Western Port Angeles Harbor

Remedial Investigation/ Feasibility Study Work Plan

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May 20, 2013

FINAL

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List of Abbreviations and Acronyms

Acronym/ Abbreviation	Definition
Agreed Order	Agreed Order No. DE 9781
BHC	Hexachlorocyclobenzene
City	City of Port Angeles
cm	Centimeter
COC	Chemical of concern
CSL	Cleanup screening level
CSM	Conceptual site model
CSO	Combined sewer overflow
DCA	Disproportionate cost analysis
DO	Dissolved oxygen
DQO	Data quality objective
E&E	Ecology and Environment, Inc.
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
FS	Feasibility Study
Harbor	Port Angeles Harbor
HASP	Health and Safety Plan
HQ	Hazard quotient
Integral	Integral Consulting Inc.
MTCA	Model Toxics Control Act
NOAEL	No observable adverse effect level
NPDES	National Pollutant Discharge Elimination System
OC	Organic carbon
Port	Port of Port Angeles
PCB	Polychlorinated biphenyl
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SMS	Sediment Management Standards
SPI	Sediment profile images

Acronym/ Abbreviation	Definition
SPME	Solid phase microextraction
SQS	Sediment Quality Standard
Strait	Strait of Juan de Fuca
TEQ	Toxic equivalency quotient
USEPA	U.S. Environmental Protection Agency
WAC	Washington Administrative Code
Work Plan	Western Port Angeles Harbor Remedial Investigation/Feasibility Study Work Plan

1.0 Introduction

This Western Port Angeles Harbor Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Work Plan) has been prepared in accordance with Chapters 173-340 and 173-204 of the Washington Administrative Code (WAC). The Western Port Angeles Harbor Group[1] shall implement this Work Plan to satisfy requirements of Agreed Order No. DE 9781 (Agreed Order).

This Work Plan describes the tasks to be performed in the Western Port Angeles Harbor RI/FS, including identification of existing data gaps and data collection to complete the Final RI/FS report. Washington State Department of Ecology (Ecology) and the Western Port Angeles Harbor Group have the mutual objective of completing the remedial action called for under the Agreed Order by January 2015.

[1] Consists of Port of Port Angeles (Port), Georgia-Pacific LLC, Nippon Paper Industries USA Co., Ltd. (NPIUSA), City of Port Angeles (City), and Merrill & Ring.

2.0 Site Description and History

2.1 PRE-INDUSTRIAL HARBOR CONDITIONS

Port Angeles Harbor (Harbor) lies in the shelter of Ediz Hook, located on the Washington shoreline of the Strait of Juan de Fuca (Strait). As summarized in *Cultural Resources Guidance for United States Coast Guard Group Port Angeles, Ediz Hook, Port Angeles, Clallam County, Washington* (Larsen 2006), the spit developed in part as a delta of the Elwha River, along with shoreline erosion of glacially derived sediments. The Harbor area enclosed by the spit is a sediment depositional area (NewFields 2012). Erosion of soils from shoreline bluffs was a significant sediment input to the Harbor prior to settlement and nearshore filling (Herrera 2011).

The Harbor naturally experiences periods of low dissolved oxygen (DO) in the water column, with periodic DO readings at levels less than 6 milligrams per liter (mg/L). The seasonal variations in DO within the Harbor mirror the seasonal variations in the Strait (FSM and Evans 2002).

2.2 WORK PLAN SCOPE

This Work Plan addresses sediments located below mean higher high water within the western Port Angeles Harbor study area, located west of the Rayonier Study Area and south of the Ediz Hook spit, except in areas where this tidal level is covered by riprap or bulkheads. In this case, the Work Plan addresses sediments below the toe of the riprap slope or bulkhead. These sediments have been impacted by a variety of historical operations including those described below. The scope of work is defined in Section 4.0.

2.3 HARBOR DEVELOPMENT TIMELINE

The Harbor's industrial development began with sawmills and fish packing operations in the late 1800s. Table 1 summarizes by year the various significant shoreline or nearshore operations, starting in 1911. Typical operations included saw mills, fish packing, bulk fuel facilities, pulp and paper mills, and other wood processing-related operations. Other uses included the U.S. Coast Guard Station, located at the tip of Ediz Hook, and marine shipping. Figures 1, 2, and 3 show changes to the historical waterfront operations over time. In general, waterfront industrial operations peaked in the 1950s and 1960s (Figure 3).

2.4 HISTORICAL AND CURRENT SHORELINE FACILITIES

As described in the Agreed Order, there have been several industrial facilities in the Harbor that have been associated with historical releases of hazardous substances and/or wood debris to sediments, based on the scale, nature of operations, and years of operation. Each of these facilities is briefly summarized below.

2.4.1 Nippon Paper Industries USA Co., Ltd. (NPIUSA) (formerly Daishowa America, James River, Crown Zellerbach, and Washington Pulp and Paper)

NPIUSA became the owner and operator of a paper mill located at 1805 Marine Drive at the base of Ediz Hook in 1988. NPIUSA's real property at this location includes a lagoon, which is connected by a channel to western Port Angeles Harbor. NPIUSA also leases aquatic lands

within western Port Angeles Harbor from the Washington State Department of Natural Resources for mill operations.

Prior owners of the paper mill, including Crown Zellerbach and James River Corporation of Nevada, owned or operated the facility from approximately 1928 through 1988 and also leased aquatic lands from the State of Washington to facilitate mill operations. From 1928 through the late 1960s, process effluents, wood fiber, and stormwater were discharged from the paper mill through multiple outfalls to the Harbor.

2.4.2 Merrill & Ring Lumber Company (Formerly Port Angeles Forest Products Inc.)

Merrill & Ring was the owner and operator of a lumber mill located at 1608 Marine Drive near the base of Ediz Hook from 1958 through 1988 on property leased from the Port. Merrill & Ring also owned and conducted operations on adjoining fee-owned property, formerly owned by Fibreboard, from 1972 through 1988. In addition, Merrill & Ring leased aquatic lands for its operations from the State of Washington. Historical records indicate stormwater outfalls were situated on the Merrill & Ring property adjacent to the Harbor.

2.4.3 Fibreboard Paper Products Corporation

Fibreboard and its predecessors were the operators of a paperboard plant located at or near 1313 Marine Drive from 1919 through 1970, which was sold in 1972. Fibreboard also operated in areas of the Harbor both contiguous with the Fibreboard plant site and along Ediz Hook leased from the State of Washington. Owens Corning acquired Fibreboard Corporation in 1997. Fibreboard discharged pulp mill wastes and stormwater directly into the Harbor via five outfalls.

2.4.4 Port Operations

The Port owns or formerly owned properties where Fibreboard Corporation and Merrill &Ring operated facilities. In addition, the Port owns and operates the Boat Haven marina. The Port also leases or has leased, and manages or has managed under a Port Management Agreement, state-owned aquatic lands in the Harbor to facilitate Port operations. The Port's lease agreements, and the terms of the Port Management Agreement, are documented in Washington State Department of Natural Resources Port Management Agreement No. 22-080013 and Lease Nos. HA-1878 and HA-2047.

2.4.5 City of Port Angeles Combined Sewer Overflows and Stormwater

The City, at times, has operated eleven combined sewer overflow (CSO) discharge points that discharged untreated wastewater and stormwater directly into the Harbor during periods of heavy rainfall. Through these CSO discharge points, the City conveyed hazardous substances into the Harbor. Four of these continue to operate.

Sampling conducted during stormwater permit applications in 1996, 2003, and 2010 detected metals and organic contaminants at levels greater than Sediment Management Standards (SMS) in some sediment results near some of the CSO discharge points.

2.4.6 Hog Fuel Boilers and Wood Debris Burners

Historically, a number of mills in the area, including but not limited to Crown Zellerbach and Fibreboard, operated hog fuel boilers that burned salt-laden wood as a portion of the fuel

source. Other mills, including earlier mills that predated the Merrill & Ring mill but were located on the same property, operated hog fuel boilers or wood debris burners, which also burned salt-laden wood as a portion of the fuel source.

2.4.7 Wood Debris Releases

Wood debris identified in the Harbor includes logs, large wood pieces, small wood pieces or chips, very fine wood particles and/or fibers, and pulp-like material. Historically, various mills and timber-related industries have operated along the shoreline of the Harbor. These facilities have at one time or another transported and stored logs, wood chips, and/or sawdust in nearshore areas or on barges in the Harbor. Releases of wood debris occurred during these operations. The western portion of the Harbor was historically utilized for extensive log rafting by a variety of entities, resulting in the release of wood debris in the rafting areas. Additionally, releases of wood debris resulted from the operation of log dumps by a variety of entities. Wood debris, in the form of very fine wood particles and/or fibers, was released to the Harbor in the process effluent from mills, including the Crown Zellerbach and Fibreboard mills, resulting in wood debris layers at the site.

2.5 CURRENT FACILITIES AND NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT HOLDERS

A number of National Pollutant Discharge Elimination System (NPDES) permits are in effect within the RI/FS study area and are listed in Table 2. Figure 4 shows the locations of these facilities, which include several wood-related loading operations, boatyard-related operations, and municipal discharges. Unlike the majority of historical operations listed in Table 1, these current operations are regulated under the Clean Water Act, with monitoring for specific analytes required as per their permit (Table 2).

2.6 LAND OWNERSHIP AND IN-WATER AQUATIC LEASE AREAS

As shown on Figure 5, subtidal aquatic land is owned and managed either by Washington State Department of Natural Resources or by the Port under a Port Management Agreement. The majority of aquatic land under active leases in the Harbor is leased to the Port. Nippon Paper Industries USA Co., LLC (known as NPIUSA) also currently leases several aquatic parcels. The remaining aquatic parcels are relatively small and leased by a number of entities including the City and Foss Maritime. Active log rafting currently occurs at three locations in the western harbor on parcels leased by the Port.

Ownership of shoreline parcels is dominated by the Port, and the federal government (e.g., the U.S. Coast Guard Station; Figure 6).

3.0 Summary of Existing Information

3.1 PREVIOUS INVESTIGATIONS

A number of investigations of the Harbor sediments have occurred beginning in the early 1970s. The purpose of a RI/FS is to adequately characterize the current conditions of the site for the purpose of developing and evaluating cleanup action alternatives and to evaluate those alternatives to enable a cleanup action to be selected. For the purpose of the Agreed Order, data from 2002 to present will be used in the RI/FS to document current environmental conditions. Table 3 provides the surveys and the types of analyses conducted during this time period. These data are mapped and discussed in *Port Angeles Harbor Marine Environment Screening Level Human Health and Ecological Risk Assessment, Final Report* (Ecology 2012b), *Port Angeles Harbor Sediment Characterization Study Sediment Investigation Report*, *Port Angeles, Washington* (Ecology 2012a), and *Port Angeles Harbor Supplemental Data Evaluation to the Sediment Investigation Report, Port Angeles, Washington* (NewFields 2012).

4.0 Remedial Investigation Approach and Data Quality Objectives

4.1 REMEDIAL INVESTIGATION APPROACH

A Remedial Investigation (RI) will be prepared consistent with WAC Chapters 173-340 and 173-204 of WAC. As discussed in WAC 173-204-550, a RI is intended to collect, develop, and evaluate sufficient information regarding a site or sediment cleanup unit for Ecology to establish sediment cleanup standards and inform selection of a cleanup action. The RI will include the following:

- General site information
- Site conditions
- Distributions of sediment contamination
- Sediment transport mechanisms
- Confirmed and suspected contaminant sources
- Recontamination potential
- Natural resources and habitat
- Human health and ecological risk assessment
- Preliminary sediment cleanup levels
- Preliminary sediment management area (or cleanup unit) boundaries

As described further in Section 4.3, Data Quality Objectives 2 and 3, Ecology has already performed a human health and ecological risk assessment. These will be incorporated into the RI, and no additional risk assessment-related data collection is proposed. Ecology is developing preliminary sediment cleanup objectives for the Harbor; these will form the basis for the development of the Harbor sediment cleanup standards.

4.2 CONCEPTUAL SITE MODELS

Conceptual site models (CSMs) addressing contaminant sources, transport mechanisms, exposure pathways and receptors for human and ecological receptors in the Harbor are provided in Figures 3-3 and 4-1 of *Port Angeles Harbor Marine Environment Screening Level Human Health and Ecological Risk Assessment, Final Report* (Ecology 2012b). These CSMs were used by Ecology to develop human health and ecological screening level risk assessments. Informed by the previous Ecology work, the CSM for this RI/FS will be refined as part of the remedial investigation process.

4.3 DATA COLLECTION OBJECTIVES AND DESIGN RATIONALE

As shown in Table 3, Western Port Angeles Harbor has been sampled extensively over the past 10 years. The available data constitute the majority of the data needed to prepare the RI/FS. A final defined data collection effort is anticipated to fill remaining RI data gaps. This section identifies the specific remaining data gaps and defines the RI/FS activities that will be performed to address them.

A systematic planning process is a key step in developing successful sampling and analysis programs to ensure the appropriate sampling, analyses, and data evaluations are conducted to meet program objectives. U.S. Environmental Protection Agency's (USEPA's) *Guidance on Systematic Planning Using the Data Quality Objective Process* (USEPA 2006) is used herein to guide data collection to support development of the RI/FS. The Data Quality Objectives (DQO) process is a tool to determine the type, quantity, and quality of data. It is a seven-step process that establishes performance and acceptance criteria to ensure that data that are collected support the goals of the RI/FS. The DQO process is shown graphically in Figure 7.

The following four DQOs have been identified to complete the RI:

- DQO 1: Evaluate benthic conditions
- DQO 2: Evaluate risks to human health
- DQO 3: Evaluate risks to ecological receptors
- DQO 4: Evaluate ongoing sources of hazardous substances to sediments

4.3.1 Evaluate Benthic Conditions

The evaluation of benthic conditions encompasses the presence of chemicals of concern (COCs) in surface sediments and the potential for associated biological impacts, as well as the potential for wood debris to influence benthic habitat quality.

DQO 1: Evaluate Benthic Conditions

DQO Step	Description
STEP 1: State the problem	Benthic conditions are described in 2012 documents (Ecology 2012b, NewFields 2012), including areas with exceedances of Sediment Quality Standards (SQS) and cleanup screening levels (CSLs). As noted in these reports, performance of the echinoderm larval bioassay across the study area was highly inconsistent, with widespread failures including in areas with an absence of SMS chemical exceedances and wood debris, as well as in samples collected from reference areas. Improved laboratory resuspension methods using bivalve larvae were recently developed and accepted by Ecology and the Dredged Material Management Program (DMMP) during the Sediment Management Annual Review Meeting that address the potential for entrainment of larvae by flocculent particulate material in tested sediments (Kendall et al. 2012). This potential laboratory artifact may have resulted in false positive echinoderm test results in numerous samples collected from the Harbor, particularly at locations with wood debris where there is a greater potential for entrainment of larvae. However, there is currently no Ecology-accepted protocol for addressing entrainment using the echinoderm larval bioassay. Previously sampled stations with possible false positive echinoderm larval test results will be retested using the Ecology-accepted bivalve larvae resuspension method to provide more reliable confirmatory bioassay data for comparison with SMS biological criteria (SQS and CSLs) as described below. A number of samples collected in the inner harbor exceeded SQS or CSL chemical criteria for one or more chemicals. Under the SMS, these samples may undergo bioassay testing to determine whether those sediments are toxic and should be considered for remedy evaluation in the Feasibility Study (FS). If the bioassays pass under the SMS framework, then those areas do not require consideration in the FS to address SMS chemicals. Harbor sediments contain wood debris in many areas (Ecology 2012b, NewFields 2012, SAIC 1999). Wood debris may affect benthic habitat. Additional data, as described below, are needed to evaluate whether areas with wood debris should be considered in the FS.
STEP 2: Identify the goals of the study	Principal Study Questions • Are SMS benthic criteria exceeded in the study area? • What influence does wood debris have on benthic habitat?

DQO 1: Evaluate Benthic Conditions

DQO Step	Description
STEP 3: Identify the information inputs	Existing Field Data/Reports • Existing data are summarized in Table 3 of this Work Plan New Data To Be Collected In The RI • Bivalve larval bioassays conducted using the Ecology-accepted resuspension modified-endpoint protocol at stations west of the Rayonier Study Area where the echinoderm larval bioassay previously exceeded SQS criteria (potentially false positive test results due to larval entrainment) during testing by Ecology and Environment, Inc. (E&E) in 2008 (Ecology 2012b) • Amphipod, larval, and polychaete bioassays at locations in Western Port Angeles Harbor where one or more SQS or CSL chemical values were exceeded; between some stations where SQS chemical values were exceeded; or in specific areas lacking bioassay data • Porewater ammonia, porewater sulfides, and conventional analyses (i.e., total organic carbon, total volatile solids, sediment grain size, and total solids) at all stations where bioassays are performed • SMS chemical analyses at bioassay stations where sediment chemical data are not already available • Limited SMS chemical analyses at stations where some sediment chemical data are available such that data will be available for all SMS chemicals • Sediment profile images (SPI) and plan view images at a subset of the stations sampled by Science Applications International Corporation in 1998 (SAIC 1999), at all stations sampled for bioassays, and at representative locations to evaluate and delineate (to the extent practicable) wood debris deposits • Benthic community data (i.e., abundance of polychaetes, mollusks, and crustaceans) only if there are significant conflicting lines of evidence regarding benthic conditions among chemical, bioassay, and SPI data that need resolution for preparation of the FS (to be determined by Ecology after consultation with the Western Port Angeles Harbor Group following collection and analysis of other RI/FS data)

DQO 1: Evaluate Benthic Conditions

DQO Step	Description
STEP 4: Define the boundaries of the study	Geographic Area • The study area for full suite bioassays and associated chemistry is Western Port Angeles Harbor. • The study area for retesting the larval bioassay and performing the SPI survey is Western Port Angeles Harbor. Timeframe • Historical data from 2002 to present. • Sampling to occur in June to optimize bioassay testing. This timing is necessary due to seasonal concerns about the availability of healthy spawning stock for the larval testing, along with safety considerations (i.e., avoiding inclement weather conditions during the winter). Benthic abundance analyses, if performed, would be a separate field event. Sample Type • Surficial sediment (i.e., top 10 cm) will be collected and analyzed for bioassays and associated chemical and conventional analyses. • SPI and plan view images.
STEP 5: Develop the analytical approach	The analytic approach for assessing benthic conditions is provided as a flowchart in Figure 8 (benthic conditions). The proposed sediment chemical and bioassay data will provide comprehensive information on current sediment quality conditions at stations that previously were not tested with bioassays and at previously sampled stations where the echinoderm larval bioassay exceeded SQS criteria due to possible false positive results due to larval entrainment. The new bivalve larval resuspension test results will be used to reflect current sediment quality conditions for making remedial management decisions. All data will be obtained using Ecology-accepted methods and evaluated according to the SMS (i.e., SMS chemical data will be compared with SQS and CSL chemical criteria, and bioassays will be evaluated relative to SQS and CSL bioassay criteria). Porewater ammonia and sulfides will be compared with bioassay SQS and CSL failures to evaluate possible causes of toxicity. The chemical data will also support the evaluation of potential ongoing sources (DQO 4 [Evaluate Ongoing Sources of Hazardous Substances in Sediments]). SPI images will be evaluated for the following qualitative metrics: apparent redox potential discontinuity depth, infaunal successional stage, presence of benthic invertebrates, presence and amount of wood debris, and sediment grain size. Changes in these metrics from the SPI data collected in 1998 (SAIC 1999) will be used to evaluate the benthic habitat and potential for habitat recovery. These data will be used as lines-of-evidence to develop and evaluate remedial alternatives in the FS.

DQO 1: Evaluate Benthic Conditions

DQO Step	Description
STEP 6: Specify performance or acceptance criteria	Performance or acceptance criteria will be described in the Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP) that will be prepared following this Work Plan. The following quality control considerations will be addressed: • Field quality control samples • Laboratory quality control • Data quality indicators for laboratory analyses (precision, accuracy, representativeness, completeness, and comparability)
STEP 7: Develop the detailed plan for obtaining data	Full Suite Bioassays • Full suite bioassays (i.e., amphipod, larval, and polychaete), porewater ammonia and sulfides, black carbon, and conventional parameters will be performed at the 20 locations shown on Figure 9. The rationale for each station, as well as the SMS sediment chemical analyses associated with each location, is provided in Table 4. Larval Bioassay Retest • The bivalve larval resuspension bioassay, porewater ammonia and sulfides, black carbon, and conventional parameters, will be performed at stations using the resuspension protocol for the larval bioassay. The stations are shown on Figure 9 and include: EH02A, FP01A, BA01A, IE03A, IE04A, IE06A, IE07A, IE09A, IE14A, IE15A, LA02A, IH02A, IH03A, IH06A, MA01A, MA02A, MA05A, MA06A, BL01A, BL03A, BL04A, BL06A, KP01A, KP02A, KP05A, KP06A, and CSO-006. Sediment Profile Imaging • SPI with plan view photos will be performed at the stations shown on Figure 10 and listed in Table 5. SPI images will be evaluated for apparent redox potential discontinuity depth, infaunal successional stage, presence of benthic invertebrates, presence and amount of wood debris, and grain size.

4.3.2 Evaluate Risk to Human Health

Assessing risk to human health involves evaluation of data for various human exposure pathways. A screening level human health risk assessment has already been completed for the Harbor (Ecology 2012b). However, data describing background conditions are lacking.

DQO 2: Evaluate Risks to Human Health

DQO Step	Description
STEP 1: State the problem	A screening level human health assessment for the Harbor was performed by E&E (Ecology 2012b; refer to Section 3.0) to address potential risks to human health from exposure to bioaccumulative and SMS chemicals. Screening level risk assessments use default assumptions and provide conservative estimates of risk. Potential exposures to chemicals in sediment, fish, and shellfish tissue were evaluated for subsistence fishers, recreational fishers, residential users, and recreational users. Ecology's threshold of 1 in 100,000 (1×10^{-5}) potential excess cancer risks for multiple hazardous substances or pathways was exceeded for the subsistence and recreational fisher receptors. Inorganic arsenic, dioxin/furan toxic equivalency quotient (TEQ), PCBs, alpha-hexachlorocyclobenzene (BHC), and carcinogenic polycyclic aromatic hydrocarbons (cPAHs) accounted for 58 percent, 23 percent, 11 percent, 4 percent, and 3 percent respectively, of the subsistence fisher excess cancer risk (Figure 3-5 of Ecology 2012b), although alpha-BHC risk was based on elevated and variable detection limits. The extent to which alternative cleanup remedies address unacceptable risks to human health and/or achieve background concentrations will be used as lines-of-evidence in the evaluation of remedial alternatives in the FS.
STEP 2: Identify the goals of the study	Principal Study Questions • Are unacceptable risks to human health from bioaccumulative and SMS chemicals present in Western Port Angeles Harbor? • Do the risks differ from background?

DQO 2: Evaluate Risks to Human Health

DQO Step	Description
STEP 3: Identify the information inputs	Existing Field Data/Reports • Existing investigations are summarized in Table 3 of this Work Plan, including the screening level human health risk assessment (Ecology 2012b). • Preliminary sediment cleanup objectives for the Harbor are under development by Ecology. New Data Needed for the RI/FS • Background values. • Under the current SMS regulations and SMS rule revisions effective on September 1, 2013, evaluation of remedial alternatives in the FS considers background concentrations of chemicals that may pose human health risks subject to the disproportionate cost analysis (DCA) and other elements of the FS evaluation to ensure potential remedies are practicable. Regional background concentrations represent local concentrations influenced by broadly distributed non-point sources in the region such as atmospheric deposition or storm water, but that are not attributable to a specific source or release. Ecology intends to develop regional background concentrations for specific chemicals within specific geographic areas. Ecology will determine the appropriate sampling design, statistical analyses, and analytical methods. Ecology will collect and analyze these samples, perform the statistical analyses, and provide final results. • However, in the event that Ecology's derivation of Harbor regional background values will not be completed in time to meet the Agreed Order schedule, the RI/FS will use the following approach: o If Ecology indicates to the Western Port Angeles Harbor Group by June 30, 2013 that it will provide regional background levels for comparative purposes to the Harbor prior to November 1, 2013, these regional background levels will be used in the RI/FS. o If Ecology does not develop definitive plans by June 30, 2013 to provide Port Angeles-specific regional background levels prior to November 1, 2013, the Western Port Angeles Harbor Group and Ecology will work cooperatively on this issue between July and November 2013 for these numbers to be input into the RI/FS process.

DQO 2: Evaluate Risks to Human Health

DQO Step	Description
STEP 4: Define the boundaries of the study	Geographic Area • The study area for the assessment of unacceptable risks to human health due to bioaccumulative and SMS chemicals is Western Port Angeles Harbor. Timeframe • Historical data from 2002 to present. Sample Type • Regional background sediment concentrations to be determined by Ecology's sampling design. No new data will be collected by the Western Port Angeles Harbor Group to address this DQO.
STEP 5: Develop the analytical approach	The screening level human health risk assessment will be used along with background information as lines-of-evidence in the evaluation of remedial alternatives in the FS.
STEP 6: Specify performance or acceptance criteria	Regional background sediment concentrations to be determined by Ecology's sampling design. No additional new data will be collected by the Western Port Angeles Harbor Group to address this DQO because adequate data exist to evaluate the potential for unacceptable human health risks.
STEP 7: Develop the detailed plan for obtaining data	No new data will be collected by the Western Port Angeles Harbor Group to address this DQO. Adequate data exist to evaluate the potential for unacceptable human health risks

4.3.3 Evaluate Risks to Ecological Receptors

Assessing risk to ecological receptors involves evaluation of data for various receptors and pathways. A screening level ecological risk assessment has already been completed for the Harbor (Ecology 2012b).

DQO 3: Evaluate Risks to Ecological Receptors

DQO Step	Description
STEP 1: State the problem	A screening level ecological risk assessment for the Harbor was performed (Ecology 2012b; refer to Section 4) to address potential risks from exposure to bioaccumulative and SMS chemicals. Screening level risk assessments use default assumptions and provide conservative estimates of risk. Risks to the following receptor groups were evaluated: marine plants and macroalgae, benthic invertebrates, fish, and wildlife. The following conclusions were developed: • *Marine plants and macroalgae*. The presence of wood debris in some nearshore areas may have compromised the ability of the Harbor to support marine plants and macroalgae. • *Benthic invertebrates*. Refer to DQO 1. • *Fish*. The risk assessment considered 10 chemicals found in fish tissue. Arsenic in rock sole was the only chemical to exceed a tissue residue risk-based concentration. Ecology concluded "fish in Port Angeles Harbor are unlikely to be adversely affected by current levels of most contaminants, except perhaps by arsenic." • *Wildlife*. Six wildlife species were evaluated: brant, double-crested cormorant, greater scaup, harbor seal, raccoon, and bald eagle. No unacceptable risks were found for brant, bald eagle, double-crested cormorant, and the greater scaup. For the raccoon, a hazard quotient (HQ) of 1 based on the no observable adverse effect level (NOAEL) was exceeded for arsenic, while the HQ lowest observed adverse effect level (LOAEL) was not exceeded; an HQ-NOAEL greater than 1.0 "doesn't necessarily indicate adverse effect." For the harbor seal, an HQ-NOAEL greater than 1.0 was observed but was based on an elevated detection limits. Ecology concluded "Overall, it seems that no chemicals pose an actual risk to harbor seals foraging in Port Angeles Harbor." Overall, the study concluded that wood debris (refer to DQO 1) appeared to be the most significant stressor to ecological receptors in the Harbor.
STEP 2: Identify the goals of the study	Principal Study Question • Are unacceptable risks to ecological receptors present in Western Port Angeles Harbor?
STEP 3: Identify the information inputs	Existing Field Data/Reports • Existing data are summarized in Table 3 this Work Plan, including the screening level ecological risk assessment prepared by E&E (Ecology 2012b). • Preliminary screening levels for the Harbor are under development by Ecology. New Data To Be Collected In The RI • No new data will be collected by the Western Port Angeles Harbor Group to address this DQO.

DQO 3: Evaluate Risks to Ecological Receptors

DQO Step	Description
STEP 4: Define the boundaries of the study	Geographic Area • The study area for the assessment of unacceptable risks to ecological receptors is Western Port Angeles Harbor. Timeframe • Historical data from 2002 to present. Sample Type • No new data will be collected by the Western Port Angeles Harbor Group to address this DQO.
STEP 5: Develop the analytical approach	Based on results of the ecological risk assessment, lines-of-evidence related to ecological risk that will be evaluated in the FS will be limited to those described in DQO 1.
STEP 6: Specify performance or acceptance criteria	New data collected by the Western Port Angeles Harbor Group as part of DQO 1 will be used to address DQO 3.
STEP 7: Develop the detailed plan for obtaining data	New data collected by the Western Port Angeles Harbor Group as part of DQO 1 will be used to address DQO 3.

4.3.4 Evaluate Ongoing Sources of Hazardous Substances to Sediments

A key objective of the RI/FS is to identify ongoing sources that have the potential to result in sediment recontamination at levels greater than prospective sediment cleanup standards. Source control assessments to be performed in the RI/FS will involve evaluation of surface sediment quality between mean higher high water and the deep subtidal zone in the Western Port Angeles Harbor study area, except in areas where this tidal level is covered by riprap or bulkheads, to identify areas that may be influenced by ongoing sources of hazardous substances. Consistent with the SMS requirements, as revised, Ecology will use this information along with its Water Quality Program and Model Toxics Control Act (MTCA) upland cleanup authorities to ensure the long-term success of the sediment cleanup efforts. Adequate source controls to prevent recontamination must be in place prior to selection and implementation of a final sediment remedial action, which is necessary to ensure that recontamination of remediated sediments, does not occur and natural recovery of the remaining sediments continues.

The Western Port Angeles Harbor Group will evaluate spatial gradients of COCs in surface sediments. This evaluation will focus on areas that exceed concentration thresholds based on sediment cleanup standards and remediation levels as approved by Ecology. Areas where surface sediments contain elevated COC concentrations may indicate an ongoing source. For

these areas, potential sources (e.g., upland activities, overwater operations, upland soil/bank erosion, spills, stormwater, creeks, and NPDES permitted outfalls) to those areas will be identified. Aerial deposition from global sources of persistent bioaccumulative compounds such as dioxins/furans will also be considered.

If the source evaluation suggests the presence of one or more active sources, Ecology will use state regulatory authorities (outside of the RI/FS Agreed Order) to follow up with the appropriate parties to control those sources. Ecology and the Western Port Angeles Harbor Group will work cooperatively to coordinate the timing of source control actions and sediment remedial actions to ensure sources are adequately controlled before sediment remediation occurs.

DQO 4: Evaluate Ongoing Sources of Hazardous Substances to Sediments

DQO Step	Description
STEP 1: State the problem	The Harbor sediments have received hazardous substance releases from a variety of sources since commercial/industrial operations began, including upland, in-water, and over-water operations; spills; leaks; discharge of stormwater, sewage, and wastewater; nearshore burning; and direct discharge. Historical releases were of greater magnitude than ongoing sources, as evidenced by the higher subsurface chemical concentrations in many areas of the Harbor (refer to Figures 5.4-1 and 5.4-2 of Ecology 2012b). The RI/FS will identify ongoing sources that have the potential to result in sediment recontamination.
STEP 2: Identify the goals of the study	Principal Study Question: • Would ongoing sources of hazardous substances pose a recontamination risk to post-remedial sediments in Western Port Angeles Harbor?
STEP 3: Identify the information inputs	Existing Field Data/Reports • Existing investigations are listed in Table 3 of this Work Plan. • Additional data to be considered include available water quality information for stormwater and creek discharges. • Bank conditions (presence/absence of riprap, exposed soils, intertidal, etc.) and available bank soil chemical information will be considered. • Nature of nearshore and overwater operations—loading/unloading, materials handled, release potential, etc. • Atmospheric deposition studies for persistent bioaccumulatives. New Data To Be Collected In The RI • Surface sediment chemical data collected as part of the DQO 1. • Puget Sound Ecosystem Monitoring Program surface sediment chemical data collected from Western Port Angeles Harbor may also be considered, if available as a final, validated data package by November 2013.

DQO 4: Evaluate Ongoing Sources of Hazardous Substances to Sediments

DQO Step	Description
STEP 4: Define the boundaries of the study	Geographic Area • The source evaluation process will encompass surface sediments within Western Port Angeles Harbor—if surface sediments exceed sediment cleanup standards or remediation levels developed in the RI/FS process, pathways to and adjacent to that area will be considered. • Pathways to be considered include upland activities, nearshore bank soil erosion, direct discharges from overwater operations, spills, stormwater, creeks, and NPDES-permitted outfalls. Timeframe • Surface sediment chemical data from 2002 to present to identify potential source areas. Other data may be used to evaluate changes in sediment chemical concentrations over time. Sample Type • Existing surface sediments, soil, groundwater (if non-aqueous phase liquid present in nearshore areas), and water quality data.

DQO 4: Evaluate Ongoing Sources of Hazardous Substances to Sediments

DQO Step	Description
STEP 5: Develop the analytical approach	• Surface sediment areas where chemical concentrations exceed thresholds developed for sediment cleanup standards or remediation levels will be delineated. These will be considered source evaluation areas of concern. • If subsurface data are available in or near a source evaluation area, those data will be reviewed to determine if there is a trend of decreasing concentrations of the COC in newer sediment; such a trend would indicate a historical rather than an ongoing source. • Potential ongoing sources and pathways to and immediately adjacent to source evaluation areas of concern will be identified using the following lines of evidence: o Nature of nearshore operation and potential for COCs to be released to the source area of concern. o The COCs present in source area of concern sediments compared with potential nearby sources. o Water quality data, if available, for stormwater and creek discharges to the source area of concern. o If exposed shoreline soils are present and erodible, available soil chemical concentration data will be considered. If no data are available, fill history may be considered. o If subsurface sediment data are available in or near a source evaluation area, those data will be reviewed to determine if there is a trend of decreasing chemical concentrations in newer sediment; such a trend would indicate a historical rather than an ongoing source. o If non-aqueous phase liquid (NAPL) is present in nearshore area(s), groundwater quality may be considered. For each source evaluation area of concern, potential sources and pathways will be classified either as a potential concern and flagged for follow-up by Ecology, or as unlikely to pose a recontamination risk. Simplified fate and transport modeling may be warranted to improve the understanding of recontamination risk. If insufficient data are available to make a recommendation, the pathway will be considered a data gap and flagged for follow-up by Ecology.
STEP 6: Specify performance or acceptance criteria	For new data collected, refer to DQO 1. For other media (stormwater, water quality, soils, atmospheric deposition) not sampled as part of this Work Plan, professional judgment will be used. Preference will be given to peer-reviewed studies and validated data.

DQO 4: Evaluate Ongoing Sources of Hazardous Substances to Sediments

DQO Step	Description
STEP 7: Develop the detailed plan for obtaining data	Refer to DQO 1 for collection of new sediment data. Data from other media will be compiled from available sources, including peer-reviewed literature, available upland reports, and Ecology's Water Quality program.

5.0 Feasibility Study Approach

Consistent with SMS requirements described in WAC 173-204, as amended and with requirements of WAC 173-340, an FS will be prepared including collection, development, and evaluation of information to enable consideration of sediment cleanup alternatives and selection of a site-specific sediment cleanup standard to inform the Cleanup Action Plan. The FS will include an evaluation of alternative cleanup actions that protect human health and the environment by eliminating, reducing, or otherwise controlling risks posed through each exposure pathway and migration route of concern identified in the RI. The number and types of alternatives to be evaluated will take into account the characteristics and complexity of Western Port Angeles Harbor.

The cleanup alternatives may include establishment of sediment cleanup units, as defined in WAC 173-204, as amended, with cleanup alternatives developed based on site physical characteristics and complexity, and in consideration of cost, technical feasibility, and net environmental impact. The FS will also include a MTCA DCA.

The FS will consider multiple lines of evidence, described further below, which will include:

- Distribution of bioassay test failures and related chemical concentrations and wood debris
- Distribution of bioaccumulative compounds in sediment, including organic carbon and/or black carbon normalized concentrations, and comparison of regional background concentrations with those distributions
- Bioaccumulation data for dioxin/furan and PCB congeners in parallel with porewater testing data as measured by solid phase microextraction (SPME) across a gradient of PCB and dioxin/furan concentrations to identify areas where sediments may be relatively more or less likely to result in bioaccumulation
- Multiple measures of benthic habitat derived from SPI images and comparison of those images to images taken in 1998 (SAIC 1999)

Additionally, treatability testing with granulated activated carbon will be performed at two locations to measure the effect of activated carbon addition on porewater concentrations of PCB and dioxin/furan congeners and the bioaccumulation of these chemicals by test organisms.

Overall, these analyses and weight of evidence approach are performed to facilitate prioritization of areas for remedial actions, and/or consideration of remedial technologies.

5.1 DISPROPORTIONATE COST ANALYSIS

The MTCA DCA described in WAC 173-340-360(3)(e) will be used in the FS to evaluate which of the alternatives evaluated are protective to the maximum extent practicable. This analysis will involve comparing the costs and benefits of alternatives whose incremental costs are not disproportionate to the incremental benefits. The evaluation criteria for the DCA are specified in WAC 173-340-360(3)(f), and include protectiveness, permanence, cost, long-term effectiveness, management of short-term risks, implementability, and consideration of public concerns.

5.2 DATA COLLECTION OBJECTIVES AND DESIGN RATIONALE

Similar to the RI data gaps discussed in Section 4.0, the extensive data collected over the last 10 years constitute the data necessary to complete the FS. However, a focused data collection effort is proposed to provide additional lines of evidence to develop and evaluate remedial alternatives, and is described in this section following the DQO process described in Section 4.2. These new data, in combination with existing data, are sufficient to complete the FS.

One DQO has been identified to supplement the FS approach for Western Port Angeles Harbor:

- DQO 5: Prioritization of Sediment Areas to Address Potential Bioaccumulation Exposures

DQO 5: Prioritization of Sediment Areas to Address Potential Bioaccumulation Exposures

DQO Step	Description
STEP 1: State the problem	As discussed in DQO 2, the extent to which alternative cleanup remedies address unacceptable risks to human health and/or achieve background concentrations will be used as lines-of-evidence in the evaluation of remedial alternatives in the FS. Information on the bioavailability of COCs that drive risk to human health will help focus the FS on high priority areas and contribute to the lines-of-evidence evaluation.
STEP 2: Identify the goals of the study	Principal Study Questions • Are there sediment areas of Western Port Angeles Harbor exceeding background levels that are associated with relatively higher potential for bioaccumulation to occur?
STEP 3: Identify the information inputs	Existing Field Data/Reports • Existing data on dry weight and organic carbon (OC) normalized sediment PCB and dioxin/furan TEQ concentrations, along with tissue concentrations, are summarized in the aforementioned reports (Ecology 2012b, NewFields 2012). New Data To Be Collected In The RI • Additional data will be collected to further inform the weight-of-evidence FS evaluation approach, including: o Black carbon (additionally, black carbon will be collected at all bioassay stations discussed in DQO 1). o Tissue concentrations of PCB and dioxin congeners derived via laboratory bioaccumulation testing. o PCB and dioxin/furan congener sediment data. o Sediment grain size, total organic carbon, total solids, and total volatile solids. o Porewater concentrations of PCB and dioxin congeners derived via SPME.

DQO 5: Prioritization of Sediment Areas to Address Potential Bioaccumulation Exposures

DQO Step	Description
STEP 4: Define the boundaries of the study	Geographic Area • The study area for the assessment of unacceptable risks to human health due to bioaccumulative chemicals is Western Port Angeles Harbor. Timeframe • Historical data from 2002 to present. • Sampling to occur in June concurrent with bioassay testing. Sample Type • Surficial sediment (i.e., top 10 cm) will be collected and analyzed for sequestering agents (e.g., black carbon), bioaccumulation, and porewater analyses via SPME.
STEP 5: Develop the analytical approach	Dry weight and OC-normalized sediment concentrations of PCBs and dioxins/furans, black carbon concentrations, tissue concentrations of PCBs and dioxins/furans derived through laboratory bioaccumulation testing, and porewater concentrations of PCBs and dioxin/furans derived via SPME devices, along with comparisons of existing Western Port Angeles Harbor and background tissue data (Ecology 2012a), will be used as lines-of-evidence in the evaluation of remedial alternatives in the FS.
STEP 6: Specify performance or acceptance criteria	Performance or acceptance criteria will be described in the SAP/QAPP that will be prepared following this Work Plan. The following quality control considerations will be addressed: • Field quality control samples. • Laboratory quality control. • Data quality indicators for laboratory analyses (precision, accuracy, representativeness, completeness, and comparability).
STEP 7: Develop the detailed plan for obtaining data	Black carbon analysis, bioaccumulation testing, and porewater sampling and analysis via SPME will be performed at the 15 locations shown on Figure 11, spanning the range of OC-normalized PCB and dioxin/furan concentrations in Western Port Angeles Harbor. Table 6 identifies the bioaccumulation testing stations and indicates analyses to be performed at these stations.

5.3 ADDITIONAL FS TREATABILITY TESTING

Concurrent with the bioaccumulation testing, surface sediment collected from two locations with relatively higher sediment PCB and dioxin/furan concentrations (and with different dioxin/furan congener profiles) will also be used for bench-scale testing of in-situ treatment using activated carbon. The two treatability testing locations are depicted on Figure 11. Each sample will be mixed with activated carbon, and submitted for black carbon analysis, bioaccumulation testing, and porewater sampling and analysis via SPME using the same procedures summarized above. The results of the treatability testing will be incorporated into the FS as appropriate.

6.0 Project Management and Schedule

6.1 ROLES AND RESPONSIBILITIES

Allison Geiselbrecht, Floyd|Snider, will serve as overall Project Coordinator for the RI/FS. As such, she will be the primary contact for routine Ecology communications and required Ecology reporting, including quarterly progress reports, schedule updates, and other project management tasks. Additionally, Floyd|Snider will be the lead author of the RI/FS, with input and support from Integral Consulting Inc. (Integral), Exponent, Inc., and Anchor QEA.

Integral, with Betsy Day as primary Integral contact, will lead the field collection efforts described in DQOs 1 through 5. Integral will be the primary author of the RI/FS SAP, as well as the associated QAPP and Health and Safety Plan (HASP), and the RI/FS Supplemental Data Report (both described below). Integral will staff the field collection effort and perform or coordinate data validation.

6.2 DATA MANAGEMENT

Data collected for this project will be validated and managed consistent with the provision in the QAPP, which is an associated document to the SAP described in Section 6.3.

All data collected as part of this project will be submitted to Ecology in a format suitable for upload into Ecology's Environmental Information Management (EIM) database. An official project database will be maintained throughout the duration of this project, which will form the basis of RI/FS analyses, including generation of tables and graphics.

6.3 DELIVERABLES

The following deliverables will be prepared:

- *Draft RI/FS SAP*. Includes procedures for quality assurance and quality control (in the form of a QAPP), to collect data needed as described in Sections 4.0 and 5.0 above. The SAP will meet the requirements of WAC 173-340-350(7)(c)(iv) and WAC 173-340-820. The SAP will include as an attachment a draft HASP meeting the requirements of WAC 173-340-350(7)(c)(iv) and WAC 173-340-810. The SAP will also include a plan for addressing cultural resources, including an inadvertent discovery plan. The SAP will also include a list of applicable permits and applicable or relevant and appropriate requirements. Ecology will review the SAP. If requested by Ecology, comments submitted by Ecology will be incorporated into a revised document, which will be issued as the *Final RI/FS SAP*.
- Data collection must occur in the late Spring and is scheduled to begin in June 2013.
- *RI/FS Supplemental Data Report (Data Report).* This Data Report will accompany the EIM data submittal. The Data Report will contain a brief synopsis of deviations from the SAP, and data validation reports. New data will be tabulated and provided in written form and an electronic format capable of being transferred into Ecology's EIM data management system (as provided in WAC 173-340-840(5)). The requirement for electronic submittal shall be complete when Ecology confirms all data are properly submitted into EIM. Ecology's comments on the Supplemental Data Report, if provided, will be incorporated into the RI/FS (below).

- *Agency Review Draft Remedial Investigation/Feasibility Study (Agency Review RI/FS*). The Agency Review RI/FS will integrate available data from prior studies in the Harbor and additional data collected as per the SAP following the DQO process in this Work Plan. The RI/FS shall define the nature and extent of contamination pursuant to WAC 173-340-350 for the purpose of developing and evaluating cleanup actions for the site. In evaluation of cleanup action alternatives, the RI/FS will follow the requirements of WAC 173-340-350 through 370.
- *Public Review Draft RI/FS.* The Agency Review Draft RI/FS, described above, shall be revised to address Ecology's comments. The revised document will be submitted to Ecology for use in the public review process.
- *Final RI/FS.* After receipt of public comments, the Public Review Draft RI/FS will be revised to generate a Final RI/FS document.

6.4 SCHEDULE

Draft Deliverable/Action[1]	**Schedule**[2]	**Anticipated Calendar Date Schedule**[3]
Prepare and submit draft SAP/QAPP/HASP including a list of appropriate permits and applicable or relevant and appropriate requirements[4]	Submit on the day the Agreed Order becomes effective.	May 2013
Ecology reviews SAP/QAPP/HASP	Ecology will endeavor to review and approve within 20 days after Agreed Order effective date.	May 2013
Fieldwork	Begin in June 2013.	June/July 2013
Ecology reviews validated data and approves for use in RI/FS	Ecology will endeavor to review and approve data for use in RI/FS within 30 days of receipt of final data validation package.	September 2013
Prepare the Draft RI/FS Supplemental Data Report	Submit 75 days after receipt of final data validation package.	October 2013
EIM data submittal	Submit 75 days after receipt of final data validation package.	October 2013
Ecology reviews RI/FS Supplemental Data Report	Ecology comments will be incorporated into RI/FS. Ecology will endeavor to review and comment on the RI/FS Supplemental Data Report within 30 days of receipt.	November 2013
Agency Review Draft RI/FS Report	Submit 180 days following receipt of final data validation package or 150 days following Ecology approval of data for use in the RI/FS (whichever is later).	January 2014
Ecology reviews Agency Review Draft RI/FS Report	Ecology will endeavor to review and comment within 60 days of receipt.	April 2014

Draft Deliverable/Action[1]	Schedule[2]	Anticipated Calendar Date Schedule[3]
Public Review Draft RI/FS Report	Submit 90 days following receipt of Ecology's final comments on Agency Review Draft RI/FS Report.	June 2014
Ecology reviews Public Review Draft RI/FS Report	Ecology will endeavor to review and approve within 30 days of receipt.	July 2014
Ecology anticipated public comment period on Public Review Draft RI/FS (estimated 30 days)		August/September 2014
Ecology reviews comments and decision on any revisions necessary to the Public Review Draft RI/FS Report	Ecology will endeavor to review comments and provide revisions within 30 days of receipt of final public comments.	October 2014
Draft Final RI/FS Report[5]	Within 60 days of receipt of revision deemed necessary by Ecology on the Public Review Draft RI/FS.	December 2014
Ecology reviews and approves the Final RI/FS Report	Ecology will endeavor to provide approval within 14 days of receipt of draft Final RI/FS Report.	December 2014
Agreed Order Quarterly Reports	Submit first report beginning 90 days following the Agreed Order effective date and continue reporting through Agreed Order.	Quarterly beginning July 2013 until end of Agreed Order.

Notes:

1 Following the submittal of each deliverable, with the exception of quarterly reports and EIM submittals, the WPAH Group and Ecology will endeavor to meet within 14 days to discuss the contents of the deliverable. Following Ecology's submittal of comments or revisions necessary on any deliverable, the WPAH Group and Ecology will endeavor to meet within 14 days to discuss the comments or revisions.

2 Ecology review periods are presented as goals. Ecology will endeavor to make these review periods to achieve the overall goal of completing the Final RI/FS Report by the end of 2014. All days are calendar days, not business days.

3 The anticipated calendar dates shown are subject to change based on the actual supplemental data collection timeframe. Unanticipated factors may result in modified dates and will be mutually agreed upon by Ecology and the WPAH Group, and documented in writing.

4 Draft RI/FS SAP/QAPP will be provided during the Agreed Order public review period, prior to execution of the Agreed Order, to accelerate Ecology's review and approval process.

5 As established during the pre-Agreed Order process, the WPAH Group will work closely with Ecology during the comment period to resolve issues and streamline report production. This may result in the submittal of draft comments and responses and meetings between the WPAH Group and Ecology.

Abbreviations:

Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
HASP	Health and Safety Plan
QAPP	Quality Assurance Project Plan
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
WPAH	Western Port Angeles Harbor

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Western Port Angeles Harbor

Remedial Investigation/ Feasibility Study Work Plan

Tables

FINAL

Table 1
Port Angeles Harbor Development History

Year	Facility/Event	Reference
1911	The Geist Thompson Co. Shingle, Saw, and Planning Mill	1911 Certified Sanborn Map (EDR 2012)
1914	Puget Sound Mill & Timber Co. Saw, Shingle, and Planing Mills (Big Mill)	1917 Certified Sanborn Map (EDR 2012)
1917	Anacortes Fish Packing Co. Cannery	1917 Certified Sanborn Map (EDR 2012)
1917	Standard Oil Co.	1917 Certified Sanborn Map (EDR 2012)
1917	The Geist Thompson Co. Shingle, Saw, and Planning Mill now Washington Mills Co. Abandoned Shingle Mill	1917 Certified Sanborn Map (EDR 2012)
1917	People's Wharf Company	1917 Certified Sanborn Map (EDR 2012)
1918	The Paraffine Companies Inc. Crescent Boxboard Co. Paper & Cardboard Mill	1924 Certified Sanborn Map (EDR 2012)
1920s	Log yard operations begin in Port of Port Angeles Log Yard	*Historical Environmental Summary Report, Port of Port Angeles Marine Terminal Log Yard* (Shannon & Wilson 1993)
1921	Washington Pulp and Paper Corporation	1924 Certified Sanborn Map (EDR 2012)
1924	Angeles Gravel and Supply Co.	1924 Certified Sanborn Map (EDR 2012)
1924	Washington Mills Co. Abandoned Shingle Mill is now Foreman Mill Co. Shingle Mill	1924 Certified Sanborn Map (EDR 2012)
1924	Port Angeles Cooperage Company	1924 Certified Sanborn Map (EDR 2012)
1924	Olympic Lumber Co. Saw Mill	1924 Certified Sanborn Map (EDR 2012)
1929	Olympic Forest Products Co.	Port Angeles -- Thumbnail History (HistoryLink 2013)
1930	Shell Oil Co.	1930 Certified Sanborn Map (EDR 2012)
1930	Associated Oil Co.	1930 Certified Sanborn Map (EDR 2012)
1930	Richfield Oil Co.	1930 Certified Sanborn Map (EDR 2012)
1930	Port of Port Angeles Municipal Wharf	1930 Certified Sanborn Map (EDR 2012)
1930	Puget Sound Mills & Timber Co. Saw, Shingle, and Planing Mills now The Charles Nelson Co. Saw and Planing Mills	1930 Certified Sanborn Map (EDR 2012)
1930	Port Angeles Cooperage Co. is now Western Cooperage Co.	1930 Certified Sanborn Map (EDR 2012)
1930	Port Angeles Western RR. Co. Engine and Car Shops	1930 Certified Sanborn Map (EDR 2012)
1930	Crescent Boxboard Company is now Fibreboard Paper Products Corp.	1930 Certified Sanborn Map (EDR 2012)
1930	Foreman Mill Co. Shingle Mill is now Cresent Logging Co. Shingle Mill	1930 Certified Sanborn Map (EDR 2012)
1935	U.S. Coast Guard Air Station	*Port Angeles Harbor Sediment Characterization Study* (Ecology 2012a)
1937	Rayonier, Inc. formed with merger of Olympic Forest Products Company and two independent companies	*Current Situation/Site Conceptual Site Model Report, Rayonier Port Angeles Mill Site* (Foster Wheeler Environmental Corporation 1997)
1941	Peninsula Plywood Co.	*Marine Trades Area Site Port Angeles, Washington Remedial Investigation/Feasibility Study* (Floyd|Snider 2012)
1949	General Petroleum Corp.	1949 Certified Sanborn Map (EDR 2012)
1949	Western Cooperage Co. is now Port Angeles Shingle Co.	1949 Certified Sanborn Map (EDR 2012)
1949	Natural Gas Washington	1949 Certified Sanborn Map (EDR 2012)
1949	The Texas Co.	1949 Certified Sanborn Map (EDR 2012)
1949	Union Oil Co.	1949 Certified Sanborn Map (EDR 2012)
1949	The Charles Nelson Co. Saw and Planing Mills is now Port Angeles Forest Products, Inc.	1949 Certified Sanborn Map (EDR 2012)
1949	Washington Pulp and Paper Corp. is now Crown Zellerbach Corporation Pulp & Paper Mill	1949 Certified Sanborn Map (EDR 2012)
1952	Port Angeles Shingle Co. now Standard Shingle Co.	1952 Certified Sanborn Map (EDR 2012)
1958	Port Angeles Forest Products, Inc. is now Merrill & Ring Western Lumber Co. (M & R)	Peninsula Daily News (Ollikainen 2011)
1964	Associated Oil Co. is now Tidewater Associated Oil Co.	1964 Certified Sanborn Map (EDR 2012)
1968	Rayonier is now ITT Rayonier	*Port Angeles Harbor Sediment Characterization Study* (Ecology 2012a)
1970	Fibreboard closed, property purchase by M & R	Memorandum re: Investigation of Reported Marine Invertebrate Kill at Old Fiberboard Dock, Port Angeles, Washington (Ecology 1973)
1980s	Majority of bulk fuel operations terminated	*Marine Trades Area Site Port Angeles, Washington Remedial Investigation/Feasibility Study* (Floyd|Snider 2012)
1988	Daishowa buys Crown Zellerbach Mill and it becomes Nippon Paper Industries USA Co., LLC (NPISUA)	*Environmental Sampling Report* for Nippon Paper Industries USA (Anchor 2008)
1989	Peninsula Plywood is now K Ply	*Marine Trades Area Site Port Angeles, Washington Remedial Investigation/Feasibility Study* (Floyd|Snider 2012)
1997	Rayonier ceases production	*Current Situation/Site Conceptual Site Model Report, Rayonier Port Angeles Mill Site* (Foster Wheeler Environmental Corporation 1997)
2008	K Ply ceases plywood and veneer manufacturing operations	*Marine Trades Area Site Port Angeles, Washington Remedial Investigation/Feasibility Study* (Floyd|Snider 2012)
2010	K Ply operations restarts under new management, Peninsula Plywood Group, LLC (PenPly)	*Marine Trades Area Site Port Angeles, Washington Remedial Investigation/Feasibility Study* (Floyd|Snider 2012)
2011	PenPly ceases operations	*Marine Trades Area Site Port Angeles, Washington Remedial Investigation/Feasibility Study* (Floyd|Snider 2012)

Table 2
Active Waterfront NPDES Permits within the RI/FS Study Area

Facility	Permit Number	Permit Type	Analytes Required
City of Port Angeles	WAR045028	Western Washington Phase II Municipal Stormwater Permit	The City of Port Angeles is currently not required to conduct water sampling or other testing. Effective August 1, 2013, monitoring will be required, either as part of the Regional Stormwater Management Program or as designed by the City of Port Angeles (to be determined).
Former Pen Ply LLC	WAR012255	Industrial GP	Turbidity, pH, Oil Sheen, Total Copper, Total Zinc.
American Gold Seafoods, LLC	WA0040894	Net Pens NDPES IP	Dissolved Oxygen.
Pettit Oil Company	WAR006702	Industrial GP	Turbidity, pH, Oil Sheen, Total Copper, Total Zinc.
City of Port Angeles Phase 1 CSO Project	WA0041068	Industrial NPDES IP	Flow, BOD, TSS, Arsenic, Cadmium, Chromium, Copper, Cyanide, Lead, Mercury, Molybdenum, Nickel, Selenium, Silver, Zinc, pH, Turbidity, Phenols, Priority Pollutants—VOCs, SVOCs, Pesticides, PCBs, TPH, Dioxins.
Port of Port Angeles Boatyard	WAG031027	Boatyard GP	Total Copper, Total Lead, Total Zinc, BOD, Nitrates.
Port of Port Angeles Marine Trades	ST0006190	Industrial to POTW/PRIVATE SWDP IP	No discharges. Permit for planned but never constructed Wash-Down, Multipurpose Work Pad at Marine Terminals 1 and 3. Permit requires sampling discharges for flow, TSS, pH, oil and grease, and metals.
Port of Port Angeles Marine Terminal	WAR000337	Industrial GP	Turbidity, pH, Oil Sheen, Total Copper, Total Zinc.
Port of Port Angeles Marine Terminal Log	WAR000191	Industrial GP	Turbidity, pH, Oil Sheen, Total Copper, Total Zinc.
Port of Port Angeles Terminal 5	WAR004623	Industrial GP	Turbidity, pH, Oil Sheen, Total Copper, Total Zinc.
Port of Port Angeles Terminal 5 Log	WAR004570	Industrial GP	Turbidity, pH, Oil Sheen, Total Copper, Total Zinc.
Port of Port Angeles Terminal 7	WAR000314	Industrial GP	Turbidity, pH, Oil Sheen, Total Copper, Total Zinc.
Westport Shipyard Inc.	WAR006713	Industrial GP	Turbidity, pH, Oil Sheen, Total Copper, Total Zinc.
Westport Shipyard Interior Plant	WAR006714	Industrial GP	Turbidity, pH, Oil Sheen, Total Copper, Total Zinc.

Abbreviations:

BOD	Biological oxygen demand
CSO	Combined Sewer Overflow
GP	General Permit
IP	Individual Permit
NPDES	National Pollution Discharge Elimination System
PCB	Polychlorinated biphenyl
POTW	Publicly Owned Treatment Works
RI/FS	Remedial Investigation/Feasibility Study
SVOC	Semivolatile organic compound
SWDP	State Waste Discharge Limit
TPH	Total petroleum hydrocarbons
TSS	Total Suspended Solids
VOC	Volatile organic compound

Table 3
Historical Surveys of Environmental Conditions in Port Angeles Harbor, 2002–Present

Study Name[1]	Ecology EIM Study ID	Year Sampled	Sample Type	Collection Depths Described	Sample Number[2]	Analyte Groups					
						Metals	PCBs	Pesticides[3]	SVOCs	Dioxins/ Furans	Bioassay
American Gold Seafoods 2007 NPDES Sampling at Puget Sound Salmon Net Pens	AGS_NPDES_2007	2007	Sediment	0–2 cm	9 (5 reps each)	X					
NPDES Sampling during 2010: American Gold Seafoods Net-Pen Sites in Puget Sound	AGS_NPDES_2010	2010	Sediment	0–2 cm	8 (2 to 5 reps each)	X					
Cypress Ediz Hook Smolt 2003 NPDES Monitoring	CIPA2003	2003	Sediment	0–2 cm	18	X					
NOAA Mussel Watch Program	NOAA-Mussel-1986-08	2006	Sediment	0–30 cm	1	X	X	X	X		
Former Rayonier Mill Phase 2 Addendum RI	PAMILLRI	2006	Sediment	0–10 cm	72		X			X	
Port Angeles Harbor Sediment Investigation	PASED08	2008	Sediment	0–302 cm (variable)	201	X	X	X	X	X	X
Port Angeles NPDES Sediment Analysis	PA_STP04	2003–2004	Sediment	0–2 cm	13	X	X		X		X
City of Port Angeles 2010 NPDES Permit WA-0023973 Sediment Characterization	PA_STP10	2010	Sediment	0-–10 cm	3	X	X		X		X
Environmental Baseline Investigation DNR Lease 22-077766	PORT ANGELES DNR08	2008	Sediment	0–52 inches (variable)	43	X	X		X	X	
The Puget Sound Assessment and Monitoring Program	PSAMP_SP	2002–2003	Sediment	0–3 cm (chemistry and bioassay); 0-17 cm (macroinvertebrate taxonomy)	33	X	X	X	X		X
Former Rayonier Mill Site	RAYONR05	2002	Sediment	0–10 ft (variable)	104	X	X	X	X	X	X
Former Rayonier WWTP Outfall Sediment Baseline Monitoring	RAYSED09	2010	Sediment	0–10 cm	7	X	X		X	X	X

Notes:

1 Source: Ecology EIM System database.

2 Sample number reflects the number of sample IDs, and includes reference samples as applicable; not all samples were analyzed for all analyte groups indicated.

3 Organochlorine pesticides.

Abbreviations:

cm	Centimeters
DNR	Washington State Department of Natural Resources
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
ft	Feet
N/A	Not applicable
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PCB	Polychlorinated biphenyl
RI	Remedial Investigation
SVOC	Semivolatile organic compound
WWTP	Wastewater Treatment Plant

Table 4
Proposed Locations and Rationale for Full Suite Bioassays and Associated Chemical Analyses

Region	Proposed Bioassay Station	Approximate Depth (ft below MLLW)[1]	Reference for Existing Data	Cadmium SQS = 5.1 CSL = 6.7 mg/Kg	Mercury SQS = 0.41 CSL = 0.59 mg/Kg	Zinc SQS = 410 CSL = 960 mg/Kg	Phenol SQS = 420 CSL = 1,200 mg/Kg OC	PCBs, Sum of Congeners LAET = 130 2LAET = 1,000 µg/Kg	Butyl Benzyl Phthalate LAET = 63 2LAET = 900 µg/Kg	Existing Chemistry: Metals	Existing Chemistry: PCBs (Aroclors or congeners)	Existing Chemistry: Other SMS Analytes	Existing Chemistry: Dioxin/ Furan	Chemical Analyses[2,3]	Rationale for Bioassay Analysis
Lagoon	LA02A-01	Shallow	Exponent 2008	7.6	0.6	–	–	na	–	√	√	√	√	None	CSL exceedance.
	NPI-L1	Shallow	Exponent 2008	6.0	0.61	411	–	–	–	√	√	√	√	None	CSL exceedance.
Inner Harbor	BA02	9	New Station	na	na	na	na	na	na	na	na	na	na	SMS Chemicals	Mercury SQS exceedances at adjacent Stations NPI-PA1 and NPI-PA2. Results will represent this area.
	IE13A	80	Ecology 2012	–	1.90	610	–	–	–	√	√	√	na	None	CSL exceedance.
	IE16A	63	Ecology 2012	–	1.30	–	–	–	–	√	√	√	na	None	CSL exceedance; buried wood pulp.
	MA03A	44	Ecology 2012	–	–	–	610	–	–	√	√	√	√	None	SQS exceedance.
	MA04A	36	Ecology 2012	–	–	–	740	–	670	√	√	√	√	None	SQS exceedance.
	BA08	47	New Station	na	na	na	na	na	na	na	na	na	na	SMS Chemicals	PCB SQS exceedances at adjacent Stations WP-01-SD and WP-03-SD. Results will represent this area.
	NPI-PA3	25	Exponent 2008	8.1	1.49	1,660	–	–	–	√	√	√	√	None	CSL exceedance.
	NPI-PA4	46	Exponent 2008	6.9	2.65	1,330	–	–	–	√	√	√	√	None	CSL exceedance.
	NPI-PA6	47	Exponent 2008	–	1.26	–	–	–	–	√	√	√	√	None	CSL exceedance.
	NPI-PA8	23	Exponent 2008	–	0.67	–	–	–	–	√	√	√	√	None	CSL exceedance.
	NPI-PA9	31	Exponent 2008	–	1.10	–	–	–	–	√	√	√	√	None	CSL exceedance.
	NPI-PA10	25	Exponent 2008	–	0.66	–	–	–	–	√	√	√	√	None	CSL exceedance.
	SPI03	40	New Station	na	na	na	na	na	na	na	na	na	na	None	Area of wood debris accumulation off-shore of Ediz Hook.
	SPI04	40	New Station	na	na	na	na	na	na	na	na	na	na	None	Area of wood debris accumulation off-shore of Ediz Hook.
	WP-05-SD	59	Malcolm Pirnie 2007	na	na	na	na	–	na	na	√	na	√	SMS Chemicals Except PCBs	Buried wood pulp.
	WP-06-SD	28	Malcolm Pirnie 2007	na	na	na	na	240	na	na	√	na	√	SMS Chemicals Except PCBs	LAET exceedance.
	WP-07-SD	53	Malcolm Pirnie 2007	na	na	na	na	–	na	na	√	na	√	SMS Chemicals Except PCBs	Spatial data gap.
	WP-11-SD	25	Malcolm Pirnie 2007	na	na	na	na	2,930	na	na	√	na	√	SMS Chemicals Except PCBs	2LAET exceedance.

Notes:

Exceeds SQS criteria.

Exceeds CSL criteria.

– Concentration less than SMS criteria.

√ Existing chemistry present (since 2002).

1 Depths are based on visual review of digital bathymetric contours, which were derived from the U.S. Department of Commerce, National Ocean and Atmospheric Administration, National Ocean Service Bathymetric Fishing Map (1990).

2 An aliquot of sediment from each sampling location will be archived for possible future chemical analysis.

3 Sediment conventional parameters, grain size, and porewater ammonia and sulfides will be analyzed at all locations.

Abbreviations:

2LAET Second lowest apparent effects threshold
CSL Cleanup Screening Level
ft Feet
LAET Lowest apparent effects threshold
µg/Kg Micrograms per kilogram
mg/Kg Milligrams per kilogram
MLLW Mean lower low water
na Not analyzed
OC Organic carbon
PCB Polychlorinated biphenyl
SMS Sediment Management Standards
SQS Sediment Quality Standards

Table 5
Proposed SPI Stations

Stations Proposed for SPI or Bioassay Sampling	Reference for Existing Data	SPI or Sediment Grab Wood Debris Observations	Successional Stage	Apparent RPD (cm)	Included in GeoSea Wood Distribution Area?[1]	Percent Silt and Clay
SPI Re-occupation						
2	SAIC 1999	Sparse, scattered wood pieces on surface	INDET	5.59	No	--
3	SAIC 1999	Sparse, scattered wood pieces on surface	I	3.77	No	--
5	SAIC 1999	Sparse, scattered wood pieces on surface	I	2.03	Yes	--
6	SAIC 1999	Sparse, scattered wood pieces on surface	I on III	2.46	No	--
7	SAIC 1999	Sparse, scattered wood pieces on surface	I	2.04	No	--
8	SAIC 1999	Large wood piece on surface	Azoic	0	Yes	--
9	SAIC 1999	Pulp/bacterial mat	INDET	INDET	Yes	--
10	SAIC 1999	None	I on III	0.54	Yes	--
11	SAIC 1999	Moderate pulp mixed with sediment	I	3.23	Yes	--
12	SAIC 1999	Pulp/bacterial mat	Azoic	0	Yes	--
13	SAIC 1999	Wood chips mixed in wood pulp	Azoic	0	Yes	--
14	SAIC 1999	Trace pulp mixed in top 5 cm	I on III	1.23	Yes	--
15	SAIC 1999	Moderate pulp mixed with sediment	I on III	2.62	Possibly	--
16	SAIC 1999	Trace pulp mixed in top 3 cm	I	2.7	Yes	--
17	SAIC 1999	None	I on III	1.97	Yes	--
18	SAIC 1999	None	I on III	0.57	Yes	--
30	SAIC 1999	Buried pulp layer	I on III	6.99	Yes	--
38	SAIC 1999	Pulp/bacterial mat	INDET	INDET	Yes	--
39	SAIC 1999	Pulp/bacterial mat	I	2.95	Yes	--
40	SAIC 1999	Trace pulp mixed in top 5 cm	I	0	Yes	--
41	SAIC 1999	Sparse wood chips mixed in trace pulp > 6.5 cm	I	2	Yes	--
42	SAIC 1999	Trace pulp/bacterial mat	I	0	Yes	--
43	SAIC 1999	Trace pulp mixed in > 8.6 cm	Azoic	0	Yes	--
44	SAIC 1999	Sparse pulp mixed in top 4.8 cm	I	4.85	Yes	--
45	SAIC 1999	Buried pulp layer	I	1	Yes	--
46	SAIC 1999	Sparse, scattered wood pieces on surface	I on III	3.65	Yes	--
47	SAIC 1999	Sparse, scattered wood pieces on surface	I	2.49	Yes	--
48	SAIC 1999	Sparse, scattered wood pieces on surface	I	3.58	Possibly	--
50	SAIC 1999	Sparse pulp and wood pieces in top 3 cm	I	3.49	Yes	--
51	SAIC 1999	Buried pulp layer	I	2.25	Possibly	--
52	SAIC 1999	Buried pulp layer	I	3.37	Possibly	--
57	SAIC 1999	Buried pulp layer	I on III	4.13	Possibly	--
58	SAIC 1999	Sparse, scattered wood pieces on surface	I on III	2.92	Possibly	--
59	SAIC 1999	Sparse, scattered wood pieces on surface	I on III	3.15	Yes	--
61	SAIC 1999	Sparse, scattered wood pieces on surface	INDET	INDET	No	--
63	SAIC 1999	Sparse pulp mixed in > 16.8 cm	I on III	3.56	Yes	--
67	SAIC 1999	Trace pulp mixed in 0.5 cm	I	2.8	Yes	--
72	SAIC 1999	None	I on III	2.6	Possibly	--
77	SAIC 1999	Sparse, scattered wood pieces on surface	I	2.21	No	--
82	SAIC 1999	None	I on III	2	Yes	--
84	SAIC 1999	None	I	0	Yes	--
91	SAIC 1999	Pulp	INDET	INDET	Yes	--
92	SAIC 1999	Trace pulp mixed in > 20 cm	I on III	0.2	Yes	--
95	SAIC 1999	Trace pulp mixed in top 7 cm	INDET	0	Yes	--
New SPI Stations Near Hook						
SPI01	--	--	--	--	Yes	--
SPI02	--	--	--	--	Yes	--
SPI05	--	--	--	--	Yes	--
SPI06	--	--	--	--	Yes	--
SPI and Full Suite Bioassay						
LA02A-01	Exponent 2008	--	--	--	Yes	--
NPI-L1	Exponent 2008	Few wood bark/wood fiber, some wood fragments	--	< 0.5	Yes	--
BA02	--	--	--	--	Yes	--
IE13A	Ecology 2012a	Red rock and sawdust; ~75% wood debris	--	1	Yes	59.8
IE16A	Ecology 2012a	70% sawdust present	--	1.5	Yes	66.5
MA03A	Ecology 2012a	None	--	3	Yes	71.1
MA04A	Ecology 2012a	Significant wood debris (~90%)	--	--	Yes	58.4
BA08	--	--	--	--	Yes	--
NPI-PA3	Exponent 2008	~1–2 mm wood mat, substantial wood fiber	--	0	Yes	--
NPI-PA4	Exponent 2008	Few wood fragments	--	0.5	Yes	--
NPI-PA6	Exponent 2008	Wood chips	--	--	Yes	--
NPI-PA8	Exponent 2008	Wood fragments	--	0.2–0.3	Yes	--
NPI-PA9	Exponent 2008	Large wood piece, pulp, some wood fragments, fibers	--	0.5	Yes	--
NPI-PA10	Exponent 2008	Bark chips, wood	--	< 0.1	Yes	--
SPI03	--	--	--	--	Yes	--
SPI04	--	--	--	--	Yes	--
WP-05-SD	Malcolm Pirnie 2007	None	--	--	Yes	64.7
WP-06-SD	Malcolm Pirnie 2007	Wood bark	--	--	Yes	64.8
WP-07-SD	Malcolm Pirnie 2007	None	--	--	Yes	68.3
WP-11-SD	Malcolm Pirnie 2007	Large wood chunks	--	--	Yes	48.6
SPI and Larval Bioassay Re-test						
BA01A	Ecology 2012a	None	--	1	No	71.5
BL01A	Ecology 2012a	Approximately 30% wood debris	--	--	Yes	57.2
BL03A	Ecology 2012a	Trace amount of wood debris	--	1	Yes	71.1
BL04A	Ecology 2012a	None	--	--	Yes	5.6
BL06A	Ecology 2012a	None	--	1.5	Possibly	62.3
EH02A	Ecology 2012a	None	--	3	No	9.7
FP01A	Ecology 2012a	Approximately 1% wood debris	--	2	No	10.3
IE03A	Ecology 2012a	Wood debris (bark) on sediment surface	--	1	Yes	65.6
IE04A	Ecology 2012a	Significant (up to 50%) wood	--	0.1	Yes	67.9
IE06A	Ecology 2012a	Approximately 75% wood	--	--	Yes	42.5
IE07A	Ecology 2012a	95% wood debris	--	--	Yes	17.9
IE09A	Ecology 2012a	Trace wood debris	--	1	Yes	66.5
IE14A	Ecology 2012a	None	--	1.5	No	78.2
IE15A	Ecology 2012a	Approximately 5% wood debris	--	1	Possibly	74.7
IH02A	Ecology 2012a	10% wood debris	--	1	Yes	62
IH03A	Ecology 2012a	Wood chips and wood debris up to 90%	--	0.3	Yes	42.9
IH06A	Ecology 2012a	None	--	--	Yes	45.9
KP01A	Ecology 2012a	None	--	2	Yes	70.7
KP02A	Ecology 2012a	20% wood debris	--	2	Yes	61.4

Table 5
Proposed SPI Stations

Stations Proposed for SPI or Bioassay Sampling	Reference for Existing Data	SPI or Sediment Grab Wood Debris Observations	Successional Stage	Apparent RPD (cm)	Included in GeoSea Wood Distribution Area?[1]	Percent Silt and Clay
SPI and Larval Bioassay Re-test (continued)						
KP05A	Ecology 2012a	Trace wood debris	--	--	Yes	70.9
KP06A	Ecology 2012a	None	--	1.5	No	61.4
LA02A	Ecology 2012a	Trace wood debris	--	0	Yes	69.7
MA01A	Ecology 2012a	None	--	0	No	23.9
MA02A	Ecology 2012a	Approximately 80% wood debris	--	--	Possibly	74.1
MA05A	Ecology 2012a	None	--	0.3	Yes	73.5
MA06A	Ecology 2012a	Approximately 5% wood	--	1	No	66.7
CSO-006	--	--	--	--	No	--

Notes:
-- Not available.
1 Very approximate; locations have not yet been overlaid with GeoSea distribution area in GIS.

Abbreviations:
cm Centimeter
GIS Geographic information system
INDET Indeterminate
mm Millimeter
RPD Redox Potential Discontinuity
SPI Sediment Profile Imaging

Table 6
Proposed Bioaccumulation Stations

Region	Proposed Bioaccumulation Station	Reference for Existing Data	Existing Chemistry		Sediment Chemical Analyses[1]	Bioaccumulation and SPME Analyses[2]	Activated Carbon Treatability Testing[3]
			PCBs (Aroclors or congeners)	Dioxins and Furans (congeners)			
Lagoon	LA01A-01	Exponent 2008	√	√	X	X	
	LA03A-01	Exponent 2008	√	√	X	X	X
Inner Harbor	IE07A	Ecology 2012a	√	√	X	X	
	IE12A	Ecology 2012a	√	√	X	X	
	IH01A	Ecology 2012a	√	√	X	X	X
	IH06A	Ecology 2012a	√	√	X	X	
	MA01A	Ecology 2012a	√	√	X	X	
	MA03A	Ecology 2012a	√	√	X	X	
	NPI-PA1	Exponent 2008	√	√	X	X	
	NPI-PA3	Exponent 2008	√	√	X	X	
	NPI-PA4	Exponent 2008	√	√	X	X	
	NPI-PA6	Exponent 2008	√	√	X	X	
	NPI-PA8	Exponent 2008	√	√	X	X	
	WP-05-SD	Malcolm Pirnie 2007	√	√	X	X	
	WP-07-SD	Malcolm Pirnie 2007	√	√	X	X	

Notes:

√ Existing chemistry available (since 2002).

X Proposed 2013 sample analyses.

1 Black carbon, PCB congeners, and dioxin/furan congeners will be analyzed in sediment, and an aliquot archived for possible future analyses.

2 PCB congeners and dioxin/furan congeners will be measured in tissue through laboratory bioaccumulation testing and in porewater via SPME devices.

3 Concurrent with the bioaccumulation and SPME testing, activated carbon treatability testing will also be performed.

Abbreviations:

PCB Polychlorinated biphenyl

SPME Solid Phase Microextraction

Western Port Angeles Harbor

Remedial Investigation/ Feasibility Study Work Plan

Figures

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Port Angeles, Washington

Figure 1
Historical Waterfront Operations Map
1910–1929

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2/22/2013

Strait of Juan de Fuca

Port Angeles Shingle Co.

Crown Zellerbach
Pulp & Paper Corporation

Ediz Hook

U.S. Coast Guard
Air Station

Ediz Hook

Port Angeles Forest Products

Fibreboard Paper Products Co.

Port Angeles
Harbor

Cresent Logging Shingle Mill
Union Oil Co.
The Texas Co.
Natural Gas Washington
Standard Oil Co.
Richfield Oil Co.
Shell Oil Co.
Peninsula Plywood Co.
POPA Municipal Wharf
Associated Oil Co.

People's Wharf Co.

Angeles Gravel & Supply Co.

Rayonier, Inc.

Port Angeles

USGS - August 1, 1939

Legend

1940 High Water Line

Notes:

- 1940 High Water Line was determined from a 1940 United States Coast and Geodetic Survey Map (NOAA) that was provided by the Port of Port Angeles.
- NOAA = National Oceanic and Atmospheric Administration.
- Facility locations are approximate and based on available Certified Sanborn Maps covering 1911 to 1964.
- Orthoimagery provided by ArcGIS World Imagery.

0 1,000 2,000 4,000

Scale in Feet

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Figure 2
Historical Waterfront Operations Map
1930–1949

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3/13/2013

Strait of Juan de Fuca

Standard Shingle Co.

U.S. Coast Guard Air Station

Crown Zellerbach Pulp & Paper Corporation

Ediz Hook

Ediz Hook

Merrill & Ring Western Lumber Co.

Fibreboard Paper Products Co.

Port Angeles Harbor

Union Oil Co.
The Texas Co.
Natural Gas Washington
Standard Oil Co.
Richfield Oil Co.
Shell Oil Co.
Peninsula Plywood Co.
POPA Municipal Wharf
Tidewater Associated Oil Co.

People's Wharf Co.
Fish Packing & Cold Storage
Angeles Gravel & Supply Co.

ITT Rayonier

Port Angeles

Army Map Service - April 9, 1956

Legend

1965 High Water Line (DNR)

Notes:

- 1965 High Water Line was determined from aerial photography by the DNR. The data were furnished by the Port of Port Angeles.
- DNR = Washington State Department of Natural Resources.
- Facility locations are approximate and based on available Certified Sanborn Maps covering 1911 to 1964.
- Orthoimagery provided by ArcGIS World Imagery.

0 1,000 2,000 4,000

Scale in Feet

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Figure 3
Historical Waterfront Operations Map
1950–1964

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3/13/2013

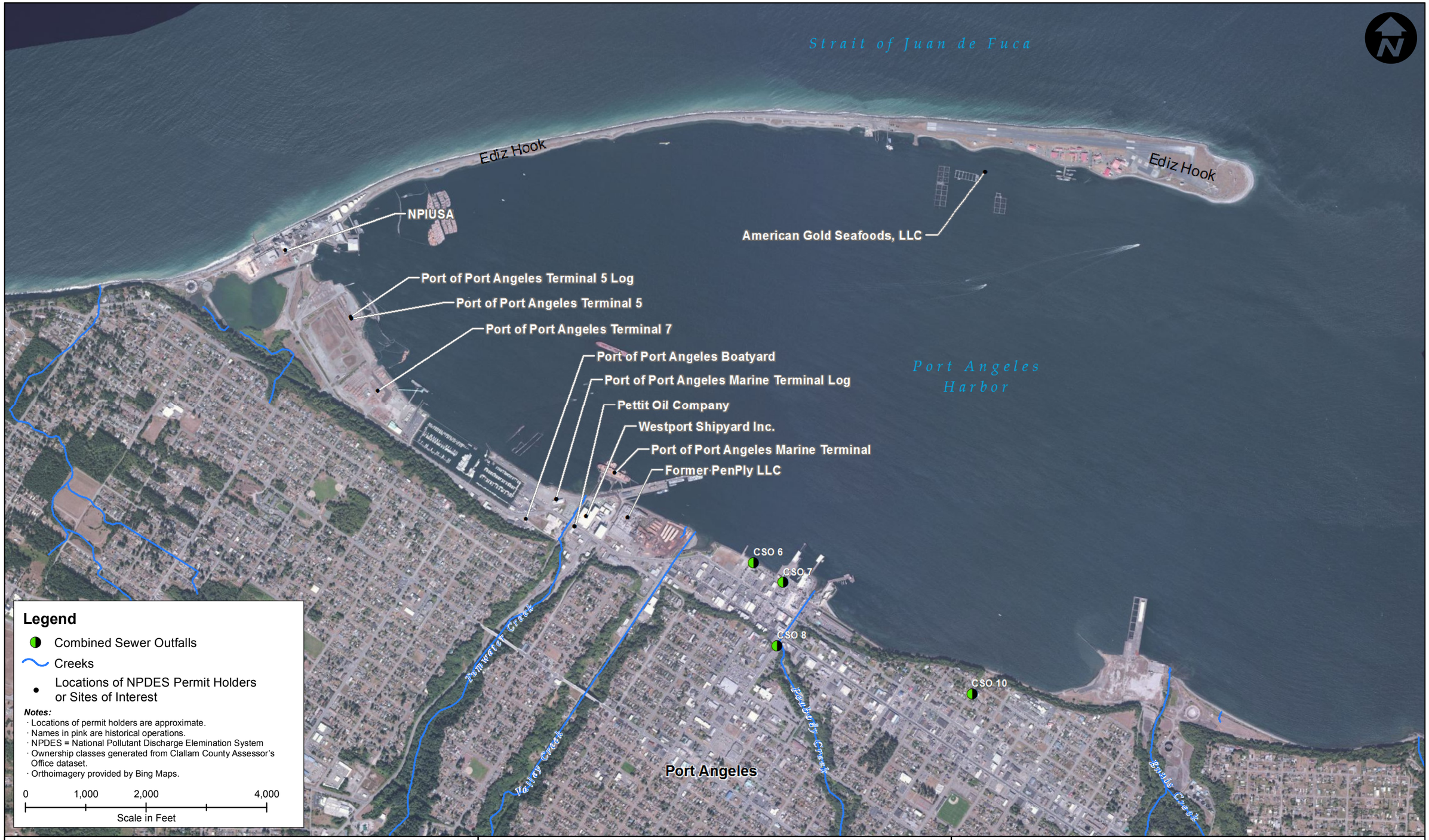

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Figure 4
Current Facilities

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2/22/2013

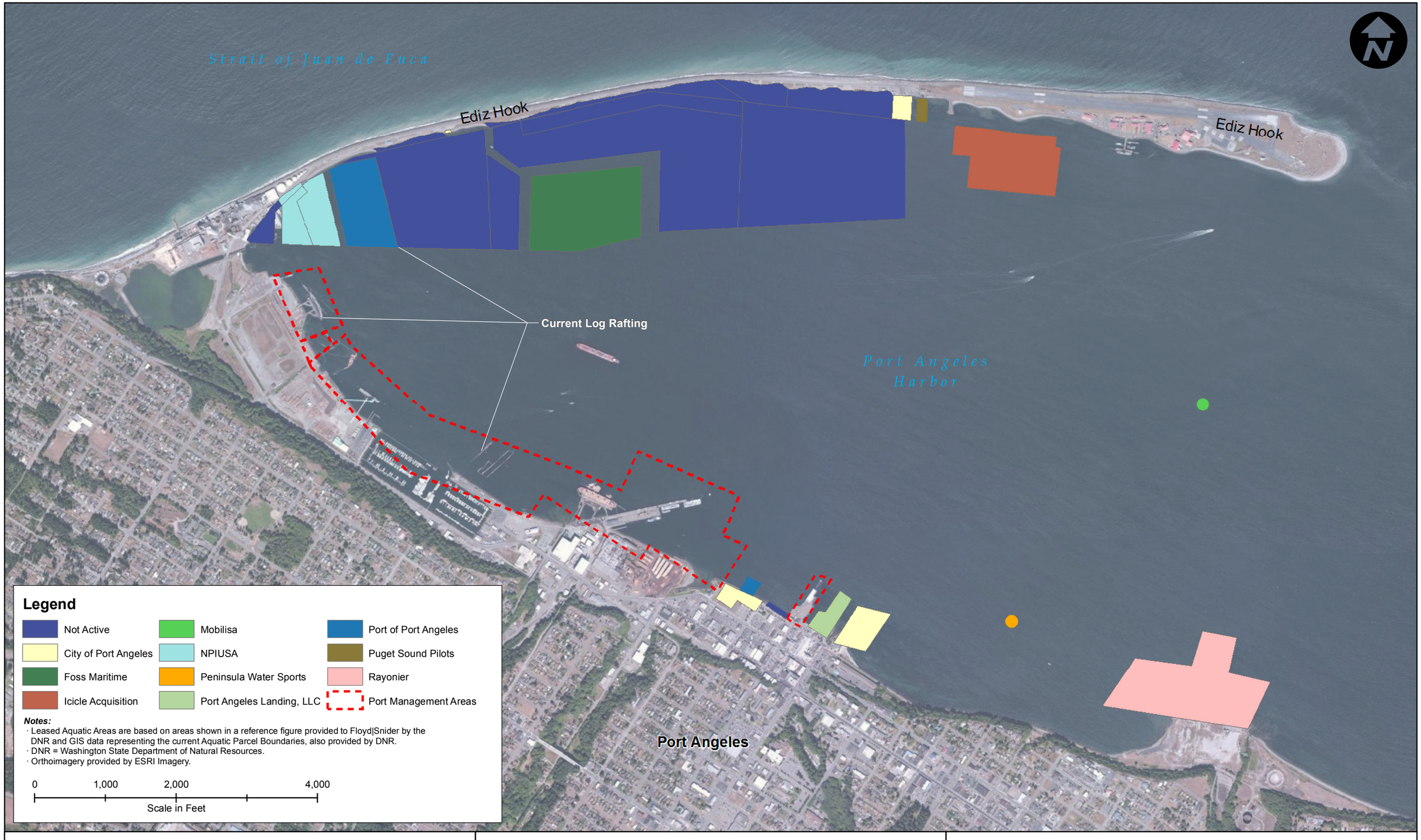

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Figure 5
Leased Aquatic Parcels

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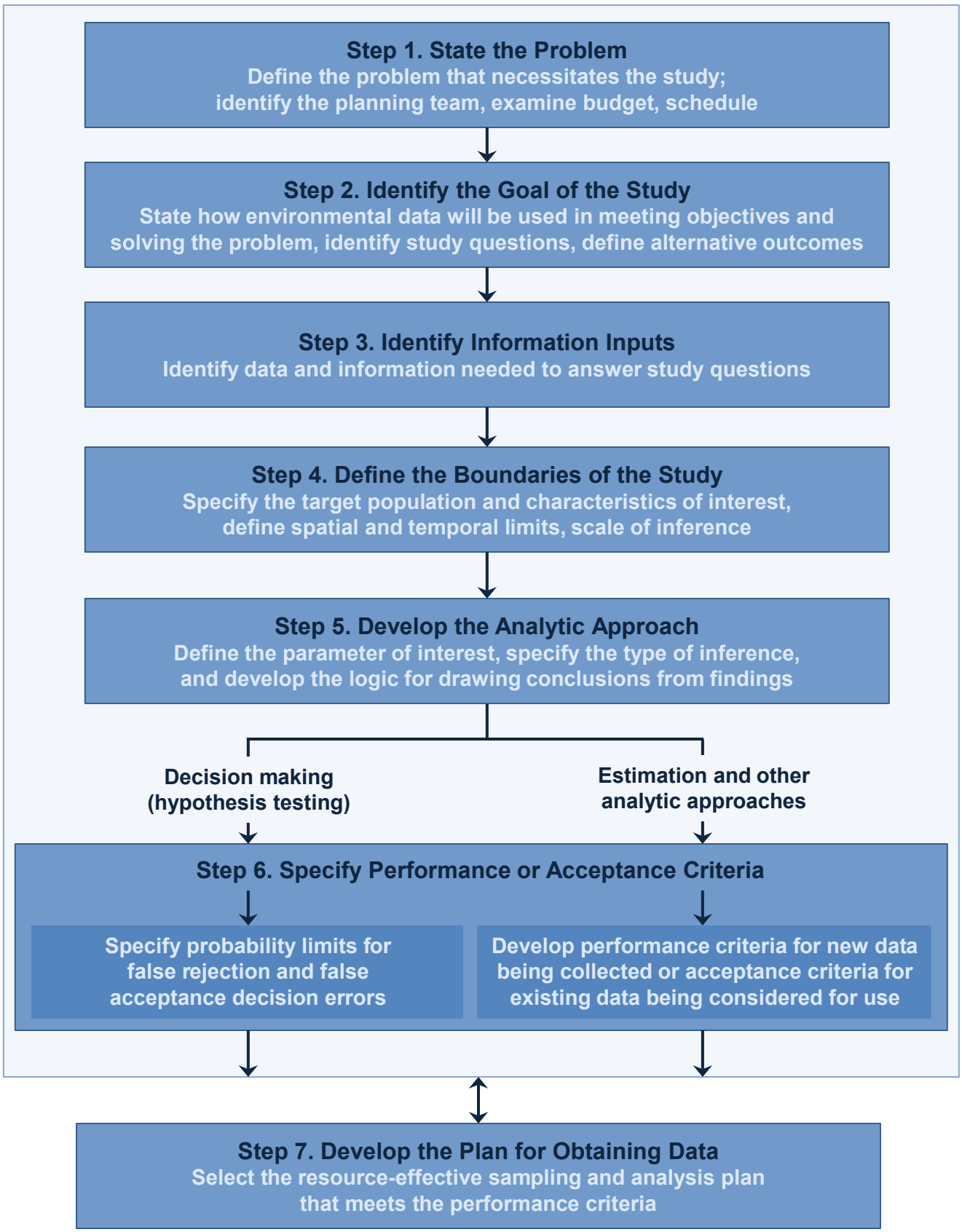
Port Angeles, Washington

Figure 6
Shoreline Parcel Ownership

I:\GIS\Projects\PI_PPAS\MXD\Task_5001\Figure 6 (Shoreline Parcels - Current Owners Draft Map - Bing Maps Background).mxd
2/22/2013



Source: USEPA (2006)

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Figure 7.
EPA's (2006) Data Quality Objective Process

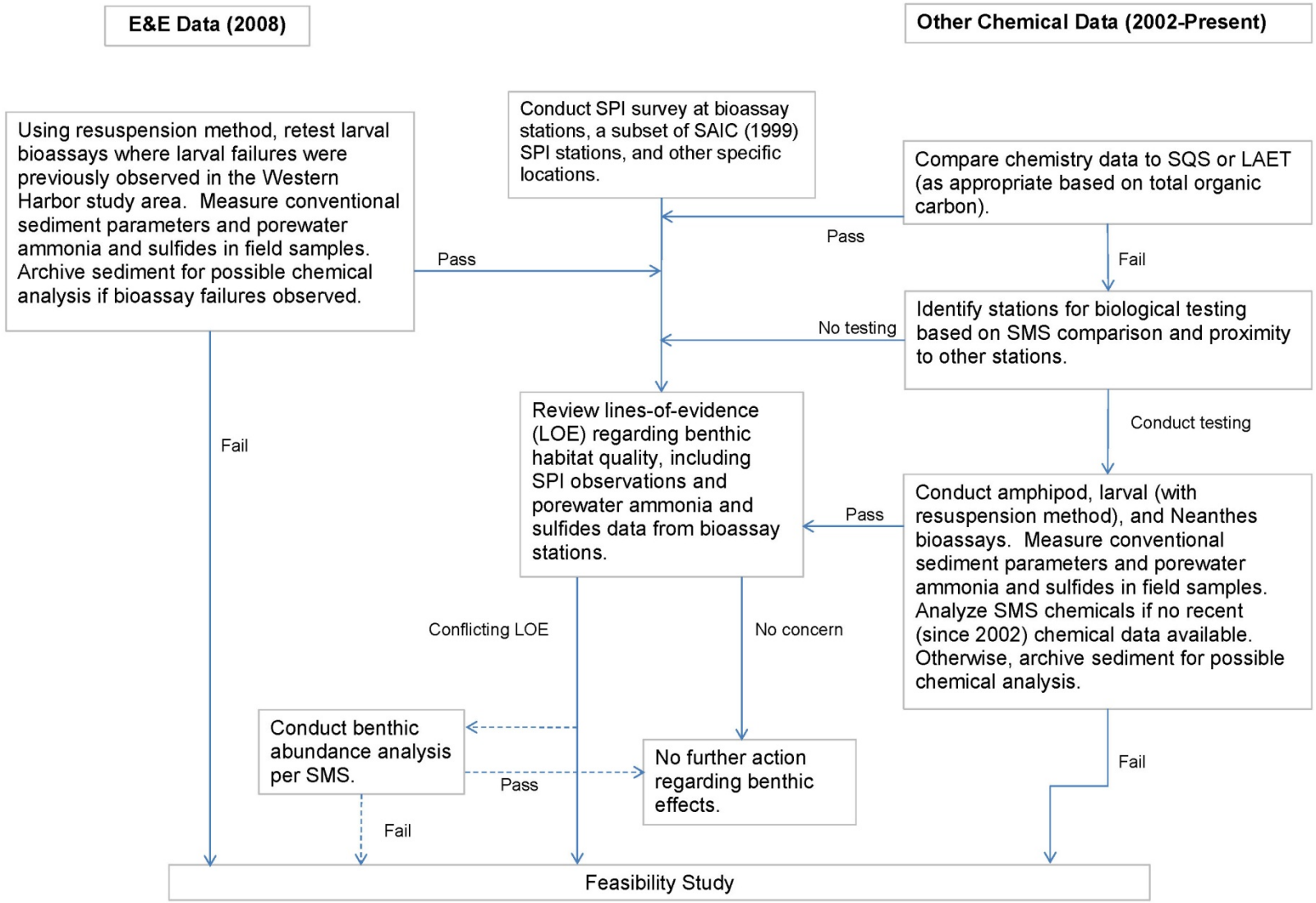

Figure 8.
Decision Tree for Benthic Conditions in Western Port Angeles Harbor

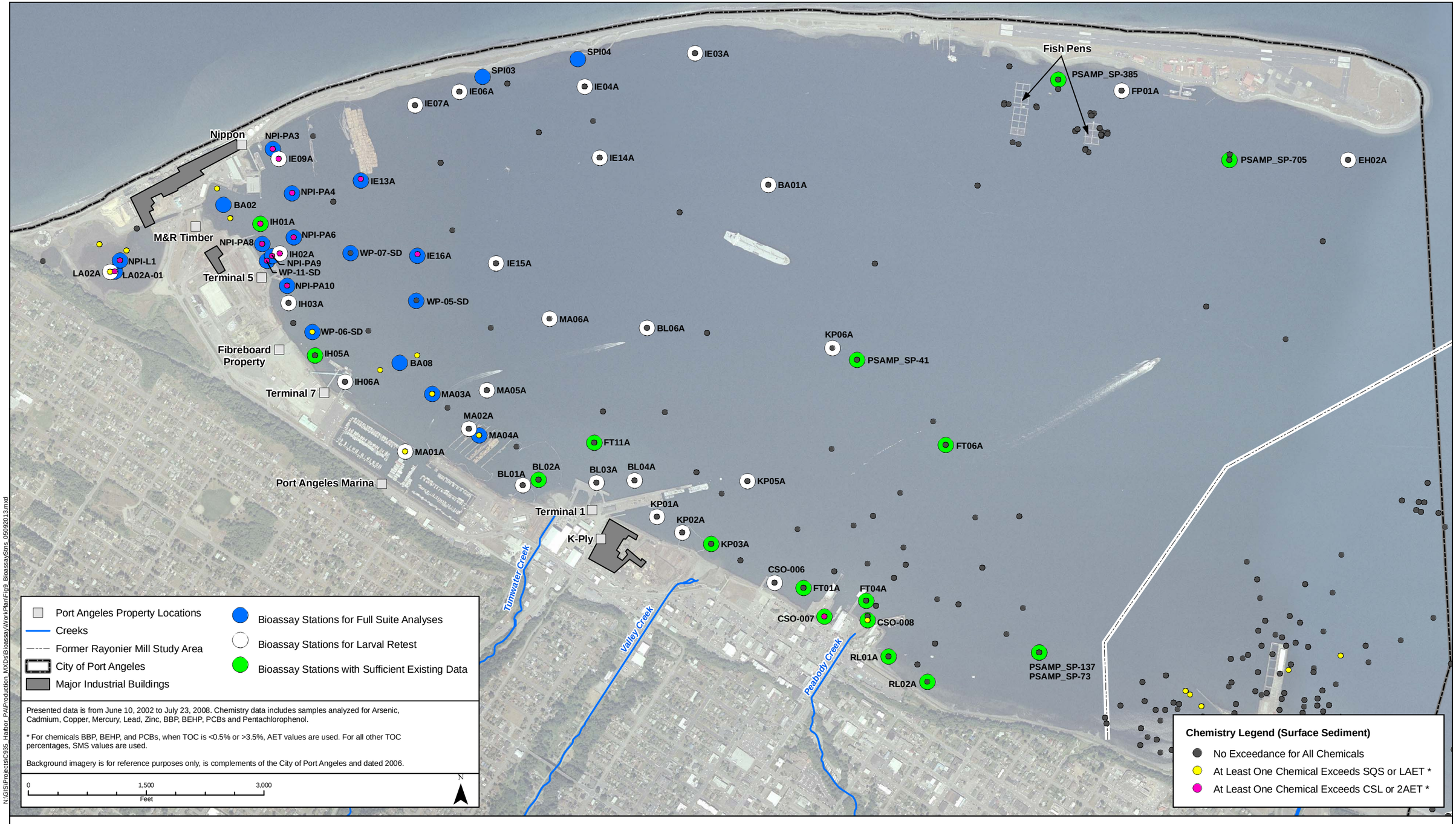

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Figure 9.
Bioassay Sampling Locations
Western Port Angeles Harbor RI/FS Work Plan

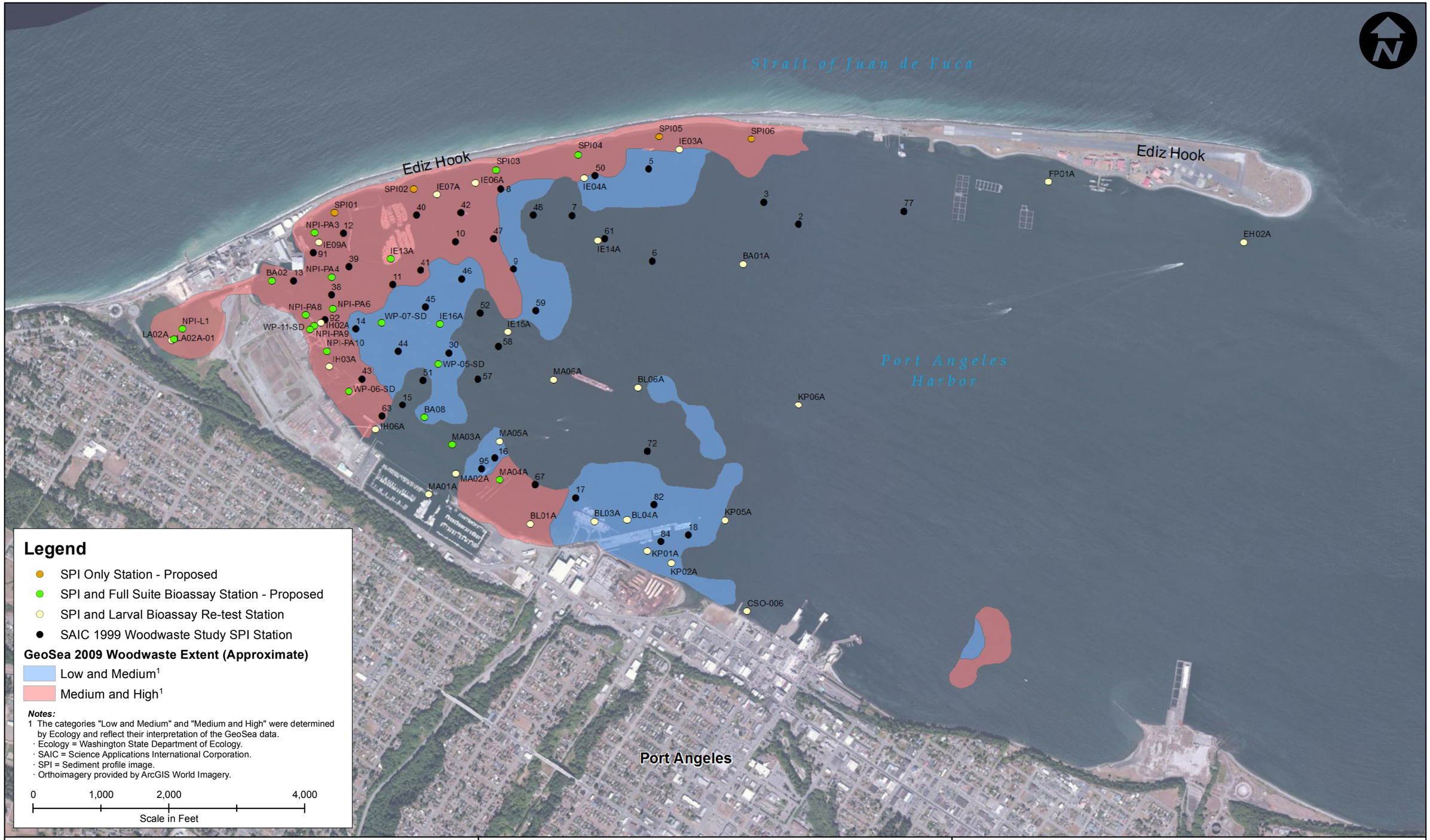

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Figure 10
Proposed SPI and Bioassay Station Locations

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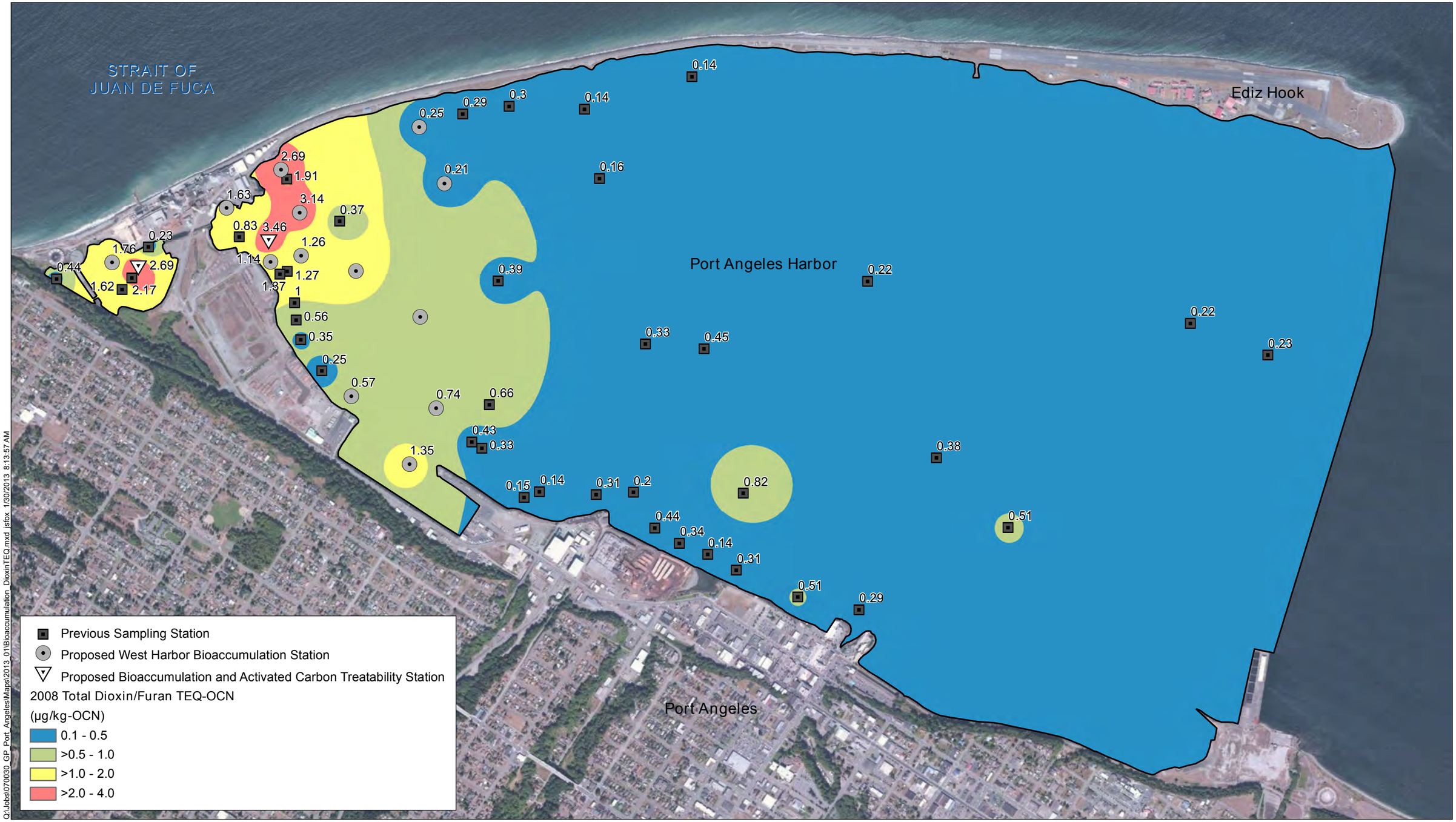
5/9/2013



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ANCHOR QEA

Feet
0 600 1,200 1,800 2,400

NOTE:
1. WP-05-SD and WP-07-SD are new proposed bioaccumulation and activated carbon treatability testing stations.
2. TEQ-OCN = Toxic Equivalent-Organic Carbon Normalized

Figure 11
Bioaccumulation Sampling Locations
Western Port Angeles RI/FS Work Plan
Port Angeles, Washington