030/PP-041698-STI-001 SE-7431-041498-JJW-031/PP-041698-STI-002
		1.7 to 4.6	B	CL/ML - CLAYEY SILT, very soft, gelatinous, lo plasticity, tan, reactive with HCL, wet	2.3 to 2.8 -0.1 to 0.6	SE-7431-041498-JJW-032/PP-041698-STI-003 SE-7431-041498-JJW-033/PP-041698-STI-004
		4.6 to 9.1	C	SP - SAND, fine, some silt, dense, dark grey to black, moist	-1.9 to -2.9	SE-7431-041498-JJW-034

Notes:

[2] Includes 0.1 feet of matrix A
SE = Sediment sample
PP = Porewater sample

TABLE B.3
GEOTECHNICAL BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	Mudline Elevation Ft. MLLW)	Depth Top (Ft. BML)	Depth Bottom	Elevation Top (Ft. MLLW)	Elevation Bottom	Matrix (1)	Description	Sample Type (2)	Sample Depth (Ft. BML)	Sample Recovery (Inches)	SPT (N Value)
29-09PS	-30.3	0	0.4	-30.3	-30.7	A	MH-SILT, with clay, trace wood debris, very soft, gelatinous, low plasticity, black, wet	PS	0 to 2.0	26	NA
		0.4	4	-30.7	-34.3	B	MH-SILT, with clay, very soft, gelatinous, low plasticity, gray, wet, black sandy silt laye 1.4 to 1.5 feet, gray and black 0.6 to 0.8 feet	PS PS	See above 2.0 to 4.0	See Above 0	NA NA
		4	6	-34.3	-36.3	C	SP/SM-SAND, fine to medium, trace silt and clay, dense, dark gray to black, moist	PS	4.0 to 6.0	22	NA
29-09SS/V	-30.7	6	8.1	-36.7	-38.8	C	SM-SILT and FINE SAND, trace clay, dark gray, moist	SS SS	6.0 to 7.5 7.5 to 9.0	18 18	8 12
		8.1	12	-38.8	-42.7		SP/SM-SAND, fine, with silt, dark gray, moi	SS SS	9.0 to 10.5 10.5 to 12.0	4 18	13 10
31-07PS	-31.0	0	0.6	-31.0	-31.6	AS	FILL-gravel, with silt, black, wet	PS	0 to 2.0	23	NA
		0.6	1	-31.6	-32.0	B	MH-SILT, with clay, very soft, gelatinous, low plasticity, gray intermixed with brown, wet	See above	See above	See above	NA
		1	15	-32.0	-32.5	A	MH-SILT, with clay, trace wood and gravel, very soft, gelatinous, low plasticity, brown, wet	See above	See above	See above	NA
		1.5	4	-32.5	-35.0	B	MH-SILT, with clay, very soft, becoming fir at 2.0 feet, gelatinous, low plasticity, gray, w	See above PS	See above 2.0 to 4.0	See above 24	NA NA
		4	5	-35.0	-36.0	AF/B	MH-SILT, with clay, wood and vegetation 4. to 4.1 feet, very soft, gelatinous, low plasticity, dark brown with white spots and gray zones, wet	PS	4.0 to 6.0	24	NA
		5	6	-36.0	-37.0	B	MH-SILT, with clay, soft, low plasticity, gray with dark zones, wet	PS	See above	See above	NA
		6	6	-37.0	39.0	C	SP/SM-SAND, fine to medium, trace silt and clay, dense, dark gray to brown, moist	PS	6.0 to 8.0	21	NA

TABLE B.3
GEOTECHNICAL BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	Mudline Elevation Ft. MLLW)	Depth Top (Ft. BML)	Depth Bottom	Elevation Top (Ft. MLLW)	Elevation Bottom	Matrix (1)	Description	Sample Type (2)	Sample Depth (Ft. BML)	Sample Recovery (Inches)	SPT (N Value)
31-07SS/V	-29.6	4	5	-33.6	-34.6	A	MH-SILT, with clay, very soft, gelatinous, low plasticity, black, wet	SS	4.0 to 5.5	18	1
		5	8.1	-34.6	-37.7	B	MH-SILT, with clay, very soft, gelatinous, low plasticity, gray, wet	SS	5.5 to 7.0	0	0
								SS	7.0 to 8.5	18	12
		8.1	13	-37.7	-42.6	C	SP/SM-SAND, fine to medium, trace silt and clay, dense, dark gray to black, moist	SS	See above	See above	See above
								SS	8.5 to 10.0	12	21
								SS	10.0 to 11.5	12	25
								SS	11.5 to 13.0	12	40
33-07PS	-33.4	0	0.8	-33.4	-34.2	AS	FILL, silt, sand and gravel, trace wood, black wet, plasticity, black	PS	0 to 2.0	24	NA
		0.8	2	-34.2	-35.4	A	MH-SILT, with clay, very soft, gelatinous, low plasticity, dark brown, wet	PS	See above	See above	NA
		2	2.4	-35.4	-35.8	AS	FILL, sandy silt, with gravel, black, wet	PS	2.0 to 4.0	23.5	NA
		2.4	4	-35.8	-37.4	A/B	MH-SILT, with clay, soft, low plasticity, gray with dark zones, wet, degassing holes 2.4 to 3 feet	PS	See above	See above	NA
		4	5.4	-37.4	-38.8	A	MH-SILT, with clay, sand below 4.9 feet, ver soft, gelatinous, low plasticity, black, wet	PS	4.0 to 6.0	20	NA
		5.4	6	-38.8	-39.4	AS	FILL, silty sand, black, wet, loose	PS	See above	See above	NA
33-07SS/V	-28.7	8	14	-36.7	-42.7	C	SP/SM-SAND, fine to medium, trace silt and clay, dense, dark gray to black, moist	SS	8.0 to 9.5	18	55
								SS	9.5 to 11.0	18	39
								SS	11.0 to 12.5	18	20
								SS	12.5 to 14.0	18	12

TABLE B.3
GEOTECHNICAL BOREHOLE LOGS
AREA 5106 SEDIMENT CHARACTERIZATION
FORMER OCC TACOMA FACILITY

Sediment Sample Location	*Mudline Elevation Ft. MLLW)*	*Depth Top (Ft. BML)*	*Depth Bottom*	*Elevation Top (Ft. MLLW)*	*Elevation Bottom*	*Matrix (1)*	*Description*	*Sample Type (2)*	*Sample Depth (Ft. BML)*	*Sample Recovery (Inches)*	*SPT (N Value)*
34-06PS	-28.9	0	0.2	-28.9	-29.1	B	MH-SILT, with clay, soft, low plasticity, tan, wet	PS	0 to 2.0	24	NA
		0.2	0.7	-29.1	-29.6	A	FILL, gravel, debris, sand, silt, wood, shells, brown to black, wet	PS	See above	See above	NA
		0.7	3	-29.6	-31.9	AF	SLUDGE, fine-grained, with gravel, brown to black	PS	2.0 to 4.0	4	NA
		3	4.4	-31.9	-33.3	AS	FILL, silty sand, degassing holes, brown, wet	PS	4.0 to 6.0	24	NA
		4.4	6	-33.3	-34.9	A/B	MH-SILT, with clay, soft, low plasticity, interbedded, gray and black, wet	PS	See above	See above	NA
34-06SS/V		5.5	10			C	SP/SM-SAND, fine to medium, trace silt and clay, compact, dark gray to black, moist	SS	5.5 to 7.0	18	25
								SS	7.0 to 8.5	12	3
								SS	8.5 to 9.0	12	11

Notes:
(1) Matrix: A - Recent fine grained natural sediment.
AF - Fine grained fill.
AS - Sand and gravel fill.
B - Visual Area 5106-like material.
C - Native sediment.
(2) Sample Type: PS - Piston Sampler.
SS - Split Spoon Sampler.
BML Below Mudline.
MLLW Mean Lower Low Water.
SPT Standard Penetration Test.

D

APPENDIX D

DESCRIPTIONS OF PRELIMINARY REMEDIAL ALTERNATIVES; SECTIONS 6.1.1 THROUGH 6.2 EXTRACTED FROM THE PTTE REPORT

6.1.1 ALTERNATIVE A - NATURAL RECOVERY

Sediment natural recovery (No Action) is a remedial alternative within the Waterway for those sediment areas that are expected to meet the SQOs within 10 years following completion of the Waterway remedial action. Natural recovery is defined by the ROD as the improvement (i.e., concentration reduction) of surface sediments over time. Among other processes, natural sediment recovery mechanisms include the disposition of clean sediment over the impacted sediment, chemical, and biologically-enhanced degradation reactions and the transport of impacted sediments out of the area.

Long-term monitoring would be implemented to ensure the effectiveness of alternatives.

6.1.2 ALTERNATIVE B - SOURCE CONTAINMENT

Source containment would utilize one of two capping technologies to isolate the Area 5106 Sediment such that the mass flux of chemicals within the porewater would be maintained below the levels necessary to satisfy SQOs and the MWQ within a 10 cm zone at the surface of the cap (marine habitat). Dredging restrictions would be implemented to prevent damage to the cap and perimeter berm.

A cap over all Area 5106 Sediment would encompass an area of approximately 140,000 square feet based on the Outer Horizontal boundary (Figure 6.1). The west boundary would be the 0-foot MLLW at the embankment and the east boundary would be the shipping channel. The south limit would be south of Pioneer's Dock No. 1, and the north limit would extend approximately 300 feet north of the POT southern property line.

Due to consolidation, the weight of a cap on the Area 5106 Sediment would displace porewater upward from the Area 5106 Sediment into the overlying native sediments and potentially into the capping materials. The concentrations in the sediment porewater may also be increased due to the "squeezing" of sediment-bound chemicals into the porewater. The increased concentration of the chemicals in the porewater could increase the mass flux potential through the cap and into the Waterway. Mass flux through the cap can be mitigated in the following ways:

i) reducing the permeability of the existing sediments or installing a lower permeability cap over the existing sediments in order to decrease the movement of impacted porewater; and/or

ii) reducing the diffusion of chemicals by reducing the porosity of the existing sediments or installing a cap with a lower porosity than the existing sediments.

The greater the porosity of the cap, the thicker the cap must be in order to provide the pore volumes required to attenuate the chemical concentration below acceptable levels within the top 10 cm of the cap.

Two alternatives for source containment were developed and evaluated:

i) Alternative B1 - Armored Sand Cap - see Figure 6.2; and

ii) Alternative B2 - Armored Sand Over Flexible Membrane Liner - see Figure 6.3.

Cross-sections at two locations (stations 29 and 35) through the Area 5106 Sediment are shown on Figures 6.4 and 6.5, respectively.

6.1.2.1 ALTERNATIVE B1 - ARMORED SAND CAP

A geotextile would be placed over the Area 5106 Sediment to separate it from the capping materials. Clean sand would then be hydraulically placed over the geotextile to reduce the mass flux of the chemicals. The sand cap would be surrounded with a perimeter beam of hydraulically placed sand. The sand cap would be protected from propeller wash by armoring in the form of gravel or light loose riprap. The armor materials may also provide habitat enhancement features.

Installation of the armored sand cap would cause minimal settlement of the existing sediments (native sediments and Area 5106 Sediment). The available ship draft would be slightly decreased primarily due to the thickness of the sand and armoring. Engineered structural supports may be necessary to provide increased long-term stability of the sand on sloping surfaces.

Installation of an armored sand cap over the Area 5106 Sediment is expected to take approximately three months.

6.1.2.2 ALTERNATIVE B2 - ARMORED SAND OVER FLEXIBLE MEMBRANE LINER

Alternative B2 is similar to Alternative B1 except that a flexible membrane liner (FML) would be installed over the geotextile prior to hydraulically placing the sand cover. The perimeter berm and the armoring on the sand would be the same as described in Alternative B1. Installation, however, would require approximately six months to complete.

Installation of Alternative B2 would cause minimal settlement of existing sediments. The available ship draft would slightly decrease after the cap was installed. As with Alternative B1, engineered structural supports may be necessary to provide increased long-term stability of the sand on the sloping surface.

6.1.3 ALTERNATIVE C - SEDIMENT REMOVAL/ TREATMENT/DISPOSAL

Sediment removal, treatment, and disposal alternatives are presented on flow charts to reflect the following:

i) hydraulic and mechanical sediment removal;

ii) water and sediment treatment to accommodate hydraulic low solids, hydraulic high solids, and mechanical dredging removal options;

iii) aquatic and upland disposal options following treatment; and

iv) in situ treatment.

The alternatives are based on the Area 5106 Sediment characterization summary presented in Section 3.0. The alternatives anticipate that clean recent sediments and overdredged native sediments will be included in the removal action. Therefore, both clean and impacted recent and native sediments will be commingled with Area 5106 Sediment and treated prior to disposal.

Removal of Area 5106 Sediment would include approximately 1-foot of over dredge below the impacted sediments. The expected bathymetry following removal of the Area 5106 Sediment within the Outer Horizontal boundary is depicted on Figure 6.6. Post removal cross-sections (stations 29 and 35) are depicted on Figures 6.7 and 6.8, respectively.

Five groups of removal, treatment, and disposal alternatives were developed and assessed:

i) Alternative C1 – Hazelton MAXI-CLONE/MAXI-STRIP;

ii) Alternative C2 – Slurry Aeration/Oxidation;

iii) Alternative C3 – Low Temperature Thermal Desorption;

iv) Alternative C4 – Incineration; and

v) Alternative C5 – Aqua Mectool™ Oxidation.

6.1.3.1 ALTERNATIVE C1 - HAZELTON MAXI-CLONE/MAXI-STRIP

The Hazelton MAXI-CLONE/MAXI-STRIP treatment process (soil washing/air stripping) alternative was developed utilizing hydraulic high solids removal as depicted on Figure 6.9 (Alternative C-1A) and hydraulic low solids removal (Alternative C-1B). The Hazelton MAXI-CLONE/MAXI-STRIP would remove VOCs and some SVOCs from contaminated media, which would include both sediments and water. Each Hazelton unit (one 6-stage MAXI-CLONE and one 12-stage MAXI-STRIP) would be designed to process water and sediments at a flow rate of up to 300 gallons per minute (GPM) at 10 percent solids by volume. Solids in excess of 1/2-inch diameter would be screened from the process stream prior to the Hazelton MAXI-CLONE treatment and screened again to below 1/8-inch prior to Hazelton MAXI-STRIP treatment. Chemicals absorbed to sediments would be removed by sheer forces in the MAXI-CLONE (hydrocyclone) and then stripped from the water. Steam injection may be used to enhance the air stripping aspect of the technology. After primary treatment in the Hazelton system, the Area 5106 Sediment would be dewatered to reduce the disposal tonnage requirements. The extracted water would be filtered and treated to achieve marine discharge standards using activated carbon prior to discharge back to the Waterway. Disposal options considered for the dewatered sediments were as follows:

i) aquatic disposal at either an HCC or OCCT Nearshore location;

ii) disposal on Site as embankment fill;

iii) disposal on the PRI site;

iv) disposal at an off-Site Subtitle D landfill; and

v) disposal at an off-Site Subtitle C landfill.

Air emissions would be contained for all stages of the treatment phase. Off-gases would be treated using vapor-phase carbon or thermal oxidizers to remove VOCs prior to atmospheric discharge. Alternatively, Hazelton equipment could be configured with a closed loop air ducting system utilizing intra-stage catalytic oxidation to treat vapors. Treatment of air emissions would not be required for dewatering operations.

Two alternatives were developed for the Hazelton MAXI-CLONE/MAXI-STRIP treatment process, depending upon the removal technology utilized.

1. Alternative C-1A - Hydraulic High Solids Removal

   Hydraulic high solids dredging (10 percent solids by volume or higher) of Area 5106 Sediment in open areas would be performed using either a Toyo Pump, a Pneuma Dredge, or an Eddy Pump. Dilution of the high solids dredging spoils may be required to provide a slurry feed at a maximum

10 percent solids by volume to the Hazelton units. Area 5106 Sediment under the docks would only be accessible by a diver-articulated hydraulic dredge which substantially reduces removal rates.

2. Alternative C-1B - Hydraulic Low Solids Removal

Hydraulic low solids dredging (less than 10 percent solids by volume) of Area 5106 Sediment in open areas would be performed using a cutterhead hydraulic dredge. Area 5106 Sediment under the docks would only be accessible by a diver-articulated hydraulic dredge which substantially reduces removal rates.

6.1.3.2 ALTERNATIVE C2 - SLURRY AERATION/OXIDATION

The Slurry Aeration/Oxidation alternative was developed utilizing hydraulic high solids removal as depicted on Figure 6.10 (Alternative C-2A) and hydraulic low solids removal (Alternative C-2B). Solids in excess of 1/2-inch diameter would be screened from the slurry prior to the aeration tanks. VOCs and some SVOCs would be removed from the slurry (10 to 20 percent solids by volume) by injection of approximately 360 scfm ambient air into the bottom of each aeration tank. As the air moves upward through the slurry, VOCs would be stripped from the water and transported to the top of the tank. Each tank would accommodate approximately 21,600 gallons of slurry. A batch of the slurry would be retained for eight hours and a mixer would continuously stir the slurry to keep the solids in suspension and in contact with the air. After primary treatment by aeration, the Area 5106 Sediment would be dewatered to reduce the disposal tonnage requirements. The extracted water would be filtered and treated to achieve marine discharge criteria using activated carbon prior to discharge back to the Waterway. Disposal options considered for the dewatered sediments were as follows:

i) aquatic disposal at either an HCC or OCCT Nearshore location;

ii) disposal on Site as embankment fill;

iii) disposal on the PRI site;

iv) disposal at an off-Site Subtitle D landfill; and

v) disposal at an off-Site Subtitle C landfill.

Air emissions would be contained for all stages of the treatment phase. Off-gases would be treated using vapor-phase carbon or thermal oxidation to remove VOCs prior to atmospheric discharge. Treatment of air emissions would not be required for dewatering operations.

Two alternatives were developed for the Slurry Aeration/Oxidation treatment process, depending upon the removal technology utilized.

1. Alternative C-2A - Hydraulic High Solids Removal

   Hydraulic high solids dredging (10 percent solids by volume or higher) of Area 5106 Sediment in open areas would be performed using either a Toyo Pump, a Pneuma Dredge, or an Eddy Pump. Area 5106 Sediment under the docks would only be accessible by a diver-articulated hydraulic dredge which substantially reduces removal rates.

2. Alternative C-2B - Hydraulic Low Solids Removal

   Hydraulic low solids dredging (less than 10 percent solids by volume) of Area 5106 Sediment in open areas would be performed using a cutterhead hydraulic dredge. Area 5106 Sediment under the docks would only be accessible by a diver-articulated hydraulic dredge which substantially reduces removal rates.

6.1.3.3 ALTERNATIVE C3 - LOW TEMPERATURE THERMAL DESORPTION

The Low Temperature Thermal Desorption (LTTD) alternative was developed utilizing mechanical dredging removal as depicted on Figure 6.11 (Alternative C-3A) and hydraulic high solids removal as depicted on Figure 6.12 (Alternative C-3B). Dredged sediments would be drained/dewatered prior to LTTD.

VOCs and SVOCs would be removed from Area 5106 Sediment by volatilization at temperatures up to 300° Fahrenheit. The anticipated treatment rate would be 30 tons per hour of sediments at 50 percent solids by weight. Off-gases from the LTTD unit would be oxidized to destroy VOCs/SVOCs and emissions would be scrubbed to remove acid prior to atmospheric discharge. Disposal options considered for the treated sediments were as follows:

i) aquatic disposal at either an HCC or OCCT Nearshore location;

ii) disposal on Site as embankment fill;

iii) disposal on the PRI site;

iv) disposal at an off-Site Subtitle D landfill; and

v) disposal at an off-Site Subtitle C landfill.

The water extracted during dewatering of the dredged Area 5106 Sediment would be filtered and treated using activated carbon to achieve marine discharge criteria prior to

discharge back to the Waterway. The dewatering of untreated Area 5106 Sediment required prior to LTTD could potentially remove some of the VOCs and SVOCs and increase aqueous phase carbon usage compared to alternatives where the Area 5106 Sediment is treated prior to dewatering.

Two alternatives were developed for the LTTD treatment process, depending upon the removal technology utilized.

1. Alternative C-3A - Mechanical Dredging

   Mechanically dredging of Area 5106 Sediment in open areas would be performed using either Cable Arm Dredge or a DRE Dry® Dredge. Area 5106 Sediment under the docks would only be accessible for removal with a diver-articulated hydraulic dredge which substantially reduces the removal rates.

2. Alternative C-3B - High Solids Removal

   Hydraulic high solids dredging of Area 5106 Sediment in open areas would be performed using either a Toyo Pump, a Pneuma Dredge, or an Eddy Pump. Area 5106 Sediment under the docks would only be accessible by a diver-articulated hydraulic dredge which substantially reduces removal rates.

6.1.3.4 ALTERNATIVE C4 - INCINERATION

The incineration alternative was developed utilizing mechanical dredging removal as depicted on Figure 6.13 (Alternative C-4A) and hydraulic high solids removal as depicted on Figure 6.14 (Alternative C-4B). Hydraulically dredged sediment would be dewatered prior to incineration. VOCs along with other organics in the Area 5106 Sediment would be combusted at temperatures up to 2,000 degree Fahrenheit (°F). Off-gases from the incineration would be quenched and processed through pollution control devices prior to atmospheric discharge. After incineration, residual ash would be disposed off Site.

The water extracted during the dewatering of the hydraulically dredged Area 5106 Sediment would be filtered and treated using activated carbon to achieve marine discharge criteria prior to discharge back to the Waterway. The dewatering of untreated Area 5106 Sediment required prior to incineration could potentially remove some of the VOCs and SVOCs and increase aqueous phase carbon usage compared to alternatives where the Area 5106 Sediment is treated prior to dewatering.

Two alternatives were developed for incineration, depending upon the removal technology utilized.

1. Alternative C-4A - Mechanical Dredge Removal

   Mechanical dredging of Area 5106 Sediment in open areas would be performed using either Cable Arm Dredge or a DRE Dry® Dredge. Area 5106 Sediment under the docks would only be accessible for removal with a diver-articulated hydraulic dredge which substantially reduces the removal rates.

2. Alternative C-4B - Hydraulic High Solids Removal

   Hydraulic high solids dredging of Area 5106 Sediment in open areas would be performed using either a Toyo Pump, a Pneuma Dredge, or an Eddy Pump. Area 5106 Sediment under the docks would only be accessible by a diver-articulated hydraulic dredge which substantially reduces removal rates.

6.1.3.5 ALTERNATIVE C5 - AQUA MECTOOL™ OXIDIZATION

The Aqua Mectool™ Oxidation alternative involves in situ treatment of Area 5106 Sediment in open areas (approximately 26,000 cubic yards) as depicted on Figure 6.15. Removal and disposal would not be required as described for Alternatives C1 through C4. The Aqua Mectool™ uses an 18-foot square caisson that would be driven through the Area 5106 Sediment into the native sediment. A rotary blade within the caisson would be used to mix sediments and add oxidizing agents such as hydrogen peroxide and ozone. A bladder in the caisson would be used to contain and collect emissions which would be treated using vapor phase carbon or thermal oxidation prior to discharge.

The Aqua Mectool™ is not readily adaptable for remediating the Area 5106 Sediment located under the docks. Two alternatives were developed for the Aqua Mectool™ Oxidation, depending upon the method of remediation utilized under the dock.

1. Alternative C-5A - Under Dock Dredging

   Area 5106 Sediment under the dock (approximately 9,200 cubic yards) would be hydraulically removed and treated utilizing Alternatives C1, C2, or C3.

2. Alternative C-5B - Under Dock Capping

   Area 5106 Sediment under the dock would be capped utilizing the cap construction described in Alternative B1. Sheet piling would be installed at the face of the dock to support the cap and allow future dredging along the face of the dock. Institutional controls would be implemented for the capped area.

6.1.4 ALTERNATIVE D - SEDIMENT REMOVAL/ TREATMENT/ DISPOSAL WITH CONTAINMENT UNDER DOCKS

Alternative D represents a combination of Alternatives B and C. The portion of Area 5106 Sediment situated under the docks from 0-foot MLLW to the face of the dock would be capped in place as described in Section 6.1.2 and Area 5106 Sediment from the face of docks into the Waterway would be removed/treated/disposed utilizing Alternatives C1 or C3. Cross-sections (stations 29 and 35) illustrating this alternative are depicted on Figures 6.16 and 6.17, respectively.

Alternative D was developed due to potential difficulties in the removal of Area 5106 Sediment under the dock. As with Alternative C removal technologies, sediment removal under the docks is potentially limited to a diver-articulated hydraulic dredge. Sheetpiling would be installed to support the cap at the face of dock during the removal of Area 5106 Sediment and during any future further dredging of native sediment to increase the available draft for ship access at the dock(s).

6.1.5 ALTERNATIVE E - COMBINED EMBANKMENT AND AREA 5106 SEDIMENT CONTAINMENT

The embankment (above 0-foot MLLW) is not included in Area 5106 Sediment, however, it is contiguous with Area 5106 Sediment. Remedial action for the embankment may include a cap/cover which could be installed over the embankment only (Figure 6.18) or combined with an Area 5106 Sediment cap. Alternative E represents a combined armored sand cap which includes Area 5106 Sediment and the embankment as depicted on Figure 6.19.

The combined cap is shown at a 3 to 1 H:V slope with a nominal thickness of 2 feet. To maintain the stability of the sand cap, the cover would be thicker in some locations. The loss of available draft at the face of dock would potentially be as much as 6 feet.

6.2 ALTERNATIVE ASSESSMENT

An assessment of the preliminary alternatives was performed to identify those alternatives with the highest potential for satisfying the remedial action objectives. These preferred alternatives identify the technologies which should be considered for further evaluation.

The assessment criteria included the following:

i) Effectiveness:

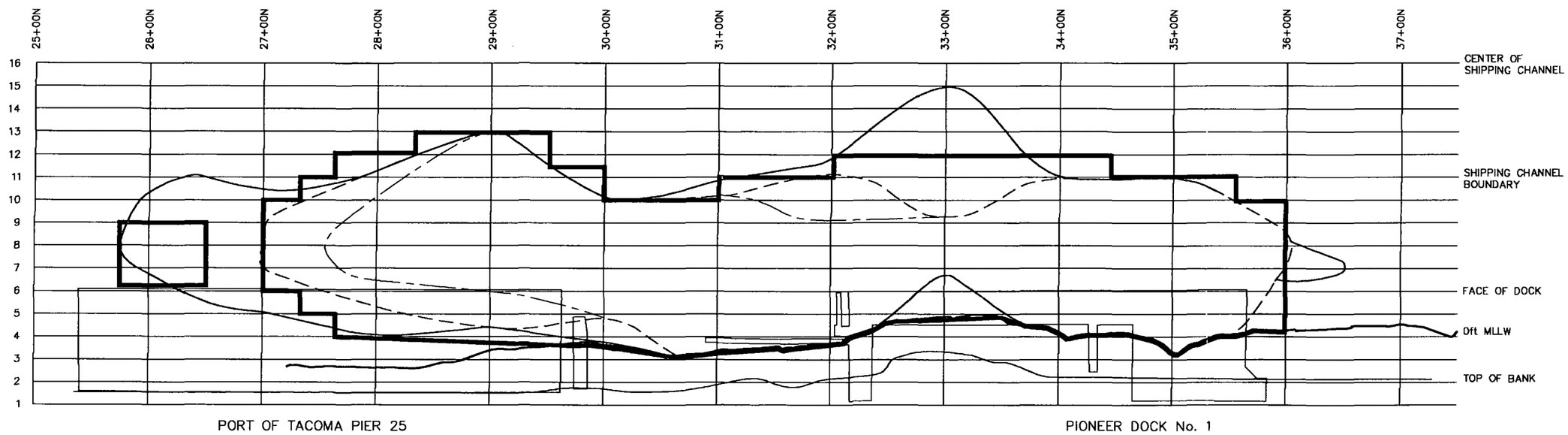
- Short-Term (Environmental and Human Health), and
- Long-Term (Remedial Objectives).

ii) Implementability:

- size and configuration of equipment, containment structures, and on-Site disposal,
- time frame to achieve remedial goals,
- material staging and handling requirements,
- disposal requirements including distances, transportation methods, and sediment characteristics; and

iii) Relative Costs.

A summary of the Alternatives assessment is presented in Table 6.1.



LEGEND

POTENTIAL HORIZONTAL BOUNDARIES

——— VISUAL HORIZONTAL BOUNDARY OF 5106 LIKE MATERIAL
(BASED ON LIMIT OF VISUAL 5106 LIKE MATERIAL)
(ESTIMATED VOLUME = 32,900yd^3, ESTIMATED AREA = 144,000ft^2)

– – – – OUTER HORIZONTAL BOUNDARY OF AREA 5106 SEDIMENT
(BASED ON POREWATER SCREENING OF HCBD)
(ESTIMATED VOLUME = 25,000yd^3, ESTIMATED AREA = 109,800ft^2)

— – — INNER HORIZONTAL BOUNDARY OF AREA 5106 SEDIMENT
(BASED ON POREWATER SCREENING OF TCE, PCE, EB)
(ESTIMATED VOLUME = 21,500yd^3, ESTIMATED AREA = 93,600ft^2)

▬▬▬ EXTENT OF REMEDIATION BASED ON OUTER HORIZONTAL BOUNDARY
(ESTIMATED AREA = 138,800ft^2)

figure 6.1

ALTERNATIVE B – CAP OF AREA 5106 SEDIMENT
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

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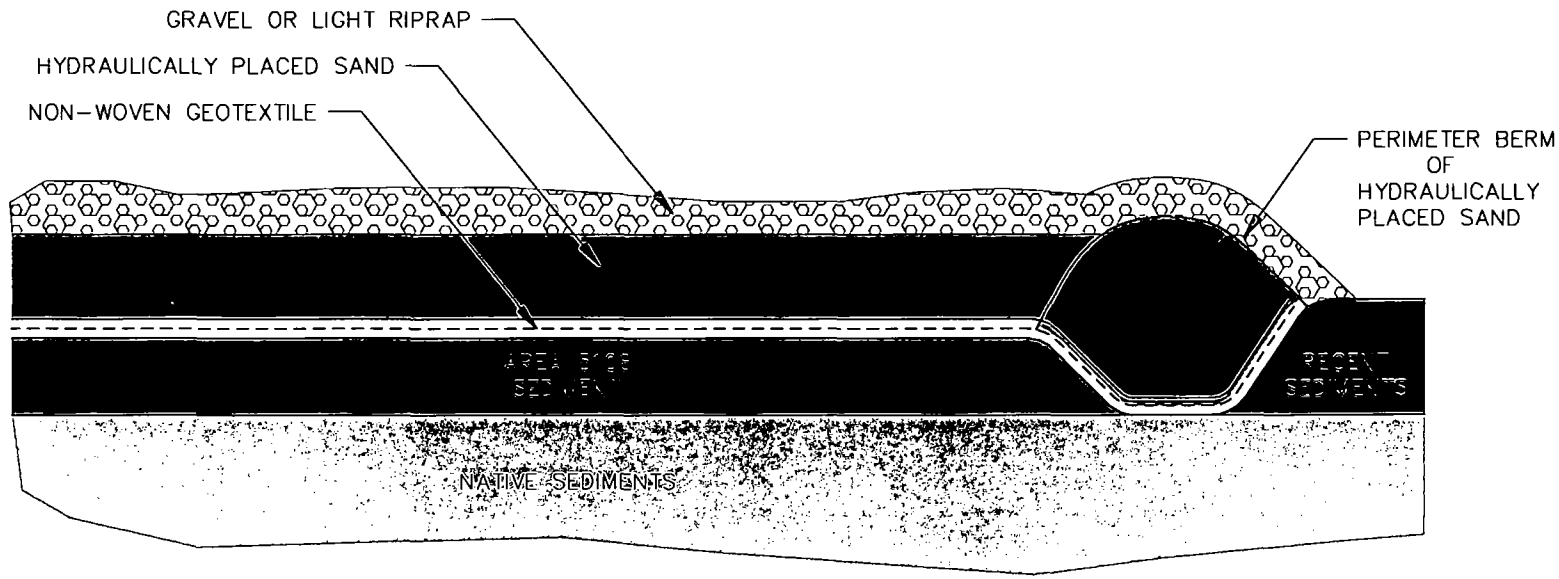

figure 6.2

ALTERNATIVE B1 – ARMORED SAND CAP
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

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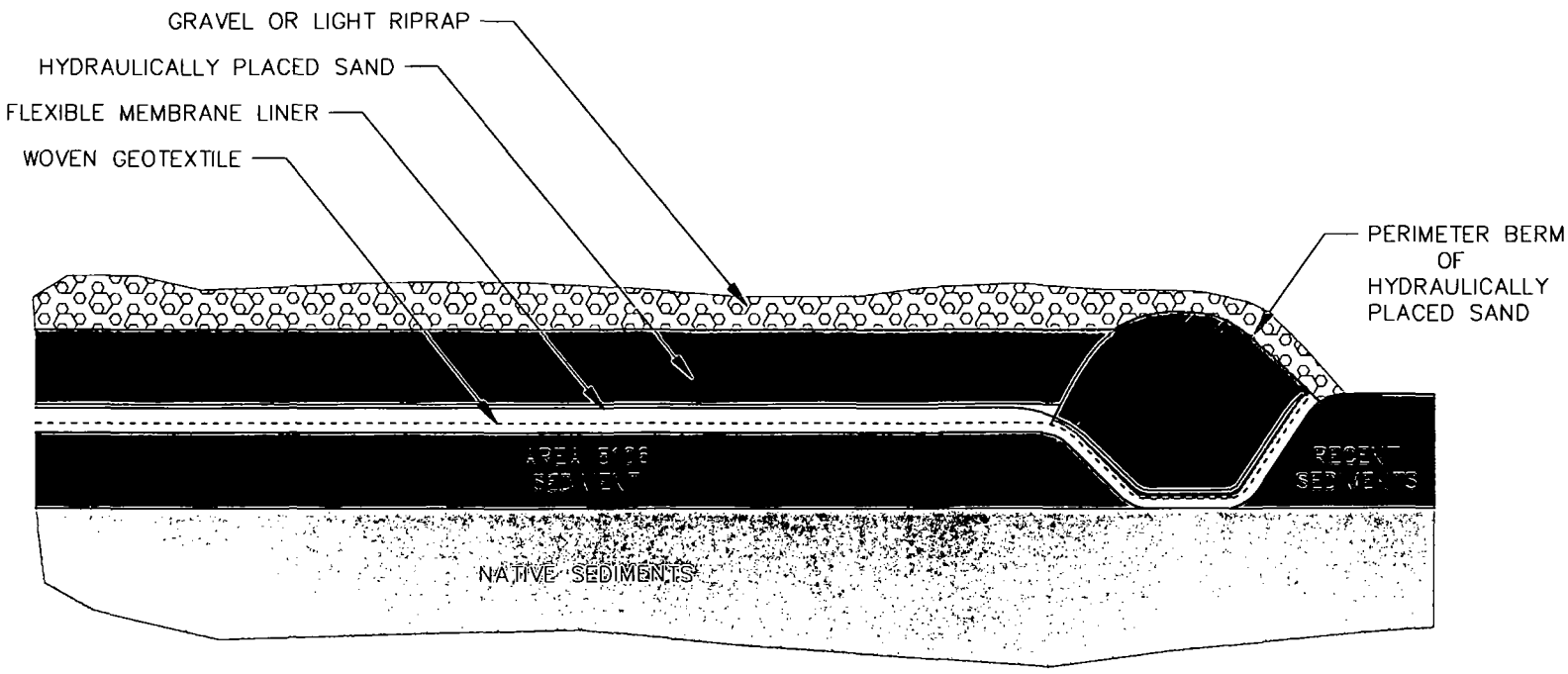

figure 6.3

ALTERNATIVE B2 – ARMORED SAND CAP OVER FLEXIBLE MEMBRANE LINER
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

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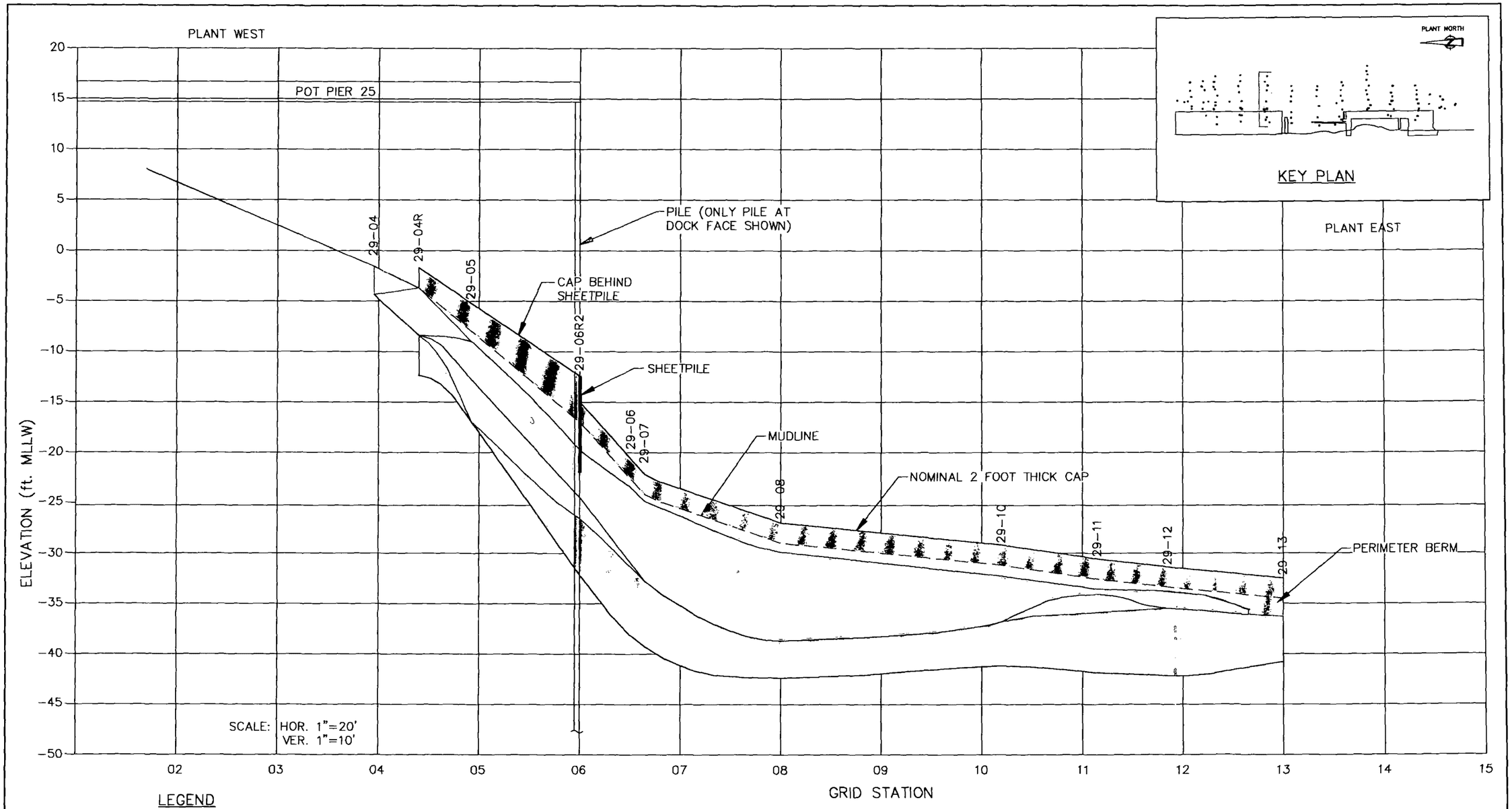

LEGEND

- RECENT SEDIMENT OR FILL
- VISUAL 5106 LIKE MATERIAL
- NATIVE SEDIMENT
- CAP

MLLW MEAN LOWER LOW WATER ELEVATION

NOTE:

MUDLINE ELEVATION BASED ON THOSE MEASURED DURING SAMPLING

figure 6.4

ALTERNATIVE B – CAP AREA 5016 SEDIMENT – SECTION 29
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

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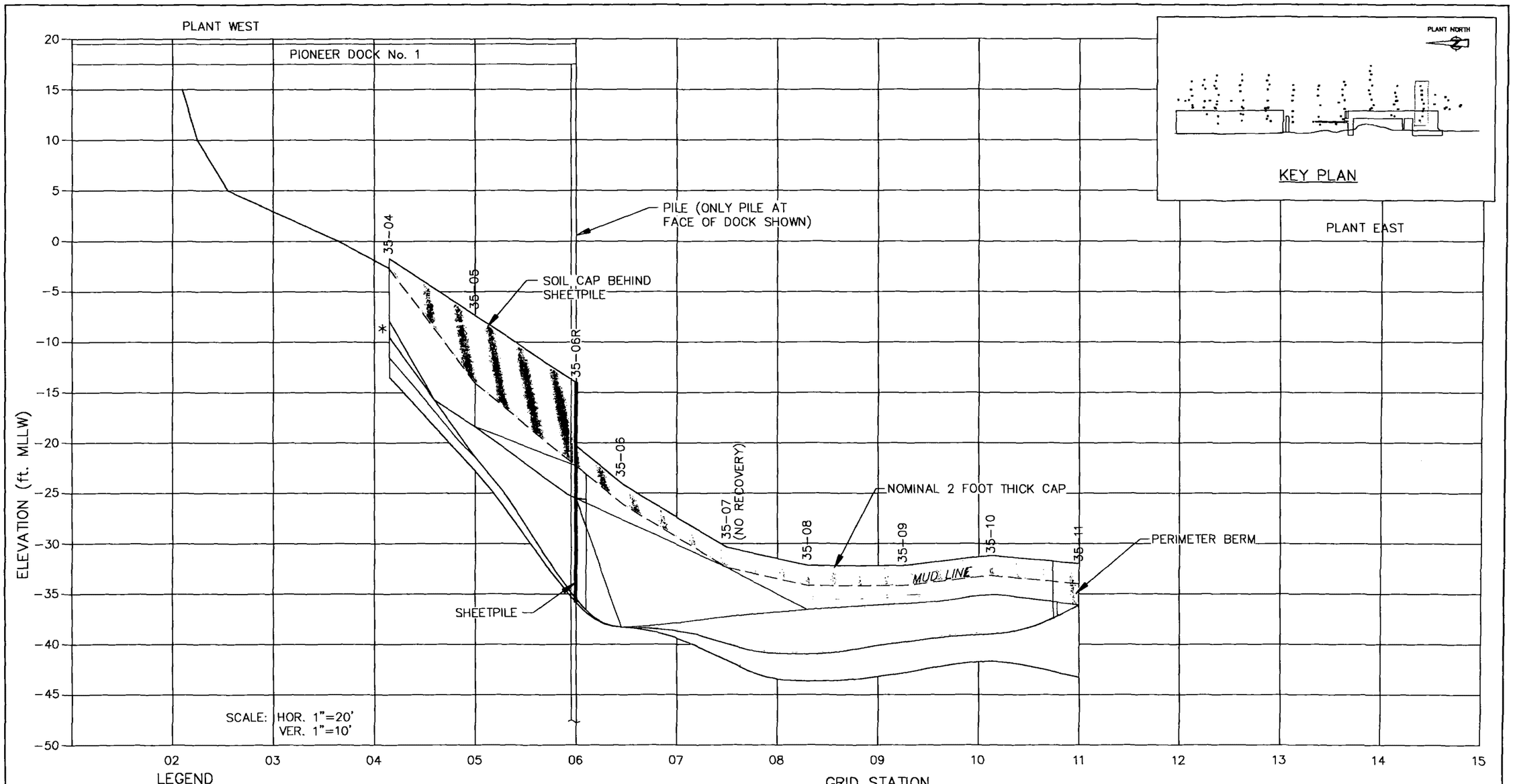

LEGEND

- RECENT SEDIMENT OR FILL
- VISUAL 5106 LIKE MATERIAL
- NATIVE SEDIMENT
- CAP

MLLW MEAN LOWER LOW WATER ELEVATION

* NO FURTHER BOUNDARY ESTIMATION SAMPLE OBTAINABLE

NOTE:

MUDLINE ELEVATION BASED ON THOSE MEASURED DURING SAMPLING

figure 6.5

ALTERNATIVE B – CAP AREA 5106 SEDIMENT – SECTION 35
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

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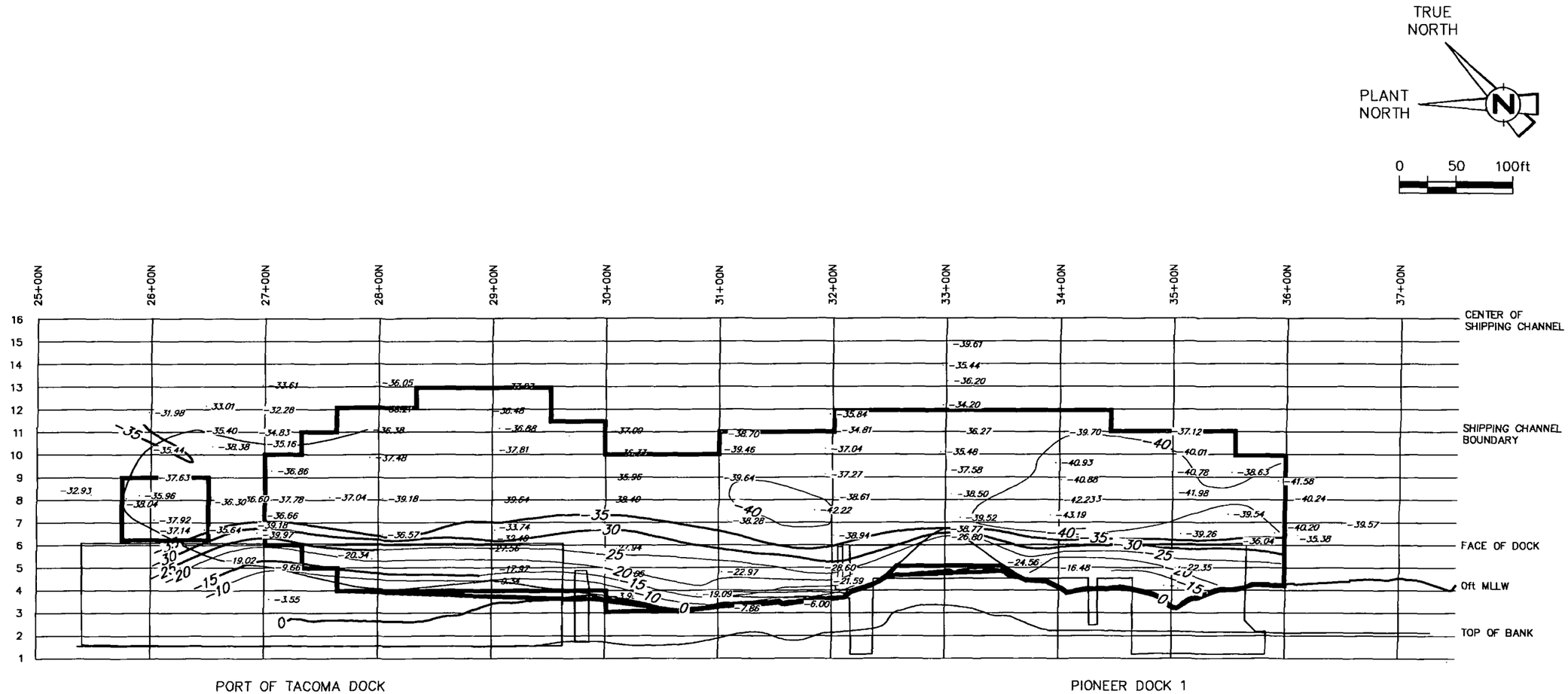

NOTE: CONTOURS BASED ON ELEVATIONS MEASURED AT BOREHOLES SAMPLED FEBRUARY TO MAY 1998

LEGEND

EXTENT OF REMOVAL BASED ON OUTER HORIZONTAL BOUNDARY (ESTIMATED VOLUME = 35,200yd^3, ESTIMATED AREA = 138,800ft^2)

-10 CONTOUR FOLLOWING COMPLETE REMOVAL (FEET MLLW)

figure 6.6

ALTERNATIVE C – REMOVE AREA 5106 SEDIMENT
BATHYMETRY FOLLOWING COMPLETE REMOVAL OF AREA 5106 SEDIMENT
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

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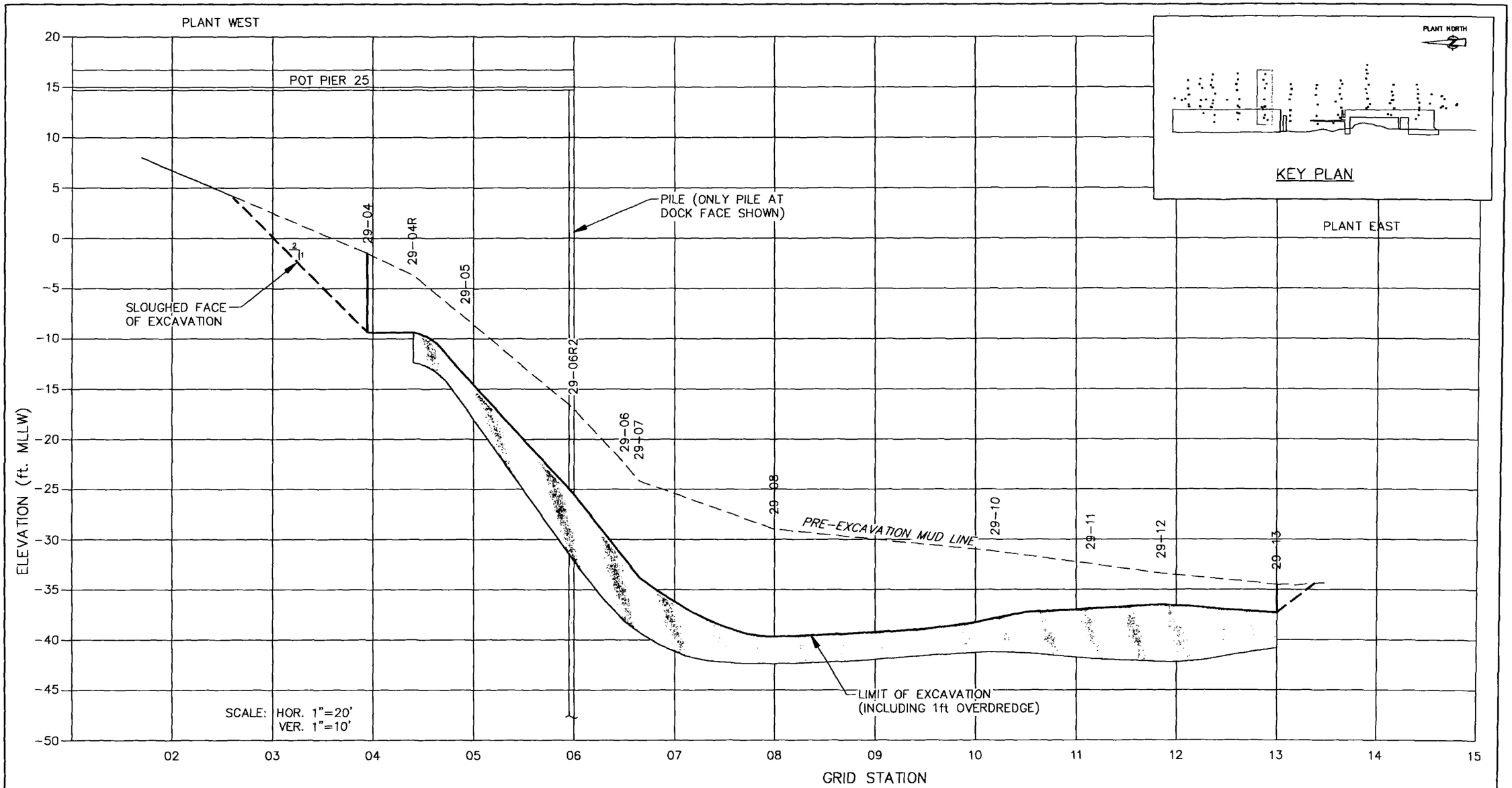

LEGEND

NATIVE SEDIMENT

MLLW MEAN LOWER LOW WATER ELEVATION

NOTE:

MUDLINE ELEVATION BASED ON THOSE MEASURED DURING SAMPLING

figure 6.7

ALTERNATIVE C – REMOVE AREA 5106 SEDIMENT – SECTION 29
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
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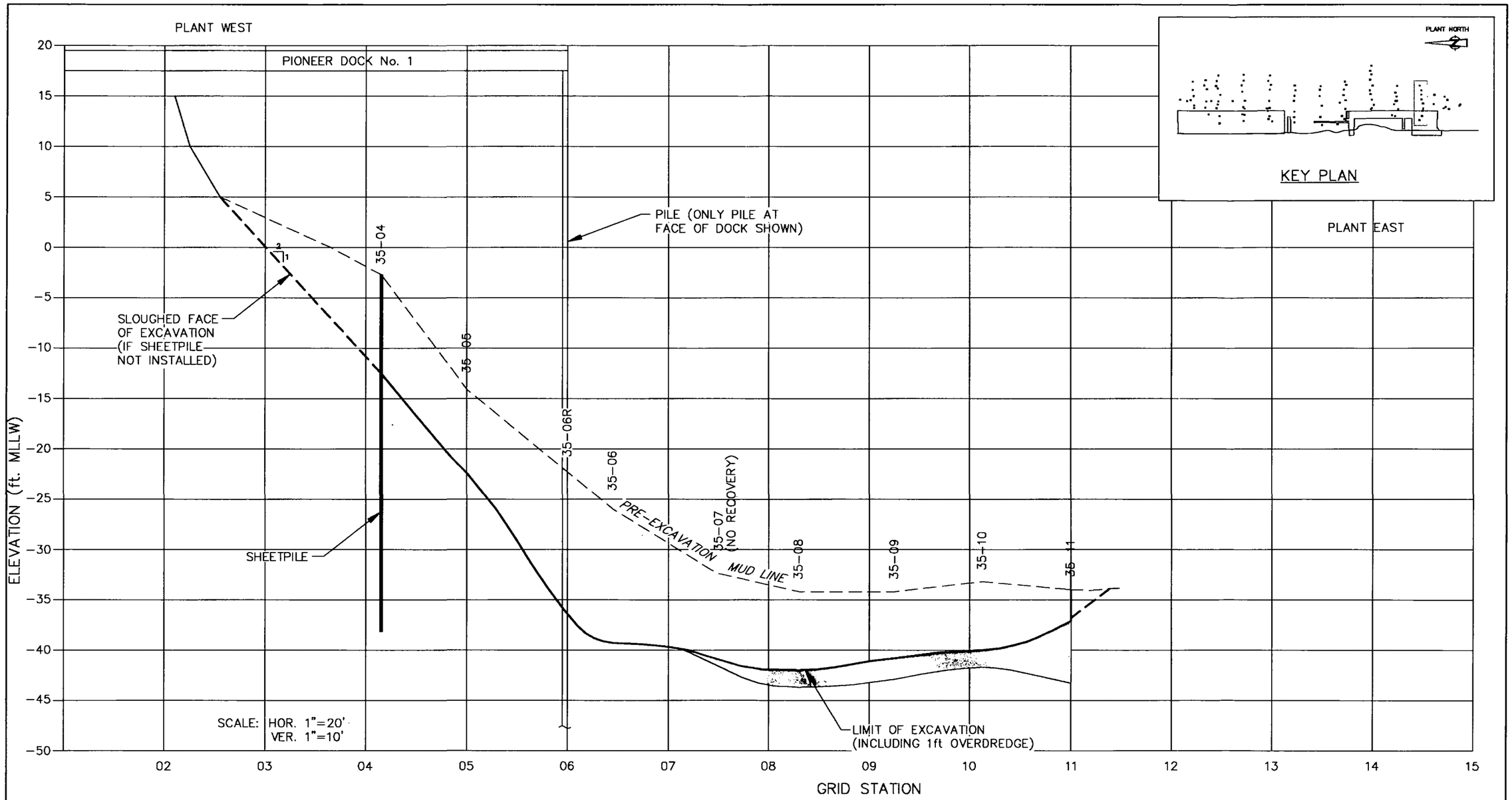

LEGEND

NATIVE SEDIMENT

MLLW MEAN LOWER LOW WATER ELEVATION

NOTE:

MUDLINE ELEVATION BASED ON THOSE MEASURED DURING SAMPLING

figure 6.8

ALTERNATIVE C – REMOVE AREA 5106 SEDIMENT – SECTION 35
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
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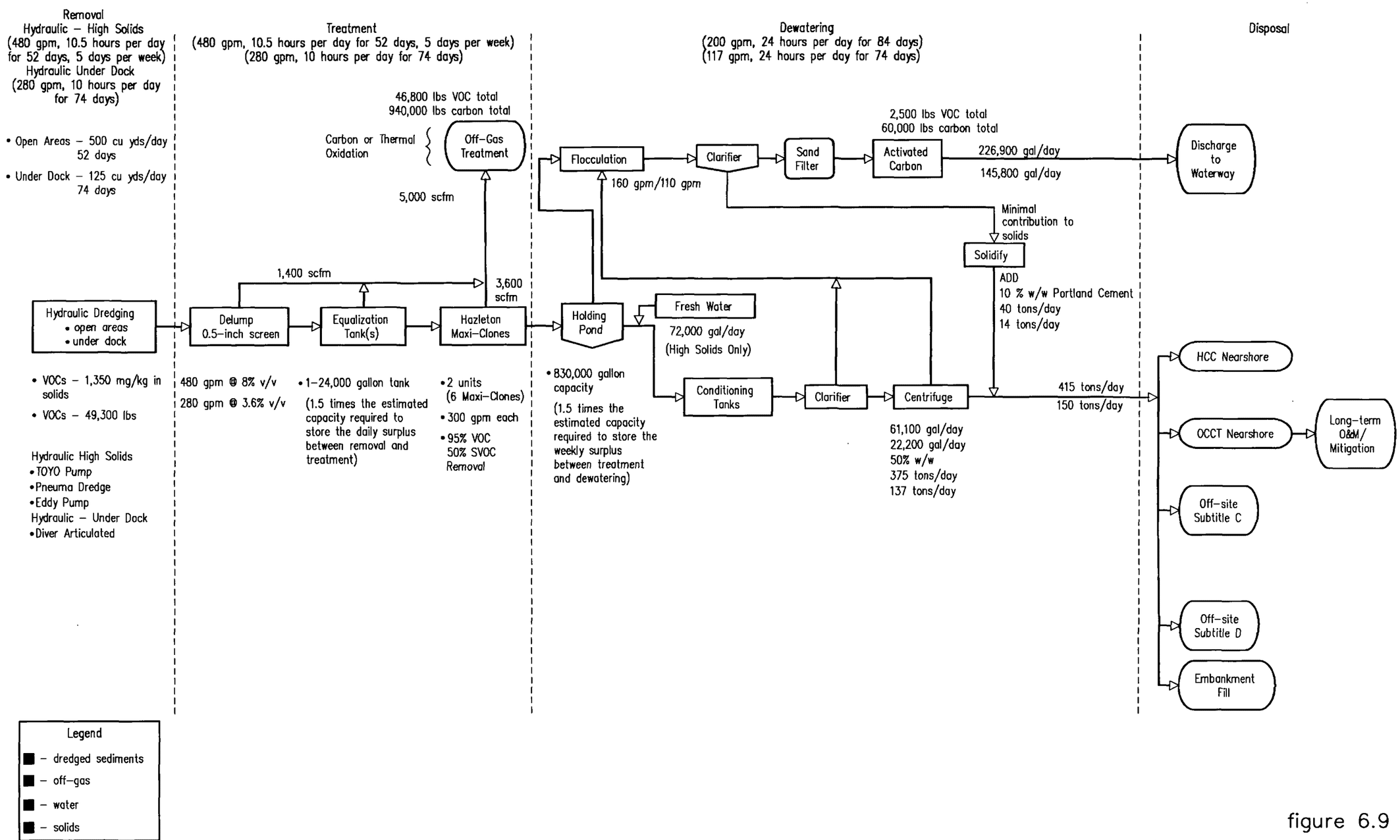

figure 6.9

ALTERNATIVE C1 – SEDIMENT REMOVAL/TREATMENT/DISPOSAL
HAZLETON MAXI-CLONE/MAXI-STRIP
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

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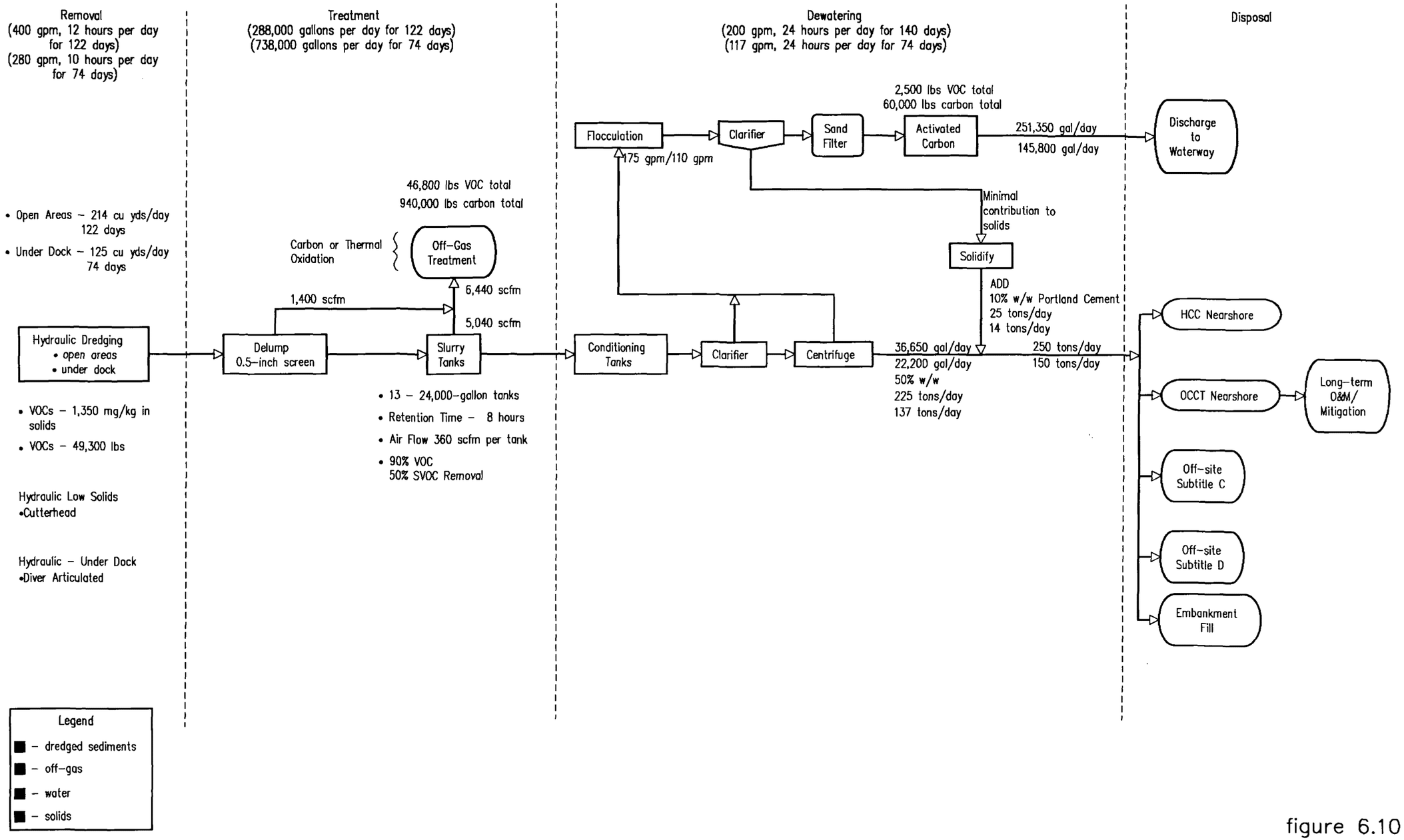

figure 6.10

ALTERNATIVE C2 – SEDIMENT REMOVAL/TREATMENT/DISPOSAL
SLURRY AERATION/OXIDATION
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

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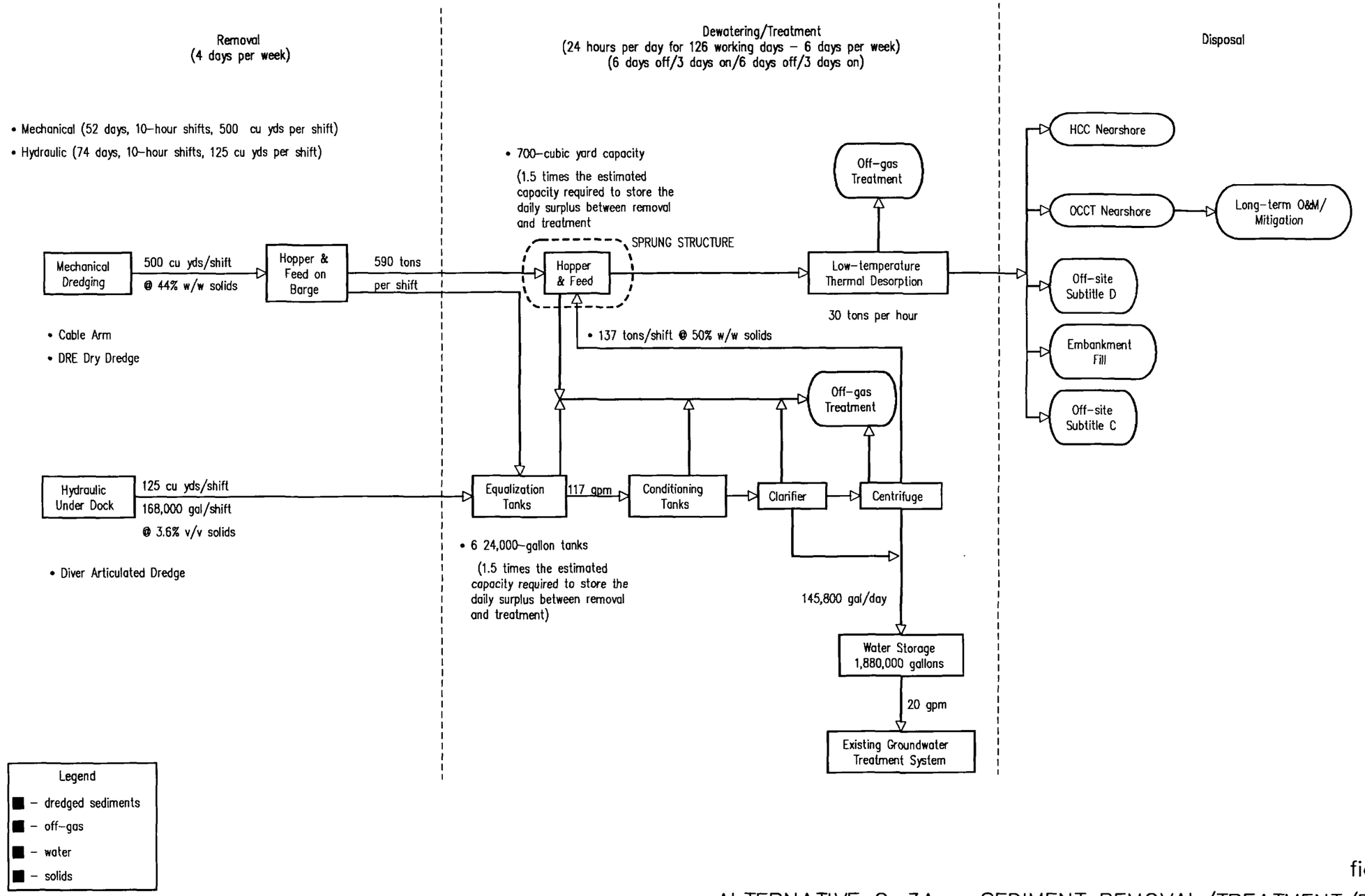

figure 6.11

ALTERNATIVE C–3A – SEDIMENT REMOVAL/TREATMENT/DISPOSAL
LOW TEMPERATURE THERMAL DESORPTION: MECHANICAL DREDGING
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

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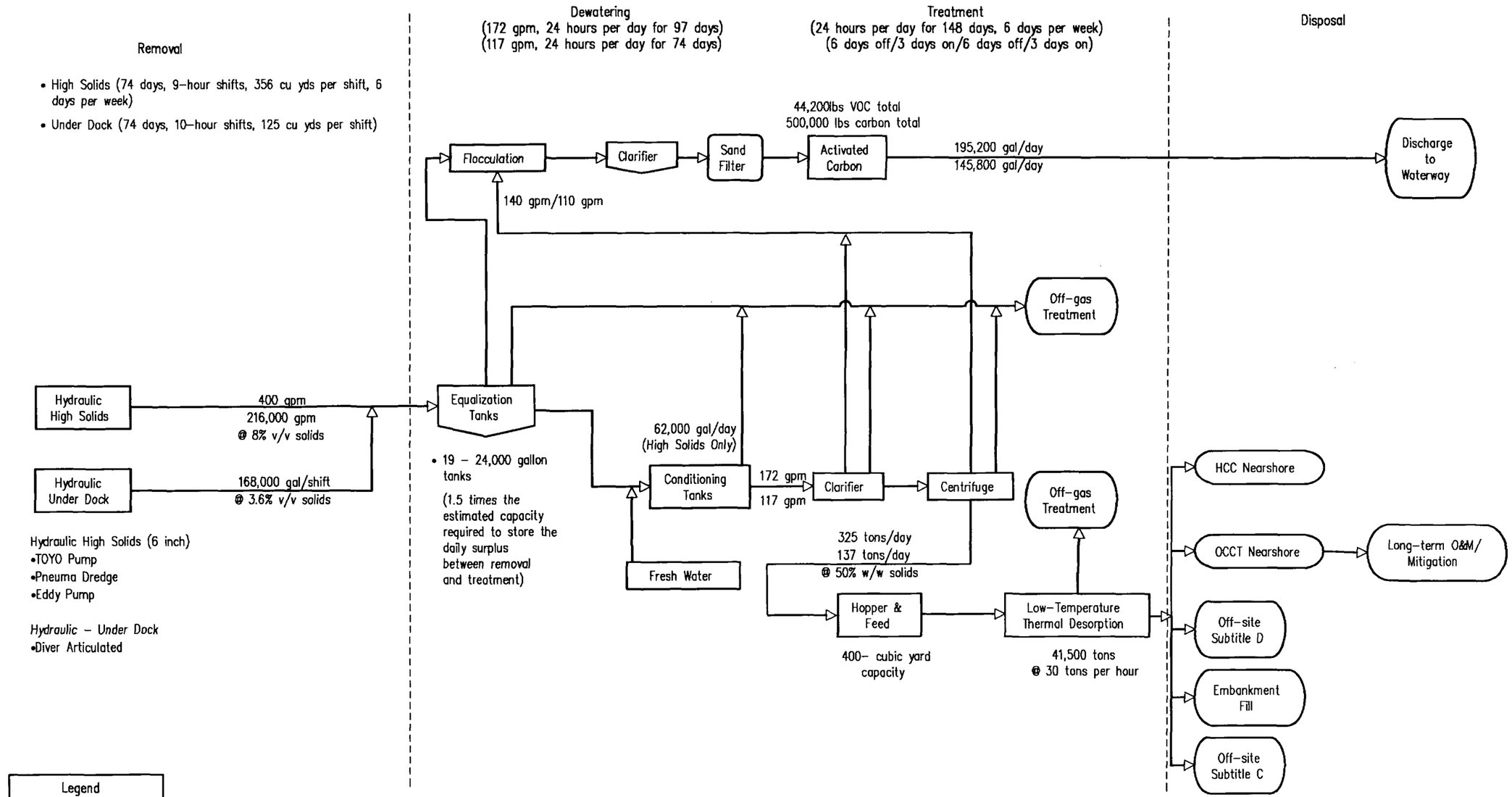

figure 6.12

ALTERNATIVE C-3B – SEDIMENT REMOVAL/TREATMENT/DISPOSAL
LOW-TEMPERATURE THERMAL DESORPTION: HYDRAULIC HIGH SOLIDS
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(008)GN-NF020 JUL 26/1999

19.3.4.6.2
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12

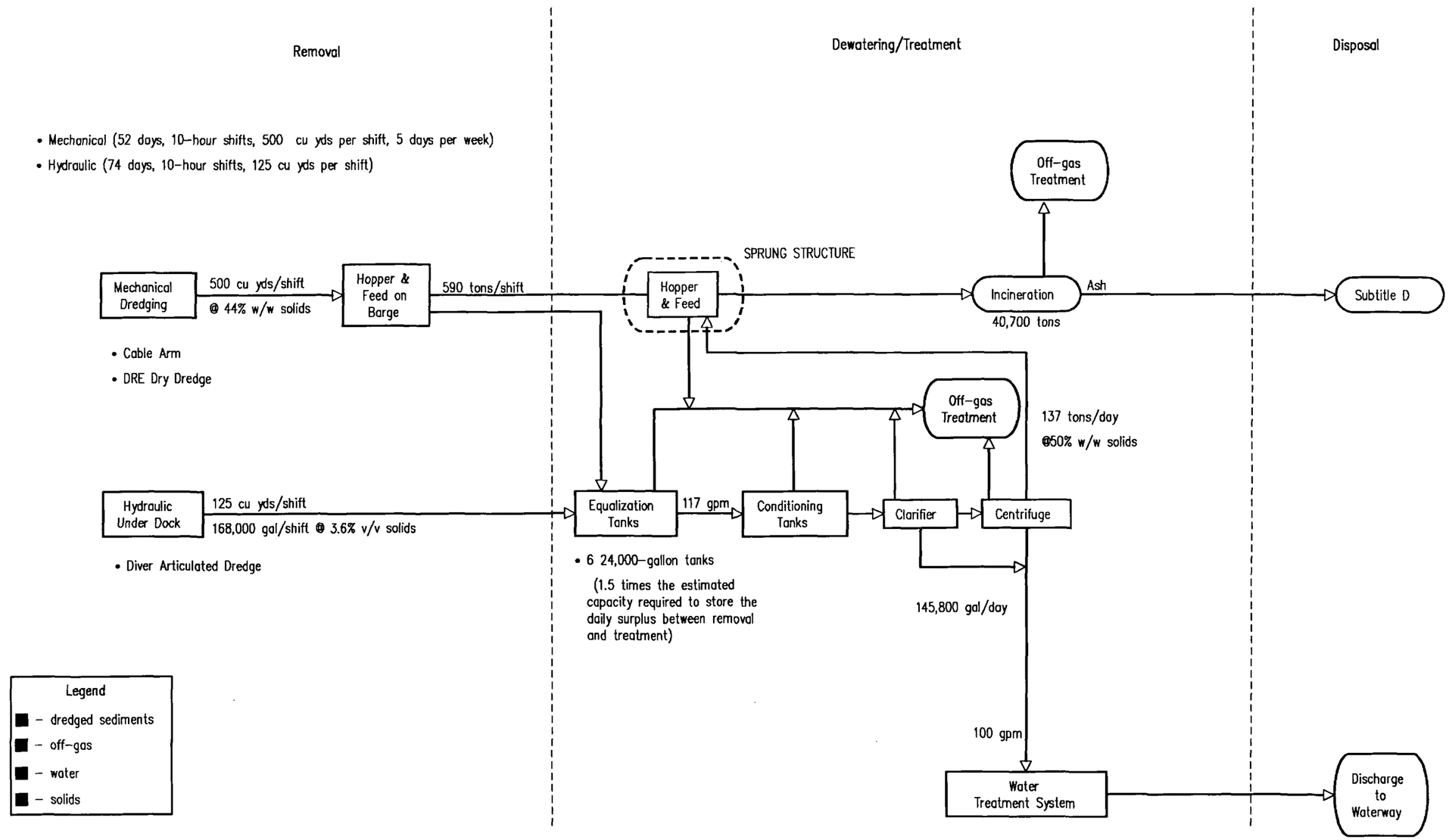

figure 6.13

ALTERNATIVE C-4A – SEDIMENT REMOVAL/TREATMENT/DISPOSAL
INCINERATION: MECHANICAL DREDGING
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(008)GN-NF021 JUL 22/1999

19.3.4.6.2
137633

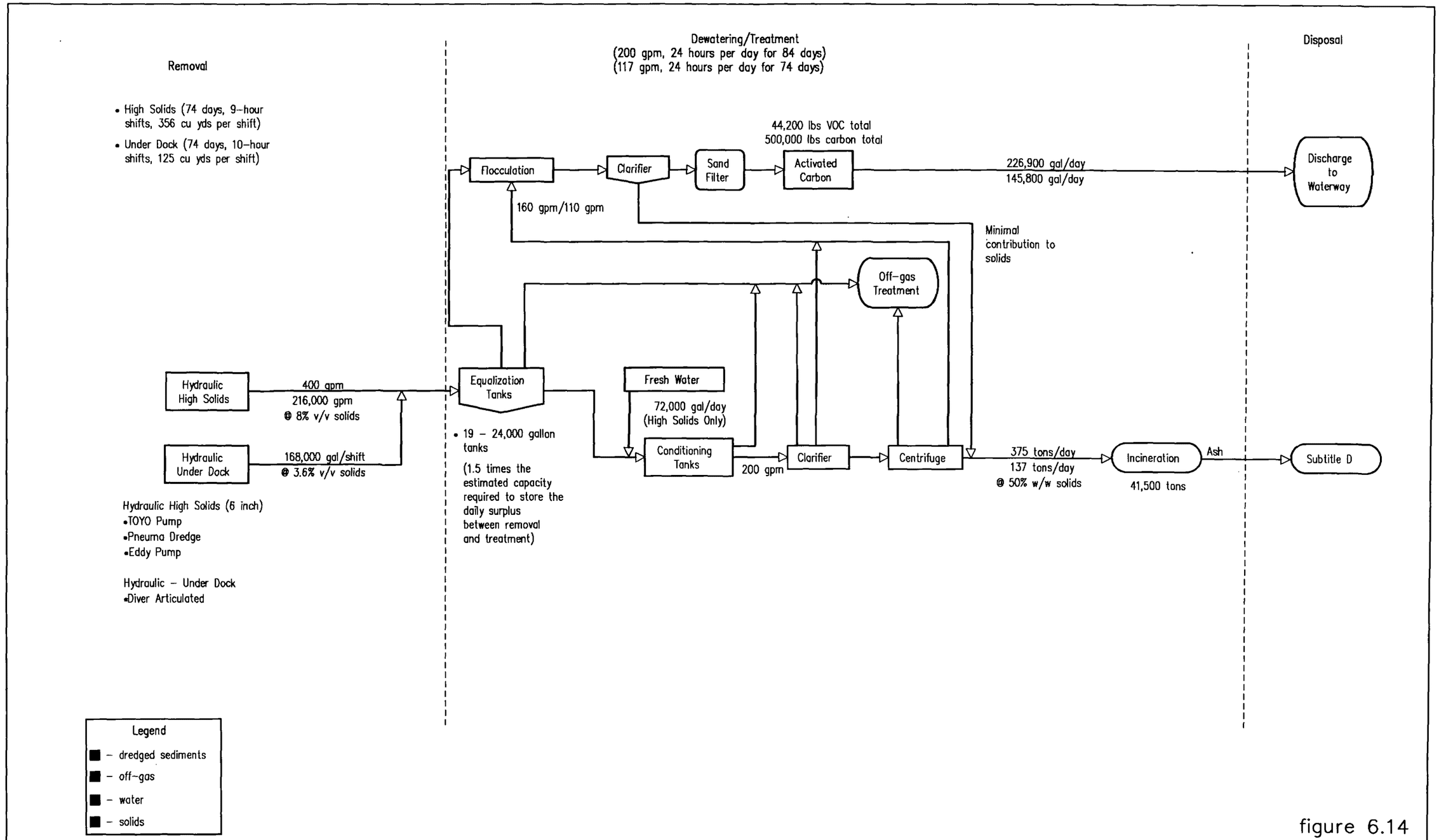

figure 6.14

ALTERNATIVE C-4B – SEDIMENT REMOVAL/TREATMENT/DISPOSAL
INCINERATION: HYDRAULIC HIGH SOLIDS
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

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07431-65(008)GN-NF022 JUL 22/1999

19.3.4.6.2
137633

14

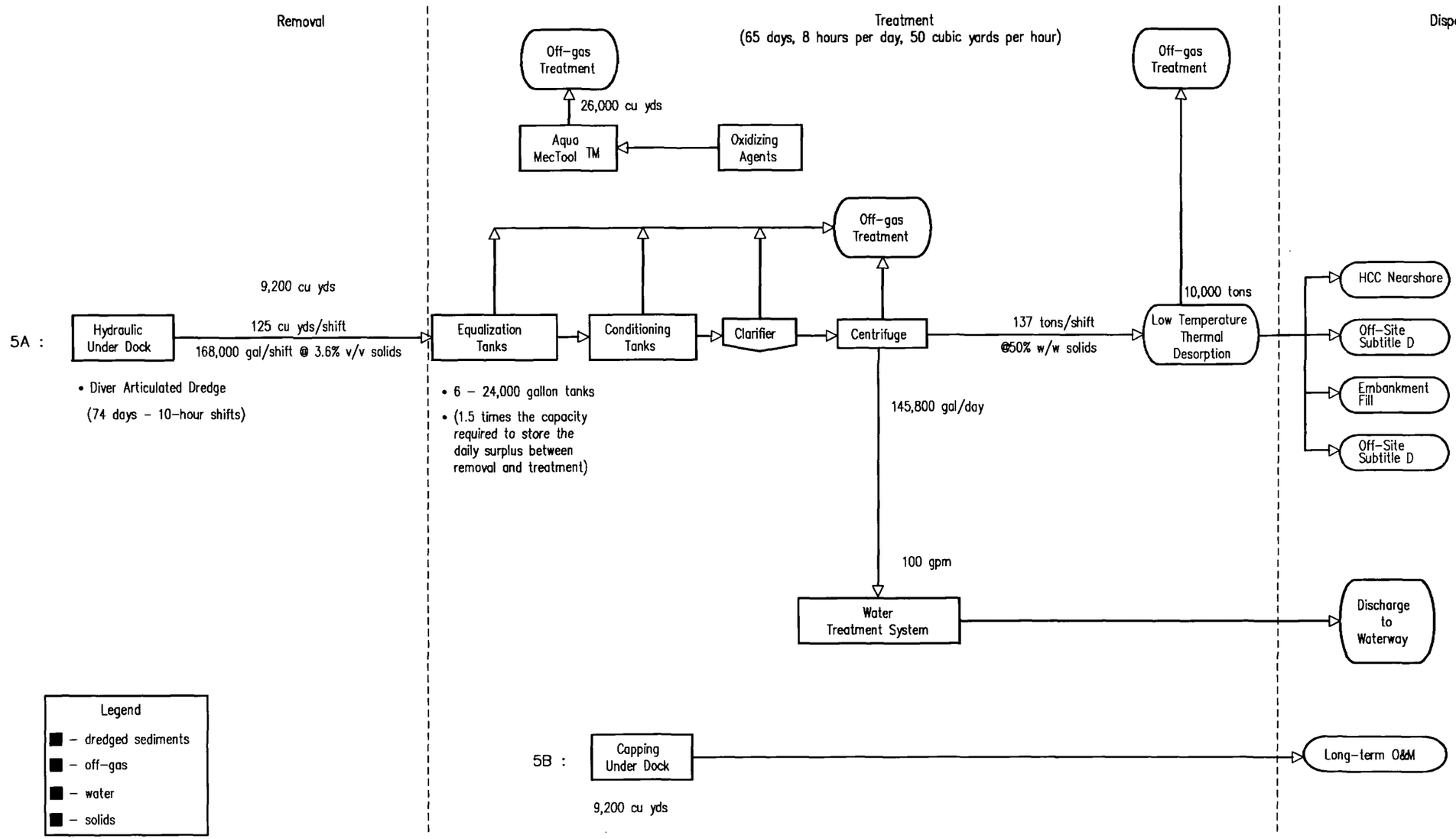


figure 6.15

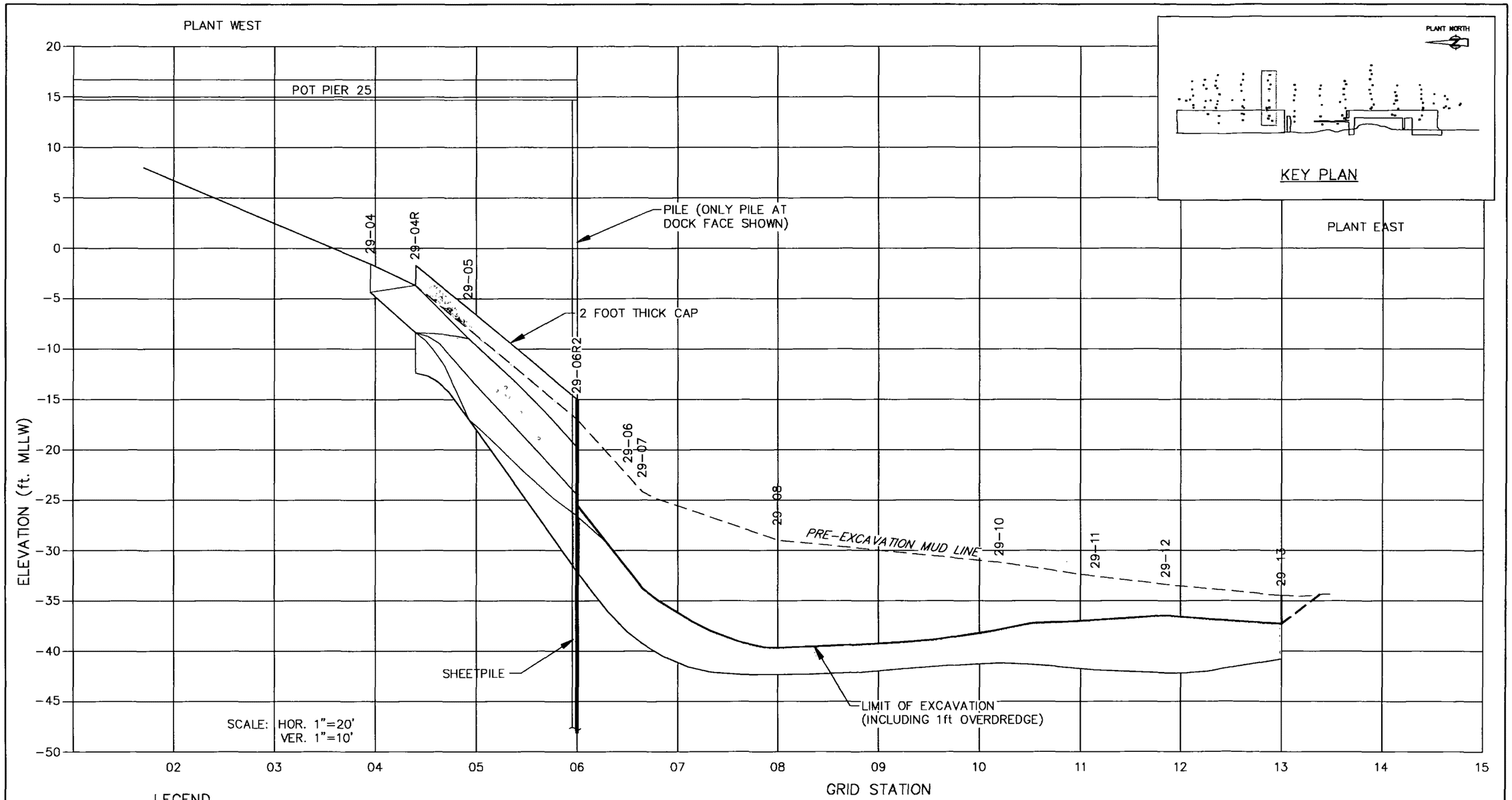
ALTERNATIVE C5A/5B – SEDIMENT REMOVAL/TREATMENT/DISPOSAL
INSITU AQUA MECTOOL™ OXIDATION WITH UNDER DOCK TREATMENT/CAPPING
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(008)GN-NF023 JUL 22/1999

19.3.4.6.2
137633

15



LEGEND

- RECENT SEDIMENT OR FILL
- VISUAL 5106 LIKE MATERIAL
- NATIVE SEDIMENT
- CAP

MLLW MEAN LOWER LOW WATER ELEVATION

NOTE:

MUDLINE ELEVATION BASED ON THOSE MEASURED DURING SAMPLING

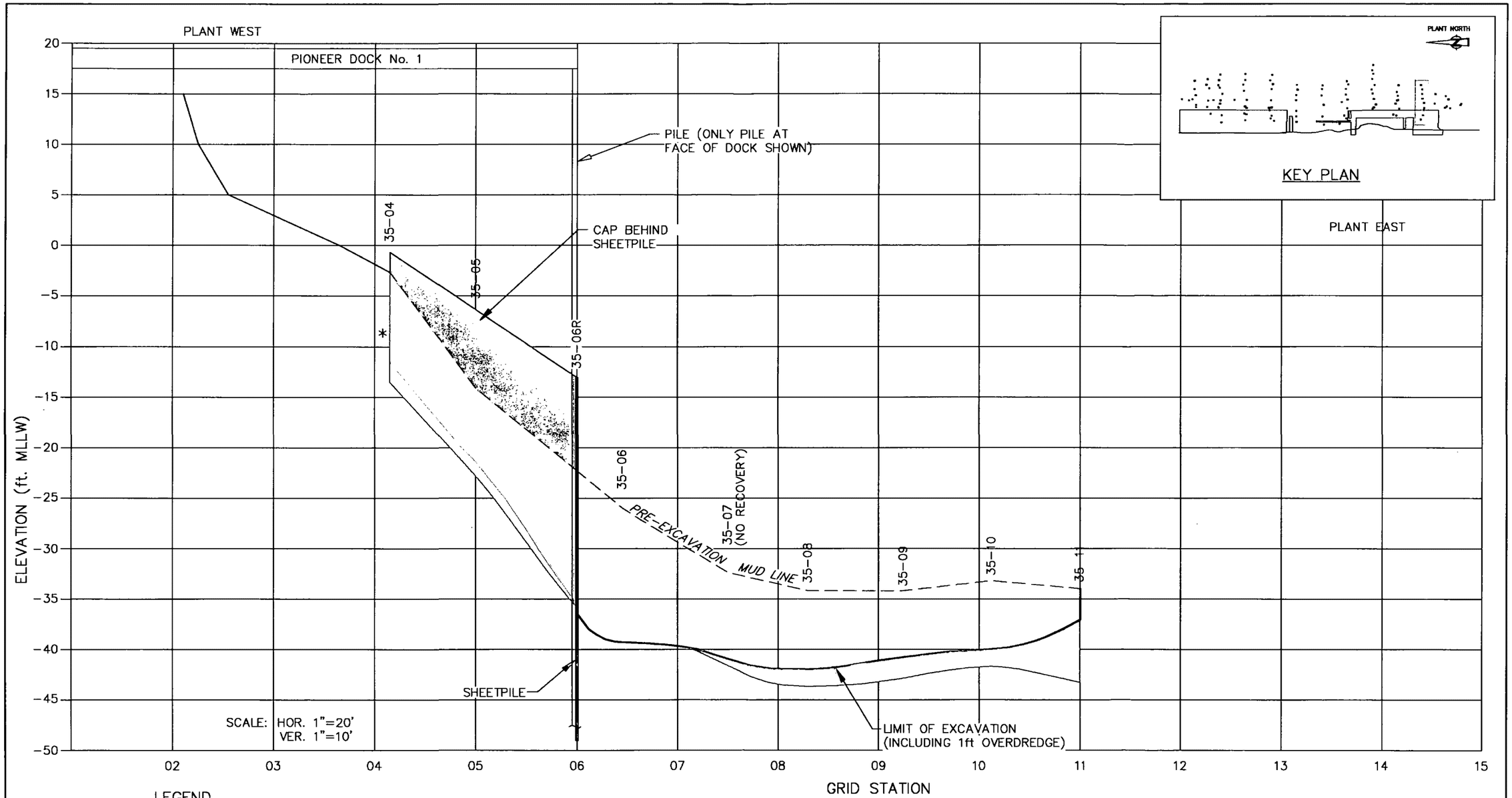
figure 6.16

ALTERNATIVE D – SEDIMENT REMOVAL/TREATMENT/DISPOSAL WITH CONTAINMENT UNDER THE DOCKS – SECTION 29
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(008)GN-NF024 JUL 26/1999

19.3.4.6.2
137633



LEGEND

- RECENT SEDIMENT OR FILL
- VISUAL 5106 LIKE MATERIAL
- NATIVE SEDIMENT
- CAP

MLLW MEAN LOWER LOW WATER ELEVATION

NOTE:

MUDLINE ELEVATION BASED ON THOSE MEASURED DURING SAMPLING

figure 6.17

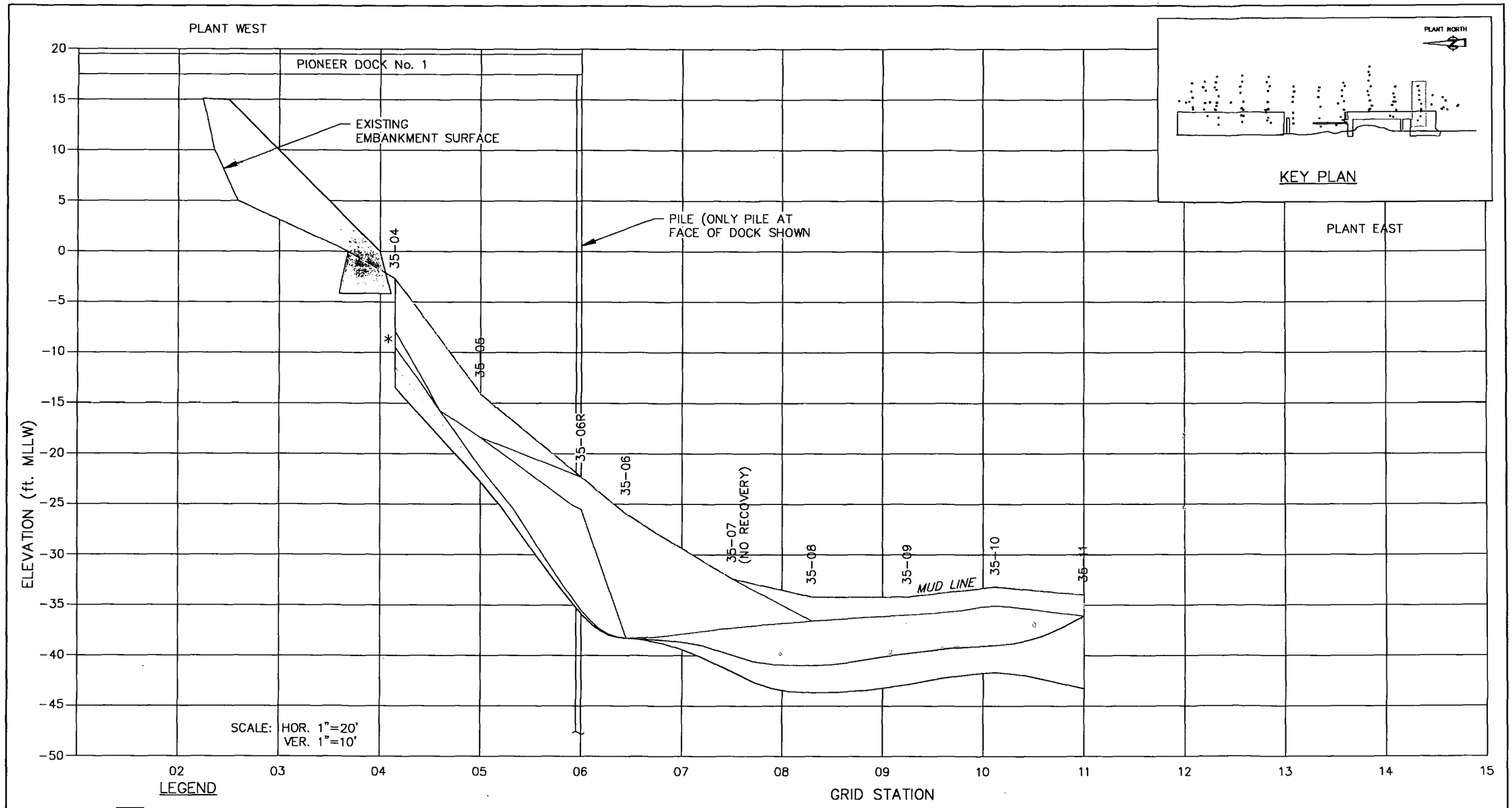
ALTERNATIVE D – SEDIMENT REMOVAL/TREATMENT/DISPOSAL WITH CONTAINMENT UNDER THE DOCKS – SECTION 35
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(008)GN-NF025 JUL 26/1999

19.3.4.6.2
137633

17



LEGEND

- RECENT SEDIMENT OR FILL
- VISUAL 5106 LIKE MATERIAL
- NATIVE SEDIMENT
- CAP

MLLW MEAN LOWER LOW WATER ELEVATION

NOTE:

MUDLINE ELEVATION BASED ON THOSE MEASURED DURING SAMPLING

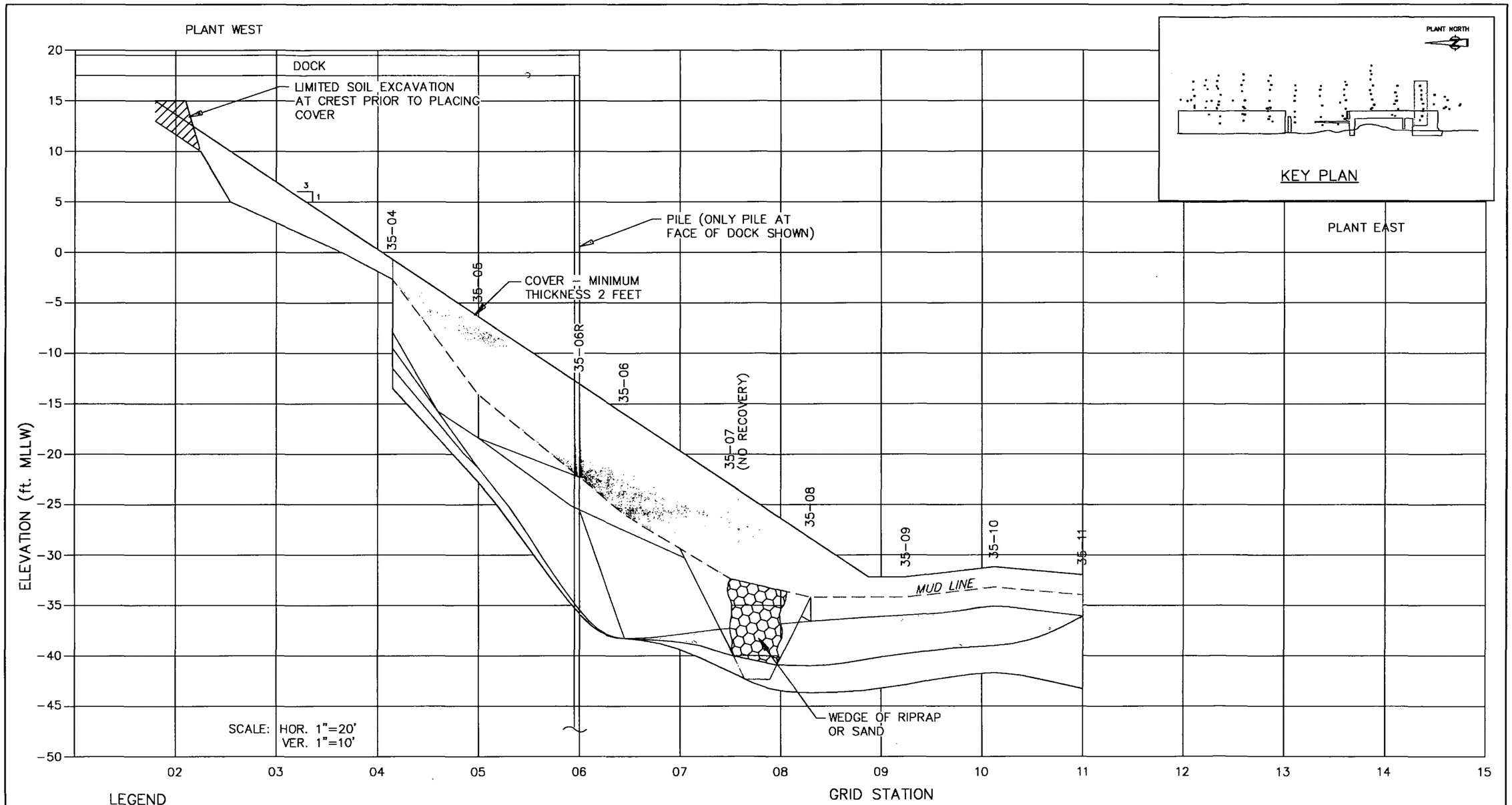
figure 6.18

EMBANKMENT COVER – SECTION 35
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(008)GN-NF026 JUL 22/1999

19.3.4.6.2
137633



LEGEND

- RECENT SEDIMENT OR FILL
- VISUAL 5106 LIKE MATERIAL
- NATIVE SEDIMENT
- CAP

MLLW MEAN LOWER LOW WATER ELEVATION

NOTE:

MUDLINE ELEVATION BASED ON THOSE MEASURED DURING SAMPLING

figure 6.19

ALTERNATIVE E – COMBINED EMBANKMENT AND AREA 5106 SEDIMENT CONTAINMENT – SECTION 35
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

CRA

07431-65(008)GN-NF027 JUL 26/1999

19.3.4.6.2
137633

TABLE 6.1

ASSESSMENT OF REMOVAL ACTION ALTERNATIVES
AREA 5106 SEDIMENT
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION REPORT
OCC TACOMA, INC.
TACOMA, WASHINGTON

			Effectiveness		*Implementability*			*Relative Costs*	
			Protectiveness		*Regulatory*				
Alternative		*Comments*	*Short Term*	*Long Term*	*Acceptance*	*Constructability*	*Schedule*	*Capital*	*O & M*
A	Natural Recovery	Preliminary modeling indicates that net sedimentation will likely be sufficient to achieve SQOs within a 10-year time frame. Some armoring may be required to stabilize sediments.	Moderate.	High.	High. Natural recovery has been accepted at other locations in Puget Sound.	High. Uses standard techniques and equipment		Very Low	Low
B1	Armored Sand Cap	Satisfies SQOs and is cost effective.	High.	High.	High. Capping has been accepted in other locations in Puget Sound.	High. Uses standard techniques and equipment.	3 months	Low	Low
B2	Armored Sand Cap Over Flexible Membrane Liner	Satisfies SQOs but liner would be difficult to install in open areas and very difficult under the dock.	High.	High.	High.	Difficult. Under dock.	6 months	Low	Low
C1	Hazelton Maxi-Clone/Maxi-Strip (High Solids/Low Solids)	Initial pilot testing was promising. Equipment compatible for low or high solids removal although limited to 10 percent solids by volume. Low solids removal may be more favorable for performance of Hazelton system and also to minimize space requirements. Target disposal would be HCC Nearshore CDF with Hylebos Sediment.	Low. Additional pilot testing required. Potential impact to Waterway during dredging. Air emissions require control.	High.	Unknown.	High with standard equipment.	6 to 12 months	Moderate	N/A
C2	Slurry Aeration/Oxidation (High Solids/Low Solids)	Initial bench testing was not promising for SVOC removal. Equipment space requirement may exceed the space available on the Former PRI property. Low solids removal may be more favorable for performance of Aeration system and also to minimize space requirements. Air emission control system would be extensive. Target disposal would be LPF with Hylebos. Target disposal would be NCC Nearshore CDF with Hylebos Sediment.	Low. Potential impact to Waterway during dredging. Air emissions require control.	High.	Unknown.	Moderate. Extensive piping and ducts for batch tanks.	6 to 12 months	Moderate	N/A
C3	Low Temperature Thermal Desorption (Mechanical/High Solids)	Effective for VOCs/SVOCs but expensive compared to capping and slurry treatment alternative. Handling of untreated sediments required prior to treatment. Air emissions would be contained. Mechanical removal would be favored to reduce dewatering. Target disposal would be HCC Nearshore CDF with Hylebos Sediment.	Low. Worker exposure to untreated sediments has to be controlled. Air emissions a concern during handling. Potential impact to Waterway during dredging.	High.	High.	High but many controls required to stage sediments and monitor emissions.	6 to 12 months	High	N/A
C4	Incineration (Mechanical/High Solids)	Very effective but very expensive. Handling of untreated sediments required prior to treatment. Air emissions would be contained. Mechanical removal would be favored to reduce dewatering.	Low. Worker exposure to untreated sediments has to be controlled. Air emissions a concern during handling. Potential impact to Waterway during dredging.	High.	High.	Moderate but many controls required to stage sediments and monitor emissions.	6 to 12 months	Very High	N/A
C5	Aqua Mectool™/Oxidization (Under Dock Capping or Under Dock Dredging)	In situ treatment eliminates removal requirements. The technology has been used for dry land applications but is unproven for underwater applications. Distribution of the sediments and impact to the Waterway is a concern.	Moderate. Potential impact to Waterway. Sedimentation control required.	Ability to achieve treatment uniformly is moderate.	Unknown.	Low to Moderate	3 to 6 months	Low to Moderate	Low
D	Sediment Removal/Treatment/ Disposal With Containment Under	Capping under the dock may be easier than dredging under the dock. Treatment (see above alternatives) could be structured for open water dredging to reduce time and equipment requirements.	As per previous evaluation.	High.	Unknown.	Moderate to High	6 to 12 months	Moderate	Low
E	Combined Embankment and Area 5106 Sediment Containment	Satisfies SQOs and is cost effective. Suitability for the embankment has not been determined. Available ship draft at the face of dock would be decreased significantly.	High.	High.	High. Capping has been accepted in other locations in Puget Sound.	Moderate. Embankment stability needs to be evaluated.	3 to 6 months	Low	Low

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CRA 7431 (8)

E

APPENDIX E

TECHNOLOGY EVALUATION WITH PRELIMINARY TESTING AND MODELING OF TECHNOLOGIES; SECTIONS 7.0 AND 7.1 EXTRACTED FROM THE PTTE REPORT

7.0 TECHNOLOGY EVALUATION

As stated in Section 2.2, the objective of the PTTE Report is to identify the most promising technologies to satisfy the remedial action objectives and to determine what other testing, pilot study, and/or modeling is required to further evaluate the preferred technologies. The most promising technologies, presented in Section 7.2, have been selected based upon the technology evaluation (Section 5.4), the preliminary alternative assessment (Section 6.2), and evaluation of the preliminary modeling/testing performed to date (Section 7.1). A plan for the further evaluation of the selected technologies is presented in Section 7.3.

7.1 PRELIMINARY TESTING AND MODELING OF TECHNOLOGIES

In order to evaluate the potential of several containment, removal, and treatment technologies to meet remedial objectives, preliminary modeling and/or limited testing was performed. Modeling was performed to evaluate how dredging could effect the marine environment and natural attenuation potential. A pilot scale test was completed for the Hazelton process and a bench scale test was completed for the Slurry Aeration process. A bench scale dewatering test was also completed. The preliminary modeling and test results are summarized below. Details of the preliminary modeling test procedures and results are presented in Appendix A.

7.1.1 PRELIMINARY MODELING

Focused sediment and water quality modeling using the Area 5106 Sediment characterization data and porewater profile data were performed. A comparison of the concentrations of the indicator compounds in the profile samples to the Area 5106 Sediment characterization data showed that the samples from location 30-08 are representative of the "average" Area 5106 Sediment and that the samples from location 33-08 are representative of the "worst case" Area 5106 Sediment.

Preliminary modeling was performed using the USEPA supported computer code WASP (Water Quality Analysis Simulation Program, Version 5).

The objectives of the modeling work were as follows:

i) Natural Recovery

- document natural sediment recovery to date within surface sediments of Area 5106 Sediment (i.e., the regulatory point of compliance),

- collect sufficient data to describe the predominant mechanisms contributing to natural recovery, and to support a preliminary evaluation of the effectiveness of future natural recovery within the boundary of the Area 5106 Sediment (i.e., without further remedial action), and
- perform a preliminary evaluation of the effectiveness of future natural recovery within the boundary of Area 5106 Sediment (i.e., without further remedial action);

ii) Containment

- document the integrity of the relatively clean surface sediment cap that has formed naturally over time within the boundary of the Area 5106 Sediment,
- collect sufficient data to evaluate the long-term effectiveness of a nominal 1-foot thick cap placed on the surface of the Area 5106 Sediment with respect to water and sediment quality, and
- perform a preliminary evaluation of the long-term effectiveness of a nominal 1-foot thick sand/gravel cap that could be placed on the surface of the Area 5106 Sediment with respect to water and sediment quality; and

iii) Removal

- collect sufficient data to evaluate the short-term and long-term water quality effects of dredging the Area 5106 Sediment, and
- perform a preliminary evaluation of short-term and long-term water quality effects of dredging the Area 5106 Sediment.

The results of the modeling work are as follows:

i) Natural Recovery

- two mechanisms appear to be contributing to natural recovery within the boundary of the Area 5106 Sediment:
  - net sedimentation (burial of Area 5106 Sediment), which averages 1 to 2 cm/year within the boundary of the Area 5106 Sediment, and
  - biodegradation, specifically the breakdown of PCE and TCE into degradation products including VC. Biodegradation appears to be more rapid in the more oxidized surface mixed layer of the sediment (0 to 10 cm),
- preliminary WASP model results (which USEPA has not concurred with) suggest that portions of surface sediments within the boundary of Area 5106 Sediment are predicted to achieve SQOs within the 10 years following the completion of the Waterway remedial action. Although several propeller wash zones identified within Area 5106 Sediment (based on detailed

bathymetric surveys) may not fully recover to SQOs without further controls (e.g., capping/armoring or dredging), such areas appear to be highly localized, and not representative of the majority of Area 5106 Sediment;

ii) Containment

- surface concentrations within the boundary of the Area 5106 Sediment peaked during the early 1960s - materials deposited during this period are present at depths between 24 and 80 cm below the mudline. The Area 5106 Sediment at these depths contain bulk sediment concentrations of key Site compounds such as HCBD, PCE, and TCE that are approximately 200 to 6,000 times higher than surface (0 to 10 cm) concentrations. These profiles document that surface sediments are less contaminated than subsurface sediments, and
- placement of a thin layer (1-foot) sand/gravel cap over Area 5106 Sediment is predicted to be effective, achieving long-term SQOs. The cap is not expected to become impacted over time, even though deeper porewaters will continue to attenuate through the cap. In this case, dispersion, bioturbation, and sedimentation processes within the cap surface will maintain water and sediment quality conditions at the regulatory point of compliance (0 to 10 cm) to below relevant and appropriate criteria. The long-term integrity of the cap is also supported by preliminary geotechnical analyses; and

iii) Removal

- short-term water quality effects of dredging Area 5106 Sediment were assessed with the WASP model (which USEPA has not concurred with). The preliminary model results indicate that acutely toxic water quality conditions may occur during periods of slack tide, exceeding acute toxicity criteria throughout most of the water column even at the prospective mixing zone boundary (typically 200 feet from the dredging zone). Further, based on current Washington State Surface Water Standards, the applicable mixing boundary for acute effects in this case is only 20 feet from the point of dredging and the preliminary model results indicate exceedance of this regulatory standard during slack tide conditions, and
- excluding the temporary slack tide acute conditions described above, the preliminary WASP model results (which USEPA has not concurred with) suggest that longer-term (i.e., daily average) water quality conditions within the prospective Area 5106 Sediment dredging zone will not likely exceed regulatory criteria. This result is primarily attributable to the considerable flushing/mixing effect of tidal exchange within the Waterway.

A complete summary of the Preliminary WASP Modeling is presented in Appendix A.

7.1.2 CONSOLIDATION ANALYSIS

Consolidation analysis was performed on ten samples: three samples of Recent Sediment; one sample of fine-grained fill; three samples of Area 5106 Sediment; two samples of Recent Sediment/Area 5106 Sediment; and one sample of Native Sediment. The results of the analysis are summarized in Table 7.1.

The analysis indicates that if a 2-foot thick cap was constructed over the Area 5106 Sediment, the Recent Sediment and Area 5106 Sediment will settle 0.5 to 1.0 inch assuming a 2-foot thickness of sediment, and 2.0 to 4.5 inches assuming an 8-foot thickness of sediment. The settlement rates for the majority of samples and stress ranges would be less than 30 days.

Using the settlement information, the stratigraphy at the profile sample locations (30-08 and 33-08) was evaluated to determine the potential for redistribution of porewater during consolidation. The results of this evaluation are shown on Figure 7.1 for the two locations. The results indicate that porewater from the sediment would advance a maximum of 3 inches into the sand cover.

7.1.3 BENCH SCALE AERATION

Bench scale aeration tests were performed on samples of 20 percent sediment slurry prepared from Area 5106 Sediment and Waterway water. The tests were run in triplicate for aeration periods of 4, 8, 12, and 24 hours representing air to water ratios of 50, 100, 150, and 300, respectively. Following aeration, the slurry was separated into solid and aqueous samples which were analyzed separately.

The concentrations of TCE and PCE in the initial slurry sample were approximately 50 percent of the average concentrations of these compounds in the Area 5106 Sediment. These concentrations are consistent when the dilution of the sediment in the preparation of the slurry is considered. Therefore, the material tested was representative of the Area 5106 Sediment.

For the aqueous samples, greater than 99 percent reduction was achieved for VOCs under all four aeration conditions. The SVOCs reduction (if any) was not statistically significant due to the low starting levels of SVOC chemistry in the water.

In the sediments, there was an increasing trend in the degree of VOC reduction versus aeration times. The reduction ranged from 93 to 98 percent, with the most significant improvement occurring while increasing the aeration time from 4 to 8 hours. The

improvement from 8 to 24 hours was less pronounced. Similar to the aqueous results, the SVOC reduction in the sediments was insignificant for all four aeration times. Even the 24-hour aeration test with nutrient adjustment (to enhance potential biological activity) produced only a 10 percent overall reduction.

The concentrations of the compounds detected in the treated sediment exceeded the SQOs for the following compounds: PCE, HCB, HCBD, and phenanthrene. Estimated TCLP concentrations from the treated sediment were all below the RCRA TCLP criteria except PCE and HCB. A summary of the analytical data for the sediment slurry treated at an air to water ratio of 100:1 is presented in Table 7.2. Test procedures and complete results are provided in Appendix A.

The aerated water samples met the MWQ criteria for all analytes.

7.1.4 PILOT-SCALE TESTING (HAZELTON SOIL WASHING)

A pilot scale batch test of soil washing/air stripping was conducted at the Site using a Hazleton MAXI-CLONE pilot unit. The three hour test was performed using a batch of approximately 20 percent solids slurry prepared from Area 5106 Sediment and Waterway water. Samples were divided into solid and aqueous components for analysis.

The concentrations of TCE and PCE in the sediment used to prepare the slurry for testing were <10 percent of the average concentrations of these compounds in the Area 5106 Sediment.

The results of the test show that there was a reduction in VOC, HCBD, and naphthalene concentrations of >90 percent. The concentrations of the other SVOCs were reduced approximately 50 percent. Metals concentrations were not significantly reduced by this process. The final concentrations of PCE, HCB, and HCBD exceed the SQOs.

TCLP analyses were performed on the treated sediment. The TCLP concentrations of all compounds detected in the final solids sample are lower than the RCRA TCLP criteria. A summary of the analytical data for the soil washing test is presented in Table 7.3. Test procedures and complete results are provided in Appendix A.

The aqueous fraction of the treated slurry meets the MWQ criteria for all constituents except copper. Copper may be representative of background conditions. However, site-specific background concentrations have not yet been determined.

7.1.5 BENCH SCALE DEWATERING

Bench scale dewatering tests were performed on the treated slurry from the soil washing pilot test. The results of the dewatering tests show that the sediment can be dewatered to approximately 50 percent solids by a combination of settling and filtration. Polymer addition did not significantly enhance either settling or filtration.

A 50 percent solids waste will pass the paint filter test and, therefore, be suitable for upland disposal without solidification.

TABLE 7.1

SUMMARY OF CONSOLIDATION ANALYSIS
AREA 5106 SEDIMENT
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION REPORT
OCC TACOMA, INC.
TACOMA, WASHINGTON

	Average Total Consolidation [1][2] (Inches)	
	2 Ft. Sediment Thickness	*8 Ft. Sediment Thickness*
Material A	1.0	4.0
Material B	1.0	4.0
Material A/B	0.25	1.0
Fill	0.25	1.0
Material C	0.1	0.1

Note:
(1) Average total consolidation based upon placement of a 2-foot thick cap over the indicated sediment thickness.
(2) Maximum total consolidation may be as great as twice the average value.

CRA 7431 (15) from
CRA 7431 (8)

TABLE 7.2

SUMMARY OF BENCH SCALE AERATION TEST RESULTS
AREA 5106 SEDIMENT
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION REPORT
OCC TACOMA, INC.
TACOMA, WASHINGTON

	Solids					*Water*		
	*Test Data **			*Criteria*		*Test Data **		*Criteria*
Compounds Detected	*Initial (mg/kg)*	*Final (mg/kg)*	*Est. TCLP ** (mg/L)*	*SQOs (mg/kg)*	*TCLP (mg/L)*	*Initial (mg/L)*	*Final (mg/L)*	*MWQs (mg/L)*
Volatile Organic Compounds								
Acetone	ND100	0.5	0.02	NS	NS	ND5.0	0.02	NS
2-Butanone	ND26	1.7	0.09	NS	200	ND2.5	0.004	NS
1,2-Dichloroethene	23	0.8	0.04	NS	NS	3.6	0.005	224 (1)
Methylene chloride	ND51	0.3	0.02	NS	NS	ND2.5	ND2.5	6.4 (1)
Tetrachloroethene	540	15.3	0.77	0.057	0.7	13	0.022	0.45 (1)
Trichloroethene	87	2.7	0.13	NS	0.5	6.6	0.008	2.0 (1)
Semi-Volatile Organic Compounds								
Chrysene	0.67	ND1.2	0.03	2.8	NS	ND0.01	ND0.01	0.3 (1)
Acenaphthene	0.58	ND1.2	0.03	0.50	NS	ND0.01	ND0.01	0.71 (1)
Fluoranthene	2.2	2.2	0.11	2.5	NS	ND0.01	ND0.01	0.016 (1)
Hexachlorobenzene	4.2	3.4	0.17	0.022	0.13	ND0.01	ND0.01	0.129 (2)
Hexachlorobutadiene	8.7	9.1	0.45	0.011	0.5	0.013	0.005	0.032 (1)
Naphthalene	1.1	ND1.2	0.03	2.1	NS	0.011	ND0.01	2.35 (1)
Phenanthrene	2.4	2.2	0.11	1.5	NS	ND0.01	ND0.01	0.0046 (3)
Pyrene	1.7	1.8	0.09	NS	NS	ND0.01	ND0.01	0.3 (1)
Bis(2-ethylhexyl)phthalate	0.61	ND1.2	0.03	1.3	NS	ND0.01	ND0.01	0.36 (3)
Fluorene	0.54	ND1.2	0.03	0.54	NS	ND0.01	ND0.01	0.3 (1)
Phenol	ND1.2	ND1.2	0.03	0.42	NS	ND0.01	0.005	5.8 (1)
Metals								
Aluminum	10300	11000	550	NS	NS	ND0.005	ND0.005	NS
Antimony	ND1.6	ND1.8	0.05	150	NS	0.0053	0.012	NS
Arsenic	13.2	14.7	0.74	57	5.0	0.024	0.028	0.036 (4,5)
Barium	38.7	42.7	2.14	NS	100.0	0.082	0.14	NS
Calcium	41700	45800	2290	NS	NS	316	343	NS
Chromium	19.9	20.1	1.01	NS	5.0	ND0.005	ND0.005	0.05 (4,5)
Cobalt	9.7	7.1	0.35	NS	NS	ND0.005	ND0.005	NS

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CRA 7431 (8)

TABLE 7.2

SUMMARY OF BENCH SCALE AERATION TEST RESULTS
AREA 5106 SEDIMENT
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION REPORT
OCC TACOMA, INC.
TACOMA, WASHINGTON

	Solids					*Water*		
	*Test Data **			*Criteria*		*Test Data **		*Criteria*
Compounds Detected	*Initial (mg/kg)*	*Final (mg/kg)*	*Est. TCLP ** (mg/L)*	*SQOs (mg/kg)*	*TCLP (mg/L)*	*Initial (mg/L)*	*Final (mg/L)*	*MWQs (mg/L)*
Metals (Cont'd)								
Copper	140.0	54.8	2.74	390	NS	ND0.005	0.007	0.0029 (4,5)
Iron	10900	11400	570	NS	NS	ND0.005	ND0.005	1 (3)
Lead	119.0	151.0	7.55	450	5.0	ND0.005	ND0.005	0.0081 (5)
Magnesium	55300	60100	3005	NS	NS	737	649	NS
Manganese	136.0	147.3	7.37	NS	NS	ND0.005	ND0.005	NS
Nickel	33.7	32.4	1.62	140	NS	0.007	0.01	0.0082 (5)
Potassium	1310	1463	73	NS	NS	0.33	0.32	NS
Sodium	28700	30100	1505	NS	NS	10.4	11.2	NS
Vanadium	41.8	43.7	2.19	NS	NS	0.006	0.01	NS
Zinc	66.6	76.0	3.80	410	NS	0.054	0.036	0.081 (5)

Notes:

(1) USEPA Quality Criteria for Water, EPA-440/5-86-001, May 1986, 51 FR 43665.
(2) Lowest Observed Effect Level (LOEL).
(3) USEPA Ambient Water Quality Criteria, 55 FR 19986, May 1990.
(4) USEPA National Toxic Rule (NTR), 51 FR 60848, Dec. 22, 1992. (Note: Metals criteria are expressed as total recoverable.)
(5) USEPA Metals Criteria Revision, National Toxic Rule (NTR), 60 FR 22229, May 4, 1995. (Note: Metals criteria are expressed as dissolved.)
* 100:1 air to water ratio
** Estimated TCLP = Final Concentration divided by 20
ND Non-detect at associated value
NS No Standard
SQOs Sediment Quality Objectives
TCLP Toxicity Characteristic Leaching Procedure

CRA 7431 (15) from
CRA 7431 (8)

SUMMARY OF PILOT SCALE HAZELTON SOIL WASHING TEST RESULTS
AREA 5106 SEDIMENT
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION REPORT
OCC TACOMA, INC.
TACOMA, WASHINGTON

	Sediment	*Slurry Solids*			*Criteria*		*Slurry Water*		*Criteria*
	Initial Conc. (mg/kg)	*Initial Conc. (mg/kg)*	*Final Conc. (mg/kg)*	*TCLP oncentration (mg/L)*	*TCLP (mg/L)*	*SQOs (mg/kg)*	*Initial Conc. (mg/L)*	*Final Conc. (mg/L)*	*MWQs (mg/L)*
Compounds Detected									
Volatile Organic Compounds									
Vinyl chloride	NA	NA	NA	ND 0.010	0.2	NS	0.2	0.012	NS
Trichloroethene	11	1.6	0.06	0.016	0.5	NS	0.74	0.0077	2.0 (1)
Tetrachloroethene	19.2	4.7	0.43	0.031	0.7	0.057	1.4	0.0095	0.45 (1)
Styrene	NA	NA	NA	-	NS	NS	ND (0.040)	ND (0.005)	NS
Semi-Volatile Organic Compounds									
Hexachlorobenzene	NA	1.9	0.98	ND 0.010	0.13	0.022	NA	NA	0.129 (5)
Hexachlorobutadiene	NA	80	4.1	ND 0.010	0.5	0.011	0.013	ND (0.010)	0.032 (1)
Acenaphthene	NA	1.6	ND (0.76)	-	NS	0.5	0.0060J	ND (0.010)	0.71 (1)
Chrysene	NA	1.0J	0.48J	-	NS	2.8	NA	NA	0.3 (1)
Fluoranthene	NA	2.6	1.3	-	NS	2.5	NA	NA	0.016 (1)
Naphthalene	NA	9.3	0.71J	-	NS	2.1	0.18	ND (0.010)	2.35 (1)
Phenanthrene	NA	2.4	1.4	-	NS	1.5	NA	NA	0.0046 (3)
Pyrene	NA	2.4	1.3	-	NS	3.3	NA	NA	0.3 (1)
Phenol	NA	NA	NA	-	NS	0.42	0.012	0.016	5.8 (1)
Metals									
Aluminum	NA	15,600	11900	7.0	NS	NS	NA	NA	NS
Antimony	NA	2.1	ND (1.1)	ND 0.5	NS	150	0.0079	0.018	NS
Arsenic	NA	20.9	14.1	ND 0.5	5.0	57	0.012	0.0065	0.036 (2,4)
Barium	NA	76.8	61	ND 2.0	100.0	NS	0.12	0.123	NS
Beryllium	NA	0.7	ND (0.5)	ND 0.2	NS	NS	NA	NA	0.0053 (1)
Calcium	NA	47,900	36,900	613	NS	NS	334	326	NS
Chromium	NA	30.5	81.8	ND 0.1	5.0	NS	NA	NA	0.05 (2,4)
Cobalt	NA	7.8	6.2	ND 0.1	NS	NS	NA	NA	NS
Copper	NA	91.2	69.2	ND 0.3	NS	390	0.0047	0.0047	0.0029 (2,4)
Iron	NA	18,600	15,300	4.1	NS	NS	0.078	0.086	1 (3)
Lead	NA	118	85.6	ND 0.5	5.0	450	NA	NA	0.0081 (4)
Magnesium	NA	41,600	24900	341	NS	NS	934	952	NS
Manganese	NA	185	138	1.1	NS	NS	0.023	0.035	NS

CRA 7431 (15) from
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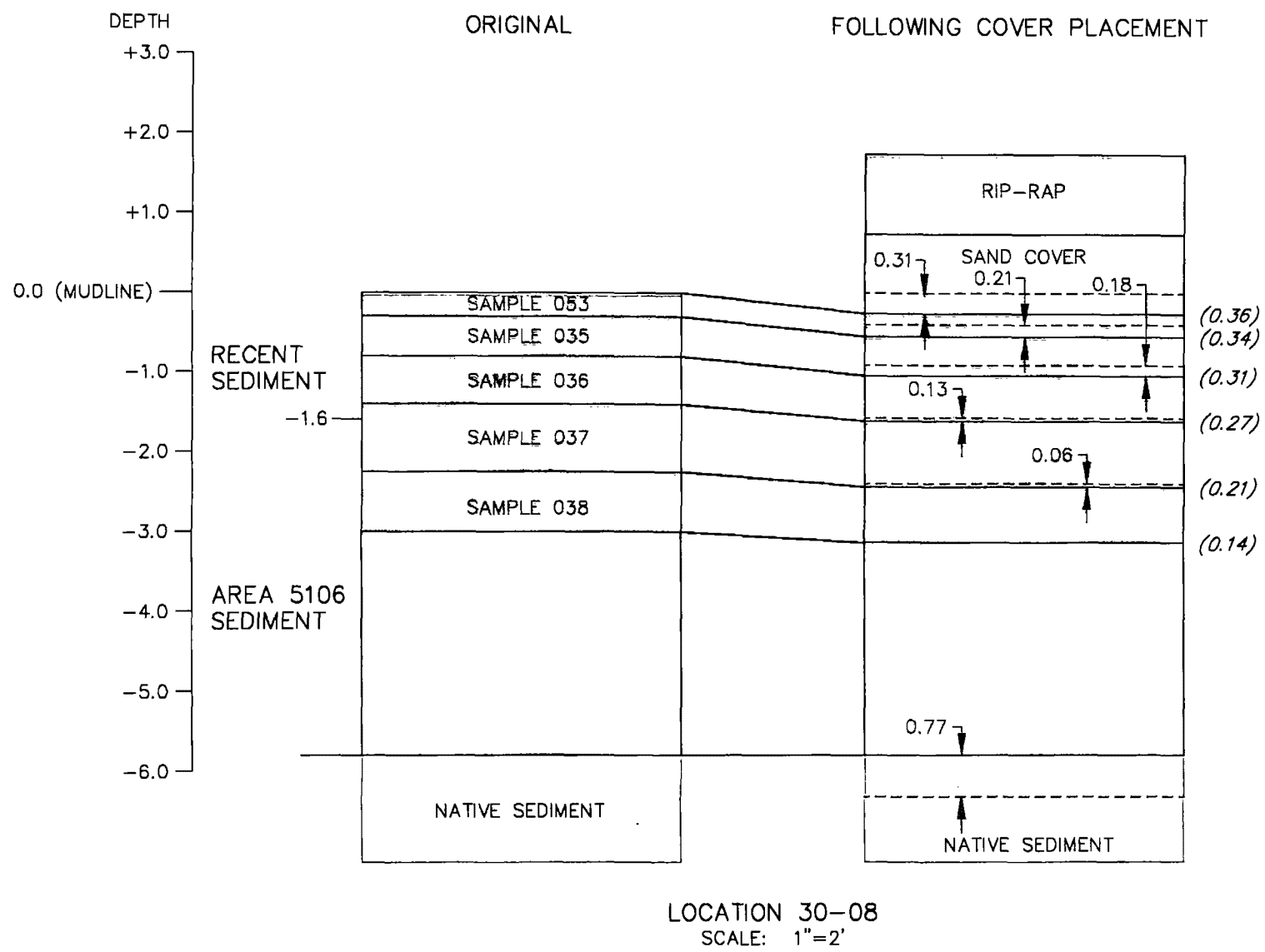
SUMMARY OF PILOT SCALE HAZELTON SOIL WASHING TEST RESULTS
AREA 5106 SEDIMENT
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION REPORT
OCC TACOMA, INC.
TACOMA, WASHINGTON

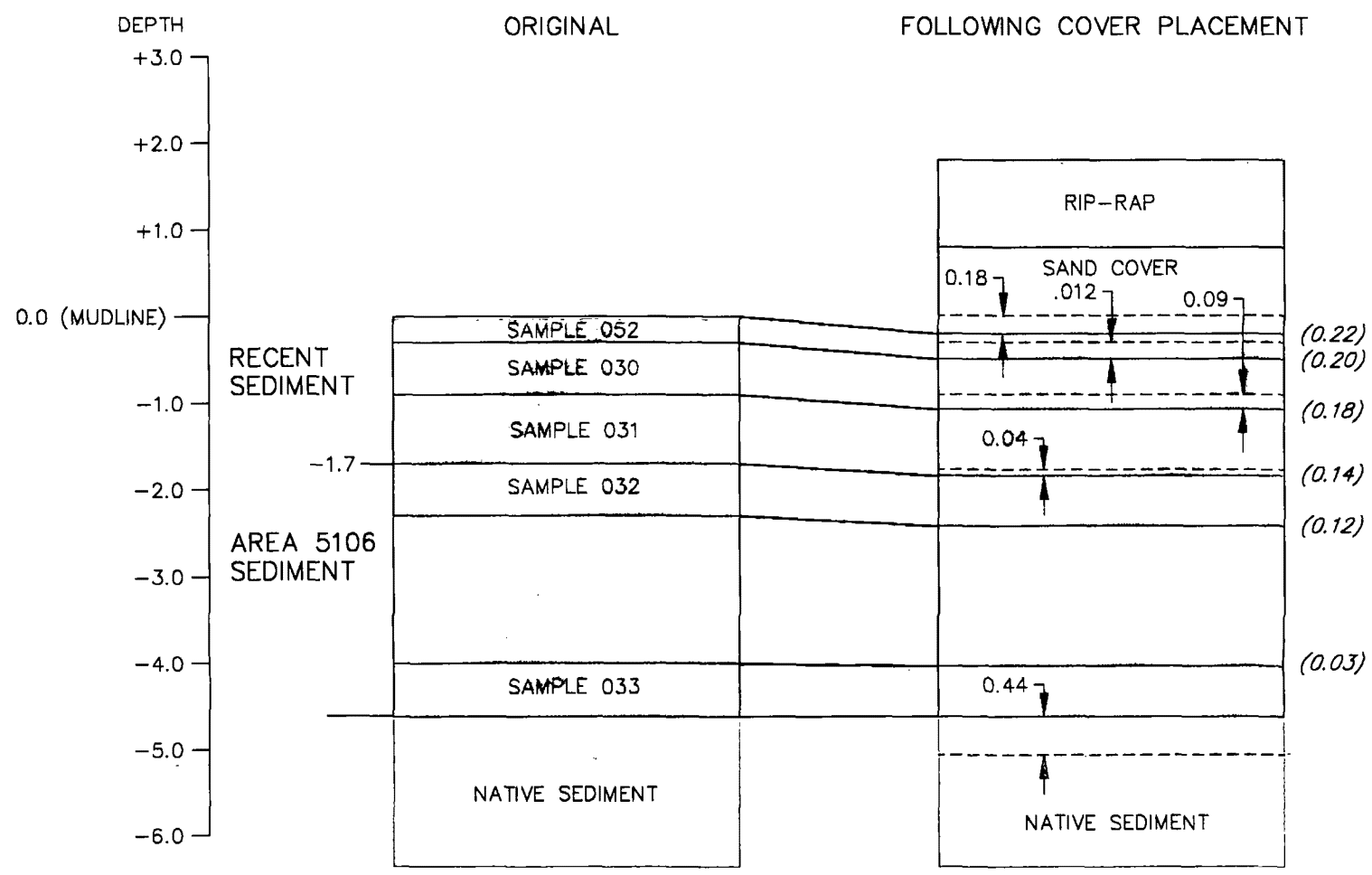
	Sediment	*Slurry Solids*			*Criteria*		*Slurry Water*		*Criteria*
	Initial Conc. (mg/kg)	*Initial Conc. (mg/kg)*	*Final Conc. (mg/kg)*	*TCLP oncentration (mg/L)*	*TCLP (mg/L)*	*SQOs (mg/kg)*	*Initial Conc. (mg/L)*	*Final Conc. (mg/L)*	*MWQs (mg/L)*
Compounds Detected									
Metals (Cont'd)									
Mercury	NA	0.3	0.5	ND 0.002	0.2	0.59	NA	NA	0.000025 (2,4)
Nickel	NA	40.3	56.8	0.3	NS	140	NA	NA	0.0082 (4)
Potassium	NA	1,720	1080	17	NS	NS	0.403	0.139	NS
Silver	NA	0.3	ND (0.2)	ND 0.2	5.0	6.1	NA	NA	0.00092 (2)
Sodium	NA	19,100	13,800	-	NS	NS	9.2	9.93	NS
Vanadium	NA	52.3	42.3	ND 0.1	NS	NS	NA	NA	NS
Zinc	NA	133	158	ND 2.0	NS	410	NA	NA	0.081 (4)

Notes:

(1) USEPA Quality Criteria for Water, EPA-440/5-86-001, May 1986, 51 FR 43665.
(2) USEPA National Toxic Rule (NTR), 51 FR 60848, Dec. 22, 1992. (Note: Metals criteria are expressed as total recoverable.)
(3) USEPA Ambient Water Quality Criteria, 55 FR 19986, May 1990.
(4) USEPA Metals Criteria Revision, National Toxic Rule (NTR), 60 FR 22229, May 4, 1995. (Note: Metals criteria are expressed as dissolved.)
(5) Lowest Observed Effect Level (LOEL).
- Not applicable.
Conc. Concentration
J Associated value is estimated.
MWQs Chronic Marine Water Quality Criteria Protective of Salt Water. Acute criteria where there is no chronic.
NA Not analyzed.
ND Non-detect at associated value.
NS No standard.
SQOs Sediment Quality Objectives
TCLP Toxicity Characteristic Leaching Procedure



LOCATION 30-08
SCALE: 1"=2'



LOCATION 33-08
SCALE: 1"=2'

0.23

LEGEND

ADVANCEMENT OF PORE WATER FRONT ABOVE SAMPLE INTERVAL (FEET)

(0.25) SETTLEMENT (FEET)

SAMPLE 053 SAMPLE NUMBER AS SHOWN IN LOG FOR PROFILE SAMPLE AT 30-08

figure 7.1

REDISTRIBUTION OF PORE WATER IN SEDIMENT AND SAND COVER
PRELIMINARY TREATMENT TECHNOLOGY EVALUATION
OCC Tacoma, Inc., Tacoma, Washington

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APPENDIX F

BENCH SCALE TREATABILITY STUDY REPORT; SLURRY AERATION OF AREA 5106 SEDIMENT

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APPENDIX B ANALYTICAL QA/QC REVIEW

1.0 INTRODUCTION

OCC Tacoma, Inc. (OCCT) is performing an Engineering Evaluation/Cost Analysis (EE/CA) for the Area 5106 Removal Action at the former OCCT facility. In preparation of the EE/CA, remedial technologies were developed and evaluated in the report entitled, "Area 5106 Removal Action, Preliminary Treatment Technology Evaluation Report" (PTTE). In that report, slurry aeration and chemical oxidation were identified as technologies requiring further evaluation. Subsequently, a Bench Scale Treatability Study was performed by Conestoga-Rovers & Associates (CRA) to assess whether volatilization alone or in conjunction with chemical oxidation could effectively treat the Area 5106 Sediment. This Bench Scale Treatability Study Report presents the results of the Treatability Study.

The main objectives of the Treatability Study were to:

i) determine the effects of various airflow rates on the volatilization process;

ii) determine the effects of temperature on the volatilization process;

iii) determine the effect of chemical oxidation on enhancing the removal of semi-volatile organic compounds (SVOCs); and

iv) determine which sediment/water mixtures, or slurries, would allow for the most effective sediment treatment.

The Bench Scale Treatability Study Work Plan (Work Plan) also proposed to assess the effect of a surfactant in enhancing the aeration and chemical oxidation. However, based on the results of the aeration and chemical oxidation tests, OCCT and USEPA agreed to eliminate the surfactant evaluation from the scope of the Treatability Study.

2.0 DESCRIPTION OF TESTS

2.1 SAMPLE COLLECTION

A representative sample of the sediment material was proposed to be collected from the Hylebos Waterway (Waterway) at grid location 34-08 using a clamshell. Grid location 34-08 was selected due to relatively high chemical concentrations determined during the characterization sampling and analysis. The sample was collected as discussed in the Work Plan and analyzed for the target volatile organic compound (VOC)/SVOC parameters presented in the Work Plan. However, the concentrations of the indicator parameters were below the respective target concentrations. Therefore, additional sampling was conducted to collect samples appropriate for the treatability study.

The additional sampling was performed by Marine Sampling Systems under the direction of a CRA representative and consisted of 10 cores driven in the area indicated on Figure 2.1. The cores were driven using a 4-inch diameter vibracore and were advanced until a reduced penetration rate was observed. Approximately 6 to 8 feet of sample core was collected from each location. From each core, approximately 4 feet of visual Area 5106 Sediment was composited, placed in a 5-gallon bucket, and then analyzed by Transglobal Environmental Geosciences Northwest, Inc. in Olympia, Washington, for vinyl chloride (VC), trichloroethene (TCE), tetrachloroethene (PCE), tetrachlorobutadiene (TCBD), and hexachlorobutadiene (HCBD). Based on the analytical results, six buckets of sediment were sent to the CRA Services' Treatability Laboratory for use in the treatability study. The analytical results for the sediment samples are presented in Table 2.1.

2.2 DESIGN

The treatability tests were conducted in 6.5-gallon cylindrical stainless steel vessels. Figure 2.2 illustrates the treatment vessel setup. The test vessels were equipped with variable speed mixers, mixing fins, and air sparging tubing. The mixing fins prevented rotation and vortexing of the slurry. An external, heated water bath was used to heat the slurry to the required test temperatures. The vessels were equipped with lids to control vapor emissions and provide representative vapor concentrations for scale-up design of the full-scale vapor recovery system. All vapors were drawn through a laboratory hood using a fan assembly.

2.3 TESTING PROCEDURE

Six 5-gallon buckets of sediment were received at the CRA Services' Treatability Laboratory. Sediment was taken from one or two of these buckets to prepare each of the ten batches tested in the Treatability Study.

The Treatability Study was performed in phases. The effect of airflow rate was evaluated during Phase I. The effect of temperature and chemical oxidant addition were evaluated during Phase II. The effect of slurry content was evaluated during both Phase I and Phase IIa. Slurry content is expressed as a percent solids by weight throughout this report.

Table 2.2 outlines the batches prepared for each phase of the treatability study and summarizes the sampling and analysis performed for each batch.

All test batches were continuously mixed at the minimum speed required to maintain a homogeneous slurry throughout the test vessel. The mixing speeds were maintained constant for the duration of each batch test and were recorded. All samples were collected as a slurry from the test batches. The solid and aqueous phases of the samples were separated prior to analysis by the CRA Services' Treatability Laboratory.

Hylebos water was utilized for preparation of the sediment slurries. A sample of the Hylebos water utilized for the tests was analyzed by APPL Laboratory in Fresno, California for VOCs, SVOCs, metals, and pH. The analytical results are presented in Table 2.3.

The test conditions, such as impeller power, temperature, etc., were monitored at each sample point. These data are included as Appendix A.

2.3.1 PHASE I

Phase I of the treatability study was conducted to determine the effect of airflow rate on the slurry aeration process. Three 20-liter batches (Batches 1, 2, and 3; refer to Table 2.2) of 10 percent slurry were prepared, maintained at 25°C, and subjected to different airflow rates (120, 240, and 480 liters/hour) for a period of 24 hours. The initial starting temperature of 25°C was selected because this temperature was obtainable without heating, based on the ambient temperature of the laboratory.

Slurry samples of each batch were collected at T=0, 2, 4, 6, 12, and 24 hours. The samples were separated into solid and aqueous phases and both phases were analyzed for the Site-specific VOCs presented in Table 2.4. Only the T=0, 6, 12, and 24 hour samples were analyzed for the Site-specific SVOCs presented in Table 2.4.

The tests were repeated using three additional 20-liter batches (Batches 4, 5, and 6; refer to Table 2.2) of 15 percent slurry. A 20 percent slurry as initially proposed in the Work Plan was not possible due to impeller/agitation limitations. These batches were also maintained at 25°C and subjected to different airflow rates (120, 240, and 480 liters/hour) for a period of 24 hours.

Slurry samples of each batch were collected at T=0, 2, 4, 6, 12, and 24 hours. The samples were separated into solid and aqueous phases and both phases were analyzed for the Site-specific VOCs presented in Table 2.4. Only the T=0, 6, 12, and 24 hour samples were analyzed for the Site-specific SVOCs presented in Table 2.4.

Based on the results of Phase I, it was determined that an airflow rate of 480 liters/hour was the most effective in removing the VOC and SVOC parameters from the sediment.

2.3.2 PHASE II

Phase II was performed to evaluate the effect of different temperatures and subsequent chemical oxidation on the slurry aeration process. Two 20-liter batches (Batches 7 and 8; refer to Table 2.2) of 10 percent slurry were prepared, heated to 25°C and 45°C, respectively, and mixed with air at 480 liters/hour for 24 hours. The second temperature of 45°C was chosen to provide a 20 degree difference in the two tests.

Slurry samples of each batch were collected at T=0, 2, 4, 6, 12, and 24 hours. The samples were separated into solid and aqueous phases and both phases were analyzed for the Site-specific VOCs presented in Table 2.4. Only the T=0, 6, 12, and 24 hour samples were analyzed for the Site-specific SVOCs presented in Table 2.4.

At the completion of the 24-hour aeration period, aeration was discontinued and 100 grams (gm) of potassium permanganate ($KMnO_4$) was added to the remaining 15 liters of each batch. This amount was selected based on results of preliminary testing which was conducted to determine the amount of $KMnO_4$ required based on visual observations (color) of reactivity. These batches (now referred to as Batches 7A and 8A; refer to Table 2.2) were maintained at their respective temperatures for 24 hours.

Slurry samples of each batch were collected at T=2, 4, 6, 12, and 24 hours. The samples were separated into solid and aqueous phases and both phases were analyzed for the Site-specific SVOCs presented in Table 2.4. The aqueous phase of each sample was also analyzed for residual MnO_4^- to determine the amount of MnO_4^- reacted to that point in time.

Based on the Phase II data, it was determined that 45°C was the more effective temperature. The effectiveness of chemical oxidation, however, was inconclusive due to chemical interferences that would not allow for an accurate quantification of the SVOC parameters. Therefore, in agreement with USEPA, the next phase was conducted to further evaluate the effect of slurry content on the aeration process without chemical oxidant addition.

2.3.3 PHASE IIA

Phase IIA was conducted to determine the effect of slurry content on the aeration process and to confirm the Batch 8 results. Batch 9 was prepared using 20 liters of 10 percent slurry and Batch 10 was prepared using 20 liters of 15 percent slurry (refer to Table 2.2). Both batches were tested at 45°C with an airflow of 480 liters/hour for 24 hours.

Slurry samples of each batch were collected at T=0, 2, 4, 6, 9, and 12 hours and the samples were separated into solid and aqueous phases. The T=0, 2, 4, and 6 hour samples were analyzed for the Site-specific VOCs presented in Table 2.4. The T=0, 2, 4, 6, 9, and 12 hour samples were analyzed for the SVOCs presented in Table 2.4.

2.4 SAMPLING PROCEDURES AND QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Grab samples were collected from the test batches at the times indicated in Table 2.2 using 40 mL teflon-lined septum vials. The samples were stored without headspace at 4°C and were analyzed for the parameters listed in Table 2.4 within the method required holding time of 7 days for waters and 14 days for sediment. Duplicate samples were collected at a frequency of 1 per every 10 samples. The samples were analyzed by gas chromatography/flame ionization (GC/FID) equipped with a purge and trap. Reagent blanks and blank spikes were analyzed daily. Surrogate compounds were added to all samples prior to sample preparation and/or analysis. Compound quantitation was

based on external standards. Compound identification was determined by comparing the relative retention time of the unknown with that of an authentic standard. Since the TCBD was analyzed by GC only, any peaks eluding between the 1,1,2,3-TCBD peak and the HCBD peak were quantified as TCBD isomers.

3.0 SUMMARY OF RESULTS

The results for the treatability tests are presented in Tables 3.1 through 3.13. The VOC and SVOC analytical results for Batches 1 through 10 are presented as Tables 3.1 through 3.12, inclusive. Percent reduction in concentration for detected compounds are shown in each table and were calculated based upon the T=0 concentrations.

The results of Batches 9 and 10 are presented graphically on Figures 3.1 and 3.2 as follows:

i) sediment results are presented as percent reduction over time; and

ii) water results are presented as separate figures of VOC and SVOC compound concentrations versus time.

Residual soluble $KMnO_4$ concentrations were analyzed for each sample in Batches 7A and 8A. The results are presented in Table 3.13 and graphically on Figure 3.3.

FIGURES

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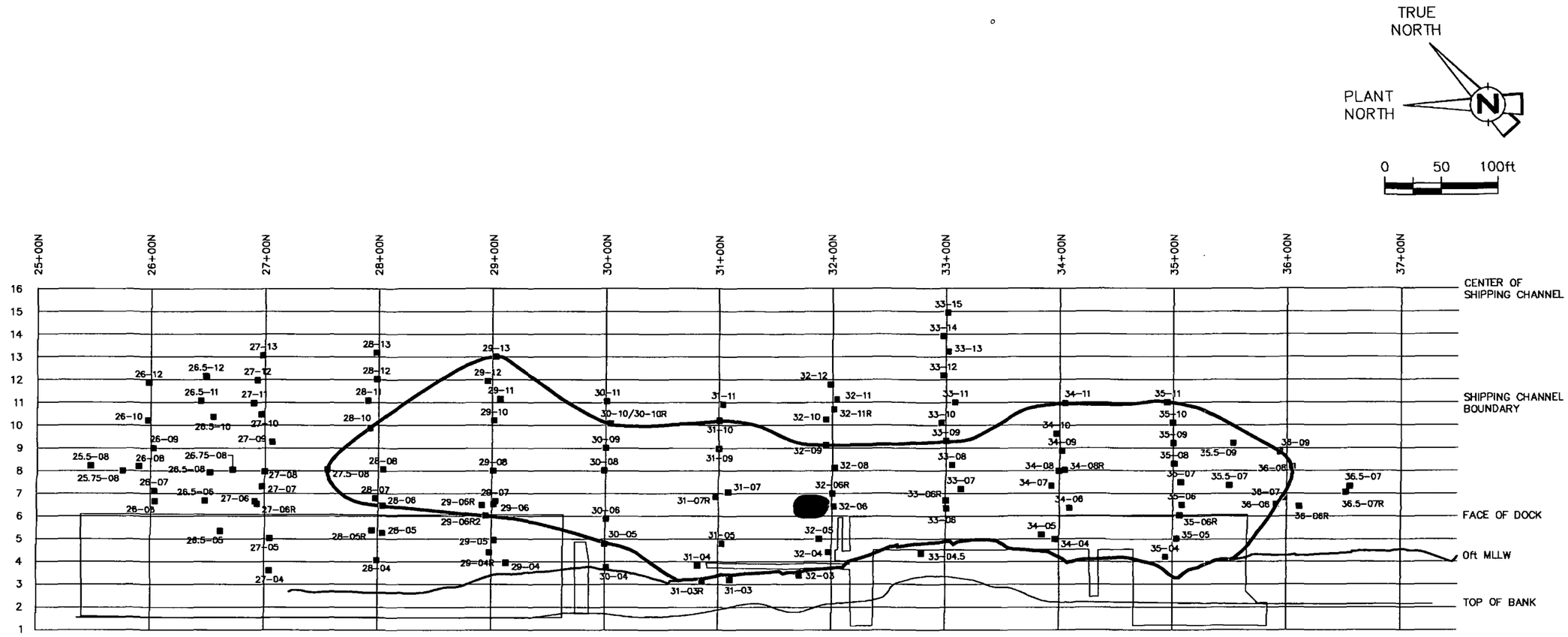

LEGEND

30-08 BOREHOLE LOCATION

LIMITS OF AREA 5106 SEDIMENT

SEDIMENT COLLECTION AREA

figure 2.1

SEDIMENT COLLECTION AREA
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
OCC Tacoma, Inc. – Tacoma, Washington

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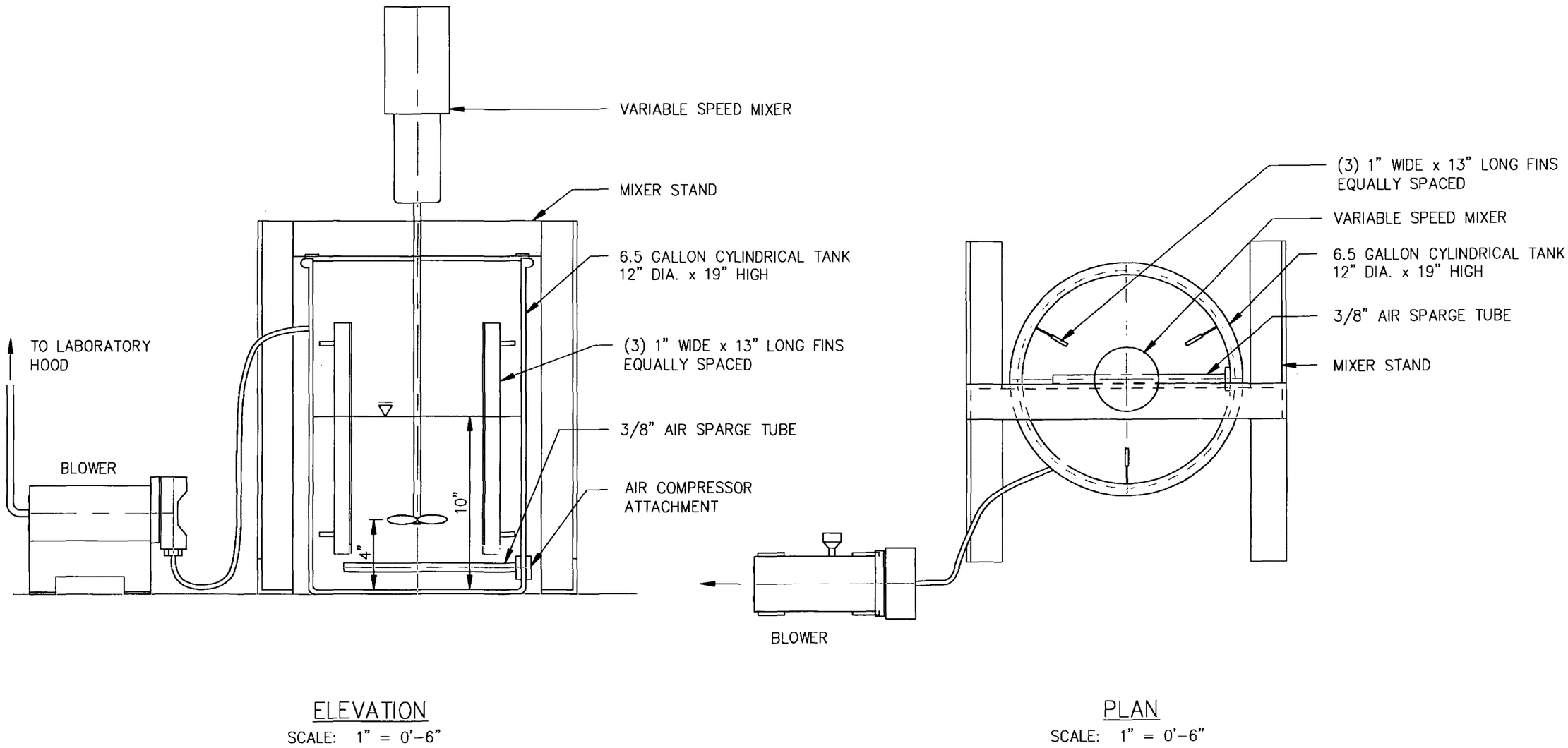

figure 2.2

TREATMENT VESSEL SETUP
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
OCC Tacoma, Inc. – Tacoma, Washington

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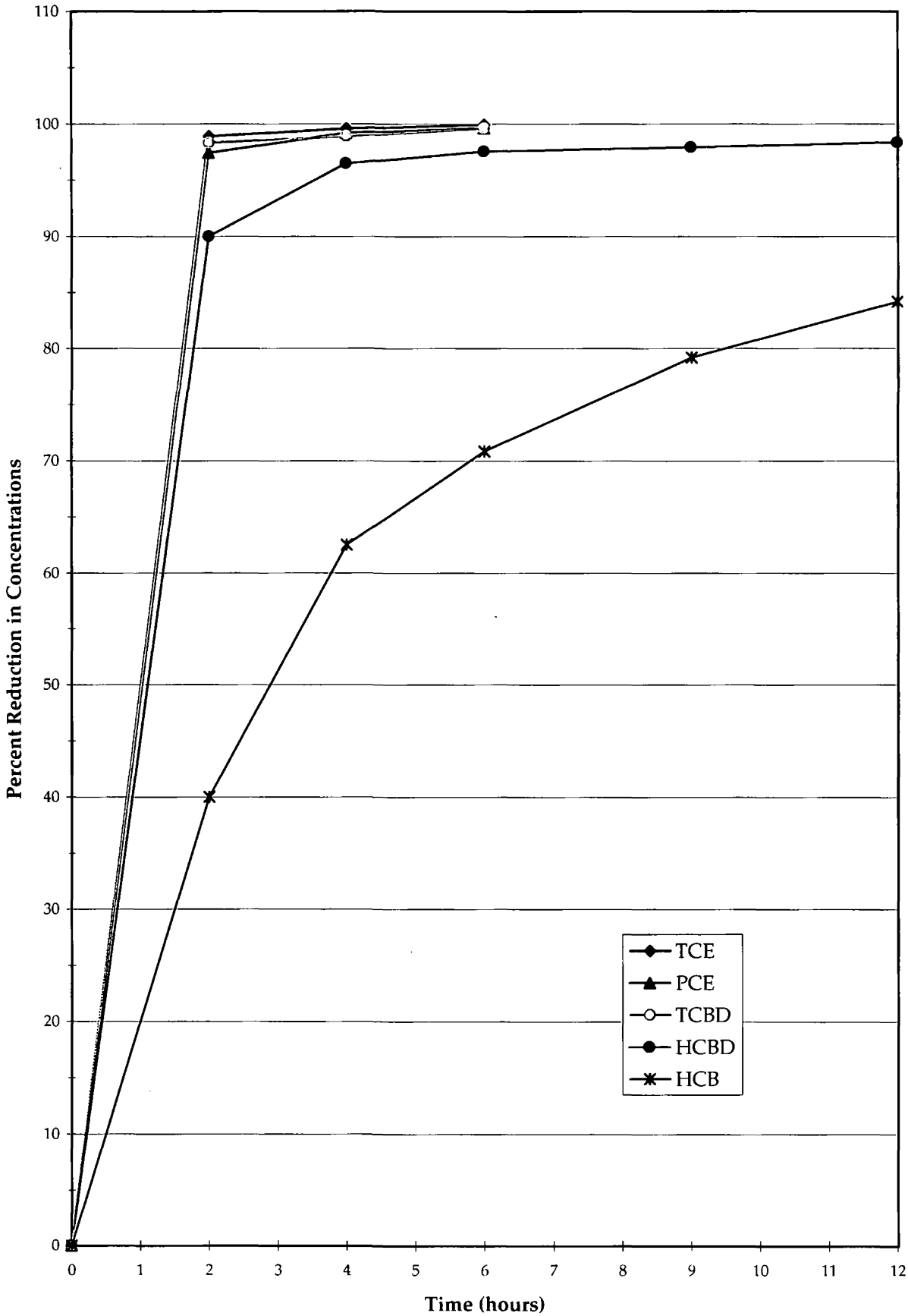

Figure 3.1a
Batch 9 Sediment Results
Bench Scale Treatability Study
Slurry Aeration of Area 5106 Sediment
OCC Tacoma, Inc. - Tacoma, Washington

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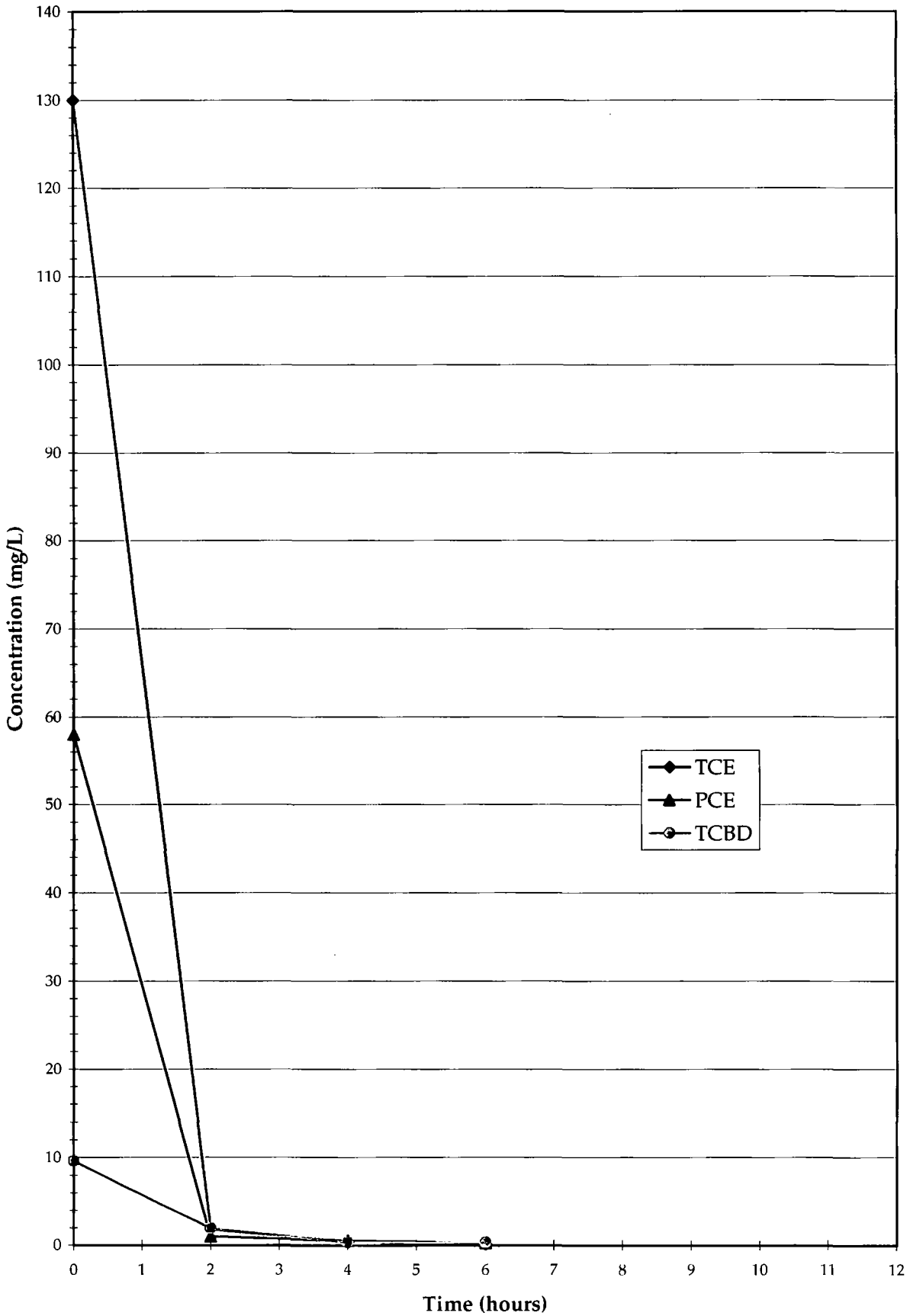

Figure 3.1b
Batch 9 Water VOC Results
Bench Scale Treatability Study
Slurry Aeration of Area 5106 Sediment
OCC Tacoma, Inc. - Tacoma, Washington

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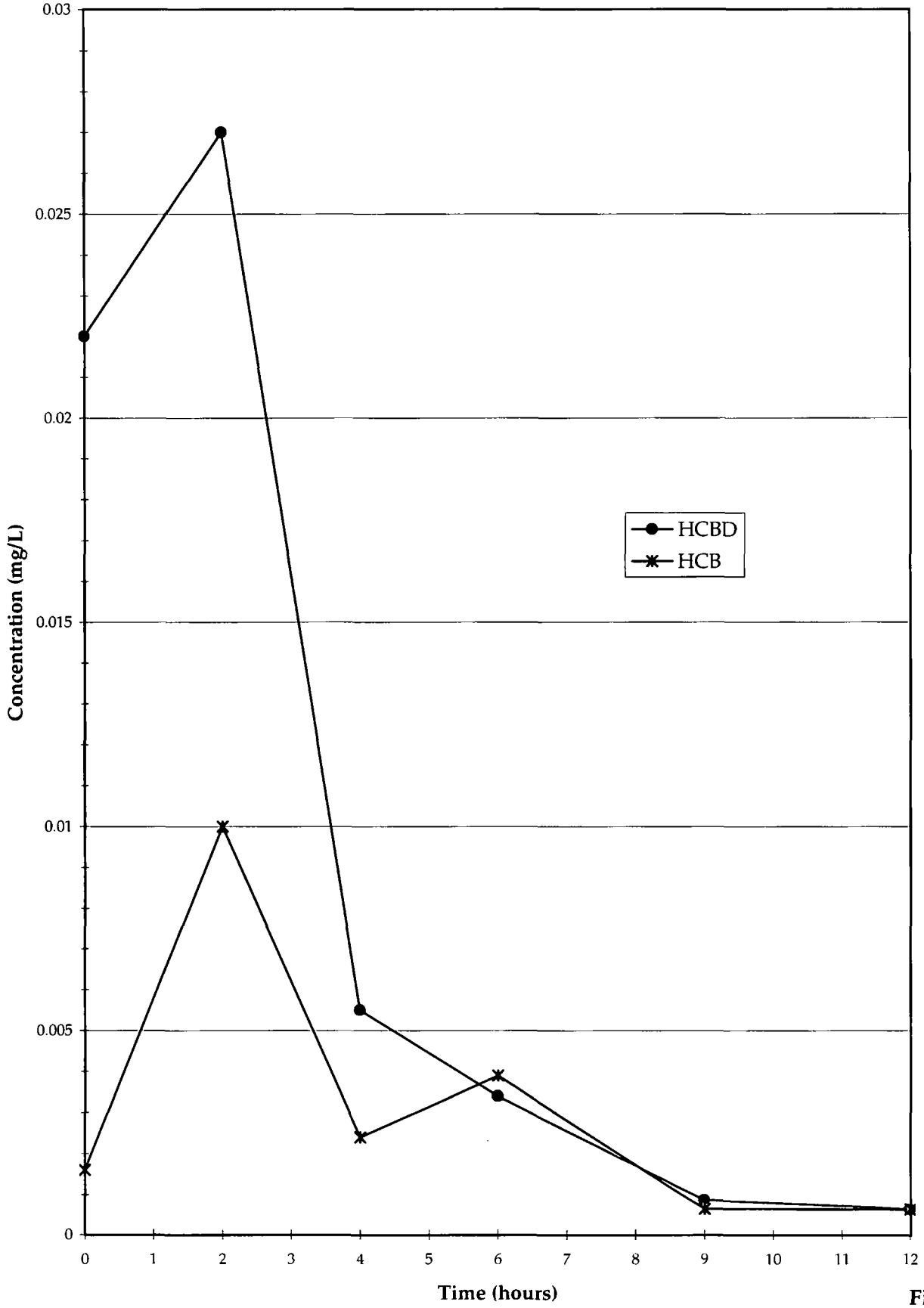

Figure 3.1c
Batch 9 Water SVOC Results
Bench Scale Treatability Study
Slurry Aeration of Area 5106 Sediment
OCC Tacoma, Inc. - Tacoma, Washington

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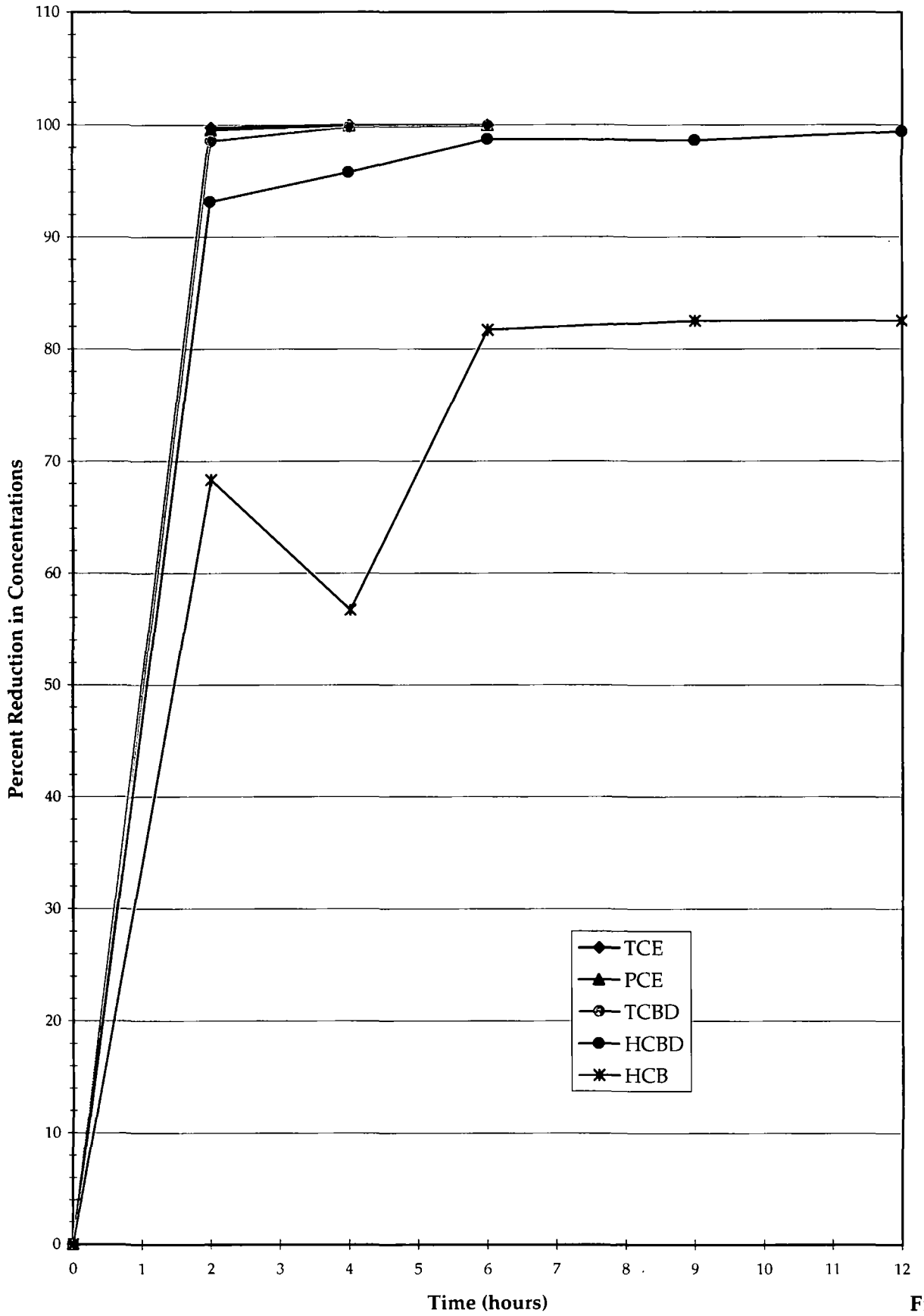

Figure 3.2a
Batch 10 Sediment Results
Bench Scale Treatability Study
Slurry Aeration of Area 5106 Sediment
OCC Tacoma, Inc. - Tacoma, Washington

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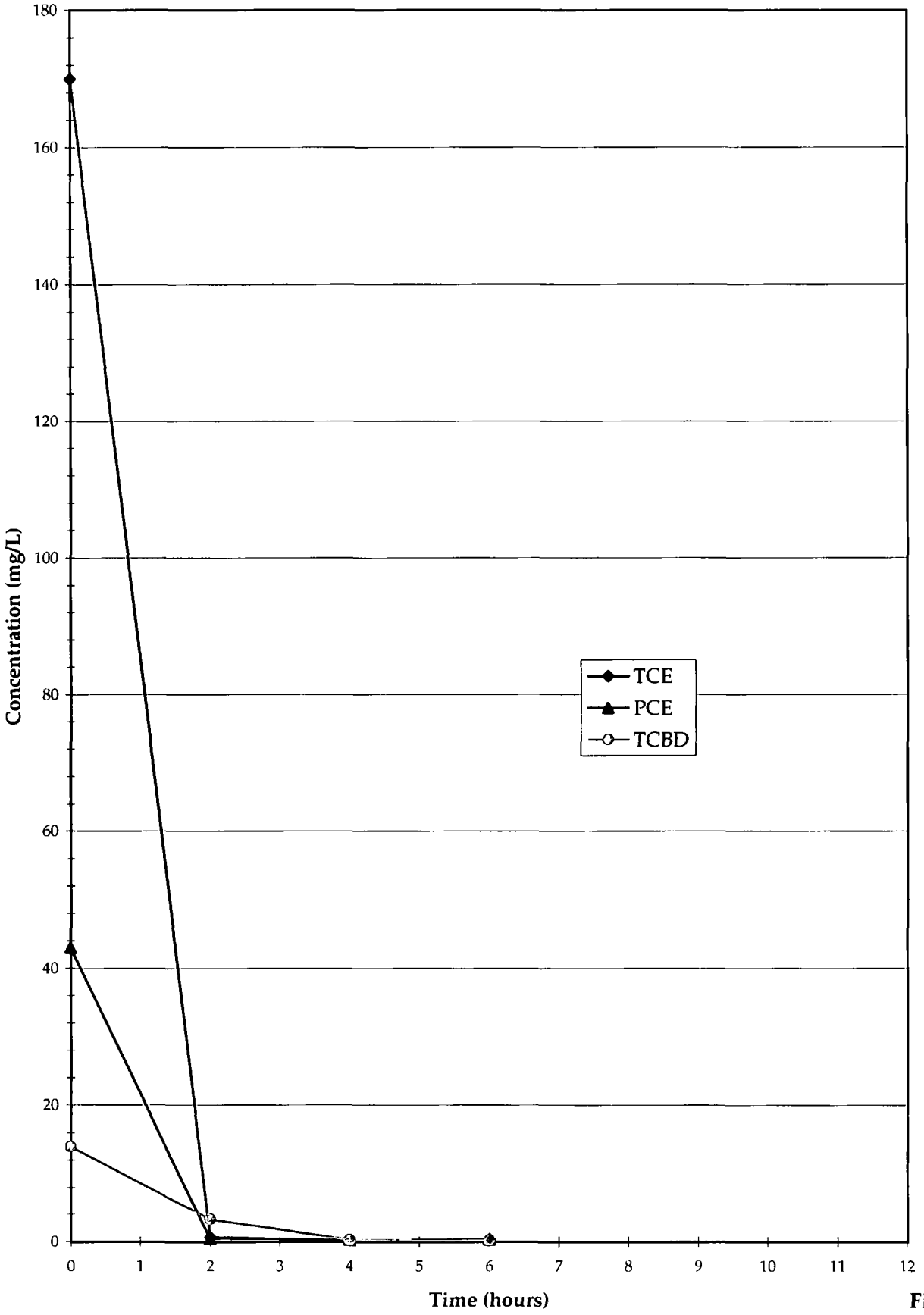

Figure 3.2b
Batch 10 Water VOC Results
Bench Scale Treatability Study
Slurry Aeratioin of Area 5106 Sediment
OCC Tacoma, Inc. - Tacoma, Washington

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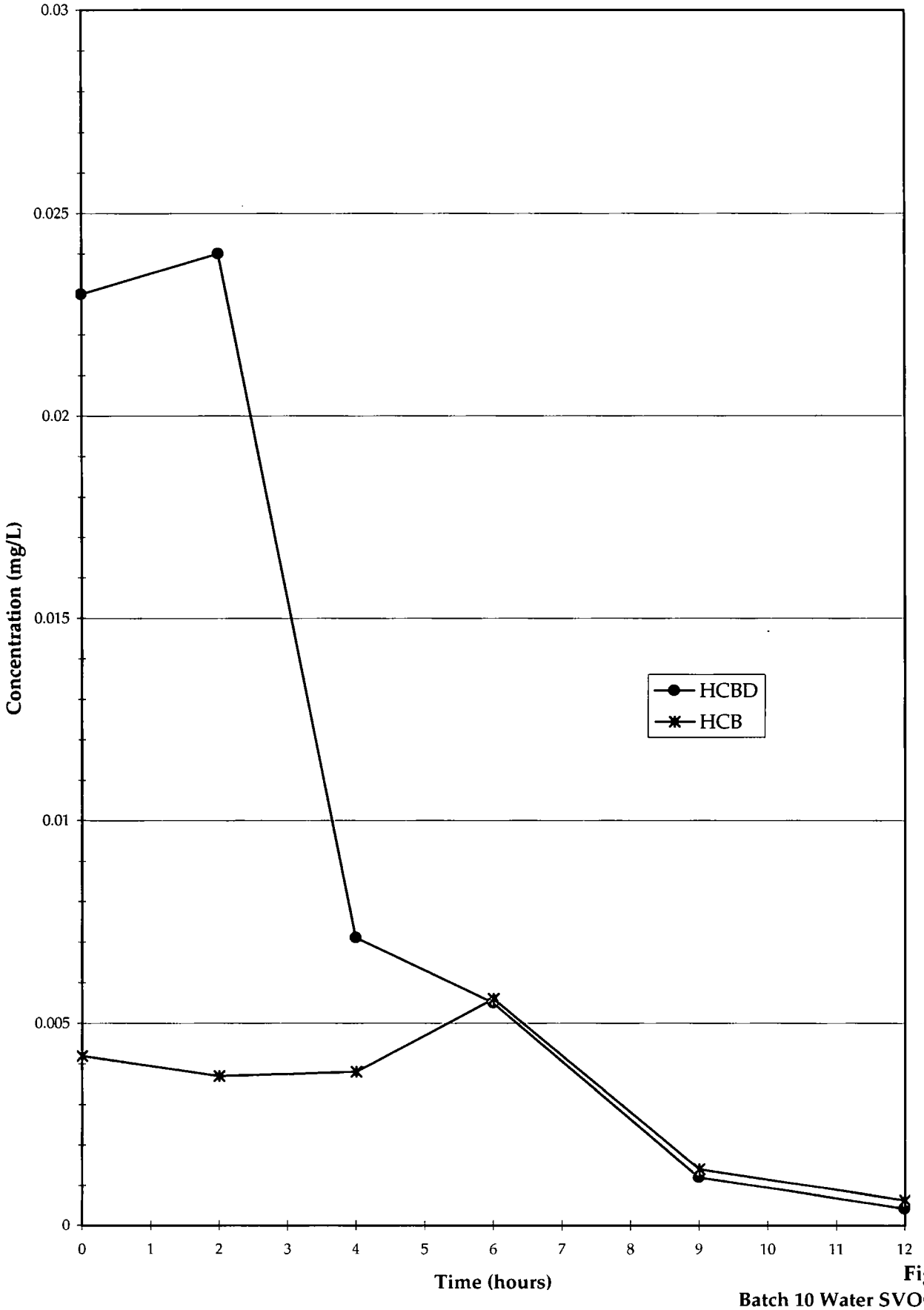

Figure 3.2c
Batch 10 Water SVOC Results
Bench Scale Treatability Study
Slurry Aeration of Area 5106 Sediment
OCC Tacoma, Inc. - Tacoma, Washington

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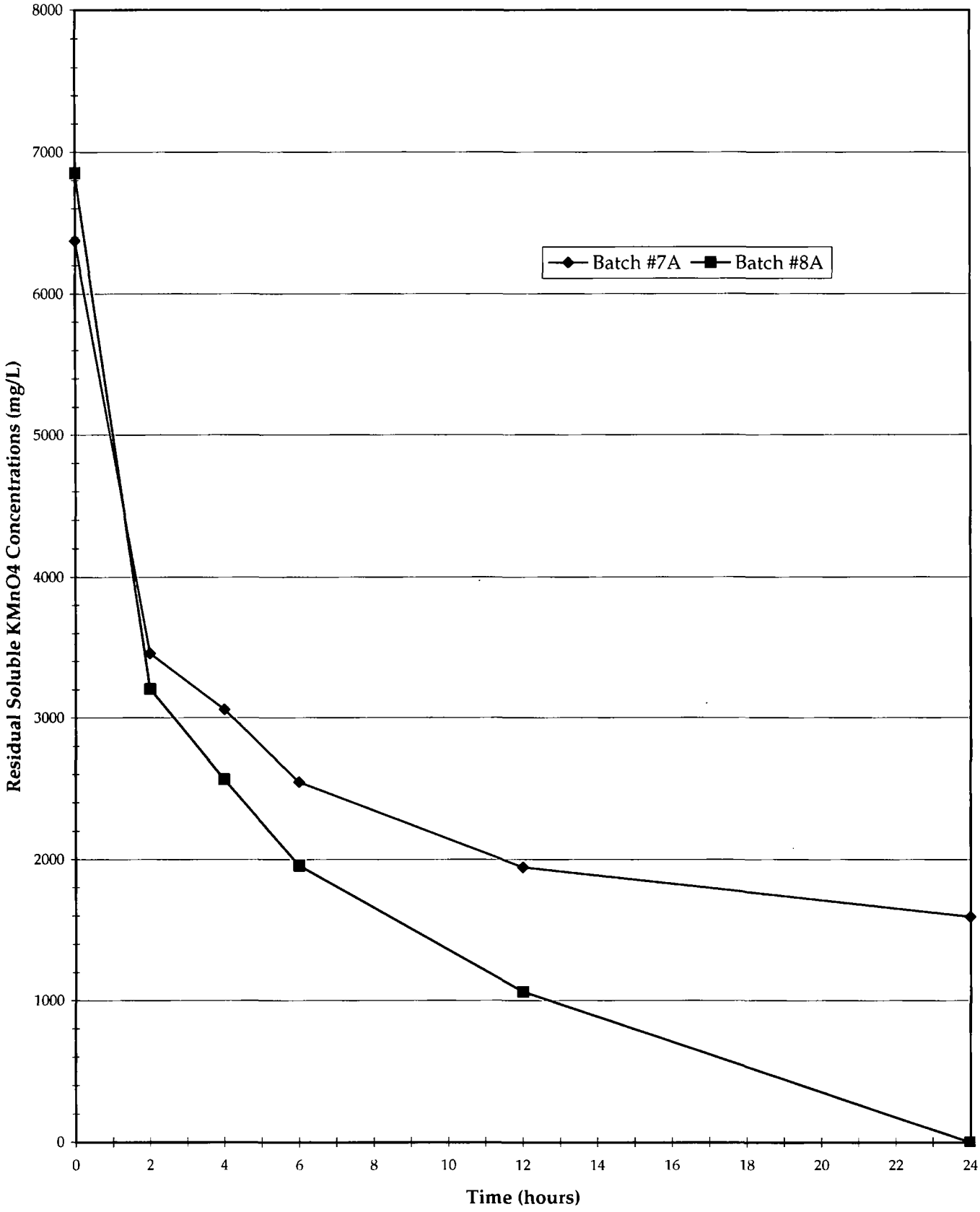

Figure 3.3
Residual Soluble $KMnO_4$ Concentrations
Bench Scale Treatability Study
Slurry Aeration of Area 5106 Sediment
OCC Tacoma, Inc. - Tacoma, Washington

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TABLES

TABLE 2.1

ANALYTICAL RESULTS SUMMARY - COMPOSITED SEDIMENT SAMPLES
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Parameters	*Sample ID:*	*Bucket #1*	*Bucket #2*	*Bucket #3*	*Bucket #4*	*Bucket #5*	*Bucket #6*	*Bucket #6*
	Collection Date:	*09/02/99*	*09/02/99*	*09/02/99*	*09/02/99*	*09/02/99*	*09/02/99*	*09/02/99*
	Units:	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*
	Target Concentration							*(Field Duplicate)*
SSPL Volatiles								
Vinyl chloride	≥3.6	ND 6.2	ND 6.2	ND 6.2	ND 5	ND 7.5	ND 7.5	ND 15
Trichloroethene	≥114	360	690	310	180	180	500	470
Tetrachloroethene	≥650	560	740	490	360	260	680	550
Tetrachlorobutadiene	-	440	590	360	140	120	420	380
Hexachlorobutadiene	≥31	41	86	46	15	2.5	34	27
SSPL Semi-Volatiles								
Hexachlorobenzene	≥2.9	0.34	2.0	2.8	0.8	2.7	2.7	2.7

Notes:
NDx Not detected at or above x.
SSPL Site-Specific Parameter List.
The sediment in each Bucket #1-6 was visual Area 5106 Sediment composited in the field from one to three cores depending on the quantity of visual Area 5106 Sediment observed and collected in each of the ten cores.

CRA 7431 (15) from
CRA 7431 (13)

TABLE 2.2

SUMMARY OF TEST BATCHES
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.	*Slurry Content (% Solids by Wt.)*	*Average Mixing Speed (RPM)*	*Impeller Type*	*Air Flow (L/Hr)*	*Temperature (°C)*	*Chemical Oxidant*	*Samples*	*Analytical*
Phase I								
Batch 1	10	1300	(1)	120	25	-	@ T = 0, 2, 4, 6, 12, 24 Hrs. @ T = 0, 6, 12, 24 Hrs.	Water and Solids - Table 2.4 VOCs Water and Solids - Table 2.4 SVOCs
Batch 2	10	1300	(1)	240	25	-	@ T = 0, 2, 4, 6, 12, 24 Hrs. @ T = 0, 6, 12, 24 Hrs.	Water and Solids - Table 2.4 VOCs Water and Solids - Table 2.4 SVOCs
Batch 3	10	1300	(1)	480	25	-	@ T = 0, 2, 4, 6, 12, 24 Hrs. @ T = 0, 6, 12, 24 Hrs.	Water and Solids - Table 2.4 VOCs Water and Solids - Table 2.4 SVOCs
Batch 4	15	1500	(1)	120	25	-	@ T = 0, 2, 4, 6, 12, 24 Hrs. @ T = 0, 6, 12, 24 Hrs.	Water and Solids - Table 2.4 VOCs Water and Solids - Table 2.4 SVOCs
Batch 5	15	1500	(1)	240	25	-	@ T = 0, 2, 4, 6, 12, 24 Hrs. @ T = 0, 6, 12, 24 Hrs.	Water and Solids - Table 2.4 VOCs Water and Solids - Table 2.4 SVOCs
Batch 6	15	1500	(1)	480	25	-	@ T = 0, 2, 4, 6, 12, 24 Hrs. @ T = 0, 6, 12, 24 Hrs.	Water and Solids - Table 2.4 VOCs Water and Solids - Table 2.4 SVOCs
Phase II								
Batch 7	10	1300	(1)	480	25	-	@ T = 0, 2, 4, 6, 12, 24 Hrs. @ T = 0, 6, 12, 24 Hrs.	Water and Solids - Table 2.4 VOCs Water and Solids - Table 2.4 SVOCs
Batch 7A	10	1300	(1)	-	25	100 gm	@ T = 2, 4, 6, 12, 24 Hrs.	Water and Solids - Table 2.4 SVOCs and Residual MnO_4
Batch 8	10	1300	(1)	480	45	-	@ T = 0, 2, 4, 6, 12, 24 Hrs. @ T = 0, 6, 12, 24 Hrs.	Water and Solids - Table 2.4 VOCs Water and Solids - Table 2.4 SVOCs
Batch 8A	10	1300	(1)	-	45	100 gm	@ T = 2, 4, 6, 12, 24 Hrs.	Water and Solids - Table 2.4 SVOCs and Residual MnO_4

TABLE 2.2

SUMMARY OF TEST BATCHES
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.	*Slurry Content (% Solids by Wt.)*	*Average Mixing Speed (RPM)*	*Impeller Type*	*Air Flow (L/Hr)*	*Temperature (°C)*	*Chemical Oxidant*	*Samples*	*Analytical*
Phase IIa								
Batch 9	10	1300	(2)	480	45	-	@ T = 0, 2, 4, 6 Hrs. @ T = 0, 2, 4, 6, 9, 12 Hrs.	Water and Solids - Table 2.4 VOCs Water and Solids - Table 2.4 SVOCs
Batch 10	15	1400	(2)	480	45	-	@ T = 0, 2, 4, 6 Hrs. @ T = 0, 2, 4, 6, 9, 12 Hrs.	Water and Solids - Table 2.4 VOCs Water and Solids - Table 2.4 SVOCs

Note:
MnO_4 Permanganate.
(1) Solids suspension impeller: Lightnin A 310, 2.5-inch diameter.
(2) Air diffusing impeller: Lightnin A 320, 2.5-inch diameter.

TABLE 2.3

ANALYTICAL RESULTS SUMMARY - HYLEBOS WATER
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Parameter	*Units*	*Sample I.D.: W-7431-081199-JW-001* *Collection Date: 08/11/99*
SSPL Volatiles		
1,1,2,3-Tetrachloro-1,3-butadiene (total)	µg/L	ND 0.5
1,1-Dichloroethene	µg/L	ND 0.5
cis-1,2-Dichloroethene	µg/L	ND 0.5
Ethylbenzene	µg/L	ND 0.5
Hexachlorobutadiene	µg/L	ND 0.5
Trichloroethene	µg/L	ND 0.5
Tetrachloroethene	µg/L	ND 0.5
trans-1,2-Dichloroethene	µg/L	ND 0.5
Vinyl chloride	µg/L	ND 0.5
Xylenes	µg/L	ND 0.5
SSPL Semi-Volatiles		
1,2,4-Trichlorobenzene	µg/L	ND 10
1,4-Dichlorobenzene	µg/L	ND 10
2,4-Dimethylphenol	µg/L	ND 10
2-Methylnaphthalene	µg/L	ND 10
2-Methylphenol	µg/L	ND 10
4-Methylphenol	µg/L	ND 10
Acenaphthylene	µg/L	ND 10
Acenaphthene	µg/L	ND 10
Anthracene	µg/L	ND 10
Benzo(a)anthracene	µg/L	ND 10
Benzo(a)pyrene	µg/L	ND 10
Benzo(b)fluoranthene	µg/L	ND 10
Benzo(g,h,i)perylene	µg/L	ND 10
Benzo(k)fluoranthene	µg/L	ND 10
bis(2-Ethylhexyl)phthalate	µg/L	ND 10
Carbazole	µg/L	ND 10
Chrysene	µg/L	ND 10
Dibenzo(a,h)anthracene	µg/L	ND 10
Dibenzofuran	µg/L	ND 10
Fluoranthene	µg/L	ND 10
Fluorene	µg/L	ND 10
hexachlorobenzene	µg/L	ND 10
Hexachlorobutadiene	µg/L	ND 10
Indeno(1,2,3-cd)pyrene	µg/L	ND 10
Naphthalene	µg/L	ND 10
Pentachlorophenol	µg/L	ND 10
Phenanthrene	µg/L	ND 10

CRA 7431 (15) from
CRA 7431 (13)

TABLE 2.3

ANALYTICAL RESULTS SUMMARY - HYLEBOS WATER
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

	Sample I.D.:	*W-7431-081199-JW-001*
	Collection Date:	*08/11/99*
Parameter	*Units*	
Phenol	µg/L	ND 10
Pyrene	µg/L	ND 10
TAL Metals		
Aluminum	µg/L	ND 100
Antimony	µg/L	ND 5
Arsenic	µg/L	ND 5
Barium	µg/L	6.2
Beryllium	µg/L	ND 2
Cadmium	µg/L	ND 5
Calcium	µg/L	352000
Chromium	µg/L	ND 5
Cobalt	µg/L	ND 5
Copper	µg/L	25.8
Iron	µg/L	55.9
Lead	µg/L	4.2
Magnesium	µg/L	1110000
Manganese	µg/L	12.4
Nickel	µg/L	ND 5
Selenium	µg/L	ND 5
Silver	µg/L	ND 1
Thallium	µg/L	ND 5
Vanadium	µg/L	ND 5
Zinc	µg/L	ND 50
Mercury	µg/L	0.3
Potassium	µg/L	328
Sodium	µg/L	12000
General Chemistry		
pH	s.u.	7.8
TSS	mg/L	ND 10
TOC	mg/L	ND 1

Notes:

NDx	Not detected at or above x.
s.u.	Standard Units.
SSPL	Site-Specific Parameter List.
TAL	Target Analyte List.
TOC	Total Organic Compounds.
TSS	Total Suspended Solids.

CRA 7431 (15) from
CRA 7431 (13)

TABLE 2.4

CHEMICAL PARAMETERS AND ANALYTICAL METHODS
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Chemical Parameters	*Analytical Methods*
VOCs	
Vinyl chloride	SW-846 8021
1,1-Dichloroethene	SW-846 8021
trans-1,2-Dichloroethene	SW-846 8021
cis-1,2-Dichloroethene	SW-846 8021
Trichloroethene	SW-846 8021
Tetrachloroethene	SW-846 8021
Ethylbenzene	SW-846 8021
m,p-Xylene	SW-846 8021
SVOCs	
Hexachlorobutadiene	SW-846 8081
Hexachlorobenzene	SW-846 8081
General Chemistry	
pH	SW-846 9045/9040

Notes:
SVOCs Semi-Volatile Organic Compounds.
VOCs Volatile Organic Compounds.

TABLE

BATCH 1 [1]

ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

SEDIMENT

Parameters	Units	T-0 09/13/99	T-2 09/13/99	Percent Reduction 2 Hrs.	T-4 09/13/99	Percent Reduction 4 Hrs.	T-6 09/13/99	Percent Reduction 6 Hrs.	T-12 09/14/99	Percent Reduction 12 Hrs.	T-24 09/14/99	Percent Reduction 24 Hrs.
SSPL Volatiles												
Vinyl chloride	mg/Kg	ND 110	ND 48		ND 48		ND 0.17		ND 0.13		ND 0.13	
1,1-Dichloroethene	mg/Kg	ND 110	R		R		ND 0.17		ND 0.13		ND 0.13	
trans-1,2-Dichloroethene	mg/Kg	ND 110	ND 48		ND 48		ND 0.17		ND 0.13		ND 0.13	
cis-1,2-Dichloroethene	mg/Kg	ND 110	ND 48		ND 48		ND 0.17		ND 0.13		ND 0.13	
Trichloroethene	mg/Kg	1000	21	97.90	14	98.60	1.7	99.83	0.65	99.94	0.42	99.96
Tetrachloroethene	mg/Kg	2600 J	83	96.81	23	99.12	20	99.23	3.1	99.88	1.2 J	99.95
Ethyl benzene	mg/Kg	ND 110	ND 48		ND 48		ND 0.17		ND 0.13		ND 0.13	
Xylene (total)	mg/Kg	ND 110	ND 48		ND 48		ND 0.17		ND 0.13		ND 0.13	
Tetrachlorobutadiene isomers [2]	mg/Kg	5200	2800	46.15	1200	76.92	780	85.00	110	97.88	13	99.75
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/Kg	69	-		-		30	56.52	7.6	88.99	1.9	97.25
Hexachlorobenzene	mg/Kg	2.5	-		-		3.4 J	-36.00	3.0 J	-20.00	2.5	0.00

WATER

Parameters	Units	T-0 09/13/99	T-2 09/13/99	Percent Reduction 2 Hrs.	T-4 09/13/99	Percent Reduction 4 Hrs.	T-6 09/13/99	Percent Reduction 6 Hrs.	T-12 09/14/99	Percent Reduction 12 Hrs.	T-24 09/14/99	Percent Reduction 24 Hrs.
SSPL Volatiles												
Vinyl chloride	mg/L	ND 0.50	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
1,1-Dichloroethene	mg/L	ND 0.50	R		R		ND 0.10		ND 0.050		ND 0.010	
trans-1,2-Dichloroethene	mg/L	ND 0.50	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
cis-1,2-Dichloroethene	mg/L	0.28 J	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Trichloroethene	mg/L	88	1.8	97.95	0.70	99.20	0.29	99.67	0.078	99.91	0.019	99.98
Tetrachloroethene	mg/L	30 J	4.8	84.00	0.92	96.93	0.35	98.83	0.14	99.53	0.022 J	99.93
Ethyl benzene	mg/L	0.13 J	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Xylene (total)	mg/L	ND 0.50	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Tetrachlorobutadiene isomers [2]	mg/L	20	39	-95.00	27	-35.00	16	20.00	2.5	87.50	0.14	99.30
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/L	0.019	-		-		0.15	-689.47	0.030	-57.89	0.0024	87.37
Hexachlorobenzene	mg/L	0.0012	-		-		0.015	-1150.00	0.0070	-483.33	0.0020	-66.67

Notes:

- Not analyzed.
J Estimated.
NDx Not detected at or above x.
R Rejected.
SSPL Site-Specific Parameter List.

[1] Batch 1 Parameters:
Slurry Content: 10% (solids by weight)
Slurry Temperature: 25°C
Air Flow: 120 liters/hour

[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.

CRA 7431 (15) from
CRA 7431 (13)

TABLE 3.2

BATCH 2 [1]

ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

SEDIMENT

Parameters	Units	T-0 09/13/99	T-2 09/13/99	% Reduction 2 Hrs.	T-4 09/13/99	% Reduction 4 Hrs.	T-6 09/13/99	% Reduction 6 Hrs.	T-12 09/14/99	% Reduction 12 Hrs.	T-24 09/14/99	% Reduction 24 Hrs.
SSPL Volatiles												
Vinyl chloride	mg/Kg	ND 110	ND 45		ND 54		ND 0.18		ND 0.14		ND 0.14	
1,1-Dichloroethene	mg/Kg	ND 110	R		R		ND 0.18		ND 0.14		R	
trans-1,2-Dichloroethene	mg/Kg	ND 110	ND 45		ND 54		ND 0.18		ND 0.14		ND 0.14	
cis-1,2-Dichloroethene	mg/Kg	ND 110	ND 45		ND 54		ND 0.18		ND 0.14		ND 0.14	
Trichloroethene	mg/Kg	910	14	**98.46**	15	**98.35**	1.1	**99.88**	0.64	**99.93**	0.19	**99.98**
Tetrachloroethene	mg/Kg	2300 J	40	**98.26**	ND 54		13	**99.43**	3.4 J	**99.85**	1.1	**99.95**
Ethyl benzene	mg/Kg	ND 110	ND 45		ND 54		ND 0.18		ND 0.14		ND 0.14	
Xylene (total)	mg/Kg	ND 110	ND 45		ND 54		ND 0.18		ND 0.14		ND 0.14	
Tetrachlorobutadiene isomers [2]	mg/Kg	5500	2000	**63.64**	730	**86.73**	500	**90.91**	54	**99.02**	13	**99.76**
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/Kg	50	-		-		26	**48.00**	7.0	**86.00**	1.9	**96.20**
Hexachlorobenzene	mg/Kg	1.9	-		-		4.8	**-152.63**	3.2 J	**-68.42**	2.5	**-31.58**

WATER

Parameters	Units	T-0 09/13/99	T-2 09/13/99	% Reduction 2 Hrs.	T-4 09/13/99	% Reduction 4 Hrs.	T-6 09/13/99	% Reduction 6 Hrs.	T-12 09/14/99	% Reduction 12 Hrs.	T-24 09/14/99	% Reduction 24 Hrs.
SSPL Volatiles												
Vinyl chloride	mg/L	ND 0.50	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
1,1-Dichloroethene	mg/L	ND 0.50	R		R		ND 0.10		ND 0.050		R	
trans-1,2-Dichloroethene	mg/L	ND 0.50	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
cis-1,2-Dichloroethene	mg/L	0.21 J	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Trichloroethene	mg/L	77	0.76	**99.01**	0.42	**99.45**	0.16	**99.79**	0.028	**99.96**	0.012	**99.98**
Tetrachloroethene	mg/L	30	2.5	**91.67**	0.76	**97.47**	0.34	**98.87**	0.036	**99.88**	0.034	**99.89**
Ethyl benzene	mg/L	0.13 J	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Xylene (total)	mg/L	ND 0.50	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Tetrachlorobutadiene isomers [2]	mg/L	21	33	**-57.14**	22	**-4.76**	11	**47.62**	0.74	**96.48**	0.15	**99.29**
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/L	0.029	-		-		0.19	**-555.17**	0.028	**3.45**	0.0062	**78.62**
Hexachlorobenzene	mg/L	0.0018	-		-		0.022	**-1122.22**	0.0089	**-394.44**	0.0039	**-116.67**

Notes:

- \- Not analyzed.
- J Estimated.
- NDx Not detected at or above x.
- R Rejected.
- SSPL Site-Specific Parameter List.

[1] Batch 1 Parameters:
Slurry Content: 10% (solids by weight)
Slurry Temperature: 25°C
Air Flow: 240 liters/hour

[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.

CRA 7431 (15) from
CRA 7431 (13)

TABLE 3

BATCH 3 [1]

ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

SEDIMENT

Parameters	*Units*	*T-0* 09/13/99	*T-2* 09/13/99	*Percent Reduction 2 Hrs.*	*T-4* 09/13/99	*Percent Reduction 4 Hrs.*	*T-6* 09/13/99	*Percent Reduction 6 Hrs.*	*T-12* 09/14/99	*Percent Reduction 12 Hrs.*	*T-24* 09/14/99	*Percent Reduction 24 Hrs.*
SSPL Volatiles												
Vinyl chloride	mg/Kg	ND 120	ND 50		ND 59		ND 0.14		ND 0.14		ND 0.09	
1,1-Dichloroethene	mg/Kg	ND 120 J	R		R		ND 0.14 J		R		R	
trans-1,2-Dichloroethene	mg/Kg	ND 120	ND 50		ND 59		ND 0.14		ND 0.14		ND 0.09	
cis-1,2-Dichloroethene	mg/Kg	ND 120	ND 50		ND 59		ND 0.14		ND 0.14		ND 0.09	
Trichloroethene	mg/Kg	680	ND 50		ND 59		1.3	**99.81**	0.91	**99.87**	0.33	**99.95**
Tetrachloroethene	mg/Kg	1700 J	23	**98.65**	ND 59		12	**99.29**	6.4	**99.62**	0.68	**99.96**
Ethyl benzene	mg/Kg	ND 120	ND 50		ND 59		ND 0.14		ND 0.14		ND 0.09	
Xylene (total)	mg/Kg	ND 120	ND 50		ND 59		ND 0.14		ND 0.14		ND 0.09	
Tetrachlorobutadiene isomers [2]	mg/Kg	5000	1000	**80.00**	300	**94.00**	170	**96.60**	39	**99.22**	5.4	**99.89**
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/Kg	57	-		-		12	**78.95**	3.5	**93.86**	1.4	**97.54**
Hexachlorobenzene	mg/Kg	2.1	-		-		3.3	**-57.14**	2.7 J	**-28.57**	2.2	**-4.76**

WATER

Sample Time: Collection Date:		*T-0* 09/13/99	*T-2* 09/13/99	*Percent Reduction 2 Hrs.*	*T-4* 09/13/99	*Percent Reduction 4 Hrs.*	*T-6* 09/13/99	*Percent Reduction 6 Hrs.*	*T-12* 09/14/99	*Percent Reduction 12 Hrs.*	*T-24* 09/14/99	*Percent Reduction 24 Hrs.*
SSPL Volatiles												
Vinyl chloride	mg/L	ND 0.50	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
1,1-Dichloroethene	mg/L	ND 0.50 J	R		R		ND 0.10		ND 0.050 J		R	
trans-1,2-Dichloroethene	mg/L	ND 0.50	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
cis-1,2-Dichloroethene	mg/L	0.12 J	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Trichloroethene	mg/L	64	0.45	**99.30**	0.32	**99.50**	0.21	**99.67**	0.036	**99.94**	0.016	**99.98**
Tetrachloroethene	mg/L	24	1.6	**93.33**	0.60	**97.50**	0.50	**97.92**	0.070	**99.71**	0.013	**99.95**
Ethyl benzene	mg/L	0.11 J	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Xylene (total)	mg/L	ND 0.50	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Tetrachlorobutadiene isomers [2]	mg/L	18	22	**-22.22**	6.4	**64.44**	2.1	**88.33**	0.33	**98.17**	0.038	**99.79**
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/L	0.021	-		-		0.027	**-28.57**	0.0058	**72.38**	0.0035	**83.33**
Hexachlorobenzene	mg/L	0.0015	-		-		0.0045	**-200.00**	0.0025	**-66.67**	0.0028	**-86.67**

Notes:

- \- Not analyzed.
- J Estimated.
- NDx Not detected at or above x.
- R Rejected.
- SSPL Site-Specific Parameter List.

[1] Batch 3 Parameters:
Slurry Content: 10% (solids by weight)
Slurry Temperature: 25°C
Air Flow: 480 liters/hour

[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.

CRA 7431 (15) from
CRA 7431 (13)

TABLE 5.4

BATCH 4 [1]

ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Sediment

Parameters	Units	T-0 09/16/99	T-0 09/16/99 (Field Dup)	T-2 09/16/99	Percent Reduction (2 Hrs.)	T-4 09/16/99	Percent Reduction (4 Hrs.)	T-6 09/17/99	Percent Reduction (6 Hrs.)	T-12 09/17/99	Percent Reduction (12 Hrs.)	T-12 09/17/99 (Field Dup)	T-24 09/17/99	Percent Reduction (24 Hrs.)
SSPL Volatiles														
Vinyl chloride	mg/Kg	ND 23	ND 23	ND 45		ND 45		ND 9.1		ND 9.1		-	ND 9.1	
1,1-Dichloroethene	mg/Kg	R	R	R		R		R		R		-	R	
trans-1,2-Dichloroethene	mg/Kg	ND 23	ND 23	ND 45		ND 45		ND 9.1		ND 9.1		-	ND 9.1	
cis-1,2-Dichloroethene	mg/Kg	ND 23	ND 23	ND 45		ND 45		ND 9.1		ND 9.1		-	ND 9.1	
Trichloroethene	mg/Kg	1500	2300	20	**98.67**	14	**99.07**	17	**98.87**	17	**98.87**	-	1.0	**99.93**
Tetrachloroethene	mg/Kg	2900	4000	150	**94.83**	59	**97.97**	15	**99.48**	91	**96.86**	-	5.0	**99.83**
Ethyl benzene	mg/Kg	ND 23	ND 23	ND 45		ND 45		ND 9.1		ND 9.1		-	ND 9.1	
Xylene (total)	mg/Kg	ND 23	ND 23	ND 45		ND 45		ND 9.1		ND 9.1		-	ND 9.1	
Tetrachlorobutadiene isomers [2]	mg/Kg	6800	8200	5400	**20.59**	5000	**26.47**	1200	**82.35**	2800	**58.82**	-	13	**99.81**
SSPL Semi-Volatiles														
Hexachlorobutadiene	mg/Kg	160 J	-	-		-		60 J	**62.50**	69	**56.88**	60	11	**93.13**
Hexachlorobenzene	mg/Kg	12 J	-	-		-		5.5	**54.17**	4.7	**60.83**	4.8	3.2	**73.33**

Water

Parameters	Units	T-0 09/16/99	T-0 09/16/99 (Field Dup)	T-2 09/16/99	Percent Reduction (2 Hrs.)	T-4 09/16/99	Percent Reduction (4 Hrs.)	T-6 09/17/99	Percent Reduction (6 Hrs.)	T-12 09/17/99	Percent Reduction (12 Hrs.)	T-12 09/17/99 (Field Dup)	T-24 09/17/99	Percent Reduction (24 Hrs.)
SSPL Volatiles														
Vinyl chloride	mg/L	ND 2.0	0.82J	ND 0.50		ND 0.50		ND 0.10		ND 0.050		-	ND 0.050	
1,1-Dichloroethene	mg/L	R	R	R		R		R		R		-	R	
trans-1,2-Dichloroethene	mg/L	ND 2.0	ND 2.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		-	ND 0.050	
cis-1,2-Dichloroethene	mg/L	0.68	0.64 J	ND 0.50		ND 0.50		ND 0.10		ND 0.050		-	ND 0.050	
Trichloroethene	mg/L	140	140	2.7	**98.07**	1.8	**98.71**	1.6	**98.86**	3.6	**97.43**	-	0.12	**99.91**
Tetrachloroethene	mg/L	52	47	6.2	**88.08**	2.5	**95.19**	1.9	**96.35**	4.7	**90.96**	-	0.24 J	**99.54**
Ethyl benzene	mg/L	ND 2.0	ND 2.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		-	ND 0.050	
Xylene (total)	mg/L	ND 2.0	ND 2.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		-	ND 0.050	
Tetrachlorobutadiene isomers [2]	mg/L	16	16	42	**-162.50**	38	**-137.50**	21	**-31.25**	27	**-68.75**	-	1.9	**88.13**
SSPL Semi-Volatiles														
Hexachlorobutadiene	mg/L	0.051	-	-		-		0.14	**-174.51**	0.072	**-41.18**	0.096	0.084	**-64.71**
Hexachlorobenzene	mg/L	0.0033	-	-		-		0.0066 J	**-100.00**	0.0038 J	**-15.15**	0.0054 J	0.017 J	**-415.15**

Notes:

- \- Not analyzed.
- J Estimated.
- NDx Not detected at or above x.
- R Rejected.
- SSPL Site-Specific Parameter List.

[1] Batch 4 Parameters:
Slurry Content: 15% (solids by weight)
Slurry Temperature: 25°C
Air Flow: 120 liters/hour

[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.

CRA 7431 (15) from
CRA 7431 (13)

TABLE 5.5

BATCH 5 [1]

ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Sediment

Parameters	*Units*	*T-0* 09/16/99	*T-0* 09/16/99 (Field Dup)	*T-2* 09/16/99	*Percent Reduction* (2 Hrs.)	*T-4* 09/16/99	*Percent Reduction* (4 Hrs.)	*T-6* 09/17/99	*Percent Reduction* (6 Hrs.)	*T-12* 09/17/99	*Percent Reduction* (12 Hrs.)	*T-24* 09/17/99	*Percent Reduction* (24 Hrs.)
SSPL Volatiles													
Vinyl chloride	mg/Kg	ND 120	-	ND 50		ND 50		ND 10		ND 10		ND 0.22	
1,1-Dichloroethene	mg/Kg	R	-	R		R		R		R		R	
trans-1,2-Dichloroethene	mg/Kg	ND 120	-	ND 50		ND 50		ND 10		ND 10		ND 0.22	
cis-1,2-Dichloroethene	mg/Kg	ND 120	-	ND 50		ND 50		ND 10		ND 10		ND 0.22	
Trichloroethene	mg/Kg	2800	-	21	**99.25**	6.0	**99.79**	55	**98.04**	6.0	**99.79**	0.90	**99.97**
Tetrachloroethene	mg/Kg	5000 J	-	140 J	**97.20**	28 J	**99.44**	390 J	**92.20**	28	**99.44**	1.6	**99.97**
Ethyl benzene	mg/Kg	ND 120	-	ND 50		ND 50		ND 10		ND 10		ND 0.22	
Xylene (total)	mg/Kg	ND 120	-	ND 50		ND 50		ND 10		ND 10		ND 0.22	
Tetrachlorobutadiene isomers [2]	mg/Kg	12000	-	5500	**54.17**	3100	**74.17**	8500	**29.17**	280	**97.67**	25	**99.79**
SSPL Semi-Volatiles													
Hexachlorobutadiene	mg/Kg	180 J	230	-		-		370 J	**-105.56**	14	**92.22**	4.9	**97.28**
Hexachlorobenzene	mg/Kg	14 J	15	-		-		24	**-71.43**	4.5	**67.86**	2.9	**79.29**

Water

	Sample Time: Collection Date:	*T-0* 09/16/99	*T-0* 09/16/99 (Field Dup)	*T-2* 09/16/99	*Percent Reduction* 2 hours	*T-4* 09/16/99	*Percent Reduction* 4 hours	*T-6* 09/17/99	*Percent Reduction* 6 hours	*T-12* 09/17/99	*Percent Reduction* 12 hours	*T-24* 09/17/99	*Percent Reduction* 24 hours
SSPL Volatiles													
Vinyl chloride	mg/L	ND 2.0	-	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
1,1-Dichloroethene	mg/L	R	-	R		R		R		R		R	
trans-1,2-Dichloroethene	mg/L	ND 2.0	-	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
cis-1,2-Dichloroethene	mg/L	0.64 J	-	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Trichloroethene	mg/L	130	-	2.4	**98.15**	1.1	**99.15**	2.8	**97.85**	0.17	**99.87**	0.20	**99.85**
Tetrachloroethene	mg/L	45	-	4.6	**89.78**	2.2	**95.11**	2.8	**93.78**	0.27 J	**99.40**	0.27 J	**99.40**
Ethyl benzene	mg/L	ND 2.0	-	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Xylene (total)	mg/L	ND 2.0	-	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Tetrachlorobutadiene isomers [2]	mg/L	13	-	40	**-207.69**	37	**-184.62**	17	**-30.77**	8.6	**33.85**	1.0	**92.31**
SSPL Semi-Volatiles													
Hexachlorobutadiene	mg/L	0.031	0.043	-		-		1.32	**-4158.06**	0.022	**29.03**	0.013	**58.06**
Hexachlorobenzene	mg/L	*0.0022*	*0.0030*	-		-		0.12 J	**-5354.55**	0.0040 J	**-81.82**	0.0061 J	**-177.27**

Notes:

- \- Not analyzed.
- J Estimated.
- NDx Not detected at or above x.
- R Rejected.
- SSPL Site-Specific Parameter List.

[1] Batch 5 Parameters:
Slurry Content: 15% (solids by weight)
Slurry Temperature: 25°C
Air Flow: 240 liters/hour

[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.

CRA 7431 (15) from
CRA 7431 (13)

TABLE 3.6

BATCH 6 [1]

ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

		Sediment										
Parameters	*Sample Time: Collection Date: Units*	*T-0 09/16/99*	*T-2 09/16/99*	*Percent Reduction (2 Hrs.)*	*T-4 09/16/99*	*Percent Reduction (4 Hrs.)*	*T-6 09/17/99*	*Percent Reduction (6 Hrs.)*	*T-12 09/17/99*	*Percent Reduction (12 Hrs.)*	*T-24 09/17/99*	*Percent Reduction (24 Hrs.)*
SSPL Volatiles												
Vinyl chloride	mg/Kg	ND 50	ND 50		ND 50		ND 10		ND 10		ND 0.22	
1,1-Dichloroethene	mg/Kg	R	R		R		R		R		R	
trans-1,2-Dichloroethene	mg/Kg	ND 50	ND 50		ND 50		ND 10		ND 10		ND 0.22	
cis-1,2-Dichloroethene	mg/Kg	ND 50	ND 50		ND 50		ND 10		ND 10		ND 0.22	
Trichloroethene	mg/Kg	2000	22	**98.90**	15	**99.25**	7.0	**99.65**	8.0	**99.60**	1.1	**99.95**
Tetrachloroethene	mg/Kg	4700 J	110 J	**97.66**	42	**99.11**	16 J	**99.66**	20	**99.57**	2.0	**99.96**
Ethyl benzene	mg/Kg	ND 50	ND 50		ND 50		ND 10		ND 10		ND 0.22	
Xylene (total)	mg/Kg	ND 50	ND 50		ND 50		ND 10		ND 10		ND 0.22	
Tetrachlorobutadiene isomers [2]	mg/Kg	20000	7500	**62.50**	6500	**67.50**	1200	**94.00**	95	**99.53**	11	**99.95**
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/Kg	220 J	-		-		83 J	**62.27**	57	**74.09**	2.3	**98.95**
Hexachlorobenzene	mg/Kg	15	-		-		11	**26.67**	5.4	**64.00**	1.9	**87.33**

		Water										
	Sample Time: Collection Date:	*T-0 09/16/99*	*T-2 09/16/99*	*Percent Reduction (2 Hrs.)*	*T-4 09/16/99*	*Percent Reduction (4 Hrs.)*	*T-6 09/17/99*	*Percent Reduction (6 Hrs.)*	*T-12 09/17/99*	*Percent Reduction (12 Hrs.)*	*T-24 09/17/99*	*Percent Reduction (24 Hrs.)*
SSPL Volatiles												
Vinyl chloride	mg/L	ND 2.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
1,1-Dichloroethene	mg/L	R	R		R		R		R		R	
trans-1,2-Dichloroethene	mg/L	ND 2.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
cis-1,2-Dichloroethene	mg/L	0.66 J	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Trichloroethene	mg/L	130	1.9	**98.54**	0.94	**99.28**	0.55	**99.58**	0.14	**99.89**	0.20	**99.85**
Tetrachloroethene	mg/L	43	2.9	**93.26**	1.10	**97.44**	1.0	**97.67**	0.28	**99.35**	0.22	**99.49**
Ethyl benzene	mg/L	ND 2.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Xylene (total)	mg/L	ND 2.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Tetrachlorobutadiene isomers [2]	mg/L	14	44	**-214.29**	33	**-135.71**	13	**7.14**	2.3	**83.57**	0.45	**96.79**
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/L	0.054	-		-		0.79	**-1362.96**	0.47	**-770.37**	0.0089	**83.52**
Hexachlorobenzene	mg/L	0.0043 J	-		-		0.098 J	**-2179.07**	0.035 J	**-713.95**	0.0030 J	**30.23**

Notes:
- \- Not analyzed.
- J Estimated.
- NDx Not detected at or above x.
- R Rejected.
- SSPL *Site-Specific Parameter List.*

[1] Batch 6 Parameters:
Slurry Content: 15% (solids by weight)
Slurry Temperature: 25°C
Air Flow: 480 liters/hour

[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.

CRA 7431 (15) from
CRA 7431 (13)

TABLE 8.7

BATCH 7[1]

ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

SEDIMENT

Parameters	Units	T-0 09/22/99	T-2 09/22/99	Percent Reduction 2 Hrs.	T-4 09/22/99	Percent Reduction 4 Hrs.	T-6 09/22/99	Percent Reduction 6 Hrs.	T-12 09/23/99	Percent Reduction 12 Hrs.	T-24 09/23/99	Percent Reduction 24 Hrs.
SSPL Volatiles												
Vinyl chloride	mg/Kg	ND 91	ND 23		ND 23		ND 0.14		ND 0.18		ND 0.14	
1,1-Dichloroethene	mg/Kg	R	R		R		R		R		R	
trans-1,2-Dichloroethene	mg/Kg	ND 91	ND 23		ND 23		ND 0.14		ND 0.18		ND 0.14	
cis-1,2-Dichloroethene	mg/Kg	ND 91	ND 23		ND 23		ND 0.14		ND 0.18		ND 0.14	
Trichloroethene	mg/Kg	1300	40	96.92	16	98.77	7.7E	99.41	2.40	99.82	1.4	99.89
Tetrachloroethene	mg/Kg	1400	73	94.79	27	98.07	29E	97.93	9.1E	99.35	2.4	99.83
Ethyl benzene	mg/Kg	ND 91	ND 23		ND 23		ND 0.14		ND 0.18		ND 0.14	
Xylene (total)	mg/Kg	ND 91	ND 23		ND 23		ND 0.14		ND 0.18		ND 0.14	
Tetrachlorobutadiene isomers[2]	mg/Kg	5500	2400	56.36	1400	74.55	540E	90.18	130E	97.64	24	99.56
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/Kg	140	-		-		14	90.00	5.5	96.07	1.2	99.14
Hexachlorobenzene	mg/Kg	12	-		-		3.3	72.50	2.3	80.83	1.6	86.67

WATER

Parameters	Units	T-0 09/22/99	T-2 09/22/99	Percent Reduction 2 Hrs.	T-4 09/22/99	Percent Reduction 4 Hrs.	T-6 09/22/99	Percent Reduction 6 Hrs.	T-12 09/23/99	Percent Reduction 12 Hrs.	T-24 09/23/99	Percent Reduction 24 Hrs.
SSPL Volatiles												
Vinyl chloride	mg/L	ND 5.0	0.13J		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
1,1-Dichloroethene	mg/L	R	R		R		R		R		R	
trans-1,2-Dichloroethene	mg/L	ND 5.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
cis-1,2-Dichloroethene	mg/L	ND 5.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Trichloroethene	mg/L	140	2.4	98.29	0.30	99.79	0.54	99.61	0.18	99.87	0.03	99.98
Tetrachloroethene	mg/L	35	2.0 J	94.29	0.80 J	97.71	0.82 J	97.66	0.28 J	99.20	0.018	99.95
Ethyl benzene	mg/L	ND 5.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Xylene (total)	mg/L	ND 5.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Tetrachlorobutadiene isomers[2]	mg/L	15	17	-13.33	43	-186.67	13	13.33	1.8	88.00	0.14	99.07
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/L	0.030	-		-		0.22	-633.33	0.015	50.00	0.0082	72.67
Hexachlorobenzene	mg/L	0.0025	-		-		0.035	-1300.00	0.0057	-128.00	0.0061	-144.00

Notes:
- \- Not analyzed.
- J Estimated.
- NDx Not detected at or above x.
- R Rejected.
- SSPL Site-Specific Parameter List.

[1] Batch 7 Parameters:
Slurry Content: 10% (solids by weight)
Slurry Temperature: 25°C
Air Flow: initially 480 liters/hour, decreased over time.

[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.

CRA 7431 (15) from
CRA 7431 (13)

TABLE 5.8

BATCH 7A [1]

ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

		SEDIMENT										
Parameters	*Sample Time: Collection Date: Units*	*T-0 [3] 09/23/99*	*T-2 09/23/99*	*Percent Reduction 2 Hrs.*	*T-4 09/23/99*	*Percent Reduction 4 Hrs.*	*T-6 09/23/99*	*Percent Reduction 6 Hrs.*	*T-12 09/24/99*	*Percent Reduction 12 Hrs.*	*T-24 09/24/99*	*Percent Reduction 24 Hrs.*
SSPL Volatiles												
Vinyl chloride	mg/Kg	ND 0.14	-		-		-		-		-	
1,1-Dichloroethene	mg/Kg	R	-		-		-		-		-	
trans-1,2-Dichloroethene	mg/Kg	ND 0.14	-		-		-		-		-	
cis-1,2-Dichloroethene	mg/Kg	ND 0.14	-		-		-		-		-	
Trichloroethene	mg/Kg	1.4	-		-		-		-		-	
Tetrachloroethene	mg/Kg	2.4	-		-		-		-		-	
Ethyl benzene	mg/Kg	ND 0.14	-		-		-		-		-	
Xylene (total)	mg/Kg	ND 0.14	-		-		-		-		-	
Tetrachlorobutadiene isomers [2]	mg/Kg	24	-		-		-		-		-	
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/Kg	1.2	9.3	**-675.00**	8.6	**-616.67**	5.3	**-341.67**	3.2	**-166.67**	1.8	**-50.00**
Hexachlorobenzene	mg/Kg	1.6	2.7	**-68.75**	2.8	**-75.00**	2.0	**-25.00**	1.8	**-12.50**	1.9	**-18.75**

		WATER										
	Sample Time: Collection Date:	*T-0 [3] 09/23/99*	*T-2 09/23/99*	*Percent Reduction 2 Hrs.*	*T-4 09/23/99*	*Percent Reduction 4 Hrs.*	*T-6 09/23/99*	*Percent Reduction 6 Hrs.*	*T-12 09/24/99*	*Percent Reduction 12 Hrs.*	*T-24 09/24/99*	*Percent Reduction 24 Hrs.*
SSPL Volatiles												
Vinyl chloride	mg/L	ND 0.010	-		-		-		-		-	
1,1-Dichloroethene	mg/L	R	-		-		-		-		-	
trans-1,2-Dichloroethene	mg/L	ND 0.010	-		-		-		-		-	
cis-1,2-Dichloroethene	mg/L	ND 0.010	-		-		-		-		-	
Trichloroethene	mg/L	0.03	-		-		-		-		-	
Tetrachloroethene	mg/L	0.018	-		-		-		-		-	
Ethyl benzene	mg/L	ND 0.010	-		-		-		-		-	
Xylene (total)	mg/L	ND 0.010	-		-		-		-		-	
Tetrachlorobutadiene isomers [2]	mg/L	0.14	-		-		-		-		-	
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/L	0.0082	0.047	**-473.17**	0.028 J	**-241.46**	0.038	**-363.41**	0.021	**-156.10**	0.0066	**19.51**
Hexachlorobenzene	mg/L	0.0061	0.0020	**67.21**	0.0024 J	**60.66**	0.0022	**63.93**	0.0020	**67.21**	0.0018	**70.49**

Notes:
- \- Not analyzed.
- J Estimated.
- NDx Not detected at or above x.
- R Rejected.
- SSPL Site-Specific Parameter List.

CRA 7431 (15) from
CRA 7431 (13)

[1] Batch 7A Parameters:
Slurry Content: 10% (by weight)
Slurry Temperature: 25°C
Air Flow: 0 liters/hour

KM_nO_4: Initial $KMnO_4$ concentration: 6,374 ppm.

[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.

[3] Results are from Batch 7 at T=24 hours.

TABL[illegible]

BATCH 8 [1]

ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

SEDIMENT

Parameters	Units	T-0 09/22/99	T-0 09/22/99 (Field Dup)	T-2 09/22/99	Percent Reduction 2 Hrs.	T-4 09/22/99	Percent Reduction 4 Hrs.	T-6 09/22/99	Percent Reduction 6 Hrs.	T-12 09/23/99	Percent Reduction 12 Hrs.	T-24 09/23/99	Percent Reduction 24 Hrs.
SSPL Volatiles													
Vinyl chloride	mg/Kg	ND 95	ND 95	ND 24		ND 24		ND 0.14		ND 0.19		ND 0.14	
1,1-Dichloroethene	mg/Kg	R	R	R		R		R		R		R	
trans-1,2-Dichloroethene	mg/Kg	ND 95	ND 95	ND 24		ND 24		ND 0.14		ND 0.19		ND 0.14	
cis-1,2-Dichloroethene	mg/Kg	ND 95	ND 95	ND 24		ND 24		ND 0.14		ND 0.19		ND 0.14	
Trichloroethene	mg/Kg	900	760	14	**98.44**	12	**98.67**	1.4	**99.84**	1.4	**99.84**	0.36	**99.96**
Tetrachloroethene	mg/Kg	1100	950	28	**97.45**	21	**98.09**	15E	**98.64**	3.4	**99.69**	0.95	**99.91**
Ethyl benzene	mg/Kg	ND 95	ND 95	ND 24		ND 24		ND 0.14		ND 0.19		ND 0.14	
Xylene (total)	mg/Kg	ND 95	ND 95	ND 24		ND 24		ND 0.14		ND 0.19		ND 0.14	
Tetrachlorobutadiene isomers [2]	mg/Kg	5200	5200	200	**96.15**	86	**98.35**	14	**99.73**	12	**99.77**	2.2	**99.96**
SSPL Semi-Volatiles													
Hexachlorobutadiene	mg/Kg	130	140	-		-		4.7	**96.38**	1.4	**98.92**	0.34	**99.74**
Hexachlorobenzene	mg/Kg	13	8.6	-		-		3.9	**70.00**	1.8	**86.15**	0.85	**93.46**

WATER

	Sample Time: Collection Date:	T-0 09/22/99	T-0 09/22/99 (Field Dup)	T-2 09/22/99	Percent Reduction 2 Hrs.	T-4 09/22/99	Percent Reduction 4 Hrs.	T-6 09/22/99	Percent Reduction 6 Hrs.	T-12 09/23/99	Percent Reduction 12 Hrs.	T-24 09/23/99	Percent Reduction 24 Hrs.
SSPL Volatiles													
Vinyl chloride	mg/L	ND 5.0	ND 5.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
1,1-Dichloroethene	mg/L	ND 5.0	R	R		R		R		R		R	
trans-1,2-Dichloroethene	mg/L	ND 5.0	ND 5.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
cis-1,2-Dichloroethene	mg/L	ND 5.0	ND 5.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Trichloroethene	mg/L	120	89	1.2	**99.00**	0.15	**99.88**	0.34	**99.72**	0.057	**99.95**	0.008	**99.99**
Tetrachloroethene	mg/L	37	48	1.8 J	**95.14**	0.4 J	**99.03**	0.37 J	**99.00**	0.038 J	**99.90**	ND 0.010	
Ethyl benzene	mg/L	ND 5.0	ND 5.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Xylene (total)	mg/L	ND 5.0	ND 5.0	ND 0.50		ND 0.50		ND 0.10		ND 0.050		ND 0.010	
Tetrachlorobutadiene isomers [2]	mg/L	28	4.0	14	**50.00**	14	**50.00**	0.37	**98.68**	0.042	**99.85**	0.026	**99.91**
SSPL Semi-Volatiles													
Hexachlorobutadiene	mg/L	0.033	0.025	-		-		0.022	**33.33**	0.0076	**76.97**	ND 0.0010	
Hexachlorobenzene	mg/L	0.0029	0.0028	-		-		0.012	**-313.79**	0.0059	**-103.45**	0.0055	**-89.66**

Notes:

- \- Not analyzed.
- J Estimated.
- NDx Not detected at or above x.
- R Rejected.
- SSPL Site-Specific Parameter List.

[1] Batch 8 Parameters:
Slurry Content: 10% (solids by weight)
Slurry Temperature: 45°C
Air Flow: initially 480 liters/hour, decreased over time

[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.

CRA 7431 (15) from
CRA 7431 (13)

TABLE [illegible]

BATCH 8A [1]
ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

SEDIMENT

Parameters	Units	T-0 [3] 09/23/99	T-2 09/23/99	Percent Reduction 2 Hrs.	T-4 09/23/99	Percent Reduction 4 Hrs.	T-6 09/23/99	Percent Reduction 6 Hrs.	T-12 09/24/99	Percent Reduction 12 Hrs.	T-24 09/24/99	Percent Reduction 24 Hrs.
SSPL Volatiles												
Vinyl chloride	mg/Kg	ND 0.14	-		-		-		-		-	
1,1-Dichloroethene	mg/Kg	R	-		-		-		-		-	
trans-1,2-Dichloroethene	mg/Kg	ND 0.14	-		-		-		-		-	
cis-1,2-Dichloroethene	mg/Kg	ND 0.14	-		-		-		-		-	
Trichloroethene	mg/Kg	0.36	-		-		-		-		-	
Tetrachloroethene	mg/Kg	0.95	-		-		-		-		-	
Ethyl benzene	mg/Kg	ND 0.14	-		-		-		-		-	
Xylene (total)	mg/Kg	ND 0.14	-		-		-		-		-	
Tetrachlorobutadiene isomers [2]	mg/Kg	2.2	-		-		-		-		-	
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/Kg	0.34	2.0	-488.24	0.48	-41.18	0.86	-152.94	0.41	-20.59	0.38 J	-11.76
Hexachlorobenzene	mg/Kg	0.85	1.7	-100.00	1.3	-52.94	1.5	-76.47	1.1	-29.41	0.73 J	14.12

WATER

Parameters	Units	T-0 [3] 09/23/99	T-2 09/23/99	Percent Reduction 2 Hrs.	T-4 09/23/99	Percent Reduction 4 Hrs.	T-6 09/23/99	Percent Reduction 6 Hrs.	T-12 09/24/99	Percent Reduction 12 Hrs.	T-24 09/24/99	Percent Reduction 24 Hrs.
SSPL Volatiles												
Vinyl chloride	mg/L	ND 0.010	-		-		-		-		-	
1,1-Dichloroethene	mg/L	R	-		-		-		-		-	
trans-1,2-Dichloroethene	mg/L	ND 0.010	-		-		-		-		-	
cis-1,2-Dichloroethene	mg/L	ND 0.010	-		-		-		-		-	
Trichloroethene	mg/L	0.008	-		-		-		-		-	
Tetrachloroethene	mg/L	ND 0.010	-		-		-		-		-	
Ethyl benzene	mg/L	ND 0.010	-		-		-		-		-	
Xylene (total)	mg/L	ND 0.010	-		-		-		-		-	
Tetrachlorobutadiene isomers [2]	mg/L	0.026	-		-		-		-		-	
SSPL Semi-Volatiles												
Hexachlorobutadiene	mg/L	ND 0.0010	0.0090	-800.00	0.0031 J	-210.00	0.0022	-120.00	0.0022	-120.00	0.0015	-50.00
Hexachlorobenzene	mg/L	0.0055	0.0015	72.73	0.0017 J	69.09	0.0014	74.55	0.0018	67.27	0.0017	69.09

Notes:
- Not analyzed.
J Estimated.
NDx Not detected at or above x.
R Rejected.
SSPL Site-Specific Parameter List.

[1] Batch 8A Parameters: Initial $KMnO_4$ concentration: 6,853 ppm.
Slurry Content: 10% (solids by weight)
Slurry Temperature: 45°C
Air Flow: 0 liters/hour
[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.
[3] Results are from Batch 8 at T=24 hours.

CRA 7431 (15) from
CRA 7431 (13)

TABLE [illegible]

BATCH 9 [1]
ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

SEDIMENT

Parameters	Units	T-0 10/12/99	T-0 10/12/99 (Field Dup)	T-2 10/12/99	Percent Reduction 2 Hrs.	T-4 10/12/99	Percent Reduction 4 Hrs.	T-6 10/12/99	Percent Reduction 6 Hrs.	T-9 10/12/99	Percent Reduction 9 Hrs.	T-12 10/13/99	Percent Reduction 12 Hrs.
SSPL Volatiles													
Vinyl chloride	mg/Kg	ND 80	ND 80	ND 0.19		ND 0.20		ND 0.13					
1,1-Dichloroethene	mg/Kg	R	R	R		R		R					
trans-1,2-Dichloroethene	mg/Kg	ND 80	ND 80	ND 0.19		ND 0.20		ND 0.13					
cis-1,2-Dichloroethene	mg/Kg	ND 80	ND 80	ND 0.19		ND 0.20		ND 0.13					
Trichloroethene	mg/Kg	880	1400	9.6	98.91	3.8	99.57	0.68	99.92				
Tetrachloroethene	mg/Kg	2000	3000	52	97.40	16	99.20	7.6E	99.62				
Ethyl benzene	mg/Kg	ND 80	ND 80	ND 0.19		ND 0.20		ND 0.13					
Xylene (total)	mg/Kg	ND 80	ND 80	ND 0.19		ND 0.20		ND 0.13					
Tetrachlorobutadiene isomers [2]	mg/Kg	4000	6000	68	98.30	44	98.90	16	99.60				
SSPL Semi-Volatiles													
Hexachlorobutadiene	mg/Kg	150 J	-	15 J	90.00	5.3 J	96.47	3.7 J	97.53	3.1 J	97.93	2.5 J	98.33
Hexachlorobenzene	mg/Kg	12 J	-	7.2 J	40.00	4.5 J	62.50	3.5 J	70.83	2.5 J	79.17	1.9 J	84.17

WATER

Parameters	Units	T-0 10/12/99	T-0 10/12/99 (Field Dup)	T-2 10/12/99	Percent Reduction 2 Hrs.	T-4 10/12/99	Percent Reduction 4 Hrs.	T-6 10/12/99	Percent Reduction 6 Hrs.	T-9 10/12/99	Percent Reduction 9 Hrs.	T-12 10/13/99	Percent Reduction 12 Hrs.
SSPL Volatiles													
Vinyl chloride	mg/L	ND 5.0	ND 5.0	ND 5.0		ND 0.050		ND 0.010					
1,1-Dichloroethene	mg/L	R	R	R		R		R					
trans-1,2-Dichloroethene	mg/L	ND 5.0	ND 5.0	ND 5.0		ND 0.050		ND 0.010					
cis-1,2-Dichloroethene	mg/L	ND 5.0	ND 5.0	ND 5.0		ND 0.050		ND 0.010					
Trichloroethene	mg/L	130	140	1.8	98.62	0.34	99.74	0.071	99.95				
Tetrachloroethene	mg/L	58	49	0.97	98.33	0.51	99.12	0.21	99.64				
Ethyl benzene	mg/L	ND 5.0	ND 5.0	ND 5.0		ND 0.050		ND 0.010					
Xylene (total)	mg/L	ND 5.0	ND 5.0	ND 5.0		ND 0.050		ND 0.010					
Tetrachlorobutadiene isomers [2]	mg/L	9.6	9.6	1.9	80.21	0.28	97.08	0.27	97.19				
SSPL Semi-Volatiles													
Hexachlorobenzene	mg/L	0.022 J	-	0.027 J	-22.73	0.0055 J	75.00	0.0034 J	84.55	0.00087 J	96.05	0.00063 J	97.14
Hexachlorobenzene	mg/L	0.0016	-	0.010	-525.00	0.0024	-50.00	0.0039	-143.75	0.00064 J	60.00	0.00063 J	60.63

Notes:

- Not analyzed.
J Estimated.
NDx *Not detected at or above x.*
SSPL Site-Specific Parameter List.

[1] Batch 9 Parameters:
Slurry Content: 10% (solids by weight)
Slurry Temperature: 45°C
Air Flow: 480 liters/hour

[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.

CRA 7431 (15) from
CRA 7431 (13)

TABLE 5.12

BATCH 10[1]

ANALYTICAL RESULTS SUMMARY
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

SEDIMENT

Parameters	Units	T-0 10/12/99	T-0 10/12/99 (Field Dup)	T-2 10/12/99	Percent Reduction 2 Hrs.	T-4 10/12/99	Percent Reduction 4 Hrs.	T-6 10/12/99	Percent Reduction 6 Hrs.	T-9 10/12/99	Percent Reduction 9 Hrs.	T-12 10/13/99	Percent Reduction 12 Hrs.
SSPL Volatiles													
Vinyl chloride	mg/Kg	ND 140	-	ND 0.11		ND 0.076		ND 0.093					
1,1-Dichloroethene	mg/Kg	R	-	R		R		R					
trans-1,2-Dichloroethene	mg/Kg	ND 140	-	ND 0.11		ND 0.076		ND 0.093					
cis-1,2-Dichloroethene	mg/Kg	ND 140	-	ND 0.11		ND 0.076		ND 0.093					
Trichloroethene	mg/Kg	1900	-	5.2	99.73	0.57	99.97	0.62	99.97				
Tetrachloroethene	mg/Kg	3200	-	14E	99.56	2.4E	99.93	1.4	99.96				
Ethyl benzene	mg/Kg	ND 140	-	ND 0.11		ND 0.076		ND 0.093					
Xylene (total)	mg/Kg	ND 140	-	ND 0.11		ND 0.076		ND 0.093					
Tetrachlorobutadiene isomers[2]	mg/Kg	6800	-	100	98.53	13E	99.81	6.2	99.91				
SSPL Semi-Volatiles													
Hexachlorobutadiene	mg/Kg	130 J	110 J	8.9 J	93.15	5.5 J	95.77	1.7	98.69	1.8 J	98.62	0.82 J	99.37
Hexachlorobenzene	mg/Kg	12 J	10 J	3.8 J	68.33	5.2 J	56.67	2.2	81.67	2.1 J	82.50	2.1 J	82.50

WATER

Parameters	Units	T-0 10/12/99	T-0 10/12/99 (Field Dup)	T-2 10/12/99	Percent Reduction 2 Hrs.	T-4 10/12/99	Percent Reduction 4 Hrs.	T-6 10/12/99	Percent Reduction 6 Hrs.	T-9 10/12/99	Percent Reduction 9 Hrs.	T-12 10/13/99	Percent Reduction 12 Hrs.
SSPL Volatiles													
Vinyl chloride	mg/L	ND 2.0	-	ND 1.0		ND 0.10		ND 0.050					
1,1-Dichloroethene	mg/L	R	-	R		R		R					
trans-1,2-Dichloroethene	mg/L	ND 2.0	-	ND 1.0		ND 0.10		ND 0.050					
cis-1,2-Dichloroethene	mg/L	ND 2.0	-	ND 1.0		ND 0.10		ND 0.050					
Trichloroethene	mg/L	170	-	0.63	99.63	0.16	99.91	0.30	99.82				
Tetrachloroethene	mg/L	43	-	0.45	98.95	0.28	99.35	0.27	99.37				
Ethyl benzene	mg/L	ND 2.0	-	ND 1.0		ND 0.10		ND 0.050					
Xylene (total)	mg/L	ND 2.0	-	ND 1.0		ND 0.10		ND 0.050					
Tetrachlorobutadiene isomers[2]	mg/L	14	-	3.3	76.43	0.28	98.00	0.20	98.57				
SSPL Semi-Volatiles													
Hexachlorobenzene	mg/L	0.023 J	0.027 J	0.024 J	-4.35	0.0071 J	69.13	0.0055 J	76.09	0.0012 J	94.78	0.00041 J	98.22
Hexachlorobenzene	mg/L	0.0042	0.0032	0.0037	11.90	0.0038	9.52	0.0056	-33.33	0.0014 J	66.67	0.00062 J	85.24

Notes:
- \- Not analyzed.
- J Estimated.
- NDx Not detected at or above x.
- R Rejected.
- SSPL Site-Specific Parameter List.

[1] Batch 10 Parameters:
Slurry Content: 15% (solids by weight)
Slurry Temperature: 45°C
Air Flow: 480 liters/hour

[2] Includes tetrachlorobutadiene and pentachlorobutadiene isomers.

CRA 7431 (15) from
CRA 7431 (13)

TABLE 3.13

RESIDUAL SOLUBLE $KMnO_4$ CONCENTRATIONS
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Sample (T=x Hrs.)	*Dilution (from 10 mL)*	*ABS (525 nm)*	*Soluble $KMnO_4$* Concentration (ppm)*	*$KMnO_4$* % Reduction*
Batch 7A (25°C)				
0			6374	
2	100	0.518	3458	46
4	100	0.458	3057	54
6	100	0.381	2543	62
12	100	0.291	1943	71
24	40	0.596	1591	76
Batch 8A (45°C)				
0			6853	
2	100	0.48	3204	51
4	100	0.384	2563	61
6	100	0.293	1956	70
12	100	0.159	1061	84
24	2	0	0	100

Note:
* The amount of $KMnO_4$ added initially to the reactor was 100 gm per 15 liter slurry.
ABS Absorbance.

CRA 7431 (15) from
CRA 7431 (13)

APPENDIX A

MONITORED TEST CONDITIONS

CRA SERVICES LABORATORY, NIAGARA FALLS, NEW YORK
BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 1
Phase: I

Target Temp.: 25°C
Target Agitation: Speed: 1300 rpm
Impeller: 310A - 2.5 inch
Slurry Data: 10%
Wt. Solid: 5.66 Kg
Volume Liquid: 15.04 Liters

Sampling Time	*Sample I.D.*	*Date*	*Time*	*Temperature (°C)*		*pH*	*Air Flow (l/min.)*	*Pressure (psi)*	*Slurry Level (cm)*	*Agitation Data*				*$KMnO_4$ Residual (ppm)*	*Recorded By*
				Ambient	*Reactor*					*Speed (rpm)*	*Power (watt)*	*Output Torque (0z. In.)*	*GPM*		
0 Hr.	Batch 1 - T0	09/13/99	12:00 p.m.	20	26	9.5	2.0	20	26.5	1296	16	22	49	NA	C. Lin
2 Hrs.	Batch 1 - T2	09/13/99	2:00 p.m.	23	26	9.5	2.0	20	26.2	1300	15	22	49	NA	C. Lin
4 Hrs.	Batch 1 - T4	09/13/99	4:00 p.m.	22	25	9.5	2.0	20	25.8	1300	15	22	50	NA	C. Lin
6 Hrs.	Batch 1 - T6	09/13/99	6:00 p.m.	23	25	9.5	2.0	20	26.0	1303	11	17	49	NA	C. Lin
12 Hrs.	Batch 1 - T12	09/14/99	12:00 a.m.	23	25	9.4	2.0	20	24.5	1299	13	22	49	NA	C. Lin
18 Hrs.	Batch 1 - T18	09/14/99	6:00 a.m.	21	25	9.4	2.0	24	25.0	1301	13	22	49	NA	C. Lin
24 Hrs.	Batch 1 - T24	09/14/99	12:00 p.m.	22	24	9.4	2.0	29	24.5	1300	9	17	48	NA	C. Lin
36 Hrs.	Batch 1 - T36	09/15/99	12:00 a.m.	21	25	9.2	2.0	34	23.5	1300	8	16	49	NA	C. Lin
48 Hrs.	Batch 1 - T48	09/15/99	12:00 p.m.	24	25	9.3	2.0	42	23.0	1301	8	15	49	NA	C. Lin

NA - Not Applicable.

CRA SERVICES LABORATORY, NIAGARA FALLS, NEW YORK
BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 2
Phase: I

Target Temp.: 25°C
Target Agitation: Speed: 1300 rpm
Impeller: 310A - 2.5 inch
Slurry Data: 10%
Wt. Solid: 5.66 Kg
Volume Liquid: 15.04 Liters

Sampling Time	Sample I.D.	Date	Time	Temperature (°C)		pH	Air Flow (l/min.)	Pressure (psi)	Slurry Level (cm)	Agitation Data				$KMnO_4$ Residual (ppm)	Recorded By
				Ambient	Reactor					Speed (rpm)	Power (watt)	Output Torque (0z. In.)	GPM		
0 Hr.	Batch 2 - T0	09/13/99	12:00 p.m.	20	26	9.5	4.0	20	26.5	1303	12	21	67	NA	C. Lin
2 Hrs.	Batch 2 - T2	09/13/99	2:00 p.m.	23	26	9.5	4.0	20	26.2	1298	14	21	65	NA	C. Lin
4 Hrs.	Batch 2 - T4	09/13/99	4:00 p.m.	22	25	9.5	4.0	20	25.8	1300	9	17	65	NA	C. Lin
6 Hrs.	Batch 2 - T6	09/13/99	6:00 p.m.	23	25	9.5	4.0	20	26.0	1301	12	18	65	NA	C. Lin
12 Hrs.	Batch 2 - T12	09/14/99	12:00 a.m.	23	25	9.4	4.0	20	25.0	1302	7	19	65	NA	C. Lin
18 Hrs.	Batch 2 - T18	09/14/99	6:00 a.m.	21	25	9.4	4.0	24	25.0	1300	9	16	64	NA	C. Lin
24 Hrs.	Batch 2 - T24	09/14/99	12:00 p.m.	22	25	9.4	4.0	29	24.5	1300	11	15	66	NA	C. Lin
36 Hrs.	Batch 2 - T36	09/15/99	12:00 a.m.	21	25	9.3	4.0	34	23.5	1300	8	15	65	NA	C. Lin
48 Hrs.	Batch 2 - T48	09/15/99	12:00 p.m.	24	25	9.2	4.0	42	23.0	1301	7	15	66	NA	C. Lin

NA - Not Applicable.

CRA SERVICES LABORATORY, NIAGARA FALLS, NEW YORK
BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 3
Phase: I

Target Temp.: 25°C
Target Agitation: Speed: 1300 rpm
Impeller: 310A - 2.5 inch
Slurry Data: 10%
Wt. Solid: 5.66 Kg
Volume Liquid: 15.04 Liters

Sampling Time	Sample I.D.	Date	Time	Temperature (°C)		pH	Air Flow (l/min.)	Pressure (psi)	Slurry Level (cm)	Agitation Data				$KMnO_4$ Residual (ppm)	Recorded By
				Ambient	Reactor					Speed (rpm)	Power (watt)	Output Torque (0z. In.)	GPM		
0 Hr.	Batch 3 - T0	09/13/99	12:00 p.m.	20	26	9.5	8.0	20	26.5	1299	9	15	48	NA	C. Lin
2 Hrs.	Batch 3 - T2	09/13/99	2:00 p.m.	23	26	9.5	8.0	20	26.2	1300	10	17	49	NA	C. Lin
4 Hrs.	Batch 3 - T4	09/13/99	4:00 p.m.	22	25	9.5	8.0	20	26.0	1300	10	17	48	NA	C. Lin
6 Hrs.	Batch 3 - T6	09/13/99	6:00 p.m.	23	25	9.5	8.0	20	26.0	1301	10	17	49	NA	C. Lin
12 Hrs.	Batch 3 - T12	09/14/99	12:00 a.m.	23	25	9.4	6.9	20	24.5	1300	10	16	49	NA	C. Lin
18 Hrs.	Batch 3 - T18	09/14/99	6:00 a.m.	21	25	9.3	6.58	24	25.0	1300	10	16	49	NA	G. Bonk
24 Hrs.	Batch 3 - T24	09/14/99	12:00 p.m.	22	25	9.3	8.0	29	24.5	1297	8	16	49	NA	C. Lin
36 Hrs.	Batch 3 - T36	09/15/99	12:00 a.m.	21	25	9.2	7.74	34	23.5	1300	8	15	49	NA	C. Lin
48 Hrs.	Batch 3 - T48	09/15/99	12:00 p.m.	24	25	9.2	7.75	42	23.0	1301	9	15	49	NA	C. Lin

NA - Not Applicable.

CRA SERVICES LABORATORY, NIAGARA FALLS, NEW YORK
BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 4
Phase: 1

Target Temp.: 25°C
Target Agitation: **Speed:** 1500 rpm
Impeller: 310A - 2.5 inch
Slurry Data: 15%
Wt. Solid: 8.65 Kg
Volume Liquid: 12.4 Liters

Sampling Time	*Sample I.D.*	*Date*	*Time*	*Temperature (°C)*		*pH*	*Air Flow (l/min.)*	*Pressure (psi)*	*Slurry Level (cm)*	*Agitation Data*				*$KMnO_4$ Residual (ppm)*	*Recorded By*
				Ambient	*Reactor*					*Speed (rpm)*	*Power (watt)*	*Output Torque (0z. In.)*	*GPM*		
0 Hr.	Batch 4 - T0	09/16/99	7:00 p.m.	23	25	10.2	2.0	38	25.2	1500	0	0	56	NA	C. Lin
2 Hrs.	Batch 4 - T2	09/16/99	9:00 p.m.	22	25	10.2	1.9	38	25.0	1499	0	20	56	NA	C. Lin
4 Hrs.	Batch 4 - T4	09/16/99	11:00 p.m.	22	25	10.2	1.9	38	24.5	1501	15	23	56	NA	C. Lin
6 Hrs.	Batch 4 - T6	09/17/99	1:00 a.m.	22	25	10.2	1.9	38	24.0	1499	0	20	57	NA	C. Lin
12 Hrs.	Batch 4 - T12	09/17/99	7:00 a.m.	22	25	10.2	2.0	40	24.0	1500	0	21	57	NA	G. Bonk
18 Hrs.	Batch 4 - T18	09/17/99	1:00 p.m.	22	25	10.2	2.0*	34	23.5	1500	14	20	56	NA	C. Lin
24 Hrs.	Batch 4 - T24	09/17/99	7:00 p.m.	22	25	10.2	2.0	38	23.5	1501	14	19	57	NA	C. Lin
36 Hrs.	Batch 4 - T36	09/18/99	7:00 a.m.	18	25	10.1	**	42	23.0	1500	0	33	56	NA	C. Lin
48 Hrs.	Batch 4 - T48	09/18/99	7:00 p.m.	22	25	10.1	1.125	53	23.0	1500	0	19	56	NA	C. Lin

NA - Not applicable.
*Around 10 a.m. air line broke for one-half hour.
**Air line broke overnight (between 24 hrs. and 36 hrs.).

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BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 5
Phase: I

Target Temp.: 25°C
Target Agitation: Speed: 1500 rpm
Impeller: 310A - 2.5 inch
Slurry Data: 15%
Wt. Solid: 8.65 Kg
Volume Liquid: 12.4 Liters

Sampling Time	Sample I.D.	Date	Time	Temperature (°C)		pH	Air Flow (l/min.)	Pressure (psi)	Slurry Level (cm)	Agitation Data				$KMnO_4$ Residual (ppm)	Recorded By
				Ambient	Reactor					Speed (rpm)	Power (watt)	Output Torque (0z. In.)	GPM		
0 Hr.	Batch 5 - T0	09/16/99	7:00 p.m.	23	25	10.1	4.0	38	25.2	1500	13	21	55	NA	C. Lin
2 Hrs.	Batch 5 - T2	09/16/99	9:00 p.m.	22	25	10.1	3.8	38	25.0	1501	15	21	57	NA	C. Lin
4 Hrs.	Batch 5 - T4	09/16/99	11:00 p.m.	22	25	10.1	3.95	38	24.5	1504	15	21	56	NA	C. Lin
6 Hrs.	Batch 5 - T6	09/17/99	1:00 a.m.	22	25	10.1	3.95	38	24.5	1500	19	22	56	NA	C. Lin
12 Hrs.	Batch 5 - T12	09/17/99	7:00 a.m.	22	25	10.1	4.0	40	24.0	1500	12	19	57	NA	G. Bonk
18 Hrs.	Batch 5 - T18	09/17/99	1:00 p.m.	22	25	10.0	4.0	34	23.5	1500	14	19	56	NA	C. Lin
24 Hrs.	Batch 5 - T24	09/17/99	7:00 p.m.	22	25	10.0	3.2*	38	23.5	1502	12	17	56	NA	C. Lin
36 Hrs.	Batch 5 - T36	09/18/99	7:00 a.m.	18	25	10.0	2.8**	42	23.0	1500	11	17	56	NA	C. Lin
48 Hrs.	Batch 5 - T48	09/18/99	7:00 a.m.	22	25	9.9	1.825	53	23.0	1500	13	18	56	NA	C. Lin

NA - Not Applicable.
*Flow dropped after 18 hrs.
**Air line broke overnight (between 24 and 36 hours).

CRA SERVICES LABORATORY, NIAGARA FALLS, NEW YORK
BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 6
Phase: 1

Target Temp.: 25°C
Target Agitation: Speed: 1500 rpm
Impeller: 310A - 2.5 inch
Slurry Data: 15%
Wt. Solid: 8.65 Kg
Volume Liquid: 12.4 Liters

Sampling Time	*Sample I.D.*	*Date*	*Time*	*Temperature (°C)*		*pH*	*Air Flow (l/min.)*	*Pressure (psi)*	*Slurry Level (cm)*	*Agitation Data*				*$KMnO_4$ Residual (ppm)*	*Recorded By*
				Ambient	*Reactor*					*Speed (rpm)*	*Power (watt)*	*Output Torque (0z. In.)*	*GPM*		
0 Hr.	Batch 6 - T0	09/16/99	7:15 p.m.	23	25	10.1	8.0	38	25.0	1500	-	-	56	NA	C. Lin
2 Hrs.	Batch 6 - T2	09/16/99	9:15 p.m.	22	25	10.1	7.7	38	25.0	1503	-	-	56	NA	C. Lin
4 Hrs.	Batch 6 - T4	09/16/99	11:15 p.m.	22	25	10.0	7.85	38	24.5	1501	-	-	57	NA	C. Lin
6 Hrs.	Batch 6 - T6	09/17/99	1:15 a.m.	22	25	10.1	7.85	38	24.5	1500	14	20	56	NA	C. Lin
12 Hrs.	Batch 6 - T12	09/17/99	7:00 a.m.	22	25	10.1	8.0	40	24.0	1500	11	19	57	NA	G. Bonk
18 Hrs.	Batch 6 - T18	09/17/99	1:00 p.m.	22	25	10.0	8.0	34	23.5	1501	12	19	56	NA	C. Lin
24 Hrs.	Batch 6 - T24	09/17/99	7:00 p.m.	22	25	10.0	8.0	38	23.5	1500	11	18	56	NA	C. Lin
36 Hrs.	Batch 6 - T36	09/18/99	7:00 a.m.	18	25	10.0	7.2	42	23.0	1500	9	17	57	NA	C. Lin
48 Hrs.	Batch 6 - T48	09/18/99	7:00 p.m.	22	25	10.0	7.45	53	23.0	1500	12	18	56	NA	C. Lin

NA - Not Applicable.

CRA SERVICES LABORATORY, NIAGARA FALLS, NEW YORK
BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 7
Phase: II

Target Temp.: 25°C
Target Agitation: Speed: 1300 rpm
Impeller: 310A - 2.5 inch
Slurry Data: 10%
Wt. Solid: 5.66 Kg
Volume Liquid: 15.04 Liters

Sampling Time	Sample I.D.	Date	Time	Temperature (°C)		pH	Air Flow (l/min.)	Pressure (psi)	Slurry Level (cm)	Agitation Data				$KMnO_4$ Residual (ppm)	Recorded By
				Ambient	Reactor					Speed (rpm)	Power (watt)	Output Torque (0z. In.)	GPM		
0 Hr.	Batch 7 - T0	09/22/99	1:00 p.m.	22	25	9.3	8.0	28	26.0	1300	10	16	49	NA	C. Lin
2 Hrs.	Batch 7 - T2	09/22/99	3:00 p.m.	22	25	9.3	6.9*	56	25.5	1300	9	17	48	NA	C. Lin
4 Hrs.	Batch 7 - T4	09/22/99	5:00 p.m.	22	25	9.3	6.0**	56	25.0	1300	10	17	49	NA	C. Lin
6 Hrs.	Batch 7 - T6	09/22/99	7:00 p.m.	22	25	9.2	5.8	34	24.0	1300	13	20	48	NA	C. Lin
12 Hrs.	Batch 7 - T12	09/23/99	1:00 a.m.	22	25	9.3	3.0	37	23.0	1300	12	18	49	NA	C. Lin
18 Hrs.	Batch 7 - T18	09/23/99	7:00 a.m.	22	25	9.3	2.8	47	22.0	1300	12	18	48	NA	G. Bonk
24 Hrs.	Batch 7 - T24	09/23/99	1:00 p.m.	22	25	9.2	2.8	51	21.5	1303	8	15	50	NA	C. Lin

NA - Not Applicable.
*After 1 1/2 hour the air was adjusted to 6.9 liters/minute.
**After 4 hours sampling, the air flow was adjusted to 6 liters/minute.

CRA SERVICES LABORATORY, NIAGARA FALLS, NEW YORK
BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 7A
Phase: II

Target Temp.: 25°C
Target Agitation: **Speed:** 1300 rpm
Impeller: 310A - 2.5 inch
Slurry Data: 10%
Wt. Solid:
Volume Liquid:

Sampling Time	*Sample I.D.*	*Date*	*Time*	*Temperature (°C)*		*pH*	*Air Flow (l/min.)*	*Pressure (psi)*	*Slurry Level (cm)*	*Agitation Data*				*$KMnO_4$ Residual (ppm)*	*Recorded By*
				Ambient	*Reactor*					*Speed (rpm)*	*Power (watt)*	*Output Torque (0z. In.)*	*GPM*		
0 Hr.	Batch 7A - T0	09/23/99	2:00 p.m.	22	25	9.1	-	-	21.5	1300	17	24	49	6374*	C. Lin
2 Hrs.	Batch 7A - T2	09/23/99	4:00 p.m.	22	25	9.1	-	-	19.5	1300	16	23	49	3458	C. Lin
4 Hrs.	Batch 7A - T4	09/23/99	6:00 p.m.	22	25	9.1	-	-	18.0	1300	18	25	49	3057	C. Lin
6 Hrs.	Batch 7A - T6	09/23/99	8:00 p.m.	22	25	9.2	-	-	17.0	1300	16	22	49	2543	C. Lin
12 Hrs.	Batch 7A - T12	09/24/99	2:00 a.m.	22	25	9.2	-	-	16.0	1301**	14	21	49	1943	C. Lin
18 Hrs.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24 Hrs.	Batch 7A - T24	09/24/99	2:00 p.m.	22	25	9.2	-	-	15.0	650	2	8	24	1591	C. Lin

* Theoretical value, since 100 gm of KMnO4 was added to the reactor.
**Changed to 650 rpm after collection of T12 samples.

CRA SERVICES LABORATORY, NIAGARA FALLS, NEW YORK
BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 8
Phase: II

Target Temp.: 45°C
Target Agitation: Speed: 1300 rpm
Impeller: 310A - 2.5 inch
Slurry Data: 10%
Wt. Solid: 5.66 Kg
Volume Liquid: 15.04 Liters

Sampling Time	Sample I.D.	Date	Time	Temperature (°C)		pH	Air Flow (l/min.)	Pressure (psi)	Slurry Level (cm)	Agitation Data				$KMnO_4$ Residual (ppm)	Recorded By
				Ambient	Reactor					Speed (rpm)	Power (watt)	Output Torque (0z. In.)	GPM		
0 Hr.	Batch 8 - T0	09/22/99	1:00 p.m.	22	45	93	8.0	28	26.0	1300	6	14	49	NA	C. Lin
2 Hrs.	Batch 8 - T2	09/22/99	3:00 p.m.	22	45	93	6.3*	56	25.5	1300	7	15	49	NA	C. Lin
4 Hrs.	Batch 8 - T4	09/22/99	5:00 p.m.	22	45	93	5.0	56	24.0	1300	6	15	49	NA	C. Lin
6 Hrs.	Batch 8 - T6	09/22/99	7:00 p.m.	22	45	93	2.7	34	23.0	1300	8	16	49	NA	C. Lin
12 Hrs.	Batch 8 - T12	09/23/99	1:00 a.m.	22	45	93	2.5	37	21.0	1300	7	15	48	NA	C. Lin
18 Hrs.	Batch 8 - T18	09/23/99	7:00 a.m.	22	45	93	2.5	47	20.0	1300	7	15	49	NA	C. Lin
24 Hrs.	Batch 8 - T24	09/23/99	1:00 p.m.	22	45	93	2.5	51	20.0	1300	7	15	48	NA	C. Lin

NA - Not Applicable.
*Flow changed to 6 liters/minute after 2 hours, and 3 liters/minute after 4 hours.

CRA SERVICES LABORATORY, NIAGARA FALLS, NEW YORK
BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 8A
Phase: II

Target Temp.: 45°C
Target Agitation: Speed: 1300 rpm
Impeller: 310A - 2.5 inch
Slurry Data: 10%
Wt. Solid:
Volume Liquid:

Sampling Time	Sample I.D.	Date	Time	Temperature (°C)		pH	Air Flow (l/min.)	Pressure (psi)	Slurry Level (cm)	Agitation Data				$KMnO_4$ Residual (ppm)	Recorded By
				Ambient	Reactor					Speed (rpm)	Power (watt)	Output Torque (0z. In.)	GPM		
0 Hr.	Batch 8A - T0	09/23/99	2:00 p.m.	22	45	9.2	-	-	20.0	1300	15	22	49	6853*	C. Lin
2 Hrs.	Batch 8A - T2	09/23/99	4:00 p.m.	22	43	9.2	-	-	18.5	1300	14	21	49	3204	C. Lin
4 Hrs.	Batch 8A - T4	09/23/99	6:00 p.m.	22	45	9.3	-	-	16.0	1300	6	14	48	2563	C. Lin
6 Hrs.	Batch 8A - T6	09/23/99	8:00 p.m.	22	45	9.3	-	-	14.5	1300	6	14	49	1946	C. Lin
12 Hrs.	Batch 8A - T12	09/24/99	2:00 a.m.	22	46	9.4	-	-	12.0	1300	5	13	49	1061	C. Lin
18 Hrs.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24 Hrs.	Batch 8A -T24	09/24/99	2:00 p.m.	22	46	9.5	-	-	10.0	650**	1	8	24	0	C. Lin

*Theoretical value, since 100 gm of KMnO4 was added to the reactor.
**Mixing speed was changed to 650 rpm after collection of T12 samples.

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BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 9
Phase: II

Target Temp.: 45°C
Target Agitation: Speed: 1300 rpm
Impeller: 320A - 2.5 inch
Slurry Data: 10%
Wt. Solid: 5.66 Kg
Volume Liquid: 15.04 Liters

Sampling Time	*Sample I.D.*	*Date*	*Time*	*Temperature (°C)*		*pH*	*Air Flow (l/min.)*	*Pressure (psi)*	*Slurry Level (cm)*	*Agitation Data*				*$KMnO_4$ Residual (ppm)*	*Recorded By*
				Ambient	*Reactor*					*Speed (rpm)*	*Power (watt)*	*Output Torque (0z. In.)*	*GPM*		
0 Hr.	Batch 9 - T0	10/12/99	1:30 p.m.	24	43	9.3	8.0	22	26.0	1300	16	21	49	NA	C. Lin
2 Hrs.	Batch 9 - T2	10/12/99	3:30 p.m.	24	46	9.3	8.0	25	25.5	1300	16	21	49	NA	C. Lin
4 Hrs.	Batch 9 - T4	10/12/99	5:30 p.m.	24	44	9.4	8.0	26	25.0	1300	16	21	49	NA	C. Lin
6 Hrs.	Batch 9 - T6	10/12/99	7:30 p.m.	24	45	9.4	8.0	30	24.5	1301	14	20	49	NA	C. Lin
9 Hrs.	Batch 9 - T9	10/12/99	10:30 p.m.	24	44	9.4	8.0	30	24.0	1302	12	17	48	NA	C. Lin
12 Hrs.	Batch 9 - T12	10/13/99	1:30 a.m.	22	42	9.4	8.0	33	23.0	1302	13	20	47	NA	C. Lin

NA - Not Applicable.

CRA SERVICES LABORATORY, NIAGARA FALLS, NEW YORK
BENCH SCALE TREATABILITY STUDY SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Batch No.: 10
Phase: II

Target Temp.: 45°C
Target Agitation: Speed: 1400 rpm
Impeller: 320A - 2.5 inch
Slurry Data: 15%
Wt. Solid: 8.65 Kg
Volume Liquid: 12.4 Liters

Sampling Time	Sample I.D.	Date	Time	Temperature (°C)		pH	Air Flow (l/min.)	Pressure (psi)	Slurry Level (cm)	Agitation Data				$KMnO_4$ Residual (ppm)	Recorded By
				Ambient	Reactor					Speed (rpm)	Power (watt)	Output Torque (0z. In.)	GPM		
0 Hr.	Batch 10 - T0	10/12/99	1:30 p.m.	24	44	10.2	8.0	22	26.0	1400	19	22	52	NA	C. Lin
2 Hrs.	Batch 10 - T2	10/12/99	3:30 p.m.	24	46	10.0	8.0	25	25.5	1400	-	-	52	NA	C. Lin
4 Hrs.	Batch 10 - T4	10/12/99	5:30 p.m.	24	44	9.9	8.0	26	25.0	1400	20	25	52	NA	C. Lin
6 Hrs.	Batch 10 - T6	10/12/99	7:30 p.m.	24	45	9.9	8.0	30	24.5	1402	12	18	52	NA	C. Lin
9 Hrs.	Batch 10 - T9	10/12/99	10:30 p.m.	24	44	9.9	8.0	30	24.0	1399	14	17	53	NA	C. Lin
12 Hrs.	Batch 10 - T12	10/13/99	1:30 a.m.	24	46	9.9	8.0	33	23.0	1400	16	21	52	NA	C. Lin

NA - Not Applicable.

APPENDIX B

ANALYTICAL QA/QC REVIEW

7431 (15) from
7431 (13)

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) REVIEW
GLENN SPRINGS HOLDINGS, INC.
BENCH SCALE TREATABILITY STUDY
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON
SEPTEMBER - OCTOBER 1999

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1.0 INTRODUCTION

CRA conducted a bench scale treatability study on sediment samples obtained from the Former Occidental Chemical Facility in Tacoma, Washington. To monitor the progress of the treatment, samples were taken from each batch, separated into aqueous and solid portions, and analyzed for Site-Specific Volatile Organic Compounds (VOCs), Hexachlorobenzene (HCB), and Hexachlorobutadiene (HCBD). The VOCs were analyzed by GC/FID with purge and trap for sample introduction. HCB and HCBD were analyzed by GC/ECD. SW846 8000 methodology was used as a reference for the analytical procedures.

The analytical results are summarized in Tables 3.1 through 3.12 of the report entitled, "Bench Scale Treatability Study, Slurry Aeration of Area 5106 Sediment". The quality assurance/quality control (QA/QC) criteria by which these data have been assessed are outlined in the "National Functional Guidelines for Organic Data Review" (February 1994) and "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 (with all subsequent revisions). Data assessment included a review of all raw data for instrument calibration, investigative samples, and all associated quality control samples.

2.0 QA/QC REVIEW

2.1 SAMPLE HOLDING TIMES

All samples were prepared and analyzed within the SW846 recommended holding times with the exception of the HCB and HCBD results for water and solid samples 9-T9, 9-T12, 10-T9 and 10-T12. The recommended holding time for extraction for these compounds is 14 days from collection, but these samples were extracted more than five weeks after collection. The results for these samples were qualified as estimated to reflect a potential low bias due to loss of analytes.

2.2 INSTRUMENT CALIBRATION

Five-point calibration curves were established for both VOCs and HCB/HCBD prior to analysis. The curves showed good linearity and analyte sensitivity.

Instrument calibration is checked on a daily basis by analyzing a check standard with a concentration in the mid-range of the calibration curve. Calibration checks were performed daily with the exception of the HCB/HCBD analyses performed on 10/15/99 and 10/16/99; calibration standards were not analyzed on these days. Since there are no data to confirm the GC/ECD on these dates, results for all samples analyzed over this period were qualified as estimated (See Table 1).

The results of the calibration check standard analyses showed acceptable instrument stability (percent difference (%D) values less than 25 percent) with some exceptions (see Table 1). Sample results associated with the outlying calibration results were qualified as estimated to reflect potential variability.

2.3 SURROGATE COMPOUND ANALYSES

Surrogates were added to all samples, blanks, and QC samples prior to extraction and/or analysis. All surrogate recoveries were within the acceptance range of 50-150 percent with the following exceptions:

i) Some surrogate recoveries could not be assessed due to necessary sample dilutions.

ii) Both trichlorotoluene and pentachlorotoluene were used as surrogates for the HCB/HCBD analysis. The raw data showed that there was significant interference with the trichlorotoluene peak and recoveries could not be accurately calculated. The trichlorotoluene results were disregarded on this basis and pentachlorotoluene only was used as the surrogate for the HCB/HCBD analyses.

iii) High surrogate recoveries were reported for some of the HCB/HCBD samples. The HCB/HCBD results for these samples were qualified as estimated to reflect a potential high bias (See Table 2).

2.4 METHOD BLANK ANALYSES

Method blanks were extracted and/or analyzed for all parameters and the results were non-detect for the compounds of interest with the exception of the following:

i) Some low level concentrations of vinyl chloride were detected in some of the method blanks. Associated sample results at concentrations near those reported for the blanks were qualified non-detect (See Table 3).

ii) Some low HCB and/or HCBD concentrations were detected in some of the method blanks. Associated sample results were significantly higher than the blank results and the data were not impacted by the potential contamination.

2.5 BLANK SPIKE (BS) ANALYSES

BSs were prepared and analyzed with most sample batches. The results showed acceptable analytical accuracy (recoveries ranging from 50-150 percent) with the following exceptions:

i) The majority of the BS recoveries for 1,1-dichloroethene were extremely low. The methanol used to extract the samples interfered with the 1,1-dichloroethene quantitation, the two peaks could not be chromatographically resolved. The associated sample results for this compound were rejected on this basis.

ii) A slightly low HCBD recovery was observed for the BS prepared on 9/17/99. HCBD results for the samples extracted with this BS were qualified as estimated to reflect a potential low bias (See Table 4).

iii) A high HCB recovery was observed for the BS extracted on 10/13/99. Positive HCB results for the samples extracted with this BS were qualified as estimated to reflect a potential high bias (See Table 4).

2.6 DUPLICATE SAMPLE ANALYSES

Duplicate portions of some samples were collected and prepared and analyzed independently. The results showed good reproducibility indicating acceptable overall analytical precision.

3.0 CONCLUSION

Based on this data review, the data were acceptable for use for the exceptions specified above.

TABLE 1

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING CONTINUING CALIBRATION RESULTS
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Parameter	*Calibration Date*	*Compound*	*%D*	*Associated Sample ID*	*Sample Matrix*	*Qualifier*
VOCs	09/13/99	Tetrachloroethene	46	B1-T0	Solid	J
				B2-T0	Solid	J
				B3-T0	Solid	J
				B1-T0	Water	J
				B2-T0	Water	J
				B3-T0	Water	J
		Ethylbenzene	27	B1-T0	Solid	J
				B2-T0	Solid	J
				B3-T0	Solid	J
				B1-T0	Water	J
				B2-T0	Water	J
				B3-T0	Water	J
	09/15/99	Tetrachloroethene	39	B2-T12	Solid	J
				B23-T12	Solid	J
				B1-T24	Solid	J
				B1-T6	Solid	J
				B2-T6	Solid	J
				B3-T6	Solid	J
				B2-T24	Solid	J
				B3-T24	Solid	J
				B1-T24	Water	J
				B2-T24	Water	J
				B3-T24	Water	J
				B1-T0	Water	J
				B2-T0	Water	J
				B3-T0	Water	J

TABLE 1

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING CONTINUING CALIBRATION RESULTS
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Parameter	*Calibration Date*	*Compound*	*%D*	*Associated Sample ID*	*Sample Matrix*	*Qualifier*
VOCs	09/20/99	Tetrachloroethene	40	B4-T0	Solid	J
				B4-T0 Dup	Solid	J
				B5-T0	Solid	J
				B6-T0	Solid	J
				B4-T6	Solid	J
				B4-T12	Solid	J
				B4-T24	Solid	J
				B4-T0	Water	J
				B4-T0 Dup	Water	J
				B5-T0	Water	J
				B6-T0	Water	J
				B4-T6	Water	J
				B5-T6	Water	J
				B6-T6	Water	J
	09/21/99	Tetrachloroethene	65	B4-T12	Water	J
				B5-T12	Water	J
				B4-T24	Water	J
				B5-T24	Water	J
				B6-T24	Water	J
				B5-T0	Solid	J
				B6-T0	Solid	J
				B5-T6	Solid	J
				B6-T6	Solid	J
				B5-T12	Solid	J
				B6-T12	Solid	J

TABLE 1

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING CONTINUING CALIBRATION RESULTS
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Parameter	*Calibration Date*	*Compound*	*%D*	*Associated Sample ID*	*Sample Matrix*	*Qualifier*
VOCs	09/22/99	Tetrachloroethene	57	B5-T24	Water	J
				B5-T6	Solid	J
				B5-T12	Solid	J
				B6-T12	Solid	J
				B4-T24	Solid	J
	09/24/99	Tetrachloroethene	58	B7-T2	Water	J
				B8-T2	Water	J
				B7-T4	Water	J
				B8-T4	Water	J
				B4-T2	Solid	J
				B5-T2	Solid	J
				B6-T2	Solid	J
				B4-T4	Solid	J
				B5-T4	Solid	J
				B6-T4	Solid	J
				B7-T6	Solid	J
				B8-T6	Solid	J
				B7-T12	Solid	J
				B8-T12	Solid	J
	10/13/99	1,1-Dichloroethene	31	B9-T2	Solid	J
				B10-T2	Solid	J
				B9-T4	Solid	J
				B10-T0	Water	J
				B9-T4	Water	J
				B10-T4	Water	J
				B9-T6	Water	J
				B10-T6	Water	J

TABLE 1

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING CONTINUING CALIBRATION RESULTS
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Parameter	*Calibration Date*	*Compound*	*%D*	*Associated Sample ID*	*Sample Matrix*	*Qualifier*
VOCs	10/13/99	1,1-Dichloroethene	31	B10-T4	Solid	J
				B9-T6	Solid	J
				B10-T6	Solid	J
	10/15/99	1,1-Dichloroethene	31	B11-T6	Solid	J
				B11-T4	Solid	J
				B11-T2	Solid	J
				B11-T0	Water	J
				B11-T2	Water	J
				B11-T4	Water	J
				B11-T6	Water	J
				B11-T0	Solid	J
				B11-T0 Dup	Water	J
				B11-T0 Dup	Solid	J
HCB/HCBD	09/21/99	Hexachlorbenzene	31	B6-T12	Water	J
				B4-T6	Water	J
				B4-T12	Water	J
				B4-T12 Dup	Water	J
				B6-T0	Water	J
				B6-T24	Water	J
				B5-T24	Water	J
				B4-T24	Water	J
				B5-T12	Water	J
	09/22/99	Hexachlorobenzene	30	B5-T6	Water	J
				B6-T6	Water	J
				B5-T0	Solid	J
				B4-T0	Solid	J

TABLE 1

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING CONTINUING CALIBRATION RESULTS
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Parameter	*Calibration Date*	*Compound*	*%D*	*Associated Sample ID*	*Sample Matrix*	*Qualifier*
HCB/HCBD	10/02/99	Hexachlorobutadiene	28	B8A-T4	Water	J
				B7A-T4	Water	J
				B8A-T24	Solid	J
		Hexachlorobenzene	33	B8A-T4	Water	J
				B7A-T4	Water	J
				B8A-T24	Solid	J
	10/15/99	Hexachlorobenzene	(1)	B9-T6	Solid	J
				B9-T4	Solid	J
				B9-T2	Solid	J
				B9-T0	Solid	J
				B10-T4	Solid	J
				B10-T2	Solid	J
		Hexachlorobutadiene	(1)	B9-T6	Solid	J
				B9-T4	Solid	J
				B9-T2	Solid	J
				B9-T0	Solid	J
				B10-T4	Solid	J
				B10-T2	Solid	J
	10/16/99	Hexachlorobenzene	(1)	B10-T0	Solid	J
		Hexachlorobutadiene	(1)	B10-T0	Solid	J

TABLE 1

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING CONTINUING CALIBRATION RESULTS
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Parameter	*Calibration Date*	*Compound*	*%D*	*Associated Sample ID*	*Sample Matrix*	*Qualifier*
	10/19/99	Hexachlorobutadiene	47	B10-T0	Solid	J
				B10-T0 Dup	Solid	J
		Hexachlorobenzene	51	B9-T6	Solid	J
				B10-T0 Dup	Solid	J

Notes:
%D Percent Difference.
VOCs Volatile Organic Compounds.
HCB Hexachlorobenzene.
HCBD Hexachlorobutadiene.
J Associated value is estimated.
(1) A daily calibration check was not performed on this analysis date.

TABLE 2

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING SURROGATE RECOVERIES
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Parameter	*Sample ID*	*Matrix*	*Surrogate Recovery (percent)*	*Control Limits (percent)*	*Analytes*	*Qualifier*
HCB/HCBD	B3-T12	Solid	178	50-150	Hexachlorobenzene	J
HCB/HCBD	B2-T12	Solid	172	50-150	Hexachlorobenzene	J
HCB/HCBD	B1-T12	Solid	172	50-150	Hexachlorobenzene	J
HCB/HCBD	B1-T6	Solid	197	50-150	Hexachlorobenzene	J

Notes:
HCB Hexachlorobenzene.
HCBD Hexachlorobutadiene.
J Associated value is estimated.

TABLE 3

QUALIFIED SAMPLE RESULTS DUE TO ANALYTE CONCENTRATIONS IN THE METHOD BLANKS
BENCH SCALE TREATABILITY STUDY
SLURRY AERATION OF AREA 5106 SEDIMENT
FORMER OCC TACOMA FACILITY
TACOMA, WASHINGTON

Parameter	*Analysis Date*	*Analyte*	*Blank Result*	*Sample ID*	*Matrix*	*Sample Result*	*Qualified Sample Result*	*Units*
VOCs	9/13/99	Vinyl Chloride	23	1-T0	Solid	38J	ND 110	mg/kg
VOCs	9/13/99	Vinyl Chloride	23	3-T0	Solid	45J	ND 120	mg/kg
VOCs	9/13/99	Vinyl Chloride	0.097	1-T0	Water	0.11J	ND 0.50	µg/L
	9/13/99	Vinyl Chloride	0.098	2-T0	Water	0.012J	ND 0.50	µg/L
	9/13/99	Vinyl Chloride	0.097	3-T0	Water	0.11J	ND 0.50	µg/L

Notes:
VOCs Volatile Organic Compounds.
J Associated value is estimated.
ND Non-detect at associated value.

TABLE 4

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING BLANK SPIKE RESULTS

BENCH SCALE TREATABILITY STUDY

SLURRY AERATION OF AREA 5106 SEDIMENT

FORMER OCC TACOMA FACILITY

TACOMA, WASHINGTON

Parameter	*Extraction Date*	*Analyte*	*Percent Recovery*	*Control Limits*	*Associated Sample ID*	*Matrix*	*Qualifier*
HCB/HCBD	9/17/99	HCBD	44	50-150	4-T0	Water	J
					5-T0	Water	J
					5-T0 Dup	Water	J
					6-T0	Water	J
					4-T6	Water	J
					5-T6	Water	J
					6-T6	Water	J
HCB/HCBD	10/13/99	HCB	170	50-150	9-T0	Water	J
					9-T2	Water	J
					9-T4	Water	J
					9-T6	Water	J
					10-T0	Water	J
					10-T2	Water	J
					10-T4	Water	J
					10-T6	Water	J
					10-T0 Dup	Water	J

Notes:
HCB Hexachlorobenzene.
HCBD Hexachlorobutadiene.
J Associated value is estimated.
Dup Duplicate.

G

APPENDIX G

DREDGING TECHNOLOGIES

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2.0 HYDRAULIC CUTTERHEAD DREDGE G-3

3.0 SPECIALTY HYDRAULIC DREDGING G-5

1.0 MECHANICAL DREDGING

Mechanical dredges remove bottom sediment through direct application of mechanical forces to dislodge the bottom at near in situ densities. The most common mechanical dredge consists of a large crane or derrick permanently mounted on a floating barge. The crane is rigged with wires to handle a clamshell bucket. The open bucket is dropped into the bed material to be dredged. The bucket is then closed by return cable to capture a load of sediment, lifted out of the water, and positioned over a haul or dump barge where the material is deposited. Two types of clamshell buckets are considered here: the standard clamshell bucket and the enclosed (environmental) bucket. The standard bucket is employed in cohesive or cemented materials and can be equipped with teeth to "break out" the consolidated material. The enclosed bucket has a flat bottom and is used for the excavation of unconsolidated materials. An advantage of the clamshell dredge is that material is removed almost as it exists in situ. Only about 5 to 10 percent water or less is added during the dredging operation.

Mechanical dredges are held in position with either spuds or wire rope/anchors during digging operations. They are repositioned in a variety of ways depending on the methods of positioning including:

i) using a kicking spud;

ii) picking up the spuds and moving with a tug;

iii) picking up the spuds and moving with the wires;

iv) moving with the wires; and

v) moving with the bucket.

Mechanical dredges use a variety of ways to measure dredging depth, production, and position ranging from operator "feel" only to the latest electronic instrumentation. The most common methods used are:

i) depth - lead line soundings and a tideboard or calibrated hoist wires and a tideboard;

ii) production - barge displacement or progress sounding surveys; and

iii) position - standard hydrographic survey techniques for horizontal position.

Modern mechanical dredging operations employ electronic tide gauges which accurately measure the water level to the nearest tenth of a foot, a Global Positioning System (GPS) which measures the horizontal position of the dredge within 1-foot of

accuracy. In the operator's cab of modern clamshell dredges, there are displays showing the horizontal position of the dredge related to the dredge channel and the vertical position of the clamshell bucket in the digging mode relative to the design dredge cut.

Production rates for clamshell dredges are a function of several factors including size and weight of the bucket, dredging depth, type of material, specific gravity, and density of material, water content, thickness of dredge cut, weather conditions, and vessel traffic in the Hylebos Waterway. Depending on these factors, production rates for a 5 cubic yard (c.y.) dredge can range between approximately 50 and 300 c.y./hour; production rates for an 8 c.y. dredge can vary between approximately 80 and 450 c.y./hour. The distance to the disposal site is also a factor influencing job production rates. Dredging projects, however, are usually planned so that the number of disposal barges will accommodate the dredge production, so that disposal would not be a limiting factor.

Standard Clamshell Bucket - Standard dredge buckets are normally of three designs: general purpose; heavy duty; and extra heavy duty. The ability to dig materials of increasing density and hardness increases with the weight of the bucket, which creates the necessary force to fracture the material and break it out of the cut. Clamshells equipped with extra heavy duty buckets can often excavate very dense materials with 50 to 60 Standard Penetration Test blow counts.

Enclosed (Environmental) Clamshell Bucket - Enclosed (environmental-type) buckets offer advantages when excavating light, loose materials, and those with high water contents. The CABLEARM clamshell bucket, distributed by Cable Arm, Inc. of Trenton, Michigan, is an enclosed bucket incorporating special features that are advantageous for capturing and retaining light, loose sediments. During the bucket descent phase of the dredging cycle, vents on the top of the bucket remain open to allow water to pass through the opened bucket creating minimum downward water pressure, thereby minimizing sediment resuspension. Correspondingly, during the bucket ascent phase, the vents are closed so that the light, loose sediments are retained in the bucket and do not wash out as the bucket is raised through the water column. Overlapping side plates reduce sediment loss during bucket closure. The benefit of these features is greatly reduced turbidity compared to conventional dredge buckets. The CABLEARM bucket has a large footprint and level cut closing action which produce a generally level bottom profile. A disadvantage of the environmental bucket is that it does not work effectively in granular (sand) material and cannot dig material with blow counts above about 3 to 5. Also, the large, flat footprint of the bucket is not amenable to excavating side slopes or a sharply undulating bed.

2.0 HYDRAULIC CUTTERHEAD DREDGE

A hydraulic dredge operation utilizes a centrifugal pump to entrain the dredged solid materials in high velocity water, and pumps the slurry through a pipeline to the deposition area. The most common and most versatile hydraulic dredge is the cutterhead, which is equipped with a rotating cutter (excavator) surrounding the intake of the suction line. The cutter excavates and translates the bottom materials into the influence of the high velocity water at the suction intake. There, the solids are entrained, passed through the dredge pump to the floating discharge pipeline, and onto the deposition area through the shore pipeline.

If the sediment is soft and loose, a plain suction may be used without the cutterhead. If necessary, a booster pump is used in the discharge line to help transfer the slurry. A booster pump is normally employed for long pumping distances when the discharge line length exceeds pump horsepower available to push the sediment slurry. The standard pipeline dredge design locates the centrifugal dredge pump on the barge at the water surface elevation. Raising the dredged material is a function of the atmospheric pressure acting on the water column in the suction pipe, which limits the dredging depth. Newer dredge design locates the pump on the ladder (ladder pump) which reduces the height of the suction column and allows increased dredging depths.

The hydraulic dredge size is defined by the diameter of the discharge pipeline. For the size of the Area 5106 Sediment project, quantity and type of sediments to be dredged, configuration of the Hylebos Waterway and dredge area, depth of cuts, and pumping distance, a hydraulic dredge of 12 inches to 16 inches is considered appropriate. The hydraulic cutterhead pipeline dredge is in common use in the Pacific northwest. Availability of a hydraulic cutterhead dredge of the size required for the Area 5106 Sediment remediation project on the west coast is good. Production rates and horsepower requirements for hydraulic dredges are a function of many factors including size of dredge, dredge depth, length of ladder, type of material, in situ specific gravity and density material, water content, height of cut face, pumping distance, vertical lift to the treatment area, tides, weather conditions, and vessel traffic in the Hylebos Waterway. Depending on these factors, production rates for a 12-inch cutterhead dredge should range between approximately 100 and 500 c.y./hour; for a 16-inch dredge, production rates should vary between approximately 200 and 800 c.y./hour.

The high water content of the silt and clay sediments (170 percent to 200 percent), and the introduction of additional water as part of the pumping/transport process, will make for a dredged slurry with a very high water content. The result is that the

sediment will occupy a much greater volume in the treatment tanks than it did before dredging and water treatment requirements will increase substantially.

3.0 SPECIALTY HYDRAULIC DREDGING

With the exception of the DRE Dry-Dredge, the specialty dredges described below are essentially submersible pumping systems. They can normally be suspended from a derrick, barge, or a long-lift excavator or telescoping boom crane mounted on a barge.

EDDY Pump - The EDDY pump consists of an energy generating rotor attached to the end of a driveshaft and placed within a volute. As the rotor begins to spin, it sets into motion the ambient fluid present within the volute (pump casing) and adjoining intake chamber. At normal operating speed, this spinning fluid is forced down, into the hollow center of the intake chamber where it creates a high speed vortex, which agitates the material to be pumped (dredge material). This vortex creates a peripheral eddy effect, which causes the agitated material to travel by reverse flow, up, along the sides of the intake chamber, into the volute. Here the material, under pressure from below, is forced into the discharge pipeline.

The action also results in a region of negative pressure in the vicinity of the pump seal. The negative pressure enables the pump to achieve zero leakage with a very simple design. The seal design allows one way passage of externally supplied low pressure air (or other fluid/gas) through the shaft seal toward the pump casing to oppose the ingress of the material being pumped.

The only moving parts in the EDDY pump are the rotor and its shaft (which is turned by electric or hydraulic motors, with power typically supplied by a diesel generator).

TOYO Pump - The TOYO pump is a submersible dredge pump with a revolving built in mechanical agitator situated directly in front of the pump suction intake. As the agitator revolves, surrounding sediment is mixed with the water into a highly concentrated slurry and injected with force into the pump's discharge line. The blades of the agitator are curved and designed to physically and hydraulically push the material away from the pumps' suction. A low pressure area in front of the pump's suction partially caused by the interaction between the impeller and agitator induces the material (slurry) back into the pump's suction ensuring the longest material path for waeter/sediment mixing, thus promoting a uniform density slurry at high solids concentration. The pump is suspended from a derrick or barge and draws sediments to the surface through a suction line. The system is capable of pushing the slurry onshore for treatment or disposal. Literature provided by TOYO Pumps, North America Corporation, Burnaby, B.C., Canada, indicates that dredge pumps are manufactured in sizes from 4-inch (Model DB-15) to 10-inch (Model DB-150B). Based on pumping free-flowing sand at 30 percent solids by weight, production rates range from approximately 25 c.y./hour for the 4-inch

pump to 200 c.y./hour for the 10-inch pump. Although they will probably pump most granular materials, the manufacturer's literature indicates that the dredge pump series is designed for heavy duty, continuous operation pumping of highly abrasive materials. Applications described include tailings reclamation, overburden removal, sand and gravel dredging, pumping out caissons, and sludge pond cleanout. However, the TOYO pump is not suitable for removing stiff or dense sediments and may not be able to dredge the lower portions of the Area 5106 Sediment.

Pneuma Pump - The Pneuma pumping system, the first dredging system to use compressed air, is manufactured by Pneuma s.r.l. of Italy. Terra-Firma Technologies LTD, Ontario, Canada, is collaborating with Pneuma s.r.l. to provide Pneuma dredging systems to North America. The Pneuma is an airlift pumping system that uses hydrostatic pressure to fill containers with sediment. When the cylinders are full, the sediment is forced up a delivery tube by compressed air. The pump has no rotating parts of mechanisms in contact with the sediment, which minimizes resuspension. The Pneuma system is used primarily for removal of fine-grained sediment. The manufacturer's literature indicates that the system pumps at a high solids concentration for the slurry (up to 90 percent). This rate would apply for light materials pumped very short distances. The Pneuma is not able to pump as well in sands.

Like other specialty dredges, the Pneuma pump is suspended into the dredge cut from a derrick or crane barge. Production rates of 50 to 1,300 c.y. per hour are cited by the manufacturer, although limited case studies indicate that production rates are typically low (50 to 80 c.y. per hour maximum).

DRE Dry-Dredge - The DRE Technologies Dry-Dredge is a relatively new environmental dredging technology that integrates a closed bucket mechanical dredge with a positive displacement pump-dredged material transport system. The Dry-Dredge provides the highest percent solids concentration of any of the dredges with pipeline transport systems evaluated for Area 5106 Sediment. This is due to the use of a positive displacement pump. The clamshell is pressed into the dredge cut and closed with hydraulic chambers. Excavated sediments are screened, mixed, and pumped with solids contents as high as 120 percent solids by weight (95 percent solids by volume). The system has been designed to eliminate the need for large disposal areas and expensive water treatment facilities. The Dry-Dredge has performed a number of small projects and demonstrated high percent solids excavation and transport. The resuspension minimization characteristics at the point of dredging appear to be good. With good operational controls, the Dry-Dredge enclosed bucket should offer low resuspension of bottom sediments. The boom used to locate the bucket appears to provide good control and positioning accuracy of the bucket.

The Dry-Dredge in its c.y. model is advertised to have a production capacity of over 75 c.y. per hour. The maximum pumping distance of the dredge is 2,000 feet. It is not known how the dredge handles debris, or to what extent encountering significant large industrial debris would effect production capacity. The Dry-Dredge appears to have completed only smaller scale (<10,000 c.y.) environmental remediation dredging projects to date. Projects completed appear to have been performed in inland lakes and reservoirs, not susceptible to tides, currents, and waves. The actual production capacity of the Dry-Dredge is estimated to be 50 c.y. per hour at the point of dredging.

H

APPENDIX H

TREATMENT CRITERIA; SLURRY AERATION TREATMENT

TREATMENT CRITERIA
SLURRY AERATION TREATMENT
AREA 5106 REMOVAL ACTION

The treatment criteria for Area 5106 Sediment using slurry aeration treatment is presented in Table 1. The treatment criteria are practicable and protective of human health and the environment. The methodology used to develop the treatment criteria is presented in Tables 2 through 4, Figures 1 through 3, and as outlined below.

Treatment Objectives

1. Provide a practical level of treatment for the chemicals representative of Area 5106 Sediment.

2. Provide a level of treatment such that, after placement in the Slip 1 Confined Disposal Facility (CDF), the leachate concentrations from the treated sediment meet, at a minimum, the relevant marine Water Quality Criteria (WQC) at the seaward face of the berm.

Basis of Evaluation

The evaluation is based upon the following components:

i) disposal in Slip 1 CDF following treatment;

ii) the effectiveness of the slurry aeration treatment is represented by the results from Batches 9 and 10 of the Bench Scale Treatability Study; and

iii) slurry aeration treatment costs are based on the process flow diagram presented on Figure 1. The process represents the treatment provided in Batches 9 and 10 of the Bench Scale Treatability Study including:

   a) slurry content of 15 percent solids by weight,

   b) treatment temperature of 45°C,

   c) treatment air flow of 1000 cubic feet per minute (cfm) (scaled up from 480 liters/hour),

   d) air dispersion agitation, and

   e) carbon vapor treatment.

Methodology

1. Initially, the results from Batches 9 and 10 were used to estimate potential treatment concentrations from the range of sediment concentrations for different levels of treatment (i.e., treatment periods) (see Table 2).

2. Potential treatment criteria were selected for each level of treatment (see Table 3). The potential treatment criteria for each level of treatment were based on two times the greater of the average values or the lowest achieved values presented in Table 2.

The factor of two was chosen to account for the practicability of achieving either the average values or the lowest achieved values. Practicability issues include:

a) The Treatability Study utilized sediment with chemistry concentrations well above the average sediment concentrations. As a result, the calculated percentage reduction will over-estimate the chemistry reduction which may be achieved on an "average" sediment; and

b) Based on the Treatability Study, the lowest achieved values represent the probable minimum concentrations using the slurry aeration treatment for the specified time period. As such, meeting the lowest achieved value on an average basis is statistically improbable. To do so, every batch would have to equal the lowest achieved value.

3. Based on the selected potential treatment criteria, the amount of each chemical remaining after the specified treatment period was calculated (see Table 3).

4. Percent reductions were then calculated, for individual chemicals and as a total, for each level of treatment (see Table 3).

5. Costs were estimated for each level of treatment (see Table 6). The cost for each level of treatment was plotted versus the total chemistry removed by that level of treatment on Figure 2.

6. The incremental costs of each level of treatment was compared to the additional chemistry removal provided by that level of treatment (see Table 3 and Figure 3). These marginal cost represent the cost-benefit for each level of treatment.

7. The 4-hour treatment level was selected as the practicable treatment criteria based on the marginal cost comparisons. In addition, further treatment would increase the potential impacts to the waterway (by extending the dredging duration), consume more energy, and utilize more resources. These impacts are not offset by the small additional quantity of contaminates removed.

8. The selected treatment criteria were then compared to the estimated maximum disposal criteria for Slip 1 (see Table 4). The treatment criteria were all well below the maximum sediment concentrations estimated for Slip 1 disposal.

9. The selected treatment criteria were also compared to the peak sediment concentrations from the composites collected for the Column Leach Tests (CLTs), Outer Horizontal Boundary Composite (OHBC), Inner Horizontal Boundary Composite (IHBC), and HCC Boundary Composite (CHCC) (see Table 4). The treatment criteria were slightly above the peak sediment concentrations for the CLTs for TCE, PCE, and HCB.

   a. HCB is not expected to leach from the sediment due to its lower solubility (i.e., high K_{oc}). The results of the CLTs further support this conclusion. The results of the CLTs indicate that HCB was not detected in the leachate (ND .005 milligrams per liter [mg/L]) with a sediment concentration of 1.3 milligrams per kilogram (mg/Kg).

Even with a sediment concentration of 9.0 mg/Kg, the maximum leachate concentration should be no greater than 0.036 mg/L, which is well below the marine WQC for HCB.

b. Based on the results of the CLTs, a TCE sediment concentration of 1.14 mg/Kg should result in a maximum leachate concentration no greater than 0.22 mg/L, which is well below the marine WQC for TCE.

c. Based on the results of the CLTs, a PCE sediment concentration of 11.44 mg/Kg should result in a maximum leachate concentration no greater than 1.29 mg/L. While this value is 2.9 times the chronic marine WQC for PCE, it is still well below the average Tidal Dilution Factor of 59 determined from the Slip 1 CDF modeling.

10. Leachate concentrations were also calculated from the selected treatment criteria using the site-specific partitioning coefficients (see Table 5). The estimated leachate concentrations for PCE, HCBD, and TCBD exceeded their relevant marine WQC, however:

a. PCE exceeds its chronic marine WQC by a factor of 10.51, well below the Slip 1 average Tidal Dilution Factor (TDF_{aver}) of 59.

b. HCBD exceeds its acute marine WQC by a factor of 1.67, well below the Slip 1 peak Tidal Dilution Factor (TDF_{peak}) of 42.

c. TCBD exceeds its <u>estimated</u> acute marine WQC by a factor of 11.49, well below the Slip 1 TDF_{peak} of 42.

Consequently, with tidal dilution, there will be no exceedances of the relevant marine WQC at the seaward face of the Slip 1 berm.

11. The criteria presented in Table 1 are considered reasonable given the variability of the chemical concentrations within the Area 5106 Sediment.

a. The maximum concentration of 2.5 times the criteria was based on the average ratio of maximum to average sediment characterization concentrations.

b. Even when treated to 2.5 times the treatment criteria there will be no exceedances of the relevant marine WQC at the seaward face of the Slip 1 berm.

Leachate concentrations were calculated from sediment concentrations 2.5 times the treatment criteria using the site-specific partitioning coefficients (see Table 5). The leachate concentrations for PCE, HCBD, and TCBD exceeds their relevant marine WQC, however:

i) PCE exceeds its chronic marine WQC by a factor of 26, well below the Slip 1 TDF_{aver} of 59.

ii) PCE exceeds its acute marine WQC by a factor of 1.2, well below the Slip 1 TDF_{peak} of 42.

iii) HCBD exceeds its acute marine WQC by a factor of 4.2, well below the Slip 1 TDF_{peak} of 42.

iv) TCBD exceeds its <u>estimated</u> acute marine WQC by a factor of 29, well below the Slip 1 TDF_{peak} of 42.

c. The five chemicals were selected as indicator chemicals to measure the effectiveness of the treatment. They were also found to be the measurable chemicals during the Bench Scale Treatability Study. 1,1-Dichloroethene and trans-1,2-dichloroethene were eliminated due to their relative low concentrations in the sediment and relatively high marine WQC.

d. Vinyl chloride and the chlorinated butadienes were not included since they do not have established marine WQC. The Bench Scale Treatability Study, however, did provide greater than 99 percent reduction in both vinyl chloride and tetrachlorobutadiene (TCBD) concentrations for the 4-hour treatment level.

12. Finally, based on the results of the Treatability Study, the water quality following 4 hours of treatment is well below the applicable acute marine WQC. As shown in Table 7, only TCBD exceeded its estimated acute marine WQC. The TCBD concentrations are also conservative since they include TCBD and pentachlorobutadiene isomers.

a. While the majority of the seawater may be recycled within the treatment process, discharge of any excess flows to the Hylebos following treatment should not present any short term water quality impacts.

b. Similarly, discharge of the treated sediment with any associated water from the disposal barges should not present any short term water quality impacts within the Slip 1 CDF.

TABLE 1

PROPOSED TREATMENT CRITERIA
SLURRY AERATION TREATMENT
AREA 5106 REMOVAL ACTION

Area 5106 Sediment shall be treated such that the treated sediment meets the following requirements for the chemicals presented below. Treatment confirmation shall be based upon samples collected from each disposal barge.[1]

1. The average concentrations for each individual chemical from all barges shall be below its respective criteria.

2. The concentration of each individual chemical within a single barge shall be less than 2.5 times its respective criteria.

Parameter	*Treated Sediment Criteria (mg/kg)*
cis-1,2-Dichloroethene	2.56
Trichloroethene	1.14
Tetrachloroethene	11.44
Hexachlorobutadiene	10.60
Hexachlorobenzene	9.00

Note:
(1) A composite sample will be collected and analyzed for HCBD and HCB.
Two VOC samples will be collected and analyzed for cis-DCE, TCE, and PCE.

POTENTIAL TREATMENT CRITERIA WORKSHEET
SLURRY AERATION TREATMENT
AREA 5106 REMOVAL ACTION

2 Hour Treatment

Parameter	Sediment Concentrations (1) Maximum (mg/kg)	Sediment Concentrations (1) Average (mg/kg)	Potential Treatment Concentrations (2 hour) Treatment (2) Reduction	Maximum (3) (mg/kg)	Average (4) (mg/kg)	Lowest Achieved (5) (mg/kg)
1,1-Dichloroethene	3.6	1.6	98.00%	0.072	0.032	**0.11** ND
trans-1,2-Dichloroethene	1.4	1.3	98.00%	0.028	0.026	**0.11** ND
cis-1,2-Dichloroethene	380	128	98.00%	**7.60**	**2.56**	0.11 ND
Trichloroethene	660	228	99.32%	4.49	1.55	**5.20**
Tetrachloroethene	3000	1301	98.48%	**45.60**	**19.78**	14.00
Ethyl Benzene	13	2.5	98.00%	**0.26**	0.05	**0.11** ND
Hexachlorobutadiene	180	63	91.58%	**15.16**	5.30	**8.90**
Hexachlorobenzene	10	5.8	54.16%	**4.58**	2.66	**3.80**
Vinyl Chloride	20	7.3	98.00%	**0.40**	**0.15**	0.11 ND
Dichlorobutadiene (TIC)	81 J	11 J				
Trichlorobutadiene (TIC)	120 J	30 J				
Tetrachlorobutadiene	1600 J	427 J	98.41%	25.44	6.79	**68.00**
Pentachlorobutadiene (TIC)	880 J	276 J				

4 Hour Treatment

	Sediment Concentrations (1) Maximum (mg/kg)	Sediment Concentrations (1) Average (mg/kg)	Potential Treatment Concentrations (4 hour) Treatment (2) Reduction	Maximum (3) (mg/kg)	Average (4) (mg/kg)	Lowest Achieved (5) (mg/kg)
1,1-Dichloroethene	3.6	1.6	99.00%	0.036	0.016	**0.076** ND
trans-1,2-Dichloroethene	1.4	1.3	99.00%	0.014	0.013	**0.076** ND
cis-1,2-Dichloroethene	380	128	99.00%	**3.80**	**1.28**	0.076 ND
Trichloroethene	660	228	99.77%	**1.52**	0.52	**0.57**
Tetrachloroethene	3000	1301	99.56%	**13.20**	**5.72**	2.40 J
Ethyl Benzene	13	2.5	99.00%	**0.13**	0.03	**0.076** ND
Hexachlorobutadiene	180	63	96.12%	**6.98**	2.44	**5.30**
Hexachlorobenzene	10	5.8	59.59%	**4.04**	2.34	**4.50**
Vinyl Chloride	20	7.3	99.00%	**0.20**	**0.07**	0.076 ND
Dichlorobutadiene (TIC)	81 J	11 J				
Trichlorobutadiene (TIC)	120 J	30 J				
Tetrachlorobutadiene	1600 J	427 J	99.35%	10.40	2.78	**13.00** J
Pentachlorobutadiene (TIC)	880 J	276 J				

TABLE 2

POTENTIAL TREATMENT CRITERIA WORKSHEET
SLURRY AERATION TREATMENT
AREA 5106 REMOVAL ACTION

6 Hour Treatment

	Sediment Concentrations[1]		Potential Treatment Concentrations (6 hour)			
	Maximum (mg/kg)	*Average (mg/kg)*	*Treatment[2] Reduction*	*Maximum[3] (mg/kg)*	*Average[4] (mg/kg)*	*Lowest Achieved[5] (mg/kg)*
1,1-Dichloroethene	3.6	1.6	99.00%	0.036	0.016	**0.093** ND
trans-1,2-Dichloroethene	1.4	1.3	99.00%	0.014	0.013	**0.093** ND
cis-1,2-Dichloroethene	380	128	99.00%	**3.80**	**1.28**	0.093 ND
Trichloroethene	660	228	99.94%	0.40	0.14	**0.62**
Tetrachloroethene	3000	1301	99.79%	**6.30**	**2.73**	1.40
Ethyl Benzene	13	2.5	99.00%	**0.13**	0.03	**0.093** ND
Hexachlorobutadiene	180	63	98.11%	**3.40**	1.19	**1.70**
Hexachlorobenzene	10	5.8	76.25%	**2.38**	1.38	**2.20**
Vinyl Chloride	20	7.3	99.00%	**0.20**	0.07	**0.093** ND
Dichlorobutadiene (TIC)	81 J	11 J				
Trichlorobutadiene (TIC)	120 J	30 J				
Tetrachlorobutadiene	1600 J	427 J	99.76%	3.84	1.03	**6.20**
Pentachlorobutadiene (TIC)	880 J	276 J				

9 Hour Treatment

	Sediment Concentrations[1]		Potential Treatment Concentrations (9 hour)			
	Maximum (mg/kg)	*Average (mg/kg)*	*Treatment[2] Reduction*	*Maximum[3] (mg/kg)*	*Average[4] (mg/kg)*	*Lowest Achieved[5] (mg/kg)*
Hexachlorobutadiene	180	63	98.28%	**3.10**	1.08	**1.80**
Hexachlorobenzene	10	5.8	80.84%	**1.92**	1.11	**2.10**

TABLE 2

POTENTIAL TREATMENT CRITERIA WORKSHEET
SLURRY AERATION TREATMENT
AREA 5106 REMOVAL ACTION

12 Hour Treatment

	Sediment Concentrations (1)		Potential Treatment Concentrations (12 hour)			
	Maximum (mg/kg)	*Average (mg/kg)*	*Treatment (2) Reduction*	*Maximum (3) (mg/kg)*	*Average (4) (mg/kg)*	*Lowest Achieved (5) (mg/kg)*
Hexachlorobutadiene	180	63	98.85%	2.07	0.72	0.82
Hexachlorobenzene	10	5.8	83.33%	1.67	0.97	1.90

TDF_{peak}
TDF_{avver}
f_{oc}

Notes:

(1) Sediment concentrations from Table 5.4 of the Area 5106 Sediment Characterization Report.

(2) Average reduction from Batches 9 and 10 of the Bench Scale Treatability Study after the specified treatment period. Values indicated as 98.00% or 99.00% are estimates based on ND values from Batches 9 and 10. Refer to Tables 3.11 and 3.12 of the Bench Scale Treatability Study Report.

(3) Potential criteria based on the treatment reduction percentage applied to the maximum sediment concentration.

(4) Potential criteria based on the treatment reduction percentage applied to the average sediment concentration.

(5) Lowest sediment concentrations achieved in Batches 9 and 10 after the specified treatment period.

(6) Estimated Marine Water Quality Criteria based on human health criteria.

(7) Estimated Marine Water Quality Criteria based on USEPA ECOSAR computer program.

J Estimated.

NDx Not detected at or above x.

NV No criteria established.

TIC Tentatively Identified Compounds. The Treatability Study did not monitor these compounds.

POTENTIAL TREATMENT CRITERIA
SLURRY AERATION TREATMENT
AREA 5106 REMOVAL ACTION

Parameter	Sediment Concentrations Maximum [1] (mg/kg)	Sediment Concentrations Average [1] (mg/kg)	Sediment Concentrations Weight [2] (kg)	2-Hour Treatment Criteria [3] (mg/kg)	2-Hour Treatment Treatment Reduction [4]	2-Hour Treatment Weight Remaining [5] (kg)	4-Hour Treatment Criteria [3] (mg/kg)	4-Hour Treatment Treatment Reduction [4]	4-Hour Treatment Weight Remaining [5] (kg)	6-Hour Treatment Criteria [3] (mg/kg)	6-Hour Treatment Treatment Reduction [4] (%)	6-Hour Treatment Weight Remaining [5] (kg)
1,1-Dichloroethene	3.6	1.6	13	0.22	86.25%	1.7	0.152	90.50%	1.20	0.186	88.38%	1.46
trans-1,2-Dichloroethene	1.4	1.3	10	0.22	83.08%	1.7	0.152	88.31%	1.20	0.186	85.69%	1.46
cis-1,2-Dichloroethene	380	128	1,008	5.12	96.00%	40.3	2.56	98.00%	20.16	2.56	98.00%	20.16
Trichloroethene	660	228	1,795	10.40	95.44%	81.9	1.14	99.50%	8.98	1.24	99.46%	9.76
Tetrachloroethene	3,000	1,301	10,243	39.56	96.96%	311.5	11.44	99.12%	90.07	5.46	99.58%	42.99
Ethyl Benzene	13	2.5	20	0.22	91.20%	1.7	0.152	93.92%	1.20	0.186	92.56%	1.46
Hexachlorobutadiene	180	63	496	17.80	71.75%	140.1	10.60	83.17%	83.45	3.40	94.60%	26.77
Hexachlorobenzene	10	5.8	46	7.60	0.00%	0.0	9.00	0.00%	0.00	4.40	24.14%	34.64
Vinyl Chloride	20	7.3	57	0.30	95.89%	2.4	0.152	97.92%	1.20	0.186	97.45%	1.46
Dichlorobutadiene (TIC)	81 J	11 J	-									
Trichlorobutadiene (TIC)	120 J	30 J	-									
Tetrachlorobutadiene	1,600 J	427 J	3,364	136.00	68.17%	1070.7	26.00	93.91%	204.70	12.40	97.10%	97.63
Pentachlorobutadiene (TIC)	880 J	276 J	-									
		Total Original Weight	17,051	Total Remaining		1,652			412			238
				Percent Reduction[7]		90.31%			97.6%			98.605%
				Removal Action Cost		$ 7.51 MM			$ 7.81 MM			$ 8.53 MM
Total Volume	25,000 cy			Marginal Cost[8]		$ 488 per kg			$ 242 per kg			$ 4,130 per kg
Weight of Solids	7,873,067 kg											

Notes:

(1) Sediment concentrations from Table 5.4 of the Area 5106 Sediment Characterization Report.

(2) Total weight of chemical within 25,000 c.y. of Area 5106 Sediment prior to removal and treatment.

(3) Criteria based on the greater of the average values or the lowest achieved values presented in Table 2 for the specified treatment period.

(4) Percent reduction in the average sediment concentration following treatment which meets the specified criteria.

(5) Weight of chemicals in sediment following treatment which meets the specified criteria.

(6) Samples for the VOCs taken at time = 9 and 12 hours were not analyzed in Batches 9 and 10. Values shown are assumed to be 99% of the previous treatment level values.

(7) Percent reduction from the total weight of chemicals prior to treatment.

(8) Marginal Cost = Incremental cost of the next level of treatment/additional amount of chemistry removed.

J Estimated.

MM Million

NV No criteria established.

TIC Tentatively Identified Compounds. The Treatability Study did not monitor these compounds.

POTENTIAL TREATMENT CRITERIA
SLURRY AERATION TREATMENT
AREA 5106 REMOVAL ACTION

Parameter	Sediment Concentrations Maximum [1] (mg/kg)	Sediment Concentrations Average [1] (mg/kg)	Sediment Concentrations Weight [2] (kg)	9 - Hour Treatment Criteria [3] (mg/kg)	9 - Hour Treatment Treatment Reduction [4]	9 - Hour Treatment Weight Remaining [5] (kg)	12 - Hour Treatment Criteria Criteria [3] (mg/kg)	12 - Hour Treatment Treatment Reduction [4]	12 - Hour Treatment Weight Remaining [5] (kg)
1,1-Dichloroethene	3.6	1.6	13	0.184 [6]	88.49%	1.45	0.182 [6]	88.61%	1.44
trans-1,2-Dichloroethene	1.4	1.3	10	0.184 [6]	85.84%	1.45	0.182 [6]	85.98%	1.44
cis-1,2-Dichloroethene	380	128	1,008	2.534 [6]	98.02%	19.95	2.509 [6]	98.04%	19.75
Trichloroethene	660	228	1,795	1.228 [6]	99.46%	9.66	1.215 [6]	99.47%	9.57
Tetrachloroethene	3,000	1,301	10,243	5.405 [6]	99.58%	42.56	5.351 [6]	99.59%	42.13
Ethyl Benzene	13	2.5	20	0.184 [6]	92.63%	1.45	0.182 [6]	92.71%	1.44
Hexachlorobutadiene	180	63	496	3.600	94.29%	28.34	1.64	97.40%	12.91
Hexachlorobenzene	10	5.8	46	4.200	27.59%	33.07	3.80	34.48%	29.92
Vinyl Chloride	20	7.3	57	0.184 [6]	97.48%	1.45	0.182 [6]	97.50%	1.44
Dichlorobutadiene (TIC)	81 J	11 J	-						
Trichlorobutadiene (TIC)	120 J	30 J	-						
Tetrachlorobutadiene	1,600 J	427 J	3,364	12.276 [6]	97.13%	96.65	12.153 [6]	97.16%	95.68
Pentachlorobutadiene (TIC)	880 J	276 J	-						
		Total Original Weight	17,051		Total Remaining	236			216
					Percent Reduction[7]	98.616%			98.735%
					Removal Action Cost	$ 9.68 MM			$ 10.87 MM
					Marginal Cost[8]	$ 575,000 per kg			$ 59,500 per kg

Total Volume	25,000 cy
Weight of Solids	7,873,067 kg

Notes:

(1) Sediment concentrations from Table 5.4 of the Area 5106 Sediment Characterization Report.

(2) Total weight of chemical within 25,000 c.y. of Area 5106 Sediment prior to removal and treatment.

(3) Criteria based on the greater of the average values or the lowest achieved values presented in Table 2 for the specified treatment period.

(4) Percent reduction in the average sediment concentration following treatment which meets the specified criteria.

(5) Weight of chemicals in sediment following treatment which meets the specified criteria.

(6) Samples for the VOCs taken at time = 9 and 12 hours were not analyzed in Batches 9 and 10. Values shown are assumed to be 99% of the previous treatment level values.

(7) Percent reduction from the total weight of chemicals prior to treatment.

(8) Marginal Cost = Incremental cost of the next level of treatment/additional amount of chemistry removed.

J Estimated.

MM Million

NV No criteria established.

TIC Tentatively Identified Compounds. The Treatability Study did not monitor these compounds.

TABLE 4

TREATMENT CRITERIA COMPARISONS
SLURRY AERATION TREATMENT
AREA 5106 REMOVAL ACTION

Parameter	Marine WQC Acute (mg/L)	Marine WQC Chronic (mg/L)	Sediment Concentrations Maximum [1] (mg/kg)	Sediment Concentrations Average [1] (mg/kg)	Treatment Criteria [2] (mg/kg)	Estimated Disposal Criteria from Modeling: Maximum Leachate [3] Acute (mg/L)	Maximum Leachate [3] Chronic (mg/L)	Koc [4]	Maximum Sediment [5] (mg/kg)	Boundary Sediments CLT Results: Leachate [6] (mg/L)	Sediment [7] (mg/kg)
1,1-Dichloroethene	224	NV	3.6	1.6	**0.152**	9408.0					
trans-1,2-Dichloroethene	224	NV	1.4	1.3	**0.152**	9408.0		100	**10349**	0.040	**0.088**
cis-1,2-Dichloroethene	224	NV	380	128	**2.56**	9408.0		100	**10349**		
Trichloroethene	2	NV	660	228	**1.14**	84.0		190	**176**	0.160	**0.820**
Tetrachloroethene	10.2	0.45	3000	1301	**11.44**	428.4	26.6	220	**64**	0.700	**6.200**
Ethyl Benzene	0.43	NV	13	2.5	**0.152**	18.1					
Hexachlorobutadiene	0.032	NV	180	63	**10.60**	1.3		18000	**266**	0.042	**14**
Hexachlorobenzene	0.16	0.129	10	5.8	**9.00**	6.7	7.6	24000	**1774**	0.005 ND	**1.3**
Vinyl Chloride	NV	0.525 [8]	20	7.3	**0.152**		31.0	70	**24**	2.600 J	**9 J**
Dichlorobutadiene (TIC)	0.282 [9]	NV	81 J	11 J		11.8				0.870 J	**4 J**
Trichlorobutadiene (TIC)	0.192 [9]	NV	120 J	30 J		8.1				0.870 J	**23 J**
Tetrachlorobutadiene	0.121 [9]	NV	1600 J	427 J	**26.00**	5.1		1700	**95**	1.500 J	**92 J**
Pentachlorobutadiene (TIC)	0.067 [9]	NV	880 J	276 J		2.8				0.100 J	**53 J**

TDF_{peak} 42
TDF_{aver} 59
f_{oc} 0.011

Notes:

(1) Sediment concentrations from Table 5.4 of the Area 5106 Sediment Characterization Report.

(2) Treatment criteria based on the 4-hour treatment on Table 3.

(3) Maximum leachate concentrations which can be placed in Slip 1 and still meet relevant Marine Water Quality Criteria (WQC) at the seaward face of berm. Calculations are based on the Tidal Dilution Factors determined through the MODFLO modeling presented in the CLT Evaluation Report. The peak Tidal Dilution Factor, TDF_{peak}, of 42 is applied to the Acute Marine WQC. The average Tidal Dilution Factor, TDF_{aver}, of 59 is applied to the Chronic Marine WQC.

(4) Site-specific partitioning coefficients calculated from characterization samples.

(5) Maximum sediment concentrations which correspond to the maximum leachate concentrations calculated as $C_s = C_w \times K_{oc} \times f_{oc}$

C_s = sediment concentration (mg/kg)
C_w = leachate concentration (mg/L)
K_{oc} = site-specific partitioning coefficient
f_{oc} = fraction of organic carbon = .011

(6) Peak leachate concentration from Column Leach Tests (CLTs) OHBC, IHBC, and CHCC. Refer to the CLT Evaluation Report.

(7) Peak sediment concentrations from the composite samples collected for CLTs OHBC, IHBC, and CHCC. Refer to the CLT Evaluation Report.

(8) Estimated Marine Water Quality Criteria based on human health criteria.

(9) Estimated Marine Water Quality Criteria based on USEPA ECOSAR computer program.

J Estimated.

NV No criteria established.

TIC Tentatively Identified Compounds. The Treatability Study did not monitor these compounds.

TABLE 5

ESTIMATED LEACHATE CONCENTRATIONS FROM TREATED SEDIMENTS
SLURRY AERATION TREATMENT
AREA 5106 REMOVAL ACTION

Parameter	Marine WQC Acute (mg/L)	Marine WQC Chronic (mg/L)	Koc [1]	Sediment Treatment Criteria [2] (mg/kg)	Estimated Leachate Concentration [3] (mg/L)	Required TDF to meet WQC at Seaward Face of Berm: Acute [4]	Required TDF to meet WQC at Seaward Face of Berm: Chronic [5]	2.5 X Treatment Criteria [6] (mg/kg)	Estimated Leachate Concentration [3] (mg/L)	Required TDF to meet WQC at Seaward Face of Berm: Acute [4]	Required TDF to meet WQC at Seaward Face of Berm: Chronic [5]
1,1-Dichloroethene	224	NV		0.152				0.38			
trans-1,2-Dichloroethene	224	NV	100	0.152	0.138	<1		0.38	0.345	<1	
cis-1,2-Dichloroethene	224	NV	100	2.56	2.327	<1		6.40	5.818	<1	
Trichloroethene	2	NV	190	1.14	0.545	<1		2.85	1.364	<1	
Tetrachloroethene	10.2	0.45	220	11.44	4.727	<1	10.51	28.6	11.818	1.2	26
Ethyl Benzene	0.43	NV		0.152				0.38			
Hexachlorobutadiene	0.032	NV	18000	10.60	0.054	1.67		26.5	0.134	4.2	
Hexachlorobenzene	0.16	0.129	24000	9.00	0.034	<1	<1	22.5	0.085	<1	
Vinyl Chloride	NV	0.525 [8]	70	0.152	0.197		<1	0.38	0.494		<1
Dichlorobutadiene (TIC)	0.282 [9]	NV									
Trichlorobutadiene (TIC)	0.192 [9]	NV									
Tetrachlorobutadiene	0.121 [9]	NV	1700	26.00	1.390	11.49		65	3.476	29	
Pentachlorobutadiene (TIC)	0.067 [9]	NV									
f_{oc}	0.011			Slip 1 Tidal Dilution Factors [7]		42	59	Slip 1 Tidal Dilution Factors [7]		42	59

Notes:

(1) Site-specific partitioning coefficients calculated from characterization samples.

(2) Treatment criteria based on the 4-hour treatment on Table 3.

(3) Leachate concentrations calculated from the treatment criteria (or 2.5 X the treatment criteria) using site specific partitioning coefficients.
Leachate concentrations are calculated as $C_w = C_s / (K_{oc} \times f_{oc})$ where:

C_s = sediment concentration (mg/kg)
C_w = leachate concentration (mg/L)
K_{oc} = site-specific partitioning coefficient
f_{oc} = fraction of organic carbon = .011

(4) Tidal Dilution Factor (TDF) required for chemical to meet acute marine WQC at the seaward face of the Slip 1 berm.
TDF calculated as Estimated Leachate Concentration / acute marine WQC

(5) Tidal Dilution Factor (TDF) required for chemical to meet chronic marine WQC at the seaward face of the Slip 1 berm.
Calculated as Estimated Leachate Concentration / chronic marine WQC

(6) 2.5 times the treatment criteria.

(7) Tidal Dilution Factors determined for the Slip 1 CDF through the MODFLO modeling presented in the CLT Evaluation Report.
The peak Tidal Dilution Factor, TDF_{peak}, of 42 is applied to the Acute Marine WQC.
The average Tidal Dilution Factor, TDF_{aver}, of 59 is applied to the Chronic Marine WQC.

(8) Estimated marine Water Quality Criteria based on human health criteria.

(9) Estimated marine Water Quality Criteria based on USEPA ECOSAR computer program.

TABLE 6
SLURRY AERATION COST ESTIMATES
SLURRY AERATION TREATMENT
AREA 5106 REMOVAL ACTION

	2-Hour Treatment	4-Hour Treatment	6-Hour Treatment	9-Hour Treatment	12-Hour Treatment
Sediment Dredging					
Equipment	$ 493,550	$ 539,250	$ 584,950	$ 653,500	$ 722,050
Materials & Installation	883,382	883,382	883,382	883,382	883,382
Operation	729,316	835,375	1,155,411	1,642,016	2,128,621
Dredging Subtotal	**$ 2,106,248**	**$ 2,258,007**	**$ 2,623,743**	**$ 3,178,898**	**$ 3,734,053**
Sediment Treatment					
Equipment	1,306,199	1,153,931	1,097,663	1,058,262	1,048,861
Materials & Installation	474,856	474,856	474,856	474,856	474,856
Operation	539,663	665,925	792,186	981,578	1,170,971
Treatment Subtotal	**$ 2,320,718**	**$ 2,294,712**	**$ 2,364,705**	**$ 2,514,696**	**$ 2,694,688**
Disposal					
Equipment	276,193	403,137	530,082	720,498	910,915
Materials & Installation	125,000	125,000	125,000	125,000	125,000
Operation	716,576	716,576	716,576	716,576	716,576
Disposal Subtotal	**$ 1,117,769**	**$ 1,244,713**	**$ 1,371,658**	**$ 1,562,074**	**$ 1,752,491**
Facility Cost	**$ 5,544,735**	**$ 5,797,432**	**$ 6,360,106**	**$ 7,255,668**	**$ 8,181,232**
Contingency (25%)	1,386,184	1,449,358	1,590,027	1,813,917	2,045,308
Engineering (1)	492,448	476,463	474,878	479,250	488,122
Construction Oversight (2)	89,587	89,587	105,760	130,514	155,268
TOTAL COST	**$ 7,512,954**	**$ 7,812,840**	**$ 8,530,771**	**$ 9,679,349**	**$ 10,869,930**

Estimate Basis						units
Area 5106 Sediment Quantity	22265	22265	22265	22265	22265	cubic yards
Estimated Overdredge Quantity	4725	4725	4725	4725	4725	cubic yards
Total in-situ Sediment	31990	31990	31990	31990	31990	cubic yards
Treatment Slurry Content	15	15	15	15	15	%
Number of Treatment Tanks	3	3	3	3	3	ea
Treatment Time	2	4	6	9	12	hours per batch
Batches	24	14.4	10.3	7.2	5.5	batches per day
Batch Capacity	18,500	18,500	18,500	18,500	18,500	gallons per batch
	35	35	35	35	35	cubic yards per batc
Treatment Rate	444,000	266,400	190,286	133,200	102,462	gallons per day
	840	504	360	252	194	cubic yards per day
Required Equalization Tank Capaci	670,000	400,000	290,000	200,000	160,000	gallons
Theortical Treatment Days	38.1	63.5	88.9	126.9	165.0	days
	6.3	10.6	14.8	21.2	27.5	weeks (6 days each)
Theoretical Dredging Days	38.1	63.5	88.9	126.9	165.0	days
	6.3	10.6	14.8	21.2	27.5	weeks (6 days each)
Minimum Dredge Rate	840.0	504.0	360.0	252.0	193.8	cubic yards per day
Dredge Capacity	50.0	50.0	50.0	50.0	50.0	cubic yards per hour
Minimum Dredge Operation	16.8	10.1	7.2	5.0	3.9	hours per day
Actual Dredging Time	639.8	639.8	639.8	639.8	639.8	hours
Chargable Dredging Time	639.8	639.8	888.6	1269.4	1650.3	hours (10 hours/day

Notes:

(1) Engineering calculated as 15% of construction (equipment, materials & installation) cost.
(2) Construction oversight based on a 12 week construction schedule plus the estimated dredging / treatment schedule.

TABLE 7

WATER / SEDIMENT TREATMENT COMPARISONS
SLURRY AERATION TREATMENT
AREA 5106 REMOVAL ACTION

Parameter	Marine WQC Acute (mg/L)	Marine WQC Chronic (mg/L)	4-hour Treatment Concentrations [1] Water Batch 9 (mg/L)	Water Batch 10 (mg/L)	Sediment Batch 9 (mg/kg)	Sediment Batch 10 (mg/kg)	Treatment Criteria [2] (mg/kg)
1,1-Dichloroethene	224	NV	0.050 N	0.10 ND	0.20 ND	0.076 ND	
trans-1,2-Dichloroethene	224	NV	0.050 N	0.10 ND	0.20 ND	0.076 ND	
cis-1,2-Dichloroethene	224	NV	0.050 N	0.10 ND	0.20 ND	0.076 ND	2.56
Trichloroethene	2	NV	0.34	0.160	3.8	0.57	1.14
Tetrachloroethene	10.2	0.45	0.51	0.28	16	2.4	11.44
Ethyl Benzene	0.43	NV	0.050 N	0.10 ND	0.20 ND	0.076 ND	
Hexachlorobutadiene	0.032	NV	0.0055	0.0071	5.3	5.5	10.60
Hexachlorobenzene	0.16	0.129	0.0024	0.0038	4.5	5.2	9.00
Vinyl Chloride	NV	0.525 [3]	0.050 N	0.10 ND	0.20 ND	0.076 ND	
Dichlorobutadiene (TIC)	0.282 [4]	NV					
Trichlorobutadiene (TIC)	0.192 [4]	NV					
Tetrachlorobutadiene	0.121 [4]	NV	0.28 [5]	0.28 [5]	44	13	
Pentachlorobutadiene (TIC)	0.067 [4]	NV					

Notes:

(1) Water and sediment concentrations following 4-hours of treatment. Refer to Tables 3.11 and 3.12 of the Bench Scale Treatability Study.

(2) Treatment criteria based on the 4-hour treatment level from Table 1.

(3) Estimated Marine Water Quality Criteria based on human health criteria.

(4) Estimated Marine Water Quality Criteria based on USEPA ECOSAR compouter program.

(5) Concentration includes tetrachlorobutadiene and pentachlorobutadiene isomers.

3.8 Value exceeds 2.5 times the proposed Treatment Criteria.

16 Value exceed the proposed Treatment Criteria but is within 2.5 time the proposed Treatment Criteria.

J Estimated.

x ND Not detected at or above x

NV No criteria established.

TIC *Tentatively Identified Compounds. The Treatability Study did not monitor these compounds.*

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13 OVERSIZED MAPS HYLEBOS WATERWAY