FOURTH FIVE-YEAR REVIEW REPORT FOR COMMENCEMENT BAY NEARSHORE/TIDEFLATS SUPERFUND SITE PIERCE COUNTY, WASHINGTON

Prepared by

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12/1/14

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Executive Summary

This is the fourth Five-Year Review (FYR) for the Commencement Bay Nearshore/Tideflats Superfund site (CB/NT site) located in Tacoma, Pierce County, Washington State. The triggering action for this statutory FYR was the signing of the previous FYR on December 23, 2009. This National Priorities List (NPL) site is divided into six Operable Units (OUs):

OU 01 Commencement Bay Nearshore/Tideflats Sediments;

OU 02 Asarco Tacoma Smelter Facility (currently renamed OU 20);

OU 03 Tacoma Tar Pits;

OU 04 Asarco Off-Property (referred to as Ruston/North Tacoma Study Area, currently renamed OU 22);

OU 05 Commencement Bay Nearshore/Tideflats Sources (associated with OU 01); and

OU 06 Asarco Sediments (referred to as Asarco Sediments/Groundwater, currently renamed OU 19).

For the CB/NT site, there are three separate project areas that are being managed as distinct sites. These project areas include the CB/NT Sediments and Sources (OU 01 and OU 05); the Asarco Smelter Facility and surrounding impacted areas (OU 20, OU 22, and OU 19); and the Tacoma Tar Pits (OU 03). The CB/NT Sediments OU (OU 01) includes eight contaminated sediment Problem Areas within six marine waterways. These Problem Areas consist of the Head and Mouth of Hylebos Waterway, the Sitcum Waterway, the St. Paul Waterway, the Middle Waterway, the Head and Mouth of Thea Foss Waterway, and the Wheeler-Osgood Waterway. The CB/NT Sediments OU also includes two non-time-critical removal actions known as the Olympic View Resource Area and the Occidental Site. The CB/NT Sources OU (OU 05) identifies and controls sources of contamination to the marine sediments associated with each of the eight Problem Areas. The CB/NT Sediments and Sources OUs are under one Record of Decision (ROD). The CB/NT Asarco OUs (OU 20, OU 22, and OU 19) are addressed by three RODs, and the Tacoma Tar Pits OU (OU 03) is addressed by one ROD. This FYR addresses all OUs except for CB/NT Sources (OU 05).

Cleanup of the OUs addressed in this FYR has been conducted by Responsible Parties under oversight by the U.S. Environmental Protection Agency (EPA).

For CB/NT Sources (OU 05), the Washington Department of Ecology (Ecology) is lead agency for CB/NT source control actions. The strategic relationship and importance of coordination between sediment cleanup and source control actions is described in Sections 5.1.5 and 5.2 of the CB/NT ROD (OU 01 and OU 05). The EPA and Ecology Source Control Strategy (EPA 1992) states that sediment cleanup will not be implemented until adequate source control efforts have been implemented to minimize the potential for sediment recontamination. The primary objective under CB/NT Sources (OU 05) was to control major sources of contamination to the waterways prior to implementation of sediment remediation in each of eight Problem Areas.

Source control completion in a Problem Area indicated that Ecology and EPA believed that source control measures were adequate for sediment remedial action to move forward in a Problem Area. This determination was documented in a Source Control Completion Report that was approved prior to remedy implementation in each of the eight Problem Areas. For CB/NT Sources (OU 05), known source control actions were implemented and deemed to be complete enough to begin sediment remediation, and thus, the protectiveness of those source control actions does not need to be re-evaluated in discussions for a separate OU (i.e., OU 05 Source Control) in EPA five-year reviews. Rather, any source control actions that are implemented under state or state-delegated programs [e.g., state MTCA cleanups, issuance of NPDES permits to individual permitees as well for the City of Tacoma's Municipal Separate Storm Sewer System (MS4)] at the site, including actions that require operations and maintenance or long-term monitoring or reporting activities, are the responsibility of the state. Similar to Superfund, state MTCA regulations (WAC 173-340-420) require a review of post-cleanup conditions and monitoring data that may be required at least every five years to ensure that human health and the environment are being protected. In addition, since approximately 2004, known remaining source control actions that require EPA Superfund regulatory oversight and affect the protectiveness of a completed sediment remedy in a problem area are discussed for each unique Problem Area. Additional details on the source control strategy are described in Section 4 of the 2004 five-year review for the CB/NT site.

The purpose of an FYR is to determine whether the remedy at a site is protective of human health and the environment. In addition, FYR reports identify issues or deficiencies found during the review, if any, and provide recommendations to address them.

Brief site descriptions are summarized below.

Commencement Bay Nearshore/Tideflats Sediments (OU 01)

The CB/NT Sediments OU 01 is located in Tacoma, Washington at the southern end of the main basin of Puget Sound (Figure 4-1). The site encompasses an active commercial seaport and includes 10-12 square miles of shallow water, shoreline, and adjacent land, most of which is highly developed and industrialized. The marine and estuarine portions of the site also support important recreational and tribal fisheries. The site is located in a tribal Usual and Accustomed fishing area.

Contaminants in the CB/NT area originate from both upland and in-water sources. Early industrial surveys conducted by the Tacoma-Pierce County Health Department (TPCHD) and the Port of Tacoma indicated that there are more than 281 active industrial facilities in the CB/NT area. With industrialization, the release of hazardous substances and waste materials into the environment resulted in alterations to the chemical quality of waters and sediments in many areas of the bay. Contaminants found in the nearshore area include arsenic, lead, zinc, cadmium, copper, mercury, and various organic compounds such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and phthalates.

The cleanup goal for the Commencement Bay problem areas is reduction of contaminant concentrations in sediments to levels that will support a healthy marine environment and will protect the health of people eating seafood from the bay[1,2]. The ROD designated biological test requirements and associated sediment chemical concentrations referred to as Sediment Quality Objectives (SQOs) in order to achieve this goal. SQOs for all problem chemicals were set based on an evaluation of the ecological and human health risks posed by these chemicals. The SQO for PCBs was based on the human health risk assessment. SQOs for all other chemicals were based on the ecological risk assessment because the ecologically-based cleanup levels were determined to be also protective of human health. A specific cleanup level/cleanup objective based on seafood tissue data was not a requirement identified in the ROD or ESDs for the site, and has not been derived as a performance standard for any of the response actions in Commencement Bay based on ARARs in the ROD. While the ROD and ESDs for the CB/NT site use the term "cleanup goal," it is clear that the intent of that language, with respect to the protection of the health of people eating seafood from the Bay, is that the term "cleanup goal" is synonymous with EPA's current terminology "remedial action objective (RAO)." Given that the term "RAO" is not used in EPA's decision documents for the site, the term "remedial objective" will be used in this FYR for discussion pertaining to the cleanup goal related to human health concerns. Recent fish tissue data for bioaccumulative chemicals have not been collected in Commencement Bay and evaluated, so it is not known whether contaminant levels in fish tissues have been reduced since the remedies have been implemented, particularly for PCBs (which have a human-health based Sediment Quality Objective).

The ROD selected a cleanup remedy that identified eight problem areas for sediment cleanup and allowed flexibility to use any one, or a combination of, five key elements in any particular area. As described in the Declaration and Section 10.2 of the ROD, these elements are: 1) site use restrictions to reduce potential human health exposure to site contamination, particularly ingestion of contaminated seafood, 2) source control to prevent recontamination of sediments and meet Applicable or Relevant and Appropriate Requirements (ARARs), 3) natural recovery for marginally contaminated sediments that are predicted to achieve acceptable sediment quality within a reasonable timeframe, 4) sediment remedial action to address sediments containing contamination that is expected to persist for unacceptable periods of time, using in-place capping, dredging/confined aquatic disposal, dredging/nearshore disposal, and dredging/upland disposal, and 5) source and sediment monitoring to characterize the effectiveness of source controls and identify whether additional actions are necessary to ensure that all necessary remedial actions have been undertaken in each problem area and to evaluate the effectiveness of the components of the remedy (including disposal sites and habitat mitigation/restoration areas) in achieving the sediment quality objectives and in relation to habitat function.

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[1] Since the CB/NT ROD (EPA 1989) for the Sediments and Source Control OUs was written prior to EPA's (1991, 1999) guidance on preparation of Proposed Plans and RODs, the short narrative statements defining "remedial action objectives" that are provided in recent RODs are not present in the CB/NT ROD.

[2] As described in the CB/NT ROD (EPA 1989; Declaration, p. 1), the overall goal of the selected remedy is "to protect the marine environment and thereby reduce associated public health concerns." The selected remedy "is protective of the marine environment and related human health concerns" (ROD; Declaration, p. 2). The subsequent PCB ESD (EPA 1997; p.4) reiterated that the cleanup goal for the Commencement Bay problem areas is to achieve reduction of contaminant concentrations in sediments [emphasis added] to levels that will support a healthy marine environment and will protect the health of people eating seafood from the Bay.

For each CB/NT Waterway Problem Area, and the two Non-Time-Critical Removal Action areas, a summary of issues, recommendations, and protectiveness statements is provided in the FYR Summary Form following this Executive Summary. The protectiveness statements are also provided below.

Commencement Bay Nearshore/Tideflats, Waterway Problem Areas and Removal Action Areas (OU 01)

For the Hylebos Waterway, the remedy is expected to be protective of human health and the environment upon completion. In the interim, remedial action construction completed to date has adequately addressed all exposure pathways that could result in unacceptable risks in those areas. Remedial action construction has been accomplished under the Head and Mouth of Hylebos Waterway Consent Decrees, whereas work being performed pursuant to the Occidental Site Administrative Order on Consent is at the end of Remedial Investigation and the beginning of the Feasibility Study. Also, work being performed at the Arkema site pursuant to a state MTCA Agreed Order is in the RI/FS phase, with EPA coordination and oversight.

For the Sitcum Waterway, the remedy has been successfully completed, and all required long-term monitoring efforts have been completed. The remedy remains protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.

For the St. Paul Waterway, the remedial actions have been successfully completed, and all required long-term monitoring efforts have been completed. The remedy remains protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.

For the Middle Waterway, all remedial actions have been completed, the remedy is currently protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled. In order for the remedy to be protective in the long-term, the Sediment Quality Objectives need to be met according to the timeframes established in the Middle Waterway Explanation of Significant Differences (ESDs), or any exceedances need to be shown to be biologically insignificant in all enhanced natural recovery (ENR) and natural recovery areas, and ICs must be fully implemented.

For the Olympic View Resource Area, the remedy is protective of human health and the environment. All long-term monitoring efforts have been completed, and exposure pathways that could result in unacceptable risks are being controlled.

For the Thea Foss and Wheeler-Osgood Waterways, the remedy is protective of human health and the environment. Sediment COC concentrations in the waterway have decreased since completing the sediment remedial actions, indicating that the caps installed in the waterway are stabilizing and performing as designed (no upward migration of contamination has been documented). Cap integrity monitoring, which includes visual and hydrographic survey work, indicates that capped and natural recovery areas are stabilizing and meeting performance criteria in much of the waterway. The capped and natural recovery areas in a large portion of the waterway are supporting benthic communities. Institutional controls have been put in place that enhance the long-term integrity of the remedy. The City of Tacoma has implemented an aggressive stormwater monitoring and source control program that has reduced contamination entering the waterway. That program is expected to continue into the foreseeable future.

Taken as a whole, the remedies for the Sediments OU are expected to be protective when completed. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in those areas. Until site remedial objectives are met [see Section 4.1.1], site use restrictions (i.e., fish and shellfish consumption advisories) shall remain in effect to limit human exposure to contaminated seafood. The absence of fish tissue contaminant data does not mean that the remedy is not protective (see EPA 2001, p. 4-14). Recent fish tissue data for bioaccumulative chemicals have not been collected in Commencement Bay and evaluated, so it is not known whether contaminant levels in fish tissues have been reduced since the remedies have been implemented, particularly for PCBs (which have a human-health based Sediment Quality Objective). Future fish tissue sampling results will be used along with other lines of evidence to evaluate protectiveness of the remedies in the long-term.

Commencement Bay Nearshore/Tideflats, Asarco Area (OUs 20, 22 and 19)

The Asarco portions of the CB/NT Superfund site consist of the Asarco Smelter Facility (Asarco Smelter; OU 20, also known as OU 2), which consists of the Smelter property and the slag peninsula; the Ruston/North Tacoma Study Area (Study Area; OU 22, also known as OU 4), which consists of contaminated properties in an approximate one-mile arc surrounding the smelter; and the Asarco Sediments/Groundwater (Asarco Sediments; OU 19, also known as OU 6), which encompasses the sediments offshore of the smelter and the Yacht Basin formed by the slag peninsula.

The Asarco Smelter is located along the Commencement Bay shoreline within the municipal boundaries of Ruston and Tacoma, Washington. The upland portion of the Smelter Facility is approximately 100 acres in size, and encompasses a 67-acre former smelter (currently being redeveloped) and a 23-acre slag breakwater peninsula. Operation of the Asarco smelter for over 95 years resulted in contamination, primarily with arsenic and lead, of the smelter site, offshore sediments, and the surrounding residential area.

For the Asarco Smelter, the remedy is expected to be protective of human health and the environment upon completion (i.e., once all redevelopment has been completed by Point Ruston LLC). In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in those areas. Exposure pathways that could result in unacceptable risks are being prevented because the site is being controlled by the developer during construction using best management practices as described in the Development and Occupancy Plan (Hydrometrics 2013b). For areas that have already been constructed, O&M requirements to maintain protectiveness are described in the Operation, Maintenance and Monitoring Plan (Hydrometrics 2013a). Within the next FYR period, EPA anticipates repairing the habitat basin and completing the armoring of the remaining portions of the slag peninsula shoreline that required armoring as part of the remedy in the ROD.

For the Asarco Ruston/North Tacoma Study Area, the remedy is protective of human health and the environment. The Expedited Response Action in 1989-91 at 10 non-residential high-use areas addressed immediate concerns. The subsequent removal/replacement of soils with concentrations above the action level brought long-term risk exposures within EPA's acceptable risk range. These cleanup actions were completed in 2012. Community protection measures, mostly educational in nature, are in place for those areas that have soil arsenic concentrations between the MTCA cleanup level of 20 ppm and the EPA action level of 230 ppm. Ecology has assumed responsibility for all future work, including properties where owners have refused sampling or cleanup.

For the Asarco Sediments, the remedy is expected to be protective of human health and the environment upon completion, once Point Ruston LLC and EPA have implemented the remedy for the Yacht Basin sediments. In the interim, remedial activities completed to date in the capped offshore sediments (i.e., where the remedy has been implemented) have adequately addressed all exposure pathways that could result in unacceptable risks in those areas.

Commencement Bay Nearshore/Tideflats, Tacoma Tar Pits (OU 03)

The Tacoma Tar Pits OU is located in Tacoma, Washington, within the Tacoma Tideflats industrial area near Commencement Bay. It is situated on a peninsula of land located between the Puyallup River and the Thea Foss Waterway, approximately three-quarters of a mile north of Interstate 5 (Figure 6-1). The total area of the site encompasses approximately 52 acres, and several active facilities are currently within the site boundaries including Simon Metals (a metals recycling business), the Northwest Detention Center (NWDC; an immigration detention facility), and a capped engineered waste pile and groundwater treatment plant constructed as part of the remedial action for the site.

Results of site investigations conducted in the 1980s indicated that soil, surface water, and groundwater across most of the site were contaminated with organic and inorganic contaminants from former onsite coal gasification plant operations and the recycling of automobiles and electrical transformers. The primary contaminants included metals, PAHs, PCBs, and various volatile organic compounds (VOCs), including benzene. Soil and surface water cleanup criteria have been achieved; in 1998, due to continued exceedances of the groundwater cleanup criteria, EPA directed the PRP to design and install a groundwater extraction and treatment system to treat on-site groundwater contamination (focused on benzene) and to prevent it from migrating off site and potentially impacting the Puyallup River. The groundwater extraction and treatment has been operating since 2002.

The results of this FYR indicate that the Tacoma Tar Pits remedy is functioning as intended and currently protects human health and the environment in the short-term because 1) sources of contamination (e.g., waste materials and contaminated soils) have been excavated, disposed of off site or treated and contained on site, 2) low permeability caps and surface water controls have been placed across critical areas of the site, 3) institutional controls that prohibit using site groundwater are in place, and 4) the groundwater extraction and treatment system has contained contaminated groundwater such that exposures are under control and there are no unacceptable risks to humans or the environment, e.g. contaminated site groundwater is not being used as, or migrating to, a drinking water source nor is it discharging to the downgradient Puyallup River.

However, in order for the remedy to remain protective over the long-term, the follow-up actions recommended in this report need to be implemented which include 1) continuing maintenance of the cap, cover and ancillary surface water drainage features, 2) optimizing all property owner compliance with institutional control requirements, and 3) continuing operation and optimization of the groundwater extraction, treatment and monitoring systems to reduce the size and concentration of the benzene-contaminated groundwater plume across the site.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Commencement Bay Nearshore/Tideflats (CB/NT)		
EPA ID: WAD980726368		
Region: 10	**State:** WA	**City/County:** Tacoma/Pierce County
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** No	
REVIEW STATUS		
Lead agency: EPA ***[If "Other Federal Agency", enter Agency name]*:**		
Author name (Federal or State Project Manager): Nancy Harney, Karen Keeley, Tamara Langton, Kevin Rochlin, Bill Ryan, Jonathan Williams		
Author affiliation: US EPA Region 10		
Review period: December 2013 to December 2014		
Date of site inspection: Ongoing at each waterway and/or each Operable Unit		
Type of review: Post-SARA		
Review number: Fourth		
Triggering action date: Previous FYR report signed on December 23, 2009		
Due date *(five years after triggering action date)*: December 23, 2014		

Five-Year Review Summary Form (continued)

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
Asarco Smelter (OU 20)

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
Ruston/North Tacoma Study Area (OU 22)

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
Asarco Sediments (OU 19)

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 01, CB/NT Sediments	**Issue Category: Monitoring**			
	Issue: Recent fish tissue data for bioaccumulative chemicals have not been collected in Commencement Bay. Thus, it is not known whether contaminant levels in fish tissues have been reduced since the remedies have been implemented, particularly for PCBs (which have a human-health based Sediment Quality Objective), and whether fish advisories should be continued, modified, or removed.			
	Recommendation: Develop and implement a Quality Assurance Project Plan, including a sampling plan for collection and analysis of bay-wide fish tissue data for bioaccumulative chemicals (particularly for PCBs, which have a human-health based Sediment Quality Objective). Provide results to appropriate state and local agencies to evaluate protectiveness of health-based fish consumption advisories for Commencement Bay.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	December 2019

Five-Year Review Summary Form (continued)

OU(s): 03, Tacoma Tar Pits	**Issue Category: Remedy Performance**			
	Issue: Benzene concentrations in the groundwater plume within the sand aquifer continue to exceed ROD criterion across the site.			
	Recommendation: Evaluate and address issues related to benzene exceedances and make recommendations for optimizing the groundwater extraction and treatment (GWET) system and the groundwater monitoring systems to reduce the benzene plume.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	December 2019

OU(s): 03, Tacoma Tar Pits	**Issue Category: Remedy Performance**			
	Issue: The ROD groundwater remedy and RAOs focused on treatment and containment of the contaminated plume, but do not appear to have considered groundwater restoration.			
	Recommendation: Evaluate whether groundwater restoration at this site is feasible and necessary to 1) comply with ARARs, CERCLA, and EPA's CERCLA groundwater policies, and 2) ensure long-term protectiveness.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	December 2019

OU(s): 03, Tacoma Tar Pits	**Issue Category: Institutional Controls**			
	Issue: Property owner compliance with site institutional control requirements is not optimal.			
	Recommendation: Request site property owners to comply with all Consent Decree conveyance of site/institutional control requirements. Voluntary compliance with the state of Washington's Uniform Environmental Covenants Act (UECA) should also be requested to ensure the long-term effectiveness of site institutional controls.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Other	EPA	December 2019

Five-Year Review Summary Form (continued)

Protectiveness Statement(s)
Include each individual OU protectiveness determination and statement. If you need to add more protectiveness determinations and statements for additional OUs, copy and paste the table below as many times as necessary to complete for each OU evaluated in the FYR report.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
01, CB/NT Sediments	Will be Protective	Click here to enter date.
Protectiveness Statement: Taken as a whole, the remedies for the Sediments OU are expected to be protective when completed. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in those areas. Until site remedial objectives are met (see Section 4.1.1), site use restrictions (i.e., fish and shellfish consumption advisories) shall remain in effect to limit human exposure to contaminated seafood. The absence of fish tissue contaminant data does not mean that the remedy is not protective (see EPA 2001, p. 4-14). Recent fish tissue data for bioaccumulative chemicals have not been collected in Commencement Bay and evaluated, so it is not known whether contaminant levels in fish tissues have been reduced since the remedies have been implemented, particularly for PCBs (which have a human-health based Sediment Quality Objective). Future fish tissue sampling results will be used along with other lines of evidence to evaluate protectiveness of the remedies in the long-term. Please note that protectiveness statements for each Problem Area Waterway (e.g., Hylebos, Sitcum, St. Paul, Middle, Thea Foss, and Wheeler-Osgood Waterways) and the removal action are provided in Section 8.		

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU 20, Asarco Smelter	Will be Protective	Click here to enter date.
Protectiveness Statement: The remedy is expected to be protective of human health and the environment upon completion (i.e., once all redevelopment has been completed by Point Ruston LLC). In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in those areas. Exposure pathways that could result in unacceptable risks are being prevented because the site is being controlled by the developer during construction using best management practices as described in the Development and Occupancy Plan (Hydrometrics 2013b). For areas that have already been constructed, O&M requirements to maintain protectiveness are described in the Operation, Maintenance and Monitoring Plan (Hydrometrics 2013a). Within the next FYR period, EPA anticipates repairing the habitat basin and completing the armoring of the remaining portions of the slag peninsula shoreline that required armoring as part of the remedy in the ROD.		

Five-Year Review Summary Form (continued)

Operable Unit: **_OU 22, Ruston/North Tacoma Study Area_**	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* Click here to enter date.

Protectiveness Statement:
The remedy is protective of human health and the environment. The Expedited Response Action in 1989-91 at 10 non-residential high-use areas addressed immediate concerns. The subsequent removal/replacement of soils above the action level brought long-term risk exposures within EPA's acceptable risk range. These cleanup actions were completed in 2012. Community protection measures, mostly educational in nature, are in place for those areas that have soil arsenic concentrations between the MTCA cleanup level of 20 ppm and the EPA action level of 230 ppm. Ecology has assumed responsibility for all future work, including properties where owners have refused sampling or cleanup.

Operable Unit: **OU 19, Asarco Sediments**	*Protectiveness Determination:* Will be Protective	*Addendum Due Date (if applicable):* Click here to enter date.

Protectiveness Statement:
The remedy is expected to be protective of human health and the environment upon completion, once Point Ruston LLC and EPA have implemented the remedy for the Yacht Basin sediments. In the interim, remedial activities completed to date in the capped offshore sediments (i.e., where the remedy has been implemented) have adequately addressed all exposure pathways that could result in unacceptable risks in those areas.

Operable Unit: **03, Tacoma Tar Pits**	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):* Click here to enter date.

Protectiveness Statement:
The results of this FYR indicate that the Tacoma Tar Pits remedy is functioning as intended and currently protects human health and the environment in the short-term because 1) sources of contamination (e.g., waste materials and contaminated soils) have been excavated, disposed of off site or treated and contained on site, 2) low permeability caps and surface water controls have been placed across critical areas of the site, 3) institutional controls that prohibit using site groundwater are in place, and 4) the groundwater extraction and treatment system has contained contaminated groundwater such that exposures are under control and there are no unacceptable risks to humans or the environment, e.g. contaminated site groundwater is not being used as, or migrating to, a drinking water source nor is it discharging to the downgradient Puyallup River. However, in order for the remedy to remain protective over the long-term, the follow-up actions recommended in this report need to be implemented which include 1) continuing maintenance of the cap, cover and ancillary surface water drainage features, 2) optimizing all property owner compliance with institutional control requirements, and 3) continuing operation and optimization of the groundwater extraction, treatment and monitoring systems to reduce the size and concentration of the benzene-contaminated groundwater plume across the site.

Five-Year Review Summary Form (continued)

Sitewide Protectiveness Statement (not applicable)	
For sites that have achieved construction completion, enter a sitewide protectiveness determination and statement.	
Protectiveness Determination: Choose an item.	*Addendum Due Date (if applicable):* Click here to enter date.
Protectiveness Statement: Click here to enter text.	

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OU 01 Attachments

Acronyms and Abbreviations

AET	Apparent Effects Threshold
AKART	All Known, Available, and Reasonable Treatment
AOC	Administrative Order on Consent
APP	Associated Petroleum Products
ARAR	Applicable or Relevant and Appropriate Requirement
BBP	benzyl butyl phthalate
BEHP	bis(2-ethylhexyl)phthalate (also known as di(2-ethylhexyl)phthalate; DEHP)
BMP	best management practice
BNRR	Burlington Northern Railroad
BNSF	Burlington Northern/Santa Fe
CB/NT	Commencement Bay Nearshore/Tideflats
CD	Consent Decree
CDF	confined disposal facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFAWQC	chronic freshwater ambient water quality criteria
CFR	Code of Federal Regulations
CHB	Citizens for a Healthy Bay
COC	contaminant of concern
CSC	Correctional Services Corporation
CSI	Comprehensive Supplemental Investigation
CSL	cleanup screening level
CSM	Conceptual Site Model
cy	cubic yards
DDT	dichlorodiphenyltrichloroethane
DMMP	Dredged Material Management Program
DNAPL	Dense, non-aqueous phase liquid
DNR	Washington State Department of Natural Resources
DOF	Dalton, Olmsted & Fuglevand, Inc.
DOH	Washington State Department of Health
E&E	Ecology and Environment
Ecology	Washington State Department of Ecology
ENR	enhanced natural recovery
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESD	Explanation of Significant Differences
FS	Feasibility Study
FWDA	Foss Waterway Development Authority
FYR	Five-Year Review
GCL	geocomposite clay liner
gpm	gallons per minute
HCC	Hylebos Cleanup Committee
HDPE	high-density polyethylene
HPAH	high molecular weight polycyclic aromatic hydrocarbons
IA	Interagency Agreement

IC	Institutional Control
IDDE	illicit discharge detection and elimination
JS&S	Joseph Simon & Sons
LMRP	Long-term Monitoring and Reporting Plan
LPAH	low molecular weight polycyclic aromatic hydrocarbon
LTMP	Long-Term Monitoring Plan
LWD	large woody debris
MAROS	Monitoring and Remediation Optimization Software
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
MLLW	mean lower low water
MOU	Memorandum of Understanding
MTCA	Model Toxics Control Act (of Washington State)
MWAC	Middle Waterway Action Committee
MWQC	marine water quality criteria
NCDF	nearshore confined disposal facility
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NWDC	Northwest Detention Center
O&M	Operation and Maintenance
OMMP	Operations, Maintenance, and Monitoring Plan
OCF	onsite containment facility
OF	Outfall
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
OVRA	Olympic View Resource Area
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	Perchloroethylene or tetrachloroethene
PDT	Project Delivery Team
PLC	Programmable Logic Controller
POTW	Publicly-Owned Treatment Works
ppm	parts per million
ppt	parts per trillion
PRG	Preliminary Remediation Goal
PRP	Potentially Responsible Party
PSE	Puget Sound Energy
PSWQA	Puget Sound Water Quality Authority
PVC	polyvinyl chloride
RA	Remedial Action
RAOs	Remedial Action Objectives
RACR	Remedial Action Construction Report
RCRA	Resource Conservation and Recovery Act

RCW	Revised Code of Washington
RD	Remedial Design
RI/FS	Remedial Investigation/Feasibility Study
RNA	regulated navigation area
ROD	Record of Decision
RPD	Redox potential discontinuity
RPM	Remedial Project Manager
RSE	Remedial Systems Evaluation
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SMA	Sediment Management Area
SMS	Sediment Management Standards
SMU	Sediment Management Unit
SOW	Statement of Work
SPI	Sediment Profile Imaging
SQO	Sediment Quality Objective
SQS	Sediment Quality Standard
SR	State Route (i.e., State Highway)
SRAL	Sediment Remedial Action Level
SSPM	stormwater suspended particulate matter
SVOC	Semi-volatile organic compounds
SW	Surface water
SWPO	Shellfish and Water Protection Office
TBC	To Be Considered
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxicity Equivalent Quotient
TIC	Temporary impermeable cap
TSCA	Toxic Substances Control Act
TPCHD	Tacoma-Pierce County Health Department
TPH	total petroleum hydrocarbon
TSP	Tacoma Smelter Plume
UAO	Unilateral Administrative Order
UECA	Uniform Environmental Covenants Act
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USEPA	U. S. Environmental Protection Agency (also EPA)
USFWS	U. S. Fish and Wildlife Service
VCP	Voluntary Cleanup Program (Washington State Department of Ecology)
VOC	volatile organic compound
WAC	Washington Administrative Code
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
$\mu g/m^3$	Micrograms per meter cubed

COMMENCEMENT BAY NEARSHORE/TIDEFLATS
SUPERFUND SITE
TACOMA, WASHINGTON

1. Introduction

The Commencement Bay Nearshore/Tideflats Superfund site (CB/NT site) is located in Tacoma, Pierce County, Washington at the southern end of the main basin of Puget Sound. This National Priorities List (NPL) site is divided into six Operable Units (OUs):

OU 01 Commencement Bay Nearshore/Tideflats Sediments.

OU 02 Asarco Tacoma Smelter Facility (currently renamed OU 20).

OU 03 Tacoma Tar Pits.

OU 04 Asarco Off-Property (referred to as Ruston/North Tacoma Study Area, currently renamed OU 22).

OU 05 Commencement Bay Nearshore/Tideflats Sources.

OU 06 Asarco Sediments (currently renamed Asarco Sediments/Groundwater OU 19).

For the CB/NT site, there are three separate project areas that are being managed as distinct sites. These project areas include the Commencement Bay Nearshore/Tideflats Sediments and Sources (OU 01 and OU 05); the Asarco Smelter Facility and surrounding impacted areas (OU 20, OU 22, and OU 19); and the Tacoma Tar Pits (OU 03).

The CB/NT Sediments OU (OU 01) includes the following eight contaminated sediment Problem Areas within six marine waterways: Head and Mouth of Hylebos Waterway, Sitcum Waterway, St. Paul Waterway, Middle Waterway, Head and Mouth of Thea Foss (formerly City) Waterway, and Wheeler-Osgood Waterway. The CB/NT Sediments OU also includes two non-time-critical removal actions known as the Olympic View Resource Area and the Occidental Site. The CB/NT Sources OU (OU 05) identifies and controls sources of contamination to the marine sediments associated with each of the eight Problem Areas. The CB/NT Sediments and Sources OUs are under one Record of Decision (ROD) (EPA 1989).

The CB/NT Asarco OUs (OU 20, OU 22, and OU 19) are addressed by three RODs (EPA 1995, EPA 1993, and EPA 2003, respectively), and the Tacoma Tar Pits OU (OU 03) is addressed by one ROD[3] (EPA 1987). This Five-Year Review (FYR) addresses all OUs, except for CB/NT Sources.

3 In the Tacoma Tar Pits ROD, the Tacoma Tar Pits site is identified as OU 23. For this fourth FYR, it will be referred to as OU 03.

Cleanup of the OUs addressed in this FYR has been conducted by Responsible Parties, under oversight by the U.S. Environmental Protection Agency (EPA). For CB/NT Sources (OU 05), the Washington Department of Ecology (Ecology) is the lead regulatory agency for CB/NT source control actions. The strategic relationship and importance of coordination between sediment cleanup and source control actions is described in Sections 5.1.5 and 5.2 of the CB/NT ROD (OU 01 and OU 05).

The EPA and Ecology "Source Control Strategy, Commencement Bay Nearshore/Tideflats Superfund Site" (EPA/Ecology May 1992) states that sediment cleanup will not be implemented until adequate source control efforts have been implemented to minimize the potential for sediment recontamination. The primary objective under CB/NT Sources (OU 05) was to control major sources of contamination to the waterways prior to implementation of sediment remediation in each of eight Problem Areas. Source control completion in a Problem Area indicated that Ecology and EPA believed that source control measures were adequate for sediment remedial action to move forward in a Problem Area. This determination was documented in a Source Control Completion Report that was approved prior to remedy implementation in each of the eight Problem Areas. For CB/NT Sources (OU 05), known source control actions were implemented and deemed to be complete enough to begin sediment remediation, and thus, the protectiveness of those source control actions does not need to be re-evaluated in discussions for a separate OU (i.e., OU 05 Source Control) in EPA five-year reviews. Rather, any source control actions that are implemented under state or state-delegated programs (e.g., state MTCA cleanups, issuance of NPDES permits to individual permitees as well for the City of Tacoma's Municipal Separate Storm Sewer System [MS4]) at the site, including actions that require operations and maintenance or long-term monitoring or reporting activities, are the responsibility of the state. Similar to Superfund, state MTCA regulations (WAC 173-340-420) require a review of post-cleanup conditions and monitoring data that may be required at least every five years to ensure that human health and the environment are being protected. In addition, since approximately 2004, known remaining source control actions that require EPA Superfund regulatory oversight and affect the protectiveness of a completed sediment remedy in a problem area are discussed for each unique Problem Area. Additional details on the source control strategy are described in Section 4 of the 2004 five-year review for the CB/NT site.

The purpose of a FYR is to evaluate the implementation and performance of a remedy in order to determine if the remedy at a site remains protective of human health and the environment. In addition, FYR reports identify issues or deficiencies found during the review, if any, and document recommendations to address them.

The EPA is preparing this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121 and the National Contingency Plan (NCP). CERCLA §121(c) states:

> *"If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon*

> *such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews."*

EPA interpreted this requirement further in the NCP, at 40 Code of Federal Regulations (CFR) §300.430(f)(4)(ii), which states:

> *"If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action."*

EPA Region 10 conducted this FYR on the remedy implemented at the CB/NT Site. EPA is the lead agency for developing and implementing the remedy for the site.

This is the fourth FYR for the CB/NT Site. The triggering action for this statutory review is the completion date of the previous FYR. This FYR was conducted from December 2013 through November 2014. This report documents the results of the review. For this FYR, the U.S. Army Corps of Engineers (USACE), Seattle District, provided support to EPA under an Interagency Agreement. Also, for some portions of the site, Responsible Parties conducted analyses in support of the FYR, which are described in unique sections below.

2. Site Chronology

Information for this section is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

3. Background

3.1. Site Location and Description

Information for this section is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

3.2. Land and Resource Use

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

In March 2013, EPA compiled information on habitat restoration and mitigation projects within the general Commencement Bay area. Figure 3-1 shows restoration and mitigation projects that were completed or were underway in the Commencement Bay area prior to June 2010. Some proposed mitigation and restoration projects are also shown on the map. Certain mitigation and restoration projects that are located further upstream of the Puyallup River (e.g., 96th Street Oxbow, Sportsman Oxbow, Old soldiers Home, Pioneer Way, Sha Dadx) remain in the .kmz file maintained by EPA, but are not depicted in the Commencement Bay Area (Figure 3-1). Data regarding the specific projects and boundaries are considered estimates, and for any official agency decision, the agency shall rely upon the original source of data or information, not the .pdf file or .kmz file, as the basis for that decision.

The Tacoma Tar Pits site and surrounding area is located within the city limits of Tacoma, in the industrialized tide flats where the Puyallup River discharges to Commencement Bay on Puget Sound. The site and adjacent properties are zoned as "PMI – Port Maritime Industrial." The site is currently occupied by the following businesses: 1) Simon Metals, a metals recycling business, 2) the Northwest Detention Center (NWDC), an immigration detention facility located on the former Hygrade meat packing plant property, 3) Tri-Pak, a transloading facility, 4) Burlington Northern Railroad (BNRR) and Union Pacific Railroad (UPRR) rail lines, 5) a Puget Sound Energy (PSE) natural gas regulation station, 6) an Associated Petroleum Products (APP) card lock fueling station, and 7) a portion of the City of Tacoma's vactor facility along Cleveland Way, which was established in that location during the period of this FYR.

3.3. History of Contamination

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

3.4. Initial Response

3.4.1. Commencement Bay Nearshore/Tideflats Sediments

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

3.4.2. Asarco Area

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

3.4.3. Tacoma Tar Pits

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

3.5. Basis for Taking Action

3.5.1. Commencement Bay Nearshore/Tideflats Sediments

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

3.5.2. Asarco Area

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

3.5.3. Tacoma Tar Pits

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4. Remedial Actions and Five-Year Review Process for CB/NT Sediments Operable Unit 01 ("Problem Area Waterways")

4.1. Remedy Selection

EPA issued the CB/NT ROD in September 1989. EPA selected a remedial action for the following eight of nine sediment Problem Areas that were identified during the RI/FS: 1) Mouth of Hylebos Waterway, 2) Head of Hylebos Waterway, 3) Sitcum Waterway, 4) St. Paul Waterway, 5) Middle Waterway, 6) Head of Thea Foss Waterway, 7) Mouth of Thea Foss Waterway, and 8) Wheeler-Osgood Waterway (see Figure 4-1). The ninth problem area, the sediments (OU 19) offshore from the Asarco Tacoma Smelter, was addressed in a separate ROD signed in July 2000.

4.1.1. Cleanup Objectives

Information for this section is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt. The cleanup goal for the Commencement Bay problem areas is reduction of contaminant concentrations in sediments to levels that will support a healthy marine environment and will protect the health of people eating seafood from the bay. As described in the CB/NT ROD (EPA 1989; Declaration, p. 1), the overall goal of the selected remedy is "to protect the marine environment and thereby reduce associated public health concerns." The selected remedy "is protective of the marine environment and related human health concerns" (EPA 1989; Declaration, p. 2). The subsequent PCB ESD (EPA 1997; p.4) reiterated that the cleanup goal for the Commencement Bay problem areas is to achieve reduction of contaminant concentrations in sediments [emphasis added] to levels that will support a healthy marine environment and will protect the health of people eating seafood from the Bay.

The ROD designated biological test requirements and associated sediment chemical concentrations referred to as Sediment Quality Objectives (SQOs) in order to achieve this goal (see Table 4-1 below).

Table 4-1. Sediment Cleanup Levels, identified as Sediment Quality Objectives

Chemical	Sediment Quality Objective [1, 4, 5, 6]
Metals (mg/kg dry weight; ppm)	
Antimony	150 B
Arsenic	57 B
Cadmium	5.1 B
Copper	390 L
Lead	450 B
Mercury	0.59 L
Nickel	140 A,B
Silver	6.1 A

Table 4-1. Sediment Cleanup Levels, identified as Sediment Quality Objectives (continued)

Chemical	Sediment Quality Objective [1, 4, 5, 6]
Zinc	410 B
Organic Compounds (µg/kg dry weight; ppb)	
Low Molecular Weight PAH	5,200 L
Naphthalene	2,100 L
Acenaphthylene	1,300 A,B
Acenaphthene	500 L
Fluorene	540 L
Phenanthrene	1,500 L
Anthracene	960 L
2-Methylnaphthalene	670 L
High Molecular Weight PAH	17,000 L
Fluoranthene	2,500 L
Pyrene	3,300 L
Benz(a)anthracene	1,600 L
Chrysene	2,800 L
Benzofluoranthenes	3,600 L
Benzo(a)pyrene	1,600 L
Indeno(1,2,3-c,d)pyrene	690 L
Dibenzo(a,h)anthracene	230 L
Benzo(g,h,i)perylene	720 L
Chlorinated Organic Compounds	
1,3-Dichlorobenzene	170 A,L
1,4-Dichlorobenzene	110 B
1,2-Dichlorobenzene	50 L, B
1,2,4-Trichlorobenzene	51 A
Hexachlorobenzene (HCB)	22 B
Total PCBs	300 [2, 3]
Phthalates	
Dimethyl phthalate	160 L
Diethyl phthalate	200 B

Table 4-1. Sediment Cleanup Levels, identified as Sediment Quality Objectives (continued)

Chemical	Sediment Quality Objective [1, 4, 5, 6]	
Di-n-butyl phthalate	1,400	A,L
Butyl benzyl phthalate	900	A,B
Bis(2-ethylhexyl)phthalate	1,300	B
Di-n-octyl phthalate	6,200	B
Phenols		
Phenol	420	L
2-Methylphenol	63	A,L
4-Methylphenol	670	L
2,4-Dimethylphenol	29	L
Pentachlorophenol	360	A
Miscellaneous Extractables		
Benzyl alcohol	73	L
Benzoic acid	650	L,B
Dibenzofuran	540	L
Hexachlorobutadiene	11	B
N-nitrosodiphenylamine	28	B
Volatile Organics		
Tetrachloroethene	57	B
Ethylbenzene	10	B
Total xylenes	40	B
Pesticides		
P,P' – DDE	9	B
P,P' – DDD	16	B
P,P' – DDT	34	B

Source: CB/NT ROD (EPA 1989; Section 7.2.4 and Table 5) and CB/NT ESD (EPA 1997). The CB/NT ROD established sediment cleanup levels, called Sediment Quality Objectives (SQOs). Note that Table 5 of the CB/NT ROD refers to Sediment Cleanup Objectives in error; the correct term is Sediment Quality Objectives, as referenced in Section 7.2.4 of the ROD.

1. These values (except for total PCBs) represent the lowest AET for the three biological effects indicators:
   - A - amphipod mortality bioassay (acute test)
   - L - oyster larvae abnormality bioassay (acute test)
   - B - benthic infauna (chronic test)

2. The CB/NT ROD (1989) identified the Sediment Quality Objective for total PCBs as 1,000 µg/kg for the protection of benthic organisms (ecological risk assessment) and 150 µg/kg for protection of human health (seafood consumption;

Table 4-1. Sediment Cleanup Levels, identified as Sediment Quality Objectives (continued)

Chemical	Sediment Quality Objective [1, 4, 5, 6]
human health risk assessment). The CB/NT ESD (1997) modified the Sediment Quality Objective for total PCBs to 300 µg/kg, to be achieved within 10 years after cleanup through natural recovery processes. The ESD stated that post-cleanup average PCB concentrations are expected to be less than 150 µg/kg total in all waterways at the CB/NT site. This modified SQO of 300 µg/kg total PCBs was based on a re-evaluation of the human health risk assessment. [See Footnote 3].	
3. The CB/NT ESD (EPA 1997) stated: *The purpose of this Explanation of Significant Differences (ESD) is to modify the cleanup level for remediation of marine sediments contaminated with polychlorinated biphenyls (PCBs) at the Commencement Bay Nearshore/Tideflats (CB/NT) Superfund site. EPA's September 30, 1989, Record of Decision (ROD) for the CB/NT Site established cleanup levels, called Sediment Quality Objectives (SQOs), for several problem chemicals found to be causing adverse effects to human health and the environment at the CB/NT Site. The SQO for PCBs was set at 150 µg/kg (micrograms per kilogram) dry weight (DW). The ROD required that the SQOs be met within ten years after completion of sediment remedial action. The ROD predicted that, if sediments with PCB concentrations greater than a Sediment Remedial Action Level (SRAL) of 240 - 300 µg/kg PCBs were removed, the 150 µg/kg PCB SQO would be met in 10 years through natural recovery processes. With this ESD, EPA is modifying the PCB SRAL to 450 µg/kg, to be achieved during cleanup, and the PCB SQO to 300 µg/kg, to be achieved within 10 years after cleanup. Cleanup to 450 µg/kg is expected to result in a post-cleanup average PCB concentration of less than 150 µg/kg in all waterways at the CB/NT Site.*	
4. The CB/NT ROD and ESD should be consulted and relied upon for determination and use of SQOs for the CB/NT site.	
5. The CB/NT ROD (EPA 1989) also identifies sediment toxicity tests that may be used to override the SQOs, except for PCBs (human health-derived SQO), as indicated in Section 8.25 of the ROD: "When both biological and chemical test results are available for a particular sediment sampling station, the results of a particular biological test will outweigh the AET predictions of that biological effect based on chemistry."	
6. A specific cleanup level/cleanup objective based on seafood tissue data was not a requirement identified in the ROD or ESDs for the site, and has not been derived as a performance standard for any of the response actions in Commencement Bay based on ARARs in the ROD.	

SQOs for all problem chemicals were set based on an evaluation of the ecological and human health risks posed by these chemicals. The SQO for PCBs was based on the human health risk assessment. SQOs for all other chemicals were based on the ecological risk assessment because the ecologically-based cleanup levels were determined to be also protective of human health. A specific cleanup level/cleanup objective based on seafood tissue data was not a requirement identified in the ROD or ESDs for the site, and has not been derived as a performance standard for any of the response actions in Commencement Bay based on ARARs in the ROD. While the ROD and ESDs for the CB/NT site use the term "cleanup goal" it is clear that the intent of that language, with respect to the protection of the health of people eating seafood from the Bay, is that the term "cleanup goal" is synonymous with EPA's current terminology "remedial action objectives (RAO)." Given that the term "RAO" is not used in EPA's decision documents for the site, the term "remedial objective" will be used in this five-year review for discussion pertaining to the cleanup goal to related to human health concerns. As set forth in the 1997 ESD, the sediment cleanup for PCBs is expected to result in a post-cleanup average PCB concentration of less than 150 µg/kg[4] in all waterways at the CB/NT site, which was determined to be protective

4 The 1997 Explanation of Significant Differences (ESD) modified the cleanup level for remediation of marine sediments contaminated with polychlorinated biphenyls (PCBs) at the CB/NT site. The 1989 ROD established cleanup levels, called SQOs, for several problem chemicals found to be causing adverse effects to human health and

of human health. Based on the method described in the ESD, EPA calculated that a PCB SQO of 150 µg/kg would result in attainment of PCB concentrations in fish tissue similar to those in Puget Sound reference areas (36 µg/kg). Recent fish tissue data for bioaccumulative chemicals have not been collected in Commencement Bay and evaluated, so it is not known whether contaminant levels in fish tissues have been reduced since the remedies have been implemented, particularly for PCBs (which have a human-health based Sediment Quality Objective). Future fish tissue sampling results will be used along with other lines of evidence to evaluate protectiveness of the remedies in the long-term.

As described in the third FYR (EPA 2009), new information on Tribal seafood consumption rates and exposure durations for Tribal populations[5] became available during that period. EPA identified the consumption rates and exposure duration as new information that could impact the estimated risk associated with residual polychlorinated biphenyls (PCBs), which could call into question the long-term protectiveness of the remedy. The complete evaluation is provided in Section 4.2.6 of the third FYR. Based on EPA's evaluation in the third FYR, EPA believes that this new information neither calls into question the protectiveness of the remedy, nor requires any additional action at this time. EPA believes that the PCB sediment quality objective (SQO; 300 µg/kg), which was based on a human health risk assessment, remains protective.

Regarding the fish and shellfish tissue sampling program recommended in the third FYR (see Section 4.8 of this fourth FYR), it is important to clarify that a specific cleanup level/cleanup objective based on fish tissue data was not a requirement identified in the ROD, and has not been derived as a performance standard for any of the response actions in Commencement Bay based on ARARs in the ROD. However, Section 11.1 of the CB/NT ROD suggests that fish tissue contaminant levels are an important indicator of human health exposure, and specifies that site use restrictions, such as advisories that limit seafood consumption, will be implemented to protect human health until recovery is complete. Accordingly, in the previous FYRs for the CB/NT Site, EPA identified plans to conduct a fish tissue sampling program.

4.1.2. Selected Remedy

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

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the environment at the CB/NT Site. The SQO for PCBs was set at 150 µg/kg dry weight. The ROD required that the SQOs be met within ten years after completion of sediment remedial action. The ROD predicted that, if sediments with PCB concentrations greater than a Sediment Remedial Action Level (SRAL) of 240 - 300 µg/kg PCBs were removed, the 150 µg/kg PCB SQO would be met in 10 years through natural recovery processes. With the 1997 ESD, EPA modified the PCB SRAL to 450 µg/kg, to be achieved during cleanup, and the PCB SQO to 300 µg/kg, to be achieved within 10 years after cleanup, and EPA stated that the cleanup to 450 µg/kg is expected to result in a post-cleanup average PCB concentration of less than 150 µg/kg in all waterways at the CB/NT Site. Based on the method described in the ESD, EPA calculated that a PCB SQO of 150 µg/kg would result in attainment of PCB concentrations in fish tissue similar to those in Puget Sound reference areas (36 µg/kg). With regards to ecological risk, the ESD summarized the updated ecological risk analysis, which showed that the 300 µg/kg PCB SQO and 450 µg/kg PCB SRAL is protective of the benthic community, juvenile salmonids, shorebirds and piscivorous birds. Cleanup to the 300 µg/kg PCB SQO will reduce all HQs estimated for these species to 1 or below.

5 EPA Region 10's "Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia" (EPA 2007; hereinafter referred to as the Framework).

4.1.3. Source Control Strategy

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.1.4. Explanation of Significant Differences

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.1.5. Sitewide Biological Assessment

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

Since 2009, the following species have been listed as threatened or endangered, or critical habitat for the species has been designated, under the Endangered Species Act (ESA):

- Pacific eulachon (*Thaleichthys pacificus*) in March 2010, and critical habitat was designated in October 2011;
- Bocaccio (*Sebastes paucispinis*), canary rockfish (*Sebastes pinniger*), and yelloweye rockfish (*Sebastes ruberrimus*) in April 2010; critical habitat for these three species was designated in August 2013;
- Revised critical habitat for bull trout (*Salvelinus confluentus*) in September 2010;
- Streaked horned lark (*Eremophila alpestris strigat*a) in November 2013; and
- Taylor's Checkerspot butterfly (*Euphydryas editha taylori*) in November 2013 and critical habitat in October 2013.

The eastern distinct population segment of Steller sea lions was de-listed in November 2013 (NFMS 2013).

4.1.6. Sitewide 404(b)(1) Analysis

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.1.7. Dredged Material and Disposal Sites

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.1.8. CERCLA Removal Actions

4.1.8.1 Olympic View Resource Area

A non-time-critical removal action was conducted in 2001 to address contaminated marine sediments at the Olympic View Resource Area (OVRA). The OVRA was not identified as a problem area in the CB/NT ROD, but it is located within the boundaries of the CB/NT site. In 1997, the OVRA site was identified as one of five City restoration projects addressed in the

City's Natural Resource Trustee Consent Decree (CD) to settle the City's liability for natural resource damages at the CB/NT site. As part of studies at OVRA, dioxin sediment contamination was found, and it was determined to be an imminent and substantial threat to human health and the environment. Section 4.6 describes the cleanup action taken in this area.

4.1.8.2 Occidental Chemical

Background: A 1997 CERCLA AOC with Occidental Chemical led to development and partial implementation of two non-time-critical removal actions at its (now former) chlor-alkali plant and adjacent areas along the Hylebos Waterway. The Area 5106 Removal Action included dredging, treatment, and disposal of approximately 36,000 cubic yards (cy) of sediment contaminated predominantly with chlorinated organic solvents and degradation products. The in-water work (October 2002 through February 2003) was completed as designed, but contaminated sediment, approaching residual DNAPL concentrations, was found to extend deeper than anticipated. Additional response actions were conducted under the Area 5106 UAO to partly characterize the remaining contamination. The Embankment Area Removal Action led to the 2003 draft design of a permeable cap to cover the intertidal and subtidal Occidental property embankment to the toe of the subtidal slope. Information obtained from the Area 5106 Removal Action and Embankment Area work identified contamination which could not be addressed by the cap as designed and pointed to the need for additional in-water and upland source control measures.

In 2005, remaining work from each of these two removal actions were melded into an overall Occidental Site CERCLA Administrative Order on Consent (AOC) to address remaining soil, groundwater, and sediment contamination. The AOC extends through the Remedial Investigation/Feasibility Study (RI/FS) and Remedial Design (RD). Another legal mechanism will be needed to implement the Remedial Action (RA) after the selected remedy has been designed under the AOC. CERCLA response actions at the Occidental Site from 2005 through 2009 are summarized in the previous FYR. From 2010 through 2014, several site investigation studies were conducted under the 2005 Amendment to the 1997 CERCLA AOC as summarized below. These studies culminated in an approved conceptual site model (CSM) report in April 2014. An overview of work performed during the past five years is presented below.

2010: Investigations associated with a deep, improperly abandoned water supply well postulated to be leaking freshwater, and thus complicating interpretation of field data collected 2005 to 2009, were conducted. The data obtained helped to better characterize part of a high-density plume formed by salt brine and caustic soda releases, identified stratigraphic control associated with the density plume depth, and found no discernible hydraulic impacts from the abandoned water well on site.

Several phases of elevated (9-14 pH) neutralization pilot testing work, in-situ and ex-situ, were summarized into a draft summary report.

Occidental completed a draft groundwater flow model for EPA and Ecology review, and then proposed an interim action to install a sheet-pile wall, to replace the treatment plant, and to enhance the existing extraction well network. EPA and Ecology rejected the interim action proposal because the proposed sheet-pile wall could be inconsistent with future response actions needed to address contaminated sediment and groundwater, the partial hydraulic containment plan depended upon a draft groundwater flow model that the agencies had not reviewed, and additional data were needed to complete the nature/extent of contamination and groundwater flow site characterization work. EPA and Ecology pointed out that other types of interim actions, which would not interfere with potential future response actions, would be welcomed.

2011: EPA and Ecology identified the need to fill several significant data gaps to characterize the nature/extent of contamination, groundwater flow, and contaminant transport. A revised project schedule was developed to fill necessary data gaps and complete the RI.

2012: The Comprehensive Supplemental Investigation (CSI) work plan was approved. Field work included numerous shallow and deep monitoring well installations to obtain contaminant distribution, groundwater density, and hydraulic pressure data, and several soil borings to characterize chlorinated volatile organic compounds (VOCs), dense non-aqueous phase liquid (DNAPL), and elevated pH (9-14) areas caused by historic caustic soda releases.

An evaluation of the existing groundwater treatment plant was performed to assess its life expectancy and potential use as part of any future remedial alternatives.

2013: Occidental proposed an interim action to replace the groundwater treatment plant and install a new extraction well system designed in response to the updated understanding of groundwater contamination. The agencies agreed with this work being conducted in parallel with completing the RI/FS and remedy selection. EPA and Ecology review of the draft interim action work plan was completed in June 2013. Occidental then withdrew the proposal, and the agencies accepted that withdrawal in July.

A work plan for additional deep monitoring well installation and extraction well pilot testing was approved. The wells were installed and an initial pumping well aquifer test was conducted.

EPA and Ecology provided comments in November 2013 on the draft pH pilot testing summary report. The comments identified revisions needed to finalize the report and additional pH neutralization testing needed.

With the completion of RI data acquisition, Occidental developed the draft CSM report for EPA and Ecology review. Occidental also submitted a draft Evaluation of Remedial Technologies (ERT) report as an initial screening of technologies prior to beginning the FS.

A work plan for vapor intrusion (VI) investigation of buildings at the Occidental Site was approved by EPA in February. An initial round of indoor air and subslab vapor sampling was conducted in March. A second round in July used both Summa canisters for short-term (hours) measurements and passive samplers for longer-term (one week) indoor air measurements.

2014: The draft CSM report was modified in response to EPA and Ecology comments and approved in April. The draft Site Characterization report (SCR) was submitted in August, and the final SCR is anticipated to be approved in December.

Ongoing treatability testing associated with high pH neutralization, extraction well pilot testing, and contaminant transport modeling parameter investigations are expected to continue. Treatability testing needed to further evaluate certain remedial technologies is expected to occur.

A third round of VI sampling occurred under an amendment to the 2013 approved work plan in March for buildings not recommended to be mitigated. This round of sampling included both Summa canister and passive samplers for indoor air measurements. A VI mitigation design plan for buildings to be mitigated was submitted in April and approved by EPA in June 2014.

4.1.9. Puyallup Land Settlement

The CB/NT site is within the usual and accustomed fishing and gathering areas for the Puyallup Tribe of Indians (Tribe), and thus the Tribe has an ongoing interest in site cleanup efforts. Additionally, the Puyallup Land Transfer Consent Decree (*United States v Port of Tacoma, Puyallup Tribe of Indians as Intervenor*) [CD], No. C94-5648 (W.D. Wash. Jan. 1995) describes the obligations and responsibilities that the Port of Tacoma (Port) and the Tribe have regarding environmental cleanups and long-term monitoring at six properties within the CB/NT Site, which were transferred from the Port of Tacoma to the Puyallup Tribe. The Consent Decree was associated with the 1988 Puyallup Settlement Agreement and the Puyallup Land Claims Settlement Act of 1989. Two Port mitigation actions being performed under this CD are within the Mouth of Hylebos Problem Area (see Section 4.2). The Tribe is the beneficial owner of the trust lands on which these mitigation sites are located. The Port and Tribe have proposed that the Tribe designate the mitigation sites as “Conservancy” and that the Tribe take action, under Tribal law, to protect them.

The Tribe, the Port, and EPA developed a 2012 Contingency Plan in response to EPA identifying work that had not been completed as required by the 1995 CD. The Contingency Plan presents mitigation actions at two locations to address a shortfall of intertidal wetland mitigation credit at the Outer Hylebos Mitigation Site, which was constructed pursuant to the 1995 CD.

Implementation of the 2012 Contingency Plan began with construction of the two mitigation areas during the spring and summer of 2012. EPA conducted a field inspection of the two sites in September 2013 and found them to be functioning well. A second EPA field inspection occurred on May 16, 2014 and EPA also found the sites to be functioning within the performance standards; however, ongoing maintenance will be needed to ensure continued compliance. Monitoring at the mitigation site is required for a minimum of five years, and if performance standards are not met, will continue longer.

4.1.10. Partial Deletion of the Site

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.2. Hylebos Waterway

4.2.1. Background

The Hylebos Waterway is the northeastern-most waterway in the CB/NT area (see Figure 4-1). Since the early 1900s, the three-mile-long waterway has been the site of several industries, such as manufacturing of chlorine and chlorinated chemicals, shipbuilding and repair, scrap metal recycling, lumber milling, and log exporting. Sampling during the 1984 RI showed several contaminants of concern in Hylebos Waterway sediments, including arsenic, VOCs, polycyclic aromatic hydrocarbons (PAHs), hexachlorobenzene, hexachlorobutadiene, and PCBs. The 1989 ROD identified contaminated sediment problem areas at the Mouth and Head of Hylebos Waterway that required Superfund cleanups.

Other information through 2009 for this section is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.2.2. Site Chronology

Site chronology information through 2009 is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

Site chronology information since 2009 is included below.

2010 CERCLA Mitigation Requirements Evaluation for sediment management area (SMA) 421; Head of Hylebos sediment sampling conducted at Schnitzer Steel; Occidental Site RI investigations focused on groundwater flow.

2011 Hylebos Bridge Rehabilitation Project Post-construction Sediment Monitoring Report; Port of Tacoma acquired U.S. Navy property within and adjacent to southern part of Occidental Site; Occidental Site RI data gaps identified; Head of Hylebos Remedial Action Construction Report (RACR) approved.

2012 CSI Work Plan approved for Occidental Site; Draft Operations, Maintenance, and Monitoring Plan (OMMP) for Mouth of Hylebos submitted; Slip 5 Mitigation Site Monitoring Report (Year 6); Pre-OMMP Sediment Sampling for Head of Hylebos Waterway performed.

2013 Mouth of Hylebos RACRs conditionally approved for Segment 5 and Slip 1 nearshore confined disposal facility (NCDF), Segment 3/4 and Slip NCDF, and Pier 24/25 embankment cap; RI field work for Occidental Site completed.

2014 Final CSM report approved for Occidental Site; Draft OMMP for Pier 24/25 cap submitted; Pre-OMMP sampling for Mouth and Head planned.

4.2.3. Remedial Actions

4.2.3.1 Remedy Selection

Remedy selection for the CB/NT Sediments OU 01 was described in Section 4.1.

4.2.3.2 Remedy Implementation (Sources)

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt. Source control efforts are continuing with a particular focus on the Arkema and Occidental sites.

4.2.3.2.1 *Arkema*

EPA and Ecology have been concerned about arsenic-contaminated groundwater and high pH plumes at the former Elf Atochem 2901 Taylor Way property, later acquired by Arkema Chemical, at the Head of Hylebos waterway.

In 2011, Ecology developed a Model Toxics Control Act (MTCA) Agreed Order with the Port of Tacoma to replace the pre-MTCA enforcement order with Arkema, and effectively released Arkema from state liability.

EPA has not released Arkema from its liability under CERCLA. EPA certification of Remedial Action to be completed, under the Head of Hylebos CD, is dependent upon cleanup of the Arkema site to EPA's satisfaction. Arkema site cleanup has been progressing under the 2011 Ecology MTCA Order.

4.2.3.2.2 *Occidental Site*

A second major source of remaining contamination is the former production facility and surrounding areas of the Occidental Chemical Corporation, within and adjacent to the Mouth of Hylebos Waterway. Key accomplishments during the past five years were described in Section 4.1.8.

4.2.3.3 Remedial Action (Sediments)

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt. Information for the Head and Mouth of Hylebos Waterways for the fourth FYR period (2009-2014) is presented below.

4.2.3.3.1 *Segments 1 and 2 (Head of Hylebos)*

Surface sediment[6] samples (top 10 cm) were collected in accordance with the EPA-approved Sampling and Analysis Plan at the Schnitzer Steel property during October 2010 along the shoreline cap. Samples were analyzed for metals, PCBs, PAHs, dichlorodiphenyltrichloroethane (DDT), and semi-volatile organic compounds (SVOCs). The Sediment Quality Standards (SQS) were exceeded as follows: PCBs at 9 stations; benzyl butyl phthalate (BBP) at 7 stations; bis(2-ethylhexyl)phthalate (BEHP) at 4 stations; zinc at 3 stations; and mercury at 1 station. A dive inspection of the outfall found it was in disrepair but still functional (DOF 2011a).

The Sediment Sampling Data Report (2012) describes the sediment sampling conducted during February 2012 at the Head of the Hylebos (DOF 2012). The purpose of the sediment sampling was to establish current sediment chemical concentrations in a manner that allows for direct comparison to the 2004-2006 Type 4 post-dredging confirmation sampling data. This data collection effort was implemented to support the development of a revised long-term OMMP. Concentrations of 15 of the 20 analytes in all the confirmation areas decreased between 2004-2006 and 2012, in some cases possibly due only to lower analytical detection limits achieved in 2012. Concentrations of 4 of the 20 analytes increased in between 2004-2006 and 2012 (total PCBs 3.9 times greater; arsenic 1.7; zinc 1.9; benzo(b+k)fluoranthene 1.1). Total PCBs were the

6 Surface sediment is the top 10 cm of sediment; all sediment below (deeper than) 10 cm is subsurface sediment.

only parameter with 2012 individual sample results that exceed the Sediment Quality Objective (SQO)[7] within three confirmation sampling areas (CO-6b, C0-10, CO-11). The increased averaged concentrations of the four analytes, especially for PCBs, warrant additional investigation.

A Sampling and Analysis Plan (SAP) Addendum was prepared in April 2010 for data gaps as part of the Arkema Site 2006 MTCA Agreed Order RI/FS following removal of the woodwaste/slag containment cell at the former Arkema log sort yard facility at 3009 Taylor Way, Tacoma, Washington. The SAP Addendum for data gaps was prepared in accordance with Sections 5.3.1 and 5.3.3 of the RI/FS Work Plan. The remedial action construction report (RACR) for the Head of Hylebos Waterway sediment remediation project, which describes remedial work completed from 2002 through 2006, was originally submitted in July 2006, then updated to reflect additional response actions and resubmitted in 2009, and approved by EPA on August 31, 2011. The RACR attests that the construction was completed as required by EPA-approved plans. Remedial actions completed included the dredging of 405,000 cy of sediment over approximately 42 acres, capping of intertidal and subtidal slope over approximately 1.5 acres, and long-term monitoring of the cap at General Metals. EPA certification of Remedial Action completion under the CD will depend upon longer-term monitoring results and cleanup of the Arkema Site to EPA's satisfaction.

4.2.3.3.2 *Segments 3, 4, and 5 (Mouth of Hylebos)*

Remedial Action dredging did not occur within the 11th Street (Hylebos) Bridge Right-of-Way (ROW), and sampling data within the ROW and nearby is sparse. This issue was brought into focus when the City of Tacoma alerted EPA of its plans to rebuild (rehabilitate) the bridge, with the in-water construction portion of the work scheduled between August 2009 and February 2010. The in-waterway work required removal of pilings within the ROW and installation of new approaches on either side of the span. This work has been completed.

Discrete composite surface sediment samples (0 to 10 cm) were collected from 24 locations (and combined in seven samples) on September 6 and 7, 2011, to characterize the post-construction conditions associated with the Hylebos Bridge rehabilitation. Contaminants of concern (COCs) were either not detected or were detected at concentrations less than SQOs in five of the seven composite surface sediment samples. In two samples, two COCs were detected at concentrations greater than the SQOs (fluoranthene, pyrene) and all other COCs were either not detected or were detected at concentrations less than the SQOs. For example, even though the concentrations of PAHs and several other SVOCs were detected at higher concentrations in the post-construction samples (September 2011) than in pre-construction samples (July 2009), the detected concentrations of those chemicals were still well below the SQOs in 2011 except for fluoranthene and pyrene. Analytical variability likely accounted for the change in detected concentrations because the method of sample extraction for SVOCs and PCBs changed between the pre- and post-construction sampling events, from the sonication method to the microwave method. Analytical results for samples prepared using the microwave method have generally

7 As defined in the CB/NT ROD (EPA 1989), an SQO is "a discrete and measurable target for project cleanup related to the Puget Sound goal. The objective is measurable in terms of specific human health risk assessments and environmental effects tests, and associated interpretive guidelines. The resulting biological effect levels or chemical concentrations are scientifically acceptable definitions of the sediment quality goal using available information."

been higher than for samples prepared using the sonication method. Therefore, the change in PAH and other chemical concentrations observed in the post-construction samples may largely be the result of analytical variability. In general, the comparison of pre-construction (July 2009) and post-construction (September 2011) results indicated that COC concentrations remained relatively unchanged in surface sediment within the right-of-way of the Hylebos Bridge Rehabilitation Project.

Mouth of Hylebos Pier 24 and 25 RACR

The RACR for the Pier 24 and 25 Embankment Remediation Project was finalized in December 2013, consistent with EPA conditional approval in September 2013. The 2007 to 2008 remedial action construction work documented in the RACR involved capping contaminated intertidal and subtidal sediments after partial or complete excavation of identified PCB and arsenic hot spots, consistent with the approved remedial design.

Remediation for the project generally included capping the embankment slopes below approximately elevation 15 to 17 feet mean lower low water (MLLW) beneath Pier 24 and Pier 25. The embankment was capped along the North Slope bayward of existing heavy rock riprap below about 5 feet to minus 10 feet (+5 to -10 MLLW).

Capping extended through the subtidal zone to elevations below -30 MLLW on both the Hylebos Waterway side and the North Slope (within Commencement Bay itself). Capping for the upper and lower cap component for Pier 25 and the North Slope consisted of a layer of gravelly sand covered by a layer of crushed rock. The sand cap consisted of a minimum 2-foot-thick layer of gravelly sand. This sand and gravel blend was successful at maintaining stability during and following placement, with no obvious slumping, sliding, or significant down-slope movement of the material. To protect the sand cap on the lower slope of the Pier 25 embankment against potential wave scour and propeller-wash, a minimum 1-foot-thick layer of angular, 1.5-inch-minus crushed rock was placed as armor.

Excavation activities before capping were conducted at two locations in 2007 to remove sediments with arsenic concentrations substantially in excess of the 57 mg/kg SQO. An estimated 52 cy of excavated material were removed from the Pier 25 area, and an estimated 50 cy of material were removed from the North Slope area. Removal of the PCB hot spot materials required four separate rounds of excavation and verification sampling. Final excavation was successful in removing Toxic Substances Control Act (TSCA)-level material from the PCB hot spot area. The excavation was backfilled on January 25, 2008.

Mouth of Hylebos Segment 3/4 RACR

The Final RACR for Segment 3/4 dredging and for the primary and final cap for the Slip 1 nearshore confined disposal facility (NCDF) was conditionally approved by EPA in September 2013. The report summarizes construction activities completed for the dredging of Segment 3 and 4 and associated disposal of sediments at the Slip 1 NCDF, and for the completion of a primary and final cap at the NCDF. Site construction work was performed between July 2004 and March 2006.

In some areas of Segments 3/4 COCs in surface sediment were below SQOs while being above SQOs in subsurface sediment. These were “no action” areas and generally no dredging was performed in these areas. Other areas in Segment 3/4 have contaminated subsurface sediment and surface sediment that was found to be marginally contaminated, and in these areas the remedial action was “natural recovery” where recovery to SQO chemical criteria was expected to occur within 10 years following completion of remedial actions. In sediment management areas (SMAs) where remedial dredging occurred, it was usually to the depth of the clean native sediment surface, and confirmation sampling was conducted to verify that the bottom of contamination had been reached. In both no-action and natural-recovery areas, where remedial action dredging did not occur, the depth of subsurface contamination is likely limited to the recent sediment (deposited within the last 50 to 100 years atop the dredged native sediment surface) unless its affected by contaminated groundwater.

All sediments from SMAs within Segments 1, 3, and 4 were transported and disposed of at the Slip 1 NCDF. Dredging was completed in October 2004 for all areas except Taylor Way properties. The volume of material placed in the NCDF from Segments 1, 3, and 4 was 223,040 cy. The design volume (without contingency) for Segments 1, 3, and 4 was estimated at 133,200 cy (excluding SMA 421B). The NCDF was able to accept 90,000 cy from SMA 421B because the previously planned excess capacity sediment from the Duwamish Waterway was not deposited into Slip 1, and thus additional capacity was available. The design volume did not include SMA 421B because the embankment at SMA 421B at Taylor Way properties was originally proposed for capping, not dredging. However, during cap design review, a revision to dredge the embankment area instead of capping it was proposed by the performing parties, reviewed, and conditionally approved by the EPA on October 15, 2004.

After all dredged sediments had been placed in the NCDF, it was capped with first a primary cap, which was then covered with a final cap layer. A 7-foot-thick layer of clean sandy material was placed to complete the primary cap to approximately +16 feet MLLW. Imported material from the buttress (berm) was placed in the NCDF (Slip 1) in the upper 12 to 18 inches of the primary cap. The final cap was constructed over the primary cap by the Port of Tacoma in March 2006. The final cap consisted of 12 inches of base course material capped with 10 inches of asphalt concrete pavement. This amount exceeded the requirements of the final design, which called for 8 inches of base course material and 6 inches of asphalt. A thicker pavement section was installed to accommodate future use of the site.

No capping of dredged areas was completed based on the post-construction sediment quality verification sampling. In accordance with the work plan, sediment remediation was considered successful if the 95 percent upper confidence limit (UCL) concentration for all COCs did not exceed SQOs, and if no single sample concentration exceeded the location-specific sediment remedial action level (SRAL). Post-dredge sampling concentrations exceeded SQOs, but were below SRALs for SMAs 421B, 123, and S44. SMAs 421B and S44 are considered natural-recovery areas, whereas SMA 123 was backfilled with several feet of clean material.

Mouth of Hylebos Segment 5 and Slip 1 NCDF RACR

The RACR for Segment 5 and Slip 1 was conditionally approved by EPA in September 2013. The report summarizes construction activities completed for the dredging of Segment 5 and associated disposal of sediments at the Slip 1 NCDF and the completion of the Stage II containment berm at the NCDF. Site construction work was performed between July 2003 and February 2004.

Some areas of Segment 5 were found to contain subsurface contamination, but surface sediment met SQOs, and dredging was not planned for these no-action areas. Similarly, some areas of Segment 5 were found to have subsurface contamination, where surface sediment did not meet SQOs but was within SRALs, and dredging was not planned in these natural-recovery areas. Where remedial action dredging occurred, as designed, it was typically to the depth of the native sediment surface. The total volume of sediments dredged in Segment 5 and placed in the approved offshore disposal location was 150,838 cy. The design volume (without contingency) for offshore disposal of dredged material was estimated at 163,500 cy.

As part of the preliminary characterization activities conducted in 1994 for the CB/NT site, a portion of Segment 5 adjacent to the Occidental Chemical Corporation property, referred to as Area 5106, was found to be impacted with a mixture of chlorinated organic chemicals, primarily tetrachloroethene (also known as perchloroethylene (PCE)), trichloroethene (TCE), hexachlorobenzene (HCB), and hexachlorobutadiene (HCBD). Sampling indicated that sediments from Area 5106 were not appropriate for disposal with the remainder of the Segment 5 sediments. Dredging, treatment, and dewatering of Area 5106 sediment occurred between October 2002 and February 2003 as a non-time-critical removal action under a separate CERCLA unilateral administrative order (UAO). Confirmation sampling, however, indicated concentrations of chlorinated organic chemicals that exceeded SQO chemical criteria within the underlying native sediment by several orders of magnitude. Consequently, additional post-Area 5106 sediment removal investigations were performed to delineate the nature and extent of remaining subsurface sediment and groundwater contamination in this area. Analytical data from borings indicated that exceedances of SQO chemical criteria in this area were observed for PCE, TCE, HCB, and HCBD. Remaining work required under the Area 5106 UAO was incorporated into the Occidental Site CERCLA AOC as amended in 2005.

The volume of material placed in the NCDF from Segment 5 was 254,281 cy. The total volume of sediments from all sources disposed of in the Slip 1 NCDF was approximately 450,000 cy. Approximately 200,000 cy of material was found suitable for open-water disposal.

The construction of the Slip 1 Stage I Containment Berm was completed on January 16, 2003. This was a component of the conversion of Slip 1 to an NCDF to contain dredged sediments that were unsuitable for unconfined open-water disposal in Commencement Bay. The Stage I earthen containment berm was constructed across the mouth of Slip 1 to create an enclosed basin for the future placement of dredged sediments in the NCDF. The berm construction included excavation of the existing sediment, backfilling with imported fill, and construction of the berm Stage I to a height of -5.0 MLLW. The Stage II berm was constructed to +14 feet MLLW, and a sediment transfer facility was constructed on top of the berm to transfer sediments from the Blair Waterway side of the berm into Slip 1. A total of 25,271 tons of select fill, 20,979 tons of blended riprap, and 238 tons of light riprap was used to construct the berm.

Federal Navigation Channel Dredged Material Characterization

As authorized by Congress, the USACE, Seattle District, conducts maintenance dredging of the Hylebos Waterway Federal Navigation Channel. The authorized depth for that portion of the channel proposed for dredging in 2014 was -30 feet MLLW. The channel bottom width is 200 feet, with the following exceptions: the width is increased to 250 feet at the bend upstream of the East 11th Street Bridge, to 300 feet at the Lincoln Avenue bend, to 510 feet at the channel widening above Lincoln Avenue, and to 770 feet at the turning basin at the head of the waterway.

USACE proposed to dredge portions of the authorized navigation channel between the mouth and the head of the waterway where shoaling has occurred. Two feet of allowed over-depth dredging (-32 feet MLLW) was to be included in the proposed dredging. Bathymetric surveys conducted by Seattle District in June 2012 and March 2013 indicate that approximately 47,445 cy of material would need to be removed from the waterway to restore authorized channel depths.

USACE, with input from EPA and Ecology, completed a SAP in October 2013 for characterizing sediment to be removed for channel maintenance dredging in FY 2013/2014. Sediment vibracores were collected at sixty locations at the five shoal areas from November 4 to November 13, 2013 (see Figure 4-2). Composite samples were characterized in the five shoal areas along the Mouth, Middle, and Head of the Hylebos Waterways. Dredged Material Management Program (DMMP) chemicals of concern were detected above the screening level (SL) and bioaccumulation trigger (BT) in all five shoal areas. Mercury, pyrene, 2,4-dimethylphenol, hexachlorobutadiene, hexachlorobenzene, and dieldrin were detected above the SL in at least one shoal area. Total PCBs exceeded the SL in four of the five shoal areas. The toxicity equivalent (TEQ) calculated for dioxin/furan congeners exceeded the BT at all waterway shoal areas. Tributyltin was detected above the BT in three of five shoal areas (USACE 2014, Data Report, Hylebos Waterway Federal Navigation Channel, Dredged Material Characterization). Based upon these results, USACE has dropped its maintenance dredging plans.

The quality of sediment within the proposed dredge prisms was characterized in bulk (from 0 to 4 feet), without regard to the distribution of contamination with respect to depth. Therefore, the data cannot be used to determine whether the contaminated sediment within the formerly proposed dredge prisms is found within the biologically active zone (generally the top 10 centimeters).

Helena Star (Derelict Vessel) Removal Surface Sediment Characterization

The U.S. Coast Guard, Ecology, and Washington Department of Natural Resources jointly acted to remove the sunken vessel Helena Star from the Head of Hylebos Waterway in July 2014. Previous work by the U.S. Coast Guard had removed petroleum products and other hazardous materials from the sunken vessel. The vessel sunk in a part of the waterway where subsurface sediment characterization by the Corps of Engineers had identified subsurface contamination and the quality of surface sediment was not known. Ecology and EPA coordinated efforts to collect and analyze surface sediment samples before and after the sunken vessel removal. Based upon available information, the sediment samples were analyzed for metals, PCBs, and dioxins/furans. Results are expected to be available in October 2014.

4.2.3.3.3 *Disposal of Dredged Material*

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.2.3.3.4 *Habitat Mitigation*

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

Key events associated with mitigation sites during the 2009-2014 timeframe include the following:

- Mouth of Hylebos Consent Decree (CD) Slip 5 Mitigation Area annual post-construction monitoring occurred, with EPA approval of final report in 2013.

- Mouth of Hylebos CD Clear Creek Mitigation Area annual post-monitoring occurred as planned through 2012. Additional monitoring occurred in 2013 as performance standards were not all met. Additional monitoring, but only every five years, is anticipated as described in the final report.

- Puyallup Land Transfer CD (1995) Contingency Plan was approved by EPA in 2012 for two mitigation sites in the Hylebos Waterway. The Port of Tacoma completed construction in 2012. EPA field inspections occurred in September 2013 and May 2014, and results indicated both sites are performing well so far. Annual monitoring is required through at least 2017.

Details are provided below.

<u>Mouth of Hylebos (Segments 3, 4, and 5) Consent Decree</u>

The Clear Creek Habitat Improvement Project, Phase II site (habitat site) was constructed as one of the habitat components of the mitigation package for the construction of the Mouth of the Hylebos Waterway Segment 5 Remediation, Slip 1 NCDF Project. The original monitoring program for the habitat site was completed in 2009. In November 2009, the Port of Tacoma planted the Riparian Planting Areas with native vegetation. The Port has conducted annual maintenance of the area, including removal of invasive vegetation. In 2012, maintenance activities included removal of Himalayan blackberry and the application of an approved herbicide to control reed canary grass (*Phalaris arundinacea*). The Port committed to monitor the Riparian Planting Area through 2012 to document the success of the planted area. While the final report (November 2012) recommended that no further monitoring should be required, EPA review of the November 2012 report found that monitoring had been conducted at a new location, so the data were not comparable to the previous data. EPA required that additional monitoring be conducted in 2013 and that an updated report be submitted. The 2014 report documented that although not all performance standards had been strictly met, the intent had been, and annual monitoring could be replaced by monitoring on a five-year basis.

The Slip 5 mitigation site was built to offset the adverse impacts associated with the construction of the NCDF. The mitigation site included the creation of intertidal and subtidal habitat for use by juvenile salmonids. The Year 6 monitoring report (2011) described physical and biological monitoring to determine the acreage by habitat type, characterized the substrate, quantified and estimated biomass of epibenthic invertebrates, determined usage by juvenile salmonids, and identified habitat type and usage by avifauna. The 2011 survey indicated that 6.7 acres of aquatic habitat exist, and juvenile salmonid and avifauna observations demonstrated full use of the site by both salmonids and waterfowl. A substantial shift in sediment composition was noted between 2008 and 2011, from high concentrations of gravel to overwhelmingly sand. This change may have influenced the area available for epibenthic invertebrates. EPA approved the final monitoring report for the Slip 5 mitigation site in 2012.

Consistent with requirements defined in the previous UAO and current CD between EPA and the PRPs for remedial design and remedial action in the Mouth of the Hylebos Waterway, a plan to dredge SMA 421B (Taylor Way) was submitted by American Construction (new property owner) as an agent for the CERCLA PRPs, and was conditionally approved by EPA on October 15, 2004. The plan included dredging the entire SMA 421B area to clean sediment elevations to remove all contaminated sediments identified in SMA 421B, especially PCBs present at concentrations exceeding SQOs. The remedial action included the replacement of a failing historical timber bulkhead with a new steel sheet-pile bulkhead. Remedial actions in SMA 421B occurred during November and December 2004, and resulted in dredging approximately 62,000 cy of contaminated sediments from the area, with disposal of these materials at the Slip 1 NCDF.

Following American Construction's dredging project within SMA 421B, area changes were calculated as a net loss of littoral habitat (11.8 to -10 feet MLLW) of 1.39 acres and a net gain in subtidal habitat (<10 feet MLLW) of 1.35 acres. American Construction prepared a Mitigation Requirement Evaluation (2010) that proposed constructing an additional compensatory mitigation project that would result in the creation of 0.22 acre of upper intertidal habitat. The area changes resulting from the remedial action and the construction of the compensatory mitigation project would result in a net gain in total aquatic habitat of 0.18 acre. An additional 0.33 acre of vegetated buffer (above +11.8 feet MLLW but within 25 feet) would be planted around the constructed intertidal habitat, improving the function and value of the adjacent intertidal habitat. EPA reviewed the proposed mitigation plan and found that the calculations did not accurately represent losses, directed the performing parties to propose a mitigation plan consistent with the need to replace lost shallow subtidal habitat, and described how this could generally be accomplished. A revised proposal is anticipated in September 2014.

Puyallup Land Transfer CD

On June 3, 2010, EPA issued a dispute resolution decision affirming EPA's decision to approve a wetland mitigation contingency plan that was developed and submitted to EPA by the Port of Tacoma. The dispute was subject to the terms of the Puyallup Land Transfer Consent Decree, *United States v. Port of Tacoma, Puyallup Tribe of Indians, Intervenor*, No. C94-5648, W.D. Wash., January 15, 1995. The contingency plan (completed in April 2011) provides for additional mitigation work at two locations, the Hylebos Peninsula Mitigation Site (0.68 acre) and the Outer Hylebos Mitigation Site (0.42 acre), and will satisfy the performance standards required by the initial mitigation effort. The restored intertidal salt marsh areas are expected to directly support the production of juvenile salmonid prey organisms and serve as a net exporter of organic detritus that will nourish the surrounding mudflats and help sustain salmonid species.

Construction at the two sites was completed in 2012. An EPA representative inspected the mitigation sites in September 2013, and again in May 2014. Each inspection found them to be on track for meeting design performance standards if regular maintenance to remove invasive plants occurs.

4.2.3.4 Institutional Controls

Institutional controls for the Hylebos Waterway remedial actions include sitewide fish use advisories maintained by the Tacoma-Pierce County Health Department (TPCHD) in designated areas.

Site use restrictions are often needed for areas where contaminants remain in place (i.e., caps and the NCDF). The following remedial action elements are subject to institutional controls:

- General Metals of Tacoma (MTCA covenant filed with title);
- Arkema southeast shoreline - notice to successor in title and MTCA covenant required by consent decree;
- Blair Slip 1 NCDF, where contaminated sediments are to remain in a containment structure for some time.

Institutional controls might also be needed to augment OMMPs in one or more of the following areas:

- Piers 24 and 25 (remedial action construction completed 2008);
- Occidental site (after RD/RA is accomplished);
- Arkema site (after RD/RA is accomplished).

Institutional control plans or plans for other means to regulate subsurface exploration and/or excavation necessary to protect response actions might also be developed for other areas of the waterway and adjacent uplands. If so, this could be accomplished as part of the approval process for upcoming remedial action construction completion documentation.

4.2.3.5 Occidental Site Removal Actions

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.2.3.6 Post-Construction Monitoring/Operation and Maintenance (O&M)

Long-term monitoring and maintenance is required for all of the remedial action components to assess the overall effectiveness of the remedy and ongoing source control actions. Draft OMMPs for both the Mouth and Head of Hylebos have been prepared. EPA has determined that additional post-construction sampling, beyond the post-construction verification sampling, is appropriate before finalizing a long-term OMMP. One round of surface sediment sampling has occurred within the Head of Hylebos, and another is planned in 2014 to be coincident with post-construction sediment sampling in the Mouth of Hylebos.

For the Hylebos Waterway, O&M monitoring will be required for the following key remedy elements:

- Dredged, no action, and natural recovery areas, to evaluate sediment quality trends and determine if recontamination is occurring;
- Intertidal and subtidal caps, to confirm that buried contaminants remain physically and chemically isolated, and recontamination from the surface water column is not occurring;
- Blair Slip 1 NCDF, to confirm with groundwater monitoring that contaminants remain within the disposal facility; and
- Mitigation sites (Blair Slip 5 and Clear Creek Phase II), to confirm that the desired habitat function(s) are being achieved.

An OMMP – Part 2 ("OMMP-2") was submitted by Arkema Inc. in 2006 for capping elements of remedial actions on the Arkema Southeast Shoreline of the Head of Hylebos Problem Area of the CB/NT site. A combination of removal and capping has been implemented for the Arkema Southeast Shoreline in accordance with Addendum No. 2 to the 2004 Remedial Action Work Plan (subtidal cap) and Addendum No. 3 to the 2003 Work Plan (intertidal cap). OMMP-2 defines operations, maintenance, and monitoring of the two caps and would satisfy Section IV Task 6 of the Head of Hylebos Waterway SOW for the capped areas. EPA has not approved this OMMP and explained in a letter to Arkema that the cap was not designed to treat dissolved arsenic. Cap construction was approved by EPA with the written understanding that source control at the Arkema site still remains to be accomplished. Cleanup of the Arkema site to EPA's satisfaction will need to occur before Remedial Action certification under the CD as described in EPA's cap approval letter.

A revised draft OMMP for Piers 24 and 25 was submitted to EPA in February 2014. The project involved capping contaminated intertidal and subtidal sediments and related remediation activities as described in the Final RACR. Site construction work for the project was performed between October 2007 and February 2008. This current, revised draft OMMP responds to comments presented in EPA's conditional project approval document following EPA's review of the design package (2007), and has been modified to address post-construction, long-term maintenance and monitoring efforts throughout the anticipated lifetime of the cap for the Pier 24 and 25 Embankment Remediation Project.

A draft final Operations, Monitoring, and Maintenance Plan for the Mouth of Hylebos Waterway (Segments 3, 4, and 5) was prepared in December 2012. The primary objective of the sediment monitoring is to verify that surface sediment concentrations in post-dredging residual areas and other natural recovery areas within Segments 3 to 5 achieve SQOs within the time-frame established by EPA in the ROD and SOW. The Draft OMMP is being reviewed by EPA with the expectation that pre-OMMP sampling will occur in the Mouth of Hylebos, consistent with that which has occurred and is planned for the Head of Hylebos in 2014.

4.2.4. Progress since the Last Five-Year Review

See the previous section for detailed information about progress during the period of this FYR in the Head of Hylebos problem area, Mouth of Hylebos problem area, and Occidental Site.

4.2.4.1 Previous Protectiveness Statement

The protectiveness statement in the third FYR (2009) stated:

> "For the Hylebos Waterway, the remedy is expected to be protective of human health and the environment upon completion. Most remedial action construction has been accomplished, and the additional actions needed for the remedy throughout the waterway to be protective described in the ROD and this report, are progressing toward completion."

4.2.4.2 Status of Recommendations

One issue with recommendation was made for the Hylebos Waterway in the third FYR, as described below, and an evaluation of progress follows.

- Issue: Arkema site source control is needed to meet RA performance standards.
- Recommendation: Perform RI/FS and RD/RA for the Arkema site to investigate and address contamination upland and beneath the waterway.

Note: This issue is now described as an action that needs to be implemented to complete remedial action. Thus, for this FYR, the action is listed in Table 7-2 as an action item that does not affect protectiveness.

RD and RA activities that were completed between 2001 and 2006 are documented in the 2011 RACR for the Head of Hylebos. RD and RA activities that have been completed recently were focused on sediment sampling. Sediment sampling of the sediment cap was completed on January 29, 2009, and there were no SQO exceedances for organic compounds, arsenic, or mercury.

Sediment sampling was conducted on October 19-20, 2010 (adjacent to the Schnitzer Steel of Tacoma shoreline sediment cap) after Ecology approved the Sediment SAP on April 14, 2010. PCBs, BEHP, BBP, mercury, and zinc exceeded the SQS or SQOs. A diver inspection of the outfall pipe during August 2010 found that approximately a 25-30 foot length of pipe was exposed; however, the outfall is still functional. Additional sediment sampling was conducted during February 14-17, 2012 at the Head of Hylebos Waterway. The 2012 sampling program was based on replicating the 2004-2006 post-dredging Type 4 confirmation sampling program. Concentrations of total PCBs, arsenic, zinc, and benzo(b+k)fluoranthene had increased in all sampled areas, and total PCBs in 2012 exceeded the SQO.

4.2.5. Five-Year Review Process

4.2.5.1 Administrative Components

The Hylebos Waterway FYR team was led by Jonathan Williams, EPA Remedial Project Manager (RPM). Deborah Johnston (biologist) with USACE, Seattle District, assisted with the review as a representative of the support agency.

By December 2013, the review team had been formed and the review schedule had been established for the following activities:

- Document collection and review;
- Data assessment and analysis;
- Site inspection;
- Interviews and community notification and involvement; and
- FYR report development and review.

The FYR has a statutory completion date of December 23, 2014.

4.2.5.2 Community Involvement

On January 17, 2014, a display advertisement ran in the Tacoma News Tribune newspaper providing notification and contact information for the FYR. In addition, on January 21, 2014, EPA Community Relations staff sent postcards to stakeholders and neighbors included on the CB/NT project mailing list (approximately 1,150 addressees), providing notification about the FYR process. Both notifications requested that any information that people would like EPA to consider during the review be provided to EPA before April 15, 2014.

On February 19, 2014, Kevin Rochlin, Bill Ryan, and Jonathan Williams (all with EPA Region 10) met with Bill Andersen, the Executive Director of Citizens for a Healthy Bay (CHB), at which time EPA provided information on CB/NT activities and preparation of the fourth FYR. A telephone interview was completed with CHB.

No input was received from the public for the overall CB/NT site Sediment OU or for the Hylebos Waterway.

4.2.5.3 Document Review

A review of reports pertinent to this FYR was conducted by the review team. The types of documents reviewed included decision documents, risk assessment documents, annual data reports, technical memoranda, and other supporting materials. OU 01 Attachment 1 is a complete list of documents reviewed during this FYR.

4.2.5.4 Data Review and Evaluation

Data review and evaluation of remedial activities are discussed in the previous Sections 4.2.3 and 4.2.4. In order to protect the remedy and prevent spreading of subsurface sediment contamination within waterways, EPA has, to a great extent, depended upon coordination with

USACE, Seattle District, who issues permits under the Clean Water Act for in-water construction projects. The Seattle District office has a Standard Operating Procedure (SOP) for coordinating with EPA prior to issuing permits within the CB/NT site. This SOP allows EPA to work through Seattle District to include permit conditions needed to prevent the spread of contamination and/or protect remedial actions already accomplished. The Seattle District Regulatory Branch has also developed standard permit language for CERCLA sites that is applied even if EPA does not identify any particular concerns or the need for particular permit conditions.

Operations, maintenance, and monitoring plans (OMMPs) are being developed for dredged, capped, and natural recovery areas within Hylebos Waterway. As the OMMPs are developed, EPA will evaluate whether some type of institutional controls are needed to supplement the OMMP provisions.

4.2.5.5 Interviews

No interviews were conducted.

4.2.6. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes.

However, not all remedial actions are complete. Ongoing response actions include RI/FS work associated with the Occidental site (Mouth of Hylebos Problem Area) and the Arkema site (Head of Hylebos Problem Area). A definitive assessment will require all aspects of the remedy to be completed, and will require trend analysis of long-term monitoring data.

The ROD addresses source control and sediment remediation needed to reach sediment cleanup objectives, which are then expected to provide a benthic habitat protective of human health and the environment. Source control efforts are continuing, focused on the Arkema and Occidental sites. Most surface sediment within the waterway has been remediated to SQOs.

To protect the remedy, EPA has, to a great extent, depended upon coordination with the USACE, Seattle District, as described above (under Data Review and Evaluation). OMMPs, which might include institutional controls (ICs), are being developed for long-term remedy protection and evaluation purposes. Sitewide ICs in the form of fish advisories have been put in place to provide current protectiveness.

Buried contaminated sediments are known and suspected to exist in some areas where remedial dredging did not occur. To remain protective, these areas need to be relatively quiescent and receive clean sediment. Active tugboat operations, both existing and proposed, in relatively shallow waters could bring contaminated sediment to the surface.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy still valid?

Answer: Yes.

Changes in Standards and To Be Considered. Applicable or relevant and appropriate requirements (ARARs) cited in the ROD were reviewed to evaluate changes in the ARARs, if any, since the third FYR. The 2013 revisions to the Sediment Management Standards (SMS) resulted in no material changes relative to the pre-revision SMS and MTCA. The marine sediment cleanup objective (SCO) benthic protection values under the 2013 SMS are the same as the 1991 SQS values (which were established after the 1989 CB/NT ROD was issued), and the requirements for protection of human health and higher trophic-level species are consistent with MTCA, which was promulgated in 1996. EPA has previously determined that the CB/NT ROD SQOs are protective in light of the 1991 SMS and MTCA.

There are no TBCs and no newly promulgated standards that might be ARARs to the site that affect the protectiveness of the remedy.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics. The ROD described current and future land uses and identified likely exposure pathways; at the time of this review, the descriptions of land use remain accurate for the Site conditions, and there are no actual or potential changes in exposure pathways that have occurred.

There have been no changes in the toxicity standards for the COCs that affect the protectiveness of the remedy. The Apparent Effects Threshold (AET) approach was used to establish both the ROD SQOs and the State SMS. It is acknowledged that for non-polar organic compounds, the ROD SQO values are in dry weight units (mg/kg) and the State SMS values (promulgated after the ROD) are in organic normalized dry weight units (mg/kg-organic carbon (oc)). However, when the State standards were developed using the AET approach, both total organic carbon (TOC)-normalized AET values and dry weight-normalized AET values were generated using the same data set of paired sediment chemistry and sediment toxicity test results. Unit conversions between dry weight and oc-normalized data are common in sediment evaluations.

It should be noted that since the ROD, the DMMP has listed both chlordane and dioxins/furans as bioaccumulative chemicals. Neither chemical was evaluated for human health risks in the RI/FS.

The USACE shoal sediment characterization study in 2013 identified dioxins/furans at concentrations of several hundred ppt TEQ. Almost all previous sediment quality investigations excluded analysis of dioxin/furan compounds, and the ROD does not have an SQO for dioxins/furans. Additional data, focused on surface sediment quality, would be needed to determine whether the contamination is site-related and action is warranted due to newly identified contamination.

Sediment sampling at the Head of Hylebos has identified that concentrations of some contaminants (e.g., PCBs and zinc) are trending upward. If these trends were to continue over time, and SQOs were exceeded more broadly in the area, then additional actions may be needed to ensure protectiveness. Ongoing sediment sampling will be used to monitor this trend.

Changes in Land Use. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

Remedial Action Objectives. The RAOs from the ROD are still valid and protective for the site.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

No other information is known that calls into question the protectiveness of the remedy.

4.2.6.1 Technical Assessment Summary

According to the data reviewed and information obtained, the remedy is incomplete but is functioning as intended where implemented; there is no information which definitively calls into question the anticipated protectiveness of the remedy once fully implemented. The most important actions that remain to be completed include source control efforts, with a particular focus on the Arkema and Occidental sites, and implementation of legally enforceable Institutional Controls to protect against future actions that could adversely impact areas of the waterway where sediment has been remediated. No other information is known that calls into question the protectiveness of the remedy. A meaningful long-term evaluation of remedy functionality will require all aspects of the remedy to be completed and sediment monitoring trends to remain favorable for some time.

4.2.7. Issues and Recommendations/Follow-up Actions

Issues and recommendations/follow-up actions that affect protectiveness for the Hylebos Waterway are provided in Section 7, Table 7-1.

Action items for the Hylebos Waterway that do not affect remedy protectiveness, but are expected to require future action, are presented in Table 7-2.

4.2.8. Protectiveness Statement

The protectiveness statement is provided in Section 8.

4.3. Sitcum Waterway

4.3.1. Background

The Sitcum Waterway is located between the Blair Waterway to the northeast and the former Milwaukee Waterway and Milwaukee Habitat Area to the southwest (see Figure 4-1). Sitcum Waterway is a deep navigational waterway that was created by dredging and filling native mudflats since 1910. The Port of Tacoma owns the submerged land and bottom sediment in the waterway and the land adjacent to the waterway. The Port operates Terminal 7 as a container handling and bulk unloading facility.

The Sitcum Waterway Problem Area comprised a 55-acre area of contaminated marine sediments in the main navigational channel and berth areas. Sediments were contaminated with metals (arsenic, cadmium, copper, lead, nickel, and zinc) and PAHs at concentrations above the

SQOs identified in the CB/NT ROD. Primary contaminant sources included historical releases of metal ores handled at Terminal 7, and releases from a stormwater outfall (SI-172) that discharges runoff from an industrial and commercial area covering approximately 170 acres. Contaminated sediments were dredged and disposed of in the Milwaukee Waterway NCDF. The Milwaukee Waterway Habitat Area and the Clear Creek Habitat Improvement Project (also known as the Clear Creek Phase 1 Area) are the mitigation sites for the Sitcum Waterway Remediation Project.

4.3.2. Site Chronology

Information for this section is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.3.3. Remedial Actions

4.3.3.1 Remedy Selection

Remedy selection for the CB/NT Sediments OU 01 is described in Section 4.1.

4.3.3.2 Remedy Implementation (Sources)

The major sources of contaminants to the waterway were addressed by the cessation of black ore off-loading at Terminal 7 and implementation of source control efforts (including storm drain sediment clean out) associated with the storm drain SI-172.

4.3.3.3 Remedial Action (Sediments)

Subsequent to EPA's issuance of the 1989 CB/NT ROD, the remedial action for addressing contaminated sediments in the Sitcum Waterway Problem Area was approved in a 1993 Explanation of Significant Differences (ESD). Based on these documents and the EPA-approved Remedial Design, the Sitcum Waterway Remediation Project included the following:

- Dredging approximately 428,000 cy of contaminated sediments from Sitcum Waterway for disposal in the Milwaukee Waterway NCDF[8].
- Dredging approximately 2.1 million cy of sediment from the Blair Waterway for construction of, and disposal in, the Milwaukee Waterway NCDF. Of the 2.1 million cy, 1,225,400 cy were designated as "clean" (appropriate for in-water disposal under DMMP) and targeted for construction of the Milwaukee Waterway nearshore fill berm. The remainder of the Blair Waterway sediment was targeted for disposal in the Milwaukee NCDF.

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8 The bulk of this volume, approximately 396,000 cy, was to be removed from the "Phase 1 Area," or bottom sediments from Sitcum Waterway, the extent of which was limited by riprap and Pier 7 along the northern shoreline. The "Phase 2 Area," or areas of sediment over existing riprap and slopes under Pier 7, was to be removed to the extent technically feasible. The ESD estimated approximately 32,300 yards would be removed in the Phase 2 Area. After construction, Phase 2 was to be evaluated for potential future action. In the EPA-approved memorandum from the Port, dated October 1, 1995, it was determined that no further action would be required in the Phase 2 Area, and that the area beneath Pier 7 would continue to be evaluated for monitored natural recovery as specified in the OMMP. The area beneath Pier 7 is now known as Area B, while the original Phase 1 Area is now known as Area A. Area B is a 4.5-acre monitored natural recovery area.

- Construction of a NCDF utilizing approximately 72 percent of the Milwaukee Waterway.

To compensate for the fill of the Milwaukee Waterway, construction of habitat mitigation occurred at two locations: 1) at the Milwaukee Habitat Area located in front of the nearshore fill closure berm in the Mouth of the Milwaukee Waterway, consisting of approximately 20 acres of intertidal habitat; and 2) at an "additional mitigation area" consisting of approximately 9.5 acres of restored, off-site, refuge habitat for salmon and other fish from the Puyallup River. Subsequent to the ESD, the Clear Creek Habitat Improvement Project[9] was selected as the "additional mitigation area."

Final dredging and fill volumes were adjusted slightly during construction. EPA approved the Construction Completion Report for the dredging of Sitcum and Blair Waterways, for the Milwaukee NCDF, and for the Milwaukee Habitat Mitigation Area on July 25, 1995. EPA approved the Construction Completion Report for the Clear Creek Habitat Area on December 17, 1998.

As discussed above, the ESD was issued and a consent decree for implementation of the Sitcum Waterway Remediation Project was finalized in 1993. In the consent decree, the Port committed to operate and maintain the NCDF and habitat restoration areas in the long term.

4.3.3.4 Post-Construction Monitoring/Operation and Maintenance

The long-term monitoring efforts associated with the Sitcum Waterway Remediation Project are documented in the OMMP for the Sitcum Waterway Remediation Project (1994, updated 1995). Long-term monitoring efforts have been completed for the sediments in Sitcum Waterway and for the mitigation sites associated with the Sitcum Waterway Remediation Project (i.e., Milwaukee Habitat Mitigation Area, Clear Creek Habitat Improvement Project). Results of those long-term monitoring efforts are described in previous FYRs. The only remaining long-term monitoring effort is for the Milwaukee NCDF.

4.3.3.5 Groundwater Quality Monitoring Associated with the Milwaukee Nearshore Confined Disposal Facility

Groundwater quality monitoring is associated with the Milwaukee NCDF, which was filled with contaminated sediment and completed in 1995. The groundwater monitoring program was designed to detect and evaluate possible long-term changes in groundwater quality in the areas surrounding the containment facility to ensure compliance with the performance standards (marine chronic criteria or ambient surface water quality in adjacent surface water, whichever is greater) at the point of compliance. The monitoring results provide information to determine whether certain constituents are being leached from the fill material and horizontally transported outside the fill area by groundwater. The point of compliance is the sediment/surface water

9 Attachment A to the CD (1993) detailed a conceptual design for the "Clear Creek" Habitat Improvement Project (sometimes referred to as the Clear Creek Phase 1 Project) proposed for the "additional mitigation" required in the ESD. The Clear Creek site is located near the mouth of Clear Creek, a left bank tributary of the Puyallup River near River Mile 2.9. The project was designed to provide refuge, feeding, and rearing habitat for juvenile salmonids and other wildlife in the lower reaches of the Puyallup River system. Project components included development of a pond/wetland habitat complex, excavation of a refuge bay, excavation of a tidal mudflat, improvement of upland habitat, and modification of the flood gate to facilitate passage of juvenile and adult salmonids and other fish.

interface outside of the berm and peninsulas. Stage 1 monitoring compares groundwater quality to baseline conditions.

Groundwater sampling and analysis is consistent with the Groundwater Sampling Operations Manual (Appendix A) included in the 1994 OMMP (Port of Tacoma 1994), with some modifications agreed to by the Port and EPA (see Hart Crowser 2013). In its transmittal letter for Round 2 monitoring (Port of Tacoma 2008), the Port proposed to add zinc as an additional indicator metal to the analyte list, since zinc has increasingly been identified as a metal of concern at a number of sites in Commencement Bay. EPA concurred with these recommendations and zinc was added to the analysis regime in 2013.

The first round of groundwater quality monitoring was completed in 2003, the second round was completed in 2008, and the third round was completed in 2013 (Hart Crowser 2013) with reported results that were approved by EPA in July 2013. Samples were collected in March and April 2013, and were analyzed for dissolved arsenic, copper, lead, nickel, zinc, salinity, and total organic carbon.

Based on Stage 1 monitoring results (2003, 2008, 2013), the monitoring program indicates that the performance standard at the point of compliance has not been exceeded. There have been no increases above baseline conditions, and thus no statistically significant increases, at any given well for any of the indicator metals. Based on analysis of indicator metals and conventional parameters, there appears to have been little to no change in containment facility fill conditions in MW-14 since post-construction baseline sampling in 1996. As Stage 1 monitoring indicated, there were no statistically significant increases at any given well in any of the rounds of monitoring, and concentrations were well below marine chronic water quality criteria; therefore, Stage 2 monitoring is not proposed.

These results indicate that the NCDF is functioning as intended, and that constituents are not being leached from the sediment fill.

All groundwater data have been input to the Washington State Department of Ecology Environmental Information Management (EIM) database, under the EIM Study ID “Sitcum Waterway”.

The next monitoring event is scheduled for March 2018.

4.3.4. Progress since the Last Five-Year Review

Since the third FYR, the 2013 groundwater monitoring effort associated with the Milwaukee NCDF was completed.

4.3.4.1 Previous Protectiveness Statement

The protectiveness statement in the third FYR (2009) stated:

> “The remedy at the Sitcum Waterway Problem Area is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.”

4.3.4.2 Status of Recommendations

There were no issues or recommendations/follow-up actions made for Sitcum Waterway in the third FYR (2009).

4.3.5. Five-Year Review Process

4.3.5.1 Administrative Components

The Sitcum Waterway FYR team was led by Karen Keeley, EPA RPM, Region 10.

By December 2013, the review team had been formed and the review schedule had been established for the following activities:

- Document collection and review;
- Data assessment and analysis;
- Interviews and community notification and involvement; and
- FYR report development and review.

The FYR has a statutory completion date of December 23, 2014.

4.3.5.2 Community Involvement

On January 17, 2014, a display advertisement ran in the Tacoma News Tribune newspaper providing notification and contact information for the FYR. In addition, on January 21, 2014, EPA Community Relations staff sent postcards to stakeholders and neighbors included on the CB/NT project mailing list (approximately 1,150 addressees), providing notification about the five-year review process. Both notifications requested that any information that people would like EPA to consider during the review be provided to EPA before April 15, 2014. A telephone interview was completed with Citizens for a Healthy Bay.

On February 19, 2014, Kevin Rochlin, Bill Ryan, and Jonathan Williams (all with EPA Region 10) met with Bill Andersen, the Executive Director of Citizens for a Healthy Bay (CHB), at which time EPA provided information on CB/NT activities and preparation of the fourth FYR.

No input was received from the public for the overall CB/NT site Sediment OU or for the Sitcum Waterway.

4.3.5.3 Document Review

The types of documents reviewed included documents related to the analysis of institutional controls. Results of long-term monitoring efforts were discussed in a previous section.

With regards to institutional controls, documents reviewed include:

- The Notice of Consent Decree for the Sitcum Waterway Remediation Project Consent Decree (No. 93-5462 RJB) was recorded in Pierce County on December 23, 2009.
- The Port of Tacoma finalized and recorded four Environmental Covenants pursuant to the

Uniform Environmental Covenants Act (UECA)[10]:

- o Second Amended and Restated Environmental Covenant for the Milwaukee Nearshore Confined Disposal Facility and Closure Berm, Sitcum Waterway Remediation Project, recorded in Pierce County on November 22, 2011.
- o Amended and Restated Environmental Covenant for the Milwaukee Habitat Area – Port of Tacoma-Owned, Sitcum Waterway Remediation Project, recorded in Pierce County on November 22, 2011.
- o Environmental Covenant for the Milwaukee Habitat Area – State-Owned within Port Aquatic Lands Management Area, recorded in Pierce County on December 14, 2011.
- o Clear Creek Habitat Improvement Project (Phase 1), recorded in Pierce County on May 6, 2010.

- For each of the properties subject to an Environmental Covenant related to the Sitcum Waterway Remediation Project, the Port of Tacoma provided institutional control information to the City of Tacoma for incorporation into the City's "govME" website, which is available at the link: http://wspwit01.ci.tacoma.wa.us/govME/Admin/Inter/StartPage/default.aspx

This website allows users to see locations of cleanup projects in relation to tax parcel numbers, as well as many other layers. In February 2012, EPA confirmed that the information was accurately entered on the website.

To be consistent with other document mapping, the City of Tacoma named the Sitcum Waterway documents as follows:

- o COV-0003 201111220132 (Milwaukee Nearshore Confined Disposal Facility and Closure Berm)
- o COV-0004 201111220414 (Milwaukee Habitat Area – Port of Tacoma Owned)[11]
- o COV-0005 201112140597 (Milwaukee Habitat Area – State-Owned within Port Aquatic Lands Management Area)
- o COV-0006 201112140598 (Aquatic Lands Easement for Conservation Uses).

- The Port of Tacoma provided Ecology with the Environmental Covenants for input into Ecology's UECA registry in the ISIS database[12]. In February 2012, EPA confirmed that

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10 The Uniform Environmental Covenants Act (UECA) was passed by the State of Washington in 2007. RCW 64.70.

11 UECA includes a requirement for consultation with the local land use planning authority. EPA formally consulted with the City of Tacoma for the two Milwaukee Habitat Area ECs, as documented in correspondence dated July 19, 2011.

12 Ecology's UECA registry is a download from Ecology's ISIS (contaminated sites) database. All environmental covenants are input to the ISIS database and the UECA web site searches the ISIS database to provide the report for a given geographical area. To access the UECA registry, start from Ecology's internet site: http://www.ecy.wa.gov/. In the green bar at the top click "databases." The fourth link is for Contaminated Site Cleanup, which is a direct link to the database https://fortress.wa.gov/ecy/tcpwebreporting/Default.aspx . Click "Create a Report" and select "Environmental Covenant Registry" report type. Click Environmental Covenants Registry Report, and select your filter criteria (i.e., zip code, county, site name). Click "show report." Scroll to the 13th column to see the county filing number. To see the actual document, use the County Auditor or Assessor Web site for the appropriate county. Specific instructions may change as the database may be revised in the future.

the information was accurately entered on the website.

- The State of Washington and the Port of Tacoma entered into an Aquatic Lands Easement for Conservation Uses (Easement No. 51-087166) related to the Sitcum Waterway Remediation Project, Milwaukee Habitat Area. The easement was recorded in Pierce County on December 14, 2011.

The CD for the Sitcum Waterway Remediation Project remains an effective Enforcement Tool and IC for requiring certain administrative duties in support of the remedy. With the additional covenant restrictions and general deed notices completed as part of the Port's IC analysis efforts, proprietary and informational controls should provide adequate and appropriate protectiveness and effectiveness. The proprietary controls will be properly executed, run with the land, and are effective for binding future interest holders.

4.3.5.4 Data Review and Evaluation

Results from the long-term monitoring activities are discussed in the previous section on Post-Construction Monitoring/O&M.

4.3.5.5 Site Inspection

EPA did not conduct any site inspections.

4.3.5.6 Interviews

An interview was performed by telephone with CHB for the overall CB/NT site. No comments were provided.

4.3.6. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes.

The remedial action is complete, long-term monitoring is complete, and all results show that performance standards were met. Institutional controls are in place to address all areas of site-related contaminants that are at levels that do not allow for unrestricted use/unrestricted exposure. Institutional controls are properly implemented and effective in preventing exposure and protecting the remedy, and mitigation habitat areas are also protected by Environmental Covenants.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy still valid?

Answer: Yes.

Changes in Standards and To Be Considered. See Section 4.2.6 (Question B).

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics. See Section 4.2.6 (Question B).

Changes in Land Use. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

Remedial Action Objectives. The RAOs from the ROD are still valid and protective for the site.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

No other information is known that calls into question the protectiveness of the remedy.

4.3.6.1 Technical Assessment Summary

According to the data reviewed, the remedy is functioning as intended by the ROD as amended by the ESD. There have been no changes in the ARARs, standards, or To Be Considered that could affect the protectiveness of the remedy. The remedy is still protective of human health and the environment. No other information is known that calls into question the protectiveness of the remedy

4.3.7. Issues and Recommendations/Follow-up Actions

No issues or recommendations/follow-up actions were identified during this fourth FYR for the Sitcum Waterway.

4.3.8. Protectiveness Statement

The protectiveness statement is provided in Section 8.

4.4. St. Paul Waterway

4.4.1. Background

The St. Paul Waterway is located between the Puyallup River to the north and the Middle Waterway to the south (see Figure 4-1). The St. Paul Waterway Problem Area is a 17-acre area of contaminated marine sediments adjacent to the Simpson Tacoma Kraft Mill (former owners include Champion International and St. Regis). Due to releases from the pulp and paper mill, sediments were contaminated with VOCs, SVOCs, PAHs, and organic debris.

4.4.2. Site Chronology

Information for this section is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.4.3. Remedial Actions

4.4.3.1 Remedy Selection

Remedy selection for the CB/NT Sediments OU 01 is described in Section 4.1.

4.4.3.2 Remedy Implementation (Sources)

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.4.3.3 Remedial Action (Sediments)

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.4.3.4 Post-Construction Monitoring/Operation and Maintenance

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

The remedial actions initiated for the St. Paul Waterway Problem Area of the CB/NT site have been successfully completed, long-term monitoring efforts have been completed, and the remedy implemented remains protective of human health and the environment.

4.4.4. Progress since the Last Five-Year Review

Between December 2004 and December 2009, EPA completed an IC analysis to ensure that ICs are consistent with recent EPA guidance and recommendations. Since 2009, EPA evaluated whether additional ICS are needed, and whether a decision document modification is appropriate. EPA determined that the ICs in place are protective for the long term.

4.4.4.1 Previous Protectiveness Statement

The protectiveness statement in the third FYR (2009) stated:

> "The remedial actions at the St. Paul Waterway Problem Area of the CB/NT Site have been successfully completed, all required long-term monitoring efforts have been completed, and the remedy remains protective of human health and the environment."

4.4.4.2 Status of Recommendations

There were no issues or recommendations/follow-up actions identified for St. Paul Waterway in the third FYR (2009).

4.4.5. Five-Year Review Process

4.4.5.1 Administrative Components

The St. Paul Waterway FYR team was led by Karen Keeley, EPA RPM, Region 10.

By December 2013, the review team had been formed and the review schedule had been established for the following activities:

- Document collection and review;
- Data assessment and analysis;
- Interviews and community notification and involvement; and

- FYR report development and review.

The FYR has a statutory completion date of December 23, 2014.

4.4.5.2 Community Involvement

On January 17, 2014, a display advertisement ran in the Tacoma News Tribune newspaper providing notification and contact information for the FYR. In addition, on January 21, 2014, EPA Community Relations staff sent postcards to stakeholders and neighbors included on the CB/NT project mailing list (approximately 1,150 addressees), providing notification about the five-year review process. Both notifications requested that any information that people would like EPA to consider during the review be provided to EPA before April 15, 2014. A telephone interview was completed with Citizens for a Healthy Bay.

On February 19, 2014, Kevin Rochlin, Bill Ryan, and Jonathan Williams (all with EPA Region 10) met with Bill Andersen, the Executive Director of Citizens for a Healthy Bay (CHB), at which time EPA provided information on CB/NT activities and preparation of the fourth FYR.

No input was received from the public for the overall CB/NT site Sediment OU or for the Sitcum Waterway.

4.4.5.3 Document Review

The only documents reviewed for this FYR were those reviewed as part of the institutional control analysis, as described below.

The third FYR (2009) for the CB/NT site included this text for the St. Paul Waterway:

> *"The Washington Department of Natural Resources indicated that a Notice of Consent Decree, pursuant to the 1991 Consent Decree, could not be found, and that a notice would be recorded in December 2009. The actual recording date for the notice will be provided in the next five-year review."*

The Washington Department of Natural Resources (DNR) recorded a Notice of Consent Decree, pursuant to the 1991 Consent Decree, with the Pierce County Auditor's Office on December 14, 2009. This action satisfies the requirement in the 1991 Consent Decree to record notice of the Consent Decree on the property DNR manages that is a part of the St. Paul Waterway remediation at the CB/NT site. Copies of the documents are in the EPA Site File.

In addition, the third FYR (2009) included this text:

> *"The evaluation of institutional controls concludes that ICs in place are satisfactory given circumstances of the St. Paul Waterway Problem Area cleanup and CD. However, the IC evaluation raises some questions about whether the existing decision document and/or ICs would be protective under potential future scenarios where there may be changes in land use either through lease agreements by Washington DNR, a subsequent owner of the Simpson Property, or property transfer from DNR. Over the next year, EPA will evaluate if additional ICS are needed, and whether a decision document modification*

is appropriate."

For the St. Paul Waterway, EPA has evaluated whether the existing decision document and/or ICs would be protective under potential future scenarios where there may be changes in land use either through lease agreements by Washington DNR, a subsequent owner of the Simpson Property, or property transfer from DNR.

In evaluating this issue, EPA has considered the terms and conditions of the St. Paul Waterway Consent Decree:

- The 1991 CD, Section VI, states, in part:

  "The obligations of each Settling Defendant who owns any interest in the Mill or property included in the St. Paul Waterway Problem Area, with respect to undertaking and maintaining the Work set forth in this Consent Decree and the attached Monitoring Plan, or developed there under, shall run with the land and shall be binding upon any and all persons who acquire any interest in the Mill or any property included in the St. Paul Waterway Problem Area. Within thirty (30) calendar days of the effective day of this Consent Decree, the Settling Defendants shall record a copy of this Decree with the Recorder's Office, Pierce County, Washington. A copy of the recorded notice shall be sent to EPA." [Paragraph 40]

  Paragraph 41 of the Consent Decree permits free alienation of the property within the Problem Area with 60 days notice to EPA of such alienation.

  Paragraph 42 of the Consent Decree requires that any deed, title, or other instrument of conveyance regarding the Mill or St. Paul Waterway Problem Area shall contain a notice that such property is the subject of this Consent Decree.

Additionally, DNR and Simpson entered into a lease and a Material Deposition Agreement that includes all of the 17 acres included in the cleanup area. The lease references the obligations of the parties to maintain the remedy under the 1991 CD. EPA confirmed that Simpson and the State complied with the requirements of the CD, and copies of the documents are in the EPA Site File.

As described in earlier FYRs, EPA conducted an analysis of the institutional controls to ensure that they are consistent with EPA's September 2004 "Strategy to Ensure Institutional Control Implementation at Superfund Sites." ICs were determined to be complete for St. Paul Waterway, and a "Notice of Consent Decree" has been recorded for the relevant properties.

Given site-specific information described above, including obligations as set forth in the CD and DNR Lease Agreements, EPA evaluated whether additional ICs were necessary and determined that the ICs in place are protective for the long term. No further work is required.

4.4.5.4 Data Review and Evaluation

Long-term monitoring has been completed for this site. No new data were made available for review.

4.4.5.5 Site Inspection

No site inspection was conducted.

4.4.5.6 Interviews

No interviews were performed.

4.4.6. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes.

The remedial action and long-term monitoring efforts are completed, and performance standards have been met. Institutional controls are in place to address all areas of site-related constituents that are at levels that do not allow for unrestricted use/unrestricted exposure. Institutional controls are properly implemented and effective in preventing exposure and protecting the remedy. Future long-term monitoring efforts associated with the sediment cap will occur if there is a significant earthquake or wind storm.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy still valid?

Answer: Yes.

Changes in Standards and To Be Considered. See Section 4.2.6 (Question B).

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics. See Section 4.2.6 (Question B).

Changes in Land Use. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

Remedial Action Objectives. The RAOs from the ROD are still valid and protective for the site.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

No other information is known that calls into question the protectiveness of the remedy.

4.4.6.1 Technical Assessment Summary

According to the data reviewed and information obtained from the site inspection, the remedy is functioning as intended by the ROD, as amended by the ESD. There have been no changes in the ARARs, standards, or To Be Considered that could affect the protectiveness of the remedy. The remedy is still protective of human health and the environment. No other information is known that calls into question the protectiveness of the remedy.

4.4.7. Issues and Recommendations/Follow-up Actions

No issues or recommendations/follow-up actions were identified during this fourth FYR for the St. Paul Waterway.

4.4.8. Protectiveness Statement

The protectiveness statement is provided in Section 8.

4.5. Middle Waterway

4.5.1. Background

The Middle Waterway is bordered by the Thea Foss Waterway on the southwest and the St. Paul Waterway on the northeast. The Middle Waterway is approximately 3,500 feet long and 300 feet wide. The total area of the Middle Waterway is approximately 49 acres. The head of the Middle Waterway consists of one of the few remaining natural intertidal mudflats in Commencement Bay.

Additional background information is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.5.2. Site Chronology

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

Key Middle Waterway actions that have been completed by the Middle Waterway Action Committee (MWAC) and the Washington Department of Natural Resources (DNR) since 2009 are presented below:

June 2009	MWAC completes Year 5 monitoring in Areas A and B
Summer 2009	DNR completes Year 5 monitoring in Area C
Summer 2010	DNR completes Year 6 monitoring in Area C
July 2012	MWAC completes Year 8 monitoring in Areas A and B
February 2013	MWAC completes Additional Response Action in Area A
June 2013	DNR completes Year 10 monitoring in Area C

4.5.3. Remedial Actions

4.5.3.1 Remedy Selection

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.5.3.2 Remedy Implementation (Sources)

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.5.3.3 Remedial Action (Sediments)

Since the third FYR, remedial activities in the Middle Waterway for Areas A and B, and Area C, have been completed as described below.

4.5.3.3.1 *Remedial Action - Areas A and B*

After evaluating the increasing sediment mercury concentrations reported in the third FYR, EPA determined that an additional response action (ARA) was required in Area A of the Middle Waterway. No additional remediation was conducted in Area B.

The EPA-approved Final Additional Response Action Completion Report (Anchor QEA 2013a) provides details of the ARA that was completed to address mercury concentrations near the Natural Recovery areas (sediment management units [SMUs] 4c and 25) of Area A (see Figure 4-3). The ARA included placement of Enhanced Natural Recovery (ENR) and shore protection material within and immediately adjacent to SMUs 4c and 25 and in portions of SMUs 19a, 19b, and 20 (location of SMUs are shown in Figures 4-3 and 4-4); removal of large broken concrete and debris that had been used as slope protection along the bank of SMU 25 to allow for placement of the material; and improvements to the uplands to allow access for placement of the ENR and shore protection materials. Locations of these actions are shown on Figure 4-4.

ARA construction occurred between January 23 and February 14, 2013. MWAC selected RV Associates, Inc. (RV Associates) to perform the construction activities, and Anchor QEA provided construction oversight. The construction activities included mobilization and upland property preparation, debris removal and disposal, placement of ENR material, placement of shore protection material, and property cleanup and demobilization. Before and after construction photographs of the ARA in Area A are shown on Figure 4-5.

The Year 10 Monitoring Event, which consists of a sediment sampling effort, is planned for summer 2014. This sampling event will also verify if the remedial action is working as designed.

Figure 4-6 shows the final EPA-Approved Remedies Applied to Areas A and B before the ARA was completed.

4.5.3.3.2 *Remedial Action - Area C*

No additional remediation has been conducted since the third FYR in Area C. Figure 4-7 shows the prior remedial actions completed in Area C (Hart Crowser 2013b).

4.5.3.3.3 *Post-Construction Monitoring/O&M - Areas A and B*

Long-term monitoring in Middle Waterway Areas A and B is being conducted in accordance with the Final Revised Operations, Monitoring, and Maintenance Plan – Areas A and B (Anchor 2005). The Year 0 monitoring occurred in two phases, in 2004 (Phase I) and 2005 (Phase II). Although the Year 0 monitoring occurred over 2 years, EPA and MWAC agreed that the Year 3 monitoring would occur in one phase in 2007. Per the requirement of EPA, Year 4 monitoring activities were conducted in 2008. The purpose of the Year 4 monitoring was to further evaluate surface sediment mercury concentrations within the areas treated with ENR, with Dredged with ENR, and with natural recovery (NR), and to perform the same analyses as those conducted in Year 3. The results of Year 3 and Year 4 were combined into one report. A summary of these previous years of sampling is available in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

Year 5 monitoring was conducted in the summer of 2009, and Year 8 monitoring was conducted in July 2012. Monitoring activities are discussed immediately below. Data review and evaluation is discussed in Section 4.5.5.4. Based on results of Year 5 monitoring efforts, EPA and MWAC determined that an ARA was necessary to address increasing mercury concentrations in sediment in the NR area of Area A (as described above). Figure 4-8 shows the location of surface sediment samples and dive transects for Year 8 (2012) sampling events.

Monitoring of Areas A and B –Year 5 (2009)

Surface Sediment Chemical Monitoring

Sediment samples were collected in areas identified as ENR, Dredged with ENR, and natural recovery remedies.

ENR and Dredged with ENR Monitoring

Year 5 monitoring activities were performed in areas with ENR (SMUs 8, 10, and 11) and Dredged with ENR remedies (Dredge Areas D-1, D-3, D-4 and portions of D-5 and D-6) to confirm that the RA work is achieving performance standards specified in the ROD. As part of Year 5 monitoring activities, surface sediment grabs were collected in June 2009 and submitted to the laboratory for chemical analysis of the COCs. Results from this sampling effort are provided in Section 4.5.5.

Natural Recovery Monitoring

Monitoring was performed in the NR areas, including SMUs 4c and 25, to confirm that the RA work is achieving performance standards specified in the ROD. In June 2009, a composite intertidal sample (0-10 cm) was collected by hand from the base of the slope representing the MWW-316 sample location (see Figure 4-3), and the sample was analyzed for COCs. A subtidal surface sediment discrete sample (0-10 cm) was also collected by boat, and the sample was analyzed for COCs. Results of the surface sediment chemistry analyses for this area are discussed in Section 4.5.5.

Visual Observations

Visual inspections were performed in ENR areas with surficial sediment cap monitoring and in dredged areas with backfill.

ENR with Surficial Cap Monitoring

Monitoring during Year 5 was performed in SMU 5a to confirm that the RA work is achieving performance standards specified in the ROD. The monitoring objective was achieved by conducting a visual inspection at low tide to assess the coverage of surficial cap material. Visual observations were collected on June 22, 2009, and the tidal elevation was between approximately -2.5 feet and -3.7 feet.

The inspection confirmed that surficial cap material was present in all areas, and no areas of concern were identified. Based on the visual survey and associated photographs from Year 5 and the previous monitoring events, the ENR with surficial cap remedy is achieving performance standards and no additional visual monitoring activities are recommended.

Dredged Areas with Backfill Monitoring

Monitoring was performed in Dredge Area D-2 to confirm that the RA work is achieving performance standards specified in the ROD. The monitoring objective was achieved by conducting a visual survey of the dredged areas with backfill to confirm the presence of the 2-inch layer of backfill material. Two locations (MWW-308 and MWW-309) were selected for the visual survey.

Based on the presence of habitat mix material on the surface of the area identified during Year 5 and previous monitoring events, the dredged areas with backfill remedy has achieved performance standards and is expected to continue to achieve performance standards.

Hydrographic/land Surveys and Visual Dive Inspections for Thick-Layer Caps

Hydrographic/land surveys and visual dive inspections were conducted for the thick-layer cap areas. Monitoring was performed during Year 5 in the thick-layer cap areas (Dredge Areas D-1 [east slope], portions of D-6, D-9, the Marine Railway, and Area B [SMU 53]) to confirm that RA work is achieving performance standards specified in the ROD. Monitoring activities that were implemented to achieve the monitoring objective included bathymetric/topographic surveys of the thick-layer cap areas, as well as dive/visual surveys with video or pictures of each thick-layer cap area.

In areas that had a silt layer depth greater than 2 cm that was covering the cap material, surface samples were collected using hand cores. Samples were analyzed for metals, PAHs, grain size, TOC, and total solids. Results from the samples are discussed in Section 4.5.5.

Bathymetric surveys conducted in the thick-layer cap areas in 2009 were compared to results from Year 3 (2007) monitoring results, and results indicate that the cap material is stable.

Monitoring of Areas A and B –Year 8 (2012)

Surface Sediment Chemical Monitoring

Samples were collected in areas identified as ENR and Dredged with ENR. Year 8 monitoring activities were performed in areas with ENR (SMUs 8, 10 and 11) and Dredged with ENR remedies (Dredge Areas D-1, D-3, and D-4, and portions of D-5 and D-6) to confirm that the RA work is achieving performance standards specified in the ROD. The monitoring objectives for Year 8 were achieved through sediment chemistry testing on surface material collected at various locations within ENR and Dredged with ENR areas.

As part of Year 8 monitoring activities, surface sediment grabs were collected in July and August 2012 and submitted to the laboratory for chemical analysis of the COCs to provide information about surface sediment chemistry. Results for Year 8 monitoring are discussed in Section 4.5.5.

Visual Observations

Visual inspections were performed in ENR areas with surficial cap monitoring and in dredged areas with backfill.

ENR with Surficial Cap Monitoring

Monitoring during Year 8 was performed in SMU 5a to confirm that the RA work is achieving performance standards specified in the ROD. The monitoring objective was achieved by conducting a visual inspection at low tide to assess the coverage of surficial cap material. Visual observations were collected on July 31, 2012, and the tidal elevation was between approximately -1.3 feet and -2.2 feet.

The inspection confirmed that surficial cap material was present in all areas, and no areas of concern were identified. Based on the visual survey and associated photographs from Year 8 and the previous monitoring events, the ENR with surficial cap remedy is achieving performance standards, and no additional visual monitoring activities are recommended.

Dredged Areas with Backfill Monitoring

Monitoring was performed in Dredge Area D-2 to confirm that the RA work is achieving performance standards specified in the ROD. The monitoring objective was achieved by conducting a visual survey of the dredged areas with backfill to confirm the presence of the 2-inch layer of backfill material. Two locations (MWW-308 and MWW-309) were selected for the visual survey.

Based on the presence of habitat mix material on the surface of the area identified during Year 8 and previous monitoring events, the dredged areas with backfill remedy has achieved performance standards and is expected to continue to achieve performance standards.

Hydrographic/Land Surveys and Visual Dive Inspections for Thick-Layer Caps

Hydrographic/land surveys and visual dive inspections were conducted for the thick-layer cap areas. Monitoring was performed during Year 8 in the thick-layer cap areas (Dredge Areas D-1 [east slope], portions of D-6, D-9, the Marine Railway, and Area B [SMU 53]) to confirm that

RA work is achieving performance standards specified in the ROD. Monitoring activities that were implemented to achieve the monitoring objective included bathymetric/topographic surveys of the thick-layer cap areas, as well as dive/visual surveys with video or pictures of each thick-layer area.

In areas that had a silt layer depth greater than 2 cm that was covering the cap material, surface samples were collected using hand cores. Samples were analyzed for metals, PAHs, grain size, TOC, and total solids. Results from the samples are discussed in Section 4.5.5.

Bathymetric surveys conducted in the thick-layer cap areas in 2012 were compared to results from 2009 surveys. Results indicate that the cap material is stable.

4.5.3.3.4 *Post-Construction Monitoring/O&M - Area C*

Monitoring activities in Middle Waterway Area C are being conducted in accordance with the Operations, Monitoring, and Maintenance Plan, Middle Waterway Problem Area C, Sediment Management Units 51a and 51b, Commencement Bay Nearshore/Tideflats Superfund Site (Hart Crowser 2006).

In Area C, the remedial action was completed by October 2004. Monitoring was conducted in 2004 for Year 0, in 2005 for Year 1, in 2007 for Year 3, and in 2008 for Year 4. A summary for these previous years of sampling is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

Monitoring results described in this FYR were conducted in summer 2009 for Year 5, summer 2010 for Year 6, and June 2013 for Year 10. Monitoring activities are discussed below. Data review and evaluation is discussed in Section 4.5.5.4.

Monitoring of Area C –Year 5 (2009)

Physical Monitoring

Observations were made regarding the overall tideflat condition and sediment characteristics at long-term monitoring locations as part of the physical assessment of the restored tideflat surface in SMU 51a and SMU 51b. The visual inspection for Year 5 (2009) was completed on August 18 and 19, 2009, during an approximately -2 foot elevation daytime tide. Survey efforts in Year 5 included a channel location survey of the City Outfall No. 200, a topographic survey of the SMU 51a and SMU 51b tideflat surface, and a baseline channel location/elevation survey of the northern Mylet stormwater drainage channel. The grade stake survey that had been conducted in previous years was discontinued for the Year 5 monitoring event following discussions with DNR and EPA, given the difficulty of maintaining reliable rebar survey stations. Alternatively, the broader topographic survey provides more representative data on tideflat elevation changes over a larger area.

No major areas of erosion or adverse backfill and thin-layer cap performance have been noted since completion of construction in 2004. Overall tideflat capping, restoration, and City Outfall No. 200 channel stabilization appear to be "self-maintaining" with no additional corrective actions needed, aside from the recommended replenishment of thin-layer capping material in the Mylet drainage channels.

Sediment Chemical Monitoring

Year 5 sampling of the backfilled surface of SMU 51a and capped surface of SMU 51b was conducted in August 2009. The Year 5 sampling grid was the same as for Year 3. In total, 25 discrete samples were collected from the upper 10 cm of the tideflat surface by hand during low-tide periods for the Year 5 event. Sampling also included three blind field duplicates of SMU 51a Grid G sample, SMU 51b Grid P sample, and sediment from crab and other invertebrate burrows to assess the potential effect of bioturbation from SMU 51b Grid O (O-Crab-2009 and O-Burrow-2009) and Grid P (P-Burrow-2009).

Sediment sample testing data to date indicate that the backfill and cap components of the remedy are performing as intended. Results from Year 5 monitoring are discussed in Section 4.5.5. Figure 4-9 (for SMU 51a) and Figure 4-10 (for SMU 51b) show the locations of samples and SQO exceedances for Year 5 monitoring.

Monitoring of Area C –Year 6 (2010)

Physical Monitoring

The Year 6 monitoring activities were focused on observing the physical condition of the project area, measuring the tideflat elevation to assess cap integrity, and assessing upland and tideflat habitat conditions. Additional activities included the repair of the northern Mylet drainage channel and completion of elevation surveys for the City Outfall No. 200 and northern Mylet drainage channels.

Overall, the physical characteristics of the remedy in Area C exhibit long-term integrity, with repair of the downcut area completed on September 8, 2010. The repair work involved placing one cubic yard of habitat mix in the eroded area of the Mylet channel. The performance of the repair appeared satisfactory about one month after placement.

Overall, the backfill and thin-layer caps in SMUs 51a and 51b, respectively, have maintained similar physical features over the past 6 years. The survey results for City Outfall No. 200 showed that there was no significant channel migration, erosion, or change in channel bottom elevations. Changes in elevation were within 0.1 foot of Year 5 (2009) elevations. Visual observations indicate that the channel migration is not compromising the integrity of SMU 51a backfill or downstream portions of the tideflat.

The maximum elevation loss at any point in SMU 51a and SMU 51b was 0.34 foot and the maximum gain was 0.44 foot. No measurement locations exceeded the threshold of 0.5 foot elevation loss in SMU 51b thin-layer cap.

Monitoring of Area C - Year 10 (2013)

Physical Monitoring

Observations were made regarding the overall tideflat condition and sediment characteristics at long-term monitoring locations as part of the physical assessment in Middle Waterway. The visual inspection for Year 10 was completed on August 29, 2013, during an approximately -2 foot elevation daytime tide. Visual inspections included observations of the physical appearance and integrity of the restored tideflat surface in SMU 51a and SMU 51b. Survey efforts in Year 10 included completion of a topographic survey to evaluate tideflat elevation, grade changes, channel migration, elevation near the City Outfall No. 200, and included completion of a topographic survey of the northern Mylet drainage channel.

Overall, the physical characteristics of the remedy in Middle Waterway Area C exhibit long-term integrity, as demonstrated from 10 years of post-construction monitoring. The backfill and thin-layer caps in SMUs 51a and 51b, respectively, have maintained similar physical features over the past 10 years. The only exception to this finding is localized erosion observed along the northern and central Mylet runoff drainage channels in SMU 51b sampling Grids O and P. This minor downcutting has locally affected the conditions on the thin layer cap, but does not appear to threaten overall performance. Following repairs to the northern Mylet drainage channel in 2010, an elevation survey conducted in 2013 showed no evidence of additional downcutting.

The topographic survey results concluded that there has been no significant channel migration erosion or change in the channel bottom elevations of City Outfall No. 200. The elevation survey concluded that one location in Grid O had an elevation loss of 0.51 foot and in Grid L an elevation loss of 0.99 foot. These two locations exceeded the early warning trigger of a 0.5-foot elevation loss on the SMU 51b thin-layer cap, but no locations exceeded the performance standard of greater than 1.0 elevation loss. A location and elevation survey of Mylet channel in Year 10 showed that the habitat mix remained on the channel floor at the area that had previously had the greatest downcutting.

Sediment Chemical Monitoring

Year 10 sampling of the backfilled surface of SMU 51a and capped surface of SMU 51b was conducted in April 2013. The Year 10 sampling grid was the same as for Years 3 and 5. In total, 20 discrete samples were collected from the upper 10 cm of the tideflat surface by hand during low-tide periods for the Year 10 event. Sampling also included two blind field duplicates of SMU 51a Grid CD sample and SMU 51b Grid O sample. One burrow sample (O-Crab-2013) was collected as a composite of excavated sediment material at the site of burrows located along the northern Mylet channel, in Grid P.

Sediment sample testing data to date indicate that the backfill and cap components of the remedy are performing as intended. As a result of elevated concentrations in the burrow sample, habitat mix and quarry spall was placed in the northern Mylet drainage channel to reduce potential transport of contaminated sediment caused by erosion and bioturbation. Results from Year 10 monitoring are discussed in Section 4.5.5. Figure 4-11 (for SMU 51a) and Figure 4-12 (for SMU 51b) show the locations of samples and SQO exceedances for Year 10 monitoring.

4.5.4. Progress since the Last Five-Year Review

Results from the OMMP activities are discussed in the previous Section 4.5.3, Post-Construction Monitoring/O&M.

4.5.4.1 Previous Protectiveness Statement

The protectiveness statement in the third FYR (2009) stated:

> "The remedial action in Middle Waterway has been completed, the remedy is currently protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled. In order for the remedy to remain protective in the long-term, the Sediment Quality Objectives need to be met according to the timeframes established in the Middle Waterway ESDs, or any exceedances need to be shown to be biologically insignificant in all ENR and natural recovery areas, and ICs must be fully implemented."

4.5.4.1.1 *Status of Recommendations*

Table 4-2 below presents the issues and recommendations made for the Middle Waterway in the third FYR and provides a progress evaluation.

Table 4-2. Recommendations for Middle Waterway from the Third FYR and Progress

Issue	Recommendations/Follow-up Actions	Progress	Year of Completion
Possible recontamination of surface sediments due to erosion and large burrowing organisms bringing the underlying, native sediments to the surface in Area C. Drainage from the Mylet property down-cutting such that the underlying tideflat and wood debris are exposed in Area C.	Chemical monitoring of burrows within drainage channels or other erosion features should be included in future monitoring events. Evaluate options to prevent further erosion.	Chemical monitoring of invertebrate burrows was completed in 2009 and 2013. Composite samples were collected in Grids O and P and in the Central and Northern Mylet Drainage channels. The results are documented in the DNR Year 5 (2009) monitoring report, Section 3.1 (Hart Crowser 2010) and Year 10 (2013) monitoring report, Section 3.2 and Section 5.1 (Hart Crowser 2013b).	2013
Ineffectiveness of grade stake survey due to stakes missing during survey monitoring in Area C.	Replace with periodic topographic surveys to map the long-term effects of the outfall on the tideflat and remedy performance.	Completed and documented in the DNR Year 10 (2013) monitoring report, Section 2.2.4 (Hart Crowser 2013b).	2013
SQO exceedances for mercury in Areas A and B in NR areas where SQOs are expected to be met within a ten year timeframe.	Continue monitoring and evaluate Year 5 data to evaluate potential causes of SQO exceedances in Areas A and B.	ARA was completed in February 2013 to address mercury exceedances. See Section 4.5.3 for additional information.	2013
SQO exceedance of bis (2-ethylhexyl) phthalate, with elevated (but below SQO) concentrations of mercury and PAH found in Area C sediments near the Mylet roof drain.	Include chemical monitoring of burrows within drainage channels or other erosion features in future monitoring events. Evaluate options to prevent further erosion.	Monitoring was completed and documented in DNR Year 10 (2013) monitoring report (Hart Crowser 2013b), and supplemental work to prevent erosion and bioturbation was also completed in summer 2013.	2013

Table 4-2. Recommendations for Middle Waterway from the Third FYR and Progress (continued)

Issue	Recommendations/Follow-up Actions	Progress	Year of Completion
Beached logs have been a problem primarily for the recovering pickleweed and other vegetation at the upper tidal levels at the head of the waterway due to smothering or sediment gouging.	Develop a Memorandum of Understanding (MOU) with Simpson. Also evaluate the possibility of installing a breakwater to replace the protective function of the former piling field.	No actions have been implemented. DNR attempted to work with Simpson but Simpson determined the logs are not their responsibility. In the past few years, DNR noted that the impact of the logs is less severe, and DNR does not intend to pursue the MOU at this time.	Agencies now agree that beached logs are not a CERCLA issue.
Institutional controls have not been fully implemented.	Conduct an IC study; follow up with the USCG about status of final regulated navigation area (RNA); verify that easements have been executed and recorded with Pierce County.	The Coast Guard was provided accurate coordinates in 2014 and is in the process of establishing an RNA in which certain activities that could damage the cap will be prohibited. An IC study has not been completed and it has not been documented that easements and/or environmental covenants have been executed and entered into Ecology's UECA registry in the ISIS database and the City of Tacoma govMe database.	Ongoing.
Year 5 monitoring results from summer of 2009 have not been included in this review and need to be evaluated to further assess status of sediments in the waterway.	Evaluate Year 5 data; discuss options and potential need for additional remedial action.	Based on evaluation of the Year 5 monitoring results, an ARA was completed in Area A. Results are discussed in Section 4.5.5. No further action is needed.	2013

4.5.5. Five-Year Review Process

4.5.5.1 Administrative Components

The Middle Waterway FYR team was led by Nancy Harney, the EPA RPM, Region 10. Karah Haskins (physical scientist) with the USACE, Seattle District, assisted with the review as a representative of the support agency.

By December 2013, the review team had been formed and the review schedule had been established for the following activities:

- Document collection and review;
- Data assessment and analysis;
- Interviews and community notification and involvement; and
- FYR report development and review.

The FYR has a statutory completion date of December 23, 2014.

4.5.5.2 Community Involvement

On January 17, 2014, a display advertisement ran in the Tacoma News Tribune newspaper providing notification and contact information for the FYR. In addition, on January 21, 2014, EPA Community Relations staff sent postcards to stakeholders and neighbors included on the CB/NT project mailing list (approximately 1,150 addressees), providing notification about the five-year review process. Both notifications requested that any information that people would like EPA to consider during the review be provided to EPA before April 15, 2014.

On February 19, 2014, Kevin Rochlin, Bill Ryan, and Jonathan Williams (all with EPA Region 10) met with Bill Andersen, the Executive Director of Citizens for a Healthy Bay (CHB), at which time EPA provided information on CB/NT activities and preparation of the fourth FYR. A telephone interview was completed with CHB.

No input was received from the public for the overall CB/NT site Sediment OU or for the Middle Waterway.

4.5.5.3 Document Review

A review of reports pertinent to this FYR was conducted by the review team. The types of documents reviewed included decision documents, risk assessment documents, annual data reports, technical memoranda, and other supporting materials. OU 01 Attachment 1 is a complete list of documents reviewed during this FYR.

An institutional control study has not been performed to date. A regulated navigation area (RNA) request was prepared for the thick-layer sediment cap areas in Middle Waterway and submitted to the USCG in the spring of 2005. The RNA will prohibit activities such as anchoring, dragging, trawling, or other activities that involve disrupting the function of the thick-layer caps. The USCG issued a Notice of Proposed Rulemaking for the Establishment of an RNA for the Middle Waterway cap areas. Final rule making had been delayed due to issues regarding the coordinates for the RNA. In January 2014, the coordinate issue was resolved and MWAC submitted updated coordinates to the Coast Guard. In February 2014, the Coast Guard indicated that the coordinates now match, and that they will move ahead with the notice of proposed rulemaking to establish the RNA.

4.5.5.4 Data Review and Evaluation

4.5.5.4.1 *Middle Waterway Areas A and B*

<u>Results for Areas A and B - Year 5 (2009)</u>

Results from Year 5 (2009) surface sediment sampling in the ENR areas and the Dredged with ENR areas are summarized below:

- One mercury exceedance (1.27 times the SQO) was observed at station MWW-324 (Dredged with ENR area).

- One exceedance of lead (1.60 times the SQO) was observed at station MWW-320 (Dredged with ENR area).

According to the Final Year 5 Monitoring Report (Anchor QEA 2011), the mercury concentrations in surface sediments were consistent with or below concentrations that were previously determined not to warrant cleanup action due to lack of biological impacts identified during bioassay testing in Area B. In the ENR and Dredged with ENR areas, average mercury concentrations in sediments for Years 3, 4, and 5 were well below the mercury SQO of 0.59 mg/kg. These findings support the assertion that the post-RA mercury concentrations within these areas are equilibrating with the surrounding sediment concentrations and that there is no increasing trend. The lead exceedance at Station MWW-320 was an isolated exceedance, and there was no trend from the previous sampling activities to indicate an increasing concentration of lead in this location.

Results from Year 5 of monitoring in the NR areas are summarized below:

- The results from the composite intertidal sample collected from the base of the slope from the top 10 cm representing the MWW-316 sample location detected a mercury exceedance (1.86 times the SQO). This result was unchanged from Year 4 monitoring.
- A subtidal surface sediment discrete sample (MWW-315) was collected by boat. Results for the analyses for this area indicated exceedance of mercury and zinc (12.7 and 1.78 times the SQO, respectively). This mercury concentration is greater than the concentrations identified in Area B that passed biological testing during the pre-RA sediment investigation (Anchor 2001).

Results from Year 5 monitoring in the thick-layer cap areas are summarized below:

- Samples MWW-507 and 508 collected within the Marine Railway area indicated mercury exceedances (2.7 and 1.05 times the SQO, respectively). A low-level copper exceedance (1.2 times the SQO) was also observed at MWW-508.
- A mercury exceedance was detected in sample MWW-503 (1.05 times the SQO) within Area D-6 underneath the dry dock.
- In area D-9 there was a minor exceedance of phenanthrene (1.2 times the SQO) at station MWW-502.

Similar to the mercury exceedances in the ENR and Dredged with ENR remedy areas, the mercury concentrations identified in these samples are consistent with or below concentrations that have been previously determined not to warrant cleanup action due to lack of biological impacts identified during bioassay testing in Area B.

Results for Areas A and B - Year 8 (2012)

Results from Year 8 (2012) surface sediment sampling in ENR and Dredged with ENR areas (no monitoring of NR areas occurred during Year 8 because of planned ARA) are summarized below:

- Three minor exceedances of the mercury SQO (between 1.05 and 1.1 times the SQO) were observed at stations MWW-313, MWW-320 and MWW-322, all within the Dredged with

ENR area.

- No SQO exceedances of any other analytes were observed.

According to the Year 8 Monitoring Report, the mercury concentrations are consistent with or below concentrations that have been previously determined not to warrant cleanup action due to the lack of biological impacts identified during bioassay testing in Area B. Average mercury concentrations within Dredged with ENR and ENR areas for Years 3, 4, 5, and 8 were well below the mercury SQO of 0.59 mg/kg. Average Year 8 mercury concentrations of 0.332 mg/kg within the Dredged with ENR and ENR areas remained consistent among those reported for Years 3, 4 and 5 (0.342, 0.249, and 0.276 mg/kg mercury, respectively).

Results from Year 8 (2012) surface sediment sampling from the thick-layer cap area are summarized below:

- One mercury exceedance (3.2 times the SQO) was observed at station MWW-803 in the thick-layer cap area of Marine Railway.
- One low-level copper exceedance (1.26 times the SQO) was observed at station MWW-803 in the thick-layer cap area of Marine Railway.

Similar to the mercury exceedances in the ENR and Dredged with ENR remedy areas, the mercury concentrations identified in these samples are consistent with or below concentrations that have been previously determined not to warrant cleanup action due to the lack of biological impacts identified during bioassay testing in Area B. A similar exceedance of the copper SQO within material that had accumulated on top of the thick-layer cap in the Marine Railway was observed during the Year 5 monitoring event. Overall, copper concentrations in the waterway are approximately 78 percent less than the concentrations that existed before the RA. Table 4-3 summarizes the post-remediation chemical exceedances in sediments for Areas A and B for 2007 through 2012.

Table 4-3. Areas A and B Post-Remediation Chemical Exceedances for 2007 through 2012 (Sediment SQO Exceedances Only)

Chemical	Unit	SQO1	No. Results	Min	Max	Average	No. of Exceedances[2]	Min EF3	Max EF
Year 3 (2007)									
Lead	mg/kg	450	25	5.2	530	70.3	1	1.18	1.18
Mercury	mg/kg	0.59	25	0.013	0.9	0.386	5	1.07	1.53
Benzo(a)anthracene	mg/kg	1600	25	3	1700	133	1	1.06	1.06
Benzo(g,h,i)perylene	mg/kg	720	25	2.3	1100	79.4	1	1.53	1.53
Fluoranthene	mg/kg	2500	25	6.8	3800	297	1	1.52	1.52
Year 4 (2008)									
Mercury	mg/kg	0.59	21	0.034	3.6	0.45	2	1.86	6.1
Year 5 (2009)									
Copper	mg/kg	390	29	18	480	130	1	1.23	1.23
Lead	mg/kg	450	29	4.4	720	65.2	1	1.6	1.6
Mercury	mg/kg	0.59	29	0.019	7.5	0.62	6	1.05	12.7
Zinc	mg/kg	410	29	23	730	119	1	1.78	1.78
Phenanthrene	mg/kg	1500	29	2	1800	178	1	1.2	1.2
Year 8 (2012)									
Copper	mg/kg	390	25	20	490	104	1	1.26	1.26
Mercury	mg/kg	0.59	25	0.052	1.9	0.394	4	1.05	3.22

1. SQO= Commencement Bay Sediment Quality Objectives
2. Exceedance= Result greater than SQO
3. EF= Exceedance Factor= Chemical Concentration/SQO

4.5.5.4.2 *Middle Waterway - Area C*

<u>Results for Area C - Year 5 (2009)</u>

Monitoring concluded that there was one SQO exceedance and three exceedances of early warning triggers[13] (one of these exceedances was in a field duplicate) in the Year 5 surface sediment samples.

- B-2-M-2009, benzyl alcohol exceeded the SQO. Also in sample B-2-M-2009, BEHP exceeded its early warning trigger.
- O-CRAB-COMP-2009 and field duplicate OD-CRAB-COMP-2009, composite samples collected from invertebrate burrow mounds along the Mylet central drainage channel, had mercury concentrations that exceeded the early warning trigger. The latter sample was composited from the excavated mound material at the burrow site.

<u>Results for Area C - Year 6 (2010)</u>

No surface sediment sampling occurred. Only visual monitoring was performed.

13 An early warning trigger occurred when the detected concentration exceeded one-half of the respective SQO.

<u>Results for Area C - Year 10 (2013)</u>

Monitoring concluded that there were two SQO exceedances and eleven exceedances of early warning triggers in the Year 10 surface sediment samples. The exceedances were observed in four samples:

- A-2-M-2013: Benzyl alcohol exceeded the SQO. Mercury, BEHP, benzoic acid, and phenol exceeded their early warning triggers.
- AB-M-2013: Nickel exceeded the early warning trigger.
- B-2-M-2013: BEHP and benzyl alcohol exceeded the early warning triggers.
- O-Crab-2013: The analyte 2,4-dimethylphenol exceeded the SQO. Mercury, naphthalene, phenanthrene, and total low molecular weight PAHs (LPAHs) exceeded their early warning triggers. This sample was composited from the invertebrate burrow mound material along the northern Mylet channel walls in Grid P.

Table 4-4 summarizes the post-remediation chemical exceedances in sediments for Area C for 2007 through 2013.

Table 4-4. Area C Post-Remediation (Sediment SQO Exceedances Only)

Chemical	Unit	SQO1	Max	No. of Exceedances2	Max EF3
Year 3 (2007)					
Bis(2-ethylexyl)phthalate	µg/kg	1300	1400	1	1.08
Year 5 (2009)					
Benzyl alcohol	µg/kg	73	140	1	1.92
Year 10 (2013)					
Benzyl alcohol	µg/kg	73	150	1	2.05
2,4-Dimethylphenol	µg/kg	29	42	1	1.45

1. SQO = Commencement Bay Sediment Quality Objectives
2. Exceedance = Result greater than SQO
3. EF = Exceedance Factor = Chemical Concentration/SQO

4.5.5.4.3 *Interviews*

An interview was performed by telephone with Citizens for a Healthy Bay for the overall CB/NT site. No comments were provided.

4.5.6. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes.

The current remedy for the Middle Waterway is functioning as intended by the ROD. The current state of each ROD cleanup objective and any indicators of remedy problems are described below:

- **Sediment Quality Goal: the sediment quality goal is a conceptual target condition for Puget Sound defined by element P-2 of the 1989 Puget Sound Water Quality**

Management (PSWQA) Plan as the absence of acute or chronic adverse effects on biological resources or significant human health risk.

Overall, the sediment concentrations have decreased since pre-remedial action. Quantitative data has not been collected to show an absence of acute or chronic adverse effects on biological resources or significant human health risk. In Areas A and B, surficial ENR material has remained in the general area in which it was placed, and the remedy is performing as designed. In Area C, there are finely structured, hair-like algae and various ulvoid algal species that have formed an almost continuous cover over the tideflat. These algal mats tend to trap fine silts and provide substrate for other plants and invertebrates.

- **Sediment Quality Objective: the sediment quality objective is a discrete and measurable target for project cleanup related to the Puget Sound goal. The objective is measurable in terms of specific human health risk assessments and environmental effects tests, and associated interpretive guidelines. The resulting biological effect levels or chemical concentrations are scientifically acceptable definitions of the sediment quality goal using available information.**

Sediment Quality Objectives were generally met throughout the site immediately following the remedial action. As stated in the ROD, the results of the risk assessments during the remedial investigation were used in the FS to develop sediment cleanup guidelines to protect human health and the environment.

To date, in Areas A and B, there are still some mercury concentrations that exceed the SQO. The mercury concentrations identified in these samples are consistent with or below concentrations that have been previously determined not to warrant cleanup action due to the lack of biological impacts identified during bioassay testing in Area B.

In Area C, drainage from the Mylet property has caused two channels to form in the thin-layer cap (enhanced natural recovery area). Following repairs to the northern Mylet drainage channel in 2010, an elevation survey conducted in 2013 showed no evidence of additional downcutting. Bioturbation (invertebrate burrowing) was noted in the Mylet drainage channel and chemical monitoring results show an SQO exceedance of 2,4-dimethylphenol in sample O-Crab-2013 collected from the northern Mylet drainage channel. Also in Area C is the City Outfall No. 200 channel, which could potentially be affecting concentrations in this area. There is no indication that the detections in this area are related to the performance of the SMU 51a backfill, or the restored outfall channel. To date, sediment concentrations remain below the SQO, with the exception of benzyl alcohol and 2,4-dimethylphenol.

- **Sediment Remedial Action Level (SRAL): the sediment remedial action level differentiates areas that exceed the sediment quality objective, but are predicted to recover naturally, from those that are more significantly contaminated and therefore require active remediation to achieve the SQO. The intent of any active remediation of sediments is to achieve a net environmental and public health benefit, and therefore requires consideration of habitat issues.**

The SRAL is used to evaluate natural recovery areas. In Areas A and B there were two sample locations (MWW-315 [subtidal discrete] and MWW-316 [intertidal composite]) that showed mercury exceedances in Year 5 (2009). Sample results from these locations were similar compared to the previous year's mercury results, which were greater than the concentrations identified in Area B that passed biological testing during the pre-RA sediment investigations. An ARA was completed to address the mercury concentrations, and sampling of this area will be conducted in summer 2014.

- **Source Control Level: the goals and objectives of source control are defined as targets that will achieve respective sediment goals and objectives. Source control will be implemented according to ARARs and All Known, Available, and Reasonable Treatment (AKART) Systems. Compliance with the sediment quality objective will be confirmed through monitoring.**

  Data indicate that there may be source control issues in Middle Waterway. In Area A and B, the elevated mercury concentrations in the ENR areas could be attributed to site activities not yet identified such as prop wash, dry dock activities, and releases permitted under the National Pollutant Discharge Elimination System (NPDES). There is also the possibility that increases in mercury concentrations compared to Year 0 may be attributed to the natural redistribution of sediments that had concentrations that were above the SQO. Although exceedances were observed, the concentrations are generally below the levels found to have impacts from biological testing conducted during pre-remedial design. Ongoing evaluation is required to determine the impacts of this recontamination and the need to address it.

There is no site-specific habitat mitigation objective outlined in the ROD. Habitat function and enhancement of fisheries resources are incorporated as part of the overall project cleanup objective. Habitat mitigation objectives and goals are site-specific and were developed for the site prior to construction. Generally, the mitigation sites are performing in accordance with the project goals.

Institutional controls are related to the long-term integrity of the thick-layer cap areas. A regulated navigation area (RNA) request has been prepared for the thick-layer cap areas and was submitted to the USCG in the spring of 2005. In January 2014, discrepancies were resolved, and the Coast Guard is moving forward with establishing the RNA. Within the RNA, activities such as anchoring, dragging, trawling, or other activities that could disrupt the function of the thick-layer caps will be prohibited. An Institutional Control Implementation Plan should be prepared by the Respondents to ensure that all required institutional controls are in place, and that environmental covenants have been prepared for areas with capped remedies. Environmental covenants should be recorded, and submitted to Ecology for the ISIS database and to the City of Tacoma for the govMe website.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy still valid?

Answer: Yes.

Changes in Standards and To Be Considered. See Section 4.2.6 (Question B).

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics. See Section 4.2.6 (Question B).

Changes in Land Use. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

Remedial Action Objectives. The RAOs from the ROD are still valid and protective for the site.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

No other information is known that calls into question the protectiveness of the remedy.

4.5.6.1 Technical Assessment Summary

According to the data reviewed and information obtained from the visual observations, the remedy is functioning as intended by the ROD, as amended by the ESD, because the remedial action was successful in significantly decreasing PAH and metals concentrations in Middle Waterway sediments.

In Areas A and B, exceedances of mercury have been identified during the course of two monitoring events (Years 5 (2009) and Year 8 (2012) post-construction) in both the Dredged with ENR area and NR area. To address the mercury concentrations in the NR area from Year 5 monitoring, an ARA was completed in February 2013. During Year 8 monitoring there were only 4 locations that exceeded the mercury SQO. This change represents considerable improvement from Year 1, when 45 locations exceeded the SQO. According to the ESD, there is a 10-year timeframe to meet the overall sediment cleanup objectives, and there is approximately 1 year remaining to determine if the remedy has been successful. In the interim, sediment concentrations will continue to be monitored, and the need for further remedial action will be assessed.

In Area C, the SMU 51a backfill and the SMU 51b thin-layer capping are performing as anticipated. There were two exceedances of SQO levels. One exceedance was near the City Outfall No. 200 channel and could potentially be due to off-site sources from runoff discharge. The other location was a composite sample of invertebrate burrow mound material in the northern Mylet channel walls. Supplemental construction work was completed in summer 2013 to reduce erosion and bioturbation in the northern Mylet drainage channel. Further physical and chemical monitoring of the northern Mylet channel will determine if bioturbation is transporting contaminated sediment to the surface.

There have been no promulgated changes in the ARARs, standards or To Be Considered, only non-promulgated changes to the AET database from which the SQOs were derived. No other information is known that calls into question the protectiveness of the remedy.

4.5.7. Issues and Recommendations/Follow-up Actions

No issues or recommendations/follow-up actions were identified during this fourth FYR for Middle Waterway.

Action items that do not affect protectiveness, but are expected to require future action, are listed in Table 7-2.

4.5.8. Protectiveness Statement

The protectiveness statement is provided in Section 8.

4.6. Olympic View Resource Area

4.6.1. Background

The Olympic View Resource Area (OVRA) is offshore of the peninsula between the Thea Foss and Middle Waterways (Figure 4-13). The OVRA site was not identified as a problem area in the CB/NT ROD, but sediment contamination was identified in 1998. Pursuant to an EPA AOC, the City performed a non-time-critical removal action to address approximately 3 acres of contaminated marine sediments at OVRA. EPA's Action Memorandum was signed in July 2001.

The primary COC found in sediments at the OVRA site was dioxins. Sediments contaminated with certain metals (arsenic, copper, mercury, and zinc), PCBs, and PAHs were more localized and did not exhibit the broader distribution shown for dioxin-contaminated sediments. The CB/NT SQOs were used as cleanup standards for OVRA, as well as a site-specific sediment quality criterion of 20 parts per trillion (ppt) Toxicity Equivalent Quotient (TEQ) dioxins.[14] TEQ is the expression of toxicity based on the overall toxicity of specific congeners of a compound containing multiple congeners.

4.6.2. Site Chronology

Information for this section is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.6.3. Removal Actions

4.6.3.1 Remedy Selection

Remedy selection for the OVRA non-time-critical removal action is described in Section 4.1.8.

4.6.3.2 Remedy Implementation (Sources)

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

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14 As set forth in the Action Memorandum for OVRA, the sediment quality criterion of 20 ppt TEQ dioxins will ensure that the average remaining concentration at the OVRA will not exceed the site-specific background concentration of 7.4 ppt TEQ dioxins. This SQO and the background approach used to derive it are not necessarily applicable to other Superfund sites or problem areas identified in the CB/NT ROD.

4.6.3.3 Removal Action (Sediments)

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

4.6.3.4 Post-Construction Monitoring/Operation and Maintenance

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

All long-term monitoring efforts for the sediment remedy at OVRA have been completed. Since the third FYR, no long-term monitoring or operation and maintenance activities have been completed.

4.6.4. Progress since the Last Five-Year Review

Since the third FYR, no long-term monitoring or operation and maintenance activities have been completed.

4.6.4.1 Previous Protectiveness Statement

The protectiveness statement in the third FYR (2009) stated:

> "The remedy at the Olympic View Resource Area is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled."

4.6.4.2 Status of Recommendations

There were no issues or recommendations/follow-up actions made for Olympic View Resource Area in the third FYR (2009).

4.6.5. Five-Year Review Process

4.6.5.1 Administrative Components

The OVRA FYR team was led by Karen Keeley, EPA RPM, Region 10.

By December 2013, the review team had been formed and the review schedule had been established for the following activities:

- Document collection and review;
- Data assessment and analysis;
- Site inspection;
- Interviews and community notification and involvement; and
- FYR report development and review.

The FYR has a statutory completion date of December 23, 2014.

4.6.5.2 Community Involvement

On January 17, 2014, a display advertisement ran in the Tacoma News Tribune newspaper providing notification and contact information for the FYR. In addition, on January 21, 2014, EPA Community Relations staff sent postcards to stakeholders and neighbors included on the CB/NT project mailing list (approximately 1,150 addressees), providing notification about the FYR process. Both notifications requested that any information that people would like EPA to consider during the review be provided to EPA before April 15, 2014. A telephone interview was completed with Citizens for a Healthy Bay.

On February 19, 2014, Kevin Rochlin, Bill Ryan, and Jonathan Williams (all with EPA Region 10) met with Bill Andersen, the Executive Director of Citizens for a Healthy Bay (CHB), at which time EPA provided information on CB/NT activities and preparation of the fourth FYR.

No input was received from the public for the overall CB/NT site Sediment OU or for the OVRA.

4.6.5.3 Document Review

For this FYR, there were no long-term monitoring reports for the sediment cleanup project.

With regard to institutional controls, EPA confirmed that the boundaries of the sediment cap at the OVRA site are accurately documented in the City of Tacoma, Government Made Easy (govME) website (Figure 4-14).

The City of Tacoma added information about the OVRA site to its govME website http://wspwit01.ci.tacoma.wa.us/govME/Admin/Inter/StartPage/default.aspx) , which allows users to see locations of cleanup projects in relation to tax parcel numbers, as well as many other map layers.

Public access, signage, and marker buoys remain in effect at the site. Desiree Pooley (City of Tacoma) has confirmed that the signage at OVRA is still in place, and that two of three marine buoys are in place (Pooley, D., personal communication, 8 January 2014, email to Karen Keeley, EPA). A replacement third buoy was ordered and was installed on February 17, 2014, and new No Anchor labels were placed on each of the three buoys on the same date. Figure 4-15 shows the current flyer that is distributed by the City of Tacoma to inform boaters of the Regulated Navigation Area at the site. Desiree Pooley, City of Tacoma Project Manager, contacted CHB and City of Tacoma police and fire boats to confirm that parties had adequate flyers for distribution to boaters.

4.6.5.4 Data Review and Evaluation

No long-term sediment monitoring activities were conducted during the period of this FYR. The City of Tacoma continues to maintain site access and related institutional controls.

Since the OVRA project was also a restoration project for the Natural Resource Trustees, the City of Tacoma performs an “Environmental Stewardship Project, Qualitative Ground Survey” at OVRA during the winter (generally February) and the summer (generally August). These twiceyearly surveys include photo documentation of the project area and qualitative observations of habitat, including plantings and wildlife.

4.6.5.5 Site Inspection

Site inspections by the City of Tacoma have occurred annually. No issues were identified.

4.6.5.6 Interviews

Interviews were performed by telephone with Desiree Pooley, City of Tacoma, for the OVRA.

4.6.6. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes.

The remedial action is complete, five years of long-term monitoring is complete, and all results show that performance standards were met. Institutional controls are in place to address all areas of site-related constituents that are at levels that do not allow for unrestricted use/unrestricted exposure. Institutional controls are properly implemented and effective in preventing exposure and protecting the remedy.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy still valid?

Answer: Yes.

Changes in Standards and To Be Considered. See Section 4.2.6 (Question B).

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics. The Action Memorandum described current and future land uses and identified likely exposure pathways; the descriptions are accurate for the site conditions at the time of this review.

Changes in Land Use. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

Remedial Action Objectives. The RAOs from the Action Memorandum are still valid for the site.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

***Answer: No*.**

No other information is known that calls into question the protectiveness of the remedy.

4.6.6.1 Technical Assessment Summary

According to the data reviewed and information obtained from the site inspection, the remedy is functioning as intended by the Action Memorandum. There have been no changes in the ARARs, standards, or To Be Considered that could affect the protectiveness of the remedy. The remedy is still protective of human health and the environment. No other information is known that calls into question the protectiveness of the remedy.

4.6.7. Issues and Recommendations/Follow-up Actions

No issues or recommendations/follow-up actions were identified during this fourth FYR for the OVRA.

4.6.8. Protectiveness Statement

The protectiveness statement is provided in Section 8.

4.7. Thea Foss and Wheeler-Osgood Waterways

4.7.1. Background

The Thea Foss Waterway is the western-most waterway in Commencement Bay, and is adjacent to the downtown core of the city of Tacoma. The waterway runs north-south and makes up about 1.5 miles of downtown shoreline (110 acres) for the City. The Wheeler-Osgood Waterway is approximately 0.3 miles long, runs east-west, and enters the Thea Foss Waterway approximately halfway down the east shoreline, just south of the 11th Avenue Bridge and north of J.M. Martinac Shipbuilding. See Figure 4-16 for waterway locations. The land use along the waterways was primarily industrial from the early 1890s until the 1980s.

In the past 25 years, the City of Tacoma and other entities have worked to enhance public access and create green spaces along the Thea Foss Waterway. A significant urban renewal project is underway along the waterway. Marinas have been upgraded and new development has occurred, such as the Tacoma Glass Museum, a renovated Albers Mill, and Thea's Landing condominiums. Active commercial businesses remain along the waterway such as marinas, J.M. Martinac, and Johnny's Restaurant and Johnny's Seafood. The majority of the submerged lands of the Thea Foss Waterway are state-owned aquatic lands, managed by DNR. The Wheeler-Osgood Waterway is privately owned.

Contaminants found at elevated levels in the Thea Foss and Wheeler-Osgood Waterways include zinc, lead, mercury, cadmium, copper, nickel, PAHs, 2-methylphenol, 4-methylphenol, BEHP, BBP, and PCBs. In addition to these contaminants, non-aqueous phase liquid (NAPL) seeps have been found at the head of the Thea Foss Waterway. Two responsible parties are implementing the remedy: the Utilities party is responsible for cleaning up the head of the Thea Foss waterway, and the City is responsible for the remaining areas.

4.7.2. Site Chronology

Information through 2009 is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

Key activities for the waterways since 2009 are presented below:

October 2009-2013	Annual Qualitative Ground Surveys completed (both City and Utilities work areas)
November 2009	Additional planting area constructed in Puyallup River Channel Side Channel Habitat Area
February 2010	Additional planting area constructed in North Beach Habitat Area
December 2010	City's Year 4 Annual Operations, Maintenance, and Monitoring Plan (OMMP) Report completed
January 2011	Coast Guard rule establishing regulated navigation area in Thea Foss Waterway finalized
February 2011	Technical Memorandum documenting changes to City's 2006 OMMP
October 2011	Utilities' Year 7 OMMP Head of Thea Foss Report completed
December 2011	Additional planting area constructed in the Middle Waterway Tideflat Habitat Area
December 2012	Technical Memorandum documenting changes to City's 2006 OMMP
December 2012	Remediation of American Plating property completed
November 2013	City's Year 7 Annual OMMP Report completed

4.7.3. Remedial Actions

4.7.3.1 Remedy Selection

Remedy selection for the CB/NT Sediments OU 01 is described in Section 4.1.

4.7.3.2 Remedy Implementation (Sources)

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

In the course of developing the remedial design for waterway sediments required by the AOC, the City identified marinas as a source of contamination to waterway sediment for PAHs and phthalates. The predicted impacts of marinas to sediment were cause for concern because marinas are an important part of the existing waterway, as well as critical to the City's plans for downtown redevelopment. The City and the Foss Waterway Development Authority began working with the DNR, Ecology, marina owners, marina operators, and marina clients on ways to manage and minimize the predicted impacts of marinas on sediments.

The need for additional source control is driven by the need to protect post-remediation sediment quality in the waterways from urban contaminants conveyed in municipal stormwater and is evaluated using multiple lines of evidence: long-term outfall monitoring, computer model predictions, and post-construction sediment quality monitoring. The City continues to evaluate potential sources of concern for the Thea Foss basin through monitoring of stormwater, baseflow, and particulate matter in seven outfalls. The City is continuing to evaluate possible stormwater treatment options. As additional sediment sampling results become available, the areas and need for further source control measures will be identified.

4.7.3.3 Remedial Action (Sediments)

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

For background, remedial action construction was completed in 2006 by the City of Tacoma under a Consent Decree issued by the EPA. The Utilities are responsible for Remedial Action (RA) areas 23 and 24, consistent with the Consent Decree, and portions of RAs 19b, 20, and 22, as described in a confidential agreement with the City of Tacoma. Portions of the waterway south of a sheet pile wall installed at Station 70+10 are the responsibility of the Utilities. Construction of the remedy for the Utilities' Work Area was completed in February 2004. See Figures 4-17a and 4-17b (a two-part figure) for the RA areas.

4.7.3.4 Post-Construction Monitoring/Operation and Maintenance

4.7.3.4.1 *City's Area*

Following the completion of the City's remedial action activities, the OMMP for the City's work area was finalized based on as-built conditions. The City's OMMP sampling program includes the following:

- Performance monitoring of capped, enhanced natural recovery, and natural recovery areas located within the Thea Foss and Wheeler-Osgood Waterways to evaluate the long-term effectiveness of the remedial actions and progress toward natural recovery;
- Cap integrity monitoring through low tide inspections and hydrographic surveys to ensure that the sediment caps remain intact;
- Early warning monitoring of remediated areas within the Thea Foss and Wheeler-Osgood Waterways to evaluate the potential for recontamination;
- Benthic recolonization monitoring to evaluate the post-construction recovery of benthic organism communities within the Thea Foss and Wheeler-Osgood Waterways;
- Monitoring of groundwater quality in the vicinity of the St. Paul Confined Disposal Facility (CDF), to ensure the contaminated dredged sediments are effectively contained in the disposal facility; and
- Habitat area monitoring to evaluate habitat conditions established within the project area

and to confirm that mitigation sites are making progress toward providing habitat function necessary to meet site specific objectives.

Monitoring activities were conducted in 2009, 2010, 2011, 2012 and 2013 (Monitoring Years 3 – 7) during this review period. Surveys were conducted in each of these years, with more comprehensive monitoring being conducted in Years 4 (2010) and 7 (2013). The Year 7 monitoring results represent the most current and comprehensive characterization of the condition of the various remedy components within the City's work area, but all years are reported below.

Monitoring by City –Year 3 (2009)

Operations, maintenance, and monitoring activities were performed during Year 3 throughout the waterways, at the confined disposal facility (CDF), and at the habitat areas within the Thea Foss Project site. Monitoring conducted in Year 3 included qualitative habitat ground surveys, elevation monitoring, juvenile salmonid monitoring, invertebrate monitoring, and water surface elevation monitoring.

Baseline Confined Disposal Facility monitoring

Ambient surface water samples detected copper and nickel at similar concentrations at all locations sampled. Groundwater sampling found mercury and PAHs in contaminated sediments in the CDF. Wells outside the CDF showed no elevated PAHs. The majority of the analytes showed relatively stable concentrations over time.

Habitat Mitigation Area Monitoring (2009)

The habitat mitigation areas for the project are the North Beach Habitat, Middle Waterway Tideflat Habitat, Puyallup River Side Channel, and the Hylebos Creek Mitigation site. The Thea Foss Habitat Enhancement Areas are Johnny's Dock Habitat Enhancement, Head of Thea Foss Shoreline Habitat, SR 509 Esplanade Riparian Habitat and the Log Step Habitat Enhancement. Year 3 habitat monitoring activities were initiated on May 5, 2009, and continued intermittently at the various sites until September 1, 2009. The activities at each area are presented below.

North Beach Habitat

The qualitative ground survey was conducted on June 25, 2009. There were no indications of animal damage or vandalism. There is no indication of vegetative disease with the exception of the remnant effects of the willow weevil. Repairs to the goose exclusion grids are needed. There continues to be minimal success of saltgrass but the pickleweed is spreading in the marsh restoration area. There is mixed success survival of the riparian plantings. Invasive species need weed management. Sediment elevation changes averaged +1.2 inches from baseline. Juvenile salmonids were not observed during the May 6-7, 2009 event, but were observed during the May 27, 2009 event.

Middle Waterway Tideflat Habitat

The qualitative ground survey was conducted on June 25, 2009. There were no indications of animal damage or vandalism. There is no indication of vegetative disease. The goose exclusion grids are generally in good condition. Vegetative plantings in the riparian zone are doing well with high survival rates in the irrigated areas. Invasive species need weed management. Sediment elevation changes averaged -1.6 inches from baseline. Juvenile salmonids were observed during both May events.

Puyallup River Side Channel

The qualitative ground survey was conducted on June 24, 2009. There were minimal indications of animal damage (beaver removing vegetation) or vandalism. There is no indication of vegetative disease. Vegetative plantings in the riparian zone are doing well. Sediment elevation changes averaged +3.0 inches from baseline. Juvenile salmonids were not observed during the May events.

Hylebos Creek Mitigation Site

The qualitative ground survey was conducted on June 24, 2009. There no indications of animal damage or vandalism. There is minimal indication of vegetative disease (willow leaf galls). Vegetative plantings in the riparian zone are doing well. Invasive species need weed management. Sediment elevation changes averaged +0.4 inches from baseline. Juvenile salmonids were not observed during the May events.

Johnny's Dock Habitat Enhancement

The qualitative ground survey was conducted on June 23, 2009. There no indications of animal damage or vandalism. There is no indication of vegetative disease. Vegetative plantings in the marsh zone are doing well with the saltgrass covering approximately 95% of the area.

Head of Thea Foss Shoreline Habitat

The qualitative ground survey was conducted on June 23, 2009. There no indications of vandalism and minimal geese damage to the planted vegetation. This may be due to the removal of the goose exclusion grid. There is no indication of vegetative disease. Vegetative plantings in the marsh zone are doing well with the gumweed spreading to the upper beach area. Invasive species need weed management.

SR 509 Esplanade Riparian Habitat

The qualitative ground survey was conducted on June 23, 2009. There no indications of vandalism or animal damage. There is no indication of vegetative disease. Vegetative plantings in the marsh zone are doing fairly well. Invasive species need weed management.

Log Step Habitat Enhancement

The qualitative ground survey was conducted on June 23, 2009. There no indications of vandalism or animal damage. There is no indication of vegetative disease even with the removal of the goose exclusion grid. Vegetative plantings in the marsh zone are doing fairly well. Invasive species need weeding management.

Monitoring by City –Year 4 (2010)

Operations, maintenance, and monitoring activities were performed during Year 4 (2010) throughout the waterways, at the confined disposal facility, and at the habitat areas within the Thea Foss Project site. Sediment remediation area performance monitoring is conducted to evaluate the long-term effectiveness of sediment caps, enhanced natural recovery, and natural recovery remedies implemented by the City of Tacoma. See Figures 4-17a and 4-17b for locations of RA areas. Monitoring conducted in Year 4 (2010) included the following: low tide slope cap inspections, subtidal cap hydrographic surveys, sediment quality observations, sediment profile imaging, CDF performance monitoring, and qualitative ground surveys and quantitative vegetation surveys in habitat areas.

Low Tide Slope Cap Inspections

In accordance with the OMMP, Year 4 performance monitoring to evaluate the physical integrity of intertidal slope cap areas consisted of low tide inspections of the slope caps in Remedial Areas (RA) 1B, 3, 8, 14, 19A, 19B, 20, and the Sheen Source Removal Area. No deficiencies were identified upon inspection of RAs 14, 19A, 19B, 20, and the Sheen Source Removal Area. Three of the five monitoring intervals within RA 1B were observed to have piling present at the surface of the capped area. Since no SQO exceedances were detected in the slope cap composite sample collected from RA 1B, it was recommended that exposed piling areas continue to be monitored to determine if the cap is performing as required. There is a small, approximately 6-inch-diameter hole at the surface of the grout mat in Monitoring Interval RA 3-2. However, this hole does not appear to be impacting the integrity of the cap or containment of the underlying contaminated sediments. No deficiencies were identified upon inspection of 15 of 17 monitoring intervals in RA 8. At the mouth of Outfall 230, erosion and downslope movement of the riprap material on the slope has occurred. For the erosion and downslope movement observed at the mouth of Outfall 230 in RA 8-2, a plan for evaluating and potentially repairing this area will be prepared and submitted to EPA for review in a separate memorandum.

Subtidal Cap Hydrographic Survey

In general, the Year 4 cap surface elevations are within six inches of the baseline surface elevation and within the allowable accuracy of the survey equipment. A comparison of the Year 4 to the Year 2 survey shows that the elevations in most areas have remained fairly consistent during the past two years. There are limited locations where the decrease in the cap surface elevation from baseline to Year 4 is greater than six inches but less than one foot. These locations are generally small, localized, and non-contiguous. In areas where subsidence of greater than 6 inches but less than 1 foot are documented, no response action is warranted but will be resurveyed in Year 7. In areas where subsidence is greater than 1 foot, small in nature, and non-contiguous, no response action is warranted, but the areas will be resurveyed in year 7. The two areas where subsidence was greater than 1 foot were RA 8 and RA 9. At Outfall 230 in the area identified by the hydrographic survey (RA 8), exposed sand and a depression resulting from loss of cap material was observed at the mouth of the outfall greater than 18 inches. A composite sediment sample was collected and no SQO exceedances were noted. In RA 9 an area of decreased cap elevation (cap scour depression) with an associated area of elevated cap area adjacent to the depression was observed. This area is located immediately adjacent to a marine float, where a tug boat was moored at the time of the Year 4 survey. Detected chemical concentrations did not exceed the SQOs.

Sediment Quality

Detected chemical concentrations did not exceed the SQOs in any of the slope cap samples collected as part of Year 4 performance monitoring (RAs 1B, 3, 8, 14, 19A, 19B, and 20.). Nickel was detected just below the SQO in sample SC-03-Y4, with an SQO exceedance factor of 0.96. With the exception of some nickel and BEHP concentrations detected near the SQOs in the slope cap samples, the remaining detected chemical concentrations in the slope cap samples were substantially less than the SQOs. In accordance with the OMMP, Year 4 performance monitoring slope cap sample results were compared to the Year 2 slope cap sample results. While there were no SQO exceedances, nickel concentrations were detected at substantially higher levels in the Year 4 slope cap samples compared to the Year 2 slope cap samples. During Year 2, silver was detected at all the slope cap sampling locations but was not detected in any of the Year 4 slope cap samples. The reason for the nickel and silver differences between Year 2 and Year 4 remain unclear, but may be due to a change in the analytical method between Year 2 and Year 4. These metals will continue to be monitored in the slope cap samples collected in Year 7.

A total of 6 of the 11 Year 4 channel sand cap samples (0 to 10 cm) had no SQO exceedances. Four of the 11 samples had only one SQO exceedance in Year 4, for BEHP (CC-23-Y4, CC-29-Y4, CC-33-Y4) or nickel (CC-30-Y4), and only one sample had multiple SQO exceedances (CC-32-Y4). The Year 4 channel sand cap sample concentrations were also generally comparable to the Year 2 channel sand sample concentrations. In general, concentrations of PAHs and BEHP appear to be increasing over time at the southern end of the Thea Foss Waterway, a depositional area within the Thea Foss Waterway. The areas with SQO exceedances will be monitored in Year 7.

Samples from 8 of the 13 natural recovery stations had no SQO exceedances in Year 4. Three of the 13 stations had samples with only one SQO exceedance, BEHP, and three stations had samples with multiple SQO exceedances (samples NR-12-Y4, NR-17-Y4, and NR- 25-Y4). The Year 4 sample collected from the enhanced natural recovery station, Station 16, had no SQO exceedances. Two of the three natural recovery / slope rehabilitation stations had samples with no SQO exceedances. Sample SR-10-Y4 had one exceedance for mercury, just above the SQO. Additional confirmation and verification sampling performed at Stations 12 and 17 in Year 4 showed that the elevated concentrations and multiple SQO exceedances in samples NR-12-Y4 and NR-17-Y4 were not typical of the sediment quality at or in the vicinity of these stations.

Benzoic acid in the Year 4 early warning samples was detected more frequently and generally at higher concentrations than in the Year 2 early warning samples. The higher Year 4 benzoic acid results in the early warning samples were confirmed with the reanalysis of three of the Year 4 early warning samples. Silver concentrations decreased substantially between Year 2 and Year 4 in all of the early warning samples. Five of the 27 stations with early warning samples had Year 4 nickel concentrations that were substantially higher, although still below the SQO, when compared to the Year 2 early warning concentrations. It should be noted that the increased concentration of nickel (and benzoic acid) in Year 4 as compared to Year 2 was attributed to a change in analytical methods, rather than a new source (e.g.,) in the waterway (City of Tacoma 2010).

Sediment Profile Imaging

The sediments throughout the Thea Foss and Wheeler-Osgood Waterways, as observed from the sediment profile images, were primarily very fine-grained silts and clays (all stations had a sediment grain size major mode of >4 phi [phi is a unitless measure]), with eight of the stations showing a depositional layer of silt to fine sand at the surface, ranging from 3.9 cm to 8.2 cm in depth. The depth of the apparent redox potential discontinuity (RPD) in the sediment column is an important time-integrator of dissolved oxygen conditions within sediment porewater. The depth is related to the supply rate of molecular oxygen by diffusion into the bottom sediments and the consumption of that oxygen by the sediment and associated microflora. The distribution of mean RPD depths ranged from a low of 0.0 cm in the highly organic sediments observed at Station BR-23, to a high of 3.39 cm at Station BR-21 in the dredge to clean area. Over ninety percent of all images taken as part of Year 4 benthic recolonization monitoring, regardless of remedial area type, have evidence of Stage 3 infaunal taxa present (Stage 3 is the mature, equilibrium community of deep-dwelling, head-down deposit feeders), consistent with the results of the Year 2 survey. Year 4 monitoring of the channel sand cap areas showed locations with the presence of Stage 1, and Stage 1 and 2 infaunal successional assemblages, including BR-18, BR-23, BR-31 and BR-33. In Year 2 there were no stations in the study area where photos showed domination by Stage 1, or mixed Stage 1 and 2 infaunal successional assemblages. It was concluded that "No further action is warranted at this time based on the results of benthic recolonization monitoring performed in Year 4."

Confined Disposal Facility Monitoring

The first performance monitoring event at the St. Paul Waterway CDF was conducted June 2-9, 2010. Performance monitoring included surface water and groundwater sampling and analysis as well as CDF berm and cap inspections. The metals lead, zinc, nickel, and mercury were not detected in the surface water sample. Copper concentrations were consistent with the baseline monitoring results. Groundwater metals were not detected for dissolved lead and mercury. Copper, zinc, nickel were detected within the range of the baseline monitoring concentrations. All the groundwater PAH detections and concentrations were within the range of those observed during baseline monitoring. No seeps, sheens, or other indications of contamination were identified during the berm and cap visual inspections. The maximum observed loss of topsoil at the containment berm due to erosion was a height of approximately 39 inches and appears relatively consistent with previous observations. No deficiencies were identified upon inspection of the offset berm and CDF cap.

Habitat Mitigation Area Monitoring (2010)

The primary function of habitat monitoring is to evaluate the effectiveness of the development of biological features and physical features at the mitigation and enhancement sites to confirm that they are on a trajectory to provide habitat function necessary to meet the objectives for each site, and to confirm that the individual habitat sites have attained and continue to meet their objectives over time. Qualitative monitoring was performed at both the mitigation and enhancement sites to document visual observations at the site and to identify any general maintenance concerns, track site naturalization, and document use of the sites by wildlife. Photo documentation was performed at both the mitigation and enhancement sites to record habitat site development over time from specific photo locations.

North Beach Habitat

The qualitative ground survey confirmed that the site is in fair condition, and becoming more established. For both the existing riparian area and the salt marsh, there was an increase in habitat values comparing Year 2 to Year 4 (2010).

Middle Waterway Tideflat Habitat

The qualitative ground survey confirmed that the site was continuing to develop adequately and the brackish marsh plants were continuing to spread outside of the planted nodes within the sprinkled area. Based on the analyses performed, the site meets all of the performance criteria for vegetation establishment.

Puyallup River Side Channel

The qualitative ground survey confirmed that the site was developing adequately and the plants were becoming better established in the riparian areas relative to the previous year's monitoring. The site meets the performance criteria for riparian vegetation establishment.

Hylebos Creek Mitigation Site

The qualitative ground survey confirmed that the site was continuing to flourish and the emergent wetland plants were continuing to spread. Vegetation within the forested wetland area was doing well. The site meets all of the performance criteria for vegetation establishment. No obstruction to fish passage was identified in the channel areas.

Johnny's Dock Habitat Enhancement

The qualitative ground survey confirmed that the site is well established and the planted species were continuing to spread, although the plants are somewhat less lush than they had been in Year 3 (2009).

Head of Thea Foss Shoreline Habitat

The qualitative ground survey confirmed that the site is established and the planted species were continuing to spread.

SR 509 Esplanade Riparian Habitat

The qualitative ground survey confirmed that the site was generally continuing to establish well, although it was modified by construction of a park on the adjacent site during the spring and summer of 2009. Overall, the site appeared to be in fair condition.

Log Step Habitat Enhancement

The qualitative ground survey confirmed that the site is adequately established and the plants were continuing to thrive.

Additional Project Related Activities (2010)

The City submitted a request to update navigational charts to the National Oceanic and Atmospheric Administration (NOAA). Per communications with NOAA representatives on September 1, 2010, the updated navigation charts showing the modified shoreline near the St.

Paul Waterway are available. According to a December 8, 2010 email from a USCG representative, the rule (establish a regulated navigation area in the Thea Foss Waterway prohibiting anchorage and other activities that could disturb the cap) had been published in the Federal Register and would become effective on January 7, 2011. The City submitted a request to the United States Coast Guard (USCG) to establish a regulated navigation area (RNA) in the Thea Foss Waterway prohibiting anchorage and other activities that could disturb the cap. The rule was finalized on January 7, 2011. Therefore, the City now has the authority to post “No Anchoring” signs in the capped portions of the waterway, if determined necessary.

Project representatives continued to work with the City's Building and Land Use Services division to implement procedures to ensure that future development in and adjacent to the Foss Project areas where remedial actions and habitat mitigation work have been completed, are undertaken in a manner that protects the remedy and the habitat. Projects in review or development include: 21st Street Park, Waterway Park, public esplanade, construction of the Center for Urban Waters, rehabilitation of the Murray Morgan Bridge, development of plans for a cogeneration facility to be placed on top of the CDF, reconfigure the Commencement Bay Marine Services marina, and Tacoma metals site remediation.

Under the Unilateral Administrative Order dated September 30, 2002, and the Consent Decree with EPA dated May 9, 2003, the City is implementing a stormwater monitoring and source control program for the municipal storm drains entering the Thea Foss and Wheeler-Osgood Waterways to help provide long-term protection of sediment quality in the waterways. Phthalates were identified as a contaminant expected to exceed Sediment Quality Objectives (SQO) yet defied source tracing efforts for the monitoring reported in the City’s 2010 annual source control report. Storm pipes were scrubbed to reduce legacy contaminants found adhering to the walls of the old pipes. Decreasing chemical concentrations in stormwater discharges into the Thea Foss Waterway have been noted as a result of the stormwater management program.

Monitoring by City –Year 5 (2011)

Only elevation monitoring, water surface elevation monitoring, and Habitat Mitigation Area monitoring (qualitative ground surveys of all components) occurred in 2011 (Year 5). See Figures 4-17a and 4-17b (a two-part figure) for the completed RA areas where monitoring occurs.

Two areas were re-inspected following recommendations from Year 2 and Year 4 monitoring: the Outfall 230 slope cap (for erosion) and RA-8 piling area (for exposure). The results of the Year 4 survey indicated a reoccurrence of the decrease in cap elevation at Outfall 230. It is currently unknown whether the additional loss of cap material identified was associated with the winter 2009/2010 storm events and the associated heavier drainage flows, or if the loss occurred more slowly over time since the Year 2 hydrographic survey. However, slope cap performance monitoring does not indicate that there is a concern with the slope cap in RA 8 surrounding Outfall 230 relative to chemical concentrations and compliance, and the slope cap is still performing as required. During the Year 4 low tide slope cap inspections, seven pilings were observed in RA-8 (low tide inspection interval 10), with the top of the piling estimated to range from approximately 0.5 to 3 feet above the mud line. There are no other indications of cap subsidence in the area, so maintenance actions do not appear warranted. The City returned to the location of these pilings on May 18, 2010, during a daytime low tide and determined that no maintenance actions were deemed necessary because the areas will continue to be monitored during routine OMMP events.

Habitat Mitigation Area Monitoring (2011)

Year 5 habitat mitigation area monitoring activities are set forth in the OMMP. The primary function of habitat monitoring is to evaluate the effectiveness of the development of biological features and physical features at the mitigation and enhancement sites to confirm that they are on a trajectory to provide habitat function necessary to meet the objectives for each site, and to confirm that the individual habitat sites have attained and continue to meet their objectives over time. Year 5 habitat monitoring activities were initiated on July 1, 2011, and continued intermittently at the various sites until August 31, 2011. The activities at each area are presented below.

North Beach Habitat

An additional planting area was constructed by the City in 2010, as authorized by EPA, to provide additional habitat acreage owed by the City as a result of the remediation construction project. The qualitative ground survey noted the success of the plantings, but no transects were required to verify that success is occurring. The island is noted as not having any volunteer vegetation, and original plantings on the slope along the confined disposal facility berm area are being lost to erosion. The Year 5 OMMP report (City of Tacoma 2011) stated that "there is a high survival rate for the new plantings, although some have not survived." Elevation monitoring showed an average change from the baseline as +3.8 inches.

Middle Waterway Tideflat Habitat

This brackish marsh is supported by supplemental irrigation to dilute the influence of sea water. The qualitative ground survey was conducted on July 11, 2011. Overall, the site was noted to be in good condition and was being used by avian species (geese eating grass). Erosion was noted at two locations and may be the result of a sprinkler malfunction. Elevation monitoring showed an average change from the baseline as +4.5 inches.

Puyallup River Side Channel

The mitigation area provides off-channel habitat for juvenile salmonids during out-migration. The qualitative ground survey was conducted on July 11, 2011. Plantings appeared to be growing well, and the levee had recently been mowed by USACE. Elevation monitoring showed an average change from the baseline as +4.0 inches.

Hylebos Creek Mitigation Site

This area was created to enhance the riparian/forested wetlands and create aquatic habitat. While invasive species were removed originally, their presence is still noted in the mitigation area. The qualitative ground survey was conducted on July 12, 2011. Both the upland forest and forested wetland portion of the site appear to be doing well, and no required maintenance activities were noted. Elevation monitoring showed an average change from the baseline as +0.6 inches. Surface water elevation monitoring was conducted between July 1 and August 31, 2011. There were 2,802 measurements recorded from the water level logger monitoring with an elevation of 2 feet

National Geodetic Vertical Datum (NGVD) 29 or higher. This value represents 47% of the time and meets the performance goal of 30%.

Johnny's Dock Habitat Enhancement

This area is a pocket beach to enhance habitat between commercial establishments. The qualitative ground survey was conducted on July 13, 2011. The site condition was considered to be fair and avian species were present. Geese seem to be eating the planted grasses, preventing complete establishment.

Head of Thea Foss Shoreline Habitat

This area was created to provide aquatic habitat below ordinary high water at the head of the waterway. The qualitative ground survey was conducted on July 13, 2011. The site appears to be in good condition with no indication of animal damage to the plantings. Plantings are thriving and volunteer species are becoming established, increasing habitat value.

SR 509 Esplanade Riparian Habitat

This area was planted in upland vegetation to provide riparian habitat. The qualitative ground survey was conducted on July 13, 2011. The site plantings are doing well outside the bridge shadow but have minimal success in the shaded area under the bridge. The sprinkler system was damaged, potentially due to vandalism.

Log Step Habitat Enhancement

This area consisted of a two-step log transition (where the treated timber pilings and other debris were removed) and was replanted with saltmarsh grasses. The qualitative ground survey was conducted on July 13, 2011. The site appeared to be in good condition, although no usage by wildlife was noted. Volunteer saltmarsh plants are becoming established at the site.

Additional Project-Related Activities (2011)

Institutional Controls

The City submitted a request to the United States Coast Guard (USCG) to establish a regulated navigation area (RNA) in the Thea Foss Waterway prohibiting anchorage and other activities that could disturb the cap. The rule was finalized on January 7, 2011. Therefore, the City now has the authority to post "No Anchoring" signs in the capped portions of the waterway, if determined necessary.

Project representatives continued to work with the City's Building and Land Use Services division to implement procedures to ensure that future development, in and adjacent to the Foss Project areas where remedial actions and habitat mitigation work have been completed, is undertaken in a manner that protects the remedy and the habitat. Several development plans are currently under construction or consideration and are being evaluated relative to their potential impact on the cleanup areas. These proposals include the following: Waterway Park, North Moorage, Public Esplanade, Seaplane Float, Murray Morgan (11th Street) Bridge, Simpson cogeneration Facility, Commencement Bay Marine Services, and Tacoma Metals Site Remediation.

Stormwater Source Control

The Thea Foss and Wheeler-Osgood Waterways are located in a highly urbanized basin with residential, commercial, and industrial land uses and transportation corridors. Sources of COCs continue to exist in the drainage basins and are conveyed to the waterways via stormwater drains (municipal and private), aerial deposition, marinas, and groundwater seeps. The contaminants identified as having the greatest potential to affect sediment quality following the cleanup action include PAHs and phthalates.

The City of Tacoma prepared and submitted the Thea Foss and Wheeler-Osgood Waterways 2010 Source Control and Water Year 2010 Stormwater Monitoring Report in March 2011. Twenty-six statistically significant time trends (26 out of 49 tests, or slightly greater than 50 percent of the tests) were observed in Tacoma's stormwater monitoring record. All trends were in the direction of decreasing concentrations. In 2010, City staff performed the following field activities within the Thea Foss Basin:

- Responded to 212 spills/complaints, including conducting investigations;
- Provided technical assistance on source control and best management practices (BMPs);
- Conducted 996 business and BMP inspections; and
- Continued the Illicit Discharge Detection and Elimination (IDDE) program, which investigates and removes illicit connections to the stormwater drainage system.

While overall stormwater COC concentration trends are decreasing, analytical data indicate that there are some areas with higher concentrations of certain contaminants that could benefit from additional source control efforts. The City believes further improvements in stormwater quality may be realized in the future through ongoing Phase I NPDES permit programs and continued improvement in source control.

Recontamination in the Head of the Thea Foss Waterway

Sediment sampling and analysis was performed in the Head of the Thea Foss Waterway in coordination with the Utilities as part of Year 7 (2011) OMMP activities. These activities were conducted on April 18-20, 2011. Compliance interval (0 to 10 cm) sediment samples were collected from a total of 18 waterway sample locations and 4 intertidal slope cap locations (the latter were composited into four samples). The results are summarized below:

- The laboratory reporting limits were above the SQOs in one or more of the waterway sediment samples for ten SVOCs including dimethyl phthalate, phenol, 2-methylphenol, 2,4-dimethylphenol, pentachlorophenol, benzoic acid, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, and N-nitrosodiphenylamine, and for two of the pesticides, including 4,4'- DDE and 4,4'-DDT.
- The detected concentrations of most chemicals were substantially below their SQOs in the waterway sediment samples. BEHP, benzyl alcohol, benzoic acid, six of the nine individual high molecular weight polycyclic aromatic hydrocarbons (HPAHs), and total HPAHs were detected at concentrations greater than their SQOs at more than one sample location. Phenanthrene, one of the low molecular weight polycyclic aromatic hydrocarbons (LPAHs), only exceeded its SQO at one sample location (WC-02). Metals, pesticides, and

PCBs were not detected at concentrations above their respective SQOs in the waterway sediment samples that were tested. In general, the average detected concentrations for HPAHs, phthalates, and other SVOCs were higher in Year 7 relative to Years 2, 3, and 4. LPAH average detected concentrations generally increased in Year 7 relative to the average detected concentrations in Year 3 and Year 4.

Monitoring by City –Year 6 (2012)

OMMP activities were performed during 2012 (Year 6) in the waterway and at the habitat areas within the Thea Foss Project site and at the confined disposal facility. The following monitoring tasks were performed in 2012: Habitat mitigation area monitoring, including qualitative monitoring of the cap and berm at the St. Paul Waterway Confined Disposal Facility (CDF), and additional project related tasks.

Habitat Mitigation Area Monitoring (2012)

The habitat mitigation areas for the project are the North Beach Habitat, Middle Waterway Tideflat Habitat, Puyallup River Side Channel, and the Hylebos Creek Mitigation site. The Thea Foss Habitat Enhancement Areas are Johnny's Dock Habitat Enhancement, Head of Thea Foss Shoreline Habitat, SR 509 Esplanade Riparian Habitat and the Log Step Habitat Enhancement. Year 5 habitat monitoring activities were initiated on July 19, 2012, and continued intermittently at the various sites until August 20, 2012. The activities at each area are presented below.

North Beach Habitat

The qualitative ground survey at this site was conducted on July19, 2012. The site was noted to be in good condition. There were no indications of animal damage or vandalism found, and very minimal amounts of trash and wrack associated with the tide line. There was no change noted in the appearance of the surface soils in the riparian or aquatic areas relative to previous monitoring events. There was no indication of odor or sheen in either area. Planted pilot nodes due to their exposure and were not successful in becoming established. There continues to be minimal success of the saltgrass in the remainder of this area; however, the pickleweed is spreading in the potential marsh area although the area appears somewhat reduced from previous observations. A few invasive weeds were present in the overall riparian area, including white sweet clover, willow herb, daisy, and cudweed. Oxeye daisy is present all along the berm. Minor weeding of the riparian area is therefore needed.

Middle Waterway Tideflat Habitat

The qualitative ground survey at this site was conducted on July 19, 2012. The site was noted to be in good condition. There was some minor indication of animal damage in the marsh area where it appeared that geese/birds were continuing to eat the grasses (goose exclusion grids were previously removed), but there continues to be no indication of disease or animal damage in the riparian area. The animal damage in the marsh does not seem to be significantly impacting the continued growth and development of the site. There were no indications of vandalism at the site and only very small amounts of trash present in the tide line. It was noted during the inspection that all of the plants were doing well, with continued growth and spreading of both established plants and volunteers.

Puyallup River Side Channel

The qualitative ground survey at this site was conducted on July 19, 2012. The site was noted to be in good condition. No new areas of erosion were observed within the side channel. There was no indication of animal damage or disease at the site. There was minimal trash present, and some cut branches noted. An occupied transient camp was found near the breach on the old levee structure, and the Tacoma Police Department was subsequently notified. It was noted during the inspection that overall on the old levee the riparian plants were doing well, and both original and newer plants are growing and spreading. The plants on the new levee were not doing as well with the alder and willow showing better success than the red-osier dogwood. Recently it was observed that the waterward face of the new levee had been mowed by USACE down to the mud line. Some invasive species, including butterfly bush, chamomile, birdsfoot trefoil and reed canary grass were present. Minor weeding of this area is therefore required.

Hylebos Creek Mitigation Site

The qualitative ground survey at this site was conducted on July 20, 2012. The site was noted to be in good condition. There was no indication of disease noted and only minor beaver damage observed. The only trash present was one large, suspicious-looking black plastic bag that had an odor. This was referred to the Tacoma Police Department. There were no wrack or organic material accumulations present. The LWD were present and in good condition and no maintenance actions were identified. No obstruction to fish passage in the channels was observed. Several willows and alder have fallen into the marsh area, providing shade and diversity without blocking fish passage. Some invasive weeds were identified at the site, including reed canary grass, poison hemlock, tansy, curled dock and blackberry, and minor weeding as a part of regularly scheduled maintenance is needed.

According to the OMMP, the performance criteria relative to elevation changes at this site indicate that the average elevation change along the centerline transect of the channels must be less than 0.2 feet from the as-built elevations. Based upon this criteria, the south lobe does not meet this performance criteria (average Year 6 change in south lobe relative to as-built elevations was 0.45 feet) while the north lobe is right at the criteria with an average change of 0.20 feet (Table 6-5). However, when the elevations are compared to either the design elevations or the Year 0 elevations, both lobes meet the performance criteria.

Johnny's Dock Habitat Enhancement

The qualitative ground survey at this site was conducted on July 19, 2012. The site was noted to be in fair condition. Extensive goose predation on the grasses was noted, but there were no indications of disease, vandalism, trash or wrack present. The goose exclusion grid was previously removed and the LWD was found to be in good condition. There were no invasive species identified during the inspection.

Head of Thea Foss Shoreline Habitat

The qualitative ground survey at this site was conducted on July 19, 2012. The site was noted to be in good condition. There were no indications of animal damage, disease or vandalism at the site, and only minor amounts of trash and wrack found at the high tide line. The goose exclusion grid has been removed, and the site appears stable. The log step appeared to be in good condition. South of the site near the twin 96ers outfalls, a number of invasive species are present including blackberry, nightshade, Scotch broom and white sweet clover. The City will look into maintaining this area to eliminate this seed source.

SR 509 Esplanade Riparian Habitat

The qualitative ground survey at this site was conducted on July 19, 2012. The site was noted to be in fair condition. Vegetation outside of the bridge shadow is doing well while those plants under the bridge are nearly non-existent. There was some damage to the sprinkler system and some broken limbs on the trees which may have been a result of vandalism. The sprinkler system needs to be inspected to ensure that it is in good, working order. Invasive species identified during the inspection include plantain, tansy, poison hemlock and oxeye daisy. Ongoing weeding of the site is needed.

Log Step Habitat Enhancement

The qualitative ground survey at this site was conducted on July 19, 2012. The site was noted to be in good condition. The log step appeared to be in good condition and only minor maintenance, including checking the anchors on the logs, is needed. Some invasive species are present adjacent to the site including St. John's Wort and a cherry tree. Therefore, only minor weeding is needed.

Additional Project-Related Activities (2012)

Several development plans and proposals are currently under construction or consideration and are being evaluated for their potential to impact the cleanup areas. These proposals include the following: Waterway Park, North Moorage, Public Esplanade, Seaplane Float, Murray Morgan (11th Street) Bridge, Simpson cogeneration Facility, Commencement Bay Marine Services, and Tacoma Metals Site Remediation.

The Thea Foss and Wheeler-Osgood Waterways are located in a highly urbanized drainage basin with residential, commercial and industrial land uses and transportation corridors. Sources of COCs continue to exist in the drainage basins and are conveyed to the waterways via stormwater (municipal and private), aerial deposition, marinas, and groundwater seeps. The City prepared and submitted the Thea Foss and Wheeler-Osgood Waterways 2011 Source Control and Water Year 2011 Stormwater Monitoring Report (Stormwater Annual Report) in March 2012. This Stormwater Annual Report outlines the City's existing programs and studies completed in 2011 and includes a discussion of the need for additional source controls. Included are annual source control evaluations for the seven major outfalls discharging to the waterways; Outfalls 237A, 237B, 235, 230, 243, 245 and 254.

The time trends were modeled with best-fit regression equations to estimate percent reductions over the 10-year monitoring period for these constituents and outfalls (OFs):

- **TSS:** 44 to 67 percent reduction in OFs 230, 235, 237A, and 237B
- **Lead:** 41 to 49 percent reduction in OFs 235, 237A, 237B, and 245
- **Zinc:** 48 to 51 percent reduction in OFs 237B and 254, respectively
- **PAHs:** 80 to 96 percent reduction in phenanthrene in all seven drains

- **Pyrene:** 83 to 97 percent reduction in all seven drains
- **Indeno(1,2,3-c,d)pyrene**: 85 to 96 percent reduction in all seven drains
- **BEHP:** 57 to 87 percent reduction in OFs 230, 235, 237A, 237B, 243, and 245

While overall stormwater trends are decreasing, analytical data indicate that there are some areas with higher concentrations of certain contaminants where additional source control efforts can be implemented. The City believes further improvements in stormwater quality may be realized in the future with ongoing Phase I NPDES permit programs and continuing improvements in source control implementation.

Monitoring by City –Year 7 (2013)

OMMP activities were performed during 2013 (Year 7) in the waterway and at the habitat areas within the Thea Foss Project site and at the confined disposal facility. The following monitoring tasks were performed in 2013: low tide slope cap inspections, hydrographic surveys, sediment chemical monitoring, benthic recolonization monitoring, and confined disposal facility monitoring.

Low Tide Slope Cap Inspections

Remedial Area (RA) 3 has five small (2-3 inch) holes in the surface of the grout mat cap. They do not appear to be impacting the integrity of the containment. No SQO exceedances were present in the slope cap composite sample.

Some potential down-slope movement of rip rap was noted below Outfall 230 in Remedial Area 8, but it does not appear to be impacting cap integrity. No SQO exceedances were found. Some debris remained on the beach below the Colonial Fruit Warehouse that was demolished, and the contractor will be required to remove the debris.

In Remedial Area 14, a potential vessel-scour area was noted near the waterline, which previously was only a small depression. However, no SQO exceedances were noted.

Hydrographic Survey

The Year 7 multi-beam hydrographic survey was conducted on April 9-10, 2013. In general, the Year 7 cap surface elevations are within six inches of the baseline surface elevation and within the allowable accuracy of the survey equipment. A comparison of the Year 4 to the Year 7 survey shows that the elevations in most areas have remained fairly consistent during the past three years. There are limited locations where the decrease in the cap surface elevation from baseline to Year 7 is greater than six inches but less than one foot. These locations are generally small, localized, and non-contiguous.

Sediment Chemical Performance Monitoring

In Year 7, a total of 4 of the 11 channel sand cap performance monitoring samples had no SQO exceedances (samples CC-01-Y7, CC-18-Y7, CC-26-Y7, and CC-30-Y7). Five of the 11 samples had only one SQO exceedance, for BEHP (samples CC-27-Y7, CC-29-Y7, CC-31-Y7, CC-33-Y7, and CC-RA9-Y7), and two samples had multiple SQO exceedances (CC-23-Y7 and CC-32-Y7). Figures 4-18a and 4-18b (a two-part figure) show sampling locations.

At Station 23 in RA 6, adjacent to Outfall 230, a total of 4 analytes were detected at concentrations greater than the SQOs in the Year 7 channel sand cap sample. Analytes that exceeded the SQOs in sample CC-23-Y7 included three HPAHs and BEHP, with SQO exceedance factors ranging from 1.04 to 1.29 for the HPAHs and approximately 3.5 for BEHP. Specific PAHs exceeding the SQOs have fluctuated in different monitoring years. BEHP remained relatively stable between Year 4 and Year 7.

At Station 32, located in the south end of the City's work area in RA 19A, there were detections of phenanthrene, dibenz(a,h)anthracene, and BEHP at concentrations greater than the SQOs; however, the number of SQO exceedances and magnitude of exceedances decreased or remained comparable between Year 4 and Year 7 in the channel sand cap samples, indicating possible stabilization.

Early Warning Monitoring for Recontamination

In the Year 7 monitoring, PCBs were detected in 24 of 27 of the early warning samples collected; however, there were no PCB SQO exceedances detected. In contrast to Year 7, there were only two detections of PCBs in the Year 2 early warning samples, and PCBs were not detected in any of the Year 4 early warning samples. In general, there were no new source control issues identified for follow-up. The vast majority of early warning exceedances of the threshold concentrations were for BEHP and PAHs. General stormwater source control activities are being implemented on an ongoing basis, and are reducing concentrations of BEHP and PAHs in stormwater sediments.

Natural Recovery Monitoring

In Year 7, a total of 8 of the 13 natural recovery stations had performance monitoring samples with no SQO exceedances. Two of the 13 stations had natural recovery samples with only one SQO exceedance in Year 7, both for BEHP with SQO exceedance factors of less than 2; and three of these stations had natural recovery samples with multiple SQO exceedances (NR-12-Y7, NR-20-Y7, and NR-25-Y7).

Station 25, on the mudflat behind the Delin Docks Marina slips, has consistently had multiple analytes detected at concentrations above the SQOs. In Year 7, there were 5 analytes detected at concentrations above the SQOs. Total PCBs were present at this location with an exceedance factor of 1.67. This value is somewhat higher than the exceedance factor found for total PCBs in this location in Year 2 sampling. No action is recommended at this time, and this area will be monitored next in Year 10 (2016).

Slope Cap and Slope Rehabilitation Monitoring

There were no SQO exceedances in 6 out of 7 slope cap areas sampled. SC-20, which is a composite sample from the shoreline area on the east side of the waterway between the sheet-pile wall (i.e., the south end of the City's work area and the north end of Johnny's Dock restaurant), had SQO exceedances for BEHP and benzyl alcohol at exceedance factors of approximately 1.2 and 1.6, respectively. No follow-up action was recommended.

Two of the three natural recovery/slope rehabilitation stations also had samples with no SQO exceedances. Natural recovery/slope rehabilitation sample SR-10-Y7 on the northern shoreline of Wheeler-Osgood had one SQO exceedance for total PCBs. The concentration was similar to that found in Year 2 monitoring.

Benthic Recolonization Monitoring

For benthic monitoring, nearly all of the areas sampled show evidence of mature infaunal communities present and evidence of benthic ecosystem recovery.

Confined Disposal Facility (CDF) Monitoring

In general, groundwater samples collected from shallow and deep wells adjacent to the CDF had similar or lower metals results than the quarterly baseline monitoring results and the Year 4 performance monitoring results. The Year 7 detected concentrations of PAHs for all performance monitoring wells located adjacent to the CDF, and for MW-04 within the CDF, were less than or within the range of concentrations detected in each well throughout quarterly baseline monitoring and Year 4 performance monitoring.

Erosion at North Beach continues, but containment does not appear compromised. Dune grass is establishing on the upper beach, which will help to stabilize the berm.

Habitat Mitigation Area Monitoring (2013)

Four habitat mitigation sites were monitored during this period: North Beach, Middle Waterway Tideflat Habitat, Puyallup River Side Channel, and Hylebos Creek. Overall, areas are performing as designed; however, some issues still need to be addressed by EPA and the City to determine if objectives should be altered.

North Beach Habitat

A qualitative ground survey confirmed that the site is in good condition, and continues to become more established in both the marsh and riparian areas, particularly with the growth and development of the more recently planted area on top of the berm. The pickleweed is continuing to spread well throughout the potential marsh portion of the site, and is the dominant species in this area. Some small areas of salt grass are present, but it is much less prevalent than the pickleweed. Dune grass is also present and doing well at the upper elevations on the beach between the marsh and riparian areas. The original pilot nodes were not particularly successful, but the plants are very well developed higher on the shoreline and amongst the large woody debris where conditions are more conducive to survival.

Middle Waterway Tideflat Habitat

A qualitative ground survey confirmed that the site was continuing to develop well, and the brackish marsh plants were continuing to spread outside of the planted nodes within the area watered by sprinklers (irrigated). The vast majority of the upper intertidal area is filled with vegetation. As described in the Habitat Preliminary Findings Memorandum, a break in the sprinkler header line just south of mid-site was noted during the inspection. Water flowing from the break caused an area of erosion on the slope. Upon identification of the issue, the City turned off the sprinkler system and the end of the header pipe was capped. Following placement of the cap, the system was turned back on. As a result of this break, the northern portion of the marsh is not currently being irrigated. The City has notified EPA of this issue and plans to further discuss the need for any restoration of the eroded area with the agencies, and to determine whether or not repair of the sprinkler system will be required. Since the time of the inspection, two additional minor breaks in the system were identified and repaired. Maintenance of the irrigation system remains an ongoing issue at this site.

Puyallup River Side Channel

A qualitative ground survey confirmed that the site was developing well and the plants are filling in the riparian areas along the old levee section. The primary issue noted at the site was the fairly extensive use of the site by transients. Due to the presence of encampments, the Tacoma Police Department (TPD) accompanied staff during the inspection. This undesirable use of the site has damaged the vegetation to some extent, since it has been cut or trampled during access and development of the campsites. Removal of these campsites and the associated trash will likely be an ongoing issue to coordinate with the TPD.

Hylebos Creek Mitigation Site

A qualitative ground survey confirmed that the site was continuing to flourish, with vegetation in both the riparian and marsh areas thriving and spreading, and many volunteer plants noted. Trees on the slope area are growing well. There is minimal presence of invasive species, with the exception of some blackberry and reed canary grass, which is extremely difficult to control with upstream seed sources present. No obstruction to fish passage was identified in the channel areas. Overall, this site appeared to be in good condition, with only minor weeding and tightening of the large woody debris anchors needed at this time.

Additional Project-Related Activities (2013)

The Foss Waterway Development Authority (FWDA) received a grant for remediation of the American Plating property, which was completed in December 2012. Slope stabilization and habitat plantings were completed. The FWDA completed the design of a public esplanade immediately south of the Murray Morgan Bridge on the western shoreline. The existing seawall supporting the timber esplanade in this area has been failing in recent years, and it was recently determined that the failure rate had increased substantially. In 2014, the City removed the seawall and cut back the slope to an acceptable angle to eliminate the need for a bulkhead in this area. A confining cap was placed over the shoreline in accordance with the Slope Area Maintenance Plan that was developed by the City and approved by EPA as part of the Year 0 Baseline Monitoring Annual OMMP Report.

In early 2010, the City took ownership of the Murray Morgan Bridge under a turnback agreement with the Washington Department of Transportation (WSDOT). Rehabilitation and re-opening of the bridge to vehicular traffic was recently completed. Sampling revealed differences between the pre- and post-construction sediment data that indicated a sediment quality impact caused by the rehabilitation work on the bridge. Additional sediment sampling was performed in the spring of 2014 to determine the extent of contamination of sediments below the bridge to determine if there is a need for additional response actions and where such actions would needed. Results of that effort indicate that additional response actions are needed to address elevated metals levels (primarily lead) in sediments below the bridge. EPA and the City of Tacoma are currently working on planning and implementing cleanup work in this area.

The Tacoma Metals Site Remediation site is located adjacent to the Puyallup River Side Channel habitat mitigation area. As of the date of this report, the property owners are continuing to work with Ecology to finalize the update to the RI/FS. Once that is complete, the parties will work to develop the cleanup action plan for the site.

Over a 12-year period (August 2001-September 2013), stormwater and stormwater suspended particulate matter (SSPM) have been sampled at the 7 major outfalls that discharge into the Thea Foss and Wheeler-Osgood Waterways. In addition, baseflow was sampled at the same 7 outfalls for the first 10 years of the program. Over the last 12 years, more than 1,400 samples have been collected: 322 baseflow and 846 stormwater samples were collected at the outfalls, and 74 (outfall) and 230 (upline) SSPM samples were collected in pipeline sediment traps deployed throughout the watershed. The number of statistically significant time trends (in this case, showing improving conditions) observed in Tacoma's stormwater monitoring record increased to forty-four (44 out of 49 tests, or approximately 90 percent of the tests) in Year 12 using simple linear regression. All trends were in the direction of decreasing concentrations (City of Tacoma 2014).

4.7.3.4.2 *Utilities' Area*

Following the completion of the Utilities' remedial action activities, the OMMP for the Utilities' work area (a 2003 document prepared by Tetra Tech FS, Inc.) was finalized based on as-built conditions. The Utilities' OMMP sampling program is designed to collect data to meet the following objectives:

- Evaluate the effectiveness of the hybrid cap installed over contaminated sediments (evaluated principally by coring).
- Determine compliance with the SQOs (by collection of compliance sediment samples [0 to 10 cm]).
- Assess source control effectiveness (by collection of early warning sediment samples ([0 to 2 cm]).

Monitoring activities were conducted in 2009, 2010, 2011, 2012 and 2013 (Monitoring Years 5 – 9) during this review period. Qualitative ground surveys were conducted in each of these years, with more comprehensive monitoring being conducted in Year 7. The Year 7 (2011) monitoring results represent the most current and comprehensive characterization of the conditions of the various remedy components within the Utilities' work area and are reported below, as are findings from the Year 9 (2013) qualitative ground survey. The Utilities completed their Year 10 field monitoring activities in May 2014, but the results of those efforts were not available for inclusion in this review. Those results will be reported in the next FYR in 2019.

Results from the Utilities' OMMP monitoring activities conducted during this review period (Years 5, 7 and 9) are summarized below.

<u>Monitoring by Utilities –Year 5 (2009)</u>

To meet the OMMP objectives, monitoring of the Utilities Work Area included physical cap integrity assessment, and compliance and recontamination sampling. Physical observations included visual inspections of the cap. Sediment sampling included collection of samples for chemical testing (compliance – 0-10 cm, early-warning recontamination, and core samples). See Figure 4-19 for the Utilities' OMMP monitoring locations.

Visual Inspection

The visual inspection assessed the slope cap and outfall scour cap protection. A visual inspection of the cap was made on April 13, 2009 and July 9, 2009 during low tide events. The scour protection apron was functioning as intended. Side slopes showed no visible evidence of slope erosion, sloughing, etc. At Outfall 235, both wing walls were separating from the Outfall 235 head wall. The new kayak float and the associated anchor pad for the ramp to connect to the float were installed on the east side of the Waterway just south of the SR-509 Bridge. The new park on the west side of the waterway (Former Standard Chemical site) was being landscaped during the site visit. The associated parking lot and restroom facilities had been completed. Based on the physical observations made during the Year 5 monitoring, it was recommended that the slope armor and outfall scour protection adjacent to Outfall 235 be restored.

Sediment Samples

Available data continued to indicate that the top of the Utilities' cap has been recontaminated at levels above the CBNT SQOs. Evaluation of a variety of data concluded that the recontamination sources were stormwater outfalls that discharge to the head of the waterway. Fifteen early warning (recontamination core [RC]; 0 to 2 cm deep) surface sediment samples and 19 waterway compliance (waterway cap [WC]; 0 to 10 cm deep) surface sediment samples were collected for Year 5 OMMP monitoring. Based on the stratigraphy of the grab samples, it was evident that the material had accumulated on top of the sand cap and had increased in depth each year. The most likely source of the material deposited over the cap is from the stormwater outfalls. The waterway cap compliance samples (0 to 10 cm) from the locations beneath and south of the SR 509 Bridge were analyzed for partial SVOCs (PAHs, BEHP, and phthalates), TOC, and total solids. BEHP concentrations were higher than the SQO (1,300 µg/kg) in all compliance samples south of the SR 509 Bridge in May 2009. In December 2004, the City remediated the area north of the bridge by placing additional capping material to address recontamination from dredging activities. In Year 5, five of the seven samples collected from the compliance sampling interval north of the bridge contained BEHP concentrations exceeding the SQO of 1,300 µg/kg as a result of the increasing thickness of sediment above the cap. Fluoranthene was detected at its SQO (2,500 µg/kg). All early-warning samples south of the SR 509 Bridge contained BEHP concentrations above the SQO of 1,300 µg/kg. The early-warning samples contained concentrations of individual PAHs and/or total HPAH that exceeded their SQOs. BEHP was the only parameter that exceeded its SQO for early-warning samples north of the bridge. Compliance sample concentrations of BEHP and HPAH within the turning basin below and south of the SR 509 Bridge have consistently increased between 2007 and 2009. In addition, the number of individual PAH SQO exceedances had increased between 2008 and 2009. The average concentration of BEHP increased from approximately 3,100 µg/kg in 2007 to 5,500 µg/kg in 2009, while HPAH concentrations increased from approximately 6,171 µg/kg in 2007 to 14,000 µg/kg in 2009. Compliance sample concentrations of BEHP and HPAH north of the SR509 Bridge have increased between 2007 and 2009. The average concentration of BEHP increased from 529 µg/kg to 3,200 µg/kg, while the average concentration of HPAH increased from 1,133 µg/kg to 7,200 µg/kg from 2007 to 2009; resulting in a six-fold increase since 2007.

Monitoring by Utilities - Year 6 (2010)

Consistent with the requirements of the Consent Decree, Year 6 of the OMMP had no requirement to conduct physical integrity monitoring. No qualifying events (earthquakes or large storms) that would have triggered the need for monitoring had occurred since the last monitoring event. As a follow up to the recommendations made in Year 5 OMMP report, site observations and maintenance activities at Outfall #235 were conducted. A Technical Memorandum was submitted for Year 6 OMMP activities.

At Outfall 235, both wing walls are separating from the Outfall 235 head wall. The separation between the head wall and the south wing wall was larger than the separation between the head wall and the north wing wall. The distances measured during this site visit were approximately 9 1/2 inches and 7 3/4 inches respectively, slightly greater than the distances measured during Year 5 observations (9 3/8 inches and 7 1/2 inches respectively).

The slope armor adjacent to both the south and north wing walls was observed to have been displaced or sloughed, leaving the underlying slope cap exposed. It is believed the intentional displacement of the outfall scour material in front of Outfall 235 and from the toe of adjacent slopes contributed to instability and caused downward movement of armor material from the slope areas. As a result, the underlying slope cap became exposed and potentially subject to erosion. The Year 5 OMMP Technical Memorandum recommended restoration of the outfall scour protection to ensure the integrity of the underlying slope cap. At the time of the site visit in April 2010 (Year 6), the area of exposed slope cap adjacent to both the south and north wing walls appeared slightly greater than was observed during Year 5 OMMP. Armor stones were replaced back into the original locations.

The condition of the scour protection apron at the south end of the waterway was consistent with observations presented in the Year 5 OMMP Technical Memorandum. Water was flowing out of Outfalls 237a and 237b during the site visit.

The new kayak float on the east side of the Waterway just south of the SR-509 Bridge was in use.

The scour protection adjacent to Outfall 243 (at Station 73+40 on the east side of the waterway under the SR-509 Bridge) showed no further signs of erosion or displacement. The Tideflex™ valve at the end of Outfall 243, which was extensively covered with barnacles and mussels at the time of the Year 5 observations, appeared to have been cleaned.

Monitoring by Utilities - Year 7 (2011)

Available data indicate that the top of the Utilities' cap has been recontaminated at levels above the CB/NT SQOs. BEHP exceeds the SQOs by the greatest degree and over the widest area. Several individual PAHs, total HPAHs, benzyl alcohol, and benzoic acid also exceed their respective SQOs at one or more locations. The greatest exceedance of the SQOs occurs at sample location RC/WC-05, where BEHP was measured at 21,000 µg/kg with an exceedance factor of 16.2. The HPAH and BEHP trend relationship in early warning sediment samples is similar to the trend relationship of stormwater sediment samples collected near the end of the Twin 96-inch outfalls at the Head of Thea Foss. These data indicate that the Twin 96-inch outfalls are the primary source of PAHs and BEHP to the Head of the Thea Foss Waterway.

Physical Observations

Visual inspections of the cap were made on May 16 and May 17, 2011, during predicted low tides of -2.1 feet MLLW and -2.4 feet MLLW. The scour protection apron is functioning as intended. No obvious signs of significant erosion were observed. A series of small shallow channels are present in the apron near the middle of the south end of the waterway, as previously noted in the Year 0 through Year 6 observations. Waterway slopes show no visible evidence of slope erosion, sloughing, etc. Gas bubbles were observed throughout the head of the waterway and in the vicinity of the former SR-509 seep area during the site visit, but no sheens were observed in the former SR-509 seep area.

Hydrographic Survey

The Year 7 (2011) bathymetry survey has revealed the sediment cap to be relatively stable when compared with the Year 4 OMMP August 2008 survey. At the south end of the waterway, some erosion of habitat mix placed on the scour protection apron sill was occurring in 2008, likely due to the flow from the Twin 96-inch outfalls. This erosion was not observed in the 2011 survey data. However, material appears to be depositing in a mound just below the sill. The results of the hydrographic survey indicate that the minimum cap thickness performance criterion is being met as provided for in the OMMP, and no further evaluation or remediation is warranted at this time.

Sediment Samples

The waterway cap (WC) compliance samples (0 to 10 cm) from the WC locations beneath and south of the SR-509 Bridge were analyzed for grain size, total organic carbon (TOC), metals, TPH-Dx (diesel range), SVOCs, DDT compounds, and PCB Aroclors. The percent fines ranged from 4.2 percent at location RC/WC-01 south of the bridge at the edge of the scour apron to 65.2 percent at location WC-13 under the SR-509 Bridge, averaging 49.8 percent. The high percentage of fines is an indicator of sedimentation occurring south of the bridge. BEHP concentrations were higher than the SQO (1,300 µg/kg) in all compliance samples south of the SR-509 Bridge in April 2011. In addition, SQOs were exceeded for individual PAHs and total HPAHs at locations WC-02, WC-04, WC-05, and WC-06; for individual PAHs at location WC-03; for benzyl alcohol at location WC-01 to WC-06, WC-13, and WC-14; and for benzoic acid at locations WC-02 and WC-05.

The early-warning "top down" (0 to 2 cm) sediment samples south of the SR-509 Bridge were analyzed for partial SVOCs (PAHs and BEHP), metals (lead, mercury, and zinc), TPH-Dx, PCB Aroclors, TOC, total solids, and grain size. All early-warning samples south of the SR-509 Bridge (WC/RC-01 through WC/RC-09, RC-13, and RC-14) contained BEHP concentrations above the SQO of 1,300 µg/kg. BEHP concentrations ranged from 3,300 µg/kg (2.5 exceedance factor) at RC/WC-07 to 8,900 µg/kg (6.8 EF) at WC/RC-02. The early warning samples collected at locations WC/RC-01, WC/RC-02, WC/RC-03, WC/RC-04, WC/RC-05, WC/RC-6, RC-13, and RC-14 contained concentrations of individual PAHs and/or total HPAH that exceeded their SQOs.

Recolonization

As part of the Utilities' OMMP, the primary means to evaluate habitat recolonization is through the use of sediment profile imaging (SPI). While the overall site benthic habitat status and recolonization were not significantly different between the first two surveys, the results from this most recent survey show a dramatic regression in both habitat conditions and benthic community assemblages. While there were some indications of stalled recovery in the 2008 survey because conditions were essentially the same as those detected in 2006, the profile images from the 2011 survey were notably different because of the increased deposition of low oxygen/anoxic, fine-grained sediments throughout the area that erased most visible signatures of the capping layer. Given the study area's location and the point sources of input to this system (mainly stormwater outfalls at the head of the waterway and on the east and west sides under the SR-509 Bridge), there appears to be a constant supply of organically enriched material to the study area that will continue to be a stressor to benthic community.

Monitoring by Utilities - Year 8 (2012)

Consistent with the requirements of the Consent Decree, Year 8 of the OMMP had no requirement to conduct physical integrity monitoring. No qualifying events (earthquakes or large storms) that would have triggered the need for monitoring had occurred since the last monitoring event. The Utilities continued to conduct low tide site observations on an annual basis during the spring/summer timeframe. A Technical Memorandum was submitted for Year 8 OMMP activities.

At Outfall 235, both wing walls were separating from the Outfall 235 head wall. The separation between the head wall and the wing walls were similar to Year 4, 5, 6 and 7 observations indicating little to no additional movement. The distance between the head wall and the north wing wall was measured at 7.5 inches, and the distance between the head wall and the south wing wall was measured at 9.5 inches. Slope armor stone adjacent to Outfall #235 showed minimal signs of erosion and displacement. There continued to be a pool with a sandy bottom directly in front of the outfall as noted in previous years.

As previously noted in the Years 0, 1, 2, 3, 4, 5, 6 and 7 site observation memoranda, the coarser slope cap materials and habitat mix were covered with algae, seaweed, and barnacles at the exposed east and west bank waterway slopes.

The scour protection apron placed at the head of the waterway was functioning as designed and no corrective action was recommended.

The American Plating Site occupies approximately 1.4 acres of land that is located along the eastern shoreline at the head of the Thea Foss Waterway. Remedial action was conducted by the Foss Waterway Development Authority (FWDA) to address contamination resulting from releases from past metal plating operations at the Site. Observations of the former American Plating remediation site along the top of the east slope of the waterway showed that it was fenced in by heavy duty silt barriers. The planned restoration of the capped portion of the site adjacent to the shoreline in the habitat enhancement area at and above the ordinary high water line with native plantings had not been completed as of the June 4th or 6th site visits.

The scour protection adjacent to Outfall 243 (on the east side of the waterway under the SR-509 Bridge) showed no obvious signs of erosion or displacement. The Tideflex™ valve at the end of Outfall 243 did not appear to have been cleaned recently and had more barnacles than the observations in previous years.

Monitoring by Utilities - Year 9 (2013)

In Year 9, the Utilities monitored the outfalls, bank work, the scour protection apron, and the former American Plating site.

Condition of Outfall 235 Wing Walls

At Outfall 235, both wing walls are separating from the head wall. The separation in the south wing wall is larger than the separation in the north wing wall. The distance between the sets of Parker-Kalon (PK) nails in the north wing wall was measured as 7.5 inches. The same measurement at the south wing wall was done using the existing nail holes and the measurement was 9.5 inches from the first nail hole. The measurements were also taken from the second and the third nail hole on the head wall. These measurements were 10.25 and 11.25 inches. The measured separation between the wing walls was similar to previous observations, indicating little to no additional movement.

Upper Bank Work

Above Outfall 235 and along the upper part of the west bank, some work was completed that allows the public closer access to the Waterway. The work includes construction of a new walking path and restacking of erosion control quarry spalls above the head wall of Outfall 235 and placement of toe protection for the walking path. It appears that the upper west bank slopes below the Thea Foss Waterway Public Esplanade and the 21st Street Park were scraped and shaped to create a bench slope during construction of the path. The origins of the constructed path are unknown, and in checking with the City, they had no information regarding who installed it or when it was constructed.

Scour Protection Apron

A series of small, shallow channels are present in the apron near the middle of the south end of the waterway. The configuration and shallow depth of these channels appear unchanged from previous observations, and the overall integrity of the cap has not been observed as adversely impacted by the presence of these features. No corrective action was proposed. Silt continues to build up on and adjacent to this scour apron, with the greatest accumulation on the east side of the scour apron.

Former American Plating Upland Remediation Site

The American Plating Site occupies approximately 1.4 acres of land that is located along the eastern shoreline at the head of the Thea Foss Waterway. Remedial action was conducted in 2012 by the FWDA to address contamination resulting from releases from past metal plating operations at the Site. The remediation included excavation and capping of soil with contaminant concentrations greater than the Site cleanup levels, and restoration of the site to support the planned future development of the site as a public park with public access to the waterway.

4.7.4. Progress since the Last Five-Year Review

Results from the OMMP activities are discussed in the previous Section 4.7.3, Post-Construction Monitoring/O&M.

4.7.4.1 Previous Protectiveness Statement

The protectiveness statement in the third FYR (2009) stated:

> "The remedy at the Thea Foss and Wheeler-Osgood Waterways currently protects human health and the environment because the sediment remedial action significantly reduced sediment concentrations and most of the required institutional controls are in place to protect the integrity of the sediment cap. However, in order for the remedy to be protective in the long-term, additional source control activities need to be identified and implemented to reduce the extent of recontamination in the waterway and the USCG institutional control needs to be completed to help protect the long-term integrity of the sediment cap."

4.7.4.2 Status of Recommendations

The recommendations made in the third FYR (2009) for the Thea Foss and Wheeler-Osgood Waterways are summarized below, along with a progress evaluation presented in italics.

- Thea Foss and Wheeler-Osgood Waterways – source control does not appear adequate to prevent recontamination; continue to monitor and evaluate sources of phthalates and PAHs to sediments. *Results from the Utilities' Year 7 (2011) monitoring indicate that stormwater from the Twin 96-inch outfalls continues to be a source of BEHP and PAH sediment concentrations exceeding the SQOs at the Head of Thea Foss. Year 10 (2014) monitoring results were not available for inclusion in this review, but will provide valuable information about whether the Twin 96-inch outfalls are continuing to contribute BEHP and PAHs to the sediments at the head of the waterway.*

4.7.5. Five-Year Review Process

4.7.5.1 Administrative Components

The Thea Foss and Wheeler-Osgood FYR team was led by Bill Ryan, the EPA RPM, Region 10. Deborah Johnston (biologist) with the USACE, Seattle District, assisted with the review.

By December 2013, the review team had been formed and the review schedule had been established for the following activities:

- Document collection and review;
- Data assessment and analysis;
- Site inspection;
- Interviews and community notification and involvement; and
- FYR report development and review.

The FYR has a statutory completion date of December 23, 2014.

4.7.5.2 Community Involvement

On January 17, 2014, a display advertisement ran in the Tacoma News Tribune newspaper providing notification and contact information for the FYR. In addition, on January 21, 2014, EPA Community Relations staff sent postcards to stakeholders and neighbors included on the CB/NT project mailing list (approximately 1,150 addressees), providing notification about the five-year review process. Both notifications requested that any information that people would like EPA to consider during the review be provided to the EPA before April 15, 2014. On February 19, 2014, Kevin Rochlin, Bill Ryan, and Jonathan Williams (all with EPA Region 10) met with Bill Andersen, the Executive Director of Citizens for a Healthy Bay, at which time EPA provided information on CB/NT activities and preparation of the fourth FYR.

The Foss Waterway Development Authority (FWDA) provided comments describing the pro-active stewardship actions taking place at the marinas in the waterway and the EnviroStar certifications obtained by those marinas.

No other community input was provided related to the review of the Thea Foss and Wheeler-Osgood Waterways.

4.7.5.3 Document Review

A review of reports pertinent to this FYR was conducted by the review team. The types of documents reviewed included decision documents, annual data reports, technical memoranda, and other supporting materials. OU 01 Attachment 1 is a complete list of documents reviewed during this FYR.

4.7.5.4 Data Review and Evaluation

Results from the OMMP activities are discussed in Section 4.7.3, Post-Construction Monitoring/O&M. Institutional Control Plans for the City's Work Area and the Utilities' Work Area were approved in September 2006. The City's project representatives also continue to work with the City's Building and Land Use Services division to implement procedures to ensure that future development in and adjacent to the Foss Project areas, where remedial actions and habitat mitigation work have been completed, are undertaken in a manner that protects the remedy and the habitat. Additionally, publicly-owned marinas on the waterway require the use of Department of Ecology Best Management Practices (BMPs) in the leases with boaters as well as pump-out requirements. The FWDA also actively educates marina staff and boaters, and partners with Citizens for a Healthy Bay (an environmental organization) on BMPs to ensure compliance with BMPs. Spill response plans are also in place.

A request was submitted to the U.S. Coast Guard (USCG) to establish a regulated navigational area (RNA) in the Thea Foss Waterway prohibiting anchorage and other activities that could disturb the cap. The rule was finalized on January 7, 2011. Therefore, the City now has the authority to post "No Anchoring" signs in the capped portions of the waterway, if determined to be necessary.

The City is implementing a stormwater monitoring and source control program for the municipal storm drains entering the Thea Foss and Wheeler-Osgood Waterways to help provide long-term protection of sediment quality in the waterways. The City continues to pursue control of sources to stormwater and continues to evaluate enhanced BMPs and their effectiveness on reducing COC loads to the waterway. Over a 12-year period (August 2001-September 2013), stormwater and SSPM have been sampled at the 7 major outfalls that discharge into the Thea Foss and Wheeler-Osgood Waterways. In addition, baseflow was sampled at the same 7 outfalls for the first 10 years of the program. Over the last 12 years, over 1,400 samples have been collected: 322 baseflow and 846 stormwater samples were collected at the outfalls, and 74 (outfall) and 230 (upline) SSPM samples were collected in pipeline sediment traps deployed throughout the watershed. The number of statistically significant time trends observed in Tacoma's stormwater monitoring record increased to forty-four (44 out of 49 tests, or approximately 90 percent of the tests) in Year 12 using simple linear regression. All trends were in the direction of decreasing concentrations (City of Tacoma 2014).

No interviews were conducted.

4.7.6. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes.

Overall, sediment concentrations in the waterway have decreased since completing the sediment remedial actions, indicating that the caps throughout the waterway are stabilizing and performing as designed (no upward migration of contamination has been documented).

Cap integrity monitoring, which includes visual and hydrographic survey work, indicates that capped and natural recovery areas are stabilizing and meeting performance criteria in much of the waterway. The remedy in a large portion of the waterway is supporting benthic communities. In the head of the Thea Foss Waterway, some analyte concentrations appear to have increased while other analyte concentrations appear to have decreased in Year 7 (2013) samples relative to the baseline samples. Broad variability exists in data trends from station to station, as described in Section 4.7.3.4, Post-Construction Monitoring/O&M. Additional monitoring is needed at most stations to further evaluate the variation in data trends. Whether remedial actions taken in the natural recovery and enhanced natural recovery areas have been successful will be determined once a 10-year period of monitoring is completed by the City in 2016. Those determinations, and any associated actions, will be presented in the next FYR report.

Results of stormwater sampling show overall downward trends of COC concentrations in stormwater and contaminant loading to the Thea Foss Waterway, though contaminants are still entering the waterway via stormwater outfalls. Data indicate that the discharges from stormwater outfalls in the head of the waterway are the likely sources of the PAH and BEHP recontamination. Capped areas in the head of the Thea Foss Waterway are being overlain with contaminated sediments that appear to be discharged by the Twin 96-inch outfalls located at the southern end of the waterway. These sediments contain concentrations of PAHs and BEHP and other site contaminants (benzyl alcohol, benzoic acid) that exceed SQOs. Two other areas (near Outfall 230 and in RA 19) in the waterway also show evidence of being recontaminated with PAHs and BEHP, but the exact sources have not been identified at this time.

The incoming, stormwater-generated sediments are organically enriched, fine-grained materials that appear to be limiting the suitability of the area as habitat for benthic communities. The City of Tacoma continues its efforts to reduce or eliminate the discharge of the contaminated sediments to the waterway from the City's stormwater system. Those efforts are expected to further reduce contamination entering the waterway over time, though the reductions are likely to be smaller than what has been achieved during the first 12 years of the City's stormwater monitoring and source control program.

There is no site-specific habitat mitigation objective outlined in the ROD. The Department of Health (DOH) has a flatfish and rockfish consumption advisory in place for the Commencement Bay waterways. Habitat function and enhancement of fisheries resources is incorporated as part of the overall project cleanup objective. Habitat mitigation objectives and goals are site-specific and were developed for the site prior to construction. Generally, the mitigation sites appear to be performing in accordance with the overall project goals.

A request was submitted to the U.S. Coast Guard (USCG) to establish a regulated navigational area (RNA) in the Thea Foss Waterway prohibiting anchorage and other activities that could disturb the cap. The rule was finalized on January 7, 2011. Therefore, the City of Tacoma now has the authority to post "No Anchoring" signs in the capped portions of the waterway, if determined to be necessary.

The City submitted a request to the U.S. Army Corps of Engineers (ACOE) in 2007 to deauthorize portions of the federally authorized navigation channel in the Thea Foss where capping materials encroach on the authorized channel. The City worked with the ACOE and the Congressional delegation in drafting deauthorization language for inclusion in the Water Resources Development Act (WRDA). The most recent version of WRDA was enacted in 2014, but the deauthorization language for the Thea Foss was not included in the law. The City plans to continue to coordinate with the ACOE and Congressional delegation in an effort to have the deauthorization language included in the next version of WRDA that is enacted.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy still valid?

Answer: *Yes.*

Changes in Standards and To Be Considered. See Section 4.2.6 (Question B).

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics. See Section 4.2.6 (Question B).

Changes in Land Use. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

Remedial Action Objectives. The RAOs from the ROD are still valid and protective for the site.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: *No.*

4.7.6.1 Technical Assessment Summary

According to the data reviewed and information obtained from site monitoring efforts, the sediment remedial actions have reduced sediment concentrations (the sediment concentrations remain below SQOs in most areas of the waterway), and the capped areas appear to be stabilizing and functioning as designed (no upward migration of contamination has been documented). Cap integrity monitoring, which includes visual and hydrographic survey work, indicates that capped and natural recovery areas are stabilizing, meeting performance criteria, and supporting benthic communities in much of the waterway. Stormwater control efforts, critical to the long-term effectiveness of the sediment remedial actions, have reduced contaminants entering the waterway. Those efforts, however, have not yet been fully successful because top-down recontamination is occurring near some stormwater outfalls in the southern portion (head) of the waterway. Recontamination constituents include PAHs, phthalates, pesticides, and PCBs. The City of Tacoma has implemented an aggressive stormwater monitoring and source control program that has reduced contamination entering the waterway. That program is expected to continue into the foreseeable future.

Institutional controls have been put in place that enhance the long-term integrity of the remedy. The USCG institutional control (prohibiting anchorage and other cap-disturbing activities) was completed in 2011 and will help protect the long-term integrity of the cap. The City continues to work with USACE and Congressional delegation to deauthorize the capped areas of the authorized navigation channel in the Thea Foss Waterway. There have been no promulgated changes in the ARARs, standards, or To Be Considered (only non-promulgated changes to the AET database from which the SQOs were derived) that could affect the protectiveness of the remedy. Overall, the sediment remedy remains protective of human health and the environment. There is no other information that calls into question the protectiveness of the sediment remedy.

4.7.7. Issues and Recommendations/Follow-up Actions

No issues or recommendations/follow-up actions were identified during this fourth FYR for the Thea Foss and Wheeler-Osgood Waterways.

Action items that do not affect protectiveness, but are expected to require future action, are listed in Table 7-2.

4.7.8. Protectiveness Statement

The protectiveness statement is provided in Section 8.

4.8. CB/NT Sediments OU 01, OU-wide Issue

4.8.1. CB/NT Sediments OU 01, OU-wide Issue and Recommendation/Follow-up Action

For the CB/NT Sediments OU 01, the ROD specifies that site use restrictions, such as advisories restricting seafood consumption, will be implemented to protect human health until recovery is complete. The third FYR (2009) provided a rationale for using fish tissue data to address the "Site Use Restrictions" element of the remedy (the 2009 FYR is available at the link http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt).

A summary of the issue and the recommendation/follow-up action made in the 2009 FYR and an evaluation of its progress are presented below:

> "Sediments OU 01, OU-wide Issue from Third Five-Year Review (2009) – Recent fish tissue data for bioaccumulative chemicals have not been collected in Commencement Bay. Thus, it is not known whether contaminant levels in fish tissues have been reduced since the remedies have been implemented, particularly for PCBs (which have a human-health based Sediment Quality Objective), and whether fish advisories should be continued, modified, or removed.
>
> Sediments OU 01, OU-wide Recommended Follow-Up Action from Third Five-Year Review (2009) – Develop and implement a sampling plan for collection and analysis of bay-wide fish tissue data for bioaccumulative chemicals (particularly for PCBs, which have a human-health based Sediment Quality Objective). Provide results to appropriate state and local agencies to evaluate protectiveness of health-based fish consumption advisories for Commencement Bay.
>
> Planned Completion Date for the Recommendations/Follow-Up Actions from Third Five-Year Review (2009) – December 29, 2014."

In the third FYR (2009), EPA concluded:

> "EPA believes that a fish tissue sampling effort is necessary to evaluate progress toward remedial objectives and whether fish advisories should be continued, modified, or removed. EPA envisions developing a sampling plan for collection and analysis of bay-wide fish tissue data for the overall site. EPA believes that it would be appropriate to initiate the fish tissue sampling effort at this time, since the majority of remedial actions within the Sediments OU have been completed (by 2008), and the PCB-contaminated sediments have been addressed by these actions.
>
> Moreover, since sediment quality monitoring is the primary means of assessing whether ROD objectives have been met, fish tissue data could be used for informational purposes to evaluate short-term risk reduction for human health since the remedies have been implemented (e.g., do data suggest a reduction in fish tissue levels?). In Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites, EPA (2002) notes "*While it is generally more practical to use measures such as contaminant concentrations in sediment to identify areas to be remediated, other measures should be used to ensure*

> *that human health and/or ecological risk reduction goals are being met. Such measures may include direct measurements of indigenous fish tissue concentrations…*" "

Background information on this Issue and Recommendation/Follow-up Action is provided below, followed by a description of progress made since the last five-year review.

4.8.1.1 Background

As described in the CB/NT ROD (EPA 1989; Declaration, p. 1), the overall goal of the selected remedy is "to protect the marine environment and thereby reduce associated public health concerns." The selected remedy "is protective of the marine environment and related human health concerns" (ROD; Declaration, p. 2). The subsequent PCB ESD (EPA 1997; p.4) reiterated that the cleanup goal for the Commencement Bay problem areas is to achieve reduction of *contaminant concentrations in sediments* [emphasis added] to levels that will support a healthy marine environment and will protect the health of people eating seafood from the Bay.

Neither the CB/NT ROD nor the PCB ESD specifies a cleanup goal or cleanup level for contaminants in seafood tissue. As set forth in the ROD and described in Section 4.1.1 of this Five-Year Review, Sediment Quality Objectives for all problem chemicals were set based on an evaluation of the ecological and human health risks posed by these chemicals. Only the SQO for PCBs was based on the human health risk assessment (EPA 1989; EPA 1997). SQOs for all other chemicals were based on the ecological risk assessment, *because the ecologically-based cleanup levels were determined to be also protective of human health* [emphasis added].

The ROD specifies five key elements of the selected remedy for sediments. The ROD does not include seafood tissue sampling as a specific element of the selected remedy (see Sections 10.2.5 and 10.3 of the ROD). Subsequent ESDs for the individual waterways, including the PCB ESD (EPA 1997), do not discuss seafood tissue sampling for the Sediments OU.

In reviewing the CB/NT ROD, it can be surmised that the OU-wide recommendation for fish tissue sampling in the second Five-Year Review was intended to address the "Site Use Restrictions" element of the remedy. The ROD describes site use restrictions as follows:

> "Site use restrictions, such as advisories against seafood consumption, will be implemented to protect human health until recovery is complete." [Declaration, p. 2]
>
> "Site use restrictions: protect human health by limiting access to edible resources prior to and during implementation of source and sediment remedial activities." [Section 8]
>
> "Site use restrictions consist mainly of public warnings and educational programs intended to reduce potential exposure to site contamination, particularly ingestion of contaminated seafood. Local health advisories are an integral part of the overall remedy because the ultimate objectives will be achieved over a 15-20 year period." [Sections 8.2 and 10.2.1]
>
> "Site use restrictions (e.g., public warnings and fisheries advisories to reduce potential human exposure) implemented by state and local health authorities." [Section 2.4.2]

Thus, the ROD for the Sediments OU specifies site use restrictions in the form of fish advisories to limit human exposure to contaminated seafood until the remedial objectives are met [see Section 4.1.1].

Fish and shellfish advisories were put in place before the ROD (1989). According to the CB/NT RI (1985; p. 1.6), an advisory on fish consumption was issued by the Tacoma-Pierce County Health Department (TPCHD) in 1982. According to the CB/NT Summary Report of the RI (1985; p. 6), an advisory on fish consumption (advising against any consumption of bottom fish from Hylebos Waterway and against regular consumption of bottom fish from the other waterways) was issued by the TPCHD in January 1983. Relevant information on restrictions after 1984 was described in the RI and summarized by Hanowell 2008 of TPCHD, as provided in OU 01 Attachment 2 and described below:

- The original fish and shellfish (including crab) advisories issued by TPCHD were based on results from environmental investigations in Commencement Bay and EPA's *Assessment of Human Health Risk from Ingesting Fish and Crabs from Commencement Bay* (EPA 910/9-85-129, April 1985, prepared by Versar, Inc. for Ecology, under contract to EPA). The 1985 human health risk assessment utilized fish and crab tissue data collected in 1984. After the 1985 assessment, the TPCHD, in conjunction with the Washington Department of Social and Health Services (DSHS), issued a revised health advisory. The advisory recommended against the consumption of fish from the Commencement Bay waterways (EPA 1985, Summary Report of the RI, p. 52). DSHS (1985) listed precautions for fishing in Commencement Bay in April 1985 (see OU 01 Attachment 3). DSHS recommended that "individuals not fish or gather shellfish from parts of Elliott, Commencement and Port Gardner Bays adjacent to industrial areas. This recommendation pertains particularly to bottom fish such as sole and cod, which have the greatest exposure to chemical waste. Should it be necessary to fish in these areas, it would be prudent to eat only the fish muscle (flesh). Strip away and discard the skin, fat, internal organs and head. This is recommended because muscle tissue contains the lowest levels of chemical contamination. Consumption should be limited to an occasional fish. Since the liver contains the highest concentration of chemical contaminants, the liver should not be eaten from any fish caught anywhere in these bays." Specific meal recommendations or limits were not provided.

- In 1985, the TPCHD posted fish and shellfish advisory signs in City Waterway (now Thea Foss Waterway), Hylebos Waterway, and Blair Waterway (Hanowell 2008; OU 01 Attachment 2).

- In 1996, TPCHD replaced the original signs with similar signs that were written in English and other languages (Hanowell 2008; OU 01 Attachment 2). A map showing locations of these signs is provided in OU 01 Attachment 2.

- Over time (prior to 2008), many of the fish and shellfish advisory signs in Hylebos and Blair Waterways disappeared and were not replaced because TPCHD observed that fishers were not utilizing these areas (Hanowell 2008; OU 01 Attachment 2). In 2012, TPCHD identified and photographed three remaining signs in these waterways (see OU 01 Attachment 2).

- Currently, fish and crab/shellfish advisory signs are maintained by TPCHD in Thea Foss Waterway, and are updated when new signs (in many languages) are provided to TPCHD from the Washington DOH (Tuttle 2012a; see OU 01 Attachment 2). TPCHD posts signs in Thea Foss Waterway because this is the area where recreational harvesters are observed fishing and harvesting crab (Tuttle 2012b).

- A photograph of the current signage and a map showing the current location of seafood advisory signs in Thea Foss Waterway is provided in OU 01 Attachment 2 (Tuttle 2012c). The current advisory signs read: "Do Not Eat Crab, Shellfish, or Bottom-Feeding Fish due to Pollution." While the DOH and TPCHD agreed on this language for the Commencement Bay waterways – Hylebos, Thea Foss, and Blair (December 2008; see OU 01 Attachment 2), this advisory is not an official advisory due in part to the lack of data.

Fish, crab, and shellfish advisories remain in effect in the Commencement Bay area. Puget-Sound wide advisories for fish, crab, and shellfish apply to Commencement Bay, and the specific advisory "Do Not Eat Crab, Shellfish, or Bottom-Feeding Fish due to Pollution" currently applies to Thea Foss, Blair, and Hylebos Waterways.

4.8.1.2 Fish Consumption Advisories

The most recent information on fish advisories for the Commencement Bay area was published in a report released by the Washington State Department of Health (DOH) in October 2006. In that report, DOH (2006) assessed available fish tissue data to address potential health impacts to humans who eat marine fish from the Puget Sound area. Crabs and shellfish (e.g., clams, oysters, mussels) were not included in the assessment. The Commencement Bay area, which is part of Puget Sound, was included in the DOH assessment (see Figure 4-20).

For the Puget Sound-wide area, DOH evaluated over 100 individual chemicals in tissue muscle data available for Chinook and Coho salmon, English sole, and four species of rockfish (see Appendix E of DOH 2006).[15,16] DOH (2006) concluded that two of the contaminants are of

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15 From DOH 2006: "Contaminants were not considered for assessment if they were detected in fewer than 10% of fish tissue samples. Only a few chemicals or chemical groups were detected in more than 10% of the samples analyzed (alpha chlordane, arsenic, benzyl alcohol, copper, DDT and degradation products, DEHP, mercury, and PCBs). Ninetieth percentile contaminant levels in Puget Sound fish tissue were then compared to health-based comparison values. DOH used EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories to determine health-based comparison values (EPA 2000). Comparison values were based on a consumption rate representative of a subsistence consumer (142.4 g/day) and derived for non-cancer and cancer endpoints. Contaminant levels exceeding comparison values indicate a subsistence consumer receives a dose greater than the RfD, or results in a cancer risk greater than 1x10-5."

16 From WDOH 2006: "Of the species collected for PSAMP, rockfish can live the longest (up to 90 years), followed by English sole (between 2 and 21 years), Chinook salmon (typically up to a few months in freshwater and 2 to 4 years in the marine environment), and then Coho salmon (typically one winter in freshwater and 16 – 18 months in the marine environment) (Hart 1973; S. O'Neill, personal communication, 2004; G. Ruggerone, personal communication, 2005)."

"English sole are bottom feeders with a limited home range while rockfish tend to be even more sedentary. Contaminant levels in English sole and other bottom fish may show greater spatial variation than other species due to the localized nature of sediment contamination in Puget Sound. Contaminants such as PCBs and mercury may be potential public health concern: PCBs and mercury (methylmercury). A summary of PCBs and mercury measured in fish tissue from Puget Sound is provided in OU 01 Attachment 4 (reproduced from Table 3 of DOH 2006). DOH developed meal recommendations for salmon, English sole and other flatfish, and rockfish from Puget Sound. The specific fish consumption advisories and meal recommendations for the Commencement Bay area (which occurs within Recreational Marine Area 11) are provided in OU 01 Attachment 5 (Attachment KK-3 [reproduced from Table 11 of DOH 2006]). The consumption advisory and meal recommendations for English sole are the most relevant to the evaluation of sediment contamination in the CB/NT Site.[17]

While a summary of the fish advisories is provided below, the full advisory should be reviewed for details:

- Salmon – See Page 3 of Fact Sheet in OU 01 Attachment 5 (Attachment KK-9 [DOH Fish Consumption Advice Fact Sheet]).[18]
- Flatfish including English sole, starry flounder, and rock sole.
    - No more than 2 meals per month in Inner Commencement Bay (SE of imaginary boundary between Sperry Ocean dock and Cliff House Restaurant).
    - No more than 1 meal per week in Outer Commencement Bay (SE of imaginary boundary between Boathouse Marina and Brown's Point).
- Rockfish (based on contaminant levels in brown, quillback, and copper rockfish).
    - No more than 2 meals per month in Inner Commencement Bay (SE of imaginary boundary between Sperry Ocean dock and Cliff House Restaurant).
    - In addition to contaminant concerns, non-tribal harvest of yelloweye and canary rockfish is prohibited for conservation purposes.

4.8.1.3 Crab Consumption Advisories

For crab, DOH provides consumption advisories on these species at their website (available at the link below by clicking on "Puget Sound"):

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present at higher levels in older (i.e., rockfish) and larger fish because these metabolically-resistant contaminants can bioaccumulate over time (i.e., exposure time is greater in older fish). Further, contaminants biomagnify (chemical concentrations increase in species toward the top of the food chain) as fish grow and consequently feed on higher trophic level prey (Rand 1995)."

17 English sole are demersal species that live on the bottom where they are exposed to contaminants in sediments and prey species at the site. PCBs in tissue of English sole reflect conditions in the sediments where they live. English sole are more prevalent than rockfish in the Commencement Bay waterways, and historical data for English sole were collected in and near the waterways prior to and after the remedial action. Salmon are a migratory species, and accumulate most of their body weight and associated burden of contaminants while foraging in marine waters (O'Neill et al. 1998).

18 http://www.doh.wa.gov/Portals/1/Documents/Pubs/334-098.pdf

- http://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/Advisories.aspx

The consumption advisory for crab in Puget Sound states:

- "Crab: Eat Dungeness or red rock crab from non-urban areas of Puget Sound. Don't eat the crab butter or viscera. Viscera are the internal organs under the shell. If you cook crab in boiled water, don't use the water for soup stock, broth, or gravy. Limited data show that crab from industrial urban areas contain more contaminants than those from non-urban areas, and crab butter has more contaminants than crab muscle."

  http://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/Advisories.aspx

Due to limited crab tissue data, DOH does not have specific definitions or boundaries for urban, near-urban, or non-urban areas in Puget Sound. For geographical boundaries of urban and near-urban areas, DOH often refers to the Shellfish Safety Information maps (link follows) with the understanding that this is likely to be over protective for crab.

- http://ww4.doh.wa.gov/scripts/esrimap.dll?Name=bioview&Step=1

Also, the Washington Department of Fish and Wildlife (WDFW), who regulates crab harvesting in Puget Sound,[19] identifies State and County Fish Advisories and Consumption Advice in 2013 regulations posted at their website:

- http://wdfw.wa.gov/publications/01384/wdfw01384.pdf

The WDFW 2013 regulations provide a link to Washington DOH consumption advisories (as listed above), and in addition, WDFW describes Safe Handling Practices for crab:

- "Crab can also concentrate pollutants in their internal organs (crab butter). Clean crab before cooking. Eat only the meat."

http://wdfw.wa.gov/publications/01384/wdfw01384.pdf

[See WDFW 2013 regulations, p. 124; excerpt provided in OU 01 Attachment 5 (Attachment KK-10)]

Regarding the DOH crab advisory for Puget Sound, DOH (McBride 2012a) clarified that the crab advisory posted on the DOH website is a precautionary advisory due to the general understanding of pollution in urban areas and the limited availability of specific contaminant data for crab tissue from Puget Sound. In 2011 and 2012, crab and spot prawn samples were collected in Puget Sound (including one station in Commencement Bay) by WDFW for analysis of contaminants. Tissue analyses began in Fall 2012, and analytical data are scheduled to be available by Spring 2013 (McBride 2012b). DOH will assess these data to address potential health impacts to humans who eat crab and spot prawn from Puget Sound.

19 WDFW establishes schedules (including closures) for recreational crab fishing in the Commencement Bay area, which is identified as Marine Area 11.

DOH (McBride 2012b) advises that crab from Commencement Bay should not be eaten until new data have been collected and evaluated and DOH has determined that a modification to the advisory is warranted.

4.8.1.4 Shellfish Consumption Advisory

DOH and WDFW have closed all beaches in the Commencement Bay area, as well as many other nearshore areas in Puget Sound, for the harvesting of clams, mussels, and oysters due to health restrictions (see WDFW regulations and DOH advisories in OU 01 Attachment 5 [Attachment KK-10]). DOH and TPCHD have issued "A guide to SAFE shellfish harvesting in Pierce County" (see OU 01 Attachment 5 [Attachment KK-11]). The DOH Shellfish and Water Protection Office (SWPO) is concerned about harm to human health based on high coliform counts, and previously issued a "Do not eat shellfish" advisory due to biological pollution in the Commencement Bay waterways (see December 26, 2008 memorandum in OU 01 Attachment 2). Contaminant concentrations in shellfish (e.g., clams, mussels, and oysters) tissue are not being evaluated as part of this FYR.

4.8.1.5 Summary of Fish and Crab Consumption Advisories

While the DOH fish and crab advisories and meal recommendations for Puget Sound are intended to limit human exposure and are considered to be a good tool available to do so, consumption advisories are not enforceable under law. A consumption advisory is not a regulation, but rather a voluntary recommendation issued to inform people.[20] Throughout Puget Sound, including Commencement Bay, there is anecdotal evidence that some people do not follow the consumption advice provided in the advisories.

After reviewing the status of the remedial actions in the CB/NT Sediments OU, it is EPA's assessment that the overall remedy for sediments is expected to be protective once all actions (including monitored natural recovery) are complete. In the interim, until site remedial objectives are met [see Section 4.1.1], site use restrictions (i.e., fish and shellfish consumption advisories) shall remain in effect to limit human exposure to contaminated seafood.

4.8.2. Progress since the Last Five-Year Review

Since the last Five-Year Review, EPA has summarized relevant historical fish and shellfish tissue data for the nearshore Commencement Bay area. Due to workload restraints, EPA was unable to prepare or implement a sampling and analysis plan for fish and/or crab near the Hylebos and Thea Foss Waterways of the CB/NT Site. EPA intends to develop a plan to assess contaminant concentrations in fish and/or crab tissue data to evaluate progress toward achieving remedial objectives (e.g., do data suggest a reduction in contaminants in seafood tissue?) and to provide data that may be used by DOH in their assessment of fish and shellfish advisories and meal recommendations[21] for the Commencement Bay area. Some of the historical data evaluated by EPA in this report are the same data evaluated by DOH (2006) in their health assessment for advisories.

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20 http://water.epa.gov/scitech/swguidance/fishshellfish/fishadvisories/archive/2003_index.cfm

21 Washington DOH is the state agency responsible for decisions on whether advisories are continued, modified, or removed.

This FYR summarizes historical fish tissue (muscle) data for English sole (*Parophrys vetulus*) and for Dungeness crab (*Cancer magister*) and red rock crab (*Cancer productus*). These species were selected for the sampling and analysis plan for the following reasons:

- English sole and crab are demersal species that live on sandy and muddy bottoms in estuaries and nearshore areas where they may be exposed to contaminants in sediments and prey species at the site. PCBs in tissue of English sole and crabs reflect conditions in the sediments where they live.[22,23]

- These species are generally considered non-migratory, and they have more site fidelity than salmonids.

- English sole and crab tissue data were collected in Commencement Bay in 1984 for the RI.

- English sole and crabs are consumed by fishers. English sole were used by DOH to develop fish consumption advisories and meal recommendations for English sole and other flatfish in Puget Sound.

- The Puget Sound Assessment and Monitoring Program (PSAMP) and WDFW have collected English sole data at the mouth of Thea Foss Waterway since 1989, which allows for potential trends analyses in contaminant concentrations in fish tissue.

For this FYR, historical tissue data are summarized for two contaminants: PCBs and mercury. PCB tissue data are summarized because the CB/NT Sediment Quality Objective for PCBs was based on the human health risk assessment (see Sections 4.1.1 and 4.8.1 of this Five-Year Review), and in the CB/NT ROD, PCBs were identified as a problem chemical in sediments in two waterways: Hylebos Waterway and Thea Foss Waterway (EPA 1989; EPA 1997). While limited, the RI (1985) stated that the English sole and crab tissue data showed that those two waterways consistently had the highest concentrations of PCBs in tissue. Historical PCB tissue data are available for total PCBs (Aroclors) and PCB Congeners. Over the years, various

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22 From http://wdfw.wa.gov/conservation/research/projects/marine_toxics/englishsole.html: Much of the research on contaminant accumulation in fish in the Puget Sound has focused on English sole. These demersal fish are moderately long-lived (age of the oldest English sole collected by the Fish Component was estimated at 21 years), have a close association with the bottom sediments, consume benthic invertebrates, and have relatively restricted movements associated with seasonal migration for reproduction. These characteristics suggest that their probability of exposure to persistent bioaccumulative toxins is moderately high and that they will reflect regional spatial patterns of contamination in bottom sediments. Also, because they are purchased from the commercial fishery and are captured and consumed by some anglers, English sole represent a food-web pathway through which contaminants can move from sediments to humans.

23 From http://wdfw.wa.gov/conservation/research/projects/marine_toxics/dungenesscrab.html: Dungeness crab are an important predator and prey organism at all life history stages. They have pelagic larvae (zoea and megalops stages) which are preyed on by many fishes, including copper rockfish and Coho and Chinook salmon. Being planktivorous, the larvae may be exposed to pollutants that are present in the water column and plankton. Once they molt into the juvenile stage, they become demersal, feeding in the benthic food web. They can readily adjust their diet, but the younger/smaller crabs generally eat mollusks, progressing to shrimp and then to fish as they age and grow. The adults have developed an evolutionary niche for feeding on mud-sand substrate, thus providing a food-web pathway through which contaminants can move from sediments to humans. Dungeness crabs are relatively short-lived with a maximum lifespan of 8 to 10 years. They move between estuaries and offshore waters seasonally.

analytical methods for PCBs and PCB Congeners have been used, and resulting PCB data must be evaluated in consideration of the analytical methods performed (see OU 01 Attachment 5 [Attachment KK-5, "Final meeting notes"]).

Mercury tissue data are summarized because mercury was identified in the CB/NT ROD as a problem chemical in Middle Waterway and in the head of Thea Foss Waterway (EPA 1989). As described previously, the Sediment Quality Objective for mercury was based on an ecological risk assessment and was determined to be also protective of human health.

As discussed previously, PCBs and mercury are the two human health contaminants of concern in fish and shellfish in Puget Sound according to an assessment by Washington DOH (2006).

In evaluating fish and crab tissue concentrations, it is relevant to consider home ranges of species. The size of the home range of resident species (e.g., English sole and crab) to the entire Commencement Bay is unclear, because no site-specific research on home ranges has been conducted. As cited in the RI for the Lower Duwamish Waterway Superfund Site (LDWG 2003), "the unconstrained average home range of English sole, as reported by PSDDA (1988c) is 9 km^2. Similarly, the unconstrained home range of Dungeness crab has been reported to range from 0.1 to 1 km per day (Breen 1985; Waldron 1958), and Ecology has used an area of 10 km^2 in crab-based risk assessments performed elsewhere in Puget Sound (e.g., Bellingham Bay)."

Other considerations are that an adequate baseline data set (before cleanups were implemented) is not available for mercury, methyl mercury or PCBs, background concentrations of mercury and PCB tissue data are not readily available, appropriate statistical methods have not been identified for trend analyses, and contaminant reductions in seafood tissue may or may not be linked.

EPA has compiled available fish and shellfish tissue data, as summarized in OU 01 Attachment 5. However, a fish and shellfish sampling effort has not been implemented due to EPA resource constraints. Thus, this issue remains as a recommendation with follow-up actions for this FYR.

4.8.3. Issues and Recommendations/Follow-up Actions

Issues and recommendations/follow-up actions that affect protectiveness for the site-wide Sediments OU 01 are provided in Section 7.

4.8.4. Protectiveness Statement

The protectiveness statement for the site-wide Sediments OU 01 (seafood advisories) is provided in Section 8.

4.9. CB/NT Sediments OU 1, Commencement Bay Environmental Data

In April 2010, the Washington Department of Ecology (Publication No. 10-03-019) published results of an environmental assessment conducted in 2008 in Commencement Bay. As stated in the Abstract:

> "The Urban Waters Initiative (UWI) is a multi-agency program to reduce toxic chemical pollution in selected urban bays of Puget Sound. As part of the UWI, the Washington State Department of Ecology is assessing sediment quality throughout those bays to determine current conditions and compare them to past conditions. These bay-scale assessments provide information to environmental managers concerned whether and how the collective effects of multiple localized cleanups and source controls improve bay-wide conditions over time. In 2008 Ecology sampled Commencement Bay, including adjoining waterways."

Surface sediment samples were collected at 30 locations throughout Commencement Bay, including many stations located outside the waterways addressed by the CB/NT RODs (see Figure 4-21 for locations). Each sample was analyzed to measure three different indicators of sediment quality: sediment chemistry, sediment toxicity, and the composition of benthic (bottom-dwelling) invertebrate assemblages. These three indicators were then combined into Ecology's Sediment Quality Triad Index (SQTI), an important, multi-variable indicator of sediment quality in Puget Sound. Samples were collected and analyzed for sediment chemistry, sediment toxicity, and benthic infaunal community structure.

The report concluded:

> "In 2008, approximately 15% of Commencement Bay *[samples were collected in a much larger area than addressed by the CB/NT ROD]* had contaminated sediments and 35% had adversely affected benthic communities. About 12% of the area had both. None of the sediments were highly toxic in two kinds of laboratory tests. Overall, 61% of the area had high sediment quality."

Comparisons with similar data from 1999 showed:

- Decreased sediment contamination by numerous toxics, primarily polycyclic aromatic hydrocarbons and metals.
  - *For the 30 stations, chemical exceedances of the SQS were found at 8 stations, and chemical exceedances of the cleanup screening level (CSL) were found at 4 stations.*
  - *For total PCBs at the 30 stations in Commencement Bay:*
    - *Total PCBs were undetected in 10 of 30 samples*
    - *In 10 of the 20 samples with detected concentrations of PCBs, samples had only single Aroclor detections slightly above the detection limit (e.g., Aroclor 1254 reported at 7 ppb dw, with a DL of 5 ppb dw).*
    - *Total PCBs exceeded the SQS at only one station throughout the Commencement Bay area.*
    - *Total PCBs did not exceed the CSL at any station.*

        - *There were too few detected concentrations of PCBs in sediments in either 1999 or 2008 to conduct a statistical comparison.*

- Increased contamination by phthalates.

- Slightly decreased toxicity.

    - *In the 2008 survey, two types of toxicity tests were performed: sea urchin fertilization success and amphipod survival test. For the 30 stations, no sediment toxicity was observed, as compared to standards.*

- Improved benthic community health in the waterways, but deterioration in the central-southeastern bay.

- Shifts from both degraded conditions and high sediment quality to intermediate conditions, possibly reflecting both positive effects of numerous cleanups and source controls and negative effects of habitat changes in the central-southeastern portion of the bay.

    - *In 2008, none of the 30 stations were identified as degraded, as compared to the Sediment Quality Triad Index.*

The full report is available at the link:

https://fortress.wa.gov/ecy/publications/publications/1003019.pdf

5. Remedial Actions and Five-Year Review Process for CB/NT Asarco Operable Units 20, 22, and 19

5.1. Background

The Asarco Area Site consists of the former Asarco copper and lead smelter facility and the surrounding areas. The Asarco Area Site was divided into three OUs, each with its own ROD, as described below:

- Asarco Smelter Facility (Asarco Smelter) OU 20 (also known as OU 02), which consists of the smelter property and the slag peninsula;
- Ruston/North Tacoma Study Area (Study Area) OU 22 (also known as OU 04), which consists of contaminated properties in an approximate one-mile arc surrounding the smelter; and
- Asarco Sediments/Groundwater (Asarco Sediments) OU 19 (also known as OU 06), which encompasses the sediments offshore of the smelter and the Yacht Basin formed by the slag peninsula.

See Figure 5-1 for a general map of the majority of these areas, and see Figure 5-2 for a parcel map with taxpayer information.[24]

The Asarco Smelter (OU 20) is located along the Commencement Bay shoreline within the municipal boundaries of Ruston and Tacoma, Washington. The upland portion of the Asarco Smelter is approximately 100 acres in size and encompasses the 67-acre smelter area and the 23-acre slag breakwater peninsula. The habitat basin is also discussed as part of this OU. Point Ruston LLC is the taxpayer for the Asarco Smelter property, and the Metropolitan Park District (Metro Parks) is the taxpayer for the slag peninsula. See Figure 5-1 for the areas surrounding the slag peninsula, and see Figure 5-3 for the former Asarco Smelter upland site and the former fuel, copper, and ore docks.

The Ruston/North Tacoma Study Area (OU 22) encompasses approximately 950 acres in a one-mile arc around the former Asarco Smelter. The OU includes an estimated population of approximately 5,000 people, and about 1,820 housing units. See Figure 5-4 for a map of the Ruston/North Tacoma Study Area.

The Asarco Sediments (OU 19) encompasses the Yacht Basin formed by the slag peninsula and the sediments offshore of the smelter. The taxpayer for the Yacht Basin is the Metropolitan Park District, and the taxpayer for the sediments offshore of the smelter is Point Ruston LLC. Additional offshore areas are owned by the State of Washington and are managed by DNR. See Figure 5-5 for a map of the Asarco Sediments area.

24 Taxpayer information is publicly available; determining ownership typically requires a full title search.

Smelter operations caused contamination of the area by releasing metals such as copper, lead, and arsenic into the air, soil, and Commencement Bay. In addition, much of the smelter property and the peninsula are constructed entirely of slag from the smelting process. The Ruston/North Tacoma Study Area was contaminated primarily with arsenic and lead in soil due to airborne emissions from smelting operations. Offshore sediments were contaminated primarily with copper, arsenic, and lead due to smelter site runoff, contaminated groundwater discharges, and slag spills.

5.2. Site Chronology

Information through 2009 is available in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

Current site chronology information, as well as a brief history of Asarco bankruptcy information, is provided below.

5.2.1. Recent Site Chronology

5.2.1.1 Asarco Smelter

2006 -present Point Ruston LLC has been and is redeveloping the site into an upscale waterfront community. EPA is overseeing their work to ensure that their redevelopment activities meet the performance standards for remediation of the Asarco Smelter site. In 2013, Metro Parks, as part of a contribution protection claim by Point Ruston LLC, capped the slag peninsula areas that Point Ruston was required to remediate under the Second Amendment to the Consent Decree (2006).

2014 In September 2014, EPA began design for repair of the habitat basin that was damaged in the 2001 Nisqually earthquake. The design to cap the portion of the slag peninsula occupied by the Tacoma Yacht Club and for armoring the remaining section of the slag peninsula described in the ROD is ongoing. See further discussion in Section 5.3.2.1.2.

5.2.1.2 Ruston/North Tacoma Study Area

2009 EPA began remediation on the remaining properties.

2012 Property cleanup was completed except for a small number of refusals. The 2013 Remedial Action Report was approved by EPA for this portion of the work (EPA 2013).

2014 A cooperative agreement was put in place with Ecology, who will handle any future work, including institutional controls.

5.2.1.3 Asarco Sediments

2006 The Second Amendment to the Asarco Consent Decree (CD) was issued. This 2006 amendment added Point Ruston LLC as a new party to the CD, and required Point Ruston LLC to remediate the Asarco smelter, cap the slag peninsula, cap offshore sediments, and excavate shallow sediments in the Yacht Basin. The area for excavation of shallow Yacht Basin Sediments in shown by the blue line in Figure 5-7.

2010 EPA began evaluating options for remediating the Yacht Basin sediments. As of 2014, no remedial work in the Yacht Basin has occurred.

2011 Washington State DNR, as part of a contribution action by Point Ruston LLC, demolished the fuel, ore, and copper docks (see Figure 5-3) along the Asarco Smelter shoreline and placed a 1.6-acre quarry spall cap over the sediments where the docks had been. This work was required of Point Ruston LLC under the Second Amendment to the Consent Decree (2006). DNR manages the State-owned aquatic land where the ore and copper docks were located. Point Ruston LLC owns the upland site and the aquatic lands where the fuel (north) dock was located.

2013 Point Ruston LLC placed a 3-foot-thick layer of clean riprap over approximately 6.1 acres of contaminated sediment and placed a 3-foot-thick layer of clean sand and gravel over approximately 1.9 acres of contaminated sediment in Commencement Bay, for a total of 8 acres capped (see Figure 5-8).

5.2.2. Asarco Bankruptcy Information and Summary of Enforcement Actions

Prior to 2005, Asarco was the responsible party required by a 1997 CD and subsequent amendments to the CD to remediate the former Asarco Smelter property, the slag peninsula, the Yacht Basin, the Ruston/North Tacoma Study Area, and sediment contamination in Commencement Bay. Following the Asarco bankruptcy, EPA took responsibility for the Ruston/North Tacoma Study Area and the Yacht Basin, and Point Ruston LLC purchased the Asarco Smelter property. As a condition of the purchase, the United States in 2006 amended the 1997 Consent Decree with Asarco to require Point Ruston LLC, as the new owner, to remediate the former Asarco Smelter property, cap the slag peninsula, cap offshore sediments, and excavate a small area of shallow sediments in the Yacht Basin (USDC 2006). The general chronology is below. [25]

1997 Asarco entered into a CD to cleanup up the Asarco Tacoma Smelter site.

2000 First amendment to CD occurred, stipulating penalties for Asarco's failure to achieve specified milestone dates.

2003 Asarco and its parent company, Grupo Mexico, signed a CD with the United States deferring enforcement of their national environmental liabilities in exchange for setting up a $100 million trust fund (the Trust) to

25 For more detailed Asarco bankruptcy information prior to 2009, see pages 148-149 of the third FYR.

be used for Asarco's environmental liabilities around the country.

2005 Asarco declared bankruptcy.

2005 Asarco sold 97 acres of its property in Tacoma and Ruston, WA, to MC Construction Consultants, who in turn assigned their rights to Point Ruston LLC.

2006 The Second Amendment to the CD was issued. This 2006 amendment added Point Ruston LLC as a new party to the CD, and required Point Ruston LLC to remediate the Asarco smelter, cap the slag peninsula, cap offshore sediments, and excavate shallow sediments in the Yacht Basin. The **Schedule for Implementation** for these activities is below.

2009 The Bankruptcy Court for the Southern District of Texas, Corpus Christi Division, issued the *Amended Settlement Agreement Regarding Miscellaneous Federal and State Environmental Sites* (USBC 2009a). The bankruptcy court approved a settlement of $27 million plus interest between Asarco and the United States for the three operable units related to the Asarco Area Site.

Schedule for Implementation

Table 5-1 below provides the implementation schedule for Point Ruston LLC that was provided in the statement of work (SOW) that accompanied the 2006 Second Amendment to the Asarco CD. The SOW described how Point Ruston LLC would implement the remedial requirements (EPA 2006a). The inferred dates for when work should have been completed, as well as the actual status of completion, have been added. Because the project has been delayed, a new schedule will be negotiated between EPA and Point Ruston LLC.

Table 5-1. 2006 Implementation Schedule for Point Ruston LLC for Remedial Action

Action Required	Due	When Work Should Have Been Completed	Year of Actual Completion
Cap Nearshore/Offshore Sediment with Sand/Silt Cap (apprx. 10.5 acres)	One year from effective date of Second Amendment	2007	2006-2007
Cap Slag Peninsula	Prior to EPA Certification of the First Phase (October 30, 2008) [1]	October 30, 2008	2014
Construction of temporary site cap	Prior to EPA Certification of the First Phase (October 30, 2008) [1]	October 30, 2008	2014
Excavation of shallow sediments in Yacht Basin per SOW requirements	Prior to EPA Certification of the Second Phase (No later than November 15, 2009) [1]	November 15, 2009	Not started
Site Cap 50 percent complete	Four years from effective date of Second Amendment	2010	Ongoing
Complete Site Cap	Seven years from effective date of Second Amendment	2013	Ongoing
Complete Sediment Cap [2]	Seven years from effective date of Second Amendment	2013	2013

1 Certification refers to EPA issuing a Certification of Completion for a phase of the project. Certification must be issued before occupancy is allowed.

2 This sediment cap was also referred to as the "hard cap" in the third FYR.

5.3. Remedial Actions

5.3.1. Remedy Selection

Three RODs were prepared for the Asarco Area Site, one each for the Asarco Smelter (1995), the Ruston/North Tacoma Study Area (1993), and the Asarco Sediments/Groundwater (2000). In addition, one ESD (1996) has been issued for the Asarco Smelter Facility, and one ESD (1994) has been issued for the Ruston/North Tacoma Study Area.

5.3.1.1 Asarco Smelter

The selected remedy in the ROD is summarized below:

- Excavation of soil and granular slag from five source areas. Soils that fail the Toxic Characteristic Leaching Procedure (TCLP) will be excavated from stack hill, the cooling ponds, arsenic kitchen, the former copper refinery, and fine ore bins building, and disposed of on site.
- Construct a RCRA Subtitle C on-site containment facility (OCF) on the property for disposal of contaminated material from the source areas. The facility will be designed to hold approximately 240,000 CY of material.
- Construct surface and groundwater diversion and controls to protect the OCF from water infiltration.
- Grade and prepare site for capping using residential material from the Study Area as sub-base.
- Incorporate plans for future development into the cap design.
- Armor the shoreline around the plant site to prevent further erosion of the shore.
- Mitigate for shoreline armoring activities where they adversely impact intertidal lands.

5.3.1.2 Ruston/North Tacoma Study Area

The remedy addresses the principal threat posed by soil and dust in the Study Area, and contains the following elements:

- Designation of "action levels" for arsenic or lead in soil. Engineering measures will address properties or areas that exceed action levels.
- Sampling of individual properties to determine if soil exceeds the action levels.
- Excavation and off-site disposal of contaminated soil and slag from properties that exceed action levels. Contaminated soil below 18 inches will not be excavated but will be capped.
- Replacement of excavated soil and slag with clean soil and gravel.
- Asphalt capping or soil removal and replacement with gravel of contaminated dirt alleys and parking areas.
- Fencing and planting low lying shrubs in steep areas that cannot be excavated.
- Soil collection program for soil above action levels that is not excavated during the cleanup (e.g., soil below 18 inches that is uncovered in the future).

- The development and implementation of Community Protection Measures (CPMs). CPMs are administrative requirements that will address soil that is not excavated but that contains concentrations of contaminants above 20 parts per million (ppm) arsenic and 250 ppm lead, but below the 230 ppm arsenic and 500 ppm lead action levels.

5.3.1.3 Asarco Sediments/Groundwater

The selected remedy for the Asarco Sediments/Groundwater OU includes groundwater and sediments. EPA determined in a Groundwater Task Force, comprised of Asarco, EPA, and other regulatory agencies, that additional groundwater remedial actions, over and above those already being implemented under the Smelter Facility ROD, were not necessary.

The selected remedy for marine sediments included the following elements:

- Dredge contaminated sediment in the Yacht Basin and place the dredged sediment beneath a low-permeability soil cap to be constructed on the upland portion of the Smelter Facility. The sediments will be contained under the low-permeability cap at an elevation such that groundwater will not come in contact with the sediment. The areas for dredging and capping are severely impacted areas where chemical concentrations exceeded cleanup screening levels (CSLs) and multiple biological impacts (e.g., more than one biological test exhibited a significant effect) were observed. This also included all areas where benthic community structure indicated a stressed environment.
- Monitor the dredged area in the Yacht Basin to verify that it does not become recontaminated.
- Cap contaminated sediments in selected offshore areas.
- Monitor the sediment caps to confirm that they remain in place, continue to isolate the underlying contaminated sediment, become recolonized with healthy biological communities, and do not become recontaminated.
- Use institutional controls to prevent activities that could damage the sediment caps.
- Monitor the areas outside the capped and dredged areas to confirm that these areas meet RAOs.
- Continue to monitor groundwater to evaluate the long-term effects that the Facility cleanup will have on future groundwater quality.
- Implement institutional controls to restrict future use of Smelter facility groundwater.

5.3.2. Remedy Implementation

Information through 2009 is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

5.3.2.1 Asarco Smelter

Remedial actions for the Smelter and slag peninsula have been occurring since the mid-1990s. By December 2005 the OCF had been constructed and filled, all buildings had been demolished, and most of the shoreline armoring had been completed. Recent remedy implementation activities that have occurred since the third FYR for Point Ruston, the slag peninsula, and the habitat basin are provided below.

5.3.2.1.1 *Point Ruston*

Since 2006, the site developer, Point Ruston LLC, under a 2006 CD with EPA, has been transforming the Smelter site into an upscale waterfront community known as Point Ruston (USDC 2006; EPA 2006a). The community consists of new condominiums and apartments ("Copperline"), new homes ("Stack Hill"), a Waterwalk (boardwalk), and a ferry-based event center.[26] The transformation is ongoing as of 2014. Site capping is being accomplished through use of specially designed impermeable hardscapes, multi-layer RCRA-compliant caps and building foundations to meet the performance standards for remediation of the Asarco Smelter site.

As of February 2014, the following progress has been made on the Smelter site remediation.

Master infrastructure for Point Ruston was constructed site-wide, which included main-line water infrastructure; public and private sewer and stormwater-sewer conveyance systems; and electrical, gas, and communication systems.

The fuel, ore, and copper docks that extended from the Smelter into Commencement Bay were demolished. Shoreline armoring in Commencement Bay was constructed in areas that were not accessible when the docks were present.

The Waterwalk portion of the remediated Smelter site, which is approximately 100 feet wide (from the edge of the shoreline armoring to approximately 100 feet inland) and nearly a mile long, was remediated using a multi-layer cap composed of a geocomposite clay liner (GCL), 40-mil high-density polyethylene (HDPE), a drainage net, 9 inches of clean backfill, a woven marker layer, and 9 more inches of clean fill. Asphalt, cement concrete, or vegetation was placed on top of the clean fill depending on the final surface design.

Phase 1 remediation was completed and consisted of construction of the Copperline apartments and condominiums (Building 2A); the foundation slab for Building 2B located between 2A and the Waterwalk; portions of a multi-layer cap in green areas; and hardscapes consisting of low-permeability asphalt concrete and low-permeability cement concrete. See Figure 5-9 for a map of the Point Ruston development.

A temporary impermeable cap (TIC) composed of welded 40-mil HDPE on a graded subsurface was constructed over areas of the site that did not have a minimum of 6 inches of clean gravel, a building foundation, or other permanent infrastructure in place. The TIC is held in place using sandbags and a gravel berm located around the edge. The areas of the site that did not receive the TIC were construction roads that had a clean gravel surface, the nursery which has up to 10 feet of topsoil, or areas of the site where remedial action has been completed (i.e., Phase 1 areas).

The portion of Ruston Way located in Ruston, WA, and a section of Ruston Way (approximately

26 See "Lifestyle" at http://www.pointruston.com/site/ for a description of the Point Ruston redevelopment plans including a map of the site itself, the Waterwalk, and the ferry event center (Point Ruston LLC 2014).

50 feet long) in Tacoma east of the Grand Avenue traffic circle was constructed using composite GCL/HDPE liner located below a conventional asphalt road bed.

The OMMP for the site-wide cap was completed and approved by EPA (Hydrometrics 2013a), and the Development and Occupancy Plan (DOP) was completed and approved by the EPA (Hydrometrics 2013b). An extensive air monitoring network consisting of high-volume samplers and real-time samplers was installed on-site and is being used to monitor air quality as redevelopment continues. Phase 2 development, which focuses on the commercial core, is beginning in 2014 and estimated to be completed in 2015. The details are described in the *Point Ruston Construction Management Plan*, *Phase 2 Remedial Action* (Hydrometrics 2013c).

5.3.2.1.2 *Slag Peninsula*

Approximately 15 acres of the slag peninsula have been permanently capped using the multi-layer cap design (i.e., GCL, HDPE, drainage net, 9 inches of clean fill, woven marker layer, and 9 inches of additional clean fill). The cap extends from the tip of the peninsula to the property line with Point Ruston, and from the Commencement Bay side of the peninsula to the fence delineating the portion of the peninsula controlled by the Tacoma Yacht Club. Design for capping the remainder of the Slag Peninsula (i.e., the area of the Slag Peninsula occupied by the road to, parking areas of, and areas in front of, the Tacoma Yacht Club) is ongoing and is expected to be implemented by EPA in 2015.

The area of shoreline around the North Tacoma outfall on the slag peninsula was armored.

About 3,500 feet of shoreline has not been armored (Griffiths 2014). As depicted in Figure 5-6, this segment is between the red arrows along the yellow dashed line along the Yacht Basin side of slag peninsula. EPA's consultant, CH2M HILL (2013b) recommended that this segment of shoreline be armored. However, it should be noted that armoring of this segment is NOT required as part of the Asarco Smelter ROD, and based on communication with Metro Parks, the armoring might be done separately by Metro Parks. The ROD for the Asarco Smelter (EPA 1995) states: "The interior portion of the Yacht Club basin will not require armoring." In addition, the ROD for the Asarco Sediments/Groundwater OU (EPA 2000) also does not require armoring of the Yacht Basin; the sediments remedy for the Yacht Basin required only dredging and upland disposal. EPA will need to determine whether armoring of the Yacht Basin is warranted and therefore requires a ROD amendment or ESD, or whether armoring is not warranted for this portion of the shoreline.

5.3.2.1.3 *Habitat Basin*

The habitat basin, which runs along the north side of the slag peninsula, was constructed by Asarco in 1999 as part of mitigation measures for filling in intertidal areas during armoring of the Smelter site. To create the habitat basin, a breakwater was constructed using riprap on the outer edge of the basin (CH2M Hill 2013a), see Figure 5-6. In 2001, the Nisqually earthquake caused a portion of the breakwater forming the habitat basin to collapse, and it was determined that repair would cause a significant reduction in the size of the basin. Although the habitat basin continues to function as designed without that section of breakwater, inspection by EPA and CH2M Hill in 2013 determined that the collapsed area was causing the habitat basin to erode significantly. EPA evaluated repair options for the habitat basin in 2013 and determined repair was necessary. EPA began the design in September 2014.

5.3.2.2 Ruston/North Tacoma Study Area

Sampling and cleanup of residential yards in the Ruston /North Tacoma Study Area has been ongoing since the early 1990s. In 2009, EPA resumed work on the remainder of the residential remediation that had not been completed by Asarco (due to Asarco's bankruptcy). The USACE (Seattle District), on EPA's behalf, began cleanup activities in 2009 by acquiring sampling and construction contracts for the residential cleanups. By the end of 2012, the number of properties sampled and cleaned up was as follows:

Number of residences, parks, and vacant lots sampled	2,729	Three refusals in Zones 1-3 and nine refusals in Zone 4
Number of residences, parks, and vacant lots remediated	1,984	One refusal in Zones 1-3 and 12 refusals in Zone 4
Number of right-of-ways sampled	941	
Number of right-of-ways remediated	452	

The cleanup of the Study Area was essentially completed in 2012, and the actions have been documented in EPA's 2013 Remedial Action Completion Report (EPA 2013). There was a small number (<30) of refusals (i.e., property owners who did not want their properties sampled or remediated); those properties and all remaining work have been turned over to Ecology for completion.[27] The completion of the Study Area cleanup was funded by the 2003 Asarco Trust Fund, and American Recovery and Reinvestment Act (ARRA) federal funding (EPA 2011a). EPA used approximately $5.2 million in ARRA funds to support the cleanup activities at the Study Area.

Steep slopes on private property that were required by the ROD to be remediated but were not remediated due to erosion or stability concerns were noted on property maps. For a steep slope noted on Burlington Northern and Santa Fe Railroad (BNSF) property, the area was sampled in four locations under the Winnifred Street Bridge, and only one location exceeded action levels (230 ppm arsenic; 500 ppm lead). EPA met with BNSF Railroad in 2012 and determined that given the steep slopes, marginal contamination, existing fencing, and numerous "No Trespassing" signs posted in the area, that no further action was required on this issue.

Earlier, in 1999, Ecology had determined that it no longer concurred with the cleanup decision for the Study Area and began a separate investigation into residual contamination from smelter operations. Ecology initiated a cleanup action in 2000 for the Tacoma Smelter Plume (TSP) and will be performing a second remediation of the Study Area and the surrounding 1,000 square

27 For those properties, the address and owner information has been provided to Ecology for inclusion in their remediation project. The list of properties was provided as a hard copy (Appendix 9) to EPA's 2013 Remedial Action Completion Report (EPA 2013). That report also states that the list of properties will be revisited as part of each FYR. Ecology is currently managing the list of refusals. Ownership records will be checked to see if new owners have purchased the property. Property owners will be contacted again to see if they will allow sampling and/or remediation. No change to the list is needed at the time of this review.

miles beginning in 2013.[28] Under a cooperative agreement, Ecology will complete any remaining project tasks in coordination with EPA. Those tasks include the following:

- Remediation: Two properties will be sampled and remediated if necessary. Eight additional properties will be remediated.
- Database: Project files have been converted and uploaded to Ecology's web-based "Arsenic in Soil Database" located at https://fortress.wa.gov/ecy/areispublic/. Ecology will maintain this database and add results from their project as it progresses. Users can search this database by parcel or address to locate soil sampling results and cleanup records.
- Education: The educational program for the Study Area will be incorporated into Ecology's on-going Dirt Alert soil safety program. EPA will fund a portion of this program to cover the Study Area portion of the TSP.
- Soil Disposal: Long-term soil disposal options have not yet been identified. The issue will be addressed by a workgroup of agency representatives from the Tacoma-Pierce County Health Department (TPCHD), Ecology, EPA, and City of Tacoma Landfill.

5.3.2.3 Asarco Sediments

Prior to bankruptcy in 2005, Asarco had in 2004 completed the remedial design for capping offshore sediments and excavating the Yacht Basin, but no progress on implementing the remedy had occurred. The prior (2000) sampling results in the Yacht Basin conducted by Asarco, and future plans (at that time) for the Yacht Basin cleanup, are described in Asarco's Final Design Report for Sediment Dredging: Marine Sediments and Groundwater (Asarco 2004). In 2005 Asarco filed for bankruptcy. EPA assumed responsibility for remediation of the Yacht Basin sediments following Asarco's bankruptcy, but some of the requirements for remediating the Yacht Basin sediments were assigned to Point Ruston LLC. When Point Ruston LLC became the owner of the Asarco Smelter site in 2006, Point Ruston LLC was required under the 2006 Amendment to the Asarco CD with EPA to cap the offshore sediments with a sediment cap, complete the hard cap (the part of the sediment cap that joins the sediment cap with the shoreline armoring), and excavate shallow sediments in the Yacht Basin (in addition to its Smelter Facility responsibilities).

As of 2009, the following actions still needed to be completed in the Sediments OU: 1) limited offshore capping in Commencement Bay where the ore and copper docks had been, 2) hard capping in Commencement Bay by Point Ruston LLC, 3) excavation of shallow Yacht Basin sediments by Point Ruston LLC, and 4) remediation of remaining Yacht Basin sediments by EPA. The status of each item is discussed below.

5.3.2.3.1 *Offshore Capping in Area of Former Fuel, Copper, and Ore Docks in Commencement Bay*

Between November 2006 and February 2007, Point Ruston LLC placed approximately 10 acres of sediment to cap offshore sediments, but at that time Point Ruston LLC could not reach areas

28 Information on Ecology's cleanup can be viewed on Ecology's Toxics Cleanup Program page, http://www.ecy.wa.gov/programs/tcp/sites_brochure/tacoma_smelter/2011/ruston.html

under the fuel, copper, and ore docks in Commencement Bay because the pilings blocked the sediment capping materials from entering between them. In July 2009, Point Ruston LLC and DNR were working together to remove the docks. In 2011 the Washington State DNR demolished the docks and placed a 1.6-acre quarry spall cap over the sediments where the docks had been, effectively completing the offshore capping. See Figure 5-10 for the areas capped by DNR (Parametrix 2011).

5.3.2.3.1 *Hard Capping in Commencement Bay*

In 2013 in Commencement Bay, Point Ruston LLC completed their requirements for a hard cap by placing a 3-foot-thick layer of clean riprap over approximately 6.1 acres of contaminated sediment and a 3-foot-thick layer of clean sand and gravel over approximately 1.9 acres of contaminated sediment, for a total of 8 acres capped. See Figure 5-8 for the areas capped by Point Ruston LLC.

5.3.2.3.2 *Excavation of Shallow Yacht Basin Sediments by Point Ruston LLC*

As of 2014, Point Ruston LLC still needs to excavate the shallow Yacht Basin sediments. The details for Point Ruston's Yacht Basin responsibilities can be found in Section 2.8 of the 2006 Final Statement of Work for Remedial Design and Remedial Action (EPA 2006a); the SOW is associated with the 2006 CD.[29]

5.3.2.3.3 *Remediation of Remaining Yacht Basin Sediments by EPA*

EPA is responsible for remediating the remaining Yacht Basin sediments (e.g., non-shallow sediments) and will use settlement trust funds to accomplish the work. As of 2014, no remedial actions have been implemented. However, in January 2010, EPA met with its consultant (CH2M Hill), the Washington Department of Fish and Wildlife, and Ecology to evaluate Asarco's 2004 final design documents for dredging of Yacht Basin marine sediments and to brainstorm potential options for the site. The results of the evaluation are presented in CH2M Hill's February 2010 technical memorandum (CH2M Hill 2010a) and summarized here. Part of the 2000 ROD for OU 19 was to dredge contaminated sediments in the Yacht Basin and the North Shore hot spot area, and place the dredged material beneath a low-permeability cap on the upland portion of the adjacent Asarco facility. The RAO in the ROD for the Yacht Basin sediments is to restore and preserve aquatic habitats by limiting and/or preventing the exposure of environmental receptors to sediments with contaminants above the 1991 Washington State Sediment Management Standards (SMS, WAC 173-204), originally adopted in 1991 and amended in 1995.

29 The SOW language specific to Point Ruston LLC's Yacht Basin responsibilities states in Section 2.8.1 and 2.8.2, "For the purpose of remediation under this SOW, dredging the shallow sediments in the Yacht Basin has been separated from the dredging of the deeper sediments in the Yacht Basin. As described below, Point Ruston shall implement the excavation of these shallow sediments. Remaining sediment remediation in the Yacht Basin shall not be the responsibility of Point Ruston and shall be addressed separately by others….Point Ruston shall excavate the nearshore shallow sediments on the southwestern shoreline of the Yacht Basin which could be contacted by recreational users. Sediments shall be excavated above the MLLW tide line (0 MLLW) to a minimum depth of 12 inches. Excavation limits shall extend from the MLLW tide line to existing bulkhead or tidal grid at the northern end of the southwestern shoreline and from the MLLW tide line to existing bulkhead, shoreline or tidal grid on the southern end of the southwestern shoreline. Existing bulkheads and tidal grids will not be removed."

Contaminants of concern presented in the ROD and associated cleanup levels included arsenic (93 mg/kg), copper (390 mg/kg), lead (450 mg/kg), and zinc (410 mg/kg).

The 2010 evaluation determined that the remedy could not be implemented as currently designed because the planned upland Asarco disposal site was no longer available (i.e., it was now owned by Point Ruston LLC and has been capped), and off-site disposal options could cost more than $20,000,000. Another challenge with remediating the Yacht Basin sediments was the need to temporarily relocate the vessels and infrastructure in the Yacht Basin (up to 500 boats and 300 boat houses).

Regarding choices for another disposal site, the evaluation team considered the following options:

- Use the adjacent slag peninsula;
- Develop an extension of the OCF at the adjacent Asarco site;
- Buy back a part of the former Asarco property from Point Ruston LLC;
- Construct a new nearshore confined disposal facility (CDF), possibly along the north shore;
- Select an off-site landfill based on waste characteristics (e.g., landfill in Pierce County, Klickitat County, or in Oregon); or
- Consider a mitigation approach by reducing dredging within the Yacht Basin and implementing in-kind restoration elsewhere to achieve equal or better environmental benefit.

Regarding the challenge of remediating sediments under the vessels and infrastructure, the team considered the following options:

- Dredge only the “fairways” (i.e., open-water boat channels between the boat docks in the marina areas);
- Outside of the fairways, cap beneath the boathouses; possibly use environmentally friendly material (e.g., underwater mats such as AquaBlok™); or
- Use articulated dredging equipment.

In December 2010, EPA’s designers prepared a cost comparison of on-site and off-site disposal options for the Yacht Basin sediments (CH2M Hill 2010b). The estimated volume of sediments was 48,000 to 63,000 cy. The on-site option considered placing the sediments in a disposal cell in a 10-acre area on the slag peninsula; the off-site option considered using landfills in Oregon or Washington that could accept solid waste (i.e., it was assumed the sediments would not be hazardous or dangerous). The rough order of magnitude for the cost of the on-site option was approximately $5,000,000. The cost of the off-site option was between $10,290,000 and $11,490,000.

In a subsequent December 2010 memo (CH2M Hill 2010c), EPA’s designers noted that Metro Parks Tacoma had development plans for the slag peninsula that might allow only 15,000 to 23,000 cy of sediments to be disposed under the cap to be installed on the slag peninsula. Thus, EPA's designers developed a hybrid disposal option that would place 23,000 cy of sediments under the cap on the peninsula, and dispose of the remaining 40,000 cy of sediments at an off-site landfill. The estimated costs for the hybrid disposal option were approximately $6,700,000 to $7,200,000, depending on the location of the off-site landfill. As of 2014, EPA has not decided how the Yacht Basin sediments will be remediated or disposed; thus, this portion of the ROD remedy has not yet been constructed.

5.3.3. Post-Construction Monitoring/Operation and Maintenance

The Asarco Smelter cleanup is being completed in phases as Point Ruston LLC redevelops the site. For the portions that have been redeveloped, operations and maintenance activities have begun. There is an OMMP that addresses scheduled inspections and maintenance and repair of the Smelter site cap, the OCF, and the portion of shoreline armoring on Point Ruston's property; it also addresses maintenance of the slag peninsula cap (Hydrometrics 2013a). A Development and Occupancy Plan (DOP) was also created that describes the health and safety controls required for each element of the remedial action that will be implemented as Point Ruston carries out phased development and occupancy of the site (Hydrometrics 2013b).

The Ruston/North Tacoma Study Area yards cleanup is considered complete by EPA, and any additional work has been transferred to Ecology as of January 2014.

For the Asarco sediments, offshore capping work was done in 2006-2007 (by Point Ruston LLC), in 2011 (by Washington DNR), and in 2013 (by Point Ruston LLC). For the areas capped by Point Ruston LLC, their post-construction monitoring requirements are summarized in Section 2.8.3 of the 2006 Final Statement of Work for Remedial Design and Remedial Action (EPA 2006a).

As stated in that document, long-term monitoring shall be conducted on the sediment cap to confirm that it remains in place, continues to isolate the underlying contaminated sediments, and does not become recontaminated with site contaminants. After Point Ruston completes construction of the sediment cap required in a phase and EPA issues a Certification of Completion for that phase, Point Ruston shall no longer be required to meet performance standards with respect to the capped sediments (including making repairs to correct the effects of recontamination, settling, subsidence, erosion, physical disturbances, or other forces); provided however, that if the sediment cap does not meet performance standards at the completion of the Remedial Action, then EPA may withdraw its Certification(s) of Completion for the cap until either (i) Point Ruston demonstrates that its actions were not responsible for the cap no longer meeting Performance Standards, or (ii) Point Ruston takes those actions necessary to again meet Performance Standards. In a 2014 Consent Decree with EPA, Washington DNR is taking over O&M requirements for the offshore sediments owned by DNR.

Since no work has been done on the Yacht Basin sediments, O&M activities have not yet been implemented for that area.

5.4. Progress since the Last Five-Year Review

This section provides the previous protectiveness statements and an evaluation of the issues identified in the third FYR.

5.4.1. Previous Protectiveness Statements

The Asarco Smelter protectiveness statement in the third FYR (2009) stated:

> "Remedial actions at the Asarco Smelter are expected to be protective of human health and the environment when the remedy is completed. In the interim, exposure pathways that could result in unacceptable risks are being prevented because the site is fenced and access to the site is controlled by cell phone operated gates, monitoring during the day, and police patrols in the evenings. Dust control and other dust suppression activities (temporary capping, spraying tackifiers) are used to ensure that site contaminants remain on site."

The Ruston/North Tacoma Study Area protectiveness statement in the third FYR (2009) stated:

> "Remedial actions for the Ruston/North Tacoma Study Area are expected to be protective of human health and the environment when the remedy is completed. In the interim, exposure pathways on the unremediated properties are only controlled through the compliance with the education program (hand washing, wetting soil, etc.)."

The Asarco Sediments protectiveness statement in the third FYR (2009) stated:

> "Remedial actions for the Asarco Sediments are expected to be protective of human health and the environment when the remedy is completed. For the area of sediments offshore of the Smelter where capping has been done, the remedy is already protective of human health and the environment. For the remaining sediments offshore of the Smelter and the Yacht Basin, implementation of the remedy is expected to occur in the next two to three years using money obtained from the Asarco bankruptcy settlement."

5.4.2. Status of Recommendations

Table 5-2 below presents the issues and recommendations made in the third FYR (2009) and provides a progress evaluation for the Ruston / North Tacoma Study Area (OU 4, now OU 22); and the Asarco Sediments (OU 6, now OU 19). There were no issues or recommendations in the third FYR for the Asarco Smelter Facility (OU 2, now OU 20). Much of the progress for the Ruston/North Tacoma Study Area (OU 22) was documented in EPA's 2013 Remedial Action Completion Report (EPA 2013). It should be noted that the habitat basin was incorrectly associated with OU 6 in the issues and recommendation tables in the third FYR. The habitat basin should be associated with OU 20.

Table 5-2. Recommendations for Asarco OUs from the Third FYR and Progress

Issue [1]	Recommendations / Follow-Up Actions	Responsible Party / Oversight Agency	Planned Completion Date	Progress
OUs 2, 4, 6: Ruston/North Tacoma Study Area. Based on phone calls received by EPA and Ecology, there is a subset of the people in the study area who do not know anything about the site, the fact that yards in the study area may be contaminated, the yard cleanup program and the required institutional controls.	Review the institutional controls (ICs)/education component for the Ruston/North Tacoma Study Area and determine what changes are needed to ensure that people are aware of the controls and that they are carried forward.	EPA / EPA	January 2011	OU 22: As of 2014, ICs/educational responsibilities have been transferred to Ecology. The educational program for the Study Area will be incorporated into Ecology's on-going Dirt Alert soil safety program. EPA will fund a portion of this program to cover the Study Area portion of the TSP.
OUs 2, 4, 6: Ruston/North Tacoma Study Area. The site development may bring new people as well as different land uses to the area. This could result in differing exposures than those currently accounted for in the ROD.	Review ongoing site and area development and ensure that changes in the area do not impact remedy protectiveness.	EPA/EPA	Ongoing	OU 22: The Study Area and former smelter site have generally been developed or have approved development plans that remain residential or commercial in nature. No major changes in use are expected. Exposures remain similar to those analyzed in the ROD, thus the remedy will remain effective.
OUs 2, 4, 6: Ruston/North Tacoma Study Area. There may be recontamination of the yards that have been remediated in the Study Area.	Resample a subset of properties to ensure that recontamination has not occurred.	EPA/EPA	June 2010	OU 22: Resampling occurred in 2011 and the results are documented in EPA's 2013 *Remedial Action Completion Report.* The report concluded that the remedy effectively meets the goal of bringing the average soil exposures below 230 ppm arsenic and 500 ppm lead, and that the remedy remains effective over time.
OUs 2, 4, 6: Ruston/North Tacoma Study Area. Potential for properties outside the Study Area to be contaminated is being addressed by Ecology.	EPA will document these activities.	EPA/EPA	January 2011	OU 22: A 2014 cooperative agreement exists between EPA and Ecology that describes how any additional work will be accomplished by Ecology.

Table 5-2. Recommendations for Asarco OUs from the Third FYR and Progress (continued)

Issue [1]	Recommendations / Follow-Up Actions	Responsible Party / Oversight Agency	Planned Completion Date	Progress
OUs 2, 4, 6: Ruston/North Tacoma Study Area. Ecology has requested that EPA review the remedy for the site to ensure that it is still protective.	EPA has agreed to conduct a more in depth review of the remedy for the site to ensure its protectiveness. This review will be completed by July 27, 2010. The review will use the criteria in the "Comprehensive Five-Year Review Guidance (OSWER No. 9355.7-03B-P, June 2001 and also consider strategies that Ecology has developed for addressing arsenic and lead throughout the State and within the Tacoma Smelter Plume.	EPA/EPA	August 2010	OU 22: EPA prepared a report on January 27, 2011 to evaluate the protectiveness of the remedy (EPA 2011b). EPA concluded that the remedy is still protective. EPA also noted that more properties in Zone 4 required remediation than were predicted at the time of the ROD; thus required remediation (rather than voluntary sampling) was expanded to include Zone 4 and has been completed (except for a few refusals).
OUs 2, 4, 6 Sediments: The habitat basin is functioning as designed even though part of the breakwater collapsed in the 2001 Nisqually earthquake. Because the "shelf" holding the breakwater is no longer there, replacement would require a significant reduction in size of the habitat basin.	EPA will need to determine whether the habitat basin should be repaired or left as it is.	EPA/EPA	January 2011	OU 20: EPA has decided to repair the habitat basin, and began the design work in September 2014.

1 - The text is taken from Table 23 of the third FYR, which did not specify the exact OU, but instead combined all the OUs together as "2, 4, 6."

5.5. Five-Year Review Process

5.5.1.1 Administrative Components

The Asarco Area Site FYR team was led by Karen Keeley and Kevin Rochlin, the EPA RPMs in Region 10. Veronica Henzi (environmental engineer) and Karah Haskins (physical scientist) with USACE, Seattle District, assisted with the review as representatives of the support agency.

By December 2013, the review team had been formed and the review schedule had been established for the following activities:

- Interviews and community notification and involvement;
- Document collection and review;
- Data assessment/analysis;
- Site inspection; and
- FYR report development and review.

The FYR has a statutory completion date of December 23, 2014.

5.5.1.2 Community Involvement

On January 17, 2014, a display advertisement ran in the Tacoma News Tribune newspaper providing notification and contact information for the FYR. In addition, on January 21, 2014, EPA Community Relations staff sent postcards to stakeholders and neighbors included on the CB/NT project mailing list (approximately 1,150 addressees), providing notification about the FYR process. Both notifications requested that any information that people would like EPA to consider during the review be provided to EPA before April 15, 2014.

On February 19, 2014, Kevin Rochlin, Bill Ryan, and Jonathan Williams (all with EPA Region 10) met with Bill Andersen, the Executive Director of Citizens for a Healthy Bay, at which time EPA provided information on CB/NT activities and preparation of the fourth FYR. A telephone interview was completed with CHB.

No input was received from the public for the overall CB/NT site or for the Asarco Area Site.

5.5.1.3 Document Review

A review of reports pertinent to this FYR was conducted by the review team. The types of documents reviewed included decision documents, construction management plans, completion reports, technical memoranda, and other supporting materials. See Attachment 1 for OUs 20, 22, and 19 for a complete list of documents reviewed for the Asarco Area Site.

5.5.1.4 Data Review and Evaluation

Data reviewed and evaluated as part of the document review is summarized throughout Section 5 but concentrated in Section 5.3.

5.5.1.5 Site Inspection

Asarco Smelter: EPA holds construction meetings and inspections of the site on a regular basis (every 2 to 3 weeks). Participants include EPA oversight personnel, Point Ruston LLC and their contractors, and Ecology. Additional biweekly meetings are held with personnel from the city of Tacoma and Town of Ruston who work on the site. Therefore, a significant separate site inspection was not conducted. However, Kevin Rochlin, the EPA RPM, conducted a brief site inspection on May 8, 2014. See Attachment 2 for OUs 20, 22, and 19 for the site inspection checklist.

Ruston/North Tacoma: The remediation consisted of property soil replacement. EPA conducted a drive by inspection of the properties on May 8, 2014, to ensure that soil caps remained in place. No exceptions were noted. See Attachment 2 for OUs 20, 22, and 19 for the site inspection checklist.

Asarco Sediments: The sediments are underwater. No inspection was conducted.

5.5.1.6 Interviews

No interviews were conducted for the Asarco OUs.

5.6. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Asarco Smelter

Answer: Yes.

Site remediation is ongoing as Point Ruston LLC continues to redevelop the site with condominiums, homes, parking areas, etc. Their construction monitoring plans and other associated redevelopment plans are reviewed by EPA and contain measures to ensure that the intent of the remedy is being met as the site is redeveloped. In the interim (i.e., until construction/redevelopment is complete), exposure pathways that could result in unacceptable risks are being prevented because the site is being controlled by the developer. The O&M responsibilities of Point Ruston LLC are explained in the 2013 OMMP and cover the Smelter site cap, the slag peninsula cap, the shoreline armoring, and site utilities. The obligations of the OMMP are incorporated as institutional controls in the Covenants, Conditions and Restrictions (CCRs) for the site. Property management will be conducted by either Point Ruston LLC or the Point Ruston Homeowners' Association (HOA), once the latter entity is formed. The HOA will then assume O&M responsibilities from Point Ruston LLC.

Although the habitat basin does not affect remedy protectiveness, it was intended to be mitigation for armoring. It was damaged in 2001 and currently provides less fish habitat than as designed. EPA evaluated repair options for the habitat basin in 2013 and determined repair was necessary. EPA began the design in September 2014.

Ruston/North Tacoma Study Area

Answer: Yes.

Site remediation is complete except for a small number of yards where the property owners refused. These properties and any remaining work have been transferred to Ecology as of early 2014.

Asarco Sediments

Answer: Yes.

The offshore sediments have been capped, and the remedy is functioning as intended in this area. The sediment remedy has not yet been implemented for the Yacht Basin sediments.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy still valid?

Asarco Smelter

Answer: Yes.

Changes in Standards and To Be Considered. ARARs cited in the ROD were not reviewed during this FYR. Since the entire site is being capped, there will be no exposure when the remediation is completed and CCRs are implemented.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics. The ROD described current and future land uses and identified likely exposure pathways; the descriptions are accurate for the site conditions at the time of this review.

Changes in Land Use. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Point Ruston LLC is redeveloping the site with oversight by EPA to ensure that the intent of the remedy is being met as the site is redeveloped.

Remedial Action Objectives. The RAOs from the ROD are still valid and protective for the site.

Ruston/North Tacoma Study Area

Answer: Yes.

In 1999, Ecology decided that it no longer concurred with the cleanup decision for the Study Area and began a separate investigation into residual contamination from smelter operations. Ecology initiated a cleanup action in 2000 for the Tacoma Smelter Plume (TSP) and will be performing a second remediation of the Study Area and the surrounding 1,000 square miles beginning in 2013.

In the 2009 FYR, Ecology also requested that EPA conduct a more in-depth review of the remedy for the site to ensure its protectiveness. This review was completed by EPA and documented in their report dated January 27, 2011 (EPA 2011b). EPA concluded that the remedy is still protective. EPA did acknowledge that more properties in Zone 4 required remediation than were predicted at the time of the ROD; thus, remediation was expanded to include Zone 4 and has been completed (except for a few refusals).

Changes in Standards and To Be Considered. ARARs cited in the ROD were not reviewed during this FYR since the remedy is complete except for a small number of properties (refusals) that have been turned over to Ecology.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics. The ROD described current and future land uses and identified likely exposure pathways; the descriptions are accurate for the site conditions at the time of this review.

Changes in Land Use. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

Remedial Action Objectives. The RAOs from the ROD are still valid and protective for the site.

Asarco Sediments

Answer: Yes.

Changes in Standards and To Be Considered. See Section 4.2.6 (Question B).

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics. Prior to any remediation of the Yacht Basin, the Yacht Basin sediments will need to be resampled, and the sediment sample results will need to be compared to the toxicity data available at that time. See also Section 4.2.6 (Question B).

Changes in Land Use. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

Remedial Action Objectives. The RAOs from the ROD are still valid and protective for the site.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Asarco Smelter
Answer: No.

Ruston/North Tacoma Study Area
Answer: No.

Asarco Sediments
Answer: No.

5.6.1. Technical Assessment Summary

Asarco Smelter

The remedy has not been fully constructed, but it is functioning as intended where implemented. Point Ruston LLC continues to redevelop the site (and thereby construct the remedy) in accordance with plans approved by EPA. No information was evaluated related to ARARs, toxicity, or otherwise that calls into question the protectiveness of the remedy. Additional repair of the habitat basin is anticipated to occur within the next (fifth) FYR period.

Ruston/North Tacoma Study Area

The remedy has been fully constructed (i.e., all properties have been cleaned up), with the exception of a small number of refusals. Those properties and all future work have been transferred to Ecology as of early 2014. No information was evaluated related to ARARs, toxicity, or otherwise that calls into question the protectiveness of the remedy.

Asarco Sediments

The offshore sediments have been capped, and the remedy is functioning as intended in those areas. The remedy for the Yacht Basin sediments is not functioning as intended since it has not yet been implemented. The Yacht Basin sediments still need to be remediated. The sediment ARAR information indicated that the revisions to the 2013 SMS resulted in no material changes relative to the pre-revision SMS and MTCA (see Section 4.2.6). Since no Yacht Basin sediment work has occurred, no toxicity data were evaluated. Toxicity data will be evaluated when future samples are collected. No other information is known that calls into question the protectiveness of the remedy.

5.7. Issues and Recommendations/Follow-up Actions

No issues that affect protectiveness were identified for the Asarco OUs (Table 7-1).

Action items that do not affect remedy protectiveness, but are expected to require future action, are provided in Table 7-2.

5.8. Protectiveness Statement

Protectiveness statements for the Asarco OUs are provided in Section 8.

6. Remedial Actions and Five-Year Review Process for CB/NT Tacoma Tar Pits Operable Unit 03

6.1. Background

The Tacoma Tar Pits site is designated as OU 03, an uplands component of the overall CB/NT Superfund site in Tacoma.[30] The site is situated within a peninsula of land between the Puyallup River and the Thea Foss Waterway, approximately three-quarters of a mile north of Interstate 5 (see Figure 6-1). The total area of the site encompasses approximately 52 acres.

Results of site investigations conducted in the 1980s indicated that soil, surface water, and groundwater across most of the site were contaminated with organic and inorganic contaminants from former on-site coal gasification plant operations and the recycling of automobiles and electrical transformers. The primary contaminants in soil, surface water, and groundwater included metals, PAHs, PCBs, and various volatile organic compounds (VOCs), including benzene. Soil and surface water cleanup goals have been achieved; groundwater in one of the aquifers is still being addressed.

The ROD (EPA 1987) called for excavation and stabilization of contaminated soils into an engineered waste pile covered by a low permeability cap, and surface water controls to 1) manage storm water runoff from the waste pile and metal recycling operations, and 2) limit infiltration of surface water into the subsurface. The remedy also called for continued groundwater monitoring across the entire site to discern whether the remedial action implemented for soils and surface water caused contaminants in groundwater to drop below the ROD cleanup criteria. If it did not do so in a timely manner, the ROD anticipated the need for a groundwater remedy to be implemented.

In 1998, due to continued exceedances of the groundwater cleanup criteria, EPA directed the PRP to design and install a groundwater extraction and treatment (GWET) system to treat on-site groundwater contamination (focused on benzene) and to prevent it from migrating off the site and potentially impacting the Puyallup River. The GWET system has been operating since 2002.

Several active facilities are located within the site boundary including Simon Metals (formerly known as Joseph Simon & Sons, or JS&S) on about 9 acres of the east interior of the site; a portion of the Tri-Pak transloading facility and Union Pacific Railroad (UPRR) tracks on the northeast; the approximately 14-acre Northwest Detention Center (NWDC) property on the northwest (site of the former Hygrade meat packing plant); Burlington Northern Railroad (BNRR) tracks on the southwest; a Puget Sound Energy (PSE) natural gas regulator station on the south; and, on the far southeastern portion of the site, an Associated Petroleum Products (APP) card lock fueling station and a portion of the City of Tacoma's vactor facility (along Cleveland Avenue). The remainder of the site is occupied by an 8-acre capped engineered waste pile containing stabilized soils and wastes, two lined detention ponds, and light industrial buildings. Figure 6-2 shows most of these facilities and site features.

30 In the 1987 ROD, the site is known as OU 23.

6.2. Site Chronology

Information through 2009 for this section is in the third FYR (EPA 2009), which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

Key activities since 2009 are presented below:

2010	The defective programmable logic controller (PLC) unit and modules for groundwater extraction and treatment (GWET) were replaced.
2010	A new Signet 2551 Magmeter (flow meter) was installed at the request of the City of Tacoma for the GWET system.
2011	Asphalt permeability testing occurred.
2012	Trench line sampling and evaluation occurred near the buried sewer lines on the southeastern border of the site to assess benzene migration.
2013	Two East Branch groundwater monitoring wells (DOF-35M and DOF-36M) were installed.
2013	Cracked asphalt was repaired in the detention basins.

6.3. Remedial Actions

6.3.1. Remedy Selection

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

6.3.2. Explanation of Significant Differences

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

6.3.3. Remedy Implementation

Information for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

6.3.4. Post-Construction Monitoring/Operation and Maintenance

The Operation and Maintenance (O&M) program encompasses two main elements: 1) the initial remedy consisting of low-permeability covers and storm water drainage systems completed in 1995, and 2) the groundwater extraction and treatment (GWET) system completed in 2002. General O&M information is provided below, and progress since the third FYR is discussed in more detail in Section 6.5.4.

6.3.4.1 Inspection and Routine Maintenance of Site Areas

Inspection and maintenance (I&M) activities are carried out by Puget Sound Energy's (PSE's) consultant, Dalton, Olmstead and Fuglevand, Inc. (DOF), and follow the 1995 Inspection and

Maintenance Manual (Ebasco 1995) for the components of the initial remedy. The manual calls for routine inspection of the following items: the Simon Metals facility drainage system including Detention Basin No. 2, asphalt and concrete pavements, waste pile cover drainage systems and turf, and the waste pile drainage system including Detention Basin No. 1. Inspections occur at least yearly and also after heavy rainfall events. I&M activities completed during this fourth FYR period were summarized in DOF's 2010-2011 Inspection and Maintenance Report (DOF 2012j) and 2012-2013 Inspection and Maintenance Report (DOF 2014c) and are presented in Section 6.5.4.

6.3.4.2 Groundwater Extraction and Treatment System

Operations and maintenance (O&M) activities for the GWET system are conducted in accordance with the 2003 Groundwater Remediation System, Operation and Maintenance Plan (DOF 2003). Typical maintenance items for the GWET system include the following inspections and operational checks: 1) weekly monitoring of general plant operations and resupply of biofouling treatment chemicals if needed, 2) monthly check of meter functions and the need for replacement of vapor-phase carbon, and 3) other system checks (monitored remotely) to verify the plant is operating properly.

In addition to the above O&M activities, the City of Tacoma reviews and renews PSE's Industrial Wastewater Discharge Permit every five years. The current discharge permit TAC-031-2011 was renewed on May 1, 2012, and expires on April 30, 2017; it will need to be renewed during the next FYR cycle.

6.3.4.3 Groundwater Monitoring Program

Post-remediation groundwater monitoring has been occurring since March 2002, generally in accordance with the 2002 Revised Water Quality Monitoring Program (DOF 2002). The monitoring occurs quarterly (with some exceptions) during the months of March, June, September, and December of each year. The consultant DOF performs the groundwater quality monitoring and discharge reporting on behalf of PSE.

6.3.5. Remedy and O&M Costs

Costs associated with post-construction inspections and maintenance, O&M of the GWET system, and water quality monitoring averaged $203,000 per year from 2009-2013.

6.4. Progress since the Last Five-Year Review

6.4.1. Previous Protectiveness Statement

The Tacoma Tar Pits protectiveness statement in the previous FYR (2009) stated:

> "The results of this Five-Year Review indicate that the Tacoma Tar Pits remedy is functioning as intended and is currently protective of human health and the environment because 1) sources of contamination (e.g., waste materials and contaminated soils) have been excavated, disposed of off-site or treated and contained on site, 2) low permeability caps and surface water controls have been placed across critical areas of the site, 3) institutional controls are in place, and 4) contaminated groundwater is not used as a

drinking water source and does not appear to be discharging to the Puyallup River. In order for the remedy to remain protective over the long-term, the follow-up actions recommended in this report need to be performed which include 1) continuing maintenance of the cap, cover and ancillary surface water drainage features, 2) continuing operation and optimization of the groundwater extraction, treatment and monitoring systems to reduce the size and concentration of the benzene plume, and 3) optimizing property owner compliance with institutional control requirements."

6.4.2. Status of Recommendations

Table 6-1 below presents the issues and recommendations made for the Tacoma Tar Pits site in the third FYR (2009) and provides a progress evaluation.

Table 6-1. Recommendations for Tacoma Tar Pits OU from the Third FYR and Progress

Issue	Recommendations / Follow-Up Actions	Responsible Party / Oversight Agency	Planned Completion Date	Progress
A small pavement failure was observed in the asphalt road leading to the top of the waste pile, as shown in OU 3 Attachment 5, photo 8 [Note: in 2009 FYR]. This feature represents a potential pathway for surface water erosion of the cap. (NOTE: this is a separate pavement failure than the one noted in – and repaired after – the 2003 Five-Year Review).	Repair the pavement hole.	PSE / EPA	2009	Completed November 2009
Hydraulic conductivity testing of asphalt pavement covers has not been performed in accordance with the Inspection and Maintenance Manual. This was recommended in the 2003 Five-Year Review Report.	Implement asphalt pavement permeability testing or develop and conduct an alternative way of systematically assessing asphalt pavement conditions and permeability and revise the Inspection and Maintenance Manual accordingly.	PSE / EPA	2010	Permeability testing was completed in 2011 (DOF 2012 b); the Inspection and Maintenance Manual still needs to be revised to include regular inspection, maintenance, and permeability testing.

Table 6-1. Recommendations for Tacoma Tar Pits OU from the Third FYR and Progress (continued)

Issue	Recommendations / Follow-Up Actions	Responsible Party / Oversight Agency	Planned Completion Date	Progress
The TTP-3M (East Branch) Area benzene plume within the site boundary has not appreciably diminished in size or concentration over the past several years. In addition, although this plume appears to be contained especially when looking at non-detect benzene concentrations in downgradient monitoring well DOF-19, Figure 6-5 [Note: in 2009 FYR] shows a sewer line trench in hydraulic connection with the benzene plume which may convey the plume away from DOF-19.	Optimize the TTP-3M (East Branch) Area system and conduct a capture zone analysis in order to reach the ROD groundwater cleanup criterion for benzene and reduce the size of the plume. A determination is also needed on the fate and transport of the benzene plume and its hydraulic relationship to the sewer line trench along the southern boundary of the site.	PSE / EPA	2011	Trench line sampling and evaluation occurred near the buried sewer lines on the southeastern border of the site to assess benzene migration in 2012. Although benzene was determined not to be reaching the Puyallup River along this pathway, two new wells (DOF-35M, DOF-36M) were installed in 2013 to better assess benzene migration along the site's southeastern boundary. DOF-35M has had minor ROD exceedances in 2013 (DOF 2014b). See Section 6.5.4.3 for further discussion. Optimization and a capture zone analysis of the East Branch Area were not implemented due to EPA resource constraints. Issues with the East Branch Area are still evident in this FYR. See Table 7-1 for the recommended follow-up action for the entire benzene plume over the next 5YR period.

Table 6-1. Recommendations for Tacoma Tar Pits OU from the Third FYR and Progress (continued)

Issue	Recommendations / Follow-Up Actions	Responsible Party / Oversight Agency	Planned Completion Date	Progress
The TTP-18M (North Branch) Area benzene plume appears to be contained or captured as seen through decreasing benzene concentrations; however, the concentrations are well above the ROD groundwater cleanup performance criterion for benzene (53 µg/L) and are also outside the site boundary.	Optimize the TTP-18M (North Branch) Area system and conduct a capture zone analysis in order to reach the ROD groundwater cleanup criterion for benzene and reduce the size of the plume. An additional monitoring well may also be needed just beyond the stagnation point of Extraction Well A to help determine effectiveness.	PSE / EPA	2011	Optimization and a capture zone analysis of the North Branch Area were not implemented due to EPA resource constraints. Issues with the North Branch Area are still evident in this FYR. See Table 7-1 for the recommended follow-up action for the entire benzene plume over the next 5YR period.
The ROD groundwater remedy and RAOs focused on treatment and containment of the contaminated plume, but do not appear to have considered groundwater restoration.	Evaluate whether groundwater restoration at this site is feasible and necessary to 1) comply with ARARs, CERCLA, and EPA's CERCLA groundwater policies, and 2) ensure long-term protectiveness.	EPA / EPA	2012	The recommendations to address this issue were not implemented due to EPA resource constraints. This issue will be evaluated over the next 5YR period.
Property owner compliance with site institutional control requirements is not optimal.	Request site property owners to comply with all Consent Decree conveyance of site/institutional control requirements. Voluntary compliance with the state of Washington's Uniform Environmental Covenants Act (UECA) should also be requested to ensure the long-term effectiveness of site institutional controls.	Site property owners / EPA	2012	The recommendations to address this issue were not implemented due to EPA resource constraints. This issue will be evaluated over the next 5YR period.

In addition to the above recommendations/follow-up actions, the third FYR (2009) also recommended that the following actions be considered to ensure the protectiveness of human health and the environment. The status of each item is explained in italics:

- If EPA and PSE decide that a vegetative management plan is necessary for the site, control of Spotted Knapweed should be a component of that plan as it is designated for control in the Tacoma CB/NT area. *Determining the need to prepare a vegetative management plan was not implemented during this FYR period due to EPA resource constraints. This action will be implemented once resources become available.*

- Include the Correctional Services Corporation (CSC)/GEO Group, Inc.-owned Northwest Detention Center property, the City of Tacoma/CSC-owned parcel southeast of the Detention Center, and the 1616 St. Paul parcel north of the Detention Center as part of the Tacoma Tar Pits site on the City of Tacoma's GOV.ME GIS website. *This action was not implemented during the last FYR period due to EPA resource constraints. This action will be implemented once resources become available.*

6.5. Five-Year Review Process

This section describes the process taken to conduct this fourth FYR of the Tacoma Tar Pits site, and provides an evaluation of the data and the progress made to ensure the protectiveness of the remedy.

6.5.1. Administrative Components

The Tacoma Tar Pits site FYR team was led by Tamara Langton, the EPA RPM in Region 10. Veronica Henzi (environmental engineer) and Karah Haskins (physical scientist) with USACE, Seattle District, assisted with the review as representatives of the support agency.

By December 2013, the review team had been formed and the review schedule had been established for the following activities:

- Interviews and community notification and involvement;
- Document collection and review;
- Data assessment/analysis;
- Site inspection;
- FYR report development and review; and
- Identification and evaluation of institutional controls

The FYR has a statutory completion date of December 23, 2014.

6.5.2. Community Involvement

On January 17, 2014, a display advertisement ran in the Tacoma News Tribune newspaper providing notification and contact information for the FYR. In addition, on January 21, 2014, EPA Community Relations staff sent postcards to stakeholders and neighbors included on the CB/NT project mailing list (approximately 1,150 addressees), providing notification about the FYR process. Both notifications requested that any information that people would like EPA to consider during the review be provided to the EPA before April 15, 2014.

One inquiry was received regarding the Tacoma Tar Pits site from a reporter with the Seattle Globalist. The questions were answered by the EPA RPM for the Tacoma Tar Pits site (Tamara Langton), as described in OU 3 Attachment 3.

6.5.3. Document Review

A review of reports pertinent to this FYR was conducted by the review team. The types of documents reviewed included decision documents, water quality and discharge reports, I&M reports, and technical memoranda. See OU 3 Attachment 1 for a complete list of documents reviewed for the Tacoma Tar Pits site.

6.5.4. Data Review and Evaluation

Since the third FYR (2009), activities at the Tacoma Tar Pits site have been related to inspection, operations, and maintenance of the remedy. Data in the following documents were evaluated, and the results are presented in a detailed technical memorandum (see OU 3 Attachment 2):

- 2010-2011 Inspection and Maintenance (I&M) Report
- 2012-2013 I&M Report
- Water quality monitoring reports (2009-2013)
- Discharge reports (2009-2014)
- Asphalt permeability testing technical memorandum
- Trench line sampling technical memorandum
- Well installation technical memorandum

6.5.4.1 Inspection and Maintenance Activities - Soil Capping and Surface Water Drainage

Table 6-2 below summarizes the facilities and areas that were inspected during this fourth FYR period, and indicates the status as of 2013 (DOF 2012j; DOF 2014c).

Table 6-2. Tacoma Tar Pits Areas Subject to I&M, and Current Condition

Areas covered by I&M plan	Current condition
Covered stabilized waste pile, which is waste material covered by geosynthetic fabrics, compacted soil, and a vegetative layer	The site was mowed in 2010, 2011, 2012 and 2013 and no substantial settlement or erosion was noted. Some minor soil scraping and rutting were observed, similar to past years. Past soil scraping and rutting have not been observed to adversely affect the soil cover, and the grass cover quickly re-establishes after mowing. Brush was removed from the rocked drainage channels on the stabilized waste pile. The waste pile access road had developed a few holes along the ecology block wall, and these were repaired.

Table 6-2. Tacoma Tar Pits Areas Subject to I&M, and Current Condition (continued)

Areas covered by I&M plan	Current condition
Stabilized waste materials covered by low permeability asphalt – former construction water treatment area located between the covered stabilized waste pile and Detention Basin No. 1 (DB#1)	In 2013 the asphalt-covered area between DB#1 and the covered waste pile was observed to be in good condition. Simons uses the area for truck and trailer parking. The treatment plant currently lies within the eastern portion of this area and is surrounded with a chain-link fence that minimizes the possibility of inadvertent damage from vehicle traffic.
Concrete and asphalt covers (paving) in the Simons operating area	Little change was evident from previous inspections, and the operating area drainage system continues to operate as designed. Some asphalt gouging, concrete raveling along joints, and concrete cracking and gouging were observed in 2013. The observed "wear and tear" damage to the paving was expected, and, in the opinion of DOF, did not significantly affect the capping function of the paving. DOF conversations with Simon's staff indicated that the metal recycling operating area continues to drain well during periods of heavy precipitation.
Box culverts, lined ditch, and DB#1 that drain the stabilized waste pile	The box culverts and drainage ways leading to and from the detention basins continue to operate as designed. Some sediment/soil/debris has accumulated in the bottom of some portions of the culverts without restricting flow to the detention basins. Drainage ways into detention basin DB#1 remain clear. Some cracked asphalt was identified in the detention basins, primarily DB#1. Asphalt cores were collected for permeability testing in 2011 and confirmed that the cracks did not extend through the full asphalt thickness. Repairs were also made in 2013 – see additional text below this table.
Catch basins and DB#2, which are storm drainage facilities for the Simons operating area. The catch basins, and for the most part DB#2, are maintained by Simons.	Simons cleaned the catch basins annually (last in 2013); storm water was discharged to the BNRR ditch through a control structure under an industrial stormwater discharge permit with Ecology. Flow from DB#2 is restricted to 1.0 cfs. Storm water is treated to remove oils and metals prior to discharge.
The BNRR ditch that drains both detention basins	Vegetation continues to grow in the BNRR ditch, particularly at the east end where discharge occurs to a buried culvert. Observations during heavy precipitation indicate the vegetation does not cause water to back-up in the ditch, and it likely acts as a biofiltration swale. During late summer/early fall, vegetation is removed from the east end of the ditch so that flow is not restricted.
Signs and fencing	The 2012-2013 Inspection and Maintenance Report did not discuss any issues related to signs or fencing.

Because cracking had been observed in the detention basin asphalt, EPA requested that the asphalt be investigated and repaired. In 2011, DOF performed asphalt permeability testing and summarized the results in their 2012 Technical Memorandum for Results of Asphalt Permeability Testing (DOF 2012b). Of particular interest to EPA had been cracking at location DB1-KT2, where a crack of 1.5 inches deep had developed and the permeability was 2.3×10^{-7} cm/sec, which slightly exceeded the performance criterion of 1×10^{-7} cm/sec. This crack, along with several others, was repaired in August 2013 (DOF 2014c). Figure 6-3 is a photo showing an example of the asphalt repair.

In general, site observations made by DOF from 2010 to 2013 indicate that the remedial systems installed at the Tacoma Tar Pits site are in acceptable condition and are functioning as intended. The cracked asphalt has been repaired. However, it was not clear from the 2012-2013 Inspection and Maintenance Report if DOF's 2006 Asphalt Repair/Maintenance Plan for the Detention Basins or their 1995 Inspection and Maintenance Manual has been formally updated to incorporate EPA's 2012 request to make "periodic observations of the integrity of the asphalt, and [make] repairs where necessary" (EPA 2012a). During the site visit on June 12, 2014, DOF indicated that they have not updated either their 2006 Plan or their 1995 Manual to incorporate EPA's 2012 request.

6.5.4.2 Groundwater Extraction and Treatment (GWET) System Performance

Overall, review of the water quality and discharge reports indicates that the GWET system is functioning as intended, and that the benzene plume in the Sand Aquifer (the aquifer of interest, shown on Figure 6-4) is generally being contained by the extraction and treatment system (DOF 2014a; DOF 2014b). Over the review period (2009-2014), the system operated on average 93% of the time. The only significant down-time occurred in mid-January 2010, when the programmable logic controller (PLC) failed. For that period (January-March 2010), the system only operated 66% of the time. After extensive trouble-shooting, the PLC unit and defective modules were replaced, and the system was restarted in February 2010. The calculated average flow rate over the review period was 9.2 gallons per minute (gpm), with the flow rate trending downward. Until June 2010, flows were approximately 10-13 gpm. After June 2010, flows were less than 10 gpm, varying from 6.5 to 9.3 gpm. No discussion was provided by DOF for the decrease; however, on September 28, 2010, a new Signet 2551 Magmeter (flow meter) was installed at the request of the City of Tacoma, which may have contributed to the change in flow readings.

The City of Tacoma reviews and renews PSE's Industrial Wastewater Discharge Permit every five years. The current discharge permit No. TAC-031-2011 was renewed on May 1, 2012 and expires on April 30, 2017; it will need to be renewed during the next FYR cycle.

Since the containment system began operation (2002), benzene influent concentrations have generally declined from greater than 4,000 µg/L to approximately between 750 and 2,000 µg/L. In 2013, flow measurements and water quality testing of influent samples indicated substantially lower flow rates and higher benzene concentrations from the East Branch wells as compared to the North Branch wells. These differences are consistent with the system operational history and hydrogeologic conditions (see the third FYR, Section 6.1.2, for a discussion of hydrogeology at the Site, http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt). Regarding influent concentrations from the East Branch wells, the data from 2009 to 2013 show a decreasing trend (see Figure 6-5) for the entire period from 2002-2013, with concentrations ranging from approximately 3,300 µg/L to 1,500 µg/L. Regarding influent concentrations from the North Branch wells, the data from 2009 to 2013 show a slight increasing trend (see also Figure 6-5), with concentrations ranging from approximately 480 µg/L to 610 µg/L. Four extraction (pumping) wells are used for the GWET system (see Figure 6-6): wells A and B in the North Branch area, and wells C and TW-1 in the East Branch area.

The individual benzene effluent concentrations from the GWET system for all quarters (2009-2014), except for the quarter ending March 2014, were less than 1.6 µg/L which is significantly less than the permit discharge criterion of 500 µg/L. On February 26, 2014, a concentration of 550 µg/L was detected in an effluent sample. This exceedance was duly reported to the appropriate City of Tacoma authorities in accordance with the discharge permit and immediate action to correct the problem was taken. The cause of the exceedance was traced to delayed maintenance of the air-stripper due to winterization equipment that impeded access. Timely corrective action was taken (i.e., the air stripper was cleaned) and the results for June and August 2014 effluent samples indicated benzene concentrations that fall within the normal range of less than 1.6 µg/L and well below the discharge criterion. The sanitary sewer authorities were satisfied with the actions taken to report and rectify the problem, and a revised maintenance schedule for the air stripper was developed and will be implemented as long as the treatment system is in operation.

6.5.4.3 Groundwater Monitoring Results

The sections below provide sampling locations, results of monitoring, and recommendations. See Figure 6-6 for locations of the monitoring wells, extraction (pumping) wells, the surface water (SW) sampling site, and the Hygrade Well No. 2 for reference.

6.5.4.3.1 *Sampling Locations*

In May 2013 the groundwater monitoring program was expanded from 22 to 24 wells with the installation of two new wells, DOF-35M and DOF-36M, on the southeastern border of the site. The need for the wells was established based on push-probe and trench line sampling and evaluation conducted in 2012 (DOF 2012a). The purpose of the new wells is to assess whether benzene is migrating downgradient along the existing buried sewer line. The wells were incorporated into the monitoring program starting in June 2013.

In general (but with some exceptions), all wells are monitored quarterly, and two other locations are also sampled. The first location is a surface water location designated “SW” in the BNRR ditch, and the second is the Hygrade well located outside the fence of the NWDC. The SW location is sampled semi-annually in March and September, but was not sampled in September 2013 because the ditch was dry. The second location is the “exterior” Hygrade well located outside the NWDC fencing. The exterior Hygrade well is an artesian well located approximately 20 feet to the west of Hygrade Well No. 2 (see Figure 6-6 for location of the SW sample location and the Hygrade Well No. 2 location). This exterior well is currently sampled once every two years. Hygrade Well No. 2 is also an artesian well and located inside the security fencing, and it is currently not being sampled, presumably due to accessibility issues. The exterior Hygrade well was sampled in September 2010 and September 2012, and is scheduled for sampling in September 2014. It should be noted that the exterior Hygrade well currently being sampled is not shown on the figures in DOF’s water quality monitoring reports; its location has to be inferred from the location of Hygrade Well No. 2.

6.5.4.3.2 *Analysis of Monitoring Well Data*

See Figure 6-7 for the current benzene plume data as of December 2013, where benzene concentrations continue to exceed the ROD criterion of 53 µg/L. See Figure 6-8 for groundwater contours and estimated flow directions in the Sand Aquifer (the aquifer of concern) as of December 2013. The current monitoring wells are grouped into 10 East Branch wells (TTP-3M Area) and 14 North Branch wells (TTP-18M Area).

The **East Branch** area is located along the southeastern site boundary and generally lies between wells TTP-12M and DOF-36M. Two extraction wells are located in the source area of this Branch; TW-1 is upgradient of the site boundary and well C is closer to the southeastern site boundary. These wells are designed to capture and contain East Branch groundwater contamination.

The currently monitored East Branch wells are as follows:

- Within source area (upgradient of site boundary): DOF-26M
- Near site boundary: TTP-2M, TTP-3M, DOF-24M, DOF-25M, DOF-34M, DOF-35M (starting June 2013), DOF-36M (starting June 2013)
- Downgradient of site boundary: DOF-19M, DOF-20M (semi-annual wells) T

The wells near and downgradient of the site boundary, with the exception of DOF-35M and DOF-36M (which are too new for trend analysis), were evaluated using the Mann-Kendall nonparametric test for trends. The results are provided below in Table 6-3.

Table 6-3. Mann-Kendall Test for Trends in East Branch Boundary & Downgradient Wells (2009-2013)

Monitoring Well	Within Capture Zone?	Benzene Concentrations above ROD Criterion (53 µg/L)?	Benzene Concentration Trend	Confidence in Trend (%)
TTP-2M	Yes	No	Decreasing	>99.9
TTP-3M	Yes	Yes	No Trend	63.8
DOF-19M	Yes	No	Probably Decreasing	94.6
DOF-20M	Yes	No	No Trend	70
DOF-24M	Yes	Yes	No Trend	63.8
DOF-25M	Yes	Yes	Increasing	95.4
DOF-34M	Yes	Yes	Probably Decreasing	91.3

As indicated in Table 6-3, the East Branch site boundary wells that exceeded the ROD criterion for benzene are TTP-3M, DOF-24M, DOF-25M, and DOF-34M. These wells, however, are within the East Branch area capture zone. Site boundary well TT-2M, also within the capture zone, had non-detect concentrations of benzene or levels significantly below the ROD criterion.

For the newly installed boundary well DOF-35M, which was incorporated into the monitoring program in June 2013, the June, September, and December benzene concentrations were 81, 12, and 86 µg/L, respectively. Two of these three values exceeded the ROD benzene criterion; however, this well is too new to analyze trends with any certainty. For the other newly installed boundary well, DOF-36M, there were no detections (detection limit of 0.10 µg/L) in June, September, or December 2013.

Downgradient wells DOF-19M and DOF-20M benzene concentrations were either non-detect or significantly below the ROD criterion. The Puyallup River is located downgradient from all of the aforementioned wells and there are no indications that the benzene plume from the East Branch is reaching the River.

The **North Branch** area is located on the north part of the site and generally lies between wells AGI-14M(R) and AGI-5M. Two extraction wells are located in the source area of this Branch; well A is located in the northern lobe and well B is in the southern lobe. These wells are designed to capture and contain North Branch groundwater contamination.

The currently monitored North Branch wells are as follows:

- Upgradient of source area (and covered waste pile): TTP-16M(R), TTP-17M
- Within source area (upgradient of site boundary): DOF-22M, DOF-23M, DOF-29M, DOF-30M
- Near site boundary: AGI-14M(R), DOF-33M, TTP-18M, DOF-31M, AGI-5M
- Downgradient of site boundary: DOF-27M, DOF-28M, MW-03

These wells are on a mix of quarterly, semi-annual, and annual sampling. The benzene concentrations vary considerably, but the higher concentrations (above the ROD criterion) are present in the two lobes generally centered on wells DOF-33M and TTP-18M/DOF-31M, respectively. The wells near and downgradient of the site boundary were evaluated using the Mann-Kendall nonparametric test for trends. The results are provided below in Table 6-4.

Table 6-4. Mann-Kendall Test for Trends in North Branch Boundary & Downgradient Wells (2009-2013)

Monitoring Well	Within Capture Zone?	Benzene Concentrations above ROD Criterion (53 µg/L)?	Benzene Concentration Trend	Confidence in Trend (%)
TTP-18M	Yes	Yes since December 2011	Increasing	>99.9
DOF-27M	No	No	No Trend	78.4
DOF-28M	No	No except one instance (68 µg/L) in March 2013 (1)	No Trend (1)	60.3
DOF-31M	Yes	Yes - since March 2011	Increasing	99.7
DOF-33M	Yes	Yes except once instance (0.1 µg/L) in December 2013 (2)	Probably Decreasing (2)	93.2
MW-03	No	No	Stable	89.2

(1) The exceedance was thought by DOF to be a lab error (DOF 2014a); if the exceedance is removed from the dataset, the trend becomes “stable” with 58% confidence.
(2) The value of 0.1 µg/L appears inconsistent with all prior values, which have ranged since March 2009 from 650 µg/L to 1400 µg/L. If 0.1 µg/L is removed from the dataset, the trend becomes “stable” with 82.5% confidence.

As indicated in Table 6-4, the boundary wells with increasing benzene concentrations and above the ROD criterion are TTP-18M and DOF-31M. DOF-33M also has benzene concentrations that significantly exceed the ROD criterion but appears to have a decreasing or stable trend. These wells are located just outside the North Branch area site boundary (see Figure 6-6, upper portion) but are within the capture zone of this Branch.

Benzene has generally not been detected in wells DOF-27M, DOF-28M, and MW-03, which are located downgradient of the site boundary. The Puyallup River is located downgradient from all of the aforementioned wells and there are no indications that the benzene plume from the North Branch is reaching the River.

The surface water (SW) location is supposed to be sampled in March and September, but the BNRR ditch is frequently dry in September. The available sampling data indicate that the benzene concentrations have been <1.0 µg/L for this FYR period. The SW samples did not exceed the ROD criteria for other sampled COCs as well.

Regarding the exterior Hygrade well, the 2010 and 2012 benzene concentrations were <1.0 µg/L. The Hygrade well samples did not exceed the ROD criteria for other sampled COCs as well.

6.5.4.3.3 *Water Quality Summary*

In general, the benzene concentrations in the monitoring wells at the Tacoma Tar Pits site vary considerably, but the shape of the benzene plume (areas with concentrations greater than 53 µg/L and greater than 1,000 µg/L) in December 2013 appears generally similar to the shape of plume in December 2009 (see Figure 6-7 for 2013 plume and Figure 6-9 for 2009 plume). With respect to effluent discharges from the GWET system, there has been only one exceedance of the 500 µg/L benzene criterion on February 26, 2014 where concentrations of 550 µg/L were detected in a sample. This exceedance was an isolated event due to a delay in maintaining the air-stripper, and the necessary steps to avoid an exceedance in the future have been implemented.

With respect to the East Branch site boundary wells, the TTP-3M, DOF-24M, DOF-25M, and DOF-34M have mixed results for benzene concentrations and trends; however, all are within the capture zone of this Branch. Site boundary well TTP-2M, also within the capture zone, has non-detect concentrations of benzene or levels significantly below the ROD criterion during this 5YR period. Of the two East Branch boundary wells installed in 2013 near the sewer lines (DOF-35M and DOF-36M), only DOF-35M has had benzene concentrations that slightly exceed the ROD criterion. Data from future sampling events will help assess trends from these new wells and provide a more complete picture of possible benzene migration beyond the site's southeastern boundary. Downgradient wells DOF-19M and DOF-20M benzene concentrations were either non-detect or significantly below the ROD criterion. The Puyallup River is located downgradient from all of the aforementioned wells and there are no indications that the benzene plume from the East Branch is reaching the River.

With respect to the North Branch wells located just outside the site boundary, wells TTP-18M and DOF-31M have exceeded the ROD criterion at increasing values since 2011. DOF-33M, also located just outside the site boundary, has had generally stable benzene concentrations but at levels significantly above the ROD criterion. Other site boundary wells have mixed results for benzene concentrations and trends. Although there are concerns about benzene exceedances, these site boundary wells are within the North Branch capture zone and groundwater in this area is estimated to flow west towards extraction wells A and B and the site's interior (see Figure 6-8). Downgradient wells east of the North Branch boundary wells have generally been non-detect for benzene (DOF-27, DOF-28, and MW-03). The Puyallup River is located downgradient from all of the aforementioned wells and there are no indications that the benzene plume from the North Branch is reaching the River.

6.5.5. Site Inspection

A site inspection was conducted for the Tacoma Tar Pits component of the CB/NT Superfund Site on June 12, 2014, to physically observe the conditions of the site and components of the remedy. Participants included EPA and their support agency, USACE; PSE and their remediation contractor, DOF; the City of Tacoma Public Works Department; and Simon Metals. The site inspection team roster, site inspection checklist, and pertinent photographs, are included as OU 3 Attachment 4.

6.5.6. Interviews

Interviews were performed informally during the site inspection on June 12, 2014, and the results are documented in OU 3 Attachment 4. Parties were identified for the interviews based on the following criteria:

- Parties directly or indirectly responsible for remedial O&M program
- Parties adjacent to the site or affected by site-related contaminants
- Utilities affected by operation of the remedy

Parties interviewed included the following:

- John Rork, PSE Project Manager
- Matt Dalton, DOF (Consultant for PSE)
- Dave Cooper, DOF
- Mark Stafford, City of Tacoma, Public Works
- Alan Aplin, City of Tacoma, Public Works
- Greg Barrowman, Simon Metals

In 2009, the following recommendations were made by the City of Tacoma Public Works Department to PSE regarding the operation of the groundwater treatment plant during the site inspection and in follow-up letters pursuant to PSE's Industrial Wastewater Discharge Permit which discharges effluent to Tacoma's Central Treat Plant #1 (a publicly owned treatment works [POTW]). PSE's contractor, DOF, provided responses on 6/27/14 (Dalton 2014), which are shown below in italics:

- PSE must obtain approval from the City of Tacoma prior to modifying the pre-treatment system. *DOF, on behalf of PSE, re-submitted an engineering update to the discharge permit that included a process flow diagram, which was approved by the City of Tacoma.*
- A non-mechanical type flow meter should replace the existing flow meter to measure discharge quantities of treatment water to the POTW to obtain greater accuracy. *DOF installed and the City of Tacoma approved the new meter in 2010.*
- As required by the approved treatment plant design, a sequestering agent should be used to

reduce precipitates or scale from forming. *It was determined that a sequestering agent was not needed based on approval of the process flow (first bullet above)*

- Service bag filters 1 and 2 or replace the pressure gauges. *The bag filters and pressure gauges have been replaced, and the filters continue to be replaced as required.*
- Determine the purpose of the 8-inch private storm line originating north of the capped engineered waste pile area, then passing underneath it and terminating within the Simon Metal's northwest detention pond. *This pipe drained the local area and was plugged in 2009.*

6.5.7. Identification of Institutional Controls

Information through 2009 for this section is in the third FYR, which is available online at http://yosemite.epa.gov/r10/cleanup.nsf/sites/cbnt.

As of 2014, the recommendations to address the issue with Institutional Controls were not implemented due to EPA resource constraints. This issue will be evaluated over the next 5YR period.

These will be addressed once resources are made available.

6.6. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes. The remedy is functioning as intended by the decision documents based on a review of site data, interviews, and on observations made during the site inspection.

Soil and Surface Water (Capped Areas and Drainage Systems)

The cap and surface drainage features continue to be generally in good condition and routinely inspected and repaired when required to maintain their intended functions. Surface water cleanup criteria identified in the ROD have been achieved as measured ("SW" sample) at the site boundary in the BNRR ditch.

Regarding the detention basins and asphalt, the PRP's remediation contractor, DOF, conducted asphalt permeability coring and testing in 2011 and repaired cracks in the detention basins. However, DOF indicated during the site visit on June 12, 2014 that they have not updated either their 2006 Asphalt Repair/Maintenance Plan for the Detention Basins or their 1995 Inspection and Maintenance Manual to incorporate EPA's 2012 request to make "periodic observations of the integrity of the asphalt, and [make] repairs where necessary" (EPA 2012a). DOF should inform EPA of their planned procedures for regularly inspecting, repairing, maintaining, and doing permeability testing on the asphalt, and indicate which of their documents will be updated to incorporate those activities. See Table 7-2 for recommended future actions.

Groundwater

Site groundwater has been monitored quarterly since 1991, and the GWET system has been in operation since 2002. Monitoring data indicates that ROD cleanup criteria have been achieved for all indicator contaminants in two of the site aquifers (the Fill and Lower Aquifers). The ROD cleanup criteria for lead, PCBs and PAHs have also been achieved in the Sand Aquifer; only benzene exceeds the ROD criterion of 53 µg/L. As such, benzene in the Sand Aquifer continues to be the focus of the groundwater monitoring program.

In general, the benzene concentrations in the monitoring wells at the Tacoma Tar Pits site vary considerably, but the shape of the benzene plume (areas with concentrations greater than 53 µg/L and greater than 1,000 µg/L) in December 2013 appears generally similar to the shape of plume in December 2009 (see Figure 6-7 and Figure 6-9).

With respect to the East Branch site boundary wells, the TTP-3M, DOF-24M, DOF-25M, and DOF-34M have mixed results for benzene concentrations and trends; however, all are within the capture zone of this Branch. Site boundary well TTP-2M, also within the capture zone, has non-detect concentrations of benzene or levels significantly below the ROD criterion during this 5YR period. Of the two East Branch boundary wells installed in 2013 near the sewer lines (DOF-35M and DOF-36M), only DOF-35M has had benzene concentrations that slightly exceed the ROD criterion. Data from future sampling events will help assess trends from these new wells and provide a more complete picture of possible benzene migration beyond the site's southeastern boundary. Downgradient wells DOF-19M and DOF-20M benzene concentrations were either non-detect or significantly below the ROD criterion. The Puyallup River is located downgradient from all of the aforementioned wells and there are no indications that the benzene plume from the East Branch is reaching the River.

With respect to the North Branch wells located just outside the site boundary, wells TTP-18M and DOF-31M have exceeded the ROD criterion at increasing values since 2011. DOF-33M, also located just outside the site boundary, has had generally stable benzene concentrations but at levels significantly above the ROD criterion. Other site boundary wells have mixed results for benzene concentrations and trends. Although there are concerns about benzene exceedances, these site boundary wells are within the North Branch capture zone and groundwater in this area is estimated to flow west towards extraction wells A and B and the site's interior (see Figure 6-8). Downgradient wells east of the North Branch boundary wells have generally been non-detect for benzene (DOF-27, DOF-28, and MW-03). The Puyallup River is located downgradient from all of the aforementioned wells and there are no indications that the benzene plume from the North Branch is reaching the River.

While the ROD groundwater cleanup criterion for benzene in the sand aquifer has not yet been achieved at the Tacoma Tar Pits site, the groundwater remedy component (GWET system) is functioning as intended by containing the majority of the contaminated groundwater plume such that exposures are under control and human and ecological receptors are not impacted. Specific recommendations to address the site-wide benzene issue are provided in Table 7-1.

Institutional Controls

Institutional controls, such as restrictions on the use of site groundwater, are in place across the site and protect the remedy in the short-term. However, based on the preliminary title search conducted by the PRP's remediation contractor, DOF, it does not appear that site property owners have complied with all Consent Decree conveyance of site/institutional control requirements. As of 2014, the recommendations to address this issue were not implemented due to EPA resource constraints. This issue will be evaluated over the next 5YR period.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy still valid?

Answer: Yes. There have been changes in the standards, exposure pathways, toxicity, and land use since the 1987 ROD; however, those identified in the ROD are still valid and none of the changes negatively impact the protectiveness of the remedy.

Changes in Standards and To Be Considered (TBCs). Applicable or relevant and appropriate requirements (ARARs) cited in the ROD were reviewed to evaluate changes since the third FYR. A summary table is presented in OU 3 Attachment 5. There were no changes during the fourth FYR period; consequently, there were no changes that affect protectiveness.

Spotted Knapweed, which was observed on top of the engineered waste pile cover during the third FYR, is included on the Washington State Class B Noxious Weed List and is designated for control in the Tacoma area. The third FYR recommended that if EPA and PSE consider a vegetative management plan necessary for the site, the plan should include control of Spotted Knapweed since Spotted Knapweed is designated for control in the Tacoma CB/NT area. Determining the need to prepare a vegetative management plan was not implemented during this FYR period due to EPA resource constraints. This action will be implemented once resources are available.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics.

There have been no changes in exposure pathways (e.g., site receptors, sources) during the fourth FYR period. There have also been no toxicity changes that would affect protectiveness of the remedy. According to EPA's Integrated Risk Information System (IRIS), there have been no changes to the oral reference dose, the inhalation reference dose, or the carcinogenicity assessment for benzene.

Changes in Land Use. Although the City of Tacoma has a new vactor facility that is partially on the site, there have been no changes in land use that would affect the protectiveness of the remedy.

Remedial Action Objectives (RAOs). The RAOs in the 1987 ROD were not defined in explicitly descriptive terms for the Tacoma Tar Pits site, and the ROD groundwater remedy component did not appear to consider groundwater restoration. Instead, numerical maximum allowable contaminant concentrations for indicator contaminants and affected media served as the RAOs, and focused on excavation, treatment and containment (EPA 1987; ROD Table

2). The numerical RAOs for soil and surface water have been met and remain valid; however, not all of the numerical RAOs for groundwater have been met (i.e., 53 µg/L for benzene in the sand aquifer). Recommendations to address issues with the GWET system and the groundwater monitoring systems identified in the third FYR were not implemented due to EPA resource constraints. However, given the exceedances of benzene across the site over this and the previous 5YR period, it seems prudent to consider optimizing the GWET system and the monitoring system during this next FYR period.

The recommendations to address the feasibility of a groundwater restoration RAO was not implemented during the last 5YR period also because of EPA resource constraints. This issue will be evaluated over the next 5YR period.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

6.6.1. Technical Assessment Summary

The remedy is functioning as intended by the decision documents based on a review of site data, interviews, and observations made during site inspections

The soil and surface water components of the remedy (capped waste piles; surface water drainage systems and basins) were completed in 1995, and soil and surface water cleanup criteria have been achieved. The remedy features continue to be monitored regularly as part of inspection and maintenance activities. Asphalt permeability testing in the detention basins occurred in 2011, and asphalt repairs were made in 2013.

Groundwater monitoring data indicate that the footprint of the benzene groundwater plume (areas with concentrations greater than 53 µg/L and greater than 1,000 µg/L in the Sand Aquifer) has not shrunk appreciably since the last FYR. In general, the footprint in December 2013 footprint appeared similar to the footprint in December 2009 (see Figure 6-7 and Figure 6-9). While the groundwater containment system is functioning as intended and the benzene plume is currently being contained, benzene concentrations in many wells across the site are still significantly above the ROD criterion. Given the ongoing benzene exceedances and negligible reduction in benzene plume size during the fourth FYR period, it seems prudent to consider optimizing the GWET system and the groundwater monitoring systems. See Table 7-1, which combines the 2009 FYR East and North Branch benzene plume issues into one overall benzene issue for the entire site.

Institutional controls are in place across the site and protect the remedy in the short-term. To ensure protectiveness in the long-term, property owners must at a minimum comply with all Consent Decree conveyance of site/institutional control requirements. As of 2014, the recommendations to address this issue were not implemented due to EPA resource constraints. This issue will be evaluated over the next 5YR period.

No other information is known at the time of this fourth FYR that would call into question the protectiveness of the site remedy.

6.7. Issues and Recommendations/Follow-up actions

Issues and recommendations/follow-up actions that affect protectiveness for the Tacoma Tar Pits site (OU3) are provided in Section 7, Table 7-1.

Action items for the Tacoma Tar Pits site that do not affect remedy protectiveness, but are expected to require future action, are presented in Table 7-2.

6.8. Protectiveness Statement

The protectiveness statement for the Tacoma Tar Pits site (OU3) is provided in Section 8.

7. Summary of Issues and Recommendations/Follow-Up Actions

Issues and recommendations/follow-up actions that were identified during this fourth FYR and affect protectiveness are summarized below in Table 7-1.

Action items that were identified during this fourth FYR and *do not* affect protectiveness, but are expected to require future action, are summarized below in Table 7-2. These recommendations are summarized herein to allow EPA to track this information, as suggested by FYR guidance (EPA 2001).

Table 7-1. Summary of Issues and Recommendations/Follow-up Actions for the 2014 FYR

OU # Name, FYR Section	Issue	Recommendations/ Follow-up Actions	Responsible Party	Oversight Agency	Planned Completion Date	Affects Protectiveness? (Y/N)	
						Current	Future
OU 01 Site-Wide, Section 4.8	Recent fish tissue data for bioaccumulative chemicals have not been collected in Commencement Bay. Thus, it is not known whether contaminant levels in fish tissues have been reduced since the remedies have been implemented, particularly for PCBs (which have a human-health based SQO), and whether fish advisories should be continued, modified, or removed.	Develop and implement a Quality Assurance Project Plan, which will include a sampling plan for collection and analysis of bay-wide fish tissue data for bioaccumulative chemicals (particularly for PCBs, which have a human-health based SQO). Provide results to appropriate state and local agencies to evaluate protectiveness of health-based fish consumption advisories for Commencement Bay.	EPA	EPA	December 2019	N	Y

Table 7-1. Summary of Issues and Recommendations/Follow-up Actions for the 2014 FYR (continued)

OU # Name, FYR Section	Issue	Recommendations/ Follow-up Actions	Responsible Party	Oversight Agency	Planned Completion Date	Affects Protectiveness? (Y/N)	
						Current	Future
OU 01 Hylebos Waterway, Section 4.2	Additional post-construction sediment sampling needs to be conducted throughout the entire Hylebos Waterway to determine the status of the remedy as constructed.	Conduct sediment sampling and evaluate if the remedy is meeting performance standards. Update existing OMMP based on results.	Mouth and Head PRP Groups: Occidental; Port of Tacoma	EPA	December 2016	N	Y
OU 03 Tacoma Tar Pits, Section 6	Benzene concentrations in the groundwater plume within the sand aquifer continue to exceed ROD criterion across the site.	Evaluate and address issues related to benzene exceedances and make recommendations for optimizing the GWET system and the groundwater monitoring systems to reduce the benzene plume.	PSE	EPA	December 2019	N	Y
OU 03 Tacoma Tar Pits, Section 6	The ROD groundwater remedy and RAOs focused on treatment and containment of the contaminated plume, but do not appear to have considered groundwater restoration.	Evaluate whether groundwater restoration at this site is feasible and necessary to 1) comply with ARARs, CERCLA, and EPA's CERCLA groundwater policies, and 2) ensure long-term protectiveness.	EPA	EPA	December 2019	N	Y

Table 7-1. Summary of Issues and Recommendations/Follow-up Actions for the 2014 FYR (continued)

OU # Name, FYR Section	Issue	Recommendations/ Follow-up Actions	Responsible Party	Oversight Agency	Planned Completion Date	Affects Protectiveness? (Y/N)	
						Current	Future
OU 03 Tacoma Tar Pits, Section 6	Property owner compliance with site institutional control requirements is not optimal.	Request site property owners to comply with all Consent Decree conveyance of site/institutional control requirements. Voluntary compliance with the state of Washington's Uniform Environmental Covenants Act (UECA) should also be requested to ensure the long-term effectiveness of site institutional controls.	Site property owners	EPA	December 2019	N	Y

NOTE: "FYR Section" refers to the section of this document in which the referenced OU or waterway is discussed.

Table 7-2. Action Items That Do Not Affect Remedy Protectiveness

OU # Name, FYR Section	Action Item	Responsible Party	Oversight Agency	Planned Completion Date
OU 01 Hylebos Waterway, Section 4.2	Complete Occidental Site FS pursuant to CERCLA AOC.	Occidental	EPA	2016
OU 01 Hylebos Waterway, Section 4.2	Complete Arkema Site RI/FS pursuant to state MTCA Agreed Order, with EPA coordination and oversight to complete source control to ensure RA performance standards are met.	Port of Tacoma	EPA	2016
OU 01 Sitcum Waterway, Section 4.3	None.			
OU 01 St. Paul Waterway, Section 4.4	None.			

Table 7-2. Action Items That Do Not Affect Remedy Protectiveness (continued)

OU # Name, FYR Section	Action Item	Responsible Party	Oversight Agency	Planned Completion Date
OU 01 Middle Waterway, Section 4.5	MWAC will conduct another round of monitoring in the summer of 2014; EPA needs to evaluate how the remedy is performing based on the latest round of data and in particular, how the ARA is performing.	MWAC	EPA	2014
OU 01 Middle Waterway, Section 4.5	Based on the 2014 monitoring results, EPA needs to determine future sampling frequency.	EPA	EPA	2015
OU 01 Middle Waterway, Section 4.5	DNR should continue visual monitoring at least every two years as described in the Year 10 (2013) monitoring report (Hart Crowser 2013b).	DNR	EPA	Ongoing.
OU 01 Middle Waterway, Section 4.5	DNR should conduct another round of sediment chemical monitoring at least one year before the next FYR (i.e., prior to December 2019) so that data results and analysis can be included in the next review.	DNR	EPA	Prior to December 2019
OU 01 Middle Waterway, Section 4.5	The Coast Guard Regulated Navigation Area for Middle Waterway must be completed. The RNA will restrict certain activities that could damage the sediment cap. An Institutional Control study should be completed, in part to document that easements and/or environmental covenants have been executed and entered into Ecology's Uniform Environmental Covenants Act (UECA) registry in the Integrated Site Information System (ISIS) database and the City of Tacoma govMe database.	EPA	EPA	2018
OU 01 Olympic View Resource Area, Section 4.6	None.			

Table 7-2. Action Items That Do Not Affect Remedy Protectiveness (continued)

OU # Name, FYR Section	Action Item	Responsible Party	Oversight Agency	Planned Completion Date
OU 01 Thea Foss and Wheeler-Osgood Waterways, Section 4.7	Because recontamination is occurring in the Thea Foss Waterway, OMMP monitoring should continue to evaluate contaminant trends and assess whether additional measures are necessary to protect human health and the environment.	City of Tacoma	EPA	Ongoing
OU 01 Thea Foss and Wheeler-Osgood Waterways, Section 4.7	Because recontamination is occurring in the Thea Foss Waterway, 1) OMMP monitoring should continue to evaluate contaminant trends and assess whether additional measures are necessary to protect human health and the environment, and 2) the City of Tacoma should continue to implement its aggressive storm water control and monitoring program to further reduce contaminant inputs to the waterway.	City of Tacoma	WA Department of Ecology	Ongoing
OU 20 Asarco Smelter, Section 5	EPA should repair the habitat basin that was damaged in 2001, to provide the required habitat.	EPA	EPA	December 2016
OU 22 Ruston/North Tacoma Study Area, Section 5	None.			
OU 19 Asarco Sediments, Section 5	None.			
OU 03 Tacoma Tar Pits, Section 6	Update the 1995 Inspection & Maintenance Manual & Annual Reports to include at a minimum: 1) Regular inspection, maintenance, and permeability testing of asphalt in the two Detention Basins 2) Procedure to notify EPA when all I&M activities are to be conducted, and if any serious issues are discovered.	PSE	EPA	December 2015

Table 7-2. Action Items That Do Not Affect Remedy Protectiveness (continued)

OU # Name, FYR Section	Action Item	Responsible Party	Oversight Agency	Planned Completion Date
OU 03 Tacoma Tar Pits, Section 6	Update Water Quality Monitoring Reports to include at a minimum:* 1) Monitoring wells are accurately located, e.g., DOF-26M is identified as within remediation/source area but on some figures it looks to be along southeastern boundary. 2) Location of the exterior Hygrade well to DOF figures and include in DOF reports. 3) Figure that summarizes effluent benzene concentrations to help assess effluent trends. *Notify EPA approx. 2-business after incident if GWET is down, if there are effluent exceedances or unusual benzene samples from any monitoring well.	PSE	EPA	December 2015
OU 03 Tacoma Tar Pits, Section 6	Renew the City of Tacoma Industrial Wastewater Discharge Permit for the GETS system every five years.	PSE	City of Tacoma	April 2017
OU 03 Tacoma Tar Pits, Section 6	Update GWET O&M Plan based on outcome of optimization evaluation.	PSE	EPA	December 2019
OU 03 Tacoma Tar Pits, Section 6	Update Water Quality Monitoring Program Plan based on outcome of optimization evaluation.	PSE	EPA	December 2019
OU 03 Tacoma Tar Pits, Section 6	Include the Northwest Detention Facility on the City of Tacoma's GOV.ME GIS website.	EPA	City of Tacoma	December 2019
OU 03 Tacoma Tar Pits, Section 6	Determine the need for a vegetative management plan. If needed, prepare plan.	PSE	EPA	December 2019

NOTE: "FYR Section" refers to the section of this document in which the referenced OU or waterway is discussed.

8. Summary of Protectiveness Statements

This section presents the protectiveness statements for each of the OUs (OU 01 CB/NT Sediments; OU 19, OU 20, and OU 22 CB/NT Asarco Area; and, OU 03 CB/NT Tacoma Tar Pits) for the CB/NT site. For OU 01 CB/NT Sediments, specific protectiveness statements are also provided as supplemental information for each of the Problem Area waterways and the removal action.

8.1. OU 01 CB/NT Sediments, OU-Wide

Taken as a whole, the remedies for the Sediments OU are expected to be protective when completed. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in those areas. Until site remedial objectives are met (see Section 4.1.1), site use restrictions (i.e., fish and shellfish consumption advisories) shall remain in effect to limit human exposure to contaminated seafood. The absence of fish tissue contaminant data does not mean that the remedy is not protective (see EPA 2001, p. 4-14). Recent fish tissue data for bioaccumulative chemicals have not been collected in Commencement Bay and evaluated, so it is not known whether contaminant levels in fish tissues have been reduced since the remedies have been implemented, particularly for PCBs (which have a human-health based Sediment Quality Objective). Future fish tissue sampling results will be used along with other lines of evidence to evaluate protectiveness of the remedies in the long-term.

8.1.1. OU 01 CB/NT Sediments, Hylebos Waterway

For the Hylebos Waterway, the remedy is expected to be protective of human health and the environment upon completion. In the interim, remedial action construction completed to date has adequately addressed all exposure pathways that could result in unacceptable risks in those areas. Remedial action construction has been accomplished under the Head and Mouth of Hylebos Waterway Consent Decrees, whereas work being performed pursuant to the Occidental Site Administrative Order on Consent is at the end of Remedial Investigation and the beginning of the Feasibility Study. Also, work being performed at the Arkema site pursuant to a state MTCA Agreed Order is in the RI/FS phase, with EPA coordination and oversight.

8.1.2. OU 01 CB/NT Sediments, Sitcum Waterway

For the Sitcum Waterway, the remedial actions have been successfully completed, and all required long-term monitoring efforts have been completed. The remedy remains protective of human health and the environment, and the exposure pathways that could result in unacceptable risks are being controlled.

8.1.3. OU 01 CB/NT Sediments, St. Paul Waterway

For the St. Paul Waterway, the remedial actions have been successfully completed, and all required long-term monitoring efforts have been completed. The remedy remains protective of human health and the environment, and the exposure pathways that could result in unacceptable risks are being controlled.

8.1.4. OU 01 CB/NT Sediments, Middle Waterway

For the Middle Waterway, all remedial actions have been completed, the remedy is currently protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled. In order for the remedy to be protective in the long-term, the Sediment Quality Objectives need to be met according to the timeframes established in the Middle Waterway Explanation of Significant Differences (ESDs), or any exceedances need to be shown to be biologically insignificant in all enhanced natural recovery (ENR) and natural recovery areas, and ICs must be fully implemented.

8.1.5. OU 01 CB/NT Sediments, Olympic View Resource Area

For the Olympic View Resource Area, the remedy is protective of human health and the environment. All long-term monitoring efforts have been completed, and exposure pathways that could result in unacceptable risks are being controlled.

8.1.6. OU 01 CB/NT Sediments, Thea Foss and Wheeler-Osgood Waterways

For the Thea Foss and Wheeler-Osgood Waterways, the remedy is protective of human health and the environment. Sediment COC concentrations in the waterway have decreased since completing the sediment remedial actions, indicating that the caps installed in the waterway are stabilizing and performing as designed (no upward migration of contamination has been documented). Cap integrity monitoring, which includes visual and hydrographic survey work, indicates that capped and natural recovery areas are stabilizing and meeting performance criteria in much of the waterway. The capped and natural recovery areas in a large portion of the waterway are supporting benthic communities. Institutional controls have been put in place that enhance the long-term integrity of the remedy. The City of Tacoma has implemented an aggressive stormwater monitoring and source control program that has reduced contamination entering the waterway. That program is expected to continue into the foreseeable future.

8.2. OU 20 Asarco Smelter, CB/NT Asarco Area

For the Asarco Smelter, the remedy is expected to be protective of human health and the environment upon completion (i.e., once all redevelopment has been completed by Point Ruston LLC). In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in those areas. Exposure pathways that could result in unacceptable risks are being prevented because the site is being controlled by the developer during construction using best management practices as described in the Development and Occupancy Plan (Hydrometrics 2013b). For areas that have already been constructed, O&M requirements to maintain protectiveness are described in the Operation, Maintenance and Monitoring Plan (Hydrometrics 2013a). Within the next FYR period, EPA anticipates repairing the habitat basin and completing the armoring of the remaining portions of the slag peninsula shoreline that required armoring as part of the remedy in the ROD.

8.3. OU 22 Ruston/North Tacoma Study Area, CB/NT Asarco Area

For the Ruston/North Tacoma Study Area, the remedy is protective of human health and the environment. The Expedited Response Action in 1989-91 at 10 non-residential high-use areas addressed immediate concerns. The subsequent removal/replacement of soils with concentrations above the action level brought long-term risk exposures within EPA's acceptable risk range. These cleanup actions were completed in 2012. Community protection measures, mostly educational in nature, are in place for those areas that have soil arsenic concentrations between the MTCA cleanup level of 20 ppm and the EPA action level of 230 ppm. Ecology has assumed responsibility for all future work, including properties where owners have refused sampling or cleanup.

8.4. OU 19 Asarco Sediments, CB/NT Asarco Area

For the Asarco Sediments, the remedy is expected to be protective of human health and the environment upon completion, once Point Ruston LLC and EPA have implemented the remedy for the Yacht Basin sediments. In the interim, remedial activities completed to date in the capped offshore sediments (i.e., where the remedy has been implemented) have adequately addressed all exposure pathways that could result in unacceptable risks in those areas.

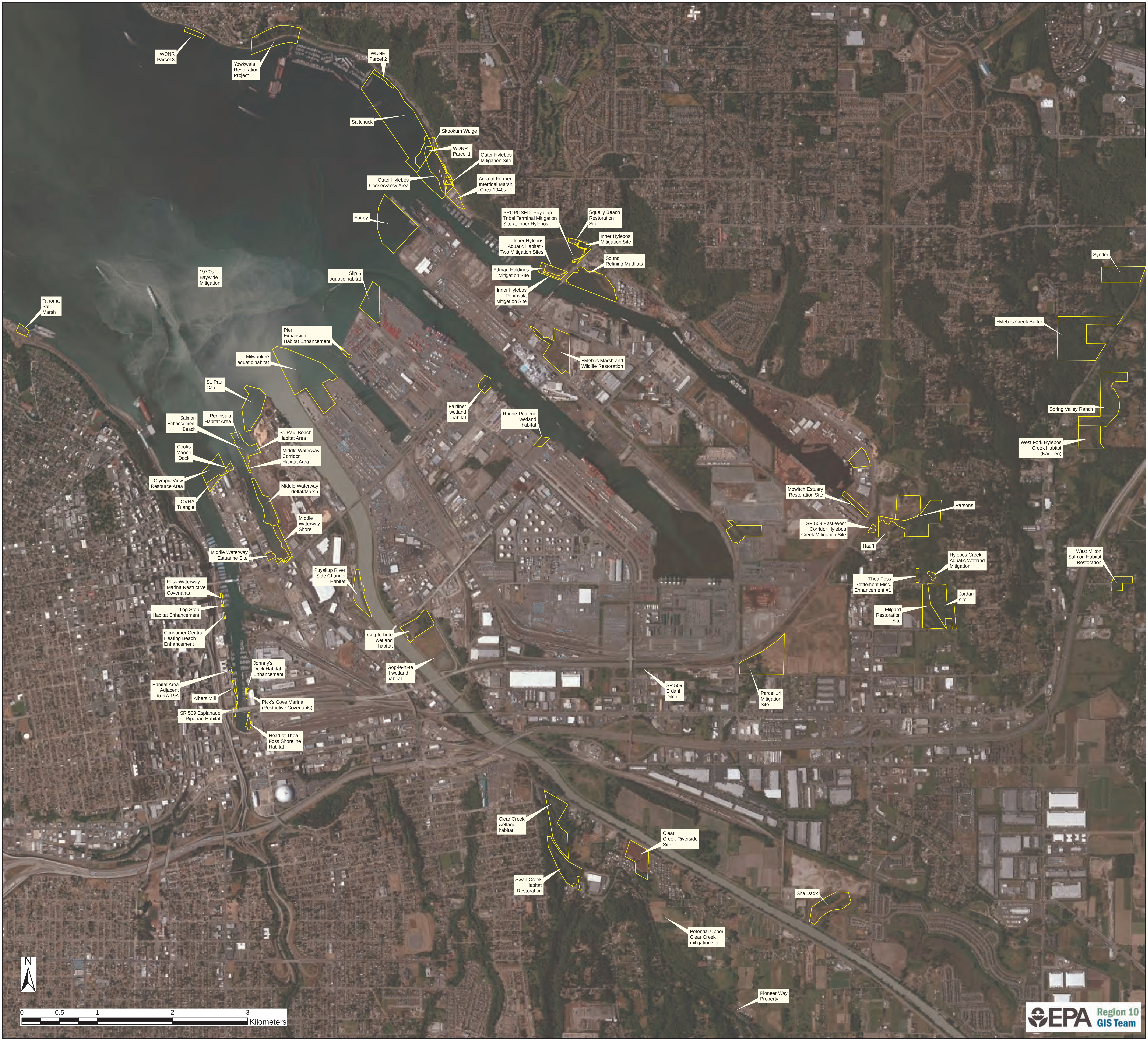
8.5. OU 3 CB/NT Tacoma Tar Pits

The results of this FYR indicate that the Tacoma Tar Pits remedy is functioning as intended and currently protects human health and the environment in the short-term because 1) sources of contamination (e.g., waste materials and contaminated soils) have been excavated, disposed of off site or treated and contained on site, 2) low permeability caps and surface water controls have been placed across critical areas of the site, 3) institutional controls that prohibit using site groundwater are in place, and 4) the groundwater extraction and treatment system has contained contaminated groundwater such that exposures are under control and there are no unacceptable risks to humans or the environment, e.g. contaminated site groundwater is not being used as, or migrating to, a drinking water source nor is it discharging to the downgradient Puyallup River. However, in order for the remedy to remain protective over the long-term, the follow-up actions recommended in this report need to be implemented which include 1) continuing maintenance of the cap, cover and ancillary surface water drainage features, 2) optimizing all property owner compliance with institutional control requirements, and 3) continuing operation and optimization of the groundwater extraction, treatment and monitoring systems to reduce the size and concentration of the benzene-contaminated groundwater plume across the site.

9. Next Review

The next FYR for the CB/NT Superfund site is required by December 2019, five years from the date of this review.

Figures


WDNR Parcel 3
Yowkwala Restoration Project
WDNR Parcel 2
Saltchuck
Skookum Wulge
WDNR Parcel 1
Outer Hylebos Mitigation Site
Outer Hylebos Conservancy Area
Area of Former Intertidal Marsh, Circa 1940s
Earley
PROPOSED: Puyallup Tribal Terminal Mitigation Site at Inner Hylebos
Squally Beach Restoration Site
Inner Hylebos Mitigation Site
Inner Hylebos Aquatic Habitat - Two Mitigation Sites
Sound Refining Mudflats
Edman Holdings Mitigation Site
Inner Hylebos Peninsula Mitigation Site
Synder
1970's Baywide Mitigation
Slip 5 aquatic habitat
Tahoma Salt Marsh
Pier Expansion Habitat Enhancement
Hylebos Creek Buffer
Milwaukee aquatic habitat
Hylebos Marsh and Wildlife Restoration
St. Paul Cap
Fairliner wetland habitat
Spring Valley Ranch
Salmon Enhancement Beach
Peninsula Habitat Area
Rhone-Poulenc wetland habitat
St. Paul Beach Habitat Area
Cooks Marine Dock
Middle Waterway Corridor Habitat Area
West Fork Hylebos Creek Habitat (Karileen)
Olympic View Resource Area
Middle Waterway Tideflat/Marsh
Mowitch Estuary Restoration Site
OVRA Triangle
Parsons
Middle Waterway Shore
SR 509 East-West Corridor Hylebos Creek Mitigation Site
Hauff
Middle Waterway Estuarine Site
West Milton Salmon Habitat Restoration
Hylebos Creek Aquatic Wetland Mitigation
Puyallup River Side Channel Habitat
Foss Waterway Marina Restrictive Covenants
Thea Foss Settlement Misc. Enhancement #1
Jordan site
Log Step Habitat Enhancement
Milgard Restoration Site
Consumer Central Heating Beach Enhancement
Gog-le-hi-te I wetland habitat
Johnny's Dock Habitat Enhancement
Gog-le-hi-te II wetland habitat
SR 509 Erdahl Ditch
Parcel 14 Mitigation Site
Habitat Area Adjacent to RA 19A
Albers Mill
Pick's Cove Marina (Restrictive Covenants)
SR 509 Esplanade Riparian Habitat
Head of Thea Foss Shoreline Habitat
Clear Creek wetland habitat
Clear Creek-Riverside Site
Swan Creek Habitat Restoration
Sha Dadx
Potential Upper Clear Creek mitigation site
Pioneer Way Property
N
0 0.5 1 2 3
Kilometers
EPA Region 10 GIS Team

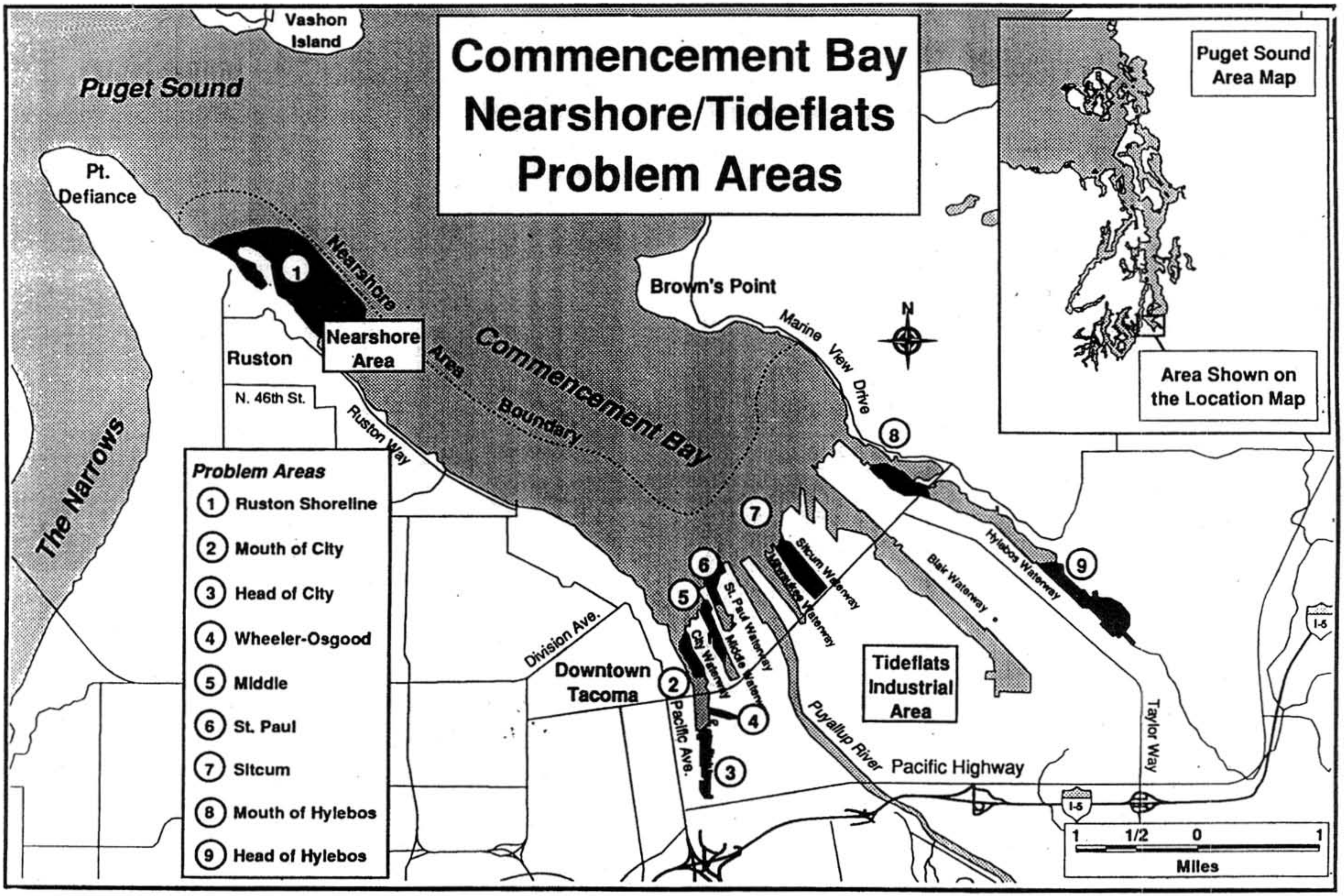
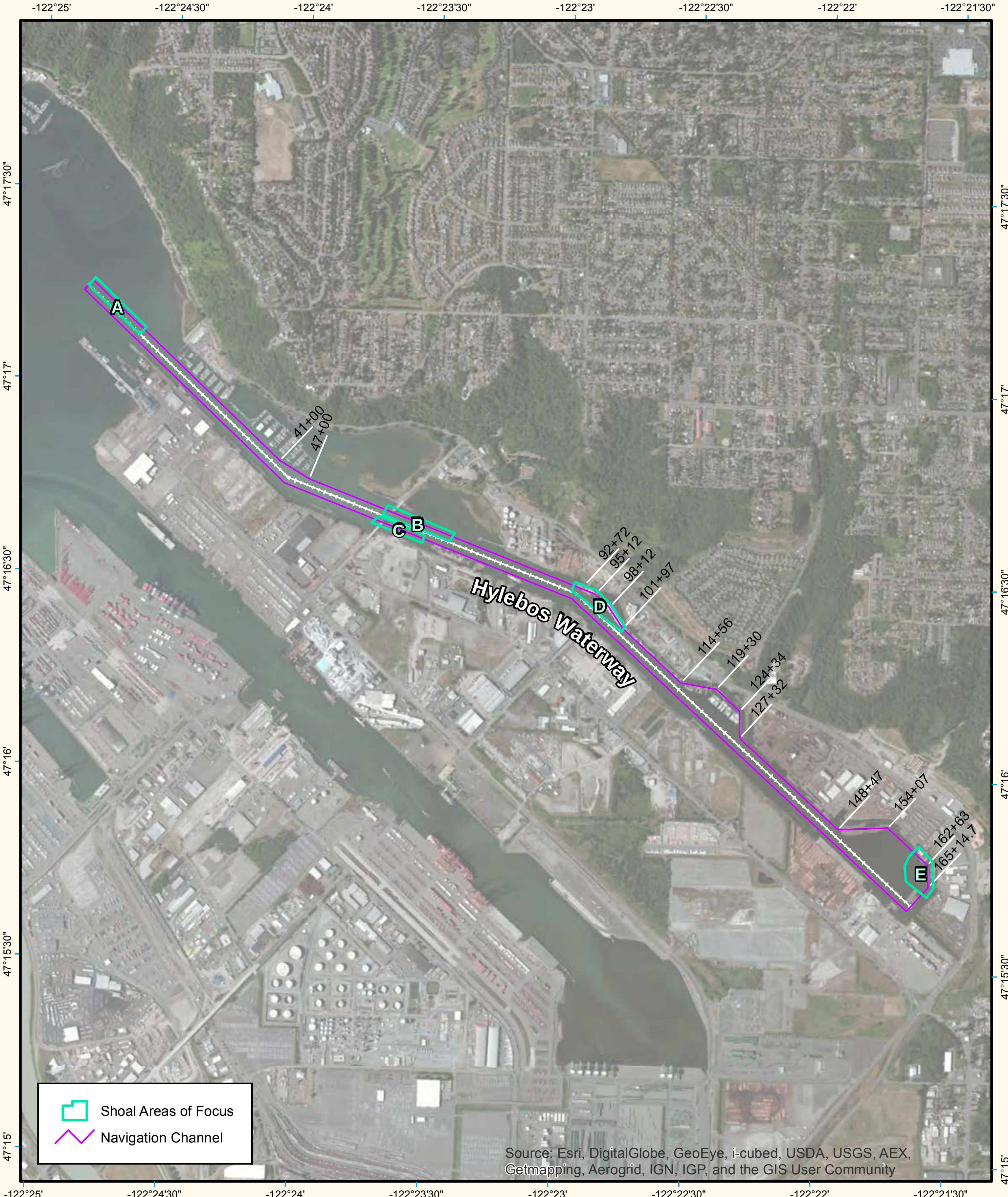
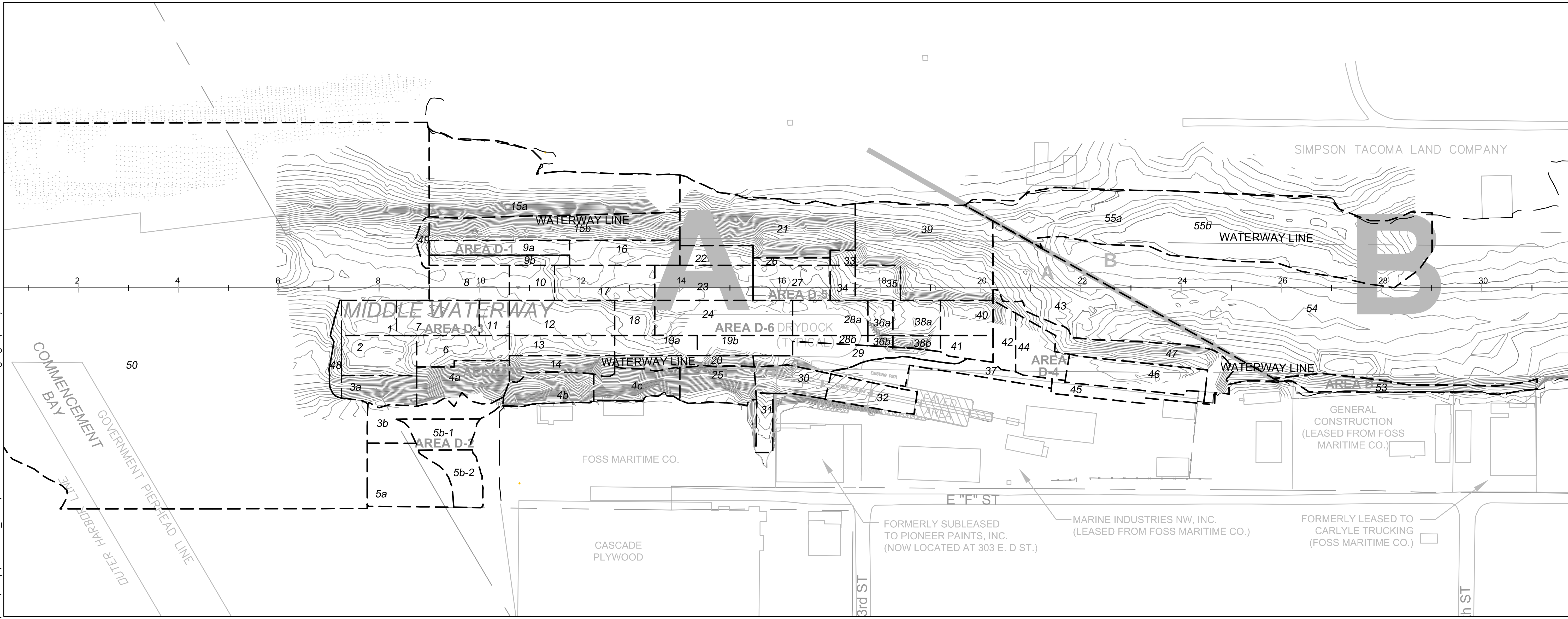


Figure 4-1. Commencement Bay Nearshore/Tideflats Vicinity Map (Source: Environmental Protection Agency, 1989)



-122°25'
-122°24'30"
-122°24'
-122°23'30"
-122°23'
-122°22'30"
-122°22'
-122°21'30"
47°17'30"
47°17'
47°16'30"
47°16'
47°15'30"
47°15'
A
B
C
D
E
41+00
47+00
92+72
95+12
98+12
101+97
114+56
119+30
124+34
127+32
148+47
154+07
162+63
165+14.7
Hylebos Waterway
Shoal Areas of Focus
Navigation Channel
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



HORIZONTAL DATUM: WA State Plane South Zone (NAD83)
VERTICAL DATUM: NOAA Mean Lower Low Water

SURVEY DATA:
YEAR 5 - Bathymetry and topography survey by Bluewater Engineering, Inc. and Sitts & Hills Engineers, Inc. dated August 2, 2009.

NOTES:
1. Property line information has been compiled from multiple data sources, which have not been verified. These data are to be used for reference purposes only.

LEGEND:
SMU Boundaries

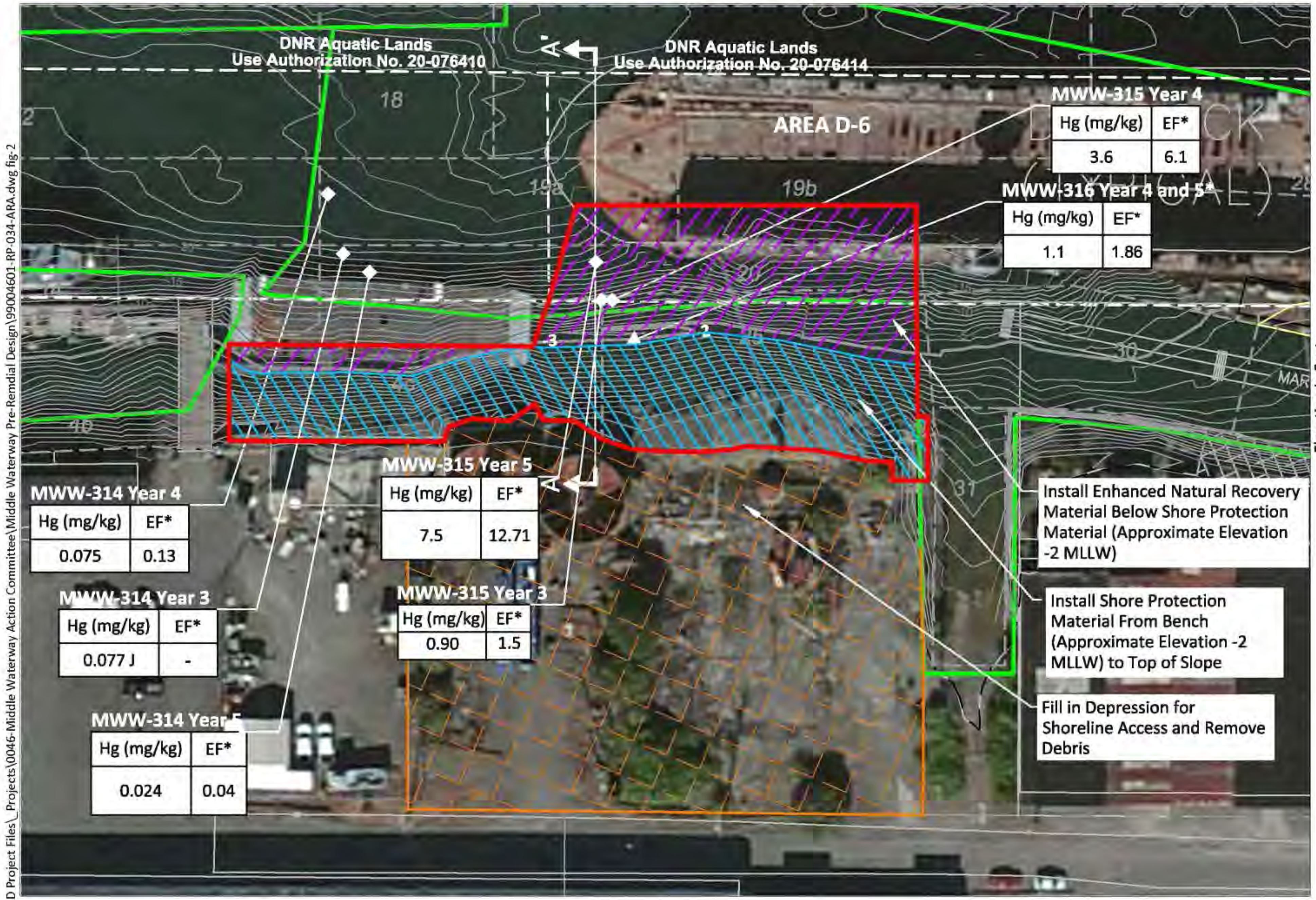
Waterway Areas
A Working Waterway Area
B Central Tideflats

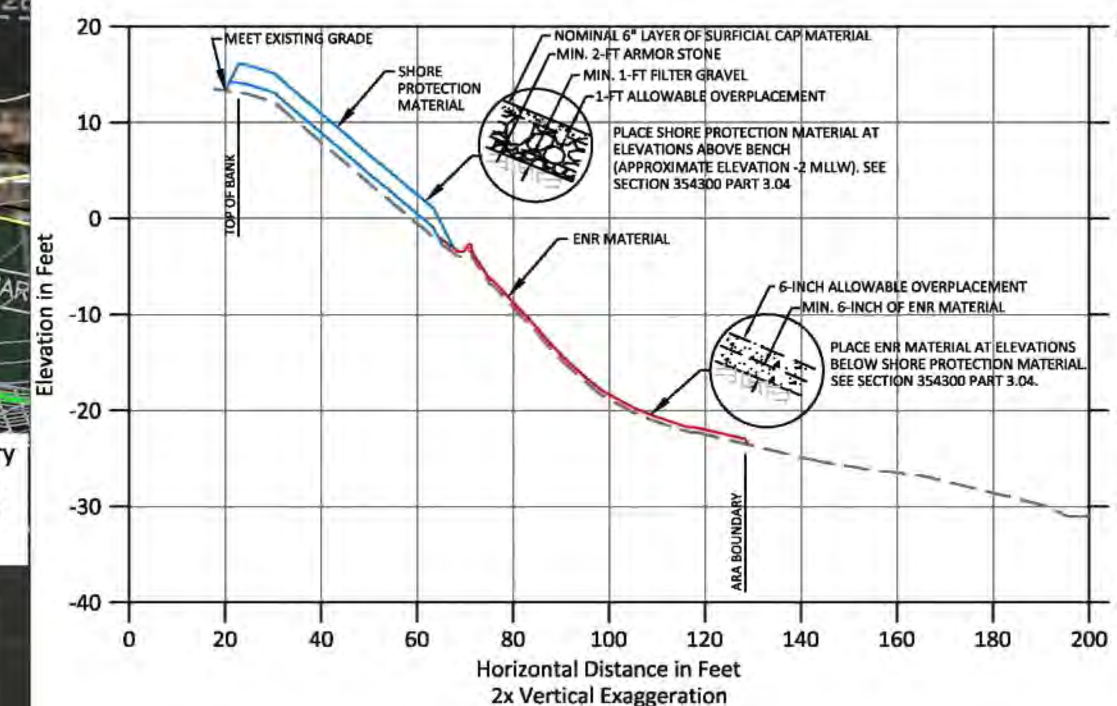
0 200
Scale in Feet

C:\Users\dholmer\appdata\local\temp\AcPublish_8284\99004601-RP-031-EPA-REM.dwg Fig-1 (SMU)
Apr 30, 2014 5:00pm dholmer

ANCHOR QEA

Figure 1
Sediment Management Units
Middle Waterway Problem Area - Areas A and B





Cross Section A
Scale 1" = 40'

NOTES:
1. ENR Material is 1/2-inch minus gravel.
2. Filter gravel is 4-inch minus cobble/gravel.
3. Armor Stone is 3-inch to 21-inch rock.
4. Surficial Cap is 2-inch minus gravel.

L:\AutoCAD Project Files_Projects\0046-Middle Waterway Action Committee\Middle Waterway Pre-Remdial Design\99004601-RP-034-ARA.dwg fig-2

Mar 07, 2013 8:56am ghowell

HORIZONTAL DATUM: WA State Plane South Zone (NAD83)
VERTICAL DATUM: NOAA Mean Lower Low Water

SURVEY DATA:
YEAR 5 - Bathymetry and topography survey by Bluewater Engineering, Inc. and Sitts & Hill Engineers, Inc. dated August 2, 2009.

NOTES:
1. Property line information has been compiled from multiple data sources, which have not been verified. These data are to be used for reference purposes only.

LEGEND:
- Existing Thick-Layer Cap
- Additional Response Action Area
- Shore Protection Material
- Enhanced Natural Recovery Material
- SMU Boundaries
- Contractor Selected Dredge Areas
- Upland Access Area

* MWW-316 - Composite samples taken along toe of slope in SMU 4c and 25 as approximate elevation -3 MLLW. Mercury concentration is the same for both years.

0 60
Scale in Feet

ANCHOR QEA

Figure 1
Additional Response Action Area
Middle Waterway Problem Area - Areas A and B

View from south shoreline looking north. (Before)

View from south shoreline looking north. (After)

View form north shoreline looking south. (Before)

View from north shoreline looking south. (After)

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Figure 2
Additional Response Action Area Before and After Construction
Middle Waterway Problem Areas – Areas A and B

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May 14, 2013 10:57am herliksen

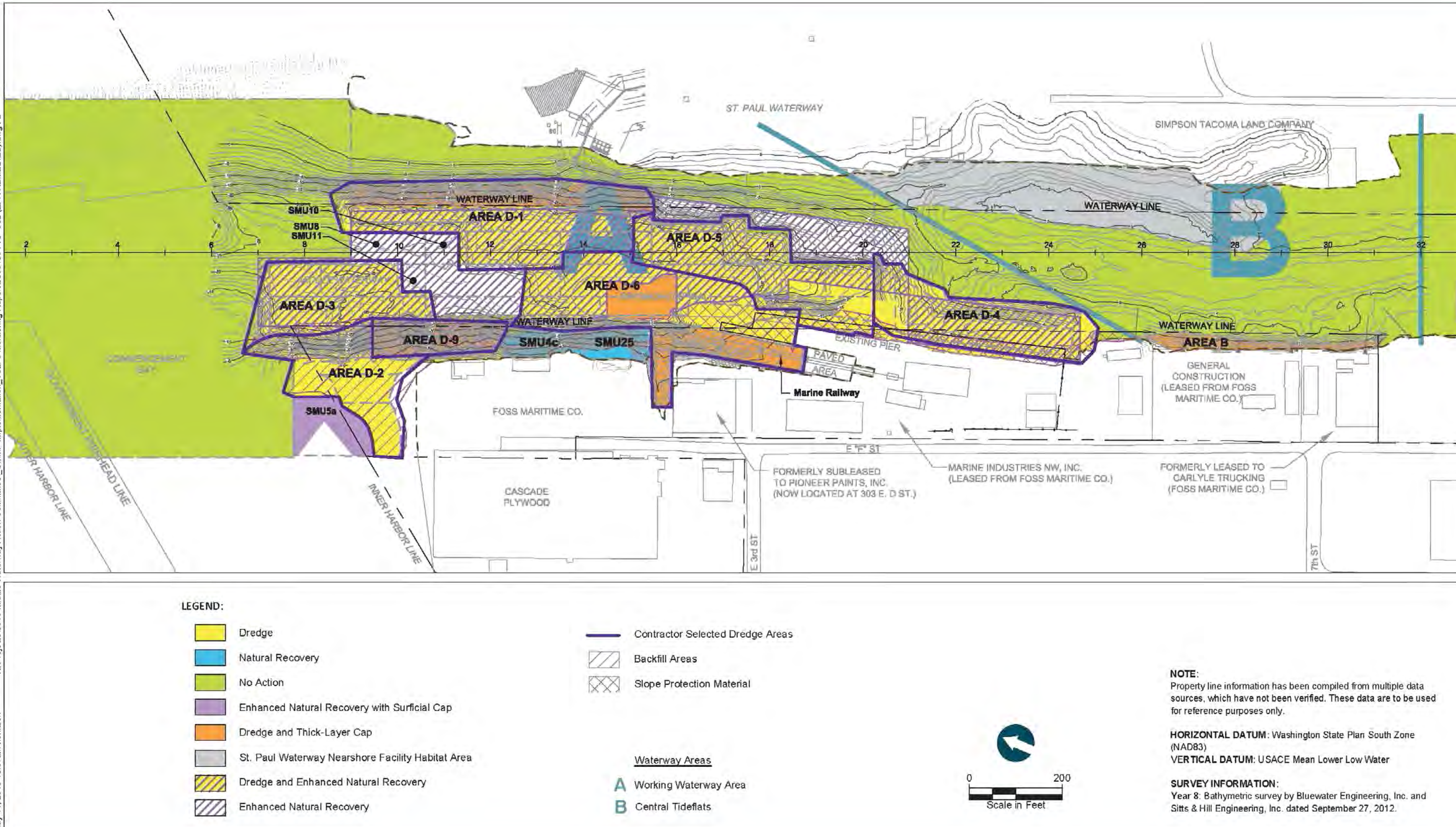

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Figure 2
Final EPA-Approved Remedies Applied to Areas A and B
Middle Waterway Problem Area
Year 8 Monitoring Report

Site Plan
Middle Waterway Problem Area C

Source: Aerial photograph from Google Earth, 2009.

SMU Number

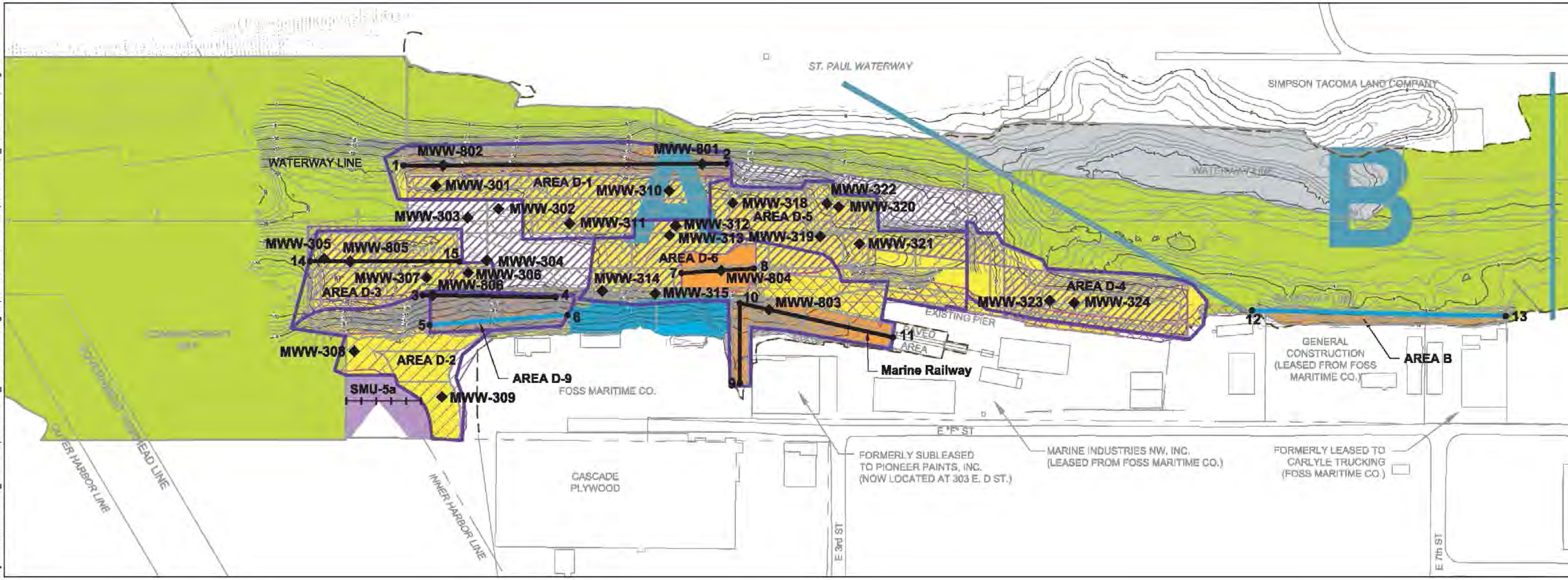
SMU Boundary (Within Area C)

Northern Extent of Area C

HARTCROWSER

17947-00 *6/13*

Figure 2



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May 13, 2013 1:55pm herikson

LEGEND:

- Dredge
- Natural Recovery
- No Action
- Enhanced Natural Recovery with Surficial Cap
- Dredge and Thick-Layer Cap
- St. Paul Waterway Nearshore Facility Habitat Area
- Dredge and Enhanced Natural Recovery
- Enhanced Natural Recovery
- Contractor Selected Dredge Areas
- Backfill Areas
- Slope Protection Material

Waterway Areas

- A Working Waterway Area
- B Central Tideflats

- MWW-301 ◆ Discrete Surface Grab Sample Location and Number (collected from boat within Dredged with ENR and ENR Areas)
- 1● Transect Start and Stop Point Location and Number
- Potential Hand Core Transect Location
- Diver Transect Lines
- Transects that were evaluated in the dry during a low tide event

0 200
Scale in Feet

NOTES:

1. Property line information has been compiled from multiple data sources, which have not been verified. These data are to be used for reference purposes only.
2. Bathymetry data not collected where ships and MINI dry-dock blocked access.

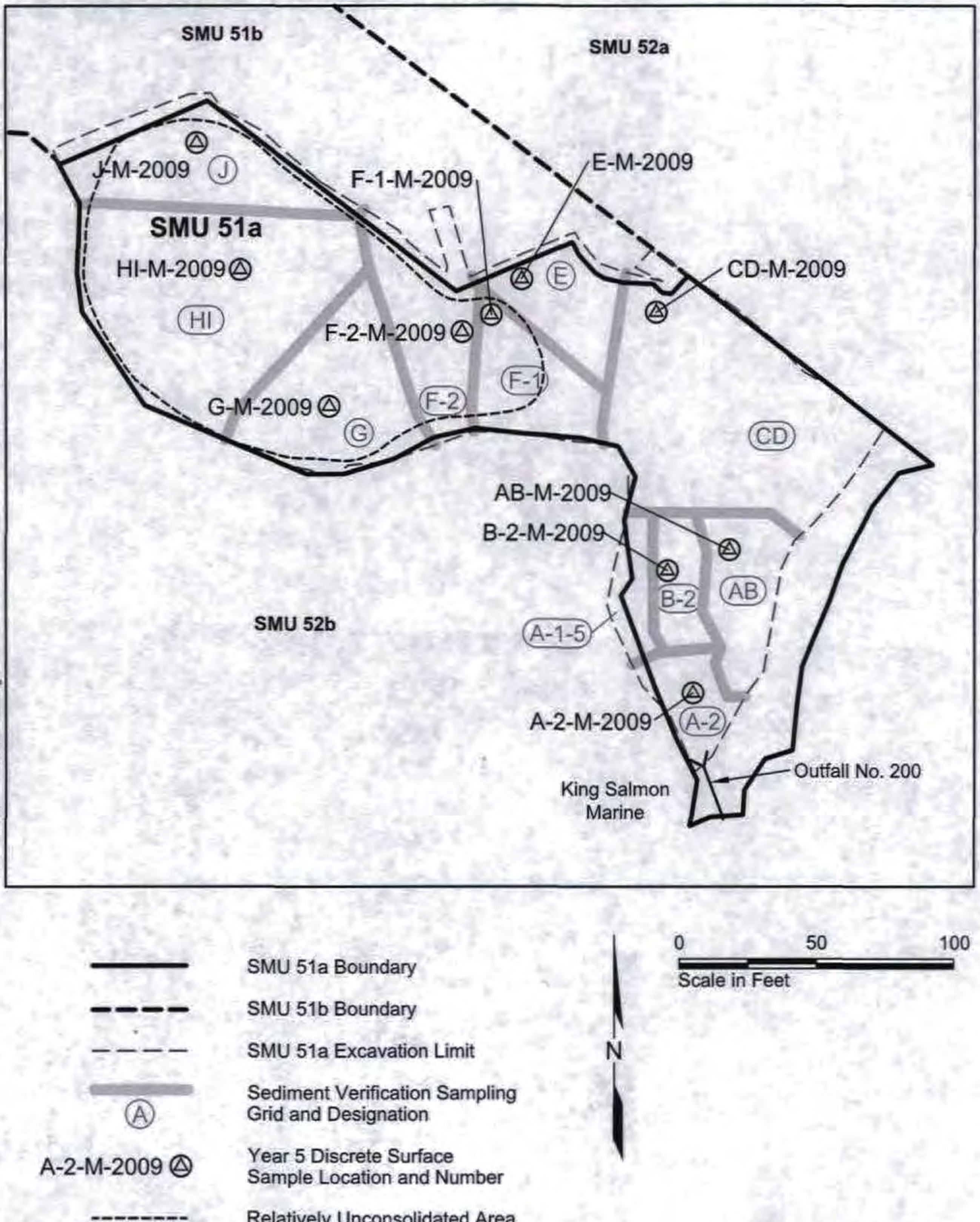
HORIZONTAL DATUM: Washington State Plane South Zone (NAD83)
VERTICAL DATUM: USACE Mean Lower Low Water

SURVEY INFORMATION:
Year 8: Bathymetric survey by Bluewater Engineering, Inc. and Sitts & Hill Engineering, Inc. dated September 27, 2012.

ANCHOR QEA

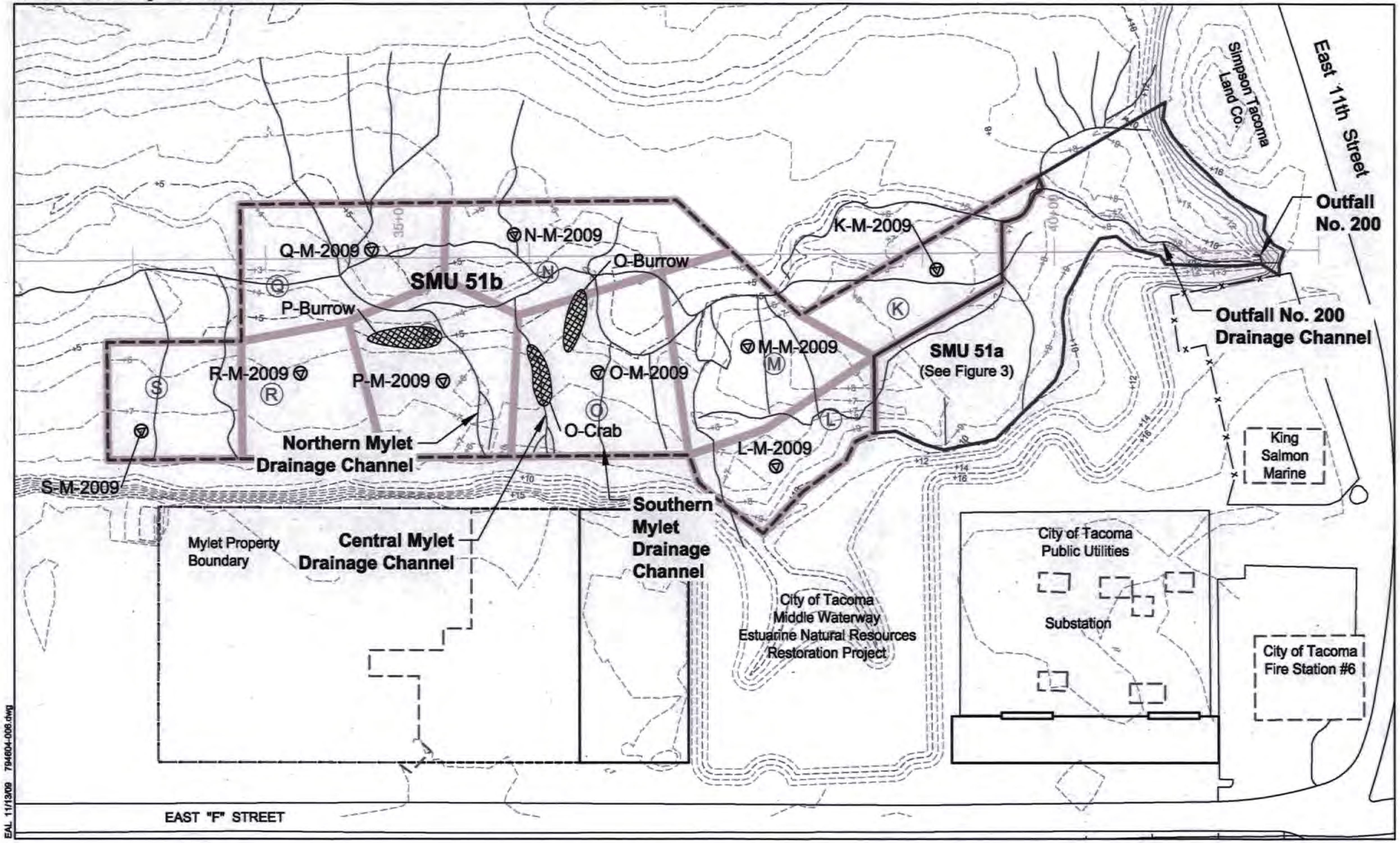
Figure 10
Actual Surface Sample and Dive Transect Locations for Year 8
Middle Waterway Problem Area
Year 8 Monitoring Report

Year 5 Excavated Areas with Backfill Sample Collection Locations (SMU 51a)
Middle Waterway Problem Area C



HARTCROWSER
7946-04 *11/09*
Figure 3

Year 5 Thin-Layer Cap Sample Collection Locations (SMU 51b)
Middle Waterway Problem Area C



SMU 51a Boundary

SMU 51b Boundary

Channel Location

K-M-2009 Year 5 Thin-Layer Cap Assessment/Observation Location and Number

Ⓚ Sediment Sampling Grid and Designation

Sediment Composite Sampling Area

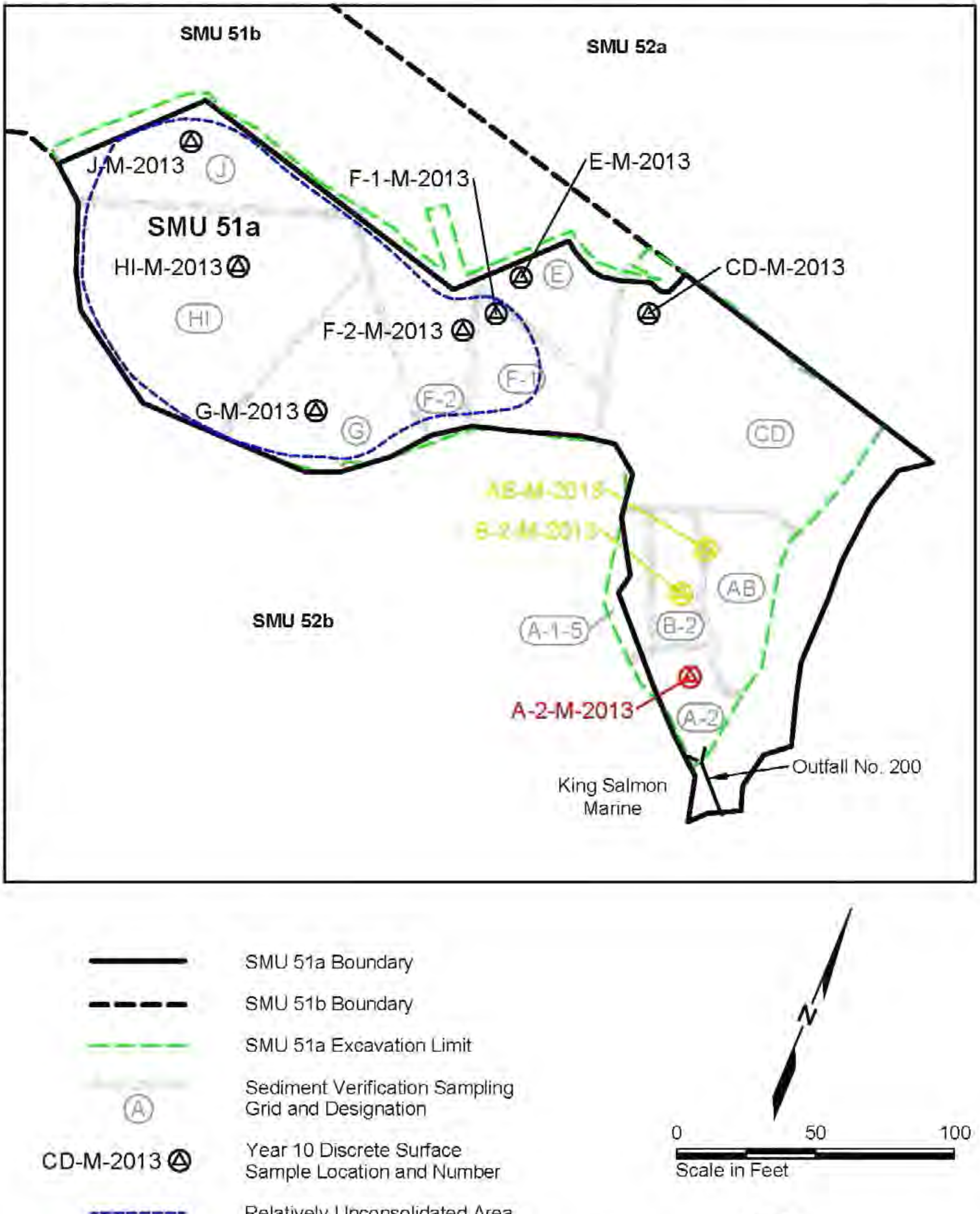
Notes:
1. Elevation contours outside SMU 51a and SMU 51b from Foster Wheeler and Blue Water Engineering Survey, 1998.
2. Elevation contours within SMU 51a and SMU 51b from Baseline Engineering Survey, October 2004.

Vertical Datum:
Datum: Corps of Engineers mean lower low water based on benchmark: BME406 1965 monument located on the south side of the east end of the East 11th Street bridge elevation: 24.09'

Basis of Bearings:
Washington State Plane coordinate system south zone, NAD83/1991

HARTCROWSER
7946-04 11/09
Figure 4

Year 10 Excavated Areas with Backfill Sample Collection Locations (SMU 51a)
Middle Waterway Problem Area C



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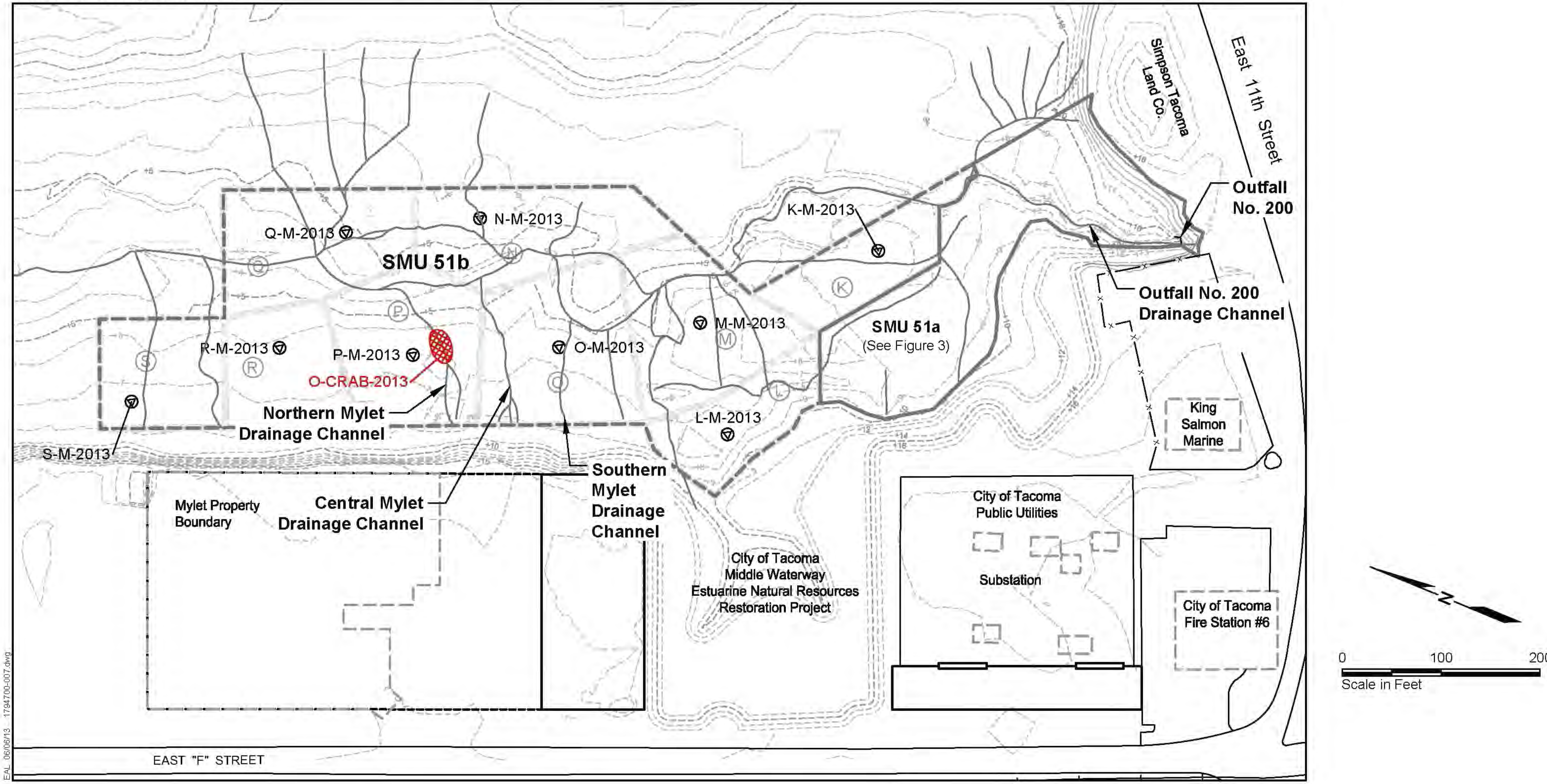
17947-00 ***6/13***

Figure 3

Year 10 Thin-Layer Cap Sample Collection Locations (SMU 51b)
Middle Waterway Problem Area C



SMU 51a Boundary

SMU 51b Boundary

Channel Location

K-M-2013 Year 10 Thin-Layer Cap Assessment/Observation Location and Number

(K) Sediment Sampling Grid and Designation

Sediment Composite Sampling Area (Sample exceeded SQO and early warning triggers)

Notes:

1. Elevation contours outside SMU 51a and SMU 51b from Foster Wheeler and Blue Water Engineering Survey, 1998.
2. Elevation contours within SMU 51a and SMU 51b from Baseline Engineering Survey, October 2004.

Vertical Datum:
Datum: Corps of Engineers mean lower low water based on benchmark: BME406 1965 monument located on the south side of the east end of the East 11th Street bridge elevation: 24.09'

Basis of Bearings:
Washington State Plane coordinate system south zone, NAD83/1991

HARTCROWSER

17947-00 *6/13*

Figure 4

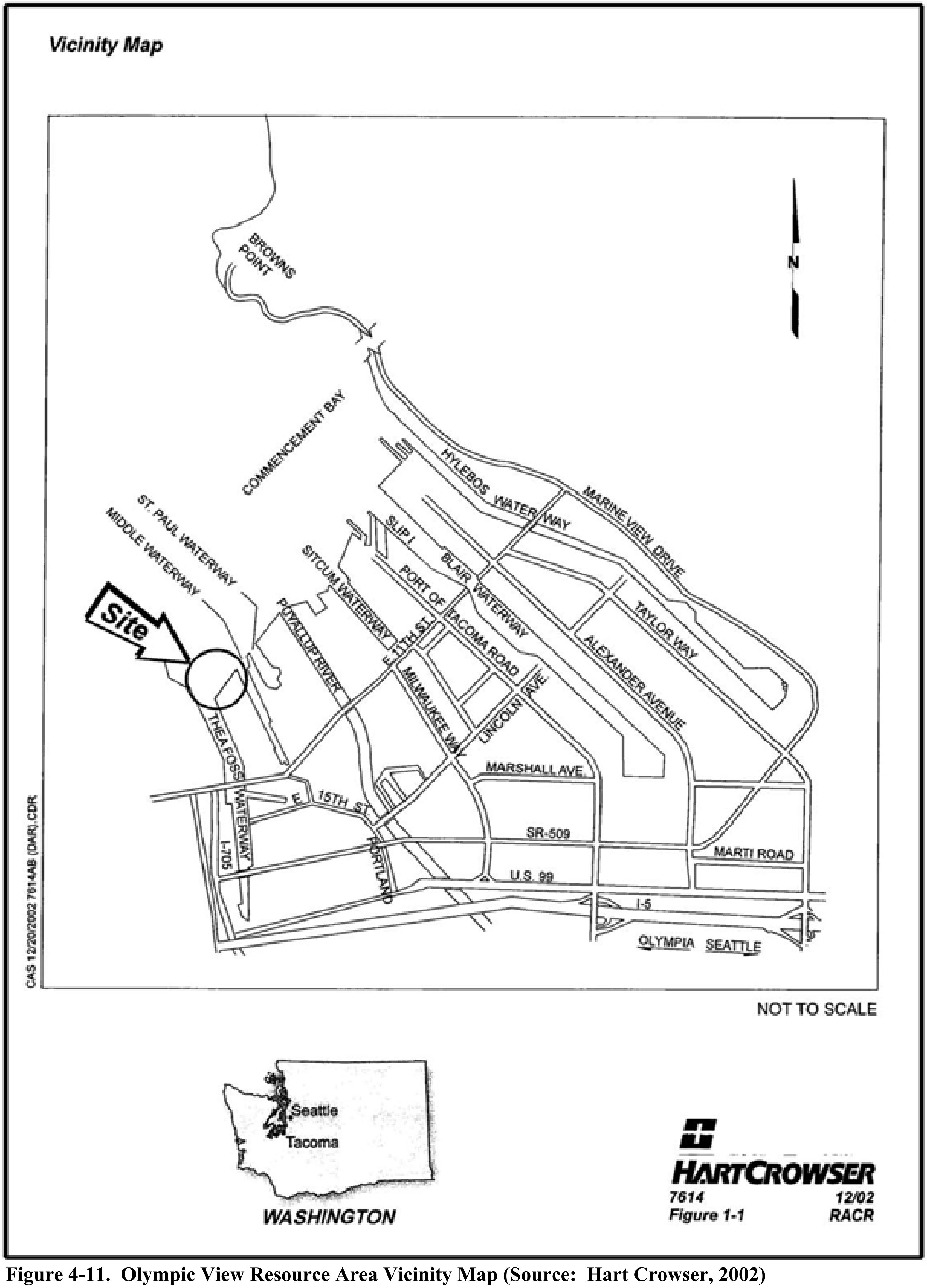


Figure 4-11. Olympic View Resource Area Vicinity Map (Source: Hart Crowser, 2002)

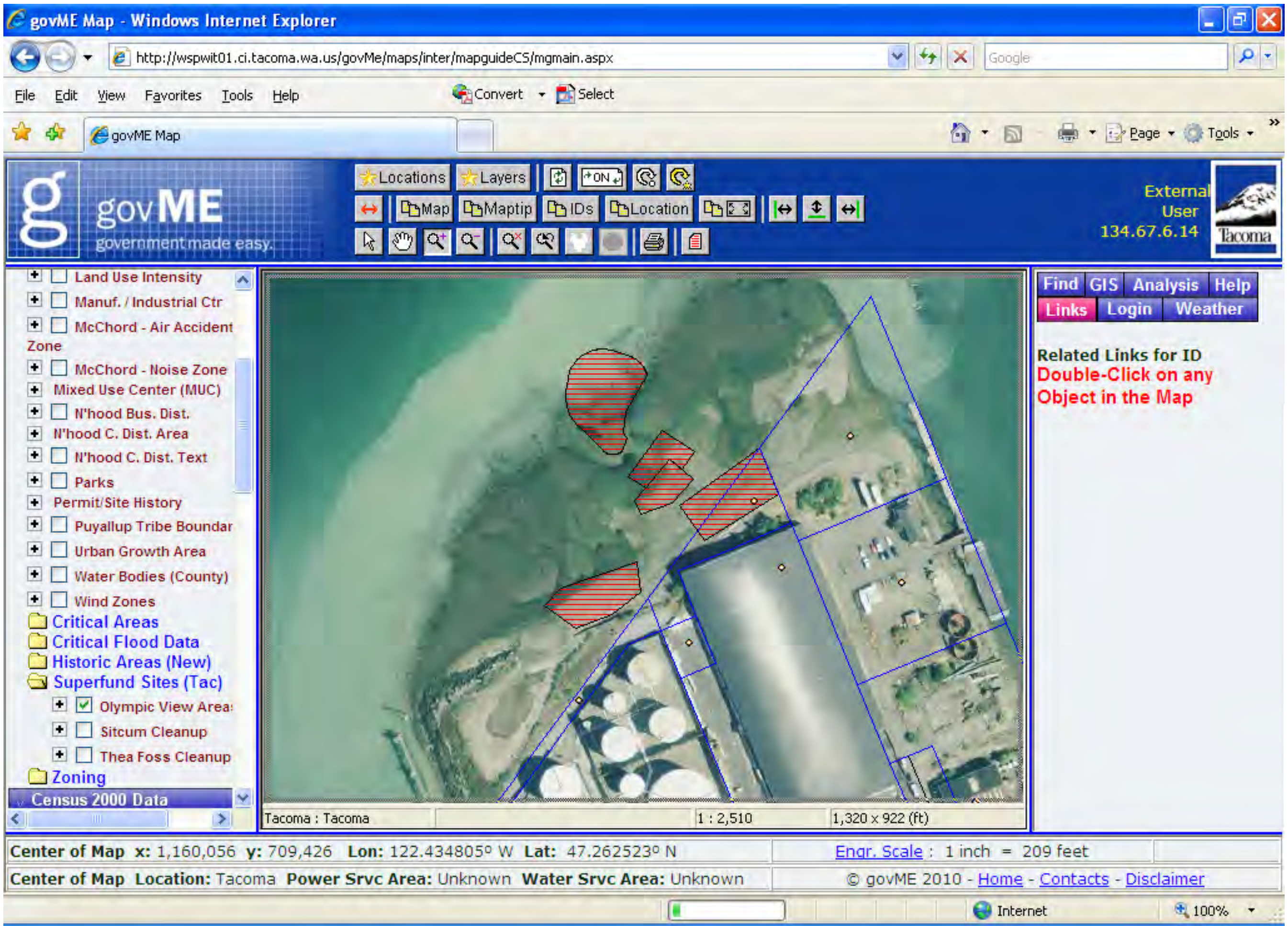


Figure 4-14. OVRA Government Made Easy Website

THIS IS A REGULATED NAVIGATIONAL AREA

Please **DO NOT ANCHOR HERE**

This is a Coast Guard-enforced Regulated Navigational Area, meant to protect eelgrass meadows as well as the sand cap below which helps to seal off contaminants.

Anchor damage to eelgrass affects habitat for whole populations of fish (such as threatened salmon), waterfowl, shellfish and other animals, as well as the stability of our shorelines.

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Why anchoring is not allowed in this area:

1) To protect eelgrass habitat located on-site.
2) To protect the 3-foot sand cap that was placed over contaminated sediments as part of a cleanup by the Environmental Protection Agency and the City of Tacoma.

Why protecting eelgrass habitat is important:

- Eelgrass meadows are a vital part of the nearshore food web.
- Eelgrass provides important habitat for many fish and shellfish.
- Eelgrass grows only in shallow, subtidal elevations and is very susceptible to damage caused by dredging, light availability and smothering sediments.
- Eelgrass communities prevent shoreline erosion by softening wave action.
- Commencement Bay has very limited areas of eelgrass habitat.

We understand that where there is eelgrass there are usually fish. However, this is also why we should focus on preserving this area by avoiding anchoring.

Washington state has lost about 33 percent of its eelgrass habitat. Help protect the creatures that reside here by protecting our eelgrass beds.

For more information about eelgrass:
www.ecy.wa.gov/programs/sea/pugetsound/species/eelgrass.html
www.ptmsc.org/html/eelgrass.html

For more information about this site, contact Desiree Pooley (253) 502-2126.

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Public Works
Environmental Services
Surface Water Management

www.cityoftacoma.org/surfacewater

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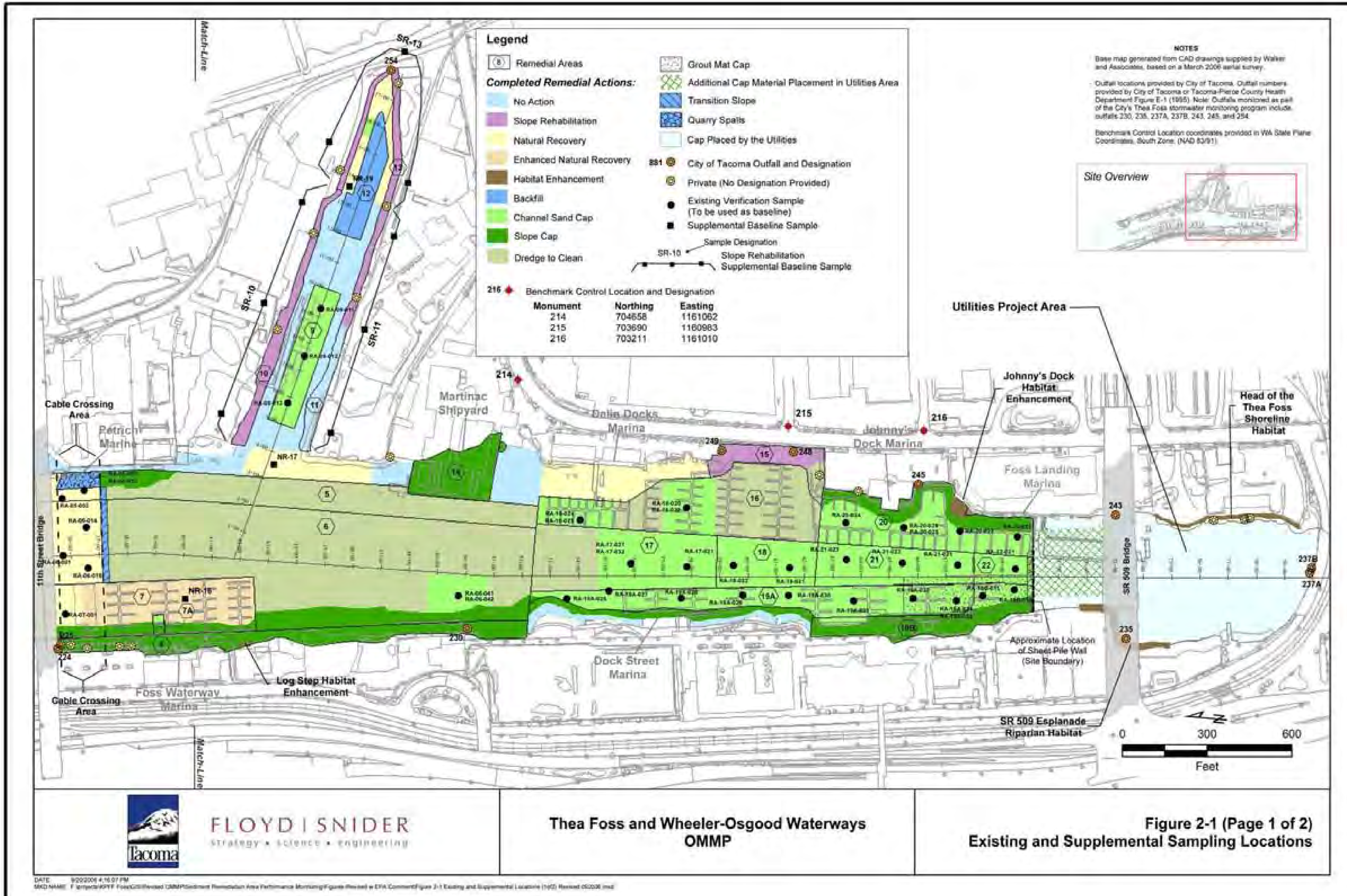
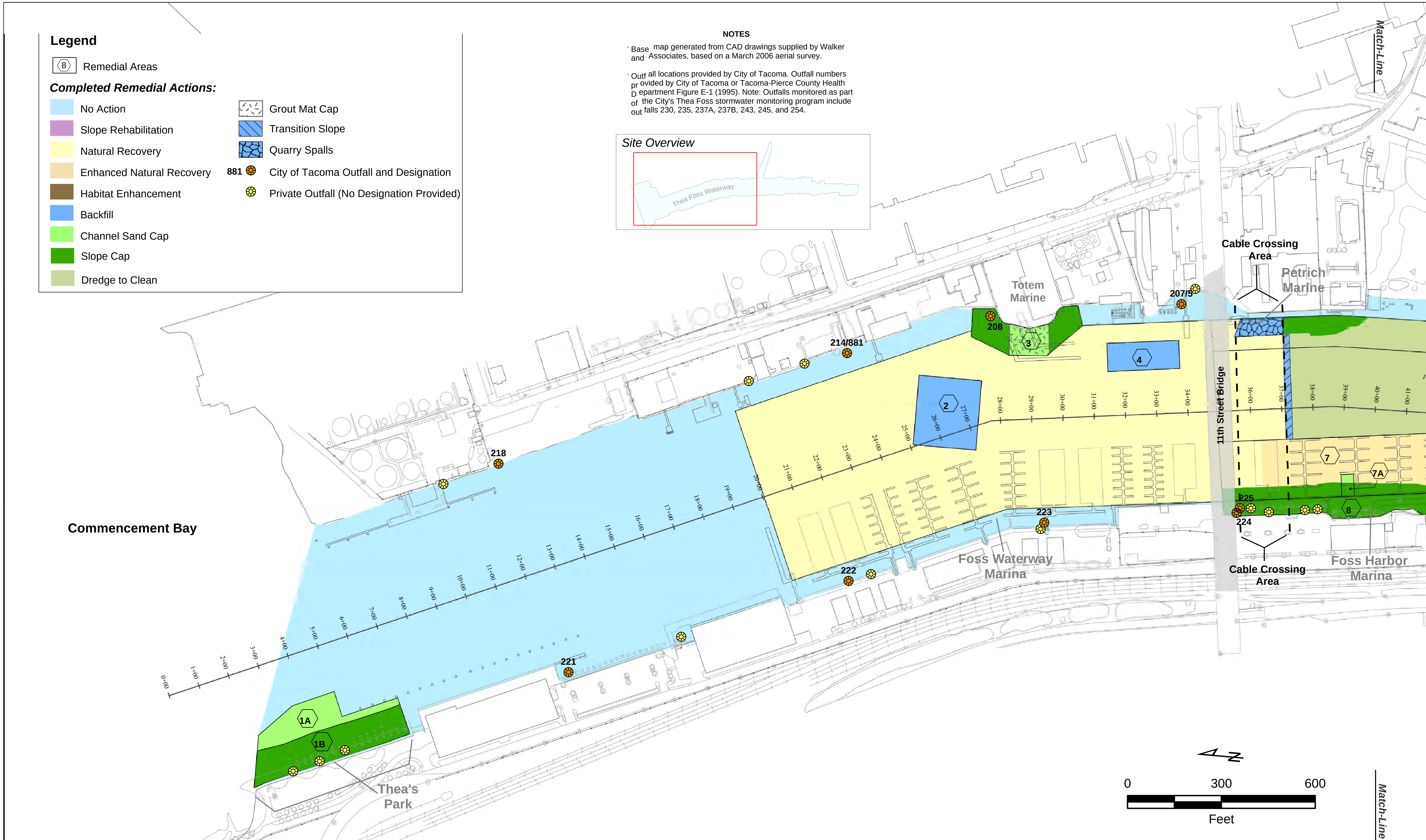


Figure 4-13. Main and Head of Thea Foss Waterway (Source: City of Tacoma, 2006b)



Thea Foss and Wheeler-Osgood Waterways
Annual OMMP Report

Figure 1-2 (Page 1 of 2)
Completed Remedial Actions

File: F:\projects\COT-Oncall\GIS\2008 Yr 2 Annual OMMP Report\Figure 1-2 Completed Remedial Actions (1of2).mxd
Date: 1/22/2009

Tacoma

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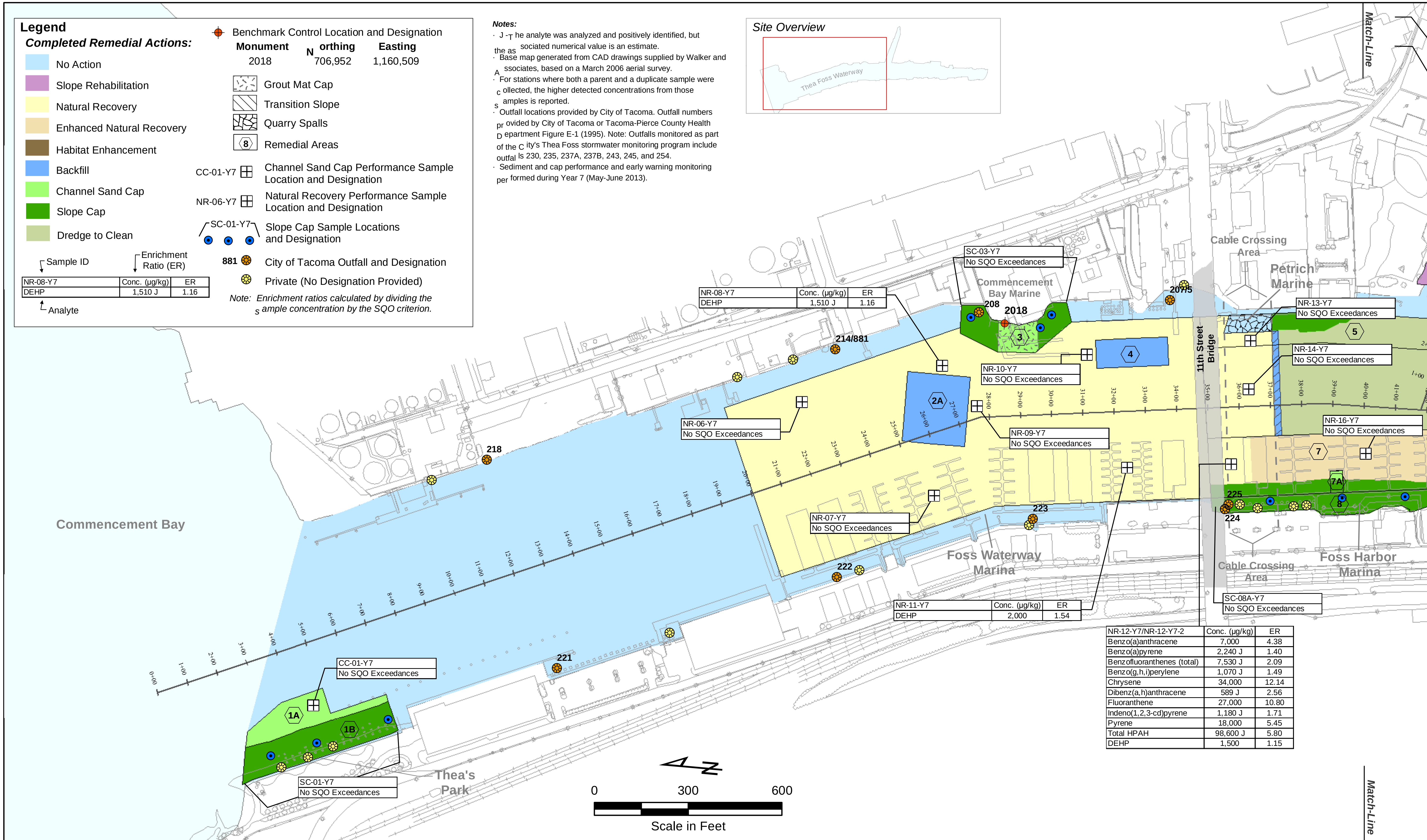
Thea Foss and Wheeler-Osgood Waterways
Annual OMMP Report

Figure 1-2 (Page 2 of 2)
Completed Remedial Actions

File: F:\projects\COT-Oncall\GIS\2008 Yr 2 Annual OMMP Report\Figure 1-2 Completed Remedial Actions (2of2).mxd
Date: 1/22/2009



NR-08-Y7	Conc. (µg/kg)	ER
DEHP	1,510 J	1.16

NR-08-Y7	Conc. (µg/kg)	ER
DEHP	1,510 J	1.16

NR-11-Y7	Conc. (µg/kg)	ER
DEHP	2,000	1.54

NR-12-Y7/NR-12-Y7-2	Conc. (µg/kg)	ER
Benzo(a)anthracene	7,000	4.38
Benzo(a)pyrene	2,240 J	1.40
Benzofluoranthenes (total)	7,530 J	2.09
Benzo(g,h,i)perylene	1,070 J	1.49
Chrysene	34,000	12.14
Dibenz(a,h)anthracene	589 J	2.56
Fluoranthene	27,000	10.80
Indeno(1,2,3-cd)pyrene	1,180 J	1.71
Pyrene	18,000	5.45
Total HPAH	98,600 J	5.80
DEHP	1,500	1.15

Tacoma

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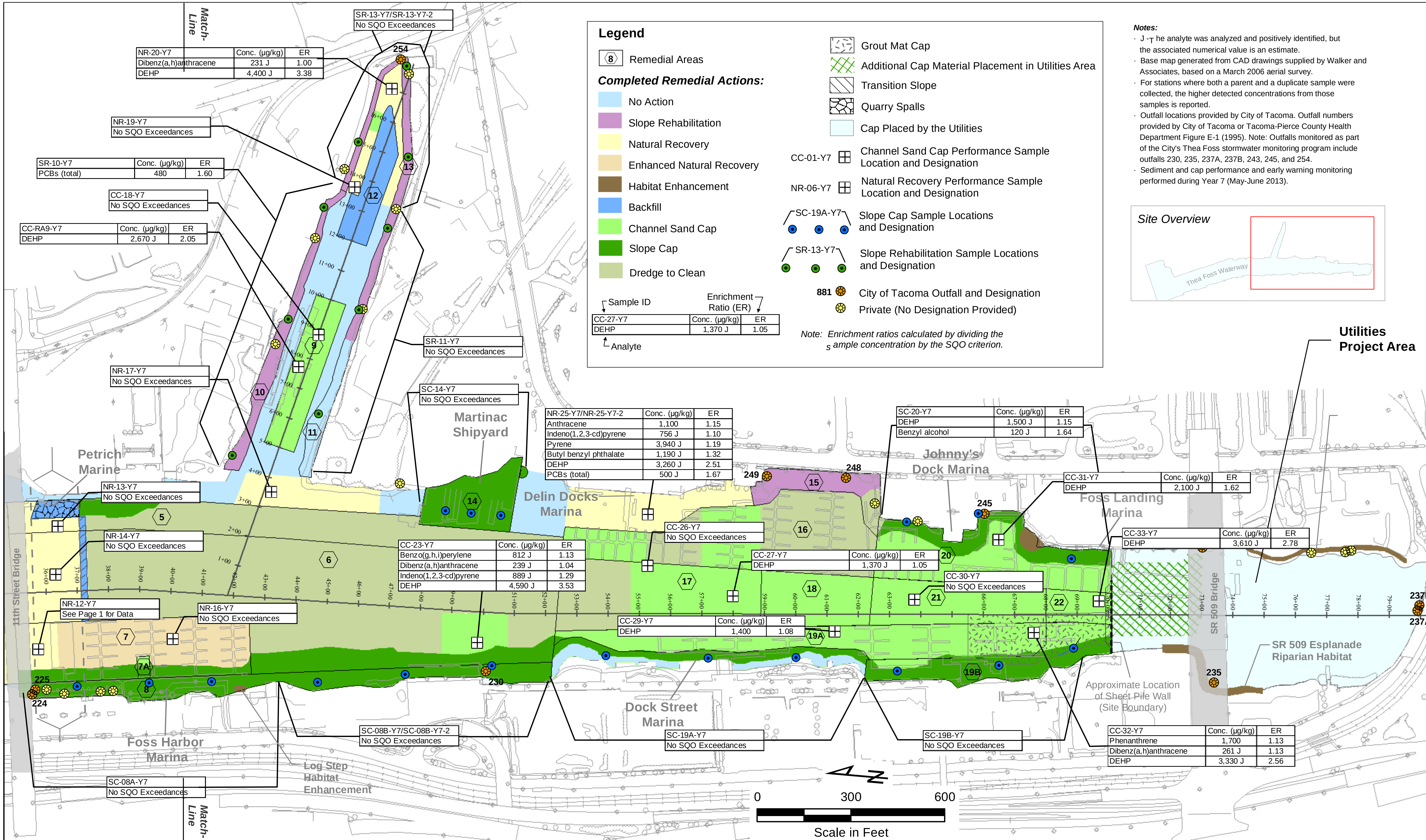
Thea Foss and Wheeler-Osgood Waterways OMMP

Figure 2-4 (Page 1 of 2) Year 7 SQO Exceedances in Performance Monitoring Surface Samples (0-10 cm)

File: I:\GIS\Projects\COT_ON_CALL\MXD\2013 Yr 7 Sediment Monitoring Inspection and Reporting\Figure 2 (Year 7 SQO Exceed in Perf Mon Samp (0-10 cm) Frame 1.mxd
Date: 9/10/2013



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Thea Foss and Wheeler-Osgood Waterways OMMP

Figure 2-4 (Page 2 of 2) Year 7 SQO Exceedances in Performance Monitoring Surface Samples (0-10 cm)

File: I:\GIS\Projects\COT_ON_CALL\MXD\2013 Yr 7 Sediment Monitoring Inspection and Reporting\Figure 2 (Year 7 SQO Exceed in Perf Mon Samp (0-10 cm) Frame 2.mxd
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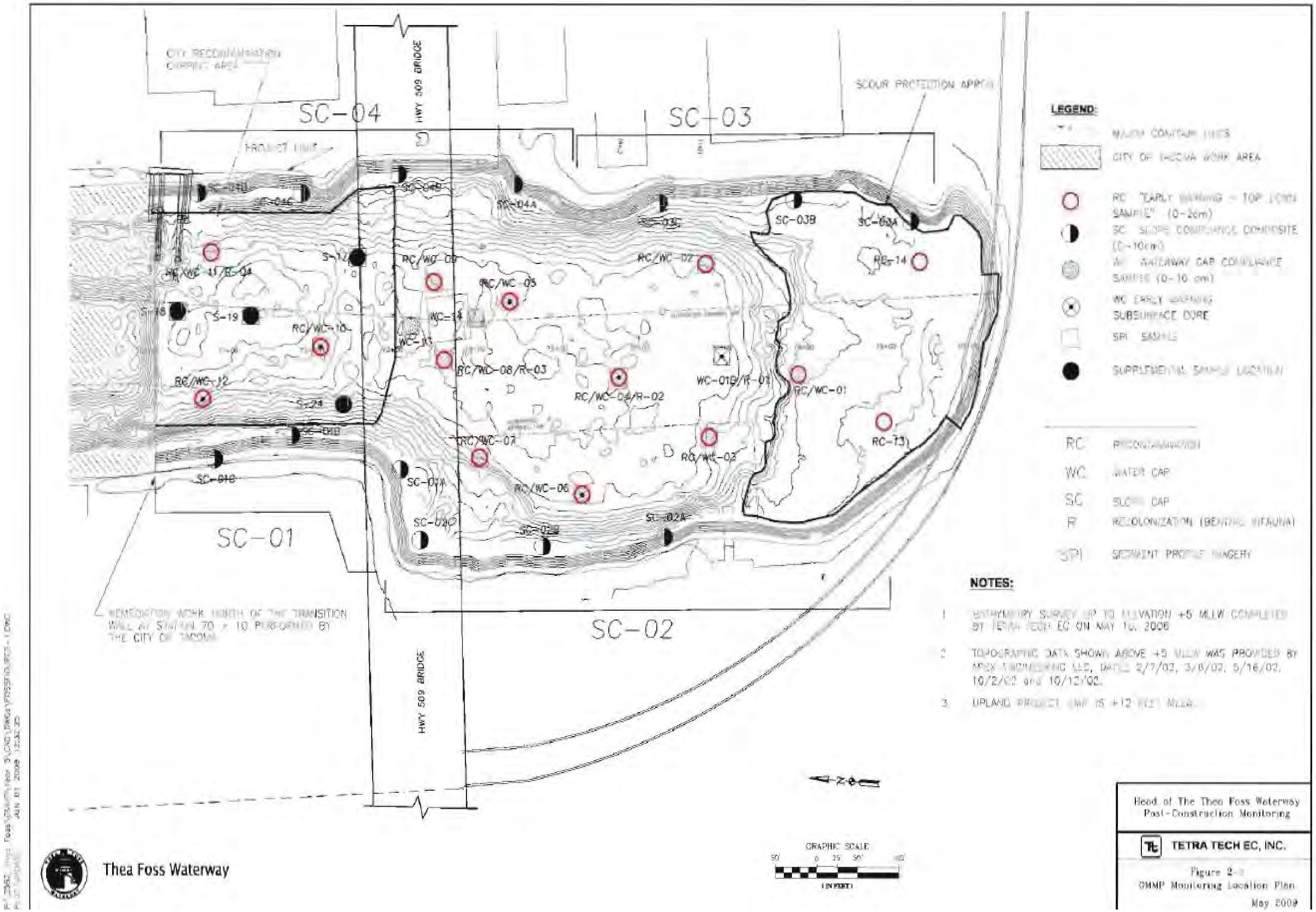


Utilities OMMP Monitoring Locations

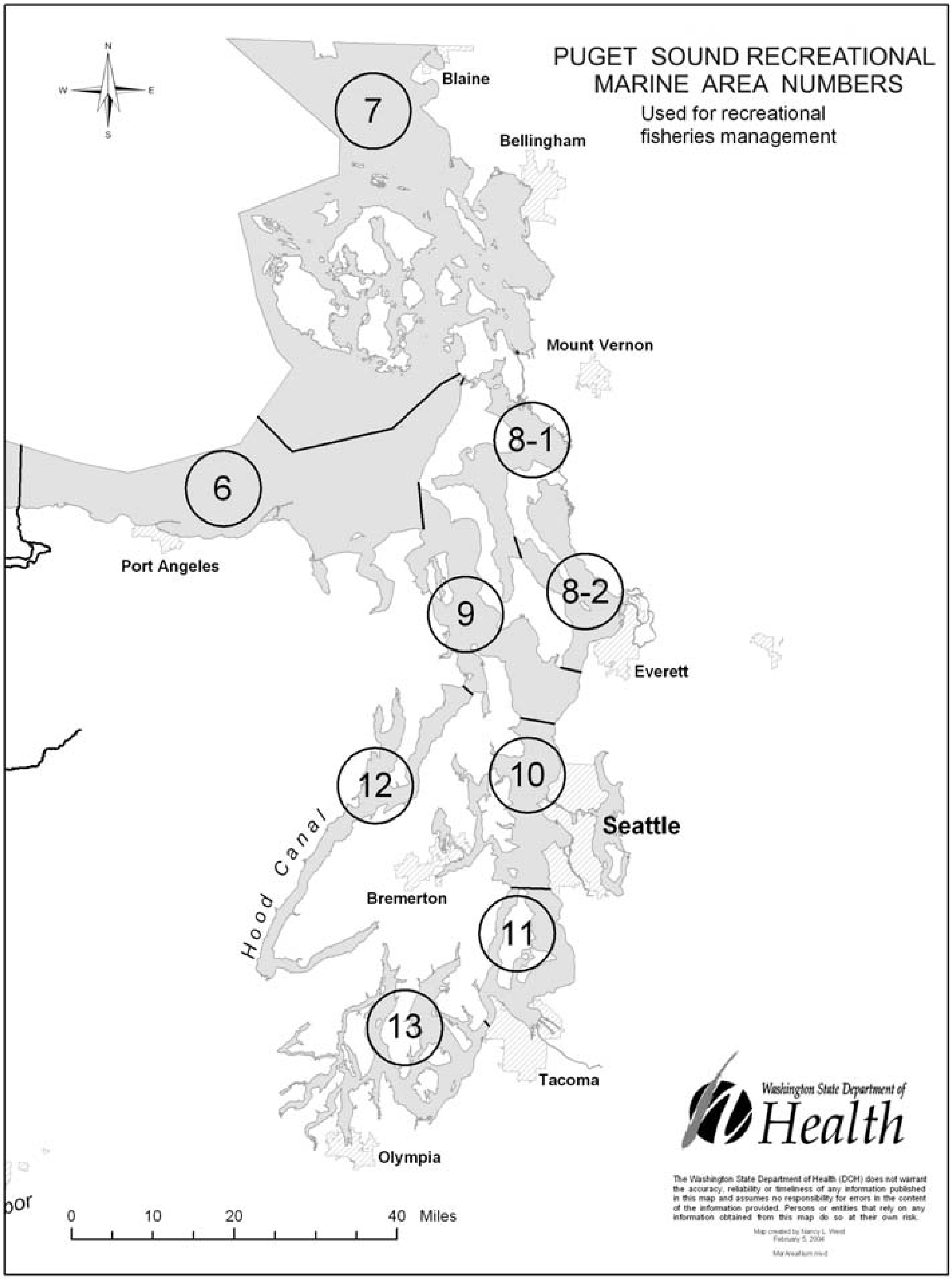
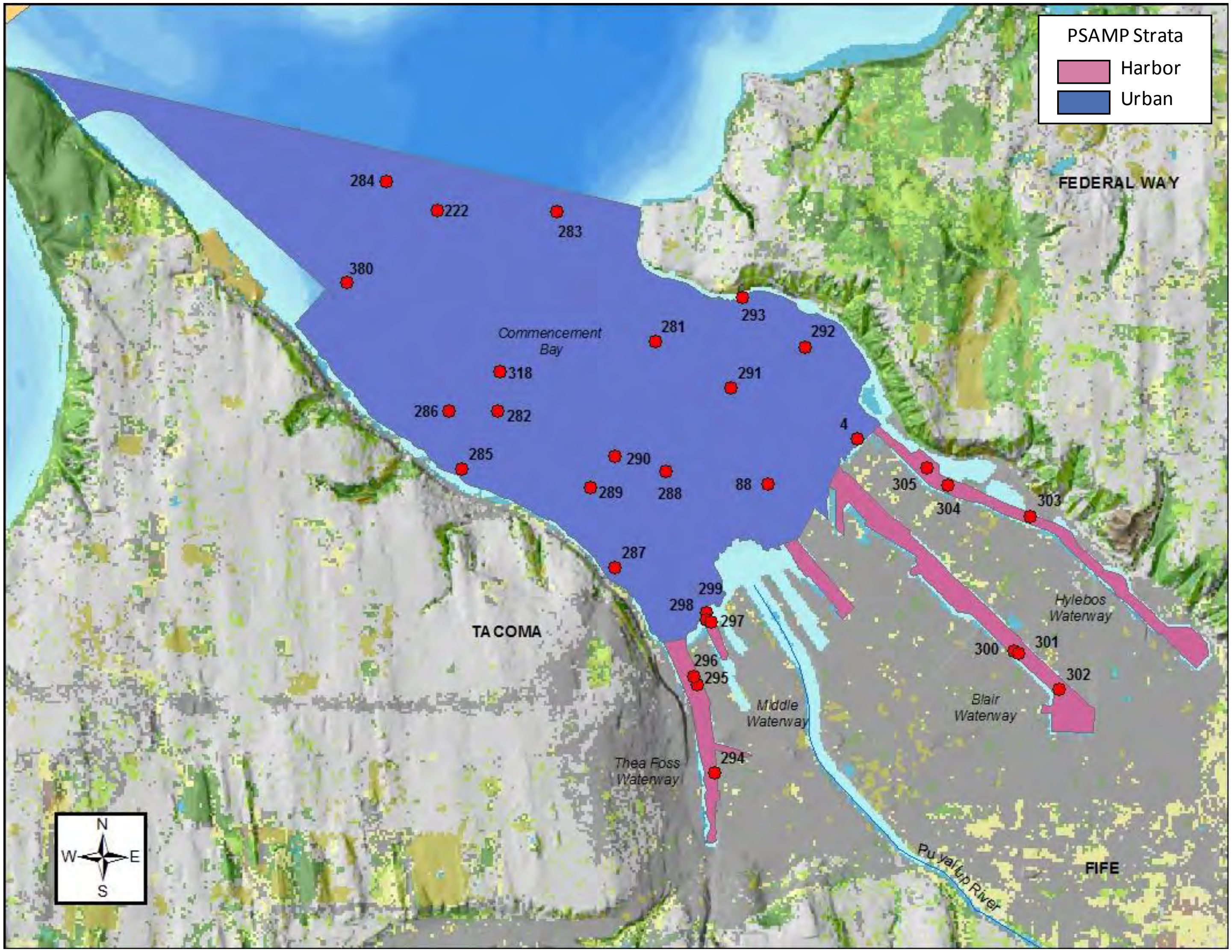


Figure 4-20. Puget Sound Recreational Marine Areas (Source: DOH 2006)

Note: Commencement Bay occurs within Recreational Marine Area 11 (Tacoma-Vashon Area).



Outer Bay
222
283
284
380
Central Bay
281
282
318
Southeast Bay
288
289
290
South Shoreline
285
286
287
East Bay
88
Northeast Bay
4
291
292
293
Thea Foss Waterway
294
295
296
Middle Waterway
297
298
299
Blair Waterway
300
301
302
Hylebos Waterway
303
304
305

Figure 4. Station locations for the 2008 Urban Waters Initiative sediment study.
Stations 4, 88, 222, 318, and 380 were sampled in 2008 only; all of the other stations were sampled in both 2008 (UWI) and 1999 (PSAMP/NOAA).

Figure 5-1. Map of Asarco Area Sites (not including Ruston / North Tacoma Study Area).

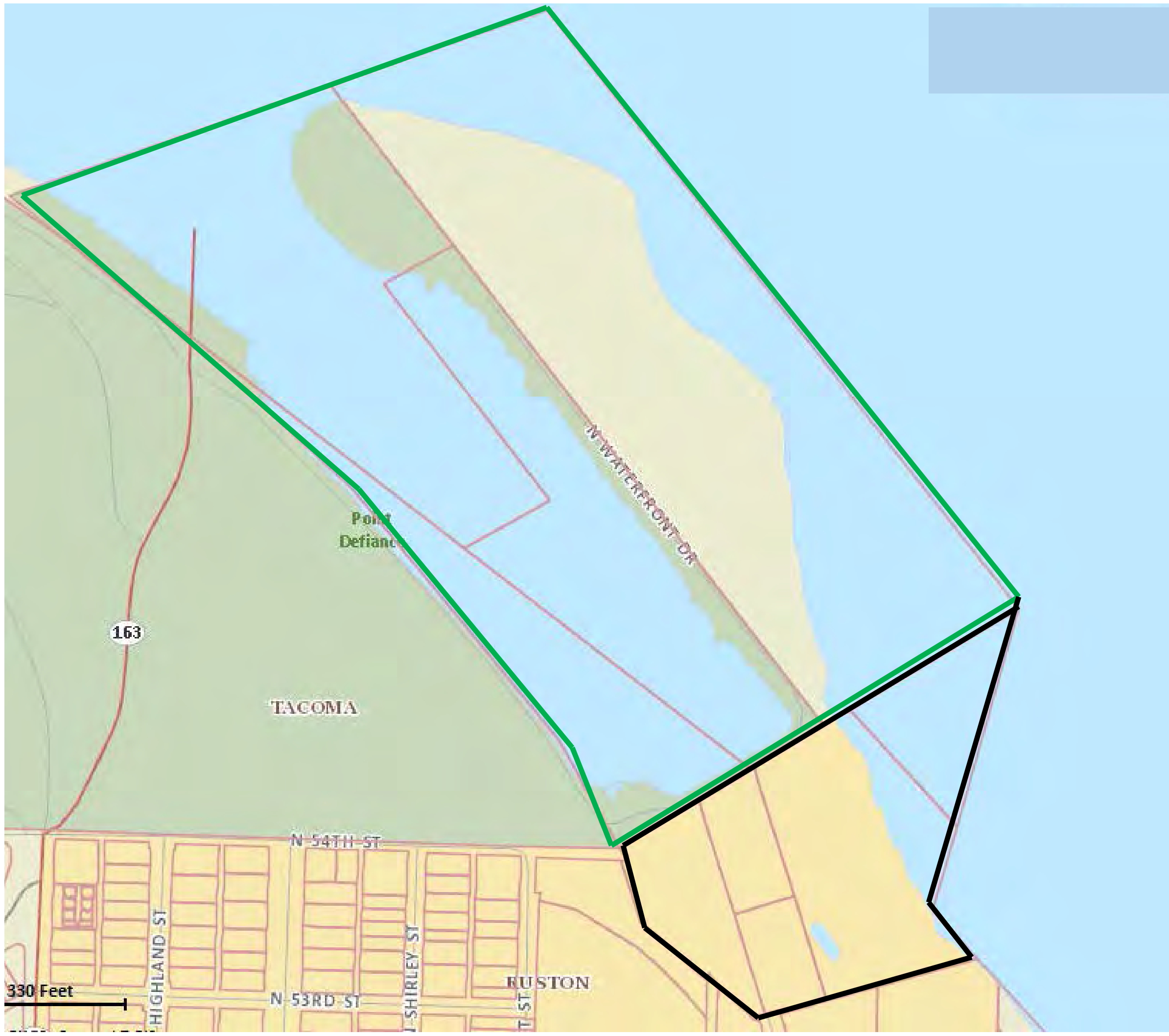


Figure 5-2. Taxpayer Parcel Map (Source: Pierce County 2014)

Notes:

a. The taxpayer for the parcels within the green lines is the Metropolitan Park District
b. The taxpayer for the parcels (shown) within the black lines is Point Ruston LLC.

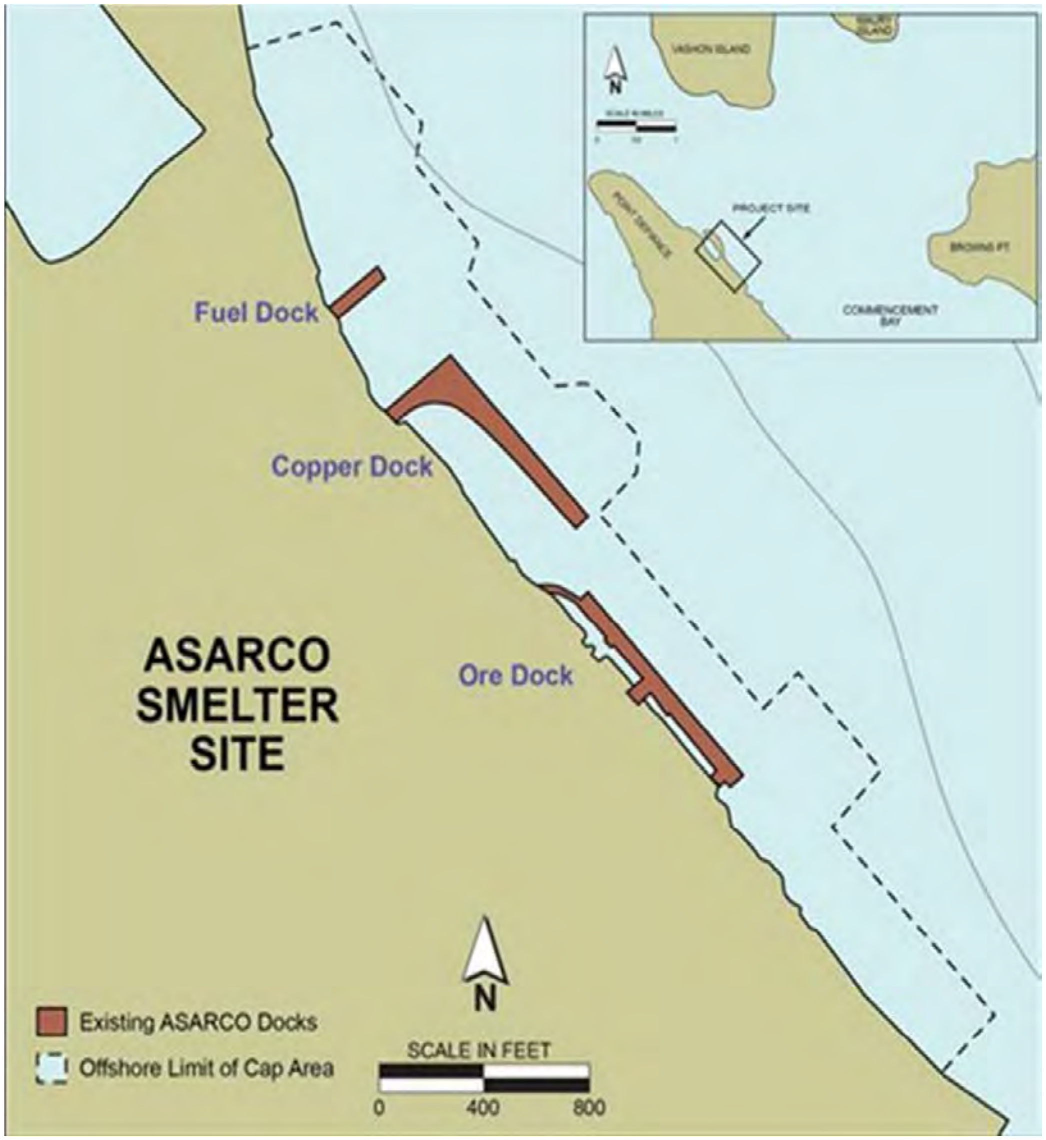
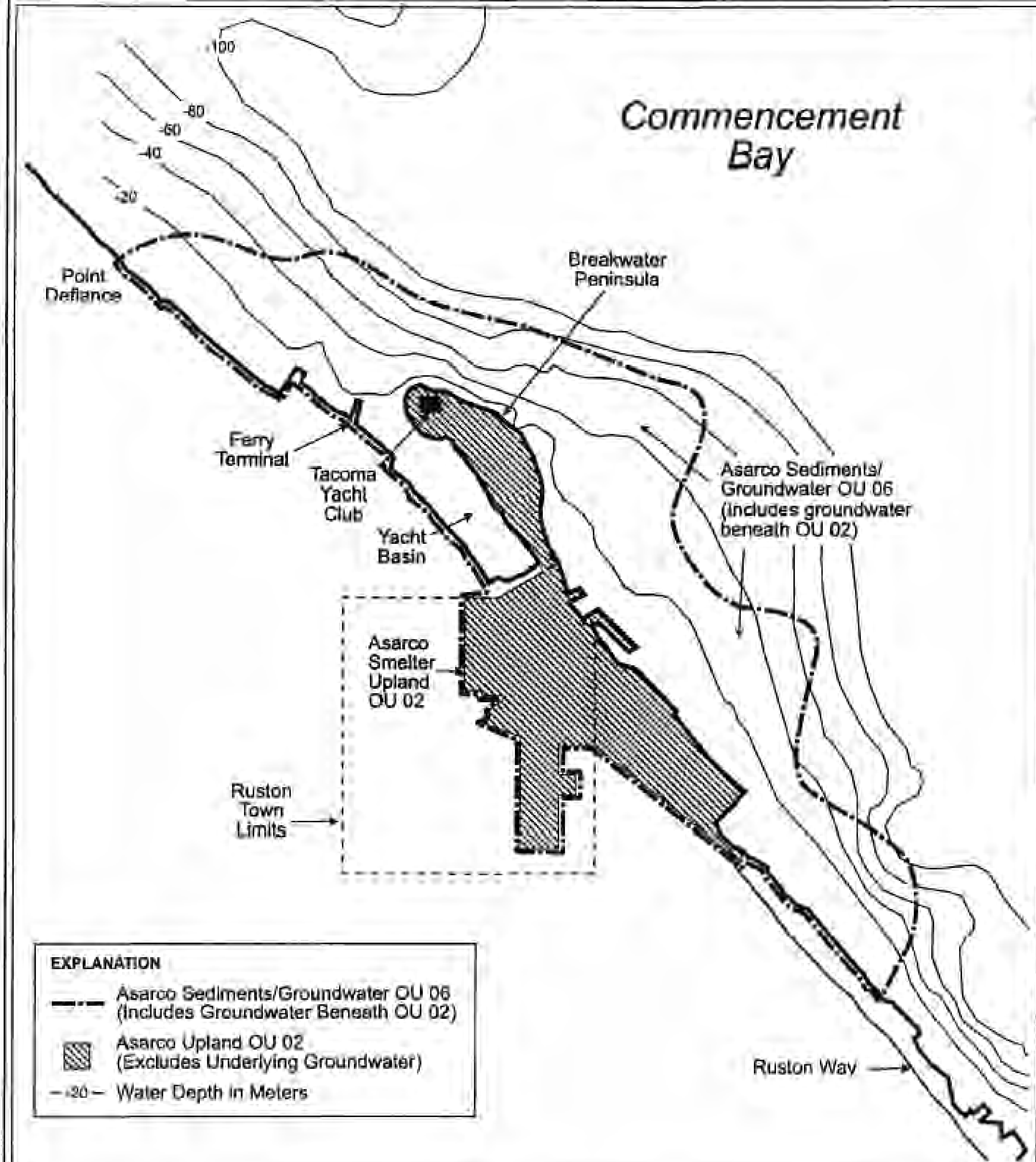


Figure 5-3. Locations of Former Asarco Docks in Commencement Bay (Source: Parametrix 2011).

Figure 5-2. Rushton/North Tacoma Study Area (Source: MRC Construction, 2008)



0 0.2 0.4
Scale in Kilometers

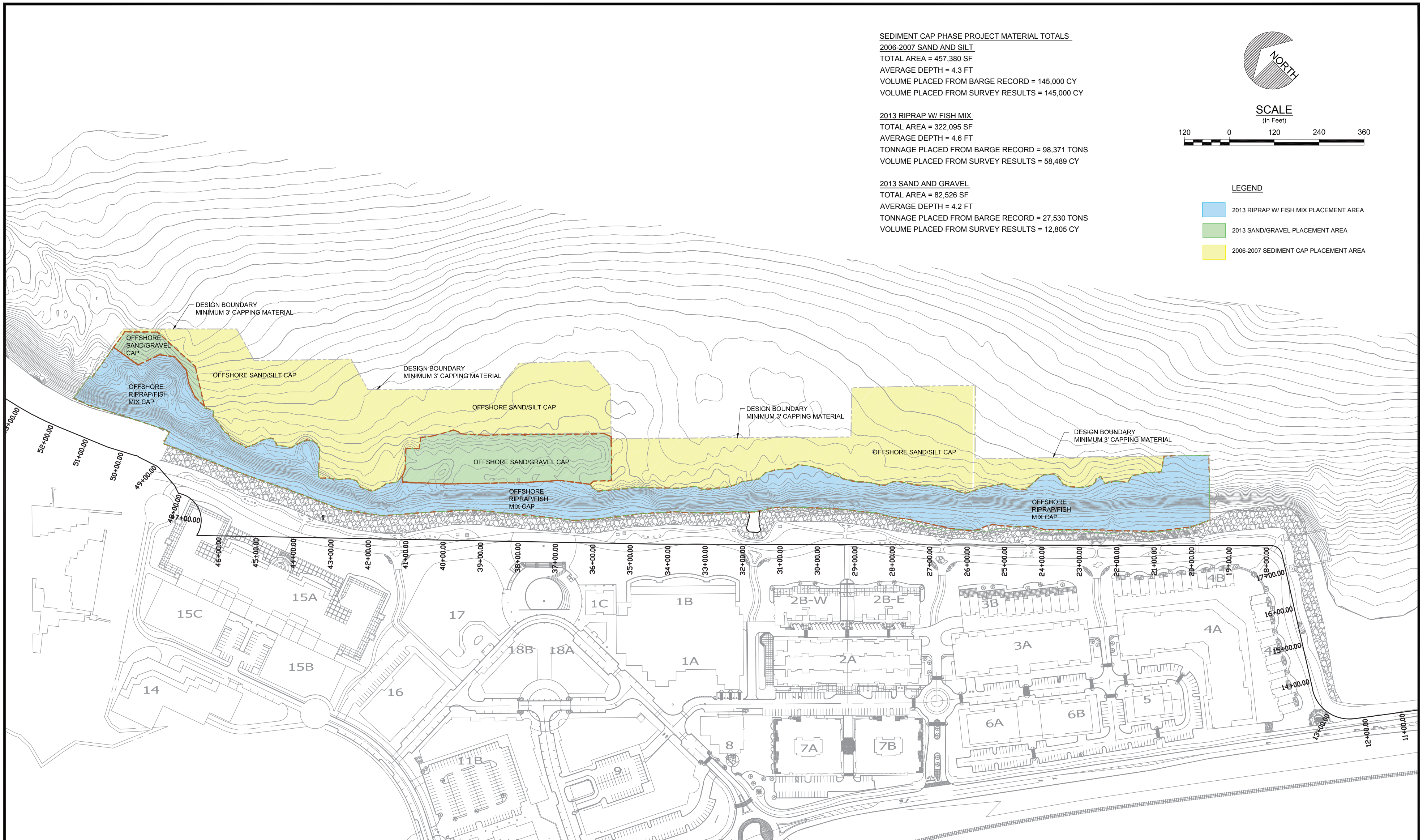
Figure 1-2
Operable Unit 06 Site Boundary
Asarco Sediments/Groundwater OU 06 ROD

Figure 5-6. Map of Slag Peninsula Showing Areas Where Work is Planned (Source: CH2M Hill 2013b)

Note: The area of breakwater failure will be repaired. Shoreline to be armored by EPA is shown by the yellow-dashed line; the segment between the red arrows is not required by the ROD and may be done by Metro Parks. Area to be capped by EPA in 2015 is shown by the yellow area with the orange border.

Figure 5-7. Approximate Location of Shallow Yacht Basin Sediments for Excavation

Area between red arrows is not covered under the ROD and may be armored by metro parks.



POINT RUSTON, LLC
FINAL CONSTRUCTION REPORT
SEDIMENT CAP PHASE

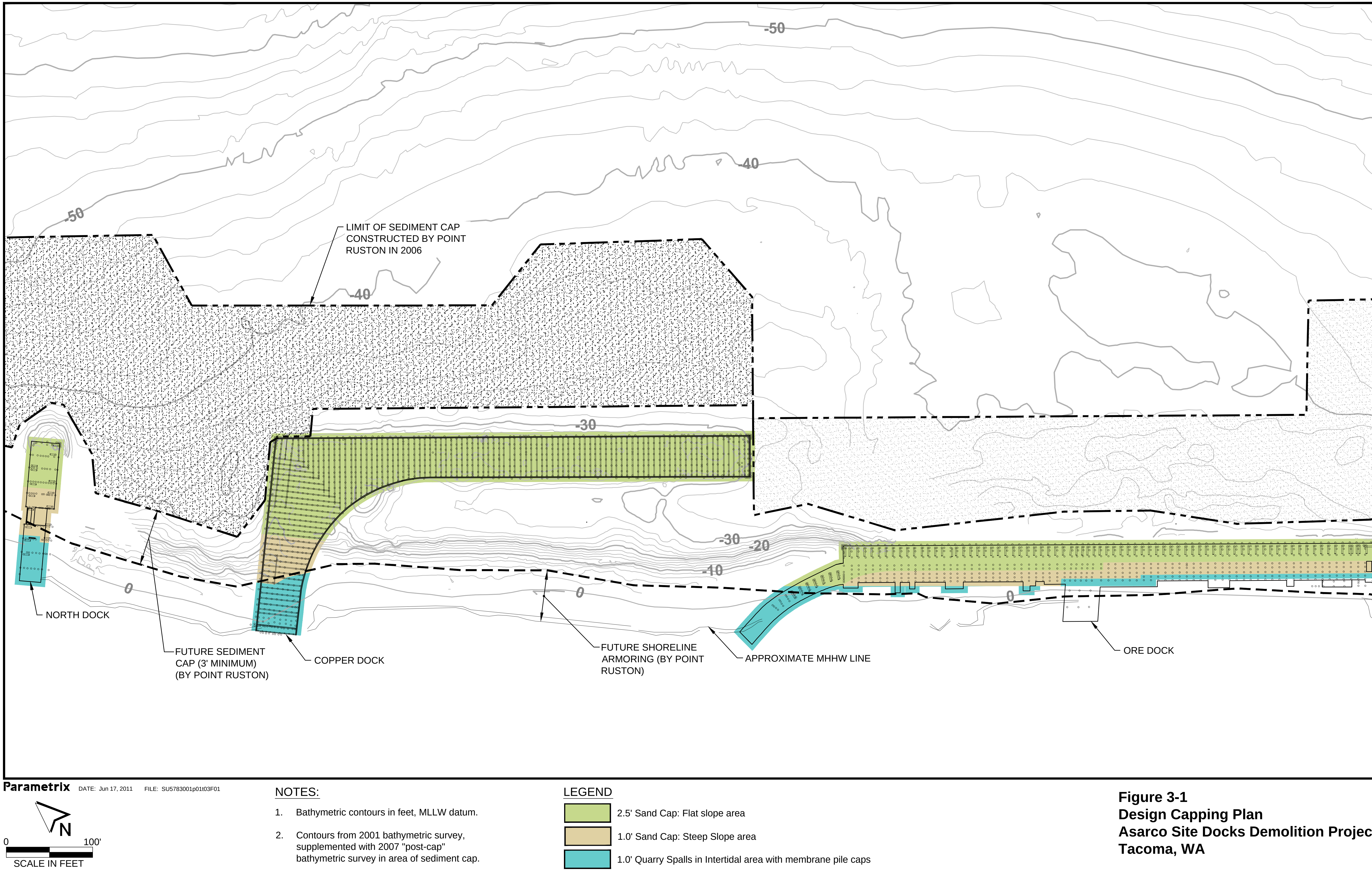
SEDIMENT CAP PHASE
PROJECT OVERVIEW

FIGURE
1-1

UPDATE TIME: 12:12 PM
GLORENSON\HEL\20130325\I:\LAND PROJECTS\1100107\DWG\1100107H009.DWG

Hydrometrics, Inc.
Consulting Scientists and Engineers

PT. DEFIANCE PARK ZOO & AQUARIUM
TACOMA YACHT CLUB
COMMENCEMENT BAY
POINT RUSTON
HISTORIC FERRY
TACOMA
RUSTON
WATER/BEACH ACCESS
AMPHITHEATER PLAZA
PLAY STRUCTURE
GRAND PLAZA
COPPERLINE CONDOMINIUMS
43 RESIDENTIAL HOMES
SILVER CLOUD
HOTEL SUITES
175 ROOMS
CONFERENCE
12,000 SQ FT
139 RESIDENTIAL HOMES
CENTURY THEATRE
9 SCREEN CINEMA
COPPERLINE APARTMENTS
173 RESIDENTIAL HOMES
15A
15B
15C
14B
17
16
1A
1B
1C
18A
18B
2A
2B
3B
4A
4B
5
6A
6B
7A
7B
8
9
11A
11B
10A
10B
10C
12
PT. DEFIANCE PARK INTERIM TRAIL
YACHT CLUB RD.
RUSTON WAY
DOWNTOWN TACOMA
RUSTON WAY WATERFRONT & RESTAURANTS
NEIGHBORHOOD GROCER
AT POINT RUSTON
STACK HILL
POINT RUSTON
51 ST.
BALTIMORE ST.
49 ST.
N
POINTRUSTON.COM



Parametrix DATE: Jun 17, 2011 FILE: SU5783001p01t03F01

NOTES:

1. Bathymetric contours in feet, MLLW datum.
2. Contours from 2001 bathymetric survey, supplemented with 2007 "post-cap" bathymetric survey in area of sediment cap.

LEGEND

- 2.5' Sand Cap: Flat slope area
- 1.0' Sand Cap: Steep Slope area
- 1.0' Quarry Spalls in Intertidal area with membrane pile caps

Figure 3-1
Design Capping Plan
Asarco Site Docks Demolition Project
Tacoma, WA

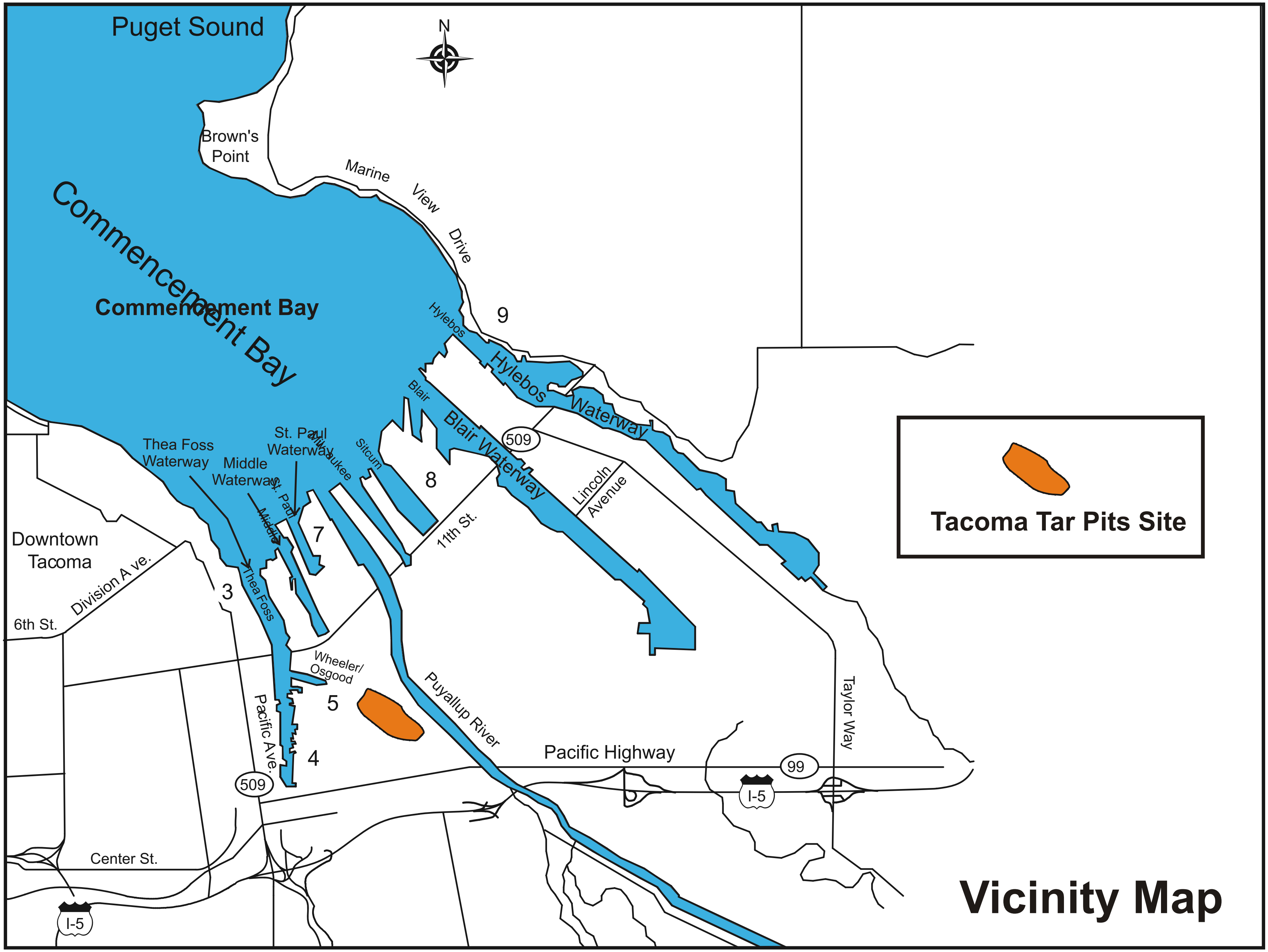


Figure 6-1. Tacoma Tar Pits Site Vicinity Map (Source: Dalton, Olmsted & Fuglevand, 2009d)

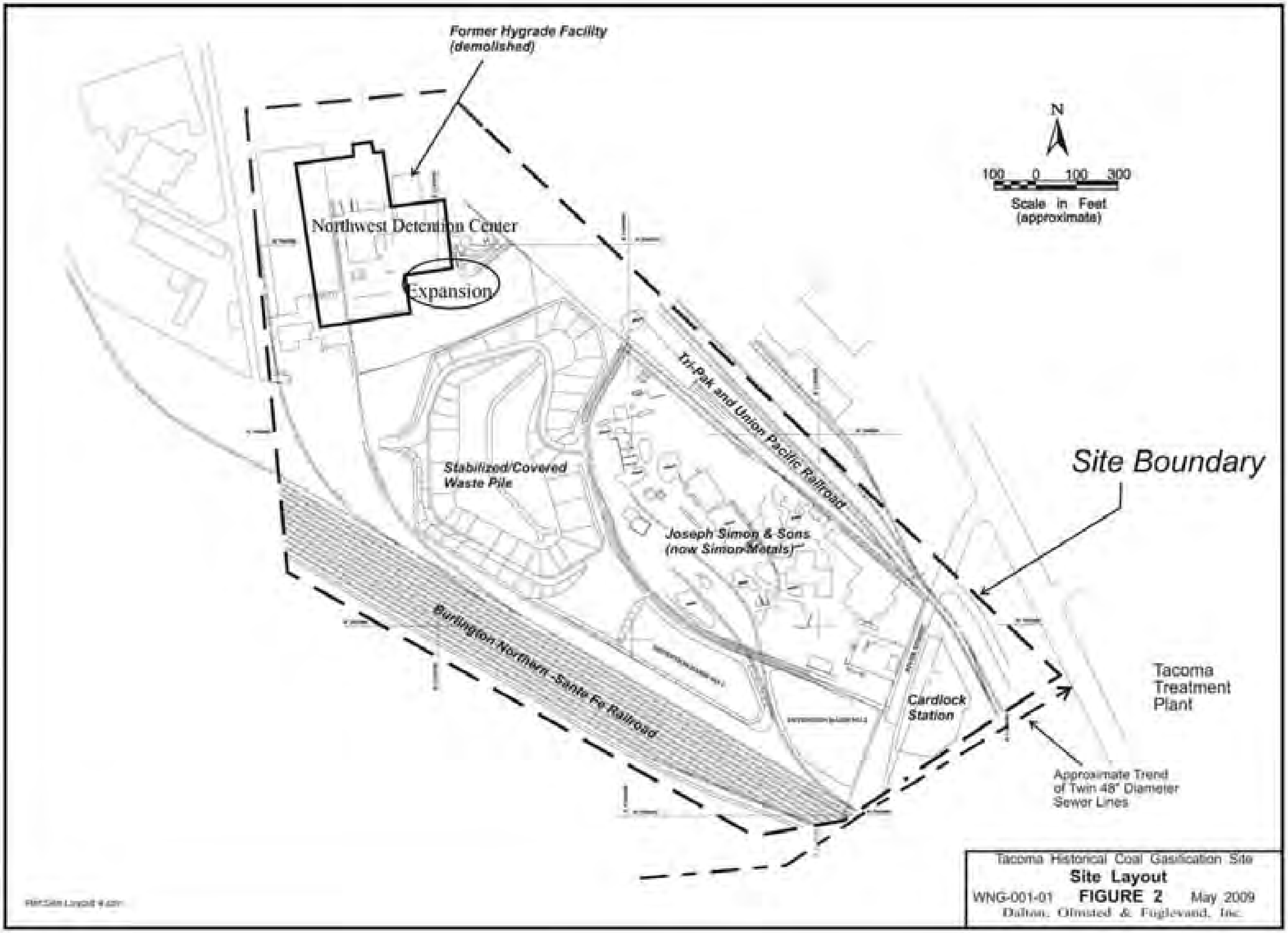
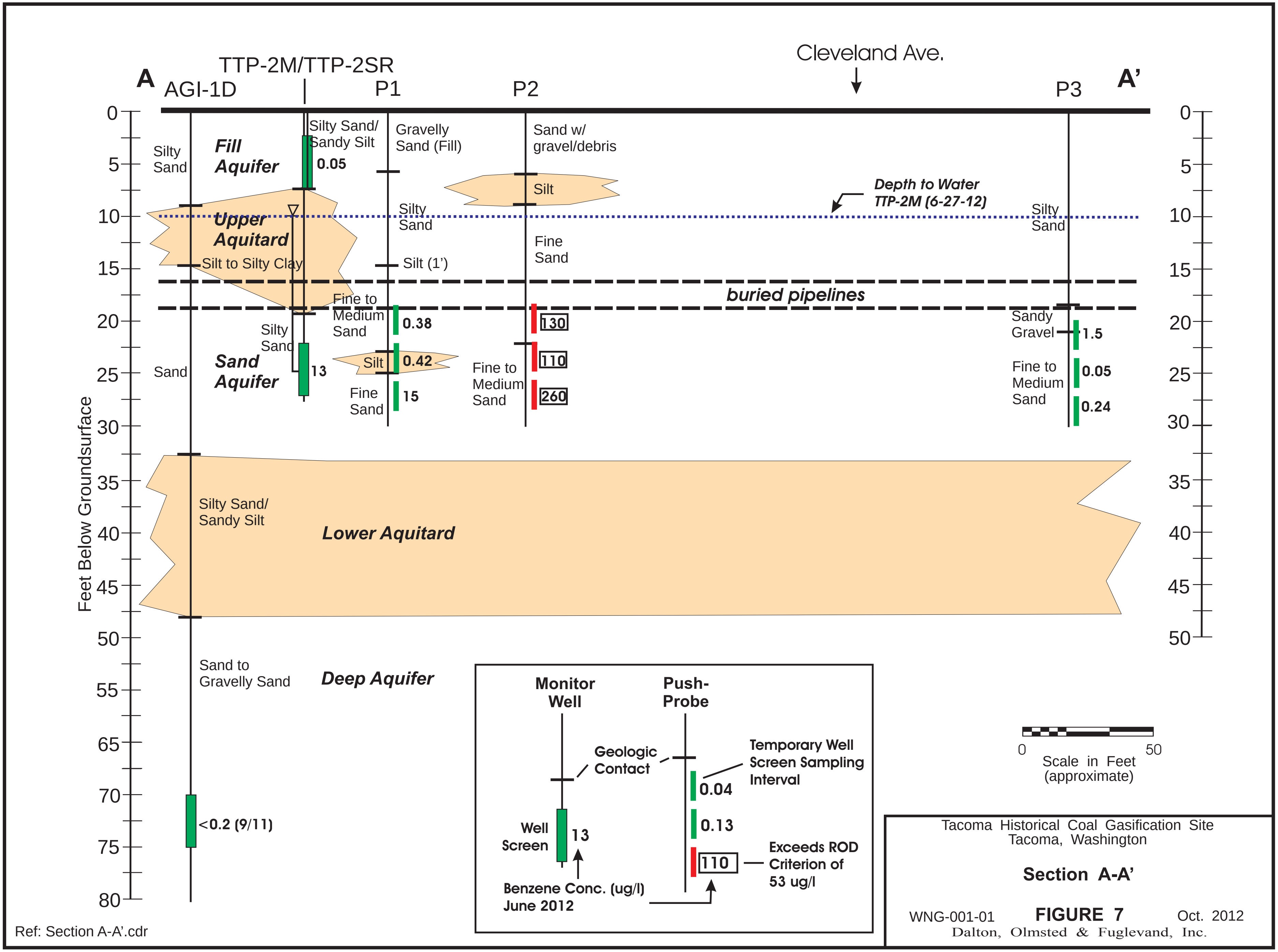
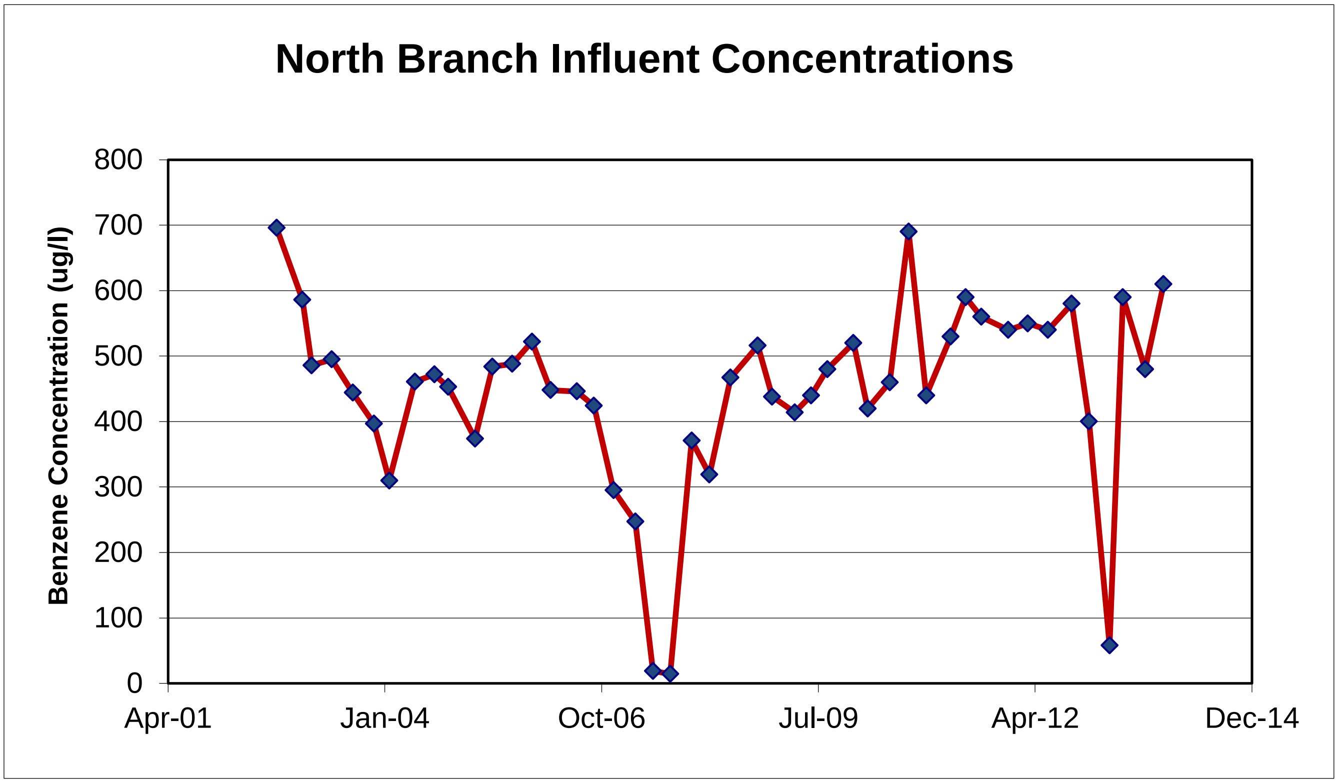


Figure 6-2. Tacoma Tar Pits Site Features (Source: Dalton, Olmsted & Fuglevand, 2009c)

Figure 6-3. Photo of 2013 Asphalt Crack Repair in Detention Basin (Source: DOF 2014c)


A
A'
AGI-1D
TTP-2M/TTP-2SR
P1
P2
Cleveland Ave.
P3
Feet Below Groundsurface
0
5
10
15
20
25
30
35
40
45
50
55
65
70
75
80
Silty Sand
Fill Aquifer
Silty Sand/ Sandy Silt
0.05
Gravelly Sand (Fill)
Sand w/ gravel/debris
Silt
Depth to Water TTP-2M (6-27-12)
Upper Aquitard
Silty Sand
Silty Sand
Fine Sand
Silt to Silty Clay
Silt (1')
buried pipelines
Fine to Medium Sand
0.38
130
Sandy Gravel
1.5
Silty Sand
Sand
Sand Aquifer
13
Silt
0.42
110
Fine to Medium Sand
0.05
Fine to Medium Sand
Fine Sand
15
260
0.24
Silty Sand/ Sandy Silt
Lower Aquitard
Sand to Gravelly Sand
Deep Aquifer
<0.2 (9/11)
Monitor Well
Push-Probe
Geologic Contact
Temporary Well Screen Sampling Interval
0.04
0.13
Well Screen
13
Exceeds ROD Criterion of 53 ug/l
110
Benzene Conc. (ug/l) June 2012
0
50
Scale in Feet (approximate)
Tacoma Historical Coal Gasification Site
Tacoma, Washington
Section A-A'
WNG-001-01
FIGURE 7
Oct. 2012
Dalton, Olmsted & Fuglevand, Inc.
Ref: Section A-A'.cdr



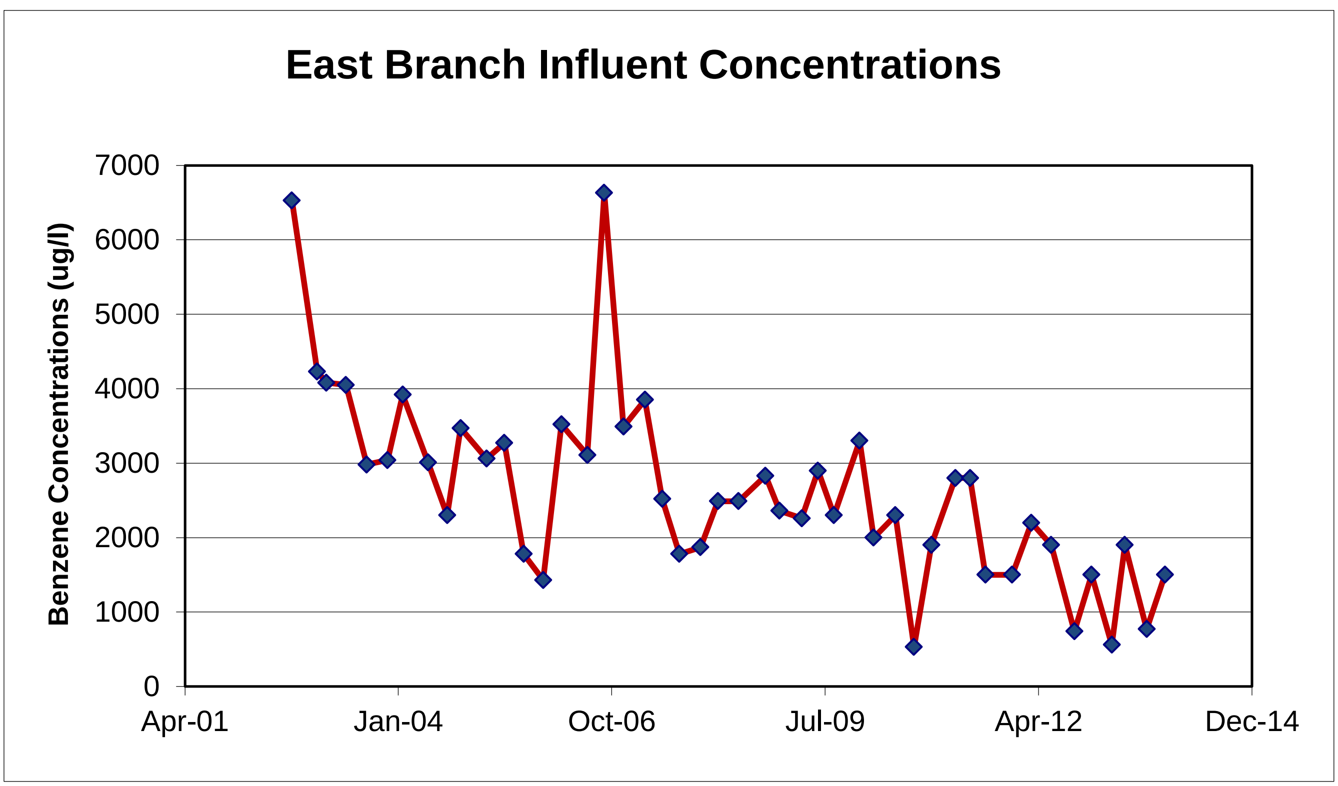
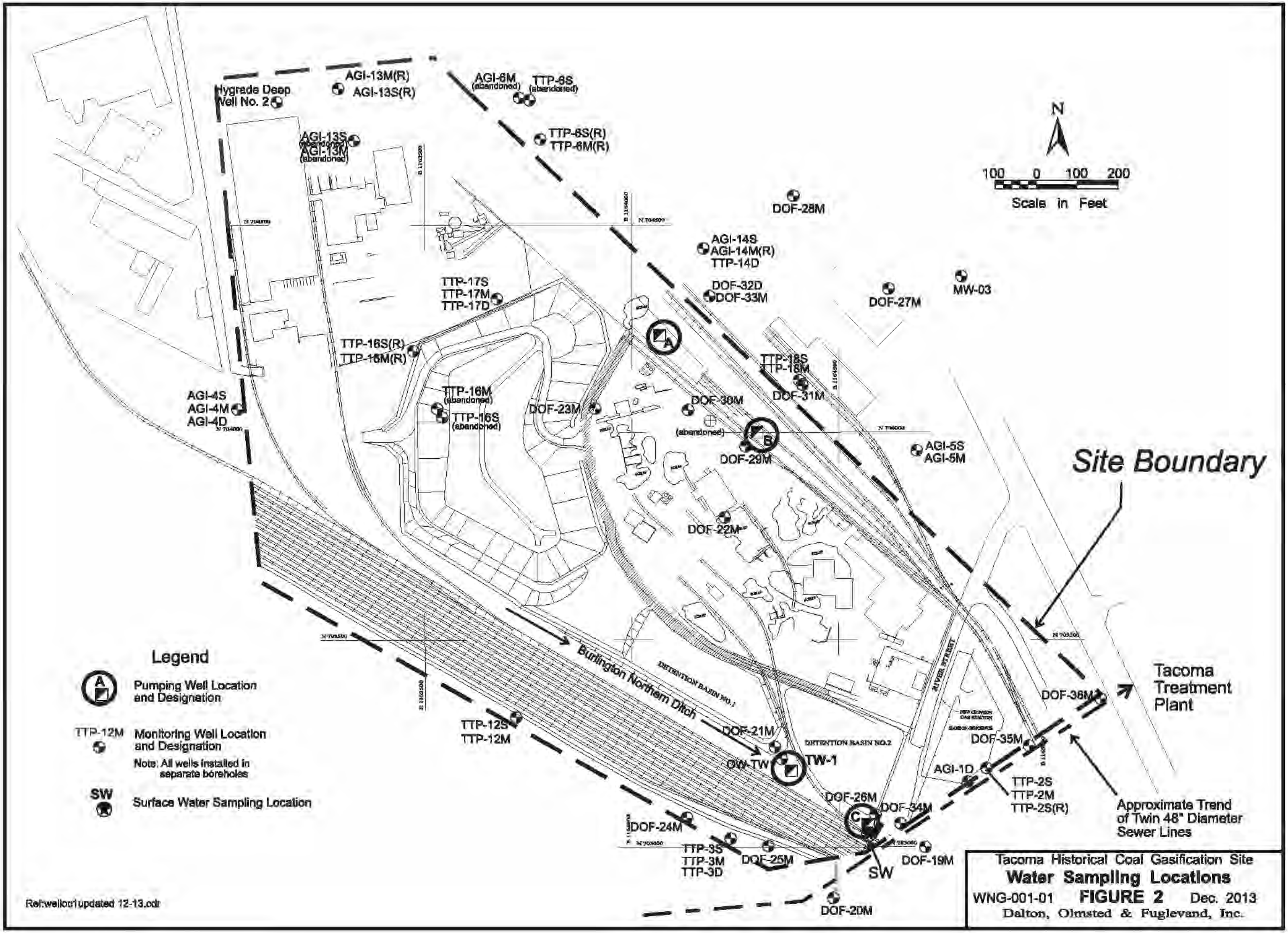


FIGURE 3
Treatment Plant Influent Concentrations

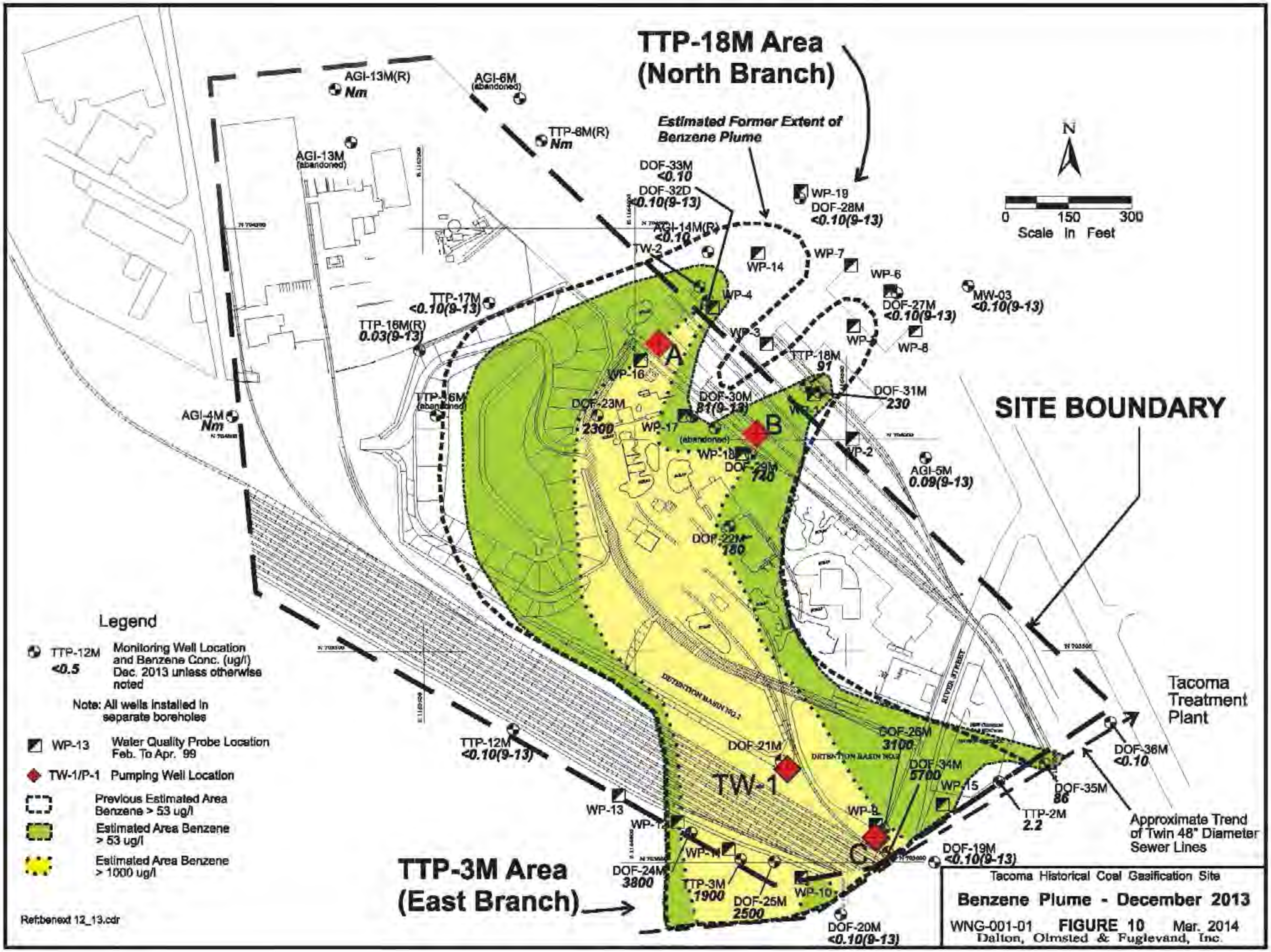


Tacoma Historical Coal Gasification Site

Water Sampling Locations

WNG-001-01 **FIGURE 2** Dec. 2013

Dalton, Olmsted & Fuglevand, Inc.

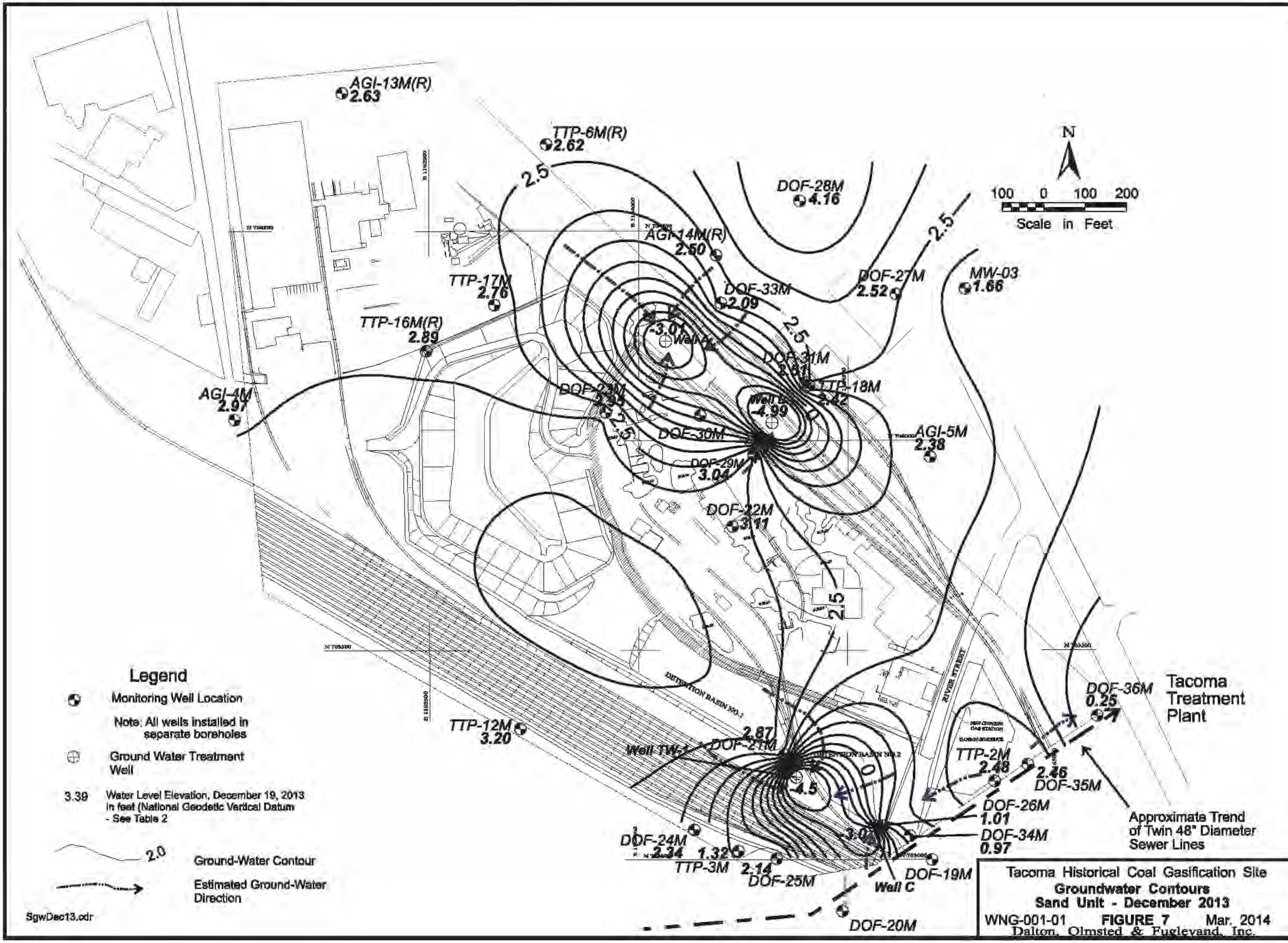


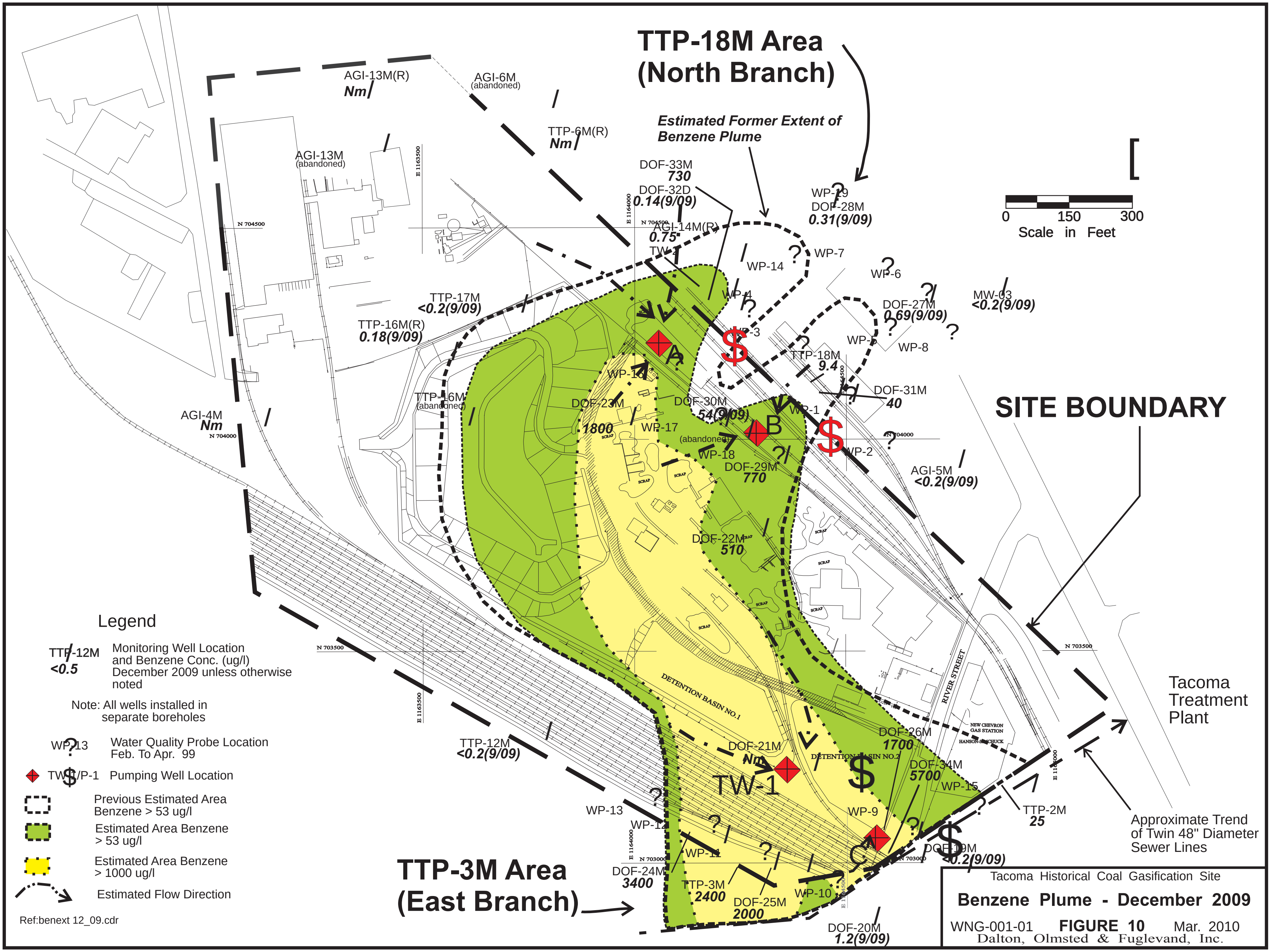
Tacoma Historical Coal Gasification Site

Benzene Plume - December 2013

WNG-001-01 **FIGURE 10** Mar. 2014

Dalton, Olmsted & Fuglevand, Inc.


AGI-13M(R) 2.63
TTP-6M(R) 2.62
DOF-28M 4.16
AGI-14M(R) 2.50
TTP-17M 2.76
TTP-16M(R) 2.89
DOF-33M 2.09
DOF-27M 2.52
MW-03 1.66
-3.01 Well A
DOF-31M 2.51
TTP-18M 2.42
Well B -4.99
AGI-4M 2.97
DOF-23M
DOF-30M
AGI-5M 2.38
DOF-29M 3.04
DOF-22M 3.11
2.5
0
RIVER STREET
DETENTION BASIN NO.1
DETENTION BASIN NO.2
TTP-12M 3.20
2.87
Well TW-1
DOF-21M
-4.5
TTP-2M 2.48
2.46 DOF-35M
DOF-26M 1.01
DOF-34M 0.97
-3.0
DOF-24M 2.34
1.32
TTP-3M
2.14 DOF-25M
DOF-19M
Well C
DOF-20M
DOF-36M 0.25
Tacoma Treatment Plant
Approximate Trend of Twin 48" Diameter Sewer Lines
N
100 0 100 200
Scale in Feet
Legend
Monitoring Well Location
Note: All wells installed in separate boreholes
Ground Water Treatment Well
3.39 Water Level Elevation, December 19, 2013 in feet (National Geodetic Vertical Datum - See Table 2
2.0 Ground-Water Contour
Estimated Ground-Water Direction
SgwDec13.cdr
Tacoma Historical Coal Gasification Site
Groundwater Contours
Sand Unit - December 2013
WNG-001-01 FIGURE 7 Mar. 2014
Dalton, Olmsted & Fuglevand, Inc.



Tacoma Historical Coal Gasification Site

Benzene Plume - December 2009

WNG-001-01 **FIGURE 10** Mar. 2010

Dalton, Olmsted & Fuglevand, Inc.

Fourth Five-Year Review Report For
Commencement Bay Nearshore/Tideflats Superfund Site
Pierce County, Washington

Summary of Attachments

OU 01 Attachments
OU 01 Attachment 1 - List of Documents Reviewed
OU 01 Attachment 2 - Historic and Current Fish and Shellfish Advisory Signs
OU 01 Attachment 3 - 1985 Fish Advisory in Commencement Bay
OU 01 Attachment 4 – Summary of PCBs and Mercury in Fish Tissue from Puget Sound
OU 01 Attachment 5 – Fish and Shellfish Data [Note: it has multiple attachments]

OU 20, 22, 19 Attachments
OU 20, 22, 19 Attachment 1 – List of Documents Reviewed
OU 20, 22, 19 Attachment 2 - Site Inspection Checklist for OU 20 and OU 22

OU 3 Attachments
OU 3 Attachment 1 – List of Documents Reviewed
OU 3 Attachment 2 – 2014 Technical Memorandum on Water Quality and I&M
OU 3 Attachment 3 – Public Input on Tacoma Tar Pits Site
OU 3 Attachment 4 - Site Inspection Team Roster, Checklist, and Photographs
OU 3 Attachment 5 - ARARs Review Summary

OU 01 Attachment 1 - List of Documents Reviewed

OU 01 Attachment 1 – List of Documents Reviewed

General / Sediments OU 01, OU-Wide

The Washington State Department of Health (DOH). 2006. *Human Health Evaluation of Contaminants in Puget Sound Fish.* October 2006.

Department of Social and Health Services (DSHS). 1985. *Precautions Listed for Fishing in Certain Areas of Puget Sound [including Commencement Bay].* April 12, 1985.

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EPA. 2007. *Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia*. August 2007.

EPA. 2009. Five-Year Review Report. *Third Five-Year Review Report for Commencement Bay Nearshore/Tideflats Superfund Site, Tacoma, Washington. Prepared by the U.S. Environmental Protection Agency, Region 10.* December 23, 2009.

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McBride. 2012a. Phone communication on 10/31/12 from Dave McBride (WDOH) with Karen Keeley (EPA). Subject: DOH crab advisory for Puget Sound.

McBride. 2012b. Phone communication on 11/15/12 from Dave McBride (WDOH) with Karen Keeley (EPA). Subject: Crab tissue data for Puget Sound and state advisories.

National Marine Fisheries Service (NMFS). 2013. *Status Review of the Eastern Distinct Population Segment of Steller Sea Lion (Eumetopias jubatus).* Available at: *http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/stellersealion_eastern_statusreview.pdf*

Tuttle. 2012a. Email communication on 11/7/12 from Lindsay Tuttle (TPCHD) to Karen Keeley (EPA). Subject: 2012 Photograph of Advisory Warning Signs in Thea Foss Waterway, Commencement Bay.

Tuttle 2012b. Phone communication on 11/5/12 from Lindsay Tuttle (TPCHD) with Karen Keeley (EPA).

Tuttle 2012c. Email communication on 11/19/12 from Lindsay Tuttle (TPCHD) with Karen Keeley (EPA). Subject: Thea Foss Fish Advisories.

Hylebos Waterway

AMEC Geomatrix. 2010. *CERCLA Mitigation Requirements Evaluation Taylor Way Properties Tacoma, Washington*.

AMEC Geomatrix. 2012. Memo – *SMA 421B Proposed Mitigation*.

Anchor QEA, LLC. 2012. *Draft Final Operations, Monitoring, and Maintenance Plan Mouth of Hylebos Waterway (Segments 3,4, and 5) Tacoma, Washington*.

Conestoga-Rovers & Associates (CRA). 2010a. *Draft Production Well Investigation Report Groundwater and Sediment Remediation*.

CRA. 2010b. *Work Plan Additional Production Well Investigation – Existing Well Geochemistry Evaluation Groundwater and Sediment Remediation*.

CRA. 2011. *Draft Data Gap Evaluation for Site Characterization Groundwater and Sediment Remediation*.

CRA. 2013a. *Draft Evaluation of Remedial Technologies Groundwater and Sediment Remediation*.

CRA. 2013b. *Remedial Action Construction Report (RACR) Segment 3 / 4 Dredging and Disposal and Slip 1 Nearshore Confined Disposal (NCD) Facility Mouth of Hylebos Waterway Consent Decree.*

CRA. 2014a. *Draft Conceptual Site Model Report Groundwater and Sediment Remediation*.

CRA. 2014b. *Remedial Action Construction Report – Segment 5 and Slip 1 Mouth of Hylebos Problem Area Commencement Bay Nearshore/Tideflats Superfund Site Tacoma, Washington*.

Dalton, Olmsted & Fuglevand, Inc (DOF). 2009a. *Year 10 Cap Monitoring Report Schnitzer Steel of Tacoma Shoreline Cap Hylebos Waterway, Tacoma, Washington Administrative Order on Consent No. 10-98-0133*.

DOF. 2009b. *Soil Characterization Work Plan Wypenn Site Tacoma, Washington*.

DOF. 2009c. *Sediment Sampling and Analysis Plan Schnitzer Steel of Tacoma, Hylebos Waterway, Tacoma, Washington*.

OU 01 Attachment 1 – List of Documents Reviewed

DOF. 2010a. Memo *Sampling and Analysis Plan Addendum for Data Gaps Post Removal of Woodwaste/Slag Containment Cell 3009 Taylor Way Tacoma, Washington*.

DOF. 2010b. *Sediment Sampling and Analysis Plan. Schnitzer Steel of Tacoma. Hylebos Waterway, Tacoma, Washington*.

DOF. 2011a. *Sediment Sampling Data Report. Schnitzer Steel of Tacoma. Hylebos Waterway, Tacoma, Washington*. January 2011.

DOF. 2011b. *Summary Report. Contaminant Investigation. Former Tacoma Steam Plant Site. Tacoma, Washington*.

DOF. 2011c. *Remedial Action Construction Report. Head of Hylebos Waterway Problem Area. Commencement Bay Nearshore/Tideflats Superfund Site. Tacoma, Washington*.

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Department of Ecology. 2011. Memorandum to Mr. Babcock: *Draft "Data Gap Evaluation for Site Characterization" Submittal.*

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GeoEngineers. 2013. *Memorandum: Environmental Sampling and Analysis Plan – PSE Tacoma Future Fuels Project*.

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Grette Associates. 2010b. *Technical Memorandum: Clear Creek Phase II Invasive Vegetation Removal Monitoring*.

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Grette Associates. 2012a. *Technical Memorandum: Clear Creek Habitat Improvement Project - Phase II Contingency Plan Final Monitoring Report, 2012*.

Grette Associates. 2012b. *Slip 5 Mitigation Site Final Monitoring Report, 2011 (Year 6) RD/RA Consent Decree. Mouth of Hylebos Waterway Problem Area. Commencement Bay Nearshore/Tideflats Superfund Site*.

OU 01 Attachment 1 – List of Documents Reviewed

HartCrowser. 2011. *Memorandum: October 4, 2010 Environmental Cap Inspection Summary. Piers 24 and 25 Embankment Remediation Project. Mouth of the Hylebos Waterway Problem Area, Tacoma, Washington.*

HartCrowser. 2013. *Final Remedial Action Construction Report. Piers 24 and 25 Embankment Remediation Project E1934. Mouth of the Hylebos Waterway Problem Area, Tacoma, Washington*.

HartCrowser. 2014a. *Operations, Maintenance, and Monitoring Plan. Piers 24 and 25 Embankment Remediation Project E1934. Mouth of the Hylebos Waterway Problem Area, Tacoma, Washington*.

HartCrowser. 2014b. *Institutional Control Plan Piers 24 and 25 Embankment Remediation Project E1934 Mouth of Hylebos Waterway Problem Area, Tacoma, Washington*.

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Occidental Chemical Corporation. 2011. *Memo – Performance Evaluation Report and Groundwater Migration Control Proposal*.

Pacific International Engineering. 2000. *Exhibit E Clear Creek Habitat Improvement Project – Phase II.*

Port of Tacoma. 2011. *Outer Hylebos Mitigation Site Contingency Plan Puyallup Land Transfer Consent Decree.*

U.S. Army Corps of Engineers. 2014. *Hylebos Mitigation Site Evaluation – Year 1 – Final Report.*

<u>Sitcum Waterway</u>

Hart Crowser. 2013. *Data Report, Third Round of Stage 1, Groundwater Quality Monitoring, Sitcum Waterway Remediation Project, Port of Tacoma, Washington.* Prepared for Port of Tacoma. June 12, 2013.

Port of Tacoma. 1994. *Operations, Maintenance, and Monitoring Plan, Sitcum Waterway Remediation Projec*t. June 3, 1994.

Port of Tacoma. 2008. *Letter to EPA re: Sitcum Waterway Consent Decree (C93-5462), Groundwater Quality Monitoring Report, Stage 1, Second Round (2008).* June 2, 2008.

<u>Middle Waterway</u>

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OU 01 Attachment 1 – List of Documents Reviewed

Anchor QEA. 2011. Final Year 5 Monitoring Report: Middle Waterway Problem Area- Areas A and B Commencement Bay Nearshore/ Tideflats Superfund Site. June 30, 2011.

Anchor QEA. 2013a. *Final Additional Response Action Completion Report.* May 2013.

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Hart Crowser. 2010. *Year 5(2009) Monitoring Report. Middle Waterway Problem Area C. Sediment Management Units 51a and 51b. Commencement Bay Nearshore/Tideflats Superfund Site*. February 5, 2010.

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Hart Crowser. 2013a. *Technical Memorandum: Supplemental Work in Middle Waterway Area C*. June 28, 2013.

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Thea Foss / Wheeler-Osgood

City of Tacoma. 2010. *Thea Foss and Wheeler-Osgood Waterways Remediation Project. Year 4 Monitoring - Annual Operations, Maintenance, and Monitoring Report.* December 15, 2010.

City of Tacoma. 2011. *Thea Foss and Wheeler-Osgood Waterways Remediation Project. Year 5 Monitoring Annual Operations, Maintenance, and Monitoring Report*. October 12, 2011.

City of Tacoma. 2012. *Memorandum. OMMP Revisions Based on Years 5 and 6 Monitoring*.

City of Tacoma. 2013. *Thea Foss and Wheeler-Osgood Waterways Remediation Project. Year 7 Monitoring Annual Operations, Maintenance, and Monitoring Report*. November 15, 2013.

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Floyd | Snider. February 2014. *Memo: Murray Morgan Bridge Rehabilitation: Verification Sediment Sampling Results*.

OU 01 Attachment 1 – List of Documents Reviewed

PacificCorp. 2014. *Head of Thea Foss Waterway Remedial Design/Remedial Action Progress Report No. 82, October 1, 2013 through December 31, 2013*.

Tetra Tech EC, Inc. 2009. *Results of Year 5 Operations, Maintenance, and Monitoring Plan Sampling Head of the Thea Foss Waterway Remediation Project*.

Tetra Tech EC, Inc. 2010. *Results of Year 6 Operations, Maintenance, and Monitoring Plan Site Activities Head of the Thea Foss Waterway Remediation Project*.

Thea Foss / Wheeler-Osgood, continued

Tetra Tech EC, Inc. 2011. *Results of Year 7 Operations, Maintenance, and Monitoring Plan Sampling Head of the Thea Foss Waterway Remediation Project*.

Tetra Tech EC, Inc. 2013. *Results of Year 9 Operations, Maintenance, and Monitoring Plan Site Activities Head of the Thea Foss Waterway Remediation Project*.

OU 01 Attachment 2 - Historic and Current Fish and Shellfish Advisory Signs

Historic and Current Fish and Shellfish Advisory Signs in CB/NT

Ray Hanowell - Commencement Bay Waterways Fish Advisory

From: Ray Hanowell
To: Carr, Liz
Subject: Commencement Bay Waterways Fish Advisory
CC: Dibiase, Frank; Tuttle, Lindsay

Liz,

Our advisory to not eat fish and shellfish from the waterways of Commencement Bay is based upon the EPA study, Assessment of Human Health Risk from Ingesting Fish and Crabs from Commencement Bay, EPA 910/9-85-129, April 1985. This report was prepared by Versar, Inc. for James Krull, at the Department of Ecology, under EPA Contract No. 68-03-3149. I loaned out my copy of the report a few years ago and it hasn't yet been returned.

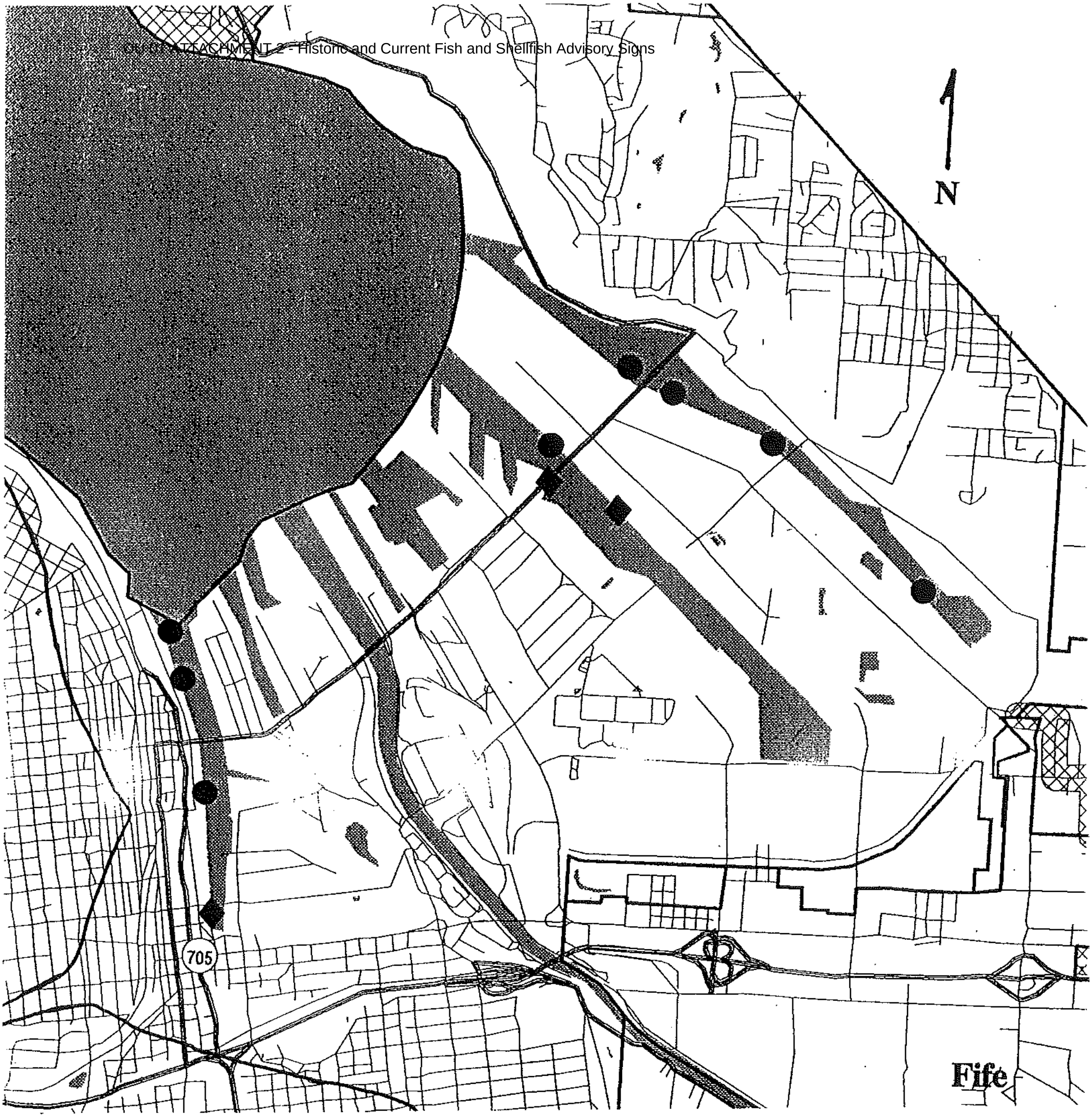
Based upon the findings of this study, we posted signs in 1985 in the City Waterway (now called the Thea Foss Waterway), the Blair Waterway, and the Hylebos Waterway. The original signs were in English only and were replaced in 1996 with signs in a number of languages.

Over the years, the Blair and Hylebos signs have disappeared and have not been replaced, since we don't think folks are fishing/shellfishing in these areas. We've maintained signs in the Thea Foss Waterway, replacing our old signs with DOH signs several years ago and with newer DOH signs fairly recently.

We check on the signs periodically and often see folks fishing near the signs, so the signs are not very effective at stopping people from fishing and shellfishing. We have talked with a number of fishermen and tried to explain that they are increasing their risk of cancer but the response has generally been, "we have never gotten sick and don't think there is a real concern."

I hope this information is helpful.

Thanks, Ray



Map of the Fish Consumption Warning Sign Locations in the Waterways of Commencement Bay, October 18, 1996.

● New multi-lingual sign

◆ Old warning sign, in english only (these signs weren't replaced because they are in good condition, difficult to get to, and/or are in industrial areas that don't have public access).

December 26, 2008
DOH file name: TPCHD Commencement Bay Waterways_FINAL_01_08_09.doc

TO: **Files**
FROM: **Joan Hardy, Dave McBride**
RE: **Use of Signs in Commencement Bay Waterways**

Background

Washington State Department of Health (DOH) conducted a human health assessment for contaminants in fish in Puget Sound (2006). This assessment was done, in part, to consider fish consumption in the context of the entire Sound rather than to consider consumption issues using a more localized approach. The goals of risk communication for fish consumption in Puget Sound were to make any consumption guidance advice clear and consistent.

In November, 2008, Tacoma-Pierce County Health Department (TPCHD) requested that DOH review consumption advice for the Commencement Bay Waterways, which include the Thea Foss Waterway, the Blair Waterway, and the Hylebos Waterway. Fish tissue data from this area were not available for use in the 2006 health assessment. TPCHD previously had posted signs recommending that the public not eat fish or shellfish in this area.

Discussion

TPCHD based its recommendation of "no consumption of fish or shellfish" on an EPA study entitled "Assessment of Human Health Risk from Ingesting Fish and Crabs from Commencement Bay" (EPA 910/9-85-129, April 1985). Issuing such advice is not consistent with DOH protocols that recommend issuing consumption guidance only when it is based on fish and/or shellfish contaminant data. However, certain circumstances may warrant advice in the absence of data; for example, sites such as urban embayments with known or suspected contamination.

Ecology's Toxics Cleanup Program, Southwest Regional Office, was concerned that shellfish harvest from the waterway would disturb their proposed cap of sediment contaminants. They prefer using signs that state: "Do not eat crab, shellfish or bottom feeding fish due to pollution."

An additional concerned raised by Shellfish and Water Protection Office (SWPO), DOH, is harm to human health based on high coliform counts.

The SWPO previously issued a "Do not eat shellfish" advisory due to biological pollution in the Commencement Bay waterways.

Alternative DOH language to "Do not eat crab, shellfish or bottom fish is "Bottomfish, shellfish, and crab maybe unsafe to eat due to pollution." DOH considered this sign, which is our current recommendation for use in Puget Sound when data are missing. However, DOH concluded that the message "Do not eat crab, shellfish, or bottom fish" would be appropriate in this circumstance, based on:

- Ecology's concern of disturbing the sediment cap by fishing,
- Pierce County's previous use of "Do not eat shellfish, or fish" signs, and
- DOH's OSWP advisory for the area: "Do not eat shellfish due to biological pollution."

Recommendation
Signs for fish and shellfish consumption along the Commencement Bay Waterways, Pierce County, should read:

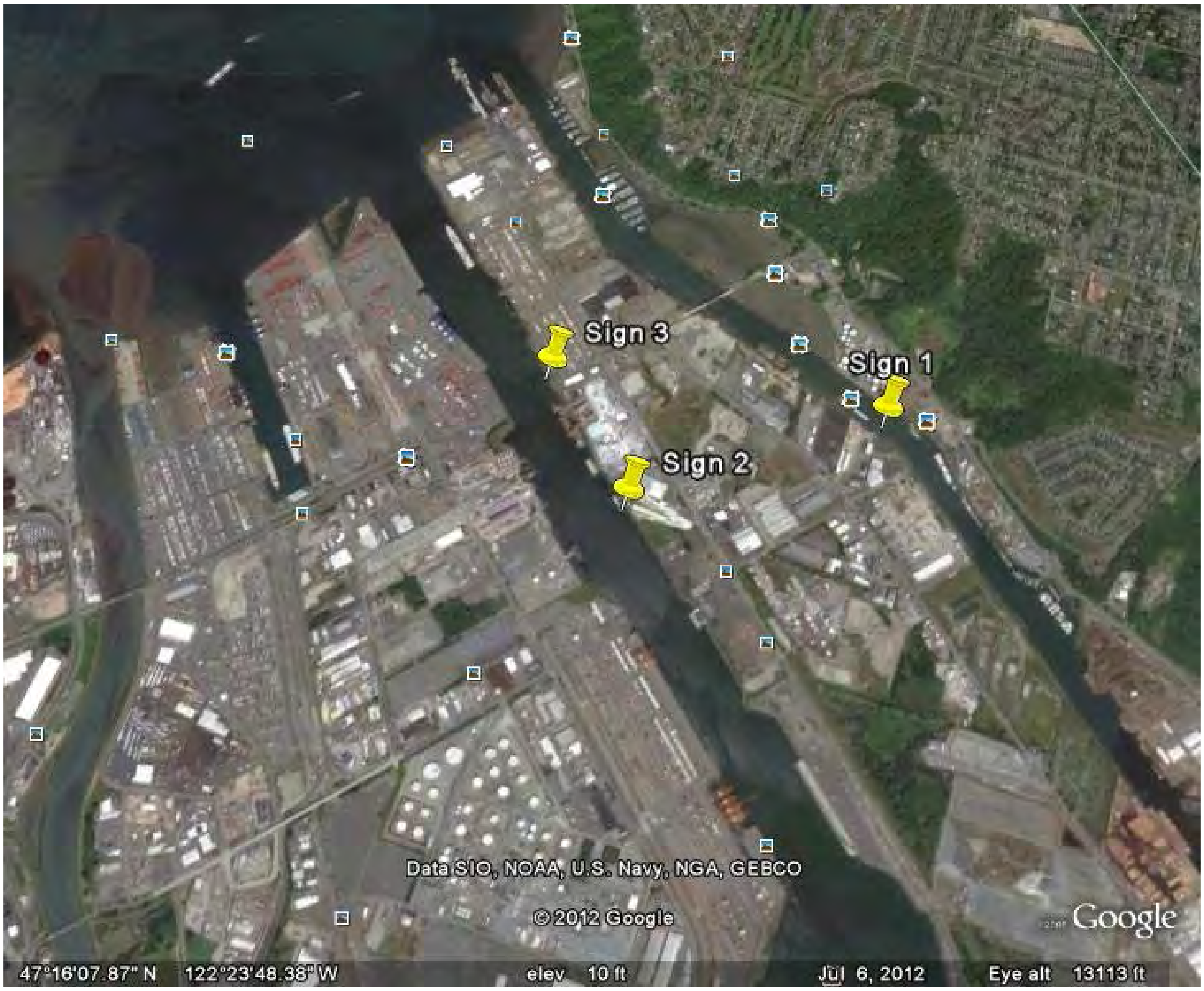
"Do not eat crab, shellfish or bottom feeding fish due to pollution."

This message is clear, concise, and consistent with current signs in Pierce County and the Duwamish River. Further, the message is protective of fish and shellfish consumers.

2012 Photograph of Advisory Warning Signs in Thea Foss Waterway, Commencement Bay.

Source: Lindsay Tuttle, TPCHD, personal communication, November 7, 2012.

The map features are approximate and are intended only to provide an indication of said feature. Additional areas that have not been mapped may be present. This is not a survey. Orthophotos and other data may not align. Pierce County assumes no liability for variations ascertained by actual survey. All data is expressly provided AS IS and WITH ALL FAULTS. Pierce County makes no warranty of fitness for a particular purpose.


Sign 3
Sign 1
Sign 2
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Google
47°16'07.87" N 122°23'48.38" W elev 10 ft Jul 6, 2012 Eye alt 13113 ft


CONSUMPTION
of Fish or Shellfish from These Waters
NOT RECOMMENDED
No se recomienda consumir
pescado o marisco de estas aguas
Tacoma-Pierce County Health Department
206/591-6470


RESTRICTED
AREA
AUTHORIZED
PERSONNEL ONLY
Unauthorized Presence
Constitutes a Breach of Security
33CFR104.270(c)(6) 33CFR105.260(c)(6)
WARNING
CONSUMPTION OF
FISH & CRAB
FROM THESE WATERS
NOT RECOMMENDED
TACOMA · PIEPCE COUNTY
HEALTH DEPARTMENT


CONSUMPTION
NOT RECOMMENDED

OU 01 Attachment 3 - 1985 Fish Advisory in Commencement Bay

1985 Fish Advisory in Commencement Bay

CBNSF 6.5.1 V1

JOHN SPELLMAN
Governor

WG

ALAN J. GIBBS
Secretary

STATE OF WASHINGTON
DEPARTMENT OF SOCIAL AND HEALTH SERVICES
Olympia, Washington 98504

RECEIVED
APR 16 1985
DSHS-HEALTH SERVICES

FOR FURTHER INFORMATION: Contact Floyd Frost, (206) 464-6289

NEWS RELEASE
NO: 82-218
FOR IMMEDIATE RELEASE

Howard Shuman
Public Affairs Administrator
(206) 753-2745

PRECAUTIONS LISTED FOR FISHING IN CERTAIN AREAS OF PUGET SOUND

OLYMPIA -- Fishermen in certain areas of Puget Sound should take extra precautions, according to Dr. John Beare, director of the State Division of Health.

The recent release of study results by the National Marine Fisheries Service, (NOAA), has raised concerns about the potential hazards of eating fish caught in Commencement, Elliot and Port Gardner Bays of Puget Sound. The studies, conducted between 1978 and 1981, were performed to determine the level of chemical pollution in Puget Sound and to assess if its fish and other marine life had been adversely affected.

Results indicate that potentially toxic chemicals are present in the sediments of the bays adjacent to industrial urban centers. The sites studied are near the mouth of the Puyallup, Duwamish and Snohomish Rivers. Bottom fish and shellfish in these waters have been shown to have higher concentrations of chemical pollutants than specimens collected in non-urban areas. However, a small sample of fish and shellfish caught in these areas has shown chemical concentrations within the ranges now considered to be "safe" for human consumption -- for the chemicals tested. The studies also found a higher level of tissue abnormalities in fish caught in areas near urban centers when compared with fish caught in other areas.

continued . . . .

Based on a review of the NOAA study, and in consultation with the Seattle-King County, Snohomish and Tacoma-Pierce County Health Department, Beare offered the following advice:

1. Fishermen whose habit is to fish along the Seattle, Tacoma or Everett waterfront should be aware that chemical wastes have been detected in those parts of Puget Sound.

2. Because of the chemical contamination and the uncertainty about possible health effects, the Health Division recommends that individuals not fish or gather shellfish from parts of Elliot, Commencement and Port Gardner Bays adjacent to industrial areas. This recommendation pertains particularly to bottom fish such as sole and cod, which have the greatest exposure to chemical waste.

3. Should it be necessary to fish in these areas, it would be prudent to eat only the fish muscle (flesh). Strip away and discard the skin, fat, internal organs and head. This is recommended because muscle tissue contains the lowest levels of chemical contamination. Consumption should be limited to an occasional fish. Since the liver contains the highest concentration of chemical contaminants, the liver should not be eaten from any fish caught anywhere in these bays.

There is no cause for concern that migratory fish, such as salmon and steelhead, are in any way affected, Beare said. Further, there is no evidence that levels of synthetic organic chemicals reported to date can cause any acute or chronic health problem. The above recommendations are precautionary and advisory and recognize the limitations of current knowledge on the toxicity of many synthetic organic chemicals.

For further information, call Floyd Frost, (206) 464-6289.

OU 01 Attachment 4 – Summary of PCBs and Mercury in Fish Tissue from Puget Sound

Human Health Evaluation of Contaminants in Puget Sound Fish

October 2006

Prepared by
The Washington State Department of Health
Division of Environmental Health
Office of Environmental Health Assessments
Olympia, Washington

Washington State Department of Health
Division of Environmental Health

Table ES-1. Meal recommendations for rockfish from Puget Sound listed by Washington State Department of Fish and Wildlife recreational marine areas.

Recreational Marine Area (see Figure ES-1)		**Consumption Guidance for rockfish from Puget Sound**	**Exceptions** (see Figure ES-2)
6	East Juan de Fuca Strait	No more than 1 meal/week	**None**
7	San Juan Islands	No more than 1 meal/week	**None**
8.1	Deception Pass, Hope Island, and Skagit Bay	No more than 1 meal/week	**None**
8.2	Port Susan and Port Gardner	No more than 1 meal/week - with noted exceptions	**No more than 2 meals per month:** Mukilteo-Everett and Port Gardner.
9	Admiralty Inlet	No more than 1 meal/week	**None**
10	Seattle-Bremerton Area	No more than 1 meal/week - with noted exceptions	**No consumption**: Elliott Bay (east of imaginary boundary from Duwamish Head to Pier 91, including the Duwamish River) and Sinclair Inlet (west of Dyes Inlet and Mitchell Point).
11	Tacoma-Vashon Area	No more than 1 meal/week - with noted exceptions	**No more than 2 meals per month:** Commencement Bay (SE of imaginary boundary between Sperry Ocean dock and Cliff House Restaurant).
12	Hood Canal	No more than 1 meal/week	**None**
13	South Puget Sound	No more than 1 meal/week	**None**

NOTE: Meal size equals eight ounces of uncooked fish for an average-sized adult.

English Sole and Other Flatfish

English sole was the only flatfish sampled and analyzed by PSAMP. While differences in life history may result in varied contaminant concentrations between species, DOH used chemical results from English sole tissue analyses to develop consumption recommendations for all Puget Sound flatfish. WDFW sport fish regulations use the term “bottomfish” to define numerous species. Meal limits specified for flatfish may not be applicable to other bottomfish such as lingcod.

The following table is a summary of consumption guidance for all consumers of Puget Sound English sole and other flatfish. Note that consumption of English sole and other flatfish from urban bays should be limited (Everett, Eagle Harbor, Commencement Bay) or avoided (Duwamish Waterway). Before fishing, anglers should consult WDFW fishing guidance for catch limits.

Table ES-2. Meal recommendations for English sole and other flatfish from Puget Sound listed by recreational marine areas (see Figure ES-3).

Recreational Marine Area (see Figure ES-1)		Consumption Guidance for English Sole and other Flatfish from Puget Sound	Exceptions (see Figure ES-3)
6	East Juan de Fuca Strait	**No meal limit**	**None**
7	San Juan Islands	**No meal limit**	**None**
8.1	Deception Pass, Hope Island, and Skagit Bay	**No meal limit**	**None**
8.2	Port Susan and Port Gardner	**No meal limit** – with noted exceptions	**No more than 2 meals per month:** Everett-waterfront from Mukilteo ferry dock to City of Everett. Based on extrapolation from sediment concentrations.
9	Admiralty Inlet	**No meal limit**	**None**
10	Seattle-Bremerton Area	**No meal limit** – with noted exceptions	**No consumption:** Duwamish Waterway (includes Harbor Island East and West Waterways) **No more than 1 meal per month**: Sinclair Inlet (west of Dyes Inlet and Mitchell Point). **No more than 2 meals per month:** Elliott Bay (east of imaginary boundary from Duwamish Head to Pier 91). **No more than 1 meal per wk**: Eagle Harbor and Port Orchard (waterway separating Bainbridge Island and Kitsap Peninsula).
11	Tacoma-Vashon Area	**No meal limit** – with noted exceptions	**No more than 2 meals per month**: Inner Commencement Bay (SE of imaginary boundary between Sperry Ocean dock and Cliff House Restaurant). **No more than 1 meal per wk**: Outer Commencement Bay (SE of imaginary boundary between Boathouse Marina and Brown's Point).
12	Hood Canal	**No meal limit**	**None**
13	South Puget Sound	**No meal limit**	**None**

NOTE: Meal size equals eight ounces of uncooked fish for an average sized-adult.

Puget Sound Salmon

DOH recommends the following with respect to Chinook and coho salmon in Puget Sound:

- Chinook salmon from Puget Sound may be consumed once (eight ounces) per week (or four times per month).
  - Anglers who catch resident Chinook salmon (also known as blackmouth) in the Puget Sound winter blackmouth fishery should limit their consumption to two eight-ounce meals per month. A Chinook caught in the Puget Sound wintertime fishery weighing

Figure ES-2. Meal limit recommendations for rockfish from urban areas of Puget Sound. Area designations are consistent with WDFW recreational marine areas. The general meal limit recommendation for rockfish throughout Puget Sound is 1 meal per week.

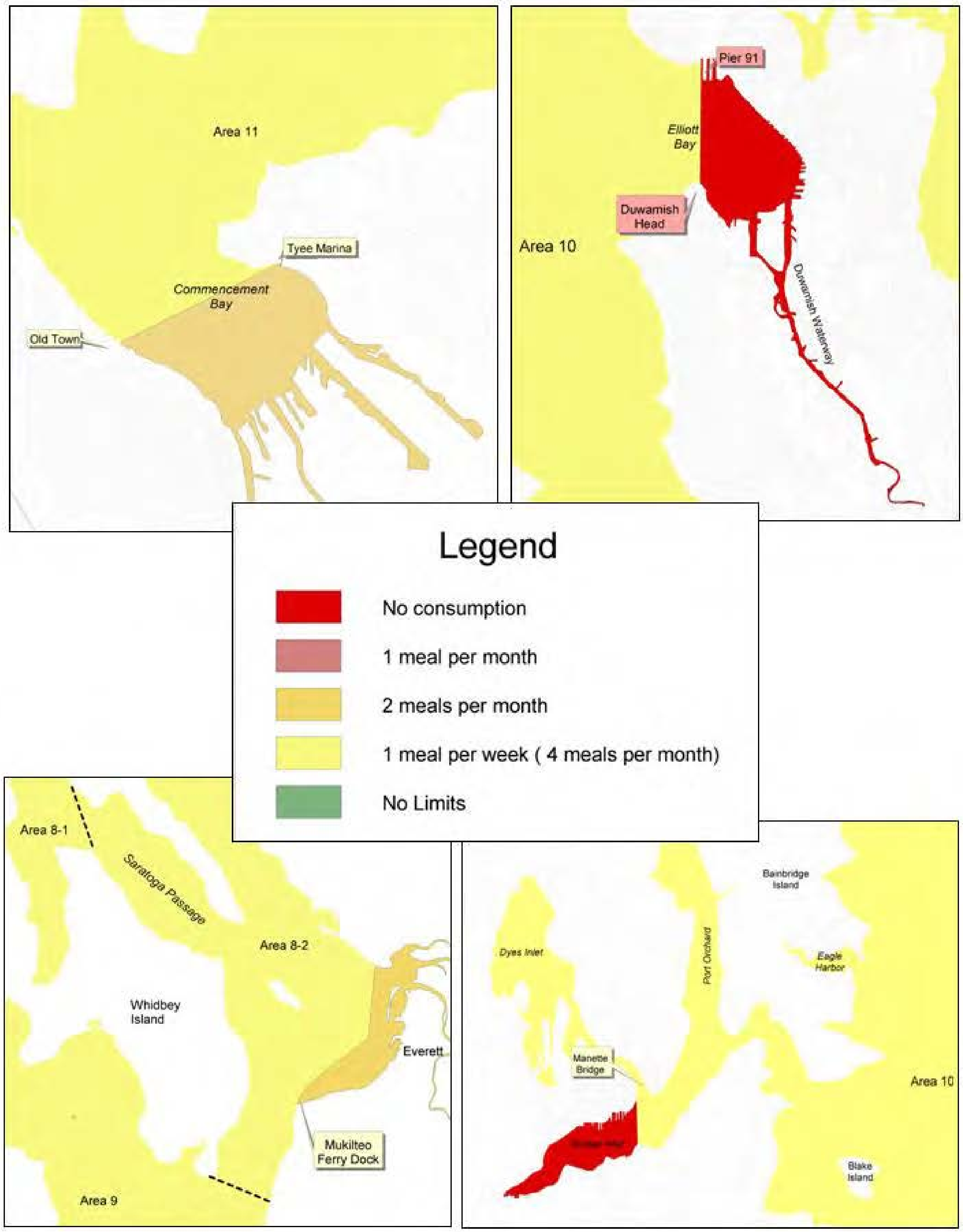


Figure ES-3. Meal limit recommendations for English sole and flatfish from urban areas of Puget Sound. Area designations are consistent with WDFW recreational marine areas.

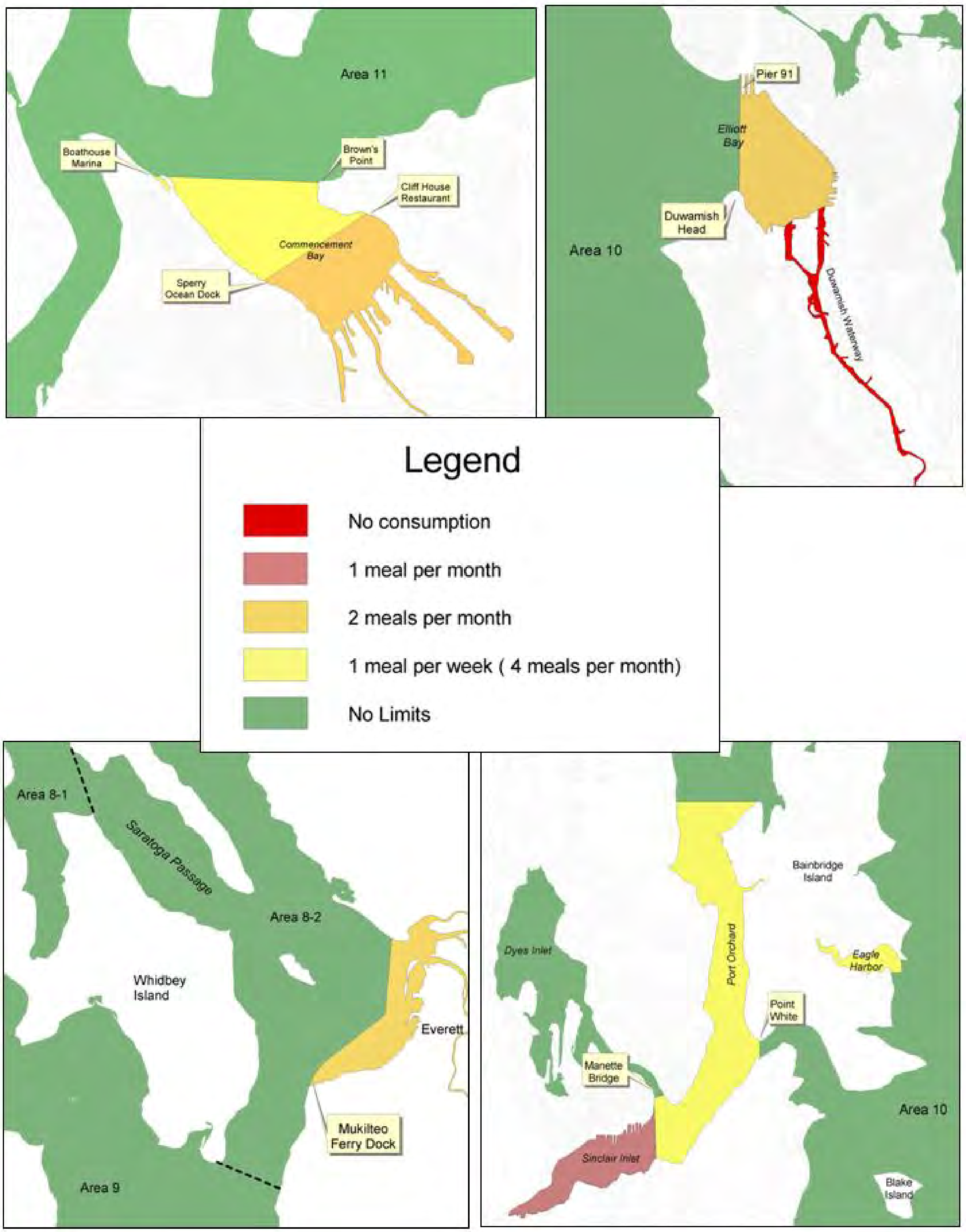


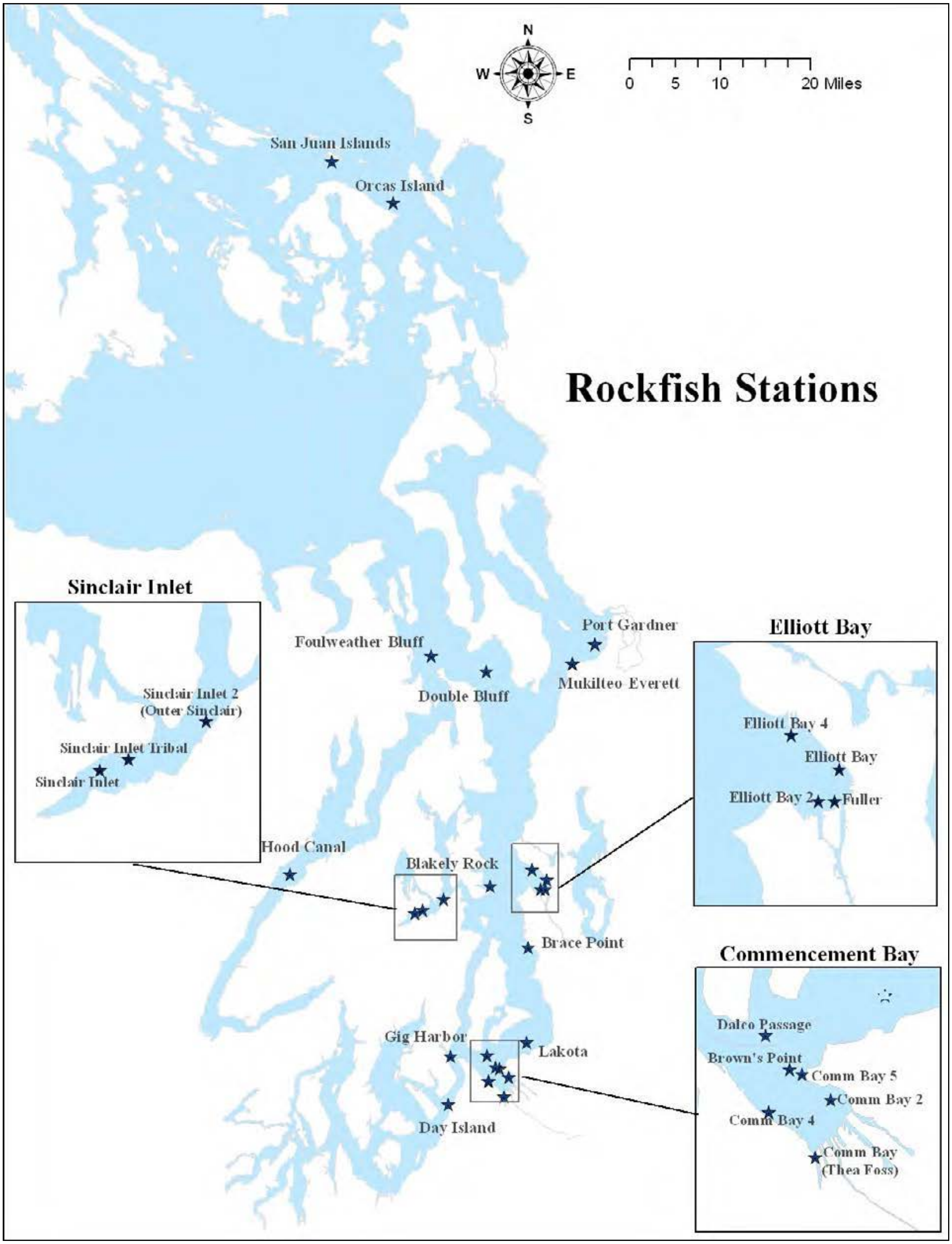
Table 1. Puget Sound English sole (ES) and rockfish (R) sampling stations classified by urban, near-urban, or non-urban setting.*

Urban stations		Near urban stations		Non urban stations	
Commencement Bay (Thea Foss)	ES, R	Budd Inlet	ES	Apple Cove Point	ES
Commencement Bay 2	ES, R	Bellingham Bay (outer)	ES	Birch Point	ES
Duwamish	ES	Blakely Rock	R	Carr Inlet 1	ES
Eagle Harbor	ES	Brown's Point	R	Case Inlet 1 (South Case Inlet)	ES
Elliott Bay (Seattle Waterfront)	ES, R	Cherry Point	ES	Case Inlet 3 (North Case Inlet)	ES
Elliott Bay 2 (Harbor Island)	ES, R	Commencement Bay 3 (Ruston)	ES	Day Island	R
Elliott Bay 4 (Myrtle Edwards)	ES, R	Commencement Bay 4 (Old Tacoma)	ES, R	Discovery Bay	ES
Fuller Shipwreck (Elliott Bay)	R	Commencement Bay 5 (Brown's Point)	ES, R	Double Bluff	R
Mukilteo-Everett	ES, R	Dalco Passage	R	Fern Cove	ES
Outer Commencement Bay	ES	Dash Point	ES	Foulweather	R
Port Gardner	ES, R	Dyes Inlet	ES	Hood Canal	ES, R
Sinclair Inlet	ES, R	Elliott Bay 5 (Alki)	ES	Hood Canal M	ES
Sinclair Inlet (Tribal)	R	Gig Harbor	R	Hood Canal S	ES
		Lakota	R	McAurther Bank	ES
		Liberty Bay	ES	Nisqually	ES
		Port Orchard	ES	Orcas Island	ES, R
		Port Townsend	ES	Outer Birch Point	ES
		Sinclair Inlet 2 (Outer Sinclair)	ES, R	Pickering Passage	ES
		Sinclair Inlet 3	ES	Possession Point	ES
		Sinclair Inlet 4 (Battle Point)	ES	Port Ludlow	ES
		Sinclair Inlet 5 (Blake Island)	ES	Port Madison	ES
				Point Roberts	ES
				Port Susan	ES
				San Juan Islands	R
				Saratoga Passage	ES
				Shilshole	ES
				Strait of Juan de Fuca	ES
				Strait of Georgia	ES
				Vendovi Island	ES
				Wollochet	ES

* Urban, near-urban, and non-urban stations were determined by WDFW (West et al. 2001) and updated for this report.

Figure 2. Puget Sound sites where English sole were sampled by WDFW for the Puget Sound Assessment and Monitoring Program.

Figure 1. Puget Sound sites where rockfish were sampled by WDFW for the Puget Sound Assessment and Monitoring Program.



Tissue Analysis

A detailed description of analytical methods used to measure contaminants in Puget Sound fish sampled and analyzed by PSAMP is available (West et al. 2001). The following provides a summary of information described in the WDFW report. Chemical analyses for organic and inorganic compounds followed procedures from the Puget Sound Estuary Program (PSEP 1989a, 1989b). These protocols reference USEPA Contract Laboratory Program Procedures (EPA 1986a, 1986b) and incorporate additional Quality Assurance/Quality Control (QA/QC) requirements.

All metals, including mercury, were analyzed as total elemental concentrations and reported as parts per million wet weight (ppm). Separate digestates were prepared for mercury using the nitric acid/sulfuric digestion method then analyzed by the cold vapor atomic absorption method. DOH assumed that total mercury concentrations were available as methylmercury because 90 - 100% of total mercury is typically in the form of methylmercury in adult fish (EPA 2001a).

Organic compounds were extracted from tissue samples by soxhlet extraction (for 1989 and 1990 samples) or sonication with a methylene chloride and acetone mix (for 1991, 1992, and 1993 samples). Beginning in 1991, all extracts were cleaned by gel permeation chromatography. The extracts were split, one for pesticide and PCB analyses and the other for base/neutral/acid-extractable (BNA) compounds.

Pesticides and PCBs were analyzed using gas chromatography-electron capture detection (GC/ECD), with Aroclor mixtures used as standards for quantifying PCB concentrations and reported as parts per billion (ppb) wet weight. In 1989 and 1990, a dual megabore column was used on the GC/ECD, but in 1991, 1992, and 1993, a dual narrow-bore column better suited to analyzing low concentrations was substituted. Starting with 1992 rockfish samples, new chromatography software was used for quantification of pesticides and PCBs, allowing laboratory chemists to more accurately quantify low concentrations of these chemicals. Because of these method changes, PCB data from 1989 and 1990 were not included in this evaluation. Chromatographic peaks used to quantify individual Aroclors may have contributions from multiple Aroclors, resulting in overestimation of an individual Aroclor level. Total PCBs in tissue can be overestimated when inflated results for individual Aroclors are summed.

A congener-specific screening method and estimation of total PCBs and pesticides (using high performance liquid chromatography with photodiode array - HPLC/PDA) was adopted in 1997 (Krahn et al. 1994). The method provided measures of 15 of 209 PCB congeners (77, 101, 105, 110, 118, 126, 128, 138, 153, 156, 157, 169, 170, 180, and 189). In 1997 and 1998, a number of tissue samples were analyzed using both the Aroclor-PCB (GC/ED) and the congener-PCB (HPLC/PDA) method. Results of both methods are included in this report. The HPLC/PDA method avoids overestimation of PCB concentration inherent in the Aroclor-summation procedure but may underestimate total PCBs because it only analyzes a fraction of PCB congeners.

Total PCBs were estimated in this report using two methods:

- Arithmetic summation of individual Aroclors (1248, 1254, and 1260), and
- Analytical measurement of total PCBs by the HPLC/PDA screening method (measuring the concentration of 15 of 209 PCB congeners). This method provided estimates of "total PCBs" from measurements of total area under the congener curve. These results were later adjusted to derive an Aroclor-equivalent concentration based on observed trends from samples analyzed using both methods.

WDFW staff validated 1989 and 1990 data and, beginning in 1991, an independent QA/QC chemist reviewed tissue chemistry data. Internal QA/QC reports are available from WDFW on request. For this report, one-half of the detection value was used when chemicals were not detected above the analytical detection level. The average detection limit for Aroclors was 2.0 ppb and <1.0 ppb for individual congeners by the HPLC/PDA method.

Risk Assessment

The following is an overview of steps used by DOH to determine whether or not fish consumers are potentially overexposed to contaminants in fish and to develop meal recommendations for consuming these fish (Figure 4).

- The first step is to determine how much fish is consumed by potentially-exposed anglers, tribal members, additional high-consuming populations, and other citizens. DOH typically uses mean and 90th (or 95th) percentile population-specific consumption rates to estimate average and high-end exposures.
- The second step is to obtain contaminant data (in this case from PSAMP) or to analyze fish samples for contaminant concentrations to estimate levels in fish tissue.
- Using this information, DOH can establish what contaminants people are exposed to and estimate the doses a person would receive from consuming fish.
- The next step is to determine if the calculated exposure dose is potentially unsafe. This is done in this report by comparing the calculated exposure dose to an oral reference dose (RfD) specific to each chemical of concern. A reference dose is a level of exposure below which non-cancer adverse health effects are not likely to occur. Further, lifetime increased cancer risk attributable to carcinogenic contaminants (i.e., PCBs) in fish is calculated and presented.
- Finally, if a population is over-exposed (i.e. PCB HQ > 1) based on a representative consumption rate, DOH then calculates acceptable meal limits based on non-cancer endpoints. A reference dose is considered protective of both non-cancer and cancer health effects for contaminants evaluated in this assessment (i.e., PCBs and mercury).

- The highest mean PCB level in English sole was found at the Duwamish station (168 ppb). This area is undergoing cleanup under EPA's Superfund process. DOH recently issued a fish advisory that recommends avoiding resident fish species within the Lower Duwamish Waterway (e.g., English sole, flounder and perch).

- Several other stations (e.g., Harbor Island, Sinclair Inlet, Commencement Bay – Thea Foss, and Eagle Harbor) were located where sediment cleanups have occurred or are occurring. The second highest mean PCB level in English sole was observed at Sinclair Inlet (123 ppb) where sediment cleanup is being conducted by the U.S. Navy. The high level of contaminants in English sole from these areas resulted in more restrictive meal limit calculations for these sites (Appendix D, Table D2).

Table 11. Calculated meal limits for English sole at non-urban, near-urban and select urban locations of Puget Sound.

Location	Average Mercury concentration (ppm)	Average PCB concentration (ppb)	Calculated meals per month based on mercury	Calculated meals per month based on PCBs	Calculated meals per month based on additive endpoint
Non-urban locations	0.051	9.3	16	17	9.8
Near-urban locations	0.053	17.2	15	9.3	7.3
Elliott Bay [a]	0.080	69.0	10	2.3	2.2
Sinclair Inlet	0.074	121	11	1.3	1.3
Commencement Bay [b]	0.069	60.9	12	2.6	2.5

[a] Comprised of Elliott Bay, Elliot Bay 2, and Elliott Bay 4 stations.
[b] Comprised of Commencement Bay, Commencement Bay 2, and Outer Commencement Bay stations.

English sole – based on PSAMP sediment PCB concentrations

PCB concentration in sediment appears to be the major factor influencing PCB concentration in English sole muscle tissue for a given location. In order to address the lack of sampling in some Puget Sound urban bays, WDFW determined a relationship based on PSAMP sediment and tissue data to predict English sole PCB concentrations where fish were not sampled (O'Neill and West 2006). In conjunction with mean sediment PCB concentrations from PSAMP, the following equation was used to estimate PCBs in English sole tissue at these sites:

$$[mPCB] = e^{1.64} * [sPCB]^{0.35} * e^{0.13} * Age$$

Where:

mPCB = concentration of PCBs in muscle as sum of 3 Aroclors, ng/g, wet wt.,
sPCB = concentration of PCBs in sediments as sum of 3 Aroclors, ng/g, dry wt.,
Age = fish age in years.

Although the resulting predicted concentration in fish tissue is an estimate, it is useful to calculate meal limits for locations where sediment concentrations are known but where English

Table D1 (cont.). Estimated meals per month for rockfish from Puget Sound, based on contaminant concentrations for each station and chemical.

Location	Rockfish Species	Type	Mercury			Total PCBs (Aroclors)			Total PCBs (Sum of 15 congeners)		
Lakota	Quillback	I	4	0.295	3	4	62.8	3	0	NA	NA
Recreational Management Area 12											
Hood Canal	Quillback	C	8	0.183	4	2	7.7	21	0	NA	NA
	Copper	C	1	0.170	5	1	6.5	25	0	NA	NA
Recreational Management Area 13											
Day Island	Quillback	C	6	0.098	8	0	NA	NA	0	NA	NA
	Copper	C	18	0.095	8	11	8.3	19	0	NA	NA

NOTE: Meal = eight ounces
N = sample size
Type: I = individual sample, C = composite sample
NA = Not available

Table D2. Estimated meals per month for English sole from Puget Sound, based on contaminant concentrations for each station and chemical.

Location	Mercury				Total PCBs (Aroclors)			Total PCBs (sum of 15 congeners)		
	Type	N	Mean (ppm)	Meals/ month	N	Mean (ppb)	Meals/ month	N	Mean (ppb)	Meals/ month
Recreational Management Area 6										
Discovery Bay	C	3	0.093	9	3	3.9	41	0	NA	NA
Strait of Juan de Fuca	C	6	0.050	16	6	7.0	23	0	NA	NA
Recreational Management Area 7										
Bellingham Bay (outer)	C	9	0.031	26	9	3.8	42	0	NA	NA
Birch Point	C	6	0.034	24	6	5.1	32	0	NA	NA
Cherry Point	C	3	0.038	21	0	NA	NA	3	13.9	12
McAurther Bank	C	3	0.043	19	3	3.2	50	0	NA	NA
Orcas Island	C	3	0.027	30	3	3.6	45	0	NA	NA
Outer Birch Pt.	C	3	0.047	17	3	3.1	52	0	NA	NA
Point Roberts	C	3	0.020	40	3	4.8	33	0	NA	NA
Strait of Georgia	C	34	0.051	16	21	5.8	28	15	11.2	14
Vendovi Island	I and C	44	0.038	21	23 I 11 C	3.8	42	014	7.8	21
Recreational Management Area 8-1										
Saratoga Passage	C	6	0.072	11	6	20.2	8	0	NA	NA
Recreational Management Area 8-2										
Mukilteo-Everett	C	2	0.040	20	0	NA	NA	0	NA	NA
Port Gardner	C	34	0.048	17	21	17.5	9	8	22.4	7
Port Susan	C	3	0.070	11	0	NA	NA	1	5.5	29
Recreational Management Area 9										
Possession Point	C	6	0.057	14	6	11.7	14	0	NA	NA

Table D2 (cont.). Estimated meals per month for English sole from Puget Sound, based on contaminant concentrations for each station and chemical.

	Mercury				Total PCBs (Aroclors)			Total PCBs (sum of 15 congeners)		
Location	Type	N	Mean (ppm)	Meals/ month	N	Mean (ppb)	Meals/ month	N	Mean (ppb)	Meals/ month
Port Ludlow	C	3	0.070	11	3	6.7	24	0	NA	NA
Port Townsend	C	12	0.049	16	12	9.7	17	0	NA	NA
Recreational Management Area 10										
Apple Cove Pt.	C	6	0.063	13	6	9.8	16	0	NA	NA
Duwamish	C	9	0.064	13	6	168	1	3	164	1
Dyes Inlet	C	6	0.047	17	6	28.0	6	0	NA	NA
Eagle Harbor	C	12	0.095	8	6	42.6	4	6	52.3	3
Elliott Bay	C and I	63	0.079	10	29 I 21 C	64.4	2	15	75.8	2
Elliott Bay 2	C	3	0.095	8	2	26.5	6	3	85.9	2
Elliott Bay 4	C	3	0.080	10	0	NA	NA	3	21.0	8
Elliott Bay 5	C	3	0.072	11	3	16.7	10	3	22.4	7
Liberty Bay	C	6	0.046	17	6	23.3	7	0	NA	NA
Port Madison	C	3	0.046	17	3	13.3	12	0	NA	NA
Port Orchard	C	6	0.067	12	6	36.8	4	0	NA	NA
Sinclair Inlet	C and I	58	0.074	11	24 I 21 C	121	1	15	122	1
Sinclair Inlet 2	C	3	0.071	11	0	NA	NA	3	22.8	7
Sinclair Inlet 3	C	3	0.063	13	0	NA	NA	3	63.8	3
Sinclair Inlet 4	C	3	0.061	13	0	NA	NA	3	38.8	4
Sinclair Inlet 5	C	3	0.086	9	0	NA	NA	3	31.0	5
Shilshole	C	6	0.059	14	5	22.9	7	0	NA	NA
Recreational Management Area 11										
Commenceme nt Bay	C and I	57	0.068	12	35 I 20 I	63.0	3	14	79.1	2
Commenceme nt Bay 2	C	3	0.067	12	0	NA	NA	3	82.4	2
Commenceme nt Bay 3	C	3	0.049	16	0	NA	NA	3	34.2	5
Commenceme nt Bay 4	C	3	0.051	16	0	NA	NA	3	43.2	4
Commenceme nt Bay 5	C	3	0.062	13	0	NA	NA	3	55.5	3
Dash Point	C	6	0.082	10	6	28.5	6	0	NA	NA
Fern Cove	C	3	0.072	11	3	19.3	8	0	NA	NA
Outer Commenceme nt	C	6	0.075	11	6	41.8	4	0	NA	NA
Recreational Management Area 12										
Hood Canal	C	36	0.059	14	21	6.4	25	15	11.8	14
Hood Canal M	C	6	0.038	21	6	3.5	46	0	NA	NA
Hood Canal S	C	6	0.030	27	6	4.8	33	0	NA	NA

Table D2 (cont.). Estimated meals per month for English sole from Puget Sound, based on contaminant concentrations for each station and chemical.

Location	Mercury				Total PCBs (Aroclors)			Total PCBs (sum of 15 congeners)		
	Type	N	Mean (ppm)	Meals/ month	N	Mean (ppb)	Meals/ month	N	Mean (ppb)	Meals/ month
Recreational Management Area 13										
Budd Inlet	C	9	0.035	23	9	8.8	18	0	NA	NA
Carr Inlet	C	6	0.052	15	6	14.0	11	0	NA	NA
Case Inlet 1	C	6	0.045	18	6	16.0	10	0	NA	NA
Case Inlet 3	C	3	0.040	20	3	8.3	19	0	NA	NA
Nisqually	C	24	0.061	13	12	21.5	7	15	24.0	7
Pickering	C	6	0.032	25	6	9.2	17	0	NA	NA
Wollochet	C	6	0.055	15	6	26.3	6	0	NA	NA

NOTE: Meal = eight ounces
N = sample size
Type: I = individual sample, C = composite sample
NA = Not available

Table D3. Estimated meals per month for Chinook salmon from Puget Sound, based on contaminant concentrations for each station and chemical.

Location	Mercury				Total PCBs (Aroclors)		
	Type	N	Mean (ppm)	Meals/ month	N	Mean (ppb)	Meals/month
In-river Fisheries							
Nooksak River	C	18	0.087	9	28	37.9	4
Skagit River	C and I	18 C	0.100	8	3 I 26 C	40.6	4
Duwamish River	C and I	18 C	0.102	8	34 I 31 C	57.2	3
Nisqually River	C and I	12 C	0.085	9	1 I 19 C	41.9	4
Deschutes River	C and I	12 C	0.108	7	12 I 22 C	60.4	3
Marine Fisheries							
Central Sound	C	**22**	**0.074**	**11**	**18**	**75.7**	**2**
Apple Cove Pt.	C	12	0.062	13	12	90.8	2
Central Sound	C	4	0.070	11	0	NA	NA
Sinclair Inlet	C	6	0.099	8	6	45.5	4
South Sound	C	**6**	**0.113**	**7**	**16**	**70.6**	**2**
Budd Inlet	C	0	NA	NA	10	55.5	3
South Sound	C	6	0.113	7	6	95.7	2

NOTE: Meal = eight ounces
N = sample size
Type: I = individual sample, C = composite sample
NA = Not available
Shading = Total sample size, mean, and meals/month for all marine fishery stations in Central and South Sound.

Table 3. (cont.) Summary of mercury (ppm, wet weight) and PCBs (ppb, wet weight) measured in four species of rockfish, English sole, Chinook salmon and coho salmon from Puget Sound.

	Mercury			Total PCBs (Aroclors)[a]			Total PCBs (Aroclor Equivalent)[b]		
	n	Range (ppm)	Mean (ppm)	n	Range (ppb)	Mean (ppb)	n	Range (ppb)	Mean (ppb)
ENGLISH SOLE	577	0.017-0.14	0.060	434	2-462	38.6	169	4-214	46.6
Urban	256	0.023-0.140	0.072	191	6-462	73.6	82	12-214	74.1
Near-urban	81	0.020-0.118	0.053	57	3-76	17.2	27	13-96	36.2
Non-urban	240	0.017-0.130	0.051	186	2-52	9.3	60	4-39	13.7
SALMON									
Chinook									
All of Puget Sound	106	0.051-0.160	0.093	210	11-223	54.0	NA	NA	NA
In-river[c]	78	0.058-0.160	0.096	176	11-223	50.2	NA	NA	NA
Marine[d]	28	0.051-0.130	0.082	34	21-212	73.2	NA	NA	NA
Central Sound	22	0.051-0.120	0.074	18	21-170	75.6	NA	NA	NA
South Sound	6	0.092-0.130	0.113	16	24-212	70.6	NA	NA	NA
Coho									
All of Puget Sound	225	0.008-0.110	0.039	221	5-126	31.8	224	16-106	35.5
In-river[c]	183	0.008-0.110	0.038	175	5-98	31.1	139	17-82	34.6
Marine[d]	32	0.028-0.071	0.051	46	8-126	34.4	42	21-106	42.1
Minter Creek and Wallace River Hatchery	10	0.020-0.043	0.029	NA	NA	NA	43	16-106	32.1
Central Sound	26	0.028-0.069	0.049	20	8-61	18.3	10	30-59	46.8
South Sound	6	0.045-0.071	0.057	26	18-126	46.8	32	21-106	40.6

Note: Means reflect equal weighting of individual and composite samples.
[a] Sum of Aroclors 1248, 1254, and 1260.
[b] Approximation of equivalent Aroclor concentration from HPLC data.
[c] "In-river" refers to nearshore areas near rivers and river mouths from which salmon most likely originated.
[d] "Marine" refers to offshore areas where the origins of salmon are unknown.

Estimating Exposure to Contaminants in Puget Sound Fish

Fish Consumption Rates

Numerous Puget Sound human seafood consumption surveys have been conducted. Consumption surveys that ask how much fish is being eaten, how often, and which species are being consumed can be used to estimate exposure rates from eating contaminated fish. DOH considered four regional seafood consumption surveys for Puget Sound. Members of the Suquamish Indian Tribe (Suquamish 2000) and the Tulalip and Squaxin Island Tribes (Toy et al. 1996) were interviewed in two separate studies to estimate Puget Sound Native American consumption rates. A survey of the Asian Pacific Islander (API) community was conducted by EPA (EPA 1999b) to estimate consumption rates. Recreational anglers from four Puget Sound areas were surveyed in two studies by NOAA (Landolt et al. 1985, 1987).

OU 01 Attachment 5 – Fish and Shellfish Data [Note: it has multiple attachments]

Historical Fish and Crab/Shellfish Tissue Data for PCBs and Mercury

1. Historical Fish (English sole) and Crab Tissue Data, Remedial Investigation for the CB/NT Site - 1984

The CB/NT Remedial Investigation[1] (Tetra Tech 1985) included collection and analysis of English sole tissue from five discrete samples at each of 15 locations (trawl transects) in Commencement Bay and 2 locations in Carr Inlet (Reference Area) (Versar 1985). The study area included all waterways: Hylebos, Blair, Sitcum, Milwaukee, St. Paul, Middle, and Thea Foss (formerly City) Waterways, and the Ruston-Point Defiance Shoreline (see Attachment KK-1 for station locations). For the five samples at each location, five individual fish were randomly selected from 60 fish that were collected for histopathological analysis. Samples were collected in mid-1984. Fish tissue[2] samples were analyzed for PCBs and other contaminants (mercury was not analyzed). Sampling was biased to larger sole (230 mm total length, or greater than 3 years old).

While not a statistically valid approach, data were averaged for Thea Foss and Hylebos Waterways for data presentation purposes only, as shown in Table KK1.[3] Data were only summarized for Thea Foss and Hylebos Waterways because these were the problem areas where PCBs were present.

Table KK1. Total PCB Concentrations in English sole muscle tissue sampled in 1984 from Thea Foss and Hylebos Waterways in Commencement Bay reported in the CB/NT Remedial Investigation (Tetra Tech 1985; Versar 1985).

Sample Location	Total PCBs (ppb wet weight)	
	Mean	Standard Deviation
Thea Foss, Head	470	215
Thea Foss, Mouth	238	176
Hylebos, Head	536	517

[1] See Section 2.2.4 'Field Sample Design', Section 2.7 'Bioaccumulation', Section 3.1.2.3 'Bioaccumulation', and Section 3.2 'Public Health Assessment' of the RI (Tetra Tech 1985). Data collection and analysis are provided in Versar 1985, "Assessment of Human Health Risk from Ingesting Fish and Crabs from Commencement Bay."
[2] Each fish (whole body minus liver and head) was tagged with a code number, wrapped in aluminum foil, stored on ice and returned to the shore-based laboratory for tissue removal. In the laboratory, both fillets were removed, and cut into a 6 g portion for metals analyses and a 36 g portion for organics analyses. No tissue composites were analyzed. Total PCB (Aroclor) analyses were performed using EPA Method 608 (tissue) and analysis with extraction/GC/ECD.
[3] Data were averaged and presented in this table by Laura Buelow, EPA Region 10.

OU 01 ATTACHMENT 5 – Fish and Shellfish Data

Sample Location	Total PCBs (ppb wet weight)	
Hylebos, Middle	300	185
Hylebos, Mouth	143	96
Carr Inlet, Reference	36	

The RI also included collection and analysis of crab tissue data, collected from two species: Dungeness crab *(Cancer magister)* and red rock crab *(Cancer productus)* (p. 9, Versar 1985). Three samples (i.e, 3 crabs) were collected from the head of Thea Foss Waterway, two samples were collected from the mouth of Thea Foss Waterway, and one sample was collected from the middle of Hylebos Waterway. Other sampled waterways are shown in Table KK1-Crab-PCB. Muscle tissue samples[4] were analyzed for PCBs (Table KK1Crab-PCBs) and for mercury (Table KK1Crab-Hg). In addition to Thea Foss and Hylebos Waterways, crab samples were collected in other waterways and in the Carr Inlet reference area. In all cases, the method detection limit was used in the calculation of means if a substance (e.g., specific Aroclor) was not detected.

Table KK1. Crab-PCB. Total PCB Concentrations in edible Dungeness and red rock crab meat sampled in 1984 from Commencement Bay RI (Versar 1985).

Sample Location	Total PCBs (ppb wet weight)	
	Mean	**Standard Deviation**
Thea Foss, Head; 3 samples	83	25
Thea Foss, Mouth; 2 samples	40	14
Hylebos, Middle; 1 sample	120 (single sample)	0
Middle Waterway; 2 samples	40	14
Sitcum Waterway; 4 samples	233	200
St. Paul Waterway; 1 sample	20 (single sample)	0
Milwaukee Waterway (not a problem area); 5 samples	74	38
Blair Waterway (not a problem area); 1 sample	130 (single sample)	0
Carr Inlet, Reference; 3 samples and 4 samples, respectively	22 23	3 5

[4] Crabs were collected from the trawl catches at each study site. Crab pots were also fished near each trawl transect to provide additional specimens. Each crab (whole body) was tagged, placed in a polyethylene bag, held live on ice, and returned to the shore-based laboratory for tissue removal. Muscle tissue from body and leg were removed and cut into a 6 g portion for metals analysis and a 36 g portion for organics analysis. Total PCB (Aroclor) analyses were performed using EPA Method 608 (tissue) with extraction using GC/ECD.

Table KK1. Crab-Hg. Mercury (methylmercury) concentrations in edible Dungeness and red rock crab meat sampled in 1984 from Commencement Bay RI (Versar 1985).

Sample Location	Mercury (ppm wet weight)	
	Mean	Standard Deviation
Thea Foss, Head; 3 samples	0.06067	0.01332
Thea Foss, Mouth; 2 samples	0.0780	0.01414
Hylebos, Middle; 1 sample	0.22	0
Middle Waterway; 2 samples	0.05	0.01414
Sitcum Waterway; 4 samples	0.167	0.10543
St. Paul Waterway; 1 sample	0.04	0
Milwaukee Waterway (not a problem area); 5 samples	0.11	0.05916
Blair Waterway (not a problem area); 1 sample	0.04	0
Carr Inlet, Reference; 3 sample and 4 samples, respectively	0.040U 0.048	0 0.01347

Very limited crab tissue data were collected in Commencement Bay. Based on this limited data set, PCBs in crab tissue were elevated in Commencement Bay compared to Carr Inlet (Reference Area), and as reported in Versar (1985), mercury in crab tissue was lower in Commencement Bay (10.3 ppb ww, mean of all waterways) than in Carr Inlet (44.6 ppb ww).

Based on analytical methods used for PCBs in tissue during the 1980s, most research scientists do not support the use of these historical RI data in evaluating long-term trend analyses of PCB concentrations in fish and crab tissue.

2. <u>Historical Fish (English sole) Tissue Data - Washington DOH Summary – 1991 to 2001</u>

In 2006, Washington DOH published the *Human Health Evaluation of Contaminants in Puget Sound Fish* (Washington DOH 2006). The report (p. 24) stated:

> *From 1989 to 2001 WDFW collected English sole annually with an otter trawl in the months of April and May, at numerous locations throughout Puget Sound. … Most English sole samples were composites comprising 20 individuals per composite. Each station was comprised of three composite samples (total number of fish at one station*

would be 60). Equal amounts of skinned muscle tissue were collected from individual fish. Sampling methods for fish tissue are described in West et al. (2001).

Analytical methods are discussed in West et al. 2001 and in DOH (2006; p. 30). DOH stated that because of changes in analytical methods for PCBs, PCB tissue data from 1989 and 1990 were not included in the DOH human health evaluation (WDOH 2006; pp. 30-31; reproduced herein in Attachment KK-3). The WDFW fish tissue data utilized by DOH are not currently available in Ecology's Environmental Information Management (EIM) system, and raw data must be obtained from Jim West of WDFW (james.west@dfw.wa.gov).

DOH estimated total PCBs in their report using two methods:

- Arithmetic summation of individual Aroclors (1248, 1254, and 1260)
- Analytical measurement of total PCBs by the HPLC/PDA screening method (measuring the concentration of 15 of 209 PCB congeners). This method provided estimates of "total PCBs" from measurements of total area under the congener curve. These results were later adjusted to derive an Aroclor-equivalent concentration based on observed trends from samples analyzed using both methods.

Based on the 1991-2001 fish tissue data, DOH (2006) reported an average concentration of 60.9 ppb PCBs in English sole muscle tissue in Commencement Bay, as shown in Table KK2. Station locations are shown in Attachment KK-3.

Table KK2. From Washington DOH (2006; Table 11). Calculated meal limits for English sole at non-urban, near-urban and select urban locations of Puget Sound.

Location	Average Mercury concentration (ppm)	Average PCB concentration (ppb)	Calculated meals per month based on mercury	Calculated meals per month based on PCBs	Calculated meals per month based on additive endpoint
Non-urban locations	0.051	9.3	16	17	9.8
Near-urban locations	0.053	17.2	15	9.3	7.3
Elliott Bay [a]	0.080	69.0	10	2.3	2.2
Sinclair Inlet	0.074	121	11	1.3	1.3
Commencement Bay [b]	0.069	60.9	12	2.6	2.5

[a]Comprised of Elliott Bay, Elliott Bay 2, and Elliott Bay 4 stations.
[b]Comprised of Commencement Bay (Thea Foss), Commencement Bay 2, and Outer Commencement Bay stations. Only the Commencement Bay (Thea Foss) station was located near the problem areas addressed by Superfund cleanup actions. Station locations are shown in Attachment KK-3.

DOH (2006; Table C3) also reported average concentrations of 63 ppb total PCBs in Commencement Bay (Thea Foss) and 41.8 ppb total PCBs in Outer Commencement Bay. Total PCBs, based on the sum of 15 PCB congeners, ranged from 34.2 ppb to 82.4 ppb (Table KK3).

Table KK3. From Washington DOH (2006; Table D2 from Appendix D). Estimated meals per month for English sole from Puget Sound, based on contaminant concentrations for each station and chemical.

Location	Mercury				Total PCBs (Aroclors)			Total PCBs (sum of 15 congeners)		
	Type	N	Mean (ppm)	Meals/ month	N	Mean (ppb)	Meals/ month	N	Mean (ppb)	Meals/ month
Recreational Management Area 11										
Commencement Bay	C and I	57	0.068	12	35 I 20 I	63.0	3	14	79.1	2
Commencement Bay 2	C	3	0.067	12	0	NA	NA	3	82.4	2
Commencement Bay 3	C	3	0.049	16	0	NA	NA	3	34.2	5
Commencement Bay 4	C	3	0.051	16	0	NA	NA	3	43.2	4
Commencement Bay 5	C	3	0.062	13	0	NA	NA	3	55.5	3
Dash Point	C	6	0.082	10	6	28.5	6	0	NA	NA
Fern Cove	C	3	0.072	11	3	19.3	8	0	NA	NA
Outer Commencement Bay	C	6	0.075	11	6	41.8	4	0	NA	NA

NOTE: Meal = eight ounces. Station locations are shown in Attachment KK-3.
N = sample size
Type: I = individual sample, C = composite sample
NA = Not available

DOH also reported data for rockfish tissue from Commencement Bay. Rockfish data were reported for average concentrations of PCBs and mercury in rockfish tissue as shown in Table KK4. Station locations in Commencement Bay are shown in Figure 1 of DOH 2006 (see Attachment KK-3).

Table KK4. From Washington DOH (2006; Table 10). Rockfish meal limit calculations based on area-specific chemical concentrations for brown, copper, and quillback rockfish.

Location	Average Mercury concentration (ppm)	Average PCB concentration (ppb)	Calculated meals per month based on mercury	Calculated meals per month based on PCBs	Calculated meals per month based on additive
Non-urban locations	0.218	5.8	3.7	28	3.4
Near-urban locations	0.225	45.1	3.6	3.6	2.2
Commencement Bay [a]	0.099	53.6	8.1	3.0	2.7
Elliott Bay [b]	0.340	140	2.4	1.1	1.0
Port Gardner Everett [c]	0.267	46.0	3.0	3.5	1.9
Sinclair Inlet [d]	0.748	198	1.1	1.1	0.6

[a] Comprised of Commencement Bay (Thea Foss), Commencement Bay 2, and Commencement Bay 4 stations. See DOH 2006 Figure 1 re-produced in Attachment KK-3.
[b] Comprised of Elliott Bay, Elliott Bay 2, Elliott Bay 4, and Fuller Shipwreck stations.
[c] Comprised of Mukilteo-Everett and Port Gardner stations
[d] Comprised of Sinclair Inlet and Sinclair Inlet Tribal stations.

3. Historical Shellfish (Mussel) Tissue Data, Washington State Pesticide Monitoring Program - 1995

In May 1995, the Washington Department of Ecology collected samples of mussels (*Mytilus trossulus*, formerly *M. edulis*) from the mouth of Hylebos Creek at the head of Hylebos Waterway (Ecology 1996) (see Attachment KK-2; Ecology 1996). The sample consisted of a composite of 30 or more mussels. PCB results were reported as follows:

- PCB 1248 = 18 ppb ww; PCB 1254 = 46 ppb ww; and PCB 1260 = 6J ppb ww. PCBs were reported at 72 ppb total PCBs (Ecology 1996; p. 8).

Ecology reported that none of the mussel samples (in the entire study area) had PCB residues that would be considered a concern for consumption by wildlife (Ecology 1996; p. v).

4. Historical Fish (English sole) Tissue Data – EPA EMAP - 2000

In July 2000, the U.S. EPA Environmental Monitoring and Assessment Program (EMAP; Hayslip et al. 2000) collected English sole in Hylebos Waterway. Station location information and tissue data for PCB congeners are provided in Attachment KK-4.

5. Historical Fish (English sole) Tissue Data – WDFW - PSAMP - 2002 to 2004

After 2001, WDFW modified their sampling schedule in Commencement Bay to collect samples every two years. Thus, English sole data were not collected in 2002 or 2004, but data were collected in 2003. In 2003, WDFW modified the composite sampling approach to collect six composite samples of 20 fish each per station location. WDFW made this change because it was determined that earlier compositing schemes (using three composite samples of 20 fish each for each station location) may not be statistically valid.

A historical perspective on the "Progression of PCB Analysis in PSAMP Fish Sampling Program" (Godtfredsen et al. 2012) is provided in Attachment KK-5. The WDFW did not provide 2003 data to EPA.

6. Historical Fish (Pacific staghorn) Data – NOAA - 2003

In 2003, NOAA collected and analyzed Pacific staghorn tissue data from Middle Waterway and in the vicinity of the Olympic View Resource Area. A station location map and data are available in Ecology's EIM system, and are reproduced in Attachment KK-6. Total PCB tissue concentrations ranged between 43 and 140 ppb ww in samples from Middle Waterway, and between 59 and 130 ww in samples from Olympic View Resource Area.

7. Historical Fish (English sole) Tissue Data – WDFW - 2005 - 2011

In 2005 to 2011, the WDFW PSAMP collected English sole from Thea Foss Waterway in Commencement Bay. Information and data from this sampling effort was provided to EPA by James West (personal communication, October 1, 2012). As described previously, analytical methods are described in the "Progression of PCB Analysis in PSAMP Fish Sampling Program" (Godtfredsen et al. 2012), which is provided in Attachment KK-5.

Sampling was conducted in 2005, 2007, 2009, and 2011 during the spring (April/May) of each year. Samples were collected at the "Baseline Station[5]" located in Thea Foss Waterway in Commencement Bay (Attachment KK-7). All fish were collected by bottom trawl, following environmental sampling protocols developed by the Puget Sound Estuary Program (PSEP 1990), and more recently summarized in a WDFW SOP ("Standard Operating Procedures For Collecting Benthic Fish and Macroinvertebrates Using a Bottom Trawl in Puget Sound") provided as Appendix D[6] to a recent WDFW QAPP. Fish were weighed (to the nearest gram) and measured [fork length (FL)]. Minimum fish size was 23 cm (which was the same minimum fish size as used during the CB/NT RI sampling event) and is considered representative of adult fish. Fish sex and fish ages were determined in all sampled sole. Fish age was estimated to the nearest year by counting the number of clearly defined opaque zones in interopercular bones under a binocular dissecting microscope. For 2005, 2007, and 2009, six composite samples were

[5] Latitude 47.2594559 and Longitude -122.4361766.
[6] http://wdfw.wa.gov/publications/01436/wdfw01436.pdf

analyzed at the station, and in 2011 only two composite samples were analyzed. Each sample is a composite of twenty fish.

Fish muscle tissue[7] was sampled and analyzed for the sum of 40 PCB congeners (ng/g wet weight) and gravimetric lipids (percent). According to WDFW (James West, personal communication, April 7, 2011), 2005 was the first year that WDFW used a GC/MS sum of congener method with a consistent extraction technique[8]. The rationale for selecting the 40 congeners for PCB analysis is that they were the most common and abundant congeners in environmental samples from this region, and are representative of the most bioaccumulative PCB congeners in this region (James West, personal communication, October 1, 2012). J. West indicated that other congeners are rare in tissue. Also, WDFW has analyzed fish tissue using the high-resolution analysis of 209 PCB congeners and J. West stated that data show that the low-resolution analysis of 40 congeners captures all of the important congeners (i.e., none of the important congeners are missed by doing low-resolution instead of high-resolution analysis of PCB congeners). Further discussion on this issue is found in Attachment KK-5.

WDFW PSAMP tissue data are not currently available in Ecology's EIM system, but may be obtained from J. West (james.west@dfw.wa.gov). For this report, WDFW provided the English sole tissue sample results that are shown in Table KK5.

[7] The filet was used for the sample. The filet tissue was removed in checkerboard pattern, excluding skin and organs, such as stomach).

[8] Prior to 2005, WDFW used either a different extraction method or a different analytical method, which all required significant corrections for method biases that are not simple (see Technical Memorandum in Attachment KK-5). Due to these concerns with earlier analytical methods and results, WDFW did not provide EPA with tissue data prior to 2005, and WDFW recommends that those earlier data not be used in any trends analyses of PCB concentrations in fish tissue.

Table KK5. Fish and Shellfish Data from WDFW

Sample ID	Species	Year	Station ID	LatNum	LongNum	Matrix	Compo-siteN	nMale	nFem	nUnk	MFUnkRatio	Mean Composite Length (Fork Length, mm)	Mean Composite Age (years)	Gravimetric Lipids (%)	SumPCBs 2x17 (ng/g wet)	SumPCBs40 Congeners (ng/g wet)	Mean and Range
05CB-ESM01	ENGLISH	2005	Thea Foss	47.2594559	-122.436177	muscle	20	14	6		14:6:0	268.5	5.5	0.394124535	84.82	66	75 +/- 8 66to83
05CB-ESM02	ENGLISH	2005	Thea Foss	47.2594559	-122.436177	muscle	20	14	6		14:6:0	260.55	5.8	0.427886379	87.54	69	
05CB-ESM03	ENGLISH	2005	Thea Foss	47.2594559	-122.436177	muscle	20	12	8		12:8:0	274	6.35	0.311222339	90.86	69	
05CB-ESM04	ENGLISH	2005	Thea Foss	47.2594559	-122.436177	muscle	20	6	4	10	6:4:10	258.25	5.3	0.427550028	110.22	85	
05CB-ESM05	ENGLISH	2005	Thea Foss	47.2594559	-122.436177	muscle	20	15	5		15:5:0	253.65	5.75	0.397348976	100.38	77	
05CB-ESM06	ENGLISH	2005	Thea Foss	47.2594559	-122.436177	muscle	19	12	2	5	12:2:5	249.105263	6.05	0.455935109	104.3	83	
07CB-ESM01	ENGLISH	2007	Thea Foss	47.2594559	-122.436177	muscle	20	13	7		13:7:0	265.15	6.93	0.223731809	69.18	53	40 +/- 9 28to53
07CB-ESM02	ENGLISH	2007	Thea Foss	47.2594559	-122.436177	muscle	20	7	13		7:13:0	269.25	6.1	0.200551533	49.58	38	
07CB-ESM03	ENGLISH	2007	Thea Foss	47.2594559	-122.436177	muscle	20	9	11		9:11:0	264.95	6.47	0.235373033	58.24	45	
07CB-ESM04	ENGLISH	2007	Thea Foss	47.2594559	-122.436177	muscle	20	11	9		11:9:0	242.85	5.8	0.266469727	41.04	32	
07CB-ESM05	ENGLISH	2007	Thea Foss	47.2594559	-122.436177	muscle	20	9	11		9:11:0	251.25	5.7	0.164638482	39.6	28	
07CB-ESM06	ENGLISH	2007	Thea Foss	47.2594559	-122.436177	muscle	20	9	11		9:11:0	254.2	6.6	0.261432205	54.78	43	
09CB-ESM01	ENGLISH	2009	Thea Foss	47.2594559	-122.436177	muscle	20	10	10		10:10:0	275.4	6.5	0.177982135	91.52	67	85 +/-26 62to130
09CB-ESM02	ENGLISH	2009	Thea Foss	47.2594559	-122.436177	muscle	20	12	8		12:8:0	266.45	6.25	0.210885491	174.32	130	
09CB-ESM03	ENGLISH	2009	Thea Foss	47.2594559	-122.436177	muscle	20	14	6		14:6:0	271.85	7.45	0.127508613	98.68	73	
09CB-ESM04	ENGLISH	2009	Thea Foss	47.2594559	-122.436177	muscle	20	16	4		16:4:0	255.8	6.2	0.146260352	103.88	76	
09CB-ESM05	ENGLISH	2009	Thea Foss	47.2594559	-122.436177	muscle	20	12	8		12:8:0	249.3	5.5	0.18694131	134.6	99	
09CB-ESM06	ENGLISH	2009	Thea Foss	47.2594559	-122.436177	muscle	20	11	9		11:9:0	257.6	6.05	0.1365926	83.78	62	
11CB-ESM01	ENGLISH	2011	Thea Foss	47.2594559	-122.436177	muscle	20	10	8	2	10:8:2	265		0.270899147	95	71	71to92
11CB-ESM02	ENGLISH	2011	Thea Foss	47.2594559	-122.436177	muscle	20	10	10	0	10:10:0	290.2			120	92	

Results in Table KK5 are provided for two different methods: 1) as "two times the sum of 17 PCB congeners" (note: one of the congeners co-elutes so the sum is actually two times the sum of 18 PCB congeners; see Table 1 in Attachment KK-5); and, 2) as the sum of 40 PCB congeners (note: six of the congeners co-elute so the sum is actually two times the sum of 46 PCB congeners; see Table 1 in Attachment KK-5). WDFW indicates that two times the sum of 17 PCB congeners is a better comparison to total PCBs (Aroclors) than using the sum of 40 PCB congeners.

8. Historical Crab Tissue Data, Commencement Bay – WDFW – 2011 and 2012

James West of WDFW (October 31, 2012) indicated that WDFW collected crab and spot prawn from Puget Sound in 2011 and 2012[9]. Crab and spot prawn tissue are being analyzed for contaminants, and data will be available for WDOH to use in evaluating potential health impacts to humans who eat these species. In 2012, a QAPP ("Toxic Contaminants in Dungeness crab (*Cancer magister*) and Spot Prawn (*Pandalus platyceros*) from Puget Sound, Washington, USA") was completed for ongoing work, and is available at this link:

http://wdfw.wa.gov/publications/01436/wdfw01436.pdf

In Commencement Bay, five samples of crab tissue were collected from the bottom trawl (as part of the fish sampling effort) at the Thea Foss Waterway location. Samples were analyzed for normal PSAMP parameters (41 PCB congeners, PBDE, metals, PAHs).

Historical Non-urban Puget Sound Tissue Dataset for Total PCBs: English sole and Crab - 1989- 2006

For comparison purposes, this section provides information on a recent compilation of total PCB concentrations in fish and crab tissue collected from non-urban Puget Sound locations outside of known contaminated sites.

In WDOH 2006, Table 3 summarizes mercury (ppm, wet weight) and PCBs (ppb, wet weight) measured in four species of rockfish, English sole, Chinook salmon and coho salmon from Puget Sound, in urban, near-urban, and non-urban areas (see Attachment KK-3).

In 2009, the remedial investigation for the Lower Duwamish Waterway Superfund Site in Seattle, WA, included a summary of PCB and PCB congener data in fish and crab tissue (see Attachment KK-12). These data may be useful for comparison purposes in later evaluations in Commencement Bay.

[9] Jim West (WDFW) indicated to EPA that WDFW collected Dungeness crab from Commencement Bay, but crab muscle was not analyzed for PCBs. In 2005, WDFW collected crabs from some of the English sole trawl locations - crab muscle, paired with egg samples for maternal crabs, was analyzed for PCBs (it is not clear if data were collected in Thea Foss Waterway). Data have not yet been published.

OU 01 ATTACHMENT 5 – Fish and Shellfish Data

In 2012, EPA Region 10 compiled a non-urban Puget Sound tissue data set from various studies as part of the RI/FS (AECOM 2012) for the Lower Duwamish Waterway Superfund site. Total PCB concentrations in fish and crab collected from non-urban Puget Sound locations outside of known contaminated sites. Total PCB concentrations (ug/kg wet weight) were summarized and are provided in Attachment KK-8. Data summaries in Attachment KK-8 include some WDFW PCB tissue data for the time period prior to 2005 – as described in earlier sections, J. West (WDFW) recommends that EPA not use any PCB tissue data prior to 2005 for PCB tissue trend analyses in Commencement Bay.

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Attachment KK-1. Station locations for fish and crab trawl locations in Commencement Bay, 1985 (Source: Versar 1985)

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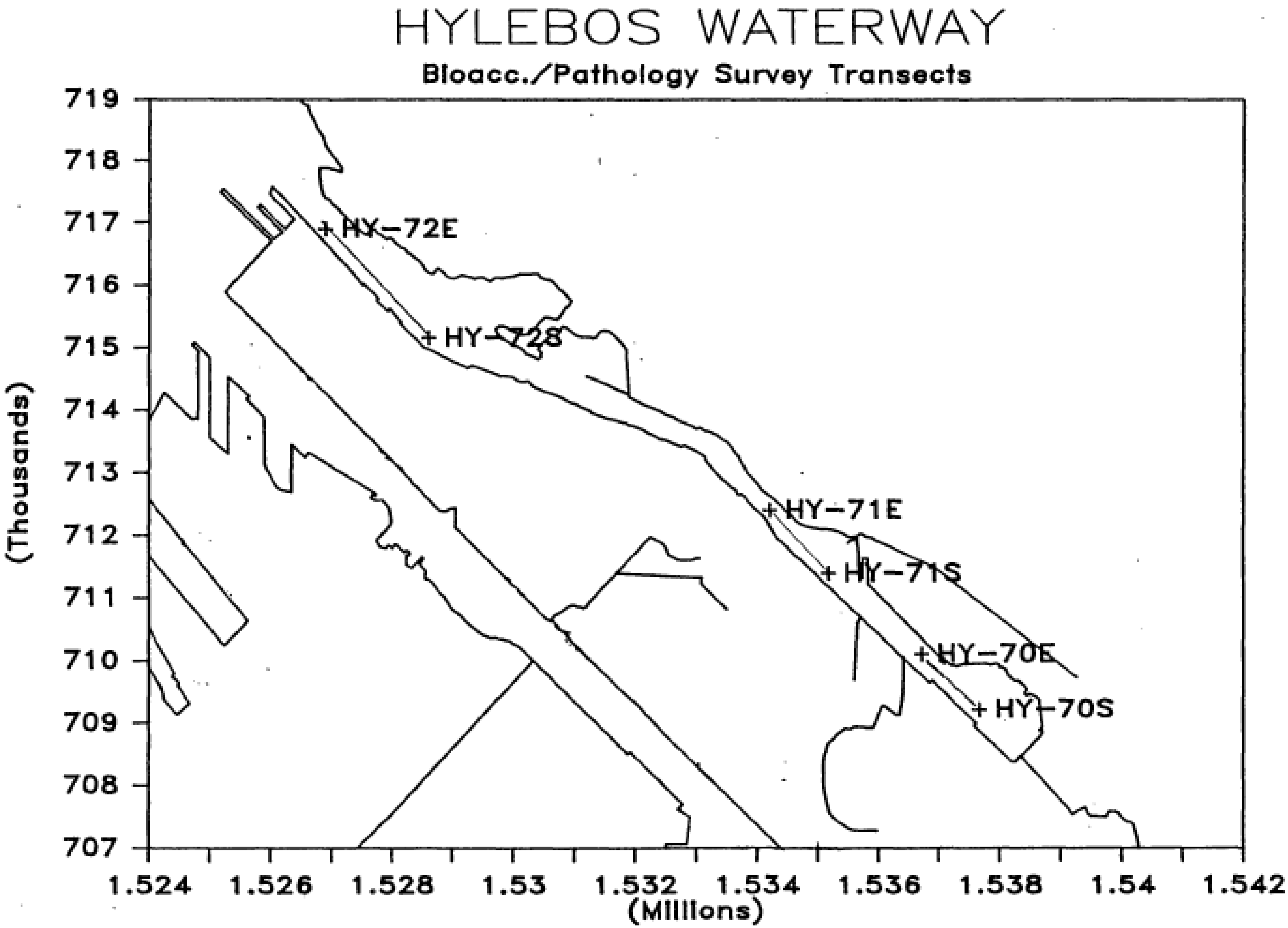
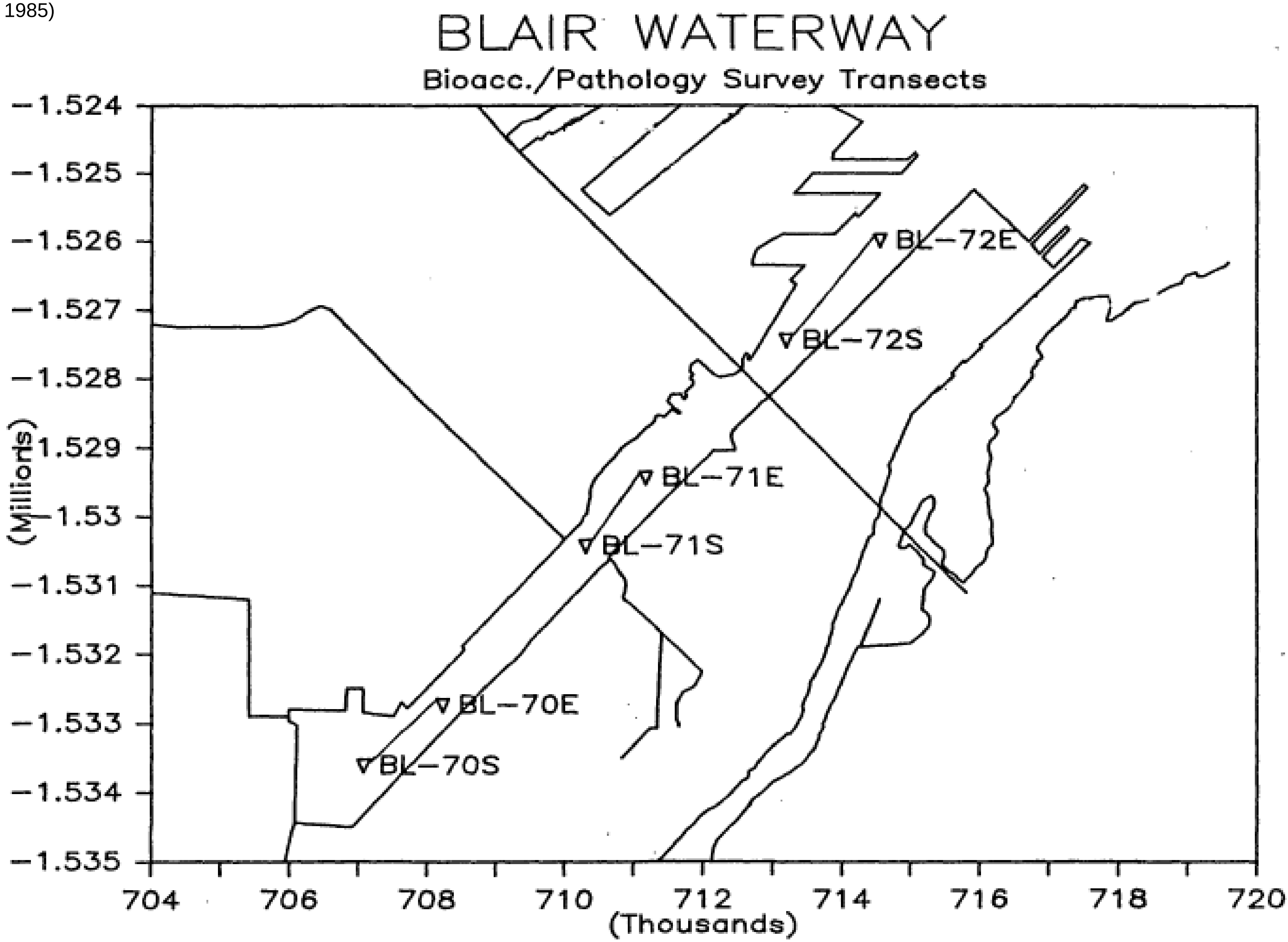
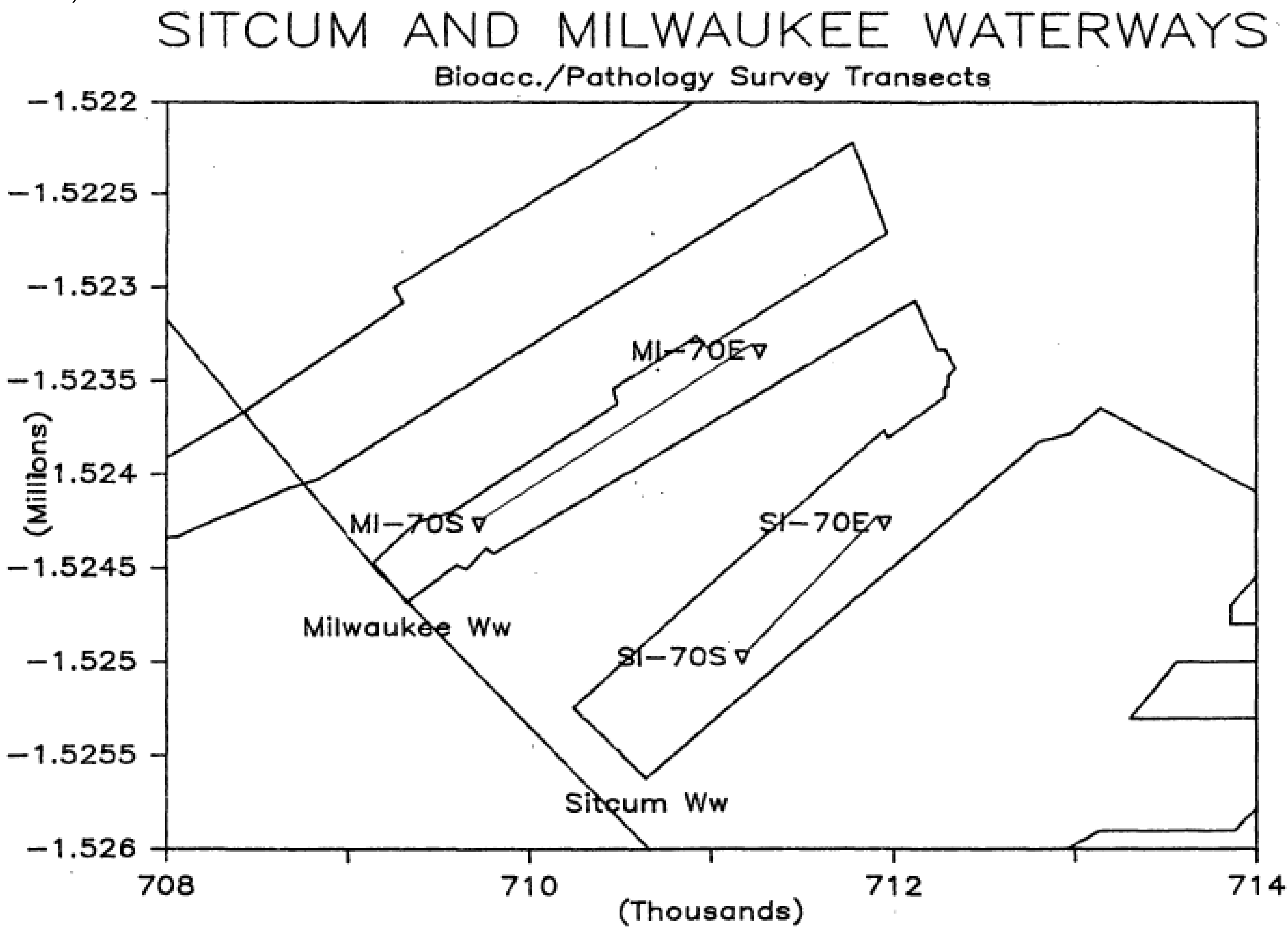


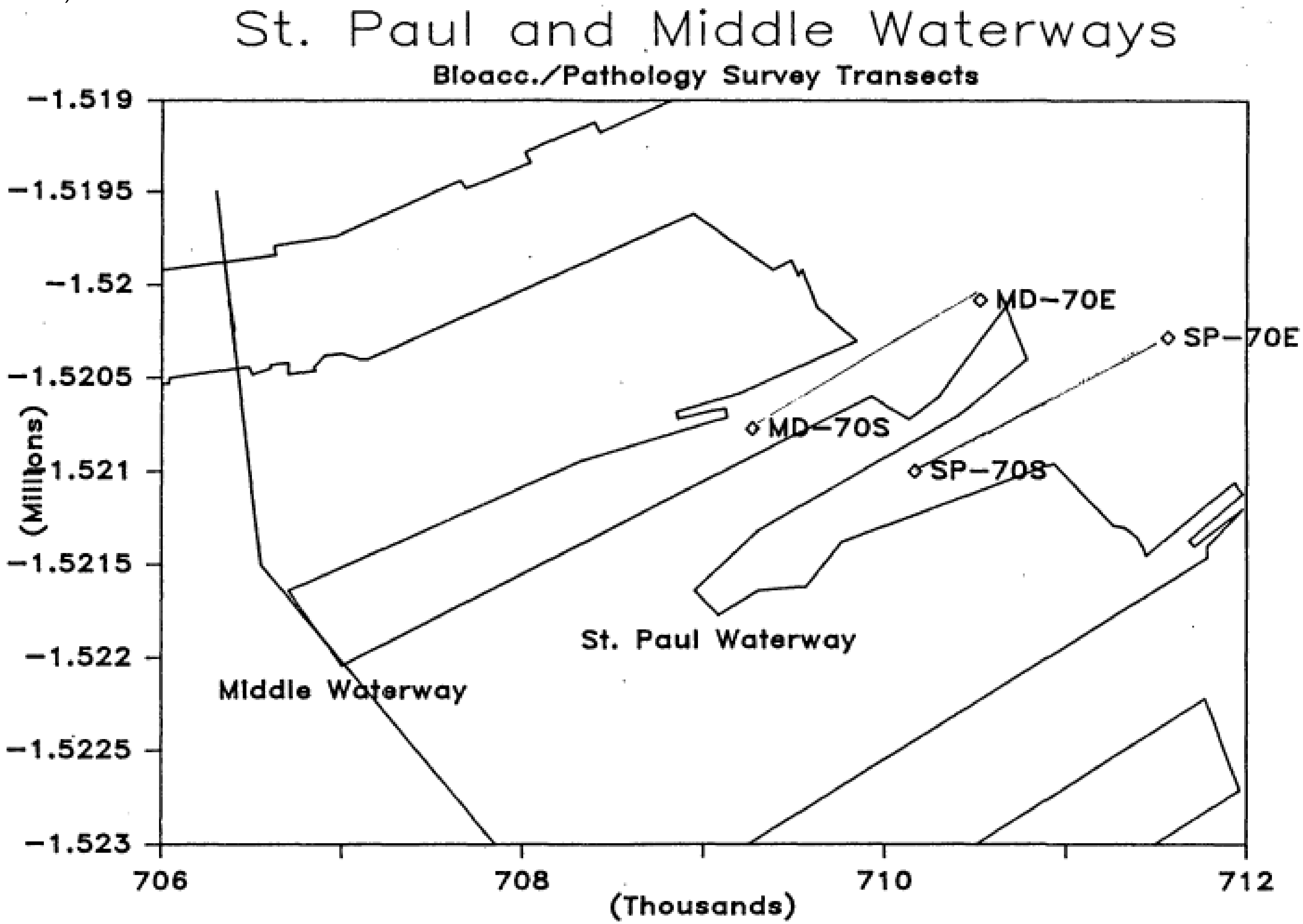
Attachment KK-1. Station locations for fish and crab trawl locations in Commencement Bay, 1985 (Source: Versar 1985)



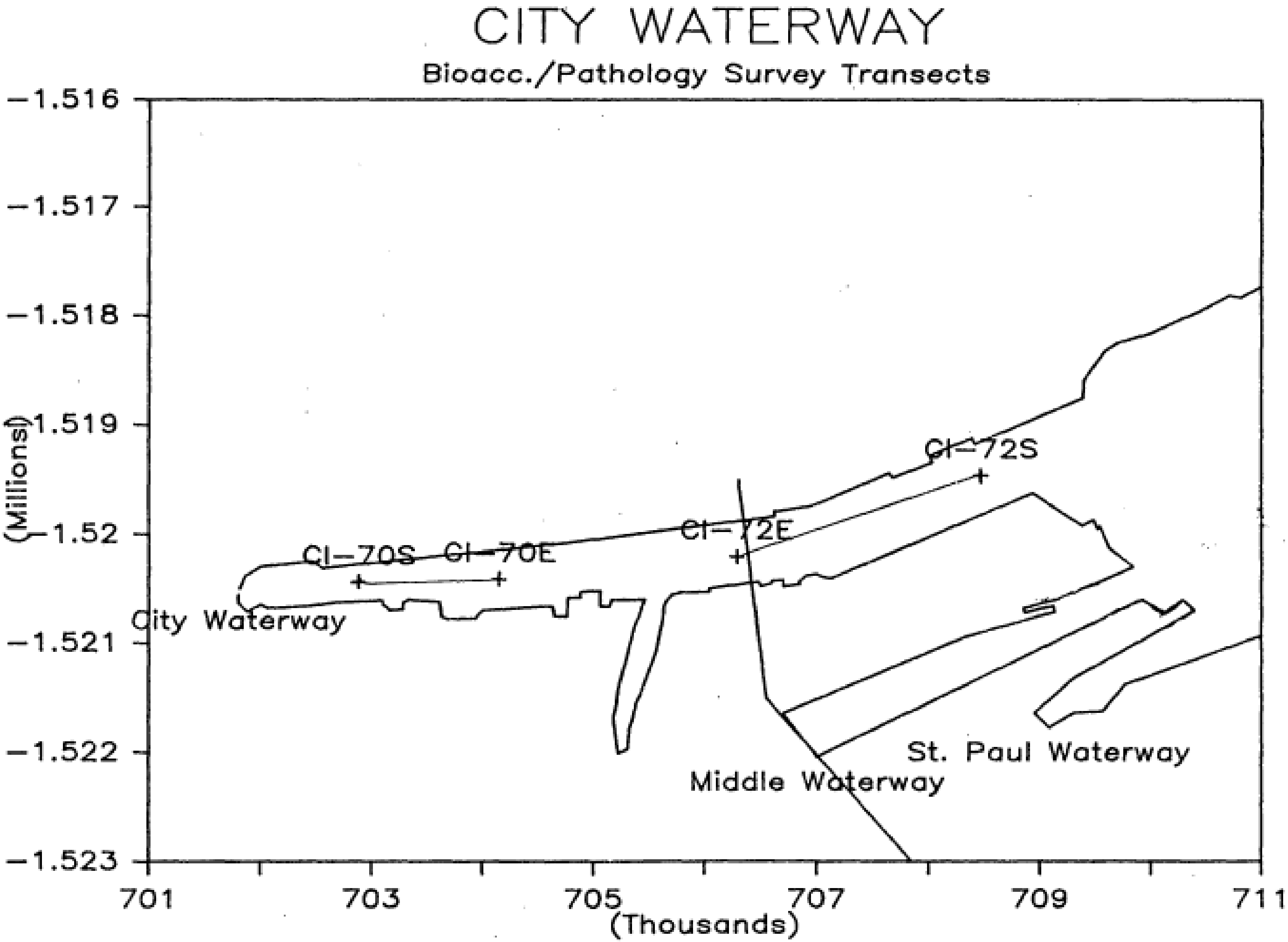
Attachment KK-1. Station locations for fish and crab trawl locations in Commencement Bay, 1985 (Source: Versar 1985)



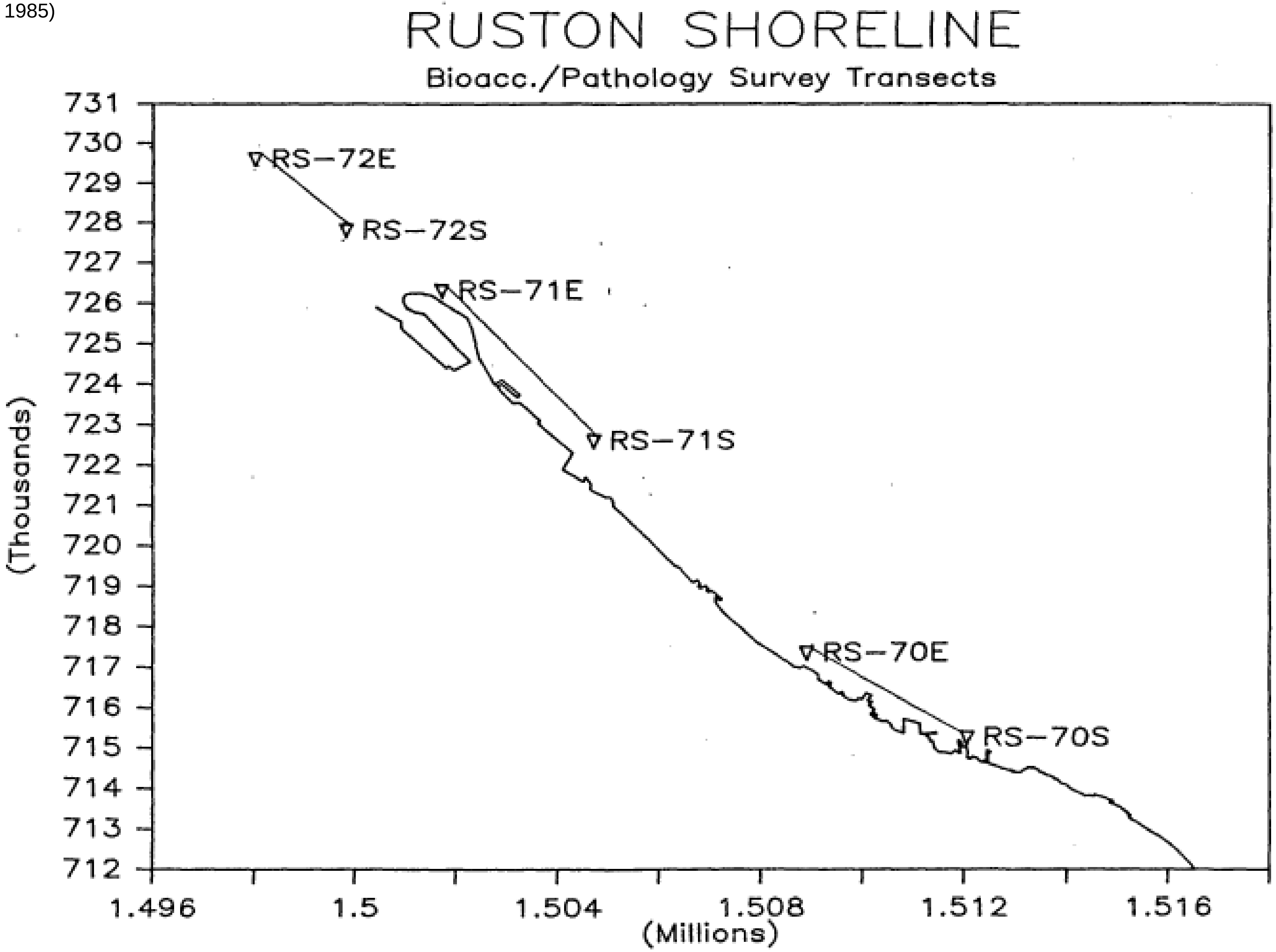
Attachment KK-1. Station locations for fish and crab trawl locations in Commencement Bay, 1985 (Source: Versar 1985)



Attachment KK-1. Station locations for fish and crab trawl locations in Commencement Bay, 1985 (Source: Versar 1985)



Attachment KK-1. Station locations for fish and crab trawl locations in Commencement Bay, 1985 (Source: Versar 1985)



WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Washington State Pesticide Monitoring Program

Pesticides and PCBs in Marine Mussels, 1995

March 1996

Publication No. 96-301

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Table 3. Pesticides and PCBs Detected in 1995 WSPMP Mussel Samples (ug/Kg (ppb) wet wt.)

Compound	Padilla Bay	Duwamish Waterway	Hylebos Waterway	Chambers Creek	Budd Inlet	Ilwaco
DDT & Analogs						
4,4'-DDT	0.12 J	2.8 NJ	5.6 NJ	nd	nd	0.91
4,4'-DDE	0.57 J	1.4	6.2	0.33 J	0.70	6.5
4,4'-DDD	0.05 J	0.88 J	3.8	nd	0.45 J	1.8
2,4'-DDT	nd	0.61 J	1.6	nd	nd	0.25 J
2,4'-DDE	nd	nd	0.14 J	nd	nd	nd
Cyclodienes						
dieldrin	nd	0.22	0.74	0.16 N	nd	0.43 J
endosulfan I	0.15 J	nd	24	nd	0.66 NJ	0.18
endosulfan II	nd	nd	12	nd	nd	nd
endosulfan sulfate	nd	nd	7.9	nd	nd	nd
cis-chlordane	nd	0.97	1.2	0.37 J	0.49 J	0.33 J
trans-chlordane	nd	0.91	1.0	nd	0.58	0.50
cis-nonachlor	nd	0.20 J	0.32 J	nd	nd	nd
trans-nonachlor	nd	0.66 NJ	1.0 NJ	0.38	0.34	nd
heptachlor	nd	nd	nd	nd	nd	0.01 J
heptachlor expoxide	nd	nd	nd	nd	nd	0.14 J
Benzene Hexachloride						
alpha BHC	0.06 J	0.06 J	0.11 J	nd	0.07 J	nd
gamma BHC	nd	nd	0.08 J	nd	nd	nd
Misc. Chlorinated Pesticides						
hexachlorobenzene	0.03 J	nd	0.45	nd	nd	0.14 J
DCPA (dacthal)	nd	nd	nd	nd	nd	0.33
Phenols						
pentachloroanisole	nd	0.05 J	0.30 J	nd	0.15 J	nd
Polychlorinated Biphenyls						
PCB-1248	nd	nd	18	nd	nd	nd
PCB-1254	2 J	32	46	6	21	6 N
PCB-1260	nd	12 J	6 J	2 J	nd	nd
% lipid	0.8	1.1	1.2	1.0	1.4	1.1
% non-polar lipid	0.1	0.1	0.4	0.1	0.1	0.1
% moisture	90	87	86	87	84	89

nd = not detected J = estimated value N = tentatively identified

Appendix A. Location and Size of 1995 WSPMP Mussel Samples

Site	Date	Latitude (N)	Longitude (W)	Sample No.	N =	Length (mm) (mean+/-2sd)
Padilla Bay (1)	5/17	48 30.4	122 28.9	20-8041	84	31+/-6
Duwamish Waterway (2)	5/17	47 34.4	122 21.2	20-8042	57	40+/-8
Hylebos Waterway (3)	5/17	47 15.6	122 21.4	20-8043	45	45+/-9
Chambers Creek (4)	5/17	47 11.0	122 34.7	20-8044	33	51+/-8
Budd Inlet (5)	5/25	47 02.9	122 53.6	21-8046	30	52+/-7
Columbia R. nr Ilwaco (6)	5/16	46 17.2	124 03.1	20-8040	56	40+/-7

(1) Old pilings near Joe Leary Slough, one mile north of research station
(2) East shore of west waterway, just upstream of Fisher Mills
(3) Railroad bridge pilings at mouth of Hylebos Creek
(4) South shore of creek mouth at Thomas M. Chambers monument
(5) Head of East Bay at culvert at mouth of Moxlie Creek
(6) Fort Canby State Park boat launch

Appendix C. Historical Data on Pesticides/PCBs in Washington Mussels (ug/Kg (ppb) wet wt.)

Compound	Year	Elliott Bay	Commencement Bay	Budd Inlet	Columbia River
t-DDT	1975(1)	na	na	na	na
	1976(2)	na	na	na	0.3*
	1977(2)	na	na	na	0.8*
	1978(2)	na	na	na	na
	1981(3)	na	6.8	na	na
	1982(3)	na	nd	na	na
	1986(4)	17	4.3	1.8	9.8
	1987(4)	4.6	2.6	2.6	4.7
	1988(4)	6.4	0.8	3.2	8.2
	1995(5)	5.1	16	1.2	3.4
dieldrin	1981	na	nd	na	na
	1982	na	nd	na	an
	1986	1.6	0.7	0.6	0.6
	1987	0.3	1.8	0.9	0.9
	1988	0.4	nd	0.4	0.5
	1995	nd	0.1	nd	0.4
t-chlordane**	1981	na	nd	na	na
	1982	na	nd	na	na
	1986	3.5	1.8	0.9	1
	1987	0.8	2.5	1.7	0.6
	1988	1.3	0.2	1.4	0.8
	1995	1.2	1.5	0.5	0.5
gamma BHC	1981	na	nd	na	na
	1982	na	nd	na	na
	1986	0.04	0.2	0.2	0.1
	1987	nd	0.09	0.2	0.04
	1988	0.2	0.02	0.1	0.1
	1995	nd	0.08	nd	nd
hexachlorobenzene	1981	na	nd	na	na
	1982	na	nd	na	na
	1986	nd	nd	nd	nd
	1987	nd	0.09	0.04	nd
	1988	0.3	0.4	0.2	0.1
	1995	nd	0.4	nd	0.1

Appendix C. (continued)

Compound	Year	Elliott Bay	Commencement Bay	Budd Inlet	Columbia River
t-PCBs	1975(1)	210	72	27	na
	1976(2)	na	na	na	5
	1977(2)	na	na	na	3
	1978(2)	na	na	na	3
	1981(3)	na	82	na	na
	1982(3)	na	26	na	na
	1986(4)	143	25	17	11
	1987(4)	75	44	22	12
	1988(4)	58	5	18	14
	1995(5)	44	70	21	6

na = not analyzed
nd = not detected
* DDE only
** t-chlordane = alpha-chlordane + trans-nonachlor + heptachlor + heptachlor epoxide (as reported in NOAA, 1989)
(1) Mowrer et al., 1977 [Elliott Bay site is W. Duwamish WW; Commencment Bay site is mouth of Hylebos WW; Budd Inlet site is Priest Point Park]
(2) Farrington et al., 1982 [Columbia River site is North Jetty: *Mytilus californianus*]
(3) Hopkins et al., 1985 [Commencement Bay site is mouth of City Waterway]
(4) NOAA ,1989 [Elliott Bay site is Four-Mile Rock; Commencement Bay site is Tahlequah Pt.]
(5) present study [Elliott Bay site is W. Duwamish WW; Commencement Bay site is head of Hylebos WW]
Note: Data from references (2) and (4) converted from dry wt. to wet wt. assuming 87% moisture (Table 2)

ATTACHMENT KK-3. Summary of PCBs and mercury in fish tissue from Puget Sound (Source: DOH 2006)

Human Health Evaluation of Contaminants in Puget Sound Fish

October 2006

Prepared by
The Washington State Department of Health
Division of Environmental Health
Office of Environmental Health Assessments
Olympia, Washington

Table ES-1. Meal recommendations for rockfish from Puget Sound listed by Washington State Department of Fish and Wildlife recreational marine areas.

Recreational Marine Area (see Figure ES-1)		Consumption Guidance for rockfish from Puget Sound	Exceptions (see Figure ES-2)
6	East Juan de Fuca Strait	No more than 1 meal/week	**None**
7	San Juan Islands	No more than 1 meal/week	**None**
8.1	Deception Pass, Hope Island, and Skagit Bay	No more than 1 meal/week	**None**
8.2	Port Susan and Port Gardner	No more than 1 meal/week - with noted exceptions	**No more than 2 meals per month:** Mukilteo-Everett and Port Gardner.
9	Admiralty Inlet	No more than 1 meal/week	**None**
10	Seattle-Bremerton Area	No more than 1 meal/week - with noted exceptions	**No consumption**: Elliott Bay (east of imaginary boundary from Duwamish Head to Pier 91, including the Duwamish River) and Sinclair Inlet (west of Dyes Inlet and Mitchell Point).
11	Tacoma-Vashon Area	No more than 1 meal/week - with noted exceptions	**No more than 2 meals per month:** Commencement Bay (SE of imaginary boundary between Sperry Ocean dock and Cliff House Restaurant).
12	Hood Canal	No more than 1 meal/week	**None**
13	South Puget Sound	No more than 1 meal/week	**None**

NOTE: Meal size equals eight ounces of uncooked fish for an average-sized adult.

English Sole and Other Flatfish

English sole was the only flatfish sampled and analyzed by PSAMP. While differences in life history may result in varied contaminant concentrations between species, DOH used chemical results from English sole tissue analyses to develop consumption recommendations for all Puget Sound flatfish. WDFW sport fish regulations use the term “bottomfish” to define numerous species. Meal limits specified for flatfish may not be applicable to other bottomfish such as lingcod.

The following table is a summary of consumption guidance for all consumers of Puget Sound English sole and other flatfish. Note that consumption of English sole and other flatfish from urban bays should be limited (Everett, Eagle Harbor, Commencement Bay) or avoided (Duwamish Waterway). Before fishing, anglers should consult WDFW fishing guidance for catch limits.

Table ES-2. Meal recommendations for English sole and other flatfish from Puget Sound listed by recreational marine areas (see Figure ES-3).

Recreational Marine Area (see Figure ES-1)		Consumption Guidance for English Sole and other Flatfish from Puget Sound	Exceptions (see Figure ES-3)
6	East Juan de Fuca Strait	**No meal limit**	**None**
7	San Juan Islands	**No meal limit**	**None**
8.1	Deception Pass, Hope Island, and Skagit Bay	**No meal limit**	**None**
8.2	Port Susan and Port Gardner	**No meal limit** – with noted exceptions	**No more than 2 meals per month:** Everett-waterfront from Mukilteo ferry dock to City of Everett. Based on extrapolation from sediment concentrations.
9	Admiralty Inlet	**No meal limit**	**None**
10	Seattle-Bremerton Area	**No meal limit** – with noted exceptions	**No consumption:** Duwamish Waterway (includes Harbor Island East and West Waterways) **No more than 1 meal per month**: Sinclair Inlet (west of Dyes Inlet and Mitchell Point). **No more than 2 meals per month:** Elliott Bay (east of imaginary boundary from Duwamish Head to Pier 91). **No more than 1 meal per wk**: Eagle Harbor and Port Orchard (waterway separating Bainbridge Island and Kitsap Peninsula).
11	Tacoma-Vashon Area	**No meal limit** – with noted exceptions	**No more than 2 meals per month**: Inner Commencement Bay (SE of imaginary boundary between Sperry Ocean dock and Cliff House Restaurant). **No more than 1 meal per wk**: Outer Commencement Bay (SE of imaginary boundary between Boathouse Marina and Brown's Point).
12	Hood Canal	**No meal limit**	**None**
13	South Puget Sound	**No meal limit**	**None**

NOTE: Meal size equals eight ounces of uncooked fish for an average sized-adult.

Puget Sound Salmon

DOH recommends the following with respect to Chinook and coho salmon in Puget Sound:

- Chinook salmon from Puget Sound may be consumed once (eight ounces) per week (or four times per month).
    - Anglers who catch resident Chinook salmon (also known as blackmouth) in the Puget Sound winter blackmouth fishery should limit their consumption to two eight-ounce meals per month. A Chinook caught in the Puget Sound wintertime fishery weighing

Figure ES-2. Meal limit recommendations for rockfish from urban areas of Puget Sound. Area designations are consistent with WDFW recreational marine areas. The general meal limit recommendation for rockfish throughout Puget Sound is 1 meal per week.

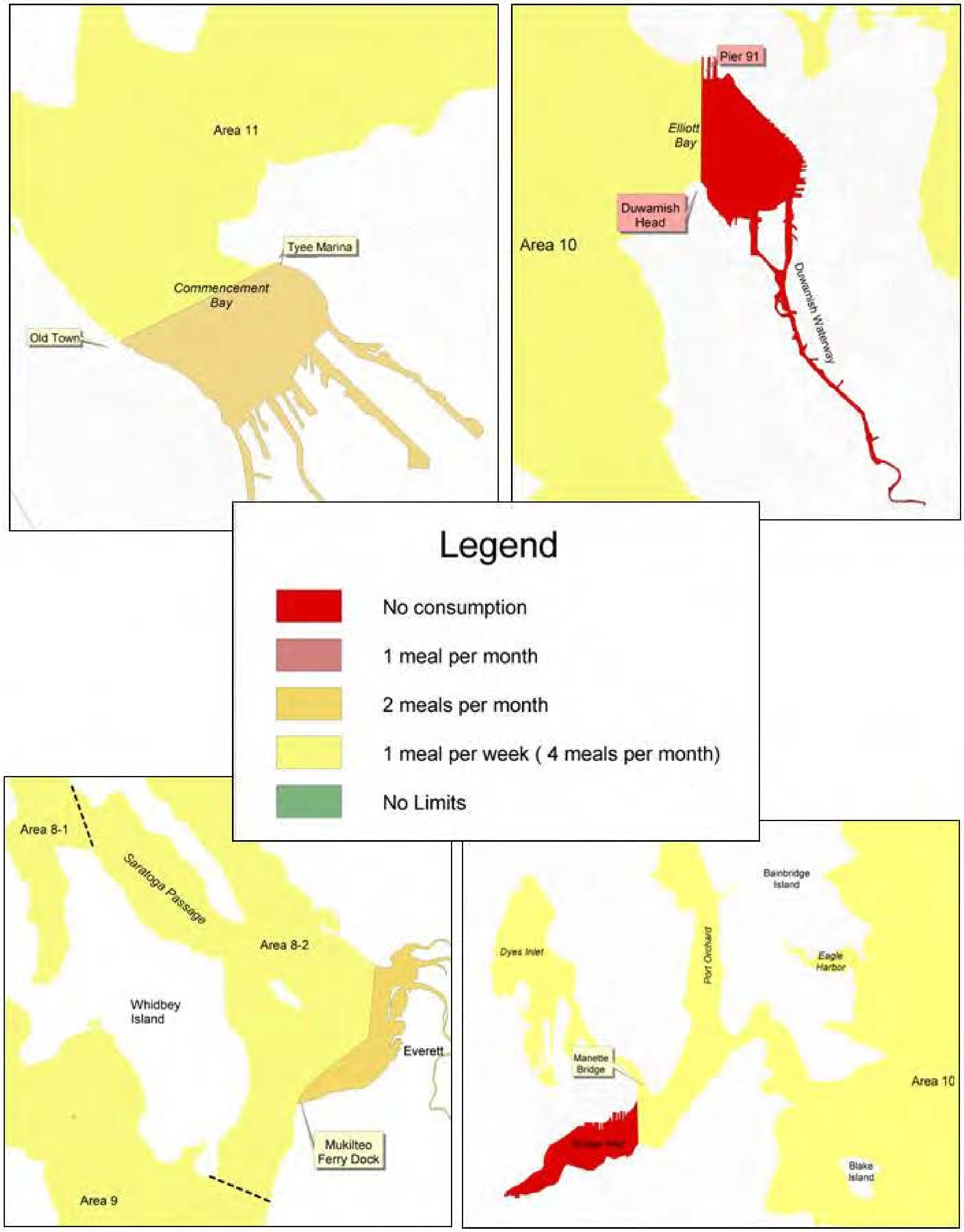


Figure ES-3. Meal limit recommendations for English sole and flatfish from urban areas of Puget Sound. Area designations are consistent with WDFW recreational marine areas.

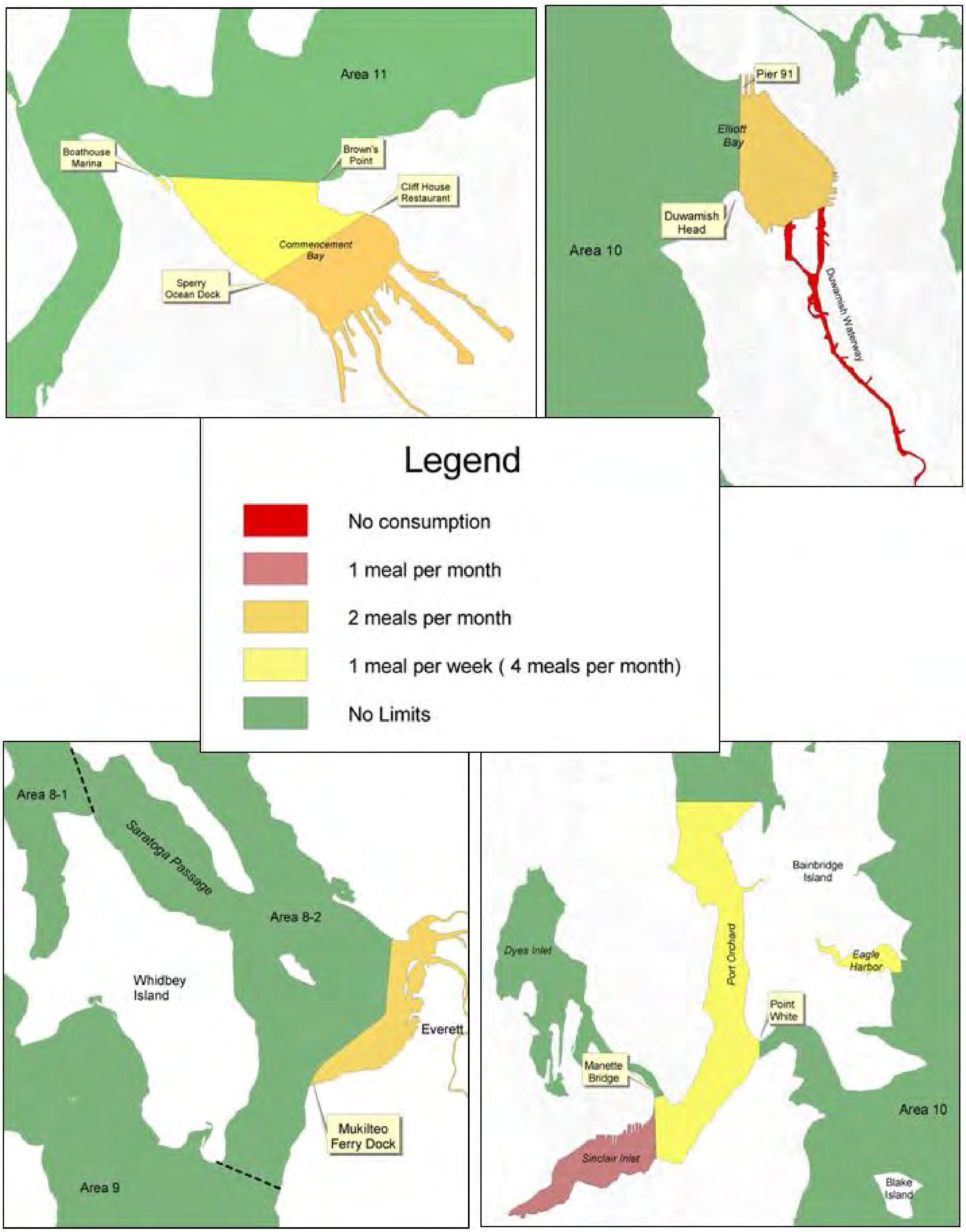


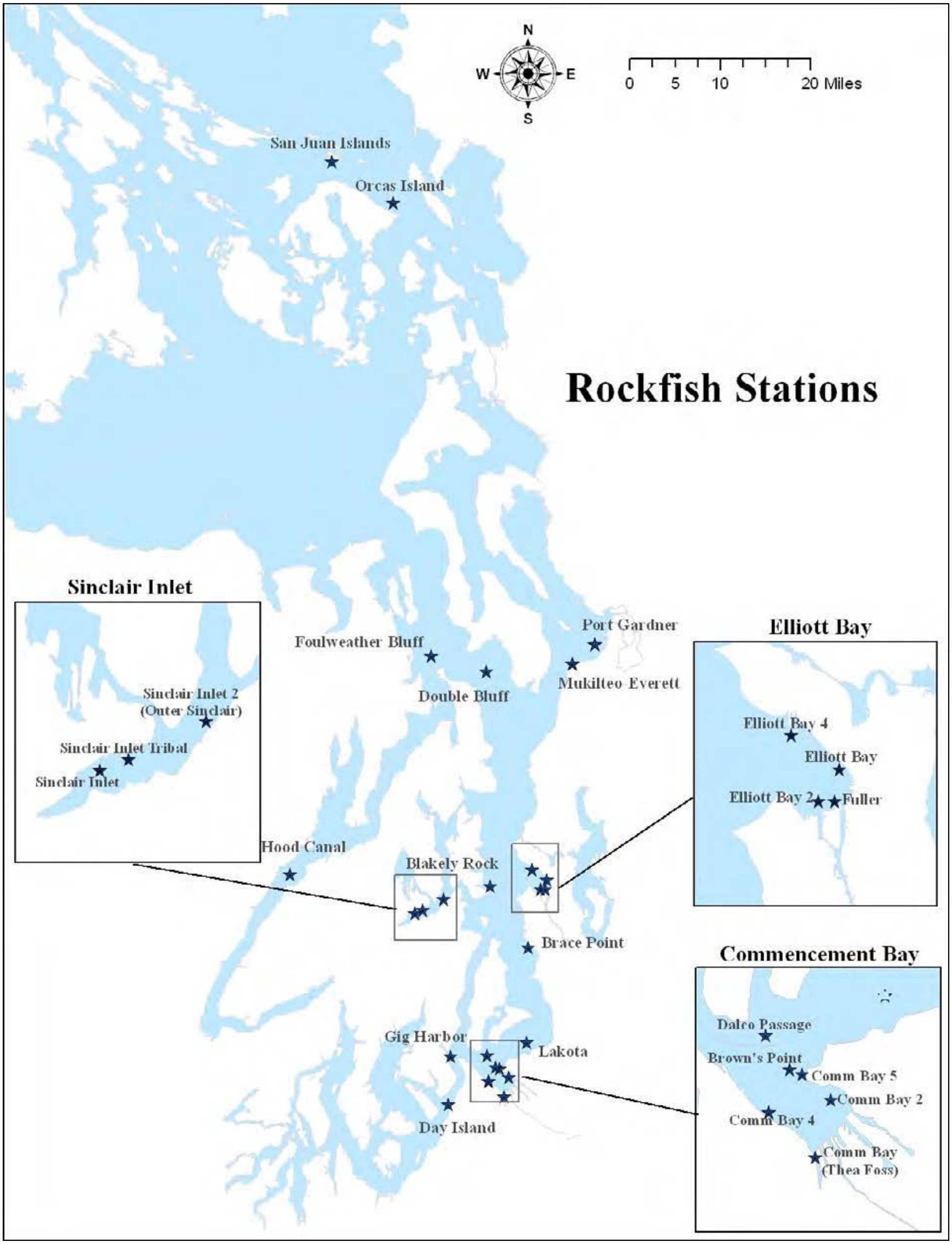
Table 1. Puget Sound English sole (ES) and rockfish (R) sampling stations classified by urban, near-urban, or non-urban setting.*

Urban stations		Near urban stations		Non urban stations	
Commencement Bay (Thea Foss)	ES, R	Budd Inlet	ES	Apple Cove Point	ES
Commencement Bay 2	ES, R	Bellingham Bay (outer)	ES	Birch Point	ES
Duwamish	ES	Blakely Rock	R	Carr Inlet 1	ES
Eagle Harbor	ES	Brown's Point	R	Case Inlet 1 (South Case Inlet)	ES
Elliott Bay (Seattle Waterfront)	ES, R	Cherry Point	ES	Case Inlet 3 (North Case Inlet)	ES
Elliott Bay 2 (Harbor Island)	ES, R	Commencement Bay 3 (Ruston)	ES	Day Island	R
Elliott Bay 4 (Myrtle Edwards)	ES, R	Commencement Bay 4 (Old Tacoma)	ES, R	Discovery Bay	ES
Fuller Shipwreck (Elliott Bay)	R	Commencement Bay 5 (Brown's Point)	ES, R	Double Bluff	R
Mukilteo-Everett	ES, R	Dalco Passage	R	Fern Cove	ES
Outer Commencement Bay	ES	Dash Point	ES	Foulweather	R
Port Gardner	ES, R	Dyes Inlet	ES	Hood Canal	ES, R
Sinclair Inlet	ES, R	Elliott Bay 5 (Alki)	ES	Hood Canal M	ES
Sinclair Inlet (Tribal)	R	Gig Harbor	R	Hood Canal S	ES
		Lakota	R	McAurther Bank	ES
		Liberty Bay	ES	Nisqually	ES
		Port Orchard	ES	Orcas Island	ES, R
		Port Townsend	ES	Outer Birch Point	ES
		Sinclair Inlet 2 (Outer Sinclair)	ES, R	Pickering Passage	ES
		Sinclair Inlet 3	ES	Possession Point	ES
		Sinclair Inlet 4 (Battle Point)	ES	Port Ludlow	ES
		Sinclair Inlet 5 (Blake Island)	ES	Port Madison	ES
				Point Roberts	ES
				Port Susan	ES
				San Juan Islands	R
				Saratoga Passage	ES
				Shilshole	ES
				Strait of Juan de Fuca	ES
				Strait of Georgia	ES
				Vendovi Island	ES
				Wollochet	ES

* Urban, near-urban, and non-urban stations were determined by WDFW (West et al. 2001) and updated for this report.

Figure 2. Puget Sound sites where English sole were sampled by WDFW for the Puget Sound Assessment and Monitoring Program.

Figure 1. Puget Sound sites where rockfish were sampled by WDFW for the Puget Sound Assessment and Monitoring Program.



Tissue Analysis

A detailed description of analytical methods used to measure contaminants in Puget Sound fish sampled and analyzed by PSAMP is available (West et al. 2001). The following provides a summary of information described in the WDFW report. Chemical analyses for organic and inorganic compounds followed procedures from the Puget Sound Estuary Program (PSEP 1989a, 1989b). These protocols reference USEPA Contract Laboratory Program Procedures (EPA 1986a, 1986b) and incorporate additional Quality Assurance/Quality Control (QA/QC) requirements.

All metals, including mercury, were analyzed as total elemental concentrations and reported as parts per million wet weight (ppm). Separate digestates were prepared for mercury using the nitric acid/sulfuric digestion method then analyzed by the cold vapor atomic absorption method. DOH assumed that total mercury concentrations were available as methylmercury because 90 - 100% of total mercury is typically in the form of methylmercury in adult fish (EPA 2001a).

Organic compounds were extracted from tissue samples by soxhlet extraction (for 1989 and 1990 samples) or sonication with a methylene chloride and acetone mix (for 1991, 1992, and 1993 samples). Beginning in 1991, all extracts were cleaned by gel permeation chromatography. The extracts were split, one for pesticide and PCB analyses and the other for base/neutral/acid-extractable (BNA) compounds.

Pesticides and PCBs were analyzed using gas chromatography-electron capture detection (GC/ECD), with Aroclor mixtures used as standards for quantifying PCB concentrations and reported as parts per billion (ppb) wet weight. In 1989 and 1990, a dual megabore column was used on the GC/ECD, but in 1991, 1992, and 1993, a dual narrow-bore column better suited to analyzing low concentrations was substituted. Starting with 1992 rockfish samples, new chromatography software was used for quantification of pesticides and PCBs, allowing laboratory chemists to more accurately quantify low concentrations of these chemicals. Because of these method changes, PCB data from 1989 and 1990 were not included in this evaluation. Chromatographic peaks used to quantify individual Aroclors may have contributions from multiple Aroclors, resulting in overestimation of an individual Aroclor level. Total PCBs in tissue can be overestimated when inflated results for individual Aroclors are summed.

A congener-specific screening method and estimation of total PCBs and pesticides (using high performance liquid chromatography with photodiode array - HPLC/PDA) was adopted in 1997 (Krahn et al. 1994). The method provided measures of 15 of 209 PCB congeners (77, 101, 105, 110, 118, 126, 128, 138, 153, 156, 157, 169, 170, 180, and 189). In 1997 and 1998, a number of tissue samples were analyzed using both the Aroclor-PCB (GC/ED) and the congener-PCB (HPLC/PDA) method. Results of both methods are included in this report. The HPLC/PDA method avoids overestimation of PCB concentration inherent in the Aroclor-summation procedure but may underestimate total PCBs because it only analyzes a fraction of PCB congeners.

Total PCBs were estimated in this report using two methods:

- Arithmetic summation of individual Aroclors (1248, 1254, and 1260), and
- Analytical measurement of total PCBs by the HPLC/PDA screening method (measuring the concentration of 15 of 209 PCB congeners). This method provided estimates of "total PCBs" from measurements of total area under the congener curve. These results were later adjusted to derive an Aroclor-equivalent concentration based on observed trends from samples analyzed using both methods.

WDFW staff validated 1989 and 1990 data and, beginning in 1991, an independent QA/QC chemist reviewed tissue chemistry data. Internal QA/QC reports are available from WDFW on request. For this report, one-half of the detection value was used when chemicals were not detected above the analytical detection level. The average detection limit for Aroclors was 2.0 ppb and <1.0 ppb for individual congeners by the HPLC/PDA method.

Risk Assessment

The following is an overview of steps used by DOH to determine whether or not fish consumers are potentially overexposed to contaminants in fish and to develop meal recommendations for consuming these fish (Figure 4).

- The first step is to determine how much fish is consumed by potentially-exposed anglers, tribal members, additional high-consuming populations, and other citizens. DOH typically uses mean and 90^{th} (or 95^{th}) percentile population-specific consumption rates to estimate average and high-end exposures.
- The second step is to obtain contaminant data (in this case from PSAMP) or to analyze fish samples for contaminant concentrations to estimate levels in fish tissue.
- Using this information, DOH can establish what contaminants people are exposed to and estimate the doses a person would receive from consuming fish.
- The next step is to determine if the calculated exposure dose is potentially unsafe. This is done in this report by comparing the calculated exposure dose to an oral reference dose (RfD) specific to each chemical of concern. A reference dose is a level of exposure below which non-cancer adverse health effects are not likely to occur. Further, lifetime increased cancer risk attributable to carcinogenic contaminants (i.e., PCBs) in fish is calculated and presented.
- Finally, if a population is over-exposed (i.e. PCB HQ > 1) based on a representative consumption rate, DOH then calculates acceptable meal limits based on non-cancer endpoints. A reference dose is considered protective of both non-cancer and cancer health effects for contaminants evaluated in this assessment (i.e., PCBs and mercury).

- The highest mean PCB level in English sole was found at the Duwamish station (168 ppb). This area is undergoing cleanup under EPA's Superfund process. DOH recently issued a fish advisory that recommends avoiding resident fish species within the Lower Duwamish Waterway (e.g., English sole, flounder and perch).

- Several other stations (e.g., Harbor Island, Sinclair Inlet, Commencement Bay – Thea Foss, and Eagle Harbor) were located where sediment cleanups have occurred or are occurring. The second highest mean PCB level in English sole was observed at Sinclair Inlet (123 ppb) where sediment cleanup is being conducted by the U.S. Navy. The high level of contaminants in English sole from these areas resulted in more restrictive meal limit calculations for these sites (Appendix D, Table D2).

Table 11. Calculated meal limits for English sole at non-urban, near-urban and select urban locations of Puget Sound.

Location	Average Mercury concentration (ppm)	Average PCB concentration (ppb)	Calculated meals per month based on mercury	Calculated meals per month based on PCBs	Calculated meals per month based on additive endpoint
Non-urban locations	0.051	9.3	16	17	9.8
Near-urban locations	0.053	17.2	15	9.3	7.3
Elliott Bay [a]	0.080	69.0	10	2.3	2.2
Sinclair Inlet	0.074	121	11	1.3	1.3
Commencement Bay [b]	0.069	60.9	12	2.6	2.5

[a] Comprised of Elliott Bay, Elliot Bay 2, and Elliott Bay 4 stations.
[b] Comprised of Commencement Bay, Commencement Bay 2, and Outer Commencement Bay stations.

English sole – based on PSAMP sediment PCB concentrations

PCB concentration in sediment appears to be the major factor influencing PCB concentration in English sole muscle tissue for a given location. In order to address the lack of sampling in some Puget Sound urban bays, WDFW determined a relationship based on PSAMP sediment and tissue data to predict English sole PCB concentrations where fish were not sampled (O'Neill and West 2006). In conjunction with mean sediment PCB concentrations from PSAMP, the following equation was used to estimate PCBs in English sole tissue at these sites:

$$[mPCB] = e^{1.64} * [sPCB]^{0.35} * e^{0.13} * Age$$

Where:

mPCB = concentration of PCBs in muscle as sum of 3 Aroclors, ng/g, wet wt.,
sPCB = concentration of PCBs in sediments as sum of 3 Aroclors, ng/g, dry wt.,
Age = fish age in years.

Although the resulting predicted concentration in fish tissue is an estimate, it is useful to calculate meal limits for locations where sediment concentrations are known but where English

Table D1 (cont.). Estimated meals per month for rockfish from Puget Sound, based on contaminant concentrations for each station and chemical.

Location	Rockfish Species	Type	Mercury			Total PCBs (Aroclors)			Total PCBs (Sum of 15 congeners)		
Lakota	Quillback	I	4	0.295	3	4	62.8	3	0	NA	NA
Recreational Management Area 12											
Hood Canal	Quillback	C	8	0.183	4	2	7.7	21	0	NA	NA
	Copper	C	1	0.170	5	1	6.5	25	0	NA	NA
Recreational Management Area 13											
Day Island	Quillback	C	6	0.098	8	0	NA	NA	0	NA	NA
	Copper	C	18	0.095	8	11	8.3	19	0	NA	NA

NOTE: Meal = eight ounces
N = sample size
Type: I = individual sample, C = composite sample
NA = Not available

Table D2. Estimated meals per month for English sole from Puget Sound, based on contaminant concentrations for each station and chemical.

Location	Mercury				Total PCBs (Aroclors)			Total PCBs (sum of 15 congeners)		
	Type	N	Mean (ppm)	Meals/ month	N	Mean (ppb)	Meals/ month	N	Mean (ppb)	Meals/ month
Recreational Management Area 6										
Discovery Bay	C	3	0.093	9	3	3.9	41	0	NA	NA
Strait of Juan de Fuca	C	6	0.050	16	6	7.0	23	0	NA	NA
Recreational Management Area 7										
Bellingham Bay (outer)	C	9	0.031	26	9	3.8	42	0	NA	NA
Birch Point	C	6	0.034	24	6	5.1	32	0	NA	NA
Cherry Point	C	3	0.038	21	0	NA	NA	3	13.9	12
McAurther Bank	C	3	0.043	19	3	3.2	50	0	NA	NA
Orcas Island	C	3	0.027	30	3	3.6	45	0	NA	NA
Outer Birch Pt.	C	3	0.047	17	3	3.1	52	0	NA	NA
Point Roberts	C	3	0.020	40	3	4.8	33	0	NA	NA
Strait of Georgia	C	34	0.051	16	21	5.8	28	15	11.2	14
Vendovi Island	I and C	44	0.038	21	23 I 11 C	3.8	42	014	7.8	21
Recreational Management Area 8-1										
Saratoga Passage	C	6	0.072	11	6	20.2	8	0	NA	NA
Recreational Management Area 8-2										
Mukilteo-Everett	C	2	0.040	20	0	NA	NA	0	NA	NA
Port Gardner	C	34	0.048	17	21	17.5	9	8	22.4	7
Port Susan	C	3	0.070	11	0	NA	NA	1	5.5	29
Recreational Management Area 9										
Possession Point	C	6	0.057	14	6	11.7	14	0	NA	NA

Table D2 (cont.). Estimated meals per month for English sole from Puget Sound, based on contaminant concentrations for each station and chemical.

	Mercury				Total PCBs (Aroclors)			Total PCBs (sum of 15 congeners)		
Location	Type	N	Mean (ppm)	Meals/ month	N	Mean (ppb)	Meals/ month	N	Mean (ppb)	Meals/ month
Port Ludlow	C	3	0.070	11	3	6.7	24	0	NA	NA
Port Townsend	C	12	0.049	16	12	9.7	17	0	NA	NA
Recreational Management Area 10										
Apple Cove Pt.	C	6	0.063	13	6	9.8	16	0	NA	NA
Duwamish	C	9	0.064	13	6	168	1	3	164	1
Dyes Inlet	C	6	0.047	17	6	28.0	6	0	NA	NA
Eagle Harbor	C	12	0.095	8	6	42.6	4	6	52.3	3
Elliott Bay	C and I	63	0.079	10	29 I 21 C	64.4	2	15	75.8	2
Elliott Bay 2	C	3	0.095	8	2	26.5	6	3	85.9	2
Elliott Bay 4	C	3	0.080	10	0	NA	NA	3	21.0	8
Elliott Bay 5	C	3	0.072	11	3	16.7	10	3	22.4	7
Liberty Bay	C	6	0.046	17	6	23.3	7	0	NA	NA
Port Madison	C	3	0.046	17	3	13.3	12	0	NA	NA
Port Orchard	C	6	0.067	12	6	36.8	4	0	NA	NA
Sinclair Inlet	C and I	58	0.074	11	24 I 21 C	121	1	15	122	1
Sinclair Inlet 2	C	3	0.071	11	0	NA	NA	3	22.8	7
Sinclair Inlet 3	C	3	0.063	13	0	NA	NA	3	63.8	3
Sinclair Inlet 4	C	3	0.061	13	0	NA	NA	3	38.8	4
Sinclair Inlet 5	C	3	0.086	9	0	NA	NA	3	31.0	5
Shilshole	C	6	0.059	14	5	22.9	7	0	NA	NA
Recreational Management Area 11										
Commenceme nt Bay	C and I	57	0.068	12	35 I 20 I	63.0	3	14	79.1	2
Commenceme nt Bay 2	C	3	0.067	12	0	NA	NA	3	82.4	2
Commenceme nt Bay 3	C	3	0.049	16	0	NA	NA	3	34.2	5
Commenceme nt Bay 4	C	3	0.051	16	0	NA	NA	3	43.2	4
Commenceme nt Bay 5	C	3	0.062	13	0	NA	NA	3	55.5	3
Dash Point	C	6	0.082	10	6	28.5	6	0	NA	NA
Fern Cove	C	3	0.072	11	3	19.3	8	0	NA	NA
Outer Commenceme nt	C	6	0.075	11	6	41.8	4	0	NA	NA
Recreational Management Area 12										
Hood Canal	C	36	0.059	14	21	6.4	25	15	11.8	14
Hood Canal M	C	6	0.038	21	6	3.5	46	0	NA	NA
Hood Canal S	C	6	0.030	27	6	4.8	33	0	NA	NA

Table D2 (cont.). Estimated meals per month for English sole from Puget Sound, based on contaminant concentrations for each station and chemical.

Location	Mercury				Total PCBs (Aroclors)			Total PCBs (sum of 15 congeners)		
	Type	N	Mean (ppm)	Meals/ month	N	Mean (ppb)	Meals/ month	N	Mean (ppb)	Meals/ month
Recreational Management Area 13										
Budd Inlet	C	9	0.035	23	9	8.8	18	0	NA	NA
Carr Inlet	C	6	0.052	15	6	14.0	11	0	NA	NA
Case Inlet 1	C	6	0.045	18	6	16.0	10	0	NA	NA
Case Inlet 3	C	3	0.040	20	3	8.3	19	0	NA	NA
Nisqually	C	24	0.061	13	12	21.5	7	15	24.0	7
Pickering	C	6	0.032	25	6	9.2	17	0	NA	NA
Wollochet	C	6	0.055	15	6	26.3	6	0	NA	NA

NOTE: Meal = eight ounces
N = sample size
Type: I = individual sample, C = composite sample
NA = Not available

Table D3. Estimated meals per month for Chinook salmon from Puget Sound, based on contaminant concentrations for each station and chemical.

Location	Mercury				Total PCBs (Aroclors)		
	Type	N	Mean (ppm)	Meals/ month	N	Mean (ppb)	Meals/month
In-river Fisheries							
Nooksak River	C	18	0.087	9	28	37.9	4
Skagit River	C and I	18 C	0.100	8	3 I 26 C	40.6	4
Duwamish River	C and I	18 C	0.102	8	34 I 31 C	57.2	3
Nisqually River	C and I	12 C	0.085	9	1 I 19 C	41.9	4
Deschutes River	C and I	12 C	0.108	7	12 I 22 C	60.4	3
Marine Fisheries							
Central Sound	C	**22**	**0.074**	**11**	**18**	**75.7**	**2**
Apple Cove Pt.	C	12	0.062	13	12	90.8	2
Central Sound	C	4	0.070	11	0	NA	NA
Sinclair Inlet	C	6	0.099	8	6	45.5	4
South Sound	C	**6**	**0.113**	**7**	**16**	**70.6**	**2**
Budd Inlet	C	0	NA	NA	10	55.5	3
South Sound	C	6	0.113	7	6	95.7	2

NOTE: Meal = eight ounces
N = sample size
Type: I = individual sample, C = composite sample
NA = Not available
Shading = Total sample size, mean, and meals/month for all marine fishery stations in Central and South Sound.

Table 3. (cont.) Summary of mercury (ppm, wet weight) and PCBs (ppb, wet weight) measured in four species of rockfish, English sole, Chinook salmon and coho salmon from Puget Sound.

	Mercury			**Total PCBs (Aroclors)[a]**			**Total PCBs (Aroclor Equivalent)[b]**		
	n	Range (ppm)	Mean (ppm)	n	Range (ppb)	Mean (ppb)	n	Range (ppb)	Mean (ppb)
ENGLISH SOLE	577	0.017-0.14	0.060	434	2-462	38.6	169	4-214	46.6
Urban	256	0.023-0.140	0.072	191	6-462	73.6	82	12-214	74.1
Near-urban	81	0.020-0.118	0.053	57	3-76	17.2	27	13-96	36.2
Non-urban	240	0.017-0.130	0.051	186	2-52	9.3	60	4-39	13.7
SALMON									
Chinook									
All of Puget Sound	106	0.051-0.160	0.093	210	11-223	54.0	NA	NA	NA
In-river[c]	78	0.058-0.160	0.096	176	11-223	50.2	NA	NA	NA
Marine[d]	28	0.051-0.130	0.082	34	21-212	73.2	NA	NA	NA
Central Sound	22	0.051-0.120	0.074	18	21-170	75.6	NA	NA	NA
South Sound	6	0.092-0.130	0.113	16	24-212	70.6	NA	NA	NA
Coho									
All of Puget Sound	225	0.008-0.110	0.039	221	5-126	31.8	224	16-106	35.5
In-river[c]	183	0.008-0.110	0.038	175	5-98	31.1	139	17-82	34.6
Marine[d]	32	0.028-0.071	0.051	46	8-126	34.4	42	21-106	42.1
Minter Creek and Wallace River Hatchery	10	0.020-0.043	0.029	NA	NA	NA	43	16-106	32.1
Central Sound	26	0.028-0.069	0.049	20	8-61	18.3	10	30-59	46.8
South Sound	6	0.045-0.071	0.057	26	18-126	46.8	32	21-106	40.6

Note: Means reflect equal weighting of individual and composite samples.
[a] Sum of Aroclors 1248, 1254, and 1260.
[b] Approximation of equivalent Aroclor concentration from HPLC data.
[c] "In-river" refers to nearshore areas near rivers and river mouths from which salmon most likely originated.
[d] "Marine" refers to offshore areas where the origins of salmon are unknown.

Estimating Exposure to Contaminants in Puget Sound Fish

Fish Consumption Rates

Numerous Puget Sound human seafood consumption surveys have been conducted. Consumption surveys that ask how much fish is being eaten, how often, and which species are being consumed can be used to estimate exposure rates from eating contaminated fish. DOH considered four regional seafood consumption surveys for Puget Sound. Members of the Suquamish Indian Tribe (Suquamish 2000) and the Tulalip and Squaxin Island Tribes (Toy et al. 1996) were interviewed in two separate studies to estimate Puget Sound Native American consumption rates. A survey of the Asian Pacific Islander (API) community was conducted by EPA (EPA 1999b) to estimate consumption rates. Recreational anglers from four Puget Sound areas were surveyed in two studies by NOAA (Landolt et al. 1985, 1987).

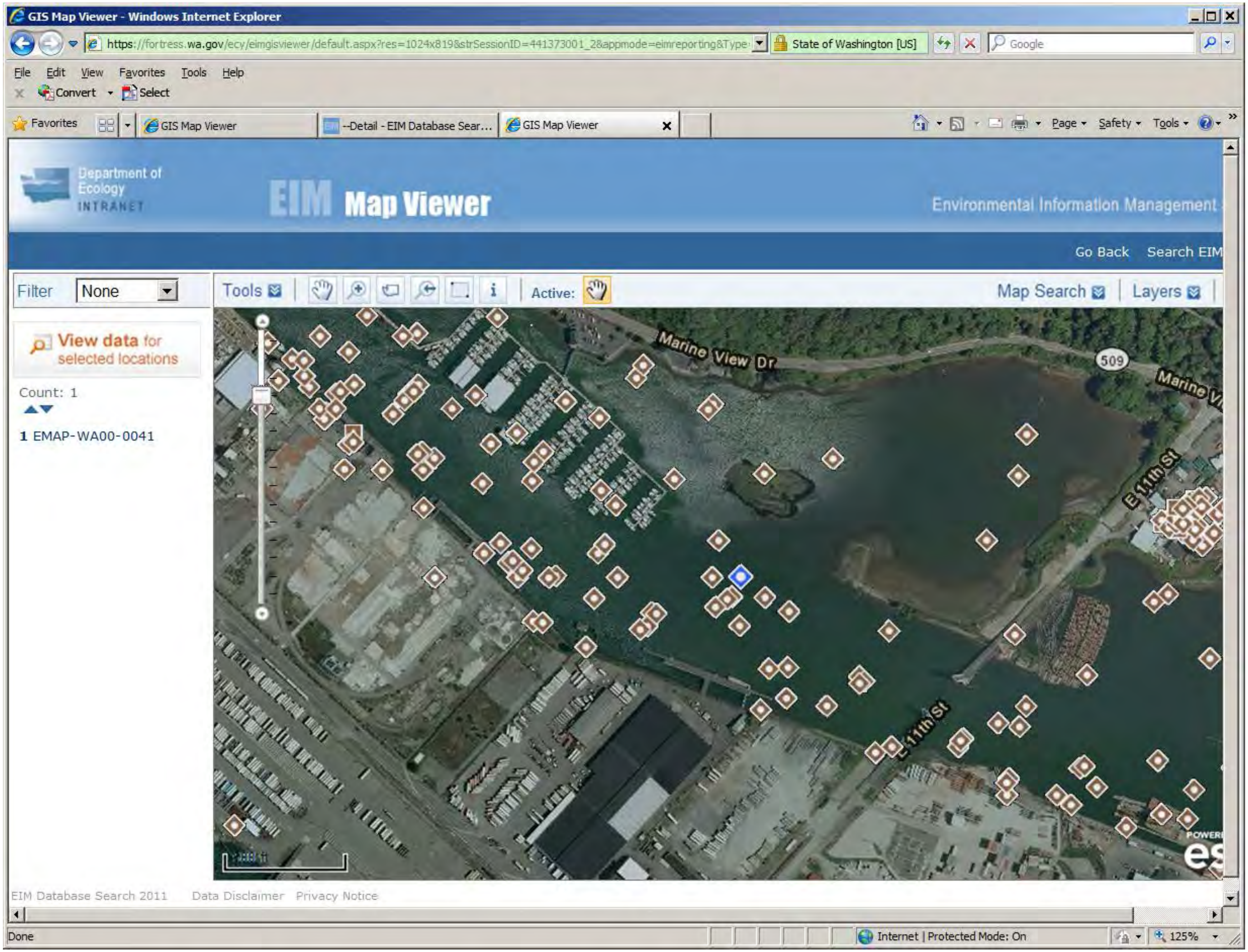
ATTACHMENT KK-4. English Sole Tissue Data in Hylebos Waterway

EMAP-WA00-0041 (Hylebos Waterway) English sole Tissue Data, July 2000.

Study ID	Location ID	Study Location Name	Field Activity Start Date	Sample Matrix	Sample Source - English sole	Result Parameter Name	Result Reported Value	Result Data Qualifier	Result Measurement Basis Code	Result Value UOM	Result Method Code
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	Fish Total Length, Mean of Individuals in Composite Sample	224			mm	WESLENGTH
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	Fish Weight, Mean of Individuals in Composite Sample	109			g	WESWEIGHT
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	Fish, Number in Composite Sample	7			count	COUNT
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-008	0.6	U	WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-018	0.36	U	WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-028	9.2		WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-044	6.1		WET	ng/g	SW8082

EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-052	17		WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-066	0.19	U	WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-077	0.86	U	WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-077/110	36		WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-101	56		WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-105	16		WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-118	42		WET	ng/g	SW8082
EMAP 1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-126	0.8	U	WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-128	10		WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-138	60		WET	ng/g	SW8082

EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-153	83		WET	ng/g	SW8082
EMAP 1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-180	30		WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-187	35		WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-189	14		WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-195	2.2		WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-206	18		WET	ng/g	SW8082
EMAP_1999-2002	EMAP-WA00-0041	WA00-0041	7/19/2000	Tissue	Animal Tissue	PCB-209	8.1		WET	ng/g	SW8082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Attachment KK-5, Godtfredsen 2012.

Godtfredsen, K., S. McGroddy, J. West, L. Kissinger, E. Hoffman, and D. Hotchkiss. 2012. Technical Memorandum: 6/20/12 Meeting Notes: PCB Analysis in Tissue. Final text revised by consensus on 12/5/12.

6/20/12 Meeting Notes: PCB Analysis in Fish Tissue

Final text revised by consensus on 12/5/12.

Attendees: Kathy Godtfredsen, Susan McGroddy, Jim West, Lon Kissinger, Erika Hoffman, Doug Hotchkiss

Progression of PCB Analysis in PSAMP Fish Sampling Program

1990 to 1997/8 - PSAMP used Aroclor analysis with GC/ECD at King County Environmental Lab (KCEL) using manual quantitation.

1995 – Aroclors analyzed by King County laboratory using automated quantitation.

PSAMP 1997/8 to 2004 - Switched to using an HPLC/PDA “screening method” of PCB congener analysis, which quantified 15 congeners. Sum of identified congener data + “area under the curve for unidentified PCB congeners” was used to estimate total PCB concentration. James West notes that it was later determined that this method underestimated Sum209Congener PCBs (see below).

1997/98 - Conducted a comparison study during the switch to congener-based methods. Ninety-three samples were run to generate an Aroclor–to-HPLC/PDA conversion model. Using linear regression the HPLC/PDA method for Total PCBs underestimated the sum of Aroclors (calculated as the sum of two routinely detected Aroclors, 1254 and 1260) by 70% (i.e., HPLC-PDA totals were 30% of the Sum of Aroclors).

1997-2002 - Used manual solvent extraction methods for HPLC/PDA.

2003/4 - Switched to Accelerated Solvent Extraction (ASE). Many pre-2003 samples were run retrospectively using HPLC/PDA with ASE. Thirty-six samples were run by both methods to evaluate bias and generate a correction factor. In later years, chemists suspected interferences from PBDEs, so the screening method was dropped in favor of a more traditional GC/MS approach.

2004 to present - Switched to a 40-congener low resolution GC/MS congener analysis with ASE. Selection of the 40 congeners was based on those most frequently detected in Puget Sound tissues.

- Congeners 126 and 169, which co-elute and have a low concentration, were not included.
- Low resolution method has a higher LOQ (500 pptr range) and fewer standards than high resolution.
- The low resolution method is inadequate for TEQ-based human health risk assessment because critical TEQ congeners were not analyzed. DOH used PSAMP Aroclor and HPLC/PDA total PCB data for their human health risk assessment of salmon, rockfish, and English sole. They will use PSAMP GC/MS LowRes data to run similar human health risk assessments for crab and shrimp in 2012/3.
- PSAMP adopted NOAA’s “2xSum18 Congeners” as one estimate of total PCB concentration, in addition to the “Sum of 40 Congeners.”

2004 - PSAMP compared total PCB estimates from congener-based monitoring methods with Hi Resolution GC/MS “Sum 209 Congener“ (HiRes) methods, assuming the latter provides the most accurate quantitation for total PCBs. PSAMP ran 28 samples using HPLC-PDA (ASE) against GC/MS

HighRes and 5 samples by 40-congener GC/MS LowRes against GC/MS HiRes; comparison was conducted using a number of different species to cover a wide range of lipids.

- Sum 40 congeners by GC/MS under-predicted Sum209Congeners by 34%.
- HPLC/PDA/ASE under-predicted Sum209Congeners by 28%.
- 2xSum18 Congeners was equivalent to Sum209Congeners (slope=0.991).

LDWG also ran sample splits of 6 PSAMP GC/MS LowRes samples of English sole fillet at Axys for HighRes and Aroclor analysis at ARI (see Table 1 for results).

- Calculating NOAA's 2xSum18 using PSAMP's and LDWG's GC/MS HighRes results gives good estimate of HiRes Sum209Congeners.
- Conclusion: 2xSum18Congeners is a good proxy for Sum209Congeners.

Other PSAMP comparisons are consistent with these results: The total PCB estimate generated by the HPLC/PDA method (i.e., sum of 15 congeners plus unidentified congeners) under predicted the sum 2x18 congeners by approximately 27% (ASE) and 33% (NoASE).

2007 – PSAMP revisited the Aroclor question; they compared GC/MS results with Aroclor-based results by running archived samples collected in the early 2000s by both methods simultaneously. The Aroclor samples were run by KCEL using their current (2007) protocols and it is unclear how those protocols differed from the 1990s (if at all). At a minimum, extraction methods were different – ASE was used in 2007 but not in previous years. No consistent relationship was found to predict one from the other from this comparison effort.

2009 - A study with 40 samples (with a range of species) was done by LDWG in which samples were analyzed by high res GC/MS and also by the King County lab using prior Aroclor-based methods. Erika Hoffman indicated that the analytical methods were detailed in a March 5, 2009 report ("Chemical Analyses of Fish, Crab, and Clam tissue samples and co-located sediment samples collected in 2007"), and that PCB congeners were analyzed by Axys using HRGC/HRMS EPA 1886 and PCB Aroclors were analyzed by ARI using GC/ECD EPA 8082. Highly variable results were found, lending further uncertainty to the 1990s Aroclor results.

2011 – English sole were sampled by PSAMP near Kellogg Island and in 2007, '09, and '11 found to have an average total PCB concentration of 286, 314, and 274 ng/g wet wt based on GC/MS 2xSum18Congeners.

Table 1 shows the list of PCB congeners used in the three summation procedures by PSAMP.

Bottom Lines of PCB Analysis in PSAMP Fish Sampling Program

Jim strongly recommends caution in using Aroclors to estimate total PCBs from the pre-1997 Aroclor analysis for trends.

Susie recommended including Aroclor data on Vital Sign plots, but omitting them from the trend analysis.

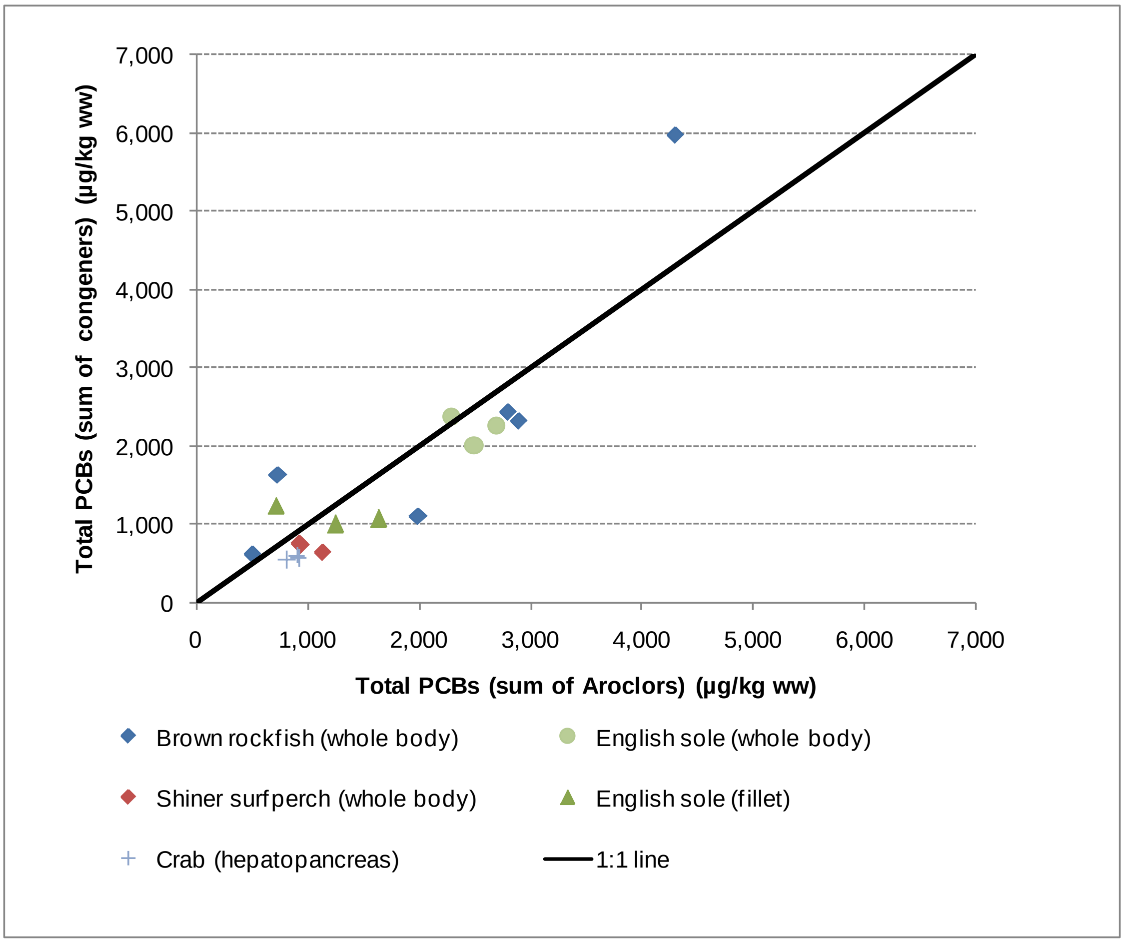
Jim is working on a report that will document all the PSAMP PCB methods changes, and the implications of these changes on evaluating long-term time trends.

Lacking is a comparison of the 2xSum18Congeners summation method with Sum209Congeners, for all samples that have ever been run on the latter. That is, pull out the 18 congeners from the HiRes analysis, sum them, multiply by two and compare with the sum of all congeners from the HiRes analysis.

East Waterway Data (2005)

The East Waterway data had a decent relationship between high res total PCBs and Aroclor-based totals in all fish/crab tissue. Overall, concentrations were much higher in the EWW than in the LDW (concentrations ranged from approximately 700 to 3,000 ppb ww vs. < 500 ppb in fish collected by PSAMP near Kellogg Island). Aroclor analyses generally resulted in overestimates of total PCB concentrations in EWW samples.

It should be noted that English sole samples were replicate "super composite samples" created by combining all the composites together. The PCB Aroclor results were much more variable than the PCB congener results in English sole fillets. Overall, the two methods gave comparable results.



Lower Duwamish Waterway Data (2007)

Six PSAMP English sole fillet (without skin) samples were shared with the LDW group in 2007. These samples were analyzed for PCB congeners (Axys) and Aroclors (ARI). The sum of PCB Aroclors was consistently lower than the sum of 209 PCB congeners (Table 1).

Table 1. Comparison of total PCBs as sum of 209 PCB congeners and PCB Aroclors for six PSAMP split samples

	Total PCBs (µg/kg ww)		
Sample	**Sum of 209 PCB congeners**	**Sum of PCB Aroclors**	**2xSum18 Method (NOAA)**
07DU-ESM01	315.4	128	315
07DU-ESM02	279.9	115	221
07DU-ESM03	316.0	148	324
07DU-ESM04	396.0	136	396
07DU-ESM05	307.2	121	236
07DU-ESM06	262.0	92	227

The PSAMP total PCB values calculated using the NOAA 2xSum18 method on LoRes GC/MS data from these samples collected in 2007 are shown above. These results are more consistent with the Sum 209 congener totals than the Sum Aroclors. Other PCB tissue data from the LDW RI are presented below (using Table 4-33 and Figure 4-12 as numbered from the RI, for ease of reference). Table 4-33 provides the total PCB data that are graphed in Figure 4-12.

Table 4-33. Total PCB concentrations (sum of PCB congeners) in composite tissue samples collected from the LDW

		2004				2005				2007			
			Total PCBs (µg/kg ww)				Total PCBs (µg/kg ww)				Total PCBs (µg/kg ww)		
Tissue Type	Area[a]	N	Min	Max	Mean[b]	n	Min	Max	Mean[b]	n	Min	Max	Mean[b]
Fish, Whole Body													
English sole	T1	2	1,614 J	2,481 J	2,048	1	2,589 J	2,589 J	2,589	2	774 J	1,165 J	970
	T2	2	2,126 J	2,712 J	2,419	1	3,214 J	3,214 J	3,214	2	1,603 J	1,632 J	1,618
	T3	2	1,419 J	2,457 J	1,938	1	1,433 J	1,433 J	1,433	2	1,032 J	2,928 J	1,980
	T4	1	1,361 J	1,361 J	1,361	0	no data			0	no data		
Shiner surfperch	T1	2	700.1 J	876.6 J	788.4	1	683.1 J	683.1 J	683.1	2	504.1 J	974 J	739
	T2	2	1,055 J	12,228 J	6,642	1	1,047 J	1,047 J	1,047	2	401.6 J	648.3 J	525.0
	T3	3	1,009 J	8,010 J	4,180	1	2,048 J	2,048 J	2,048	2	1,103 J	2,462 J	1,783
	T4	2	532.4 J	770 J	651	0	no data			0	no data		

		2004				2005				2007			
			Total PCBs (µg/kg ww)				Total PCBs (µg/kg ww)				Total PCBs (µg/kg ww)		
Tissue Type	Area[a]	N	Min	Max	Mean[b]	n	Min	Max	Mean[b]	n	Min	Max	Mean[b]
Pacific staghorn sculpin	T1	2	532.4 J	668.4 J	600.4	0	no data			0	no data		
	T2	2	481.6 J	496.3 J	489.0								
	T3	2	1,048 J	1,907 J	1,478								
	T4	2	349.6 J	504.9 J	427.3								
Starry flounder	T4	1	458 J	458 J	458	0	no data			0	no data		
Fish, Fillet													
English sole (with skin)	T1	2	857.5 J	1,119.2 J	988.4	0	no data			0	no data		
	T2	2	1,264.6 J	1,269 J	1,266.8								
	T3	2	641.1 J	1,022.9 J	832								
	T4	1	510 J	510 J	510								
Starry flounder (with skin)	T4	1	295.2 J	295.2 J	295.2	0	no data			0	no data		
Pile perch (with skin)	T3	1	192.2 J	192.2 J	192.2	0	no data			0	no data		
Striped perch (with skin)	RM 4.0 – RM 4.1	1	442.3 J	442.3 J	442.3	0	no data			0	no data		
Crab, Edible Meat													
Dungeness crab	T1	1	111 J	111 J	111	0	no data			1	49.45 J	49.45 J	49.45
	T3	1	149.3 J	149.3 J	149.3					1	86.2 J	86.2 J	86.2
	T4	1	148.7 J	148.7 J	148.7					0	no data		
Slender crab	T1	2	174.7 J	186.5 J	180.6	0	no data			1	112 J	112 J	112
	T2	2	129.7 J	180.6 J	155.2					1	86.2 J	86.2 J	86.2
	T3	1	134.3 J	134.3 J	134.3					0	no data		
Crab, Hepatopancreas													
Dungeness crab	T1	0	no data			0	no data			1	612.1 J	612.1 J	612.1 J
	T3	1	3,622 J	3,622 J	3,622					0	no data		
	T4	1	3,618 J	3,618 J	3,618								
Slender crab	T1	1	790.1 J	790.1 J	790.1	0	no data			0	no data		
	T2	1	1,047 J	1,047 J	1,047								
Crab, Whole Body (calc'd)[c]													
Dungeness crab	T1	0	no data			0	no data			1	223.9 JM	223.9 JM	223.9
	T3	1	1,226 JM	1,226 JM	1,226					0	no data		
	T4	1	1,224 JM	1,224 JM	1,224								

Tissue Type	Area[a]	N	2004 Total PCBs (µg/kg ww)			n	2005 Total PCBs (µg/kg ww)			n	2007 Total PCBs (µg/kg ww)		
			Min	Max	Mean[b]		Min	Max	Mean[b]		Min	Max	Mean[b]
Slender crab	T1	2	365.5 JM	373.6 JM	369.6	0	no data			0	no data		
	T2	2	414.06 JM	449.18 JM	431.62								
Invertebrates, Whole Body													
Benthic Invertebrates	LDW-wide [d]	8	32.13	1,346	393.5	0	no data			0	no data		
Shellfish													
Clams, non-depurated	LDW-wide [e]	8	41.05 J	930 J	222	0	no data			0	no data		

[a] Tissue sampling areas are shown on Maps 4-9 and 4-10.

[b] Mean concentration is the average of detected concentrations. There were no undetected results for total PCBs (as sum of PCB congeners).

[c] Data from composite hepatopancreas samples were mathematically combined with data from composite samples of edible meat to form composite samples of edible meat plus hepatopancreas. Total PCB concentrations in whole-body (i.e., edible meat plus hepatopancreas) crab were calculated assuming 69% (by weight) edible meat and 31% hepatopancreas, based on the relative weights of these tissues in a 16.6-cm Dungeness crab dissected by Windward in 2004 (unpublished data).

[d] Benthic invertebrate and clam samples were collected throughout the LDW (Map 4-10).

J – estimated concentration

JM – calculated from an estimated concentration

LDW – Lower Duwamish Waterway

M – calculated concentration

n – number of samples

PCB – polychlorinated biphenyl

RM – river mile

ww – wet weight

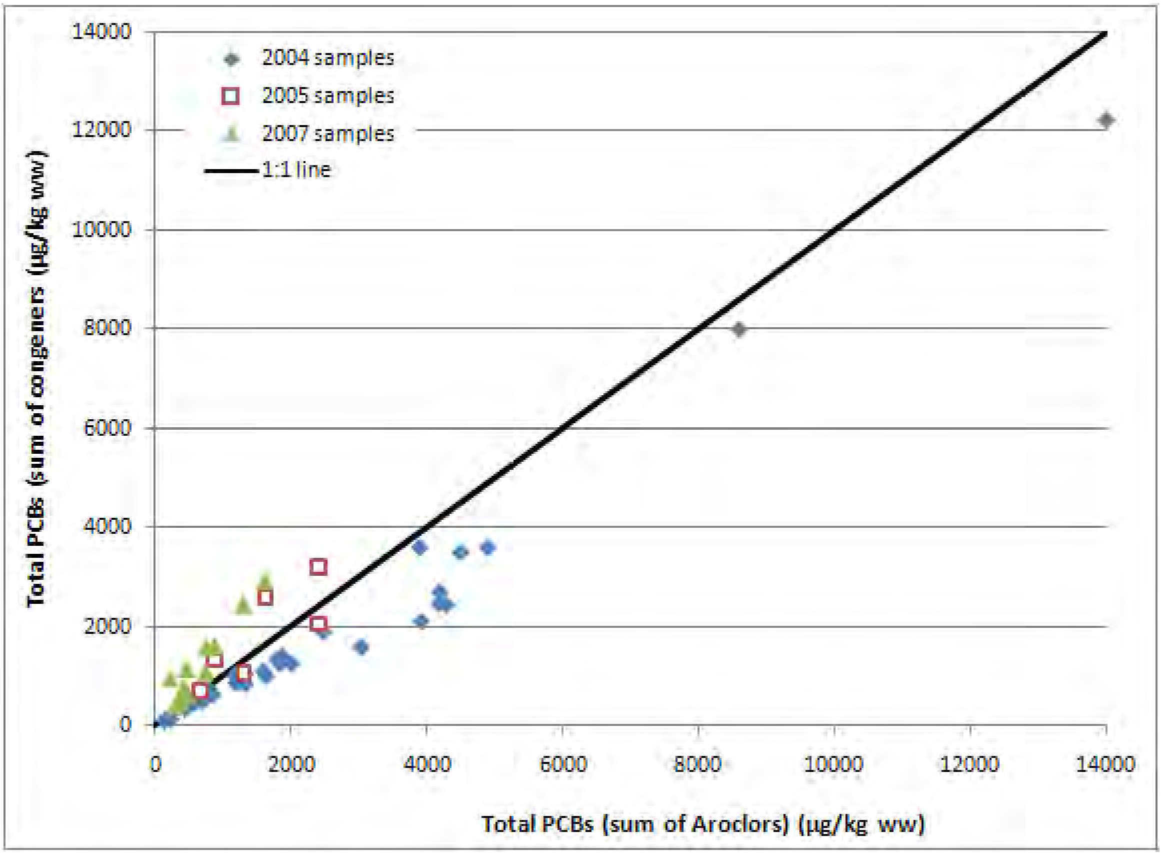


Figure 4-12. Total PCB concentration (sum of PCB congeners) compared with total PCB concentrations (sum of Aroclors) in fish and crab tissue samples

Dashboard Indicator Recovery Targets

Discussed concerns with use of Meador's tissue threshold for effects in juvenile salmonids. As an alternative, discussed presenting percentiles of TRVs for comparisons to raw data.

Given uncertainties in trend data for pre-1997 (see above), Jim will assign "yellow" indicator (indeterminate for trend) to Elliott Bay/LDW area (PSAMP's "Duwamish" station).

PSP's Leadership Council wants Vital Sign to use scientifically sound effects thresholds as recovery targets. Jim will pursue these but many are unavailable or contentious. Other reference values will be included in Vital Sign to put recovery targets in context, including "background" or "screening values." These could be "clicked on or off" by the user.

Could consider DOH thresholds (generally < 10 ppb PCBs – no advisory; 10-100 ppb advisory; > 100 ppb PCBs "bad") – based on noncancer endpoints. Would need to research a bit more.

Recent advisory levels for PCBs (and other contaminants) developed by California EPA may be pertinent here. Suggest this team review their work on Advisory Tissue Levels (ATLs) and Fish Contaminant Goals (FCGs):

Klasing, S. and R. Brodberg (2008). Development of fish contaminant goals and advisory tissue levels for common contaminants in California sport fish: chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene, Pesticide and Environmental Toxicology Branch, Office of Environmental Health Hazard Assessment
California Environmental Protection Agency**:** 122.

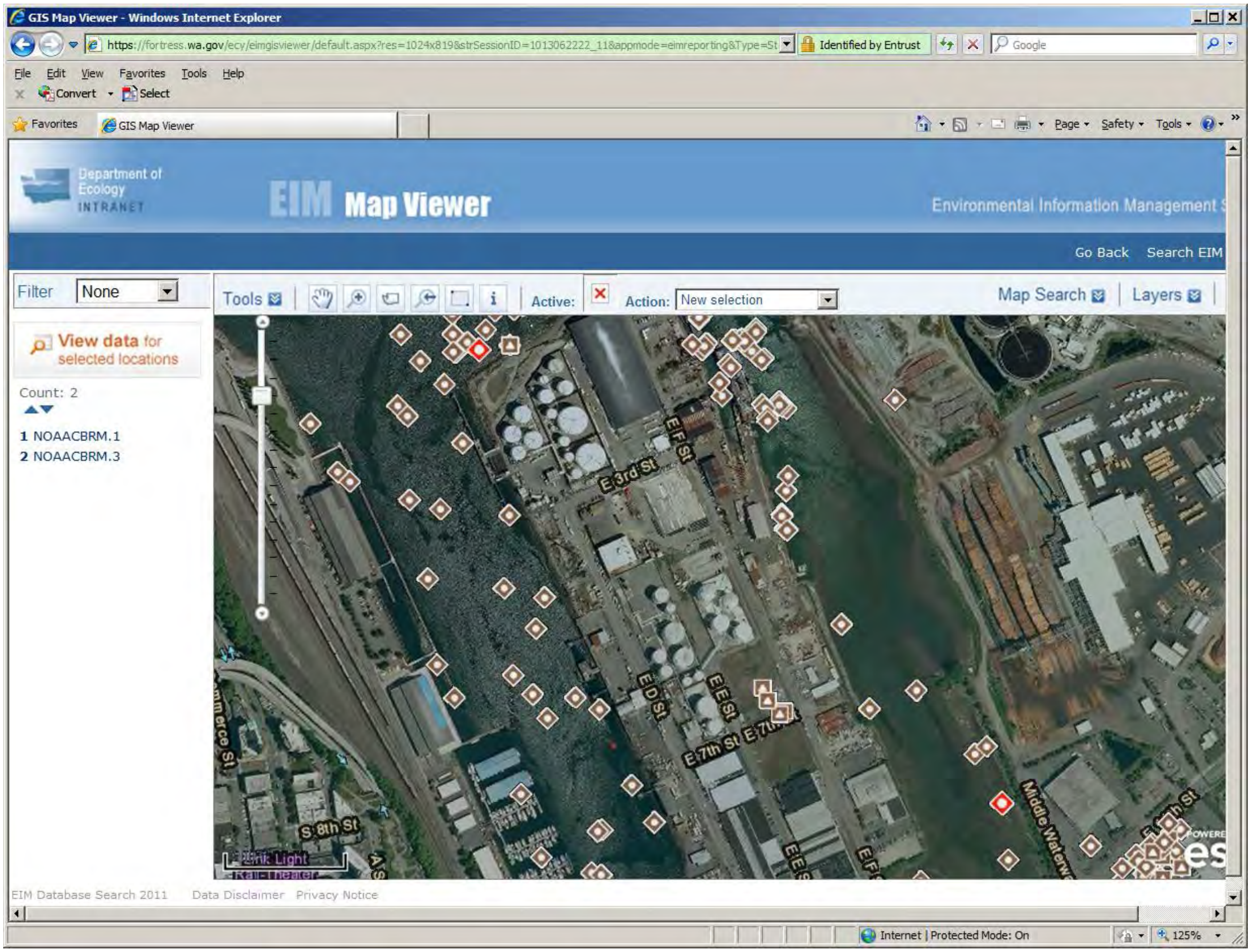
www.oehha.**ca**.gov/**fish**/gtlsv/pdf/FCGsATLs27June2008.pdf

Tables

Table 1. List of PCB congeners used in three summation procedures by PSAMP, as compiled by Jim West 12/4/2012.			
	NWFSC GC/MS Low Resolution	NWFSC HPLC/PDA	NOAA 2x18 (MusselWatch)
	Sum of 40 quantitated congeners	Sum of 15 identified congeners plus area under the curve for unidentified PCBs	"Two times the sum of 18 congeners" quantitated by any method
	PCB017		
	PCB018		PCB018
	PCB028		PCB028
	PCB031		
	PCB033		
	PCB044		PCB044
	PCB049		
	PCB052		PCB052
	PCB066		
	PCB070		
	PCB074		
		PCB077	
	PCB082		
	PCB087		
	PCB095		PCB095
	PCB099		
	PCB101/90	PCB101	PCB101
	PCB105	PCB105	PCB105
	PCB110	PCB110	
	PCB118	PCB118	PCB118
		PCB126	
	PCB128	PCB128	PCB128
	PCB138/163/164	PCB138	PCB138
	PCB149		
	PCB151		
	PCB153/132	PCB153	PCB153
	PCB156	PCB156	

		PCB157	
	PCB158		
		PCB169	
	PCB170	PCB170/194	PCB170
	PCB171		
	PCB177		
	PCB180	PCB180	PCB180
	PCB183		
	PCB187/159/182		PCB187
		PCB189	
	PCB191		
	PCB194		
	PCB195		PCB195
	PCB199		
	PCB205		
	PCB206		PCB206
	PCB208		
	PCB209		PCB209
TOTAL	40	15	17
Incl. Coeluters	46	16	18*
*Jim West (WDFW) will check the NOAA reference to clarify which of these coelutes to yield n=18.			

Attachment KK-6. Historical Fish Data – Pacific Staghorn – NOAA 2003. From Ecology EIM database (accessed 10-24-12).


GIS Map Viewer - Windows Internet Explorer
EIM Map Viewer
Environmental Information Management
Go Back
Search EIM
Filter None
View data for selected locations
Count: 2
1 NOAACBRM.1
2 NOAACBRM.3
Tools
Active:
Action: New selection
Map Search
Layers
E 3rd St
E F St
E D St
E E St
E 7th St
S 8th St
Middle Waterway
EIM Database Search 2011
Data Disclaimer
Privacy Notice
Internet | Protected Mode: On
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Study ID	Location ID	Study Location Name	Field Activity Start Date	Sample Matrix	Sample Source - Pacific staghorn	Result Parameter Name	Result Reported Value	Result Measurement Basis Code	Result Value UOM
NOAACBRM	NOAACBRM.1	Middle Waterway	6/9/2003	Tissue	Animal Tissue	PCB	100	WET	ng/g
NOAACBRM	NOAACBRM.1	Middle Waterway	6/9/2003	Tissue	Animal Tissue	PCB	45	WET	ng/g
NOAACBRM	NOAACBRM.3	Olympic View	6/9/2003	Tissue	Animal Tissue	PCB	110	WET	ng/g
NOAACBRM	NOAACBRM.3	Olympic View	6/9/2003	Tissue	Animal Tissue	PCB	130	WET	ng/g
NOAACBRM	NOAACBRM.1	Middle Waterway	6/9/2003	Tissue	Animal Tissue	PCB	43	WET	ng/g
NOAACBRM	NOAACBRM.3	Olympic View	6/9/2003	Tissue	Animal Tissue	PCB	59	WET	ng/g
NOAACBRM	NOAACBRM.3	Olympic View	7/9/2003	Tissue	Animal Tissue	PCB	100	WET	ng/g
NOAACBRM	NOAACBRM.1	Middle Waterway	8/9/2003	Tissue	Animal Tissue	PCB	140	WET	ng/g
-	-	-	-	-	-	-	-	-	-

Location of PSAMP Baseline Station in Thea Foss Waterway where English sole were collected in April/ May in 2005, 2007, 2009, and 2011.

Source: http://wdfw.wa.gov/conservation/research/projects/marine_toxics/graphics/cb-sole-map.jpg

ATTACHMENT KK-7. PSAMP English sole station locations and data.

SampleID	Species	Year	StationID	LatNum	LongNum	Matrix	CompositeN	nMale	nFem	nUnk	MFUnkRatio	Mean Composite Length (Fork Length, mm)	Mean Composite Age (years)	GravimetricLipids (%)	SumPCBs 2x17 (ng/gwet)	SumPCBs40 Congeners (ng/gwet)	Mean and Range
05CB-ESM01	ENGLISH	2005	Thea Foss	47.2594559	-122.4361766	muscle	20	14	6		14:6:0	268.5	5.5	0.394124535	84.82	66	75 +/- 8
05CB-ESM02	ENGLISH	2005	Thea Foss	47.2594559	-122.4361766	muscle	20	14	6		14:6:0	260.55	5.8	0.427886379	87.54	69	66to83
05CB-ESM03	ENGLISH	2005	Thea Foss	47.2594559	-122.4361766	muscle	20	12	8		12:8:0	274	6.35	0.311222339	90.86	69	
05CB-ESM04	ENGLISH	2005	Thea Foss	47.2594559	-122.4361766	muscle	20	6	4	10	6:4:10	258.25	5.3	0.427550028	110.22	85	
05CB-ESM05	ENGLISH	2005	Thea Foss	47.2594559	-122.4361766	muscle	20	15	5		15:5:0	253.65	5.75	0.397348976	100.38	77	
05CB-ESM06	ENGLISH	2005	Thea Foss	47.2594559	-122.4361766	muscle	19	12	2	5	12:2:5	249.10526	6.052631579	0.455935109	104.3	83	
07CB-ESM01	ENGLISH	2007	Thea Foss	47.2594559	-122.4361766	muscle	20	13	7		13:7:0	265.15	6.93	0.223731809	69.18	53	40 +/- 9
07CB-ESM02	ENGLISH	2007	Thea Foss	47.2594559	-122.4361766	muscle	20	7	13		7:13:0	269.25	6.1	0.200551533	49.58	38	28to53
07CB-ESM03	ENGLISH	2007	Thea Foss	47.2594559	-122.4361766	muscle	20	9	11		9:11:0	264.95	6.47	0.235373033	58.24	45	
07CB-ESM04	ENGLISH	2007	Thea Foss	47.2594559	-122.4361766	muscle	20	11	9		11:9:0	242.85	5.8	0.266469727	41.04	32	
07CB-ESM05	ENGLISH	2007	Thea Foss	47.2594559	-122.4361766	muscle	20	9	11		9:11:0	251.25	5.7	0.164638482	39.6	28	
07CB-ESM06	ENGLISH	2007	Thea Foss	47.2594559	-122.4361766	muscle	20	9	11		9:11:0	254.2	6.6	0.261432205	54.78	43	
09CB-ESM01	ENGLISH	2009	Thea Foss	47.2594559	-122.4361766	muscle	20	10	10		10:10:0	275.4	6.5	0.177982135	91.52	67	85 +/- 26
09CB-ESM02	ENGLISH	2009	Thea Foss	47.2594559	-122.4361766	muscle	20	12	8		12:8:0	266.45	6.25	0.210885491	174.32	130	62to130
09CB-ESM03	ENGLISH	2009	Thea Foss	47.2594559	-122.4361766	muscle	20	14	6		14:6:0	271.85	7.45	0.127508613	98.68	73	
09CB-ESM04	ENGLISH	2009	Thea Foss	47.2594559	-122.4361766	muscle	20	16	4		16:4:0	255.8	6.2	0.146260352	103.88	76	
09CB-ESM05	ENGLISH	2009	Thea Foss	47.2594559	-122.4361766	muscle	20	12	8		12:8:0	249.3	5.5	0.18694131	134.6	99	
09CB-ESM06	ENGLISH	2009	Thea Foss	47.2594559	-122.4361766	muscle	20	11	9		11:9:0	257.6	6.05	0.1365926	83.78	62	
11CB-ESM01	ENGLISH	2011	Thea Foss	47.2594559	-122.4361766	muscle	20	10	8	2	10:8:2	265		0.270899147	95	71	71to92
11CB-ESM02	ENGLISH	2011	Thea Foss	47.2594559	-122.4361766	muscle	20	10	10	0	10:10:0	290.2			120	92	

Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

Appendix B
Updated Beach Play Risk Estimates, Species-Specific RBTC Calculations, and the Puget Sound Tissue Dataset

Final Feasibility Study

Lower Duwamish Waterway
Seattle, Washington

FOR SUBMITTAL TO:

The U.S. Environmental Protection Agency
Region 10
Seattle, WA

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, WA

October 31, 2012

Prepared by: AECOM
710 Second Avenue, Suite 1000 • Seattle, Washington • 98104
Windward environmental LLC
200 W Mercer St # 401 • Seattle, Washington • 98119

To calculate the clam RBTC, these values are substituted into Equation 3, as shown in Equation 5.

$$C_{clam} = RBTC_{clam} = \frac{RBTC_{overall} \times Average_{clam}}{Average_{ingestionweighted}} = \frac{42 \times 140}{394} = 15$$

Equation 5

This approach assumes that relative contaminant concentrations among the species remain the same even when conditions change. This proportionality calculation is then repeated for the other tissue types that comprise the diet. Different species-to-species relationships may be calculated if multiple empirical datasets or model outputs are available, which in turn would result in a range of RBTCs (rather than a single number). This concept is further explored in Section B.3.2.

B.3.2 Species-Specific RBTCs for Risk Drivers

Following the methodology described in Section B.3.1, species-specific RBTCs were calculated for the risk drivers identified for the LDW: total PCBs, inorganic arsenic, and cPAHs (Tables B-5 through B-9). Species-specific RBTCs could not be derived for dioxins/furans because no site-specific empirical data were available to calculate the ratios that describe concentration relationships among the species. Data and methods used to establish the species-specific RBTCs for each risk driver are summarized below.

Species-specific RBTCs for total PCBs were developed based on three sources of species-to-species relationship information: 1) the LDW HHRA empirical dataset (as in the example in Section B.3.1), 2) the LDW 2007 empirical dataset, and 3) the calibrated FWM. Because the calibrated FWM predicts concentrations for each species in the scenario-specific diets, it can also be used to estimate the concentration relationships among the different species. Because the relationships were similar, but not exactly the same based on the three sources of information, a range of species-specific RBTCs were developed for each RME seafood consumption scenario/risk level combination for total PCBs, as presented in Tables B-5 through B-7.

It was not possible to calculate a range of species-specific RBTCs for inorganic arsenic or cPAHs because the 2007 tissue samples were not analyzed for these contaminants for all market basket species and because no FWM exists for these risk drivers. Therefore, species-specific RBTCs for inorganic arsenic and cPAHs are presented as single values.

B.4 Non-Urban Puget Sound Tissue Dataset

To help provide context for tissue RBTCs, a tissue dataset of samples collected from non-urban areas away from known contaminated sites in Puget Sound was compiled for each of the four risk drivers (i.e., total PCBs, arsenic, cPAHs, and dioxins/furans).

Section B.4.1 describes the criteria used to develop the non-urban Puget Sound tissue dataset and provides detailed tables and figures showing the data included in this dataset. Section B.4.2 presents human health risk estimates calculated based on the non-urban Puget Sound tissue dataset.

B.4.1 Dataset Development

The non-urban Puget Sound tissue dataset consists of data from various studies. For total PCBs and arsenic, the tissue data from some of these studies were presented in the LDW RI; this RI dataset served as a starting point for these two risk drivers. In addition, data for all four risk drivers were obtained from Ecology's Environmental Information Management (EIM) database. It is important to note that the non-urban Puget Sound dataset has been compiled from various sources, and the datasets from these sources were generally used as reported without further data quality reviews. In addition, the sampling and analytical methods used to produce these datasets varied from study to study. Thus, although these data provide a general indication of the concentrations of these risk drivers in tissues collected throughout Puget Sound, they should not be regarded as a single dataset generated using a consistent methodology that is representative of Puget Sound.

Once the preliminary data had been compiled, criteria for using the data in the non-urban Puget Sound tissue dataset were determined in consultation with EPA and Ecology. The following list summarizes the criteria for including data in this dataset:

- **Species**: Only those species representative of the consumption categories evaluated in the LDW HHRA (i.e., benthic fish, pelagic fish, crabs, clams, and mussels) were included in the dataset. Available data for other species, including shrimp, oysters, and other fish species (e.g., salmon and rockfish[1]) were excluded.
- **Proximity to urban areas:** In consultation with EPA and Ecology, sampling locations near urban areas were excluded from the non-urban Puget Sound tissue dataset. Examples of excluded areas include: Commencement Bay (Tacoma), Elliott Bay (Seattle), Budd Inlet (Olympia), Port Gardner (Everett), Sinclair Inlet (Bremerton), Port Angeles Harbor, and Bellingham Bay.
- **Proximity to known contaminated sources:** In consultation with EPA and Ecology, sampling locations near known contaminant sources were excluded based on consideration of the type, distance, and magnitude of any known sources identified in the Integrated Site Information System (ISIS) and EIM

[1] Rockfish were not included in the non-urban Puget Sound dataset as a surrogate pelagic species for two reasons: 1) rockfish were not included in the LDW market basket because "adult rockfish are likely to constitute a very small component of a seafood consumption scenario because existing data suggest that adult rockfish abundance is low in the LDW" (Windward 2004), and 2) their long life spans may contribute to higher contaminant concentrations than in other pelagic fish with shorter life spans.

databases. Examples of sampling locations excluded based on proximity to a known source include the areas of Fidalgo Bay/March Point (near Anacortes), Point Wells (near Edmonds), Port Washington Narrows (near Bremerton), and Keyport (near Poulsbo).

- **Inorganic arsenic data quality**: For inorganic arsenic, only those data collected as part of the LDW RI/FS specifically for the purpose of evaluating Puget Sound tissue concentrations were used in this dataset. This RI/FS dataset was sufficiently large to meet the goals associated with the non-urban Puget Sound dataset and had already undergone extensive review and validation, whereas the analytical methods and the data quality of the relatively small number of additional available samples analyzed for inorganic arsenic were less well known.

The resulting non-urban Puget Sound tissue dataset contains different numbers of samples for the various risk drivers and tissue types, depending on data availability. Acceptable data are summarized in Tables B-10 through B-13; sampling locations are shown on Figures B-5 through B-12. In summary, the following numbers of samples were available for each risk driver (after filtering based on criteria listed above):

- **Total PCBs**: 344 tissue samples, including 242 fish samples, 17 crab edible-meat samples, 15 crab whole-body samples,[2] and 70 clam samples;
- **Inorganic arsenic**: 81 tissue samples, including 33 fish samples, 12 crab edible-meat samples, 12 crab whole-body samples, and 24 clam samples;
- **cPAHs**: 28 samples, including 1 fish sample, 8 crab edible-meat samples, 7 crab whole-body samples, 1 mussel sample, and 11 clam samples;
- **Dioxins/furans**: 106 samples, including 11 fish samples, 27 crab edible-meat samples, 25 crab whole-body samples, and 43 clam samples.

Fish sample counts included both benthic fish and pelagic fish (although relatively few pelagic fish data were available), crab sample counts were divided by tissue type (i.e., edible-meat and whole-body samples), and clam sample counts included various clam species.

B.4.2 Risk Estimates Based on the Non-Urban Puget Sound Tissue Dataset

This section provides risk estimates calculated using the non-urban Puget Sound tissue dataset. In consultation with EPA, it was agreed that a market basket approach would be used to more closely approximate the approach taken in the LDW HHRA. However, because the available non-urban Puget Sound data did not perfectly match all of the

[2] Crab whole-body samples for all risk drivers were calculated based on concentrations in edible meat and hepatopancreas samples, as described in Tables B-10 through B-13.

seafood consumption categories used in the LDW HHRA, a simplified approach was used. The following five consumption categories were used to calculate risks based on the Puget Sound tissue dataset: clams, mussels, crab edible meat, crab whole-body, and fish (pelagic and benthic fish combined) (Table B-4).

In the LDW HHRA, concentrations of the four risk drivers in seafood were represented by an upper confidence limit (UCL). This approach was not selected for the non-urban Puget Sound risk estimates because the compiled dataset represents various studies, sample sizes, and methods. Instead, risk estimates for the four risk drivers were calculated based on the minimum, mean, and maximum values for each consumption category (Table B-14). These values were used to calculate the ingestion-weighted concentrations that were presented in Figures 3-3 through 3-6 in Section 3 of the FS (see Section B.3.1 for details on how these values were calculated).

Excess cancer risk estimates (both for the individual risk drivers and as total risk estimates across all four risk drivers) are shown in Figures B-13 through B-15 and in Table B-15 for the three RME scenarios. Total excess cancer risks ranged from 1×10^{-5} to 6×10^{-5} using minimum exposure values, from 5×10^{-5} to 3×10^{-4} using mean exposure values, and from 2×10^{-4} to 9×10^{-4} using maximum exposure values. Total excess cancer risks were greater than the MTCA threshold of 1×10^{-5} for all scenarios and exposure values with one exception: the total excess cancer risk for the Child Tribal RME scenario using the minimum exposure values was 1×10^{-5}. Additionally, risk estimates for the individual risk drivers were compared with MTCA's 1×10^{-6} excess cancer risk threshold. For inorganic arsenic and dioxin/furan TEQ, excess cancer risks were greater than this threshold regardless of the statistic used (i.e., when minimum, mean, or maximum values were used; Table B-15). For total PCBs and cPAHs, excess cancer risks were greater than this threshold for all scenarios when maximum values were used and for some scenarios (i.e., the Adult Tribal RME and/or Adult API RME scenarios; see Table B-15) when either the minimum or mean values were used.

As shown in Figures B-13 through B-15, the majority of the total excess cancer risk for each of the RME scenarios was attributable to inorganic arsenic and dioxins/furans. The risks associated with inorganic arsenic in the non-urban Puget Sound dataset were attributable primarily to clams (as was the case in the LDW HHRA). Risks associated with dioxins/furans were attributable primarily to clams for risks based on the mean and maximum concentrations but were attributable primarily to fish for risks based on the minimum concentrations. Risks associated with total PCBs and cPAHs were lower, together contributing 5% or less to the total excess cancer risk.

For both total PCBs and inorganic arsenic, non-cancer HQs were less than 1 when using the minimum and mean exposure values. When the maximum exposure values were used, HQs for the three RME scenarios ranged from 0.6 to 3 (Table B-15). The only HQs greater than 1 were those calculated using the maximum exposure values for the Child Tribal RME scenario (the total PCB HQ was equal to 2, and the inorganic arsenic HQ was equal to 3). The proportional contributions of the various seafood consumption categories to the HQs for total PCBs and inorganic arsenic were similar to those to the excess cancer risks (Figures B-13 through B-15). Thus, clams were the primary contributor to the inorganic arsenic HQs, while fish were the primary contributor to the total PCB HQ.

Figures B-16 through B-19 present a comparison of excess cancer risks and non-cancer HQs estimated for the non-urban Puget Sound tissue dataset and those estimated for the LDW HHRA tissue dataset for both total PCBs and inorganic arsenic. For both the non-urban Puget Sound and LDW tissue datasets, the risk estimates shown in these figures were calculated using mean exposure values. The excess cancer risk estimates and non-cancer HQs calculated for total PCBs based on the LDW data were approximately 120 to 200 times higher than those calculated based on the non-urban Puget Sound dataset. For inorganic arsenic, excess cancer risks and non-cancer HQs calculated based on the LDW dataset were also higher than those based on the non-urban Puget Sound dataset; although, unlike PCBs, LDW excess cancer risks and non-cancer HQs were only approximately 5 times higher than those in non-urban Puget Sound locations. The majority of risk for inorganic arsenic (in both these datasets) is attributable to clam consumption. Similar figures were not created for cPAHs because of low detection frequencies in the non-urban Puget Sound tissue dataset. Similar figures were not created for dioxins/furans because insufficient tissue data were available from the LDW to calculate a market basket risk estimate.

B.5 References

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Table B-10 Total PCB Concentrations in Fish and Shellfish Collected from Non-Urban Puget Sound Locations Outside of Known Contaminated Sites

Species	Tissue Type	Sampling Location	Sampling Year(s)	Detection Frequency	Individuals per Composite (Average)	Total PCB Concentration[a] (µg/kg ww)			Source
						Mean[b]	Minimum	Maximum	
Clams									
Butter clam	soft parts	Various locations[c]	1994 – 2005	0/42	NS	nc	2.5 U	6.5 U	King County 1995, 2000, 2001, 2002, 2005, 2006, 2009
Butter clam	soft parts	Padilla/Fidalgo Bay	1999	0/1	50	nc	2.5 U	2.5 U	Ecology 2000
Littleneck clam	soft parts	Padilla/Fidalgo Bay	1999	0/1	50	nc	2.5 U	2.5 U	Ecology 2000
Littleneck clam	soft parts	Salsbury Point	2003	0/2	NS (10-20)	nc	2.5 U	2.6 U	Parametrix 2003
Geoduck	edible meat	Freshwater Bay[d]	2006	8/8	1	0.64	0.24	1.43	Malcolm Pirnie 2007[e]
	gut ball			5/5	1	1.35	0.92	2.10	
Horse clam	edible meat	Dungeness Bay[d]	2006	8/8	1	0.12	0.09	0.14	Malcolm Pirnie 2007[e]
	gut ball			5/5	1	1.26	0.95	1.49	
Horse clam	edible meat	Freshwater Bay[d]	2006	8/8	1	0.14	0.10	0.23	Malcolm Pirnie 2007[e]
	gut ball			5/5	1	1.66	1.35	2.14	
Crabs									
Dungeness crab	edible meat	Padilla/Fidalgo Bay	1999	2/2	5	1.3	1.2 J	1.4 J	Ecology 2000
Dungeness crab	edible meat	Dungeness Bay[d]	2006	7/7	1	1.02	0.46	1.92	Malcolm Pirnie 2007[e]
	hepatopancreas			7/7	1	25.0	13.1	49.5	
	calculated whole-body[f]			7/7	1	8.44	4.39	16.0	
Dungeness crab	edible meat	Freshwater Bay[c]	2006	8/8	1	0.62	0.43	0.99	Malcolm Pirnie 2007[e]
	hepatopancreas			8/8	1	17.8	8.80	32.3	
	calculated whole-body[f]			8/8	1	5.96	3.03	10.7	

Table B-10 Total PCB Concentrations in Fish and Shellfish Collected from Non-Urban Puget Sound Locations Outside of Known Contaminated Sites (continued)

Species	Tissue Type	Sampling Location	Sampling Year(s)	Detection Frequency	Individuals per Composite (Average)	Total PCB Concentration[a] (µg/kg ww)			Source
						Mean[b]	Minimum	Maximum	
Benthic fish									
English sole	fillet	PSAMP – non urban[g]	1989 – 1999	117/189	15.2	11.6	1.3	50.8	West et al. 2001
English sole	fillet	PSAMP – near urban[g]	1989 – 1999	36/42	13.6	15.9	2.0	75.4	West et al. 2001
English sole	fillet	Case Inlet/Dana Passage	2005	3/3	4.7	8.5	5.6 J	13.2 J	Era-Miller 2006
English sole	fillet	Pickering Passage	2005	0/2	5	nc	5.5 U	5.6 U	Era-Miller 2006
English sole	fillet	South Puget Sound	2005	2/2	20	6.5	6.1 J	6.8 J	Era-Miller 2006
Rock sole	fillet	Carr Inlet	2005	0/1	5	nc	5.5 U	5.5 U	Era-Miller 2006
Rock sole	fillet	Case Inlet/Dana Passage	2005	0/1	5	nc	5.5 U	5.5 U	Era-Miller 2006
Rock sole	fillet	Hale Passage	2005	0/2	5	nc	5.1 U	5.5 U	Era-Miller 2006

Note: Rows highlighted in light green indicate new total PCB tissue concentrations in fish and shellfish collected from Puget Sound locations outside of known contaminated sites, not previously reported in the RI (Windward 2010a).

a. For PCB Aroclors, the total PCB concentration represents the sum of detected concentrations of up to nine individual PCB Aroclors for a given sample. For samples in which none of the individual Aroclors were detected, the maximum RL for an individual PCB Aroclor in that sample is used as the concentration. For PCB congeners, the total PCB concentration represents the sum of the detected PCB congener concentrations for a given sample.

b. Mean concentrations were calculated using one-half of the RL for non-detect values. A mean value was not calculated when there were no detected values.

c. Locations include Edmonds, Carkeek Park, Golden Gardens, Alki Point, Vashon Island, and Normandy Park. Data for clams collected by King County were compiled from seven King County reports (1995, 2000, 2001, 2002, 2005, 2006, 2009).

d. Dungeness Bay and Freshwater Bay were the reference sites used in the Rayonier Mill RI near Port Angeles, Washington (Malcom Pirnie 2007).

e. The total PCB concentrations in this study were analyzed as PCB congeners.

f. Data from composite hepatopancreas samples were mathematically combined with data from composite samples of edible meat to form composite samples of edible meat plus hepatopancreas. Total PCB concentrations in whole-body (i.e., edible meat plus hepatopancreas) crab were calculated assuming 69% (by weight) edible meat and 31% hepatopancreas, based on the relative weights of these tissues in a 16.6-cm Dungeness crab dissected by Windward in 2004 (unpublished data).

g. PSAMP data are from various non-urban and near-urban sites around Puget Sound (Figure B-5).

cm = centimeters; J = estimated concentration; µg/kg = micrograms per kilogram; nc = not calculated (no detected values); NS = not specified; PCB = polychlorinated biphenyl; PSAMP = Puget Sound Ambient Monitoring Program; RI = remedial investigation; RL = reporting limit; U = not detected; ww = wet weight

Figure B-5. Non-Urban Puget Sound Sampling Locations for Fish Tissue Analyzed for PCBs

Figure B-6. Non-Urban Puget Sound Sampling Locations for Clam Tissue Analyzed for PCBs

Figure B-7. Non-Urban Puget Sound Sampling Locations for Crab Tissue Analyzed for PCBs

The CB/NT FYR includes fish and crab tissue data as originally summarized in Table B-10 "Total PCB Concentrations in Fish and Shellfish Collected from Non-Urban Puget Sound Locations Outside of Known Contaminated Sites" of the Feasibility Study (FS) for the Lower Duwamish Waterway Superfund Site (AECOM 2012). The FS includes the following text associated with Table B-10:

> *"The data in this excel file came from a variety of sources, none of which are the laboratories which originally generated the data. While we have made every attempt to faithfully reproduce the data from those sources, we have NOT gone back to the original laboratory sources and QCed the accuracy of the data using Form 1s or other electronic sources as this would be a rather substantial effort. Any questions regarding this data set and it's compilation should be directed to Erika Hoffman (EPA Region 10) at hoffman.erika@epa.gov"*

Washington State Department of Health
Division of Environmental Health
Office of Environmental Health Assessments

Puget Sound Fish Consumption Advice

October 2006

Advice for People Who Eat Salmon, Rockfish, and Flatfish from Puget Sound

Why is there a fish advisory for Puget Sound?

Over the past decade, the Puget Sound Assessment and Monitoring Program has tested for contaminants in several Puget Sound fish (Chinook and coho salmon, English sole, and four species of rockfish). Some types of fish were found to have higher levels of contaminants than others.

The Washington State Department of Health (DOH) has identified two contaminants that pose a potential health concern for people who eat certain species of Puget Sound fish:

- PCBs (Polychlorinated biphenyls)
- Mercury (Methylmercury)

DOH is providing consumption advice for particular species of fish in Puget Sound based on levels of one or both of these contaminants. We recommend that people, especially women who might become pregnant or who are pregnant, nursing mothers, and young children, minimize exposure to these contaminants by following advice in this healthy fish eating guide.

What are the health benefits of fish?

Fish is high in protein and is an excellent source of omega-3 fatty acids, which are not found naturally in our bodies. Omega-3 fatty acids are essential during pregnancy for the healthy development of a child's brain, retina, and nerve tissue. Omega-3 fatty acids help prevent heart disease and stroke by reducing blood pressure, inflammation, and blood clotting.

Other foods like beef, poultry, and pork also have some contaminants. Removing fish from your diet will not eliminate your exposure, but will eliminate the many health benefits that you get from eating fish. So, keep eating fish!

What are PCBs and mercury and how do they affect health?

PCBs - PCBs are a group of chemicals that were once used widely in products such as coolants and lubricants for transformers. In 1977, PCBs were banned because of their potential to affect health and persistence in the environment. Children exposed to PCBs in the womb may have learning and behavior problems later in life. PCBs can also impact the immune system.

Mary Selecky

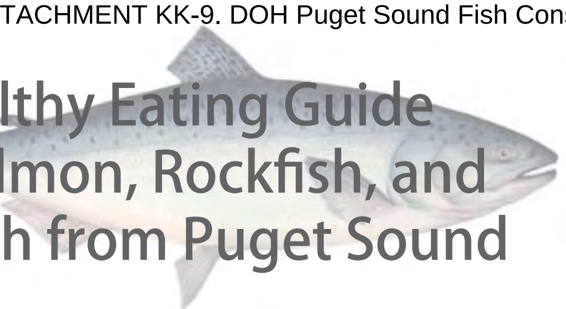
Secretary of Health

"It's good to know that fish in Puget Sound, especially our salmon, remain a healthy choice for the dinner table. While we provide clear information on the many choices of fish that are low in contamination, let's also be clear about the need to keep toxics out of Puget Sound."

Mercury - Mercury occurs naturally in the environment. It also comes from industrial air pollution and improper disposal of thermostats, electrical switches, and fluorescent bulbs. Mercury is linked to learning and behavior problems in kids. Like PCBs, exposure to mercury in the womb can cause learning and behavior problems later in life.

How do PCBs and mercury get into Puget Sound fish?

PCBs and mercury enter rivers and streams through air or direct release, then settle into sediments. Some fish eat prey associated with sediments. Aquatic organisms do not eliminate these chemicals easily. These contaminants can move up the food chain into predatory fish, then passed to humans who eat fish.



A Healthy Eating Guide for Salmon, Rockfish, and Flatfish from Puget Sound

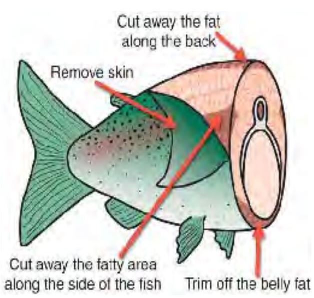
Advice for anyone concerned about contaminants in fish, especially women who might become pregnant, women who are pregnant, nursing mothers, and young children.

Puget Sound Fish Consumption Guidance -

Fish is a vital part of a healthy diet. Do not stop eating fish. Most foods have some contaminants in them, not just Puget Sound fish. The following advice will limit your exposure to contaminants and maximize the many health benefits from eating fish.

The two main ways to reduce your exposure to contaminants in fish are through wise choices and good fish preparation. Fish preparation recommendations can reduce, by up to 50 percent, PCBs and other contaminants that collect in the fat of fish. Mercury is stored in the muscle of fish and cannot be reduced by cleaning this way.

DOH Fish Preparation Recommendations



Consume younger, smaller fish (within legal limits).

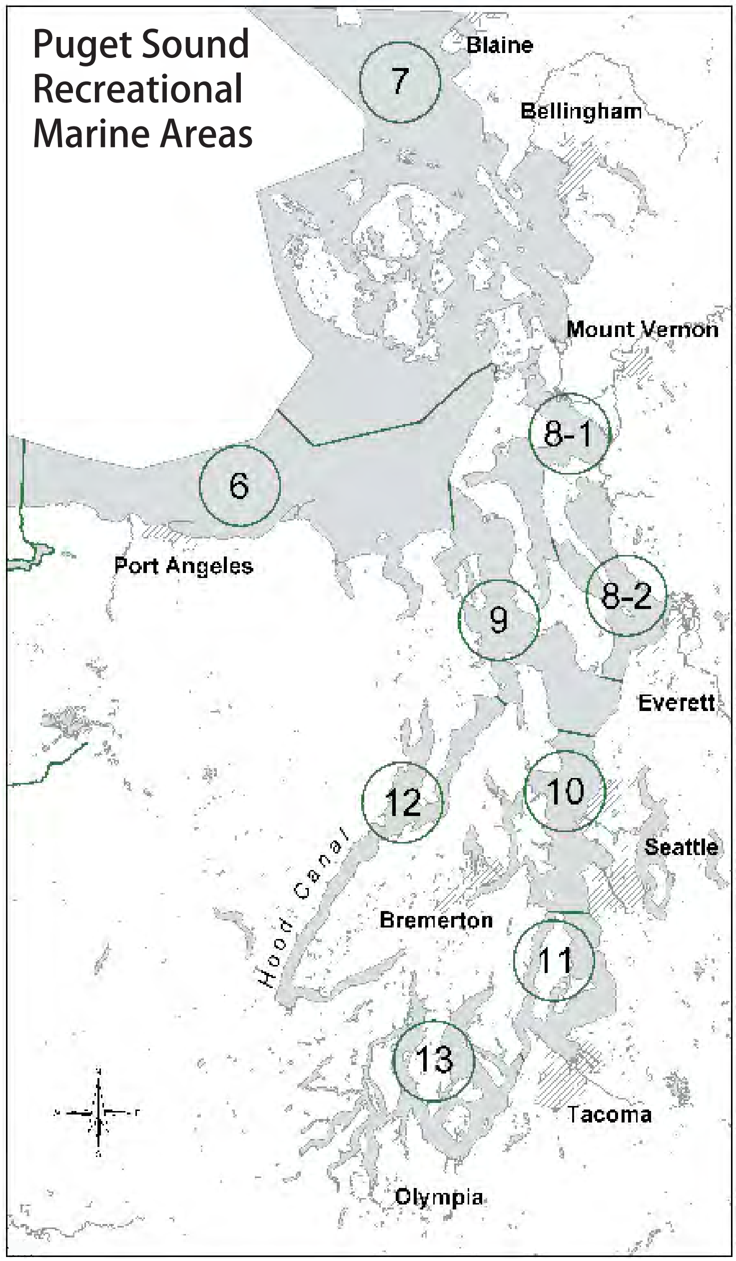
When cleaning fish, remove the skin, fat, and internal organs before cooking.

Grill, bake, or broil fish so that the fat drips off while cooking.

How to Use the Following Tables

Fish consumption guidance is organized by Washington State Department of Fish and Wildlife's (WDFW) marine areas. To use the following tables, locate the "Recreational Marine Area" where you catch fish. Follow the consumption advice for that area. Note, one meal is eight ounces of fish uncooked and no restrictions means you can eat 2 to 3 meals per week. If you eat the amount recommended for the week, be sure to choose other fish that are lower in contaminants for any other meals that week. Some good choices are canned light tuna, cod, flounder, coastal salmon, and trout. For additional choices visit www.doh.wa.gov/fish.

If there are "no restrictions" for the fish you like to eat in these tables, follow the American Heart Association recommendations and enjoy at least 2 heart healthy meals per week.



OU 01 Attachment 5

Puget Sound Salmon

Salmon from Puget Sound have low levels of contaminants and are a healthy food. The American Heart Association recommends that people eat at least two fish meals per week for a healthy heart.

Salmon are a good choice when choosing fish from Puget Sound. There are no meal restrictions for coho, chum, pink, and sockeye salmon which means you can eat 2 to 3 meals per week. DOH recommends eating Puget Sound Chinook once per week.

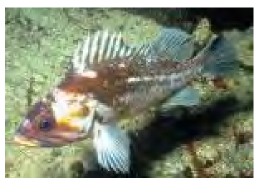
Resident Chinook (blackmouth) appear to have higher levels of contaminants, so eat only two meals per month. Most blackmouth remain in Puget Sound rather than migrate to the ocean, so they accumulate more contaminants.

Puget Sound Salmon* — All Puget Sound Marine Areas

Marine Area	Salmon Species	Consumption Advice
6 thru 13	Chinook	No more than 1 meal per week
6 thru 13	Chinook (Blackmouth)	No more than 2 meals per month
6 thru 13	Coho	No restrictions
6 thru 13	Chum, Pink, Sockeye**	No restrictions

* High-end consumers (more than 2 meals per week) should follow DOH's fish preparation recommendations.
** Chum, pink, and sockeye salmon were not sampled as part of PSAMP. Data from other sources show that these species tend to have low PCB levels.

Puget Sound Rockfish



Rockfish consumption advice is based on contaminant levels in brown, quillback, and copper rockfish from Puget Sound. In addition to contaminant concerns, non-tribal harvest of yelloweye and canary rockfish is prohibited for conservation purposes.

Puget Sound Rockfish

Marine Area/ Location		Rockfish Species	Consumption Advice	Exceptions
6 thru 13	All Puget Sound Marine Areas	Yelloweye Rockfish*	No consumption	None
6 thru 13	All Puget Sound Marine Areas	Canary Rockfish*	No consumption	None
6	East Juan de Fuca Strait	Rockfish	No more than 1 meal per week	None
7	San Juan Islands	Rockfish	No more than 1 meal per week	None
8.1	Deception Pass, Hope Island & Skagit Bay	Rockfish	No more than 1 meal per week	None
8.2	Port Susan/ Port Gardner	Rockfish	No more than 1 meal per week	Yes
	Mukilteo-Everett/ Port Gardner	Rockfish	No more than 2 meals per month	
9	Admiralty Inlet	Rockfish	No more than 1 meal per week	None
10	Seattle-Bremerton	Rockfish	No more than 1 meal per week	Yes
	Elliott Bay	Rockfish	No consumption	
	Sinclair Inlet	Rockfish	No consumption	
11	Tacoma-Vashon	Rockfish	No more than 1 meal per week	None
12	Hood Canal	Rockfish	No more than 1 meal per week	None
13	South Puget Sound (South of the Tacoma Narrows)	Rockfish	No more than 1 meal per week	None

* Non-tribal harvest of yelloweye and canary rockfish is prohibited for conservation purposes.

English Sole & Other Flatfish

The following advice applies to consumption of Puget Sound flatfish including English sole, starry flounder, and rock sole. No restrictions means you can eat 2 to 3 meals per week.

Puget Sound English Sole & Other Flatfish*

Marine Area/ Location		Consumption Advice	Exceptions
6	East Juan de Fuca Strait	No restrictions -	None
7	San Juan Islands -	No restrictions	None
8.1	Deception Pass, Hope Island & Skagit Bay	No restrictions -	None
8.2	Port Susan/ Port Gardner	No restrictions -	Yes
	Mukilteo Ferry Dock to City of Everett	No more than 2 meals per month	
9	Admiralty Inlet -	No restrictions	None
10	Seattle-Bremerton -	No restrictions	Yes
	Duwamish Waterway -	No consumption	
	Elliott Bay	No more than 2 meals per month	
	Eagle Harbor	No more than 1 meal per week	
	Port Orchard Passage	No more than 1 meal per week	
	Sinclair Inlet	No more than 1 meal per month	
11	Tacoma- Vashon -	No restrictions	Yes
	Inner Commencement Bay	No more than 2 meals per month	
	Outer Commencement Bay	No more than 1 meal per week	
12	Hood Canal	No restrictions	None
13	South Puget Sound (South of the Tacoma Narrows)	No restrictions -	None

* Recommendations for consuming other bottomfish such as lingcod, are not included in the above advice.

For More Information About:

Fish Advisories in Washington State
Contact: Washington State Department of Health
Fish Consumption Advisory Program
Toll Free: 1.877.485.7316
www.doh.wa.gov/fish

The Health of Puget Sound
Contact: Puget Sound Partnership
Toll Free: 1.800.54.Sound
www.psp.wa.gov

Puget Sound Ambient Monitoring Program Fish Component
Contact: Washington State Department of Fish & Wildlife
Ph: 360.902.2200
www.wdfw.wa.gov/fish/psamp

Fishing Regulations in Puget Sound
Contact: Washington State Department of Fish & Wildlife
Ph: 360.902.2700
www.wdfw.wa.gov/fishing

"It is important to continue to eat fish, be smart, and choose fish wisely. "

Maxine Hayes
State Health Officer

Washington State Department of Health

Graphics and Photo Credits:
Fish graphic courtesy of Windsor Nature Discovery (Toll-Free 1.800.833.6388), Puget Sound image courtesy of Don Lennartson, and Angler with Chinook courtesy of Dom Reale.

This document is available in other formats for persons with disabilities. TDD LINE: 1-800-833-6388.

October 2006 DOH Publication #334-098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WASHINGTON
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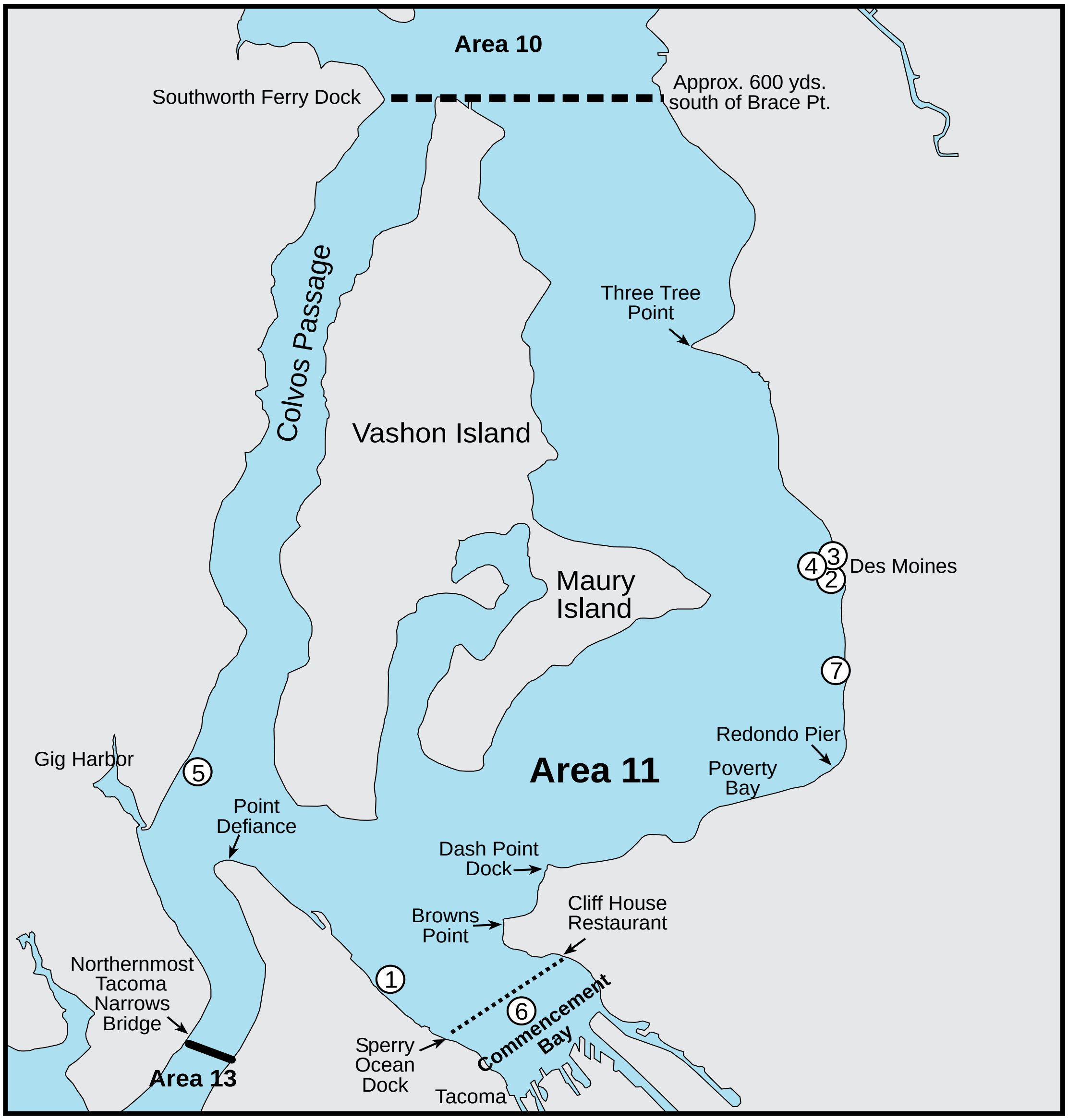
Fishing
Rules
Effective
May 1, 2012 to
April 30, 2013
Buy your fishing license today
fishhunt.dfw.wa.gov
WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

Marine Area 11 Map



1 **Les Davis Fishing Pier:** Waters within 100 yards of the Les Davis Fishing Pier, CLOSED to fishing for food fish and to the harvest of SHELLFISH except when fishing from the pier.

2 **Des Moines Fishing Pier:** Waters within 100 yards of the Des Moines Public Fishing Pier, CLOSED to fishing for food fish and to the harvest of SHELLFISH except when fishing from the pier.

3 **City of Des Moines Park Conservation Area:** CLOSED to all harvest.

4 **South 239th Street Park Conservation Area:** CLOSED to all harvest.

5 **Colvos Passage Marine Preserve:** Area enclosed by a line starting at extreme low water 300' SW of the southern boundary of Sunrise County Park, Pierce Co. (latitude 47°20.9'N) due east 300', then southwesterly paralleling the shoreline for 500', then west to the extreme low water line, then northeasterly along extreme low water line to point of origin, CLOSED to all harvest, except SALMON trolling allowed.

6 **Commencement Bay Closure:** Waters east of a line bearing 215° true (195°30' magnetic) from the Cliff House Restaurant on north shore (approximate position 47°17'51"N, 122°25'54"W) through Sperry Ocean Dock (approximate position 47°16'26"N, 122°27'22"W) - Apr. 1- Apr. 30, and June 1-July 31: CLOSED to fishing for SALMON. Aug. 1-Mar. 31 and May 1-May 31: same rules as Marine Area 11 - ENTIRE AREA. **See Department of Health (DOH) Fish Consumption Advisory on page 20.**

7 **Saltwater State Park Marine Preserve:** Those waters, bedlands, and tidelands of Saltwater State Park within a line projected from the northernrmost marker at the DNR high tide line through 122°19'39.02"W, 47°22'25.14"N; then to 122°19'44.14"W, 47°22'26.11"N; then to 122°19'45.91"W, 47°22'21.54"N; then to 122°19'40.86"W, 47°22'20.60"N; then to the southernmost marker on the shoreline and back along the high tide line to the northermost marker, CLOSED to all harvest.

Marine Area 11 - Tacoma-Vashon Island

(From the north tip of Vashon Island to the Northernmost Tacoma Narrows Bridge)

SPECIES	SEASON	ADDITIONAL RULES
SALMON - ENTIRE AREA	June 1-Sept. 30	CHINOOK - min. size 22". Other SALMON species - no min. size. Daily limit 2 (combined). Release wild CHINOOK. **See Commencement Bay Closure on previous page.**
	Oct. 1-Oct. 31	CHINOOK - min. size 22". Other SALMON species - no min. size. Daily limit 2 (combined).
	Nov. 1-Dec. 31	CHINOOK - min. size 22". Other SALMON species - no min. size. Daily limit 2 (combined). Only 1 CHINOOK may be retained.
	Feb. 1-Apr. 30	CHINOOK - min. size 22". Other SALMON species - no min. size. Daily limit 2. Release wild CHINOOK. **See Commencement Bay closure on previous page.**
Dash Point Dock, Les Davis Pier, Des Moines Pier, Redondo Pier, Point Defiance Boathouse Dock	Year-round	CHINOOK - min. size 22". Other SALMON species - no min. size. Daily limit 2 (combined). Only 1 CHINOOK may be retained.
TROUT	Year-round	Catch-and-release except up to 2 hatchery STEELHEAD may be retained.
STURGEON	Year-round	Catch-and-release.
	June 1-June 30 Sept. 1-Oct. 15	Min. size 38" fork length. Max. size 54" fork length. Daily limit 1. Release GREEN STURGEON.
MACKEREL	Year-round	No min. size. No daily limit.
HERRING, SMELT, ANCHOVY, SARDINE, and SAND LANCE	Year-round	No min. size. Daily limit 10 lbs., all species combined. All SMELT caught must be kept and count toward the daily limit except **CLOSED** to Columbia River SMELT (eulachon). **For SMELT:** Jig gear may be used 7 days a week. Dipnets may be used 8:00 a.m. Fridays through 8:00 a.m. Wednesdays.
PACIFIC HALIBUT	CLOSED	
BOTTOMFISH	Year-round season. Daily limit is a total of 15 BOTTOMFISH (see definition page 10) regardless of species, subject to individual limits and seasons shown below. Fishing for BOTTOMFISH prohibited in waters deeper than 120 feet.	
LINGCOD	May 1-June 15 May 21-June 15	**Hook and line season.** Min. size 26". Max. size 36". Daily limit 1. **Spearfishing season.** Max. size 36". Daily limit 1.
SURFPERCH	Year-round	No min. size. Daily limit 10. Except SHINER PERCH daily limit 15: not included in BOTTOMFISH limit.
ROCKFISH	CLOSED	
PACIFIC COD, POLLOCK, HAKE, WOLF-EEL, SIXGILL SHARK	CLOSED	SIXGILL SHARK may not be removed from the water.
CABEZON	May 1-Nov. 30	No min. size. Daily limit 2.
OTHER FOOD FISH	Year-round	No min. size. Daily limit 2 of each species.
ALL OTHER FISH	Year-round	CLOSED

Photo provided by the Northwest Straits Initiative.

Derelict Fishing Gear

Reporting lost or abandoned nets or pots

Still Fishing After All These Years

Lost and abandoned fishing gear continues to fish, impacting marine animals and destroying their habitat, entangling divers, and damaging propellers and rudders of boats.

What's being done?

Federal, state, tribal, and local governments, NGOs, and grassroots organizations and individuals are collaborating to protect and restore Washington marine resources by locating and removing harmful derelict fishing gear.

How can you help?

Record as much information as you can when you find derelict gear, including:

- Date of sighting
- Type of gear
- Approximate water depth
- General location
- Latitude (example 48.34333)
- Longitude (example -123.00333)

You can report this information to:

Washington Department of FISH and WILDLIFE

(Toll Free) 855-542-3935 or go to http://wdfw.wa.gov/fishing/derelict

Northwest Straits

360-428-1084 or go to www.derelictgear.org

There are no penalties associated with reporting lost fishing gear.

The Derelict Fishing Gear Removal Project is a no-fault program. The goals are simply to remove lost and abandoned gear, to help restore Puget Sound, to improve public safety, and to assist species recovery.

Nets are dangerous! Never attempt to remove them. Divers, stay a safe distance away.

Shellfish/Seaweed Rules

3 Steps to Safe and Legal Shellfish Harvest - It's your responsibility!

1 • • • Know the Rules **(You could get a ticket)**

Is the harvesting season open? Read the rules for seasons, size, and bag limits. Always check the toll free WDFW Emergency Shellfish Rule Change Hotline (866) 880-5431. Current harvesting season information can always be found by using the clickable map on the WDFW website at http://wdfw.wa.gov/fishing/shellfish/beaches.

2 • • • Pollution Closures **(You could get sick)**

Does the beach meet standards for healthy eating? Some closures are shown on the map on page 127. For more pollution closures visit the Washington Department of Health website at www.doh.wa.gov/shellfishsafety.htm, call (360) 236-3330, the Shellfish Safety toll-free Hotline at (800) 562-5632, or the local county health department.

3 • • • Marine Biotoxin Closures and *Vibrio* Warnings **(You could get sick or die)**

Is there an emergency closure due to Shellfish Poisoning (PSP/ASP/DSP) or *Vibrio* bacteria? Check the DOH website at www.doh.wa.gov/shellfishsafety.htm, call (360) 236-3330, or the Shellfish Safety toll-free Hotline at (800) 562-5632.

NOTE: Emergency rules may occur throughout the year and will supersede the rules contained in this pamphlet. Changes can be found by calling the **Shellfish Rule Change toll-free Hotline at (866) 880-5431,** contacting statewide customer service, or by visiting the WDFW website.

Licenses

A Combination or a Shellfish/Seaweed License is required for all shellfish (except CRAWFISH) and SEAWEED harvest. A catch record card, and endorsement is required to fish for DUNGENESS CRAB in Puget Sound. (See License Requirements, page 6).

Designated Harvesters

Persons with a disability must have a designated harvester card issued by WDFW if using another harvester to assist them with their catch. The person harvesting the catch on behalf of the licensee with a disability must be in possession of the designated harvester card while assisting the person with a disability. Both the digger and the person with a disability must be licensed. The licensee is also required to be in the direct line of sight of the designated harvester who is harvesting shellfish for them. If this is not possible, the licensee is required to be within ¼ mile of the designated harvester who is harvesting shellfish for them.

Safe Handling Practices

- Water color does not indicate SHELLFISH safety.
- Rinse your catch in salt (not fresh) water before leaving the beach, quickly cool your catch on ice or in a refrigerator, and cook as soon as possible.
- Wash all SEAWEED before eating.
- Cook shellfish thoroughly before eating.
- Cooking, rinsing, or freezing **DOES NOT** destroy all pollutants. CRAB can also concentrate pollutants in their internal organs (crab butter). Clean CRAB before cooking. Eat only the meat.

Shellfish Safety

Eating contaminated shellfish or seaweed can cause serious illness or death. The only way to be safe is to "Know Before You Dig." Check the Department of Health (DOH) website www.doh.wa.gov/ehp/sf/default-sf.htm, or call the local health department. For shellfish safety closures call the Shellfish Safety Hotline at (800) 562-5632.

Don't harvest in areas that are polluted. It can make you sick. Pollution can come from many sources like sewage drain pipes, failing septic systems, farm practices, wildlife, and pet waste. Use sani-cans, vault toilets and other approved facilities. Properly dispose of human and pet waste if no facilites are available.

Don't harvest in areas with marine biotoxins (PSP/ASP/DSP) or *Vibrio* warnings. You could get sick or die.

PARALYTIC SHELLFISH POISONING (PSP) & AMNESIC SHELLFISH POISONING (ASP):

- Can make you sick or cause death
- Can't be destroyed by cooking or freezing
- Are produced by algae that usually can't be seen
- Do not turn water red like the old name suggests

***NEW:* DIARRHETIC SHELLFISH POISONING (DSP)**:

- Can make you sick
- Can't be destroyed by cooking or freezing
- Is produced by algae that can't be seen

***VIBRIO* BACTERIA: In the summer, sea water often has high levels of naturally occuring bacteria.** Unlike biotoxins, these bacteria can be killed by cooking. To avoid getting sick, DOH advises that you COOK ALL SHELLFISH thoroughly.

For more information on PSP, ASP, DSP and *Vibrio* bacteria, visit the DOH website, call the main office at (360) 236-3330, or contact the local county health department.

Possession Limit

One daily limit in fresh form. Additional shellfish may be possessed in frozen or processed form.

Marine Preserves & Conservation Closures

For all Shellfish Species, see Marine Area maps (pages 99-123) for closures pertaining to the following areas:

AREA 7: San Juan Islands Marine Preserve.
AREA 9: Edmonds Public Fishing Pier, Brackett's Landing Shoreline Sanctuary, Keystone Conservation Area, and Admiralty Head Marine Preserve.
AREA 10: Elliott Bay Public Fishing Pier, Orchard Rocks Conservation Area, Carkeek Park, Golden Gardens, Discovery Park, Richey Viewpoint, Emma Schmitz Memorial, Lincoln Park, and Eagle Harbor.
AREA 11: Des Moines Fishing Pier, Les Davis Fishing Pier, Colvos Passage Marine Preserve, City of Des Moines Park, and South 239th Street Park, Saltwater State Park Marine Preserve.
AREA 12: Sund Rock Conservation Area, Waketickeh Creek Conservation Area, and Octopus Hole Conservation Area.
AREA 13: Saltar's Point Conservation Area, Titlow Beach Marine Preserve, and Z's Reef Marine Preserve.

Tideland Ownership

Most Puget Sound, Hood Canal, Grays Harbor, and Willapa Bay beaches are privately owned. SHELLFISH and SEAWEED may not be taken from private beaches without the owner's or lessee's permission. Private tideland owners and lessees, and members of their immediate family (grandparents, parents, spouse, siblings, children, and grandchildren) are exempt from personal use daily limits when taking CLAMS, OYSTERS, and MUSSELS harvested for their own personal use from their own tidelands. Daily limits apply for all other shellfish, all other people, and all other beaches. Everyone harvesting shellfish in excess of the daily limit from private beaches for presumed commercial purposes needs a shellfish certification from the Department of Health (see RCW 69.30.010(8)).

2012 Public Beach List - Special Rules

Two different state agencies are responsible for two different types of recreational shellfish harvest closures. The Washington Department of Fish and Wildlife (WDFW) is responsible for conservation closures or season adjustments, which are listed in the Public Beach List (below). These closures are designed to protect and conserve intertidal shellfish populations. The Washington Department of Health (DOH) is responsible for human health-related closures in response to potentially life-threatening environmental conditions, which result from PSP/ASP/DSP, *Vibrio* bacteria or pollution, as described in the Shellfish Safety section on page 124. Some, but not all of these beaches are also closed by WDFW. Permanent WDFW/DOH closures and periodic DOH harvest advisories are shown on page 127.

DOH SEASON	WDFW SEASON	HARVEST STATUS	REASON
Open	Open	SAFE & LEGAL	
Open	Closed	ILLEGAL	Conservation closure or season adjustment
Closed	Open	NOT SAFE	Potentially life-threatening environmental conditions
Closed	Closed	NOT SAFE & ILLEGAL	

Not all beaches have been evaluated by DOH, so if you have any concerns call the local health department or DOH at (360) 236-3330 or (800) 562-5632. In addition, some beaches may be posted with warning signs - look for signs as you access the beach.

ALWAYS CHECK BOTH THE CURRENT WDFW SEASON AND THE DOH HEALTH CLOSURE STATUS BEFORE HARVESTING ANY PUBLIC BEACH.

Beaches that do not appear on the Public Beach List (below) or on the Health Restrictions map on page 127 may be open to harvest year-round. For beach locations check the WDFW website at http://wdfw.wa.gov/fishing/shellfish/beaches/. The website includes interactive beach maps providing information about access, available species, harvest tips, driving directions, facility descriptions and links to the DOH Shellfish Safety webpages. Also, check the Marine Preserves and Conservation Closures on page 124 before planning your trip.

Note: Between Jan. 1-Apr. 30 you MUST check the website https://fortress.wa.gov/dfw/erules/efishrules/, Shellfish Rule Change Hotline (866) 880-5431 or contact the WDFW customer service desk (360) 902-2700 to verify seasons. Emergency rules will supersede the rules contained in this pamphlet.

RAZOR CLAM seasons occur only after clam samples have been tested by Washington Department of Health (DOH) and are found to be safe for human consumption.

BEACH NAME	CLAM/MUSSEL SEASON	OYSTER SEASON	ADDITIONAL RULES
Ala Spit	May 1-May 31	May 1-May 31	Limited natural production of OYSTERS.
Belfair State Park	Year-round	Year-round	Open only in area defined by boundary markers and posted signs.
Cama Beach State Park	CLOSED	CLOSED	
Camano Island State Park	CLOSED	CLOSED	
Dosewallips State Park	Mar. 1-Oct. 31	Year-round	Open only in area defined by boundary markers and posted signs.
Duckabush	Year-round	Year-round	All state-owned tidelands on the west shore of Hood Canal from Quatsap Point to the south end of the Duckabush River flats.
Dungeness Spit and National Wildlife Refuge Tidelands	May 15-Sept. 30	May 15-Sept. 30	Limited natural production of OYSTERS.
Eagle Creek	July 1-July 31	Year-round	
Fort Flagler State Park	May 15-Sept. 30	May 15-Sept. 30	Including that portion of the spit west of the Park boundary (Rat Island). Limited natural production of OYSTERS.
Frye Cove County Park	Jan. 1-May 15	Jan. 1-May 15	
Garrison Bay/British Camp	All tidelands of Guss Island, and all state and federally owned tidelands at British Camp (San Juan County) between the National Park Service dinghy dock and the southern park boundary, are closed to CLAM harvest year-round. Tidelands north of the dinghy dock to Bell Point are open year-round.		
Hope Island State Park	May 1-May 31	May 1-May 31	Located in South Puget Sound.
Illahee State Park	Apr. 1-July 31	Apr. 1-July 31	Limited natural production of CLAMS.
Kayak Point County Park	CLOSED	CLOSED	
Kitsap Memorial State Park	CLOSED	CLOSED	
Kopachuck State Park	June 1-July 31	Mar. 1-July 31	
Mystery Bay State Park	Oct. 1-Apr. 30	Oct. 1-Apr. 30	Health closure May 1-Sept. 30. See page 127.
Nahcotta Tidelands	CLOSED	Year-round	Open only in the area defined by boundary markers and posted signs.
Oak Bay County Park	May 1-July 31	May 1-July 31	Limited natural production of OYSTERS.
Oyster Reserves of North Bay (Case Inlet)	Year-round	Year-round	
Oyster Reserves of Oakland Bay	Year-round	Year-round	EXCEPT area defined by boundary markers and signs is closed year-round to CLAM and OYSTER harvest.

Shellfish/Seaweed

Continued on next page

2012 Public Beach List - Special Rules

BEACH NAME	CLAM/MUSSEL SEASON	OYSTER SEASON	ADDITIONAL RULES
Oyster Reserves of Totten and Eld Inlets	CLOSED	CLOSED	
Oyster Reserves of Willapa Bay	CLOSED	CLOSED	EXCEPT Diamond Point on the northwest side of Long Island between reserve monuments 39-41, and Pinnacle Rock on the southwest side of the Long Island between reserve monuments 58-59, are open year-round to CLAM and OYSTER harvest.
Pacific Ocean beaches	Nov. 1-Mar. 31	Nov. 1-Mar. 31	Closed Apr. 1-Oct. 31 (unless listed otherwise) because of PSP (except RAZOR CLAMS).
Penrose Point State Park	Mar. 1-May 15	Mar. 1-May 15	
Pitt Island	CLOSED	CLOSED	
Point Whitney Lagoon	Apr. 1-Apr. 30	Year-round	
Point Whitney Tidelands	Mar. 1-Mar. 31	Jan. 1-June 30	Excluding Point Whitney Lagoon.
Port Townsend Ship Canal/ Portage Canal	Jan. 1-July 31	Jan. 1-July 31	See Marine Area 9 map, page 114. Limited natural production of OYSTERS.
Potlatch DNR Tidelands	Apr. 1-June 30	Apr. 1-June 30	
Potlatch State Park	Apr. 1-June 30	Apr. 1-June 30	
Purdy Spit County Park	CLOSED	CLOSED	Southern shore of the spit, from the boat ramp east to the bridge, is closed.
Quilcene Bay WDFW Tidelands	Apr. 1-Dec. 31	Apr. 1-Dec. 31	All state-owned tidelands in Quilcene Bay north of a line drawn from the Quilcene Boat Haven to Fisherman's Point are closed, except those state-owned tidelands on the west side of the bay, north of the Quilcene Boat Haven, are open Apr. 1- Dec. 31. Open from official sunrise to official sunset. **CLAM min. size 1¼"**.
Scenic Beach State Park	CLOSED	CLOSED	
Sequim Bay State Park	May 1-June 30	Year-round	
Shine Tidelands State Park	Jan. 1-May 15	Jan. 1-May 15	Limited natural production of OYSTERS.
South Indian Island County Park	May 15-Aug. 31	May 15-Aug. 31	And adjacent tidelands. Limited natural production of OYSTERS.
Spencer Spit State Park	Mar. 1-July 31	Mar. 1-July 31	Limited natural production of OYSTERS.
Triton Cove Tidelands	June 1-Aug. 31	Year-round	¼ mile north of Triton Cove State Park.
Twanoh State Park	Aug. 1-Sept. 30	Year-round	
West Dewatto (DNR 44A)	Aug. 1-Sept. 30	Year-round	
Willapa Bay	Year-round	Year-round	Bonus limit: 24 COCKLES in addition to the regular CLAM limit. See Oyster Reserves, state-owned, and Nahcotta Tidelands.
WINAS-Maylor Point - East	National security concerns control access. Contact John Phillips, Naval Air Station, (360) 257-8873 or (360) 257-1009, for information on access requirements.		
Wolfe Property State Park	Jan. 1-May 15	Jan. 1-May 15	From 7 Sisters Rd. north to the lagoon channel adjacent to the spit connecting Hood Head to the mainland. North and east of the lagoon channel is private property.

Intertidal Shellfish Enhancement Program

WDFW's shellfish program has planted several public beaches with OYSTERS, CLAMS, and GEODUCKS. Some beaches have increased harvest opportunity as a result of WDFW's enhancement activities. If a beach is open for CLAMS, MUSSELS, or OYSTERS, harvest is encouraged on these beaches.

Birch Bay State Park - Oysters
Blake Island State Park - Geoducks
DNR 24 - Oysters
DNR 44A West Dewatto - Clams/Oysters
Frye Cove County Park - Clams/Oysters
Illahee State Park - Oysters
Kopachuck State Park - Oysters

Mystery Bay State Park - Oysters
Oak Bay County Park - Clams
Penrose State Park - Clams/Oysters
Point Whitney Lagoon - Clams
Point Whitney Tidelands - Clams
Potlatch State Park - Oysters
Quilcene Bay WDFW Tidelands - Oysters

Sequim Bay State Park - Clams/Oysters
Shine Tidelands State Park - Clams/Geoducks
South Indian Island County Park - Clams
Triton Cove Tidelands – Clams
Twanoh State Park - Clams
West Penn Cove - Oysters
Wolfe Property State Park - Clams/Oysters

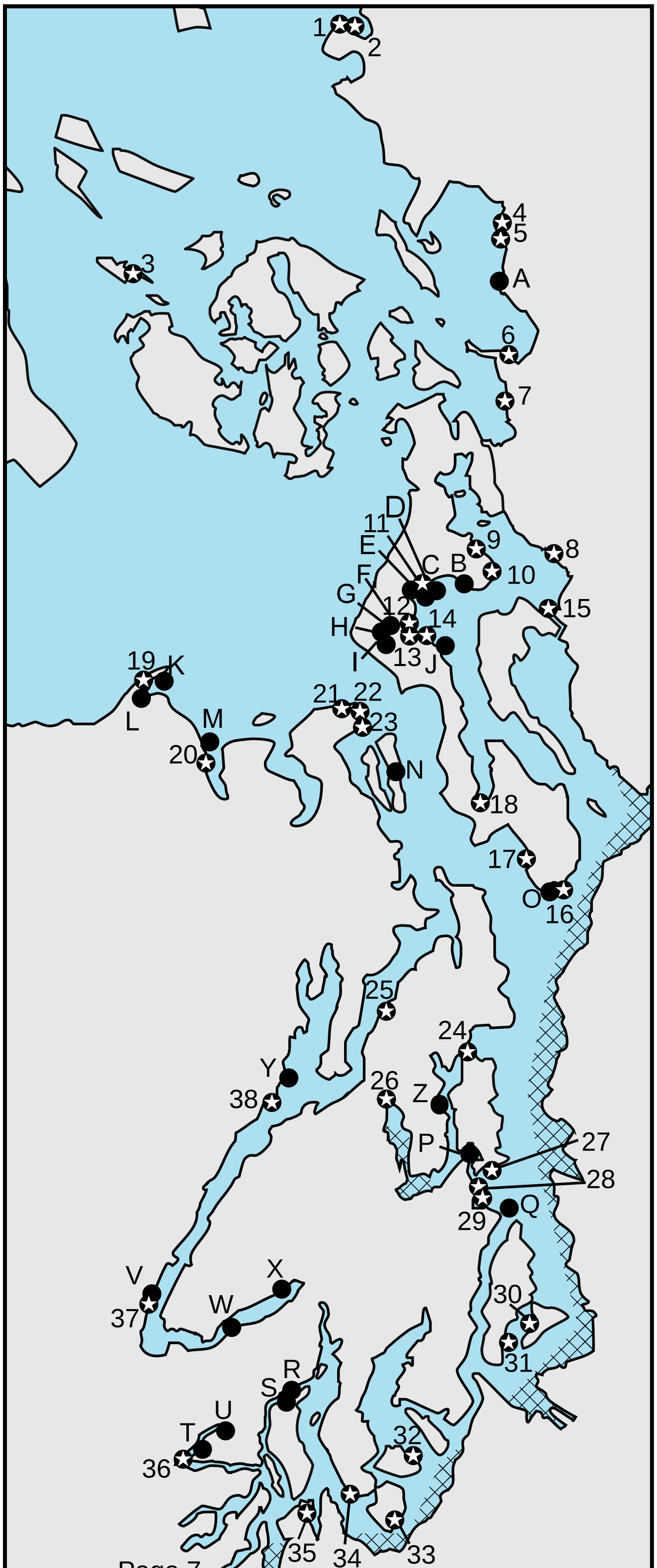
Varnish Clams have the ability to retain biotoxins at higher levels and longer than other clams.
Always check the biotoxin hotline before harvesting.
1-800-562-5632 or
www.doh.wa.gov/shellfishsafety.htm

Varnish clam
Nuttallia obscurata

Up to 2½", with shiny brown coating on the outside, purple on the inside of shell.

Health Restrictions - Clams, Oysters, and Mussels

Before harvesting shellfish check the Department of Health toll-free Shellfish Safety hotline, (800) 562-5632, or (360) 236-3330 in the Olympia area, or on the Internet, www.doh.wa.gov/ehp/sf/default-sf.htm. If you need further assistance, contact the county health department. County health department phone numbers are published in the government pages of local telephone directories.



These areas and all beaches in the following list are CLOSED year-round by the Department of Fish and Wildlife (WDFW) and Department of Health (DOH):

- On the Strait of Juan de Fuca - Port Angeles Harbor and Port Angeles Coast Guard.
- All beaches within the (cross-hatched) areas.
- All beaches around ferry docks.
- All beaches below indicated by this symbol on the map: ✪

1 Semiahmoo County Park
2 Semiahmoo
3 Reid Harbor - South Beach
4 Post Point
5 Chuckanut Bay (Mud Bay)
6 Samish Beach
7 Bay View State Park
8 Skagit Wildlife Area
9 DNR-144 (Sleeper)
10 DNR-142
11 Oak Harbor City Park
12 Monroe Landing
13 Coupeville
14 Harrington Beach
15 West Pass Access
16 Northeast Cultus Bay
17 Dave Mackie County Park
18 Freeland County Park
19 Graveyard Spit
20 Pitship Point
21 North Beach County Park
22 South Point Wilson
23 North Point Hudson
24 Suquamish (Old Man House) and Old Man House State Park
25 Bangor
26 Silverdale Waterfront Park
27 Fort Ward State Park
28 Manchester State Park
29 Little Clam Bay
30 Dockton County Park
31 DNR-79
32 McNeil Island/Gertrude Island
33 South Oro Bay
34 Taylor Bay
35 Woodard Bay
36 Walker County Park
37 Hoodsport
38 Pleasant Harbor State Park

The Department of Health (DOH) has harvest advisories on the following beaches, as indicated by this symbol: ●

An advisory is placed on beaches that MAY be subject to periodic contamination from pollution sources or MAY intersect polluted areas. Check the DOH website for details, or contact the county health department prior to harvesting these beaches.

A. Larrabee State Park (north end)
B. WINAS Crescent Harbor
C. WINAS-Maylor Point - E (north end)
D. Blowers Bluff
E. WINAS-Maylor Pt - W (inside Oak Harbor)
F. East San de Fuca
G. San de Fuca
H. West Penn Cove (N Penn Cove)
I. Madrona (Penn Cove)
J. Long Point
K. Dungeness National Wildlife Refuge
L. Cline Spit
M. DNR-411A
N. Mystery Bay State Park
O. Scatchet Head
P. Point White
Q. Blake Island State Park (east side)
R. DNR-34
S. Jarrell Cove
T. North Chapman Cove, Northeast Chapman Cove, and Southeast Chapman Cove
U. Oakland Bay
V. North Hoodsport Hatchery
W. Twanoh State Park
X. Belfair State Park
Y. Dosewallips State Park
Z. Brownsville

Washington State Department of Health

Shellfish Safety Information

You are here: DOH Home » EH Home » OSWP » Biotoxin   Search | Employees

Only the HEALTH STATUS of beaches are shown on these maps.
For SEASONS & LIMITS visit Washington State Department of Fish and Wildlife.

Marine Biotoxin Closure Zones

Closed for clams, geoduck, scallops, mussels, oysters, snails and other invertebrates.

Marine Biotoxin status updated, 10/31/2012 3:39:03 PM

Public Beaches

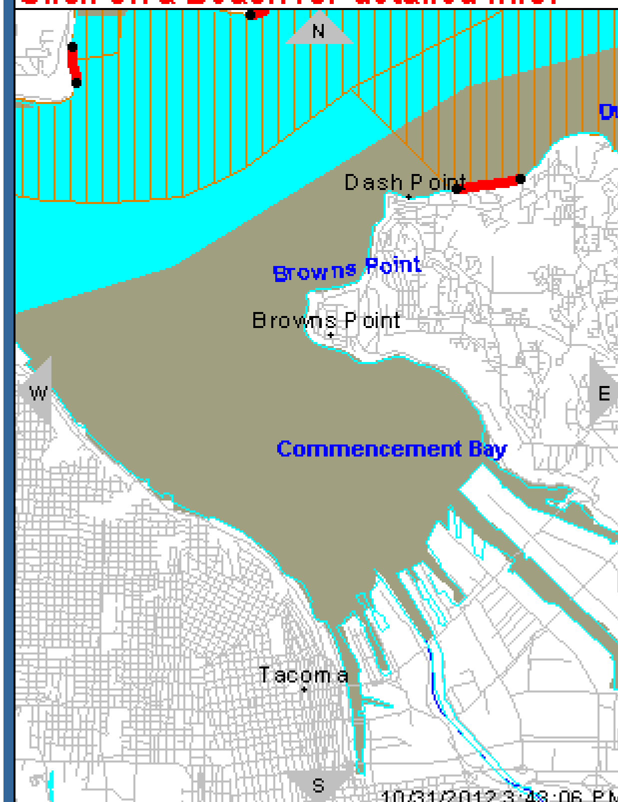
Closed

Area closed due to pollution.

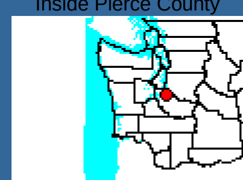
Tide Predictions

Not all beaches are mapped,
call your local health department/district
http://www.doh.wa.gov/lhjmap/lhjmap.htm
or (360)236-3330

Click on a Beach for detailed info.



Inside Pierce County



Start Over

Emergency Closures Due to Marine Biotoxins - Text Version

NEW County Beach List

Recreational Program

Fact Sheets

Citation:
http://ww4.doh.wa.gov/scripts/esrimap.dll?name=BIOVIEW&Left=1054000&Bottom=620016&Right=1180000&Top=791984&Step=2&click.x=255&click.y=174

2012 Guide to SAFE Shellfish Harvesting

in Pierce County - Mussels, Clams, and Oysters

(Washington DOH and TPCHD)

Source: http://www.tpchd.org/files/library/065d4e306417d533.pdf

Shellfish: A Natural Resource

Health and Safety Concerns

Many Pierce County beaches are safe for shellfish harvesting and shellfish are usually safe to eat. Shellfish from some beaches are not safe to eat due to pollution and natural poisons (biotoxins), bacteria, viruses or chemicals in the water that can be dangerous. Shellfish feed by filtering water and can accumulate contaminants. Pay attention to where and when you gather shellfish and know where the danger areas are located. It is important to check both the Washington Department of Fish & Wildlife website and Washington State Department of Health website for the latest closures.

Shellfish may have biotoxins, chemicals, bacteria and viruses that are not visible.
--Saltwater biotoxins include Paralytic Shellfish Poison (PSP), Amnesic Shellfish Poison (ASP) and Diarrhetic Shellfish Poisoning (DSP).
--Eating shellfish with high concentrations of biotoxins can kill you.

Cooking does not destroy the PSP, ASP or DSP toxin.

Washing and cooking shellfish will not remove chemicals or biotoxins, but may kill bacteria and viruses.

Harvested shellfish spoil quickly. Keep iced or refrigerated. Cook 4-6 minutes prior to eating.

Call 911 right away if you notice any of these symptoms after eating shellfish:
--numb tongue or lips
--tingling in the toes of fingertips
--loss of muscular control
--difficulty breathing, nausea, vomiting, abdominal pain and diarrhea

Additional Contact Information

Tacoma-Pierce County Health Department

(253) 798-3767
www.tpchd.org/shellfish

Diarrhetic Shellfish and Paralytic Shellfish Poisoning Hotline

(800) 562-5632
www.doh.wa.gov/ehp/sf/biotoxin.htm
www.doh.wa.gov/shellfishsafety.htm

Washington Department of Fish & Wildlife

Open beaches, emergency closures due to conservation concerns and rule changes information
(866) 880-5431, press 2
Recreational license information
(360) 902-2464
wdfw.wa.gov/fishing/shellfish.html

Washington Department of Health

For beach closures due to health concerns
(360) 236-3330
www.doh.wa.gov/ehp/sf/
To report possible shellfish related illness send an email to:
sf.illness@doh.wa.gov

Washington State Parks Boating Programs

(360) 902-8555
parks.wa.gov/boating

Washington State Department of Health
Division of Environmental Health
Office of Shellfish and Water Protection

Tacoma - Pierce County Health Department
Healthy People in Healthy Communities
www.tpchd.org

03/01/2012

2012 Guide to SAFE Shellfish Harvesting In Pierce County

Mussels
Clams
Oysters

General Rules

A Shellfish License is required to harvest on a public beach. Licenses are available at many sporting goods stores.

	Wear the license so it can be seen while digging.
	There are limits to the number and kind of shellfish you can gather. --check with Washington Department of Fish & Wildlife for the latest information about rules and fishing licenses.
	Be safe around and on the water. --wear life jackets at all times. --Puget Sound water can be colder than you think and you can lose your ability to swim in as little as ten minutes in cold water.
	Many Pierce County beaches are privately owned. --do not remove shellfish from private beaches without permission from the owner. --remain within public beach boundaries when harvesting.
	Call (253) 798-3767 or visit www.tpchd.org/shellfish (Recreational Shellfish Beach Closures) to check if the beach is open and safe for shellfish harvesting.
	A beach may be closed at any time to prevent over-harvesting. For updated conservation closures, please call (866) 880-5431.

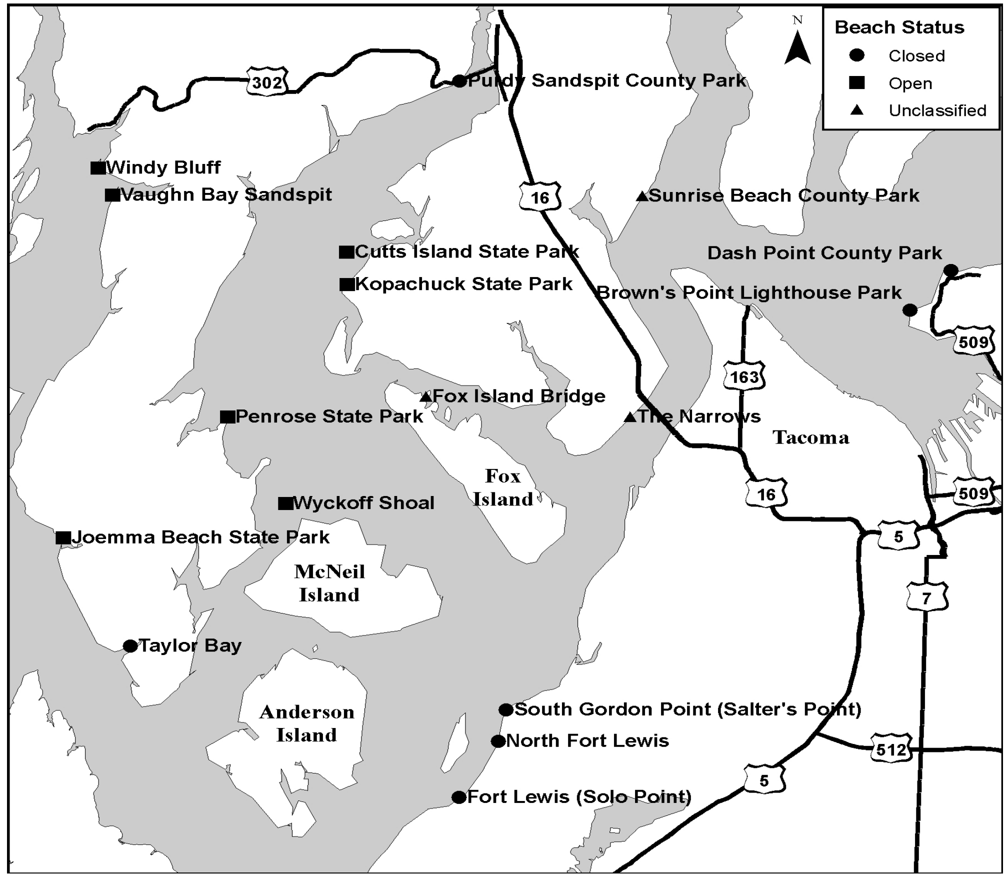
Unclassified Beaches

Use extreme caution when harvesting shellfish from these areas where water is not tested.

- Fox Island Bridge
- Sunrise Beach County Park
- The Narrows

Recreational Shellfish Harvesting Beaches

Classifications by Washington Department of Health and Washington Department of Fish & Wildlife



Open Beaches

- Cutts Island: Boat access only, clams and oysters open all year.
- Joemma Beach State Park: Clams and oysters, open all year.
- Kopachuck State Park: Clams, June 1-July 31 and oysters, March 1-July 31.
- Penrose Point State Park: Clams and oysters, March 1-May 15.
- Vaughn Bay Sandspit (DNR-18): Boat access only, clams and oysters, open all year.
- Windy Bluff: Boat access only, clams and oysters, open all year.
- Wyckoff Shoal (DNR-39): Boat access only, clams and oysters, open all year.

Closed Beaches

- Brown's Point Lighthouse Park: Health restrictions
- Dash Point County Park: Health restrictions
- Fort Lewis (Solo Point): Health restrictions due to proximity to sewage outfall.
- North Fort Lewis: Health restrictions due to proximity to sewage oufall.
- Purdy Sandspit County Park: Conservation closure
- South Gordon Point (Salter's Point): Health restrictions due to proximity to sewage outfall.
- Taylor Bay: Health restrictions due to proximity to sewage outfall.

Attachment KK-12

Lower Duwamish Waterway congener and total PCB tissue comparison

Table 4-4. Coplanar PCB congener concentrations in fish and crab composite samples, including both wet weight and lipid-normalized total PCB concentrations (PCB congener sum)

Sample ID	Coplanar PCB Congener Concentrations (ng/kg ww)												Total PCB Concentration[a] (µg/kg ww)	Lipid (%)	Lipid-Normalized total PCB Concentration (mg/kg lipid)[b]
	PCB-077	PCB-081	PCB-105	PCB-114	PCB-118	PCB-123	PCB-126	PCB-156	PCB-157	PCB-167	PCB-169	PCB-189			
English sole – whole body															
LDW-07-T1-M-ES-WB-comp3	291	29.1	12,800	855	44,800	702	77.7	8,130 C	C156	4,470	4.46	635	1,165 J	6.85	17.01
LDW-07-T1-M-ES-WB-comp5	181	18.0	9,610	727	31,100	480	41.7	5,000 C	C156	2,010	2.18	408	774 J	3.83	20.2
LDW-07-T2-A-ES-WB-comp2	533	48.0	19,900	1,570	75,400	1,230	113	11,600 C	C156	5,320	5.66	625	1,632 J	9.00	18.13
LDW-07-T2-A-ES-WB-comp4	420	37.4	21,800	1,270	68,800	1,200	110	11,300 C	C156	4,910	5.50	762	1,603 J	8.07	19.86
LDW-07-T3-M-ES-WB-comp4	1,030	87.3	37,400 J	2,700	136,000	2,090	184	20,500 C	C156	8,870	7.95	1,270	2,928 J	10.9	26.86
LDW-07-T3-M-ES-WB-comp6	255	20.4	9,030	708	38,900	537	50.7	6,820 C	C156	3,300	3.44	553	1,032 J	4.40	23.45
Shiner surfperch – whole body															
LDW-07-T1-B-SS-WB-comp1	588	48.7	14,500	1,110	45,600	720	96.1	9,750 C	C156	4,140	4.16	835	974 J	2.20	44.3
LDW-07-T1-C-SS-WB-comp1	449	41.9	7,830	548	24,600	465	59.1	5,840 C	C156	2,570	1.75	376	504.1 J	4.94	10.2
LDW-07-T2-B-SS-WB-comp1	314	26.8	5,050	371	18,200	342	45.2	4,180 C	C156	1,890	2.19 J	304	401.6 J	4.40	9.127
LDW-07-T2-E-SS-WB-comp1	431	31.1	10,500	810	35,400	590	61.5	6,820 C	C156	2,960	2.26	500	648.3 J	4.46	14.54
LDW-07-T3-E-SS-WB-comp1	230	20.0	6,770	538	25,200	406	62.9	8,420 C	C156	4,330	4.88	1,140	1,103 J	3.43	32.16
LDW-07-T3-F-SS-WB-comp1	501	39.1	17,000	1,360	53,900	889	91.2	14,100 C	C156	5,860	5.11	1,980	2,462 J	4.94	49.84
Dungeness crab – edible meat															
LDW-07-T1-M-DC-EM-comp1	85.0	5.40 U	835	56.9	2,350	40.9	7.39 U	357 C	C156	150	3.98 U	23.3	49.45 J	0.440	11.24
LDW-07-T3-M-DC-EM-comp3	78.3	5.21 U	1,190	82.0	3,760	47.1	9.89 UJ	583 C	C156	226	5.31 U	38.2	86.2 J	0.531	16.23
Dungeness crab – hepatopancreas															
LDW-07-T1-M-DC-HP-comp1	688	41.4	9,470	606	26,800	494	72.4	4,740 C	C156	1,980	4.67	372	612.1 J	3.72	16.45
Slender crab – edible meat															
LDW-07-T1-M-SC-EM-comp2	137	8.20	1,830	119	5,540	98.4	10.1	1,000 C	C156	423	6.56 U	51.2	112 J	0.428	26.17
LDW-07-T2-M-SC-EM-comp1	129	7.14	1,620	111	4,530	71.8	8.68	662 C	C156	267	4.49 U	33.4	86.2 J	0.592	14.56

[a] Total PCBs are calculated as the sum of all 209 individual PCB congeners. The method for calculating total PCBs is presented in Appendix D.

[b] Lipid-normalized concentrations (in units of mg/kg lipid) represent the wet-weight total PCB concentration (calculated as the sum or all 209 individual PCB congeners in units of mg/kg ww) divided by the decimal fraction corresponding to the percent lipid (e.g., 2.0% lipid = 0.02).

C – concentration represents a co-elution

C156 - PCB-156 and PCB-157 co-elute; the combined concentration is presented as the concentration of PCB-156

ID - identification

J – estimated concentration

PCB – polychlorinated biphenyl

U – not detected at the reporting limit shown

ww – wet weight

OU 20, 22, 19 Attachment 1 – List of Documents Reviewed

Asarco Consulting, Inc. (Asarco). 2004. *Final Design Report for Sediment Dredging: Marine Sediments and Groundwater. Commencement Bay Nearshore/Tideflats Superfund Site. Asarco Sediments/Groundwater Operable Unit 06. Town of Ruston and City of Tacoma, Washington.* June 2004.

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EPA. 2006b. "Environmental Fact Sheet. ASARCO Superfund Site, Ruston/Tacoma, Washington." March 2006. Viewed on 4/9/14 at: *http://yosemite.epa.gov/R10/CLEANUP.NSF/9f3c21896330b4898825687b007a0f33/c73c106fd187e1b6882569150064ad86/$FILE/Asarco%20fs%203-13-06.pdf*

EPA. 2009. *Five-Year Review Report. Third Five-Year Review Report for Commencement Bay Nearshore/Tideflats Superfund Site, Tacoma, Washington.* Prepared by U.S. Environmental Protection Agency (EPA), Region 10. December 23, 2009.

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EPA. 2011b. *Evaluation of the Remediation Goal for Arsenic at the Ruston/North Tacoma Study Area Operable Unit, Commencement Bay Nearshore/Tideflats Superfund Site.* January 27, 2011.

EPA. 2013. *Remedial Action Completion Report. Ruston/North Tacoma Residential Remediation. Commencement Bay Nearshore/Tideflats Superfund Site. Ruston/North Tacoma Study Area*. 2013.

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Griffiths. 2014. Email communication on 4/29/14 from Evan Griffiths (CH2M Hill) to Veronica Henzi (USACE). Subject: Re: TM on Slag Peninsula Armoring.

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Hydrometrics. 2013b. *Point Ruston. Development and Occupancy Plan.* Prepared for Point Ruston LLC. Revised February 2013.

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Hydrometrics. 2013d. *Point Ruston, LLC. Final Construction Report. Sediment Cap Phase.* Prepared for Point Ruston LLC. March 2013.

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USBC. 2009b. *Amended Settlement Agreement and Consent Decree Regarding Residual Environmental Claims for the Coeur d'Alene, Idaho, Omaha, Nebraska, and Tacoma, Washington Environmental Sites*. Case 05-21207. Document 10541. Filed in TXSB on March 13, 2009. Available at: *http://www2.epa.gov/enforcement/consent-decree-5-settlement-agreements-associated-2009-asarco-bankruptcy*

United States District Court for the Western District of Washington (USDC). 2006. *Second Amendment to Asarco Tacoma Smelter Consent Decree in the matter of United States v. ASARCO Incorporated, relating to the Asarco Tacoma Smelter Site, Operable Units 02 and 06 of the Commencement Bay Nearshore Tideflats Superfund Site.* Civil Action No C91-5528 B. June 29, 2006. Available at: *http://yosemite.epa.gov/r10/CLEANUP.NSF/6ea33b02338c3a5e882567ca005d382f/c73c106fd187e1b6882569150064ad86/$FILE/ASARCO-2nd.pdf*

OU 20, 22, 19 Attachment 2 - Site Inspection Checklist for OU 20 and OU 22

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION

Site name: Asarco Smelter/Point Ruston	**Date of inspection:** 5/9/14
Location: Ruston/Tacoma WA	**EPA ID:**
Agency, office, or company leading the five-year review: Air monitoring, dust control.	**Weather/temperature** Cloudy/55 degrees

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☐ Groundwater pump and treatment
- ☒ Surface water collection and treatment
- ☐ Other: *e.g. Groundwater monitoring*
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Air monitoring, dust control.

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** N/A ______ ______ ______
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ______
   Problems, suggestions; ☐ Report attached ______

2. **O&M staff** N/A ______ ______ ______
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ______
   Problems, suggestions; ☐ Report attached ______

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency ____________________
Contact ____________________ ____________ ______ ________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ______________________________

Agency ____________________
Contact ____________________ ____________ ______ ________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ______________________________

Agency ____________________
Contact ____________________ ____________ ______ ________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ______________________________

Agency ____________________
Contact ____________________ ____________ ______ ________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ______________________________

4. **Other interviews** (optional) ☐ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

■ O&M manual	■ Readily available	■ Up to date	☐ N/A
■ As-built drawings	■ Readily available	■ Up to date	☐ N/A
■ Maintenance logs	■ Readily available	■ Up to date	☐ N/A

Remarks

2. **Site-Specific Health and Safety Plan** ■ Readily available ■ Up to date ☐ N/A
■ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☐ N/A
Remarks Health and safety training requirements and schedules are recorded on site id badges.

3.	**O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	■ N/A
	Remarks CERCLA permit exemption, permits not required. Effluent records are provided in monthly progress reports. Real time air monitoring records are provided weekly to the EPA project manager			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	☐ N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	■ N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	■ N/A
	■ Other permits____________________	☐ Readily available	☐ Up to date	■ N/A
	Remarks CERCLA permit exemption, permits not required. Effluent records are provided in monthly progress reports. Real time air monitoring records are provided weekly to the EPA project manager			
5.	**Gas Generation Records**	■ Readily available	☐ Up to date	■ N/A
	Remarks			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	■ N/A
	Remarks			
7.	**Groundwater Monitoring Records**	☐ Readily available	☐ Up to date	☐ N/A
	Remarks			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	☐ N/A
	Remarks Leachate records from the onsite landfill are provided			
9.	**Discharge Compliance Records**			
	☐ Air	■ Readily available	☐ Up to date	■ N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	☐ N/A
	Remarks			
10.	**Daily Access/Security Logs**	■ Readily available	☐ Up to date	☐ N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

- ☐ State in-house
- ☒ PRP in-house
- ☐ Federal Facility in-house
- ☐ Other
- ☐ Contractor for State
- ☒ Contractor for PRP
- ☐ Contractor for Federal Facility

2. **O&M Cost Records**

☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place

Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost

From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost

From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost

From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost

From__________ To__________ __________________ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons:

No O&M Costs provided. The number of joints on phase 1 of the project between different cap materials is going to result in high maintenance costs.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A

Remarks All exclusion zones as well as non occupied site entrances are fenced.

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A

Remarks All exclusion zones are signed.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented	☐ Yes	☐ No	☒ N/A
Site conditions imply ICs not being fully enforced	☐ Yes	☐ No	☒ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ______
Frequency ______
Responsible party/agency ______
Contact ______ Name ______ Title ______ Date ______ Phone no.

Reporting is up-to-date	☐ Yes	☐ No	☒ N/A
Reports are verified by the lead agency	☐ Yes	☐ No	☒ N/A
Specific requirements in deed or decision documents have been met	☒ Yes	☐ No	☐ N/A
Violations have been reported	☐ Yes	☐ No	☒ N/A

Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☐ No vandalism evident
Remarks 24 hour site security. Vandalism has occurred. Issues reported to EPA. Any problems have been repaired.

2. **Land use changes on site** ☒ N/A
Remarks

3. **Land use changes off site** ☒ N/A
Remarks

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks

B. Other Site Conditions

Remarks

VII. LANDFILL COVERS ■ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ■ Settlement not evident
   Areal extent______________ Depth____________
   Remarks

2. **Cracks** ☐ Location shown on site map ■ Cracking not evident
   Lengths____________ Widths___________ Depths__________
   Remarks

3. **Erosion** ☐ Location shown on site map ■ Erosion not evident
   Areal extent______________ Depth____________
   Remarks

4. **Holes** ☐ Location shown on site map ■ Holes not evident
   Areal extent______________ Depth____________
   Remarks

5. **Vegetative Cover** ■ Grass ■ Cover properly established
   ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks

6. **Alternative Cover (armored rock, concrete, etc.)** ■ N/A
   Remarks

7. **Bulges** ☐ Location shown on site map ■ Bulges not evident
   Areal extent______________ Height____________
   Remarks

8. **Wet Areas/Water Damage**	☒ Wet areas/water damage not evident		
☐ Wet areas	☐ Location shown on site map	Areal extent______________	
☐ Ponding	☐ Location shown on site map	Areal extent______________	
☐ Seeps	☐ Location shown on site map	Areal extent______________	
☐ Soft subgrade	☐ Location shown on site map	Areal extent______________	
Remarks			
9. **Slope Instability** ☐ Slides	☐ Location shown on site map	☒ No evidence of slope instability	
Areal extent______________			
Remarks			
B. Benches ☒ N/A	☐ Applicable		
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)			
1. **Flows Bypass Bench**	☐ Location shown on site map	☒ N/A or okay	
Remarks			
2. **Bench Breached**	☐ Location shown on site map	☒ N/A or okay	
Remarks			
3. **Bench Overtopped**	☐ Location shown on site map	☒ N/A or okay	
Remarks			
C. Letdown Channels ☐ Applicable	☒ N/A		
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)			
1. **Settlement**	☐ Location shown on site map	☒ No evidence of settlement	
Areal extent______________	Depth____________		
Remarks			
2. **Material Degradation**	☐ Location shown on site map	☒ No evidence of degradation	
Material type_______________	Areal extent_____________		
Remarks			
3. **Erosion**	☐ Location shown on site map	☒ No evidence of erosion	
Areal extent______________	Depth____________		
Remarks			

4.	**Undercutting** ☐ Location shown on site map ■ No evidence of undercutting Areal extent______________ Depth____________ Remarks
5.	**Obstructions** Type_____________________ ■ No obstructions ☐ Location shown on site map Areal extent______________ Size____________ Remarks
6.	**Excessive Vegetative Growth** Type____________________ ■ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent______________ Remarks
D. Cover Penetrations ☐ Applicable ■ N/A	
1.	**Gas Vents** ☐ N/A ☐ Active ☐ Passive ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration Remarks
2.	**Gas Monitoring Probes** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ■ N/A Remarks
3.	**Monitoring Wells** (within surface area of landfill) ■ Properly secured/locked ■ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks
4.	**Leachate Extraction Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ■ N/A Remarks
5.	**Settlement Monuments** ☐ Located ☐ Routinely surveyed ■N/A Remarks

E. Gas Collection and Treatment ☐ Applicable ■ N/A	
1.	**Gas Treatment Facilities** ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks
2.	**Gas Collection Wells, Manifolds and Piping** ☐ Good condition ☐ Needs Maintenance Remarks
3.	**Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks
F. Cover Drainage Layer ☐ Applicable ■ N/A	
1.	**Outlet Pipes Inspected** ☐ Functioning ☐ N/A Remarks
2.	**Outlet Rock Inspected** ☐ Functioning ☐ N/A Remarks
G. Detention/Sedimentation Ponds ☐ Applicable ■ N/A	
1.	**Siltation** ☐ N/A ☐ Siltation not evident Areal extent______________ Depth____________ Remarks
2.	**Erosion** Areal extent______________ Depth____________ ☐ Erosion not evident Remarks
3.	**Outlet Works** ☐ Functioning ☐ N/A Remarks
4.	**Dam** ☐ Functioning ☐ N/A Remarks

H. Retaining Walls	☒ Applicable	☐ N/A	
1.	**Deformations** Horizontal displacement_____________ Vertical displacement_______________ Rotational displacement_____________ Remarks	☐ Location shown on site map	☒ Deformation not evident
2.	**Degradation** Remarks	☐ Location shown on site map	☒ Degradation not evident
I. Perimeter Ditches/Off-Site Discharge	☒ Applicable	☐ N/A	
1.	**Siltation** Areal extent______________ Depth____________ Remarks	☐ Location shown on site map	☒ Siltation not evident
2.	**Vegetative Growth** Areal extent______________ Type____________ Remarks	☐ Location shown on site map ☐ Vegetation does not impede flow	☒ N/A
3.	**Erosion** Areal extent______________ Depth____________ Remarks	☐ Location shown on site map	☒ Erosion not evident
4.	**Discharge Structure** Remarks	☒ Functioning	☐ N/A
VIII. VERTICAL BARRIER WALLS	☒ Applicable	☒ N/A	
1.	**Settlement** Areal extent______________ Depth____________ Remarks	☐ Location shown on site map	☐ Settlement not evident
2.	**Performance Monitoring** Type of monitoring__________________________ ☐ Performance not monitored ☐ Evidence of breaching Frequency_______________________________ Head differential__________________________ Remarks		
IX. GROUNDWATER/SURFACE WATER REMEDIES	☐ Applicable	☒ N/A	
A. Groundwater Extraction Wells, Pumps, and Pipelines	☐ Applicable	☐ N/A	
1.	**Pumps, Wellhead Plumbing, and Electrical** ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks		

2.	**Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks
3.	**Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	**Collection Structures, Pumps, and Electrical** ■ Good condition ☐ Needs Maintenance Remarks
2.	**Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ■ Good condition ☐ Needs Maintenance Remarks
3.	**Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks
C. Treatment System ☐ Applicable ■ N/A	
1.	**Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters______________________________ ☐ Additive (*e.g.*, chelation agent, flocculent)______________________________ ☐ Others______________________________ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually________________ ■ Quantity of surface water treated annually________________ Remarks
2.	**Electrical Enclosures and Panels** (properly rated and functional) ■ N/A ■ Good condition ■ Needs Maintenance Remarks

3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ■ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks
4.	**Discharge Structure and Appurtenances** ☐ N/A ■ Good condition ☐ Needs Maintenance Remarks
5.	**Treatment Building(s)** ■ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks
6.	**Monitoring Wells** (pump and treatment remedy) ■ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks
D. Monitoring Data	
1.	Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining
D. Monitored Natural Attenuation	
1.	**Monitoring Wells** (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks
X. OTHER REMEDIES	
	If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). Remedy being implemented as described in the ROD and design documents. Site is occupied. Air monitoring shows dust controls are effective in preventing spread of contamination.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. Very little O&M ongoing as site is still under construction.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. The potential O&M of the numerous joints on site may lead to redesign of the cap in the future.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. N/A

OU 3 Attachment 1 – List of Documents Reviewed

City of Tacoma (and PSE). *2012-2017 Permit No. TAC-031-2011.* Permit renewed 5/1/12. Issued to Dalton, Olmsted & Fuglevand, Inc.

Dalton, Olmsted & Fuglevand, Inc. (DOF). 2002. *Revised Water Quality Monitoring Program, Tacoma Historical Coal Gasification Site*. January 4, 2002.

Dalton. 2014. Email communication on 6/27/14 from Matt Dalton (DOF) to Veronica Henzi (USACE). Subject: RE: Requesting information for Tacoma Tar Pits Five-Year Review report.

DOF. 2003. *Groundwater Remediation System, Operation and Maintenance Plan, Tacoma Historical Coal Gasification Site*. Prepared for Puget Sound Energy, Inc. February 2003.

DOF. 2009a. *Quarterly Report. April 1, 2009 to June 30, 2009. Permit No. 001-636-456. Tacoma Historical Coal Gasification Site*. July 14, 2009.

DOF. 2009b. *Quarterly Report. July 1, 2009 to September 30, 2009. Permit No. 001-636-456. Tacoma Historical Coal Gasification Site*. October 12, 2009.

DOF. 2010a. *Quarterly Report. October 1, 2009 to December 31, 2009. Permit No. 001-636-456. Tacoma Historical Coal Gasification Site*. January 14, 2010.

DOF. 2010b. *Quarterly Report. January 1, 2010 to March 31, 2010. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. April 13, 2010.

DOF. 2010c. *Quarterly Report. April 1, 2010 to June 30, 2010. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. July 30, 2010.

DOF. 2010d. *Quarterly Report. July 1, 2010 to September 30, 2010. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. October 14, 2010.

DOF. 2010e. *Water Quality Monitoring Report. March and June 2009 Sampling Events. Tacoma Historical Coal Gasification Site.* May 14, 2010.

DOF. 2010f. *Water Quality Monitoring Report. September and December 2009 Sampling Events. Tacoma Historical Coal Gasification Site.* December 21, 2010.

DOF. 2011a. *Technical Memorandum. Asphalt Permeability Testing Work Plan, Detention Basins THCGS.* September 9, 2011.

DOF. 2011b. *Quarterly Report. October 1, 2010 to December 31, 2010. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. January 12, 2011.

DOF. 2011c. *Quarterly Report. January 1, 2011 to March 31, 2011. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. April 10, 2011.

DOF. 2011d. *Quarterly Report. April 1, 2011 to June 30, 2011. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. July 14, 2011.

DOF. 2011e. *Quarterly Report. July 1, 2011 to September 30, 2011. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. October 10, 2011.

DOF. 2011f. *Water Quality Monitoring Report. March and June 2010 Sampling Events. Tacoma Historical Coal Gasification Site.* January 10, 2011.

DOF. 2012a. *Technical Memorandum. Results of Trench Line Sampling, Tacoma Historical Coal Gasification Site (Tacoma Tar Pits), Tacoma, Washington.* Dec 9, 2012.

DOF. 2012b. *Technical Memorandum. Results of Asphalt Permeability Testing, Detention Basins, THCGS.* May 8, 2012.

DOF. 2012c. *Quarterly Report. October 1, 2011 to December 31, 2011. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. January 6, 2012.

DOF. 2012d. *Quarterly Report. January 1, 2012 to March 31, 2012. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. April 12, 2012.

DOF. 2012e. *Quarterly Report. April 1, 2012 to June 30, 2012. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site*. July 13, 2012.

DOF. 2012f. *Quarterly Report. July 1, 2012 to September 30, 2012. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site*. October 12, 2012.

DOF. 2012g. *Water Quality Monitoring Report. September and December 2010 Sampling Events. Tacoma Historical Coal Gasification Site*. January 9, 2012.

DOF. 2012h. *Water Quality Monitoring Report. March and June 2011 Sampling Events. Tacoma Historical Coal Gasification Site.* August 7, 2012.

DOF. 2012i. *Water Quality Monitoring Report. September and December 2011 Sampling Events. Tacoma Historical Coal Gasification Site.* August 13, 2012.

DOF. 2012j. *Inspection and Maintenance Report. January 2010 to December 2011. Tacoma Historical Coal Gasification Site. Prepared for PSE by DOF, Inc.* May 2012.

DOF. 2013a. *Technical Memorandum. New Monitoring Well Installations, Tacoma Historical Coal Gasification Site, Tacoma, Washington.* December 23, 2013.

DOF. 2013b. *Quarterly Report. October 1, 2012 to December 31, 2012. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site.* January 8, 2013.

DOF. 2013c. *Quarterly Report. January 1, 2013 to March 31, 2013. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site*. April 10, 2013.

DOF. 2013d. *Quarterly Report. April 1, 2013 to June 30, 2013. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site*. July 12, 2013.

DOF. 2013e. *Quarterly Report. July 1, 2013 to September 30, 2013. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site.* October 7, 2013.

DOF. 2013f. *Water Quality Monitoring Report. March and June 2012 Sampling Events. Tacoma Historical Coal Gasification Site.* December 21, 2013.

DOF. 2013g. *Water Quality Monitoring Report. September and December 2012 Sampling Events. Tacoma Historical Coal Gasification Site.* December 27, 2013.

DOF. 2014a. *Water Quality Monitoring Report. March and June 2013 Sampling Events. Tacoma Historical Coal Gasification Site. March 28, 2014.*

DOF. 2014b. *Water Quality Monitoring Report. September and December 2013 Sampling Events. Tacoma Historical Coal Gasification Site. March 31, 2014.*

DOF. 2014c. *Inspection and Maintenance Report. January 2012 to December 2013. Tacoma Historical Coal Gasification Site. Prepared for PSE by DOF, Inc.* January 2014.

DOF. 2014d. *Quarterly Report. October 1, 2013 to December 31, 2013. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site.* January 13, 2014.

U.S. Environmental Protection Agency (EPA). 1987. *Record of Decision for Commencement Bay, Near Shore/Tide Flats OU 23 (Tacoma Tar Pits), Pierce County, WA.* December 30, 1987.

Ebasco. 1995. *Inspection and Maintenance Manual, Tacoma Historical Coal Gasification Site*. Prepared for Washington Natural Gas Company. August 1995.

EPA. 1991. *Explanation of Significant Differences for Commencement Bay, Near Shore/Tide Flats OU 23 (Tacoma Tar Pits), Pierce County, WA*. November 1, 1991.

EPA. 1995. *Explanation of Significant Differences for the Tacoma Tar Pits Operable Unit*. May 9, 1995.

EPA. 2009. *Five-Year Review Report. Third Five-Year Review Report for Commencement Bay Nearshore/Tideflats Superfund Site, Tacoma, Washington.* Prepared by U.S. Environmental Protection Agency, Region 10. December 23, 2009.

EPA. 2012a. Letter dated November 13, 2012 from Tamara Langton (EPA) to Matt Dalton (DOF) regarding *EPA Comments on the Asphalt Permeability Testing Results and the Trench Line Sampling Results, Tacoma Historical Coal Gasification Site (Tacoma Tar Pits).*

OU 3 Attachment 2 – 2014 Technical Memorandum on Water Quality and I&M

MEMORANDUM FOR RECORD

SUBJECT: Water Quality and Inspection and Maintenance Technical Memorandum for Tacoma Tar Pits Site (OU 3), CBNT Superfund Site, Tacoma, WA, Fourth Five-Year Review

PREPARED BY: Veronica Henzi, Environmental Engineer, Seattle District, U.S. Army Corps of Engineers

PREPARED FOR: Tamara Langton, EPA Region 10 Remedial Project Manager for Tacoma Tar Pits Site (OU 3)

Date: September 4, 2014

1. Introduction and Purpose

This technical memorandum summarizes two sets of activities: water quality monitoring (WQM) for the onsite groundwater extraction and treatment (GWET) system and the monitoring wells, and inspection and maintenance (I&M) activities for the remedial components installed in 1995. Those components include a capped engineered waste pile, storm water detention basins, and features (e.g. paving) at the Simons Metals LLC recycling facility operating area.

1.1. Water Quality Monitoring for the GWET System and Wells

The primary objective of WQM has been to provide data to assess compliance with the performance criteria presented in the Record of Decision (ROD; EPA 1987) for lead, PCBs, PAHs, and benzene in surface water and groundwater. The groundwater monitoring has been completed in a number of phases as summarized below:

- Pre-remediation monitoring – March 1991 to December 1994
- Post-remediation monitoring without groundwater containment – January 1995 to January 2002
- Post-remediation monitoring with groundwater containment – March 2002 to present

Post-remediation data collected after 1994 indicated that the criteria established in the ROD for lead, PCBs, and PAHs are being met at the site boundary in surface water and groundwater, and that the benzene criterion has been achieved in surface water and in groundwater within the fill and deep aquifers. However, at the end of 2013, benzene continues to exceed the ROD criterion (53µg/L) in the Sand Aquifer along portions of the site boundary. The results are described in more detail below.

The purpose of the groundwater hydraulic containment system is to intercept and treat groundwater along portions of the site boundary that contain benzene concentrations above the ROD criterion. The containment system consists of four extraction wells. Extraction wells A and B provide water from the "North Branch" of the system and wells C and TW-1 provide water from the "East Branch" of the system. Groundwater from these wells is pumped to a central treatment plant where it is treated by air-stripping. The stripped vapors are collected using vapor-phase carbon. Treated groundwater is discharged to the City of Tacoma sanitary sewer in accordance with the requirements of Industrial Wastewater Discharge Permit No. TAC-031-2011 (prior permit numbers were 001-636-456 and 500043736). The permit discharge limit for benzene is 500 µg/L, and the system can treat up to 20,000 gallons per day. The current discharge permit TAC-031-2011 issued by the City of Tacoma was renewed on 5/1/12 and expires 4/30/17; it will need to be renewed during the next FYR cycle.

WQM Data Review and Analysis

The list of documents reviewed can be found at the end of this memo and are repeated in OU 3 Attachment 1 - List of Documents Reviewed. Reports reviewed included water quality monitoring reports and discharge reports with quarterly data from March 2009 to December 2013. These reports were prepared by Dalton, Olmsted, and Fuglevand, Inc. (DOF) on behalf of Puget Sound Energy (PSE). Other documents reviewed included the 2012 Technical Memorandum for Results of Trench Line Sampling (DOF 2012a) and the 2013 Technical Memorandum for New Monitoring Well Installations (DOF 2013a).

Analysis of GWET System

Overall, review of the water quality and discharge reports indicates that the GWET system is functioning as intended, and that the benzene plume in the Sand Aquifer (the aquifer of concern) is generally being contained by the extraction and treatment system (DOF 2014a; DOF 2014b). Over the review period (2009-2013), the system operated on average 93% of the time (as calculated by this reviewer). The only significant down-time occurred in mid-January 2010, when the programmable logic controller (PLC) failed. For that period (January-March 2010), the system only operated 66% of the time. After extensive trouble-shooting, the PLC unit and defective modules were replaced and the system was restarted in February 2010. The calculated average flow rate over the review period was 9.2 gallons per minute (gpm), with the flow rate trending downward. Until June 2010, flows were approximately 10-13 gpm. After June 2010, flows were less than 10 gpm, varying from 6.5 to 9.3 gpm. No discussion was provided by DOF for the decrease; however, on September 28, 2010, a new Signet 2551 Magmeter (flow meter) was installed at the request of the City of Tacoma, which may have contributed to the change in flow readings.

Since the containment system began operation (2002), benzene influent concentrations have generally declined in concentration from greater than 4,000 µg/L to approximately between 750 and 2,000 µg/L. In 2013, flow measurements and water quality testing of influent samples indicated substantially lower flow rates and higher benzene concentrations from the East Branch wells as compared to the North Branch wells. These differences are consistent with the system operational history and hydrogeologic conditions. Regarding influent concentrations from the East Branch wells, the data from 2009 to 2013 show a decreasing trend (see Figure 1 at the end of this document) for the entire period from 2002-2013, with concentrations ranging from approximately 3,300 µg/L to 1,500 µg/L. Regarding influent concentrations from the North Branch wells, the data from 2009 to 2013 show a slight increasing trend (see also Figure 1), with concentrations ranging from approximately 480 µg/L to 610 µg/L. Four extraction wells are used for the GWET system (see Figure 2): wells A and B in the North Branch area, and wells C and TW-1 in the East Branch area.

The individual benzene effluent concentrations from the GWET system for all quarters (during the 2009-2013 period) except for the quarter ending September 2013, were less than 1.6 µg/L, which is less than the ROD criterion of 53 µg/L and significantly less than the permit discharge criterion of 500 µg/L. Only on August 22, 2013, did the benzene effluent concentration (64 µg/L) exceed the ROD criterion. However, this value was still well below the permit criterion of 500 µg/L. Over this entire FYR period, the average benzene effluent concentration was calculated by this reviewer to be 5.2 μg/L; omitting the exceedance, the value drops to <1 μg/L.

FYR recommendation: DOF should include a figure that summarizes effluent benzene concentrations to help assess effluent trends. Currently, only influent concentrations are provided.

Summary of Monitoring Well Location Information

For the recent monitoring program, the program consisted of 22 wells until May 2013, when two additional wells were installed (DOF-35M and DOF-36M). The purpose of the news wells was to assess whether benzene was migrating downgradient along the existing buried sewer line. The two new wells were incorporated into the monitoring program starting in June 2013. See text below on "Rationale for New Wells / Trench Line Sampling" for additional information.

In addition to these 24 wells, two other locations are sampled. The first is a surface water location designated "SW," and the second is the Hygrade well located outside the fencing of the Northwest Detention Center. The SW site is located within the Burlington Northern ditch located on the south side of the Tacoma Tar Pits site, and is approximately 65 feet upstream of where flow from the ditch enters a buried culvert. This ditch receives surface water runoff from the detention basins and surrounding areas, and groundwater discharge from the Fill Aquifer. The SW location is sampled semi-annually in March and September, but was not sampled in September 2013 because the ditch was dry.

The second location is the "exterior" Hygrade well located outside the Northwest Detention Center fencing. The exterior Hygrade well is an artesian well located approximately 20 feet to the west of Hygrade Well No. 2. This exterior well is currently sampled once every two years. Hygrade Well No. 2 is also an artesian well and located inside the security fencing. It is currently not being sampled, presumably due to accessibility issues. The exterior Hygrade well was sampled in September 2010 and September 2012, and is scheduled for September 2014.

See Figure 2 for locations of the monitoring wells, extraction wells, the SW sampling site, and the Hygrade Well No. 2 for reference. It should be noted that the exterior Hygrade well currently being sampled is NOT shown on the figure; its location has to be inferred from the location of Hygrade Well No. 2. In addition, many other possible sampling locations (there are 44 total locations) have been eliminated from the monitoring program over the years.

FYR recommendation: The location of the exterior Hygrade well should be added to the DOF reports since it is part of the sampling scheme.

Rationale for New Wells / Trench Line Sampling

EPA expressed concern in 2012 that benzene may be migrating through the backfill along the pipe trench, to the Puyallup River (i.e., moving northeast), at concentrations greater than the ROD performance criterion. Post-remediation monitoring of groundwater conditions at the Tacoma Tar Pits has indicated that benzene concentrations along a portion of the eastern/southeastern site boundary within the Sand Aquifer exceed the performance criterion (53 μg/L) specified in the ROD. Two buried sewer lines run along the eastern site boundary.

DOF evaluated the sewer lines in 2012 and documented their results in their Results of Trench Line Sampling Technical Memorandum (DOF 2012a). Details are summarized as follows. The sewer lines include two parallel 48-inch diameter lines that are buried approximately 15 to 20 feet below ground surface. One line was constructed in 1960 and the other in 1976. The type of backfill used to fill the pipe trenches was not reported. Monitoring well TTP-2M is a site boundary monitoring well located west of the sewer lines (and just inside of the Tacoma Tar Pits Site boundary) within the area of interest (See Figure 3).

The 2012 groundwater contours indicated that the groundwater flow from TTP-2M was toward the southwest, away from the Puyallup River. Figure 4 shows the benzene concentration pattern for the site based on groundwater samples collected on June 27 and 28, 2012, in relation to the area of interest associated with the sampling effort in 2012. The higher benzene concentration area was located southwest of TTP-2M. While benzene concentrations have fluctuated in samples from TTP-2M, benzene concentrations historically have always been substantially lower at TTP-2M than those in samples from wells located to the southwest within the higher benzene concentration area. Concentrations in samples from Sand Aquifer well TTP-2M were below the ROD criterion of 53 µg/L (at 13 µg/L as of June 27, 2012).

As part of the trench line sampling efforts, twelve push-probe samples were collected on June 19 and 20, 2012. The probe locations (P1, P2, P3, P4) can be seen on Figure 3. The analytical results ranged between 0.037 and 260 µg/L and are summarized below.

Location	**Depth (feet BGS)**	**Highest Benzene Concentration (µg/L)**
P1	26 to 29	15
P2	26 to 29	260
P3	19 to 22	1.5
P4	26 to 29	0.2

Figures 3 and 4 show the horizontal benzene concentration pattern along the buried sewer lines. Figure 5 shows the vertical benzene profile for probes P1, P2, and P3 (and well TTP-2M). The highest benzene concentrations were detected in the three samples collected at different depths from location P2 (110 to 260 µg/L), while lower concentrations were detected on either side of probe P2. Concentrations were 13 to 15 µg/L to the southwest in samples from well TTP-2M and probe P1, and 0.2 to 1.5 µg/L to the northeast in samples from probes P3 and P4. The 260 µg/L was collected at the deepest sample depth for probe P2, at 29 feet bgs.

Based on the geologic logs, the probes appeared to have been drilled into the edges of the pipeline trench. The benzene concentration patterns suggested that some benzene has migrated within the pipeline trench backfill. The highest-concentration sample from probe P4 (0.2 µg/L) was lower than the highest-concentration sample from probe P3 (1.5 µg/L); P3 is located closer to the pipelines. These values for probes P3 and P4 were well below the ROD criterion of 53 µg/L.

Detected concentrations at probe P2 (110 to 260 µg/L) were within the range of the past higher concentrations detected in most samples from well TTP-2M (100 to 300 µg/L). The data suggest that the higher benzene concentrations periodically observed at location TTP-2M and more recently detected at probe P2 are caused by fluctuation of the benzene plume footprint. If this is the case, it should be noted that the recent push-probe testing program was completed at a time when the shift had apparently moved the plume to the northeast.

While the groundwater flow is generally to the southwest in the pipe trench area, there is a possibility that a localized groundwater divide may be present in the vicinity of and/or to the northeast of TTP-2M. The position of such a feature could shift, which would also cause the plume to shift.

To further evaluate the migration of benzene along the sewer line trench and identify the possible cause of the observed benzene fluctuations, DOF recommended that two additional Sand Aquifer wells (Well A and Well B) be drilled and incorporated into the long-term monitoring program. These wells are now known as DOF-35M and DOF-36M. Well A (now DOF-36M) would be located near P3. Data from Well A (DOF-36M) would be used to assess local groundwater flow gradients and assess benzene concentrations near the northeast corner of the site boundary, within the pipeline trench backfill. Well B (now DOF-35M) would be located near P2. Data from DOF-35M would also be used to assess local groundwater flow gradients and benzene concentrations on the northeast side of the East Branch lobe of the benzene plume.

The two new monitoring wells were installed on May 13, 2013. DOF prepared a technical memorandum (DOF 2013a) that documented the installation of new monitoring wells known as TTP-35M and TTP-36M in that memorandum. These wells are currently identified as DOF-35M and DOF-36M in the monitoring and discharge reports. The well locations are shown on Figure 2. Elevations were established relative to the top of casing (TOC) of existing Well TTP-2M. The purpose of the two new wells is to collect data to further assess possible benzene migration along two buried municipal sewer lines that are located along the southeastern site boundary. Monitoring of these new wells would be at the same frequency as for TTP-2M (i.e., quarterly).

Analysis of Monitoring Well Data

See Figure 6 for the current plume data as of December 2013, where benzene concentrations continue to exceed the ROD criterion of 53 µg/L. See Figure 7 for groundwater contours and estimated flow directions in the Sand Aquifer as of December 2013. The current monitoring wells are grouped into 10 East Branch wells (TTP-3M Area) and 14 North Branch wells (TTP-18M Area).

The **East Branch** area is located along the southeastern site boundary and generally lies between wells TTP-12M and DOF-36M. The specific East Branch wells are as follows:

- Within remediation area (upgradient of site boundary): DOF-26M
- Near site boundary: TTP-2M, TTP-3M, DOF-24M, DOF-25M, DOF-34M, DOF-35M (starting June 2013), DOF-36M (starting June 2013)
- Downgradient of site boundary: DOF-19M, DOF-20M (semi-annual wells)

The wells near the site boundary and downgradient of the site boundary, with the exception of DOF-35M and DOF-36M (which are too new for trend analysis), were evaluated using the Mann-Kendall nonparametric test for trend to evaluate benzene trends at or near the East Branch site boundary. The results are provided below in Table 1 and Figure 8.

Table 1. Mann-Kendall Test for Benzene Trends in East Branch Wells (2009-2013)

Well	Benzene Concentrations above ROD Criterion (53 µg/L)?	Benzene Concentration Trend	Confidence in Trend (%)
TTP-2M	None since June 2009	Decreasing	>99.9
TTP-3M	All	No Trend	63.8

Well	Benzene Concentrations above ROD Criterion (53 µg/L)?	Benzene Concentration Trend	Confidence in Trend (%)
DOF-19M	None	Probably Decreasing	94.6
DOF-20M	None	No Trend	70
DOF-24M	All	No Trend	63.8
DOF-25M	All	**Increasing**	95.4
DOF-34M	All	Probably Decreasing	91.3

For the newly installed well DOF-35M, which was incorporated into the monitoring program in June 2013, the June, September, and December benzene concentrations were 81, 12, and 86 µg/L, respectively. Two of these three values exceed the ROD benzene criterion. For the other newly installed well, DOF-36M, there were no detections (detection limit of 0.10 µg/L) in June, September, or December 2013.

Thus, the East Branch site boundary wells that exceed the ROD criterion are TTP-3M, DOF-24M, DOF-25M, DOF-34M, and DOF-35M. DOF-35M is closest to the sewer lines and located just within the site boundary. DOF-25M, located further away from the sewer lines, has increasing benzene concentrations above ROD criterion.

The **North Branch** area is located on the north part of the site and generally lies between wells AGI-14M(R) and AGI-5M. The specific North Branch wells are as follows:

- Upgradient of remediation area (and covered waste pile): TTP-16M(R), TTP-17M(R)
- Within remediation area (upgradient of site boundary): DOF-22M, DOF-23M, DOF-29M, DOF-30M
- Near site boundary: AGI-14M(R), DOF-33M, TTP-18M, DOF-31M, AGI-5M
- Downgradient of site boundary: DOF-27M, DOF-28M, MW-03

These wells are on a mix of quarterly, semi-annual, and annual sampling. The benzene concentrations vary considerably, but the higher concentrations (above the ROD criterion) are present in two lobes generally centered on wells DOF-33M and TTP-18M/DOF-31M, respectively. The wells near the site boundary and downgradient of the site boundary were evaluated using the Mann-Kendall nonparametric test for trend to evaluate benzene trends at or near the North Branch site boundary. The results are provided below in Table 2 and Figure 9.

Table 2. Mann-Kendall Test for Benzene Trends in North Branch Wells (2009-2013)

Well	Benzene Concentrations above ROD Criterion (53 µg/L)?	Benzene Concentration Trend	Confidence in Trend (%)
TTP-18M	All since December 2011	**Increasing**	>99.9
DOF-27M	None	No Trend	78.4
DOF-28M	One instance (68 µg/L) in March 2013 (1)	No Trend (1)	60.3
DOF-31M	All since March 2011	**Increasing**	99.7
DOF-33M	All except once instance (0.1 µg/L) in December 2013 (2)	Probably Decreasing (2)	93.2
MW-03	None	Stable	89.2

1 – The exceedance was thought by DOF to be a lab error (DOF 2014a); if the exceedance is removed from the dataset, the trend becomes “stable” with 58% confidence.
2 – The value of 0.1 µg/L appears inconsistent with all prior values, which have ranged since March 2009 from 650 µg/L to 1400 µg/L. If 0.1 µg/L is removed from the dataset, the trend becomes “stable” with 82.5% confidence.

As indicated in Table 2, the wells with increasing benzene concentrations above the ROD criterion are TTP-18M and DOF-31M. DOF-33M also has benzene concentrations significantly above the ROD criterion. These wells are located just outside the North Branch area site boundary (see Figure 2, upper portion). However, benzene has generally not been detected in wells DOF-27M, DOF-28M, and MW-03, which are located downgradient of wells TTP-18M, DOF-31M, and DOF-33M. The Puyallup River is located downgradient from all of the aforementioned wells.

The SW location is supposed to be sampled in March and September, but the ditch is frequently dry in September. The available sampling data indicate that benzene concentrations have been <1.0 µg/L for this fourth FYR period. The SW samples did not exceed the ROD criteria for other sampled COCs as well. Regarding the exterior Hygrade well, the 2010 and 2012 benzene concentrations were <1.0 µg/L. The Hygrade well samples did not exceed the ROD criteria for other sampled COCs as well.

1.2. Water Quality Summary & Recommendations

In general, the benzene concentrations in the monitoring wells at the Tacoma Tar Pits site vary considerably, but the shape of the benzene plume (areas with concentrations greater than 53 µg/L and greater than 1,000 µg/L) as of December 2013 appears generally similar to the shape of plume in December 2009 (see Figure 6 and Figure 10). With respect to effluent discharges from the GWET system as described above, there has been only one exceedance of the ROD criterion during this FYR period, on August 22, 2013 (64 µg/L). However, this value was still well below the permit criterion of 500 µg/L.

With respect to the new East Branch site boundary wells installed in 2013 (DOF-35M, DOF-36M) near the sewer lines, only DOF-35M has had benzene concentrations that slightly exceed the ROD criterion. Data from future sampling events will help assess trends from these new wells and provide a more complete picture of possible benzene migration beyond the boundary. Other East Branch site boundary wells have mixed results for benzene concentrations and trends (see Table 1): TTP-3M, DOF-24M, DOF-25M, and DOF-34M exceed the ROD criterion, and DOF-25M has increasing benzene concentrations above the ROD criterion.

With respect to the North Branch site boundary wells, wells TTP-18M and DOF-31M are located just outside the boundary and have had increasing benzene concentrations above the ROD criterion since 2011. DOF-33M also has benzene concentrations significantly above the ROD criterion and is located outside the boundary. Other North Branch site boundary wells have mixed results for benzene concentrations and trends (see Table 2). While groundwater (see Figure 7) as of December 2013 is estimated to flow toward extraction wells A and B (and hence the site interior), the benzene concentrations in wells TTP-18M, DOF-31M, and DOF-33M are of concern since these wells exceed the ROD criterion and are located outside the site boundary.

The PRP's contractor, DOF, indicates that the containment system is functioning as intended, and that the benzene plume in the Sand Aquifer is being contained by the pump and treat system. However, it appears based on this data analysis and review, that benzene concentrations in some East Branch boundary wells (DOF-25M, DOF-35M) and some North Branch off-site boundary wells (TTP-18M, DOF-31M) are exceeding the ROD criterion at increasing values. The following recommendations are suggested for the water quality data:

- DOF should include a figure that summarizes effluent benzene concentrations to help assess effluent trends. Currently, only influent concentrations are provided.

- DOF should add the location of the exterior Hygrade well to the DOF reports since it is part of the sampling scheme.
- DOF should monitor East Branch and North Branch site boundary wells closely, since the trends indicate that the benzene ROD criterion is being exceeded at increasing values.

2. Inspection and Maintenance Activities

The primary objective of inspection and maintenance (I&M) activities is to ensure that the remedial components installed in 1995 are still functioning as intended. In general, the site consists of a capped engineered waste pile, storm water detention basins, and the Simons Metals LLC recycling operating area. The need for I&M of the cover and drainage facilities at the Tacoma Tar Pits site is largely directed toward identifying and repairing damage caused by severe weather. Generally, it is anticipated that the greatest potential for damage would occur during the wetter (late fall to early spring) portions of the year as compared to the drier portions of the year. Site inspections are generally made in the fall.

2.1. I&M Data Review and Analysis

The list of documents reviewed can be found at the end of this memo and are repeated in OU 3 Attachment 1 - List of Documents Reviewed. Documents reviewed included the 2010-2011 Inspection and Maintenance Monitoring Report (DOF 2012j), the 2012-2013 Inspection and Maintenance Monitoring Report (DOF 2014c), and the 2012 Technical Memorandum for Results of Asphalt Permeability Testing (DOF 2012b).

I&M Inspection Dates

Site inspections were made on the following dates:

- September 22, 2010 (general inspection)
- October 4, 2010 (general inspection)
- October 28, 2010 (finish general inspection)
- December 15, 2010 (after heavy rain)
- September 22, 2011 (general inspection)
- October 27, 2011 (finish general inspection)
- October 4, 2012 (general inspection)
- November 1, 2012 (inspection after heavy rain)
- August 14, 2013 (asphalt basin cleaning/observation)
- August 20, 2013 (pre-mowing inspection/basin observation)
- August 21, 2013 (basin crack sealing)
- October 21, 2013 (post-mowing/general inspection)

Other inspections occur as part of quarterly groundwater monitoring activities and as part of O&M of GWET system.

Summary of Site Observations for Areas Covered

Areas covered by the 1995 I&M plan and the current conditions of those areas have been summarized in Table 3 below. Photos of the areas and repairs made can be seen in the 2012-2013 Inspection and Maintenance Monitoring Report (DOF 2014c), the most current report.

Table 3. Tacoma Tar Pits Areas Subject to I&M, and Current Condition

Facility covered by I&M plan	Current condition
Covered stabilized waste pile, which is stabilized waste material covered by geosynthetic fabrics, compacted soil, and a vegetative layer	The site was mowed in 2010, 2011, 2012 and 2013 and no substantial settlement or erosion was noted. Some minor soil scraping and rutting were observed, similar to past years. Past soil scraping and rutting have not been observed to adversely affect the soil cover, and the grass cover quickly re-establishes after mowing. Brush was removed from the rocked drainage channels on the stabilized waste pile. The waste pile access road had developed a few holes along the ecology block wall, and these were repaired.
Stabilized waste materials covered by low permeability asphalt – former construction water treatment area located between the covered stabilized waste pile and Detention Basin No. 1 (DB#1)	In 2013 the asphalt-covered area between DB#1 and the covered waste pile was observed to be in good condition. Simons uses the area for truck and trailer parking. The treatment plant currently lies within the eastern portion of this area and is surrounded with a chain-link fence that minimizes the possibility of inadvertent damage from vehicle traffic.
Concrete and asphalt covers (paving) in the Simons operating area	Little change was evident from previous inspections, and the operating area drainage system continues to operate as designed. Some asphalt gouging, concrete raveling along joints, and concrete cracking/gouging were observed in 2013. The observed “wear and tear” damage to the paving was expected, and, in the opinion of DOF, did not significantly affect the capping function of the paving. DOF conversations with Simon’s staff indicated that the metal recycling operating area continues to drain well during periods of heavy precipitation.
Box culverts, lined ditch, and DB#1 that drain the stabilized waste pile	The box culverts and drainage ways leading to and from the detention basins continue to operate as designed. Some sediment/soil/debris has accumulated in the bottom of some portions of the culverts without restricting flow to the detention basins. Drainage ways into detention basin DB#1 remain clear. Some cracked asphalt was identified in the detention basins, primarily DB#1. Asphalt cores were collected for permeability testing in 2011 and confirmed that the cracks did not extend through the full asphalt thickness. Repairs were also made – see additional text below.
Catch basins and DB#2, which are storm drainage facilities for the Simons operating area. The catch basins, and for the most part DB#2, are maintained by Simons.	Simons cleaned the catch basins annually (last in 2013); storm water was discharged to the BN ditch through a control structure under an industrial stormwater discharge permit with Ecology. Flow from DB#2 is restricted to 1.0 cfs. Storm water is treated to remove oils and metals prior to discharge.
The Burlington Northern (BN) ditch that drains both detention basins	Vegetation continues to grow in the BN ditch, particularly at the east end where discharge occurs to a buried culvert. Observations during heavy precipitation indicate the vegetation does not cause water to back-up in the ditch, and it likely acts as a biofiltration swale. During late summer/early fall, vegetation is removed from the east end of the ditch so that flow is not restricted.

Facility covered by I&M plan	**Current condition**
Signs and fencing	No issues were identified with signs or fencing.

In general, site observations made by DOF in 2012 and 2013 indicate that the remedial systems installed at the Tacoma Tar Pits site in 1995 are in acceptable condition and are functioning as intended.

Asphalt Permeability Testing

A separate technical memorandum was prepared by DOF in 2012 that describes the results (with photos) of asphalt permeability testing completed in 2011 for the bottom of the asphalt-lined stormwater detention basins at the Tacoma Tar Pits site (DOF 2012b). Four cores were collected from each basin for a total of eight cores. Consistent with their 2011 work plan (DOF 2011a), DOF collected two cores from each basin in areas where visible observation indicated asphalt to be in good condition and two cores from each basin in areas with some evidence of surface asphalt deterioration (i.e., surface cracking).

Detention Basin No. 1 (DB#1)

Cores DB1-KT1 and DB1–KT4 were obtained in areas where no surface cracking of asphalt was observed, while cores DB1-KT2 (core of primary interest to EPA) and DB1–KT3 were obtained in areas where cracking was observed. Pertinent observations and test results for DB#1 are summarized below in Table 4.

Table 4. DB#1 Observations and Results

Location	Asphalt Thickness (ft)	Observation	Permeability (cm/sec)
DB1-KT1	0.46	Core in un-cracked asphalt	1.3E-8
DB1-KT2	**0.42**	**Cracked asphalt – 1.5 inches deep**	**2.3E-7**
DB1-KT3	0.33	Cracked asphalt – 1 to 1.25 inches deep	<1.0E-7
DB1-KT4	0.42	Core in un-cracked asphalt	<1.0E-7

DB#1 asphalt thickness ranged from 0.33 to 0.43 feet (approximately 4 to 5.5 inches). Surface cracking did not extend more than approximately 1.5 inches deep below the asphalt surface at locations DB1-KT2 and DB1-KT3. The deepest crack in either basin (1.5 inches) was observed in the core from DB1-KT2.

DB#1 asphalt core permeability ranged from 1.3E-8 cm/sec to 2.3E-7 cm/sec. One of the four core test results was slightly higher than the performance criterion of 1E-7cm/sec; the permeability at DB1-KT2 was 2.3E-7 cm/sec. The average of the test results is less than the performance criterion (approximately 6.6E-8 cm/sec) assuming a value of 1E-8 cm/sec for cores DB1-KT3 and DB1-KT4 where no flow was observed during the testing and the permeability was determined to be less than 1E-7 cm/sec.

Detention Basin No. 2 (DB#2)

Cores DB2-KT1 and DB2–KT4 were obtained in areas where cracked asphalt was observed, while cores DB2-KT2 and DB2–KT3 were obtained in areas where cracking was not observed. Pertinent observations and test results are summarized below in Table 5.

Table 5. DB#2 Observations and Results

Location	Asphalt	Observation	Permeability (cm/sec)

	Thickness (ft)		
DB2-KT1	0.50	Asphalt surface cracking	3.2E-8
DB2-KT2	0.52	Core in un-cracked asphalt	<1.0E-7
DB2-KT3	0.46	Core in un-cracked asphalt	3.7E-9
DB2-KT4	0.42	Cracked asphalt – 1 inch deep	8.0E-8

DB#2 asphalt thickness ranged from 0.42 to 0.52 feet (approximately 5 to 6 inches). Surface cracking did not extend more than approximately 1 inch deep below the asphalt surface at locations DB2-KT1 and DB2-KT-4. DB#2 asphalt permeability ranged from 3.7E-9 cm/sec to less than 1.0E-7 cm/sec. The four test results indicate the permeability of DB-2 asphalt is less than the performance criterion of 1E-7 cm/sec.

Detention Basin Asphalt Repair

In a letter dated November 13, 2012, EPA requested that DOF repair the cracks in the asphalt at the DB1-KT2 sampling location (EPA 2012a). EPA also recommended that periodic inspections and repair of the asphalt should occur.

The cracks were sealed in August 2013 as shown in Figures 27 to 30 of the 2012-2013 Inspection and Maintenance Monitoring Report (DOF 2014c). An example of the repair is shown in Figure 11 of this technical memorandum. Specifically, DOF subcontracted Asphalt Patch Systems of Puyallup, Washington to clean and fill the cracks in the low-permeability asphalt that line the storm water detention basins (DB#1 and DB#2). DB#1 (western basin) is a single basin that receives runoff from the stabilized/covered waste pile and is approximately 51,000 square feet. DB#2 (eastern basin) is divided into thirds, receives runoff from Simons Metals, and is approximately 49,150 square feet.

On August 14th, 2013, after an extended period of dry weather leaving the basins dry, a vacuum-equipped street sweeper was deployed to remove sediment and debris in DB#1 and in the southern two-thirds of DB#2. The remaining third of DB#2, which contained a heavy layer of sediment because it serves as Simon's primary settlement basin, was scraped and swept clean by Simons on August 20, 2013. The basins were inspected to identify cracks for repair by DOF. On August 21, 2013, Asphalt Patch Systems mobilized to the site to fill the cracks. The cracks were further cleaned using a hand-broom followed by a high-velocity backpack blower. The cracks were filled with Dura Fill H.S Crack Filler A-420, a rubberized joint and crack sealing compound that requires pre-melting. The material was melted in propane-fired vessels and applied using a hand-operated applicator cart.

The majority of the cracks resided in DB#1 and approximately 1,350 lineal feet were sealed. Approximately 100 lineal feet of cracking in DB#2 and 180 lineal feet along Simon's perimeter road adjacent to the basins were also sealed.

2.2. I&M Summary and Recommendations

In general, site observations made by DOF in 2012 and 2013 indicate that the remedial systems installed at the Tacoma Tar Pits site in 1995 are in acceptable condition and are functioning as intended. The cracked asphalt has been repaired. In 2012, EPA asked PSE's contractor (DOF) to incorporate periodic observations of asphalt integrity and repair into their annual I&M activities. DOF has not updated either their 2006 Asphalt Repair/Maintenance Plan for the Detention Basins or their 1995 Inspection and Maintenance Manual. The following action is recommended:

- DOF should inform EPA of their planned procedures for regularly inspecting and repairing the asphalt, and indicate which of their documents will be updated to incorporate those activities.

3. Documents Reviewed

City of Tacoma (and PSE). *2012-2017 Permit No. TAC-031-2011.* Permit renewed 5/1/12. Issued to Dalton, Olmsted & Fuglevand, Inc .

Dalton, Olmsted & Fuglevand, Inc. (DOF). 2002. *Revised Water Quality Monitoring Program, Tacoma Historical Coal Gasification Site*. January 4, 2002.

DOF. 2003. *Groundwater Remediation System, Operation and Maintenance Plan, Tacoma Historical Coal Gasification Site*. Prepared for Puget Sound Energy, Inc. February 2003.

DOF 2009a. *Dalton, Olmsted & Fuglevand, Inc (DOF). Quarterly Report. April 1, 2009 to June 30, 2009. Permit No. 001-636-456. Tacoma Historical Coal Gasification Site*. July 14, 2009.

DOF 2009b. *Quarterly Report. July 1, 2009 to September 30, 2009. Permit No. 001-636-456. Tacoma Historical Coal Gasification Site*. October 12, 2009.

DOF 2010a. *Quarterly Report. October 1, 2009 to December 31, 2009. Permit No. 001-636-456. Tacoma Historical Coal Gasification Site*. January 14, 2010.

DOF 2010b. *Quarterly Report. January 1, 2010 to March 31, 2010. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. April 13, 2010.

DOF 2010c. *Quarterly Report. April 1, 2010 to June 30, 2010. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. July 30, 2010.

DOF 2010d. *Quarterly Report. July 1, 2010 to September 30, 2010. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. October 14, 2010.

DOF 2010e. *Water Quality Monitoring Report. March and June 2009 Sampling Events. Tacoma Historical Coal Gasification Site.* May 14, 2010.

DOF 2010f. *Water Quality Monitoring Report. September and December 2009 Sampling Events. Tacoma Historical Coal Gasification Site.* December 21, 2010.

DOF 2011a. *Technical Memorandum. Asphalt Permeability Testing Work Plan, Detention Basins THCGS.* September 9, 2011.

DOF 2011b. *Quarterly Report. October 1, 2010 to December 31, 2010. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. January 12, 2011.

DOF 2011c. *Quarterly Report. January 1, 2011 to March 31, 2011. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. April 10, 2011.

DOF 2011d. *Quarterly Report. April 1, 2011 to June 30, 2011. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. July 14, 2011.

DOF 2011e. *Quarterly Report. July 1, 2011 to September 30, 2011. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. October 10, 2011.

DOF 2011f. *Water Quality Monitoring Report. March and June 2010 Sampling Events. Tacoma Historical Coal Gasification Site.* January 10, 2011.

DOF 2012a. *Technical Memorandum. Results of Trench Line Sampling, Tacoma Historical Coal Gasification Site (Tacoma Tar Pits), Tacoma, Washington.* Dec 9, 2012.

DOF 2012b. *Technical Memorandum. Results of Asphalt Permeability Testing, Detention Basins, THCGS.* May 8, 2012.

DOF 2012c. *Quarterly Report. October 1, 2011 to December 31, 2011. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. January 6, 2012.

DOF 2012d. *Quarterly Report. January 1, 2012 to March 31, 2012. Permit No. 500043736. Tacoma Historical Coal Gasification Site*. April 12, 2012.

DOF 2012e. *Quarterly Report. April 1, 2012 to June 30, 2012. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site*. July 13, 2012.

DOF 2012f. *Quarterly Report. July 1, 2012 to September 30, 2012. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site*. October 12, 2012.

DOF 2012g. *Water Quality Monitoring Report. September and December 2010 Sampling Events. Tacoma Historical Coal Gasification Site*. January 9, 2012.

DOF 2012h. *Water Quality Monitoring Report. March and June 2011 Sampling Events. Tacoma Historical Coal Gasification Site.* August 7, 2012.

DOF 2012i. *Water Quality Monitoring Report. September and December 2011 Sampling Events. Tacoma Historical Coal Gasification Site.* August 13, 2012.

DOF. 2012j. *Inspection and Maintenance Report. January 2010 to December 2011. Tacoma Historical Coal Gasification Site. Prepared for PSE by DOF, Inc.* May 2012.

DOF 2013a. *Technical Memorandum. New Monitoring Well Installations, Tacoma Historical Coal Gasification Site, Tacoma, Washington.* December 23, 2013.

DOF 2013b. *Quarterly Report. October 1, 2012 to December 31, 2012. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site.* January 8, 2013.

DOF 2013c. *Quarterly Report. January 1, 2013 to March 31, 2013. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site*. April 10, 2013.

DOF 2013d. *Quarterly Report. April 1, 2013 to June 30, 2013. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site*. July 12, 2013.

DOF 2013e. *Quarterly Report. July 1, 2013 to September 30, 2013. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site.* October 7, 2013.

DOF 2013f. *Water Quality Monitoring Report. March and June 2012 Sampling Events. Tacoma Historical Coal Gasification Site.* December 21, 2013.

DOF 2013g. *Water Quality Monitoring Report. September and December 2012 Sampling Events. Tacoma Historical Coal Gasification Site.* December 27, 2013.

DOF 2014a. *Water Quality Monitoring Report. March and June 2013 Sampling Events. Tacoma Historical Coal Gasification Site. March 28, 2014.*

DOF 2014b. *Water Quality Monitoring Report. September and December 2013 Sampling Events. Tacoma Historical Coal Gasification Site. March 31, 2014.*

DOF 2014c. *Inspection and Maintenance Report. January 2012 to December 2013. Tacoma Historical Coal Gasification Site. Prepared for PSE.* January 2014.

DOF 2014d. *Quarterly Report. October 1, 2013 to December 31, 2013. Permit No. TAC-031-2011. Tacoma Historical Coal Gasification Site.* January 13, 2014.

U.S. Environmental Protection Agency (EPA). 1987. *Record of Decision for Commencement Bay, Near Shore/Tide Flats OU 23 (Tacoma Tar Pits), Pierce County, WA.* December 30, 1987.

Ebasco. 1995. *Inspection and Maintenance Manual, Tacoma Historical Coal Gasification Site*. Prepared for Washington Natural Gas Company. August 1995.

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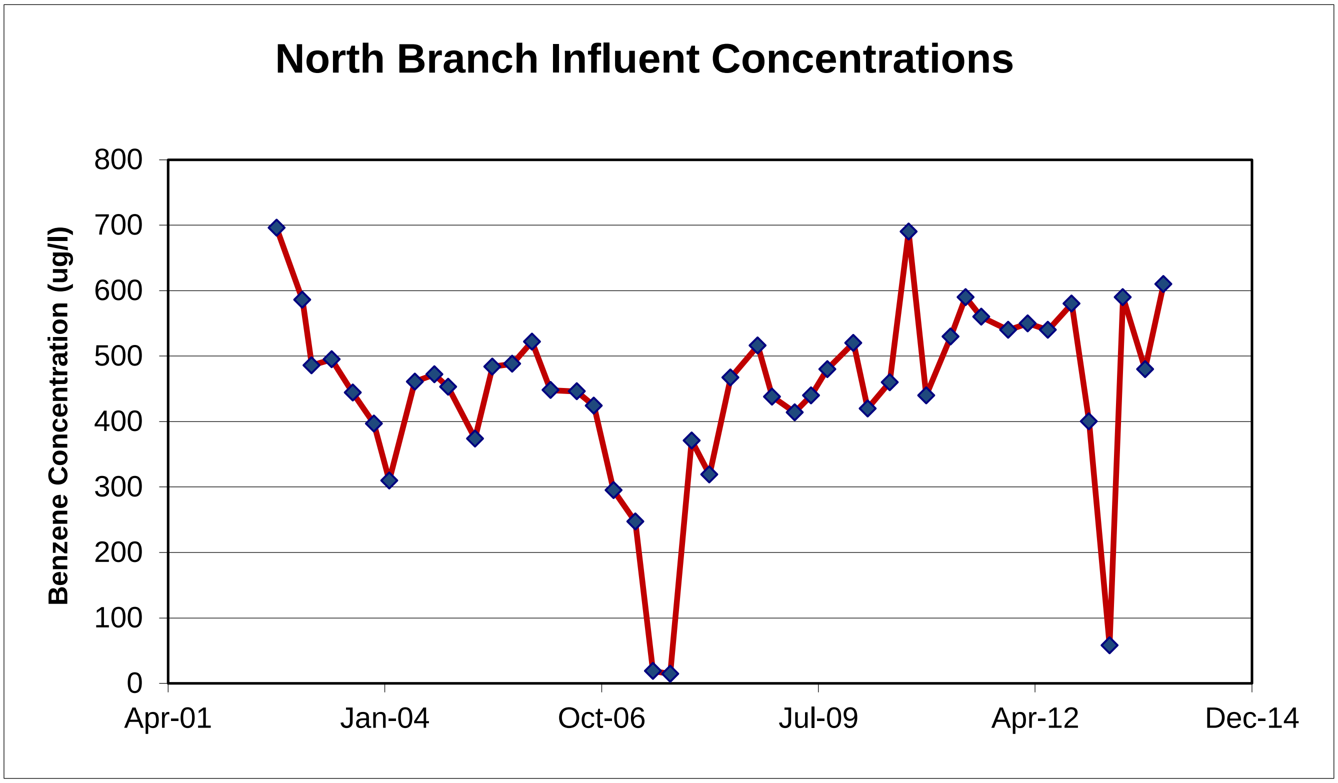
EPA. 1995. *Explanation of Significant Differences for the Tacoma Tar Pits Operable Unit*. May 9, 1995.

EPA. 2009. *Five-Year Review Report. Third Five-Year Review Report for Commencement Bay Nearshore/Tideflats Superfund Site, Tacoma, Washington.* Prepared by U.S. Environmental Protection Agency, Region 10. December 23, 2009.

EPA. 2012a. Letter dated November 13, 2012 from Tamara Langton (EPA) to Matt Dalton (DOF) regarding *EPA Comments on the Asphalt Permeability Testing Results and the Trench Line Sampling Results, Tacoma Historical Coal Gasification Site (Tacoma Tar Pits).*

OU 3 Attachment 2 - FIGURES



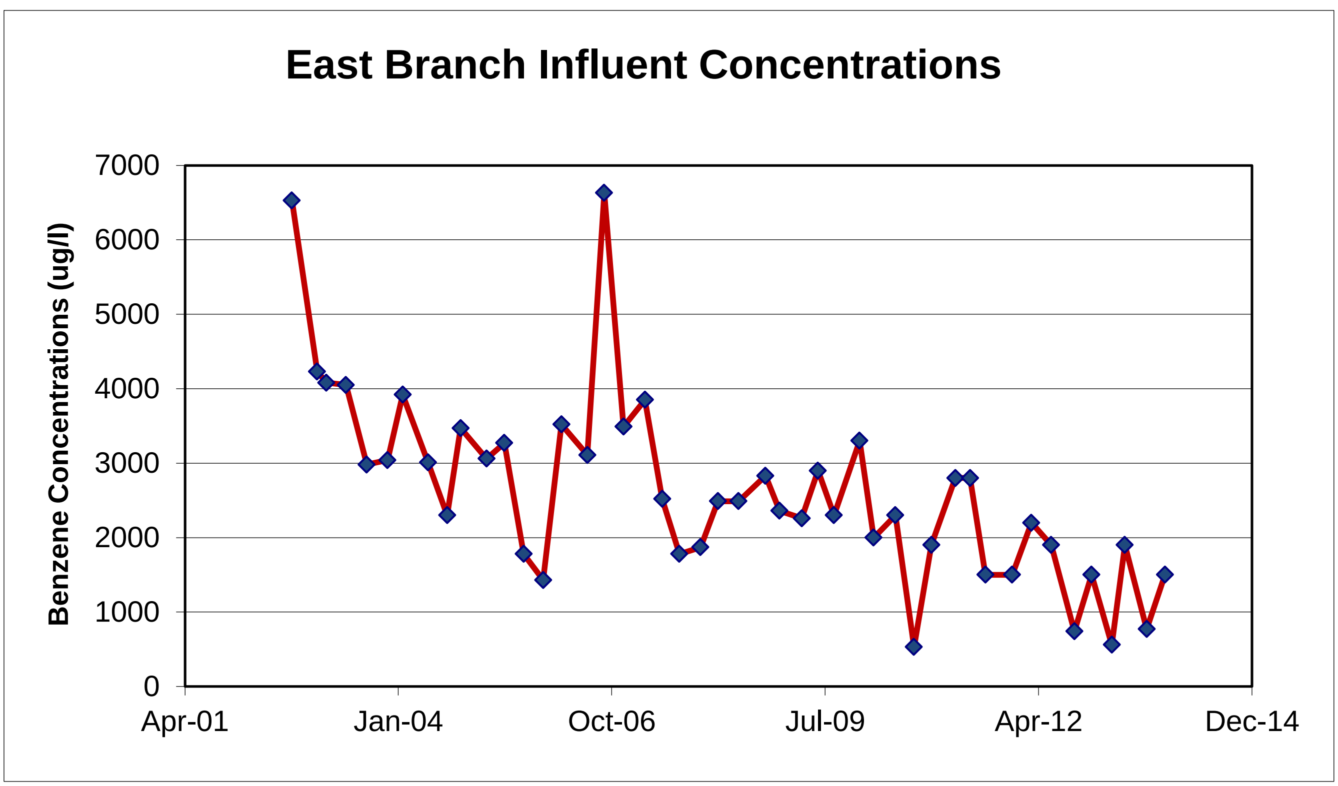
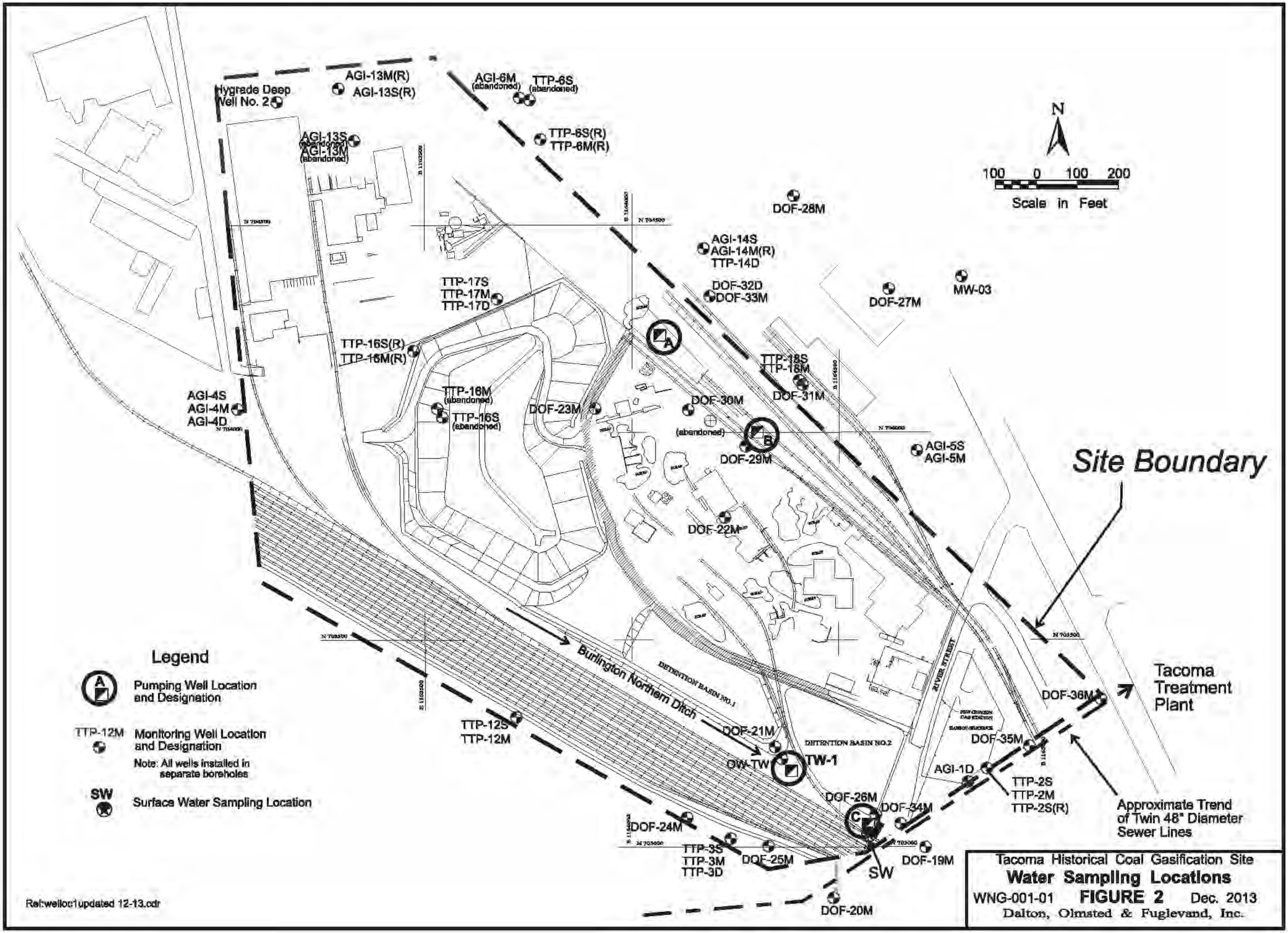


FIGURE 3
Treatment Plant Influent Concentrations

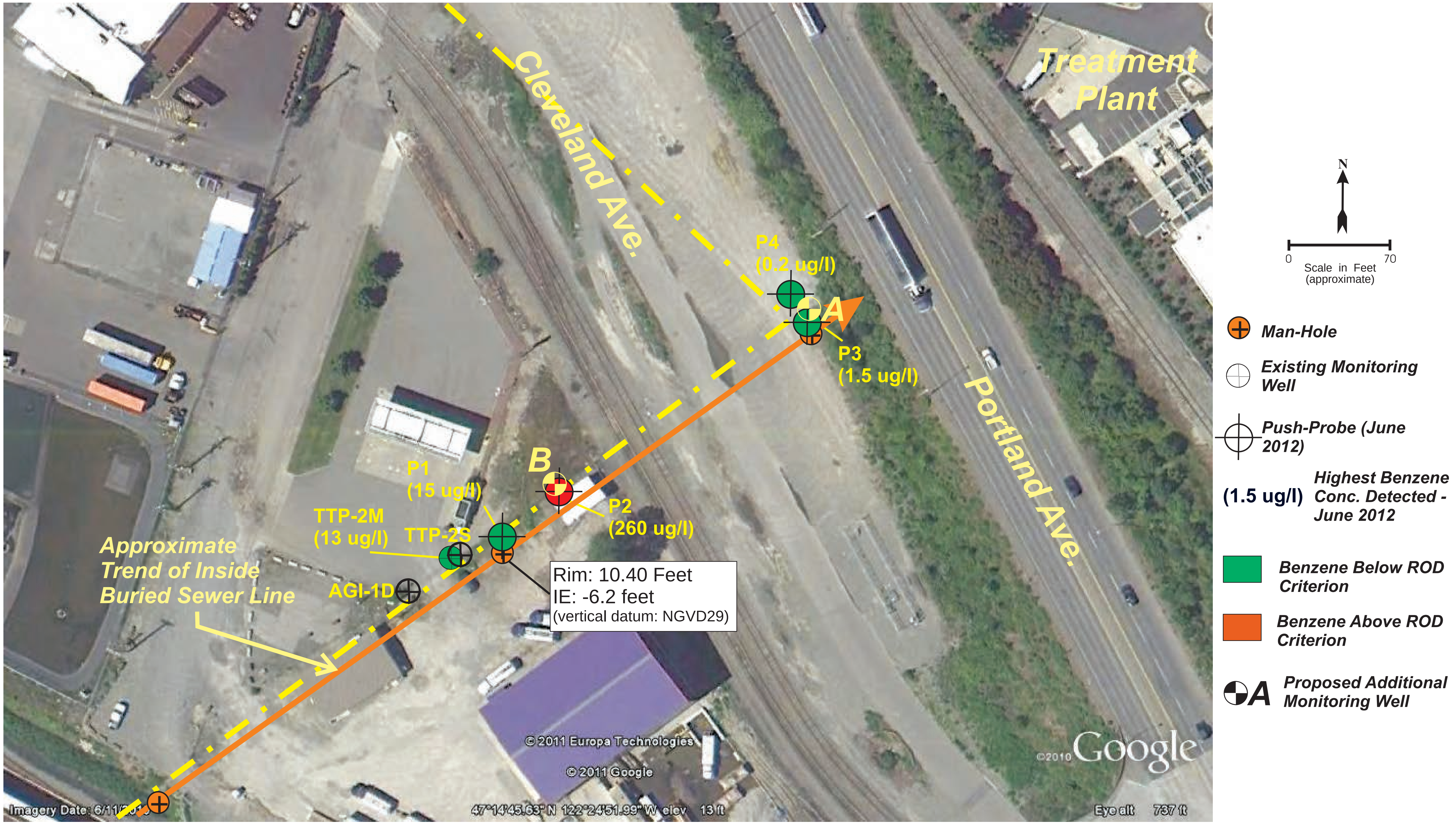


Tacoma Historical Coal Gasification Site

Water Sampling Locations

WNG-001-01 **FIGURE 2** Dec. 2013

Dalton, Olmsted & Fuglevand, Inc.



Date: June 11, 2011
(Google Earth)

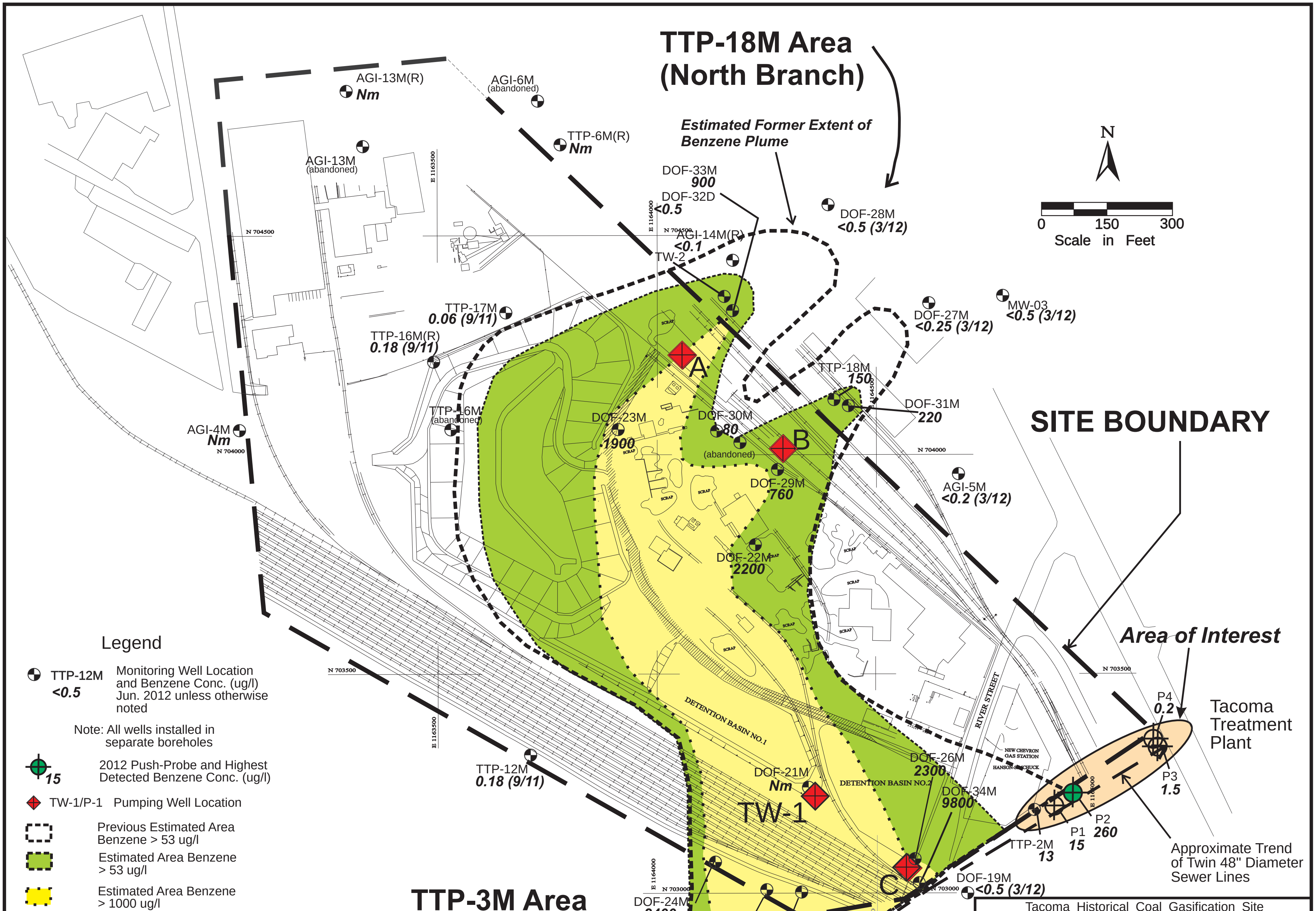
Tacoma Historical Coal Gasification Site
Tacoma, Washington

Push-Probe and Well Locations

WNG-001 **FIGURE 3** Sept. 2012

Dalton, Olmsted & Fuglevand, Inc.

Ref: Push-ProbeLoc.cdr

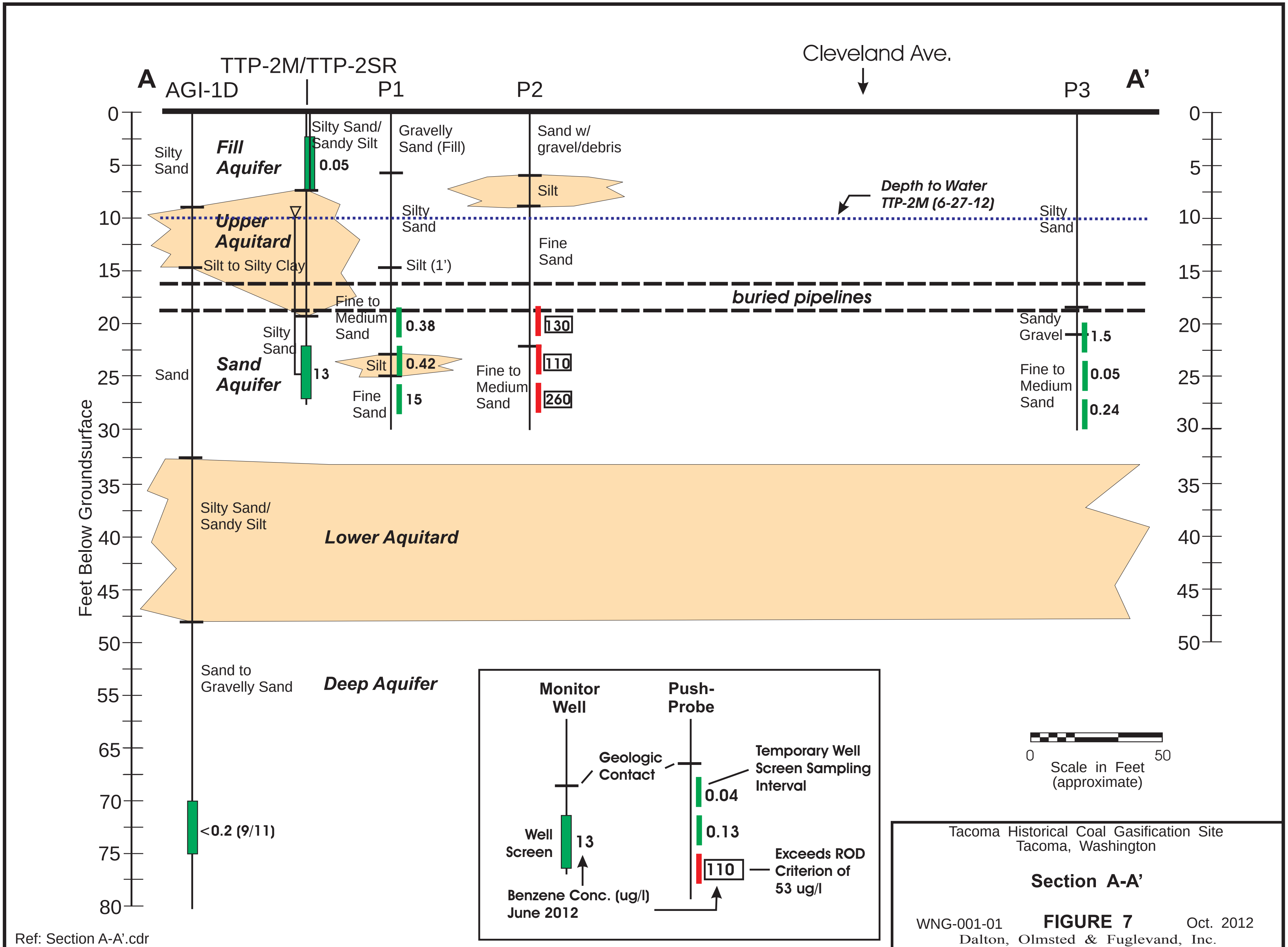


Tacoma Historical Coal Gasification Site

Benzene Plume - June 2012

WNG-001-01 **FIGURE 5** Oct. 2012

Dalton, Olmsted & Fuglevand, Inc.

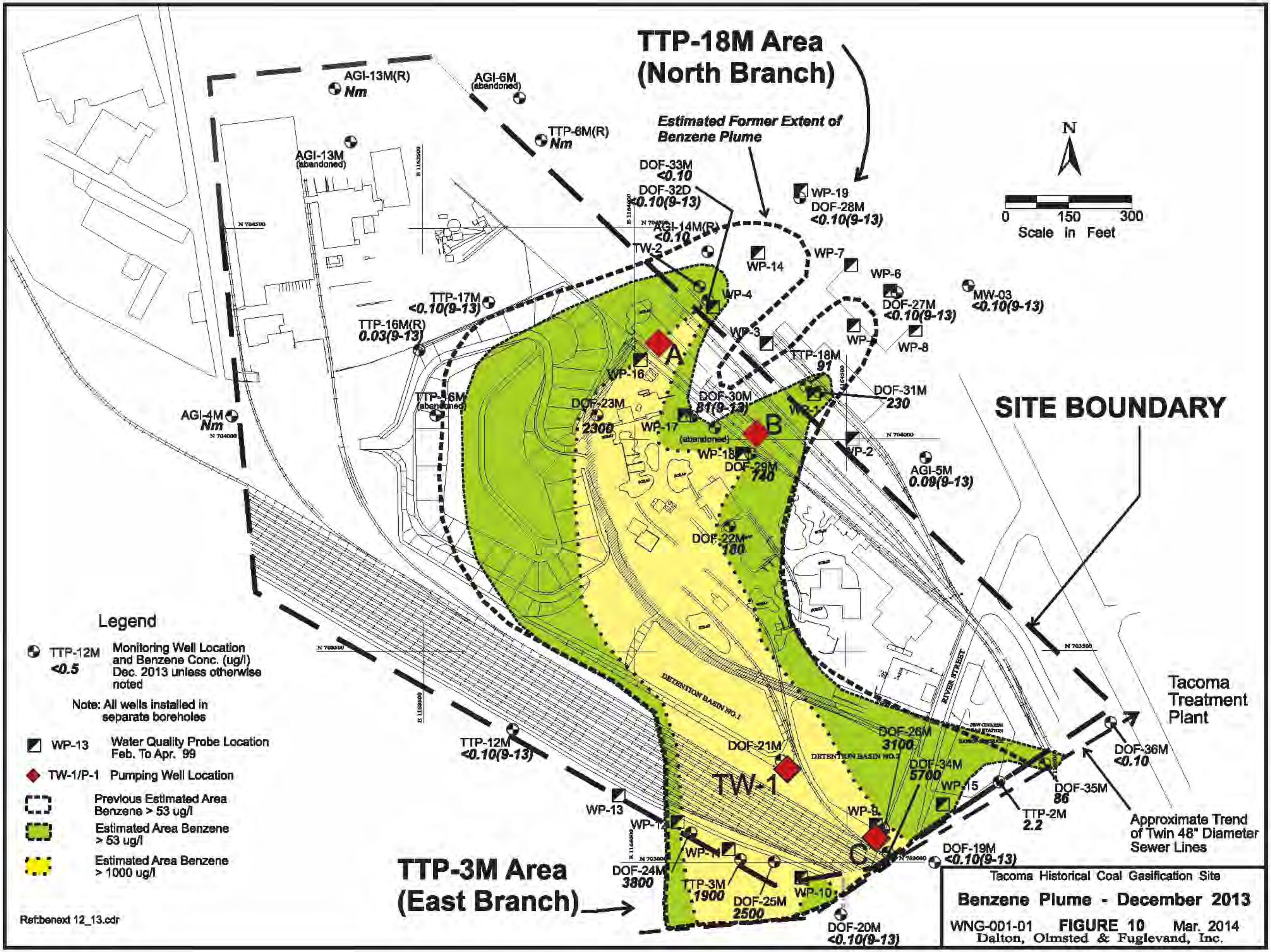


Tacoma Historical Coal Gasification Site
Tacoma, Washington

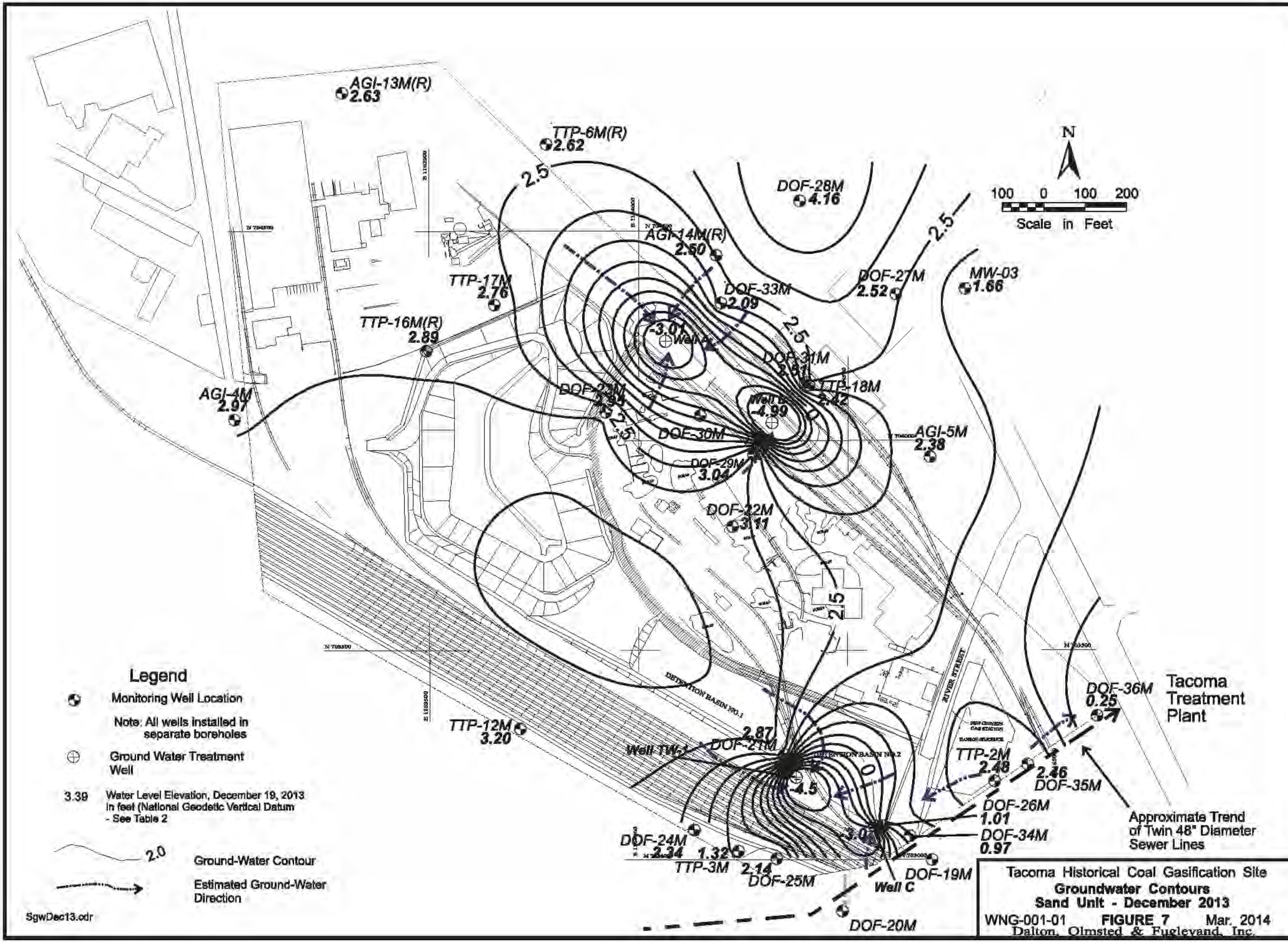
Section A-A'

WNG-001-01 **FIGURE 7** Oct. 2012

Dalton, Olmsted & Fuglevand, Inc.



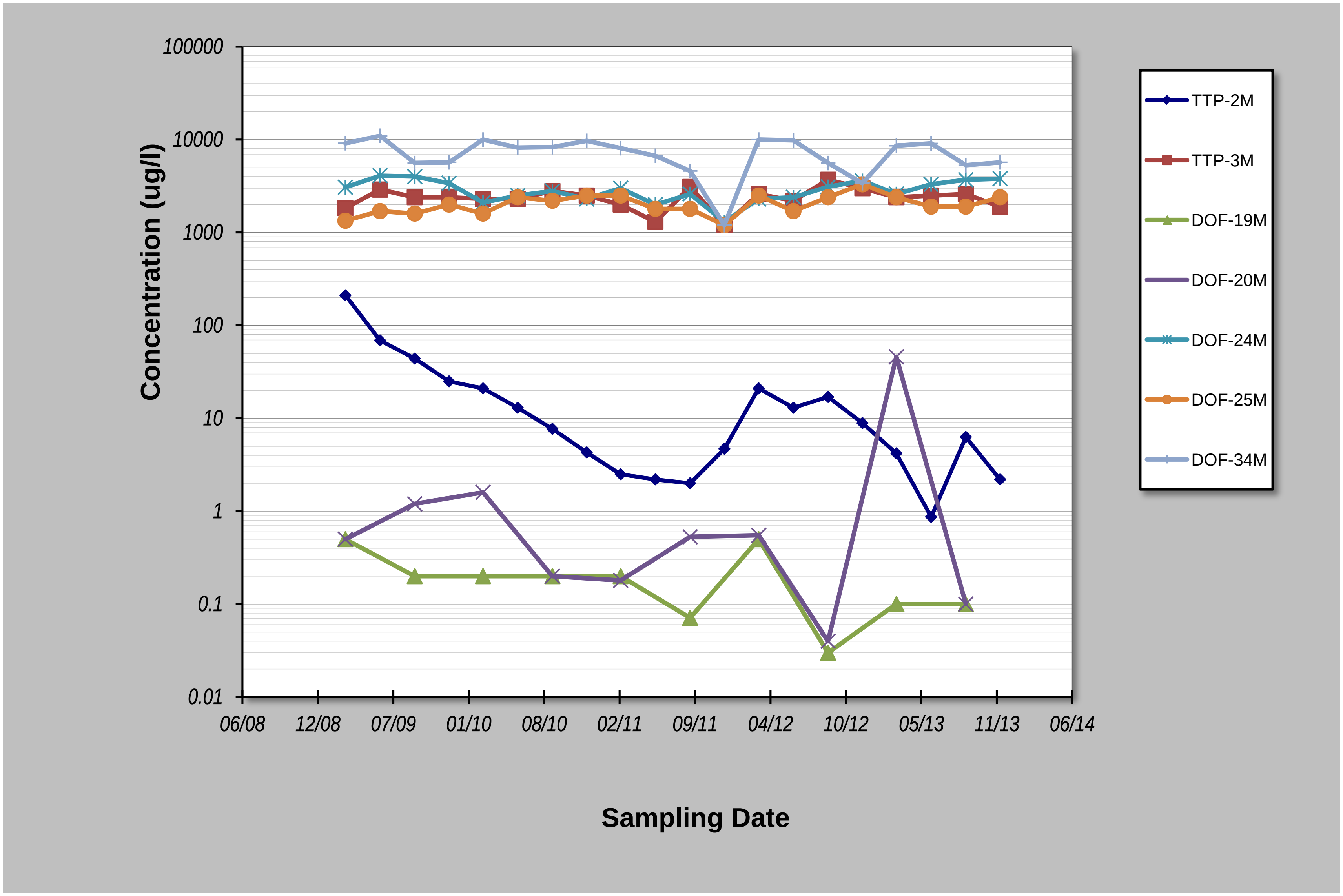
TTP-18M Area
(North Branch)
Estimated Former Extent of Benzene Plume
SITE BOUNDARY
TTP-3M Area
(East Branch)
Tacoma Treatment Plant
Approximate Trend of Twin 48" Diameter Sewer Lines
N
0 150 300
Scale in Feet
AGI-13M(R) Nm
AGI-6M (abandoned)
TTP-6M(R) Nm
AGI-13M (abandoned)
DOF-33M <0.10
DOF-32D <0.10(9-13)
AGI-14M(R) <0.10
WP-19
DOF-28M <0.10(9-13)
TW-2
WP-14
WP-7
WP-6
WP-4
DOF-27M <0.10(9-13)
MW-03 <0.10(9-13)
TTP-17M <0.10(9-13)
TTP-16M(R) 0.03(9-13)
WP-3
WP-5
WP-8
A
TTP-18M 91
WP-16
TTP-16M (abandoned)
DOF-30M 81(9-13)
DOF-31M 230
DOF-23M 2300
WP-1
B
AGI-4M Nm
WP-17
(abandoned)
WP-18
WP-2
DOF-29M 740
AGI-5M 0.09(9-13)
DOF-22M 180
DETENTION BASIN NO.1
DETENTION BASIN NO.2
RIVER STREET
TTP-12M <0.10(9-13)
DOF-21M
DOF-26M 3100
DOF-34M 5700
TW-1
DOF-36M <0.10
DOF-35M 86
WP-15
TTP-2M 2.2
WP-13
WP-12
WP-9
WP-11
C
DOF-19M <0.10(9-13)
DOF-24M 3800
TTP-3M 1900
DOF-25M 2500
WP-10
DOF-20M <0.10(9-13)
Legend
TTP-12M <0.5 Monitoring Well Location and Benzene Conc. (ug/l) Dec. 2013 unless otherwise noted
Note: All wells installed in separate boreholes
WP-13 Water Quality Probe Location Feb. To Apr. 99
TW-1/P-1 Pumping Well Location
Previous Estimated Area Benzene > 53 ug/l
Estimated Area Benzene > 53 ug/l
Estimated Area Benzene > 1000 ug/l
Ref:benext 12_13.cdr
Tacoma Historical Coal Gasification Site
Benzene Plume - December 2013
WNG-001-01 FIGURE 10 Mar. 2014
Dalton, Olmsted & Fuglevand, Inc.



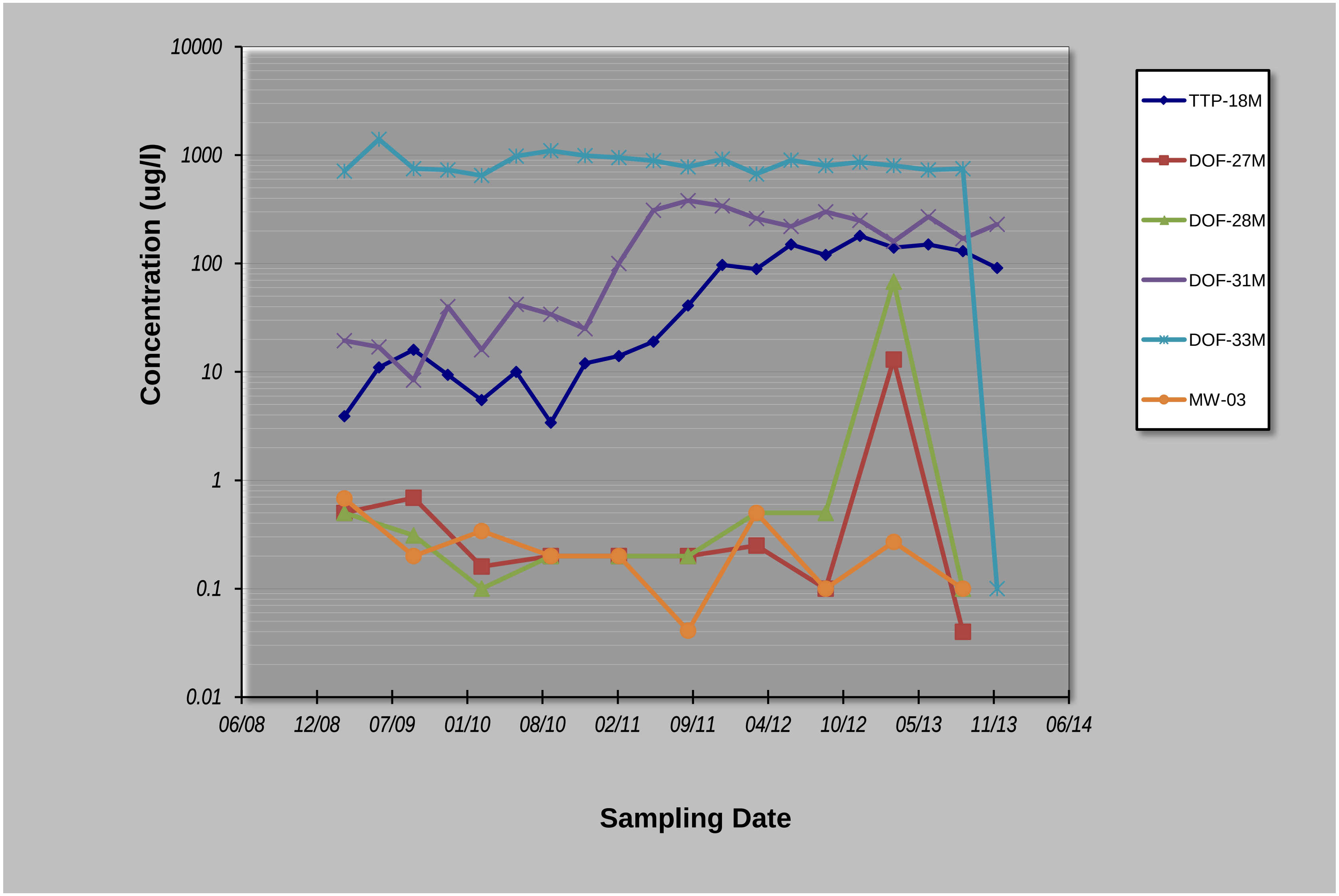
Tacoma Historical Coal Gasification Site
Groundwater Contours
Sand Unit - December 2013

WNG-001-01 **FIGURE 7** Mar. 2014

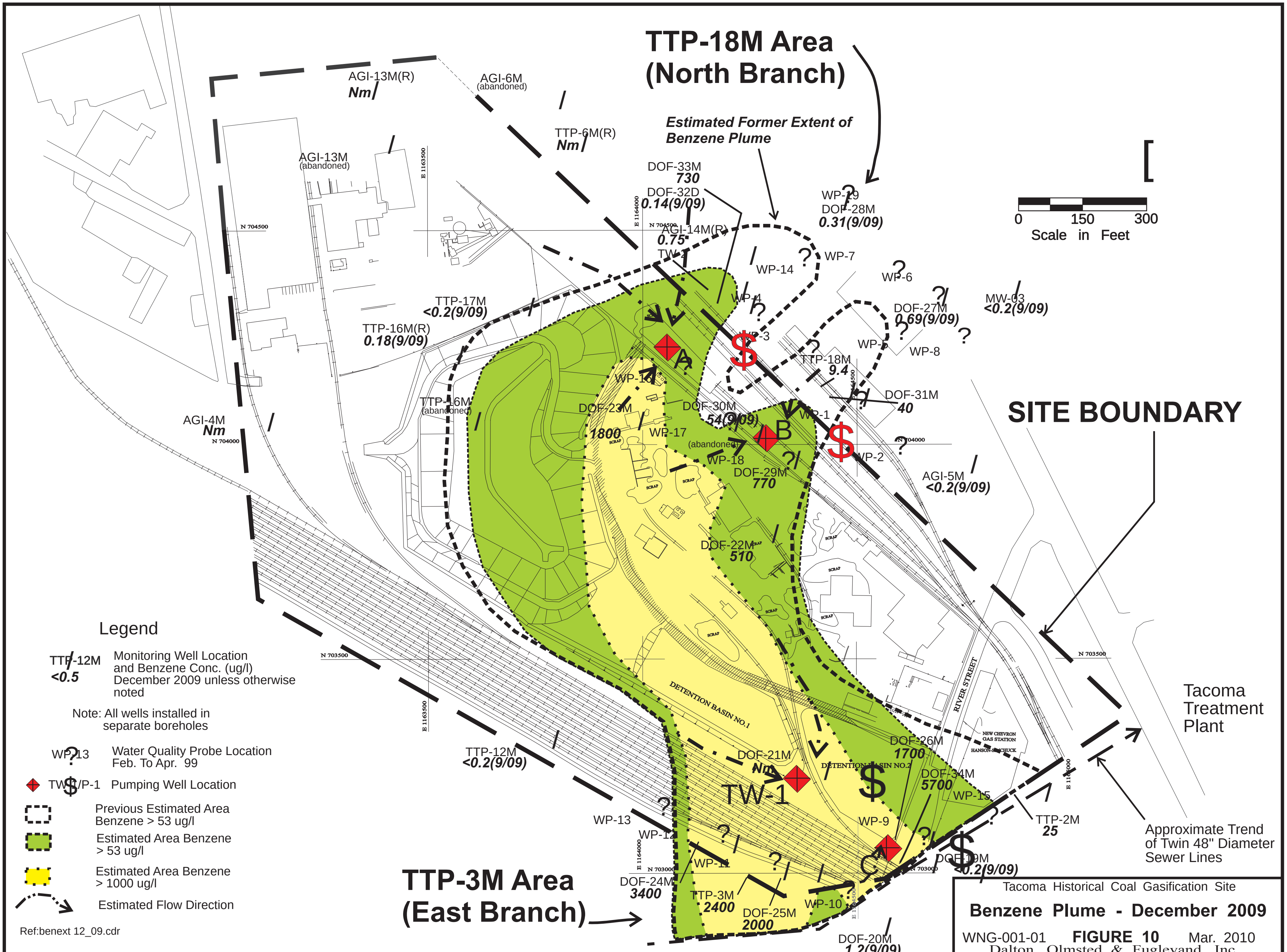
Dalton, Olmsted & Fuglevand, Inc.



OU 3 Att 2 - Figure 8. Mann-Kendall Graph of Benzene Concentrations in East Branch Wells (2009-2013)



OU 3 Att 2 - Figure 9. Mann-Kendall Graph of Benzene Concentrations in North Branch Wells (2009-2013)



TTP-18M Area
(North Branch)
Estimated Former Extent of
Benzene Plume
SITE BOUNDARY
TTP-3M Area
(East Branch)
Tacoma
Treatment
Plant
Approximate Trend
of Twin 48" Diameter
Sewer Lines
0
150
300
Scale in Feet
AGI-13M(R)
Nm
AGI-6M
(abandoned)
TTP-6M(R)
Nm
AGI-13M
(abandoned)
DOF-33M
730
DOF-32D
0.14(9/09)
AGI-14M(R)
0.75
TW-2
WP-19
DOF-28M
0.31(9/09)
WP-7
WP-14
WP-6
WP-4
DOF-27M
0.69(9/09)
MW-03
<0.2(9/09)
WP-3
WP-5
WP-8
TTP-18M
9.4
TTP-17M
<0.2(9/09)
TTP-16M(R)
0.18(9/09)
A
WP-16
DOF-31M
40
TTP-16M
(abandoned)
DOF-23M
1800
DOF-30M
54(9/09)
WP-1
B
WP-17
(abandoned)
WP-18
WP-2
AGI-4M
Nm
DOF-29M
770
AGI-5M
<0.2(9/09)
DOF-22M
510
DETENTION BASIN NO.1
RIVER STREET
NEW CHEVRON GAS STATION
TTP-12M
<0.2(9/09)
DOF-21M
Nm
DETENTION BASIN NO.2
DOF-26M
1700
DOF-34M
5700
TW-1
WP-15
WP-13
WP-9
TTP-2M
25
WP-12
WP-11
C
DOF-19M
<0.2(9/09)
DOF-24M
3400
TTP-3M
2400
DOF-25M
2000
WP-10
DOF-20M
1.2(9/09)
N 704500
N 704000
N 703500
N 703000
E 1163500
E 1164000
Legend
TTP-12M
<0.5
Monitoring Well Location and Benzene Conc. (ug/l) December 2009 unless otherwise noted
Note: All wells installed in separate boreholes
WP-13
Water Quality Probe Location Feb. To Apr. 99
TW-1/P-1
Pumping Well Location
Previous Estimated Area Benzene > 53 ug/l
Estimated Area Benzene > 53 ug/l
Estimated Area Benzene > 1000 ug/l
Estimated Flow Direction
Ref:benext 12_09.cdr
Tacoma Historical Coal Gasification Site
Benzene Plume - December 2009
WNG-001-01
FIGURE 10
Mar. 2010
Dalton, Olmsted & Fuglevand, Inc.

Figure 6-3. Photo of 2013 Asphalt Crack Repair in Detention Basin (Source: DOF 2014c)

OU3 Attachment 3 – Public Input on Tacoma Tar Pits Site

From:	Langton, Tamara
To:	Keeley, Karen; Rochlin, Kevin; Ryan, William (Region 10); Williams, Jonathan
Cc:	Blocker, Shawn; Gallaher, Jo
Subject:	RE: CBNT FYR - Public Input?
Date:	Wednesday, April 16, 2014 1:04:04 PM

Yes. I received one public inquiry on Tacoma Tar Pits yesterday.

Inquirer: Reporter from Seattle Globalist, Lael Henterly, doing on an article on the Northwest Detention Center which is an Immigration, Customs and Enforcement (ICE) facility located on the northwest portion of the Tacoma Tar Pits Site.

Questions: What is a Superfund Site? What is a Five-Year Review? What is the history (past uses) of this Site? What contamination is/was on the Site? What cleanup actions have taken place? What do the recent groundwater monitoring reports show, especially those on the Northwest Detention Center portion of the property.

Response: Briefly answered the questions above, and also said that I am not expecting any surprises during this Five-Year Review because of the results of the quarterly groundwater monitoring reports, and the annual "above-ground" inspection and maintenance reports. I am sending her more information on the Site, including the 2013 groundwater monitoring reports. I also told her that the final Five-Year Report will be available in December 2014.

From: Keeley, Karen
Sent: Wednesday, April 16, 2014 12:54 PM
To: Langton, Tamara; Rochlin, Kevin; Ryan, William (Region 10); Williams, Jonathan
Cc: Blocker, Shawn; Gallaher, Jo
Subject: CBNT FYR - Public Input?

Please send me an email with a note clarifying 'yes or no' if you received any public input (closed yesterday).

If you received information, please identify your 'project/site' by the NAME that we are using on our FYR spreadsheet, and a short bullet of the comment (if verbal) or a copy of the comment (if email/letter).

I will make sure it gets in the correct section of the FYR Site File.

I did not hear anything from CHB.

Karen Keeley | **Superfund Remedial Project Manager**
U.S. Environmental Protection Agency | Region 10
Office of Environmental Cleanup
1200 6th Avenue, Suite 900, ELC-111 | Seattle, WA 98101
p: 206.553.2141

OU 3 Attachment 4 - Site Inspection Team Roster, Checklist, and Photographs

Tacoma Tar Pits 2014 Five-Year-Review
Site Inspection Roster
June 12, 2014

Name	Affiliation	Phone No.
Tamara Langton	EPA Remedial Project Manager	206-553-2709
Karah Haskins	USACE (on behalf of Veronica Henzi)	206-764-6964
John Rork	Puget Sound Energy	425-456-2228
Matt Dalton	Dalton, Olmsted & Fuglevand, Inc. (PSE's Contractor)	360-380-0862
Dave Cooper	Dalton, Olmsted & Fuglevand, Inc.	425-827-4588
Mark Stafford	City of Tacoma, Public Works	253-502-2110
Alan Aplin	City of Tacoma, Public Works	253-502-2110
Greg Barrowman	Simon Metals Operations Manager	253-507-9866

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION

Site name: Tacoma Tar Pits (OU3)	**Date of inspection:** Thursday, June 12, 2014
Location: Tacoma, Pierce County, Washington	**EPA ID:** WAD980726368
Agency, office, or company leading the five-year review: EPA Region 10	**Weather/temperature** Overcast, 70 degrees F

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☒ Surface water collection and treatment
- ☐ Other: *e.g. Groundwater monitoring*
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☒ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** John Rork — PSE Project Manager — June 12, 2014
   Name — Title — Date
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ______
   Problems, suggestions; ☐ Report attached Informally interviewed during site inspection;

2. **O&M staff** Matt Dalton (PRP's contractor) — Dalton, Olmstead, Fuglevand Inc. — June 12, 2014
   Name — Title — Date
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ______
   Problems, suggestions; ☐ Report attached ______

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency ______________________
Contact ______________________ ______________ ________ __________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ______________________________

Agency ______________________
Contact ______________________ Dalton, Olmstead, Fuglevand Inc. June 12, 2014 __________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ______________________________

Agency ______________________
Contact ______________________ ______________ ________ __________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ______________________________

Agency ______________________
Contact ______________________ ______________ ________ __________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ______________________________

4. **Other interviews** (optional) ☐ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

■ O&M manual	■ Readily available	■ Up to date	☐ N/A
■ As-built drawings	■ Readily available	■ Up to date	☐ N/A
■ Maintenance logs	■ Readily available	■ Up to date	☐ N/A

Remarks

2. **Site-Specific Health and Safety Plan** ☐ Readily available ☐ Up to date ☐ N/A
☐ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☐ N/A
Remarks Spill Plan and MSDS sheets on site.

3.	**O&M and OSHA Training Records** Remarks	☒ Readily available	☐ Up to date	☐ N/A
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	☐ N/A
	☒ Effluent discharge	☒ Readily available	☒ Up to date	☐ N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
	☐ Other permits______________________	☐ Readily available	☐ Up to date	☐ N/A
	Remarks			
5.	**Gas Generation Records** Remarks Gas generation is not a concern with this landfill.	☒ Readily available	☐ Up to date	☒ N/A
6.	**Settlement Monument Records** Remarks	☐ Readily available	☐ Up to date	☐ N/A
7.	**Groundwater Monitoring Records** Remarks Not kept on site.	☒ Readily available	☒ Up to date	☐ N/A
8.	**Leachate Extraction Records** Remarks	☐ Readily available	☐ Up to date	☒ N/A
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	☐ N/A
	☒ Water (effluent)	☐ Readily available	☐ Up to date	☐ N/A
	Remarks Records are not kept on site,			
10.	**Daily Access/Security Logs** Remarks	☒ Readily available	☒ Up to date	☐ N/A

IV. O&M COSTS
1. **O&M Organization** ☐ State in-house ☐ Contractor for State ☐ PRP in-house ■ Contractor for PRP ☐ Federal Facility in-house ☐ Contractor for Federal Facility ☐ Other
2. **O&M Cost Records** ☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place Original O&M cost estimate____________________ ☐ Breakdown attached Total annual cost by year for review period if available From__________ To__________ __________________ ☐ Breakdown attached Date Date Total cost From__________ To__________ __________________ ☐ Breakdown attached Date Date Total cost From__________ To__________ __________________ ☐ Breakdown attached Date Date Total cost From__________ To__________ __________________ ☐ Breakdown attached Date Date Total cost From__________ To__________ __________________ ☐ Breakdown attached Date Date Total cost
3. **Unanticipated or Unusually High O&M Costs During Review Period** Describe costs and reasons:
V. ACCESS AND INSTITUTIONAL CONTROLS ■ Applicable ☐ N/A
A. Fencing
1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A Remarks Fencing was in good condition.
B. Other Access Restrictions
1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A Remarks Rare trespassing occurrences at site, which have not affected remedy.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ■ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ■ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) On-site inspection
Frequency Quarterly at a minimum
Responsible party/agency DOF, the PRP Remedial contractor
Contact Matthew Dalton (Name) Hydrogeologist (Title) ____ (Date) ____ (Phone no.)

Reporting is up-to-date ☐ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☐ Yes ■ No ☐ N/A

Specific requirements in deed or decision documents have been met ■ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☐ No ■ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ■ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☐ No vandalism evident
Remarks Rare trespassing related to Simon Metals business.

2. **Land use changes on site** ■ N/A
Remarks

3. **Land use changes off site** ■ N/A
Remarks

VI. GENERAL SITE CONDITIONS

A. Roads ■ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate ■ N/A
Remarks

B. Other Site Conditions
Remarks

VII. LANDFILL COVERS ☐ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ■ Settlement not evident
   Areal extent______________ Depth____________
   Remarks

2. **Cracks** ☐ Location shown on site map ■ Cracking not evident
   Lengths____________ Widths___________ Depths__________
   Remarks

3. **Erosion** ☐ Location shown on site map ■ Erosion not evident
   Areal extent______________ Depth____________
   Remarks

4. **Holes** ☐ Location shown on site map ■ Holes not evident
   Areal extent______________ Depth____________
   Remarks

5. **Vegetative Cover** ■ Grass ■ Cover properly established
   ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks The grass covering is maintained annually.

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
   Remarks

7. **Bulges** ☐ Location shown on site map ■ Bulges not evident
   Areal extent______________ Height____________
   Remarks

8. **Wet Areas/Water Damage**	■ Wet areas/water damage not evident		
☐ Wet areas	☐ Location shown on site map	Areal extent______________	
☐ Ponding	☐ Location shown on site map	Areal extent______________	
☐ Seeps	☐ Location shown on site map	Areal extent______________	
☐ Soft subgrade	☐ Location shown on site map	Areal extent______________	
Remarks			
9. **Slope Instability** ☐ Slides	☐ Location shown on site map	■ No evidence of slope instability	
Areal extent______________			
Remarks			
B. Benches ■ N/A	■ Applicable		
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)			
1. **Flows Bypass Bench**	☐ Location shown on site map	■ N/A or okay	
Remarks			
2. **Bench Breached**	☐ Location shown on site map	■ N/A or okay	
Remarks			
3. **Bench Overtopped**	☐ Location shown on site map	■ N/A or okay	
Remarks			
C. Letdown Channels ■ Applicable	☐ N/A		
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)			
1. **Settlement**	☐ Location shown on site map	■ No evidence of settlement	
Areal extent______________	Depth____________		
Remarks			
2. **Material Degradation**	☐ Location shown on site map	■ No evidence of degradation	
Material type_______________	Areal extent_____________		
Remarks			
3. **Erosion**	☐ Location shown on site map	■ No evidence of erosion	
Areal extent______________	Depth____________		
Remarks			

4.	**Undercutting** ☐ Location shown on site map ☒ No evidence of undercutting Areal extent______________ Depth____________ Remarks	
5.	**Obstructions** Type_____________________ ☒ No obstructions ☐ Location shown on site map Areal extent______________ Size____________ Remarks	
6.	**Excessive Vegetative Growth** Type____________________ ☒ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent______________ Remarks	
D. Cover Penetrations	☐ Applicable ☒ N/A	
1.	**Gas Vents** ☐ N/A ☐ Active ☐ Passive ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration Remarks	
2.	**Gas Monitoring Probes** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks	
3.	**Monitoring Wells** (within surface area of landfill) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks	
4.	**Leachate Extraction Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks	
5.	**Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐N/A Remarks	

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**
☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
☐ Good condition ☐ Needs Maintenance
Remarks

2. **Gas Collection Wells, Manifolds and Piping**
☐ Good condition ☐ Needs Maintenance
Remarks

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
☐ Good condition ☐ Needs Maintenance ☐ N/A
Remarks

F. Cover Drainage Layer ☒ Applicable ☐ N/A

1. **Outlet Pipes Inspected** ☒ Functioning ☐ N/A
Remarks No problems mentioned or observed.

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A
Remarks

G. Detention/Sedimentation Ponds ☒ Applicable ☐ N/A

1. Siltation ☐ N/A ☐ Siltation not evident
Areal extent______________ Depth____________
Remarks 2 Asphalt-lined basins. Minor siltation is evident in the Detention Basin 2. Detention basins are swept occasionally.

2. **Erosion** Areal extent______________ Depth____________ ☒ Erosion not evident
Remarks

3. **Outlet Works** ☒ Functioning ☐ N/A
Remarks Outlet pipe of Detention Basin 1 appears to be in good condition.

4. **Dam** ☐ Functioning ☒ N/A
Remarks

H. Retaining Walls ☐ Applicable ☒ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
Horizontal displacement__________ Vertical displacement__________
Rotational displacement__________
Remarks

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks

I. Perimeter Ditches/Off-Site Discharge ☒ Applicable ☐ N/A

1. **Siltation** ☐ Location shown on site map ☒ Siltation not evident
Areal extent__________ Depth__________
Remarks

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☒ Vegetation does not impede flow
Areal extent__________ Type__________
Remarks There are some blackberry bushes, but they do not block the flow of water in the perimeter ditches

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent__________ Depth__________
Remarks Channels drain runoff by pipe directly into detention basin

4. **Discharge Structure** ☒ Functioning ☐ N/A
Remarks Discharge pipes flow directly into Detention Basin 1.

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
Areal extent__________ Depth__________
Remarks

2. **Performance Monitoring** Type of monitoring__________
☐ Performance not monitored ☐ Evidence of breaching
Frequency__________ Head differential__________
Remarks

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks

2.	**Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☒ Good condition ☐ Needs Maintenance Remarks
3.	**Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☒ Requires upgrade ☐ Needs to be provided Remarks There are spare air strippers available
B. Surface Water Collection Structures, Pumps, and Pipelines ☒ Applicable ☐ N/A	
1.	**Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks Surface water detention basins are the collection structure. Cracking is patched with polymer as needed.
2.	**Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☒ Needs Maintenance Remarks
3.	**Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks
C. Treatment System ☒ Applicable ☐ N/A	
1.	**Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☒ Air stripping ☒ Carbon adsorbers ☐ Filters__________ ☐ Additive (*e.g.*, chelation agent, flocculent)__________ ☐ Others__________ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually__________ ☐ Quantity of surface water treated annually__________ Remarks
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks Appear to be in good condtion.

3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ■ Good condition ■ Proper secondary containment ☐ Needs Maintenance Remarks The secondary containment has a overflow shutoff float.
4.	**Discharge Structure and Appurtenances** ☐ N/A ■ Good condition ☐ Needs Maintenance Remarks Pipeline from plant is buried, but has leak detection system.
5.	**Treatment Building(s)** ☐ N/A ■ Good condition (esp. roof and doorways) ☐ Needs repair ■ Chemicals and equipment properly stored Remarks Fence and locked gate appear to be in good condition. The covered roof also appears to be in good condition.
6.	**Monitoring Wells** (pump and treatment remedy) ■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks
D. Monitoring Data	
1.	Monitoring Data ■ Is routinely submitted on time ■ Is of acceptable quality
2.	Monitoring data suggests: ■ Groundwater plume is effectively contained ■ Contaminant concentrations are declining
D. Monitored Natural Attenuation	
1.	**Monitoring Wells** (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ■ N/A Remarks

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

The waste pile cap and cover remedy are intended to encapsulate treated soils and minimize precipitation infiltration. This remedy appears to be functioning as intended.

The groundwater extraction and treatment system uses air stripping to eliminate benzene from groundwater and uses granular activated carbon to sorb VOCS from the vapor stream. Treated groundwater effluent is discharged to the City of Tacoma. Inspection by the PSE occurs quarterly and the City of Tacoma inspects annually. There was a discharge criteria (0.50 mg/L) exceedance of 0.51 mg/L found by PSE and reported to the City of Tacoma. After maintenance to the air stripper was completed, the discharge criteria was met.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

O&M procedures appear to be functioning as intended. Any issues are corrected in a timely manner.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

None

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

None

Photo 1. Tall grass growing in drainage ditch. Grass is maintained annually.

Photo 2. Sedimentation in Detention Basin 2.

Photo 3. Detention Basin 1

Photo 4. Drainage into Detention Basin 1

Photo 5. Drainage pipe into Detention Basin 1.

Photo 6. Groundwater treatment plant.

Photo 7. Spare air stripper parts.

Photo 8. Perimeter drain clear grates.

Photo 9. Vegetation growing in armored drainage channel between waste pile and access road.

Photo 10. NW Detention Center Expansion from access road on top of waste pile.

Photo 11. Waste pile from entrance to access road.

Photo 12. Top of waste pile.

OU 3 Attachment 5 - ARARs Review Summary

Media	Source/ARAR Citation	Requirement Synopsis	Status	Current ARAR Evaluation
Soil	[Federal] Resource Conservation and Recovery Act (RCRA) 42 USC 6901, Subtitle C, 40 CFR 264, Subpart G	Post-closure care must be provided for at least thirty years and includes monitoring, reporting, and maintenance of waste containment systems. Covers and similar structures must not be disturbed unless special conditions arise. A local land use authority must be notified of the presence of remaining contamination and the locations of waste facilities. Also, the previous use of the site and restrictions on the future use of the site must be recorded in the property deed.	Relevant and appropriate	Still relevant and appropriate. No changes which affect site or remedy. Monitoring, reporting, and maintenance of waste-pile cover continues.
Soil	[Federal] RCRA 42 USC 6901, Subtitle C, 40 CFR 264, Subpart N	Provisions pertaining to the capping, monitoring, closure, and post-closure care of the site. A final cover must be placed which minimizes the migration of liquids through the landfill, requires minimal maintenance, promotes drainage, and minimizes degradation of the surface, accommodates settling and subsidence without the loss of effectiveness, and has permeability less than the underlying materials. The cap must be inspected and maintained, and groundwater monitoring conducted.	Relevant and appropriate	Still relevant and appropriate. No changes which affect site or remedy. Monitoring, reporting, and maintenance of waste-pile cover continues.
Soil	[Federal] Department of Transportation (DOT) 49 CFR Parts 171 to 173	Transport, packaging, labeling, placarding, and manifesting of hazardous waste shipments. These regulations apply to the off-site shipment of contaminated soils and perhaps spent activated carbon. Waste materials must be identified, loaded in non-leaking containers, labeled and placarded as appropriate for the contents, and manifested to verify that the shipments reach their intended destination.	Applicable	Currently only potentially applicable to transport off site of spent carbon (if determined to be hazardous waste) from groundwater treatment plant vapor treatment train.
Surface Water	[Federal] Clean Water Act (CWA) 33 USC 1251	National Pollution Discharge Elimination System (NPDES, 40 CFR 122). These regulations govern point source discharges into navigable waterways such as the Puyallup River. Limits on the concentrations of contaminants which may be discharged are determined on a case-by-case basis.	Applicable	Updates/changes to 40 CFR 122 since the 1987 ROD do not affect site or remedy. Treated groundwater is discharged to City of Tacoma POTW under their NPDES permit; continues to apply to untreated surface water discharging from site retention basins into BNSF drainage ditch.

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Surface Water	[Federal] Federal Water Quality Criteria	Water quality criteria are established placing limits on the concentration of compounds in fresh and marine waters. These criteria may apply to discharges into off-site surface water. The action levels include water quality criteria for on site and boundary surface waters.	Applicable	ROD-selected indicator chemicals in surface water are: benzo(a)pyrene, PCBs, benzene, and lead. 1987 ROD clean up level for lead in surface water at site boundary was 3.2 ug/l, and was based on chronic freshwater ambient water quality criteria (CFAWQC) and the detection limit at that time. Current CFAWQC is 2.5 ug/l since detection limit has been reduced. Similarly, clean up level for lead in surface water on the site was reduced from 172 to 65 ug/l (during the third FYR period). Surface water lead concentrations during the fourth FYR period in the "SW" sample location (BNSF ditch, boundary) did not exceed 1.7 ug/L.
Ground-water	[Federal] RCRA 42 USC 6901, Subtitle C, 40 CFR 264, Subpart F	Pertains to groundwater monitoring, hazardous constituents, concentration limits, points of compliance, and corrective action. A program of groundwater monitoring must be implemented to detect the presence of contaminants at the point of compliance, which is usually at site boundaries. If concentrations of particular compounds are detected above designated limits more extensive monitoring is necessary and corrective actions may be required.	Relevant and appropriate	RCRA, 42 USC 6901, Subtitle C was amended in 1984, 1992, and 1996; however, the substantive requirements that apply to the groundwater remedy at the Tacoma Tar Pits site (40 CFR 264) remain unchanged since the time the 1987 ROD was signed and has no impact on the protectiveness of the groundwater remedy. ROD-selected indicator chemicals in groundwater are: benzo(a)pyrene, PCBs, benzene, and lead. ARAR is still relevant and appropriate since benzene in groundwater is above clean up levels at site boundary.

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Ground-water	[Federal] Safe Drinking Water Act (SWDA) 42 USC 300, 40 CFR 141	Maximum contaminant levels (MCLs) must be attained for sources of drinking water. The MCL for lead was included in the action levels. Drinking water regulations are relevant and appropriate to the lower aquifers at the site.		ROD-selected indicator chemicals in groundwater are: benzo(a)pyrene, PCBs, benzene, and lead. Of the 1987 ROD indicator chemicals, lead was the only one for which the groundwater clean up goal/maximum allowable contaminant concentration was based solely on its Maximum Contaminant Level (MCL, 40 CFR 141). At the time of the ROD the MCL for lead was 50 ug/l; however, in 1992 this value was lowered to 15 ug/l, where it currently remains. These chemicals are at acceptable levels in the lower aquifers at the site, even considering the lowered action level for lead. The last time groundwater was tested for lead was in 2001, where the maximum concentration within the fill/sand aquifers was 14.4 ug/l, and within the lower aquifers was 1.5 ug/l. The ROD requires clean up criteria be achieved for these chemicals in the upper aquifers at the site. ARAR, including new action level for lead, is still relevant and appropriate; however, groundwater from all aquifers at/downgradient of the site is not used for drinking purposes.

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Soil	[State] Washington Administrative Code (WAC) 17-303-081 to 103	Designation of Dangerous Waste (DW) and Extremely Hazardous Waste (EHW). The state definition of a hazardous waste incorporates EPA designation of hazardous waste which is based on the compound being specifically listed as such or on the waste exhibiting the properties of reactivity, ignitability, corrosivity, or Extraction Procedure (EP) toxicity. Ecology distinguishes hazardous waste as Extremely Hazardous Waste (EHW) or Dangerous Waste (DW). The distinction is based on the properties of persistence, concentration, carcinogenicity, mutagenicity, teratogenicity, concentration of certain compounds, and toxicity. Residues, contaminated soils, water, or other debris from the clean up of spills of compounds listed on the "moderately dangerous chemical products list" (WAC 173-303-9903) in excess of 400 pounds are designated as DW. If the spilled compounds are listed on the "acutely dangerous chemical products list" (WAC 173-303-9903), soils, residues, water, or other debris in excess of 220 pounds are considered EHW. Materials containing greater than 1 percent PAH are considered EHW when the total quantity exceeds 220 pounds. However, wastes which were not designated as hazardous waste at the time of disposal are not considered DW or EHW.	Relevant and appropriate	At the time of the ROD, EPA and Ecology had determined that the EHW classification, while not applicable because on site disposal pre-dated hazardous waste classification, was relevant and appropriate.

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Surface Water	[State] WAC 173-201	Water Quality Standards for Surface Waters of the State of Washington. Surface water bodies are classified according to the water quality and uses of the water. The surface waters near the site are classified as follows: Class B (good) – Puyallup River, Inner Commencement Bay Class C (fair) – Commencement Bay – City Waterway Criteria are established for fecal coliform bacteria, dissolved oxygen, total dissolved gas, temperature, pH, and turbidity. In addition, concentrations of contaminants must be below levels which may adversely affect human health, the environment, or uses of the water body. The criteria and classifications of the State Water Quality Standards do not apply within a dilution zone defined by Ecology. Within the dilution zone, fish and shellfish must not be killed or aesthetic values diminished.	Applicable	Update to 173-201A-240. Fresh Water Designated Uses and Criteria/Toxic Substances. PCB cleanup level for surface water at site boundary and groundwater in sand and fill aquifers stated in ROD is 0.2 ug/l and was based on the chronic freshwater ambient water quality criterion and detection limit at that time. Since then the State's freshwater Water Quality Standards criterion for PCBs in surface water have been reduced to 0.014 ug/l. No PCBs were detected in RI and have been discontinued since at least 1999, although detection limits have decreased since the RI. Remedy still protective.
Surface Water	[State] WAC 173-216	NPDES Permits administered by the State. Discharges of water to off-site navigable waterways may require an NPDES permit. The concentration limits of contaminant discharges are determined on a case-by-case basis.	Applicable	PSE holds Industrial Wastewater Discharge Permit No. TAC-031-2011 authorizing discharge of treated groundwater to Tacoma sanitary sewer. ARAR still applies.
Surface Water, Ground-water	[State] RCW 90.48, 90.52, 90.54	Water Pollution Control and Discharge Standards. Waters of the State of Washington, which include surface water and groundwater, are to be protected to maximize their beneficial use. Materials and substances which might enter these waters must receive prior treatment with known, available, and reasonable methods.	Applicable	Powers, duties and functions of water pollution control commission, director thereof, transferred to Department of Ecology. RCW 90.48 includes oil, sewer, hazardous waste and most discharges. Does not affect site or remedy. Additional obligations related to oil entering State waters, fees and credits; does not affect site or remedy.
Surface Water, Ground-water	[State] State Water Code (RCW 90.03) and Water Rights (RCW 90.14)	These laws specify the conditions for extracting surface water or groundwater for nondomestic uses. Water extraction must be consistent with beneficial uses of the resources and must not be wasteful. Groundwater extraction wells, which may be used to control the migration of contamination, must comply with the substantive requirements necessary to obtain a water rights permit. Water rights laws may pertain if groundwater is extracted for treatment.	Applicable	No water code changes that affect site or remedy. No water rights changes since ROD.

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Ground-water	[State] WAC 173-303-645	Groundwater protection requirements for waste management facilities are generally comparable to Federal regulations. The point of compliance, the determination of dangerous constituents which are monitored, and the compliance concentrations, however, are determined by Ecology on a case-by-case basis.	Applicable	Grammatical changes to WAC in 2009 do not affect site or remedy; no other changes that affect site or remedy.
Ground-water	[State] WAC 173-154	Upper Aquifers and Upper Aquifer zones must be protected to the extent practicable to avoid depletions, excessive water level declines, or reductions in water quality in order to preserve the water for domestic, stockwater, and similar uses, and preserve spring and stream flow.	Applicable	These WAC rules have not been updated since the last FYR; site remains in compliance.
Ground-water	[State] RCW 13.104 and WAC 173-160	Minimum standards exist for resource protection and water well construction, construction reports, and examination and licensing well construction contractors and equipment operators. These standards apply if monitoring or extraction wells are installed.	Applicable	Monitoring/extraction wells in upper aquifer zones have been installed in accordance with WAC 173-360; minor ARAR changes do not affect site or remedy.
Ground-water	[State] WAC 173-240	Submission of plans and reports. Ecology must review plans for wastewater treatment facilities.	Applicable	No changes since ROD.
Air	[State] WAC 173-400-040(5)	Contaminant air emissions from any sources must not be detrimental to the health, safety, or welfare of any person and must not damage any property or business. Emissions from incinerators must satisfy this requirement.	Applicable	Rule updated in 2005 to conform to recent Federal changes with respect to new source review. Does not affect site or remedy.

TBC or Other since ROD was issued

Soil, Surface water, Ground-water	Washington Model Toxics Control Act (RCW 70.105D.900)	The Washington State Model Toxics Control Act (MTCA) was promulgated in 1989 under Washington Administrative Code (WAC) 173-340, two years after the Tacoma Tar Pits ROD was signed. It states that hazardous waste clean up must be conducted in consideration of human and environmental health. Communities must be notified of releases of hazardous, clean up remedies, enforcement of standards, state funding procedures have been modified.	To Be Considered	This rule established that the appropriate clean up level for sites undergoing remedial action are the clean up levels in effect at the time the final clean up action was selected (WAC 173-340-702(12)(a-c)). Since the ROD identified the final clean up action and clean up levels prior to the promulgation of MTCA, the original MTCA is not an ARAR. Likewise, MTCA as amended in February 2001 and October 2007 is not an ARAR.

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Soil	WAC 16-752, Washington Noxious Weeds Law	Washington State has enacted laws to control the introduction and spread of designated, non-native noxious weeds.	To Be Considered	Spotted Knapweed was observed atop the engineered waste pile cover during the fourth FYR Site Inspection. Spotted Knapweed is on the Washington State Class B Noxious Weed List, and is designated for control in the Tacoma area. This requirement, however, was not deemed an ARAR or a To Be Considered (TBC) requirement at the Tacoma Tar Pits site as it does not cause the soil remedy component to be less protective against potential exposure to hazardous substances for humans or avian receptors. Should a vegetation management plan be developed for the site, control of Spotted Knapweed should be a component of that plan as it is less than optimum habitat for birds.