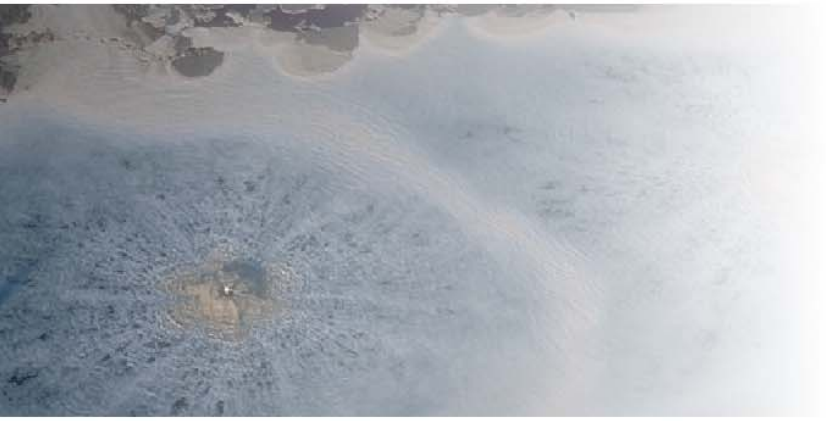

Remedial Investigation
Westbay Marina
2100 West Bay Drive NW
Olympia, Washington

Prepared for
Washington State
Department of Ecology

June 30, 2011
17330-35

HARTCROWSER

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Remedial Investigation
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2100 West Bay Drive NW
Olympia, Washington

Prepared for
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OLYMPIA, WASHINGTON

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ACRONYMS

AET	apparent effects threshold
ARI	Analytical Resources, Inc.
AST	aboveground storage tank
ARAR	applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
AWQC	ambient water quality criteria
BTEX	benzene, toluene, ethylbenzene, xylene
CCV	continuing calibration verification checks
CSL	cleanup screening level
DCBP	decachlorobiphenyl
DGPS	differential global positioning system
DMMP	Dredged Material Management Program
DNR	Department of Natural Resources
DQO	data quality objective
DRO	diesel-range organics
Ecology	Washington State Department of Ecology
EDL	estimated detection limit
EISC	ecological soil indicator concentration
EMPC	estimated maximum possible concentration
EPA	US Environmental Protection Agency
GPS	global positioning system
GRO	gasoline-range organics
HPAH	heavy polycyclic aromatic hydrocarbons
LAET	lowest apparent effects threshold
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
LPAH	light polycyclic aromatic hydrocarbons
MS/MSD	matrix spike/matrix spike duplicate
MTCA	Model Toxics Control Act
NFA	no further action
OC	organic carbon
OCDD	octachlorodibenzodioxin
OPR	ongoing precision and accuracy sample recoveries
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
ppt	parts per trillion
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance/quality control
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RL	reporting limits
RME	reasonable maximum exposure
RPD	relative percent differences

RSD	relative standard deviation
RSET	Regional Sediment Evaluation Team
SAP	Sampling and Analysis Plan
SAPA	Sediment Sampling and Analysis Plan Appendix
Site	Westbay Marina
SMS	Sediment Management Standards
SRM	Standard Reference Material
SQS	Sediment Quality Standards
SVOC	semivolatile organic compound
TBT	tributyltin
TCDD	tetrachlorodibenzodioxin
TCMX	tetrachlorometaxylene
TEE	terrestrial ecological evaluation
TEF	toxic equivalency factors
TEQ	toxics equivalent
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TVS	total volatile solids
UST	underground storage tank
WAC	Washington Administrative Code
WBMA	Westbay Marina Association
WHO	World Health Organization

REMEDIAL INVESTIGATION
WESTBAY MARINA
2100 WEST BAY DRIVE NW
OLYMPIA, WASHINGTON

EXECUTIVE SUMMARY

The Westbay Marina property (the Site) was first developed as a lumber mill by Buchanan Lumber Company in 1919. Subsequent activities at the Site include a sawmill, veneer plant, stud mill, boatyard, and marina. A hog fuel burner was located along the northern property line and most of the lumber mill operations were located off-site to the north. Available information indicates that lumber treating never occurred at this location, and the closest lumber treating operation is approximately one mile southeast of the Site at the foot of Budd Inlet.

Formerly, small boat maintenance activities on the site included hydroblasting, scraping, sanding, and painting boats. A restaurant was constructed on the Site in the mid-1980s, was destroyed by fire in 1993, and was rebuilt in 1995. Westbay Marina currently operates solely as a marina with a 30-year Aquatic Land Lease (No. 2618) from the Washington State Department of Natural Resources (DNR) for state-owned tidelands, effective January 1, 1984, through January 1, 2014.

This remedial investigation (RI) characterizes upland soil and groundwater within the Westbay Marina property and sediment conditions along the shoreline and within the DNR aquatic lease area. A limited wood debris survey was completed to estimate the extent of wood debris in the subtidal portions of the marina, and a limited benthic organism survey was completed to help determine the ecological health of intertidal and subtidal areas. The work that was performed for this RI supplements and discusses the previous work conducted by Anchor QEA for Westbay Marina Associates (WBMA) under an existing Remedial Investigation/Feasibility Study (RI/FS) Work Plan.

Soil, groundwater, sediment, wood debris, and benthic organism sampling, collection, handling, and analysis were performed in general accordance with the 2011 project sampling and analysis plan (SAP) and all samples collected were acceptable for chemical and physical analysis as qualified.

The total volatile solids (TVS)/total organic carbon (TOC) ratio, sulfide concentration, and ammonia concentrations indicate that wood debris levels in subtidal portions of the site are high enough to result in elevated concentrations of ammonia and sulfide. However, the detected concentrations of these

chemicals were not great enough to indicate widespread impacts to aquatic biota, especially as benthic invertebrate samples confirmed the presence of a variety of taxa in the sediment.

Analytical testing results indicate that Westbay Marina soil, groundwater, and sediment have not been significantly impacted by chemical constituents based on Sediment Management Standards (SMS) criteria (intertidal samples) or AET dry-weight screening values (subtidal samples). Fluoranthene, butylbenzylphthalate, and total polychlorinated biphenyls (PCBs) exceeded AET screening criteria in one sample each collected from subtidal sediment, however these exceedances were seen as isolated occurrences and therefore do not warrant additional action.

Groundwater from the 2011 investigation was analyzed for nickel and copper, which did not exceed Ecology's Model Toxics Control Act (MTCA) Method B criteria based on drinking water use. Groundwater data were also compared to marine surface water criteria. Groundwater had minor exceedances of marine chronic criteria in both total and dissolved copper samples collected from the two wells sampled. Total and dissolved nickel and total ammonia results from both groundwater well samples were below their respective marine surface water criteria. Similar results are observed in previous groundwater data collected by Anchor QEA from the site. Slight exceedances of marine surface water criteria for total and dissolved copper and nickel were observed in groundwater (Anchor 2009a).

Groundwater seeps that surface in the intertidal area were sampled and analyzed for a variety of organic and inorganic constituents in 2009 by Anchor QEA. As with the groundwater results, copper and nickel were detected at concentrations that slightly exceeded their respective marine surface water criteria. In addition, one seep sample slightly exceeded the marine surface water criterion for zinc and three seep results exceeded the criterion for arsenic. Organic results did not exceed marine criteria used in the data evaluation.

Porewater tributyltin (TBT) concentrations from samples collected by both Anchor QEA and Hart Crowser were evaluated for TBT in sediment because the dissolved fraction of TBT is the main exposure pathway. None of the intertidal or subtidal sediment samples had porewater TBT concentrations that exceeded the Dredged Material Management Program DMMP or the Regional Sediment Evaluation Team (RSET) criteria. Therefore, data indicate that TBT in marine sediment does not pose a significant risk at the site.

Dioxin/furan were detected in both intertidal sediment samples and the four upland soil samples collected by Hart Crowser. Anchor QEAs dioxin/furan

results from the 2010 investigation had similar dioxin/furan results in the soil samples. Soil samples were collected at or near the location of a historical wood waste burner suspected of having created dioxins/furans. Concentrations in two of the Hart Crowser upland soil samples closest to the suspected burner's former location and both Anchor QEA sample results exceeded MTCA Method B criteria, assuming unrestricted land use. The lack of cover by clean fill or impervious surfaces to limit human exposure or erosion into surface water or the marine environment suggest that additional action is warranted for upland soil impacted by dioxins/furans under the MTCA.

TEQ concentrations and congener patterns found during the 2011 investigation in the intertidal sediment samples exceeded the Puget Sound non-urban background sediment samples. However they did not exceed average concentrations found in Budd Inlet. In addition, concentrations in the intertidal zone were much lower than in nearby upland soil, suggesting at best a weak link between these sources. Given both levels below applicable background, and the absence of a strong linkage to dioxin/furan sources from upland soil at the site, the RI indicates that cleanup of sediments may not be warranted under MTCA. The pattern of the congener ratios in the upland soil and the intertidal sediment are similar, indicating a similar source.

Wood debris was observed in 100 percent of the sediment core samples taken to quantify the extent of wood debris. In addition, large wood fragments and wood debris were found in all subtidal sediment samples. All intertidal sediment samples had small amounts of woody organic debris (less than 10 percent). The highest accumulations of wood waste were observed near the northwest boundary of the Westbay Marina DNR lease with adjacent property owned by Dunlap Towing Company (greater than 25 percent wood waste).

All sediment samples collected for benthic infauna evaluation contained invertebrates. The benthic infauna samples contained a variety of organisms that can be found in both aerobic and anaerobic environments including nematodes, polychaetes, oligochaetes, bivalves, gastropods, and arthropods. The subtidal benthic infauna samples had less than one-third the number of organisms observed in the intertidal samples. The lack of diversity in the subtidal samples may be due to the abundance of fine sediment compared to the more sandy intertidal samples. Alternately, it may be indicative of an anaerobic environment due to abundant wood debris in the subtidal areas.

The results of this RI indicate that the only constituents of potential concern in Westbay Marina warranting additional action under the MTCA are dioxins/furans in the upland soil in the vicinity of the former hog fuel burner. Dioxins/furans in this area is of potential concern with respect to both direct and

indirect human health exposures. It is recommended that the upland soil with dioxins/furans exceedances be further evaluated for cleanup action in accordance with the MTCA process.

In addition, minor exceedances of marine surface water criteria were identified for a few metals (e.g., copper and nickel) in both groundwater and seep samples collected from the site. These minor exceedences of water quality criteria may not warrant additional cleanup actions at the site.

1.0 INTRODUCTION

This report presents the results of a remedial investigation (RI) performed for the Washington State Department of Ecology (Ecology) at Westbay Marina in Olympia, Washington (Figure 1). This RI characterizes upland soil and groundwater within the Westbay Marina property and sediment conditions along the shoreline and within the Department of Natural Resources (DNR) aquatic lease area (the Site). The land use for the Site is zoned as urban waterfront (UW) and residential (R-4-8). The work that was performed for this RI supplements the previous work conducted by Anchor QEA for Westbay Marina Associates (WBMA) under an existing Remedial Investigation/Feasibility Study (RI/FS) work plan (Anchor 2009a). Hart Crowser's investigation is being conducted under contract to the Washington State Department of Ecology (Ecology) in partial fulfillment of the requirements of an Agreed Order (No. DE_5272) between Ecology and WBMA. Results presented are based on field and laboratory work completed for Ecology by Hart Crowser between March and May 2011. Additional results are presented from field and laboratory work completed for WBMA by Anchor QEA in 2009 and 2010.

Specific tasks conducted by Hart Crowser include:

- Collecting additional data to characterize upland soil for dioxins/furans near the historical hog fuel burner;
- Collecting additional data to characterize groundwater;
- Collecting additional data to characterize intertidal sediment quality near outfalls and seeps;
- Collecting data to characterize subtidal sediment quality within the DNR aquatic lease area of the marina;

- Determining extent of wood debris along the northern boundary of the DNR aquatic lease;

- Collecting data to characterize benthic diversity along the shoreline and within the DNR lease area of the marina; and

- Performing a Terrestrial Ecological Evaluation (TEE).

Tasks performed by Anchor QEA in 2009 and 2010, which provided data in support of this RI include:

- Collecting data to characterize upland soil for dioxins/furans near the historical hog fuel burner;

- Collecting data to confirm that copper levels in the Southern Ditch have been remediated to less than MTCA Method B criteria;

- Collecting data to confirm that the diesel-range total petroleum hydrocarbons (TPH) at the underground storage tank (UST) system valve box have been successfully remediated;

- Collecting data from existing monitoring wells to determine if remediation of petroleum-impacted groundwater was successful;

- Collecting data to characterize groundwater in seeps discharging from the Site to adjacent sediment; and

- Collecting data to characterize intertidal sediment quality.

1.1 Remedial Investigation Approach

The Westbay Marina Association (WBMA) entered into Agreed Order (AO) No. DE_5272 with Ecology effective March 4, 2008. In compliance with AO requirements, WBMA retained Anchor QEA to develop an RI/FS Work Plan to provide for remedial action and present an evaluation process to address the potential that a "release" or "threatened release" of "hazardous substance(s)" has occurred at Westbay Marina (Anchor 2009a). The RI/FS Work Plan provided steps to "determine the nature and extent of any potential Site soil and/or groundwater contamination, assess the potential for impacts from the Site to sediment on adjacent Washington State Department of Natural Resources (DNR)-owned aquatic lands, and lay out the framework for potential future remedial action if required" (Anchor 2009a).

Anchor subsequently conducted soil, groundwater, seep, and intertidal sediment sampling and analysis, in partial fulfillment of the Work Plan. Analytical results from this investigation were provided to Ecology in two letters (Anchor 2009b and Anchor 2010). No further work was performed at Westbay Marina by Anchor QEA, and Ecology retained Hart Crowser to perform additional work presented in the Work Plan but not completed by WBMA, in support of the RI.

Hart Crowser's work included collecting additional upland soil, groundwater, and intertidal sediment samples to further characterize the site and address data gaps. Additionally, subtidal surface sediment grab samples were collected at selected locations for chemical testing in order to evaluate sediment chemical properties. Sediment core samples were collected to visually determine the extent and amount of wood debris in the DNR aquatic lease area. Benthic organisms were collected to characterize diversity along the intertidal shoreline and subtidal areas of the DNR aquatic lease area. Sampling and testing protocols are discussed further in the March 2011 SAP for the project (Hart Crowser 2011), as approved by Ecology.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Location

The Site is located at 2100 West Bay Drive NW in Olympia, Washington. The Site is the location of a marina, boat yard, and a restaurant. The Site encompasses just over 3 acres of upland, which is predominantly paved and is used for parking and storage. The marina has about 400 slips that can accommodate boats up to 70 feet in length and is located on Budd Inlet under an aquatic land lease (Lease No. 2618) from the Washington State Department of Natural Resources (DNR) (Figure 1).

The Site is bounded by a log sorting yard to the north (Dunlap Towing Company), Puget Sound (Budd Inlet) to the east, an abandoned lumber storage yard (Delson Lumber Company) to the south, and a steep hill and residences to the west (Figure 2). West Bay Drive NW and abandoned railroad tracks divide the property from north to south.

Currently, the harbor area leased by WBMA lies in front of Olympia Tidelands Blocks 385 to 388, inclusive, and comprises 13.6 acres of water-dependent use and 0.0495 acres of non-water-dependent use (Tugboat Annie's Restaurant building). The aquatic lands to the north are currently leased by Dunlap Towing, and those to the south are leased by the Delson Lumber Company.

2.2 Historical Summary

The Site was first developed as a lumber mill by Buchanan Lumber Company in 1919 (Hart Crowser 1993). Between 1919 and 1966, the Site was used for various activities including a sawmill, veneer plant, and stud mill. These timber-related activities also included a hog fuel burner located along the northern property line. Historical maps and aerial photos show that most of the lumber mill operations were located off-site to the north. The planing shed, mill office, and some lumber sheds were located on the Site east of the Northern Pacific Railroad tracks. Additional lumber storage, motor vehicle parking, and an oil shed were located west of the tracks adjacent to the bluff. According to an interview with the former property owner, Mr. Buchanan, the Site was filled with soil that sloughed off the steep bank to the west and wood debris from mill operations. Mr. Buchanan also indicated that lumber treating never occurred at this location, and the closest lumber treating operation was located approximately one mile southeast of the Site on the opposite side of Budd Inlet.

Between 1966 and 2002, the Site was a boatyard and marina. Westbay Marina Associates (WBMA) has owned the Westbay Marina since 1990. In 2002, boat maintenance and repair activities ceased at the Site and it has operated solely as a marina since that time (Anchor 2009). Prior to 2002, small boat maintenance activities included hydroblasting (using water jets to remove loose paint and marine growth from bottoms prior to scraping), scraping, sanding, and painting boats.

Tugs Restaurant was constructed on the Site in 1984 or 1985. The restaurant was destroyed in a fire in 1993. Tugboat Annie's restaurant was constructed in 1995 at the same location.

Westbay Marina currently operates solely as a marina under a 30-year Aquatic Land Lease (No. 2618) from the DNR, effective January 1, 1984, through January 1, 2014 (Anchor 2009).

2.3 Previous Environmental Characterizations/Sampling Investigations

2.3.1 Summary of Existing Upland Investigation Results

Previous upland soil and groundwater investigations were conducted in 1993, 1999, 2009, and 2010.

Preliminary Environmental Assessment and Soil Remediation (Hart Crowser 1993)

In 1993, Hart Crowser, under contract to WBMA, conducted a preliminary site assessment (Phase I) resulting from Ecology inspections of the marina and boat maintenance facilities (Hart Crowser 1993). The Phase I included historical records research, an agency file review, and a site reconnaissance. The assessment included limited environmental soil testing, followed by a cleanup action, discussed in Section 2.4. The soil testing focused on a ditch located along the southern property line near boat maintenance and repair activities, and on an aboveground waste oil storage tank (AST) located in the southwest corner of the Site. Initial sampling results indicated that soil along the Southern Ditch contained elevated concentrations of copper, and soil around the AST contained elevated levels of petroleum. Following initial sampling, the upper 3 inches of soil, which contained elevated concentrations of copper, were removed from the Southern Ditch line. Approximately 55 tons of soil containing petroleum from the aboveground waste oil tank area was also removed. After excavation, all but one verification soil sample from this area demonstrated that site soil met the MTCA Method B direct contact cleanup for constituents of potential concern. One verification soil sample exceeded the MTCA Method B direct contact cleanup level for copper.

UST Removal (Stemen Environmental 1999)

In 1999, Stemen Environmental removed three underground storage tanks (USTs) from the Site (Anchor 2009a). These three USTs contained leaded gasoline, unleaded gasoline, and diesel fuel. Petroleum contamination was observed during excavation to remove the soil around the tanks, fuel dispenser, and fuel supply lines. A total of 675 tons of contaminated soil, 56 tons of demolition debris, and an unreported amount of oily water skimmed from the UST excavation were sent off site for disposal In late 1999, four groundwater monitoring wells were installed around the location of the former USTs. A groundwater sample collected in 1999 indicated that benzene, toluene, ethylbenzene, and xylenes (BTEX), gasoline-range petroleum, and diesel-range petroleum were either not detected or were below the MTCA Method A groundwater cleanup levels. Based on a Site Hazard Assessment by the Thurston County Health Department, a No Further Action (NFA) determination was issued by Ecology for the UST removal and cleanup.

Remedial Investigation (Anchor QEA 2009 and 2010)

In August 2009, Anchor QEA collected groundwater samples from two existing monitoring wells (MW-01 and MW-02) located near the former fuel USTs

(Anchor 2009b). The two groundwater samples and one field duplicate were analyzed for ammonia, dissolved and total metals, polychlorinated biphenyls (PCBs), semivolatile organic compounds (SVOCs), and total petroleum hydrocarbons (TPH) as gasoline and diesel (Figure 3 and Table E-1). Ammonia (as nitrogen) was detected in all three samples at concentrations ranging from 0.015 to 0.384 mg/L. The groundwater sample from well MW-01 exceeded the marine chronic surface water standard of 0.035 mg/L for ammonia. Arsenic, copper, nickel, and selenium were detected in one or more groundwater samples and arsenic, copper, and nickel concentrations in one or more of these wells exceeded marine surface water quality criteria. The metals did not exceed MTCA Method A groundwater cleanup criteria.

Only one sample, the field duplicate for monitoring well MW-02 (sample WB-MW-03-090819*), contained detectable concentrations of a few SVOCs. Concentrations for these analytes were at or near the analytical reporting limit and were below surface water quality standards. These analytes were not detected in the primary sample collected from well MW-02 (WB-MW-02-090819).

The groundwater analyses were conducted to determine if historical hazardous substances released on the site were presently being transported by groundwater. The analytical results showed no indication of TPH (as gasoline, diesel, or motor oil) or PCBs. SVOCs and metals were detected below MTCA Method A and Method B groundwater cleanup criteria. Historical hazardous substances released on the site do not appear to be present in groundwater at this location.

In January 2010, Anchor QEA collected upland soil samples from the Southern Ditch, the UST system valve box, and from the north side of the property near the historical hog fuel burner (Anchor 2010; Figure 3 and Table E-2) Three soil samples collected within the Southern Ditch (stations WB013, WB014, and WB015) were analyzed for copper only. Copper results were below the MTCA Method B direct soil contact cleanup level of 3,000 mg/kg, with results ranging from 76.6 to 1360 mg/kg.

Two additional soil samples (stations WB017 and WB018) collected near the former location of the hog fuel burner were analyzed for dioxins/furans. Sample concentrations were 61.9 and 14.2 ng/kg (parts per trillion or ppt based on 1/2 the detection limit for non-detected results) total toxics equivalents (TEQ), exceeding the MTCA Method B unrestricted use direct contact cleanup level of 11 ng/kg TEQ.

One soil sample collected from the former UST valve box (station WB016) was analyzed for diesel- and oil-range petroleum. The sample contained both diesel- and oil-range hydrocarbons at concentrations below the MTCA Method A soil cleanup level for these petroleum constituents (2,000 mg/kg).

The soil analyses for copper at the Southern Ditch were conducted to determine if copper remaining in soil exceeded MTCA Method B criteria. The copper results do not exceed the MTCA Method B direct soil contact cleanup level, but do exceed Washington State regional background levels of copper in the Puget Sound area (90th percentile) of 36.4 mg/kg (Ecology 1994).

The soil analysis for TPH at the location of the former UST valve box was conducted to determine if Stemen Environmental's plan for treatment of the valve box area via *in situ* bioremediation was successful. While TPH was present in the diesel and motor oil ranges, the sample results fell well below the MTCA Method A cleanup levels. Soil sample results indicated the remediation at that location appears to be working.

The soil analyses for dioxins/furans near the historical hog fuel burner were conducted to delineate the spatial extent and severity of contamination in the soil. Both samples analyzed contained elevated levels of dioxins/furans calculated as TEQ above the MTCA Method B cleanup levels (Table E-2).

2.3.2 Summary of Existing Sediment and Seep Investigation Results

Previous investigations for sediment and groundwater seeps into Budd Inlet from the Site were conducted on the site in 1993, 1998, 2009, and 2010. Additional sediment studies conducted in Budd Inlet near the DNR aquatic lease are also summarized below.

Preliminary Environmental Assessment and Soil Remediation (Hart Crowser 1993)

In 1993, as part of the environmental assessment and cleanup of the Southern Ditch, Hart Crowser collected one sediment sample for metals analysis from just below the outfall of the Southern Ditch. The sample was analyzed for SMS metals, and none of the metal results exceeded the SMS criteria in effect at that time.

In 1993, DNR and the Department of Health collected and analyzed 13 sediment samples from Westbay Marina. Seven samples were collected within the DNR-owned aquatic lease area and the remaining six samples were

collected near the leased land but outside the lease boundary. Metals and TBT were analyzed. None of the detected metal concentrations exceeded the SMS criteria in effect at that time. No SMS criterion exists for TBT. The range of TBT detections in sediment during the 1993 investigation was between 2.4 and 70.6 ug/kg.

Ecology conducted a study of sediment in lower Budd Inlet in 1999. Two of the 14 sediment samples collected were located adjacent to the Southern Ditch of Westbay Marina (WB-1 and WB-2). Benzoic acid and dimethylphthalate were found to exceed SMS criteria in effect at that time. Bulk TBT was reported as "elevated" by Anchor (Anchor 2009a), at estimated concentrations of 1646.5 and 1094.7 ug/kg. Porewater TBT was apparently not analyzed. Bulk TBT values do not correlate well with porewater TBT, which is the fraction considered to be bioavailable to organisms.

One study conducted for Ecology by SAIC in 2008 included dioxins/furans analysis on 46 sediment samples collected from three regions within the inlet (Anchor 2009a). None of the samples were collected on the Westbay Marina site. However, the three sediment samples collected closest to the marina contained dioxin/furan TEQ concentrations ranging between 14.6 and 19.3 ng/kg TEQ and an average concentration of 16.6 ng/kg TEQ, which is below the reported mean concentration of 19.1 ng/kg TEQ based on inlet-wide sample results.

In August 2009, Anchor QEA collected five nearshore sediment samples (WB001 through WB004) (Anchor 2009b). Three samples (WB001, WB002, and WB003) were collected adjacent to seeps and their associated seep samples (WB009, WB011, and WB012, respectively) (Anchor 2009a, Figure 3 and Tables E-3 and E-4). Sediment porewater samples were analyzed for sulfide and TBT, while sediment samples were analyzed for gasoline-range hydrocarbons. Porewater sulfide was detected in four of the five sediment samples ranging in concentrations from 0.708 to 78.1 mg/l. Porewater TBT was detected in three of the five sediment samples at concentrations ranging between 0.008 and 0.023 ug/L. No gasoline-range hydrocarbons were detected in the five sediment samples analyzed.

Four seep samples (WB009 through WB012), one field duplicate, and one rinse blank were also collected by Anchor QEA during the August 2009 sampling event. Seep samples were analyzed for ammonia, total and dissolved metals, PCBs, SVOCs, and TPH. Some total metal results for arsenic, copper, and nickel exceeded one or more of the marine water quality criteria. Most of the organic compounds analyzed for were not detected in the seep samples (Table E-4). Naphthalenes were the most common hydrocarbons detected in the seep

samples. Naphthalene was detected in all four seep samples at estimated concentrations ranging from 0.13 to 0.71 ug/L, less than the MTCA Method B marine surface water cleanup level of 4,900 ug/L.

2.4 Summary of Previous Cleanup Actions

Two cleanup actions have been conducted on the Site. In 1993, Hart Crowser conducted cleanup of the Southern Ditch and the area around an aboveground waste oil storage tank. In 1999, Stemen Environmental removed three underground storage tanks (USTs) from the Site.

2.4.1 1993 Cleanup Action for Copper and TPH

As part of the Phase I Environmental Assessment, Hart Crowser conducted soil sampling along the Southern Ditch and around a waste oil AST. Initial sampling results indicated that soil along the Southern Ditch contained elevated concentrations of copper, and soil around the AST contained elevated levels of petroleum. Following initial sampling, the upper 3 inches of soil, which contained elevated concentrations of copper, was removed from the Southern Ditch. Approximately 55 tons of soil containing petroleum from the aboveground waste oil tank area was also removed. After excavation, all but one verification soil sample from this area demonstrated that site soil met the MTCA Method B direct contact cleanup for constituents of potential concern. One verification soil sample exceeded the MTCA Method B direct contact cleanup level for copper.

2.4.2 1999 UST Removal and TPH Cleanup

In 1999, Stemen Environmental removed three USTs from the parking area of Westbay Marina. The three fuel tanks contained leaded gasoline, unleaded gasoline, and diesel fuel, and were of single wall steel construction and included submersible pumps, pressurized underground steel fuel supply lines, and remote fuel dispensers.

Petroleum contamination was observed during excavation to remove the soil around the tanks, fuel dispenser, and fuel supply lines. An oily sheen was observed on the surface of water in the excavation, and a floating pump and portable storage tank were installed to skim petroleum product from the surface water. In accordance with Ecology requirements, groundwater and soil samples were collected from the perimeter of the UST excavation, the entire length of the fuel supply lines, and beneath the dispenser mounting location. The results of this investigation confirmed the remaining presence of benzene, total xylenes, gasoline range TPH, diesel fuel range TPH, and heavy oil range TPH in the

subsurface soil and/or water exceeding MTCA Method A cleanup levels in the pump island area, the valve box area, and the underground fuel supply line areas.

Additional soil was excavated and removed, and soil samples collected from the limits of the excavation confirmed the removal of impacted soil to below the 1999 MTCA Method A cleanup levels. The excavation was backfilled and the site closed. A total of 675 tons of contaminated soil, 56 tons of demolition debris, and an unreported amount of oily water skimmed from the UST excavation were sent off site for disposal. A large quantity of impacted wood debris was also removed from the excavation along with the soil, and disposed of off-site.

Analysis of soil collected in the valve box area confirmed the presence of diesel fuel-range TPH at levels exceeding MTCA Method A standards. As the soil at this location was not reasonably accessible for excavation and removal, and because of the small estimated quantity of impacted soil, *in situ* bioremediation was chosen for remediation at that location (Anchor 2009a).

3.0 SOIL, GROUNDWATER, AND SEDIMENT SAMPLING

Anchor QEA collected soil, groundwater, seep, and sediment samples in 2009 and 2010, in accordance with their 2009 work plan (Anchor 2009a). The work was performed for WBMA, and only summary tables of the data were presented to Ecology. Some information regarding the sampling event is presented in Section 2.3 of this report; and information regarding the chemical results is presented in Section 4 of this report. Accordingly, information in this section of the report applies to the 2011 sampling activities performed by Hart Crowser.

Sediment sampling, collection, handling, and analysis were performed in general accordance with the 2011 project SAP. Sampling and testing activities were conducted in general accordance with the protocols established in Ecology's Sediment Management Standards (SMS; Chapter 173-204 Washington Administrative Code [WAC]), and Puget Sound Estuary Program (PSEP 1997a, 1997b, and 1997c), as referenced in Ecology's Sediment Sampling and Analysis Plan Appendix (SAPA; Ecology 2008). The samples collected were acceptable for chemical and physical analysis.

The number, type of samples, and associated analyses are summarized in Table 1. The locations of samples collected are presented on Figure 2.

3.1 Deviations from the 2011 SAP

Minor deviations from the SAP were made based on adaptations to the field conditions encountered, and to deal with minor equipment malfunctions. Deviations from the Ecology-approved SAP for the Westbay Marina investigation are summarized below and are discussed in more detail in the applicable report sections:

- Based on field observations and consultation with Ecology, two of the upland soil sampling locations were moved from the proposed locations in the gravel yard behind the marina office. The sample locations were shifted to the north perimeter of the property.

- Based on consultation with Ecology, only four upland soil samples (rather than the five proposed in the SAP) were collected.

- A van Veen grab sampler was used for surface sediment collection rather than the power grab sampler at sampling location HC-WB-SS-008.

- Due to soft sediment throughout the marina, the majority of the surface sediment grab samples overpenetrated or showed mounding even after removing all the weights from the sampler. Sample volumes were collected from the least-disturbed sediment present in the sampler.

- Global positioning system (GPS) measurements collected for intertidal samples HC-WB-SS-001 and HC-WB-SS-003 and upland samples HC-WB-US-003 and HC-WB-US-004 did not plot accurately on the site map (Figure 2). Those sample locations were subsequently shifted using known landmarks on the site map, and the coordinates included on Table A-1 in Appendix A were determined from the updated locations within the georeferenced AutoCAD file.

3.2 Sample Location Control

A differential global positioning system (DGPS) was used aboard the sampling vessel for location positioning for vibracore and subtidal surface sediment grab sampling. The DGPS receiver was placed on the sampling device deployment boom to accurately record the sampling location position. Once the sampler was deployed, the actual position was recorded when the sampler was on the bottom and the deployment cable was in a vertical position. State Plane (Northing and Easting and latitude and longitude) coordinates for the actual sampling locations are presented in Table A-1 in Appendix A. The *R/V* Selkirk,

operated by Gravity Environmental under subcontract to Hart Crowser, was the sampling vessel for the vibracore and surface sediment grab sample activities.

Sample locations for upland soil samples and intertidal sediment samples were collected using a handheld Garmin GPS unit or GPS-enabled smart phone. When the GPS coordinates collected for samples HC-WB-US-003, HC-WB-US-004, HC-WB-SS-001, and HC-WB-SS-003 were plotted on the site map, it was apparent that the coordinates collected differed by several feet from the actual sample locations based on known landmarks visible on the base map aerial photograph. Those samples were subsequently plotted on the aerial photograph, and updated coordinates derived using the georeferenced AutoCAD file. These corrected coordinates are presented in Table A-1 in Appendix A.

Sample mudline elevations for the subtidal sediment samples and the vibracore samples were determined using the *R/V* Selkirk's sonar system and predictive tide charts. Sample mudline elevations for the intertidal sediment samples were determined using a stadia rod and a CST/Berger SAL Series automatic level. The elevation of the sample location was determined in relation to water height. Predictive tide charts were used to determine the elevation of the sample location above Mean Lower Low Water (MLLW).

3.3 Upland Soil Sampling

Four soil samples (HC-WB-US-001, -002, -003, and -004) were collected along the north end of the property, close to the location of the historic hog fuel burner. After consultation with Ecology, a fifth proposed soil sample was not collected. The sampling locations for two of the samples were originally planned to be collected to the west of the Westbay Marina office building, within the gravel parking area. However, the gravel yard contained multiple layers of historical gravel placement at greater than one foot depth, and was not considered representative of conditions associated with the historic hog fuel burner. The two samples, HC-WB-US-003 and HC-WB-US-004, were moved northward and collected outside the graveled area (Figure 2).

The upland soil samples were collected following the procedure described in the SAP. After the sample station was located, a square measuring approximately 1 meter was marked using pin flags. At the four corners of the square, the surface groundcover material including grasses, mosses, fir needles, and twigs, was removed. Roughly equal volumes of the upper 0 to 3 inches of soil were collected from each corner using a pre-cleaned stainless steel spoon and placed in a pre-cleaned stainless steel bowl. The sample was homogenized until the soil appeared uniform in color and texture. The soil was than placed into a pre-

labeled glass container provided by the laboratory and placed on ice under chain of custody until delivery to the laboratory.

The samples were submitted to ARI and analyzed for dioxins/furans by United States Environmental Protection Agency (EPA) Method 1613B and for total solids by EPA Method 160.3 modified. Sample results are presented on Table 2. Observations regarding the sample location, groundcover, and soil characteristics were recorded in Table A-2 in Appendix A. Selected, representative photographs are presented in Appendix D.

3.4 Groundwater Sampling

Two groundwater samples were collected from the existing monitoring wells MW-01 and MW-04 (samples HC-WB-MW-01 and HC-WB-MW-04) located downgradient of the former USTs. As more than a year had passed since the last sampling event, the monitoring wells were redeveloped by pumping and surging with a disposable bailer on March 24, 2011, prior to groundwater sampling on March 28 and 30, 2011.

The groundwater samples were collected following the sampling protocols described in the SAP. The samples were collected using a peristaltic pump and low-flow sampling techniques, on a rising tide. Groundwater samples were collected after field parameters had stabilized. Dissolved metals were field filtered using a 45-um filter. Sample HC-WB-MW-01 was collected on March 28, 2011. A sample from well MW-04 could not be collected on that date, as the well purged dry. Sample HC-WB-MW-04 was collected on March 30, 2011.

Samples were submitted to ARI under chain of custody and analyzed for ammonia by EPA Method 350.1 modified, total copper and nickel by EPA Method 200.8, and dissolved copper and nickel by EPA Method 200.8. Sample results are presented on Table 3.

3.5 Intertidal Surface Sediment Grab Sampling

Four surface sediment grab samples (HC-WB-SS-001, -002, -003, and -004) were collected from intertidal locations along the shoreline of Westbay Marina (Figure 2). The sampling stations were selected based on the locations of outfalls and surface seeps, and the samples were collected on minus tides.

The intertidal sediment samples were collected following the sampling protocols in the SAP. A roughly one-meter square was measured below the location of an outfall or surface seep. Roughly equal volumes from the 0- to 10-cm-depth interval of the four corners of the square were collected into a pre-cleaned

stainless steel bowl or high density polyethylene bucket and homogenized. The homogenized sample was transferred to pre-labeled containers and placed on ice prior to shipment to the laboratory under chain of custody.

The samples were submitted to ARI for chemical laboratory testing for the parameters listed in Table 1. Sample results are presented on Tables 4, 5, 6, and 7. Descriptions for surface sediment grab samples are presented in Table A-2 in Appendix A. Selected, representative photographs are presented in Appendix D.

3.6 Subtidal Surface Sediment Grab Sampling

Four surface sediment grab samples were collected from subtidal locations within Westbay Marina (Figure 2). Surface sediment grab samples HC-WB-SS-005, HC-WB-SS-006, and HC-WB-SS-007 were collected using a 0.2-square-meter (m^2) power grab sampler. Surface sediment grab sample HC-WB-SS-008 was collected using a van Veen grab sampler, due to power equipment failures. Samples from each surface grab location were collected from the 0- to 10-cm-depth interval and homogenized and submitted for chemical laboratory testing. If necessary, multiple grabs were collected to provide sufficient sediment volume for chemistry. Descriptions for surface sediment grab samples are presented in Table A-2 in Appendix A. The sampler was decontaminated between sampling locations following the procedure in the SAP.

Upon retrieval of the surface sediment grab samples, the acceptability of each grab was assessed relative to the criteria established in the SAP. At the first location (HC-WB-SS-008), the initial van Veen grab overpenetrated and was rejected. After removing the weights from the grab sampler, a second grab was attempted, which also overpenetrated and was rejected. A third grab attempt was made, which partially overpenetrated, due to the soft substrate. Sediment was collected from the portion of the sample which was not in contact with the top or side walls of the sampler. Two additional grabs were attempted; the fourth overpenetrated and was rejected, while the fifth attempt was acceptable. A sufficient amount of sediment was collected for the chemical analysis and the benthic organism survey.

At sample locations HC-WB-SS-005, HC-WB-SS-006, and HC-WB-SS-007, the power grab was used for sample collection. Due to the soft sediment, all weights were removed from the sampler but, mounding was observed during sample collection. As no more weight could be removed, it was decided to accept the sample and collect sediment from the areas in the grab that were least disturbed

The samples were submitted to ARI under chain of custody for chemical laboratory testing for the parameters listed in Table 1. Sample results are presented on Tables 8, 9, and 10. Descriptions for surface sediment grab samples are presented in Table A-2 in Appendix A. Selected, representative photographs are presented in Appendix D.

3.7 Limited Wood Debris Survey

Six sediment cores were collected from subtidal locations within Westbay Marina (vibracore sampling locations are shown on Figure 2). The core locations were selected based on planned transects along the northern DNR lease property line to identify the location and depth of wood debris.

Sediment core samples were collected using a vibracore sampling device. The vibracore device uses a vibration source to drive a core tube or sample barrel into unconsolidated water-saturated sediment. The core tube was constructed of rigid, clear, 4-inch-diameter Lexan (polycarbonate) in which the sediment sample was recovered. A Lexan core catcher attached to the end of the barrel was used to hold the undisturbed sediment inside the barrel when withdrawn from the seafloor sediment.

During sampling, a core tube was driven below the sediment surface with the vibracore device until the desired penetration was achieved. Sediment cores were collected to depths of up to 14 feet below the sediment-water interface. Upon retrieval of the core, the acceptability was assessed relative to the criteria established in the SAP.

After sample collection, the outer core tube was cleaned and visually examined. Sediment from the cores was extruded on the vessel. Each core was visually examined in general accordance with American Society for Testing and Materials (ASTM) D 2488, Standard Practice for the Classification of Soils (Visual-Manual Procedure). Each core was photographed and visual observations and sediment descriptions were documented on core logs presented in Appendix A. Sample results are presented on Table 12. Selected, representative photographs are presented in Appendix D. No sediment was collected for chemical analyses.

3.8 Limited Benthic Organism Survey

Four intertidal benthic core samples and four subtidal benthic core samples were collected from locations within Westbay Marina (Figure 2). The intertidal sampling stations were locations of outfalls and surface seeps, and the samples were collected on minus tides. The intertidal samples were taken using a 0.008 m2 corer. A 1.0-square-meter (m^2) area was established and three individual

cores were taken within each area. Only one core per station was analyzed in the lab. Subtidal benthic core samples were co-located with the subtidal sediment samples. Samples HC-WB-SS-005, HC-WB-SS-006, and HC-WB-SS-007 were collected using a 0.2 m^2 power grab sampler. One subtidal benthic core sample was co-located with the subtidal sediment sample HC-WB-SS-008 and was collected using a van Veen grab, due to power equipment failures. Descriptions for surface sediment grab samples are presented in Table A-2 in Appendix A. The sampler was decontaminated between sampling locations following the procedure in the SAP.

Upon retrieval of the surface sediment grab samples, the acceptability of each grab was assessed relative to the criteria established in the SAP. At the first location (HC-WB-SS-008), the initial van Veen grab overpenetrated and was rejected. After removing the weights from the grab sampler, a second grab was attempted, which overpenetrated and was rejected. A third grab attempt was made, which partially overpenetrated, due to the soft substrate. Sediment was collected from the portion of the sample which was not in contact with the top or sidewalls of the sampler. Two additional grabs were attempted; the fourth overpenetrated and was rejected, while the fifth attempt was acceptable.

At sample locations HC-WB-SS-005, HC-WB-SS-006, and HC-WB-SS-007, the power grab was used for sample collection. Due to the soft sediment, all weights were removed from the sampler. However, mounding was observed during sample collection. As no more weights could be removed, it was decided to accept the sample and collect sediment from the areas in the grab that were least disturbed.

The benthic infauna samples were returned to Hart Crowser for analysis and identification. Sample results are presented in Table 13. Descriptions for surface sediment grab samples are presented in Table A-2 in Appendix A. Selected, representative photographs are presented in Appendix D.

4.0 UPLAND SOIL CHEMICAL ANALYSIS RESULTS

The upland soil samples and associated analyses are summarized in Table 1. Samples collected in 2011 were submitted to ARI for chemical analysis. No field duplicates or equipment rinse blanks were collected for analysis. Sample analytical results are summarized in Table 2.

The four upland soil samples were analyzed for the following:

- Dioxins/furans by EPA Method 1613B; and

- Total solids by EPA Method 160.3 modified.

Six upland soil samples were collected by Anchor QEA in 2009 and 2010. Sample analytical results are summarized in Table E-1. The samples were analyzed for the following:

- Copper by EPA Method 6010/6020;
- Total petroleum hydrocarbons as diesel and motor oil by NWTPH-Dx method; and
- Dioxins/furans by EPA Method 1613B.

Total solids values were not reported in the summary tables provided by Anchor, though laboratories normally report dry-weight-corrected values for analytes requested.

4.1 Data Quality Review Summary

All analyses were performed in a manner consistent with the methods stated in the SAP/QAPP. The chemistry data from samples collected in 2011 was reviewed and validated by Hart Crowser chemists. Overall, the data quality objectives (DQOs), as set forth in the SAP, were achieved, and the data for this project are acceptable for use, as qualified. Results for several analytes were qualified as estimated concentrations that fell below the method reporting limit. A few analytes did not meet identification criteria and were qualified as not detected. A detailed chemical data quality review and chemical laboratory reports are presented in Appendix B.

Chemistry data from samples collected by Anchor QEA in 2009 and 2010 were available as summary tables only. Some of the analytical results appear to have been validated, but no validation report was included for review. Analytical methods actually used were not provided on the summary tables, though it can be assumed that the methods listed in the Work Plan (Anchor 2009a) were followed. The sample results are presented in Appendix E, as received.

4.2 Dioxins/Furans

Analytical results for dioxins/furans in soil expressed as 2,3,7,8-TCDD (tetrachlorodibenzodioxin) toxic equivalents (TEQs) are presented in Table 2. TEQs were calculated using the World Health Organization (WHO) 2005 toxic equivalency factors (TEF) for mammals. Total dioxin TEQs are reported using two conventions: adding only detected congeners, and using 1/2 the detection

limit for non-detected congeners. There was no significant difference in reported totals since the majority of the congeners were present in the samples.

Dioxin/furan congeners were detected in all samples. The total TEQ concentrations ranged from 5.99 to 87.06 pg/g (picograms/gram or parts per trillion). The highest concentration was in sample HC-WB-US-001, located close to the historic hog fuel burner (Figure 2).

Dioxin/furan concentrations were compared to MTCA Method B criteria of 11 pg/g. Two samples, HC-WB-US-001 and HC-WB-US-002, located closest to the historic hog fuel burner, exceeded this criterion. It should be noted that sample HC-WB-US-001 had a significantly lower total solids result, compared to the other upland soil samples (45.4 percent compared to approximately 70 percent). When dioxins/furans extract results are dry-weight normalized, this low total solids value contributes to a higher sample result.

The relative congener ratios in the upland soil samples were compared to the ratios from the two intertidal sediment samples also analyzed for dioxins/furans (Figures 4 and 5). The octachlorodibenzodioxin (OCDD) relative ratio is excluded from Figure 5 because the OCDD congener is typically present at much higher concentrations than other congeners, regardless of dioxin source, and dominates the relative fraction. The pattern of the congener ratios in the upland soil and the intertidal sediment are similar, indicating a similar source.

In addition to the data collected in 2011, Anchor QEA collected upland soil samples from the location of the former hog fuel boiler that were analyzed for dioxins/furans. Sample concentrations were 61.9 and 14.2 ng/kg (nanograms/kilogram, equivalent to pg/g or ppt) based on 1/2 the detection limit TEQs, exceeding the MTCA Method B unrestricted use direct contact TEQ of 11 ng/kg (Table E-2).

4.3 Total Solids

Three of the upland soil samples had similar values for total solids, from 70 to 75 percent (Table 2). Sample HC-WB-US-001 was significantly lower, at 45.4 percent. The laboratory was contacted regarding this possible anomaly, and confirmed that the value was accurate. As total solids values are used to normalize sample results (dry-weight correction), the appreciably lower value contributed to a higher sample result.

Total solids values were not reported for the 2009 and 2010 data collected by Anchor QEA. It is assumed that the summary tables provided by Anchor QEA contained dry-weight-corrected results from the laboratory.

4.4 Total Petroleum Hydrocarbons

One soil sample collected by Anchor QEA in 2009 was analyzed for TPH (Table E-2, Figure 3). Diesel-range hydrocarbons and motor oil-range hydrocarbons were detected in this sample with concentrations of 35 mg/kg and 250 mg/kg, respectively (Table E-2).

5.0 GROUNDWATER CHEMICAL ANALYSIS RESULTS

Two groundwater samples and associated analyses are summarized in Table 1. Samples were submitted to ARI for chemical analysis. No trip blanks or field duplicates were collected for analysis. Sample analytical results are summarized in Table 3.

The two groundwater samples were analyzed for the following:

- Ammonia by EPA Method 350.1 modified;
- Total metals (copper and nickel) by EPA Method 200.8; and
- Dissolved metals (copper and nickel) by EPA Method 200.8.

In addition, Anchor QEA collected groundwater samples from two of the existing monitoring wells (MW-01 and MW-02) in 2009 (Table E-1). A trip blank and a field duplicate were also collected and analyzed. The samples were reported to be analyzed for the following:

- Ammonia by EPA Method 350.1;
- Total metals by EPA Methods 200.8/6010/7470A;
- Dissolved metals by EPA Methods 200.8/6010/7470A;
- SVOCs by EPA Method 8270D;
- Gasoline-range TPH by NWTPH-Gx method; and
- Diesel- and motor oil-range TPH by NWTPH-Dx method.

Review of the summary table shows that the samples were also analyzed for polychlorinated biphenyls.

5.1 Data Quality Review Summary

All analyses were performed in a manner consistent with the methods stated in the SAP/QAPP. The chemistry data from samples collected in 2011 was reviewed and validated by Hart Crowser chemists. Overall, the DQOs as set forth in the SAP were achieved, and the data for this project are acceptable for use. A detailed chemical data quality review and chemical laboratory reports are presented in Appendix B.

Chemistry data from samples collected by Anchor in 2009 were available as summary tables, only. Some of the analytical results appear to have been validated, but no validation report was included for review. The sample results are presented in Appendix E, as received.

5.2 Total and Dissolved Metals

All metal concentrations were well below applicable MTCA Method B screening criteria assuming drinking water use. Results for dissolved and total copper and nickel were comparable (Table 3).

The 2009 groundwater samples had detected concentrations of arsenic, copper, nickel, and selenium in one or more groundwater samples. Arsenic, copper, and nickel concentrations in one or more of these wells exceeded marine surface water quality criteria. The metals did not exceed MTCA Method A groundwater cleanup criteria assuming drinking water use (Table 3).

The MTCA assumes that the highest beneficial use of groundwater is drinking water use. However, at this site groundwater is not likely to ever be used for drinking water purposes because of its proximity to marine water. Thus, it is more appropriate to compare groundwater quality to those standards and criteria established for protection of aquatic life and protection of human health due to ingestion of aquatic organisms.

Table 3 includes both drinking water and marine aquatic protect criteria for wells sampled recently by Hart Crowser. Of the two groundwater samples collected by Hart Crowser for this RI, both slightly exceeded the MTCA Surface Water Criteria for dissolved and total copper (Table 3). The Anchor groundwater samples similarly had small exceedances of Surface Water Criteria for dissolved and total copper and nickel in one of three samples (Table E-1).

5.3 Ammonia

The ammonia concentration in sample HC-WB-MW-04 was below the laboratory reporting limit (0.100), while the concentration in sample HC-WB-MW-01 was slightly above the reporting limit at 0.134 mg/L. This detected concentration is well below drinking water cleanup levels. The marine surface water criterion is for total ammonia and has to be calculated for specific temperatures and pH levels. Assuming typical Puget Sound conditions of 50 degrees F, and a pH of 7.8 the criterion would be 2.92 mg/l total ammonia. So the detected concentration was also below the surface water criterion. Elevated ammonia concentrations are indicative of organic-rich, anaerobic sediment and may be associated with low oxygen due to degradation of wood debris, even though wood itself contains very little nitrogen. The low values for ammonia in the groundwater do not indicate the presence of degrading wood debris.

The 2009 groundwater samples collected by Anchor contained ammonia at concentrations of 0.384 mg/L and 0.015 mg/l (as nitrogen), which are also below the Marine Chronic Surface water standard.

5.4 PCBs, SVOCs, and TPH

Only one sample from 2009, the field duplicate for monitoring well MW-02 (sample WB-MW-03-090819), contained detectable concentrations of a few semivolatile organic compounds (SVOC) analytes. Concentrations for these analytes were below surface water quality standards (Table E-1). These analytes were not detected in the primary sample collected from well MW-02 (WB-MW-02-090819).

The groundwater analyses were conducted to determine if historical hazardous substances released on the site were presently being transported by groundwater. The analytical results showed no indication of TPH (as gasoline, diesel, or motor oil) or PCBs. SVOCs and metals were detected below MTCA Method A and Method B groundwater cleanup criteria based on drinking water use. Historical hazardous substances released on the site do not appear to be present in groundwater at this location.

6.0 SEDIMENT CHEMICAL AND PHYSICAL ANALYSIS RESULTS

Sediment samples and associated analyses are summarized in Table 1. Four intertidal sediment samples and four subtidal sediment samples were submitted to ARI for chemical analysis. Two intertidal samples were also analyzed for

dioxins/furans. No field duplicates or equipment rinse blanks were collected for analysis.

The samples were analyzed for the following:

- Conventional parameters including:
  - Grain size following PSEP;
  - Total organic carbon (TOC) following Plumb, 1981;
  - Total volatile solids (TVS) by EPA Method 160.4;
  - Total solids by EPA Method 160.3 modified;
  - Porewater ammonia by EPA Method 350.1 modified; and
  - Porewater sulfide by EPA Method 376.2.
- Bulk tributyltin following Krone 1988;
- Porewater tributyltin following Krone 1988;
- SMS metals (arsenic, cadmium, chromium, copper, lead, silver, and zinc) by EPA Method 6010B, and mercury by EPA Method 7471A;
- Diesel- and lube oil-range hydrocarbons by NWTPH-Dx;
- Gasoline-range hydrocarbons by NWTPH-Gx;
- SVOCs by EPA Method 8270D;
- Polycyclic Aromatic Hydrocarbons (PAHs) by EPA Method 8270D-SIM;
- Hexachlorobenzene and hexachlorobutadiene by EPA Method 8081;
- PCBs by EPA Method 8082; and
- Dioxins/furans analysis by EPA Method 1613B.

Sample analyses are summarized in Tables 4 through 11 for both organic carbon-normalized and dry-weight results. Results of the sediment chemical analysis of organic carbon-normalized data were compared to applicable SMS marine criteria, including sediment quality standard (SQS) and cleanup screening level (CSL) thresholds, as described in WAC 173-204-320 and WAC 173-204-520. The dry-weight normalized results were also compared to the dry-weight equivalents of the SMS, SQS, and cleanup screening level (CSL) (i.e., lowest

apparent effects threshold (LAET) and second lowest apparent effects threshold (2LAET), respectively).

The marine SQS and LAET numerical chemical concentration criteria define the degree of sediment quality that is expected to cause no adverse effects to biological resources in marine sediment. At concentrations at or below the CSL or 2LAET, effects to biota are expected to be minor. CSL and 2LAET represent the upper bound of the minor adverse effects and above these concentrations, effects are anticipated to become increasingly significant with increasing concentration.

Anchor QEA collected four sediment samples and one field duplicate in 2009. While the work plan (Anchor 2009a) indicated that these samples were to be analyzed for grain size, total solids, ammonia, porewater sulfide, total organic carbon, total metals, bulk tributyltin, porewater tributyltin, SVOCs, TPH as gasoline and diesel, and dioxins/furans, results for only the following analyses were reported:

- Porewater sulfide following Plumb, 1981;
- Porewater tributyltin following Krone 1988; and
- Gasoline-range hydrocarbons by NWTPH-Gx;

Summary results for these analyses are presented in Table E-3. The summary table does not indicate which sample the field duplicate (WB-051-SS-090819) is associated with. However, Anchor's Work Plan describes the naming convention for field duplicates, indicating that this sample is a duplicate of WB-001-SS-090819.

6.1 Data Quality Review Summary

All analyses were performed in a manner consistent with the methods stated in the SAP/QAPP. The chemistry data from samples collected in 2011 was reviewed and validated by Hart Crowser chemists. Overall DQOs as set forth in the SAP were achieved, and the data for this project are acceptable for use, as qualified. Results for several analytes were qualified as estimated concentrations based on minor exceedances of quality control criteria. A detailed chemical data quality review and chemical laboratory reports are presented in Appendix B.

In some samples, reporting limits for benzyl alcohol, N-nitrosodiphenylamine, hexachlorobenzene, and 2,4-dimethylphenol were above SQS and/or dry-weight equivalent criteria. When analytes were present, the laboratory reported

estimated results to the method detection limit, which was generally below SQS and dry-weight criteria for all analytes.

Chemistry data from samples collected by Anchor in 2009 were available as summary tables only. Some of the analytical results appear to have been validated, but no validation report was included for review. The sample results are presented in Appendix E, as received.

6.2 Grain Size

The intertidal sediment samples were sandy gravel or gravelly sand, which is generally indicative of a higher energy environment. The samples were collected from below outfalls and freshwater seeps, so the low amounts of silt in the sediment may also be due to washing of finer grained particles by the seeps and outfalls. The subtidal sediment samples were dominated by silt and clay, indicative of a low energy depositional environment. The grain size distribution data are presented in Table 11. Laboratory reports are presented in Appendix B.

The laboratory noted that all four intertidal sediment samples (HC-WB-SS-001, HC-WB-SS-002, HC-WB-SS-003, and HC-WB-SS-004) contained shells or shell fragments, and/or organic matter or wood debris. The four subtidal samples (HC-WB-SS-005, HC-WB-SS-006, HC-WB-SS-007, and HC-WB-SS-008) contained organic matter. The shells, shell hash, and/or organic matter or wood debris were not removed prior to the grain size analysis. Sample results are, therefore, reported as apparent grain size.

6.3 Conventional Parameters

Analytical results for sediment conventional parameters are presented in Tables 4, 5, 8, and 9. Analytical results for porewater ammonia and sulfide are presented in Tables 7 and 10.

6.3.1 TOC

Total organic carbon concentrations in intertidal sediment samples ranged from 1.87 to 2.7 percent (Table 4). TOC values in the subtidal samples ranged from 4.95 to 7.75 percent (Table 8). The maximum TOC concentration (7.75 percent) was reported in subtidal surface sediment sample HC-WB-SS-005, located in the northwest corner of the DNR lease, closest to the visible wood debris.

6.3.2 TVS

Total volatile solids concentrations in the intertidal sediment samples ranged from 4.51 to 5.42 percent (Table 4). TVS concentrations in the subtidal sediment samples ranged from 12.97 to 22.27 percent (Table 8). As for TOC, the maximum TVS concentration was also reported in subtidal sediment sample HC-WB-SS-005, located in the northwest corner of the DNR lease, closest to the visible wood debris.

Specific numerical criteria are not established for wood or wood indicator surrogates (such as TOC or TVS) above which cleanup would be required. Rather, wood debris and wood degradation products are commonly assessed through biological testing procedures listed in the SMS.

6.3.3 Total Solids

Total solids values for the intertidal samples ranged from 56.2 to 71.4 percent (Table 4). Total solids values for the subtidal samples ranged from 30 to 33.3 percent (Table 8). The intertidal samples were collected at low tide, from locations coinciding with outfalls or seeps, while the subtidal samples were collected from saturated sediment.

Total solids values were not reported for the 2009 data. It is assumed that the summary tables provided by Anchor QEA contained dry-weight-corrected results from the laboratory.

6.3.4 Porewater Ammonia

Porewater ammonia concentrations in the intertidal sediment samples ranged from 2.39 to 6.01 mg/L (Table 7). Porewater ammonia concentrations in the subtidal sediment samples ranged from 4.18 to 10.6 mg/L (Table 10). The highest concentration was detected in subtidal sediment sample HC-WB-SS-005 near the northwest corner of the DNR lease, closest to the visible wood debris. Elevated ammonia concentrations are indicative of organic-rich, anaerobic sediment and may be associated with low oxygen due to degradation of wood debris, even though wood itself contains very little nitrogen.

6.3.5 Porewater Sulfide

Porewater sulfide concentrations in the intertidal sediment samples ranged from below the reporting limit of 0.05 to 0.067 mg/L (Table 7). Porewater sulfide concentrations in the subtidal sediment samples ranged from below the reporting limit of 0.05 to 5.16 mg/L (Table 10). The highest concentration was

detected in subtidal sediment sample HC-WB-SS-005 near the northwest corner of the DNR lease, closest to the visible wood debris. Elevated sulfide concentrations are indicative of organic-rich, anaerobic sediment and may be associated with low oxygen due to degradation of wood debris.

Porewater sulfide was also detected in three of four sediment samples and the field duplicate collected by Anchor QEA in 2009. These samples had concentrations of porewater sulfide ranging from 0.708 to 78.1 mg/l (Table E-3). The highest level was found in sample WB-002-SS-090819, which is the same location as HC-WB-SS-002, directly beneath Tugboat Annie's restaurant. This value is substantially different from the 2011 value from the same area (0.061 mg/L). The difference could be due to changing conditions below the restaurant during the 2-year interval.

6.4 Tributyltin

Analytical results for bulk tributyltin (TBT) are presented in Tables 4, 5, 8, and 9. Analytical results for porewater tributyltin are presented in Tables 7 and 10.

6.4.1 Bulk Tributyltin

Bulk tributyltin concentrations in the intertidal sediment samples ranged from 7.7 to 2000 ug/kg (Table 4). Bulk tributyltin concentrations in the subtidal sediment samples ranged from 2.3 to 6.9 ug/kg (Table 8). The highest concentration was detected in intertidal sediment sample HC-WB-SS-001 collected from below the outfall and seep associated with the Southern Ditch. High concentrations of butyltin and dibutyltin were also found at this location.

The highest concentrations of the tin ions were found in the intertidal sediment. Westbay Marina has historically conducted boat maintenance activities, with subsequent drainage into the Southern Ditch and through catch basins and outfalls in the parking area. The elevated levels of tin ions are likely due to the boat maintenance activities. Bulk TBT has no SMS criteria for cleanup, and it has been shown that bulk TBT is not a good indicator of bioavailable tin that might harm benthic organisms (Weston 1996).

6.4.2 Porewater Tributyltin

Porewater tributyltin concentrations in the intertidal sediment samples ranged from 0.014 to 0.055 ug/L (Table 4). Porewater TBT concentrations in the subtidal sediment samples were below the reporting limit (Table 8). The highest concentration was detected in intertidal sediment sample HC-WB-SS-004 near the northern outfall.

Porewater TBT was also detected in two of the four samples and the field duplicate collected by Anchor QEA in 2009. These samples had concentrations ranging from 0.0008 to 0.023 ug/l (Table E-3).

There are no SMS criteria for porewater TBT. There is a screening level criterion under the DMMP program of 0.15 ug/L which is used to determine whether dredged sediment is suitable for open water disposal. None of the samples at Westbay Marina exceeded this criterion.

6.5 Total Metals

Analytical results for total metals are presented in Tables 4, 5, 8, and 9. All metal concentrations were below applicable SQS screening criteria. The highest copper concentration was found in intertidal sample HC-WB-SS-001, downstream from the Southern Ditch, which was remediated in 1993 for copper-impacted soil. Zinc levels were generally elevated in subtidal samples compared to intertidal samples, which may be attributed to sacrificial zinc anodes attached to boats.

6.6 Total Petroleum Hydrocarbons

Analytical results for total petroleum hydrocarbons (TPH) as diesel-range, lube oil-, and gasoline-range are presented in Tables 4, 5, 8, and 9.

6.6.1 Diesel Range and Lube Oil TPH

Diesel-range organics (DRO) concentrations in intertidal samples ranged from 5.8 to 40 mg/kg (Table 4). DRO in subtidal samples ranged from below the reporting limit of 15 to 20 mg/kg (Table 8). Lube oil concentrations in intertidal samples ranged from 14 to 410 mg/kg (Table 4). Lube oil concentrations in subtidal samples ranged from below the reporting limit of 30 to 64 mg/kg (Table 8). The highest concentrations were seen in intertidal sample HC-WB-SS-002, which was located at the north corner of Tugboat Annie's restaurant, downslope from a seep.

There are no SMS criteria for TPH. MTCA Method A criteria for diesel and lube oil for unrestricted land use for soil is 2000 mg/kg. No sediment samples exceeded this criteria.

6.6.2 Gasoline-Range TPH

Gasoline-range organics (GRO) concentrations in intertidal samples ranged from below the reporting limit of 10 to 37 mg/kg (Table 4). GRO in subtidal samples

were all reported as non-detect and qualified as estimated due to significant matrix effects (Table 8). The only detection concentration was found in intertidal sample HC-WB-SS-002, which was located at the north corner of Tugboat Annie's restaurant, downslope from a seep. No GRO was detected in samples collected by Anchor QEA in 2009 (Table E-3).

There are no SMS criteria for TPH. MTCA Method A criteria for gasoline for unrestricted land use for soil is 100 mg/kg. No sediment samples exceeded this criterion.

6.7 Semivolatile Organic Compounds

Analytical results for semivolatile organic compounds (SVOCs) in sediment samples compared to AET dry-weight sediment quality values are presented in Tables 4 and 8. Analytical results for sediment samples compared to organic carbon-normalized SMS criteria are presented in Tables 5 and 9. All samples are presented and compared to both SMS and AET criteria.

The intertidal sediment samples had TOC concentrations that were within the 0.5 to 3.5 percent range for organic carbon normalization of non-polar organic compounds. These results are compared to SMS criteria and presented in Table 5. TOC concentrations in the subtidal sediment samples fell outside the range for organic carbon normalization. These results are compared to AET dry-weight-corrected criteria, and are presented in Table 8.

The light polycyclic aromatic hydrocarbons (LPAHs), heavy polycyclic aromatic hydrocarbons (HPAHs), and dibenzofuran were analyzed by both EPA Method 8270D and EPA Method 8270D-SIM. Hexachlorobenzene and hexachlorobutadiene were analyzed by both EPA Method 8270D and EPA Method 8081. Both sets of results are presented in the tables.

6.7.1 LPAHs

None of the samples analyzed exceeded SMS organic carbon-normalized criteria or AET dry-weight screening values for LPAHs.

Low concentrations of LPAHs were detected in all the samples. The subtidal sediment samples generally contained higher levels of LPAHs compared to the intertidal samples.

6.7.2 HPAHs

None of the intertidal samples analyzed exceeded SMS organic carbon-normalized criteria or AET dry-weight screening values for HPAHs. Only one subtidal sediment sample exceeded the AET screening value.

Fluoranthene in sample HC-WB-SS-007 exceeded the 2LAET screening value for the analysis by EPA Method 8270D. Fluoranthene in that sample did not exceed criteria when analyzed by EPA Method 8270D-SIM (Appendix B). Samples are generally analyzed by EPA Method 8270D-SIM to achieve lower detection limits. The laboratory extracted separate aliquots of the samples for the different analyses. A comparison of sample results by the two different methods shows that while relative ratios of the PAHs within each sample are similar, values by the two analyses can differ significantly. This is an indication of sample heterogeneity.

Concentrations of HPAHs were detected in all the samples but, with the exception of sample HC-WB-SS-007 noted above, were at low concentrations. The subtidal sediment samples generally contained higher levels of HPAHs compared to the intertidal samples.

PAHs are often associated with creosote, coal tar, petroleum, road runoff, and incomplete combustion of organic matter. PAHs may be associated with treated pilings and structures along the shoreline or runoff from the highway along the western part of the bay.

6.7.3 Chlorinated Benzenes

Chlorinated benzenes were not detected in any of the samples.

Hexachlorobenzene in sample HC-WB-SS-002 analyzed by EPA Method 8270D was reported by the lab as non-detect above the SQS screening level due to an elevated reporting limit. Hexachlorobenzene and hexachlorobutadiene were also analyzed by EPA Method 8081, which has lower detection limits. There were no exceedances of screening level criteria for those analytes.

6.7.4 Phthalate Esters

None of the intertidal samples analyzed exceeded SMS organic carbon-normalized criteria (Table 5). Sample HC-WB-SS-004 had an LAET exceedance of butylbenzylphthalate for the AET dry-weight screening values (Table 4). However, the intertidal samples had TOC concentrations that were within the

0.5 to 3.5 percent range for organic carbon normalization of non-polar organic compounds. Therefore, the AET dry-weight-based criteria are not applicable.

One subtidal sample, HC-WB-SS-006, had an LAET exceedance for butylbenzylphthalate (Table 8). Butylbenzylphthalates is used as a plasticizer, commonly used for making polyvinyl chloride (PVC) materials.

6.7.5 Ionizable Organic Compounds

None of the samples analyzed exceeded SMS organic carbon-normalized criteria or AET dry-weight screening values for ionizable organic compounds. Benzyl alcohol in samples HC-WB-SS-002, HC-WB-SS-005, HC-WB-SS-006, HC-WB-SS-007, and HC-WB-SS-008 were reported as non-detect above the CSL and the 2LAET criteria due to an elevated reporting limit associated with sample dilutions.

Phenol was found in one intertidal sample and two subtidal samples above the reporting limit (Tables 5 and 8). Phenol is a product of wood degradation and is also a component of creosote and coal tar. In addition to phenol, 4-methylphenol was detected in all the subtidal samples at concentrations below SQS and AET. This compound is also often associated with wood debris as well as creosote and coal tar.

6.7.6 Miscellaneous Compounds

None of the samples analyzed exceeded SMS organic carbon-normalized criteria or AET dry-weight screening values for miscellaneous compounds.

N-nitrosodiphenylamine in sample HC-WB-SS-002 was reported as non-detect above the LAET criteria due to an elevated reporting limit associated with sample dilutions. However, the intertidal samples had TOC concentrations that were within the 0.5 to 3.5 percent range for organic carbon-normalization of non-polar organic compounds. Upon organic carbon-normalization, the reporting limit for that compound did not exceed the SMS criteria.

6.8 Polychlorinated Biphenyls

Analytical results for sediment samples compared to AET dry-weight sediment quality values are presented in Tables 4 and 8. Analytical results for sediment samples compared to organic carbon-normalized SMS criteria are presented in Tables 5 and 9. All samples are presented and compared to both SMS and AET criteria.

PCBs were detected above the reporting limit in only one intertidal sediment sample at concentrations below the SQS screening criteria of 12 mg/kg organic carbon (OC). Aroclor 1254 was found in sample HC-WB-SS-001, located downslope of the Southern Ditch, at a relatively low concentration of 17 ug/kg (0.81 mg/kg OC) (Tables 4 and 5). PCBs were detected above the reporting limit in two subtidal sediment samples, with one sample exceeding the 2LAET criteria of 1000 ug/kg. Aroclor 1254 was present in sample HC-WB-SS-005, at a concentration of 1100 ug/kg (20.95 mg/kg OC) (Tables 8 and 9). Sample HC-WB-SS-008 contained Aroclors 1248 and 1254, but at levels below the LAET criteria of 130 ug/kg.

Aroclor 1254 has historically been associated with transformer oils. However, no TPH was found in sample HC-WB-SS-006. Review of the laboratory chromatogram indicated a strong PCB pattern present. The laboratory noted the possible presence of additional Aroclors, but due to congener overlap with Aroclor 1254, those PCBs were not reported for this sample.

6.9 Dioxins/Furans

Analytical results for dioxins/furans in the intertidal sediment expressed as 2,3,7,8-TCDD toxic equivalents (TEQs) are presented in Table 6. TEQs were calculated using the WHO 2005 toxic equivalency factors (TEF) for mammals. Total dioxin TEQs are reported using two conventions: adding only detected congeners, and using 1/2 the detection limit for non-detected congeners. The latter made no significant difference in reported totals since concentrations for many congeners were above detection limits (Table 6).

Dioxin/furan congeners were detected in both samples. The total TEQ concentrations ranged from 10.72 to 13.09 pg/g (parts per trillion). The highest concentration was in sample HC-WB-SS-003, located downslope of a seep to the south of the historic hog fuel burner (Figure 2).

Dioxin/furan concentrations do not have numerical criteria under SMS for marine sediment. However, for comparative purposes, the detected TEQ concentrations exceed the Puget Sound background concentrations, as reported in EPA's 2008 Puget Sound Background Study (EPA 2008b). TEQ concentrations in the Puget Sound study ranged from 0.24 to 11.63 pg/g with a lognormal mean of 1.35 and a median of 1.0 pg/g. If comparison is limited to samples collected from the South Sound area, which includes Budd Inlet and Carr Inlet, average TEQ concentrations fall between 7.24 and 8.64 pg/g. If a bay-specific background criteria is used, a comparison of sample results from north Budd Inlet, average TEQ concentrations are approximately 14 pg/g (SAIC 2008).

The relative congener ratios in the intertidal sediment samples were compared to the ratios from the four upland soil samples also analyzed for dioxins/furans (Figures 4 and 5). The OCDD relative ratio is excluded from Figure 5 because the OCDD congener is typically present at much higher concentrations than other congeners, regardless of dioxin source, and dominates the relative fraction. The pattern of the congener ratios in the upland soil and the intertidal sediment are similar, indicating a similar source.

7.0 SEEP SAMPLES RESULTS

Four seep samples (WB009 through WB012), one field duplicate, one trip blank, and one rinse blank were collected by Anchor QEA during the August 2009 sampling event. The samples were analyzed for the following:

- Ammonia by EPA Method 350.1;
- Total metals by EPA Methods 200.8/6010/7470A;
- Dissolved metals by EPA Methods 200.8/6010/7470A;
- SVOCs by EPA Method 8270D;
- Gasoline-range TPH by NWTPH-Gx Method; and
- Diesel- and motor oil-range TPH by NWTPH-Dx Method.

The samples were not analyzed for porewater TBT as stated in the work plan, but were analyzed for PCBs. The data are presented in Table E-4. The data appear to have been validated, but no data validation report was available for review.

Some total metal results for arsenic, copper, and nickel exceeded one or more of the marine water quality criteria (Table E-4). Most of the organic compounds analyzed were not detected in the seep samples. Naphthalenes were the most common hydrocarbons detected in the seep samples. Naphthalene was detected in all four seep samples at estimated concentrations ranging from 0.13 to 0.71 ug/L, less than the marine surface water criterion of 4,900 ug/L (Table E-4).

8.0 LIMITED WOOD DEBRIS SURVEY

Surface sediment samples and sediment cores were photographed and visual observations and soil descriptions were documented on core logs presented in Appendix A. Visual sample descriptions of surface sediment grabs are presented in Table A-2 in Appendix A.

8.1 Distribution and Estimated Percentage of Wood Debris

Surface sediment grab samples and sediment core samples from each location within the Westbay Marina were examined for wood debris. Wood debris identification was based on field interpretations and is subjective. For purposes of this report, wood debris included bark, wood chips, wood particles, as well as terrestrial wood debris (i.e., twigs and sticks). The estimated percentage of wood debris for sediment samples are summarized in Table 12.

Surface sediment grab samples and sediment core samples were evaluated in the field for wood debris. The locations of the sediment cores and sediment grab samples are presented on Figure 2. Grain size analyses at the laboratory also identified organic matter or wood debris in several samples. While examining samples by microscope for the benthic organism survey, wood fibers were also identified. The intertidal benthic samples had only small quantities of wood debris and wood fibers. The subtidal benthic samples had large quantities of fibrous wood debris, along with wood chips. The wood debris material often made up the majority of the benthic core taken. A summary of the surface sediment grab samples are provided in Table A-2, and sediment core sample bore logs are presented in Appendix A.

Hart Crowser field representatives wet sieved on one sediment core (HC-WB-SC-006), using a 1.0 mm sieve to look for wood debris that was too small to be observed in bulk sediment.

Wood debris was identified in:

- All of the sediment core samples (100 percent);
- All of the subtidal sediment samples, either large fragments observed during sampling or wood debris identified during grain size analysis (100 percent);
- All of the intertidal sediment samples, either as discrete wood pieces observed at the sampling location, or woody organic debris identified during grain size analysis (100 percent); and

- The one wet sieve sediment core sample where obvious visual wood debris was not observable (100 percent).

Wood debris was observed with the highest accumulations near the northwest boundary of the DNR lease with Dunlap Towing Company, where a large accumulation of wood debris mixed with silt was seen. Three sediment cores (HC-WB-SC-001, HC-WB-SC-002, and HC-WB-SC-003) and one surface sediment grab (HC-WB-SS-005) were collected in that location, and all contained greater than 25 percent wood debris.

Small amounts (less than ten percent) of wood debris were observed at the intertidal locations. As the intertidal sampling locations were selected downslope from outfalls and active seeps, it is possible that wood debris might had been washed away from those areas. A sediment core collected close to an intertidal sample (HC-WB-SC-004) contained abundant amounts of wood debris (40 to 95 percent) in the upper two feet of the core.

One sediment core was collected at the northeast corner of the DNR lease, close to the boundary with Dunlap Towing Company (HC-WB-SC-006) (Figure 2). This core contained wood chips in the upper 6 inches. The remaining 13.5 feet of core consisted of silt with occasional shells and shell hash. As noted, sections of this length of core were washed through a sieve, to determine if fine wood fibers were present. A low amount of wood fibers by volume were identified using the sieve.

Wood debris appears to be present throughout the DNR leased area at Westbay Marina, with the majority found close to the boundary with Dunlap Towing Company. The wood debris appears to be primarily derived from logs, as it consists of bark, twigs, long stringy wood fibers, and fine wood fragments. Sawdust and processed wood were not observed during the investigation.

A chemical indicator of the presence of organic loading such as wood debris and the overall "availability" of organic matter contained in sediment is the TVS/TOC ratio. Typical, unimpacted marine sediment has a TVS/TOC ratio less than about 2, according to Jack Word of NewFields Northwest (R. McGinnis personal communication). Conversely, ratios greater than 2 often indicate labile organic matter such as wood debris that is available for chemical or microbial breakdown. This often results in anaerobic conditions and elevated sulfides concentrations. TVS/TOC ratios for Westbay Marina sediment samples were calculated, and all values exceeded a 2 ratio. Samples containing the highest TVS/TOC ratios (HC-WB-SS-005 an HC-WB-SS-006) are located closest to the Dunlap Towing Company boundary (Figure 2).

9.0 LIMITED BENTHIC ORGANISM SURVEY

Marina benthic infauna were observed and identified in all eight benthic infauna samples. Four intertidal and four subtidal samples were analyzed. All samples were rinsed in the lab prior to analysis. The intertidal benthic samples were subsampled for analyses due to the large volume of material. Benthic sample HC-WB-BS-001 was subsampled into 200 mL aliquots to count polychaetes, gastropods, and bivalves and then down to 100 mL samples to count nematodes. Organism counts were multiplied by 4 and 2, respectively, for final counts. HC-WB-BS-002 was subsampled into 225 mL aliquots and numbers of organisms counted were multiple by 2.67 for final counts. HC-WB-BS-003 was subsampled into 200 mL aliquots and numbers of organisms counted were multiplied by 2.75 for final counts. HC-WB-BS-004 was subsampled into 200 mL aliquots and numbers of organisms counted were multiplied by 2.25 for final counts. HC-WB-BS-005 was the only subtidal benthic sample that needed to be subsampled. It was subsampled into spoonfuls and multiplied by the total number of spoonfuls. The remaining subtidal benthic samples (HC-WB-BS006, HC-WB-BS-007, and HC-WB-BS-008 had the entire sample counted due to the small amount of biological material found.

The intertidal benthic samples had much more diversity and generally more organisms than the subtidal benthic samples. Organisms present in the intertidal samples included smooth worms (nematodes), polychaetes, gastropods, bivalves, arthropods (mysids and amphipods), and crabs. Shell fragments, shell hash, and minor amounts of wood debris were also found in the intertidal samples. Organisms in the subtidal samples included smooth worms (nematodes), polychaetes, oligochaetes, gastropods, bivalves, and arthropods (Table 13). With the exception of subtidal sample HC-WB-BS-005, the subtidal samples had less than one-third the number of organisms observed in the intertidal samples. The subtidal samples contained large quantities of dense, fibrous wood material along with some shell hash and shell fragments.

10.0 TERRESTRIAL ECOLOGICAL EVALUATION

Sampling of upland soil on the Westbay site by Anchor (2009) and this study both documented dioxins/furans levels in excess of MTCA criteria. Anchor found two samples with concentrations of 61.9 and 14.2 ng/kg (parts per trillion [ppt] using 1/2 the detection limit approach). The current study found concentrations of dioxins/furans of 5.99-87.06 pg/g (also ppt). Both of the Anchor study samples, and 2 of the 4 soil samples in the current study exceeded the MTCA Method B unrestricted use soil direct contact TEQ of 11 ng/kg.

As required by the MTCA, a TEE was conducted on the terrestrial portion of the Westbay Marina site compliant with WAC 173-340-7490 through -7494. The MTCA TEE procedures are consistent with EPA ecological risk assessment guidelines (EPA 1997). This TEE consisted of three tiers: a TEE exclusions analysis (Tier 1), a Simplified TEE (Tier 2) and a site-specific TEE (Tier 3). Details of the procedures and findings of the TEE conducted for the Site are presented in Appendix C. The results are summarized in the following subsections.

10.1 Tier 1 TEE Exclusions Analysis

A TEE exclusion analysis was conducted to determine if the Westbay site could be excluded from further analysis or consideration. The site failed all four exclusion criteria: 1) All affected soil is not below the point of compliance; 2) All affected soil is not, nor will it be, covered in ways that will prevent ecological exposure; 3) Contiguous, undeveloped land within 500 feet of the site does not cover less than 0.25 acres; and 4) contaminant levels in the soil are not below natural background levels. Accordingly, the TEE exclusions analysis concluded the Westbay Marina does not qualify for an exclusion from a TEE, and further analysis was required.

10.2 Simplified TEE

The Westbay Marina site satisfied the criteria for a Simplified TEE. The Simplified TEE consists of three parts: 1) an exposure analysis; 2) pathways analysis; and 3) contaminants analysis (WAC 173-340-7493).

10.2.1 Exposure Analysis

The exposure analysis consists of two criteria: 1) If the total area of impacted soil is less than 350 square feet; or 2) If land use at the site and surrounding area makes substantial wildlife exposure unlikely, the TEE may be ended and a determination of no ecological hazard made.

The Westbay Marina site has more than 350 square feet of impacted soil and so fails criterion 1. Criterion 2 is evaluated using five parameters in Table 749-2 of MTCA. Using this table, the Westbay site also failed criterion 2. Accordingly, a determination of no ecological hazard could not be made using the exposure analysis and additional steps under a Simplified TEE were required.

10.2.2 Pathways Analysis

Under the pathways analysis (WAC 173-340-7492[2][b]) the TEE may be ended and a no ecological risk conclusion reached if there is no potential exposure

pathways from constituents in soil to ecological receptors. The Westbay Marina site contains contaminated soil in the northern strip and Southern Ditch areas that are open and available for foraging and burrowing by terrestrial animals. Potential exposure pathways, therefore, are present and a determination of no ecological hazard could not be made using the pathways analysis. Additional steps under a Simplified TEE were required.

10.2.3 Contaminants Analysis

Under the contaminants analysis (WAC 173-340-7492(2)(c)) the TEE may be ended and a no ecological risk conclusion reached if either no priority constituents of ecological concern listed in MTCA Table 749-2 are detected in site soil, or no constituent is detected at a concentration higher than its listed value in MTCA Table 749-2. Copper is a constituent of ecological concern, and copper levels in the Southern Ditch of 1,360 mg/kg exceed the MTCA Table 749-2 level of 550 mg/kg. Similarly dioxins/furans are constituents of ecological concern, and dioxins/furans levels in the northern strip of 6 to 88 ng/kg exceed the MTCA Table 749-2 levels of 5 ng/kg. These results indicate that the TEE cannot be ended using the Simplified TEE approach.

Having exhausted all three analyses in the Simplified TEE, the Westbay Marina site was found to require a Site-Specific TEE.

10.3 Site-Specific TEE

The Site-Specific TEE consists of two phases: 1) problem formulation to focus the Site-Specific TEE on those elements of the ecosystem where potential ecological hazards exist; and 2) select and implement one or more methods for assessing ecological hazards.

10.3.1 Problem Formulation

The first step of the problem formulation is to identify chemicals of potential ecological concern (CPOC). This is done by comparing reasonable maximum exposure (RME) concentrations of contaminants at the site to ecological soil indicator concentrations (EISC) provided in MTCA Table 749-3. This analysis found that RME at the site for copper is 360 mg/kg versus an EISC of 217 mg/kg, and the RME at the site for dioxins is 80 ng/kg versus an EISC of 2 ng/kg. Thus, copper and dioxins are the chemicals of potential ecological concern at the site.

The second step in problem formulation is an exposure pathways analysis. Although the exposure pathways analysis shares many elements in common with

the exposure pathways analysis of the Simplified TEE, additional information may be used to help characterize exposures and determine if potential exposures are sufficient to pose a potential ecological hazard. This site-specific exposure analysis for the Westbay Marina found that wildlife may be exposed to contaminants in the soil at Westbay Marina, such exposure is considered minor or *de minimis* because:

- The spatial extent of constituents in soil potentially contacted by wildlife is small;
- The quality of habitat in open areas of the site having contaminants is low;
- The commercial nature of the site indicates low potential usage by wildlife;
- Alternative high quality habitat in the hillside area west of the site will be attractive to wildlife; and
- Local populations of wildlife will not be adversely affected.

10.4 Conclusion

The exposure analysis step of the problem formulation phase of the Site-Specific TEE was used to refine the results of the Simplified TEE. Five lines of evidence were used to demonstrate that, although potential exposure of wildlife to contaminants present in soil at the Westbay Marina site may be complete, exposures are considered to be minor or *de minimis*.

Based on the results of the TEE, it is concluded that the residual contaminants present in surface soil in open areas of the Westbay Marina site do no pose an ecological hazard to wildlife.

11.0 RISK EVALUATION FOR HUMAN HEALTH RECEPTORS

A human health exposure pathway is the mechanism by which a chemical is transported from the source to the exposed individual. A complete description of an exposure pathway involves the following four elements (EPA, 1989):

1. A source and mechanism of chemical release;
2. A retention or transport medium;
3. A point of potential human contact with the chemical (referred to as the exposure point); and
4. An exposure route, such as ingestion, at the point of contact.

This section presents a qualitative evaluation of potential human health hazards associated with residual chemical concentrations in soil, groundwater and sediment at the Westbay Marina Site. Comparison of contaminant concentrations to applicable cleanup levels by media and potential exposure pathways was deemed the most appropriate method for this assessment. Where available, constituent concentrations were compared to applicable MTCA cleanup levels, including applicable or relevant and appropriate requirements (ARARs), when available. For constituents that do not have MTCA cleanup levels, concentrations were compared to other regulatory criteria, or to estimates of background concentrations.

The evaluation of potential exposure pathways and receptors at the Westbay Marina site is summarized in the conceptual model flow-diagram (Figure 6). Contaminated media within the Site include upland soil, groundwater, and intertidal and subtidal sediment. Constituents are transported through stormwater and marine water erosion/dispersion and groundwater movement, with some wind erosion/dispersion from soil possible during historical operations of the hog fuel burner on the Site. Exposure pathways include ingestion of soil and sediment, and direct contact. Given that Westbay Marina is a commercial facility used for recreation, the receptors include commercial/industrial workers, construction workers, and recreational users. The Site is also considered residential due to zoning and live-aboards on boats in the marina. As discussed in Section 10, terrestrial and marine biological communities are also potential receptors.

11.1 Potential Exposure Pathways in Soil

This RI investigated the potential for soil at the Westbay Marina site to have elevated levels of dioxins/furans from historical operation of the hog fuel burner in the northwest portion of the site. These were the only constituents tested for in the four soil samples taken. The results were expressed as 2,3,7,8-TCDD toxic equivalents (TEQs), and are presented in Table 2.

Dioxin/furan concentrations were compared to the MTCA Method B criterion of 11 pg/g. Two soil samples collected by Hart Crowser, HC-WB-US-001 and HC-WB-US-002, located closest to the historic hog fuel burner, exceeded this criterion. In addition, the two soil samples analyzed for these constituents by Anchor in 2009 (WB017 and WB018) also exceeded the 11 pg/g MTCA criterion (Table E-2 and Figure 3). In contrast, Anchor tested for soil copper concentrations in the Southern Ditch area and for diesel- and oil-range hydrocarbons at the former UST valve box. All constituents were below MTCA Method B (copper in Southern Ditch) or Method A (hydrocarbons at UST valve) soil cleanup levels based on direct contact exposures. Thus, potential exposure

pathways for upland soil are of concern for this RI for dioxins/furans, but not for other tested constituents.

Soil as an environmental medium at the site relates to a number of potential exposure pathways, to other media, and to receptors (Figure 6). These include: soil ingestion/absorption and direct contact with contaminated soil or to sediment contamination through water erosion or groundwater leaching through contaminated soil.

Soil in the area of the four samples with elevated dioxin/furan detections are not screened or fenced to prevent human access. They also are not covered with a clean vegetated soil cap, or an impervious covering such as asphalt or cement. Accordingly, dioxins/furans at the site remains available for direct contact or ingestion. It is also still susceptible to potential wind or water based erosion that could carry contaminants to nearby marine sediment, freshwater runoff in the adjacent ditch, and marine water.

11.2 Potential Exposure Pathways for Groundwater/Seeps

This RI investigated the potential for groundwater at the Westbay Marina site to have elevated levels of N-ammonia, and dissolved and total levels of the metals copper and nickel. Samples were taken from two wells at the site and compared to the MTCA Method B criteria (Table 3). These criteria generally assume that groundwater protection is based on its use or potential use as a drinking water source. Levels of N-ammonia, copper, and nickel in the groundwater samples did not exceed MTCA criteria for drinking water use. In addition, the three groundwater samples collected by Anchor (2009) also had either undetectable concentrations of metals or the concentrations were below MTCA Method B groundwater criteria (Table E-1). The Anchor study also found that groundwater had SVOCs below MTCA Method B groundwater criteria, and TPH and PCBs were not detected (Table E-1). Consequently, exposure pathways for groundwater as a drinking water source are not relevant to this RI.

The Westbay Marina site is directly adjacent to Budd Inlet and is, therefore, strongly influenced by tides. Saltwater intrusion into the groundwater occurs to an unknown degree during high tides, and a combination of groundwater and intruded saltwater drain into Budd Inlet during low tides. Some of this groundwater/saltwater mix is evident as seeps in the intertidal portions of the Site. Anchor sampled several of these seeps during low tide (Anchor 2009). It seems extremely unlikely, given the location of the Westbay Marina site, and the mixture of freshwater and saltwater at the site, that the groundwater would ever be used for drinking water.

Accordingly, this RI conducted a second analysis, which treats groundwater and the seeps draining this groundwater, as contributors to marine surface water that would be subject to MTCA Surface Water Quality-based criteria. Many of these criteria are more restrictive than MTCA standards based on a presumption of drinking water use of groundwater.

Of the two groundwater samples collected by Hart Crowser for this RI, both slightly exceeded the MTCA Surface Water Criteria for dissolved and total copper (Table 3). The Anchor groundwater samples similarly had small exceedances of Surface Water Criteria for dissolved and total copper and nickel in one of three samples (Table E-1). The Anchor seep samples exceeded these criteria for dissolved and total copper (5 of 6, and 6 of 6 samples, respectively), dissolved and total nickel (4 of 6 and 5 of 6 samples, respectively), total arsenic (3 of 6 samples), and total zinc (1 of 6 samples) (Table E-4). The seep sample exceedances were also small.

Given that the exceedances of groundwater and seep samples were small when compared to surface water quality criteria, and that exceedances were generally limited to only a subset of the samples analyzed, exposure pathways for groundwater via surface water were concluded not to require further exposure pathway analysis for this RI.

11.3 Potential Exposure Pathways for Sediment

The RI investigated the potential for intertidal and subtidal sediment at the Westbay Marina site to have elevated levels of various constituents of concern. Samples were taken from four intertidal locations, and four subtidal locations and analyzed for 16 different parameters (Table 1, Figure 2).

Constituent levels in the sediment samples were compared to a variety of criteria. SMS Sediment Quality Criteria were used for most parameters in the intertidal samples. Because their total organic carbon levels exceeded the acceptable range for the SMS, most parameters in the subtidal samples were compared to AET dry-weight sediment quality values. Using these values, none of the intertidal samples contained constituents that exceeded sediment criteria. Consequently, exposure pathways for intertidal sediment are not relevant to this RI (but see discussion for tributyltin and dioxins/furans below).

Using AET dry weight sediment quality values, the subtidal samples had three exceedances of sediment criteria (Table 8). These included a single exceedance for total PCBs, a single exceedance for butylbenzylphthalate, and a single exceedance for fluoranthene.

After discussion with Ecology staff, it was decided that the limited exceedances may not warrant cleanup as the isolated occurrences in the samples failed to demonstrate a widespread distribution of such constituents. In particular, Ecology often looks for a "cluster" of three or more samples containing constituents at levels that exceed sediment criteria to demonstrate that the potential risk to human health or the environment warrants cleanup. Given this conclusion, exposure pathways for subtidal sediment are not of concern to this RI (but see discussion for tributyltin and dioxins/furans below).

The Anchor study (2009) also analyzed sediment at the Westbay Marina site for porewater sulfides, porewater tributyltin, and gasoline-range hydrocarbons. Hydrocarbons were not detectable, and porewater sulfides varied from undetectable to 78.1 mg/l, but do not have MTCA criteria. Thus, neither of these constituents support an exposure pathway analysis for sediment (but see discussion below for tributyltin).

Neither MTCA or the SMS have criteria for levels of tributyltin (TBT) or dioxins/furans in sediment. Analysis of levels of these constituents were evaluated as noted below.

TBT cleanup levels for sediment were evaluated for porewater results only. This is because the dissolved fraction is the main exposure pathway resulting in adverse impacts to aquatic life, and by extension, humans. This RI evaluated a number of existing threshold criteria and additional studies to determine whether TBT levels at the Site were a risk to human health and should be cleaned up. These include:

- The Dredged Material Management Program (DMMP) has established a TBT porewater standard of 0.15 ug/L for deep water disposal.
- RSET has also established a dredge disposal porewater criteria of 0.15 ug/L.
- EPA has established an Ambient Water Quality Criteria (AWQC) for TBT of 0.42 ug/L (acute) and 0.0074 ug/L (chronic).

Since AWQC are applicable to overlying water concentrations rather than sediment porewater *per se*, the RI concludes that use of the DMMP/RSET criterion of 0.15 ug/L, which reflects a protective concentration for benthic organisms, would be an appropriate criterion for assessing TBT constituent levels in the intertidal and subtidal samples. None of the intertidal or subtidal samples collected in the present study, or in the Anchor study (2009) had porewater TBT levels that exceeded 0.15 ug/l. (Tables 7, 10, E-3). Consequently, exposure pathways for TBT are not a concern to this RI.

Two intertidal sediment samples were collected and analyzed for dioxins in the northern portion of the Westbay Marina site near the location of the historical hog fuel burner. The RI evaluated a number of existing threshold criteria and additional studies for determining whether dioxin/furan levels at the Site were a risk to human health and should be cleaned up. These include:

- DMMP has established a dioxin dredge disposal value of 4 ng/kg TEQ. This is likely below even urban background levels for Puget Sound, limiting its usefulness for this RI.

- The "Bold Study" collected dioxin data from throughout the Puget Sound region in 2008. A total of 10 samples from South Sound (but excluding Budd Inlet samples.) and 5 samples from Carr Inlet were selected and MTCA statistics on the data conducted to derive the 90th percentile value from these nearby bays and inlet areas. These data indicate a 90th percentile value of between 7 ng/kg TEQ and 9 ng/kg TEQ depending on which statistical test is used (i.e., log normal or nonparametric). This may represent a regional background level for dioxins/furans for the local area excluding Budd Inlet.

- SAIC conducted a sediment study of dioxins in Budd Inlet in 2008. The southern half of Budd Inlet had noticeably higher dioxin concentrations than the northern half of the inlet. Twelve sample locations from about Westbay Marina and north were selected and the data analyzed resulting in a 90th percentile value of 24 ng/kg. This may represent an area background for Budd Inlet but excluding those areas nearest to the Cascade Pole site, a known contributor of dioxins/furans to the area.

- A second analysis of the SAIC data was conducted using only those stations closest to Westbay Marina. The nine sample locations were selected and the data analyzed resulting in a 90th percentile value of 35 ng/kg. This may represent an area background for Budd Inlet in the immediate vicinity of Westbay Marina.

After discussions with Ecology staff it was decided that a criterion based on background levels was appropriate and that, given the potentially large role of dioxins/furans from the Cascade Pole site, the background value should be derived from sampling locations in Budd Inlet. Neither of the intertidal samples had dioxin/furan levels that exceeded either the 24 ng/kg or 35 ng/kg background levels calculated for Budd Inlet (Table 6). In addition, the purpose of collecting intertidal samples was to try and determine whether sediment near the former hog fuel burner may have adversely affected adjacent sediment. The TEQ dioxin results for the two sediment samples are about three times lower

than the average upland soil results. Thus, any connection, if present, appears weak. Consequently, exposure pathways for dioxins/furans in sediment are not of concern to this RI.

12.0 SUMMARY AND CONCLUSIONS OF REMEDIAL INVESTIGATION

Soil, groundwater, groundwater seep, and sediment quality testing data presented in this RI report provide additional information for characterizing environmental conditions at Westbay Marina. This investigation included a limited survey of wood debris and benthic organisms.

RI investigation methods included a wide array of assessment and testing techniques to determine the extent of soil, groundwater, seep, and sediment impacts associated with historical activities at the site. A limited wood waste survey was completed to determine the extent of wood waste in the subtidal portions of the marina, and a limited benthic organism survey to help determine the ecological health of intertidal and subtidal areas.

A number of key conclusions are summarized below based on the sampling and testing results presented in this RI.

12.1 Conventional Chemical Testing Conclusions

There appears to be a general spatial correlation between the presence of visible wood debris, the TVS/TOC ratio, sulfide concentration, and ammonia concentrations. Collectively, these metrics indicate that the impacts from wood debris in subtidal portions of the site are high enough to result in elevated concentrations of ammonia and sulfide. However, the detected concentrations of these chemicals were not great enough to indicate widespread impacts to aquatic biota, especially as benthic invertebrate samples confirmed the presence of a variety of taxa in the sediment. The absence of co-located MTCA criteria exceedances for most other constituents in sediment at the site does not support cleanup of wood debris.

12.2 Organic and Metals Testing Conclusions

Analytical testing results indicate that Westbay Marina sediment have not been significantly impacted by chemical constituents based on SMS criteria (intertidal samples) or AET dry-weight screening values (subtidal samples). All constituents tested for were below MTCA criteria in intertidal samples, and nearly all were below criteria for subtidal samples. One subtidal sediment sample exceeded the AET screening value for fluoranthene. A second subtidal sample exceeded the

AET screening criteria for butylbenzylphthalate and total PCBs. However, these exceedances are seen as isolated occurrences and failed to demonstrate a widespread distribution of such constituents. As a result, these exceedances do not appear to warrant additional action under the MTCA.

Seep sample results indicate that a few metals slightly exceed marine surface water criteria. Copper and nickel are the predominant metals. Additional evaluation of metal impacts on the aquatic environment may be necessary.

Groundwater is not a likely current or future drinking water source at the site because of its proximity to tidally influenced saline water. However, because the potential use of site groundwater as a future drinking water source has not been determined by Ecology, the potential human health effects assuming drinking water use were evaluated. None of the organic or inorganic analytes tested for in groundwater by Hart Crowser and Anchor QEA were detected at concentrations that would exceed MTCA Method B groundwater criteria based on an assumed drinking water use.

Bulk TBT concentrations were detected at elevated levels in some of the intertidal sediment samples. However, MTCA and the SMS do not have criteria for levels of TBT, and bulk TBT is not a good indicator of bioavailable tin that might harm benthic organisms. Sediment porewater TBT sample results collected and analyzed by both Hart Crowser and Anchor QEA were evaluated for TBT in sediment because the dissolved fraction of TBT is the main benthic organism exposure pathway. None of the intertidal or subtidal sediment samples had porewater TBT concentrations that exceed the DMMP or RSET criteria. Therefore, data do not indicate that additional MTCA action is necessary due to the presence of TBT in sediment.

Dioxins/furans were detected in both intertidal sediment samples and the six upland soil samples for which this constituent was analyzed. Soil samples were located at or near the location of a historical wood waste burner suspected of having created dioxins/furans. Concentrations in four of the upland soil samples closest to the burner's former location were found to exceed MTCA Method B unrestricted use criteria, and lack cover by clean fill or impervious surfaces to limit human exposure or erosion into surface water or the marine environment. Additional evaluation of these dioxin/furan impacted upland soil under the MTCA process is warranted.

Dioxin/furan TEQ concentrations and congener patterns in the intertidal sediment samples exceeded the Puget Sound non-urban background sediment values. However they did not exceed average concentrations found in Budd Inlet. In addition, concentrations in the intertidal zone were much lower than in

nearby upland soil, suggesting a weak link between these the upland source and intertidal sediment results. The pattern of the congener ratios in the upland soil and the intertidal sediment are similar, indicating a similar source. However, these congener pattern characteristics can be found anywhere wood burning has occurred. Available dioxins/furans data in intertidal sediment do not indicate a direct linkage to the upland source area identified during this investigation.

12.3 Wood Debris Occurrence and Distribution

Wood waste was observed in 100 percent of the sediment core samples taken to quantify wood debris. In addition, large wood fragments and wood debris were found in all subtidal sediment samples. All intertidal sediment samples had small amounts of wood organic debris (less than 10 percent). The highest accumulations of wood waste were observed near the northwest boundary of the DNR lease with adjacent property owned by Dunlap Towing Company (greater than 25 percent wood waste).

Wood waste appears to be present throughout the DNR leased area at Westbay Marina. TVS/TOC ratios provide an indication of the presence of organic loading. The ratio found in Westbay Marina (greater than 2) indicates the presence of labile organic matter such as wood debris that is available for chemical or microbial breakdown, thus resulting in anaerobic conditions. The highest TVS/TOC ratios were found adjacent to the Dunlap Towing Company boundary.

12.4 Benthic Organism Survey Conclusions

All sediment samples contained invertebrates. The benthic infauna samples contained a variety of organisms that can be found in both aerobic and anaerobic environments including nematodes, polychaetes, oligochaetes, bivalves, gastropods, and arthropods. The most abundant organisms were polychaetes and oligochaetes, both in subtidal and intertidal samples.

The subtidal benthic infauna samples had less than one-third the number of organisms observed in the intertidal samples. Taxa that were relatively common in intertidal samples, including nematodes, gastropods, bivalves, and arthropods were rare or absent in subtidal samples. By contract, subtidal samples contained only one taxon not present in intertidal samples, and that taxon, oligochaetes, can be an indicator of poor sediment conditions. The lack of diversity in the subtidal samples may be due to the abundance of fine sediment compared to the more sandy intertidal conditions. Alternately, it may indicate an anaerobic environment due to abundant wood debris in the subtidal areas.

13.0 LIMITATIONS

Work for this project was performed, and this report prepared, in general accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of the Washington State Department of Ecology for specific application to the Westbay Marina property. This report is not meant to represent a legal opinion. No other warranty, express or implied, is made.

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Table 1 - Sediment Sample Testing Summary

Sample Number	ARI Job No.	SMS Metals [a]	SMS SVOCs	PAHs	PCBs	HCB and HCBD [b]	Tributyltin (Bulk)	Tributyl Tin (Porewater)	Ammonia (Porewater)	Sulfides (Porewater)	NWTPH-Gx	NWTPH-Dx	Dioxins/Furans	Total Solids	TVS	TOC	Grain Size	Ammonia	Total Cu and Ni	Dissolved Cu and Ni
Upland Surface Soil Samples																				
HC-WB-US-001													X	X						
HC-WB-US-002													X	X						
HC-WB-US-003													X	X						
HC-WB-US-004													X	X						
Intertidal Surface Sediment Samples																				
HC-WB-SS-001		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X			
HC-WB-SS-002		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X			
HC-WB-SS-003		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
HC-WB-SS-004		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Subtidal Surface Sediment Samples																				
HC-WB-SS-005		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X			
HC-WB-SS-006		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X			
HC-WB-SS-007		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X			
HC-WB-SS-008		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X			
Groundwater Samples																				
HC-WB-MW-01																		X	X	X
HC-WB-MW-04																		X	X	X

a Metals analysis include the SMS Metals: arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc.
b HCB = hexachlorobenzene; HCBD = hexachlorobutadiene by EPA Method 8081.

Table 2 - Analytical Results and TCDD TEQs for Upland Soil Samples

Sample ID	MTCA	HC-WB-US-001	HC-WB-US-002	HC-WB-US-003	HC-WB-US-004
Sampling Date	Method B	3/24/2011	3/24/2011	3/24/2011	3/24/2011
SDG	Criteria	SO75	SO75	SO75	SO75
Conventionals in %					
Total Solids		45.4	74.9	74.1	72
Dioxins in pg/g					
2,3,7,8-TCDD		1.03 UK	0.549 UK	0.201 UK	0.285 UK
1,2,3,7,8-PeCDD		10.9	2.01 T	1.64 T	1.48 T
1,2,3,4,7,8-HxCDD		19.3	2.77 T	2.2 T	2.19 T
1,2,3,6,7,8-HxCDD		120	31.9	8.1	8.6
1,2,3,7,8,9-HxCDD		42.9	7.93	5.38	4.99
1,2,3,4,6,7,8-HpCDD		2910	654	142	199
OCDD		17800	3970	1050	1380
2,3,7,8-TCDF		7.36	0.974 T	0.491 T	0.631 T
1,2,3,7,8-PeCDF		9.72	1.51 T	0.543 T	0.496 T
2,3,4,7,8-PeCDF		9.66	1.64 T	0.533 T	0.612 T
1,2,3,6,7,8-HxCDF		27.7	4.24 T	1.65 T	1.38 T
1,2,3,7,8,9-HxCDF		6.87	2.71 T	0.376 T	0.383 UK
1,2,3,4,7,8-HxCDF		25.9	6.12	1.13 T	1.59 T
2,3,4,6,7,8-HxCDF		36.4	7.11	1.94 T	1.89 T
1,2,3,4,6,7,8-HpCDF		852	431	27.4	59.3
1,2,3,4,7,8,9-HpCDF		35.8	7.83	1.41 T	3.15 T
OCDF		3370	656	80.8	291
Total TCDD		39	15.8	3.68	4.8
Total PeCDD		113	9.88	10.4	12.1
Total HxCDD		776	324	52.3	54.4
Total HpCDD		6540	1170	284	378
Total TCDF		129	15.9	10.6	13.1
Total PeCDF		223	36.1	12.4	13.5
Total HxCDF		943	249	35.5	51.3
Total HpCDF		2830	962	75.4	218
TEQ (Detects only)	11	87.06	21.24	5.99	6.94
TEQ (1/2 ND)	11	87.58	21.51	6.09	7.08

Notes:
Boxed value exceeds MTCA Method B unrestricted use or direct contact criteria
U = Not detected at the reporting limit indicated.
K = Ion ratios do not meet identification criteria acceptance limits for positive identification
T = Value is between the MDL and MRL

Table 3 - Analytical Results for Groundwater Samples

Sample ID	Groundwater	Marine MTCA	HC-WB-MW-01	HC-WB-MW-04
Sampling Date	MTCA Method B	Surface Water	3/28/2011	3/30/2011
SDG	Criteria[a]	Criteria [e]	SP18	SP76
Conventionals in mg/L				
N-Ammonia	0.458[d]	2.92[b]	0.134	0.100 U
Dissolved Metals in ug/L				
Copper	640	2.4[c]	3.0	3.0
Nickel	320	8.2[c]	7.0	6.0
Total Metals in ug/L				
Copper	590	2.4[c]	4.0	3.0
Nickel	320	8.2[c]	6.0	6.0

Notes:
U = Not detected at the reporting limit indicated.
[a] Based on drinking water use per CLARC.
[b] Marine chronic criteria per Chapter 173-201A WAC per CLARC. Criterion based on unionized ammonia value of 0.035 mg/L which is 1.2% of total ammonia. Criterion presented has been converted to total ammonia assuming a temperature of 50 degrees F and pH of 7.8.
[c] Marine chronic criteria per 40CFR131 (National Toxics Rule) per CLARC.
[d] Based on input parameters from EPA Region 3 and the MTCA Method B calculation formula.
[e] Based on the most stringent criterion in CLARC.

Table 4 - Analytical Results for Intertidal Sediment Samples Compared to AET Dry-Weight Sediment Quality Values

Sample ID	AET		HC-WB-SS-001	HC-WB-SS-002	HC-WB-SS-003	HC-WB-SS-004
Sampling Date	LAET	2LAET	4/18/2011	3/24/2011	3/24/2011	3/24/2011
SDG			SS32	SO75	SO75	SO75
Conventionals in %						
Total Solids			63.60	56.2	56.4	71.4
Total Volatile Solids			5.37	5.42	4.97	4.51
Total Organic Carbon			2.09	2.59	1.87	2.7
TPH in mg/kg						
Diesel Range Organics			21	40	5.8 T	36
Lube Oil			170	410	14 T	290
Gasoline Range Organics			10 U	37	19 U	12 U
Metals in mg/kg						
Arsenic	57	93	9.6	32 U	24 U	7.4 U
Cadmium	5.1	6.7	0.8	1 U	0.9 U	0.5
Chromium	260	270	22.2	19	15	20.3
Copper	390	390	308	65	53	43.4
Lead	450	530	23	10 U	9 U	5
Silver	6.1	6.1	0.4 U	2 U	1 U	0.4 U
Zinc	410	960	83	274	77	55
Mercury	0.41	0.59	0.07	0.06	0.09	0.04
TBT in ug/kg						
Butyltin			180	7.6 J	4.4 J	110 J
Dibutyltin Ion			1800	43	14	390
Tributyltin Ion			2000	130	7.7	740
PCBs/Pesticides in ug/kg						
Aroclor 1016			9.8 U	9.8 U	9.7 U	9.7 U
Aroclor 1221			9.8 U	9.8 U	9.7 U	9.7 U
Aroclor 1232			9.8 U	9.8 U	9.7 U	9.7 U
Aroclor 1242			9.8 U	9.8 U	9.7 U	9.7 U
Aroclor 1248			9.8 U	9.8 U	9.7 U	9.7 U
Aroclor 1254			17	4.4 T	2.8 T	3.1 T
Aroclor 1260			9.8 U	9.8 U	9.7 U	9.7 U
Aroclor 1262			9.8 U	9.8 U	9.7 U	9.7 U
Aroclor 1268			9.8 U	9.8 U	9.7 U	9.7 U
Total PCBs	130	1000	17	4.4 J	2.8 J	3.1 J
Hexachlorobenzene	22	70	0.98 U	1.2 U	1.2 U	1.2 U
Hexachlorobutadiene	11	120	0.98 U	1.2 U	1.2 U	1.2 U
LPAHs in ug/kg						
1-Methylnaphthalene			2.6 U	7.9 U	2.6 U	2.6 U
2-Methylnaphthalene	670	1400	3 U	8.9 U	2.9 U	12 T
Acenaphthene	500	730	3.3 UJ	9.7 U	3.2 U	3.2 U
Acenaphthylene	1300	1300	3 U	8.9 U	2.9 U	2.9 U
Anthracene	960	4400	22	120	37	30
Fluorene	540	1000	3.5 U	30 T	3.4 U	3.5 U
Naphthalene	2100	2400	18 T	8 U	9.9 T	19 T
Phenanthrene	1500	5400	140	220	52	400
Total LPAHs*	5200	13000	180 J	370 J	99 J	450 J

Table 4 - Analytical Results for Intertidal Sediment Samples Compared to AET Dry-Weight Sediment Quality Values

Sample ID	AET		HC-WB-SS-001	HC-WB-SS-002	HC-WB-SS-003	HC-WB-SS-004
Sampling Date	LAET	2LAET	4/18/2011	3/24/2011	3/24/2011	3/24/2011
SDG			SS32	SO75	SO75	SO75
HPAHs in ug/kg						
Benzo(a)anthracene	1300	1600	42	200	77	57
Benzo(a)pyrene	1600	3000	39	130	87	57
Total Benzofluoranthenes	3200	3600	110	300	210	210
Benzo(g,h,i)perylene	670	720	25	120	59	21
Chrysene	1400	2800	90	420	180	230
Dibenz(a,h)anthracene	230	540	4.5 U	42 T	25	11 T
Fluoranthene	1700	2500	290	460	200	710
Indeno(1,2,3-cd)pyrene	600	690	25	74	58	22
Pyrene	2600	3300	170	270	170	450
Total HPAHs*	12000	17000	790	2000 J	1100	1800 J
Chlorinated Benzenes in ug/kg						
1,2,4-Trichlorobenzene	31	51	3.7 U	11 U	3.7 U	3.7 U
1,2-Dichlorobenzene	35	50	2.9 U	8.7 U	2.9 U	2.9 U
1,3-Dichlorobenzene	170	170	2.6 U	7.9 U	2.6 U	2.6 U
1,4-Dichlorobenzene	110	120	2.7 U	8 U	2.6 U	2.7 U
Hexachlorobenzene	22	70	3.3 U	10 U	3.3 U	3.3 U
Phthalate Esters in ug/kg						
bis(2-Ethylhexyl)phthalate	1300	1900	88 UJ	88	16 T	32
Butylbenzylphthalate	63	900	4.1 U	12 U	4 U	74
Diethylphthalate	200	200	3.7 UJ	11 U	3.6 U	14 T
Dimethylphthalate	71	160	29	11 U	3.6 U	33
Di-n-Butylphthalate	1400	1400	4.6 U	14 U	4.5 U	200
Di-n-Octyl phthalate	6200	6200	5.1 UJ	15 U	5.1 U	5.1 U
Ionizable Organic Compounds in ug/kg						
2,4-Dimethylphenol	29	29	7.9 UJ	24 U	7.7 U	7.8 U
2-Methylphenol	63	63	5.3 U	16 U	5.2 U	5.2 U
4-Methylphenol	670	670	4.7 U	14 U	4.7 U	4.7 U
Pentachlorophenol	360	690	27 U	81 U	27 U	27 U
Phenol	420	1200	3.7 U	11 U	3.7 U	150
Benzoic Acid	650	650	84 T	130 T	50 T	46 T
Benzyl Alcohol	57	73	45 U	*140 U*	45 U	45 U
Miscellaneous Compounds in ug/kg						
Dibenzofuran	540	700	3.1 U	9.3 U	3.1 U	28
Hexachlorobutadiene	11	120	2.9 U	8.6 U	2.8 U	2.8 U
Hexachloroethane			4.8 U	14 U	4.7 U	4.8 U
N-Nitrosodiphenylamine	28	40	13 U	*38 U*	12 U	13 U
LPAHs (SIM) in ug/kg						
1-Methylnaphthalene			1.3 U	7	5.2	3.8 T
2-Methylnaphthalene	670	1400	2.1 U	4.5 T	10	2 U
Acenaphthene	500	730	22	9.9	3.9 T	4.2 T
Acenaphthylene	1300	1300	1.4 U	8.2	11	4.8
Anthracene	960	4400	61	56	250	14
Fluorene	540	1000	36	20	40	5.2

Table 4 - Analytical Results for Intertidal Sediment Samples Compared to AET Dry-Weight Sediment Quality Values

Sample ID	AET		HC-WB-SS-001	HC-WB-SS-002	HC-WB-SS-003	HC-WB-SS-004
Sampling Date	LAET	2LAET	4/18/2011	3/24/2011	3/24/2011	3/24/2011
SDG			SS32	SO75	SO75	SO75
Naphthalene	2100	2400	15	4.9	6.2	2.6 T
Phenanthrene	1500	5400	390 J	150	110	60
Total LPAHs*	5200	13000	520 J	250	420 J	91 J
HPAHs (SIM) in ug/kg						
Benzo(a)anthracene	1300	1600	120	170	130	40
Benzo(a)pyrene	1600	3000	94	120	150	47
Total Benzofluoranthenes	3200	3600	280	280	370	180
Benzo(g,h,i)perylene	670	720	50	60	92	20
Chrysene	1400	2800	220 J	320	270	130
Dibenz(a,h)anthracene	230	540	15	18	29	2.6 T
Fluoranthene	1700	2500	640 J	370	310	240
Indeno(1,2,3-cd)pyrene	600	690	41	53	85	16
Pyrene	2600	3300	590	340	330	360
Total HPAHs*	12000	17000	2100 J	1700	1800	1000 J
Misc. Compounds (SIM) in ug/kg						
Dibenzofuran	540	700	33	10	14	3.4 T

Notes:
Blank indicates no LAET/2LAET established for specific analyte.
Boxed value exceeds LAET.
Italics indicate reporting limit above LAET.
U = Not detected at the reporting limit indicated.
J = Estimated value.
T = Value is between the MDL and MRL.
*Summed values have been rounded to two significant figures.

Table 5 - Analytical Results for Intertidal Sediment Samples Compared to SMS Sediment Quality Criteria

Sample ID	SMS		HC-WB-SS-001	HC-WB-SS-002	HC-WB-SS-003	HC-WB-SS-004
Sampling Date	SQS	CSL	4/18/2011	3/24/2011	3/24/2011	3/24/2011
SDG			SS32	SO75	SO75	SO75
Conventionals in %						
Total Solids			63.60	56.2	56.4	71.4
Total Volatile Solids			5.37	5.42	4.97	4.51
Total Organic Carbon			2.09	2.59	1.87	2.7
TPH in mg/kg						
Diesel Range Organics			21	40	5.8 T	36
Lube Oil			170	410	14 T	290
Gasoline Range Organics			10 U	37	19 U	12 U
Metals in mg/kg						
Arsenic	57	93	9.6	32 U	24 U	7.4 U
Cadmium	5.1	6.7	0.8	1 U	0.9 U	0.5
Chromium	260	270	22.2	19	15	20.3
Copper	390	390	308	65	53	43.4
Lead	450	530	23	10 U	9 U	5
Silver	6.1	6.1	0.4 U	2 U	1 U	0.4 U
Zinc	410	960	83	274	77	55
Mercury	0.41	0.59	0.07	0.06	0.09	0.04
TBT in ug/kg						
Butyltin			180	7.6 J	4.4 J	110 J
Dibutyltin Ion			1800	43	14	390
Tributyltin Ion			2000	130	7.7	740
PCBs/Pesticides in mg/kg OC						
Aroclor 1016			0.47 U	0.38 U	0.52 U	0.36 U
Aroclor 1221			0.47 U	0.38 U	0.52 U	0.36 U
Aroclor 1232			0.47 U	0.38 U	0.52 U	0.36 U
Aroclor 1242			0.47 U	0.38 U	0.52 U	0.36 U
Aroclor 1248			0.47 U	0.38 U	0.52 U	0.36 U
Aroclor 1254			0.81	0.17 T	0.15 T	0.11 T
Aroclor 1260			0.47 U	0.38 U	0.52 U	0.36 U
Aroclor 1262			0.47 U	0.38 U	0.52 U	0.36 U
Aroclor 1268			0.47 U	0.38 U	0.52 U	0.36 U
Total PCBs	12	65	0.81	0.17 J	0.15 J	0.11 J
Hexachlorobenzene	0.38	2.3	0.05 U	0.05 U	0.06 U	0.04 U
Hexachlorobutadiene	3.9	6.2	0.05 U	0.05 U	0.06 U	0.04 U
LPAHs in mg/kg OC						
1-Methylnaphthalene			0.12 U	0.31 U	0.14 U	0.10 U
2-Methylnaphthalene	38	64	0.14 U	0.34 U	0.16 U	0.44 T
Acenaphthene	16	57	0.16 UJ	0.37 U	0.17 U	0.12 U
Acenaphthylene	66	66	0.14 U	0.34 U	0.16 U	0.11 U
Anthracene	220	1200	1.05	4.63	1.98	1.11
Fluorene	23	79	0.17 U	1.16 T	0.18 U	0.13 U
Naphthalene	99	170	0.86 T	0.31 U	0.53 T	0.70 T
Phenanthrene	100	480	6.70	8.49	2.78	14.81
Total LPAHs*	370	780	8.6 J	14 J	5.3 J	17 J

Table 5 - Analytical Results for Intertidal Sediment Samples Compared to SMS Sediment Quality Criteria

Sample ID	SMS		HC-WB-SS-001	HC-WB-SS-002	HC-WB-SS-003	HC-WB-SS-004
Sampling Date	SQS	CSL	4/18/2011	3/24/2011	3/24/2011	3/24/2011
SDG			SS32	SO75	SO75	SO75
HPAHs in mg/kg OC						
Benzo(a)anthracene	110	270	2.01	7.72	4.12	2.11
Benzo(a)pyrene	99	210	1.87	5.02	4.65	2.11
Total Benzofluoranthenes	230	450	5.26	11.58	11.23	7.78
Benzo(g,h,i)perylene	31	78	1.20	4.63	3.16	0.78
Chrysene	110	460	4.31	16.22	9.63	8.52
Dibenz(a,h)anthracene	12	33	0.22 U	1.62 T	1.34	0.41 T
Fluoranthene	160	1200	13.88	17.76	10.70	26.30
Indeno(1,2,3-cd)pyrene	34	88	1.20	2.86	3.10	0.81
Pyrene	1000	1400	8.13	10.42	9.09	16.67
Total HPAHs*	960	5300	38	78 J	57	65 J
Chlorinated Benzenes in mg/kg OC						
1,2,4-Trichlorobenzene	0.81	1.8	0.18 U	0.42 U	0.20 U	0.14 U
1,2-Dichlorobenzene	2.3	2.3	0.14 U	0.34 U	0.16 U	0.11 U
1,3-Dichlorobenzene			0.12 U	0.31 U	0.14 U	0.10 U
1,4-Dichlorobenzene	3.1	9	0.13 U	0.31 U	0.14 U	0.10 U
Hexachlorobenzene	0.38	2.3	0.16 U	*0.39 U*	0.18 U	0.12 U
Phthalate Esters in mg/kg OC						
bis(2-Ethylhexyl)phthalate	47	78	4.21 UJ	3.40	0.86 T	1.19
Butylbenzylphthalate	4.9	64	0.20 U	0.46 U	0.21 U	2.74
Diethylphthalate	61	110	0.18 UJ	0.42 U	0.19 U	0.52 T
Dimethylphthalate	53	53	1.39	0.42 U	0.19 U	1.22
Di-n-Butylphthalate	220	1700	0.22 U	0.54 U	0.24 U	7.41
Di-n-Octyl phthalate	58	4500	0.24 UJ	0.58 U	0.27 U	0.19 U
Ionizable Organic Compounds in ug/kg						
2,4-Dimethylphenol	29	29	7.9 UJ	24 U	7.7 U	7.8 U
2-Methylphenol	63	63	5.3 U	16 U	5.2 U	5.2 U
4-Methylphenol	670	670	4.7 U	14 U	4.7 U	4.7 U
Pentachlorophenol	360	690	27 U	81 U	27 U	27 U
Phenol	420	1200	3.7 U	11 U	3.7 U	150
Benzoic Acid	650	650	84 T	130 T	50 T	46 T
Benzyl Alcohol	57	73	45 U	*140 U*	45 U	45 U
Miscellaneous Compounds in mg/kg OC						
Dibenzofuran	15	58	0.15 U	0.36 U	0.17 U	1.04
Hexachlorobutadiene	3.9	6.2	0.14 U	0.33 U	0.15 U	0.10 U
Hexachloroethane			0.23 U	0.54 U	0.25 U	0.18 U
N-Nitrosodiphenylamine	11	11	0.62 U	1.47 U	0.64 U	0.48 U
LPAHs (SIM) in mg/kg OC						
1-Methylnaphthalene			0.06 U	0.27	0.28	0.14 T
2-Methylnaphthalene	38	64	0.10 U	0.17 T	0.53	0.07 U
Acenaphthene	16	57	1.05	0.38	0.21 T	0.16 T
Acenaphthylene	66	66	0.07 U	0.32	0.59	0.18
Anthracene	220	1200	2.92	2.16	13.37	0.52
Fluorene	23	79	1.72	0.77	2.14	0.19

Table 5 - Analytical Results for Intertidal Sediment Samples Compared to SMS Sediment Quality Criteria

Sample ID	SMS		HC-WB-SS-001	HC-WB-SS-002	HC-WB-SS-003	HC-WB-SS-004
Sampling Date	SQS	CSL	4/18/2011	3/24/2011	3/24/2011	3/24/2011
SDG			SS32	SO75	SO75	SO75
Naphthalene	99	170	0.72	0.19	0.33	0.10 T
Phenanthrene	100	480	18.66 J	5.79	5.88	2.22
Total LPAHs*	370	780	25 J	9.6	23 J	3.4 J
HPAHs (SIM) in mg/kg OC						
Benzo(a)anthracene	110	270	5.74	6.56	6.95	1.48
Benzo(a)pyrene	99	210	4.50	4.63	8.02	1.74
Total Benzofluoranthenes	230	450	13.40	10.81	19.79	6.67
Benzo(g,h,i)perylene	31	78	2.39	2.32	4.92	0.74
Chrysene	110	460	10.53 J	12.36	14.44	4.81
Dibenz(a,h)anthracene	12	33	0.72	0.69	1.55	0.10 T
Fluoranthene	160	1200	30.62 J	14.29	16.58	8.89
Indeno(1,2,3-cd)pyrene	34	88	1.96	2.05	4.55	0.59
Pyrene	1000	1400	28.23	13.13	17.65	13.33
Total HPAHs*	960	5300	98 J	67	94	38 J
Misc. Compounds (SIM) in mg/kg OC						
Dibenzofuran	540		1.58	0.39	0.75	0.13 T

Notes:
Blank indicates no SQS/CSL established for specific analyte.
Italics indicate reporting limit above SQS.
U = Not detected at the reporting limit indicated.
J = Estimated value.
T = Value is between the MDL and MRL.
*Summed values have been rounded to two significant figures.

Table 6 - Analytical Results and TCDD TEQs for Intertidal Sediment Samples

Sample ID	HC-WB-SS-003		HC-WB-SS-004	
Sampling Date	3/24/2011		3/24/2011	
SDG	SO75		SO75	
Dioxins in pg/g				
2,3,7,8-TCDD	0.233	UK	0.24	UK
1,2,3,7,8-PeCDD	2.26	T	2.29	T
1,2,3,4,7,8-HxCDD	3.71	T	4.46	T
1,2,3,6,7,8-HxCDD	20.8		14.6	
1,2,3,7,8,9-HxCDD	6.53		6.88	
1,2,3,4,6,7,8-HpCDD	418		340	
OCDD	3030		3010	
2,3,7,8-TCDF	1.03		0.825	T
1,2,3,7,8-PeCDF	1.45	T	0.878	T
2,3,4,7,8-PeCDF	1.45	T	0.839	T
1,2,3,6,7,8-HxCDF	2.77	T	1.78	T
1,2,3,7,8,9-HxCDF	1.49	T	0.646	UK
1,2,3,4,7,8-HxCDF	4.93		2.58	T
2,3,4,6,7,8-HxCDF	2.78	T	2.65	T
1,2,3,4,6,7,8-HpCDF	82.5		42.5	
1,2,3,4,7,8,9-HpCDF	3	T	1.78	T
OCDF	84.9		45.6	
Total TCDD	7.64		6.73	
Total PeCDD	19.1		21.7	
Total HxCDD	163		163	
Total HpCDD	1230		1050	
Total TCDF	10.3		10.4	
Total PeCDF	31.2		22.3	
Total HxCDF	150		74	
Total HpCDF	384		105	
TEQ (Detects only)	13.09		10.72	
TEQ (1/2 ND)	13.20		10.84	

Notes:
See Section 11.3 in text for an evaluation of cleanup levels in sediments.
Boxed value exceeds MTCA Method B criteria.
U = Not detected at the reporting limit indicated.
K = Ion ratios do not meet identification criteria acceptance limits for positive identification.
T = Value is between the MDL and MRL.

Table 7 - Analytical Results for Intertidal Porewater Samples

Sample ID	HC-WB-SS-001	HC-WB-SS-002	HC-WB-SS-003	HC-WB-SS-004
Sampling Date	4/19/2011	3/28/2011	3/28/2011	3/28/2011
SDG	SS54	SP01	SP01	SP01
Conventionals in mg/L				
Ammonia (NH3) as Nitrogen (N)	4.61	6.01	2.83	2.39
Sulfide	0.050 U	0.061	0.067	0.05 U
TBT in ug/L				
Butyltin	0.084 J	0.007 U	0.007 U	0.015 U
Dibutyltin Ion	0.024	0.008 U	0.01	0.017
Tributyltin Ion	0.048	0.016	0.014	0.055

Notes:
See Section 11.3 in text for an evaluation of cleanup levels in sediments.
U = Not detected at the reporting limit indicated.
J = Estimated value.

Table 8 - Analytical Results for Subtidal Sediment Samples Compared to AET Dry-Weight Sediment Quality Values

Sample ID	AET		HC-WB-SS-005	HC-WB-SS-006	HC-WB-SS-007	HC-WB-SS-008
Sampling Date	LAET	2LAET	3/30/2011	3/30/2011	3/30/2011	3/30/2011
SDG			SP69	SP69	SP69	SP69
Conventionals in %						
Total Solids			30	31	33.3	32.4
Total Volatile Solids			22.27	16.17	14.1	12.97
Total Organic Carbon			7.75	5.25	5.22	4.95
TPH in mg/kg						
Diesel Range Organics			20	15 U	15 U	15 U
Lube Oil			64	30 U	30 U	47
Gasoline Range Organics			38 UJ	38 UJ	35 UJ	35 UJ
Metals in mg/kg						
Arsenic	57	93	16 U	17	16	16
Cadmium	5.1	6.7	2.9	3.8	3.8	3.7
Chromium	260	270	32	39	40	40
Copper	390	390	90.3	99.8	97.7	91.1
Lead	450	530	12	16	16	19
Silver	6.1	6.1	1 U	0.9 U	0.9 U	0.9 U
Zinc	410	960	119	134	136	135
Mercury	0.41	0.59	0.09	0.12	0.15	0.18
TBT in ug/kg						
Butyltin			4 U	3.9 U	4 U	4 U
Dibutyltin Ion			3.2 T	5.6 U	5.6 U	3.5 T
Tributyltin Ion			4.2	2.3 T	6.9	3.3 T
PCBs/Pesticides in ug/kg						
Aroclor 1016			9.9 U	99 U	9.9 U	9.9 U
Aroclor 1221			9.9 U	99 U	9.9 U	9.9 U
Aroclor 1232			9.9 U	99 U	9.9 U	9.9 U
Aroclor 1242			9.9 U	99 U	9.9 U	9.9 U
Aroclor 1248			9.9 U	200 U	9.9 U	14
Aroclor 1254			9.9 U	1100	9.9 U	14
Aroclor 1260			9.9 U	140 U	9.9 U	9.9 U
Aroclor 1262			9.9 U	99 U	9.9 U	9.9 U
Aroclor 1268			9.9 U	99 U	9.9 U	9.9 U
Total PCBs	130	1000	9.9 U	1100	9.9 U	28
Hexachlorobenzene	22	70	1.2 U	1.2 U	1.2 U	1.2 U
Hexachlorobutadiene	11	120	1.2 U	1.2 U	1.2 U	1.2 U
LPAHs in ug/kg						
1-Methylnaphthalene			5.3 U	5.3 U	5.3 U	5.3 U
2-Methylnaphthalene	670	1400	5.9 U	5.9 U	5.9 U	6 U
Acenaphthene	500	730	6.5 U	6.5 U	23 T	6.6 U
Acenaphthylene	1300	1300	5.9 U	21 T	61	6 U
Anthracene	960	4400	50	69	110	39 T
Fluorene	540	1000	22 T	20 T	34 T	7.1 U
Naphthalene	2100	2400	22 T	26 T	23 T	5.4 U
Phenanthrene	1500	5400	150	120	860	110
Total LPAHs*	5200	13000	240 J	260 J	1100 J	150 J

Table 8 - Analytical Results for Subtidal Sediment Samples Compared to AET Dry-Weight Sediment Quality Values

Sample ID	AET		HC-WB-SS-005	HC-WB-SS-006	HC-WB-SS-007	HC-WB-SS-008
Sampling Date	LAET	2LAET	3/30/2011	3/30/2011	3/30/2011	3/30/2011
SDG			SP69	SP69	SP69	SP69
HPAHs in ug/kg						
Benzo(a)anthracene	1300	1600	75	190	230	92
Benzo(a)pyrene	1600	3000	89	130	170	83
Total Benzofluoranthenes	3200	3600	260	340	700	270
Benzo(g,h,i)perylene	670	720	51	62	93	43
Chrysene	1400	2800	300	420	740	280
Dibenz(a,h)anthracene	230	540	24 T	24 T	38 T	21 T
Fluoranthene	1700	2500	760	720	3200	520
Indeno(1,2,3-cd)pyrene	600	690	47	56	97	45
Pyrene	2600	3300	330	380	1500	330
Total HPAHs*	12000	17000	1900 J	2300 J	6800 J	1700 J
Chlorinated Benzenes in ug/kg						
1,2,4-Trichlorobenzene	31	51	7.5 U	7.5 U	7.5 U	7.5 U
1,2-Dichlorobenzene	35	50	5.9 U	5.8 U	5.9 U	5.9 U
1,3-Dichlorobenzene	170	170	5.3 U	5.2 U	5.3 U	5.3 U
1,4-Dichlorobenzene	110	120	5.4 U	5.4 U	5.4 U	5.4 U
Hexachlorobenzene	22	70	6.7 U	6.7 U	6.7 U	6.7 U
Phthalate Esters in ug/kg						
bis(2-Ethylhexyl)phthalate	1300	1900	58	48	50	35 T
Butylbenzylphthalate	63	900	8.1 U	120	8.2 U	8.2 U
Diethylphthalate	200	200	7.4 UJ	7.4 UJ	7.4 UJ	7.5 UJ
Dimethylphthalate	71	160	7.4 U	7.3 U	7.4 U	7.4 U
Di-n-Butylphthalate	1400	1400	9.3 U	9.2 U	9.3 U	9.3 U
Di-n-Octyl phthalate	6200	6200	10 U	10 U	10 U	10 U
Ionizable Organic Compounds in ug/kg						
2,4-Dimethylphenol	29	29	16 U	16 U	16 U	16 U
2-Methylphenol	63	63	11 U	11 U	11 U	11 U
4-Methylphenol	670	670	98	83	66	50
Pentachlorophenol	360	690	54 U	54 U	54 U	54 U
Phenol	420	1200	56	40	32 T	7.5 U
Benzoic Acid	650	650	230 T	160 T	94 T	85 U
Benzyl Alcohol	57	73	*91 U*	*91 U*	*91 U*	*91 U*
Miscellaneous Compounds in ug/kg						
Dibenzofuran	540	700	6.2 U	6.2 U	24 T	6.3 U
Hexachlorobutadiene	11	120	5.7 U	5.7 U	5.7 U	5.8 U
Hexachloroethane			9.7 U	9.6 U	9.7 U	9.7 U
N-Nitrosodiphenylamine	28	40	25 U	25 U	25 U	25 U
LPAHs (SIM) in ug/kg						
1-Methylnaphthalene			9.1	13	16	12
2-Methylnaphthalene	670	1400	4.3 T	10	12	7.1
Acenaphthene	500	730	8.7	23	12	14
Acenaphthylene	1300	1300	11	14	20	27
Anthracene	960	4400	37	47	86	81
Fluorene	540	1000	16	30	26	29

Table 8 - Analytical Results for Subtidal Sediment Samples Compared to AET Dry-Weight Sediment Quality Values

Sample ID	AET		HC-WB-SS-005	HC-WB-SS-006	HC-WB-SS-007	HC-WB-SS-008
Sampling Date	LAET	2LAET	3/30/2011	3/30/2011	3/30/2011	3/30/2011
SDG			SP69	SP69	SP69	SP69
Naphthalene	2100	2400	5.3	9.4	10	5.8
Phenanthrene	1500	5400	110 J	280	290	420
Total LPAHs*	5200	13000	190 J	400	440	580
HPAHs (SIM) in ug/kg						
Benzo(a)anthracene	1300	1600	150	160	300	200
Benzo(a)pyrene	1600	3000	100	130	200	210
Total Benzofluoranthenes	3200	3600	310	360	570	640
Benzo(g,h,i)perylene	670	720	49	58	87	98
Chrysene	1400	2800	570	320	500	580
Dibenz(a,h)anthracene	230	540	15	21	29	31
Fluoranthene	1700	2500	610	540	990	850
Indeno(1,2,3-cd)pyrene	600	690	44	54	82	93
Pyrene	2600	3300	450	440	820	780
Total HPAHs*	12000	17000	2300	2100	3600	3500
Misc. Compounds (SIM) in ug/kg						
Dibenzofuran	540	700	8.3	22	25	14

Notes:
Blank indicates no LAET/2LAET established for specific analyte.
Boxed value exceeds LAET.
Italics indicate reporting limit above LAET.
U = Not detected at the reporting limit indicated.
J = Estimated value.
T = Value is between the MDL and MRL.
*Summed values have been rounded to two significant figures.

Table 9 - Analytical Results for Subtidal Sediment Samples Compared to SMS Sediment Quality Criteria

Sample ID	SMS		HC-WB-SS-005	HC-WB-SS-006	HC-WB-SS-007	HC-WB-SS-008
Sampling Date	SQS	CSL	3/30/2011 (a)	3/30/2011 (a)	3/30/2011 (a)	3/30/2011 (a)
SDG			SP69	SP69	SP69	SP69
Conventionals in %						
Total Solids			30	31	33.3	32.4
Total Volatile Solids			22.27	16.17	14.1	12.97
Total Organic Carbon			7.75	5.25	5.22	4.95
TPH in mg/kg						
Diesel Range Organics			20	15 U	15 U	15 U
Lube Oil			64	30 U	30 U	47
Gasoline Range Organics			38 UJ	38 UJ	35 UJ	35 UJ
Metals in mg/kg						
Arsenic	57	93	16 U	17	16	16
Cadmium	5.1	6.7	2.9	3.8	3.8	3.7
Chromium	260	270	32	39	40	40
Copper	390	390	90.3	99.8	97.7	91.1
Lead	450	530	12	16	16	19
Silver	6.1	6.1	1 U	0.9 U	0.9 U	0.9 U
Zinc	410	960	119	134	136	135
Mercury	0.41	0.59	0.09	0.12	0.15	0.18
TBT in ug/kg						
Butyltin			4 U	3.9 U	4 U	4 U
Dibutyltin Ion			3.2 T	5.6 U	5.6 U	3.5 T
Tributyltin Ion			4.2	2.3 T	6.9	3.3 T
PCBs/Pesticides in mg/kg OC						
Aroclor 1016			0.13 U	1.89 U	0.19 U	0.20 U
Aroclor 1221			0.13 U	1.89 U	0.19 U	0.20 U
Aroclor 1232			0.13 U	1.89 U	0.19 U	0.20 U
Aroclor 1242			0.13 U	1.89 U	0.19 U	0.20 U
Aroclor 1248			0.13 U	3.81 U	0.19 U	0.28
Aroclor 1254			0.13 U	20.95	0.19 U	0.28
Aroclor 1260			0.13 U	2.67 U	0.19 U	0.20 U
Aroclor 1262			0.13 U	1.89 U	0.19 U	0.20 U
Aroclor 1268			0.13 U	1.89 U	0.19 U	0.20 U
Total PCBs	12	65	0.13 U	20.95	0.19 U	0.57
Hexachlorobenzene	0.38	2.3	0.02 U	0.02 U	0.02 U	0.02 U
Hexachlorobutadiene	3.9	6.2	0.02 U	0.02 U	0.02 U	0.02 U
LPAHs in mg/kg OC						
1-Methylnaphthalene			0.07 U	0.10 U	0.10 U	0.11 U
2-Methylnaphthalene	38	64	0.08 U	0.11 U	0.11 U	0.12 U
Acenaphthene	16	57	0.08 U	0.12 U	0.44 T	0.13 U
Acenaphthylene	66	66	0.08 U	0.40 T	1.17	0.12 U
Anthracene	220	1200	0.65	1.31	2.11	0.79 T
Fluorene	23	79	0.28 T	0.38 T	0.65 T	0.14 U
Naphthalene	99	170	0.28 T	0.50 T	0.44 T	0.11 U
Phenanthrene	100	480	1.94	2.29	16.48	2.22
Total LPAHs*	370	780	3.1 J	4.9 J	21 J	3.0 J

Table 9 - Analytical Results for Subtidal Sediment Samples Compared to SMS Sediment Quality Criteria

Sample ID	SMS		HC-WB-SS-005	HC-WB-SS-006	HC-WB-SS-007	HC-WB-SS-008
Sampling Date	SQS	CSL	3/30/2011 (a)	3/30/2011 (a)	3/30/2011 (a)	3/30/2011 (a)
SDG			SP69	SP69	SP69	SP69
HPAHs in mg/kg OC						
Benzo(a)anthracene	110	270	0.97	3.62	4.41	1.86
Benzo(a)pyrene	99	210	1.15	2.48	3.26	1.68
Total Benzofluoranthenes	230	450	3.35	6.48	13.41	5.45
Benzo(g,h,i)perylene	31	78	0.66	1.18	1.78	0.87
Chrysene	110	460	3.87	8.00	14.18	5.66
Dibenz(a,h)anthracene	12	33	0.31 T	0.46 T	0.73 T	0.42 T
Fluoranthene	160	1200	9.81	13.71	61.30	10.51
Indeno(1,2,3-cd)pyrene	34	88	0.61	1.07	1.86	0.91
Pyrene	1000	1400	4.26	7.24	28.74	6.67
Total HPAHs*	960	5300	25 J	44 J	130 J	34 J
Chlorinated Benzenes in mg/kg OC						
1,2,4-Trichlorobenzene	0.81	1.8	0.10 U	0.14 U	0.14 U	0.15 U
1,2-Dichlorobenzene	2.3	2.3	0.08 U	0.11 U	0.11 U	0.12 U
1,3-Dichlorobenzene			0.07 U	0.10 U	0.10 U	0.11 U
1,4-Dichlorobenzene	3.1	9	0.07 U	0.10 U	0.10 U	0.11 U
Hexachlorobenzene	0.38	2.3	0.09 U	0.13 U	0.13 U	0.14 U
Phthalate Esters in mg/kg OC						
bis(2-Ethylhexyl)phthalate	47	78	0.75	0.91	0.96	0.71 T
Butylbenzylphthalate	4.9	64	0.10 U	2.29	0.16 U	0.17 U
Diethylphthalate	61	110	0.10 UJ	0.14 UJ	0.14 UJ	0.15 UJ
Dimethylphthalate	53	53	0.10 U	0.14 U	0.14 U	0.15 U
Di-n-Butylphthalate	220	1700	0.12 U	0.18 U	0.18 U	0.19 U
Di-n-Octyl phthalate	58	4500	0.13 U	0.19 U	0.19 U	0.20 U
Ionizable Organic Compounds in ug/kg						
2,4-Dimethylphenol	29	29	16 U	16 U	16 U	16 U
2-Methylphenol	63	63	11 U	11 U	11 U	11 U
4-Methylphenol	670	670	98	83	66	50
Pentachlorophenol	360	690	54 U	54 U	54 U	54 U
Phenol	420	1200	56	40	32 T	7.5 U
Benzoic Acid	650	650	230 T	160 T	94 T	85 U
Benzyl Alcohol	57	73	*91 U*	*91 U*	*91 U*	*91 U*
Miscellaneous Compounds in mg/kg OC						
Dibenzofuran	15	58	0.08 U	0.12 U	0.46 T	0.13 U
Hexachlorobutadiene	3.9	6.2	0.07 U	0.11 U	0.11 U	0.12 U
Hexachloroethane			0.13 U	0.18 U	0.19 U	0.20 U
N-Nitrosodiphenylamine	11	11	0.32 U	0.48 U	0.48 U	0.51 U
LPAHs (SIM) in ug/kg						
1-Methylnaphthalene			0.12	0.25	0.31	0.24
2-Methylnaphthalene	38	64	0.06 T	0.19	0.23	0.14
Acenaphthene	16	57	0.11	0.44	0.23	0.28
Acenaphthylene	66	66	0.14	0.27	0.38	0.55
Anthracene	220	1200	0.48	0.90	1.65	1.64
Fluorene	23	79	0.21	0.57	0.50	0.59

Table 9 - Analytical Results for Subtidal Sediment Samples Compared to SMS Sediment Quality Criteria

Sample ID	SMS		HC-WB-SS-005	HC-WB-SS-006	HC-WB-SS-007	HC-WB-SS-008
Sampling Date	SQS	CSL	3/30/2011 (a)	3/30/2011 (a)	3/30/2011 (a)	3/30/2011 (a)
SDG			SP69	SP69	SP69	SP69
Naphthalene	99	170	0.07	0.18	0.19	0.12
Phenanthrene	100	480	1.42 J	5.33	5.56	8.48
Total LPAHs*	370	780	2.4 J	7.7	8.5	12
HPAHs (SIM) in ug/kg						
Benzo(a)anthracene	110	270	1.94	3.05	5.75	4.04
Benzo(a)pyrene	99	210	1.29	2.48	3.83	4.24
Total Benzofluoranthenes	230	450	4.00	6.86	10.92	12.93
Benzo(g,h,i)perylene	31	78	0.63	1.10	1.67	1.98
Chrysene	110	460	7.35	6.10	9.58	11.72
Dibenz(a,h)anthracene	12	33	0.19	0.40	0.56	0.63
Fluoranthene	160	1200	7.87	10.29	18.97	17.17
Indeno(1,2,3-cd)pyrene	34	88	0.57	1.03	1.57	1.88
Pyrene	1000	1400	5.81	8.38	15.71	15.76
Total HPAHs*	960	5300	30	40	69	70
Misc. Compounds (SIM) in mg/kg OC						
Dibenzofuran	540		0.11	0.42	0.48	0.28

Notes:
Blank indicates no SQS/CSL established for specific analyte.
Boxed value exceeds SQS.
Italics indicate reporting limit above SQS.
U = Not detected at the reporting limit indicated.
J = Estimated value.
T = Value is between the MDL and MRL.
(a) TOC concentration outside of range (0.5 to 3.5%) for OC normalization.
*Summed values have been rounded to two significant figures.

Table 10 - Analytical Results for Subtidal Porewater Samples

Sample ID	HC-WB-SS-005	HC-WB-SS-006	HC-WB-SS-007	HC-WB-SS-008
Sampling Date	4/4/2011	4/4/2011	4/4/2011	4/4/2011
SDG	SQ26	SQ26	SQ26	SQ26
Conventionals in mg/L				
Ammonia (NH3) as Nitrogen (N)	10.6	4.18	5.33	7.52
Sulfide	5.16	0.05 U	0.05 U	0.05 U
TBT in ug/L				
Butyltin	0.009	0.013	0.007	0.007
Dibutyltin Ion	0.008 U	0.008 U	0.008 U	0.008
Tributyltin Ion	0.005 U	0.005 U	0.005 U	0.005 U

Notes:
U = Not detected at the reporting limit indicated.

Table 11 - Apparent Grain Size for Intertidal and Subtidal Sediment Samples

Sample ID	HC-WB-SS-001	HC-WB-SS-002	HC-WB-SS-003	HC-WB-SS-004	HC-WB-SS-005	HC-WB-SS-006	HC-WB-SS-007	HC-WB-SS-008
Sampling Date	4/18/2011	3/24/2011	3/24/2011	3/24/2011	3/30/2011	3/30/2011	3/30/2011	3/30/2011
SDG	SS32	SO75	SO75	SO75	SP69	SP69	SP69	SP69
Grain Size in %								
Gravel	24.8	46.5	55.5	53.6	6.3	0.4	0.1 U	0.3
Very Coarse Sand	10.1	11.4	12.6	10.3	1.4	2.7	5.2	6.4
Coarse Sand	10.0	5.9	6.5	8.2	1.8	2.3	2.9	3.0
Medium Sand	17.4	6.1	5.2	13.7	3.1	3.2	3.2	2.1
Fine Sand	16.9	4.0	3.7	8.8	6.1	4.7	3.6	2.9
Very Fine Sand	6.8	2.2	1.9	2.2	8.8	6.7	6.2	5.7
Coarse Silt	3.3	6.7	1.6	3.2 U	8.7	8.4	8.9	7.1
Medium Silt	2.1	10.5	5.0	3.2 U	29.9	27.5	15.5	15.2
Fine Silt	1.5	1.3	2.0	3.2 U	13.5	17.7	15.5	15.4
Very Fine Silt	1.6	0.8	1.2	3.2 U	4.9	5.7	12.3	11.1
8-9 Phi Clay	1.3	0.7	1.0	3.2 U	4.1	5.6	8.1	9.6
9-10 Phi Clay	1.2	0.8	1.2	3.2 U	3.1	4.4	6.3	7.1
< 10 Phi Clay	3.0	3.1	2.6	3.2 U	8.3	10.8	12.3	14.1
Total Fines	14.0	24.0	14.7	3.2	72.4	80.1	78.9	79.5

Notes:
U = Not detected at the reporting limit indicated.

Table 12 - Presence and Type of Wood Waste in Sediment Samples

Sample Number	Exploration Type	Total Penetration in Feet	Total Recovery in Feet	Estimated Depth of Wood Waste in Feet [a]	Wood Debris?	Estimated Percent by Volume[b]				Comments
						None	Low (<~10%)	Moderate (10-25%)	High (>25%)	
Surface Sediment (SS)										
HC-WB-SS-001	Grab	NA	NA		Yes		X			Wood fibers observed in grain size analysis
HC-WB-SS-002	Grab	NA	NA		Yes		X			Wood fibers observed in grain size analysis
HC-WB-SS-003	Grab	NA	NA		Yes		X			Wood fibers observed in grain size analysis
HC-WB-SS-004	Grab	NA	NA		Yes		X			Small wood pieces on surface; wood piece below 10 cm at one subsample location
HC-WB-SS-005	Power Grab	NA	NA		Yes				X	Multiple attempts to collect sample due to abundant woody debris
HC-WB-SS-006	Power Grab	NA	NA		Yes			X		Scattered wood fibers
HC-WB-SS-007	Power Grab	NA	NA		Yes		X			Wood fibers observed in grain size analysis
HC-WB-SS-008	Van Veen	NA	NA		Yes		X			Wood fibers observed in grain size analysis
Vibracores - Sediment Core (SC)										
HC-WB-SC-001	Vibracore	6.0	5.08	5.08	Yes				X	wood fibers and wood chunks
HC-WB-SC-002	Vibracore	7.0	6.33	6.33	Yes				X	wood fibers and woody debris
HC-WB-SC-003	Vibracore	6.0	4.92	4.92	Yes				X	wood fibers, wood chunks, and woody debris
HC-WB-SC-004	Vibracore	5.0	3.58	2	Yes				X	woody debris
HC-WB-SC-005	Vibracore	2.5 (refusal)	1.92	1.92	Yes				X	woody debris
HC-WB-SC-006	Vibracore	14.0	13.5	13.5	Yes		X			fine wood fibers and wood chips

Notes:

[a] Estimated depth of wood waste in feet is uncorrected for compaction, refer to Appendix A for individual vibracore logs.

[b] Percent volume is an estimate based on field observations.

NA = Not applicable.

Table 13 - Benthic Organism Survey Results

Sample Number	Exploration Type	Benthic Organism Number Observed						
		Nematode	Polychaete	Oligochaete	Gastropod	Bivalve	Arthropod	Comments
Intertidal Samples								
HC-WB-BS-001	Core	328[a]	18[b]		20[b]	6[b]		Shell hash (barnacles, mussels, bivalves), woody debris, and gravel
HC-WB-BS-002	Core	21.36[c]			2.67[c]	10.7[c]	5.34[c]	Shell hash (barnacles, mussels, bivalves), gravel, and small quantity of woody debris
HC-WB-SS-003	Core	24.75[d]	27.5[d]		52.25[d]	5.5[d]		Shell hash (barnacles, mussels, gastropods), sand, gravel, small quantity of woody debris
HC-WB-BS-004	Core		31.5[e]		20.25[e]	3[e]	15.75[e]	Shell hash (barnacles, bivalves), gravel
Subtidal Samples								
HC-WB-BS-005	Core		151[f]	7763[f]				Large quantity of woody debris, some shell hash, one bivalve shell
HC-WB-BS-006	Core		9		1			Large quantity of fibrous woody debris, some shell fragments of bivalves
HC-WB-BS-007	Core		5				1	Large quantity of woody debris/wood chips, some shell hash
HC-WB-BS-008	Core		3		1	2		Large quantity of woody debris/wood chips, some shell hash

Notes:

[a] Estimate based on a 100 mL subsample of the original 400 mL sample. The number of organisms found was multiplied by 4 to get the final number.
[b] Estimate based on a 200 mL subsample of the original 400 mL sample. The number of organisms found was multiplied by 4 to get the final number.
[c] Estimate based on a 225 mL subsample of the original 600 mL sample. The number of organisms found was multiplied by 2.67 to get the final number.
[d] Estimate based on a 200 mL subsample of the original 550 mL sample. The number of organisms found multiplied by 2.75 to get the final number.
[e] Estimate based on a 200 mL subsample of the original 450 mL sample. The number of organisms found was multiplied by 2.25 to get the final number.
[f] Estimate based on number of organisms found in 3 subsamples then scaled to the volume of the total sample.

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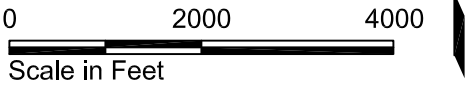
Source: Base map prepared from DeLorme Topo 7.0, 2007.



Westbay Marina
Olympia, Washington

Vicinity Map

17330-35 6/11

HARTCROWSER

Figure
1

EAL 06/24/11 1733035-003.dwg

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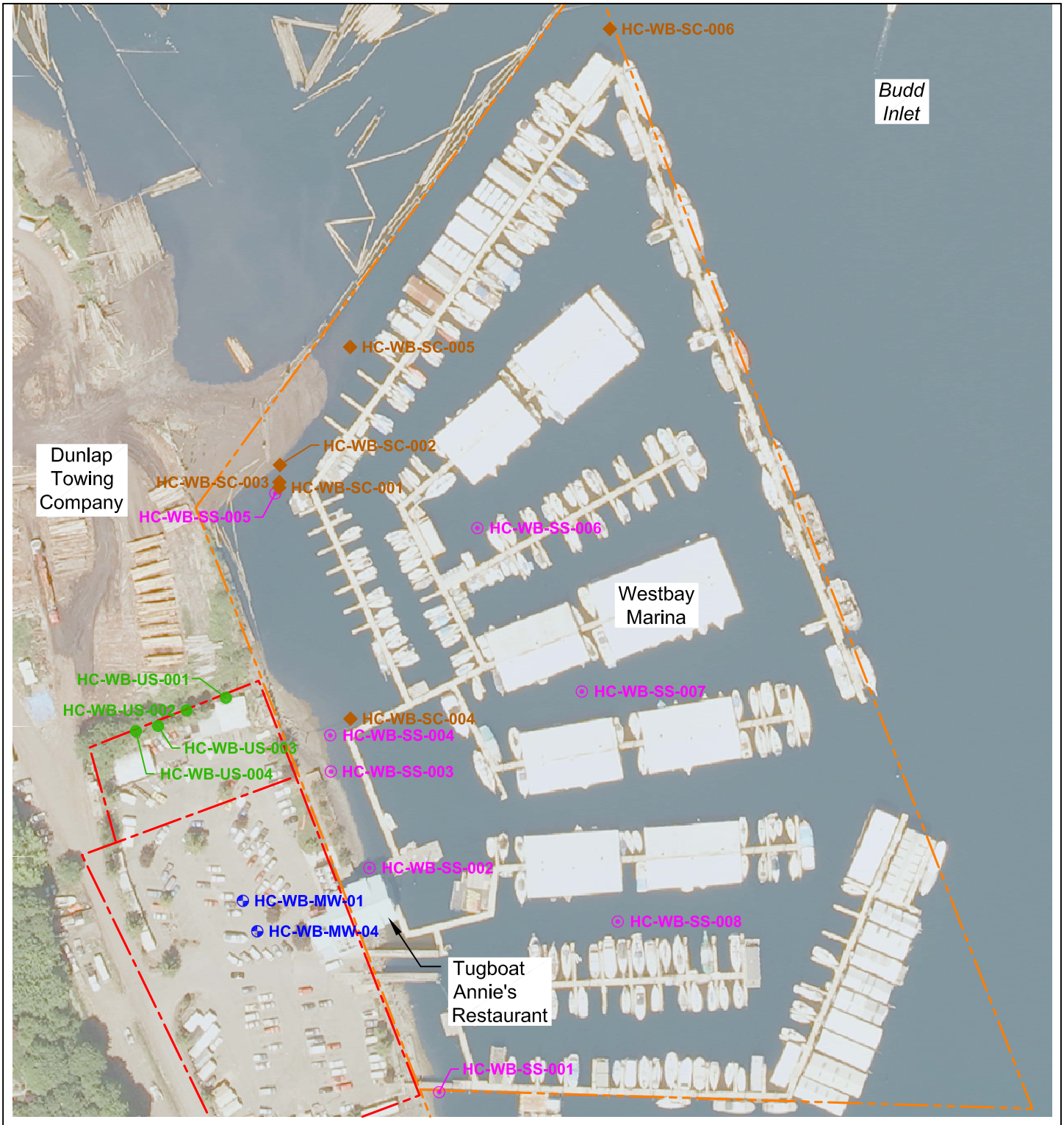

Sample Location and Number

HC-WB-SS-001 Sediment Sample

HC-WB-US-001 Upland Soil Sample

HC-WB-MW-01 Groundwater Sample

HC-WB-SC-001 Vibracore Sample

Site Boundary

DNR Aquatic Lease Boundary No. 2618

N

0 150 300

Scale in Feet

Source: Aerial photograph from USGS Seamless Server, 2010.

Westbay Marina
Olympia, Washington

2011 Site and Exploration Plan

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Figure **2**

EAL 06/29/11 1733035-004.dwg

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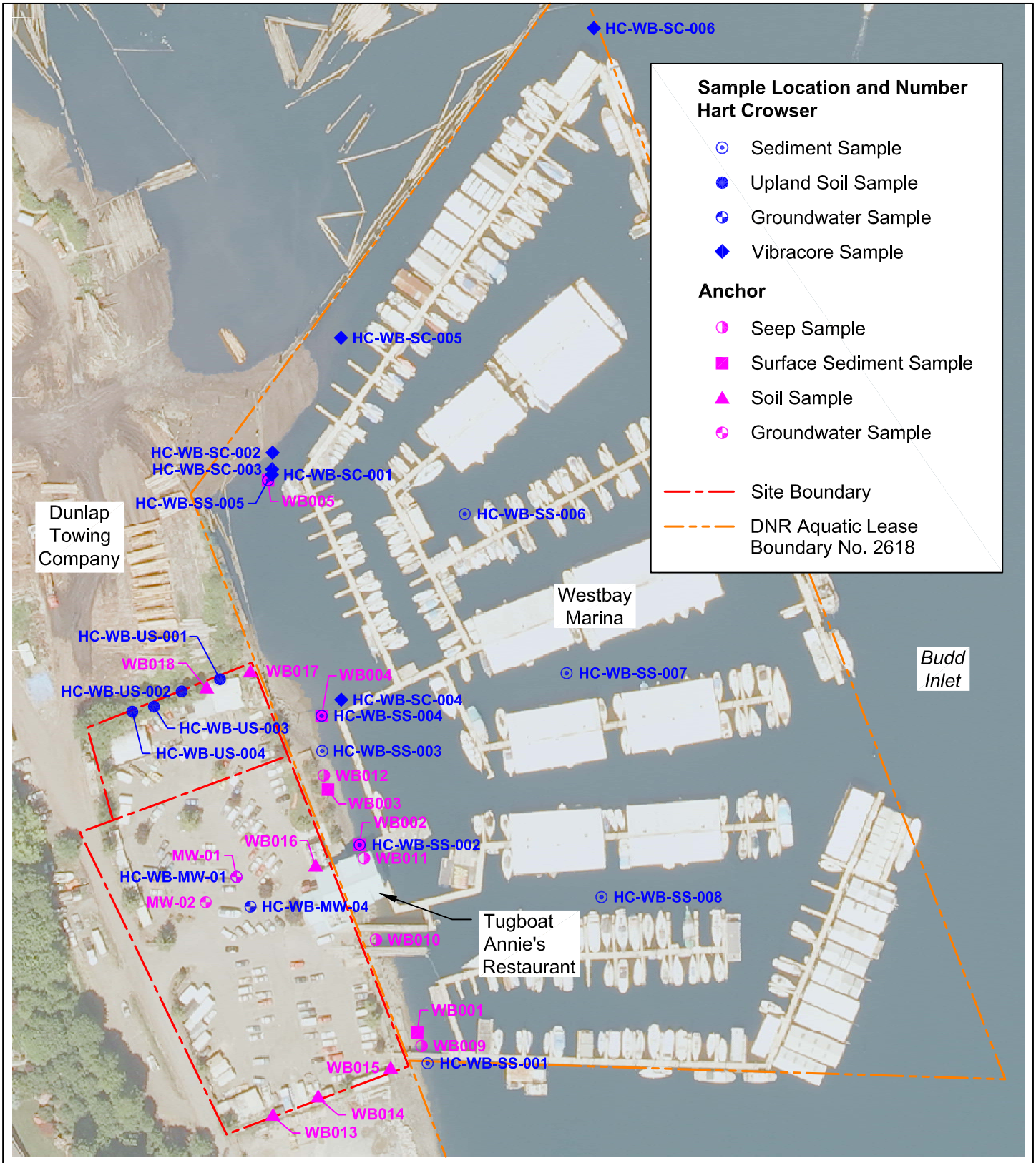

Source: Aerial photograph from USGS Seamless Server, 2010.

Westbay Marina
Olympia, Washington

2009 to 2011 Sample Location Plan

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Figure
3

EAL 06/29/11 1733035-005.dwg

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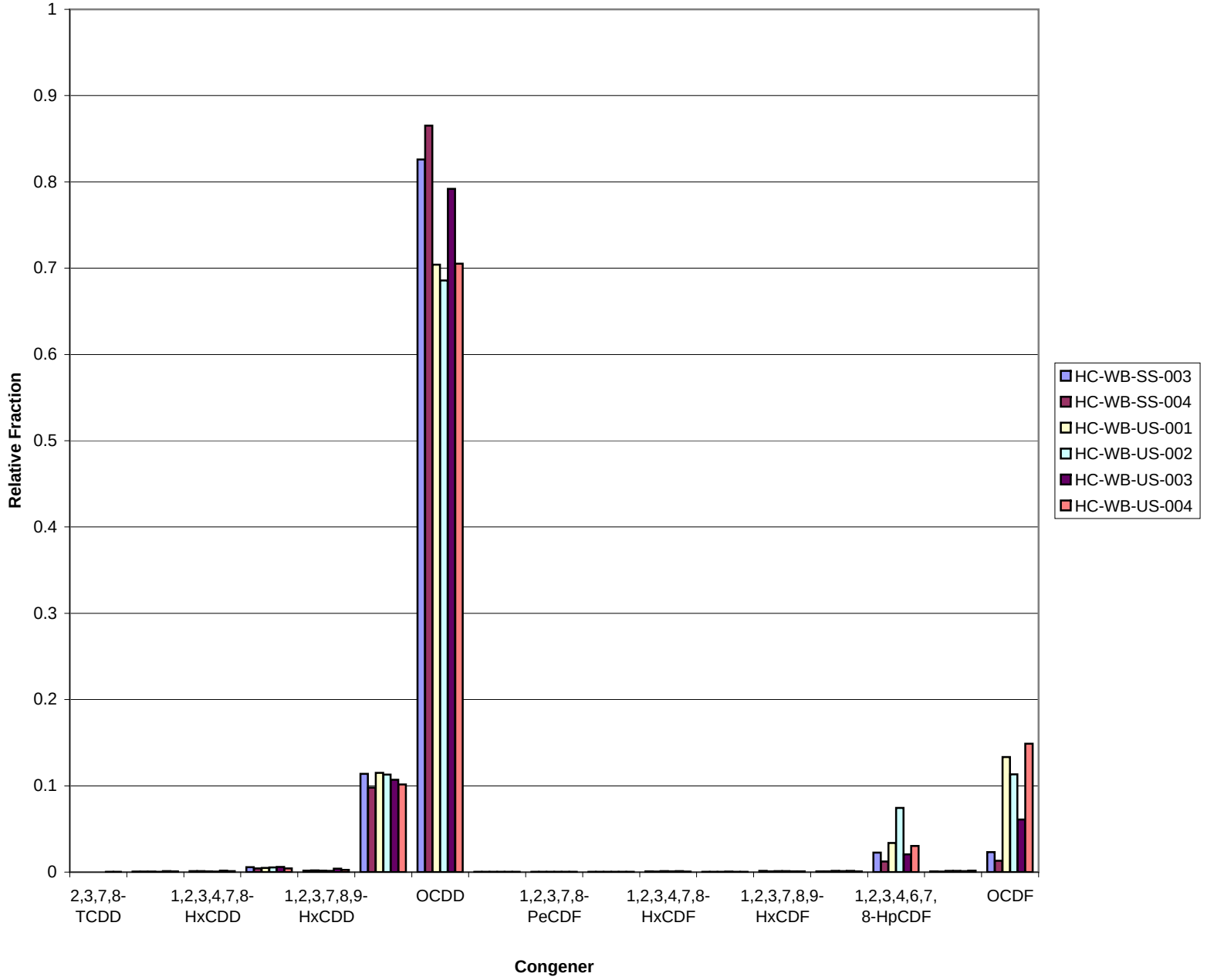

Westbay Marina
Olympia, Washington

Westbay Marina Dioxin Relative Ratios

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Figure **4**

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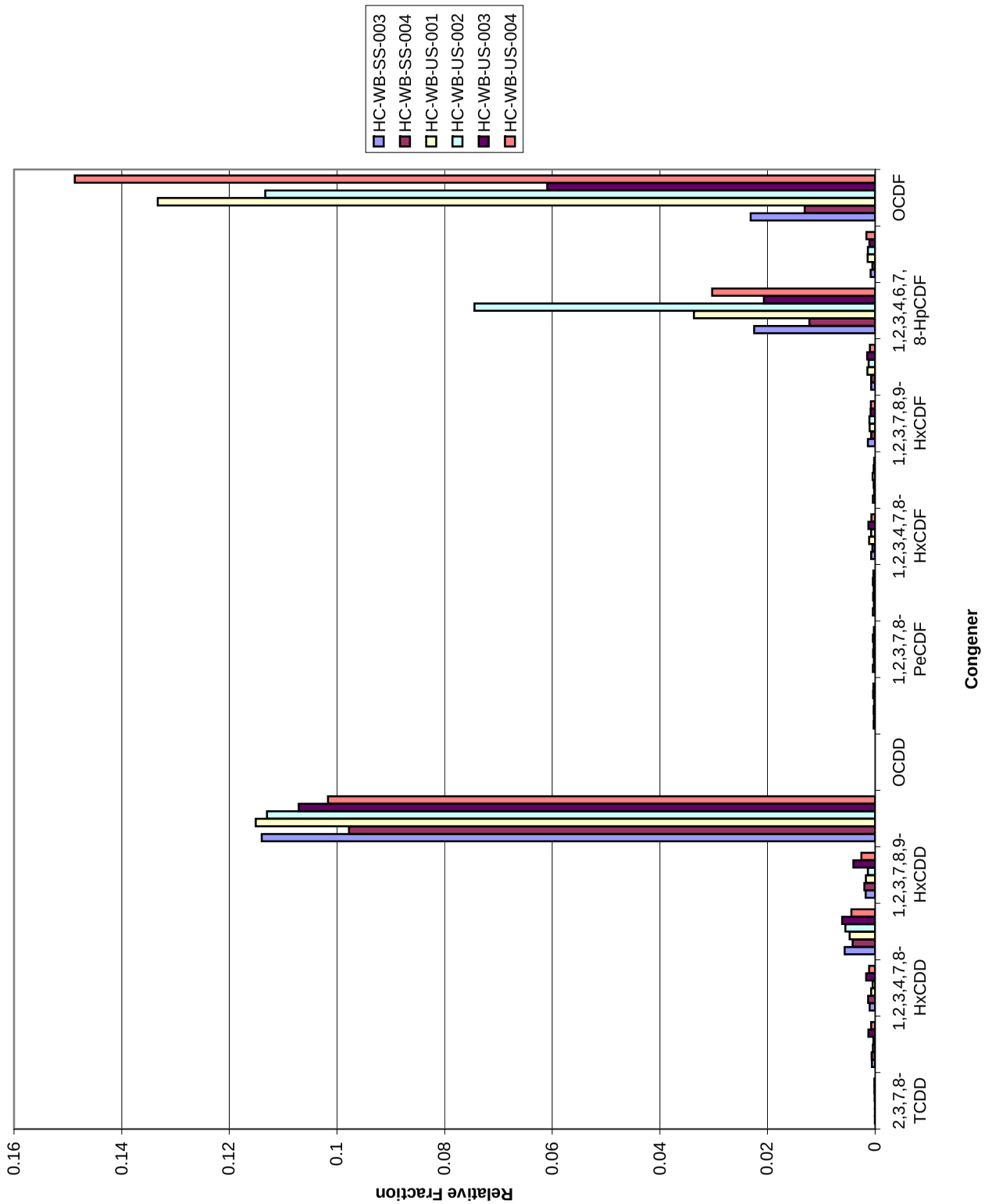

Westbay Marina
Olympia, Washington

Westbay Marina Dioxin Relative Ratios (Excluding OCDD)

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HARTCROWSER

Figure

5

JAB 6/9/11 1733035 Figure 5.xls

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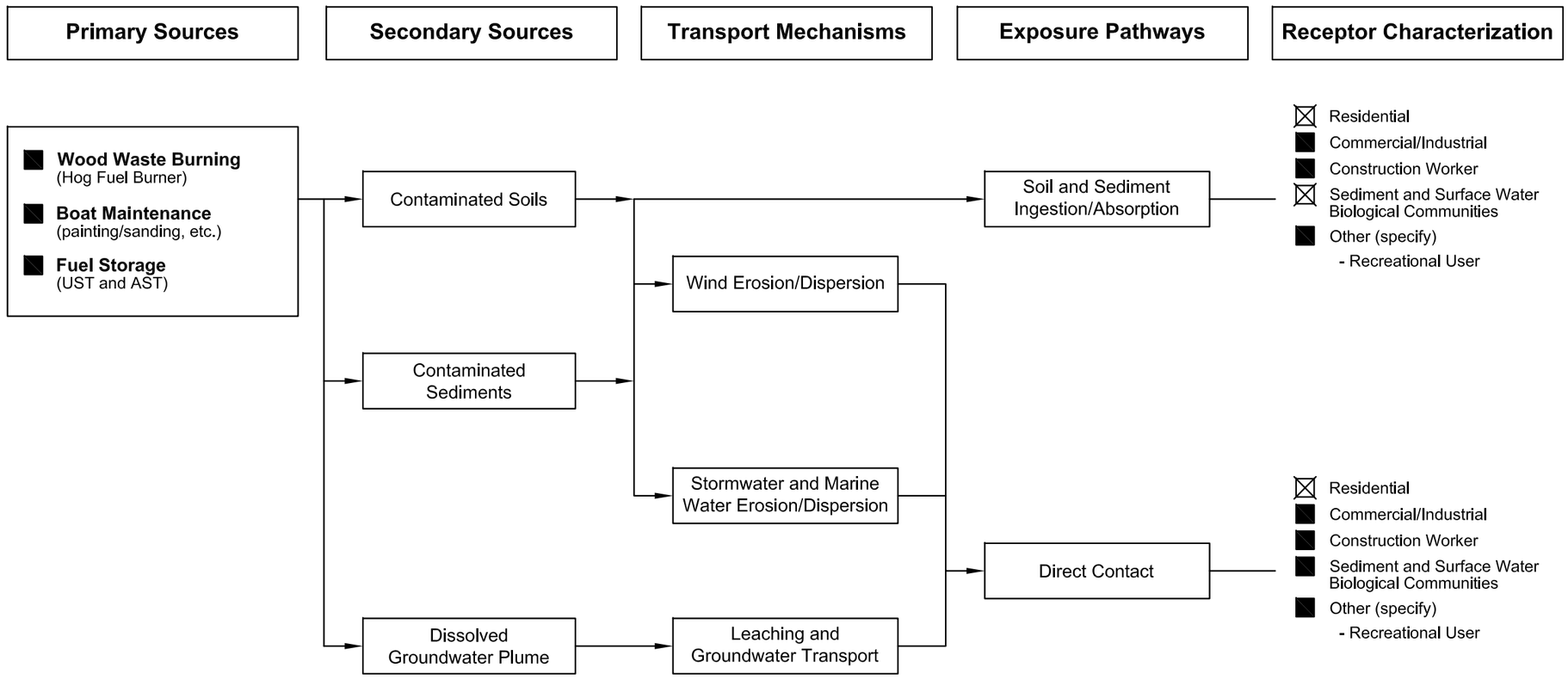

■ Applicable Component of Westbay Marina Conceptual Site Model

☒ Non-Appliciable Component of Westbay Marina Conceptual Site Model

Source: Figure was generated for Westbay Marina Remedial Investigation by Hart Crowser (2011).

Westbay Marina
Olympia, Washington

Conceptual Site Model for Westbay Marina

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HARTCROWSER

Figure
6

EAL 06/22/11 1733035-006.dwg

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APPENDIX A
FIELD DOCUMENTATION
VIBRACORE LOGS

Table A-1 - Sample Location Coordinates

Sample Name	Actual Coordinates				Mudline Elevation in Feet (MLLW)
	Northing	Easting	Latitude	Longitude	
Upland Surface Soil Samples (US)					
HC-WB-US-001	640789.6554	1038251.3543	47 03.912	122 55.000	NA
HC-WB-US-002	640776.3408	1038209.5578	47 03.910	122 55.010	NA
HC-WB-US-003	640759.7648	1038179.2603	47 03.907	122 55.017	NA
HC-WB-US-004	640754.2506	1038155.6975	47 03.906	122 55.023	NA
Intertidal Surface Sediment Samples (SS)					
HC-WB-SS-001	640370.3898	1038478.1198	477 03.844	122 54.942	0.4
HC-WB-SS-002	640608.7394	1038403.8849	47 03.883	122 54.962	0.54
HC-WB-SS-003	640711.2251	1038362.9892	47 03.900	122 54.973	0.32
HC-WB-SS-004	640749.7655	1038362.3295	47 03.906	122 54.973	3.76
Van Veen Power Grabs - Surface Sediment (SS)					
HC-WB-SS-005	641006.9794	1038303.891	47 03.948	122 54.989	-3.5
HC-WB-SS-006	640970.1124	1038518.677	47 03.943	122 54.937	-14
HC-WB-SS-007	640796.3053	1038629.788	47 03.915	122 54.909	-12.3
HC-WB-SS-008	640551.7557	1038667.925	47 03.875	122 54.898	-11.6
Vibracores - Sediment Core (SC)					
HC-WB-SC-001	641013.0546	1038308.066	47 03.949	122 54.988	-4
HC-WB-SC-002	641037.1147	1038308.803	47 03.953	122 54.988	-3.8
HC-WB-SC-003	641018.8873	1038308.245	47 03.950	122 54.988	-1
HC-WB-SC-004	640767.3518	1038383.812	47 03.909	122 54.968	-2.3
HC-WB-SC-005	641162.5387	1038383.455	47 03.974	122 54.971	-1.5
HC-WB-SC-006	641500.7248	1038659.591	47 04.031	122 54.907	-16.7

Note: Northing and Easting coordinates in NAD83 State Plane South, in U.S. feet.
NA - Not applicable.

Table A-2 - Surface Soil and Sediment Grab Sample Descriptions

Sample Number	Collection Date	Visual Description	Comments
HC-WB-US-001	3/24/2011	(Soft), damp, dark brown, sandy SILT (SM) with scattered rootlets and wood fragments.	Surface soil sample. Surface cover of grass, moss, twigs, and sticks. Located beneath conifers.
HC-WB-US-002	3/24/2011	(Soft), damp, brown, clayey SILT (ML) with numerous roots and conifer needles.	Surface soil sample. Located beneath conifers.
HC-WB-US-003	3/24/2011	(Very soft), damp, dark brown, sandy SILT (SM) with numerous rootlets and conifer needles.	Surface soil sample. Located beneath conifers; approximately 1 to 2" deep needles removed prior to sample collection.
HC-WB-US-004	3/24/2011	(Very soft), damp, dark brown, sandy SILT (SM) with occaisional gravel and numerous rootlets.	Surface soil sample. Located beneath conifers.
HC-WB-SS-001	4/18/2011	(Soft), saturated, brown-black, shelly SILT (ML).	Intertidal surface sediment sample. Located downslope from seep and outfall, on south side of dock.
HC-WB-SS-002	3/24/2011	(Very soft), saturated, brown, shelly SILT (ML).	Intertidal surface sediment sample. Located beneath Tugboat Annie's restaurant downslope from seep. Diatom layer on surface.
HC-WB-SS-003	3/24/2011	(Soft), saturated, black, shelly SILT (ML).	Intertidal surface sediment sample. Located downslope from seep.
HC-WB-SS-004	3/24/2011	(Soft), saturated, black, shelly, sandy, SILT (ML).	Intertidal surface sediment sample. Located downslope from outfall. Wood debris at 10 cm deep at one subsample location.
HC-WB-SS-005	3/30/2011	(Very soft), saturated, black, SILT (ML) with numerous wood fibers.	Subtidal surface sediment sample. Power grab. Abundant wood fibers. Strong sulfur odor.
HC-WB-SS-006	3/30/2011	(Very soft), saturated, olive-green surface diatom layer over black SILT (ML) with scattered wood fibers.	Subtidal surface sediment sample. Power grab. Scattered wood fibers. Sheen on surface water and sediment. Sulfur odor.
HC-WB-SS-007	3/30/2011	(Very soft), saturated, olive-green surface diatom layer over brown-black SILT (ML).	Subtidal surface sediment sample. Power grab. Sheen on surface water. Sulfur odor.
HC-WB-SS-008	3/30/2011	(Very soft), saturated, black, SILT (ML) with trace clay.	Subtidal surface sediment sample. Van Veen grab. Slight sulfur odor. Multiple small crabs.

Key to Exploration Logs

Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits and probes is estimated based on visual observation and is presented parenthetically on the logs.

SAND or GRAVEL Density	Standard Penetration Resistance (N) in Blows/Foot	SILT or CLAY Consistency	Standard Penetration Resistance (N) in Blows/Foot	Approximate Shear Strength in TSF
Very loose	0 to 4	Very soft	0 to 2	<0.125
Loose	4 to 10	Soft	2 to 4	0.125 to 0.25
Medium dense	10 to 30	Medium stiff	4 to 8	0.25 to 0.5
Dense	30 to 50	Stiff	8 to 15	0.5 to 1.0
Very dense	>50	Very stiff	15 to 30	1.0 to 2.0
		Hard	>30	>2.0

Sampling Test Symbols

- 1.5" I.D. Split Spoon
- Grab (Jar)
- 3.0" I.D. Split Spoon
- Shelby Tube (Pushed)
- Bag
- Cuttings
- Core Run

Moisture

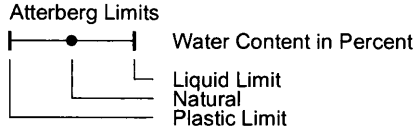
Dry	Little perceptible moisture
Damp	Some perceptible moisture, likely below optimum
Moist	Likely near optimum moisture content
Wet	Much perceptible moisture, likely above optimum

Minor Constituents

Minor Constituents	Estimated Percentage
Trace	<5
Slightly (clayey, silty, etc.)	5 - 12
Clayey, silty, sandy, gravelly	12 - 30
Very (clayey, silty, etc.)	30 - 50

Laboratory Test Symbols

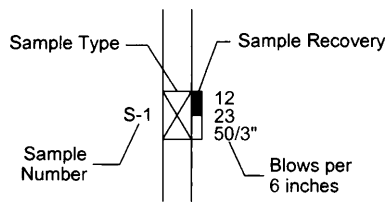
GS	Grain Size Classification
CN	Consolidation
UU	Unconsolidated Undrained Triaxial
CU	Consolidated Undrained Triaxial
CD	Consolidated Drained Triaxial
QU	Unconfined Compression
DS	Direct Shear
K	Permeability
PP	Pocket Penetrometer Approximate Compressive Strength in TSF
TV	Torvane Approximate Shear Strength in TSF
CBR	California Bearing Ratio
MD	Moisture Density Relationship
AL	Atterberg Limits
PID	Photoionization Detector Reading
CA	Chemical Analysis
DT	In Situ Density in PCF
OT	Tests by Others



Groundwater Indicators

- Groundwater Level on Date or (ATD) At Time of Drilling
- Groundwater Seepage (Test Pits)

Sample Key



SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

HARTCROWSER

17330-35 3/11

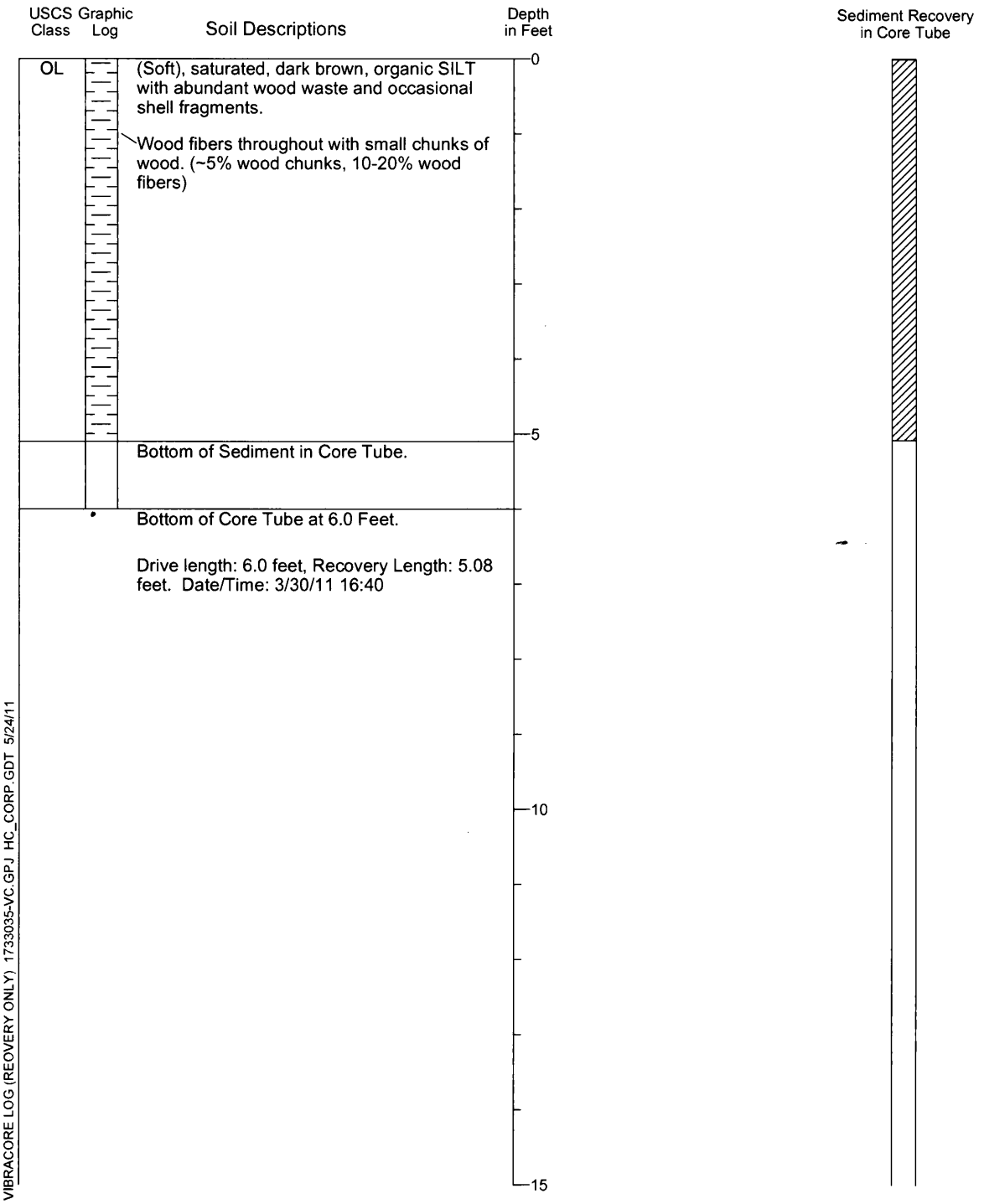
Figure A-1

KEY SHEET 1733035-VC.GPJ HC_CORP.GDT 5/24/11

Vibracore Log HC-WB-SC-001

Location: See Figure 2.
Mudline Elevation in Feet (MLLW): -4 Feet
Water Depth in Feet: 15.3 Feet

Type of Sample: Vibracore
Core Diameter: 4 inches
Northing: 641013.0546
Easting: 1038308.066
Logged By: A. Conrad Reviewed By: C. Rust



VIBRACORE LOG (REOVERY ONLY) 1733035-VC.GPJ HC_CORP.GDT 5/24/11

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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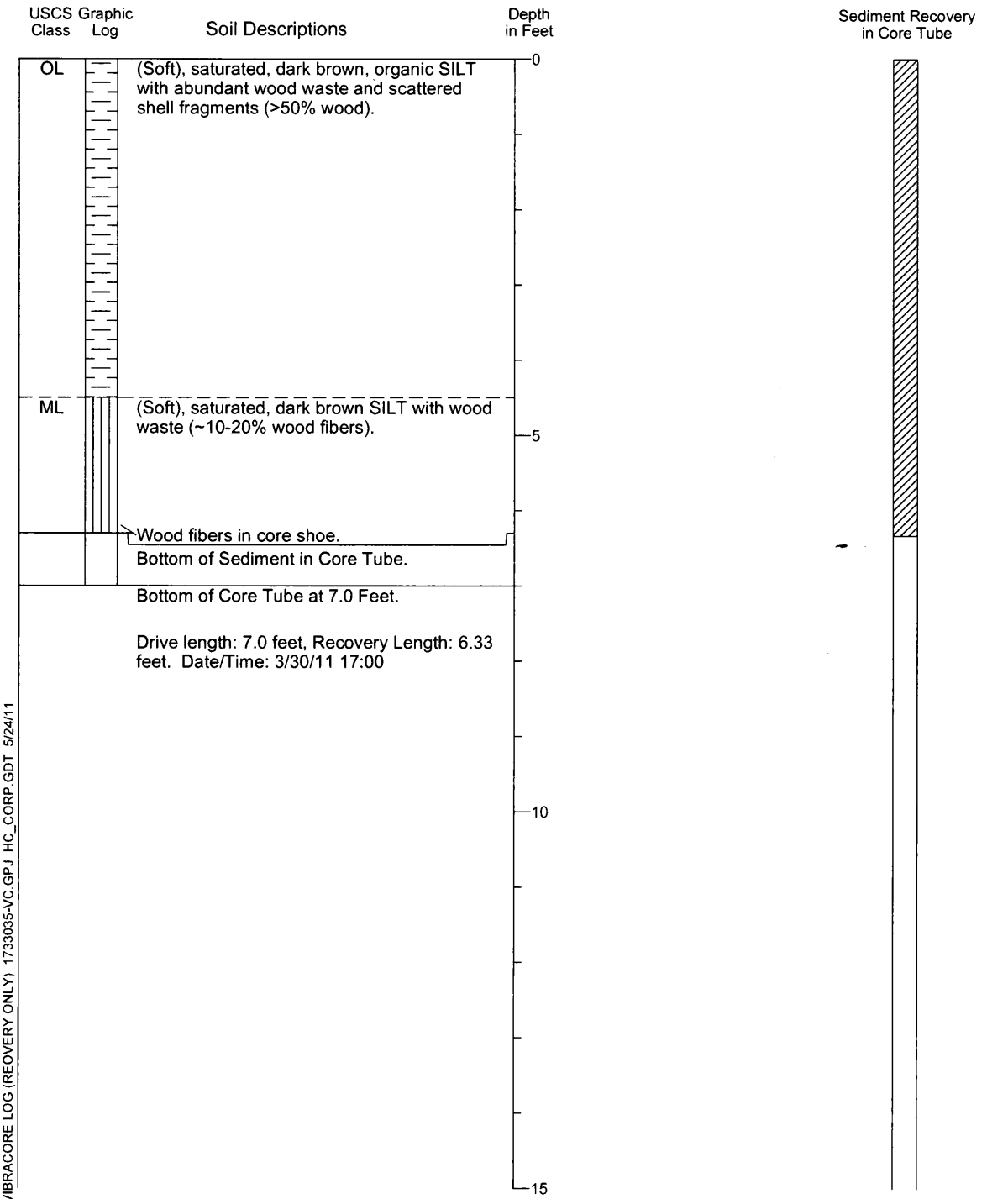
Figure A-2

Vibracore Log HC-WB-SC-002

Location: See Figure 2.
Mudline Elevation in Feet (MLLW): -3.8 Feet
Water Depth in Feet: 15 Feet

Type of Sample: Vibracore
Core Diameter: 4 inches
Northing: 641037.1147
Easting: 1038308.803
Logged By: A. Conrad Reviewed By: C. Rust



VIBRACORE LOG (REOVERY ONLY) 1733035-VC.GPJ HC_CORP.GDT 5/24/11

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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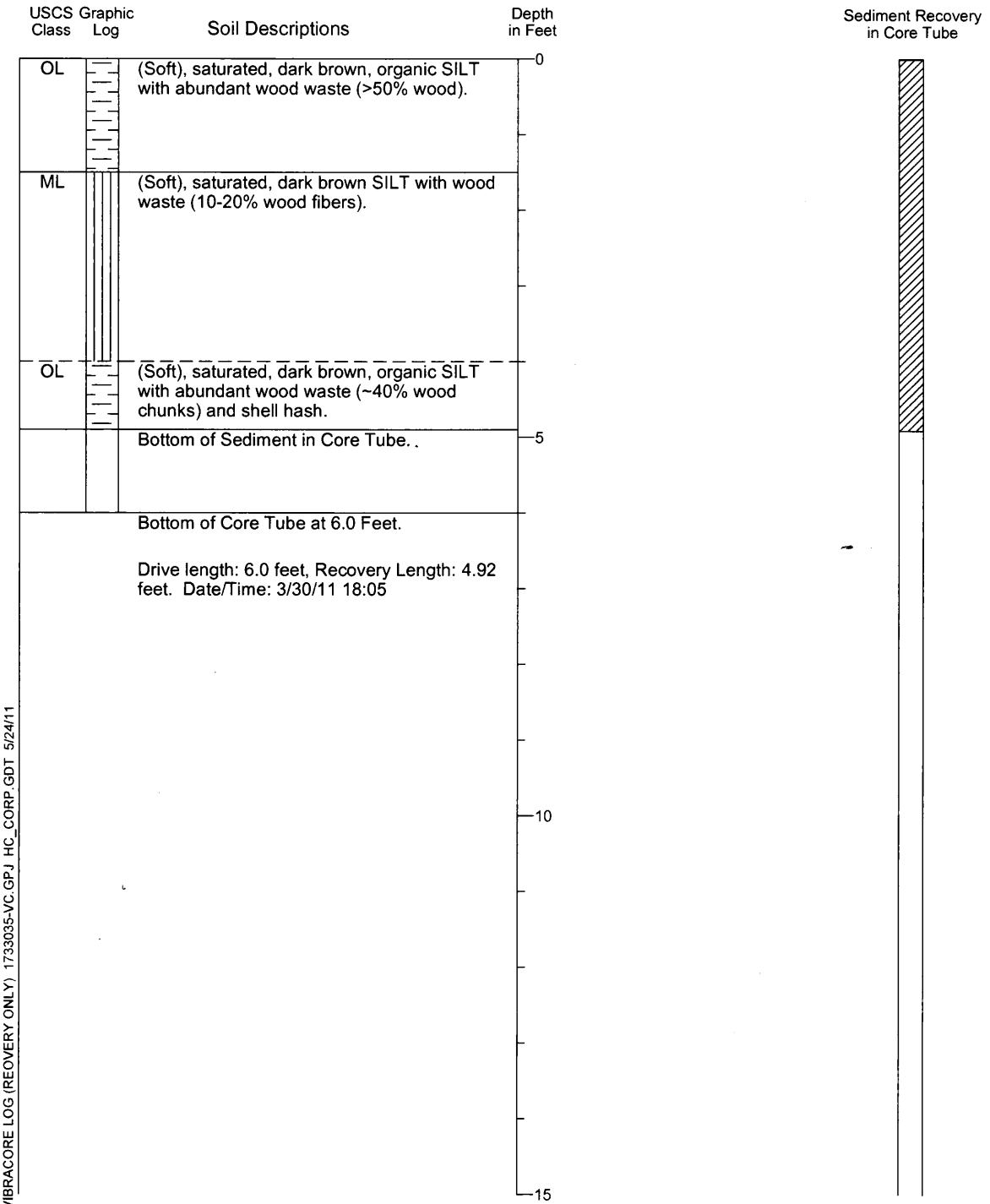
Figure A-3

Vibracore Log HC-WB-SC-003

Location: See Figure 2.
Mudline Elevation in Feet (MLLW): -1 Feet
Water Depth in Feet: 11 Feet

Type of Sample: Vibracore
Core Diameter: 4 inches
Northing: 641018.8873
Easting: 1038308.245
Logged By: A. Conrad Reviewed By: C. Rust



VIBRACORE LOG (REOVERY ONLY) 1733035-VC.GPJ HC_CORP.GDT 5/24/11

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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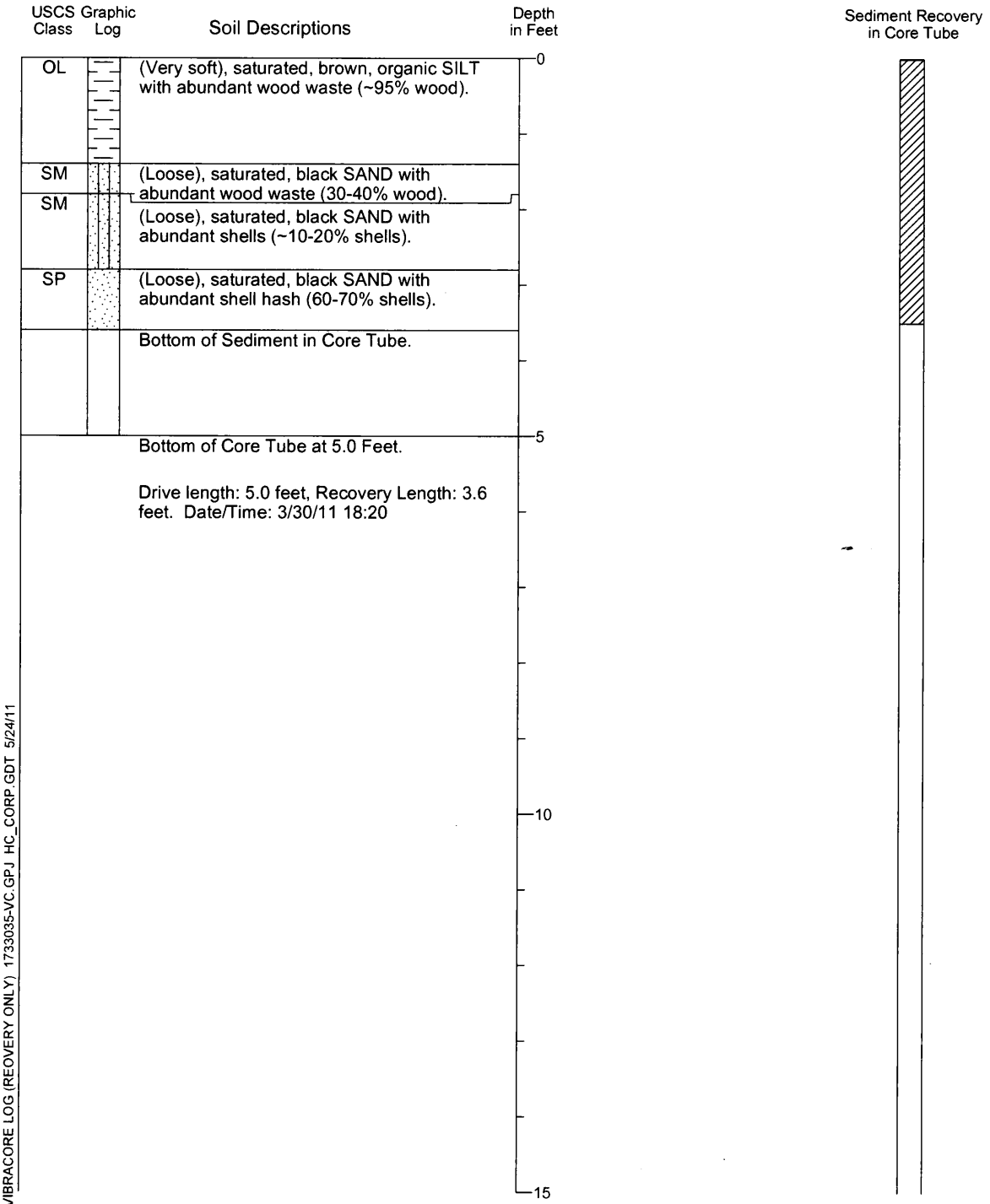
Figure A-4

Vibracore Log HC-WB-SC-004

Location: See Figure 2.
Mudline Elevation in Feet (MLLW): -2.3 Feet
Water Depth in Feet: 11 Feet

Type of Sample: Vibracore
Core Diameter: 4 inches
Northing: 640767.3518
Easting: 1038383.812
Logged By: A. Conrad Reviewed By: C. Rust



VIBRACORE LOG (REOVERY ONLY) 1733035-VC.GPJ HC_CORP.GDT 5/24/11

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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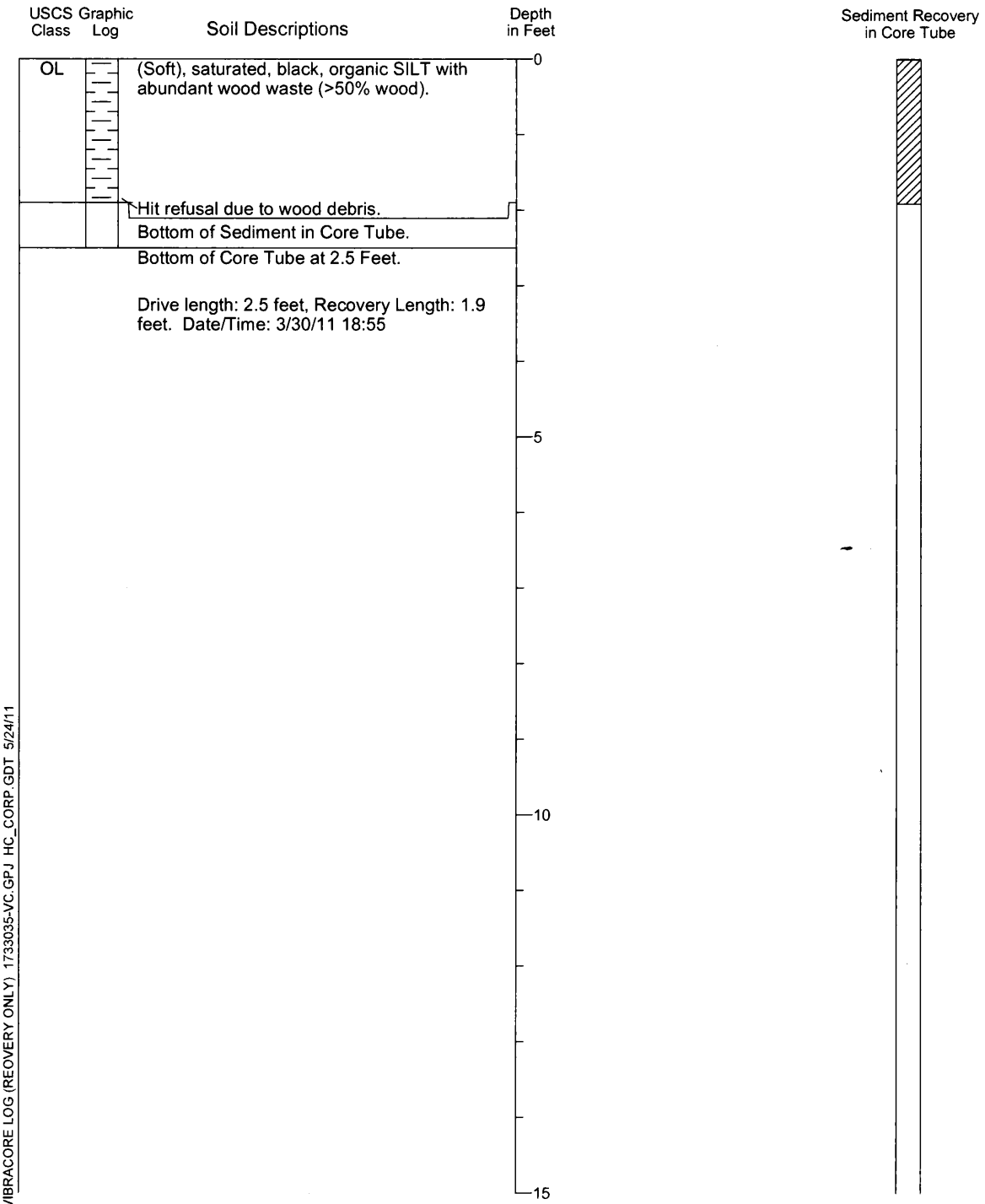
Figure A-5

Vibracore Log HC-WB-SC-005

Location: See Figure 2.
Mudline Elevation in Feet (MLLW): -1.5 Feet
Water Depth in Feet: 9 Feet

Type of Sample: Vibracore
Core Diameter: 4 inches
Northing: 641162.5387
Easting: 1038383.455
Logged By: A. Conrad Reviewed By: C. Rust



VIBRACORE LOG (REOVERY ONLY) 1733035-VC.GPJ HC_CORP.GDT 5/24/11

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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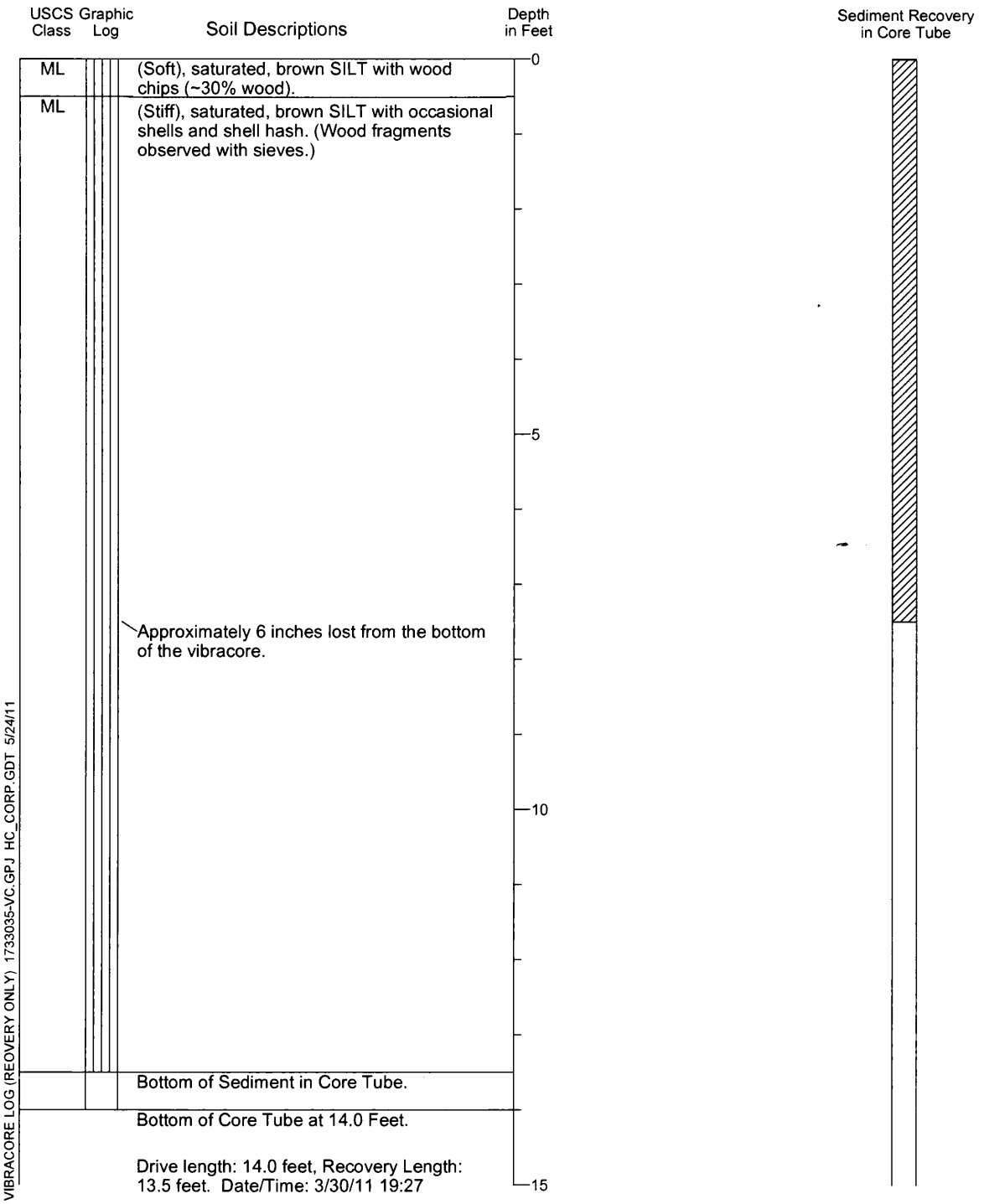
Figure A-6

Vibracore Log HC-WB-SC-006

Location: See Figure 2.
Mudline Elevation in Feet (MLLW): -16.7 Feet
Water Depth in Feet: 23 Feet

Type of Sample: Vibracore
Core Diameter: 4 inches
Northing: 641500.7248
Easting: 1038659.591
Logged By: A. Conrad Reviewed By: C. Rust



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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Figure A-7

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APPENDIX B
CHEMICAL DATA QUALITY REVIEW AND LABORATORY REPORTS

APPENDIX B
CHEMICAL DATA QUALITY REVIEW AND LABORATORY REPORTS

Chemical Data Quality Review for Upland Soil Samples

Four upland soil samples were collected from Westbay Marina on March 24, 2011. The samples were submitted to Analytical Resources, Inc. (ARI), in Tukwila, WA for analysis. Sample identifications, laboratory job numbers, and analytical tests are summarized in Table 1 of the report.

Quality assurance/quality control (QA/QC) reviews of laboratory procedures were performed on an ongoing basis by the laboratory. Hart Crowser performed the data review, using laboratory quality control results summary sheets and raw data, as required, to ensure they met data quality objectives for the project. Data review followed the format outlined in the National Functional Guidelines for Organic Data Review (EPA 2008) and the National Functional Guidelines for Dioxins/Furans Data Review (EPA 2005) modified to include specific criteria of the individual analytical methods. The following criteria were evaluated in the standard data quality review process:

- Holding times;
- Method blanks;
- Labeled compound recoveries;
- Ongoing precision and accuracy sample recoveries (OPR);
- Laboratory replicate relative standard deviation (RSD);
- Internal Standard recoveries;
- Calibration criteria (where applicable); and
- Reporting limits (RL).

The data were determined to be acceptable for use, as qualified. Full laboratory results are presented at the end of this appendix. Results of the data reviews, organized by analysis class, follow.

Sample Receiving Discrepancies

There were no sample receiving discrepancies. The samples were received at the laboratory within the recommended temperature range of less than 6°C.

Dioxins/Furans

Analytical Methods

Soil samples for dioxins/furans analysis were prepared and analyzed by EPA Method 1613B.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors. Samples were reported to the laboratory reporting limit, but calculated to the estimated detection limit (EDL). Detections that fell between the reporting limit and the EDL were qualified by the laboratory as "J." The laboratory "J" qualifier was changed to "T" to be consistent with Ecology's EIM database.

Blank Contamination

The method blank had detections for 1,2,3,4,6,7,8-HpCDF, OCDD, and Total HpCDF below the reporting limits. The laboratory qualified the detections with "J." The laboratory "J" qualifier was changed to "T." The associated samples were not qualified as the levels in the samples were significantly higher (>5 times) the levels in the method blank.

Labeled Compound Recovery

Labeled compound recoveries were within QC limits.

Ongoing Precision and Accuracy Sample Recovery

OPR recoveries were within advisory laboratory control limits.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curve was within acceptance criteria.

Continuing calibration verification checks (CCVs) were within control limits with the following exception:

- CCV 11040720 analyzed on April 8, 2011 at 02:33. The analytes 1,2,3,7,8,9-HxCDD, ^{13}C-1,2,3,4,7,8-HxCDD, ^{13}C-1,2,3,6,7,8-HxCDD, and ^{13}C-OCDD exceeded the +/- 20 percent criteria. This CCV was analyzed as a closing CCV following sample analysis. The method only requires a CCV at the beginning of each 12-hour shift. As the initial CCV was within control limits, no sample results were qualified.

Sample Qualifiers

- HC-WB-US-001: The analyte 2,3,7,8-TCDD was qualified by the laboratory as an estimated maximum possible concentration (EMPC). EMPC is defined in EPA Statement of Work DLM02.2 as a value "calculated for 2,3,7,8-substituted isomers for which the quantitation and /or confirmation ion(s) has signal to noise in excess of 2.5, but does not meet identification criteria." Results for that analyte were qualified as UK.

- HC-WB-US-002 and HC-WB-US-003: The analyte 2,3,7,8-TCDD was qualified by the laboratory with J and EMPC. Results for that analyte were qualified as UK.

- HC-WB-US-004: The analytes 2,3,7,8-TCDD and 1,2,3,7,8,9-HxCDF were qualified by the laboratory with J and EMPC. Results for those analytes were qualified as UK.

Total Solids

Analytical Methods

Total solids were determined by modified EPA Method 160.3.

Sample Holding Times

The samples met holding time limits.

Laboratory Detection Limits

Reported detection limits were acceptable.

Blank Contamination

No target analytes were detected in laboratory blanks.

Laboratory Replicate Sample Analysis

The RSD between replicate measurements met quality control limits

Chemical Data Quality Review for Groundwater Samples

Two groundwater samples were collected from monitoring wells at Westbay Marina on March 28 and 30, 2011. The samples were submitted to ARI for analysis. Sample identifications, laboratory job numbers, and analytical tests are summarized in Table 1 of the report.

Quality assurance/quality control (QA/QC) reviews of laboratory procedures were performed on an ongoing basis by the laboratory. Hart Crowser performed the data review, using laboratory quality control results summary sheets and raw data, as required, to ensure they met data quality objectives for the project. Data review followed the format outlined in the National Functional Guidelines for Inorganic Data Review (EPA 2010) modified to include specific criteria of the individual analytical methods. The following criteria were evaluated in the standard data quality review process:

- Holding times;
- Method blanks;
- Laboratory control sample/laboratory control sample duplicate (LCS/LCSD) recoveries;
- Matrix spike/matrix spike duplicate (MS/MSD) recoveries;
- Laboratory duplicate relative percent differences (RPDs);
- Standard Reference Material (SRM) recoveries (where applicable);
- Calibration criteria (where applicable); and
- Reporting limits (RL).

The data were determined to be acceptable for use, as qualified. Full laboratory results are presented at the end of this appendix. Results of the data reviews, organized by analysis class, follow.

Sample Receiving Discrepancies

There were no sample receiving discrepancies. The samples were received at the laboratory within the recommended temperature range of less than 6°C.

Total Metals

Analytical Methods

Total metals (copper and nickel) were determined by EPA Method 200.8.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits were acceptable.

Blank Contamination

No target analytes were detected in laboratory blanks.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within method control limits.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves and CCVs were within acceptance criteria.

Dissolved Metals

Analytical Methods

Dissolved metals (copper and nickel) were determined by EPA Method 200.8.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits were acceptable.

Blank Contamination

No target analytes were detected in laboratory blanks.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within method control limits.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves and CCVs were within acceptance criteria.

Ammonia

Analytical Methods

Ammonia was determined by modified EPA Method 350.1.

Sample Holding Times

The samples met holding time limits.

Laboratory Detection Limits

Reported detection limits were acceptable.

Blank Contamination

No target analytes were detected in laboratory blanks.

Matrix Spike (MS) Recovery

- MS recovery fell within control limits.

Laboratory Duplicate Sample Analysis

The RPD between replicate measurements met quality control limits.

Standard Reference Material (SRM) Recovery

SRM recoveries were within QC limits.

Chemical Data Quality Review for Intertidal Sediment Samples

Four intertidal sediment samples and one trip blank were collected from Westbay Marina on March 24 and April 18, 2011. The samples were submitted to ARI for analysis. Sample identifications, laboratory job numbers, and analytical tests are summarized in Table 1 of the report.

Quality assurance/quality control (QA/QC) reviews of laboratory procedures were performed on an ongoing basis by the laboratory. Hart Crowser performed the data review, using laboratory quality control results summary sheets and raw data, as required, to ensure they met data quality objectives for the project. Data review followed the format outlined in the National Functional Guidelines for Organic Data Review (EPA 2008), the National Functional Guidelines for Inorganic Data Review (EPA 2010), and the National Functional Guidelines for Dioxins/Furans Data Review (EPA 2005) modified to include specific criteria of the individual analytical methods. The following criteria were evaluated in the standard data quality review process:

- Holding times;
- Method blanks;
- Surrogate recoveries;
- Labeled compound recoveries;
- Laboratory control sample/laboratory control sample duplicate (LCS/LCSD) recoveries;
- Matrix spike/matrix spike duplicate (MS/MSD) recoveries;
- Laboratory duplicate relative percent differences (RPDs);
- Laboratory replicate relative standard deviation (RSD);
- Internal standard (IS) recoveries (where applicable);
- Ongoing precision and accuracy sample recoveries (OPR);
- Standard Reference Material (SRM) recoveries (where applicable);
- Calibration criteria (where applicable); and
- Reporting limits (RL).

The data were determined to be acceptable for use, as qualified. Full laboratory results are presented at the end of this appendix. Results of the data reviews, organized by analysis class, follow.

Sample Receiving Discrepancies

The cooler containing sample HC-WB-SS-002 arrived at the laboratory at 6.9°C, slightly above the recommended range of less than 6°C. The sample was received at the laboratory less than four hours from sample collection, and may

not have had time to equilibrate with the coolant. Sample results were not qualified.

Semivolatile Organic Compounds (SVOCs)

Analytical Methods

The samples were extracted by EPA Method 3546 (microwave) following PSEP modifications to attain lower reporting limits. The samples were analyzed by GC/MS following EPA Method 8270D.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors. Detections that fell between the reporting limit and the MDL were qualified by the laboratory as "J." The laboratory "J" qualifier was changed to "T" to be consistent with Ecology's EIM database.

Sample HC-WB-SS-002 was analyzed at a 3-fold dilution due to matrix interferences. Reporting limits were elevated due to the sample dilution. Reporting limits for benzyl alcohol and n-Nitrosodiphenylamine were elevated above the AET criteria. Reporting limits for benzyl alcohol and hexachlorobenzene were elevated above the SMS criteria. Hexachlorobenzene was also analyzed by EPA 8081, and met reporting limit criteria.

Blank Contamination

The method blanks were non-detect with the following exception:

- MB-041911: The method blank had a detection for bis(2-ethylhexyl)phthalate above the reporting limit. The laboratory qualified that analyte in the associated sample, HC-WB-SS-001, with "B." The amount of bis(2-ethylhexyl)phthalate in the associated sample was less than five times the amount in the method blank, and the sample was qualified as non-detect. The B qualifier was changed to U.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits with the following exception:

- LCS/LCSD-041911: The recoveries for 2,4-dimethylphenol and bis(2-ethylhexyl)phthalate fell below the control limits, but fell within the Marginal Exceedance (ME) limits for the LCS and LCSD. The recovery for di-n-octyl phthalate fell below the control limits and the ME limits in the LCS and LCSD. Results for those analytes in the associated sample, HC-WB-SS-001, were qualified as estimated (J).

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves were within acceptance criteria.

The CCVs fell within control limits with the following exception:

- CCV 04/21/11: The recoveries for diethylphthalate and the surrogate Terphenyl-d14 fell below the control limits. The target analyte acenaphthene did not meet the minimum response factor (RF) criteria. Results for those analytes in the associated sample, HC-WB-SS-001, were qualified as estimated (J).

Polycyclic Aromatic Hydrocarbons (PAHs)

Analytical Methods

Sample HC-WB-SS-001 was extracted by EPA Method 3546 (microwave) following PSEP modifications to attain lower reporting limits. Samples HC-WB-SS-002, HC-WB-SS-003, and HC-WB-SS-004 were extracted by EPA Method 3550 (sonication) following PSEP modifications to attain lower reporting limits. The samples were analyzed by GC/MS with Selected Ion Monitoring (SIM) following EPA Method 8270D-SIM.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors. Detections that fell between the reporting limit and the MDL were qualified by the laboratory as "J." The laboratory "J" qualifier was changed to "T" to be consistent with Ecology's EIM database.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits with the following exception:

- LCS/LCSD-041911: The recoveries for phenanthrene, chrysene, and fluoranthene fell below the control limits in the LCS, but fell within the control limits in the LCSD. The RPD results for the target analytes exceeded 30 percent with the exception of Total benzofluoranthenes. The results for phenanthrene, chrysene, and fluoranthene in the associated sample, HC-WB-SS-001, were qualified as estimated (J) due to recovery and RPD failures. The remaining analytes were not qualified as the LCS and LCSD recoveries were within control limits.

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves and CCVs were within acceptance criteria.

Bulk Tributyltin (TBT)

Analytical Methods

The samples were extracted by EPA Method 3546 (microwave). The samples were analyzed by GC/MS-SIM following the Krone 1988 method.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits, but fell outside the QAPP control limits. Sample results were not qualified, with the following exception:

- LCS/LCSD-040611: The recoveries fell within the laboratory control limits, but fell outside the QAPP control limits. The RPDs exceeded the laboratory control limits of 30 percent, with the RPD for butyltin exceeding 50 percent. Results for butyltin in the associated samples, HC-WB-SS-002, HC-WB-SS-003, and HC-WB-SS-004, were qualified as estimated (J).

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves were within acceptance criteria. The CCVs were within acceptance criteria.

Porewater Tributyltin

Analytical Methods

The porewater was extracted following the DMMP Clarification Paper for Tributyltin Analysis (DMMP 1998). The porewater samples were extracted by EPA Method 3510C (separatory funnel). The samples were analyzed by GC/MS-SIM following the Krone 1988 method.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for any required dilution factors.

Blank Contamination

The method blanks were non-detect with the following exception:

- MB-040111: The method blank had a detection for butyltin above the reporting limit. The associated samples, HC-WB-SS-002, HC-WB-SS-003, and HC-WB-SS-004, were qualified by the laboratory with "B." The results for butyltin in the associated samples were less than 5 times the amount in the method blank, and were qualified as non-detect. The B qualifier was changed to U.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within advisory laboratory control limits with the following exceptions:

- LCSD-042011: The recovery for butyltin fell below the control limits in the LCSD, but fell within the control limits in the LCS. The RPD exceeded control limits of 30 percent. Results for butyltin in the associated sample, HC-WB-SS-001, were qualified as estimated (J).
- LCS/LCSD-040111: The RPD for tributyl tin exceeded the laboratory control limits of 30 percent. As the LCS and LCSD recoveries for tributyl tin fell within the control limits, sample results were not qualified.

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves and CCVs were within acceptance criteria.

The DFTPP tune analyzed on April 16, 2011 failed the m/e 199 criteria. As a tune is not required for the TBT analysis by GC/MS-SIM, no sample results were qualified.

Hexachlorobenzene (HCB) and Hexachlorobutadiene (HCBD)

Analytical Methods

Sample HC-WB-SS-001 was extracted by EPA Method 3546 (microwave) following PSEP modifications to attain lower reporting limits. Samples HC-WB-SS-002, HC-WB-SS-003, and HC-WB-SS-004 were extracted by EPA Method 3550C (sonication) following PSEP modifications to attain lower reporting limits. The samples were analyzed by Gas Chromatograph fitted with an Electron Capture Detector (GC/ECD) following EPA Method 8081.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors.

Samples HC-WB-SS-002, HC-WB-SS-003, and HC-WB-SS-004 were analyzed at a 5-fold dilution due to the sample matrices. The reporting limits were elevated due to the dilutions.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits with the following exceptions:

- HC-WB-SS-002. The surrogate decachlorobiphenyl (DCBP) was not reported due to matrix interferences. The recovery for the surrogate Tetrachlorometaxylene (TCMX) fell within the laboratory control limits. The sample results were non-detect, and were not qualified as TCMX was within control.
- HC-WB-SS-003 and HC-WB-SS-004. The recovery for the surrogate DCBP exceeded the control limits. The recovery for the surrogate TCMX fell within the laboratory control limits. The sample results were non-detect, and were not qualified as TCMX was within control.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits.

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curve analyzed on April 2, 2011 was within acceptance criteria. The second source ICV was apparently not spiked with HCB and HCBD. Associated sample results were non-detect and not qualified.

The CCVs were within control limits.

The DDT breakdown check for the closing CCV on April 12, 2011, failed on one column. As DDT was not a target analyte, no sample results were qualified.

Polychlorinated Biphenyls (PCBs)

Analytical Methods

The samples were extracted by EPA Method 3546 (microwave) and the extracts were acid and sulfur cleaned. The sample extracts for HC-WB-SS-002, HC-Wb-SS-003, and HC-WB-SS-004 were also silica gel cleaned. The samples were analyzed by GC/ECD following EPA Method 8082.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors. Detections that fell between the reporting limit and the MDL were qualified by the laboratory as "J." The laboratory "J" qualifier was changed to "T" to be consistent with Ecology's EIM database.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits.

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves and CCVs were within acceptance criteria.

Diesel and Lube Oil Range Hydrocarbons

Analytical Methods

The samples were extracted by EPA Method 3546 (microwave) and the extracts were acid and silica gel cleaned. The samples were analyzed by GC fitted with a Flame Ionization Detector (GC/FID) following NWTPH-Dx method.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors. Detections that fell between the reporting limit and the MDL were qualified by the laboratory as "J." The laboratory "J" qualifier was changed to "T" to be consistent with Ecology's EIM database.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves were within acceptance criteria.

The CCVs were within control limits with the following exceptions:

- CCV 0419A024.d: The recovery of the surrogate n-Triacontane exceeded the control limits. The recoveries for the surrogates n-Triacontane and o-Terphenyl in the associated sample, HC-WB-SS-001, fell within the control limits. Sample results were not qualified.

Gasoline Range Hydrocarbons

Analytical Methods

The samples were prepared by EPA Method 5035 (methanol). The samples were analyzed by GC /FID following NWTPH-Gx method.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors.

Blank Contamination

No target analytes were detected in laboratory blanks. The trip blank was non-detect.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves were within acceptance criteria.

The CCVs were within control limits with the following exception:

- CCV 0328a003.d: The recovery for the surrogate Trifluorotoluene (TFT) exceeded the control limits. The recovery for the surrogate Bromobenzene fell within the control limits. The surrogate recoveries in the associated samples, MB-032811, LCS/LCSD-032811, were within control limits. Sample results were not qualified.

Total Metals

Analytical Methods

Sediment samples for mercury were prepared and analyzed following EPA Method 7471A. Sediment samples for arsenic, cadmium, chromium, copper, lead, silver, and zinc were analyzed following EPA Method 6010B.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors.

Blank Contamination

No target analytes were detected in laboratory blanks.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within method control limits.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves and CCVs were within acceptance criteria.

Conventional Sediment Parameters

Analytical Methods

Total solids were determined by modified EPA Method 160.3. Total volatile solids (TVS) were determined by EPA Method 160.4. Total organic carbon (TOC) was determined by Plumb (1981).

Sample Holding Times

The samples met holding time limits for total solids, TOC, and TVS.

Laboratory Detection Limits

Reported detection limits were acceptable.

Blank Contamination

No target analytes were detected in laboratory blanks.

Laboratory Control Sample (LCS) Recovery

LCS recoveries for TOC were within QC limits.

Matrix Spike (MS) Recovery

MS recoveries for TOC were within QC limits.

Laboratory Replicate Sample Analysis

The RSD between replicate measurements met quality control limits for total solids, TVS, and TOC.

Standard Reference Material (SRM) Recovery

SRM recoveries for TOC were within QC limits.

Porewater Ammonia

Analytical Methods

The porewater was extracted following the DMMP Clarification Paper for Tributyltin Analysis (DMMP 1998). The samples were prepared and analyzed following modified EPA Method 350.1.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits were acceptable.

Blank Contamination

No target analytes were detected in laboratory blanks.

Matrix Spike (MS) Recovery

MS recoveries were within QC limits.

Laboratory Duplicate Sample Analysis

The RPD between replicate measurements met control limits.

Standard Reference Material (SRM) Recovery

SRM recoveries were within QC limits.

Porewater Sulfide

Analytical Methods

The porewater was extracted following the DMMP Clarification Paper for Tributyltin Analysis (DMMP 1998). The samples were prepared and analyzed following EPA Method 376.2.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits were acceptable.

Blank Contamination

No target analytes were detected in laboratory blanks.

Laboratory Control Sample (LCS) Recovery

LCS recoveries were within QC limits.

Matrix Spike (MS) Recovery

MS recoveries within QC limits.

Laboratory Replicate Sample Analysis

The sample and duplicate were non-detect, and the RPD was not applicable.

Grain Size

Analytical Methods

The samples were analyzed following PSEP methodology.

Sample Holding Times

The samples were prepared within holding time limits

Laboratory Detection Limits

Reported detection limits were acceptable.

Laboratory Triplicate Sample Analysis

The RSD fell within control limits.

Sample Notes

Sample HC-WB-SS-001 contained organic matter and shell fragments. Sample HC-WB-SS-002 contained wood debris. Sample HC-WB-SS-003 contained shells and organics (wood debris). Grain size analysis may be affected due to potential breakdown of debris.

Sample HC-WB-SS-004 did not contain sufficient fines to perform the pipette analysis. The sample contained shells.

Dioxins/Furans

Analytical Methods

Sediment samples for dioxins/furans analysis were prepared and analyzed by EPA Method 1613B.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors. The samples were reported to the reporting limit, but calculated to the Estimated Detection Limit (EDL). Detections that fell between the reporting limit and the MDL were qualified by the laboratory as "J." The laboratory "J" qualifier was changed to "T" to be consistent with Ecology's EIM database.

Blank Contamination

The method blank had detections for 1,2,3,4,6,7,8-HpCDF, OCDD, and Total HpCDF below the reporting limits. The laboratory qualified the detections with "J." The laboratory "J" qualifier was changed to "T." The associated samples were not qualified as the levels in the samples were significantly higher (>5 times) the levels in the method blank.

Labeled Compound Recovery

Labeled compound recoveries were within QC limits.

Ongoing Precision and Accuracy Sample Recovery

OPR recoveries were within advisory laboratory control limits.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curve was within acceptance criteria.

CCVs were within control limits with the following exception:

- CCV 11040720 analyzed on April 8, 2011 at 02:33. The analytes 1,2,3,7,8,9-HxCDD, ^{13}C-1,2,3,4,7,8-HxCDD, ^{13}C-1,2,3,6,7,8-HxCDD, and ^{13}C-OCDD exceeded the +/- 20 percent criteria. This CCV was analyzed as a closing CCV following sample analysis. The method only requires a CCV at the beginning of each 12-hour shift. As the initial CCV was within control limits, no sample results were qualified.

Sample Qualifiers

- HC-WB-SS-004: The analytes 2,3,7,8-TCDD and 1,2,3,7,8,9-HxCDF were qualified by the laboratory with J and EMPC. Results for those analytes were qualified as UK.

Chemical Data Quality Review for Subtidal Sediment Samples

Four subtidal sediment samples were collected from Westbay Marina on March 30, 2011. The samples were submitted to ARI for analysis. Sample identifications, laboratory job numbers, and analytical tests are summarized in Table 1 of the report.

Quality assurance/quality control (QA/QC) reviews of laboratory procedures were performed on an ongoing basis by the laboratory. Hart Crowser performed the data review, using laboratory quality control results summary sheets and raw data, as required, to ensure they met data quality objectives for the project. Data review followed the format outlined in the National Functional Guidelines for Organic Data Review (EPA 2008), and the National Functional Guidelines for Inorganic Data Review (EPA 2010) modified to include specific criteria of the individual analytical methods. The following criteria were evaluated in the standard data quality review process:

- Holding times;
- Method blanks;
- Surrogate recoveries;
- Laboratory control sample/laboratory control sample duplicate (LCS/LCSD) recoveries;
- Matrix spike/matrix spike duplicate (MS/MSD) recoveries;
- Laboratory duplicate relative percent differences (RPDs);
- Laboratory replicate relative standard deviation (RSD);
- Internal standard (IS) recoveries (where applicable);
- Standard Reference Material (SRM) recoveries (where applicable);
- Calibration criteria (where applicable); and
- Reporting limits (RL).

The data were determined to be acceptable for use, as qualified. Full laboratory results are presented at the end of this appendix. Results of the data reviews, organized by analysis class, follow.

Sample Receiving Discrepancies

One 32-oz jar for sample HC-WB-SS-005 was mis-labeled as HC-WB-SS-006. The laboratory correctly identified the jar by the time of collection and the other sample containers.

The cooler containing sample HC-WB-SS-008 contained pink-colored water mixed with the ice. The colored water was due to Rose Bengal which leaked from ziplock bags containing the benthic samples which had been placed for a short time in the cooler. No pink colored water entered the ziplock bags containing the sample jars, and no samples were affected.

Semivolatile Organic Compounds (SVOCs)

Analytical Methods

The samples were extracted by EPA Method 3546 (microwave) following PSEP modifications to attain lower reporting limits. The samples were analyzed by GC/MS following EPA Method 8270D.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors. Detections that fell between the reporting limit and the MDL were qualified by the laboratory as "J." The laboratory "J" qualifier was changed to "T" to be consistent with Ecology's EIM database.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits.

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves were within acceptance criteria for target analytes.

The CCVs fell within control limits with the following exceptions:

- CCV 04/18/11: The target analyte acenaphthene did not meet the minimum response factor (RF) criteria. Results for that analyte in the associated samples, MB-041211, LCS/LCSD-041211, were qualified as estimated (J).
- CCV 04/25/11: The recoveries for diethylphthalate and the surrogate Terphneyl-d14 fell outside the control limits. Results for those analytes in the associated samples, HC-WB-SS-005, HC-WB-SS-006, HC-WB-SS-007, and HC-WB-SS-008, were qualified as estimated (J).

Polycyclic Aromatic Hydrocarbons (PAHs)

Analytical Methods

The samples were extracted by EPA Method 3550 (sonication) following PSEP modifications to attain lower reporting limits. The samples were analyzed by GC/MS with Selected Ion Monitoring (SIM) following EPA Method 8270D-SIM.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors. Detections that fell between the reporting limit and the MDL were qualified by the laboratory as "J." The laboratory "J" qualifier was changed to "T" to be consistent with Ecology's EIM database.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits with the following exception:

- LCS/LCSD-040811: The RPD results for the target analytes exceeded 30 percent. As the recoveries were within control limits, sample results were not qualified.

Matrix Spike (MS) Recovery

Matrix spikes were within laboratory control limits with the following exceptions:

- MS/MSD-040811: The recovery for fluorene exceeded the control limits in the MS, but fell within control limits in the MSD. The recovery for phenanthrene and dibenzofuran exceeded the Marginal Exceedance (ME) limits in the MS, but fell within control limits in the MSD. The recoveries for fluoranthene, chrysene, and pyrene were not applicable due to high levels of those analytes in the source sample compared to the spiking amount. The recovery for Benz(a)anthracene fell below the ME limits in the MS, but fell within the control limits in the MSD. The RPD values exceed 30 percent for phenanthrene and total benzofluoranthenes.

  The amounts of analytes fluoranthene, pyrene, chrysene, and total benzofluoranthenes in the source sample exceeded the amount spiked, and no results were qualified for those analytes. The results for fluorene were not qualified, as the recovery was within control limits in the MSD, and within ME limits in the MS. The results for dibenzofuran were not qualified as the recovery was within control limits in the MSD, and recovery in the MS was 105 percent. The results for benz(a)anthracene were not qualified as the amount of that analyte in the source sample was comparable to the amount spiked, and the MSD was within control limits. Phenanthrene results in HC-WB-SS-005 were qualified as estimated (J).

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves and CCVs were within acceptance criteria.

Bulk Tributyltin (TBT)

Analytical Methods

The samples were extracted by EPA Method 3546 (microwave). The samples were analyzed by GC/MS-SIM following the Krone 1988 method.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors. Detections that fell between the reporting limit and the MDL were qualified by the laboratory as "J." The laboratory "J" qualifier was changed to "T" to be consistent with Ecology's EIM database.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits, but fell outside the QAPP control limits. Sample results were not qualified.

Matrix Spike (MS) Recovery

Matrix spike recoveries were within laboratory control limits.

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves were within acceptance criteria.

The CCVs were within control limits with the following exception:

- CCV 04/12/11: The recovery of the surrogate Tripentyl tin (hexyl) exceeded the control limits. The recoveries of both surrogates within the associated samples were within control limits, and no results were qualified.

Porewater Tributyltin

Analytical Methods

Analytical Methods

The porewater was extracted following the DMMP Clarification Paper for Tributyltin Analysis (DMMP 1998). The porewater samples were extracted by EPA Method 3510C (separatory funnel). The samples were analyzed by GC/MS-SIM following the Krone 1988 method.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for any required dilution factors.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within advisory laboratory control limits.

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves and CCVs were within acceptance criteria.

The DFTPP tune analyzed on April 16, 2011 failed the m/e 199 criteria. As a tune is not required for the TBT analysis by GC/MS-SIM, no sample results were qualified.

Hexachlorobenzene (HCB) and Hexachlorobutadiene (HCBD)

Analytical Methods

The samples were extracted by EPA Method 3550C (sonication) following PSEP modifications to attain lower reporting limits. The samples were analyzed by GC/ECD following EPA Method 8081.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors.

Samples HC-WB-SS-005, HC-WB-SS-006, HC-WB-SS-007, and HC-WB-SS-008 were analyzed at a 5-fold dilution due to the sample matrices. The reporting limits were elevated due to the dilutions.

Blank Contamination

The method blank was non-detect. The reporting limit for HCBD was elevated due to chromatographic interferences and qualified by the laboratory with "Y." The Y qualifier was changed to U.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits.

Matrix Spike (MS) Recovery

Matrix spike recoveries were within laboratory control limits.

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curve analyzed on April 2, 2011 was within acceptance criteria. The second source ICV was apparently not spiked with HCB and HCBD. Associated sample results were non-detect and not qualified.

The CCVs were within control limits.

The DDT breakdown check for the bracketing CCV on April 12, 2011, failed on one column. As DDT was not a target analyte, no sample results were qualified.

Polychlorinated Biphenyls (PCBs)

Analytical Methods

The samples were extracted by EPA Method 3546 (microwave) and the extracts were acid, sulfur, and silica gel cleaned. The samples were analyzed by GC/ECD following EPA Method 8082.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors.

Sample HC-WB-SS-006 was analyzed at a 10-fold dilution due to high levels of target analytes. The reporting limits were raised due to the dilution. The reporting limits for Aroclors 1248 and 1260 were elevated due to matrix interferences, and qualified by the laboratory with "Y." The Y qualifier was changed to U.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits.

Internal Standards (IS) Recovery

Internal standards were within acceptance criteria with the following exception:

- HC-WB-SS-005: The IS 1-Bromo-2-Nitrobenzene and Hexabromobiphenyl fell below the acceptance criteria on the April 23, 2011 analysis. The sample was reanalyzed undiluted on April 25, 2011 with passing IS. The results were reported from the reanalysis and no results were qualified.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves and CCVs were within acceptance criteria.

Diesel and Lube Oil Range Hydrocarbons

Analytical Methods

The samples were extracted by EPA Method 3546 (microwave) and the extracts were acid and silica gel cleaned. The samples were analyzed by GC/FID following NWTPH-Dx method.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits.

Matrix Spike (MS) Recovery

Matrix spike recoveries were within laboratory control limits.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves were within acceptance criteria. The CCVs were within control limits.

Gasoline Range Hydrocarbons

Analytical Methods

The samples were prepared by EPA Method 5035 (methanol). The samples were analyzed by GC /FID following NWTPH-Gx method.

Sample Holding Times

The samples were prepared and analyzed within the holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors.

Blank Contamination

No target analytes were detected in laboratory blanks.

Surrogate Recovery

Surrogate recoveries were within laboratory control limits with the following exceptions:

- HC-WB-SS-005 and HC-WB-SS-006: The recoveries for the surrogate Bromobenzene (BBZ) fell below the control limits, while the recoveries for the surrogate Trifluorotoluene (TFT) fell just within control limits. The laboratory indicated that the low surrogate recoveries were due to sample matrix, and reported the results. The results for gasoline in the samples were qualified as estimated (J).
- HC-WB-SS-006 MS and HC-WB-SS-007: The recoveries of the surrogates BBZ and TFT fell below the control limits. The laboratory indicated that the low surrogate recoveries were due to sample matrix, and reported the results. The results for gasoline in the samples were qualified as estimated (J).

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within laboratory control limits.

Matrix Spike (MS) Recovery

Matrix spike recoveries fell below laboratory control limits, indicating a matrix effect. Sample results were qualified as estimated (J).

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves were within acceptance criteria. The CCVs were within control limits.

Total Metals

Analytical Methods

Sediment samples for mercury were prepared and analyzed following EPA Method 7471A. Sediment samples for arsenic, cadmium, chromium, copper, lead, silver, and zinc were analyzed following EPA Method 6010B.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits and analytical results were adjusted for moisture content and any required dilution factors.

Blank Contamination

No target analytes were detected in laboratory blanks.

Laboratory Control Sample (LCS) Recovery

Laboratory control sample recoveries were within method control limits.

Matrix Spike (MS) Recovery

Matrix spike recoveries were within method control limits.

Laboratory Duplicate Sample Analysis

The RPD between replicate measurements met quality control limits or were not applicable if the sample and duplicate were less than five times the reporting limit.

Initial Calibration Curves and Continuing Calibration Verification Checks (CCVs)

The initial calibration curves and CCVs were within acceptance criteria.

Conventional Sediment Parameters

Analytical Methods

Total solids were determined by modified EPA Method 160.3. Total volatile solids (TVS) were determined by EPA Method 160.4. Total organic carbon (TOC) was determined by Plumb (1981).

Sample Holding Times

The samples met holding time limits for total solids, TOC, and TVS.

Laboratory Detection Limits

Reported detection limits were acceptable.

Blank Contamination

No target analytes were detected in laboratory blanks.

Laboratory Control Sample (LCS) Recovery

LCS recoveries for TOC were within QC limits.

Matrix Spike (MS) Recovery

MS recoveries for TOC were within QC limits.

Laboratory Replicate Sample Analysis

The RSD between replicate measurements met quality control limits for total solids, TVS, and TOC.

Standard Reference Material (SRM) Recovery

SRM recoveries for TOC were within QC limits.

Porewater Ammonia

Analytical Methods

The porewater was extracted following the DMMP Clarification Paper for Tributyltin Analysis (DMMP 1998). The samples were prepared and analyzed following modified EPA Method 350.1.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits were acceptable.

Blank Contamination

No target analytes were detected in laboratory blanks.

Standard Reference Material (SRM) Recovery

SRM recoveries were within QC limits.

Porewater Sulfide

Analytical Methods

The porewater was extracted following the DMMP Clarification Paper for Tributyltin Analysis (DMMP 1998). The samples were prepared and analyzed following EPA Method 376.2.

Sample Holding Times

The samples were prepared and analyzed within holding time limits.

Laboratory Detection Limits

Reported detection limits were acceptable.

Blank Contamination

No target analytes were detected in laboratory blanks.

Laboratory Control Sample (LCS) Recovery

LCS recoveries were within QC limits.

Grain Size

Analytical Methods

The samples were analyzed following PSEP methodology.

Sample Holding Times

The samples were prepared within holding time limits.

Laboratory Detection Limits

Reported detection limits were acceptable.

Laboratory Triplicate Sample Analysis

The RSD fell within control limits.

Sample Notes

Samples HC-WB-SS-005, HC-WB-SS-006, HC-WB-SS-007, and HC-WB-SS-008 contained organic matter. Grain size analysis may be affected due to potential breakdown of debris.

Sample HC-WB-SS-005 had an oily sheen and oil-like odor.

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APPENDIX B
LABORATORY REPORTS
(SEE ATTACHED CD-ROM)

APPENDIX C
TERRESTRIAL ECOLOGICAL EVALUATION

Westbay Marina Site Terrestrial Ecological Evaluation

C-1.0 Introduction

This terrestrial ecological evaluation (TEE) is part of the remedial investigation/feasibility study (RI/FS) for the Westbay Marina Site (Site). The TEE assesses potential ecological hazards associated with residual constituent concentrations in soil at the Site. The Site is located at 2100 Westbay Drive NW, Olympia, Washington, on the western shore of Budd Inlet (Township 18N, Range 2W, and Section 57[1]). The Site has been owned by the Westbay Marina Association since 1990.

This TEE was performed following procedures consistent with the Washington State Model Toxics Control Act (MTCA), WAC 173-340-7490 through 7494. The MTCA TEE framework includes three evaluation tiers (Figure C-1). Tier 1, TEE Exclusions, consists of a set of criteria that are used to determine if a site can be excluded from further consideration. If results of the Tier 1 assessment indicate the Site requires further evaluation, criteria are provided to determine if the site should be evaluated using Tier 2 or Tier 3 procedures.

Tier 2 (Simplified TEE) consists of an evaluation of potential ecological exposures, an exposure pathway analysis, and a comparison of constituent concentrations in site soil to default screening concentrations protective of plants and/or animals. If the site meets any of the Tier 2 criteria, no further evaluation is required. If the site does not meet any of the Tier 2 criteria, it can either proceed into a feasibility study or a Tier 3 evaluation.

Tier 3 (Site-Specific TEE) consists of a detailed ecological evaluation. MTCA provides a general framework for conducting a Tier 3 evaluation, but because of the nature of a site-specific evaluation, MTCA does not provide explicit details for the evaluation.

The uplands Site property, consisting of Thurston County Parcels 09750018002 and 09750018003 (Figure C-2), is currently being used primarily for storage and parking for the marina. A portion of Tugboat Annie's Restaurant also lies on the uplands property. These parcels are zoned urban waterfront and residential R 4-8,[2] which is designated for a compatible mix of commercial, light industrial, limited heavy industrial, and multifamily residential uses along the waterfront, consistent with the Shoreline Master Program for Thurston Region.[3],[4] The

[1] US Department of Interior Geologic Survey Tumwater Quadrangle, Thurston Co., Washington. 7.5 Minute Series (Topographic)
[2] Information obtained from the Thurston County Permitting and Land Use website on May 8, 2011 (http://www.co.thurston.wa.us/permitting/index.htm)
[3] Comprehensive Plan for Olympia and the Olympia Growth Area available online at http://olympiawa.gov/en/city-services/planning-and-zoning/current-planning.aspx.

Delson Lumber Company property is located south of the Site and also zoned "urban waterfront." The Dunlap Towing Company property is located north of the Site and is zoned "industrial." A forested hillside area lies to the west of the Site across Westbay Drive NW and is zoned residential (R-4-8).

MTCA (WAC 173-340-7490[3][b]) stipulates that for commercial/industrial properties, the TEE should be protective of terrestrial wildlife (e.g., birds and mammals). For all other land uses, the TEE should be protective of plants, soil biota, and wildlife. Considering the current land use and zoning designation, land use for the Westbay Marina Site is determined to be commercial (WAC 173-340-7490(3)(c)) because it is currently being used for traditional commercial uses with parking, offices, and retail. Therefore, the goal of this TEE is the protection of terrestrial wildlife.

The standard point of compliance for a TEE extends from the soil surface to a depth of 15 feet (WAC 173-340-7490[4]). MTCA also allows for the use of a conditional point of compliance which represents the bioactive soil layer extending from 0 to 6 feet below ground surface (bgs). The conditional point of compliance represents a conservative estimate of the maximum depth of rooting and burrowing soil biota and wildlife. However, site-specific conditions may limit the bioactive soil layer to less than the conditional point of compliance and MTCA provides for the development of site-specific points of compliance for the TEE based on analysis of the biological and physical conditions present at the site.

An evaluation of historical aerial photographs indicate that much of the current uplands portion of the Site consists of fill placed over intertidal beach (Anchor 2009). Groundwater generally flows in an easterly direction but is influenced by two factors: the volume of groundwater flow from the west and tidally influenced water from the east. Depending on tidal cycles and weather conditions, the groundwater level continually fluctuates between approximately 4 and 10 feet bgs (Anchor 2009). Since plant roots and burrowing animals will not go below the groundwater level, the site-specific point of compliance for the Westbay Marina Site should be 4 feet bgs.

C-2.0 Environmental and Ecological Setting

The Westbay Marina Site is located on the western shore of Budd Inlet and consists of a 400-slip marina and an upland area (Figure C-2). The Site is bordered to the south by a vacant commercial property owned by the Delson Lumber Company (a log sorting operation) and the Dunlap Towing Company (a storage facility) to the north. The west side of the Site is bordered

[4] Olympia Municipal Code 18.06.020.B.4. Permitted uses include restaurants, industrial and office uses, recreation and culture, residential, retail sales, services, and lodging.

by Westbay Drive NW, a two-lane asphalt-paved road. A steep vegetated hillside is located west of Westbay Drive NW and a residential area is located at the top of the bluff.

A detailed description of the environmental history and current conditions of the Site are presented in Section 2.0 of this RI/FS. The Site was initially developed by the Buchanan Lumber Company in 1919 and wood products were produced at the Site between 1919 and 1966 (Anchor 2009). The Site was never used for wood treatment. Figure C-3 shows the areas of potential environmental concern at the Site. The environmental conditions at these areas are summarized as follows:

- **Former Hog Fuel Burner:** A teepee-type burner operated on the Site during part of the Buchanan Lumber Company operational period (1919 to 1966). It burned hog fuel (i.e., wood waste) that potentially generated dioxins/furans when saltwater-laden wood waste was burned. Dioxins/furans at concentrations of 14.2 and 61.9 ng/kg (expressed as a total 2,3,7,8-tetrachlorodibenzo-*p*-dioxin toxic equivalent (TEQ) for mammals[5]) were detected in two soil samples collected in 2010 adjacent to the former hog fuel burner. Four soil samples were collected adjacent to the former hog fuel burner in 2011 and analyzed for dioxins/furans (see Section 4.0 of this RI Report). Dioxin TEQ concentrations ranged from 6.09 to 87.58 ng/kg, with two samples having TEQs above the MTCA Method B level of 11 ng/kg.
- **Former USTs and Valve Box:** Three USTs (1,500-gallon leaded gasoline, 4,000-gallon unleaded gasoline, and 2,000-gallon diesel) were removed from the Site in 1999 along with 675 tons of affected soil. Verification sampling of the floor and side walls of the excavation showed petroleum hydrocarbons were either non-detect or were present at concentrations below MTCA Method A levels. Additional soil samples were subsequently collected in 1999 from the perimeter of the UST excavation, the entire length of the fuel supply lines, and beneath the dispenser-mounting location. Results of this sampling showed the presence of volatile organic compounds (VOCs) and TPH mixtures above MTCA Method A levels in the pump island area, the valve box area, and the underground fuel supply line area. Soil in the valve box area were inaccessible for excavation, so *in situ* bioremediation was selected as the remedy. A single soil sample was collected from the UST system valve box in 2010 to determine if the *in situ* bioremediation remedy was successful. Results of this valve box sample showed that TPH levels were below MTCA Method A levels.

[5] The total dioxin TEQs were calculated using toxic equivalency factors (TEFs) for mammals from Van den Berg et al. (2006). It should be noted that Van den Berg et al. (1998) also provide TEFs for birds that differ slightly from the 2006 mammalian TEFs.

- **Former Waste Oil Storage Area:** In 1992, a total of 55 tons of soil was excavated from the former aboveground waste oil storage area to address elevated levels of TPH. Verification sampling showed residual concentrations of TPH were below MTCA Method B levels.
- **Southern Ditch:** The southern ditch potentially received discharges from marina operations on the south side of the Site. The top three inches of soil were removed from areas of the southern ditch in 1992 to address potential discharges of organic and inorganic constituents that were detected in ditch soil to Budd inlet. Although verification sampling showed concentrations of organic and inorganic constituents were below MTCA Method B levels, a single soil sample collected from the ditch 4 months after the removal action showed copper was detected at a concentration above the MTCA Method B level. Three additional soil samples collected from the ditch in 2010 had copper concentrations ranging from 76.6 to 1,360 mg/kg, which are below the MTCA Method B (direct contact) level of 3,000 mg/kg.

The uplands portion of the Site includes approximately 3.01 acres of which most are covered by asphalt or armored gravel and serves as storage and parking areas (Anchor 2009) (Figure C-4). Tugboat Annie's Restaurant and several other structures are situated on the uplands. Approximately 0.3 acres of the upland area consists of open areas where ecological exposure to constituents present in soil could potentially occur.[6] These open areas consist of landscape plantings distributed along the perimeter of the Site, landscape islands distributed in the parking lot, and the southern ditch, which is covered by weedy vegetation (Figure C-4 and Table C-1). All landscaped areas have a topsoil surface layer varying from 6 to 24 inches in depth and many are covered by a bark/wood mulch layer. The southern ditch is not landscaped, but is vegetated with weedy grasses and forbs. Figures C-5 through C-14 provide further information on each of the open areas shown on Figure C-4 and also provide descriptions of adjacent properties.

The only open areas with constituents detected in soil are:

- Northern Strip (Area 1): The former hog fuel burner associated with Buchanan Lumber Company operated in this area and may have been a source of dioxins/furans present in soil samples.
- Southern Ditch (Area 5): This ditch may have received discharges from former marina operations that contributed to the elevated levels of copper present in soil samples.

[6] Areas covered by buildings, asphalt pavement, or armored gravel do not provide a complete pathway for ecological exposure to constituents present in soil.

All other open areas are not associated with potential sources and were not sampled during any environmental investigation.

Habitat on the Site is of limited value to wildlife because of its ornamental nature, small size, and discontinuous distribution. The industrial areas north and south of the Site also provide little wildlife habitat. The hillside located west of the Site is covered by a mixture of native and non-native vegetation and does provide reasonable quality habitat for wildlife. The hillside runs along much of the western shoreline of Budd Inlet and provides a corridor connecting other forested areas occurring on the top of the bluff. Wildlife living within the hillside corridor area may occasionally visit the Site.

The landscape plantings on the Site consist primarily of ornamental species. Non-native weedy plants species (e.g., Himalayan blackberry, Scotch broom, dandelion) are also present within the landscaped areas as well as in the southern ditch. An earthworm and a grub were observed while sampling soil adjacent to the former hog fuel burner in 2011. No wild mammals were observed on the Site during the 2011 field sampling, although exotic rodents (e.g., Norway rat, house mouse, grey squirrel) and some native mammals (e.g., raccoon, opossum, voles) would be expected to use or visit the Site. During the 2011 field investigation, pigeons and crows were observed on the Site and mallard ducks were observed in the ditch bordering the north side of the Site. Other urbanized bird species (e.g., English sparrow, gulls, geese, robins) may also use the Site.

A search of the Washington State Department of Natural Resources Natural Heritage Program website indicated that no natural heritage features (i.e., rare plant species or high-quality ecosystems)[7] are present on or near the Site. In addition, the Washington State Department of Fish and Wildlife Priority Habitats and Species (PHS) Program database was queried for information on the presence of State species of concern near the Site. State species of concern include those animal species listed as State Endangered, State Threatened, State Sensitive, or State Candidate, as well as species listed or proposed for listing by the US Fish and Wildlife Service or the National Marine Fisheries Service. Although no animal species listed on the PHS database were reported to occur on the upland portion of the Site, several species occur within the vicinity (Table C-2).

The closest occurrence of a species of concern to the Site is the purple martin, which is a State candidate species. The PHS database reported that the purple martin was observed on the outer Westbay Marina dock. Purple martins feed upon flying insects and are not expected to be potentially exposed to constituents in soil at the Site. The highest-ranked State sensitive species occurring near the Site is the peregrine falcon. The peregrine falcon was observed

[7] Information available online at http://www1.dnr.wa.gov/nhp/refdesk/search.html.

approximately 1 mile south of the Site. Peregrine falcons forage upon birds (likely pigeons) and are not expected to be potentially exposed to constituents present in soil at the Site. Information from the PHS database indicated that no priority habitats occur on the Site. The closet priority habitat is an aquatic habitat paralleling the shoreline beginning approximately 1,000 feet north of the Site. The nature of this priority habitat is not known.

The information presented above indicates that no natural heritage features for plants or species of concern for animals would be exposed to constituents in soil on the upland portion of the Westbay Marina Site.

C-3.0 Exclusions Analysis

The first tier in the TEE process is the exclusions analysis, which determines if a site can be excluded from further consideration. MTCA (WAC 173-340-7491) provides four criteria for determining that no further evaluation is required. If any of the four criteria are met, it can be concluded that the ecological exposure pathways are incomplete (or *de minimis*) or constituent concentrations are below a level of concern. The four criteria are:

- **Criterion 1:** All affected soil is or will be located below the point of compliance.
- **Criterion 2:** All affected soil is or will be covered by buildings, paved roads, pavement, or other physical barriers that will prevent ecological exposure to the contaminated soil.
- **Criterion 3:** Undeveloped land on or within 500 feet of the site is less than a quarter of an acre if any highly toxic constituents are detected in soil, or less than 1.5 acres if highly toxic constituents are not detected in soil.
- **Criterion 4:** Concentrations of constituents in the soil do not exceed natural background levels.

Criterion 1 connotes ecological exposure to constituents in soil will not occur because constituents are present only in deep soil. The standard MTCA point of compliance is 15 feet below ground surface (bgs). If all detected constituents occur below 15 feet bgs, no further evaluation is required. MTCA also specifies a conditional point of compliance at six feet bgs. The 0- to 6-foot soil strata is assumed to be the biologically active zone where most, if not all, potential ecological exposures to constituents could occur. A no further evaluation conclusion may be reached at sites where all detected constituents occur below the conditional point of compliance when institutional controls are in place to prevent excavation of soil below 6 feet bgs.

Organic and inorganic constituents are present in surface soil at several locations on the Site (e.g., adjacent to the former hog fuel burner and former UST valve box). Therefore, affected soil

is present within the site-specific point of compliance and potential ecological exposure to constituents may occur at the Site.

Criterion 2 connotes that ecological exposure to constituents will not occur when those constituents are found in soil covered by a physical barrier. Although physical barriers typically include buildings and areas paved with asphalt or concrete, areas covered by compacted soil or gravel may also provide an effective ecological exposure barrier.

Residual concentrations of constituents are present is surface soil in several open areas of the Site (e.g., former hog fuel burner and southern ditch). Therefore, potential ecological exposure to constituents in soil may occur at the Site.

Criterion 3 connotes very small sites that are unlikely to pose an ecological hazard because of limited ecological exposure to constituents present in the soil. MTCA provides two sub-criteria dependent upon the type of constituents found at the site. For sites with high priority organic constituents,[8] the criterion is 0.25 acres of contiguous,[9] undeveloped[10] land on or within 500 feet of any area of the site. For sites not affected by high-priority organic constituents, the criterion is 1.5 acres of contiguous-undeveloped land on or within 500 feet of any area of the site.

Soil adjacent to the former hog fuel burner contain dioxins/furans (Anchor 2010; see Section 4.0 of this RI Report), which are high priority organic constituents. Therefore, the criterion is 0.25 acres of contiguous undeveloped land on or within 500 feet of any area of the site. A survey of open areas on the Westbay Marina Site was conducted as part of the 2010 field investigation. Results of that survey (Figure C-4 and Table C-1) show that a total of 0.3 acres of open ground are present on the Site. However, many of these open areas are separated by extensive areas of asphalt pavement or compacted gravel and may be considered non-contiguous. Notwithstanding, the hillside area does contain greater than 0.25 acres of contiguous undeveloped land within 500 feet of the Site. Therefore, the Site does not qualify for this exclusion criterion.

Criterion 4 connotes that constituents in soil do not pose an ecological hazard when concentrations are below natural background levels. Constituents detected in soil samples from the Site (Anchor 2010, see Section 4.0 of this RI Report) include copper, diesel-range TPH, and

[8] High priority organic chemicals include chlorinated dioxins and furans, PCB mixtures, DDT, DDE, DDD, aldrin, chlordane, dieldrin, endosufan, endrin, heptachlor/heptachlor epoxide, benzene hexachloride, toxaphene, hexachlorobenzene, pentachlorophenol, and pentachlorobenzene.

[9] Contiguous undeveloped land is defined as undeveloped land that is not divided into smaller areas by highways, extensive paving, or similar structures that are likely to reduce the potential use of the overall area by wildlife. Roads, sidewalks, and other structures that are unlikely to reduce potential use of the area by wildlife shall not be considered to divide a contiguous area into smaller areas.

[10] Undeveloped land is defined as land not covered by buildings, roads, paved areas, or other barriers that would prevent wildlife from feeding on plants, earthworms, or other food in or on the soil.

dioxins/furans. Copper is a naturally occurring metal in soil. The Washington State Department of Ecology (1994) has determined the natural background copper concentrations in soil in the Puget Sound region is 36 mg/kg. Results of the 2010 soil sampling in the southern ditch (Anchor 2010) show all copper concentrations exceed the natural background concentration (i.e., range is 76.6 to 1,360 mg/kg). Although diesel-range TPH and dioxins/furans are generally considered to be manmade when found in surface soil, both may have natural sources (ATSDR 1999; EPA 2003). Nonetheless, there are no generally accepted natural background concentrations for either group of compounds. Therefore, it is not possible to evaluate Criterion 4 for diesel-range TPH and dioxins/furans, and it must be conservatively concluded that concentrations of these constituents are above natural background levels.

Since none of the four criteria are met, it is concluded that the Westbay Marina Site does not qualify for an exclusion from a TEE, and further analysis is required.

C-4.0 Selection of TEE Methods

For sites that do not qualify for an exclusion, MTCA provides three criteria for determining whether a simplified or site-specific TEE should be conducted. If any of the three criteria are met, the site must be evaluated using a site-specific TEE. The criteria are:

- **Criterion 1:** The site is located on, or directly adjacent to, an area where management or land use plans will maintain or restore native or semi-native vegetation.
- **Criterion 2:** The site is used by a threatened or endangered species, a wildlife species classified as a priority species or species of concern by the Washington State Department of Fish and Wildlife, or a plant species classified as endangered, threatened, or sensitive by the Washington State Department of Natural Resources Natural Heritage Program.
- **Criterion 3:** The site is located on a property that contains at least ten acres of native vegetation within 500 feet of the site, not including vegetation beyond the property boundaries.

The Westbay Marina Site is used for commercial purposes (see Section 1.0). The Site is bounded by commercial/industrial properties to the north and south (Dunlap Towing Company and Delson Lumber Co.) and residential properties to the west. Since none of these properties are believed to be managed to maintain or restore native or semi-native vegetation, Criterion 1 does not apply to the Site.

Information obtained from the Washington State Departments of Fish and Wildlife and Natural Resources (Section 2.0) indicates there are no known occurrences of sensitive wildlife or plant species on or near the Site. Therefore, Criterion 2 does not apply to the Site.

The total upland area of the Site is 3.01 acres and none of the open areas contains native vegetation. Therefore, Criterion 3 does not apply to the Site.

Since none of the three selection criteria apply, it is concluded that the simplified TEE methodology is appropriate for evaluating potential ecological hazards to wildlife at the Westbay Marina Site.

C-5.0 Simplified TEE

The simplified TEE consists of an exposure analysis, pathways analysis, and contaminants analysis (WAC 173-340-7493). These steps need not be followed in order, and any one step may be used to determine that no further evaluation is necessary to conclude a site does not pose a hazard to terrestrial ecological receptors.

C-5.1 Exposure Analysis

The exposure analysis consists of two criteria:

- **Criterion 1:** If the total area of impacted soil at the site is less than 350 square feet, the evaluation may be ended and a determination of no ecological hazard is made.
- **Criterion 2:** If land use at the site and surrounding area makes substantial wildlife exposure unlikely, the evaluation may be ended and a determination of no ecological hazard is made.

Residual constituent concentrations are present in several areas on the Site (see Section 2.0). For example, results of the 2010 soil sampling in the southern ditch (Anchor 2010) indicate copper is present at concentrations above natural background (see Section 3.0). The approximate area of the southern ditch is 945 square feet (Table C-1). Since the southern ditch and, hence, the Site contains more than 350 square feet of impacted soil, a determination of no ecological hazard cannot be made.

Criterion 2 is evaluated using the five parameters provided in Table 749-2 of MTCA. Results of this evaluation are shown in Table C-3. Although the amount of contiguous undeveloped land on the Site is limited (Figure C-4), the hillside area contains more than 4.0 acres of contiguous undeveloped land within 500 feet of the Site. Therefore, the score for Parameter 1 is twelve. The Site is a commercial property, so a score of three was assigned to Parameter 2. The habitat quality of the Site is low due to its ornamental nature, small size, and discontinuous distribution. Therefore, a score of three was assigned to Parameter 3. The Site is unlikely to attract wildlife because of the limited quantity of undeveloped land (i.e., 0.3 acres) and the relatively low habitat quality of the undeveloped land. Therefore, a score of two was assigned to Parameter 4. Because dioxins/furans are present in soil adjacent to the former hog fuel

burner, a score of one was assigned to Parameter 5. The total score for Parameters 2 through 5 is nine and this total is less than the score for Parameter 1 (i.e., twelve). Therefore, a determination of no ecological hazard cannot be made because substantial wildlife exposure to residual constituents present in soil may occur.

C-5.2 Pathways Analysis

Under the pathways analysis (WAC 173-340-7492(2)(b)), the TEE evaluation may be ended and a no ecological risk conclusion reached if there are no potential exposure pathways from constituents in soil to ecological receptors. Since land use at the Westbay Marine Site is commercial, only exposure pathways to wildlife need be considered. Constituents are detected in surface soil in two open areas: soil in the northern strip (Area 1) contains dioxins/furans, which may be associated with the former hog fuel burner; and soil in the southern ditch (Area 5) contains elevated levels of copper, which may be associated with past marina operations. Although the total area of affected soil in these two open areas is very small (2,665 square feet or 0.06 acres), there is a potential for wildlife exposure to occur. Since MTCA (WAC 173-340-7492[2][b]) stipulates that no potential exposure pathways may be present in order to conclude that exposures are incomplete, it must be concluded that a complete (though minor) pathway exists by which wildlife could potentially become exposed to constituents detected in open area soil at the Site.

C-5.3 Contaminants Analysis

Under the contaminants analysis (WAC 173-340-7492(2)(c)), the TEE evaluation may be ended and a no ecological risk conclusion reached when either no priority constituents of ecological concern listed in MTCA Table 749-2 are detected in Site soil or no constituent is detected at a concentration higher than its value listed in MTCA Table 749-2.

The most representative soil data for the southern ditch is the 2010 data (Anchor 2010). Copper concentrations in the three 2010 soil samples were 76.6, 113, and 1,360 mg/kg. Since there are few samples from the southern ditch, it is appropriate to use the maximum detected concentration to represent the reasonable maximum exposure point concentration (RMA) for the southern ditch. Since the maximum detected concentration of copper (1,360 mg/kg) exceeds the MTCA Table 749-2 value for sites with industrial or commercial land use (550 mg/kg), the TEE evaluation cannot be ended.

Suitable soil dioxins/furans data include the two soil samples collected in 2010 (Anchor 2010) and the four soil samples collected in 2011 by Hart Crowser (see Section 4.0 of this RI Report). The total dioxin TEQ concentrations for the six samples range from 6 to 88 ng/kg and all values

exceed the MTCA Table 749-2 value (5 ng/kg[11]). This dioxin data indicates the TEE evaluation cannot be ended.

Since results of the simplified TEE for the Westbay Marina Site indicate the TEE cannot be ended, a site-specific TEE was performed to refine these results.

C-6.0 Site-specific TEE

The site-specific TEE (WAC 173-340-7493) consists of two phases:

- Problem formulation which focuses the site-specific TEE on those elements of the ecosystem where potential ecological hazards exist, and
- Selection and implementation of one or more methods for assessing ecological hazards.

C-6.1 Problem Formulation

The problem formulation phase of the site-specific TEE can include four steps:

- Identification of chemicals of potential ecological concern
- Exposure pathways analysis
- Identification of ecological receptors of concern
- Toxicological Assessment

A no further evaluation and no ecological hazard conclusion can be made if either no chemicals of potential ecological concern or no complete exposure pathways are identified.

C-6.1.1 Chemicals of Potential Ecological Concern

The first problem formulation step is to identify chemicals of potential ecological concern. This is done by comparing the RME concentrations (i.e., the maximum or upper ninety-five percent confidence limit) for the Site to ecological indicator soil concentrations (EISC) provided in MTCA Table 749-3. The RME concentration for copper in the southern ditch (Area 5) is 360 mg/kg and exceeds the EISC for wildlife of 217 mg/kg. The RME concentration for dioxins in the northern strip (Area 1) is 80 ng/kg (the maximum total dioxin TEQ concentration) and exceeds the EISC for wildlife of 2 ng/kg. These results indicate that copper and dioxins are chemicals of potential ecological concern at the Site.

C-6.1.2 Exposure Pathways Analysis

[11] Note that the MTCA Table 749-2 value for dioxins (total) was used. This value was derived from a wildlife food-chain model for a shrew foraging on earthworms that have accumulated dioxins from the soil. This model used a dated literature-based soil-to-earthworm bioaccumulation factor for 2,3,7,8-TCDD that is an order of magnitude or more higher than those published in more recent scientific studies (Matschenko et al. 2002) and derived for earthworms in Washington State (Houkal 2005).

The second step of problem formulation is an exposure pathways analysis. Although the exposure pathways analysis has several elements in common with the information presented in the simplified TEE (Section 5.0), additional information may be used to help characterize exposures and determine if potential exposures are sufficient to pose a potential ecological hazard.

The goal of this TEE is the protection of wildlife (Section C-1.0). MTCA uses the vole, shrew, and American robin as default receptors to evaluate wildlife exposure (see MTCA Table 749-4). These receptors represent different classes of animals from different feeding guilds (i.e., insectivore versus herbivore) that maximize potential exposure to soil-borne constituents. Exposures are maximized by the relatively small home ranges and high food ingestion rates of these species. The home ranges of these species are 0.6 acres for the American robin and 0.1 acres for the vole and shrew (MTCA Table 749-4).

Although potential exposure of wildlife to constituents present in soil at the Westbay Marina Site may be complete, it is considered to be minor or *de minimis* for the following reasons:

- The spatial extent of constituents in soil potentially contacted by wildlife is small
- The quality of the habitat in open areas of the Site having constituents in soil is low
- The commercial nature of the Site indicates low potential usage by wildlife
- Alternative high-quality habitat in the hillside area will be more attractive to wildlife
- Local populations of wildlife will not be adversely affected

Constituents are present in two open areas. The northern strip (Area 1) consists of approximately 1,720 square feet (0.04 acres) and has dioxins/furans present in soil. The southern ditch (Area 5) consists of approximately 945 square feet (0.02 acres) and has copper present in soil. These two areas are separated by approximately 400 feet of primarily asphalt or armored gravel, making potential small mammal exposure to constituents in both areas remote. However, birds could potentially fly between areas to forage. Given that the northern strip and southern ditch areas have a combined area of approximately 0.06 acres and the home ranges of the three default wildlife receptors are greater than 0.06 acres, it is unlikely that an individual of any of these receptors would spend all of its time foraging on these two open areas. Therefore, potential exposures of these receptors to constituents present in soil at the northern strip and southern ditch areas would be less than assumed in the MTCA food chain models (i.e., 100 percent).

Figure C-5 shows the habitat present at the northern strip (Area 1). The area is a narrow strip of land (10 x 172 feet) covered with debris and vegetated with several large trees (cedar and birch) with a groundcover dominated by mosses and rushes with sparse grasses and forbs. The active Dunlap Towing Company property lies to the north with a narrow ditch paralleling the north

strip area. Figure C-9 shows the habitat at the southern ditch (Area 5). This area is also a narrow strip of land (5 x 189 feet) covered in debris and vegetated with a sparse covering of weedy grasses and forbs with one cedar tree located at the southern end of the area. The Delson Lumber Company property lies to the south.

The northern strip was reported to be covered by a 6- to 24-inch-thick layer of topsoil, while soil at the southern ditch appeared to consist of the original fill material. One earthworm and one small grub were observed in the northern strip during the collection of four soil samples in 2011. The habitat value of the northern strip and southern ditch areas is relatively low due to their poor structure, limited food value, and discontinuity with other open areas on the Site. These areas will not be attractive to wildlife, although wildlife may occasionally forage there. Potential wildlife exposure to constituents detected in soil in both open areas is expected to be relatively low due to the low habitat value.

The Westbay Marina is a commercial site that is subject to a relatively high level of daily human activity. This activity typically includes motor vehicle traffic, human traffic, and routine marina activities. Although several species of wildlife have adapted to urban environments, many other species are less likely to use sites with high levels of human activity. Thus, potential wildlife exposure to constituents in soil at the Site is considered to be relatively low.

Relatively high-quality wildlife habitat is present on the hillside west of the Site across Westbay Marina Drive NW. Tree, shrub, and groundcover vegetation layers are present on the hillside offering a wide variety of habitat and food sources for wildlife. Native plant species (e.g., alder, bigleaf maple, Douglas fir, sword fern) are mixed with non-native species (e.g., Himalayan blackberry, English ivy, reed canary grass) to offer a variety of cover types and food sources. The hillside continues north and south from the Site over much of the western shoreline of Budd Inlet and is connected to forested areas on the top of the bluff to provide a relatively large contiguous area to support a variety of wildlife populations. Wildlife would be preferentially attracted to the hillside area for food, shelter, and reproduction. The presence of the hillside area reduces potential wildlife use of northern strip and southern ditch areas of the Site by offering a large and continuous area of higher quality habitat. Reduced use translates to reduced exposure to soil-borne constituents on the Site.

Although not specifically stated in the MTCA TEE procedures, the overarching goal of ecological risk assessment is the protection of populations of organisms (EPA 1997). In the case of the Westbay Marina Site, the goal is protection of populations of wildlife species. Traill et al. (2010) evaluated the minimum viable size needed to maintain a population and determined the minimum viable population size to be approximately 5,000 mature individuals. Thus, it is assumed that each receptor wildlife population potentially inhabiting the Site area consists of

5,000 individual animals. The area contained in the northern strip and southern ditch areas is less than that of the home range for an individual animal of any of the three default wildlife receptor species used in MTCA. Therefore, less than one individual from a population of 5,000 would be potentially exposed to constituents present in soil at the Site. If one assumes the worst-case scenario, where the exposed individual dies from that exposure, the mortality rate associated with exposure to constituents on the Site is 0.02 percent (i.e., 1 in 5,000). The natural mortality rate for wildlife is generally much higher than 0.02 percent due to natural causes (e.g., predation, disease, starvation). For example, EPA (1993) reports the average annual mortality rate for adult American robins is 50.8 percent and for adult meadow voles ranges from 53 to 100 percent, while the maximum annual mortality rate for short-tailed shrews is 90 percent. An increase of 0.02 percent in the annual mortality rate will have a negligible effect on the overall annual mortality rates for these species. This qualitative population analysis demonstrates that wildlife populations will not be affected by exposure to constituents present in soil at the Westbay Marina Site.

C-6.1.3 Conclusions of Problem Formulation

Information presented in the exposure pathways analysis step of problem formulation (Section C-6.1.2) demonstrates that while wildlife exposure pathways are potentially complete, exposure to constituents present in the northern strip and southern ditch open areas will not pose a hazard to wildlife.

C-7.0 Summary and Conclusions

As part of the RI for the Westbay Marina Site, a MTCA-compliant TEE was performed on the uplands to assess potential ecological hazards associated with exposure to residual constituents present in soil.

The Site is currently an active marina with the upland area used primarily for parking and storage. Approximately 90 percent of the 3.01 acres of uplands are covered by asphalt or armored gravel, which effectively prohibits ecological exposures. Approximately 0.3 acres of the uplands are uncovered consisting largely of landscaped plantings of relatively low habitat value. The Site is bounded by Budd Inlet to the east, commercial/industrial properties to the north and south, and Westbay Drive NW to the west. A vegetated hillside and residential properties lie further to the west.

The Buchanan Lumber Company used the Site between 1919 and 1966. Although no lumber treating occurred, a hog fuel burner was present during part of that period and may have been a source of dioxins/furans detected in soil. Former marina operations included the underground storage tanks (USTs) area, hydroblast catch basin area, waste oil storage area, and

boat maintenance area. Environmental investigations and cleanup actions addressed constituents found at the UST and waste oil storage areas.

For purposes of this TEE, the uncovered areas of the Site were organized into seven open areas. Residual constituents in soil are present at only two of the open areas (the northern strip and the southern ditch) and have a combined area of approximately 0.04 acres.

Results of the exclusions analysis portion of the TEE (WAC 173-340-7491) showed the Site did not qualify for an exclusion and further analysis was required. Further analysis showed a simplified TEE (WAC 173-340-7492) was the most suitable methodology for evaluating the Site. Results of the simplified TEE indicated there was a potential ecological hazard and consequently, a site-specific TEE was performed to refine these conclusions.

The exposure-analysis step of the problem formulation phase of the site-specific TEE was used to refine the results of the simplified TEE. Five lines of evidence were used to demonstrate that although potential exposure of wildlife to constituents present in soil at the Westbay Marina Site may be complete, exposures are considered to be minor or *de minimis*.

Based on results of this TEE, it is concluded that residual constituents present in surface soil in open areas of the Westbay Marina Site do not pose an ecological hazard to wildlife.

C-8.0 References

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Table C-1 - Descriptions of Open Areas on the Westbay Marina Site

Area #	Area Name	Approximate Dimensions (feet)	Approximate Area (square feet)	General Description	Figure Number
1	Northern Strip	172 x 10	1,720	Planted area with added topsoil; vegetation - moss, conifers, grasses, weeds	5
2	Northeast Strip	167 x 33.5	5,594	Planted area with added topsoil; vegetation - alder, evergreen & deciduous shrubs, grasses, weeds	6
3	Northwest Strip	240 x 8.5	2,040	Planted area with added topsoil; vegetation - conifers, evergreen & deciduous shrubs, weeds	7
4	Southwest Strip	224 x 4.5	1,008	Planted area with added topsoil; vegetation - conifers, evergreen shrubs, small oak trees, weeds	8
5	Southern Ditch	189 x 5	945	Unplanted area; vegetation - weeds, grass, one conifer	9
6	Southeast Strip	96 x 3.5	336	Planted area with added topsoil; vegetation - conifers, one deciduous tree, cedar shrubs, weeds	10
7	Parking Lot Islands	various dimensions	1,574	Nine small planted areas in the parking lot with added topsoil; vegetation - evergreen & deciduous trees & shrubs, flowers, grasses, weeds	11
		Total Open Area (square feet) =	**13,217**		
		Total Open Area (acres) =	**0.30**		

Table C-2 - Washington State Species of Concern Occurring Within the Vicinity of the Westbay Marina Site

Common Name	Scientific Name	State Status	Federal Status
Purple Martin	*Pronge subis*	Candidate	None
Peregrine Falcon	*Falco peregrinus*	Sensitive	Species of Concern
Great Egret	*Ardea alba*	Monitored	None
Green Heron	*Butorides virescens*	Monitored	None
Bald Eagle	*Haliaeetus leucocephelus*	Monitored	None

Definitions: State Candidate Species – a species to be reviewed for possible listing as a State endangered, threatened, or sensitive species; State Sensitive Species – a species that is vulnerable or declining and is likely to become endangered or threatened throughout a significant portion of its range within the state without cooperative management or removal of threats; Federal Species of Concern – informal term referring to species that might be in need of concentrated conservation actions.

Table C-3 - Simplified TEE Exposure Analysis Procedure Results for the Westbay Marina Site

Parameter	Score
1) Estimate the area of contiguous (connected) undeveloped land on the site or within 500 feet of any area of the site and enter the corresponding points as the score. Area (acres) — Points 0.25 or less — 4 0.5 — 5 1.0 — 6 1.5 — 7 2.0 — 8 2.5 — 9 3.0 — 10 3.5 — 11 4.0 or more — 12	12
2) Is this an industrial or commercial property? See WAC 173-340-7490(3)(c). If yes, enter a score of 3. If no, enter a score of 1.	3
3) Enter a score for the habitat quality of the site, where high = 1, intermediate = 2, and low = 3.	3
4) Is the undeveloped land likely to attract wildlife? If yes, enter a score of 1. If no, enter a score of 2.	2
5) Are there any of the following soil contaminants present: chlorinated dioxins/furans, PCB mixtures, DDT, DDE, DDD, aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, benzene hexachloride, toxapheene, hexachlorobenzene, pentachlorohenol, pentachlorobenzene? If yes, enter a score of 1. If no, enter a score of 4.	1
6) Add the numbers in the boxes from parameters 2 through 5 and enter the score. If this number is larger than the score in parameter 1, the simplified TEE may be ended under WAC 173-340-7492(2)(a)(ii).	9

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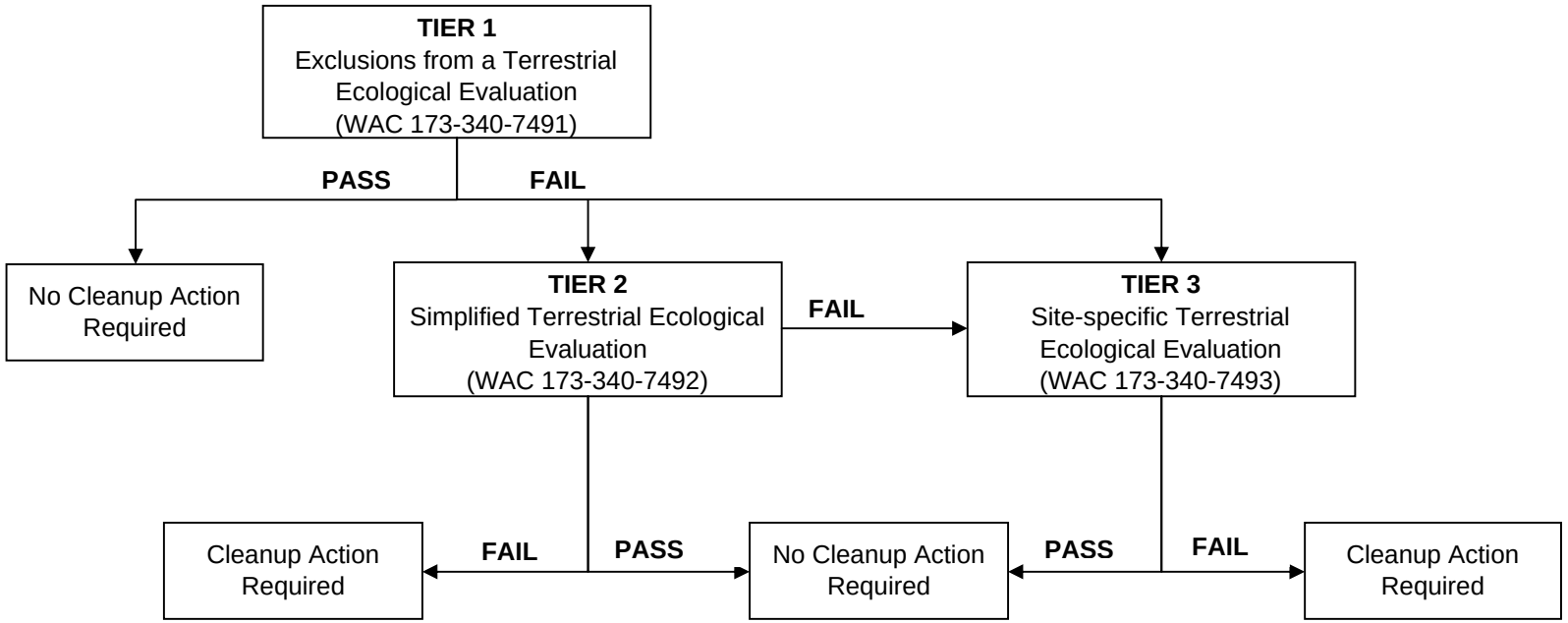
Figure C-1. MTCA Terrestrial Ecological Evaluation Framework.



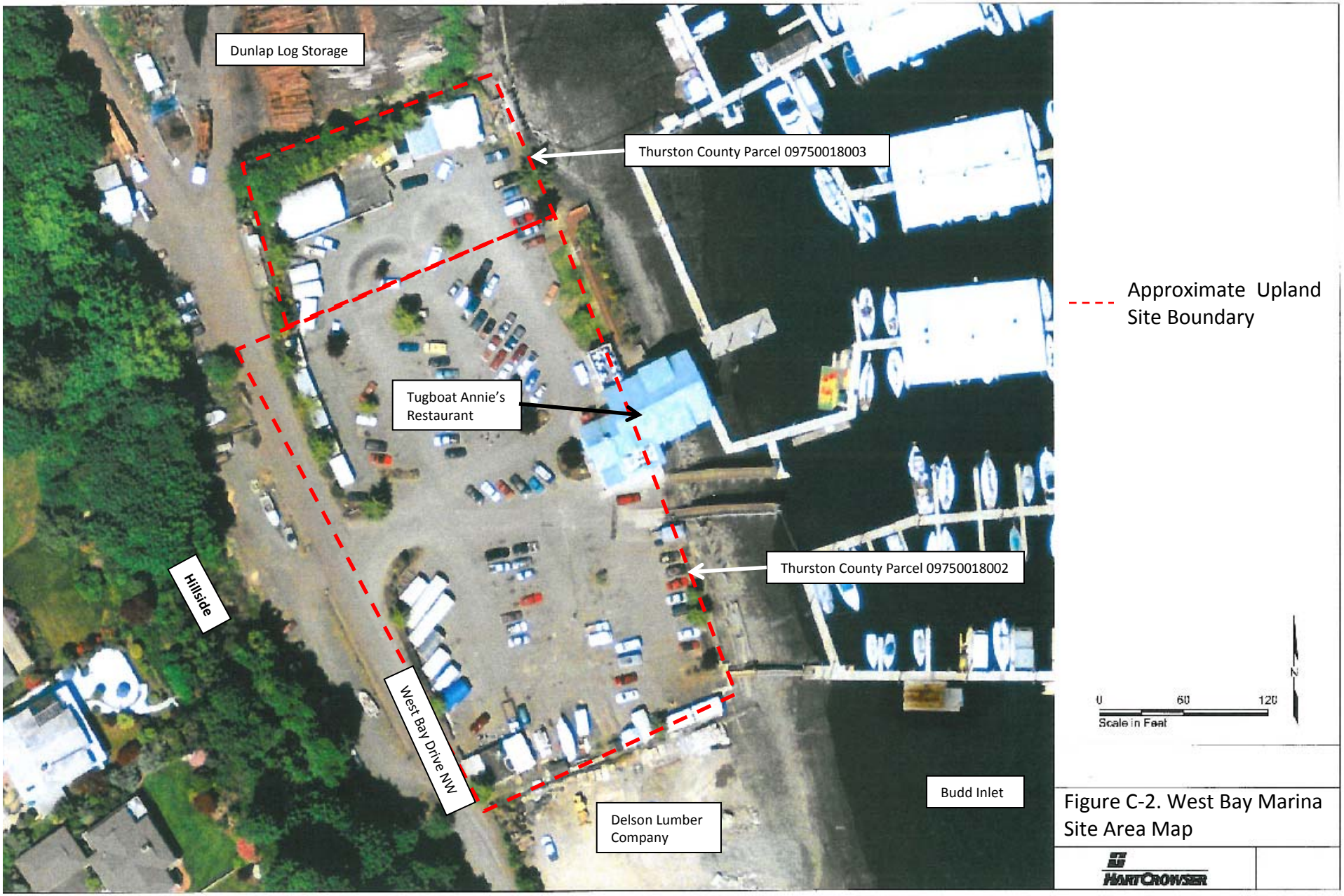


Figure C-2. West Bay Marina Site Area Map

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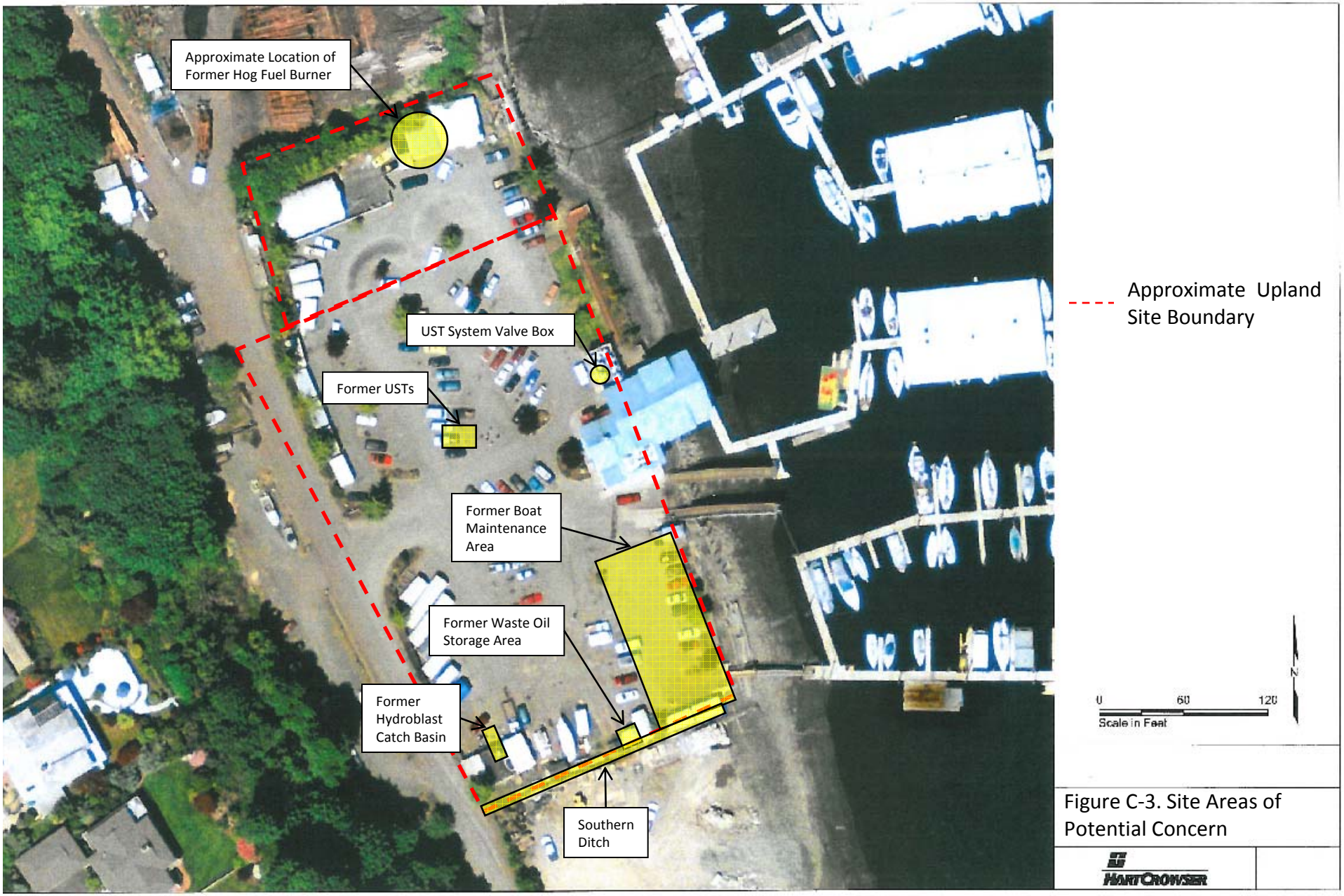

Figure C-3. Site Areas of Potential Concern

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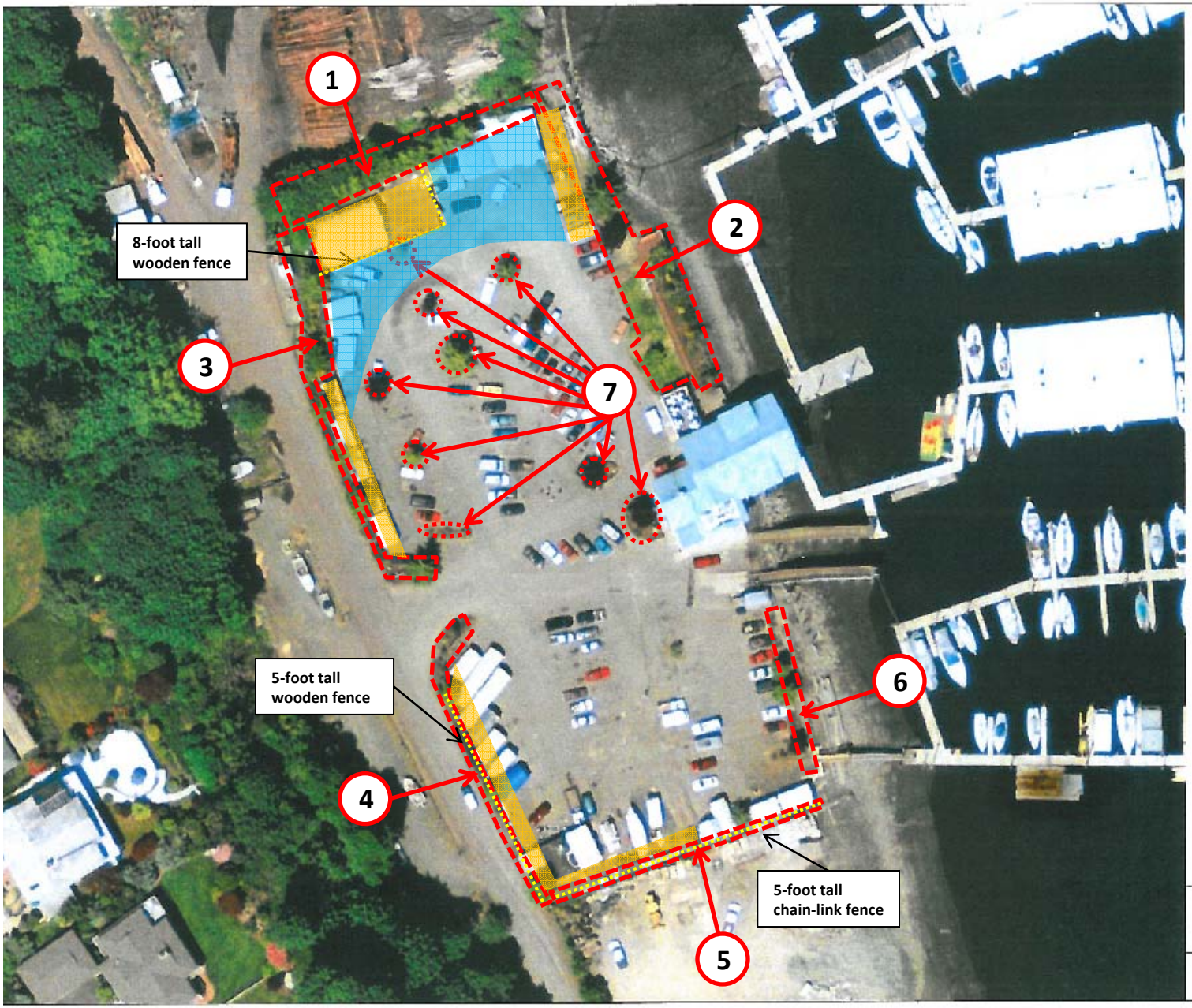


Approximate Open Area Boundaries

1 Open Area Number

Gravel Surface

Gravel and Asphalt Surface

Note: Asphalt covers the remainder of the Site

0 60 120

Scale in Feet

N

Figure C-4. Site Open Areas

HARTCROWSER

Figure C-5. Northern Strip (Area 1) [A is looking east toward Budd Inlet and B is looking west toward West Bay Drive NW. Birch and cedar trees growing over weedy groundcover. There is no fence separating the Site from the Dunlap Towing Company, but a ditch (containing water at the time of the field survey in April 2011) runs along the boundary and empties into Budd Inlet.]

Figure C-6. Northeast Strip (Area 2) [A is looking north toward Dunlap Towing Company and B is looking south toward Tugboat Annie's Restaurant. Turf grass with birch and flowering plum trees covers some areas, while juniper shrubs with wood/bark mulch covers the shoreline. Area 2 drops off onto a relatively steep cobble beach.]

Figure C-7. Northwest Strip (Area 3) [A is looking southeast toward the Site entrance and B is looking north toward Dunlap Towing Company. Juniper shrubs with mulch cover part of the area and several cedrus trees line this strip. Although no fencing is present, storage sheds act as a buffer between West Bay Drive NW and the Site.]

Figure C-8. Southwest Strip (Area 4) [A is looking north toward the Site entrance and B is a close-up of the Site entrance. The area is largely open ground with a few cedar and small oak trees.]

Figure C-9. Southern Ditch (Area 5) [A is looking east toward Budd Inlet and B is looking west toward West Bay Drive NW. The area is largely open ground with weedy grasses and forbs. There is a chain-link fence separating the Site and the Delson Lumber Company property.]

Figure C-10. Southeast Strip (Area 6) [A is looking south toward Delson Lumber Company property and B is looking north toward Tugboat Annie's Restaurant. Cedar and maple trees growing over juniper shrubs with little groundcover. This narrow strip of landscaping drops off onto a relatively steep cobble beach.]

Figure C-11. Parking Lot Islands (Area 7) [A is looking northeast toward Budd Inlet and B is looking east toward Tugboat Annie's Restaurant. Plants include cedar trees and juniper and Japanese Andromeda shrubs. Note that some islands have curbed borders, while others do not.]

Figure C-12. Hillside located west of the Site across West Bay Drive NW. [A is looking southwest from the Site and B is looking northwest from the Site. A parking/storage area is located at the base of the hillside and a shallow ditch (containing water at the time of the field survey in April 2011) occurs between the base of the hillside and the parking area. Trees include Douglas fir, bigleaf maple, and red alder. Grasses, blackberry, ferns, rush, and English ivy dominates the understory. The hillside extends over much of the western shoreline of Budd Inlet and provides a corridor for wildlife moving between forested areas on the top of the hillside.]

Figure C-13. Delson Lumber Company property located south of the Site. [A is looking southeast toward Budd Inlet and B is looking northeast toward Budd Inlet. This vacant property is a mixture of open ground and wood debris piles. Although some weedy vegetation is present along the perimeter of the property, the property provides limited habitat for wildlife.]

Figure C-14. Dunlap Towing Company property located north of the Site. [A is looking north toward entrance of Dunlap Towing Company and B is looking north from the Site. This operational facility consists of a mixture of open ground and log piles. Although some weedy vegetation is found along the perimeter of the property, it provides limited habitat for wildlife.]

APPENDIX D
FIELD INVESTIGATION PHOTOGRAPHS
WESTBAY MARINA
OLYMPIA, WASHINGTON

Photograph 1 - Upland soil sample location HC-WB-US-002.

Photograph 2 - Upland soil sample location HC-WB-US-001.

Photograph 3 - Upland soil sample location HC-WB-US-004.

Photograph 4 - Intertidal surface sediment grab sample location HC-WB-SS-002.

←Up

Photograph 5 - Intertidal surface sediment grab sample location HC-WB-SS-004.

Photograph 6 - Subtidal surface sediment grab sample.

Photograph 7 - Example of an over penetrated surface sediment grab sample.

Photograph 8 - Example of a subtidal surface sediment grab sample with overlying water.

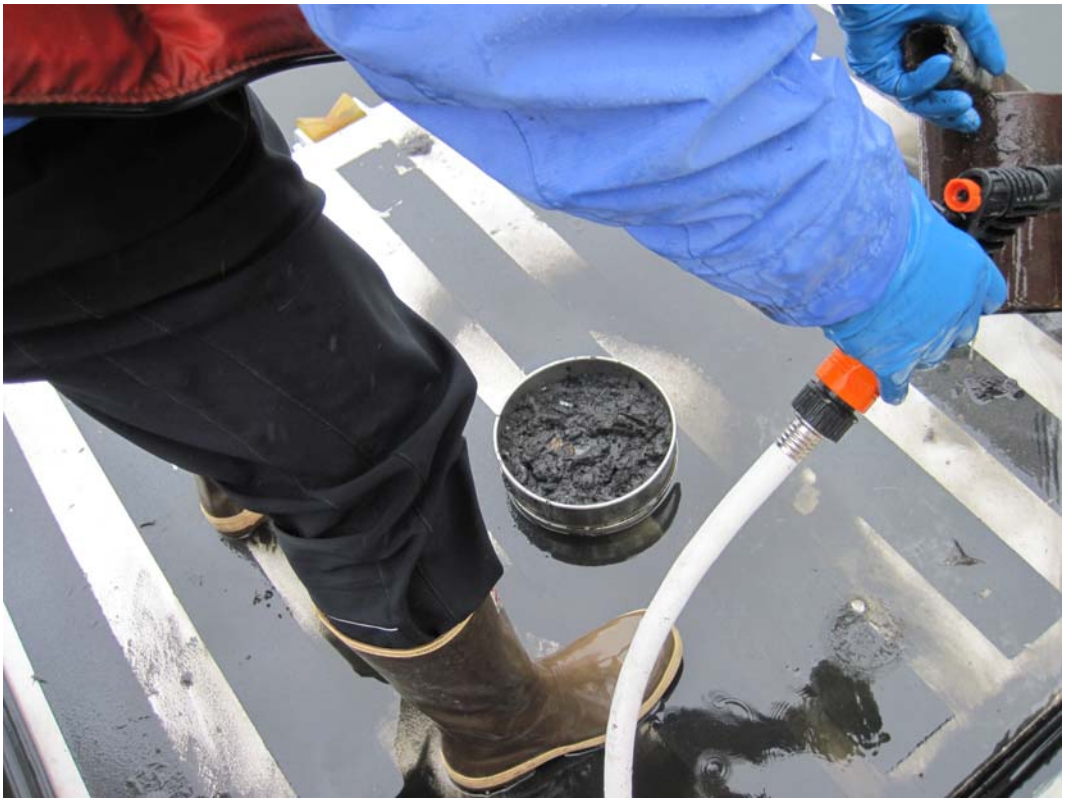
Photograph 9 - Example of wood debris found in a vibracore tube sample. Note the large wood fibers seen in this sample.

Photograph 10 - Wood debris found in a surface sediment grab sample.

Photograph 11 - Example of wood debris found in a vibracore tube sample. Note the smaller wood fibers seen in this sample.

Photograph 12 - Benthic infauna corer and core sample in sieve.

Photograph 13 - Intertidal benthic infauna core sample before being sieved.



Photograph 14 - Subtidal benthic infauna core sample being sieved on the boat.

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APPENDIX E
ANCHOR QEA 2009 AND 2010 RESULTS TABLES
WESTBAY MARINA
OLYMPIA, WASHINGTON

Table E-1 - Analytical Results for Groundwater Wells

Sample ID:	Groundwater	Groundwater	Marine MTCA	WB-MW-01-090819	WB-MW-02-090819	WB-MW-03-090819*
Sample Date:	MTCA Method A	MTCA Method B	Surface Water	08/19/2009	08/19/2009	08/19/2009
Depth:	Criteria[a]	Criteria[a]	Criteria [e]	--	--	Field Dup for MW-02
Sample Type:				Water	Water	Water
Conventional Parameters						
Ammonia (mg-N/L)		0.458[d]	2.92[b]	**0.384**	**0.015**	**0.026**
Sulfide (mg/l)				**--**	**--**	**--**
Metals, dissolved (µg/l)						
Arsenic	5		0.098[g]	2 U	**3.2**	**3.2**
Cadmium	5			1 U	0.2 U	0.2 U
Chromium	50			2 U	1 U	1 U
Copper		640	2.4[c]	**9**	0.5 U	0.5 U
Lead	15			5 U	1 U	1 U
Mercury	2			0.1 U	0.1 U	0.1 U
Nickel		320	8.2[c]	**9**	**0.7**	**0.7**
Selenium			71[c]	10 U	0.5 U	**0.5**
Silver				1 U	0.2 U	0.2 U
Zinc				20 U	4 U	4 U
Metals, total (µg/l)						
Arsenic	5		0.098[g]	2 U	**3.7**	**3.6**
Cadmium	5			1 U	0.2 U	0.2 U
Chromium	50			2 U	2 U	2 U
Copper		640	2.4[c]	**10**	0.5 U	0.5 U
Lead	15			5 U	1 U	1 U
Mercury	2			0.1 U	0.1 U	0.1 U
Nickel		320	8.2[c]	**10**	**1.2**	**1.1**
Selenium		81	71[c]	10 U	**0.6**	0.5 U
Silver				1 U	0.2 U	0.2 U
Zinc				20 U	4 U	4 U
Organometallic Compounds (µg/l)						
Tributyltin (ion)				**--**	**--**	**--**
PCB Aroclors (µg/l)						
PCB mixtures						
Aroclor 1016				0.1 U	0.1 U	0.1 U
Aroclor 1221				0.1 U	0.1 U	0.1 U
Aroclor 1232				0.1 U	0.1 U	0.1 U
Aroclor 1242				0.1 U	0.1 U	0.1 U
Aroclor 1248				0.1 U	0.1 U	0.1 U

Table E-1 - Analytical Results for Groundwater Wells

Sample ID:	Groundwater	Groundwater	Marine MTCA	WB-MW-01-090819	WB-MW-02-090819	WB-MW-03-090819*
Sample Date:	MTCA Method A	MTCA Method B	Surface Water	08/19/2009	08/19/2009	08/19/2009
Depth:	Criteria[a]	Criteria[a]	Criteria [e]	--	--	Field Dup for MW-02
Sample Type:				Water	Water	Water
Aroclor 1254				0.1 U	0.1 U	0.1 U
Aroclor 1260				0.1 U	0.1 U	0.1 U
Aromatic Hydrocarbons (µg/l)						
Naphthalene				0.1 UJ	0.1 UJ	0.1 UJ
Acenaphthylene				0.1 UJ	0.1 UJ	0.1 U
Acenaphthene		960	640[g]	0.1 UJ	0.1 U	**0.11**
Fluorene				0.1 UJ	0.1 U	**0.17**
Phenanthrene				0.1 UJ	0.1 U	**0.14**
Anthracene		4800	26000[f]	0.1 UJ	0.1 U	**0.11**
1-Methylnaphthalene				0.1 UJ	0.1 U	0.1 U
2-Methylnaphthalene				0.1 UJ	0.1 UJ	0.1 UJ
Fluoranthene		640	90[g]	0.1 UJ	0.1 U	**0.1**
Pyrene				0.1 UJ	0.1 U	0.1 U
Benzo(a)anthracene				0.1 UJ	0.1 U	0.1 U
Chrysene				0.1 UJ	0.1 U	0.1 U
Benzo(b)fluoranthene				0.1 UJ	0.1 U	0.1 U
Benzo(k)fluoranthene				0.1 UJ	0.1 U	0.1 U
Benzo(a)pyrene				0.1 UJ	0.1 U	0.1 U
Indeno(1,2,3-c,d)pyrene				0.1 UJ	0.1 UJ	0.1 UJ
Dibenzo(a,h)anthracene				0.1 UJ	0.1 UJ	0.1 UJ
Benzo(g,h,i)perylene				0.1 UJ	0.1 UJ	0.1 UJ
Chlorinated Hydrocarbons (µg/l)						
1,3-Dichlorobenzene				1 UJ	1 UJ	1 UJ
1,4-Dichlorobenzene				1 UJ	1 UJ	1 UJ
1,2-Dichlorobenzene				1 UJ	1 UJ	1 UJ
1,2,4-Trichlorobenzene				1 UJ	1 UJ	1 UJ
Hexachlorobenzene				1 UJ	1 U	1 U
Phthalates (µg/l)						
Dimethyl phthalate				1 UJ	1 U	1 U
Diethyl phthalate				1 UJ	1 U	1 U
Di-n-butyl phthalate				1 UJ	1 U	1 U
Butylbenzyl phthalate				1 UJ	1 UJ	1 UJ
Bis(2-ethylhexyl) phthalate				1 UJ	1 U	1 U
Semi-Volatile Organics (µg/l)						
Hexachlorobutadiene				1 UJ	1 UJ	1 UJ

Table E-1 - Analytical Results for Groundwater Wells

Sample ID:	Groundwater	Groundwater	Marine MTCA	WB-MW-01-090819	WB-MW-02-090819	WB-MW-03-090819*
Sample Date:	MTCA Method A	MTCA Method B	Surface Water	08/19/2009	08/19/2009	08/19/2009
Depth:	Criteria[a]	Criteria[a]	Criteria [e]	--	--	Field Dup for MW-02
Sample Type:				Water	Water	Water
Phthalates (µg/l)						
Di-n-octyl phthalate				1 UJ	1 U	1 U
Phenols (µg/l)						
Phenol				1 UJ	1 U	1 U
2-Methylphenol (o-Cresol)				1 UJ	1 U	1 U
4-Methylphenol (p-Cresol)				1 UJ	1 U	1 U
2,4-Dimethylphenol				1 UJ	1 UJ	1 UJ
Pentachlorophenol				5 UJ	5 U	5 U
Miscellaneous Extractables (µg/l)						
Benzyl alcohol				5 UJ	5 U	5 U
Benzoic acid				10 UJ	10 UJ	10 UJ
Dibenzofuran		16		0.1 UJ	0.1 U	**0.18**
Hexachloroethane				1 UJ	1 UJ	1 UJ
N-Nitrosodiphenylamine				1 UJ	1 U	1 U
Total Petroleum Hydrocarbons (mg/l)						
Diesel Range Hydrocarbons				0.25 U	0.25 U	0.25 U
Gasoline Range Hydrocarbons				0.25 U	0.25 U	0.25 U
Motor Oil Range				0.5 U	0.5 U	0.5 U

Notes:

Bold = Detected result

U = Compound analyzed, but not detected above detection limit

UJ = Compound analyzed, but not detected above estimated detection limit

* Samples collected as a field duplicate at MW-02

[a] Based on drinking water use per CLARC.

[b] Marine chronic criteria per Chapter 173-201A WAC per CLARC. Criterion based on unionized ammonia value of 0.035 mg/L, which is 1.2% of total ammonia. Criterion presented has been converted to total ammonia assuming a temperature of 50 ^{o}F and pH of 7.8.

[c] Marine chronic criteria per 40 CFR 131 (National Toxics Rule) per CLARC.

[d] Based on input parameters from EPA Region 3 and the MTCA Method B calculation formula.

[e] Based on the most stringent criterion in CLARC.

[f] Marine chronic criteria per 40 CFR 131 (National Toxics Rule) for protection of human health per CLARC.

[g] Surface water, Method B, standard formula value criterion.

Data based on Anchor QEA summary tables dated 09/23/2009.

Table E-2 - Analytical Results for Soil Samples

Sample ID: Sample Date: Sample Type:	MTCA Method B Direct Contact, Unrestricted Land Use Soil	MTCA Method A Unrestricted Land Use Soil	WB-013-SO-100107 1/7/2010 N	WB-014-SO-100107 1/7/2010 N	WB-015-SO-100107 1/7/2010 N	WB-016-SO-090819 8/19/2009 N	WB-017-SO-100107 1/7/2010 N	WB-018-SO-100107 1/7/2010 N
Metals (mg/kg)								
Copper	3000		**113**	**1360**	**76.6**	--	--	--
Dioxin Furans (ng/kg)								
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)			--	--	--	--	**1.73**	1 U
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)			--	--	--	--	**11.5**	5 U
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)			--	--	--	--	**24.4**	5 U
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)			--	--	--	--	**76.1**	**15.9**
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)			--	--	--	--	**43.2**	**7.25**
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)			--	--	--	--	**1650**	**363**
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)			--	--	--	--	**9610 J**	**3000**
2,3,7,8-Tetrachlorodibenzofuran (TCDF)			--	--	--	--	**11.2**	**2.27**
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)			--	--	--	--	**15.4**	5 U
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)			--	--	--	--	**14.9**	5 U
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)			--	--	--	--	**28.9**	**6.46**
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)			--	--	--	--	**15.9 J**	5 U
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)			--	--	--	--	**5.51**	5 U
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)			--	--	--	--	**16.4**	**7.83**
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)			--	--	--	--	**202**	**106**
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)			--	--	--	--	**14.2**	**6.21**
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)			--	--	--	--	**211**	**131**
Total Tetrachlorodibenzo-p-dioxin (TCDD)			--	--	--	--	**66.6**	**11.3**
Total Pentachlorodibenzo-p-dioxin (PeCDD)			--	--	--	--	**137 J**	**15.5**
Total Hexachlorodibenzo-p-dioxin (HxCDD)			--	--	--	--	**631**	**111**
Total Heptachlorodibenzo-p-dioxin (HpCDD)			--	--	--	--	**3400**	**798**
Total Tetrachlorodibenzofuran (TCDF)			--	--	--	--	**127**	**44.9**
Total Pentachlorodibenzofuran (PeCDF)			--	--	--	--	**178 J**	**61.8 J**
Total Hexachlorodibenzofuran (HxCDF)			--	--	--	--	**365 J**	**150**
Total Heptachlorodibenzofuran (HpCDF)			--	--	--	--	**542**	**313**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	11		--	--	--	--	**61.9**	**9.66**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	11		--	--	--	--	**61.9**	**14.2**
Total Petroleum Hydrocarbons (mg/kg)								
Diesel Range Hydrocarbons		2000	--	--	--	**35**	--	--
Motor Oil Range		2000	--	--	--	**250**	--	--

Bold = Detected result.
J = Estimated value.
N = Normal field sample.
Toxicity Equivalency (TEQ) values as of 2005, World Health Organization.

Note: Data based on Anchor QEA Summary Tables dated 1/26/2010

Table E-3 - Analytical Results for Sediment Samples

Sample ID:	Trip Blanks	WB-001-SS-090819	WB-002-SS-090819	WB-003-SS-090819	WB-004-SS-090819	WB-051-SS-090819*
Sample Date:	08/19/2009	08/19/2009	08/19/2009	08/19/2009	08/19/2009	08/19/2009
Depth:	--	--	--	--	--	--
Sample Type:	TB	Sediment	Sediment	Sediment	Sediment	Sediment
Conventional Parameters						
Ammonia (mg-N/L)	--	--	--	--	--	--
Sulfide (mg/l)	--	**1.98**	**78.1**	**21**	0.1 U	**0.708**
Metals, total (µg/l)						
Arsenic	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--
Chromium	--	--	--	--	--	--
Copper	--	--	--	--	--	--
Lead	--	--	--	--	--	--
Mercury	--	--	--	--	--	--
Nickel	--	--	--	--	--	--
Selenium	--	--	--	--	--	--
Silver	--	--	--	--	--	--
Zinc	--	--	--	--	--	--
Organometallic Compounds (µg/l)						
Tributyltin (ion)	--	**0.012**	**0.023**	0.008 U	0.008 U	**0.008**
Aromatic Hydrocarbons (mg/kg-OC)						
Naphthalene	--	--	--	--	--	--
Acenaphthylene	--	--	--	--	--	--
Acenaphthene	--	--	--	--	--	--
Fluorene	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--
Anthracene	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--
Fluoranthene	--	--	--	--	--	--
Pyrene	--	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--
Chrysene	--	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--	--
Dibenzo(a,h)anthracene	--	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--	--

Table E-3 - Analytical Results for Sediment Samples

Sample ID:	Trip Blanks	WB-001-SS-090819	WB-002-SS-090819	WB-003-SS-090819	WB-004-SS-090819	WB-051-SS-090819*
Sample Date:	08/19/2009	08/19/2009	08/19/2009	08/19/2009	08/19/2009	08/19/2009
Depth:	--	--	--	--	--	--
Sample Type:	TB	Sediment	Sediment	Sediment	Sediment	Sediment
Chlorinated Benzenes (mg/kg-OC)						
1,4-Dichlorobenzene	--	--	--	--	--	--
1,2-Dichlorobenzene	--	--	--	--	--	--
1,2,4-Trichlorobenzene	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--
Phthalates (mg/kg-OC)						
Dimethyl phthalate	--	--	--	--	--	--
Diethyl phthalate	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--
Butylbenzyl phthalate	--	--	--	--	--	--
Bis(2-ethylhexyl) phthalate	--	--	--	--	--	--
Semi-Volatile Organics (µg/l)						
Hexachlorobutadiene	--	--	--	--	--	--
Phthalates (µg/l)						
Di-n-octyl phthalate	--	--	--	--	--	--
Total Petroleum Hydrocarbons (mg/kg)						
Diesel Range Hydrocarbons	--	--	--	--	--	--
Gasoline Range Hydrocarbons	--	14 U	32 U	24 U	14 U	19 U
Motor Oil Range	--	--	--	--	--	--

Notes:

Bold = Detected result

U = Compound analyzed, but not detected above detection limit

UJ = Compound analyzed, but not detected above estimated detection limit

* This is a duplicate for WB-001-SS-090819

Table E-4 - Analytical Results for Seep Samples

Sample ID:	Groundwater	Groundwater	Marine MTCA	WB-SP-09-090819	WB-SP-59-090819*	WB-SP-10-090819	WB-SP-11-090819	WB-SP-12-090819	WB-SP-RB-090819	TRIP BLANKS
Sample Date:	MTCA Method A	MTCA Method B	Surface Water	08/19/2009	08/19/2009	08/19/2009	08/19/2009	08/19/2009	08/19/2009	08/19/2009
Sample Type:	Criteria[a]	Criteria[a]	Criteria [e]	Water	Water	Water	Water	Water	Water	TB
Conventional Parameters										
Ammonia (mg-N/L)		0.458[d]	2.92[b]	**0.204**	**0.171**	**0.273**	**0.096**	**0.143**	**0.029**	--
Sulfide (mg/l)				--	--	--	--	--	--	--
Metals, dissolved (µg/l)										
Arsenic	5		0.098[g]	2 U	2 U	2 U	1 U	2 U	0.2 U	--
Cadmium	5			1 U	1 U	1 U	0.5 U	1 U	0.2 U	--
Chromium	50			2 U	2 U	2 U	1 U	2 U	0.5 U	--
Copper		640	2.4[c]	**14**	**13**	**11**	**6**	**12**	**0.6**	--
Lead	15			5 U	5 U	5 U	2 U	5 U	1 U	--
Mercury	2			0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	--
Nickel		320	8.2[c]	**13**	**13**	**10**	**6**	**12**	**1.1**	--
Selenium			71[c]	10 U	10 U	10 U	5 U	10 U	0.5 U	--
Silver				1 U	1 U	1 U	0.5 U	1 U	0.2 U	--
Zinc				20 U	20 U	20 U	10 U	20 U	4 U	--
Metals, total (µg/l)										
Arsenic	5		0.098[g]	**3**	**3**	2 U	1 U	2 U	**0.3**	--
Cadmium	5			1 U	1 U	1 U	0.5 U	1 U	0.2 U	--
Chromium	50			2 U	2 U	2 U	1 U	2 U	**11**	--
Copper		640	2.4[c]	**14**	**14**	**11**	**6**	**13**	**3.3**	--
Lead	15		8.1[c]	5 U	5 U	5 U	2 U	5 U	**3**	--
Mercury	2			0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	--
Nickel		320	8.2[c]	**12**	**12**	**10**	**6**	**13**	**8.9**	--
Selenium			71[c]	**10**	**10**	10 U	5 U	10 U	**0.7**	--
Silver				1 U	1 U	1 U	0.5 U	1 U	0.2 U	--
Zinc			81[c]	20 U	20 U	20 U	10 U	20 U	**12**	--
Organometallic Compounds (µg/l)										
Tributyltin (ion)				--	--	--	--	--	--	--
PCB Aroclors (µg/l)										
PCB mixtures				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	--
Aroclor 1016				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	--
Aroclor 1221				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	--
Aroclor 1232				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	--
Aroclor 1242				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	--
Aroclor 1248				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	--
Aroclor 1254				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	--
Aroclor 1260										--
Aromatic Hydrocarbons (µg/l)										
Naphthalene	160		4900[g]	**0.59 J**	**0.71 J**	**0.14 J**	**0.13 J**	**0.29 J**	0.1 UJ	--
Acenaphthylene				0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	--
Acenaphthene			640[g]	0.1 UJ	**0.21**	0.1 U	0.1 U	**0.16**	0.1 UJ	--
Fluorene				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	--
Phenanthrene				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	--
Anthracene		4800		0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	--
2-Methylnaphthalene				**0.19 J**	**0.41 J**	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	--
1-Methylnaphthalene				**0.12**	**0.28**	0.1 U	0.1 U	0.1 U	0.1 UJ	
Fluoranthene		640		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	--
Pyrene				0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	--
Benzo(a)anthracene				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	--
Chrysene				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	--
Benzo(b)fluoranthene				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	--

Table E-4 - Analytical Results for Seep Samples

Sample ID:	Groundwater	Groundwater	Marine MTCA	WB-SP-09-090819	WB-SP-59-090819*	WB-SP-10-090819	WB-SP-11-090819	WB-SP-12-090819	WB-SP-RB-090819	TRIP BLANKS
Sample Date:	MTCA Method A	MTCA Method B	Surface Water	08/19/2009	08/19/2009	08/19/2009	08/19/2009	08/19/2009	08/19/2009	08/19/2009
Sample Type:	Criteria[a]	Criteria[a]	Criteria [e]	Water	Water	Water	Water	Water	Water	TB
Benzo(k)fluoranthene				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	--
Benzo(a)pyrene				0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	--
Indeno(1,2,3-c,d)pyrene				0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	--
Dibenzo(a,h)anthracene				0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	--
Benzo(g,h,i)perylene				0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ	
Chlorinated Hydrocarbons (µg/l)										
1,3-Dichlorobenzene				1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	--
1,4-Dichlorobenzene				1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	--
1,2-Dichlorobenzene				1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	--
1,2,4-Trichlorobenzene				1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	--
Hexachlorobenzene				1 U	1 U	1 U	1 U	1 U	1 UJ	--
Phthalates (µg/l)										
Dimethyl phthalate				1 U	1 U	1 U	1 U	1 U	1 UJ	--
Diethyl phthalate				1 U	1 U	1 U	1 U	1 U	1 UJ	--
Di-n-butyl phthalate				1 U	1 U	1 U	1 U	1 U	1 UJ	--
Butylbenzyl phthalate				1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	--
Bis(2-ethylhexyl) phthalate				1 U	1 U	1 U	1 U	1 U	1 UJ	--
Semi-Volatile Organics (µg/l)										
Hexachlorobutadiene				1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	--
Phthalates (µg/l)										
Di-n-octyl phthalate				1 U	1 U	1 U	1 U	1 U	1 UJ	--
Phenols (µg/l)										
Phenol				1 UJ	1 U	1 U	1 U	1 U	1 UJ	--
2-Methylphenol (o-Cresol)				1 UJ	1 U	1 U	1 U	1 U	1 UJ	--
4-Methylphenol (p-Cresol)				1 UJ	1 U	1 U	1 U	1 U	1 UJ	--
2,4-Dimethylphenol				1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	--
Pentachlorophenol				5 U	5 U	5 U	5 U	5 U	5 UJ	--
Miscellaneous Extractables (µg/l)										
Benzyl alcohol				5 UJ	5 U	5 U	5 U	5 U	5 UJ	--
Benzoic acid				10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	--
Dibenzofuran	16			0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	--
Hexachloroethane				1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	--
N-Nitrosodiphenylamine				1 UJ	1 U	1 U	1 U	1 U	1 UJ	--
Total Petroleum Hydrocarbons (mg/l)										
Diesel Range Hydrocarbons				0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	--
Gasoline Range Hydrocarbons				0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Motor Oil Range				0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	--

Notes:
Bold = Detected result
U = Compound analyzed, but not detected above detection limit
UJ = Compound analyzed, but not detected above estimated detection limit
* This is a duplicate for WB-SP-09-090819
[a] Based on drinking water use per CLARC.
[b] Marine chronic criteria per Chapter 173-201A WAC per CLARC. Criterion based on unionized ammonia value of 0.035 mg/L, which is 1.2% of total ammonia. Criterion presented has been converted to total ammonia assuming a temperature of 50°F and pH of 7.8.
[c] Marine chronic criteria per 40 CFR 131 (National Toxics Rule) per CLARC.
[d] Based on input parameters from EPA Region 3 and the MTCA Method B calculation formula.
[e] Based on the most stringent criterion in CLARC.
[f] Marine chronic criteria per 40 CFR 131 (National Toxics Rule) for protection of human health per CLARC.
[g] Surface water, Method B, standard formula value criterion.

Data based on Anchor QEA summary tables dated 09/23/2009.

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