EXISTING INFORMATION SUMMARY AND DATA GAPS MEMORANDUM BUDD INLET

Prepared by

Anchor QEA, LLC

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Suite 1900

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On behalf of

Port of Olympia

915 Washington Street NE

Olympia, Washington 98501

October 2012

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TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

LIST OF ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
A/K	Anderson-Ketron
Alternatives Memo	Identification and Evaluation of Interim Action Alternatives Memorandum
AGI	Applied Geotechnology, Inc.
AO	Agreed Order
AQ	Anchor QEA
ASTM	American Society for Testing and Materials
BEHP	bis(2-ethylhexyl)phthalate
bgs	below ground surface
BMPs	best management practices
BOD	biological oxygen demand
BTEX	benzene, toluene, ethylbenzene, and xylene
CDF	confined disposal facility
cm/s	centimeters per second
cm/y	centimeters per year
m^3/s	cubic meters per second
COCs	contaminates of concern
COD	chemical oxygen demand
County	Thurston County
cPAHs	carcinogenic polycyclic aromatic hydrocarbons
CSL	Cleanup Screening Level
CSO	combined sewer overflow
D/Fs	dioxin and furans
DMMP	Dredged Material Management Program
DMMUs	Dredged Material Management Units
DNR	Washington State Department of Natural Resources
DO	dissolved oxygen
DOH	Washington State Department of Health
DPS	distinct population segment

dw	dry weight
Ecology	Washington State Department of Ecology
EDR	Environmental Data Resources
EIM	Environmental Information Management
EISDGM	Existing Information Summary and Data Gaps Memorandum
ESA	Endangered Species Act
FS	feasibility study
GIS	geographic information system
gpd	gallons per day
gpm	gallons per minute
H:V	horizontal to vertical
HASP	Health and Safety Plan
HPAHs	high molecular weight polycyclic aromatic hydrocarbons
IAP	Interim Action Plan
IARUPLs	Interim Action Reuse Under Pavement Levels
Initiative	Puget Sound Initiative
LOTT	Lacey Olympia Tumwater Thurston County Clean Water Alliance
LPAHs	low molecular weight polycyclic aromatic hydrocarbons
MDL	method detection limit
MHHW	mean higher high water
MGD	million gallons per day
MHW	mean high water
MLLW	mean lower low water
MSL	mean sea level
MTCA	Model Toxics Control Act
NAPL	nonaqueous phase liquid
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
OC	organic carbon
Olympia	City of Olympia
PAH	polycyclic aromatic hydrocarbon

PARIS	Ecology's Permit and Reporting Information System
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PHS	Priority Habitat Species
PM	Particulate matter
PMA	Port Management Agreement
Port	Port of Olympia
ppt	parts per thousand
PSDDA	Puget Sound Dredged Disposal Analysis
PSU	practical salinity units
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RAL	remedial action level
RBTCs	risk-based tissue concentrations
RfDs	reference doses
RI	remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
ROW	right-of-way
SAIC	Science Applications International Corporation
SAP	sampling and analysis plan
SMS	Sediment Management Standards
SOW	Statement of Work
SPI	sediment profile imaging
SQS	Sediment Quality Standards
SVOC	semivolatile organic compound
TBT	tributyltin
TEF	toxicity equivalency factor
TEQ	toxic equivalency
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TPH-D	total petroleum hydrocarbons diesel
TPH-G	total petroleum hydrocarbons gasoline

TPH-HO	total petroleum hydrocarbons heavy oil
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
VCP	(Washington State Department of Ecology) Voluntary Cleanup Program
VOC	volatile organic compound
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
Work Plan	Project Investigative Work Plan
WRDA	Water Resources Development Act
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation

1 INTRODUCTION

This Existing Information Summary and Data Gaps Memorandum (EISDGM) is being prepared as required by an amendment to the Agreed Order (AO) #DE 6083 between the Port of Olympia (Port) and the Washington State Department of Ecology (Ecology). The first amendment to the AO (Ecology 2012a) signed February 15, 2012 requires the Port to conduct additional investigations into the nature and extent of contamination and potential sources of contamination to sediments in the vicinity of the Port peninsula in Budd Inlet (Figure 1-1).

The remedial action tasks required by the amendment to the AO include:

- Investigations into the nature and extent of contamination in the Study Area (Figure 1-2)
- Investigations into potential sources of contamination to sediments
- Preparation of an Investigation Report that meets the applicable requirements of the Model Toxins Control Act (MTCA) and Chapters 173-340 and 173-204 Washington Administrative Code (WAC)
- Identification and analysis of remedial action alternatives to address sediments containing contaminants above applicable cleanup levels in the Study Area
- Preparation of an Interim Action Plan (IAP) to address sediment contamination at the Study Area within the Budd Inlet

This EISDGM is the first of several steps required to complete the IAP, as outlined in the Project Investigative Work Plan (Work Plan) (Anchor QEA 2012, in progress). The main purpose of the EISDGM is to summarize readily available environmental and other appropriate data collected in Budd Inlet that are required to develop the IAP. This EISDGM is one component of the first task identified in the Statement of Work (SOW) included in the amended AO. This task also includes the preparation of the Work Plan and subsequent to Ecology review and approval of the Work Plan and the EISDGM, a Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP) that will be submitted concurrently with the final Work Plan.

1.1 Objective and Purpose

1.1.1 Project Overview

The remedial action for the Study Area will be carried out as an interim remedial action with in the Budd Inlet Sediments Site, which is one of seven bays identified by Ecology as Puget Sound Initiative priority bays in the Puget Sound. The remedial action is interim since Ecology is still evaluating the sediment quality in all of Budd Inlet. Until Ecology has made completed its assessment of Budd Inlet and developed recommended actions, all actions conducted within Budd Inlet are interim; however, it is Ecology's goal for interim actions to be the final remedy for the cleanup sites within Budd Inlet.

The interim remedial action for the Study Area will be developed after a series of tasks, and deliverables associated with those tasks. A summary of each task and associated deliverables are included in the Work Plan (Anchor QEA 2012, in progress). The approach and schedule presented in the Work Plan were developed based on Ecology's input and consideration. In fully defining the nature and extent of contamination in the Study Area and in evaluating interim action alternatives, the Port must follow the requirements of WAC 173-340-350 through 370 and WAC 173-204-560 through 580.

This EISDGM is the initial task, which will summarize readily available data and other site information for use in subsequent steps. Data and information summarized in the EISDGM is used to identify (and prioritize) data gaps in order to determine nature and extent of contamination, develop and evaluate potential remedial alternatives, and develop the IAP. The data gaps assessment will include a summary of recommended studies proposed to address the identified data gaps. Final project data needs will be identified collectively with Ecology.

Sampling efforts to address data gaps will be identified in a SAP and QAPP, which will include detailed methodologies, approaches, and descriptions of the analyses conducted for each of the data gaps. The results of the sampling efforts will then be presented in an Investigation Report that will provide validated analytical results.

The Identification and Evaluation of Interim Action Alternatives Memorandum (Alternatives Memo) will identify and evaluate potential interim action remedial alternatives following Ecology approval of the Investigation Report. The IAP for the selected interim action will be developed following Ecology approval of the Alternatives Memo.

1.1.2 Overview of EISDGM

The purpose of the EISDGM is to summarize readily available environmental, physical, and ecological studies and information relevant to the Study Area. This report identifies studies, documents, and other sources of information pertinent to the Study Area and discusses the applicability of data in order to evaluate potential interim action alternatives. Information compiled in this EISDGM will be further evaluated to develop the specific investigative data needs that will be presented in the SAP and QAPP, and used in conjunction with new data presented in the Investigation Report for consideration in the Alternatives Memo.

The EISDGM includes a summary of the nature and extent of contamination in the Study Area, based on surface and subsurface sediment and other environmental media. It also describes available dioxin and furan (D/F) concentrations in Budd Inlet to support evaluation of background concentrations. Existing information summarized in the EISDGM consists of results from environmental investigations or cleanups. These datasets are summarized and assessed for applicability. The appropriateness of each dataset is reviewed in this report using the criteria presented in Section 3.2.1.

1.2 Site Regulatory Background

In May 2007, the Puget Sound Initiative (Initiative) was enacted to begin work restoring the health of Puget Sound by 2020. One of the objectives of the Initiative is to protect and restore Puget Sound by cleaning up contaminated sites within one-half mile of Puget Sound. These cleanup actions are designed to reduce pollution and restore habitat and shorelines in Puget Sound (Ecology 2008a). Ecology identified Budd Inlet as a high priority cleanup area that required focused sediment cleanup and source control primarily due to elevated (D/F) concentrations in sediment. In April 2007, Ecology began a bay-wide investigation of the sediments in Budd Inlet. As part of the Initiative, Ecology is issuing AOs to property owners investigate and cleanup contaminated sites within the Budd Inlet Sediments Site.

Ecology and the Port signed AO #DE 6083 (Ecology 2008b) on December 5, 2008, which requires the Port to perform remedial actions in response to releases of hazardous substances at the Budd Inlet Sediments Site. In compliance with the AO, the Port completed an Interim Action to remove elevated concentrations of D/Fs in sediment from portions of the berth area adjacent to its docking facility in West Bay of Budd Inlet. The project also served as a pilot study to assess the characteristics of the in-place sediments and analysis of the benefits of proposed dredging technologies for future cleanup of Budd Inlet. This Interim Action is summarized in Section 3.1.1.

The AO was amended on February 15, 2012 requiring the Port to "conduct additional remedial actions at a portion of a facility where there has been a release or threatened release of hazardous substances". The Site boundaries have not yet been defined. (Ecology 2012a) The remedial actions required by the Amendment include nature and extent of contamination investigation within the Study Area, investigation into potential sources of contamination to sediments in the vicinity of the Port's peninsula in Budd Inlet, preparation of an Investigation Report, identification and analysis of remedial action alternatives to address sediments containing contaminants above applicable cleanup levels in the Study Area, and preparation of a draft Interim Action Plan. In order to complete cleanup activities with the Study Area in an efficient manner, Ecology has determined that the preferred remedial alternative will be implemented as an Interim Action in anticipation of it being the final clean-up remedy for the site.

Use of interim actions may result in a faster and more cost effective cleanup and is consistent with Washington Administrative Code (WAC) 173-340-430. In order to complete cleanup activities with the Study Area in an efficient manner, Ecology may select a remedial action alternative that will be implemented as an Interim Action. As defined by Ecology, an interim remedial action:

- Is technically necessary to reduce a threat to human health or the environment by eliminating or substantially reducing one or more pathways for exposure to a hazardous substance;
- Corrects a problem that may become substantially worse or cost substantially more to address if the remedial action is delayed; or

- Is needed to provide for completion of a site hazard assessment, remedial investigation/feasibility study, or a cleanup action design.

Another ongoing MTCA cleanup site, Cascade Pole, is located within the Study Area boundary. The Cascade Pole site is located on the northern end of the peninsula and includes upland and aquatic areas (Figure 1-2). The Cascade Pole site has been under multiple AOs with Ecology for investigation cleanup activities since 1990. In 1995, the Port took over the responsibility for cleaning up the Cascade Pole site and has conducted several interim cleanup actions to remove or contain contamination. Since previous and ongoing Cascade Pole site cleanup activities are being conducted under a separate AO (see Section 3.1.2) between the Port and Ecology, therefore the Cascade Pole site is not subject to the cleanup evaluation process under the AO for the Study Area.

1.3 Sources of Existing Information

All applicable information for the Study Area has been summarized in this report. Applicable information includes the most recent studies and/or information on physical characteristics, habitat, and biological communities that represent current conditions in Budd Inlet or the Study Area. In general, studies cited in this section are the most recent of their kind. However, older studies have been cited if they contain elements applicable to current Budd Inlet or Study Area conditions, or if no new information has been collected to update the information contained in the older studies. All references cited are thought to contain valuable information helpful in understanding the environmental setting of the Study Area. A list of documents that were used in the report is included in Appendix A, the Project Library List.

All of the information presented in this report comes from available existing documents, online resources (e.g., National Oceanic and Atmospheric Administration [NOAA] tides), historical Environmental Data Resources (EDR) reports and aerial photos, Ecology's Environmental Information Management (EIM) database, and information provided by City of Olympia (Olympia). The specific data sources have been cited accordingly throughout this document.

All of the previous physical and chemical sediment quality, water quality, and tissue chemistry data was compiled from EIM (Ecology 2012b) and existing available data reports. A summary of criteria for data selection and suitability is discussed in Section 3.2.1.

Historical bathymetry data was acquired through a query of the U.S. Army Corps of Engineers (USACE) Engineering Records Branch for historical bathymetric maps and dredge history information (Section 2.3.3). Recent bathymetry (Section 2.3.2) information has been updated using several surveys that were compiled from USACE and independent surveys conducted between 2005 and 2011.

The Port and Thurston County (County) provided current tenant and user information, as well as parcel boundaries (Section 2.6). Use and ownership of the Study Area and vicinity are presented based on the existing information at the time of this report's preparation.

Shoreline, structural, and utility information (Section 2.3.4) was acquired from Port, Olympia, and County utility maps. Structure and utility descriptions are based on as-built design drawings whenever possible, with updated information presented for upgraded facilities. Shoreline characteristics were verified by looking at photos and aerial imagery.

Geology and state lands information was acquired from Washington State Department of Natural Resources (DNR).

1.4 Document Organization

The remainder of this document is organized as follows:

- Section 2 presents a summary of the environmental setting and history of Budd Inlet and the Study Area, including physical characteristics, natural resources, structures and utilities, and land use.
- Section 3 summarizes the previous remedial actions conducted within the Study Area and the existing environmental data available within the Study Area and from Budd Inlet. A review of methods for evaluating analytical data quality as applied to the environmental data is included. Sampling events are described for environmental media including sediment, surface water, tissue chemistry, groundwater, toxicity

testing, and benthic community.

- Section 4 identifies known historical, ongoing, and potential sources of contamination to the Study Area and vicinity. It discusses the types of potential sources and pathways of contamination including over-water uses and spills; wastewater, combined sewer overflow (CSO), and stormwater discharges; contaminated upland sites; and atmospheric deposition.
- Section 5 summarizes the sufficiency of the available information and identifies the data gaps that need to be filled in order to identify and analyze interim action alternatives and prepare and an IAP.
- Section 6 presents the references cited in this document.

2 SITE BACKGROUND AND ENVIRONMENTAL SETTING

2.1 Site Description

The Port is located in the northern portion of the City of Olympia (Olympia) on a peninsula within Budd Inlet, which is a small embayment in southern Puget Sound (Figure 1-1). Budd Inlet is divided into the West and East Bays in the southernmost point of Budd Inlet. The filling of tidelands in the late 1800s and early 1900s created the Port peninsula, the West and East Bays of Budd Inlet, and the downtown area of Olympia. The Port peninsula consists of approximately 150 acres; the entire Study Area is approximately 271 acres. The construction of the peninsula was the last phase of tideland filling that occurred from the late 1800s through the early 1900s to accommodate the growing city of Olympia (Port of Olympia 2008).

2.1.1 West Bay

The Olympia Harbor federal navigation channel extends into Budd Inlet West Bay and widens into a turning basin near its southern end, adjacent to the Port's Marine Terminal berthing area (Figure 2-1). The navigation channel is 500 feet wide, and the turning basin is 900 feet wide, each of which is authorized to elevation -30 feet mean lower low water (MLLW) (SAIC 2008). The Port manages the harbor area under a Port Management Agreement (PMA) with DNR. Along the Marine Terminal, the harbor area is mostly defined as a 54-foot-wide swath that extends from the south end of the Marine Terminal to the north end and beyond (Figure 2-1). This narrow swath extends from the face of the Port's Marine Terminal landward, thus including the under-wharf area of the Marine Terminal. Waterward of the Marine Terminal, the berthing areas coincide with the federal turning basin (Port of Olympia 2008).

The Marine Terminal is approximately 60 acres and provides approximately 2,500 lineal feet of wharf and 76,000 square feet of warehousing. Three modern ships, or a combination of vessels, can be hosted simultaneously at the Marine Terminal. Current upland use immediately adjacent to the berths and turning basin include log storage yards and loading docks (Port of Olympia 2008).

The area south of the Marine Terminal includes a boat basin and waterfront shops and restaurants. West Bay also contains three marinas: Fiddlehead, Martin, and the Olympia Yacht Club. Within West Bay, five contaminated sites under separate AOs with Ecology are located along the western shoreline: Westbay Marina, Hardel Mutual Plywood, Reliable Steel, Solid Wood Incorporated, and Industrial Petroleum Incorporated. (Figure 2-2)

At the southern end of West Bay, the Deschutes River drains into Capitol Lake. This area was once an estuary where freshwater from the Deschutes River intermingled with salt water from Budd Inlet. The lake was created in 1951 as a reflection pond for the State Capitol by installing an earthen dam and an approximately 82-foot wide tide gate with spillways across the mouth of the Deschutes River under the 5th Avenue Bridge in Olympia (USGS 2006). The flow of freshwater into West Bay is controlled by gated discharges from Capitol Lake.

2.1.2 East Bay

A second federal navigation channel is authorized from north of the peninsula that extends into Budd Inlet East Bay to elevation –13 feet MLLW. The primary commercial facilities in East Bay are Swantown Marina and Boatworks, located on the eastern side of the peninsula (Figure 2-1). The federal navigation channel also extends to the boat launch ramp located just north of Swantown Marina. Swantown Marina has been in operation since 1983 (previously referred to as the East Bay Marina prior to 1995) and is owned and operated by the Port and maintains slips for approximately 700 vessels. Swantown Boatworks provides vessel service, haul out, and a vessel storage facility (SAIC 2008).

Two contaminated sites under AOs with Ecology are located on the Port peninsula adjacent to the East Bay (Figure 2-2); the Cascade Pole cleanup site is located on the north end of the peninsula that includes a portion of the sediment within the East Bay, and the East Bay Redevelopment Site is on the southern portion of the peninsula (Section 2.1.2).

Moxlie Creek, which originates from an artesian spring approximately 1.5 miles south of Budd Inlet, flows into East Bay through a mile-long culvert that discharges into at the southern end of East Bay (Thurston County 2007). East Bay was placed on the 1998 303(d) impaired water list for polychlorinated biphenyls (PCBs) based on a single composite sample of mussel tissue collected from the culvert at the mouth of Moxlie Creek (Ecology 2003 as cited in SAIC 2008).

2.1.3 Study Area Boundary

The AO Amendment defines the Study Area boundary and is shown on Figure 1-2; however, the interim action cleanup boundary may extend beyond. The Study Area boundary includes the aquatic areas adjacent to property owned by the Port, which comprises of the Port's berthing areas, under wharf areas, and log pond in West Bay, and areas adjacent to Port property north of the peninsula and in East Bay, as shown in Figure 1-2. The former Cascade Pole site is excluded from the Study Area since it is being investigated and remediated under a separate AO between the Port and Ecology as shown on Figure 1-2 (See Section 3.1.2 for a discussion of cleanup activities and Section 4.4.1 for site history).

2.1.4 Other Contaminated Sites

The southern portion of Budd Inlet has been used for a variety of industrial, commercial, and shipping activities since the 1890s. Due to the nature of the activities and historical practices, chemical releases have resulted in documented contamination at sites in the southern portion of Budd Inlet. Since 2007, under the Initiative, Ecology has been investigating the Budd Inlet Sediment Site, primarily focusing on D/Fs in addition to Sediment Management Standards (SMS) chemicals. In addition to the Study Area, there are 7 other contaminated sites within the Budd Inlet Sediment Site that are in various stages of investigation, remediation, or completion. Table 2-1 summarizes other contaminated sites in the vicinity of the Study Area and within the Budd Inlet Sediment Site. The locations of the contaminated sites are shown on Figure 2-2. Additional details on remediation activities conducted at these sites are summarized in Section 3.2, and the site history and summary of investigations conducted at the other cleanup sites are discussed in Section 4.1.

2.2 Site History

The following section provides a summary of the historical development and industrial operations within and in the vicinity of the aquatic and upland portions of the Study Area, potential historical sources of contamination. This subsection documents historical sources that may have contributed to existing contamination; a detailed discussion of potential historical sources is provided in Section 4. Historic aerial photographs are provided in Appendix B.

2.2.1 Early Settlement and Port Peninsula Development

Settlement of the lands surrounding Budd Inlet was primarily done in the 1850s and spurred by the U.S. Donation Land Claim Act of 1850. At this time, transportation throughout the Puget Sound region was primarily by boat in order to support commerce associated with local resources. A wharf was constructed in 1848 to deeper water on the west side of Budd Inlet to facilitate marine travel; the first ship to call at Olympia was in 1849 for the shipment of pilings to San Francisco. In 1851, Olympia was named the first custom house and ships entering Puget Sound had to register at Olympia prior to making call at other destinations. By 1851, water commerce was expanding and salmon, wood shingles, and timber were shipped out of Olympia. Steamboats were the primary route of transportation prior to the development of a road system and were calling at Olympia by 1853.

As Olympia's waterfront was expanding due to marine travel and timber-products commerce, a wharf was constructed in 1854 extending from the foot of Main Street. In 1860, the Percival dock was constructed for passenger traffic. Adjacent to the Percival dock, the 4th Avenue Bridge was constructed in 1869 for an additional wharf area. A wharf (Brown's wharf) was constructed in 1875 located approximately 1-mile north of Olympia and used for loading wood products and as a passenger landing. Historical condition surveys of Budd Inlet show the configuration of the waterfront areas prior to development of the Port peninsula.

To accommodate the rise in shipping traffic in Budd Inlet, a channel was dredged in 1887 from Main Street to deeper water. The wharf measured approximately 4,800 feet and was built on over 900 piles. By the late 1890s, a number of sawmills and timber industries existed along the western shoreline of West Bay and the existing peninsula. The USACE then dredged and expanded the navigation channel in 1893 and 1894, creating additional upland property with dredge fill and the long wharf was abandoned. Significant additional upland property was created during the 1909 to 1911 dredge and fill placement, known as the Carlyon Fill, creating 29 blocks of land from the dredging of 2 million cubic yards of sediment and creating a deep-water port. Early industrial development on the newly created land included shipbuilding and sawmills during World War I.

The Port was officially formed by a county-wide vote in 1922, soon after development of the peninsula fill. Formation of the Port spurred continued widening of the Port area and initial wharf facilities were established at the site of the shipyard. A bulkhead was constructed along the western shoreline area of the Port peninsula and developed for lumber processing and adjacent waters were used for log booming. Development brought industries to areas adjacent to the docks including lumber mills; bulk petroleum facilities; a canning facility (fruit); oyster processing; timber-product manufacturing (shingles, door and sash, and veneer/plywood); and a wood treating facility. The Port continued improvements during the 1920s and 1940s, building additional bulkheads and wharves, cold storage facility, and a Port office. Following World War II, a channel was dredged in 1945 north of the Port peninsula off of Gull Harbor to accommodate a reserve "mothball" fleet of Navy ships. Up to 185 ships were anchored in this area, with some deployed for wartime periods and others to store wheat during the 1950s. The reserve fleet was removed from Budd Inlet in 1972.

By the 1960s, finished lumber and cargo operations at the Port facilities had declined and shipment of logs began to take precedence. Many of the former shipping buildings, sawmills, and timber-product manufacturing buildings were demolished in the 1970s and 1980s to provide storage areas for log shipping. Additional land was also created in the 1980s along the eastern shoreline of the Port peninsula in East Bay from dredge filling for development of a private marina. Since the 1980s, the Port has continued the development of the Port peninsula creating a 60-acre Marine Terminal with three deep-water berths and a Port warehouse.

2.2.2 West and East Bay Nearshore Areas

2.2.2.1 West Bay Nearshore Area

The West Bay shoreline was changed over time to provide additional land for industrial development adding many acres to the natural shoreline, which was originally mostly marshy banks with some rocky beach and mudflats. Early development began in the 1890s with the construction of a sawmill in the current vicinity of West Bay Park. Additional sawmills were developed further north along the West Bay shoreline during the early 1900s. The lumber mills produced a variety of wood products including millworks, sash and doors, shingles, molding, veneer, and plywood. A majority of the water areas in West Bay were used for log dumping and booming to support the lumber mills. Timber industries changed ownership over time and continued up to the mid-1990s. Many of the mills experienced significant fires at some point during their historical operations (Ecology 2007a SAIC 2008, Parametrix 2008).

In addition to lumber mills and plywood manufacturing, other West Bay nearshore industrial operations included a bulk petroleum facility, steel fabrication, and private marina. The bulk petroleum facility was constructed in the 1950s and was used until the 1970s, at which point the storage tanks were used to store waste oil until the 1990s (Arcadis, 2012). A steel fabrication facility was developed in the late 1920s; small steel craft were initially constructed at the facility. During the 1940s, the company transitioned to building steel oil barges and tugboats until 2002 when steel tanks were built and shipped via barges (Ecology 2007b). A majority of West Bay nearshore industrial operations have currently ceased and been demolished. Olympia is in the process of developing the southwest nearshore area of West Bay into a park to provide community access. Remaining uses of West Bay include a marina and log booming to the north.

2.2.2.2 East Bay Nearshore Area

The eastern nearshore areas of the East Bay were not historically developed for industrial use. Historical property use included mostly residential development and limited commercial and retail activities in the southern vicinity of East Bay.

2.3 Budd Inlet Physical Characteristics

2.3.1 Meteorology

The climate in Budd Inlet is characterized as "Pacific marine," typical of the Puget Sound area. The prevailing winds move moist air inland from the Pacific Ocean, moderating winter and summer temperatures. Winters tend to be mild and wet, and summers are usually dry. Over 75 percent of the annual precipitation falls from October through March (WRCC 2012). Mean annual precipitation measured at Olympia between 1948 and 2012 is 50.7

inches (WRCC 2012). Monthly average winter temperatures range from 34 to 50 degrees Fahrenheit (°F) and monthly average summer temperatures range from 45 to 70°F (WRCC 2012). Winds are typically from the south and southwest with typical wind speeds from 0 miles per hour (mph) to 14 mph, rarely exceeding 21 mph (Weatherspark 2012).

2.3.2 Bathymetry

Budd Inlet is 8.8 square miles at mean high water (MHW) with an average depth of 30 feet (LOTT 2008). The inlet is 7 miles long and approximately 1 mile wide at its mouth and 2 miles wide at its center (LOTT 2008). Within the Study Area, the Port peninsula splits West Bay and East Bay at the southern end of Budd Inlet (see Figures 2-3, 2-4, and 2-5).

Other than the navigation channels and turning basin, West Bay and East Bay are shallow and contain extensive mudflats along shoreline areas that are visible at low tide. The West Bay channel turning basin is authorized to -30 feet MLLW, but is as shallow as -26 feet MLLW along the edges of the south and western turning basin boundaries. The East Bay channel is authorized to -13 feet MLLW, and is currently several feet shallower than -13 feet MLLW, especially at the southern end of the channel. The berth areas adjacent to the Marine Terminal, which partially coincide with the turning basin, were dredged to -39 feet MLLW in 2009 at portions of Berths 2 and 3, but some areas were already as deep as -42 feet MLLW. The area north of the Port peninsula within the Study Area is intertidal and no deeper than -5 feet MLLW. The log pond located north of the Marine Terminal is generally shallower than -10 feet MLLW.

A compilation of existing data on East Bay and West Bay bathymetry is shown in Figures 2-4 and 2-5, respectively. Sources of bathymetry information are listed below:

- Survey from eTrac, Dated December 14, 2010
  - Most recent multi-beam survey beneath the Marine Terminal wharf
- Survey from USACE, Dated February 2011
  - Most recent and comprehensive survey of federal navigation channels, turning basin, and Swantown Marina
- Survey from eTrac, Dated July 13, 2010

- Covers West Bay shoreline areas and West Bay turning basin
- Covers East Bay shoreline and navigation channel as well as Swantown Marina to the Boatworks

- Multi-beam survey of West Bay Park, dated May 2007
- Survey by WH Pacific, dated 2009
  - Covers shoreline areas near Percival Landing in West Bay
- Finlayson GIS Data, 2005
  - Covers bathymetry up to approximately +10 feet MLLW
  - Low resolution. Generated from 30 feet by30 feet resolution digital elevation.

2.3.3 Historical Dredging

Dredging has been historically conducted in Budd Inlet to maintain the federal navigation channels and turning basin and to maintain berthing depths at the Port's Marine Terminal and marinas. Most dredging events have occurred within West Bay. In West Bay, USACE's last maintenance dredging was in 1973, and the Port's berthing area was last dredged in 2009.

Based on bathymetry survey maps obtained from USACE, nine dredge events have occurred in the West Bay navigation channel and turning basin between 1902 and the present. Figures 2-6 and 2-7 show the deepest historic dredge elevations for East Bay and West Bay, respectively. Figures 2-8 and 2-9 show the thickness of sediment accumulated over the deepest dredged elevations (based on the most recent bathymetry survey) in the East and West Bays, respectively. Below is a list and short description of the dredge events that occurred in West Bay:

- On July 18, 1912 Puget Sound Bridge and Dredging Company completed its contract for dredging in order to improve the Olympia Harbor. The elevations from this dredge event in the turning basin area are all above -30.0 feet.
- The entrance channel to the Olympia Harbor was dredged on October 1, 1927. The dredge depths range from approximately -36.1 feet to 30.0 feet in the berth areas and are shallower than -32.0 feet in the turning basin.
- On January 24, 1934 soundings were taken of dredging that occurred in the channel and turning basin areas of Olympia Harbor. The dredging events occurred on March

22, 1932 between station 27+55 and station 168+00 and on June 27, 1933 between station 0+00 and 26+00. The dredge depths range from -38.4 feet to -30.0 feet in the berth areas and are -32.0 feet and above in the turning basin.

- Dredging was conducted by Puget Sound Bridge and Dredging Company from December 23, 1938 to February 12, 1939. The dredge depths range from -38.2 feet to -31.0 feet in the berth areas and are as deep as -37.3 feet in some areas of the turning basin.
- One of the deepest dredge events occurred from February to March and in November of 1948. The dredge depths range from -37.7 feet to -33.8 feet in the berth areas and are as deep as -38.1 feet in the turning basin.
- Soundings were taken on April 4, 1963 to survey the condition after dredging. The dredge depths range from -35.9 feet to -32.3 feet in the berth areas and were shallower than -35.9 feet in the turning basin.
- Soundings were taken on May 10, 1973 to survey the condition after dredging in September, October, and November, 1972. The dredge depths range from -39.6 feet to -21.6 feet in the berth areas. Material was removed from the Marine Terminal berth areas to -42 feet MLLW over a width of 800 feet as measured on USACE Condition After Dredge September, October, and November 1972.
- Soundings were taken on January 11, 1983 to survey the elevations from the dredging event that occurred on December 10 through December 14, 1982. The dredging occurred on the outer channel, entrance channel, and turning basin. The dredge depths range from -44.0 feet to -37.1 feet in the berth areas and are -43 and above in the turning basin.
- The most recent dredging event occurred in 2009 as part of the Berths 2 and 3 Interim Action. Dredging was conducted to -39 feet MLLW from Port station 7+20 to 15+40 within 110 feet of the pierface. Within the nearest 10 feet of the pierface, dredging occurred to -40 feet MLLW. One foot of residuals management sand cover was placed over the dredged area following completion of dredging. Total removal volume was 9,515 cubic yards (Anchor QEA 2009).

Three condition surveys are available for East Bay. Original marina construction occurred in 1982. Below is a list and short description of the surveys available for East Bay:

- Soundings were taken after the dredge condition in April 1982. East Bay Marina (i.e., Swantown Marina) was dredged to elevations of -12 feet MLLW, -10 feet MLLW, and 8 feet MLLW; however, a few areas were as deep as -17.0 feet MLLW during this event.

- A survey was completed in August 1984 to check the condition of East Bay Marina. Some areas were as deep as -18.2 feet MLLW, no dredge event was known to occur after the original dredge event.
- A survey was completed in August 1987 to check the condition of East Bay Marina. The elevations on this survey are not lower than those in 1984.
- A multi-beam bathymetric survey was conducted in 2011 in East Bay by the Port; however, no areas were deeper than previous surveys.

2.3.4 Shoreline Conditions

The Study Area is located in a highly developed industrial area, and the shoreline and surrounding upland areas have been substantially modified. The entire peninsula was created from filled tidelands, and the shoreline includes berths, docks, bulkheads, riprap, and modified natural shorelines (Integral 2007a). Figure 2-10 shows the shoreline types with the Study Area, including natural bank, overwater structures, and riprap/reinforced shoreline types.

2.3.4.1 Structural Information

The east shore of West Bay is highly developed, primarily composed of over-water wharves, piers with riprap slopes, and bulkheads for industrial and commercial use. The west shore of East Bay is also highly developed with over water concrete floats and piles for industrial and commercial use. Throughout the entire length of the shorelines, approximately 25 percent contains over water wharves above riprap. Another 50 percent is mud flats with natural shoreline. The remaining 25 percent consists of exposed shoreline armored with riprap.

Structural information is described in Table 2-2 and on Figure 2-11. The east shoreline of West Bay predominantly consists of concrete over-water wharf structures, which are the Port's Marine Terminal berthing areas ; Berth 1, Berth1-2, Berth 2, Berth 3 South, and Berth 3 North. These wharves are composed of precast concrete decks with a top elevation of approximately +21 feet MLLW. Various structural upgrades have been performed since the

Port was officially established in 1922, and these wharves were all replaced between 1979 and 1988. The precast concrete decks are supported by concrete bents spaced at approximately 20 feet on center with octagonal concrete piles at a tighter spacing along the bents. The piles are primarily 16.5-inch diameter, but there are 24-inch diameter piles supporting the crane beam(s) in several locations.

An armored riprap shoreline with a slope ranging between (1H:1V and 2H:1V) is present beneath each over-water wharf structure (See Appendix C for representative cross sections). The slope rises to meet a bulkhead that retains the uplands soils approximately 108 feet shoreward of the wharf face. The top of embankment along the bulkhead face is generally at an elevation of +13.5 feet MLLW. Water depths along the face of each wharf were originally designed to be -42 feet MLLW, as shown in Table 2-2.

There are several other shoreline sections including, but not limited to, over-water timber structures, abandoned creosote-treated wood piling, riprap, and various floats with piling. A high density of abandoned creosote treated wood piling is located just north of Berth 3. These unique sections are listed in Table 2-2 and shown in Figure 2-11, but are not detailed as information has not been made available at this time.

Most data presented in the section were obtained from archived record drawings obtained from the Port. Record drawings were not readily available for Berth 4, Anthony's restaurant's dock and foundation, the KGY Radio building, the USACE's breakwater, and the multiple Swantown Marina facilities (e.g., travel launch, guest dock, and marina infrastructure). Information on these structures may be obtained at a later date.

2.3.4.2 Outfalls

There are 14 outfalls present along the Port peninsula shoreline within the Study Area. Stormwater outfalls are generally corrugated metal pipe. Most are 12 inches in diameter with one 30-inch outfall composed of vitrified clay pipe that discharges to the log pond. The primary Lacey-Olympia-Tumwater-Thurston County Clean Water Alliance (LOTT) discharge located at the northern end of the Study Area is 48 inches in diameter, as well as the LOTT emergency overflow outfall located near Fiddlehead Marina. The Indian-Moxlie

Creek outfall is 72 inches in diameter, located just south of the Study Area in East Bay. Table 2-2 describes the outfalls and Figure 2-11 identifies location of each outfall.

2.3.5 Hydrology

The Deschutes River (through Capitol Lake) is the only major river that flows into Budd Inlet. Nine small tributaries also drain into the Budd Inlet. The Deschutes River watershed drains approximately 126,609 acres (198 square miles). The tributaries that drain directly to Budd Inlet include Garfield Creek, Butler Creek, Indian Creek, Ellis Creek, Moxlie Creek, Mission Creek, and Schneider Creek. Additionally, both the Black Lake Drainage Ditch and Percival Creek flow into Budd Inlet via Capitol Lake (ESA Adolfson 2008). The river and tributaries are shown on Figure 2-12. Olympia's Storm and Surface Water Plan (City of Olympia 2003) contains detailed information about the surface water drainages within the city, as summarized below.

2.3.5.1 Deschutes River and Capitol Lake

From its headwaters, the Deschutes River flows north-northwest for approximately 57 miles to Capitol Lake in Olympia. The Deschutes River is classified as a Class A (excellent) stream by Ecology from its mouth to river mile 48.2, the Snoqualmie National Forest Boundary. From the national forest boundary to its headwaters, it is classified as a Class AA (extraordinary) stream. All tributaries flowing into the Deschutes River are classified as Class A streams (City of Olympia, 2003).

Discharge from Capitol Lake is controlled by a dam that separates the freshwater from the saltwater at the river's mouth. The Capitol Lake dam discharges water through two radial gates, a fish gate, and a siphon that connects the lake and Budd Inlet. The radial gates are controlled by a system that regulates releases from Capitol Lake to maintain a target lake level and to prevent intrusion of brine waters into the lake. The normal lake level during the summer is approximately +6.4 feet mean sea level (MSL) (ENTRANCO 1997). When the lake rises above the desired level, the gates open as long as the difference in water level between the lake and Budd Inlet is at least one foot. Should the lake drop below the desired level or the difference in water level between the lake and Budd Inlet drop below one foot, the gates automatically begin to close (WDFW, 2008). The lake reaches full discharge mode to no-discharge several times a day during the winter, and only once or twice a day during the summer. The largest flood on record for the Lower Deschutes River occurred on February 9, 1996. The peak flow published for the Deschutes River for this event is 0.283 cubic meters per second (m^3/s) at U.S. Geological Survey (USGS) gage 12080010, located on the Deschutes River at the E Street Bridge in Tumwater. Discharges from the lake vary from 0 cubic meters per second during most of the tidal cycle to up to 100 m^3/s during low tides (and during high freshwater inputs to the lake) (LOTT 2008). A table of flood levels as determined in a 2003 Floodplain Analysis is shown in Table 2-3 (URS and Dewberry 2003).

2.3.5.2 Percival Creek – Black Lake Drainage Ditch

The Percival Creek – Black Lake Drainage Ditch system drains into Capitol Lake. Percival Creek is approximately 3.6 miles long and is one of the largest stream systems in the urbanized area of north Thurston County. The basin is located between the Black Hills on the west and Interstate 5 on the east. The stream system consists of the main stem, one major tributary, and several minor tributaries. The main stem originates at Trosper Lake and flows north for approximately 2.4 miles to its confluence with the Black Lake Drainage Ditch. The creek flows in a steep canyon downstream of the confluence for about 1.2 miles, crossing under I-5 and Cooper Point Road before dumping into Percival Cove on the west side of Capitol Lake (City of Olympia 2003).

The Black Lake Drainage Ditch is approximately 2 miles in length and was originally a natural channel that was ditched in the 1920s in order to improve drainage to the northern end of the Black Lake wetlands. The drainage ditch originates at Black Lake and flows northerly for approximately 2 miles before heading east near Mottman Road to the confluence with Percival Creek (City of Olympia 2003).

The Percival Creek drainage basin is approximately 5,300 acres (8.3 square miles), and covers the urbanized and rapidly developing west side of Olympia, and developing areas of Tumwater, and Thurston County. The basin is approximately 50 percent developed, most of which has taken place in the last 10 to 20 years. Approximately 20 to 25 percent of the basin is comprised of impervious surface. High density land use is expected to increase. Percival Creek has been given a Class A water quality designation by Ecology. Water quality problems in Percival Creek are related to storm flows and stormwater runoff rather than pollution inputs. Some of the problems stem from the Black Lake/Black Lake Drainage Ditch system and construction-related sediments (City of Olympia, 2003).

2.3.5.3 Indian and Moxlie Creek

Indian Creek is approximately 3 miles long with its headwaters at Bigelow Lake, a sphagnum bog, and flows south in a heavily vegetated drainage ditch. It is piped under several arterial roads, an industrial site, and Interstate 5. The basin area is approximately 1,559 acres and flows into Moxlie Creek near the intersection of Plum Street and Union Avenue in Olympia's central business district (City of Olympia 2003).

Moxlie Creek is approximately 1.8 miles long with its headwaters at an artesian spring located in Watershed Park and flows through the undeveloped park for about a mile before being piped under Interstate 5. The creek enters high-density commercial and industrial areas before the junction with Indian Creek. The two creeks are then piped for 3,200 feet between Union Avenue and East Bay (City of Olympia 2003).

The Indian-Moxlie basin is highly developed except for the areas around Bigelow Lake and Watershed Park. The combined Indian-Moxlie basin covers approximately 4.5 square miles and is experiencing slower growth than other basins because the area is already mostly developed. Approximately 35 to 40 percent of the basin is covered by impervious surfaces. Indian and Moxlie Creeks have been classified as Class A streams by Ecology; however, fecal coliform concentrations are consistently high, and the system has been identified as a source of fecal coliform bacterial contamination to Budd Inlet. Additionally, stormwater discharges to the creeks create high flows and contribute nonpoint pollutants. Potential excessive biological productivity can be attributed to elevated nitrogen and phosphates in the creeks. Elevated levels of trace organic compounds and metals have been found in the waters and sediment of the creeks (City of Olympia 2003).

2.3.5.4 Ellis Creek

Ellis Creek has an approximate main stem length of 1.1 miles and is formed by its three headwater tributaries converging at the Priest Park boundary just above Gull Harbor Road and Ames Road. The basin area is approximately 1,667 acres mostly located in unincorporated Thurston County and is zoned as rural residential. The remainder is zoned as suburban residential. Approximately 5 to 10 percent of the basin area is comprised of impervious surface. Ellis Creek has been given a Class A water quality designation by Ecology, and has been identified as a source of surface water contamination to Budd Inlet, as bacterial contamination intermittently exceeds state requirements (City of Olympia 2003).

2.3.5.5 Mission Creek

Mission Creek is approximately 1.5 miles long and originates at a wetland located between Ethridge and Pine Streets in Northeast Olympia. The basin area is approximately 360 acres, and is entirely within the Olympia city limits except for the southeastern tip east of Fairview and Edison Streets. It includes approximately 300 acres of undeveloped land, including wetland, in Priest Point Park. Approximately 20 to 25 percent of the basin area is comprised of impervious surface. The remaining area can be classified as single family residential and duplex units. Mission Creek has been given a Class A water quality designation by Ecology, and has been identified as a major source of bacterial surface water contamination in Budd Inlet (City of Olympia 2003).

2.3.5.6 Schneider Creek

Schneider Creek is approximately 1.3 miles long and originates in an urban residential neighborhood south of Capital Mall Drive. The creek flows east from Capital Mall underground before surfacing in a moderate density residential neighborhood west and east of Division Street. The basin area of 662 acres is located almost entirely within Olympia city limits, except for a small area at the northern tip of the basin. Land use in the basin includes single family and duplex units, commercial and industrial development, and undeveloped land. Approximately 30 to 33 percent of the basin area is covered with impervious surfaces. Schneider Creek has been given a Class A water quality designation by Ecology. There is an extensive road network and high level of commercial and residential development in the basin. Primary contaminants are suspected to be pollutants from vehicles, sediments, and possibly nutrients (City of Olympia 2003).

2.3.5.7 Garfield Creek

Garfield Creek is a degraded stream that predominantly conveys stormwater to Budd Inlet. Flows are very low to intermittent during the late summer and fall. Garfield Creek flows through a culvert that runs under the former Solid Wood Incorporated site (Puget Sound Nearshore Ecosystem Restoration Project 2011)

2.3.6 Tidal Hydrodynamics

This section describes available data on tidal hydrodynamics, including tidal range, currents, salinity, and tidal circulations.

2.3.6.1 Tides

The tidal range within Budd Inlet is one of the highest in Puget Sound, with approximately 14.4 feet difference between MLLW and mean higher high water (MHHW). There are no long term tidal gauges within Budd Inlet; however, there are several short term records of tidal elevations throughout the inlet as well as three NOAA tide stations that provide tidal predications. These data include:

- Tidal Predictions:
  - NOAA Station 9446807, south of Gull Harbor, Washington
  - NOAA Station 9446800, mouth of Budd Inlet at Boston Harbor
  - NOAA station 9446969, split between West and East Bays
- Tidal Measurements:
  - NOAA Station, 9448607, verified data between April 26, 1996 to December 3, 1998
  - Two Tide Gages installed as part of the LOTT study (LOTT 2007)
    - Boston Harbor Marina from September 1996 to September 1997
    - Port of Olympia's primary large vessel wharf from September 1996 to December 1996

Locations of the various sources of tide data are shown on Figure 2-13. Tidal datum for Budd Inlet are provided in Table 2-4 and include information provided by the tidal benchmark at

NOAA Station 9446807 (south of Gull Harbor, Washington) estimated using NOAA's VDatum (NOAA 2012) for a location adjacent to the Port's Marine Terminal.

2.3.6.2 Current and Salinity Data

Several sources of short- and long-term current and salinity data are available for Budd Inlet, including West and East Bays. The majority of the data was collected as part of three studies: The Budd Inlet Scientific Study conducted by LOTT (LOTT 1997), Budd Inlet Circulation and Flushing Study (Duxbury et al. 1972), and South Puget Sound Dissolved Oxygen Interim Data Report (Ecology 2009a).

Figure 2-13 shows locations of salinity profiles, moored current profiles and current transects collected by Duxbury et al. (1972), and the Ecology study (2008). Duxbury et. al (1972) compiled and analyzed salinity profile data collected at four locations in Budd Inlet by University of Washington in 1957 and 1958. The Ecology study (Ecology 2009a) collected acoustic Doppler current profiler (ADCP) data at two locations at the mouth of Budd Inlet and four ADCP transects between the mouth of Budd Inlet and the spilt between West and East Bays. Transect data was collected over a complete tidal cycle in July and September 2007. Moored current data was collected over 14 days in July 2007. Figure 2-14 shows the locations of salinity profiles, moored current profiles and current transects collected as part of the LOTT study. These data were collected at various temporal scales over a 13-month period between September 1996 and September 1997. Salinity profiles were taken throughout the main body of Budd Inlet as well as three locations within West Bay and two locations within East Bay. Current meters were also deployed throughout the main body of Budd Inlet with one current meter deployed in West Bay. No current data was collected in East Bay during that study (LOTT 2008).

2.3.6.3 Tidal Circulation

The tide range in Budd Inlet is one of the highest in Puget Sound, with a difference of 14.4 feet between MLLW and MHHW. Combined with the relatively shallow bathymetry in Budd Inlet, the volume of water in the inlet between MLLW and MHHW is roughly the same as the volume of water in the inlet at MLLW. Within West and East Bays, it is estimated that the tide drains 73 percent of the water volume in that area during each tidal cycle. The flushing time for Budd Inlet is estimated to be between 8 and 12 days (LOTT 2008).

Salinity within Budd Inlet, including West and East Bays, is relatively well mixed with top to bottom salinities ranging between 20 and 29 parts per thousand (ppt) throughout the year (Duxbury et al. 1972, LOTT 2008). Surface salinities are lower by a few ppt in the fall and winter (when freshwater input to the inlet is at its peak) compared to summer months. Surface salinity increases moving north towards the head of the inlet while bottom salinities remain relatively constant throughout the inlet. In addition, lower surface salinities are found on the eastern side of the inlet (north of the split between East and West Bay) than on the western side of the inlet (LOTT 2008).

Tidal circulation within Budd Inlet is quite different between West Bay and the central portion of Budd Inlet. Hydrodynamics in West Bay are heavily influenced by discharges from Capitol Lake, which is connected to West Bay through a tide gage. Discharges from the lake vary from 0 m^3/s during most of the tidal cycle to up to 100 m^3/s during low tides (and during high freshwater inputs to the lake). The intermittent discharges from the lake increase surface velocities and decrease surface salinities (sometimes by as much as 70 percent) compared to time periods (higher tides) when the discharge from the lake is close to zero (LOTT 2008). Figure 2-15 shows data collected from July 22 to 26, 1997 as part of the LOTT study (LOTT, 2008) which illustrates the impacts of Capitol Lake discharge on the currents and salinities within West Bay. From review of Figure 2-15 the velocities in West Bay are typically less than 5 cm/s, however, during a discharge from Capitol Lake (over 100 m^3/s) the velocities in West Bay can spike to over 20 cm/s. From review of salinity data from that same time period (Figure 2-15), the salinities in West Bay are typically in the 25-28 practical salinity units (PSU) range but during a discharge from Capitol Lake (over 100 m^3/s) the salinities can drop to 15 PSU or lower.

Tidal circulation in the main body of the inlet is relatively complex and consists of southern flow along the western side of the inlet and northern flow along the eastern side of the inlet (LOTT 2008). The LOTT study (LOTT 2008) collected numerous current transects throughout a 13-month time period (September 1996 and September 1997) that were used to develop a conceptual model of net circulation in the inlet. This model is shown in Figure 2-

16 indicates that higher-salinity water entering Budd Inlet flows south along the western shoreline at all depths. A portion of this water continues south and eventually flows into West Bay while another portion of the flow is directed eastward across the inlet. Flow along the eastern side of the inlet has net northward flow. Freshwater enters the inlet primarily through discharges from Capitol Lake into West Bay. This freshwater flows out of West Bay and into the main body of the inlet where it flows northward along the eastern side of the inlet. This flow pattern is supported by salinity transects in the inlet which measured lower surface salinities along the eastern portion of the inlet. In addition, there is a weak counterclockwise gyre in the center of the inlet (see Figure 2-16), which may re-circulate water within the inlet.

Eight moorings of current meters were deployed in Budd Inlet during the LOTT study for multiple time periods ranging from October 1996 to September 1997. Velocities near the mouth of the inlet range from approximately 10 to 30 centimeters per second (cm/s) and tidally averaged reach over 3 cm/s. The velocities in the center of the inlet are lower and range from approximately 10 to 15 cm/s and tidally averaged are less than 1 cm/s. The velocities near the East and West Bay split range from 10 to 15 cm/s and tidally averaged are from 1 to 1.5 cm/s

2.3.7 Sediment Physical Characteristics

This section presents a summary of grain size and total organic carbon (TOC) based on existing data from Budd Inlet. Figure 2-17 has been adapted from the Ecology sediment study shows the variation in fines, sand, and gravel throughout the inlet (SAIC 2008). TOC content in the surface sediments averaged 3.2 percent and ranging from 0.6 percent to 9.3 percent (SAIC 2008). East Bay and West Bay sediments are very fine-grained, consisting of silts and clays in most subtidal areas of Budd Inlet (SAIC 2008).

Surface sediments within the Study Area are influenced by historical dredging and shoreline development activities. Table 2-5 presents a summary of physical parameters (grain size, TOC and total solids) based on existing data within the Study Area. The subsurface and surface sediment TOC and grain results within the Study Area are consistent Ecology's data with an average TOC of around 3.0 percent (3.6 percent for surface 2.9 percent for subsurface) with the sediments consisting predominantly of fines followed by sand. Also consistent with Ecology's findings, the subsurface sediment has a greater amount of fines and less sand than the surface sediment. However, the maximum percent of gravel at 78.2 and 95 percent, surface and subsurface respectively, is unusual high, indicating that some samples may have been collected in areas with fill.

2.3.8 Sediment Transport and Sedimentation

2.3.8.1 Sources of Sediment

There are numerous sources of sediment input to Budd Inlet, as follows:

- Capitol Lake/Deschutes River and other creeks that drain into Budd Inlet (see Section 2.3.4)
- Lateral loads such as storm drains and other point source discharges/outfalls (see Section 4.3)
- Suspended load from other areas of Puget Sound
- Bank and shoreline erosion within Budd Inlet

There is little source specific sediment load data for these identified sediment sources for Budd Inlet. However, Capitol Lake sediment appears to have a large effect on the sedimentation rate in West Bay. Post-dredge monitoring reports following dredging in Berths 2 and 3 does provide some information regarding sediment loads from Capitol Lake. The 15-month monitoring report following the Berths 2 and 3 Interim Action (Anchor QEA 2010) found evidence of sedimentation in the berths greater than 20 centimeters following placement of a sand cover at the conclusion of the Interim Action (over a 15-month period). This higher than normal deposition rate was attributable to flushing of Capitol Lake several times over several months. Other sources of sediment to Budd Inlet (i.e., lateral loads, etc.) are anticipated to be small relative to loads from natural creeks and Capitol Lake/Deschutes River.

2.3.8.2 Net Sedimentation Rate

Geochronological core information is sparse within Budd inlet, with only three cores throughout the inlet and East and West Bays. Ecology conducted a sediment characterization study and estimated sedimentation rates for Budd Inlet (SAIC 2008). There were three radioisotope cores taken: one north of the East Bay and West Bay split, and one core taken in each bay outside of dredged areas as shown in Figure 2-18. Table 2-6 shows the sedimentation rates for two time periods: prior to 1951 when the dam was built and after 1951. These cores may not represent all of Budd Inlet or the bays, but it is believed that the top 10 to 20 centimeters was deposited within the past 10 to 20 years; leading to a sedimentation rate of approximately 1 to 2 centimeters per year (cm/y) for that time period (SAIC 2008).

The dredged berthing areas of West Bay were found to have a higher net sedimentation rate than areas sampled as part of the geochronological study (SAIC 2008). Comparison of bathymetry between 1979, when the berth area was last dredged to -42 feet MLLW, and 2009 (prior to most recent dredging event); provides an estimate of net sedimentation in the berth areas at approximately 3.2 cm/yr.

As mentioned previously, recent dredge monitoring reports (Anchor QEA 2010) have measured higher sedimentation rates (higher than 20 centimeter in some areas over 15 months) within Berths 2 and 3 in West Bay, which has been attributed to sediment loads from Capitol Lake (which was flushed during the monitoring period).

In addition to geochronological cores, the LOTT study (LOTT 2008) collected both short- and long-term sediment trap data over a period of 13 months from September 1996 to September 1997. Figure 2-14 shows the locations of the sediment trap data collected as part of that study. Long-term sediment trap data was collected at four locations, three along the center line of Budd Inlet with one location in West Bay. Short-term sediment trap data was collected at two locations within Budd Inlet, one in the approximate center of the inlet and another along the western side of the inlet (near Olympia Shoal).The long term traps were used to determine accumulation rates and the short term traps were used to determine loading of inorganic and organic matter to sediments. The results from the sedimentation rates found using the long term traps are shown in ranged from 0.2 to 0.8 cm/yr in the central part of Budd Inlet and 2.0 cm/yr in West Bay (LOTT 2008).

2.3.8.3 Erosion Potential

Within Budd Inlet there are hydrodynamic scenarios that can induce erosion of the bottom sediments. Currents are thought to have a low potential of erosion due to relatively small current velocities measured and predicted in Budd Inlet and West and East Bays (see Section 2.3.6.2). However, when Capitol Lake is drawn down or flushed, the velocities in West Bay are significantly higher than normal operating conditions for the tide gate between Capitol Lake and West Bay. These increased velocities could cause localized erosion in bed sediments between the outlet of Capitol Lake and the berth areas. USGS conducted a hydrodynamic and sediment transport model that primarily focused on Capitol Lake (USGS 2006), but did simulate currents due to discharge and deposition of sediments from the lake into West Bay. The results of this model predicted that that erosion would occur in West Bay due to discharge from the lake and that sediment released from the lake would settle primarily in the berthing areas in West Bay (USGS 2008).

Vessel operations within West and East Bay are anticipated to be the most significant forcing mechanism for erosion and re-suspension of bed sediments within those areas. West Bay is an active commercial port for various tugs and other large commercial vessels performing berthing maneuvers within West Bay. Although vessel activities in the berth area are actively limited through Port and pilot institutional controls, prop wash velocities from these vessels may be high enough in some instances to re-suspend bed sediments (propeller induced scour) in the berth areas. There are also three recreational marinas within West and East Bay. Vessels transiting to and from these marinas may impact bed sediments due to prop wash velocities and wakes.

2.4 Geology and Hydrogeology

2.4.1 Regional Geology

Geologic information for the Budd Inlet region was gathered primarily from DNR maps and local remedial investigation reports. Key documents include the geologic map of the Tumwater 7.5-minute Quadrangle (Walsh et al. 2003) and remedial investigation reports for sites in the Budd Inlet region (e.g., AGI 1986, Landau 1993, GeoEngineers 2008, Greylock 2008, SAIC 2008). The regional geologic condition is presented on Figure 2-19. Representative geologic cross sections are presented in Appendix C.

Budd Inlet is located at the southern end of the Puget Lowland, a broad north-south trending structural trough between the Cascade Range and the Olympic Mountains repeatedly occupied by the Puget lobe of the Cordilleran ice sheet during Pleistocene glaciation (Blunt et al. 1987; Easterbrook 1994). Over the past 2 million years, the Puget Lowland has experienced at least six episodes of glaciation (Armstrong et al. 1965). The most recent ice-sheet advance into Western Washington was the Vashon Stade period of the Fraser glaciation, approximately 15,000 years ago (Armstrong et al. 1965; Easterbrook 1994).

The uplands surrounding Budd Inlet are composed of a thick sequence of Pleistocene-age Vashon and pre-Vashon glacial deposits interbedded with non-glacial alluvial sediments; these deposits are overlain in some regions by a thin veneer of recent fill and underlain throughout the region by Eocene-age bedrock (Walsh et al. 2003). Vashon glacial deposits typically observed in upland borings and along coastal bluffs include recessional outwash deposits (unconsolidated sand and gravel), glaciolacustrine deposits (thinly interbedded silt and clay), glacial till (well-cemented gravel and sand in a matrix of silt and clay), and advance outwash deposits (compact sand and gravel). Non-glacial, pre-Vashon alluvial deposits of sand and interbedded silt form a low-permeability zone beneath Vashon glacial deposits. Over 400 feet of these glacial and non-glacial unconsolidated sediments have been encountered in borings located on the Port peninsula (AGI 1986). All Pleistocene and younger sediments in the Budd Inlet region are underlain by volcanic bedrock of the Crescent Formation (Walsh et al. 2003).

Recent fill covers the entire Port peninsula and overlies native intertidal sediments. Historically, fill was emplaced to elevate the land surface and reshape the surface morphology (Walsh et al. 2003). Fill deposits on the Port peninsula are predominantly sand with some silty and gravelly zones, and occasional clay lenses, organic matter, shells, rip-rap, and other debris (AGI 1986).

2.4.2 Fill History

The southern portion of Budd Inlet was historically a tidal flat; over the last 120 years, this area has been episodically filled to create land for the City and Port (SAIC 2008).

The fill history of the Port peninsula was investigated by GeoEngineers (2008) at the East Bay Redevelopment Site and by AGI (1986) at the Cascade Pole Site. Based on historical aerial photographs (Appendix B), GeoEngineers determined that fill on the Port peninsula in the vicinity of the East Bay Redevelopment Site was placed in five episodes, with the last fill placed after 1975 (GeoEngineers 2008). The fill history of the Port's peninsula is shown on Figure 2-20. The principal lithology associated with each fill episode include the following, as described in GeoEngineers (2008):

- Pre-1891: This fill, present beneath the southwest portion of the East Bay Redevelopment Site, consists primarily of dark sand with pockets of wood debris and silt.
- 1891 to 1908: This fill is present beneath much of the East Bay Redevelopment Site and consists of dark brown to black, fine to coarse-grained sand dredged from Budd Inlet.
- 1908 to 1948: This fill is present beneath the northwest portion of the East Bay Redevelopment Site and consists of light colored sand with pockets of gravel and wood debris.
- 1948 to 1975: This fill is present beneath the eastern portion of the East Bay Redevelopment Site and consists of light-colored sand with pockets of wood debris.
- Post-1975: This fill is present along the east portion of the East Bay Redevelopment Site, along the bay front, and consists of silty, sandy gravel.

AGI (1986) used soil boring logs to describe a fill history for the Cascade Pole site as shown in Figure 2-20. The fill history beneath the Cascade Pole was divided into five episodes:

- 1920 to 1930s: Fill consisting of light gray, loose, fine to coarse-grained sand and gravel with abundant shell fragments underlies most of the Cascade Pole site and ranges in thickness from approximately 18 to 26 feet.
- 1940s: This fill was placed over the 1920 to 1930s fill at the northern end of Cascade Pole and consists of clay and wood fragments overlying gray sand and shell fragments.
- 1965: A channel at Cascade Pole was filled with a brownish red silt and gray silty sand to approximately nine feet below the ground surface. This fill also contains some gravel and wood debris.
- 1970s: The southern shoreline of Cascade Pole contains a small area that was filled

with an eight-foot sequence of wood debris.

- Early 1980s: South and east of the former treating plant at Cascade Pole, this fill contains sandy gravel, sand and silty sand with abundant shell fragments and a zone of wood debris.

2.4.3 Geotechnical Characterization

Soil investigations within the study boundary were performed between 1972 and 2007 by Dames and Moore, Shannon and Wilson, Applied Geotechnology Inc. (AGI), GeoEngineers, Landau Associates, and Integral Consulting. The investigations were project specific and were conducted to support development of the terminal berths, marina and associated navigational channel, remedial efforts at Cascade Pole, and the main land mass of the peninsula for construction of historic (i.e., demolished) and existing structures. As a result, characterization has been limited to specific sub-areas within the study boundary.

A total of 154 sample locations (45 sediment cores and 109 soil borings) were identified in the vicinity or within the Study Area as having geotechnical and/or geologic information. 32 of the sediment cores were collected from East Bay and 13 cores have been collected from West Bay. 48 soil borings have been collected from within the Cascade Pole cleanup boundary, 12 in the East Bay region, 33 in the Marine Terminal and West Bay region, and 6 near the log pond region of the Study Area. A summary of the geotechnical investigations are presented on Table 2-7 and geotechnical sample locations are shown on Figure 2-21.

Depths of the explorations ranged from less than 10 feet to 135 feet below ground surface (bgs). Most explorations were terminated 20 to 40 feet bgs. Results of the laboratory analyses of soil samples collected are available from the reports listed in Table 2-7. Laboratory tests performed include Atterberg limits, sieve analyses, water content, one-dimensional oedometer, direct shear, and unconsolidated-drained and consolidated-un-drained tri-axial compression.

Some of the historical procedures used for in-situ geotechnical tests do not correlate directly with American Society for Testing and Materials (ASTM) standard methods for similar current tests (i.e., ASTM D 1586). However, these data can be empirically correlated to values more consistent with standard practice. The additional data collected will complement the existing data and can be used to calibrate empirical correlations.

Results of laboratory analyses of soil samples were reviewed and are of acceptable quality. The analytical methods used in standard practice to test for index properties such as Atterberg limits and particle grain size distribution (i.e., sieve analysis) have remained consistent since the earliest dated report from 1972. Strength and consolidation tests performed on samples retrieved from thick walled, split-spoon samplers are commonly considered to be too disturbed (i.e., the natural state of the soil is permanently altered) to provide reliable results for design. Therefore, test results from this sampler type will be used on a qualitative basis to discern weak soil layers and complemented with additional laboratory testing which will be the data used for design.

2.4.4 Stratigraphy and Lithology of Budd Inlet Sediments

Budd Inlet sediments were collected and described by SAIC in 2008 as part of the Sediments Characterization Study. According to the report, surface sediments in the southern portion of Budd Inlet are very fine-grained, consisting of silts and clays in most subtidal areas of Budd Inlet (SAIC 2008). Intertidal sediments at the north end of the Port peninsula form a broad, gently sloping surface; the uppermost surface of the intertidal sediments is littered with partially sunken logs, old marine pilings, old tires, and other debris (Landau 1993).

Historically, the Deschutes River was the primary source of sediments to Budd Inlet, but since the construction of Capitol Lake in 1951, the sediment input to Budd Inlet has been significantly reduced (SAIC 2008); however, recent studies have confirmed that flushing events from Capitol Lake are an ongoing source of sediment input to West Bay (Section 2.3.8). Moxlie Creek flows which flows into East Bay of Budd Inlet is another source of sediment to Budd Inlet in the vicinity of the Study Area (Thurston County 2007).

Remedial Investigations (RIs) conducted at the Cascade Pole site by AGI (1986) and Landau (1993) documented the sediment stratigraphy in sediment adjacent to the Port peninsula. The recent deposits in Cascade Pole sediments range in thickness from over 13 feet to approximately 0.3 feet and consist of interbedded silty sand, sand, and clayey silt as well as shell fragments and wood debris (Landau 1993). Recent deposits are interpreted to be predominantly fill; the thickest deposits are associated with an area bounded by fill dikes installed in the 1930s (Landau 1993). The recent fill deposits thin to the east of Port peninsula in the intertidal zone, grading to silt, which may represent a mixture of dredged fill and recent intertidal sediments (Landau 1993).

Underlying recent fill deposits are tidal and subtidal marine deposits consisting of dark gray clay and silty clay, with occasional pockets of sand and abundant shell and wood fragments (AGI 1986; Landau 1993). In borings by Landau in 1993 offshore of the Cascade Pole site, these tidal and subtidal marine deposits were determined to be approximately 17 feet thick (Landau 1993). Also observed during the 1986 study by AGI, these deposits are continuous beneath the Port peninsula, ranging in thickness from 10 to 40 feet, with the thickest portion beneath the center of the peninsula (AGI 1986; ESE 1992).

Beneath the marine tidal and intertidal deposits, Vashon recessional outwash deposits including silty sand and fine- to medium-grained sand underlie the entire peninsula, and most of Budd Inlet (Walsh et al. 2003; AGI 1986). One geotechnical boring indicates these recessional outwash deposits are over 400 feet thick beneath the Port peninsula (Washington Public Power Supply System, 1974; Walsh et al. 2003).

2.4.5 Hydrogeology of the Port Peninsula

The hydrogeologic conditions of upland sites surrounding Budd Inlet have been thoroughly investigated. Over the past 25 years, a network of groundwater monitoring wells has been installed on the Port peninsula to support various remedial investigations (e.g., AGI 1986; Landau 1993; GeoEngineers 2007; Greylock 2008).

According to previous investigations, groundwater beneath the Port peninsula occurs within a shallow, unconfined aquifer at depths of 1 to 9 feet below the ground surface. This surficial aquifer is within the recent fill unit and is composed primarily of fill sand with minor silt and gravel. The surficial aquifer is primarily recharged by precipitation; groundwater in this unit flows outward from the central portion of the peninsula toward the shoreline, where it discharges into Budd Inlet (AGI 1986). A trace amount of the surficial aquifer recharge flows vertically downward to a deeper aquifer. The surficial aquifer is not used for drinking water supply, nor does it provide recharge to any water supply aquifer (AGI 1986).

A second, deeper aquifer lies below the Port peninsula and surrounding uplands, and is separated from the surficial "fill" aquifer by a regionally-extensive aquitard composed primarily of fine-grained nearshore and marine clay and silt (AGI 1986). This deeper aquifer occurs within the thick Vashon recessional outwash deposits and is composed primarily of well-sorted, fine to medium sand and minor silt.

Groundwater flow beneath the Port peninsula has been evaluated during previous groundwater monitoring events at the East Bay Redevelopment and Cascade Pole sites. Based on a groundwater study at the East Bay Redevelopment Site, shallow groundwater flow patterns at low tide and high tide are similar beneath the peninsula, except for a steeper gradient near the shoreline at low tide (GeoEngineers 2008; Greylock 2008). Most of the groundwater beneath the peninsula flows towards Budd Inlet, and several groundwater seeps (where shallow groundwater discharges to Budd Inlet) have been identified along the eastern peninsula shoreline during low tide (GeoEngineers 2008; Greylock 2008). Tidal influence on groundwater elevations is limited to areas of coarse fill, typically within 110 feet of the shoreline (Greylock 2008).

2.5 Natural Resources

2.5.1 Habitat

Major habitat types identified in Puget Sound nearshore environments include eelgrass meadows, kelp forests, flats, tidal marshes, estuaries, sand spits, beaches and backshore, banks and bluffs, and marine riparian habitat (Battelle et al. 2001). Manmade structures such as pilings also provide habitat for fish and encrusting invertebrates such as barnacles and mussels.

Budd Inlet, despite being highly modified, includes a variety of critical areas and critical saltwater habitat. Priest Point Park has the highest levels of intact and beneficial critical areas and saltwater habitat including salt marsh, riparian shoreline, estuarine conditions, steep slopes and beach sediment, and a salmon bearing stream. Forage fish spawning grounds and habitat is present along Priest Point Park and small sections of the west shoreline. The Port owns an area at West Bay Park, which is a functioning wetland with some salt marsh habitat.

Intertidal mudflats are generally defined as the gently sloping area from MLLW up to MHW and typically consist of unconsolidated silts, clays, and sands. Intertidal mudflats serve many ecosystem functions such as providing food and habitat for benthic invertebrates, fish, shorebirds, and aquatic mammals. A diverse assemblage of invertebrate species, including chironomid larvae (midges, a type of fly), clams, polychaetes (a type of worm), oligochaetes, (a type of worm), and amphipods (small epibenthic crustaceans), can be abundant in intertidal habitats and many fish and bird species rely on these invertebrate communities for food (Battelle et al. 2001. In addition, flats containing gravel may support high densities of bivalve populations (Battelle et al. 2001). Other functions that intertidal mudflats serve include sources of nutrients to primary producers and wave attenuation for up-slope tidal marshes (Battelle et al. 2001). Within the Study Area, intertidal mudflats are located along the northern portion of the Port's peninsula and along the East Bay shoreline.

Fine-grained subtidal habitat also exists throughout the Study Area. This habitat supports a variety of benthic organisms and aquatic vegetation.

2.5.2 Fish

Budd Inlet is a significant migratory route for anadromous salmonids in the Deschutes River watershed (Giles and Cordell 1998). Salmon have been confirmed in the Deschutes River, and the Mission, Moxlie, and Schneider Creeks, which all empty into Budd Inlet. The Deschutes River and Moxlie Creek discharge in the vicinity of the Study Area. The watershed supports Chinook, Coho, and chum salmon, as well as a winter steelhead spawning habitat. Both adults returning to spawn and outmigrant juveniles travel through West Bay though a fish ladder at the 5th Avenue Bridge Dam (Giles and Cordell 1998) or through the Moxlie Creek culvert in East Bay. The peak timing of outmigration for juveniles of all species generally corresponds with March-to-June high flows.

Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*) are a federally listed species under the Endangered Species Act (ESA) with designated critical habitat which includes Budd Inlet. In 2007, the National Marine Fisheries Service (NMFS) listed the Puget Sound steelhead (*Oncorhynchus mykiss*) distinct population segment (DPS) as threatened under the ESA. Chinook salmon are documented in Budd Inlet and the Deschutes River, Moxlie Creek, and Indian Creek (WDFW 2012; USACE 2005). Chinook salmon in the action area would primarily be of Deschutes hatchery origin, although fish from the Nisqually River stock do use the same area (WDF et al. 1993). For these reasons, it is expected that adult and juvenile Chinook salmon may be present in the Study Area as follows:

- Adults are expected to occur in the deep water areas in the vicinity of the river during the spring, fall, and winter of their upstream spawning migration
- Juveniles may occur in the shallow nearshore during typical outmigration periods between February and July

The DPS includes all naturally spawned winter and summer run steelhead populations in Puget Sound. The watershed also supports state sensitive species including Dolly Varden, bull trout, Olympic mudminnow, pigmy whitefish, and sea-run cutthroat trout. Bull trout (*Salvelinus confluentus*) are also listed as threatened under the ESA and their critical habitat includes Budd Inlet.

Several fish species of bottom fish, forage fish, non-game fishes, and other groundfish may occur in the Study Area (Palsson et al. 1997). A survey has not been performed in the vicinity of the Study Area; however, species anticipated to be present in the Study Area include starry (*Platichthys stellatus*) flounder, English and rock sole *(Platichthys stellatus* and *Pleuronectes bilineatus*), various rockfish species (*Sebastes* spp.), smelt, surf perches, herring, and sculpin. Starry flounder and English sole were collected for tissue analyses with an Otter trawl in three areas of Budd Inlet for Ecology's *Budd Inlet Sediment Characterization Study* (SAIC 2008). Starry flounder was reported to be the most abundant flat fish observed in Budd Inlet (SAIC 2008).

Pacific hake, Pacific cod, walleye pollock, Pacific herring, spiny dogfish (*Squalus acanthias*), lingcod (*Ophiodon elongatus*), and English sole are important commercial marine fish species in Puget Sound expected to be present in the Study Area. Other species of bottom fish species found throughout Puget Sound include skates, spotted ratfish, sablefish, greenlings, wolf-eel, Pacific sanddab, and sole and rockfish species. Additional fish species that are less known, but widely distributed in Puget Sound, include surf smelt (*Hypomesus pretiosus*), plainfin midshipman (*Porichthys notatus*), eelpouts, pricklebacks, gunnels, Pacific sand lance (*Ammodytes hexapterus*), bay goby (*Lepidogobius lepidus*), and poachers (DeLacy et al. 1972, Robins et al. 1991).

2.5.3 Birds

Budd Inlet is part of the Pacific Flyway and provides over-wintering areas for migratory waterfowl such as grebes, loons, ducks, and cormorants. RW Morse (2002) performed an 8-month survey in West Bay in 2002 to document the use of the bay by waterfowl before and during construction of the 4th Avenue Bridge. He noted a decline in all waterfowl species in the bay when compared to preexisting survey data. Of the species he observed, most were found along the undeveloped western shoreline of Budd Inlet. The shoreline in this area from the lagoon north consists mostly of rock-lined shores with occasional mudflats.

The Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species Database indicates that there are no priority habitats, known nest sites, or documented occurrences of priority species located within the Study Area (WDFW 2007). To the south there is a priority wetland containing regular concentrations of shorebirds and waterfowl. State priority species that may occur within approximately half a mile of the Study Area include purple martin (*Progne subis*), great egret (*Ardea alba*), green heron (*Butorides virescens*), Vaux's swift (*Chaetura vauxi*), peregrine falcon (*Falco peregrines)*, and bald eagles (*Haliaeetus leucocephalus*). Bald eagles have been delisted as federally threatened under the ESA but remain classified by WDFW as a State Sensitive species. Bald eagles have been observed foraging in the general vicinity of West Bay and the Capitol Lake/Deschutes River (USFWS and Anchor Environmental 2007a). The Study Area is located approximately 1 mile from the nearest bald eagle nesting territory, which is located at Capitol Lake.

2.5.4 Mammals

Aquatic mammals occurring in Bud Inlet include whales, seal, sea lions, and sea otters. The orca (killer) whale (*Orcinus orca*), Steller sea lion (*Eumetopias jubatus*) and humpback whale

(*Megaptera novaeangliae*) are on the NMFS species lists for Puget Sound waters, but these animals are highly unlikely to occur the shallow nearshore water of the Study Area.

The southern resident orca whales and bottlenose dolphins have been recorded in Budd Inlet but not as far south as West Bay (Orca Network 2011). Humpback whales are known to be uncommon and transient in Puget Sound and suitable habitat does not occur in the Study Area.

The eastern DPS Steller sea lions, which occur in Washington waters, have been observed in Budd Inlet, and their known haulout areas include log booms on the west side of the inlet and the shoal areas on the east side of the inlet near Priest Point State Park (WDFW 2000 as cited in Integral 2007b). However, no occurrences of Steller sea lion in Washington State have been recorded in the Steller Sea Lion Count Database as of April 2006 (NMFS 2006 as cited in Anchor Environmental 2007b). The eastern DPS Steller sea lion is being considered a potential candidate for removal from listing under the ESA by NMFS (NMFS 2012).

Harbor seals have been routinely observed in West Bay (RW Morse 2002). A single sea otter (*Enhydra lutris lutris*) was observed in Budd Inlet in February 2002 (Lance et al. 2004), but none have been observed in the vicinity Study Area. (RW Morse 2002)

2.5.5 Invertebrates

The invertebrate community consists of benthic, epibenthic, and planktonic. These benthic and planktonic species are an important prey base for several special of Pacific salmonids and their fish prey.

Giles and Cordell (1998) performed a year-long zooplankton composition and abundance study at six locations in Budd Inlet, which included a sampling station within West Bay. In relation to the central inlet stations, average abundance levels were found to be lower at the West Bay station. Crustaceans dominate the zooplankton composition in West Bay, followed by larvaceans, cnidarians, and polychaete annelid larvae.

Benthic community data is available from a limited benthic organism survey completed to determine the ecological health of intertidal and subtidal areas of the Westbay Marina (Hart Crowser 2011). Intertidal benthic samples included smooth worms (nematodes), polychaetes, gastropods, bivalves, arthropods (mysids and amphipods), and crabs. Subtidal benthic samples included smooth worms (nematodes), polychaetes, oligochaetes, gastropods, bivalves, and arthropods. There was greater diversity in the benthic samples from intertidal areas compared to samples from the subtidal areas (Hart Crowser 2011). In general, based on Puget Sound wide survey, areas with sandy sediments tend to have the most species (Llansó et al. 1998), but the lowest biomass (Lie 1974). Areas with mixed sediments tend to have fewer species but the highest biomass (Lie 1974).

2.5.6 Plants

The Puget Sound southern basin, which includes Budd Inlet, as described by Bailey et al. 1998, has the least amount of vegetation in its intertidal area (12.7 ± 15.5 percent coverage), with salt marsh (9.7 ± 14.7 percent coverage) and green algae (2.1 ±1.9 percent coverage) being the most common types. Macroalgae is recognized as a contributor to habitat complexity and primary productivity that readily colonizes on rocky, cobble, or hard artificial substrates (e.g., concrete). Macroalgae is common throughout Budd Inlet on most suitable substrates that are not shaded by overwater structures. There are no eelgrass or kelp beds in the vicinity of the Study Area (Integral 2007b).

2.6 Land Use Characteristics

2.6.1 Land Use and Ownership

Land use, zoning, and land ownership within Olympia's waterfront supports a variety of uses and provides the only locations in the area for water-dependent industrial uses as well as urban waterfront facilities and public access to Budd Inlet. Land use and zoning are described in the Olympia Comprehensive Plan and amendments (City of Olympia 2006). As part of the Comprehensive Plan. The Port created ten planning districts for the Port's Budd Inlet properties on both the Port peninsula and along West Bay. Zoning designations within the project area are presented on Figure 2-22 and consist of the following:

- **Industrial:** industrial zoning is located within the central area of the Port peninsula and includes the Port's Marine Terminal and berthing area.

- **Urban Waterfront**: consists of properties along the waterfront and provides for a compatible mix of commercial, light industrial, limited heavy industrial, and multifamily residential.
- **Downtown Business**: designation allows for a wide range of activities that contribute to the cultural, civic, commercial, and employment characteristics of Olympia. Includes a dense mix of housing, pedestrian access, and proximity to transit as well as preserving downtown's historic character.
- **Professional Office/Multi-Family:** accommodates a wide range of offices, services, and retail uses applicable to the zoning district and moderate-to-high density multi-family housing.
- **Residential:** A variety of residential designations exist in areas surrounding the project area.

Property ownership and use within the project area is consistent with the zoning designations described above. Property boundaries and ownership information are provided in Figure 2-23. A majority of the historical property uses on the Port peninsula and along the West Bay shoreline are no longer occurring and the properties have since been redeveloped consistent with Olympia's Comprehensive Plan (City of Olympia 2006) for current and future land use activities.

Property north of Market Street on the Port peninsula is owned by the Port. Land use is consistent with the industrial and urban waterfront zoning designation. The Port utilizes the east portion of the Port peninsula as part of the Marine Terminal and berthing area. The Marine Terminal is used for storage and loading of logs for shipping. A warehouse is located on the Marine Terminal; however, all historical buildings and infrastructure have been demolished to accommodate current operations. The Olympia Farmers Market is located just to the south of the Marine Terminal. The Swantown Marina upland facility is located in the northeast area of the Port peninsula; facilities include a boat ramp, parking, and marina office building. To the south of the marina is the Swantown Boatworks facility where boat haulout and repair activities are performed.

The southern portion of the Port peninsula (south of Market Street) is owned by a variety of entities including the Port, Olympia, LOTT, and private parties. This area is designated as

Urban Waterfront and land use consists of commercial, light industrial, and retail. The LOTT wastewater facility and East Bay Redevelopment Site (also known as East Bay Plaza) are located in the eastern and southeastern portion of this area. The LOTT wastewater facility is described in Sections 4.2 and 4.3. Public access areas are present along a majority of the shoreline as part of the Peninsula Walk, which includes boardwalk, trails, historic landmarks, and open space.

A majority of the historical industrial facilities along West Bay have been closed and demolished. The southern portion of the West Bay upland areas is owned by the Port and City and includes the recently completed West Bay Park, which is the former Solid Wood Incorporated Site. The City now owns the 17 acre former Solid Wood Incorporated site that they are converting into West Bay Park in phases. Phase 1 was completed in 2010 and consists of approximately 3 acres. The City plans to convert the remaining 13 acres; however this portion of the site is still being investigated and evaluated for public use. Property north of West Bay Park is privately owned. Current land use in this area consists of the upland facility of Reliable Steel and Hardel Mutual Plywood, Westbay Marina, and a log and chip shipping facility north of the marina. The City Comprehensive Plan describes this area as continuing to transition toward a mix of urban uses and habitat improvements (City of Olympia 2006).

The eastern shoreline of East Bay consists mostly of residential properties with waterfront access. The City owns a narrow strip of land along the southeast shoreline as part an interconnected trail system managed in coordination with the Port, known as East Bay Waterfront Park.

2.6.2 Water Use and Ownership

Budd Inlet provides for critical water-dependent use including the Port's Marine Terminal and public and private marina facilities. Most commercial vessel traffic consists of lumber companies loading and shipping logs from the Port's three deep-water berths, of which portions of Berths 2 and 3 are maintained to a minimum depth of -39 feet MLLW. The USACE maintains navigation channels within Budd Inlet and both West Bay and East Bay. Figure 2-1 presents the navigation channel and turning basin adjacent to the Port's deep-water berths in West Bay, which are authorized to -30 feet MLLW. The navigation channel extending into East Bay is authorized to -13 feet MLLW.

Marina use within Budd Inlet includes four recreational moorage areas, three of which are outside the Study Area. Four marinas are located within West Bay: Westbay Marina located at the northwest portion of West Bay; and Fiddlehead Marina, Martin Marina, and Olympia Yacht Club located in the south area of the Study Area. Swantown Marina is located in East Bay adjacent to the Port peninsula. These five marinas are shown on Figure 2-1.
The U.S Navy Maritime Reserve “Mothball” Fleet was moored in eastern Budd Inlet near Gull Harbor from 1946-1972. The reserve fleet comprised of up to 185 boats including merchant ships, tankers, freighters, and troop transports. Scrap material, which may have included waste oils, solvents, and paints, was reportedly discarded from the ships into Budd Inlet (Tetra Tech 1988).Figure 2-23 shows aquatic land ownership in the southern portion of Budd Inlet. The aquatic areas within the Study Area are owned by the State of Washington or Port. Areas adjacent to the Port peninsula are owned by the Port or owned by the State but managed by the Port under the PMA. The southwest nearshore areas of West Bay are owned by the Port and City as part of West Bay Park. Additional nearshore areas of West Bay to the north are privately owned. Remaining aquatic areas of Budd Inlet within the project area are state-owned and managed by DNR.

Budd Inlet is a major area for recreational use, such as fishing and boating. A motorized boat launch is present at the Swantown Marina and access is also provided for kayakers and other non-motorized watercraft. A hand held boat launch is located at West Bay Park. In addition to the boat launches, there are also public access points at Percival Landing Park, Port Plaza Park, and the 5th Avenue dam (City of Olympia 2010)

3 ENVIRONMENTAL QUALITY

This section summarizes the environmental quality of sediment, water, and biological resources within Budd Inlet and the aquatic portions of the Study Area. Section 3.1 summarizes the previous sediment and source control activities within or in the vicinity of the Study Area. Section 3.2 presents the summary of existing sediment, surface water, bioassay, fish tissue, and benthic community data for both the Study Area and Budd Inlet. Section 3.3 presents the findings of previous human health and ecological risk evaluations that were conducted in Budd Inlet.

3.1 Previous Remedial Actions in the Study Area

This section describes the previous sediment remediation activities that have been conducted within the Study Area as well as source control actions that reduced or eliminated sources of contamination to sediment within the Study Area. The locations of remediation and source control activities are shown on Figure 3-1.

3.1.1 Berths 2 and 3 Interim Action and Pilot Study

The Port entered into AO #DE 6083 (Ecology 2008b) with Ecology to complete an interim cleanup action to address cleanup of West Bay sediments adjacent to the Port's Berths 2 and 3, and to accomplish maintenance dredging. The objectives of the Interim Action and Pilot Study are described in the IAP, contained in Exhibit C of the AO; (Anchor QEA 2009b). Under Ecology's oversight, the Port dredged 9,515 cubic yards of sediments containing elevated levels of D/Fs within a portion of Berths 2 and 3 to an elevation of -39 feet MLLW. The area within 10 feet of the wharf-face was dredged to -40 feet MLLW in order to provide a deeper area to allow for under wharf sediment that could potentially slump/slough into the berth area. The project area was 110 feet wide and 800 feet long. Dredged sediments were disposed of at an upland landfill. A thin layer of clean sand (6-inch minimum thickness) was placed in the dredged areas to ensure that the biologically active zone provided a viable substrate for benthic biota post-dredging as well as to ensure that risks to human health and the environment did not increase due to dredging activities. Dredging was initiated on January 19, 2009 and completed on February 24, 2009. Post-dredge sand cover placement was completed on March 3, 2009 (Anchor QEA 2011).

The post-construction monitoring included regular multi-beam bathymetric survey in the Interim Action area. Sampling was conducted at 3, 9, 15, and 21 months following completion of the Interim Action (Anchor QEA 2009a, 2010a, 2010b, and 2011, respectively), as described in the Sampling Plan (Anchor Environmental 2008). The 15-month monitoring program was expanded beyond the required sampling based on requests from the USACE and Ecology to further evaluate the potential for sloughing/slumping of contaminated sediments at the toe of slope into the berth area. The additional monitoring components included Sediment Profile Imaging (SPI) and additional surface and subsurface sediment testing. Post-construction, 3-month, and 9-month monitoring events consisted of under wharf area, berth area, and ambient surface sediment sample locations, but was expanded to include toe of slope samples within the berth area during the 15-month and 21-month monitoring events. Surface sediment coring at the wharf-face was also conducted during the 15-month event.

3.1.1.1 Surface Sediment Concentrations

According to the AO and IAP (Anchor QEA 2009b), sediment sampling was conducted on surface sediment (0 to 10 centimeters) of the newly exposed sediment surface following dredging in the berth area. The post-dredge sampling was initiated on February 26, 2009 from four locations in the berth area (BA-24, BA-25, BA-26, and BA-27B). Post-dredge surface sediment (0 to 10 cm) D/F concentrations in the berth area ranged from 32.1 to 48.3 nanogram per kilogram (ng/kg) D/F toxic equivalency (TEQ); (average of 43.1 ng/kg D/F TEQ), with the lowest concentration located to the north (BA-27B). The average berth area concentration was higher than the average pre-dredge surface sediment concentration of 22.3 ng/kg D/F TEQ, but lower than the predicted “Z” layer (i.e., post dredge sediment surface) in the dredged area, which ranged from 51.1 to 67.2, with an average concentration of 58.6 ng/kg D/F TEQ (Anchor QEA 2009b). As expected, post-cover surface sediment concentrations at the Berth Area were low and ranged from 0.03 to 0.51 ng/kg D/F TEQ, with an average of 0.16 ng/kg D/F TEQ.

Previous studies by Ecology indicated that the average sediment concentration in Budd Inlet was 19.1 ng/kg D/F TEQ (SAIC 2008). Natural deposition and movement of sediments within West Bay was expected to gradually increase berth area concentrations until equilibrated with surrounding background sediment concentrations. Average berth area concentration was 11.1 ng/kg D/F TEQ during the 9-month monitoring event. However, both 21-month and 15-month monitoring results suggested that sediments with lower concentrations of D/F were deposited throughout West Bay, thus reducing average West Bay background surface sediment concentrations between the 9-month and 15-month monitoring events (Anchor QEA 2011). The results of the poste dredge monitoring events are presented in Figure 3-2.

During the 15-month monitoring event, concentrations decreased for under wharf samples, berth area samples, and ambient samples. This decrease is thought to be associated with drawdowns/flushing of Capitol Lake, which occurred three times between December 9, 2009 and March 5, 2010 in an attempt to control invasive New Zealand mud snails (General Administration 2010). The repeated flushing of Capitol Lake likely contributed to higher-than-normal sedimentation between the 9-month and 15-month sediment monitoring events (Anchor QEA 2011). The surface sediment D/F concentrations in the berthing area decreased significantly between the 9-month (average 11.1 TEQ) and 15-month (5.4 TEQ) surveys. Previous measurements of D/F within Capitol Lake sediment ranged from 1.9 to 3.9 ng/kg D/F TEQ (SAIC 2008). This low D/F-concentration sediment from the lake is thought to have been deposited throughout West Bay as a result of the flushing events, thus reducing average West Bay sediment concentrations (Anchor QEA 2011).

Berth area toe of slope concentrations averaged 13.4 and 8.9 ng/kg D/F TEQ during the 15-month and 21-month monitoring events, respectively.

Average under wharf sediment concentrations were similar to the post-construction concentrations (38.9 ng/kg D/F TEQ), which were 37.1 and 36.7 ng/kg D/F TEQ in the 3-month and 9-month monitoring events, respectively. Average concentrations were reduced during the 15-month and 21-month monitoring events (16.6 and 15.9 ng/kg D/F TEQ, respectively).

Ambient surface sediment samples were collected outside of the project area footprint. These samples contained concentrations in the 3-month and 9-month monitoring events (22.7 and 21.8 ng/kg D/F TEQ, respectively) that were similar to post-construction concentrations (23.8 TEQ). Average concentrations were reduced during the 15-month and 21-month monitoring events (5.6 TEQ and 13.7 TEQ, respectively).

3.1.1.2 Subsurface Sediment

Three cores were collected from BA-101, BA-102, and BA-103 during the 15-month monitoring event to support evaluation of dredging at the wharf face. Z-samples were collected and analyzed between -44 to -46 feet MLLW in order to estimate potential new sediment surface conditions if dredging were to be conducted to -44 feet MLLW. Z-samples D/F TEQ results were 15.2, 154.3, and 59.8 ng/kg for cores BA-101, BA-102, and BA-103, respectively. The results from BA-102 and BA-103 were elevated above 2008 background Budd Inlet concentrations (19.1 ng/kg D/F D/F TEQ; SAIC 2008).

This information suggests that the area in the vicinity of BA-102 and BA-103 has likely been dredged to at least -44 to -46 feet MLLW at some point in the past, which allowed sediments with elevated D/F concentrations to accumulate. Subsurface sediment observations indicated the presence of native sediment at -46.8 feet MLLW in core BA-103 and at -45.0 feet MLLW in core BA-102. Core BA-101 did not contain any material characterized as native material. The pilot study concluded that based on the D/F concentrations and subsurface sediment lithology observations, if additional dredging is to be considered for the area adjacent to the wharf face, subsurface D/F concentrations should be evaluated at depths deeper than -44 to -46 feet MLLW to determine the vertical extent of D/F contamination (Anchor QEA 2010b).

3.1.1.3 Additional Pilot Study Conclusions

Additional conclusions were presented in the Completion Report (Anchor QEA 2011), are summarized below:

- SPI results presented in the 15-month monitoring memo suggested that sloughed/slumped sediment from the under wharf area did not appear to have redistributed significantly beyond approximately 10 feet from the wharf face (Anchor QEA 2011).
- As agreed upon by Ecology, the residuals management cover layer was not intended as an isolation cap; therefore, some mixing of the residuals management cover layer with the underlying exposed surface post-dredging was expected. Results of the 15-

month monitoring, as shown on Figure 3-2, indicated that low to moderate mixing of the sand cover layer with underlying un-dredged sediment appears to have occurred as a result of either vessel operations within the berth area, or natural mixing through bioturbation and/or currents (Anchor QEA 2011).

3.1.2 Cascade Pole Remedial Action

Multiple interim actions have been implemented at Cascade Pole subsequent to the completion of the upland feasibility study (FS) in 1992 (Landau 2011a). These interim actions, described below and shown on Figure 3-3 were implemented to reduce the threat to human health and the environment and to prevent further spread of contamination from site releases.

- A groundwater extraction and treatment system was implemented in 1993 to provide hydraulic containment of Site groundwater. A 350-foot-long steel sheet pile cutoff wall and product recovery trench were constructed along the northeastern shoreline of the Site to contain and recover non-aqueous phase liquid (NAPL) and to prevent further release of NAPL to the marine environment.
- A 3,600-foot-long bentonite slurry cutoff wall was constructed around the perimeter of the contaminated groundwater and upland NAPL area in 1997 to provide a physical barrier to contaminated groundwater and upland NAPL migration from the site. The bentonite slurry cutoff wall extends vertically from near the ground surface to about 2 feet into the aquitard underlying the shallow aquifer.
- In conjunction with construction of the bentonite slurry wall in 1997, portions of the existing site stormwater system were replaced with a new stormwater collection and detention system to convey stormwater from paved areas to surface water discharge, and to contain stormwater that may have come into contact with contaminated soil within the perimeter cutoff wall.
- A sediment interim action was conducted between 2000 and 2002. The sediment interim action consisted of:
  - Construction of an approximately 4.5-acre containment cell in the northeast portion of the site for disposal of the contaminated sediment and debris, and capping of the containment cell following sediment placement with a low-permeability flexible membrane liner.

- Removal of approximately 40,000 cubic yard of contaminated sediment exceeding sediment cleanup action levels of 80 ng/kg for D/F TEQ and 4,300 milligram per kilogram (mg/kg) for carcinogenic PAHs (cPAHs), and backfilling the dredged area with clean sediment.
- Construction of a second steel sheet pile wall (added to slurry wall) to form the nearshore containment cell.
- Upgrades to the groundwater extraction, treatment and monitoring systems.
- Shoreline habitat improvements, including grading and planting of various saltmarsh and riparian plant species.

- The majority of the site was paved with asphalt during a series of interim actions conducted between 1998 and 2008.
- An engineering design report was prepared in 2010 for replacement of the groundwater treatment system that has been in operation since 1993. The specific goals of the new groundwater treatment system are:
  - Meet current National Pollutant Discharge Elimination System (NPDES) discharge limits
  - Have the capability to handle changing groundwater characteristics (e.g., a flow rate that is greater than the current system flow rate and up to 25 gallons per minute [gpm] to ensure an inward hydraulic gradient toward the containment area, recovery of additional free-phase petroleum hydrocarbons, adequate space to expand the system components including additional granular activated carbon beds and solids filtration equipment, etc.).

Excavation of shallow soils impacted with cPAHs or D/Fs from the North Point area in the northwestern corner of the Port's peninsula (labeled as "Area 2" in Figure 3-3), and relocation of the contaminated soil inside the bentonite slurry cutoff wall (to area labeled as "uncapped area" in Figure 3-3) conducted in 2010 removed an additional 1,000 cubic yards of soil (Landau 2011a). The interim action includes paving the area within the containment wall where the contaminated soil is placed with an asphalt cap. Based on the results of the post excavation compliance monitoring the cleanup levels in this area have been achieved.

3.1.3 East Bay Redevelopment

The Port completed a civil engineering construction project in 2010 to improve the existing infrastructure (e.g., underground utilities and roads) within approximately 2.5-acres of public rights-of-way (PIONEER 2010). These infrastructure improvements were necessary to plat and prepare the property for redevelopment. The infrastructure improvement activities included:

- Demolition and reuse of unnecessary concrete and asphalt
- Decommissioning of unnecessary public utilities
- Installation of new public utilities (i.e., water, reclaimed water, sewer, stormwater)
- Installation of new private utilities (e.g., electricity, natural gas, telephone, cable)
- Redevelopment of existing paved streets, including addition of bike lanes and sidewalks
- Construction of new paved streets, bike lanes, and sidewalks

Interim Action cleanup activities were conducted in conjunction with infrastructure improvements to ensure subsurface soil disturbances resulting from the infrastructure improvement project complied with applicable MTCA regulations and protected human health and the environment (PIONEER 2010). Cleanup levels were based on MTCA unrestricted land use. Interim Action Reuse Under Pavement Levels (IARUPLs) were also developed for soil designated for reuse as subsurface fill underneath paved surfaces within the infrastructure corridor. As part of the interim action, soil excavated from the infrastructure corridor that had concentrations exceeding the IARUPLs was disposed of off-site. IARUPLs are conservatively protective of all receptors that could be exposed to soil within the infrastructure corridor during and following construction and are conservatively protective of potential of surface water receptors. A primary objective of the interim action was to reuse soil to the greatest extent practicable. The interim action consisted of implementation and maintenance of the following engineering controls and performance monitoring during infrastructure construction:

- Site control including fencing, traffic and pedestrian controls to limit/restrict public access
- Minimization of subsurface soil disturbance through approaches such as excavation width control (e.g., use of trench boxes)
- Dust control and suppression including use of best management practices (BMPs) and protection monitoring

- Soil segregation into separate stockpiles as follows:
- Soil that is geotechnically suitable for reuse within the utility corridor
- Soil that is geotechnically unsuitable for reuse within the utility corridor
- Temporary storage including placement of excavated soil in stockpiles on an impervious surface, tracking system to manage stockpiles, covering all stockpiles with a secure liner
- Stockpile performance monitoring to determine whether or not soil could be reused
- Stormwater control
- Soil reuse or disposal
- Confirmational monitoring

A soil-to-surface water empirical evaluation report (PIONEER 2011) was prepared to support the Remedial Investigation/Feasibility Study (RI/FS) report for the site. The purpose of the report is to evaluate empirical data at the East Bay Redevelopment Site in accordance with MTCA to determine if constituents in soil will leach to groundwater and subsequently be transported to surface water. Key findings from this evaluation are:

- With the exception of arsenic and TPH-D/TPH-HO, empirical groundwater data show that constituents in potential on-site soil sources have not impacted groundwater, and therefore will not impact surface water.
- There are few potential groundwater exceedences of surface water screening levels. There are only eight contaminates of concern (COCs) with at least one surface water screening level exceedance in groundwater (arsenic, chromium, lead, copper, nickel, total cPAHs, TPH-D, TPH-HO). However, the screening level exceedences for chromium, lead, copper, nickel and total cPAHs are not attributable to leaching from soil to groundwater.
- Although the isolated screening level exceedences for arsenic and TPH-D/TPH-HO in select monitoring wells do not appear to be attributable to leaching from site soil, the empirical demonstration is not considered complete for these constituents at this time.
- There is no accumulation of LNAPL on or in groundwater based on well gauging data and supported by observed dissolved-phase concentrations of TPH-G, TPH-D, and TPH-HO.
- Site leaching potential will decrease significantly once the East Bay Redevelopment project is completed since future paving and development will decrease infiltration.

The soil-to-surface water empirical evaluation report (PIONEER 2011) indicates that soils remaining on the East Bay Redevelopment Site are not an on-going source of contamination to groundwater or surface water. The RI work plan states that groundwater to surface water/sediment exposure is not a complete pathway.

3.2 Summary of Existing Data and Usability

The sediment chemistry and biological data generated by investigations conducted in the Budd Inlet over the last 10 years are summarized in this section. The process for selecting and evaluating the data is discussed in Sections 3.2.1. All of the sediment data are summarized in Section 3.2.2, biological data (bioassay investigations tissue chemistry data) in Section 3.2.3), and surface water chemistry data in Section 3.2.4. Soil and groundwater investigations are discussed in Section 4.4, including for nearshore contaminated sites. All data compiled for this project is in Appendix D.

3.2.1 Data Selection and Evaluation

3.2.1.1 Historical Data Acceptance Criteria

Historical analytical data are defined as chemical, biological, or geotechnical data collected by various parties and made publically available. Most historical data was obtained from Ecology's regional offices or from Ecology's EIM database (Ecology 2012b). Other data sources could be obtained directly from properties, such as stormwater or other compliance monitoring data. Several activities may be supported by historical data including regional background development, conceptual site model development, data gaps assessment, and/or risk assessment. To assure that historical data is appropriately used for each activity, the data will be reviewed for quality and appropriate usage by evaluating the following criteria:

- Study quality assurance planning level: Level of quality assurance planning for a particular study (i.e., agency approved QAPP and SAP)
- Analytical methods: Standard, currently acceptable methods used for data analysis
- Location: Sufficient geographical data is provided to locate the sample and sample depth has been recorded (if applicable)
- Study quality assurance assessment level: Level of quality assurance performed on the data (i.e., verification and validation).

3.2.1.2 Data usability rankings

Based on the information provided in EIM or an applicable data report, a data usability (DU) ranking has been assigned to each data record in Appendix D. The three DU rankings along with the quality assurance requirements for each ranking are as follows:

- **DU-1.** Data in this category are acceptable for inclusion in project databases and used for defining nature and extent of contamination, background level evaluations, and calculations of risk in risk assessments. Adequate planning documentation exists and analytical methods are known and acceptable in the Ecology regulatory framework. The location of the sample is known with sufficient accuracy to support the nature and extent of chemical constituents and to evaluate ecological and human health risk. The analytical results have sufficient information to judge data validity and qualifiers.
- **DU-2**. Data in this category are acceptable for background level evaluations and conceptual site model development, but are not acceptable for risk characterization. Location information is sufficiently accurate to support spatial assessments. Collection and analytical methods are documented. Data qualifiers and detection limits are provided, though data validation protocols are absent.
- **DU-3**. Data in this category are not acceptable for background level evaluations or risk evaluation. These data may be used as indicators of contaminants of potential concern (but not as indictors of "never detected in the Study Area") and may be used to help assess a data gaps sampling program. These data lack critical information to assess location and/or collection methods. They lack analytical method description or use unacceptable methods (e.g., not precise or accurate; not sufficiently sensitive); data qualifiers, detection limits are not available. The Quality Assurance Manager will make final decisions on the usability of data sets in this category on a case by case basis.

3.2.1.3 Data Acceptability and Exclusion Criteria

Chemistry and geotechnical data were also evaluated based on how well they represent current site conditions and applicability to this site investigation. Chemistry data considered representative of current conditions are:

- Less than 10 years old

- Have not been removed or affected by a cleanup action (e.g., dredged, covered with residuals management sand cover) since collection date

Any data that did meet these criteria were excluded from further evaluation in this report. Chemistry data associated with older monitoring events at re-occupied stations as part of the Berths 2 and 3 Interim Action monitoring were also excluded. This included surface sediment samples collected from the Berths 2 and 3 dredge area prior to placement of the sand cover and during the 3-, 6-, 9-, and 15-month post cover monitoring. Since the sample locations were re-occupied to monitor the change in surface conditions, only the data from the 21-month monitoring event were retained as representative of current conditions. Data associated with the Berths 2 and 3 Interim Action that were excluded from further evaluation are provided in Appendix D and also shown on a figure in Appendix E.

Geotechnical data was not excluded based on age or cleanup action since that information typically represents a broader (e.g., regional or site-wide) area, does not readily change over time, and the characterization techniques do not rely on analytical equipment. Geotechnical data is unlike chemistry data, which is typically localized, can change over time, and subject to newer analytical methods and laboratory reporting limits that improve the accuracy and quality of the data.

Additionally, both analytical and geotechnical data from within the site boundary of the Cascade Pole site were excluded since that site is being remediated under a separate AO with Ecology and is not considered within the Study Area boundary for this investigation. However, all available sediment data prior to the Cascade Pole remedial action (prior to 2000) along with results of the most recent sediment monitoring activity in 2007 are provided in Appendix D. A figure of the pre-remedial D/F TEQ results with in the Cascade Pole boundary is presented in Appendix E.

3.2.1.4 Data Reduction

Data reduction refers to methods used to evaluate and summarize raw data. A detailed discussion of the data reduction methods is presented in Appendix F, and briefly summarized as follows:

- Chemical concentrations obtained from the analysis of laboratory duplicates or replicates (i.e., two or more analyses of the same sample) were averaged for a closer representation of the "true" concentration as compared to the results of a single analysis.
- Field duplicates, which are discrete samples collected simultaneously at a single sampling location that were submitted to the laboratory as individual samples and analyzed separately were averaged and evaluated as a single sample, as outlined in Appendix F.
- In some instances, the laboratory generated more than one result for a chemical for a given sample if reanalysis was conducted or if two different analytical methods were used for that chemical. The procedures for selecting the best result are described in Appendix F.
- The precision of each result was stored in the project database by recording the number of significant figures assigned by the laboratory. Significant figures were tracked according to methods described in Appendix F.
- Total PCBs, total polycyclic aromatic hydrocarbons (PAHs), were calculated by summing the detected concentrations for the individual components. The individual components of each calculated sum are provided in Appendix F. For samples in which none of the individual components were detected, the total concentration was given a value equal to the highest reporting limit (RL) for an individual component and assigned a U-qualifier, indicating the lack of detected concentrations.
- D/F TEQs were calculated using toxicity equivalency factors (TEFs) to convert individual congeners prior to summing. The TEFs and the process for calculating TEQs are described in Appendix F.

3.2.2 Sediment Quality

Sediment quality in this section is summarized for both the Study Area and Budd Inlet. The nature and extent of sediment contamination in the Study Area is summarized for surface and subsurface sediment. Within the Study Area, concentrations were summarized for D/F TEQ and SMS chemical since results from these chemicals will be evaluated to develop cleanup boundaries and remedial action alternatives. For the Budd Inlet data outside the Study Area, surface sediment data is summarized for D/F TEQ, since it is anticipated that this data will be used to support evaluation of regional background concentrations (e.g., Budd Inlet region). Subsurface sediment data outside the Study Area is not included in this memorandum.

3.2.2.1 Existing Sediment Studies

Table 3-1 presents a summary of the sediment studies available to evaluate sediment concentrations in the Study Area and throughout Budd Inlet. The locations of sediment samples collected throughout Budd Inlet are shown on Figure 3-4.

3.2.2.2 Study Area

Several investigations have been conducted within the Study Area as part of Ecology-led Budd Inlet investigations as well as investigations to support maintenance dredging and previous remedial actions investigations. Figure 3-5 shows the locations of surface and subsurface samples that are consider acceptable for use in this project.

3.2.2.2.1 Surface Sediment Data

A total of 42 surface sediment samples have been collected in the Study Area. All 42 of the surface sediment samples were analyzed for D/Fs and 5 samples were analyzed for SMS chemicals. Most of the available surface data in the Study Area is in West Bay in the vicinity of the Port's berthing area. The D/F TEQ in surface sediment ranged from 0.649 to 324 ng/kg with an average concentration of 22.0 ng/kg. The highest surface sediment concentrations within the Study Area are adjacent to the Port's Marine Terminal along Berth 2 and in the log pond. None of the results from the 5 samples tested for SMS chemicals exceeded their respective criteria.

Surface sediment data within in the Study Area is summarized on Table 3-2. The acceptable surface sediment locations with either D/F TEQ or SMS chemistry data are shown on Figure 3-6. The D/F TEQs in surface samples are shown on Figure 3-7.

3.2.2.2.2 Subsurface Sediment Data

A total of 53 sediment cores have been collected in the Study Area. Acceptable subsurface sediment has been characterized for D/F TEQ concentrations in 53 cores (107 samples) and SMS chemicals in 10 cores (13 samples). Most of the subsurface data in the Study Area is in West Bay within the navigation channel, turning basin and the Port's berthing area.
Of the 38 sediment cores in West Bay, 23 cores appear to delineate the vertical extent of contamination. The remaining 15 cores either do not reach the bottom of contamination or are DMMP cores that contain larger composite sample intervals (e.g., 4 feet or greater). Of the 13 sediment cores in East Bay, 7 cores appear to delineate the vertical extent of contamination. The remaining 6 cores are DMMP cores that contain larger composite sample intervals (e.g., 4 feet or greater). North of the Study Area, one core is present within the log pond and one core is present between the navigational channels, both of these cores appear to delineate the vertical extent of contamination.

The D/F TEQ in subsurface samples in the study Area ranged from 0.0351 to 4,207 ng/kg, with an average of 91.0 ng/kg. At most locations the D/F TEQ decreased with depth, except at eleven locations in the Port's berthing area, indicating that D/Fs in this area were from a significant historical source that has since been control. The 6–7-foot interval below mudline at BI-C5 had a TEQ of 4,207 mg/kg, the highest measured in this study (Figure 3-9). Mercury, acenapthalene, fluoranthene, fluorene, Phenanthrene, total LPAH, and total HPAH concentrations exceeded SMS criteria, which targets them additional project COPCs.

Table 3-3 presents a summary of the subsurface chemistry results. The acceptable sub surface sediment locations with either D/F TEQ or SMS chemistry data are shown on Figure 3-8. The D/F TEQs in subsurface samples are shown on Figures 3-9 through 3-11.

3.2.2.3 Budd Inlet Surface Sediment Data

Based on Ecology's report D/F TEQ concentrations for the Budd Inlet surface sediment samples ranged from 2.9 to 60.3 ng/kg. Samples in the northern extent of Budd Inlet had the lowest mean D/F TEQ concentration at 14.6 ng/kg. East Bay and West Bay had similar mean concentrations of 20.2 and 19.0 ng/kg D/F TEQ, respectively (SAIC 2008). As shown on Figure 3-7, the highest D/F TEQ concentrations outside the Study Area were in the vicinity of the Hardel Mutual Plywood and Reliable Steel sites in West Bay, and near the discharge of Moxlie Creek in East Bay. Most of the Budd Inlet surface samples. D/F TEQ concentrations show a positive correlation with TOC and percent fines, and a negative correlation with percent sand (SAIC 2008).

The 2008 evaluation by Ecology resulted in a D/F TEQ of 19.1 ng/kg for Budd Inlet (SAIC 2008); however, this average value included data from within the Study Area and other contaminated sites. Additional evaluation will be conducted in the future to evaluate the use of data from some areas (e.g., known contaminated site or pre vs. post remediation data) from the regional background data set, along with selection of a preferred statistical approach (e.g., spatial weighted averaging).

3.2.2.4 Capitol Lake

Surface sediment samples were collected in Capitol Lake to determine the chemical character of sediments that could be transported into Budd Inlet. A total of six surface grab samples were collected during the Deschutes River Estuary Feasibility Study (USGS 2006). Two samples were analyzed for D/Fs and conventional parameters, and one sample was analyzed for SMS chemicals. The remaining samples were archived for future analyses. Capitol Lake sediment samples had substantially lower D/F TEQs than Budd Inlet ranging from 2.0 to 3.9 ng/kg as reported in SAIC 2008. The one Capitol Lake sediment sample exceeded the CSL for bis(2-ethylhexyl)phthalate (BEHP) and the SQS for indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, butylbenzylphthalate; indicating that Capitol Lake may be a source of those contaminants to Budd Inlet (SAIC 2008).

3.2.3 Biological Quality

3.2.3.1 Existing Biological Studies

Bioassay and tissue chemistry data are available for the Budd Inlet Sediment Characterization Study (SAIC 2008) and East Bay Puget Sound Dredged Disposal Analysis (PSDDA) Sediment Characterization Report (Integral 2007a). Limited benthic community data is available from the 2011 Westbay Marina Remedial Investigation (Hart Crowser) for the intertidal and subtidal areas of Westbay.

3.2.3.2 Bioassay Data

Bioassay testing was conducted on Budd Inlet sediment in 2006 to support evaluation of dredging and suitability for open water disposal of sediments in East Bay. Sediment was characterized in three DMMUs at the southern end of the federal navigation channel and along the western shoreline of East Bay, where shoaling has occurred. The East Bay PSDDA Sediment Characterization Report describes sample collection, testing procedures, and results for characterization of sediments in the federal navigation channel, the south basin, and around the existing shoreline of East Bay (Integral 2007a). Samples were collected from sediment core intervals 4-feet thick. Samples were analyzed for PSDDA parameters and porewater tributyltin (TBT). Bioassays were then conducted on sediment samples from DMMUs 1, 2, and 3 that exceeded chemical criteria for butylbenzyl phthalate. The following three types of bioassay tests were conducted:

- 10-day amphipod (*Eohaustorius estuaries*) survival
- 48- to 60-hour larval echinoderm (*Mytilus galloprovincialis*) survival and development
- 20-day juvenile polychaete (*Neanthes arenaceodentata*) survival and growth

Following PSDDA guidelines to determine the suitability of sediment for open water disposal, all of the tests passed, which indicates the DMMU sediments are not likely to cause adverse effects to benthic invertebrates. However, elevated D/F TEQ concentrations in dredged material and in Z-samples suggested that only sediments from DMMU 5 were suitable for open-water disposal (Integral 2007a).

3.2.3.3 Tissue Data

Tissue chemistry data for Budd Inlet are available from seven studies conducted between 1985 and 2008. Table 3-4 summarizes the tissue data studies from the past 10 years by including study name, species collected, sample count and chemical analyses. The available tissue data was obtained from EIM and two sediment characterization reports, which were then evaluated for use in this investigation. A single sample from 1985 and 2000 were not included in this summary. The 1985 study measured PAH concentrations in tissue of native littleneck clam (*Protothaca staminea*). The 2000 study measured PCB congeners and metals in tissue from English Sole (*Parophrys vetulus).*

As shown in Table 3-4, Ecology's EIM database included tissue data from five studies for one fish species, two clam species, one mussel species, and one shrimp species. Data from three of the five available studies were considered appropriate for preliminary data evaluation based on study date and location. The results from the three appropriate results are summarized in Table 3-5.

Tissue chemistry data for Budd Inlet is available from Ecology's Budd Inlet Sediment Characterization Study (SAIC 2008). D/Fs were measured in two species of fish (Starry Flounder and English Sole), three species of clams (Manila and Littleneck clams, and Bent Nose Clams) and in Ghost Shrimp. Congener profiles in biota and sediment were then evaluated, and biota sediment accumulation factors were calculated. Fish, clam, and shrimp D/F TEQ results from the SAIC (2008) investigation are presented in Tables 3-6 and 3-7, respectively. The D/F TEQs for fish, clams and shrimp (SAIC 2008) were also used in the Budd Inlet Health Consultation, prepared for Ecology (DOH 2008). The findings of the Health Consultation are described in Section 3.5.

Additional tissue data is available from the Anderson-Ketron dredged material disposal site, but this information is not included in this report because it is located 10 miles east of the Study Area in the Nisqually Reach (USACE and USEPA 2006). Paired sediment and tissue testing was conducted on three genera of clams (Yoldia, Compsomyax, and Macoma) for D/Fs. A human health risk based analysis for the A/K Dredged Material Management Program (DMMP) report is described in Section 3.5.

3.2.4 Surface Water Quality

Surface water data obtained from Ecology's EIM database are not included in this summary since the surface water data is either older than 10 years or only consists of conventional water quality parameters (no D/Fs or SMS chemicals). The available surface water data was collected from 1973 to 2004. Available surface water quality data includes ammonia, chlorophyll, conductivity, density, dissolved oxygen, Enterococci, fecal coliform, light transmission, nitrite-nitrate, ortho-phosphate, pH, pheopigments, salinity, silicate, total phosphorus, turbidity, temperature, and transparency.

3.3 Previously Conducted Ecological and Human Health Risk Evaluations

This section summarizes the Budd Inlet Health Consultation (DOH 2008) and the USACE and U.S. Environmental Protection Agency (USEPA) ecological risk screen (USACE and USEPA 2006). Budd Inlet sediments were evaluated as a potential human health hazard by the Washington State Department of Health (DOH) in 2008. An ecological risk screening analysis was developed by the USACE and USEPA in 2006 to support the suitability determination of dredged material from Budd Inlet for disposal at the A/K site. The USACE and USEPA evaluation included a risk-based screening assessment to determine whether risk-based interpretive criteria could be developed for disposal of Budd Inlet sediment at the A/K site. Although this was conducted for the A/K site, it was conducted for sediment planned to be dredged from Budd Inlet and is therefore pertinent to this study.

3.3.1 Budd Inlet Health Consultation

In cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), the DOH prepared a Health Consultation (DOH 2008) to evaluate the potential human health hazards posed by contaminated sediments, and fish and shellfish tissue in Budd Inlet. Sediments were analyzed for 10 metals and 42 organic compounds, and fish and shellfish tissues were analyzed for D/Fs. The maximum sediment concentrations were screened against health-based soil comparison values, and the contaminants that exceeded the criteria (D/Fs, cPAHs and PCBs), were evaluated as COCs.

DOH considered a fish and shellfish ingestion scenario and a beach play scenario to estimate exposure concentrations for general population adults and children, and Squaxin Island Tribe adults and children. Cancer risk and non-cancer adverse health effects were evaluated under both exposure scenarios for the populations of interest (DOH 2008).

To evaluate the potential for non-cancer adverse health effects, the DOH estimated exposure doses for each COC and compared the values to the appropriate oral reference doses (RfDs). The RfDs were developed by USEPA and represent the dose below which non-cancer adverse health effects are not expected to occur. Based on this comparison, DOH found that the general population was not likely to experience adverse non-cancer health effects from exposure to cPAHs, PCBs or D/Fs in sediment, through either exposure scenario. Although the exposure dose calculated under the fish consumption scenario for the Squaxin Island Tribe exceeded the RfD, DOH reported that the Tribe was not likely to experience adverse health effects because of the health protective nature of the RfD (DOH 2008).

DOH also evaluated cancer risk to the general population and the Squaxin Island Tribe from exposure to contaminated sediments or consumption of fish and shellfish. The estimated theoretical cancer risk from consumption of fish and shellfish ranged from slight to low, which was within the range accepted by the USEPA for fish consumption. Theoretical cancer risk from exposure to PCBs and D/Fs in contaminated sediments ranged from slight to insignificant, and theoretical cancer risk from exposure to cPAHs in sediment was insignificant.

Based on the results of the risk evaluation, DOH concluded that exposure to contaminated sediments and consumption of fish and shellfish in Budd Inlet does not represent a public health hazard for children or adults from the general population or the Squaxin Island Tribe (DOH 2008).

3.3.2 DMMP Risk Based Screening Analysis

Under the DMMP, USACE, and USEPA conducted a risk-based screening analysis to determine whether risk-based interpretive criteria could be developed for D/Fs in dredged material proposed for disposal at the A/K site (USACE and USEPA 2008). Although the risk screen was conducted for the A/K site, guidelines were developed to facilitate the management of material from the proposed dredging of the Port's berths and the federal navigation channel and turning basin in West Bay.

To conduct the screen, crab, and fish tissue concentrations of D/Fs were back-calculated from a standard risk equation using the ingestion rate determined under a subsistence tribal fisher person scenario. Risk-based tissue concentrations (RBTCs) were calculated for the consumption of crab only, consumption of fish only, and the consumption of crab and fish with the risk apportioned between the two. RBTCs were then compared to measured concentrations of D/F TEQ in clams at the A/K site, as well as modeled concentrations in English Sole and Dungeness Crab.

Measured D/F TEQ concentrations in clams were all below the fish based RBTC, but were above both the crab and fish/crab RBTCs. The modeled concentrations of D/F in English Sole and Dungeness Crab were one to two orders of magnitude higher than the RBTCs. Based on the modeled concentrations, the predicted risk for the tribal subsistence fishing exposure pathway was above the target risk of 1 excess cancer per 100,000 exposed.

Based on the results of the screen, the DMMP group determined that calculating risk-based sediment guidelines was not feasible, largely because the numerical guidelines would result in a sediment value that was near or below the analytical detection limit, and potentially lower than the sediment concentrations measured during the 2005 monitoring events at the disposal site. The DMMP group acknowledged that prohibiting disposal of all sediments with detectable D/Fs was an unacceptable approach and would not be consistent with "Site Condition II", which allows for "minor adverse impacts."

The DMMP group also performed an ecological risk screen to evaluate the ecological effects of English Sole exposure to D/Fs at the A/K site. A benchmark value of 17 ng/kg TEQ (lipid fraction = 0.0516) developed by Steevens et al. (2005) to be protective of 95 percent of the population was compared to the estimated concentration of D/F TEQ in English Sole. Based on this comparison, no adverse effects to English sole were expected at the A/K site. Estimated tissue concentrations were not screened for Dungeness Crab because benchmark values were not available.

4 POTENTIAL SOURCES AND CONTAMINANTS

The predominant historical land use in nearshore areas of Budd Inlet was related to the timber industry and associated activities including sawmills, plywood facilities, wood treating, and log rafting, as discussed in Section 2.2. Additional historical and current land use activities that could be responsible for sources of contaminants into the Study Area are discussed in this section, including over water uses and spills, permitted industrial discharges, municipal wastewater, stormwater, and CSO discharges, and nearshore property use and cleanup sites.

4.1 Over-Water Uses and Spills

Historical activities with the potential for over-water discharges and spills include petroleum storage and distribution, shipyard, marina, and boatworks facilities, upland redevelopment activities, vessel traffic, and other accidental spills.

Bulk handling facilities for petroleum products were formerly located at the current Percival Landing park area and in the northern portion of the Port's Marine Terminal (adjacent to the log pond). However, these petroleum handling facilities have been closed and cleanup actions have been implemented to address soil and groundwater contamination located in these areas following facility closure (refer to Section 4.5). Limited shipyard activities were historical located within Budd Inlet. Shipbuilding was performed during World War I from 1916 to 1919 and briefly during World War II in the 1940s however, these operation terminated soon after the wars.

Creosote-treated piles were historically used for the construction of wharves and piling along the Port peninsula and West Bay; however, the use of creosote-treated piles has been terminated and many creosoted piles have been removed during facility upgrades and updated with modern infrastructure (e.g., concrete piles, metal sheet pile walls). As indicated on Table 2-2, some creosoted pilings remain in Swantown Marina in East Bay, at Berth 4 and in the log pond in West Bay, south of the Port's berthing area in West Bay

Over-water handling of hazardous substances and petroleum products was largely limited to timber handling and shipping, petroleum use (including lubricants or hydraulic fluids) by vessels within Budd Inlet, and petroleum handling by marine fueling barges. No shore-based bulk petroleum handling facility remains along Budd Inlet.

A search of federal, state, and local spill reporting databases was conducted to assess the recent history of reported spills within and adjacent to Budd Inlet. These databases include the federal Emergency Response Notification System maintained by U.S. Coast Guard, and the spills database maintained by Ecology's Spill Prevention, Preparedness, and Response Program. A search of these spill databases was performed by EDR (EDR 2012) and is summarized in Table 4-1.

The output of the database search was summarized for the period of the early 1990s to the present (Table 4-1). During this approximately 20-year period (1994 to 2012) a total of 96 spill reports were recorded within and adjacent to Budd Inlet within the Study Area. A majority of the reports were related to limited petroleum releases and observed sheen on the surface water. Most of these releases consisted of small quantities (a sheen to less than 1 gallon) of petroleum. There were relatively few (7) spills of medium quantities (1 to 10 gallons) of petroleum, and also relatively few (10) spills of large quantities (10 to 200 gallons) of petroleum.

There were 15 spill reports relating to non-petroleum products reported during the past 20 years. These included five releases of sewage or sludge from the LOTT wastewater treatment plant (largest spill 28,000 gallons in June 2009); one release of paint, three releases of bilge water from a marina, and one release of a hazardous material not specified.

4.2 Permitted Industrial Discharges

The NPDES permit program regulates industrial and municipal wastewater and stormwater discharges to surface waters. The program is authorized by the Clean Water Act (USEPA 2006b) and in Washington State it is administered by Ecology as either individual or general discharge permits. Individual discharge permits cover discharges from single, specific facilities or activities. General permits cover a category of similar dischargers, such as from boatyards or municipal stormwater systems. Individual and general permits can be issued as a state permit or an NDPES permit. State permits are required for discharges of waste from a commercial or industrial operation to the ground or to a publicly owned treatment plant. NDPES permits are required for discharges to surface waters.

A search was conducted for active NPDES permitted industrial discharges that flow directly to Budd Inlet within the vicinity of the Study Area. This included a review of Ecology's Permit and Reporting Information System (PARIS) on-line database (Ecology 2012c). A search of the database was completed by identifying permits located within the Deschutes River Watershed, designated by Ecology as Water Resource Inventory Area (WRIA) 13, and within Olympia. The database search identified the following:

- Three general industrial stormwater permits for discharges directly to Budd Inlet within Olympia, including two for discharges within the Study Area. In addition, the search identified five general industrial stormwater permits for discharges within Olympia to creeks or other surface water body tributaries to Budd Inlet.
- Three individual industrial permits for industrial wastewater discharges directly to Budd Inlet within Olympia. All three of these permits were for discharges within the Study Area.
- One boatyard general permit for a discharge directly to Budd Inlet within Olympia and within the Study Area.
- Eight sand and gravel general permits for discharges from sand and gravel facilities in Olympia within the Deschutes River watershed. None of these are within the Study Area. Only one is within two miles of Budd Inlet. Two of these are for discharges to the Deschutes River upstream of Capitol Lake.

Table 4-2 provides a summary of industrial discharge permits for facilities that discharge directly to Budd Inlet within Olympia near the Study Area. Outfall locations for permitted discharges are shown in Figure 4-1.

In addition to the industrial permits shown in Table 4-2, the database search also identified four individual municipal permits for sewage treatment facilities that discharge directly to Budd Inlet, NPDES Phase II general stormwater permits for several local agencies, an NPDES general stormwater permit for the Washington State Department of Transportation (WSDOT), and several construction stormwater general permits. Permitted municipal wastewater, stormwater, and CSO discharges will be summarized in Section 4.3.

Industrial stormwater and wastewater discharges may carry pollutants that accumulate throughout Budd Inlet from spills, illicit discharges, automotive sources, atmospheric deposition, improper handling and storage of pollutants, contaminated soil on properties and ROWs from which the stormwater originates, groundwater pollutants infiltrating into stormwater conveyance systems, and pollutants residing within the stormwater conveyance system bed load. Key documents used in this summary that included information relevant to industrial discharges to Budd Inlet are listed in Table 4-3.

The majority of the permitted industrial discharges listed in Table 4-2 are within the Study Area and originate from properties managed by the Port. The Port has a stormwater general permit for discharges from the stormwater system that serves its Marine Terminal. The system includes primarily 12-inch diameter storm drain pipe. The system includes outfalls to Budd Inlet at multiple locations along the west side of the peninsula. A recent video assessment of the system indicates that there are many areas where pipes are in poor condition due to loading and age. The 2010 Industrial Stormwater General Permit Annual Report (Port of Olympia 2011) also indicate exceedences of water quality benchmarks set in the permit for turbidity, zinc, copper, chemical oxygen demand (COD), and total suspended solids (TSS).

Additional information on recent stormwater and stormwater solids monitoring results for the Port of Olympia stormwater system are provided in Section 4.3.3.

The Port has an individual permit for discharges from the Cascade Pole site at the north end of the peninsula. In 1993, the port started construction of a remediation system that now includes a sheet pipeline wall and a groundwater extraction and treatment system. The effluent from the treatment system is discharged to Budd Inlet via the LOTT North Outfall, which also conveys treated wastewater from LOTT's Budd Inlet Water Reclamation Facility to Budd Inlet. The individual permit regulates the effluent discharge from the Cascade Pole groundwater extraction and treatment system to Budd Inlet via LOTT's North Outfall.

The Port also has an individual permit for a portion of the Port's property under redevelopment along East Bay (Ecology 2009b). The 13-acre site is at the south end of the Port peninsula adjacent to East Bay. The NPDES permit WA0040231regulates the discharge of treated groundwater and stormwater generated from the site during construction of roads and utilities. It requires the Port to properly manage stormwater run-off from the site contaminated soil stock pile(s) through the use of approved Best Management Practices (BMPs). A water treatment system is in place to treat groundwater and stormwater runoff prior to discharge to East Bay.

Two Port tenants, Holbrook Incorporated and Swantown Boatworks, also have discharge permits. Holbrook Incorporated, a log yard that sorts and stores logs for shipping, is covered under an industrial general stormwater permit and Swantown Boatworks is covered under a boatyard general permit.

Ecology's EIM database was queried for reported stormwater quality sampling data. The query resulted in only one study with sampling focused at a stormwater outfall in the Study Area. Discharges from the Swantown Boatworks outfall (Permit WAG031043), located near the south end of East Bay, and other boatworks facilities in Puget Sound were sampled and tested prior to reissuance of the NPDES general permit for boatyards in 2006. The report, *Chemical Characterization of Stormwater Runoff from Three Puget Sound Boatyards* (Ecology 2006) provides a summary of the results. Water quality test results for samples taken at the Swantown Boatworks outfall are summarized in Table 4-4.

4.3 Municipal Wastewater, Stormwater, and CSO Discharges

A search was conducted for active NPDES permitted municipal wastewater, stormwater, and CSO discharges that flow directly to Budd Inlet. This included a review of Ecology's PARIS online database (Ecology 2012c). A search of the database was completed by identifying permits located within the Deschutes River Watershed, designated by Ecology as WRIA 13, and within Olympia. The database search identified the following:

- Four individual municipal permits for sewage treatment facilities that discharge treated wastewater directly to Budd Inlet from locations within Olympia. One of these facilities, the LOTT treatment plant, discharges treated wastewater to Budd Inlet through its north outfall within the Study Area. The other facilities discharge treated wastewater to Budd Inlet from much smaller systems located 3 to 5 miles north of the Study Area, closer to the north end of Budd Inlet. The LOTT permit also includes three CSO discharge locations near the Study Area within Olympia.

- Five municipal general stormwater permits for stormwater systems in Olympia permitted under the Phase II Western Washington general stormwater permit. This includes the Port and Olympia stormwater systems, which discharge stormwater directly to Budd Inlet at several locations in and near the Study Area.
- A general stormwater permit for the WSDOT.
- Approximately 33 active construction stormwater general permits for construction activities within Olympia.

Outfall locations for these permitted municipal wastewater and stormwater discharges are shown in Figure 4-1. Figure 4-2 provides a closer view of wastewater and stormwater facilities and outfalls located within or adjacent to Study Area on the Port peninsula.

4.3.1 Municipal Wastewater and CSO Discharges

Table 4-5 provides a summary of permitted wastewater and CSO discharges directly to Budd Inlet within Olympia near the Study Area. The primary permitted wastewater and CSO discharges near the Study Area include discharge of treated wastewater and CSO discharges covered by the individual permit for the LOTT. Three additional permits for discharges of treated wastewater from smaller sewage treatment plants that serve remote collection systems near the north end of Budd Inlet are also listed. Because these discharges are not in the vicinity of the Study Area and are not likely to impact conditions in the Study Area, they are not summarized in further detail as part of this report.

LOTT operates a regional wastewater treatment plant, the Budd Inlet Water Reclamation Facility, located near the Study Area in downtown Olympia at the north end of Adams Street. The plant provides treatment for a wastewater service area that includes the cities of Lacey, Olympia, and Tumwater, and portions of Thurston County. The following discharges are covered by the current individual municipal wastewater permit for the LOTT Budd Inlet Wastewater Reclamation Facility (Ecology 2011), Permit No. WA00370061 issued on August 26, 2011:

- Discharge of treated wastewater to Budd Inlet from the LOTT treatment plant through the North Outfall (Outfall 001)

- Emergency and CSO discharges from the LOTT treatment plant through the Fiddlehead Outfall (Outfall 002)
- CSO discharges from Olympia wastewater collection system at State and Chestnut Streets (Outfall 003)
- CSO discharges from Olympia wastewater collection system at the Water Street Pump Station (Outfall 004)
- Discharge of treated wastewater to the LOTT recycled water distribution system for recycled water use.

A number of key references provide information regarding wastewater and CSO discharges to Budd Inlet covered by Permit No. WA003770061. A summary of key documents is included in Table 4-6.

The LOTT service area includes the combined urban growth areas for the cities of Lacey, Olympia, and Tumwater, and Thurston County. The area includes approximately 53,000 acres and had a population of approximately 160,227 at the end of 2010. The LOTT 2010 Annual Capacity Reports (LOTT 2010) indicate that at the end of 2010, within the LOTT service area, approximately 21,341 acres were served by one of the sewer collection systems operated by one of LOTT's partner cities. The estimated population served by these systems was 93,911.

The Fact Sheet for NPDES Permit WA0037061 (Ecology 2005) indicates that collection systems operated by Lacey, Olympia, and Tumwater deliver flows to facilities operated by LOTT. LOTT conveys wastewater flows to the Budd Inlet Water Reclamation Facility for treatment. Treated flows are either discharged to Budd Inlet through a primary outfall (Outfall 001) or an emergency outfall (Outfall 002), or pumped into a recycled water distribution for reuse. The recycled water distribution system irrigates parks in the downtown area of Olympia and has recently been used to supply recycled water for plumbing of toilets at new facilities in the downtown area.

Discharges through the following outfalls are covered by the current discharge permit:

- **North Outfall (Outfall 001).** This outfall discharges fully treated and disinfected effluent from the LOTT treatment plant directly to Budd Inlet. The outfall consists of a 48-inch-diameter pipe that extends from the treatment plant through the Study Area to an outfall location approximately 953 feet north of the shoreline. The outfall includes a 250-foot diffuser section with 55 ports at an invert elevation approximately -19 feet MLLW. As was noted previously, the Port operates a groundwater extraction and treatment facility on the Cascade Pole site at the north end of the Port peninsula. This facility discharges treated effluent to the North Outfall pipe. The North Outfall has the capacity to discharge plant flows up to 64 million gallons per day (MGD) at MHHW and up to 85 MGD at MLLW (LOTT 2006). The effluent from the groundwater extraction and treatment facility on the Cascade Pole site are estimated to be approximately 30 gpm or 0.04 MGD and do not significantly impact the capacity of the North Outfall.

- **Fiddlehead Outfall (Outfall 002).** This outfall is used primarily as an emergency outfall. The outfall consists of an open-ended 48-inch diameter pipe that extends from the LOTT treatment plant to an outfall location west of Corky Avenue Northwest, under the Fiddlehead Marina at an invert elevation of approximately -4 feet MLLW. The permit allows "one four-hour period every six months to discharge fully treated and disinfected secondary effluent through Outfall 002 for the purpose of exercising the associated pumping equipment." This outfall is also listed on the permit as a CSO. According to the Fact Sheet for NDPES Permit WA0037061 (Ecology 2005), a CSO event would occur when equalization basins at the treatment plant are full and influent pumps are operating at full capacity. In addition, this outfall conveys flow from an Olympia storm drain pipe that ties into the outfall at a manhole near Columbia Street Northwest.
- **State and Chestnut Street CSO (Outfall 003).** This outfall consists of a flapper gate and high level alarm switch located in a manhole above the existing 42-inch sanitary sewer trunk line near the intersection of State Street and Chestnut Street in downtown Olympia. Under high flow conditions, the alarm is triggered. If flows continue to increase, flow will spill through the flapper gate and drop into the 72-inch Moxlie Creek stormwater discharge pipe and will be discharge to Budd Inlet at the south end of East Bay.
- **Water Street Pump Station CSO (Outfall 004).** This outfall originates at an overflow structure upstream of the Water Street Pump Station. Flapper gates located in the structure upstream of the bar screen at the inlet to the pump station allow overflow to

a 30-inch diameter outfall pipe when inflows to the pump station exceed pumping capacity. The 30-inch outfall pipe is designed to discharge overflow to Budd Inlet approximately 105 feet west of the pump station under the boardwalk facilities at Percival Landing at an elevation of approximately -2 feet MLLW.

The current discharge permit for LOTT was issued on August 26, 2011. The permit indicates that flow for the permitted treatment facility shall not exceed the following:

Average Flow for Maximum Month:	28 MGD
Maximum Daily Flow:	55 MGD
Peak Hourly Flow to Treatment Plant:	64 MGD

Permit conditions also require that LOTT comply with nine technology-based requirements aimed at reducing the frequency and impact of CSO events. These include implementation of procedures that will maximize the use of the collection system for storage, operating the treatment plant at the "maximum treatable flow" during high flow conditions, and CSO monitoring, among others. LOTT will also be required to submit an annual CSO Report with documentation demonstrating compliance with the permit requirements. The 2010 Combined Sewer Overflow Report (LOTT 2011) provides a summary of CSO projects that have been implemented since July 2002. These projects included infrastructure upgrades to increase capacity, televising and cleaning of existing sewer mains, and repair and rehabilitation of existing sewer facilities.

LOTT also initiated a Memorandum of Understanding with the partner cities (Lacey, Olympia, and Tumwater) in 2005 to optimize responses to sanitary sewer overflows in the LOTT service area, including CSO events. As part of that effort, LOTT entered into a reciprocal agreement with WSODT to increase availability of equipment, personnel and resources to allow for a more efficient response to overflow events.

The equalization basins at LOTT's treatment plan have a maximum capacity of 2.25 million gallons. Additional capacity can also be made available in the first anoxic basin and aeration basins. Procedures have been developed to maximize the use of flow equalization and storage options at the plant to minimize the risk of overflow through Outfall 002. These procedures, along with improvements made to the system have significantly reduced the occurrence of CSO events. Only two CSO events occurred from April 1991 through December 2011. These occurred during extreme wet weather events on December 3, 2007 and January 7-8, 2009. LOTT has indicated that no CSO events have occurred during dry weather conditions. The overflow events listed in the 2010 Combined Sewer Overflow Report (LOTT 2011) are summarized in Table 4-7.

4.3.2 Municipal Stormwater Discharges

Municipalities and other agencies in the Deschutes-Budd Inlet watershed with municipal stormwater systems covered under the Phase II General Stormwater Permit for Western Washington include the following:

- The City of Olympia (Permit No. WAR045015)
- The City of Lacey (Permit No. WAR045011)
- The City of Tumwater (Permit No. WAR045020)
- Thurston County (Permit No. WAR045025)
- Washington State Department of Corrections (Permit No. WAR045202)
- Washington State Department of General Administration (Permit No. WAR045210)
- The Port of Olympia (Permit No. WAR045206)
- Evergreen State College (Permit No. WAR045029)

Olympia and the Port offer municipal separate storm sewer systems (MS4s) that discharge stormwater through outfalls directly to Budd Inlet in the vicinity of the Study Area. Olympia and the Port surface water drainage basins, facilities, and outfalls within the vicinity of the Study Area are shown on Figure 4-1. Figure 4-2 provides a closer view of stormwater facilities and outfalls located within or adjacent to Study Area on the Port peninsula.

Stormwater is the leading contributor to water quality pollution in urban waterways. Discharges may carry pollutants that accumulate throughout Budd Inlet from spills, illicit discharges, automotive sources, atmospheric deposition, improper handling and storage of pollutants, contaminated soil on properties and ROWs from which the stormwater originates, groundwater pollutants infiltrating into stormwater conveyance systems, and pollutants residing within the stormwater conveyance system bed load. Municipalities and agencies covered under the NDPES Phase II Permit for Western Washington are required to comply with stormwater management requirements as follows:

- **Public Education and Outreach**. Implement a public outreach and education program with the goal of eliminating or reducing behaviors or practices that cause or contribute to adverse stormwater impacts.
- **Public Involvement and Participation**. Create opportunities for ongoing public involvement in development of stormwater management programs.
- **Illicit Discharge Detection and Elimination**. Implement and ongoing program to detect and eliminate any illicit connections and discharges to the system.
- **Controlling Runoff from New Development, Redevelopment and Construction Sites**. Reduce stormwater pollutants from runoff associated with new development, redevelopment, and construction sites.
- **Pollution Prevention and Operation and Maintenance for Municipal Operations**. Implement an operations and maintenance (O&M) program designed to prevent pollutant runoff from municipal operations.

A number of key references provide information regarding municipal stormwater discharges to Budd Inlet. Key documents used in this summary that included information relevant to municipal stormwater discharges to Budd Inlet are listed in Table 4-8.

Olympia has been committed to meeting the requirements of the NPDES Phase II stormwater general permit. Olympia has an active public outreach and education program, is working on detecting and eliminating illicit discharges, enforces requirements outlined in the City of Olympia Drainage Design and Erosion Control Manual (City of Olympia 2009) for all new development and redevelopment projects, and actively maintains and implements operations and maintenance practices. Olympia also manages stormwater in accordance with the goals and recommendations outlined in the City of Olympia Storm and Surface Water Plan (City of Olympia 2003).

The major goals outlined for the downtown area in 2003 as part of the *City of Olympia Storm and Surface Water Plan* (City of Olympia 2003) included improving water quality. Recommendations included implementing and illicit discharge elimination program in the downtown area, re-establishing business education program in the high-density downtown corridor, and initiating a high-tech street sweeping program in the downtown area.

The City of Olympia GIS Basin Analysis 2010 (City of Olympia 2010) used GIS to evaluate basin characteristics. Because current requirements for treatment of runoff from new developments and redevelopment are relatively new, stormwater runoff from several areas in the city are not treated prior to discharge to Budd Inlet. The GIS analysis estimated that in 2010, runoff from approximately 90 percent of the area within East Bay and West Bay basins, including the Port peninsula, was untreated. For the Moxlie Basin, which discharges stormwater to Budd Inlet at the south end of East Bay, the area generating untreated runoff was estimated at 42 percent. The report recommended focusing on providing stormwater treatment for currently untreated impervious surfaces, with priority given to those surfaces in East Bay, West Bay, Moxlie, and Indian Basins.

No water quality data from outfall monitoring events was available.

4.3.3 Port of Olympia Stormwater Solids

During July and August 2010, the Port conducted chemical testing of storm drain solids for D/Fs. The testing was not part of the Port's NPDES permit-required activities, but rather was a separate action taken by the Port to evaluate potential ongoing sources of contamination into Budd Inlet. The stormwater sampling and evaluation is ongoing. New results will be incorporated into subsequent project documents.

The testing included sampling of each of the four storm drain subbasins (A, B, C, and I) at the terminal. Locations of these basins are shown in Figure 4-2. Testing included sampling of solids trapped in portions of the storm drain system catch basins or other conveyance structures. Since receipt of the sampling data for the trapped storm system solids, the Port has conducted a clean out of the entire stormwater system and provided Ecology with its analysis of site conditions and proposed sampling methodologies to assess whether the elevated concentrations of D/Fs have been fully addressed through the completed source control activities. Subsequently, Ecology issued Order No. 8499 requiring follow-up sampling of the Port's storm drainage system (solids and stormwater), which the Port completed in April 2012.

Concentrations of D/Fs in stormwater solids pre- and post-system cleanout are shown in Table 4-9. There are no regulatory criteria applicable to storm drain solids; however, three sample locations from the A and B sub-basins had D/F TEQ concentrations greater than the average site-wide Budd Inlet surface sediment concentration (19.1 ng/kg) calculated by Ecology (SAIC 2008). The post-cleanout sampling event does indicate that the concentrations have significantly decreased at each location that was retested; however, the D/F TEQ concentrations are still greater than the average site-wide Budd Inlet surface sediment concentrations.

Stormwater was collected from the A and B sub-basins during two storm events after the system cleanout. Only concentrations of 2, 3, 7, 8-TCDD were measured and are shown in Table 4-10. These results indicate that the Port's stormwater is not a significant source of D/Fs to Budd Inlet.

4.4 Nearshore Property Use and Cleanup Sites

An evaluation of potential sources of contamination to Budd Inlet sediments includes determining the potential for historical nearshore upland property use and operations to contribute contaminants through transport mechanisms such as groundwater, stormwater conveyance, and erosion. As described in Section 2.2, historical land use in Budd Inlet consisted of a variety of industrial operations within the Port peninsula and western shoreline of West Bay. Historical industrial operations along the shoreline areas of Budd Inlet Study Area mostly included operations related to the timber industry such as wood treating, lumber mills, plywood manufacturing, and log and wood chip handling. Other upland historical industrial operations have included bulk petroleum facilities, boatbuilding, and steel fabrication.

The characterization and remediation of nearshore cleanup sites identified along the Budd Inlet Study Area are being conducted under state MTCA authority. These sites include projects performed under Ecology's Voluntary Cleanup Program (VCP) or under the direction of Ecology via an AO or Consent Decree. In addition, a limited number of upland sites have also been registered in Ecology's underground storage tank (UST) program and have been identified as leaking UST (LUST) sites.

A review of cleanup and LUST sites located away from Budd Inlet nearshore areas was not conducted as part of this evaluation. These sites located further inland from the Budd Inlet Study Area have the potential to affect sediments if contaminated groundwater or stormwater runoff from these sites discharges via storm drains and CSOs. Historical storm drain and CSO discharges are described in Section 4.3 and the potential for contaminant discharges from inland properties is best evaluated based on sediment concentrations at the point of these discharges.

Table 4-11 presents a summary of identified nearshore cleanup sites, including historical use and operations, potential historical sources of contaminants to the Budd Inlet Study Area, and investigation/cleanup status of each site. The location of nearshore cleanup sites in relation to the Budd Inlet Study Area is shown on Figure 4-3.

The following section presents a summary of upland nearshore cleanup sites identified along the Budd Inlet Study Area. For each site, the background and regulatory context, contaminants identified, and the status of investigation and related cleanup activities are described. Table 4-11 provides a list of the nearshore cleanup sites identified during this information review and presents the key documents containing information potentially relevant to evaluate the potential to affect Budd Inlet sediments. A review of groundwater monitoring events at the nearshore cleanup sites is used to evaluate the potential for contaminants to be transported via groundwater. Table 4-12 presents a summary of groundwater monitoring events within the Budd Inlet Study Area and identifies potential historical contaminants and the current status of groundwater quality at each nearshore cleanup site. Figure 4-4 presents the locations of the groundwater wells located on the Port's peninsula.

4.4.1 Cascade Pole

The Cascade Pole site is a cleanup site located at the northern end of the Port peninsula along the shoreline of the East Bay of Budd Inlet. A former wood treating facility using creosote and later pentachlorophenol (PCP) dissolved in a carrier oil. This site has historical contamination that has resulted in elevated concentrations of PAHs, PCP, and D/Fs in soil, groundwater, sediment, and benthic organisms (Ecology 2004; SAIC 2008). Groundwater investigations have been conducted at Cascade Pole from 1986 to 2011.

During an investigation of groundwater conditions at Cascade Pole in 1986, AGI installed a network of groundwater monitoring wells and tested groundwater for PAHs and phenols (AGI 1986). Both phenols and PAHs were detected in groundwater, with the highest concentrations observed near the former plant facility and an abandoned channel. PAHs or phenols were not detected in groundwater from deeper wells which penetrate the lower aquifer (AGI 1986). AGI determined that Cascade Pole groundwater impacts were limited to the upper, surficial aquifer (in fill sand) and that groundwater near the shoreline was not contaminated.

Upland cleanup actions in 1990 included the installation of a groundwater treatment system for LNAPL recovery (SAIC 2008). In addition, a slurry wall was installed on site to limit groundwater migration of contaminants to Budd Inlet (SAIC 2008).

Ecology issued an Amendment to the AO that required long-term groundwater monitoring, including semi-annual analytical testing of groundwater for TPH-D, TPH-G, PAHs, and PCP, and the installation of a new groundwater treatment system (Ecology 2004). The most recent groundwater monitoring report, February 2010 – May 2011 Groundwater Monitoring Report*,* presents recent groundwater data from shallow and deep Cascade Pole monitoring wells (Landau 2011b). The results of the 2011 report indicate that site groundwater is in compliance with the AO (i.e., no COCs above screening levels outside of the slurry wall) and that the bentonite slurry wall and hydraulic control system are effectively preventing groundwater contamination from reaching Budd Inlet (Landau 2011b).

4.4.2 East Bay Redevelopment Site

The East Bay Redevelopment Site is approximately 14.6 acres located in the southeast corner of the Port peninsula along the East Bay shoreline. The East Bay Redevelopment Site has been used for commercial and light industrial purposes since the late 1800s (e.g., wood processing and milling operations from the late 1800s to mid-1900s and warehouse and storage operations since the 1970s (PIONEER 2010). In 2011, an AO was issued between Ecology; and the Port, Olympia, and LOTT requiring an RI/FS cleanup of the site (PIONEER 2011).

Several groundwater-related investigations have been conducted at the East Bay Redevelopment Site (e.g., GeoEngineers 2007; GeoEngineers and PIONEER 2008; Greylock 2008; PIONEER 2011) between 2007 and 2011. In the Soil-to-Surface Water Empirical Evaluation Report (PIONEER 2011), there were no complete and significant groundwater exposure pathways identified for the site.

4.4.3 Hardel Mutual Plywood

Hardel Mutual Plywood is a 17.8-acre former plywood manufacturing site located along the western shoreline of West Bay. Historical releases of petroleum products to soil, groundwater, and sediment have been documented and the site is currently under an AO with Ecology for an RI/FS cleanup (Ecology 2007a; SAIC 2008).

In 2004, Stemen Environmental collected 33 groundwater samples from soil borings; TPH-D, TPH-HO, and cPAHs were detected in several groundwater and soil samples, and free product was observed floating on the water surface in one well (Stemen 2004). In 2007, Greylock installed 7 monitoring wells and tested groundwater for TPH, PAHs, and phenols. According to the Greylock (2008) report, MTCA cleanup levels were exceeded in two wells, which were both approximately 240 feet from the shoreline. Free product was observed in one of these wells, and TPH-HO and TPH-D were detected in the other well. However, Greylock determined that groundwater contamination was not migrating toward the Budd Inlet shoreline, so interim cleanup action was not recommended (Greylock 2008).

Greylock completed an FS in 2009, identifying two areas of concern associated with groundwater and soil TPH contamination. After completing a supplemental investigation later in 2009, TPH-contaminated groundwater was encountered in two new monitoring wells. In 2010, Greylock conducted an Interim Action cleanup of TPH contamination in soil and groundwater which included removal of both soil and groundwater and decommissioning of six monitoring wells; confirmation testing in 2010 showed that soil was in compliance with MTCA Method A cleanup levels (Greylock 2011). In 2011, Greylock installed five new monitoring wells as part of a groundwater monitoring program to evaluate the effectiveness of the cleanup action (Greylock 2011). Groundwater in 2011 was tested for TPH-D, TPH-HO, and PAHs; all groundwater samples were either non-detect or below MTCA clean up levels, and were in compliance with first quarter MTCA requirements for the site (Greylock 2011).

4.4.4 Reliable Steel (Brown-Minneapolis Tank Northwest)

The former Reliable Steel is a 4.25-acre site located along the West Bay shoreline, south of the Hardel Mutual Plywood site. A former lumber mill site that was converted in the 1950's to a boat building tank manufacturing, welding, and steel fabrication site. Brown-Minneapolis Tank-Northwest purchased the property in the 1990's and continues to manufacture large tanks. Site COCs include TPH, arsenic, copper, and heavy metals. In 1993, Ecology inspected the site and found levels of arsenic and copper above Ecology SMS criteria. Ecology requested that welding slag and debris on or near the shore of Budd Inlet be removed. In 2006, TPH and heavy metals exceeded MTCA cleanup levels in soil and groundwater. In early 2006, the site entered the VCP, but by August 2006 the site entered into the formal MTCA cleanup program. This site is currently under an AO between Ecology and Bojo Investments for an RI/FS cleanup (Ecology 2007b).

4.4.5 LOTT Treatment Plant

A wastewater outfall originating from the LOTT treatment plant adjacent to the East Bay of Budd Inlet crosses the upland area of the Cascade Pole site on the Port peninsula (Parametrix 1990). Soil and groundwater along the route of the outfall pipe were sampled from groundwater monitoring wells in 1989 and analyzed for VOCs, SVOCs, pesticides, PCBs, phenols, and metals (Parametrix 1990). Groundwater analytical testing determined that none of the groundwater COCs exceeded the primary drinking water MCLs (Parametrix 1990).

4.4.6 Solid Wood Incorporated Site (West Bay Park)

The 17 acre Solid Wood Incorporated site (now West Bay Park) is located along the West Bay shoreline and is undergoing major development as a waterfront park (Parametrix 2008). Solid Wood is a former lumber mill that closed in 2002; the site contains an inactive Burlington Northern Santa Fe (BNSF) rail spur that runs the entire length of the site. Wood fuel burners and several petroleum storage tanks historically occupied the site (Parametrix 2008). A Phase II Environmental Site Assessment conducted in 2007 found TPH-Dx, TPH-HO, and cPAH concentrations exceeding MTCA Method A cleanup levels in soil and groundwater (Parametrix 2008). Olympia has an AO with Ecology to clean up contaminated soil and groundwater as part of the West Bay Park development (Parametrix 2008). The Solid Wood cleanup was conducted as an Interim Action and included excavation of TPH-Dx, TPH-HO, and cPAH-contaminated soils and 12 months of quarterly groundwater monitoring following the soil removal (Parametrix 2008).

4.4.7 Westbay Marina

First developed as a lumber mill in 1919, the Westbay Marina property along the Port peninsula shoreline of the West Bay has been used as a sawmill, veneer plant, stud mill, boatyard, and marina (Hart Crowser 2011). During lumber mill operations, a hog fuel burner was located along the northern property line (Hart Crowser 2011). Westbay Marina has undergone several upland cleanup actions and investigations (Stemen Environmental 1999; Anchor QEA 2009 and 2010; Hart Crowser 2011). Westbay Marina is under an AO between Ecology and Westbay Marina Associates (Ecology 2008a) and is currently undergoing an RI/FS to clean up soil and groundwater within the site and adjacent shoreline sediments.

Site groundwater was analyzed for ammonia, total and dissolved metals, SVOCs, TPH, and PCB is 2009 and 2010 (Anchor QEA 2009, 2010). During 2009 to 2010, TPH, PCBs, SVOCs, and metals were either non-detect or were below MTCA groundwater cleanup criteria (Anchor QEA 2009, 2010). During a remedial investigation in 2011, Hart Crowser analyzed additional groundwater samples for ammonia, copper, and nickel (total and dissolved), but found no exceedences of MTCA Method B criteria based on drinking water use (Hart Crowser 2011). Groundwater seeps that surface in the intertidal area of the site were sampled and analyzed for organic and inorganic constituents in 2009; copper, nickel, zinc, and arsenic were detected at concentrations that slightly exceeded marine surface water criteria (Hart Crowser 2011). The results of the 2011 RI indicate that the only COCs that may require additional investigation or cleanup action include D/Fs present in the upload soils and the metals that exceeded the groundwater seep samples (Hart Crowser 2011).

4.4.8 Industrial Petroleum Distributors Site

The Industrial Petroleum Distributors site was formerly used as a bulk petroleum distribution facility by ARCO and Industrial Petroleum Distributors. An underground pipeline on the north side of the site was used to transfer gasoline and oil from barges into above ground storage tanks at the bulk plant. The upland area of the former Industrial Petroleum Distributors site was issued a "No Further Action" on June 25, 2003 by Ecology.

Several investigations have been conducted at the site during the past 13 years (e.g., SECOR 2001, 2007; Parametrix 2004; Arcadis 2010, 2012). Historical groundwater analyses detected TPH constituents, arsenic, and lead concentrations above MTCA Method A screening levels (SECOR 2001, 2007). PCBs were analyzed in groundwater in 2004, but were not detected (Parametrix 2004). Arcadis conducted a site investigation in 2010 and installed seven new monitoring wells. Groundwater results from six quarters of groundwater monitoring (for TPH, benzene, toluene, ethylbenzene, and xylene (BTEX), cPAHs, and total and dissolved lead) indicated that no COCs were above MTCA Method A screening levels (Arcadis 2012).

4.4.9 Other Potential Historical Source Sites

Other potential source sites were identified in the EDR report (EDR 2012). These sites are not associated with any of the cleanup site previously discussed since little to no information on site characterization or remedial activities. However; they are sites that were identified by Ecology as potential contaminated sites based on historical property use or under a VCP. The other potential historical source sites are summarized on Table 4-13.

4.5 Atmospheric Deposition

Chemicals historically and are currently emitted to the air from both point and non-point sources in the vicinity of the Study Area. Point sources include emissions (e.g., "stack emissions") from various stationary industrial facilities. Non-point sources include emissions from mobile sources such as motor vehicles, marine vessels, and trains as well as emissions from common materials (e.g., off-gassing from plastics) and road dust resulting from urban traffic. Chemicals emitted to the air may be transported over long distances, generally in the direction of the area's prevailing winds. They can be deposited from the atmosphere to land and water surfaces through wet deposition (precipitation) or dry deposition (as particles).

Historical potential regional air emissions include industrial facilities, regional smelter facilities, petroleum combustion by motor vehicles, home heating systems (e.g., coal, wood stoves, and natural gas), and other industrial and urban practices. Air emissions were not commonly monitored or regulated prior to the establishment of the Clean Air Act in the 1970s. Many of the historical lumber mills and veneer/plywood manufacturing facilities burned wood waste either in a hog fuel burner (e.g., wigwam burner) or designated wood waste fire areas (Figure 4-5); however, these practices no longer occur in the region. However, residential backyard burns or use of burn barrels are likely present within the region. In addition, a majority of the mills experienced significant fires over time causing damage to operational facilities.

Regional smelting operations included the Asarco copper smelter, which operated from 1890 to 1985 in Ruston, Washington. Documented smokestack emissions from the Asarco smelter contained arsenic and lead, and are a potential historical source of these metals to Budd Inlet. Heavy metals were distributed through atmospheric deposition to over 1,000 square miles of the Puget Sound basin from the Asarco smelter (Ecology 2011). Since the closure of the Asarco smelter, Ecology and several local health departments have initiated studies to outline the extent of the plume "footprint" by testing arsenic and lead concentrations in area soils. The current status of these studies is provided in the draft Interim Action Plan for the Tacoma Smelter Plume (Ecology 2011). In 2003, Ecology expanded the Study Area to include Thurston County and initiated the collection of soil samples to determine the smelter footprint. Based on the study findings, Ecology has removed Thurston County from the focused service area.

Air pollutants commonly associated with historical urban activities included particulate matter (PM), metals, PAHs, PCBs, and D/Fs. PM and PAHs were emitted from the burning of fossil fuels such as coal and oil, used in various industrial processes, and for domestic purposes such as transportation and heat. Wood burning and waste incineration were other historical practices that emitted PM, PAHs, D/Fs, and metals.

Current air sources are monitored by Olympic Region Clean Air Agency at the closest air monitoring station in Lacey, Washington. Air monitoring data collected from 1997 to present from this station can be used to estimate current input from atmospheric deposition (ORCAA 2012).

5 ASSESSMENT OF DATA GAPS

This section identifies data gaps for the Port of Olympia Budd Inlet Study Area cleanup evaluation. The data gaps analysis is based on information presented in Chapters 1 through 4 of this Memorandum, and will form the basis for potential additional data collection activities. Identified data gaps are intended to support the following goals:

- Fully define the nature of extent of contamination within the Study Area
- Evaluate potential ongoing sources to the Study Area
- Support the identification and evaluation of interim action alternatives

The data gaps assessment discussed in this section generally identifies the data and studies that are not found in the existing information, but the specific details (e.g., proposed locations, sample type, sample count, and analyses) of the additional sampling investigations will be presented in the draft SAP and QAPP.

5.1 Nature and Extent of Contamination

The Investigation Report will include a discussion of the nature and extent of chemical contamination in the Study Area based on the available sediment, tissue, and water data. This section identifies data gaps within the Study Area, but also identifies data gaps beyond the Study Area boundary in the event regional background sediment concentrations are needed to support cleanup levels for the Study Area. Some elements identified as data gaps to describe nature and extent of contamination are also data gaps for other areas, including evaluation of sources of contamination (Section 5.2).

5.1.1 Study Area

5.1.1.1 Surface sediment

Within the Study Area, existing surface sediment has been characterized for D/F concentrations, with a subset characterized for SMS chemicals. Surface sediment testing included for further evaluation has been conducted as part of a larger Budd Inlet investigation by Ecology (SAIC 2008), as well as investigations by the Port (Anchor QEA 2010b) as part of Berth 2 and 3 Interim Action characterization and post-construction monitoring. Existing surface sediment data contains D/F TEQ concentrations from a total of 42 samples: 27 samples in West Bay, two samples north of the peninsula, and five samples in East Bay. Five surface sediment samples have been analyzed for SMS chemicals. The density of surface sediment data is not sufficient in the entire Study Area for D/Fs and SMS chemicals to adequately spatially define nature and extent of contamination. The existing data also does not completely define surface sediment concentrations near each potential ongoing source of contamination to the Study Area (see also Section 5.2).

5.1.1.2 Subsurface sediment

Within the Study Area, existing subsurface sediment has been characterized for D/F TEQ concentrations in 53 cores (107 samples) and SMS chemicals in two cores (four samples). Subsurface sediment characterization has been conducted as part of investigations by Ecology (SAIC 2008), the Port (Integral 2007a and b, 2009), and as part of Berth 2 and 3 Interim Action characterization and post-construction monitoring (Anchor QEA 2009, 2011). Of the 38 sediment cores in West Bay, 23 cores appear to delineate the vertical extent of contamination. The remaining 15 cores either do not reach the bottom of contamination or are DMMP cores that contain larger composite sample intervals (e.g., 4 feet or greater). Of the 13 sediment cores in East Bay, 7 cores appear to delineate the vertical extent of contamination. The remaining 6 cores are DMMP cores that contain larger composite sample intervals (e.g., 4 feet or greater). North of the Study Area, one core is present within the log pond and one core is present between the navigational channels, both of these cores appear to delineate the vertical extent of contamination. However, subsurface sediment data may not be sufficient within the Study Area for D/Fs and SMS chemicals to adequately define nature and extent of contamination.

5.1.2 Outside of the Study Area

Outside the Study Area, existing surface sediment located away from known sources of contamination has been characterized for D/F TEQ concentrations. Surface sediment testing has been conducted as part of site wide investigations by Ecology and at MTCA cleanup sites along the West Bay (Ecology, 2012b, Ecology 2006, Hart Crowser 2011, Parametrix 2008, SAIC 2008, and TCPHSS 2010). The dataset includes 83 surface sediment samples outside of the Study Area, but data may not be of sufficient density to support development of a regional background concentration for cleanup purposes in Budd Inlet, if necessary. The samples in the dataset may also not provide adequate information on potential sources of contamination, including along the western shoreline of West Bay, along the eastern shoreline of East Bay, and south of the Study Area in West Bay to understand sediment concentrations potentially entering the Study Area.

5.2 Potential Ongoing Sources of Contamination

Potential ongoing sources of contamination include discharges from stormwater, CSOs, inputs from Capitol Lake, Moxlie Creek, and other drainages, nearby marinas, and soil/groundwater in adjacent upland areas.

5.2.1 Stormwater/CSO

Stormwater contaminant concentration data is available for Port stormwater systems from stormwater and stormwater solids, but potentially not of adequate density and testing parameters to meet the project needs. No contaminant concentration data is available for stormwater or stormwater solids from City stormwater systems in the vicinity of the Study Area. Discharge information for each outfall in the vicinity of the Study Area has also not been estimated. Additional discharge and contaminant concentration data may be required by Ecology to understand potential sources of contamination to the Study Area.

Quantities and frequencies of CSO discharges have been well documented and are generally well understood. Limited CSO discharge contaminant concentration data is available for each CSO that could influence the Study Area, but potentially not of adequate density and testing parameters to meet the project needs. Additional contaminant concentration data for stormwater and CSO discharges may be required by Ecology to understand potential sources of contamination to the Study Area.

5.2.2 Surface Water and Groundwater

No surface water contaminant concentration data is available within the Study Area. Groundwater quality information is available within the Cascade Pole and East Bay Redevelopment Site areas. D/Fs are not readily transported by groundwater, and therefore additional surface water and groundwater data may not be needed for the project.

5.3 Human Health Risk Evaluations

A human health risk assessment has not been conducted specifically for sediment and tissue concentrations within the Study Area. A risk evaluation was conducted by DMMP with respect to sediment that was proposed to be dredged from Budd Inlet suggested that safe sediment D/F concentrations would be below natural background levels when using tribal consumption scenarios. The human health risk evaluation conducted by DOH for D/Fs, PCBs, and cPAHs in sediment and the food chain concluded that exposure to contaminated sediments and consumption of fish and shellfish in Budd Inlet does not represent a public health hazard for children or adults from the general population or the Squaxin Island Tribe. The suitability of existing human health risk evaluations and the need for additional study will be discussed with Ecology. The need for additional contaminant concentrations in tissue will be evaluated at that point.

5.4 Physical Characteristics

Information on the physical characteristics of Budd Inlet are available that may support physical transport modeling, if needed, and also to support geotechnical evaluations for remedial alternative development and evaluation. Existing data may or may not be suitable for further evaluation depending on discussions with Ecology regarding the need to evaluate sediment loading and transport of Study Area sediment and sediment associated with potential ongoing sources of contamination.

5.4.1 Hydrodynamics and Sediment Transport

Existing information within the Study Area includes net sedimentation information, sediment loads, and hydrodynamic models. The suitability of existing net sedimentation, sediment loading, and hydrodynamic and sediment transport modeling to a support recontamination evaluation will be discussed with Ecology.

5.4.1.1 Net Sedimentation Rate in the Study Area

Empirical measurements of net sedimentation rate (NSR) within the study are not available. Ecology collected three geochronology cores in 2008 to evaluate NSR, but none were within the Study Area. BI-D1 was located west of the Study Area in West Bay, BI-D2 was located east of the Study Area in East Bay, and BI-D3 was located north of the Study Area in Budd Inlet (see Figure 2-18). Sedimentation data was collected near the port berth in West Bay as part of the LOTT (2008) study; however those measurements were collected with sediment traps which provide estimates of suspended sediment load in the water column as opposed to a net sedimentation rate at the bed. Empirical estimates of NSR within the berth areas in West Bay and in and near the marina in East Bay may be required to provide information to support evaluations of recontamination potential and natural recovery for the Study Area.

5.4.1.2 Sediment Loads to Study Area

Suspended sediment loadings to the Study Area include loads from central Budd Inlet (and Puget Sound), Capitol Lake, creeks that discharge directly to the inlet and other lateral sources (i.e., storm drains). Minimal information is available that quantifies the magnitude of these sediment loads to the inlet. Sediment traps deployed as part of the 1998 LOTT study (See Figure 2-14) are present within the Study Area in West Bay and provide long term averages of settling rates in those areas over a 13-month time period. These data could be used to estimate an average TSS concentration at those locations. Empirical measurements of TSS (or similar information) associated with discharges from Capitol Lake, other creeks that discharge to the inlet, and lateral sources are not available.

5.4.1.3 Hydrodynamic and Sediment Transport Modeling

A general understanding of hydrodynamic patterns in Budd Inlet are available based on previous studies, including several numerical modeling efforts. The need for additional hydrodynamic modeling to support this investigation will be discussed with Ecology. In the event that a hydrodynamic model is determined to be necessary for this project, an evaluation will be conducted to determine if existing models could be used or modified to support this study or if a new model or models would need to be developed to meet project objectives. If necessary, hydrodynamic and/or sediment transport modeling may require additional data collection to better understand specific model input parameters.

5.4.2 Geotechnical Data

The properties of the soils located near the log pond and northwestern region of the Port peninsula are not adequately understood for geotechnical evaluation. Additional testing for sediment characterization (i.e., particle size, plasticity, compressibility) of dredge material may be required if an on-site sediment disposal facility is considered. Additional in situ strength tests may also be required in areas where potential capping may occur.

Additional geotechnical results may also be needed in sediments beneath the overwater wharf at the Port's Marine Terminal. Limited geotechnical data is available from the area along the under wharf slope above and below the extent of armoring, which could support evaluations of dredging at the wharf face, dredging under the wharf, and other measures used to stabilize under wharf sediment.

6 REFERENCES

Anchor Environmental. 2007a. Biological Evaluation. Submitted to National Marine Fisheries Service U.S. Fish and Wildlife Service. February 2007.

Anchor Environmental. 2007b. Existing Condition Report for West Bay Park Phase 1 Improvements. Prepared for the City of Olympia Parks, Arts, and Recreation Department. October 2007.

Anchor QEA, 2009. Water Quality Monitoring and Sediment Sampling Plan. Prepared for the Port of Olympia. January 2009.

Anchor QEA, 2009. Remedial Investigation/Feasibility Work Plan, Westbay Marina. Prepared for Westbay Marina Associates. February 2009.

Anchor QEA, 2009a. Memorandum Summarizing 3-Month Monitoring Results - Berths 2 and 3 Interim Cleanup Action Pilot Study. Prepared for the Port of Olympia. September 2009.

Anchor QEA, 2009b. Completion Report – Berths 2 and 3 Interim Action Cleanup. Prepared for the Port of Olympia. June 2009.

Anchor QEA, 2010. Letter to: Guy Barrett, Site Manager, Toxics Cleanup Program, Washington State Department of Ecology. Regarding: Westbay Marina Associates Soil Sample Results. February 5, 2010.

Anchor QEA, 2010a. Memorandum Summarizing 9-Month Monitoring Results - Berths 2 and 3 Interim Cleanup Action Pilot Study. Prepared for the Port of Olympia. March 2010.

Anchor QEA, 2010b. Memorandum Summarizing 15-Month Monitoring Results - Berths 2 and 3 Interim Cleanup Action Pilot Study. Prepared for the Port of Olympia. September 2010.

Anchor QEA, 2011. Memorandum Summarizing 21-Month Monitoring Results - Berths 2 and 3 Interim Cleanup Action Pilot Study. Prepared for the Port of Olympia. February 2011.

Anchor QEA, 2011. West Bay Park Master Plan – Task 2 Memorandum. Prepared for Jonathon Turlove, Olympia Parks, Arts and Recreation (OPARD). September 2011.

Anchor QEA, 2012. Port of Olympia Budd Inlet Cleanup Evaluation: Project Investigative Work Plan. Prepared for the Port of Olympia. June 2012.

Applied Geotechnology, Inc. (AGI), 1986. Remedial Investigation, Cascade Pole Company, Olympia, Washington. Vol. I and II. Prepared for McFarland Cascade, Cascade Pole Company. Prepared by AGI, Inc., Bellevue. May 1986.

Arcadis, 2012. Remedial Investigation Report, Former ARCO Olympia Bulk Terminal, Industrial Petroleum Distributors Site. Prepared for BP West Coast Products, LLC. January 2012.

Armstrong, J.E., D.R. Crandell, D.J. Easterbrook, and J.B. Noble, 1965. Late Pleistocene stratigraphy and chronology in southwestern British Columbia and northwestern Washington. *Geological Society of America Bulletin* 76(3):321-330.

Bailey, A., H. Berry, B. Bookheim, and D. Stevens, 1998. Probability-based estimation of nearshore habitat characteristics. In Proceedings of Puget Sound Research Conference, March 12-13, 1998, p. 580-588. Puget Sound Water Quality Action Team, Olympia. 1998.

Battelle, Pentec, Striplin, Shapiro, King County, 2001. Reconnaissance assessment of the state of the nearshore ecosystem: Eastern shore of central Puget Sound, including Vashon and Maury Islands (WRIAs 8 and 9). Prepared for King County Department of Natural Resources, Seattle, WA. Battelle Marine Sciences Laboratory, Pentec Environmental, Striplin Environmental Associates, Shapiro Associates, Inc., King County Department of Natural Resources, Seattle, WA.

Blunt, D.J., D.J. Easterbrook, and N.W. Rutter, 1987. Chronology of Pleistocene sediments in the Puget Lowland, Washington. Schuster, J.E., editor. Selected papers on the geology of Washington: Washington Division of Geology and Earth Resources Bulletin 77:321-353.

Brown and Caldwell, 2006. Budd Inlet Treatment Plant Master Plan. Prepared for the LOTT Alliance. June 2006.

City of Olympia, 2003. City of Olympia Storm and Surface Water Plan. Prepared by the City of Olympia in consultation with Dorothy Craig and Associates, David Evans and Associates, Yiing Boardman, and Becky Lucas. November 2003.

City of Olympia, 2003. City of Olympia Storm and Surface Water Plan. Prepared by the City of Olympia in consultation with Dorothy Craig and Associates, David Evans and Associates, Yiing Boardman, and Becky Lucas. November 2003.

City of Olympia, 2007. City of Olympia Wastewater Management Plan, 2007-2012. Prepared in consultation with David Evans and Associates, Dorothy P. Craig and Associates, Brown and Caldwell, HDR/EES, and Financial Solutions Consulting Group. September 2007.

City of Olympia, 2010. City of Olympia GIS Basin Analysis 2010. November 2010.

Dames & Moore, 1972a. Report of Soils Investigation: Proposed Berth Dredging Area and Proposed Pier Reconstruction – Berth 2.

Dames and Moore, 1972b. Report of Preliminary Soils Investigation: Proposed Roadway. May 1972.

Dames and Moore, 1973. Report of Soils Investigation: Proposed East Bay Development Program. April 1973.

Dames & Moore, 1979. Report of Soils Investigation: Proposed Pier Reconstruction – Berth 1. April 1979.

Dames and Moore, 1978. Report Supplementary Geotechnical Investigation: Proposed East Bay Development Program. August 1978.

Dames and Moore, 1982. Supplementary Geotech Investigation East Bay Marina. August. 1982.

DeLacy, A. C., B. S. Miller, and S. F. Borton, 1972. Checklist of Puget Sound fishes. Washington Sea Grant, University of Washington, Seattle, No. WSG 72-3. 43 p. 1972.

Easterbrook, D,J. ,1994. Chronology of pre-late Wisconsin Pleistocene sediments in the Puget Lowland, Washington, In Lasmanis, R., and E.S. Cheney, Regional Geology of Washington State: Washington Division of Geology and Earth Resources Bulletin, 80:191-206.

Ecology (Washington State Department of Ecology), 2003. Fact Sheet for UNOCAL/HULCO Bulk Plant Proposed Removal from Hazardous Sites List. Prepared by the Washington State Department of Ecology. July 2003..

Ecology, 2005. Fact Sheet for NPDES Permit WA0037061. Prepared by the Washington State Department of Ecology for the LOTT Alliance Budd Inlet Wastewater Treatment Plant NPDES Permit. September 2005.

Ecology, 2006. Chemical Characterization of Stormwater Runoff from Three Puget Sound Boatyards. Prepared by Art Johnson, Steve Golding, and Randy Coots for the Washington State Department of Ecology. December 2006.

Ecology, 2007a. Fact Sheet for Hardel Mutual Plywood, Inc., Agreed Order for Remedial Investigation, Feasibility Study, and Interim Actions. Prepared by the Washington State Department of Ecology . April 2007.

Ecology. 2007b. Reliable Steel Inc. 1218 West Bay Drive, Olympia. Fact Sheet. December 2007. Washington State Department of Ecology, Olympia, WA. Ecology, 2008a. Budd Inlet Sediments Investigation Fact Sheet. Prepared by Washington State Department of Ecology. May 2008

Ecology, 2008a. Budd Inlet Sediments Investigation Fact Sheet. Prepared by Washington State Department of Ecology. May 2008.

Ecology, 2008b. Agreed Order No. DE 6083. Washington State Department of Ecology. October 2008.

Ecology, 2009a. South Puget Sound Dissolved Oxygen Study- South and Central Puget Sound Water Circulation Model Development and Calibration. October 2009.

Ecology, 2009b. Fact Sheet for NPDES Permit WA0040231. Prepared by Ecology for the Port of Olympia/East Bay Development NDPES Permit. March 2009.

Ecology, 2010. Fact Sheet for NPDES Permit WA0040533. Prepared by Ecology for the Port of Olympia/Cascade Pole Site Remediation NDPES Permit. June 2010.

Ecology, 2011. National Pollution Discharge Elimination System Waste Discharge and Reclaimed Water Permit No. WA0037061. Prepared by the Washington State Department of Ecology for the LOTT Alliance. August 2011.

Ecology, 2012a. First Amendment to the Agreed Order No. DE 6083. Washington State Department of Ecology. February 20, 2012. Ecology, 2012b. Environmental Information Management database. Accessed February 2012. Available at: http://www.ecy.wa.gov/eim

Ecology, 2012c. Permit and Reporting Information System. Accessed April 2012. Available at: https://fortress.wa.gov/ecy/wqreports/public/f?p=110:300:86604849160910

ENTRANCO 1997. 1997 Capitol Lake Drawdown Monitoring Results. Prepared for the City of Olympia. November 1997

Environmental Science and Engineering, Inc. (ESE), 1992. Supplemental Site Investigation Report, Cascade Pole Site, Olympia. Prepared for the Cascade Pole Company and the Port of Olympia. Prepared by ESE, Amherst. 1992.

Environmental Data Resources Inc. (EDR), 2012. Port of Olympia, Budd Inlet, Olympia, WA 98501. Inquiry Number: 3249945.2s. January 31, 2012

ESA Adolfson, 2008. Lacey, Olympia, and Tumwater Shoreline Analysis and Characterization Report. Prepared for Thurston Regional Planning Council. December 2008.

General Administration, State of Washington, 2010. Current News: Action to Contain New Zealand Mud Snails at Capitol Lake. Page last updated May 21, 2010. Available at: http://www.ga.wa.gov/news/currentnews.htm. GeoEngineers, 1984. Geotechnical Engineering Services – Proposed New Berthing Facilities. April 1984.

GeoEngineers, 1986. Phase II Geotechnical Engineering Services – Berth 3 Reconstruction. January 1986.

GeoEngineers and PIONEER, 2008. Remedial Investigation Work Plan, East Bay Redevelopment. Prepared for the Port of Olympia. Prepared by GeoEngineers and PIONEER. October 2008. Amended January 2009.

GeoEngineers, 2007. Draft Remedial Investigation/Feasibility Study and Conceptual Cleanup Action Plan, East Bay Redevelopment. Prepared for the Port of Olympia. Prepared by GeoEngineers. December 2007.

Giles, S. L., and J. R. Cordell, 1998. Zooplankton composition and abundance in Budd Inlet, Washington. In Proceedings of Puget Sound Research 1998 Conference, Puget Sound Water Quality Action Team, Olympia. March 1998.

Greylock Consulting (Greylock), 2008. Letter to: Joanne Snarski. Regarding: Groundwater Flow During High and Low Tides, Port of Olympia East Bay Site. August 21, 2008.

Greylock, 2011. Compliance Well Installation & First Round of Groundwater Monitoring, Former Hardel Mutual Plywood Site. Prepared for Hardel Mutual Plywood Corporation. February 2011.

Hart Crowser, 2011. Remedial Investigation, Westbay Marina. Prepared for the Washington State Department of Ecology. June 2011.

Integral Consulting, Inc. (Integral), 2007a. Draft PSDDA Sediment Characterization Report. East Bay Dredging Project. Prepared for Port of Olympia. February 2007.

Integral, 2007b. Draft Data Summary Report – West Bay Sediment Characterization Study Berths 2 and 3 Interim Action Project. Prepared for Port of Olympia. November 2007.

Johnson, Art, 2005. Quality Assurance Project Plan – Toxics in Stormwater Runoff from Puget Sound Boatyards. Prepared for the Washington State Department of Ecology. December 2005.

Lacey-Olympia-Tumwater-Thurston County Clean Water Alliance (LOTT), 1998. LOTT Wastewater Resource Management Plan. Prepared in consultation with Brown and Caldwell for the LOTT Partnership. December 1998.

Lance, M. M., S. Richardson, and H. Allen. 2004. Washington state recovery plan for the sea otter. Washington Department of Fish and Wildlife, Olympia, Washington.

Landau Associates (Landau), 1993. Remedial Investigation Report, Sediments Operable Unit, Cascade Pole Company Site. Prepared for the Washington State Department of Ecology. January 1993.

Landau, 1986a. Geotechnical Investigation and Study or Sedimentation and Erosion, Berth 2. January 1986.

Landau, 1986b. Geotechnical Investigation and Study or Sedimentation and Erosion, Berth 2. January 1986.

Landau, 1995. Results of Supplemental Exploration Program, Citifor Lease Property, Proposed Interim Remedial Action, Cascade Pole Site, Olympia, Washington. September 19, 1995.

Landau, 2011a. North Point/Phase III Capping Project Summary of Compliance Monitoring Cascade Pole Site, Olympia, Washington, Landau Associates, July 11, 2011

Landau, 2011b. Groundwater Monitoring Report, February 2010 through May 2011, Cascade Pole Site. Prepared for Port of Olympia. December 2011.

Lie, U. 1974. Distribution and structure of benthic assemblages in Puget Sound, Washington. Mar. Biol. 26:203-223.

Llanso, R. J., S. Aasen, and K. Welch. 1998. Marine Sediment Monitoring Program, II. Distribution and structure of benthic communities in Puget Sound 1989-1993. Washington Department of Ecology Publication No. 98-328. 150 p.

LOTT, 2008. Budd Inlet Scientific Study. Prepared by LOTT for the Washington State Department of Ecology. August 2008.

LOTT, 2010. 2010 Annual Capacity Reports. Prepared by LOTT in consultation with Brown and Caldwell. October 2010.

LOTT, 2011. 2010 Combined Sewer Overflow Report. Prepared by LOTT for the Washington State Department of Ecology. May 2011.

National Marine Fisheries Service (NMFS), 2007. Endangered Species Act Status of West Coast Salmon and Steelhead. Updated June 8, 2006. Available at: http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/upload/1pgr06-06.pdf.

National Marine Fisheries Service. 2012. (Draft) Status Review of The Eastern Distinct Population Segment of Steller Sea Lion (Eumetopias jubatus). Protected Resources Division, Alaska Region, National Marine Fisheries Service, 709 West 9th St, Juneau, Alaska 99802. Available at: http://alaskafisheries.noaa.gov/protectedresources/stellers/edps/draftedps0412.pdf

Orca Network, 2011. August 2011 Whale Sightings. Available at: http://www.orcanetwork.org/sightings/aug11.html

Palsson, W. A., J. C. Hoeman, G. G. Bargmann, and D. E. Day, 1997. 1995 status of Puget Sound bottomfish stocks (revised). Report No. MRD97-03. Washington Department of Fish and Wildlife.

Parametrix, 1990. Letter to: Richard O. Malin, Port of Olympia. Regarding: Report of soil and groundwater quality along the proposed LOTT Treatment Plant outfall alignment. Prepared for LOTT. January 1990.

Parametrix, 2004. West Bay Phase II Environmental Site Assessment. Prepared for OPARD. June 2004.

Parametrix, 2008. Work Plan for Remedial Investigation/Feasibility Study and Interim Action, Solid Wood Incorporated Site (West Bay Park). October 2008.

PIONEER Technologies Corporation (PIONEER), 2010. Infrastructure Interim Action Report for East Bay Redevelopment Site. Prepared for the Port of Olympia. June, 2010.

PIONEER Technologies Corporation (PIONEER), 2011. Letter to Steve Teel, Ecology. Regarding: Final Empirical Evaluation of the Potential for Soil Constituents to Migrate to Surface Water via Groundwater at the East Bay Redevelopment Site. Prepared for the Washington State Department of Ecology on behalf of the Port of Olympia. May 31, 2011.

Port of Olympia, 2008. Interim Action Plan Port of Olympia West Bay Berths 2 and 3. Prepared by Port of Olympia. December 2008

Port of Olympia, 2011. Industrial Stormwater General Permit WAR001168. Prepared by the Port of Olympia for the Washington State Department of Ecology. May 2011.

Puget Sound Nearshore Ecosystem Restoration Project, 2011. Strategic Restoration Conceptual Engineering – Design Report. Appendix A: Action Characterization Report Results. March 2011

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, and W. B. Scott, 1991. Common and scientific names of fishes from the United States and Canada. *Am. Fish. Soc. Spec.* 20:183. 1991.

RW Morse, 2002. West Bay Habitat Assessment. Prepared for Thurston Regional Planning Council. June 2002.

Science Applications International Corporation (SAIC), 2007. Budd Inlet Summary of Existing Information and Identification of Data Gaps for Sediments, Budd Inlet. Data Report. Prepared for the Washington State Department of Ecology. March 2007.

SAIC, 2008. Sediment Characterization Study, Budd Inlet. Final Data Report. Prepared for the Washington State Department of Ecology. March 2008.

SECOR, 2001. Final Remedial Investigation and Feasibility Study, Former Industrial Petroleum Distributors Bulk Terminal. October 2001.

SECOR, 2007. Draft Remedial Investigation and Feasibility Study, Former Industrial Petroleum Distributors. October 2007.

Shannon and Wilson, 1982. Evaluation of Differing Site Condition Claim East Bay Marina Dredging. June 1982.

Stemen Environmental, Inc. (Stemen), 1999. Groundwater Monitoring Well Installation and Groundwater Sampling for Westbay Marina. Prepared for Neil Falkenburg, Westbay Marina. December 1999.

Stemen, 2004. Phase 2 Environmental Site Assessment Report. Former Hardel Mutual Plywood Waterfront Property. July 2004.

Steevens, Jeffery. 2005. A methodology for deriving tissue residue benchmarks for aquatic biota: a case study for the fish exposed to 2,3,7,8-Tetrachlorodibenzo-p-Dioxin Port Madison Indian Reservation, Puget Sound Region. August 2005.

TetraTech 1988. Puget Sound Estuary Program, Budd Inlet Action Plan: Initial Data Summaries and Problem Identification. Prepared for US EPA Region X Seattle, WA. April 1988.

Thurston County Advance Planning, 1995. Budd Inlet – Deschutes River Watershed Action Plan. Prepared for the Washington State Department of Ecology. December 1995.

Thurston County Public Health and Social Services (TCPHSS), 2010. Priest Point Park Sediment Sampling Project. Prepared for the Washington State Department of Ecology. November 2010.

Thurston County, 2007. Thurston County Storm & Surface Water Program. Available at: http://www.co.thurston.wa.us/wwm/stream/onthego.htm

URS and Dewberry, 2003. Capitol Lake Floodplain Analysis. Prepared for the Federal Emergency Management Agency Region X. February 2003.

U.S. Army Corps of Engineers (USACE), 2005. Port of Olympia Routine Maintenance Dredging and Minor Widening Biological Evaluation. Seattle District.

USACE and U.S. Environmental Protection Agency (USEPA) Region 10, 2006. Appendix A-2: Analysis to Support Suitability Determination of Dredged Material with Polychlorinated Dibenzo-p-dioxins and Furans for Disposal at the Anderson-Ketron Dredged Material Disposal Site. Puget Sound Dredged Material Management Program. September 2006.

U.S. Fish and Wildlife Service (USFWS), 2012. Listed and Proposed Endangered and Species and Critical Habitat; Candidate Species; and Species of Concern in Western Washington, as prepared by the U.S. Fish and Wildlife Service Western Washington Fish and Wildlife Office; Revised December 20, 2005. Available at: http://www.fws.gov/westwafwo/se/SE_List/THURSTON.htm. Accessed on May 1, 2012.

U.S. Geological Survey (USGS), 2006. Deschutes Estuary Feasibility Study – Hydrodynamics and Sediment Transport Modeling. Final Report. Available at:http://www.ga.wa.gov/CLAMP/HSTA.pdf.

USGS 2008. Incorporation of Fine-Grained Sediment Erodibility Measurements into Sediment Transport Modeling, Capitol Lake, Washington. U.S. Geological Survey Open-File Report 2008-1340 Version 1.0, 72 p. November 2008. Available at: http://pubs.usgs.gov/of/2008/1340/

Walsh, T.J., R.L. Logan, H.W. Schasse, and M. Polenz, 2003. Geologic Map of the Tumwater 7.5-minute Quadrangle, Thurston County, Washington. Washington Division of Geology and Earth Resources Open File Report 2003-25. 1 sheet. scale 1:24,000.

Washington Department of Fish (WDF) and Western Washington Treaty Indian Tribes, 1993. Washington State salmon and steelhead stock inventory (SASSI).

Washington Department of Fish and Wildlife (WDFW), 2007. Priority Habitats and Species Maps in the Vicinity of T18, R02W, Section 15. Report Date: May 8, 2007.

WDFW, 2008. Implications of Capitol Lake Management for Fish and Wildlife. Prepared by Washington Department of Fish and Wildlife. Prepared for Capitol Lake Adaptive Management Program Steering Committee. September 2008.

WDFW, 2012. Priority Habitats and Species on the Web. Available at: http://wdfw.wa.gov/mapping/phs/ . Accessed August 8, 2012. Washington Public Power Supply System, 1974. Analysis of accelerograms recorded at Olympia, Washington. In Washington Public Power Supply System, WPPSS nuclear project no. 3-Preliminary Safety Analysis Report: Washington Public Power Supply System Docket no. 50-508, Preliminary Safety Analysis Report, Amendment 2, Appendix 2.5.K. p. 2.5.K-1 – 2.5.K-25, 13 figs.

Washington State Department of Health (DOH), 2008. Health Consultation – Budd Inlet. Updated. DOH under Cooperative Agreement with the Agency for Toxic Substances and Disease Registry. DOH Pub. 333-172. September 2008.

Weatherspark, 2012. Summary of annual metrological information for Olympia. Available from: http://weatherspark.com/averages/31131/Olympia-Washington-United-States

WRCC, 2012. Period of Record General Climate Summary – Precipitation and Temperature, Olympia Station 456114. Period of Record June 1, 1948 through February 26, 2012. Western Regional Climate Center. Available from: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wa6114

TABLES

Table 2-1
Summary of Contaminated Sites under AOs with Ecology within Budd Inlet

Project Name	Contaminants of Concerns	Current Status
West Bay		
Solid Wood Incorporated	TPH and cPAH	Phase 1 complete and opened as West Bay Park; remedial Investigation ongoing for additional portions of the site
Reliable Steel Incorporated	Arsenic, copper, and TPH	Remedial Investigation ongoing
Industrial Petroleum Incorporated	TPH and lead	Remedial Investigation ongoing
Hardel Mutual Plywood	TPH, cPAHs, and NAPL	Cleanup Action Plan is in public review; contaminated soil removed and groundwater treated; Ecology is proposing to remove the site from the Hazardous Sites List
Westbay Marina	Copper, nickel, zinc, arsenic, and D/Fs	Remedial Investigation ongoing
East Bay		
Cascade Pole	PAHs, PCPs, and D/F s	Interim Action complete; long term monitoring ongoing
East Bay Redevelopment	TPH, cPAHs, D/F s, and metals	Remedial Investigation/Feasibility Study ongoing

Notes:
cPAH = carcinogenic polycyclic aromatic hydrocarbons
D/F = dioxin and furans
NAPL = non aqueous phase liquid
PAHs = polycyclic aromatic hydrocarbons
PCP = pentachlorophenol
TPH = total petroleum hydrocarbons

Table 2-2
Explanation of Structural and Utility Information

Tag (Figure 2-11)	Property/ Structure Type	Structure/Utility Owner	Structure/Utility Description	Year of Construction	Design Dredge Depth (MLLW)	Pile/Bulkhead Embedment Depth (MLLW)	Data Source	Project No.
GM:01	Port Plaza Guest Moorage	Port of Olympia	Precast concrete floats with octagonal concrete piles.					
B1:01	Berth 1: Port of Olympia Marine Terminal (Bents 14 to 37)	Port of Olympia	Precast concrete deck panels on caps at 20-foot spacing with 16.5-inch octagonal concrete piles, concrete bulkhead, and 45-foot concrete retaining wall (at approximately station 39+40) Crane beam is predominantly supported by three 16.5-inch octagonal precast concrete piles, but there are locations where the crane beam is supported by 24-inch octagonal precast concrete piles.	1981	- 37 feet (Sheet C-113 from Dredging Plan for Berth 2 Reconstruction: EDA Project # 07-1-01242)	Crane beam and fender pile embedment depths not listed in record drawings Bottom of concrete bulkhead design Elevation +11.42 feet (Sheet 3, Section C-C) No sheet pile wall	Port of Olympia Record Drawings	EDA Project 07-01-02222
B1:02			Precast concrete fender pile system with camels: Piles 10 feet OC (Sheet 7)					
B1:04			Riprap slope on east shore of West Bay (Sheet 7)					
NW:01	Berth 1-2: Port of Olympia Marine Terminal (New Warehouse Wharf) (Bents 37 to 49)	Port of Olympia	Precast concrete deck panels on caps at 20-foot spacing with 16.5-inch octagonal concrete piles, HP 12x63 batter pile along bulkhead, and sheet pile bulkhead Crane beam is predominantly supported by three 16.5-inch octagonal precast concrete piles, but there are locations where the crane beam is supported by 24-inch octagonal precast concrete piles.	1985 (As-builts) 1984 (Design)	-37 to -42 feet (Sheet C-113 from Dredging Plan for Berth 2 Reconstruction: EDA Project 07-1-01242)[1]	Outer most crane beam pile -115 feet (Sheet C-5) Bottom of concrete bulkhead design elevation +12.67 feet (Sheet C-5 & C-10) Sheet pile wall depth -10 feet (Sheet C-5)	Port of Olympia Record Drawings	Port of Olympia Project Contract 209 and 161
NW:02			Precast concrete fender pile system with camels: Piles 10 feet OC (Sheet C-3, C-5, C-12)			Fender pile -60 feet (Sheet C-5)		
NW:03			Riprap slope and berm on east shore of West Bay (Sheet C-5)					
B2:01	Berth 2: Port of Olympia Marine Terminal (Bents 49 to 69)	Port of Olympia	Precast concrete deck panels on caps at 20-foot spacing with 16.5-inch octagonal concrete piles, and CIP concrete bulkhead Crane beam is predominantly supported by three 16.5-inch octagonal precast concrete piles, but there are locations where the crane beam is supported by 24-inch octagonal precast concrete piles.	1973	- 42 feet (Sheet C-113 from Dredging Plan for Berth 2 Reconstruction: EDA Project 07-1-01242)[1]	Crane beam and fender pile embedment; depths not listed in record drawings Bottom of concrete bulkhead design elevation +14.75 feet (Sheet C-124, C-126 & C-127) No sheet pile wall	Port of Olympia Record Drawings	EDA Project 07-01-01242 Port of Olympia Project Contract 144
B2:02			Precast concrete fender pile system with camels: Piles 10 feet OC (Sheet C-128)					
B2:03			Riprap slope and Berm on east shore of West Bay			Riprap extends along the berth, but specific details not available		

Tag (Figure 2-11)	Property/ Structure Type	Structure/Utility Owner	Structure/Utility Description	Year of Construction	Design Dredge Depth (MLLW)	Pile/Bulkhead Embedment Depth (MLLW)	Data Source	Project No.
B2:05			Timber retaining wall (Sheet C-115, C-118)					
B3S:01	Berth 3: SouthPort of Olympia Marine Terminal (Bents 69 to 82)	Port of Olympia	Precast concrete deck Panels on caps at 20-foot spacing with sheet pile bulkhead Deck panels supported on: 16.5-inch octagonal piles (solid and hollow) 24-inch octagonal piles (solid and hollow) HP 12x63	1988	- 42 feet (Sheet C-113 from Dredging Plan for Berth 2 Reconstruction: EDA Project # 07-1-01242)[1]	Sheet pile wall, crane beam pile, and fender pile embedment depths not listed in record drawings; typical design elevation of bottom of concrete bulkhead +14.05 feet (Sheet C-7 & C-15 Section C-C) Lowest design elevation of bottom of concrete bulkhead +12.72 feet (Sheet C-7 & C-15 Section A-A)	Port of Olympia Record Drawings	Not listed
B3S:02			Sheet pile bulkhead (Sheet C-6, C-11, C-15)					
B3S:03			Precast concrete fender pile system with camels: Piles 10 feet OC (Sheet C-22 through C-26)					
B3S:04			Riprap slope and berm on east shore of West Bay (Sheet C-3)			Riprap extends along the berth, but specific details not available		
B3N:01	Berth 3: North Port of Olympia Marine Terminal (Bents 82 to 101)	Port of Olympia	Precast concrete deck panels on caps at 20-foot spacing with sheet pile bulkhead/retaining wall Deck panels supported on: 16.5-inch octagonal piles (solid and hollow) 24-inch octagonal piles (solid and hollow) HP 12x63	1988	- 42 feet (Sheet C-113 from Dredging Plan for Berth 2 Reconstruction: EDA Project # 07-1-01242)	Outer most crane beam pile -97 feet (Sheet C-9) Bottom of concrete bulkhead design elevation +13.92 feet (Sheet C-9, C-10, & C-18) Sheet pile wall depth (bents 83 to 97) -10 feet (Sheet C-6 & C-9) Sheet pile wall depth (bents 97 to 101 and extending 40 feet east from back face of bulkhead) -30 Feet (Sheet C-6)	Port of Olympia Record Drawings	Port of Olympia Project Contract 181
B3N:02			Sheet pile bulkhead and retaining wall (Sheet C-4, C-5, C-6)					
B3N:03			Precast concrete fender pile system with camels: Piles 10 feet OC (Sheet C-9, C-19)			Fender pile -60 feet (Sheet C-9)		
B3N:04			Riprap slope and berm on east shore of West Bay (Sheet C-2, C-4, C-9, C-20)					

Tag (Figure 2-11)	Property/ Structure Type	Structure/Utility Owner	Structure/Utility Description	Year of Construction	Design Dredge Depth (MLLW)	Pile/Bulkhead Embedment Depth (MLLW)	Data Source	Project No.
B4:01	Berth 4: Abandoned Pier with Creosote Timber Deck and Piles	Port of Olympia	Abandoned pier with creosote timber deck and piles					
BL:01	Old Bait Shop and Boat Launch	Port of Olympia	Abandoned timber structure with creosote timber decking and piles					
AD:01	Anthony's Hearth and Grill Floating Dock	Port of Olympia	Creosote timber piles and precast concrete floats					
AS:01	Anthony's Hearth and Grill Structure	Port of Olympia	Galvanized steel beams and galvanized steel piles at varying distances					
CSO:01 (Outfall 001)	CSO Outfall	LOTT	Wastewater/CSO 48-inch diameter emergency discharge outfall					
CSO:02 (Outfall 002)	CSO Outfall	LOTT	Wastewater/CSO 48-inch diameter outfall					
PD:01	Storm Drain Outfall	Port of Olympia	12-inch diameter pipe[2]					
PD:02	Storm Drain Outfall	Port of Olympia	12-inch diameter pipe (Sheet C-112, C-115)				Port of Olympia Record Drawings	EDA Project 07-01-01242 Port of Olympia Project Contract 144
PD:03	Storm Drain Outfall	Port of Olympia	12-inch corrugated metal pipe (Sheet C-4, C-20)					Port of Olympia Project Contract 181
PD:04	Storm Drain Outfall	Port of Olympia	12-inch diameter pipe[2]					
PD:05	Storm Drain Outfall	Port of Olympia	12-inch diameter pipe[2]					
PD:06	Storm Drain Outfall	Port of Olympia	12-inch diameter pipe[2]					
PD:07	Storm Drain Outfall	Port of Olympia	12-inch diameter pipe[2]					
PD:08	Storm Drain Outfall	Swantown Boatworks	12-inch diameter pipe[2]					
PD:09	Storm Drain Outfall	Swantown Boatworks	12-inch diameter pipe[2]					
SD:01	Storm Drain Outfall	City of Olympia	12-inch diameter pipe (Section D-D, Drawing 8)				Port of Olympia Record Drawings	EDA Project 07-01-02222
SD:02	Storm Drain Outfall	City of Olympia	30-inch diameter vitrified clay pipe (Sheet C-4, C-20, P-1)					Port of Olympia

Tag (Figure 2-11)	Property/ Structure Type	Structure/Utility Owner	Structure/Utility Description	Year of Construction	Design Dredge Depth (MLLW)	Pile/Bulkhead Embedment Depth (MLLW)	Data Source	Project No.
								Project Contract 181
SD:03	Storm Drain Outfall	City of Olympia	12-inch diameter pipe[2]					
SD:04	Storm Drain Outfall	City of Olympia	12-inch diameter pipe[2]					
SD:05	Storm Drain Outfall	City of Olympia	12-inch diameter pipe[2]					
SD:06	Storm Drain Outfall	City of Olympia	12-inch diameter pipe[2]					
KGY:01	KGY Radio Station Structures	Port of Olympia	Creosote timber decking and piles					
CE:01	Breakwater	USACE	Galvanized steel pipe piles and precast concrete floats					
S1:01	Swantown Marina Docks	Port of Olympia/ Swantown Marina	Precast concrete floats and galvanized steel pipe piles (Phase 1)					
S2:01	Swantown Marina Docks	Port of Olympia/ Swantown Marina	Precast concrete floats and creosote timber piles (Phase 2)					
S3:01	Swantown Marina Docks	Port of Olympia/ Swantown Marina	Precast concrete floats and galvanized steel pipe piles (Phase 3)					
TL:01	Swantown Boat Works: Travel Lift	Swantown Boatworks	Precast concrete piles and concrete pile cap					
GD:01	Swantown Boat Works: Guest Dock	Swantown Boatworks	Precast concrete floats and galvanized steel pipe piles					
MC:01	Moxlie Creek Outfall	City of Olympia	72-inch diameter corrugated metal pipe					

Notes:
1 Navigable depth of -30 feet was taken from Port of Olympia Record Drawings for Berth 3 (North), Sheet # C-1
2 Assumed diameter, additional verification is needed to confirm size
CSO = combined sewer overflow
EDA = Economic Development Act
CIP = cast in place
OC = on center
HP = high point
MLLW = mean lower low water
USACE = U.S. Army Corps of Engineers

Table 2-3
Flood Levels in Capitol Lake

Exceedance Frequency	Lake Elevation (feet mean sea level)
10% Annual Chance (10-Year) Lake Level	10.4
2% Annual Chance (50-Year) Lake Level	11.3
1% Annual Chance (100-Year) Lake Level	11.5

Table 2-4
Tidal Datum in Budd Inlet

Parameter	NOAA Station 9446807 Tide Level [ft (m), MLLW]	At Port of Olympia (VDatum) Tide Level [ft (m), MLLW]
Mean Higher High Water	14.4 (4.4)	14.5 (4.4)
Mean High Water	13.5 (4.1)	13.5 (4.1)
Mean Sea Level	8.3 (2.5)	8.3 (2.5)
Mean Tide Level	8.3 (2.5)	8.3 (2.5)
Mean Low Water	3.1 (0.9)	3.1 (0.9)
North American Vertical Datum (NAVD88)[1]	4.0 (1.2)[1]	3.9 (1.2)
Mean Lower Low Water	0.0	0.0

Notes:
1 NAVD88 conversion to MLLW taken from VDatum at gage location
ft = feet
m = meter
MLLW = mean lower low water

Table 2-5
Summary of Sediment Grain Size and Conventional Parameter Results in the Study Area

Parameter	Units	Number of Samples	Minimum	Maximum	Mean
Surface sediment (0-10 cm)					
Fines (silt + clay)	% dw	73	10.9	90.8	57.6
Sand	% dw	73	10.6	77.0	28.5
Gravel	% dw	73	0.1	55.0	10.0
Total organic carbon	% dw	87	0.137	11.9	3.4
Total solids	% ww	64	21.0	90.0	41.2
Subsurface sediment (>1ft)					
Fines (silt + clay)	% dw	31	7.1	78.4	34.9
Sand	% dw	31	15.2	91.5	53.4
Gravel	% dw	31	1.0	54.9	12.6
Total organic carbon	% dw	43	0.031	13	3.2
Total solids	% ww	43	25	92.0	56.1

Notes:
% dw = percent dry weight
% ww = percent wet weight

Table 2-6
Budd Inlet Sedimentation Rates (SAIC 2008)

Location	Sedimentation rate prior to 1951[1]	Sedimentation rate after 1951[1]
West Bay (Core BI-D1)	0.7 g/cm^2/yr (0.4 cm/yr)	0.5 g/cm^2/yr (0.3 cm/yr)
East Bay (Core BI-D2)	0.6 g/cm^2/yr (0.4 cm/yr)	0.6 g/cm^2/yr (0.4 cm/yr)
Budd Inlet (Core BI-D3)	0.2 g/cm^2/yr (0.2 cm/yr)	0.2 g/cm^2/yr (0.1 cm/yr)

Notes:
1 An estimated bulk density of 1.73 g/cm^3 was used to find the estimated cm/yr rate and the g/cm^2/yr rate determined by Ecology
cm/yr = centimeter per year
g/cm^2/yr = grams per square centimeter per year

Table 2-7
Summary of Geotechnical Explorations and Available Data

Year	Location	Number of Explorations		Parameters	Reference
		Soil	Sediment		
1972	Marine Terminal	5	-	Grain size distribution, blow counts	Dames and Moore 1972a
1972	Central Peninsula and East Bay	2	-	Moisture content, dry density, blow counts, direct shear, consolidation	Dames and Moore 1972b
1973	East Bay	2	7	Moisture content, dry density, grain size distribution, blow counts, direct shear, tri-axial compression, consolidation	Dames and Moore 1973
1978	East Bay		12	Moisture content, dry density, permeability, blow counts, direct shear, consolidation	Dames and Moore 1978
1979	Marine Terminal	4	-	Moisture content, dry density, blow counts, direct shear	Dames and Moore 1979
1979	Marine Terminal	8	-	Moisture content, dry density, grain size distribution, blow counts, tri-axial compression, consolidation	Dames and Moore 1981
1982	East Bay		12	Blow counts	Shannon and Wilson 1982
1982	East Bay	6	1	Blow counts, penetration resistance	Dames and Moore 1982
1984	Marine Terminal	1		Blow counts	GeoEngineers 1984
1986	West Bay	2		Blow counts	Landau and Associates 1986
1986	Marine Terminal	5		Moisture content, dry density, blow counts, direct shear, consolidation	GeoEngineers 1986
1986	Cascade Pole	13	-	Stratigraphy and visual characterization	Applied Geotechnology, Inc. 1986

Year	Location	Number of Explorations		Parameters	Reference
		Soil	Sediment		
1992	Upland Cascade Pole/ Log Pond	45	-	Blow counts	Landau and Associates 1992
1995	Upland Log Pond Area	6	-	Blow counts	Landau and Associates 1995
2007	East Bay	2	-	Blow counts	GeoEngineers 2007
2007	West Bay	8	13	Moisture content, dry density, grain size distribution, Atterberg limits, tri-axial compression (unconsolidated and consolidated)	Integral 2007b

Table 3-1

Summary of Existing Applicable Sediment Studies

Study	Year[1]	Sample Count	Analytes
Study Area Surface Samples			
Olympia Federal Navigation Channel and the Port of Olympia Berthing Area (SAIC 2006)	2006	3	D/F
Budd Inlet Sediment Characterization (SAIC 2008)	2007	19	Conventionals, D/F s, grain size, metals, organic metals, PCBs, SVOCs
Port of Olympia Berths 2 and 3 Data (multiple rounds) (Anchor QEA 2010b)	2008-2010	22	Conventionals, D/F s, grain size
Study Area Subsurface Samples			
Budd Inlet Sediment Characterization (SAIC 2008)	2007	31	Conventionals, D/F s, grain size, metals, organic metals, PCBs, SVOCs
West Bay of Budd Inlet - Sediment Characterization Study: Berths 2 and 3 Interim Action Project (Integral 2007b)	2007	17	Conventionals, D/F s, grain size
Cascade Pole Sediment Confirmation Monitoring 2003 (Ecology 2012b)	2003	1	Conventionals, dioxins
East Bay Puget Sound Dredged Disposal Analysis (PSDDA) Sediment Characterization Report (Integral 2007a)	2007	14	Conventionals, D/F s, grain size, metals, organic metals, PCBs, SVOCs
Olympia Federal Navigation Channel and the Port of Olympia Berthing Area (SAIC 2006)	2006	34	D/F
Port of Olympia Berths 2 and 3 Data (multiple rounds) (Anchor QEA 2010b)	2008-2010	15	Conventionals, D/F s, grain size
Budd Inlet Surface Samples (Outside Study Area)			
Budd Inlet Sediment Characterization (SAIC 2008)	2007	32	Conventionals, D/F s, grain size, metals, organic metals, PCBs, SVOCs
Westbay Marina Remedial Investigation (Hart Crowser 2011)	2011	8	Conventionals, D/Fs, grain size, metals, organic metals, PAHs, PCBs, SVOCs, TPH

Study	Year[1]	Sample Count	Analytes
PSAMP Long-Term Temporal Monitoring (Ecology 2012b)	2010	38	Conventionals, grain size, metals, PAHs, PCBs, SVOCs, VOCs, pesticides, biological, PCB congeners, PBDEs
Solid Wood Incorporated. (West Bay Park) Rail Spur Phase II Environmental Site Assessment. (Parametrix 2008)	2007	7	Conventionals, D/Fs
Hardel EIM Results (Ecology 2012b)	2007	4	Conventional, D/Fs, grain size, metals, PCBs, SVOCs, pesticides
Solid Wood Incorporated. (West Bay Park) RI/FS (Parametrix 2008)	2008	28	Conventionals, D/Fs, grain size
Priest Point Park Sediment Sampling (TCPHSS 2010)	2010	30	Conventional sand D/Fs
Toxics in stormwater runoff from Puget Sound boatyards (Ecology 2006)	2006	1	Conventionals, grain size, metals, organic metals, PAHs, PCBs, SVOCs

Notes:
1 Data collected prior to 2002 for sediment chemistry, toxicity, and biological communities are not summarized in this report, but are available in the Project Database (Appendix D).
D/F = dioxin and furans
PAHs = polycyclic aromatic hydrocarbons
PSAMP = Puget Sound Ambient Monitoring Program
PBDEs = polybrominated diphenyl ethers
PCBs = polychlorinated biphenyls
RI/FS = Remedial Investigation/ Feasibility Study
SVOCs = semivolatile organic compounds
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds

:

Table 3-2
Summary of Surface Sediment Results in the Study Area

Chemical[1]	Unit	Sample Count	Count Detected Samples	Detection Frequency (%)	Min Detected Value	Mean Detected Value	Max Detected Value	Min Non Detected Value	Max Non Detected Value	SMS Criteria	
										SQS	CSL
Metals											
Arsenic	mg/kg dw	4	4	100	1.34	4.78	6.59	NA	NA	57	93
Cadmium	mg/kg dw	4	4	100	0.07	1.6	2.45	NA	NA	5.1	6.7
Chromium	mg/kg dw	4	4	100	11.6	27.3	35.7	NA	NA	260	270
Copper	mg/kg dw	4	4	100	10.2	45.4	65.2	NA	NA	390	390
Lead	mg/kg dw	4	4	100	5.38	16.5	26	NA	NA	450	530
Mercury	mg/kg dw	4	4	100	0.0140	0.0890	0.154	NA	NA	0.41	0.59
Silver	mg/kg dw	4	4	100	0.03	0.42	0.61	NA	NA	6.1	6.1
Zinc	mg/kg dw	4	4	100	72.8	94.6	116	NA	NA	410	960
PAHs											
2-Methylnaphthalene	mg/kg OC	5	2	40	0.30	0.35	0.40	1.0	2.4	38	64
Acenaphthene	mg/kg OC	5	3	60	0.43	0.91	1.7	1.0	2.4	16	57
Acenaphthylene	mg/kg OC	5	3	60	0.30	0.51	0.87	1.9	2.4	66	66
Anthracene	mg/kg OC	5	4	80	0.65	1.3	1.9	2.4	2.4	220	1,200
Benzo(a)anthracene	mg/kg OC	5	5	100	1.3	2.7	4.4	NA	NA	110	270
Benzo(a)pyrene	mg/kg OC	5	5	100	1.3	2.0	2.7	NA	NA	99	210
Benzo(g,h,i)perylene	mg/kg OC	5	4	80	0.95	1.4	1.9	2.4	2.4	31	78
Total benzofluoranthenes	mg/kg OC	5	5	100	2.7	5.1	8.1	NA	NA	230	450
Chrysene	mg/kg OC	5	5	100	2.7	4.7	7.5	NA	NA	110	460
Dibenzo(a,h)anthracene	mg/kg OC	5	2	40	0.21	0.28	0.36	1.0	2.4	12	33
Dibenzofuran	mg/kg OC	5	2	40	0.43	0.47	0.52	1.0	2.4	15	58

Chemical[1]	Unit	Sample Count	Count Detected Samples	Detection Frequency (%)	Min Detected Value	Mean Detected Value	Max Detected Value	Min Non Detected Value	Max Non Detected Value	SMS Criteria	
										SQS	CSL
Fluoranthene	mg/kg OC	5	5	100	4.5	9.8	17	NA	NA	160	1,200
Fluorene	mg/kg OC	5	3	60	0.60	0.72	0.80	1.0	2.4	23	79
Indeno(1,2,3-cd)pyrene	mg/kg OC	5	5	100	0.96	1.3	1.9	NA	NA	34	88
Naphthalene	mg/kg OC	5	2	40	0.32	0.44	0.56	1.0	2.4	99	170
Phenanthrene	mg/kg OC	5	5	100	1.0	5.5	13	NA	NA	100	480
Pyrene	mg/kg OC	5	5	100	4.5	8.5	14	NA	NA	1,000	1,400
Total HPAH[b] (Calculated U = 0)	mg/kg-OC	5	5	100	18	35	55	NA	NA	960	5,300
Total LPAH[c] (Calculated U = 0)	mg/kg-OC	5	5	100	1.0	8.0	17	NA	NA	370	780
Phthalates											
Bis(2-ethylhexyl) phthalate	mg/kg OC	5	5	100	1.9	5.2	16	NA	NA	47	78
Butyl benzyl phthalate	mg/kg OC	5	1	20	1.2	1.2	1.2	0.45	2.4	4.9	64
Diethyl phthalate	mg/kg OC	5	2	40	0.3	0.34	0.35	1.0	2.4	61	1,700
Dimethyl phthalate	mg/kg OC	5	0	0	NA	NA	NA	0.45	2.4	53	110
Di-n-butyl phthalate	mg/kg OC	5	1	20	1.2	1.2	1.2	0.45	2.4	220	53
Di-n-octyl phthalate	mg/kg OC	5	0	0	NA	NA	NA	0.45	2.4	58	4,500
Other SVOCs											
1,2,4-Trichlorobenzene	mg/kg OC	5	0	0	NA	NA	NA	0.5	2.4	0.81	1.8
1,2-Dichlorobenzene	mg/kg OC	5	0	0	NA	NA	NA	0.5	2.4	2.3	2.3
1,4-Dichlorobenzene	mg/kg OC	5	0	0	NA	NA	NA	0.5	2.4	3.1	9
2,4-Dimethylphenol	µg/kg dw	5	0	0	NA	NA	NA	30.0	430.0	29	29
Benzoic acid	µg/kg dw	5	0	0	NA	NA	NA	120.0	1,700.0	650	650
Benzyl alcohol	µg/kg dw	5	0	0	NA	NA	NA	12.0	170.0	57	73
Hexachlorobenzene	mg/kg OC	5	0	0	NA	NA	NA	0.45	2.4	0.38	2.3

Chemical[1]	Unit	Sample Count	Count Detected Samples	Detection Frequency (%)	Min Detected Value	Mean Detected Value	Max Detected Value	Min Non Detected Value	Max Non Detected Value	SMS Criteria	
										SQS	CSL
Hexachlorobutadiene	mg/kg OC	5	0	0	NA	NA	NA	0.45	2.4	3.9	6.2
n-Nitrosodiphenylamine	mg/kg OC	5	0	0	NA	NA	NA	0.45	2.4	11	11
Pentachlorophenol	µg/kg dw	5	0	0	NA	NA	NA	59	850	360	690
Phenol	µg/kg dw	5	0	0	NA	NA	NA	13	250	420	1,200
PCBs and D/Fs											
Total PCB Aroclors[d] (Calculated U = 0)	mg/kg-OC	5	3	60	0.19	0.28	0.42	0.9	2.1	12	65
D/F TEQ 2005[e] (Mammal) (U = 0)	mg/kg-OC	40	40	100	0.0000298	0.000575	0.00661	NA	NA	NC	NC
D/F TEQ 2005[e] (Mammal) (U = 0)	ng/kg dw	40	40	100	0.649	22.0	324	NA	NA	NC	NC
D/F TEQ 1998[f] (Mammal, Van den Berg et al.) (U = 0)	ng/kg dw	2	2	100	20.0	22.3	24.7	NA	NA	NC	NC

Notes:

1 Totals are calculated as the sum of all detected results (U=0). If all results are not detected, the highest reporting limit value is reported as the sum:

a. Total benzofluoranthenes is the sum of the detected b (i.e., benzo(b)fluoranthene), j, and k isomers.

b. Total HPAH is the sum of detected concentrations for fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

c. Total LPAH is the sum of detected concentrations for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.

d. Total PCBs is the sum of detected values for Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260.

e. Total Dioxin/Furan TEQ 2005 is calculated using the 2005 World Health Organization consensus TEF values for mammals.

f. Total Dioxin/Furan TEQ 1998 is calculated using the 1998 World Health Organization consensus TEF values for mammals.

µg/kg = micrograms per kilogram
CSL = cleanup screening level
D/F = dioxin and furans
dw = dry weight
HPAHs - high molecular weight polycyclic aromatic hydrocarbons
LPAHs = light molecular weight polycyclic aromatic hydrocarbons
mg/kg = milligrams per kilogram

NA = not applicable
NC = no SQS or CSL criteria available for this chemical
OC = organic carbon normalized
PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
SMS = Washington State Sediment Management Standards
SQS = Sediment Quality Standards
SVOCs = semivolatile organic compounds
TEQ = toxic equivalency

Table 3-3
Summary of Subsurface Sediment Results in the Study Area

Chemical[1]	Unit	Sample Count	Count Detected Samples	Detection Frequency (%)	Min Detected Value	Mean Detected Value	Max Detected Value	Min Non Detected Value	Max Non Detected Value	SMS Criteria SQS	SMS Criteria CSL
Metals											
Arsenic	mg/kg dw	12	4	33	5.56	7.51	10.5	7	20	57	93
Cadmium	mg/kg dw	12	12	100	0.50	1.5	2.58	NA	NA	5.1	6.7
Chromium	mg/kg dw	12	12	100	20	32	43	NA	NA	260	270
Copper	mg/kg dw	12	12	100	19	48	74.2	NA	NA	390	390
Lead	mg/kg dw	12	11	92	11	40	63.5	7	7	450	530
Mercury	mg/kg dw	12	10	83	0.05	0.3	**0.91**	0.05	0.07	0.41	0.59
Silver	mg/kg dw	12	10	83	0.6	0.95	1.52	0.5	1	6.1	6.1
Zinc	mg/kg dw	12	12	100	33	98	169	NA	NA	410	960
PAHs											
2-Methylnaphthalene	mg/kg OC	13	3	23	4.0	4.9	6.0	1.4	9.1	38	64
Acenaphthene	mg/kg OC	13	4	31	7.5	**22**	**40**	1.4	9.1	16	57
Acenaphthylene	mg/kg OC	13	4	31	1.7	2.7	3.6	1.4	9.1	66	66
Anthracene	mg/kg OC	13	13	100	1.7	13	60	NA	NA	220	1,200
Benzo(a)anthracene	mg/kg OC	13	13	100	1.8	18	60	NA	NA	110	270
Benzo(a)pyrene	mg/kg OC	13	13	100	2.5	17	52	NA	NA	99	210
Benzo(g,h,i)perylene	mg/kg OC	13	12	92	1.5	7.4	24	3.4	3.4	31	78
Total Benzofluoranthenes (Calculated U = 0)	mg/kg OC	12	12	100	3.8	51	116	NA	NA	230	450
Chrysene	mg/kg OC	13	13	100	3.8	22	66	NA	NA	110	460
Dibenzo(a,h)anthracene	mg/kg OC	13	4	31	2.8	7.6	12	1.4	9.1	12	33
Dibenzofuran	mg/kg OC	13	4	31	0.9	6.3	10	1.4	9.1	15	58
Fluoranthene	mg/kg OC	13	13	100	4.7	50	**163**	NA	NA	160	1,200

Chemical[1]	Unit	Sample Count	Count Detected Samples	Detection Frequency (%)	Min Detected Value	Mean Detected Value	Max Detected Value	Min Non Detected Value	Max Non Detected Value	SMS Criteria	
										SQS	CSL
Fluorene	mg/kg OC	13	5	38	1.4	15	**34**	1.4	9.1	23	79
Indeno(1,2,3-cd)pyrene	mg/kg OC	13	12	92	1.5	8.4	28	3.4	3.4	34	88
Naphthalene	mg/kg OC	13	5	38	1.7	7.9	19	1.4	9.1	99	170
Phenanthrene	mg/kg OC	13	13	100	2.5	29	**123**	NA	NA	100	480
Pyrene	mg/kg OC	13	13	100	4.9	38	129	NA	NA	1,000	1,400
Total HPAH (Calculated U = 0)	mg/kg OC	12	12	100	34	226	**1,004**	NA	NA	960	5,300
Total LPAH (Calculated U = 0)	mg/kg OC	12	12	100	4.2	63	**447**	NA	NA	370	780
Phthalates											
Bis(2-ethylhexyl) phthalate	mg/kg OC	6	46	1.4	29	41	NA	28	6	47	78
Butyl benzyl phthalate	mg/kg OC	5	38	0.3	2.7	3.7	NA	2.8	5	4.9	64
Diethyl phthalate	mg/kg OC	0	0	NA	NA	NA	NA	9.1	0	61	110
Dimethyl phthalate	mg/kg OC	0	0	NA	NA	NA	NA	9.1	0	53	53
Di-n-butyl phthalate	mg/kg OC	0	0	NA	NA	NA	NA	2.8	0	220	1,700
Di-n-octyl phthalate	mg/kg OC	1	8	1.3	2.8	2.8	NA	9.1	1	58	4,500
Other SVOCs											
1,2,4-Trichlorobenzene	mg/kg OC	2	0	0	NA	NA	NA	1.9	2.8	0.81	1.8
1,2-Dichlorobenzene	mg/kg OC	2	0	0	NA	NA	NA	1.9	2.8	2.3	2.3
1,4-Dichlorobenzene	mg/kg OC	2	0	0	NA	NA	NA	1.9	2.8	3.1	9
2,4-Dimethylphenol	µg/kg dw	4	0	0	NA	NA	NA	250	680	29	29
Benzoic acid	µg/kg dw	4	0	0	NA	NA	NA	1,000	2,800	650	650
Benzyl alcohol	µg/kg dw	4	0	0	NA	NA	NA	50	210	57	73
Hexachlorobenzene	mg/kg OC	2	0	0	NA	NA	NA	1.85	2.8	0.38	2.3
Hexachlorobutadiene	mg/kg OC	2	0	0	NA	NA	NA	1.85	2.8	3.9	6.2

Chemical[1]	Unit	Sample Count	Count Detected Samples	Detection Frequency (%)	Min Detected Value	Mean Detected Value	Max Detected Value	Min Non Detected Value	Max Non Detected Value	SMS Criteria	
										SQS	CSL
n-Nitrosodiphenylamine	mg/kg OC	2	0	0	NA	NA	NA	1.85	2.8	11	11
Pentachlorophenol	µg/kg dw	4	0	0	NA	NA	NA	500	1,400	360	690
Phenol	µg/kg dw	4	0	0	NA	NA	NA	220	410	420	1,200
PCBs and D/Fs											
Total PCB Aroclors (Calculated U = 0)	mg/kg-OC	12	9	75	0.33	2.9	7.2	1.0	1.9	12	65
D/F TEQ 2005 (Mammal) (U = 0)	mg/kg-OC	70	70	100	0.00000044	0.0031	0.14	NA	NA	NC	NC
D/F TEQ 1998 (Mammal, Van den Berg et al.) (U = 0)	ng/kg dw	27	27	100	0.00400	11.3	52.6	NA	NA	NC	NC
D/F TEQ 2005 (Mammal) (U = 0)	ng/kg dw	80	80	100	0.00351	91.0	4207	NA	NA	NC	NC

Notes:

1 Totals are calculated as the sum of all detected results (U=0). If all results are not detected, the highest reporting limit value is reported as the sum:

a. Total benzofluoranthenes is the sum of the detected b (i.e., benzo(b)fluoranthene), j, and k isomers.

b. Total HPAH is the sum of detected concentrations for fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

c. Total LPAH is the sum of detected concentrations for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.

d. Total PCBs is the sum of detected values for Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260.

e. Total Dioxin/Furan TEQ 2005 is calculated using the 2005 World Health Organization consensus TEF values for mammals.

f. Total Dioxin/Furan TEQ 1998 is calculated using the 1998 World Health Organization consensus TEF values for mammals.

Grey cell indicates SMS exceedance
Bold = SQS exceedance
Bold and Underline = CSL exceedance
µg/kg = micrograms per kilogram
CSL = cleanup screening level
D/F = dioxin and furans
dw = dry weight
HPAHs - high molecular weight polycyclic aromatic hydrocarbons
LPAHs = light molecular weight polycyclic aromatic hydrocarbons

mg/kg = milligrams per kilogram
NA = not applicable
NC = no SQS or CSL criteria available for this chemical
OC = organic carbon normalized
PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
SMS = Washington State Sediment Management Standards
SQS = Sediment Quality Standards
SVOCs = semivolatile organic compounds
TEQ = toxic equivalency

Table 3-4

Summary of Available Budd Inlet Tissue Studies

Study	Year	Sample IDs	Species	Sample Count	Sample Type	Analysis
EIM Data						
Verification of 303(d) PCB Listing for Inner Budd Inlet	2002	BUDDINLET1, BUDDINLET2, BUDDINLET3	Bay mussel (*Mytilus trossulus*)	3	Whole organism	PCBs (Aroclors)
South Puget Sound Fish and Shellfish Tissue Verification of 303(d) Listings	2005	BUDD INLT1-SF, BUDD INLT2-SF, BUDD INLT3-SF	Bay mussel (*Mytilus trossulus*)	3	Whole organism	D/Fs, PAHs
Budd Inlet Sediment Characterization	2007	BI-TISSUE3 SBI	Bent Nose clam (*Macoma nasuta*), Bay Ghost shrimp (*Neotrypaea californiensis*)	2	Whole organism	D/Fs
Reports						
DMMP Risk Analysis (USACE and USEPA 2008)[a]	2006	AKT01, AKB02, AKB03	Yoldia, Compsomyax, Macoma	5	Whole organism	D/Fs
Sediment Characterization Study - Budd Inlet, Olympia, WA (SAIC 2008)	2008	BI-S30, BI-Tissue1, BI-Tissue2, BI-Tissue3	Starry Flounder (*Platichthys stellatus*), English Sole (*Parophrys vetula*), Littleneck (*Protothaca staminea*) and Manila clam (*Venerupis philippinarum*), Bent Nose clam (*Macoma nasuta*), Ghost Shrimp (*Neotrypaea californiensis*)	43	Whole organism	D/Fs

Notes:
a Excluded based on study location (outside of Budd Inlet and collected from an open water disposal site)
D/F = dioxin and furans
DMMP = Dredge Material Management Program
PAHs = polycyclic aromatic hydrocarbons
PCBs = poly chlorinated biphenyls

Table 3-5

Tissue Data from Ecology's EIM database

Study Name	Budd Inlet Sediment Characterization (2007)		South Puget Sound Fish and Shellfish Tissue Verification of 303(d) Listings (2005)			Verification of 303(d) PCB Listing for Inner Budd Inlet (2002)		
Sample ID	**BI-TISSUES3 SBI[a]**		**BUDD INLT1-SF**	**BUDD INLT2-SF**	**BUDD INLT3-SF**	**BUDDINLET1**	**BUDDINLET2**	**BUDDINLET3**
Species	***Macoma nasuta***	***Neotrypaea californiensis***	***Mytilus trossulus***	***Mytilus trossulus***	***Mytilus trossulus***	***Mytilus trossulus***	***Mytilus trossulus***	***Mytilus trossulus***
Dioxins and Furans (ng/kg ww)								
D/F TEQ	1.71	4.90	0.55	0.38	0.72	NA	NA	NA
Polycyclic Aromatic Hydrocarbons (μg/kg ww)								
2-Methylnaphthalene	NA	NA	0.73	0.79	1.2	NA	NA	NA
Acenaphthene	NA	NA	0.93	1.1	1.3	NA	NA	NA
Acenaphthylene	NA	NA	0.49 U	0.5	0.64	NA	NA	NA
Anthracene	NA	NA	0.94	0.79	1.1	NA	NA	NA
Benz[a]anthracene	NA	NA	1.9	1.7	3.8	NA	NA	NA
Benzo(a)pyrene	NA	NA	1.8	0.86	2.6	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	0.49 U	1.4	2.5	NA	NA	NA
Benzo(ghi)perylene	NA	NA	0.49 U	0.77	1.5	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	0.49 U	4.3	6.5	NA	NA	NA
Chrysene	NA	NA	3.7	3.8	8.7	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	0.49 U	0.5 U	0.49 U	NA	NA	NA
Dibenzofuran	NA	NA	0.74	0.87	1	NA	NA	NA
Fluoranthene	NA	NA	5.6	8.1	15	NA	NA	NA
Fluorene	NA	NA	1.1	1.1	1.4	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	0.49 U	0.65	1.3	NA	NA	NA
Naphthalene	NA	NA	1.2	0.84	0.78	NA	NA	NA
Phenanthrene	NA	NA	4.8	6.2	11	NA	NA	NA
Pyrene	NA	NA	4.5	6.5	9.7	NA	NA	NA

Study Name	Budd Inlet Sediment Characterization (2007)		South Puget Sound Fish and Shellfish Tissue Verification of 303(d) Listings (2005)			Verification of 303(d) PCB Listing for Inner Budd Inlet (2002)		
Sample ID	**BI-TISSUES3 SBI[a]**		**BUDD INLT1-SF**	**BUDD INLT2-SF**	**BUDD INLT3-SF**	**BUDDINLET1**	**BUDDINLET2**	**BUDDINLET3**
Species	***Macoma nasuta***	***Neotrypaea californiensis***	***Mytilus trossulus***	***Mytilus trossulus***	***Mytilus trossulus***	***Mytilus trossulus***	***Mytilus trossulus***	***Mytilus trossulus***
PCBs (µg/kg ww)								
Total PCBs	NA	NA	NA	NA	NA	9.6	8.4	7.0
SVOCs (µg/kg ww)								
Bis(2-Ethylhexyl) Phthalate	NA	NA	42	44	41	NA	NA	NA
Pentachlorophenol	NA	NA	42	44	41	NA	NA	NA

Notes:
a Average concentration of three replicates per species
U = chemical undetected at reporting limit shown
J = estimated
D/F = dioxin and furans
µg/kg = micrograms per kilogram
NA = not analyzed
PCBs = polychlorinated biphenyls
TEQ = toxic equivalency
ww = wet weight

Table 3-6

Fish Tissue D/F TEQ Results from SAIC 2008

Location	Replicate	Tissue	Number of Fish	Mean Length (cm)	D/F TEQ (mg/kg ww)	Lipids (%)
Trawl Set 1 (West Bay)	3	Starry Flounder	30	9.7	0.37	1.20
Trawl Set 2 (North Navigation Channel)	5	Starry Flounder	22	17.6	0.46	1.31
Trawl Set 3 (North Inlet)	5	Starry Flounder	17	22.6	0.81	0.89
Trawl Set 3 (North Inlet)	3	English Sole	15	22.1	0.87	0.87

Notes:
cm = centimeter
D/F = dioxin and furans
mg/kg = milligram per kilogram
TEQ = toxic equivalency
ww = wet weight

Table 3-7
Clam and Shrimp Tissue D/F TEQ Results from SAIC 2008

Location	Species	D/F TEQ (mg/kg) Tissue Average (n=3; ww)	Sediment Average (dw)	Tissue Lipids (%)
BI-S30 (Moxlie Creek discharge)	Bent Nose Clam	2.39	60.3	0.72
BI-Tissue1 (Reliable Steel Intertidal)	Ghost Shrimp	3.08	4.3	1.31
	Bent Nose Clam	0.94	4.3	0.54
BI-Tissue1B (Reliable Steel Intertidal)	Littleneck/Manila Clam	0.30	25.1	0.86
BI-Tissue2 (South of Priest Point Park)	Ghost Shrimp	4.73	4.2	1.65
	Littleneck/Manila Clam	0.68	4.2	0.73
	Bent Nose Clam	0.76	4.2	0.51
BI-Tissue3 (Cascade Pole Intertidal)	Ghost Shrimp	4.90	9.5	1.98
	Bent Nose Clam	1.71	9.5	0.58

Notes:
D/F = dioxin and furans
dw = dry weight
mg/kg = milligram per kilogram
TEQ = toxic equivalency
ww = wet weight

Table 4-1
Summary of Reported Spills and Leaks in the Vicinity of the Study Area

Spill Material	Date of Spill	Source	Reported Location	Area	Reported Media	Reported Quantity	Reported Units	Notes
Chemical								
Chemical	2/2/2010	EDR	515 Jefferson St SE	South of Study Area	Soil	Unknown	Gallon	Fish brewery
Chemical	7/19/2000	EDR	1510 Conger Ave NW	West Bay (outside of Study Area)	Not reported	3	Cylinder	Resident
Chemical	10/12/2007	EDR	1322 Prospect Ave NE	East Bay (outside of Study Area)	Not reported	15	Other	Not reported
Chemical	7/13/2009	EDR	1401 Thomas St NW	West Bay (outside of Study Area)	Catch basin	Unknown	Unknown	Not reported
Chemical	6/1/1998	EDR	925 Central S NE	East Bay (outside of Study Area)	Not reported	Unknown	Unknown	Unknown
Chemical	3/8/2007	EDR	1000 Cherry St SE	South of Study Area	Not reported	25	Gallon	Not reported
Chemical	6/11/2010, 7/13/2007	EDR	900 Plum St SE	South of Study Area	Not reported	Unknown, 2	Unknown, other	Not reported
Ethylene Glycol	1/25/1994	ERNS	915 Washington St NE	Port peninsula	Water	<100	Gallon	Cause due to generator fire
Petroleum								
Diesel	5/22/2002	ERNS/EDR	144 Olympic Way SW	West Bay (outside of Study Area)	Water	Unknown	Unknown	Release from power pack (unknown cause)
Diesel	11/27/2002	ERNS	144 Olympic Way SW	West Bay (outside of Study Area)	Water	2	Cups	Release from generator due to operator error
Diesel	5/6/2010	ERNS	1022 Marine Dr NE	Port peninsula	Water	Unknown	Unknown	Cause due to vessel washing
Diesel	3/10/2006	ERNS/EDR	1022 Marine Dr NE	Port peninsula	Water	1	Pint	Unknown diesel sheen
Diesel	10/2/2010	ERNS	201 Simmons St NW	West Bay	Water	0.25	Gallon	Diesel fuel leak due to equipment failure
Fuel Oil No. 2	5/20/2007	ERNS	201 Simmons St NW	West Bay	Water	Unknown	Unknown	Vessel bilge pumped oily water
Gasoline	2/18/1999	ERNS	1022 Marine Dr NE Slip	Port peninsula	Water	Unknown	Unknown	Vessel sank due to unknown cause
Gasoline	10/10/2000	ERNS	201 Simmons St NW	West Bay	Water	1	Cups	Vessel sank due to unknown cause
Hydraulic oil	3/19/2002	ERNS	144 Olympic Way SW	West Bay (outside of Study Area)	Soil/Water	20	Gallon	Hydraulic hose on crane broke
Hydraulic oil	10/3/1994	ERNS	1425 N Washington St	Port peninsula	Water	50	Gallon	Log loading machine fell into bay
Motor oil	7/30/1999	ERNS	611 Columbia St NW	Port peninsula	Water	1	Quart	Outboard motor tipped over
Petroleum	7/28/1997	Other	Offshore of Marine Terminal	Port peninsula	Water	50	Gallon	Tug sank
Petroleum-diesel	12/4/1978	Other	1823 West Bay Dr NW	West Bay (outside of Study Area)	Water	70	Gallon	Olympia Forest Products-tug groundwater at low tide
Petroleum-diesel fuel	9/17/2011	EDR	303 Thurston Ave NE	Port peninsula	Soil	0	Gallon	Kenan Advantage Group Incorporated

Spill Material	Date of Spill	Source	Reported Location	Area	Reported Media	Reported Quantity	Reported Units	Notes
Petroleum-diesel fuel	1/9/2006	EDR	San Francisco St NE and Rose St NE	East Bay (out of Study Area)	Not reported	Unknown	Unknown	Not reported
Petroleum-diesel fuel	3/11/2007	ERNS/EDR	2111 East Bay Dr NE	East Bay (out of Study Area)	Not reported	5	Gallon	Unknown sheen on water
Petroleum-diesel fuel	11/7/2004, 11/8/2004	EDR	915 Washington St NE	Port peninsula	Not reported	15	Gallon and sheen	Not reported
Petroleum-diesel fuel	6/20/2001	EDR	1240 Washington St NE	Port peninsula	Not reported	Unknown	Unknown	Unknown
Petroleum-diesel fuel	4/27/2008	EDR	1022 Marine Dr NE	Port peninsula	Not reported	Unknown	Gallon	Not reported
Petroleum-diesel fuel	5/6/2010	EDR	1022 Marine Dr NE	Port peninsula	Water	Unknown	Gallon	Leak/spill from M/V Soldier
Petroleum-diesel fuel	10/2/2010	EDR	201 Simmons St NW	West Bay	Water	1	Gallon	Owner-Charlemagne
Petroleum-diesel fuel	4/23/2011	EDR	201 Simmons St NW	West Bay	Water	1	Gallon	Not reported
Petroleum-diesel fuel	11/30/2010	EDR	Not reported	--	Water	Unknown	Gallon	--
Petroleum-diesel fuel	6/4/2003	EDR	201 Simmons St NW	West Bay	Not reported	1	Sheen	Not reported
Petroleum-fuel oil	11/13/2000	EDR	2600 East Bay Dr NE	East Bay (out of Study Area)	Not reported	1	Container	Unknown
Petroleum-gasoline	1/4/2000	EDR	4th Ave E and Plum St SE	South of Study Area	Not reported	Unknown	Unknown	Unknown
Petroleum-gasoline	1/27/2000	EDR	900 Jefferson St SE	Inland of Port peninsula (out of Study Area)	Not reported	Unknown	Unknown	U.S. Post Office
Petroleum-gasoline	1/30/2006	EDR	1022 Marine Drive NE	Port peninsula	Not reported	1	Sheen	Port of Olympia
Petroleum-gasoline	9/29/2010	EDR	Not reported	--	Water	1	Gallon	--
Petroleum-gasoline	1/10/2004	EDR	201 Simmons St NW	West Bay	Not reported	1	Sheen	Vessel owner
Petroleum-hydraulic oil	4/11/2001	EDR	500 Adams St NE	Port peninsula	Not reported	30	Gallon	LOTT Facility
Petroleum-hydraulic oil	10/13/2005	EDR	1504 Marine Dr NE	Port peninsula	Not reported	5	Gallon	Not reported
Petroleum-motor oil	12/31/2008	EDR	200 Market St NE	Port peninsula	Not reported	Unknown	Unknown	Not reported
Petroleum-oil other	4/10/2004	EDR	4th Ave W and Sherman St SW	SW of Study Area	Not reported	Unknown	Unknown	Not reported
Petroleum-oil other	5/22/2008	EDR	Not reported	--	Not reported	Unknown	Gallon	Not reported
Petroleum-oil other	6/13/2001	EDR	650 Marine Dr SE	East Bay	Not reported	1	Sheen	Unknown
Petroleum-oil other	7/28/2006	EDR	201 Simmons St NW	West Bay	Not reported	5	Gallon	Not reported
Petroleum-unknown	1/10/2006	EDR	1503-1505 East Bay Dr	East Bay (outside of Study Area)	Not reported	1	Sheen	Not reported
Petroleum-unknown	6/19/2008	EDR	Marine Dr and East Bay Dr	East Bay	Not reported	Unknown	Gallon	Not reported
Petroleum-unknown	11/6/2004, 11/4/2004	EDR	611 Columbia St SW	South of Study Area	Not reported	1	Sheen	Not reported

Spill Material	Date of Spill	Source	Reported Location	Area	Reported Media	Reported Quantity	Reported Units	Notes
Petroleum-unknown	2/24/1999	EDR	722 Capitol Way SE	South of Study Area	Not reported	Unknown	Unknown	Premiere Auto Details
Petroleum-unknown	1/5/2009	EDR	1005 Adams St SE	South of Study Area	Soil	Unknown	Gallon	Goudy's Construction
Petroleum-unknown	4/9/2011	EDR	Not reported	--	Water	1	Gallon	--
Petroleum-unknown	6/25/2010	EDR	Not reported	--	Water	Unknown	Gallon	--
Petroleum-unknown	11/21/2005	ENRS/EDR	1022 Marine Dr NE	Port peninsula	Not reported	1	Sheen	Not reported
Petroleum-unknown	4/1/2011	EDR	1022 Marine Dr NE	Port peninsula	Water	Unknown	Gallon	Unknown sheen on water
Unknown (oil)	8/13/2010	ERNS	915 Washington St NE	Port peninsula	Water	Unknown	Unknown	Unknown sheen on water
Unknown (oil)	1/12/2001	ERNS	1022 Marine Dr NE	Port peninsula	Water	Unknown	Unknown	Unknown sheen on water
Unknown (oil)	6/25/2012	ERNS	1022 Marine Dr NE	Port peninsula	Water	Unknown	Unknown	Unknown sheen on water
Unknown (oil)	4/30/2000	ERNS	1022 Marine Dr NE	Port peninsula	Water	Unknown	Unknown	Unknown sheen on water
Unknown (oil)	5/29/2000	ERNS	1022 Marine Dr NE	Port peninsula	Water	Unknown	Unknown	Unknown sheen on water
Unknown (oil)	2/4/2004	ERNS	1022 Marine Dr NE	Port peninsula	Water	Unknown	Unknown	Very thick sheen on water suspected from vessel
Unknown (oil)	11/2/2000	ERNS	1022 Marine Dr NE	Port peninsula	Water	Unknown	Unknown	Unknown sheen on water
Unknown (oil)	11/23/2009	ERNS/EDR	525 N Columbia St	Port peninsula	Water	Unknown	Unknown	Unknown sheen on water
Unknown (oil)	11/1/1997	ERNS	1022 Marine Dr NE	Port peninsula	Water	Unknown	Unknown	Unknown sheen on water
Unknown (oil)	11/30/2010	ERNS	201 Simmons St NW	West Bay	Water	Unknown	Unknown	Unknown sheen on water
Unknown, Petroleum-diesel fuel	8/25/2009, 10/21/2009	EDR	2600 East Bay Dr	East Bay (outside of Study Area)	Water, Soil	55, Unknown	Drum, gallon	Not reported
Sludge/garbage								
Debris/garbage	5/23/1999	EDR	320 West Bay Dr	West Bay	Not reported	Unknown	Unknown	Unknown
Sewage/sludge	12/27/2005	EDR	Corky Ave NW and Capitol Way N	Port peninsula	Not reported	Unknown	Unknown	Not reported
Sewage/sludge	6/24/2009	EDR	500 Adams St NE	Port peninsula	Water	28,000	Gallon	LOTT Wastewater Treatment Plant
Sewage/sludge	1/22/1999	EDR	500 Adams St NE	Port peninsula	Not reported	1,000	Gallon	Public works
Sewage/sludge	4/11/2007	EDR	218 4th Ave E	South of Study Area	Not reported	50	Gallon	Not reported
Sewage/sludge	11/5/2006	EDR	219 West Bay Dr	West Bay (outside of Study Area)	Not reported	25	Gallon	Not reported
Sewage/sludge	11/8/1995	EDR	4th Ave W and Olympic St W	West Bay (outside of Study Area)	Not reported	200	Gallon/min	LOTT Wastewater Treatment Plant
Water								
Waste water	10/15/1996	EDR	10th Ave and Cherry St	South of Study Area	Not reported	Unknown	Unknown	LOTT Wastewater Treatment Plant
Effluent water	9/29/2008	ERNS/EDR	316 Jefferson St SE	East Bay	Water (via storm drain)	1,500	Gallon	Effluent from construction site inadvertently released (containing arsenic and selenium)
Bilge water	12/11/2010	EDR	1022 Marine Dr NE	Port peninsula	Water	Unknown	Gallon	Not reported
Bilge water	10/18/2010	EDR	1675 Marine Dr NE	Port peninsula	Soil	120	Gallon	Not reported
Unknown								
Unknown	10/19/2000	ERNS	1022 Marine Dr NE	Port peninsula	Water	Unknown	Unknown	Unknown sheen on water, possibly from vessel bilge pump

Spill Material	Date of Spill	Source	Reported Location	Area	Reported Media	Reported Quantity	Reported Units	Notes
Unknown	12/29/1996	ERNS	1022 Marine Dr NE, J-9	Port peninsula	Water	Unknown	Unknown	Vessel sank
Unknown	2/26/2005	EDR	1603 East Bay Dr NE	East Bay (outside of Study Area)	Not reported	Unknown	Unknown	Not reported
Unknown	12/19/2009	EDR	4th Ave and Jefferson St SE	East Bay	Roadway-paved	Unknown	Unknown	Unknown
Unknown	3/10/2009	EDR	324 West Bay Dr	West Bay (outside of Study Area)	Water	2	Drum	Not reported
Unknown	2/3/2009	EDR	1801 West Bay Dr	West Bay (outside of Study Area)	Water	Unknown	Unknown	Unknown
Unknown	7/25/2005	EDR	Legion Way SE and Eastside St SE	South of Study Area	Not reported	Unknown	Unknown	Not reported
Unknown	6/17/2009	EDR	503 Mission Dr NE	East Bay (outside of Study Area)	Water	Unknown	Unknown	Not reported
Other								
While paint	6/14/2002	ERNS	1022 Marine Dr NE	Port peninsula	Water	Unknown	Unknown	Possibly from vessel with fresh paint
Wood chips	1985	Other	1210 West Bay Drive NW	West Bay (out of Study Area)	Water	Unknown	--	Hardel Mutual Plywood. Wood chips over flow to water, old wood waste landfill
Vegetable oil	9/15/2011	EDR	212 4th Ave W	South of Study Area	Soil	55	Gallon	Lemon grass
Dust	8/27/2005	EDR	Washington St NE and 4th Ave E	South of Study Area	Not reported	Unknown	Unknown	Harlequin Theater
Mud/silt	3/18/2003	EDR	5th Ave SE and Franklin St SE	South of Study Area	Not reported	Unknown	Unknown	Christenson Incorporated
Other	6/13/2006	EDR	Legion Way SE and Jefferson St SE	South of Study Area	Not reported	Unknown	Unknown	Puget Sound Energy
Other	5/17/2007	EDR	Legion Way SE and Jefferson St SE	South of Study Area	Not reported	Unknown	Unknown	Not reported
Other	7/15/2008	EDR	State Ave NE and Puget St NE	East Bay (outside of Study Area)	Not reported	20	Gallon	Not reported
Other	2/1/2000	EDR	1328 NE Prospect	East Bay (outside of Study Area)	Not reported	Unknown	Unknown	Unknown
Other	12/28/2004	EDR	900 Capitol Way	South of Study Area	Not reported	Unknown	Unknown	Company That is Remodeling Pro
Other hazardous	12/13/2006	EDR	1700 Marine Dr NE	Port peninsula	Not reported	Unknown	Unknown	Not reported
Algae	8/4/2007	EDR	2003 East Bay Dr NE	East Bay (outside of Study Area)	Not reported	1	Other	Not reported

Notes:
-- = Information not found
EDR = Environmental Data Resources
ERNS = Emergency Response Notification System
LOTT = LOTT Clean Water Alliance

Table 4-2
NPDES Permitted Industrial Discharges to Budd Inlet

Facility Name	Permit Number	Permit Type	Address
Port of Olympia Marine Terminal[1]	WAR001168	Industrial SW GP	915 Washington St NE, Olympia 98501
Holbrook Incorporated Olympia Public Yard[a]	WAR003855	Industrial SW GP	1425 Washington St NE, Olympia 98501
Dunlap Towing Olympia Log Yard and West Bay Chip Reload[b]	WAR000106	Industrial SW GP	2003 West Bay Dr NW, Olympia 98502
Port of Olympia Budd Inlet[1]	WA0040533	Industrial NPDES IP	1412 N Washington St, Olympia 98507
East Bay Development Port of Olympia[1]	WA0040231	Industrial NPDES IP	State St, Jefferson St SE, Olympia Ave, Olympia 98501
Swantown Boatworks[1]	WAG031043	Boatyard GP	650 Marine Dr NE, Olympia 98501

Notes:
a Permitted discharge outfall is within the Study Area.
b Permitted discharge is outside the Study Area, but discharge is directly to Budd Inlet.
GP = General Permit
IP = Individual Permit
NDPES = National Pollutant Discharge Elimination System
SW = Stormwater

Table 4-3
Summary of Key Documents – Industrial Discharges

Date	Title or Description	Author	Prepared For	Notes
2005	QAPP: Toxics in Stormwater Runoff from Puget Sound Boatyards	Johnson, Art	Ecology	Prepared to outline sampling in preparation for third issuance of Boatyard General NPDES Permit
2006	Chemical Characterization of Runoff from Three Puget Sound Boatyards	Ecology	Ecology	Summary of sampling done for third issuance of Boatyard General NDPES Permit
2010	Fact Sheet for NPDES Permit WA0040533	Ecology	Ecology	Summarizes background of for permit for Port of Olympia/Cascade Pole Site Remediation
2009	Fact Sheet for NPDES Permit WA0040231	Ecology	Ecology	Summarizes background of for permit for Port of Olympia East Bay Redevelopment
2011	Industrial Stormwater General Permit WAR001168 – Annual Report	Ecology	Ecology	Summary of permit benchmark compliance or exceedences

Notes:
NPDES = National Pollutant Discharge Elimination System
QAPP = quality assurance project plan

Table 4-4

Summary of Water Quality Test Results[a] – Ecology Report AJOH0049

Sample ID	06144010	06144010	06144010	06144011	06144011	06144011	06154012	06154012	06154012	06224000	06224000
Result Date	4/12/2006	4/18/2006	5/3/2006	4/12/2006	4/18/2006	5/3/2006	4/18/2006	4/19/2006	4/26/2006	6/6/2006	6/8/2006
Metals											
Arsenic	0.74	NA	NA	0.75	NA	NA	NA	1.65	NA	NA	3.42 J
Cadmium	0.52	NA	NA	0.51	NA	NA	0.74	NA	NA	NA	2.7
Chromium	1.2	NA	NA	1.2	NA	NA	2.85	NA	NA	NA	2.5 U
Copper	953	NA	NA	1,050	NA	NA	2,650	NA	NA	NA	1,620
Lead	19.8	NA	NA	23.8	NA	NA	320	NA	NA	NA	33.3
Mercury	NA	0.05 U	NA	NA	0.05 U	NA	0.072	NA	NA	0.05 U	NA
Silver	0.1 U	NA	NA	0.1 U	NA	NA	0.1 U	NA	NA	NA	1 U
Zinc	340	NA	NA	350	NA	NA	550	NA	NA	NA	1,200
PAHs											
2-Methylnaphthalene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	3.3	NA	NA
Acenaphthene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.11	NA	NA
Acenaphthylene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	3.9	NA	NA
Anthracene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.07	NA	NA
Benz[a]anthracene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.05 J	NA	NA
Benzo(a)pyrene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA
Benzo(b)fluoranthene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.05 J	NA	NA
Benzo(ghi)perylene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.08	NA	NA
Benzo(k)fluoranthene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.07	NA	NA
Chrysene	NA	NA	0.05 J	NA	NA	0.09	NA	NA	0.08	NA	NA
Dibenzo(a,h)anthracene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA
Dibenzofuran	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.08	NA	NA
Fluoranthene	NA	NA	0.08	NA	NA	0.16	NA	NA	0.35	NA	NA
Fluorene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.29	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA
Naphthalene	NA	NA	0.06 U	NA	NA	0.06 J	NA	NA	2.6	NA	NA
Phenanthrene	NA	NA	0.09	NA	NA	0.16	NA	NA	0.12	NA	NA
Pyrene	NA	NA	0.07	NA	NA	0.13	NA	NA	0.63	NA	NA
Phthalates											
Bis(2-Ethylhexyl) Phthalate	NA	NA	2.4	NA	NA	3.2	NA	NA	1.3 UJ	NA	NA
Butyl benzyl phthalate	NA	NA	0.31	NA	NA	0.46	NA	NA	0.14	NA	NA
Dibutyl phthalate	NA	NA	2.3	NA	NA	2.8	NA	NA	0.54	NA	NA
Diethyl phthalate	NA	NA	0.25 J	NA	NA	0.31	NA	NA	0.05 J	NA	NA
Dimethyl phthalate	NA	NA	0.91	NA	NA	1.1	NA	NA	0.22	NA	NA

Sample ID	06144010	06144010	06144010	06144011	06144011	06144011	06154012	06154012	06154012	06224000	06224000
Result Date	**4/12/2006**	**4/18/2006**	**5/3/2006**	**4/12/2006**	**4/18/2006**	**5/3/2006**	**4/18/2006**	**4/19/2006**	**4/26/2006**	**6/6/2006**	**6/8/2006**
Di-N-Octyl Phthalate	NA	NA	0.13 U	NA	NA	0.12 U	NA	NA	0.13 U	NA	NA
Other SVOCs											
1,2,4-Trichlorobenzene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA
1,2-Dichlorobenzene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA
1,4-Dichlorobenzene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA
2,4-Dimethylphenol	NA	NA	0.06 U	NA	NA	0.25	NA	NA	3.0	NA	NA
Benzoic Acid	NA	NA	5.1	NA	NA	6.5	NA	NA	1.3 U	NA	NA
Benzyl Alcohol	NA	NA	0.64	NA	NA	0.65	NA	NA	0.13 U	NA	NA
Hexachlorobenzene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA
Hexachlorobutadiene	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA	0.06 U	NA	NA
N-Nitrosodiphenylamine	NA	NA	0.13 U	NA	NA	0.12 U	NA	NA	0.13 U	NA	NA
Pentachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	0.13 U	NA	NA
Phenol	NA	NA	0.73	NA	NA	0.94	NA	NA	0.55	NA	NA

Notes:
a Results reported in µg/l
µg/l – micrograms per liter
U = undetected at reporting limit shown
NA = not analyzed
PAHs = polycyclic aromatic hydrocarbons
SVOCs = semivolatile organic compounds

Table 4-5
NPDES Permitted Municipal Wastewater Discharges to Budd Inlet

Facility Name	Permit Number	Permit Type	Address
LOTT Budd Inlet Water Reclamation Facility[a]	WA0037061	Municipal NPDES IP	500 Adams St NE, Olympia 98501
Tamoshan STP[b]	WA0037290	Municipal NPDES IP	2304 63rd Ave NW, Olympia 98502
Seashore Villa STP[b]	WA0037273	Municipal NPDES IP	4805 Cushman Rd NE, Olympia 98506-1835
Boston Harbor STP[b]	WA0040291	Municipal NPDES IP	7110 Boston Harbor Rd NE, Olympia 98506

Notes:
a Permitted discharge outfall is within the Study Area.
b Permitted discharge is outside the Study Area, but discharge is directly to Budd Inlet.
IP = Individual Permit
LOTT = LOTT Clean Water Alliance
NDPES = National Pollutant Discharge Elimination System
STP = Sewage Treatment Plant

Table 4-6

Summary of Key Documents – Permitted Wastewater and CSO Discharges

Date	Title or Description	Author	Prepared For	Notes
1995	Budd Inlet – Deschutes River Watershed Action Plan	Thurston County Advance Planning	Thurston County and Ecology	General information and action items related to wastewater and stormwater management
1998	LOTT Wastewater Resource Management Plan	LOTT	LOTT	Provides framework for managing increased flow rates and increasing system capacity
1998	Budd Inlet Scientific Study	LOTT	LOTT	Provides findings on source of pollutants in Budd Inlet
2005	Fact Sheet for NPDES Permit WA0037061	Ecology	LOTT	Background information on LOTT facilities and discharges for discharge permit
2006	Budd Inlet Treatment Plant Master Plan	Brown and Caldwell	LOTT	Provides information on existing treatment facilities and master plan for expansion
2007	City of Olympia Wastewater Management Plan, 2007-2012	City of Olympia, Others	City of Olympia	Current city wastewater management plan; describes City system in relation to LOTT system
2010	NPDES Permit No. WA0037061 Infiltration and Inflow Report 2009 Submittal	LOTT	Ecology	Infiltration and Inflow report prepared for Ecology in accordance with NDPES permit requirements
2010	2010 Annual Capacity Reports	LOTT	LOTT	Report summarizing flows, loading, inflow and infiltration, and system capacity for 2010
2011	2010 LOTT Combined Sewer Overflow Report	LOTT	Ecology	CSO report submitted as part of in accordance with NDPES permit requirements
2011	NPDES Permit No. WA0037061	Ecology	LOTT	Current LOTT waste discharge and reclaimed water permit

Notes;
CSO = Combined Sewer Overflow
LOTT = LOTT Clean Water Alliance
NDPES = National Pollutant Discharge Elimination System

Table 4-7
CSO Overflow Events

Date	Volume (MG)	Notes
12/03/82	15	Due to heavy rain. Test results: TSS=83 mg/L, BOD=40 mg/L
01/05/83	1.5	Due to heavy rain. Test results: TSS=108 mg/L, BOD=56 mg/L
01/18/86	30	Due to heavy rain. Test results: TSS=98.4 mg/L, BOD=44.3 mg/L
11/23/86	5	Due to heavy rain. Test results: TSS=79 mg/L, BOD=39 mg/L
01/31/87-02/01/87		Due to heavy rain. Test results: TSS=78 mg/L, BOD=45 mg/L
12/09/87	1	Due to heavy rain (3 inches in 24 hours). Grab sample at 19:45 on 12/09/07. Test results: TSS=6 mg/L, BOD=6 mg/L, Fecal coliform=1,233 orgs/100 mL
01/09/90	10	Due to heavy rain. Outfall 003 used from 7:42 to 9:59. Test results: TSS=17 mg/L, BOD=6 mg/L, Fecal Col.=600 orgs/100 mL Outfall 003 Test results: TSS=99 mg/L, BOD=4.5 mg/L
11/23/90-11/24/90	40	Due to heavy rain (5.8 inches). Pretreated, chlorinated wastewater discharged. Grab sample at 12:05 on 11/24/90. Test results: TSS=40 mg/L, BOD=19.8 mg/L, Fecal Col. =530,000 orgs/100 mL 24-hour Composite Test results: TSS=18.6 mg/L, BOD=10.4 mg/L
04/04/91	12	Due to heavy rain. Portion of plant influent bypassed primary and secondary treatment prior to disinfection. Grab sample at 16:27. Test results: TSS=16.4 mg/L, BOD=12.7 mg/L, Fecalcoliform=80,000 orgs/100 mL
12/03/07	11.75	5.5 inches of rain between 1:00 PM on 12/02/07 and 1:00 PM on 12/03/07. Influent flows reached 79 MGD forcing LOTT to discharge a total of 9 MGD of screened, untreated, non-disinfected combined sewer effluent through Outfall 002 and 2.75 MG of primary-treated, disinfected effluent through Outfall 001. Composite sample consisting of hourly grab samples collected at Outfall 002 from 07:30 on 12/03/07 to 00:30on 12/04/07. Test results: TSS=52.5 mg/L, COD=82.1 mg/L, BOD_5<43.5 mg/L, NH_3 Total=4.74 mg/L, and Copper=49.5 mg/L Grab sample collected on 12/03 at 07:30. Test results: Fecal coliform.=230,000 mpn/100 mL

Date	Volume (MG)	Notes
01/07/09-07/08/09	6.3	5.06 inches of rain between 12:00 AM on 01/07/09 and 12:00 PM on 01/08/09. Influent flows reached 64 MGD forcing LOTT to divert a total of 1.5 MGD of screened, primary-treated effluent around the secondary treatment process for blending with treated effluent. During this time, 6.3 MG of blended, disinfected final effluent was discharged through Outfall 002. Grab sample collected for copper at 9:10 PM on 01/07/09. Test results: Copper=147.0 mg/L Composite collected from Outfall 002 on 01/07/09 and 01/08/09. 01/07/09 Test results: TSS=23.0 mg/L, BOD_5=17.7 mg/L, NH_3 Total=6.86 mg/L 01/08/09 Test results: TSS=23.7 mg/L, BOD_5=15.2 mg/L, NH_3 Total=2.98 mg/L

Notes:
BOD = biochemical oxygen demand
COD = chemical oxygen demand
LOTT = LOTT Clean Water Alliance
MG = million Gallons
MGD = million Gallons per Day
mg/L = milligrams per Liter
mpn = most probable number
NH_3 = ammonia
orgs = organisms
TSS = total suspended solids

Table 4-8
Summary of Key Documents – Municipal Stormwater Discharges

Date	Title or Description	Author	Prepared For	Notes
1995	Budd Inlet – Deschutes River Watershed Action Plan	Thurston County Advance Planning	Thurston County and Ecology	General information and action items related to wastewater and stormwater management
2003	City of Olympia Storm and Surface Water Plan	City of Olympia	City of Olympia	Current city stormwater management plan, describes city system in relation to LOTT Clean Water Alliance system
2009	City of Olympia Drainage Design and Erosion Control Manual	City of Olympia	City of Olympia	Provides requirements for design of drainage facilities and erosion control for new development and redevelopment projects to meet NDPES Phase II Permit requirements
2010	City of Olympia Geographic Information System Basin Analysis 2010	City of Olympia	City of Olympia	Summary of technical evaluation of drainage basin characteristics

Table 4-9
Stormwater Solids D/F TEQ Results

Sub-Basin	Sample	Pre-Cleanout D/F TEQ (ng/kg)	Post-Cleanout D/F TEQ (ng/kg)
A	A08CB	164	157
	A02CB	1,960	257
B	B27CB	2,020	438
C	C-101MH	3.8	NR
	SB#2	7.9	NR
	C-01MH	6.3	NR
I	I-01CB	4.2	NR

Notes:
There are no regulatory criteria applicable to in-place storm drain solids.
D/F = dioxin and furans
ng/kg = nanograms per kilogram
TEQ = toxic equivalency
NR = not re-tested

Table 4-10
Stormwater 2,3,7,8-TCDD Concentrations

Sub-Basin	Sample	Event 1- Jan 2012 (pg/L)[1]	Event 2- May 2012 (pg/L)[1]
A	A01	1.1 J	1.11 U
B	B01	0.206 JEMPC	1.74 U

Notes:
1 Only 2,3,7,8-TCDD was analyzed
J = estimated value less than reporting limit
U = not detected at reporting limit shown
pg/L = picogram per liter
EMPC = estimated maximum potential concentration (ion ratios do not meet method criteria)

Table 4-11

Summary Nearshore Property Use and Cleanup Sites

Nearshore Cleanup Sites	Former Property Name/Operators	Historical Use /Operations	Investigation/Cleanup Status	Potential Contaminants	Groundwater Source Potential	Sources
Port Peninsula						
Cascade Pole	Georgia Pacific Plywood Company	Wood treatment facility	Multiple interim actions have been implemented including the removal of contaminated sediment and soil. Soil, sediment and Groundwater investigations conducted (1986 to 2011). Groundwater treatment system for NAPL recovery installed. Slurry wall installed to limit off- site groundwater migration. Ongoing long term groundwater, upland cap and post remediation sediment monitoring.	PAHs, PCP, and D/Fs	Groundwater monitoring results are in compliance with remediation goals	Ecology 2004; SAIC 2008, Landau 2011a and b, AGI 1986
East Bay Redevelopment Site	Olympia, Veneer Company, St. Paul and Tacoma Lumber Company	Wood processing, plywood manufacturing, milling operations, warehouse and storage	VCP in 2007, AO with Ecology in 2011 required RI/FS cleanup of the site	TPHs, cPAHs, D/Fs, and metals	No complete and significant groundwater exposure pathways were identified	PIONEER 2011,GeoEngineers 2007; GeoEngineers and PIONEER 2008; Greylock 2008
LOTT Treatment Plant	NA	Wastewater treatment plant	Soil and groundwater investigated in 1989	VOCs, SVOCs, pesticides, PCBs, phenols, and metals	No soil exceedences. No groundwater COCs exceeded the primary drinking water MCLs	Parametrix 1990
West Bay						
Westbay Marina	Buchanan Lumber Company	Lumber mill, veneer plant, boatyard, marina, hog fuel burner was located on site	The Westbay Marina entered the VCP in 1999 to clean up a petroleum release from a UST. It is currently under an AO between Ecology and Westbay Marina Associates.	Arsenic, copper, nickel, zinc, and, D/Fs	In 2009 intertidal groundwater seep results slightly exceeded marine surface water criteria for copper, nickel, zinc, and arsenic	Hart Crowser 2011, Stemen Environmental 1999, Anchor QEA 2009 and 2010, Hart Crowser 2011, Ecology 2008a
Hardel Mutual Plywood	Buchanan Lumber Company	Hog fuel burner, former plywood manufacturing. Potential wood waste landfill waterside of property	Currently under an AO with Ecology for an RI/FS cleanup, FS completed in 2009. Interim Action cleanup of TPH contamination in soil and groundwater and decommissioning of six monitoring wells conducted in 2010. Ongoing groundwater monitoring.	TPH-D, TPH-HO, and cPAHs, and NAPL	First quarter results of monitoring indicate site is incompliance with MTCA requirements	Ecology 2007a, SAIC 2008, Stemen 2004, Greylock 2008, Greylock 2011
Reliable Steel	Brown-Minneapolis Tank Northwest	Former lumber mill, currently used for boat building, welding, and steel fabrication	This site is currently under an AO between Ecology and Bojo Investments for an RI/FS cleanup.	TPHs, arsenic, copper, and heavy metals	TPH and heavy metals exceeded MTCA cleanup levels in soil and groundwater	Ecology 2007b, SAIC 2008
Industrial Petroleum Distributors	ARCO, Richfield Oil Company, Ordel Oil	Bulk petroleum distribution facility	Several investigations were conducted over the past 13 years. The upland area was issued a "No Further Action" on June 25 2003 by Ecology. Discharge pipe to Budd Inlet, closed after spill in early 1980s, tank decommission in 1992	TPHs, arsenic, and lead	TPH arsenic, and lead detected in groundwater at concentrations above MTCA Method A screening levels	SECOR 2001, 2007; Parametrix 2004, Arcadis 2010, 2012
Solid Wood Incorporated (West Bay Park)	Unknown	Former lumber mill that includes an old BNSF rail spur	Phase II Environmental Site Assessment in 2007. Under an AO to clean up contaminated soil and groundwater. Interim cleanup action included excavation of TPH-D, TPH-HO, and cPAH-contaminated soils in 2009 followed by 1 year of quarterly groundwater monitoring. The park opened in July 2010. A remedial investigation to determine the full extent of contamination is underway.	TPH-D, TPH-HO, and cPAHs	Need latest groundwater monitoring results from City of Olympia	Parametrix 2008, Anchor QEA 2011

Notes:
AO = Agreed Order
BNSF = Burlington Northern Santa Fe
COCs = contaminates of concern
MCL = minimum cleanup level
cPAH = carcinogenic polycyclic aromatic hydrocarbons
MTCA = Model Toxics Control Act
NA = not applicable
NAPL = nonaqueous phase liquid
PAH = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
PCP = pentachlorophenol
RI/FS = Remedial Investigation/ Feasibility Study
SVOCs = semivolatile organic compounds
TPH = total petroleum hydrocarbons
  -D = diesel
  -G = gasoline
  -HO = heavy oil
VCP = Ecology's Voluntary Cleanup Program
VOCs = volatile organic compounds

Table 4-12
Groundwater Summary

Event	Source	Number of Wells	Chemicals Analyzed	Last Date sampled	Type of sampling
Cascade Pole Site					
Remedial Investigation Cascade Pole Company	AGI 1986	20	PAHs and PCP	1986	Well
August 2011 Long-Term Groundwater Compliance Monitoring	Landau Associates 2011	14	PAHs, PCP, TPH-G, TPH-D, and TPH-HO	Aug-2011	Well/ Piezometer
East Bay Redevelopment Site					
Remedial Investigation Work Plan East Bay Redevelopment	GeoEngineers 2008	20	VOCs, BTEX, TPH, total and dissolved metals	Aug 2007	Well
Empirical Evaluation of the Potential for Soil Constituents to Migrate to Surface Water Via Groundwater at the East Bay Redevelopment Site	PIONEER 2011	6	VOCs, BTEX, TPH, total and dissolved metals	Jun 2009	Well
Technical Memorandum East Bay Redevelopment – Parcel 4 / Parcel 5 Interim Action Work Plan	Brown and Caldwell 2010	10	Nickel, cadmium, TPH-G, BTEX, total naphthalenes, D/Fs	Mar 2012	Well
Hardel Mutual Plywood					
Former Hardel Plywood Site Remedial Investigation Report	Greylock 2007	7	TPH-D, PAHs, phenols, pH, and salinity	Aug-2007	Well
Former Hardel Mutual Plywood Site Compliance Well Installation & First Round of Groundwater Monitoring	Greylock 2011	9	TPH-D and PAHs	Dec-2012	Well
LOTT Treatment Plant					
Soil and groundwater quality along the proposed LOTT Treatment Plant outfall alignment	Parametrix 1990	6	VOCs, SVOCs, pesticides, PCBs, phenols, and metals	1989	Well

Event	Source	Number of Wells	Chemicals Analyzed	Last Date sampled	Type of sampling
Solid Wood Incorporated Site (West Bay Park)					
Work Plan for Remedial Investigation/ Feasibility Study and Interim Action Solid Wood Incorporated Site	Parametrix 2008	30	TPH, cPAHs, BTEX, metals	2008	Push probe
Westbay Marina					
Remedial Investigation Westbay Marina	Hart Crowser 2011	3	Ammonia, total and dissolved metals, PCBs, SVOCs, TPH-G, TPH-D	2011	Well
Industrial Petroleum Distributors Site					
PB West Coast Products, LLC Remedial Investigation Report	ARCADIS 2012	17	VOCs, TPH, metals, cPAH	2011	Well/test pits

Notes:
BTEX = benzene, toluene, ethylbenzene, and xylene
cPAH = carcinogenic polycyclic aromatic hydrocarbons
PAH = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
PCP = pentachlorophenol
SVOCs = semivolatile organic compounds
TPH = total petroleum hydrocarbons
-D = diesel
-G = gasoline
-HO = heavy oil
VOCs = volatile organic compounds

Table 4-13
Other Potential Historical Source Sites

Nearshore Cleanup Sites	Former Property Name/ Operators	Historical Use /Operations	Investigation/Cleanup Status	Potential Contaminants	Sources
Port Peninsula					
Texaco	,	Former bulk petroleum operations	Unknown	Unknown	1924 Sanborn Map, Floyd and Snider 2005
Former municipal dump	Unknown	Municipal waste landfill used prior to 1950	Unknown	Unknown	Sanborn Maps, Tetra Tech 1988
One Tree Island Marina	Unknown	Unknown	Unknown	Unknown	Sandborns
Georgia-Pacific	Capitol Plywood Corporation, US Plywood Corporation, Washington Veneer Company	Former wood processing and milling operations, burner and hog fuel location	Unknown	Unknown	1924 Sanborn Map
Percival Landing	General Petroleum Corporation, Chevron, Standard Oil	Former bulk petroleum operations, currently cold storage and public space	Entered the VCP	Petroleum products	1924, 1968 Sanborn Map
Unocal/Hulco Bulk Plant Properties	Shell Oil, ARCO	Former bulk petroleum storage and operations,	In 1994 and 1995, the bulk facilities were decommissioned including removal of aboveground product lines, aboveground storage tanks, containment areas and tank pads, buildings, contaminated soil, and four underground storage tanks containing gasoline, diesel fuel, and waste oil. The site was proposed for de-listing from Ecology's Hazardous Sites List in 2003	Petroleum products	Ecology 2003
West Bay West Upland Area					
Dunlap Towing / Olympia Log Yard and West Bay Chip Reload	West Side Log Dump and Olympia Towing Company	Wood chipping and wood chip storage, and tug boat operations	Two small petroleum spills reported in 2004	Petroleum products	EDR Radius Map 2012
Delson Lumber Company	Olympia Forest Products	Lumber shipping and storage, underground storage tanks located on site	Independent Remedial Action Program under review for "No Further Action". Final cleanup report submitted to Ecology. Contaminated soil removed, however groundwater and soil were still found to be contaminated.	Petroleum products	EDR Radius Map 2012
South of Study Area					
Sloan Shipyard	Olympia Shipbuilding Company	Ship building	Unknown	Unknown	
Olympia Oil and Wood Products	Rockway Mill Wood Company, The Texas Company	Former bulk petroleum facility, wood waste disposal	Unknown	Unknown	

Nearshore Cleanup Sites	Former Property Name/ Operators	Historical Use /Operations	Investigation/Cleanup Status	Potential Contaminants	Sources
Hyak Lumber Company	Springer Mill Company	Former sewage plant, currently wood processing and milling operations	Unknown	Unknown	1947 Sanborn Map

Notes:
EDR = Environmental Data Resources
VCP = Ecology's Voluntary Cleanup Program