IN-WATER REMEDIAL INVESTIGATION WORK PLAN

WEYERHAEUSER SAWMILL ABERDEEN/SEAPORT LANDING SITE

FACILITY SITE ID 1126, CLEANUP SITE ID 4987, AGREED ORDER ID 11225

Prepared for

GRAYS HARBOR HISTORICAL SEAPORT AUTHORITY

IN-WATER REMEDIAL INVESTIGATION WORK PLAN

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CONTENTS

CONTENTS (CONTINUED)

TABLES AND ILLUSTRATIONS

FOLLOWING REPORT:

TABLE

FIGURES

ACRONYMS AND ABBREVIATIONS

ac	acre
AOI	area of investigation
bgs	below ground surface
bml	below mudline
BTEX	benzene, toluene, ethylbenzene, and xylenes
COC	contaminant of concern
COI	contaminant of interest
CSL	cleanup screening level
CSM	conceptual site model
DEQ	Department of Environmental Quality (Oregon)
DGT	Diffusive Gradients in Thin films (DGT)
Ecology	Department of Ecology (Washington)
FS	feasibility study
GHHSA	Grays Harbor Historical Seaport Authority
IHS	indicator hazardous substance
MFA	Maul Foster & Alongi, Inc.
mg/kg	milligrams per kilogram
MRL	method reporting limit
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rule
ORS	Oregon Revised Statute
PAH	polycyclic aromatic hydrocarbons
PARIS	Permitting and Reporting Information System
PCP	pentachlorophenol
pg/g	picograms per gram
QA/QC	quality assurance and quality control
QIN	Quinault Indian Nation
RA	risk assessment
RI	remedial investigation
RIWP	remedial investigation work plan
SAIC	Science Applications International Corporation
SCO	sediment cleanup objective
SMS	Sediment Management Standards
SVOC	semivolatile organic compounds
TEQ	toxicity equivalence quotient
TPH	total petroleum hydrocarbons
ug/kg	micrograms per kilogram
USEPA	U.S. Environmental Protection Agency
WAC	Washington Administrative Code

1 INTRODUCTION

Maul Foster & Alongi, Inc. (MFA) has prepared this in-water remedial investigation work plan (RIWP) on behalf of the Grays Harbor Historical Seaport Authority (GHHSA) to further characterize nature and extent of environmental impacts at the in-water portions of the Weyerhaeuser Sawmill Aberdeen/Seaport Landing Site (the Site) and nearby vicinity. The Site is located adjacent to the Chehalis River at 500 North Custer Street in Aberdeen, Washington (see Figure 1-1). The Site includes approximately 23.6 acres of upland property, which is owned by GHHSA, and the adjacent approximately 16.9-acre leased tidelands, which is leased from the Washington State Department of Natural Resources (DNR) under lease number 22-092275 (see Figure 1-2). The in-water portions of the Site to be further characterized as part of the proposed activities include the Chehalis River and Shannon Slough, and are shown as the Area of Investigation (AOI) in Figure 1-2. Historically, the Site was used as a lumber mill by Weyerhaeuser and other wood products companies. The Site is proposed for future use as the homeport for the *Lady Washington* and *Hawaiian Chieftain* tall ships as part of a new maritime heritage facility called Seaport Landing.

Environmental sampling previously conducted indicates that hazardous substances have impacted sediments on the AOI. Prior investigations indicate that polychlorinated dibenzo-p-dioxins and -furans (dioxins), semivolatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH), polychlorinated biphenyls (PCBs), metals including mercury, and woodwaste are present in sediment.

MFA prepared a Study Area Investigation Report that describes results of sediment investigations that have been conducted at the Site, including the most recent investigations in October 2015[1] (MFA 2019). This work plan describes remedial investigation (RI) activities that will be used to characterize additional data gaps. This RIWP addresses only in-water areas. The upland property will be evaluated separately.

1.1 Regulatory Framework

On August 17, 2015, the GHHSA entered into Agreed Order DE 11225 with the Washington State Department of Ecology (Ecology). On March 28, 2019, the GHHSA entered into Agreed Order DE 15953 with Ecology. The Agreed Orders require the GHHSA to conduct a RI and feasibility study (FS) and develop a preliminary draft cleanup action plan for the Site in a manner that complies with requirements of the Model Toxics Control Act (MTCA) cleanup regulation, Washington Administrative Code (WAC) 173-340. The Site is listed in Ecology's database as Facility Site ID 1126/Cleanup Site ID 4987. This work plan has been prepared to satisfy the requirements of the Agreed Orders for the in-water portion of the Site.

Weyerhaeuser assumed the aquatic land lease at the time of the property's acquisition in 1955. An aquatic land lease (Aquatic Land Lease No. 22-A02150) was signed by DNR on September 13, 2001.

[1] A stormwater sample collected in January 2016 is also discussed in this report.

Subsequently, GHHSA entered into a sublease agreement with Weyerhaeuser for the leased Property. On April 14, 2017, the GHHSA entered into aquatic lands lease No. 22-092275 with the DNR. This tract borders the GHHSA-owned properties, along the Chehalis River.

This RIWP has been developed to address the substantive requirements of MTCA (Washington Administrative Code [WAC] 173-340) and the Sediment Management Standards (SMS) (WAC 173-204-550). The RIWP is a deliverable required by the Agreed Order that includes a Sampling and Analysis Plan (SAP; Appendix B) and a Health and Safety Plan (HASP; Appendix C) prepared in accordance with the Washington State MTCA cleanup regulations, as established in WAC 173-340-350 and pursuant to the Agreed Order. Per the Agreed Order, this work plan references past investigations and includes a summary of data gaps remaining to understand the nature and extent of contamination at the Site. Quarterly progress reports and an RI report will be submitted during and after completion of the RI, respectively.

1.2 Purpose and Objectives

The purpose of this RIWP is to generate data to fulfill ongoing data objectives and more thoroughly characterize the nature and extent of contaminants in sediments to allow for risk screening and support an evaluation of potential cleanup actions. The activities outlined in this work plan are intended to support the data needs and objectives outlined in Table 1-1. Other elements to be conducted as part of the RI for the Site (e.g., wetland delineation) will be described as part of a separate RIWP developed for the uplands.

1.3 Work Plan Organization

This document is organized as follows:

- *Section 2* discusses the background and physical setting of the site
- *Section 3* discusses the AOI conditions
- *Section 4* discusses the preliminary conceptual site model for the site
- *Section 5* discusses the scope of work proposed in this RIWP
- *Section 6* discusses the project management plan

2 BACKGROUND AND PHYSICAL SETTING

The background and physical setting descriptions below are summarized from prior investigations, interviews with the GHHSA, and review of past environmental reports.

2.1 Location and Current Property Conditions

The Site is located in the alluvial meander plain of the Chehalis River in the northwestern margins of the Willapa Hills physiographic region of southwest Washington. Located at 500 North Custer Street in Aberdeen, the Site is approximately 2 miles upriver from Grays Harbor. The City of Aberdeen is

situated in southwestern Washington, approximately 15 miles from the Pacific Ocean and approximately 70 air miles west-southwest of Tacoma, Washington. US Highway 101 and US Highway 105 are each located less than 0.25 mile south of the site. The Site is situated in sections 9 and 10 of township 17 north, range 9 west, Willamette Base Meridian. It is bordered on the west by a former boatyard and marine service center, to the east by a log storage yard, to the north by the Chehalis River, and to the south by residential and commercial development.

2.2 Property History

The operational history of the Site is detailed in a Level I environmental site assessment (PES, 2010). Sawmills historically operated on both the uplands and in-water portions of the Site, beginning prior to 1900. The South Aberdeen waterfront has been developed for commercial and industrial use since the early 1890s. The pilings (commonly referred to as a pile field) at the mouth of Shannon Slough marks the location of an early Aberdeen salmon cannery. In the late 1890s, the Aberdeen Lumber sawmill was constructed on the upland property with logs rafted along the shoreline to feed the mill. Aberdeen Lumber was later sold, becoming Schafer Brothers Lumber and Door Co. Mill #4. The business expanded as did its footprint. Schafer Brothers later sold the property to Simpson Timber Company.

Weyerhaeuser acquired the property in 1955 and operated several sawmills and associated support facilities through January 2009, when the mill known as the small log sawmill was permanently closed. Until the mid-1960s raw logs were brought to the mill in log rafts on the Chehalis River and tied up to pilings in the river in front of the Big Mill. After the mid-1960s, raw logs were brought to the mill by truck and staged on log decks at various locations in and adjacent to the property. The Big Mill was originally configured to manufacture shingles and slats for housing construction. During World War II, the Big Mill was converted for manufacturing ship keels for the war effort. The precursor to the small log mill was added in 1972; small log mill operations were performed in the upland portion of the site outside the AOI. The last upgrade to the small log mill took place in 2003. In 2006, the Big Mill and attached finger pier were closed; the associated structures were removed between 2006 and 2008. This area is now known as the Former Mill Area (shown on Figure 1-3). The small log mill continued to operate into early 2009. The GHHSA acquired the upland portion of the Site on March 29, 2013. Historical and current site features are shown in Figure 1-3.

2.3 Shoreline Modifications and Historical Fill Events

Historical Sanborn Fire Insurance maps (Sanborn maps) of the Site from 1906, 1914, 1928, 1948, and 1989 are provided in Appendix A. The Sanborn maps depict development of mill-related structures on pilings in the Chehalis River, shoreline modifications resulting from filling events, and other important details regarding the composition of fill materials. Shoreline modifications since 1906 illustrated in the Sanborn maps in Appendix A are summarized below.

> **1906:** The 1906 Sanborn maps show a mill and related structures extending into the Chehalis River from Front Street between North Custer and Columbus streets. The structures are constructed on posts. These former mill structures were farther east than subsequent mill structures that formed the Former Mill Area. The 1906 mill and mill-related structures were

in the approximate location of the present-day former Main Shipping Shed. While this particular area is not depicted in the 1914 Sanborns, by 1928 these mill structures no longer exist. In fact, new mill-related structures are constructed in the location of the area now referred to as the Former Mill Area (see Figure 1-3) to the west of Custer Street and extending approximately to Clark Street.

Shoreline on either side of the 1906 mill area is not fully depicted in the maps. However, the shoreline along Front Street at the mouth of the Shannon Slough is undeveloped. There is another mill to the east of the Site, just east of Lawrence Street. Sanborn maps show mill-related development consisting primarily of irregular lumber piles on planked fill or planked on sawdust.

1914: As noted above, the 1906 mill area is not visible in the 1914 Sanborn maps. However, the Sanborn maps show that the shoreline at the mouth of Shannon Slough has been modified to extend farther north into the Chehalis River, as it was filled in with irregular lumber piles.

1928: The 1928 Sanborn maps show further offshore development north into the Chehalis River. As noted in the 1906 description, the 1906 mill structures had been removed and the mill area shifted farther west between Custer and Clark streets. All of the structures shown are constructed on planks in the Chehalis River. The wharf that is currently present on Site is constructed as of 1928—the wharf and mill site are built on pilings. Shoreline to the east of the Weyerhaeuser Sawmill Aberdeen/Seaport Landing Site is relatively unchanged.

1948: As of 1948, the area between the planked over-water structures and Front Street between Clark and Custer have been filled in with refuse and planked. The over-water structures remain on planks. The shoreline to the east of the Site is relatively unchanged as of 1948.

1989: As of 1989, the entire former in-water area of the Chehalis River north of Custer Street and to the east to Shannon Slough has been filled. According to the Sanborn maps, fill material in this area consisted of earth and rock and lumber piles on filled ground. The area east of Shannon Slough is shown as fill consisting of sawdust piles.

2.4 Former Operations and Areas

Former facility operations with demonstrated or potential environmental impacts to the AOI are discussed below. Upland facility operations are not included in this discussion but are detailed in the Level I environmental site assessment (PES, 2010). The areas of the Site identified below are shown on Figure 1-3.

2.4.1 Former Mill Area and Pocket Beach

The mill that appeared in the 1928 Sanborns between Custer and Clark streets was originally constructed on pilings over the Chehalis River and the pocket beach area. This area is referred to as the Former Mill Area. Mill facilities and equipment were installed over plank flooring. Before 1970, there was no spill protection to prevent spills on the flooring from falling into the river below. In the mid-1970s, Weyerhaeuser reportedly reworked the flooring to prevent releases through the planking.

Beginning in approximately 1980, containment pans were installed beneath all mill hydraulic components.

The original mill at this site was closed in 2006 and was removed between 2006 and 2008, exposing the Chehalis River and the pocket beach. Over 1,000 creosoted wood pilings were also removed from this area during mill demolition. Personal communication with Helen Bond, former Environmental Manager at the site, suggests these pilings were removed completely during this effort. It is unknown whether these pilings were pulled out completely or removed to mudline. This data gap may be addressed during the RI sampling activities via visual observations, or as part of later investigation which may include surveys (e.g., sonar surveys to identify debris). Creosote-treated piles can be harmful and toxic to aquatic species. Therefore, the removal of the creosote-treated pilings has been a major focus of DNR's Restoration Program and has also been used in the regulatory process to generate mitigation credits. Since removal of the mill and pilings and debris in the Chehalis River, the pocket beach area has been colonized by vegetation characteristic of wetland environments, such as cattail (*Typha sp.*) and rushes (*Juncus sp.*). This location in the river has also been observed to be a depositional area with debris including loose pilings and household appliances floating downstream and becoming lodged against the wharf.

2.4.2 Lumber Shed

The lumber shed located in the northwest corner of the Site was used to store finished products. Historically, an iron fuel-oil tank was used to supply the fuel-oil-fired internal combustion engine powered cranes at the west end of the wharf. According to the GHHSA staff, a fire destroyed much of this area in 1965.

2.4.3 Former Boiler

Wood-fired boilers were located adjacent to the powerhouse at the east end of the wharf. The boilers contained asbestos that reportedly was removed during demolition of the mill. One transformer is currently present at the powerhouse and is not known to contain PCBs. The powerhouse has been cleaned, and a vault below the powerhouse has been cleaned and filled with pea gravel. An oil house was also located next to the powerhouse.

2.4.4 Tidelands and Beach Area

Along the Chehalis River, the area between the Former Mill Area and the mouth of Shannon Slough consists of former tidal flats that historically were filled with unknown types and quantities of debris, including construction debris and woodwaste. See Section 2.3 for information detailing what is known, based on historical Sanborn maps, regarding these fill events.

2.4.5 Shannon Slough

Shannon Slough meanders from south to north across the eastern portion of the property and discharges into the Chehalis River next to the former chip area. Shannon Slough receives stormwater runoff from the property, upstream residential areas, and the highway. Currently, stormwater passes

through catch basins and oil/water separators before discharging through various culverts directly into the Shannon Slough or Chehalis River. The Site's former National Pollutant Discharge Elimination System (NPDES) permit sampling location is at the outfall along the west bank of the slough. Releases of paint waste to Shannon Slough in 1989 resulted in a Clean Water Act conviction and subsequent remediation activities (PES, 2010). Shannon Slough discharges to the Chehalis River in the AOI, forming a small deltaic feature. Multiple pilings are present in the mudflats along the northeastern portion of the slough. Information is not available regarding whether these pilings contain creosote. According to Sanborn maps (provided in Appendix A), the pilings have been on the Property since at least 1906. Given their age, it is reasonable to assume that the pilings were creosote-treated.

2.5 Previous Investigations

Environmental data collected at and in the vicinity of the AOI, dating back to 1999, are summarized in the Study Area Investigation (MFA, 2019).

2.5.1 Study Area Investigation and Data Needs

Consistent with the SMS, and as stipulated in WAC 173-204-550, a Study Area Investigation was conducted in 2015 to collect, develop, and evaluate information sufficient to allow establishment of cleanup standards and selection of a cleanup action, should that be deemed necessary (MFA, 2019). Sediment samples included in this investigation are shown in Figure 2-1. This investigation identified presence of woodwaste to significant depths (greater than 10 feet in some areas) and exceedances of SMS marine screening levels in sediment for the multiple analytes: benzyl alcohol, 4-methylphenol, benzoic acid, mercury, total PCBs, phthalates, PAHs, PCP, phenol, SVOCs, and zinc. However, many of these exceedances were only observed in one sample or were slight exceedances of screening levels. The findings of this investigation and prior reports are summarized in Figure 2-2 and are provided in full tabular form in MFA (2019). These results were used to inform data needs for this RIWP, which focuses on efforts to characterize the lateral and vertical extent of woodwaste and sediment chemical contamination. The data needs identified for further characterization are summarized in Table 1-1.

3 ENVIRONMENTAL CONDITIONS

Environmental conditions, including topography, geology and hydrogeology, stormwater pathways, aquatic environment, and beneficial water and land uses are described below.

3.1 Topography and Bathymetry

Figure 3-1 shows the Site and vicinity topography and bathymetry. According to the U.S. Geological Survey Aberdeen, Washington, 7.5-minute series topographic map, the Site is located at elevations near sea level along the shoreline up to approximately 20 feet above mean sea level. The topography

northeast of Aberdeen gradually slopes upward toward the foothills and peaks of the Olympic Mountains. The topography to the east, southeast, and south consists of rolling hills.

Surface water bodies in the vicinity of the Site include the Chehalis River; the Wishkah River; one small, unnamed drainage channel that enters the Chehalis River beyond the east end of the Property; and Shannon Slough, which enters the Chehalis River at an embayment located in the middle of the AOI. The Chehalis River is tidally influenced, and some areas of the AOI are periodically submerged at high tide. All surface water drainages in the area ultimately discharge to the Chehalis River.

3.2 Geology and Hydrogeology

The Site is located in the alluvial meander plain of the Chehalis River on the northwestern margins of the Willapa Hills physiographic region of southwestern Washington. The topography of the Willapa Hills is generally characterized by gentle rolling hills with straight, moderate slopes descending to wide valley floors.

The Chehalis River valley is filled with variable thicknesses of recent alluvium consisting of river-deposited gravels, sands, and silts. Near the ocean, the thicknesses of these alluvial deposits can be significant (more than 100 feet) because of valley filling as rising sea levels decrease the river's ability to transport sediments downstream. Well logs from resource protection wells in the vicinity of the Site indicate that alluvium in the area of the Site is at least 60 feet thick and consists of sands, silts, and clayey silts. Logs from borings located along State Highway 12 to the north indicate that the bedrock encountered below the alluvium is silt/sandstone.

Cross sections from a 1951 map of the Site provided by Weyerhaeuser indicate that much of the area of the main mill facilities was tideland prior to, and during, the early development of the Site in the late 1800s and early 1900s. Most of the early Site structures were constructed on wood-piling support platforms.

The four upland soil borings advanced upgradient of the pocket beach area in 2015 indicate that silts and silty sands are present at depths of 8 to 9 feet bgs in upland areas (Table 3-1). The silts and silty sands were overlain by woodwaste (up to 80 percent by volume of primarily wood and bark chips) of varying thicknesses—occasionally woodwaste layers were over 5 feet thick. Woodwaste typically occurred around 4.5 to 5 feet bgs surrounding the pocket beach. This layer of woodwaste was overlain primarily by gravelly sands, comprising the layer to the ground surface.

On the shoreline where SAIC advanced borings on behalf of DNR in 2011, dark brown, sandy sawdust was observed at approximately 4 to 5 feet bgs, overlain by light brown sawdust and woodchips, with crushed gravel at the surface (SAIC, 2011).

Depth to groundwater in the upland areas of the Site is approximately 4 to 5 feet bgs. Based on geologic logs from previous environmental investigations, groundwater flow in the area is generally to the northwest; however, flow direction and gradient may be tidally affected. Groundwater likely discharges to the Chehalis River. A previous study determined that water originating from seeps in the pocket beach area had a different chemical signature than Chehalis River water, suggesting that the seeps do not represent bank storage of river water inundated during high tide (Floyd|Snider,

2010). An opportunistic seep sample was collected from an active seep along the western edge of the pocket beach area during the 2015 investigation. Water quality parameters, including conductivity and pH, collected for both the seep sample and nearby reconnaissance groundwater samples are similar to each other (see Table 3-2) and are all different from levels measured in Chehalis River pore water (locations CR-01 through CR-03, approximately 16,000 microsiemens/centimeter), suggesting that the seep water is more similar to groundwater (MFA, 2019).

3.3 Aquatic Environment and Bottom Substrate

The Chehalis River is a tidal river that is frequented by commercial and recreational fisherman and provides habitat to multiple fish species including Chinook, coho, and chum salmon; steelhead; and bull trout (which is listed under the federal Endangered Species Act as threatened). Following removal of the mill, pilings, and debris in the Former Mill Area, the pocket beach area was colonized by vegetation characteristic of wetland environments, such as cattail and rushes. Whether saltwater species are present is unknown, but this will be evaluated as part of the RI. This section of the river has been observed to be a depositional area, with debris—including loose pilings and household appliances—floating downstream and becoming lodged against the wharf. The apparent depositional nature of this section of river is further discussed below. Along the Chehalis River, the area between the pocket beach and the mouth of Shannon Slough consists of former tidal flats that were historically filled with unknown types and quantities of debris, including construction debris and woodwaste. Shannon Slough meanders from south to north across the property and discharges to the Chehalis River, forming a small deltaic feature. Multiple pilings are present in the mudflats along the northeastern portion of the slough.

Salinity data in 2013 Chehalis River sediment samples (e.g., samples CR-01 through CR-03) indicate that this area is estuarine according to SMS guidance. The SMS suggests that estuarine environments have salinity ranging from 0.5 to 25 parts per thousand. Samples collected in this area had salinity values ranging from 6.9 to 11 parts per thousand.

Bathymetry data (see Figure 3-1) indicate that the riverbank slopes steeply, with the top of the riverbank at an elevation of approximately 13 feet North American Vertical Datum of 1988 (NAVD-88), and the base at approximately -30 feet NAVD-88. Elevations in the pocket beach area range from approximately 9 feet NAVD-88 to 6 feet NAVD-88. The Chehalis River, which flows along the northern portion of the site, is tidally connected to Grays Harbor and the Pacific Ocean, resulting in a mixed semidiurnal tidal regime (i.e., two different high and two different low tides per lunar day). During site visits in 2013 and 2015, MFA observed that the pocket beach and other beach features in the AOI were fully inundated at high tide and exposed at low tide.

Selected sediment samples collected in 2013 and 2015 were analyzed for grain size distribution. Percentages of fines (silt and clay) were consistent within the pocket beach (CR-04 through CR-06), ranging from 29.7 percent in surface to 42.1 percent in subsurface sediment. Similarly, percent gravel was consistent and ranged from 20.2 percent to 23.6 percent. Surface sediment at CR-19D near the beach area showed higher percent fines (77.8 percent). In general, the presence of fines indicates areas of deposition, where surface water velocities may be lower, allowing fine particles to settle. Total fines data indicate that the beach area experiences more deposition than the pocket beach.

Sediment samples collected in 2013 and 2015 were analyzed for TOC. TOC concentrations at the Lumber Shed and Former Boiler areas ranged from 1.09 percent to 3.08 percent. Percent TOC was similar in the 2013 Chehalis River samples (CR-01 through CR-03) and the eastern portion of the AOI (beach area and Shannon Slough), ranging from 2.06 to 4.39 percent. In contrast, percent TOC was substantially higher in the three samples (CR-04 through CR-06) collected in 2013 in the Former Mill Area, ranging from 13.6 percent to 49.5 percent in surface and subsurface sediments. These TOC concentrations are well above the range considered normal (0.5 to 3.5 percent) (Ecology, 2015). TOC concentrations in Former Mill Area samples collected in 2015 beyond the extent of visual impacts (e.g., woodwaste) ranged from 0.415 percent to 3.99 percent, with an average (2.47 percent) well within the range considered normal.

Sediment characteristics observed in borings were summarized in the Study Area Investigation (MFA, 2019). Additional work to further characterize the depositional regime, as well as evaluation of the flooding regime, may be conducted as part of RI activities[2] or feasibility study and engineering studies.

3.3.1 Woodwaste

Woodwaste in large volumes can overwhelm the assimilative capacity of sediment and affect the aquatic environment physically, chemically, and biologically. Woodwaste impacts can result from the physical presence of woodwaste, which prevents biota from thriving and recruiting in and on healthy native substrate; decreased dissolved oxygen due to microbial decomposition, which can create an unhealthy or toxic environment for biota; and decomposition by-products such as sulfides, ammonia, and phenols, which can cause or contribute to toxicity. As a result, woodwaste is considered a deleterious substance in the environment that is subject to cleanup, consistent with MTCA and SMS rules.

Significant accumulations of woodwaste (>25 percent) were observed in the Former Boiler Area and extend eastward from the Former Mill Area to and including the beach area (MFA, 2019). In some cases during the Study Area Investigation, wood debris or other debris would obstruct the core liner and necessitate an additional boring be advanced nearby (typically within 5 to 10 feet) until a sample was obtained (MFA, 2019). In the recovered samples, the material was generally compressed into the bottom of the liner; therefore, the Study Area Investigation indicates "no recovery" of the first couple feet of sediment in some samples (MFA, 2019). However, visual observation confirmed that the upper material recovered within the liner is likely surface material because the material coloration was characteristic of surface sediment and the observations matched surface materials retrieved in the same location with a PONAR grab sampler. These observations helped inform the estimated extents of woodwaste at locations with significant accumulations that are reported in the Study Area Investigation (MFA, 2019). This investigation demonstrated that woodwaste extends from near the surface to significant depths (more than 10 feet), and that with distance from shore, the woodwaste thickness decreases and the sediment layer overlying the woodwaste increases. Sampling proposed in this RIWP will further characterize woodwaste accumulations in sediment in areas not previously assessed, and will refine woodwaste estimate within areas previously evaluated.

[2] Studies related to hydrology/hydraulics of the river, as needed, will be described in a separate work plan.

3.4 Beneficial Water and Land Uses

Providing protection for the highest beneficial use (i.e., the use requiring the highest quality in the resource) of water will generally also provide protection for other existing and future beneficial uses of water. Based on hydrogeological conditions observed on the Site and on regional topography, the following surface water and shallow groundwater conditions are present in the area:

- Surface water in the region discharges to the Pacific Ocean.
- Shallow groundwater in the area appears to flow toward the Chehalis River.

One water well within a 1-mile search radius of the Site was identified in the regulatory agency database search conducted by Environmental Data Resources, Inc., as part of the Level I environmental site assessment (PES, 2010). This well is a public water supply well operated by the City of Aberdeen. The well is located northwest of the Site, across the Chehalis River. Currently, there are no potable water wells on Site, let alone the AOI area. Groundwater monitoring wells installed in the past as part of previous investigations are still present, although in unknown condition. The condition of these monitoring wells will be addressed during the RI. According to Weyerhaeuser, all of the monitoring wells previously installed at the Site have been decommissioned. Groundwater under and near the Site is likely to remain unused for the indefinite future and the City of Aberdeen will continue to provide public water.

Shallow groundwater under and near the Property likely discharges to the Chehalis River, and current and reasonably likely future uses of the river include recreation, fishing, and fish and wildlife habitat. Grays Harbor provides habitat for a number of shellfish species, including clams, mussels, and Dungeness crab. There is limited information on the potential presence of shellfish in the Chehalis River upstream of the SR 101 bridge. A recent field investigation conducted as part of the environmental impact statement for the SR 520 Pontoon Construction facility, located approximately 1 mile downstream of the Site property, found softshell clams (*Mya arenaria*) in the lower intertidal zone.

As described above, the Quinault Indian Nation (QIN) tribal fishing operations, including both drift gillnetting and set-netting methods, are conducted within the AOI. It is unknown whether the QIN presently use the river for shellfish. This data gap will be addressed during the RI.

The Site is currently used by the GHHSA as their headquarters. The future-use plan for the Site is to develop a maritime heritage center with education, public access, tourism, and commercial uses. The Site is currently zoned by the City of Aberdeen for industrial use, but a land use and zoning change to waterfront mixed-use is in process. According to the DNR lease, the leased Property's permitted uses include moorage of vessels, public access, and education activities.

4 PRELIMINARY CONCEPTUAL SITE MODEL

The primary purpose of the conceptual site model (CSM) is to identify potential contaminant sources, evaluate contaminant fate and transport mechanisms, identify potential receptor groups, and describe pathways by which those receptors may be exposed to Site-related chemicals in the environment.

Potential source areas and chemical release and transport mechanisms that can allow chemicals to migrate to potential receptors are summarized. In addition, a discussion of significant exposure points, pathways, and potential receptors is presented separately in individual sections. The human health and ecological CSM, depicting exposure pathways and potential receptors, is shown in Figure 4-1. Note that CSMs are dynamic, and the CSM will be reevaluated and updated as part of the forthcoming RI as additional information is obtained.

4.1 Source Characterization

Suspected historical sources of sediment impacts include releases from the overwater mill and upland operations related to wood processing. Potential historical sources are discussed in Section 2.4, and include:

- Spills from the overwater sawmill hydraulic equipment previously located in the AOI, including the wood chip loader.
- Releases to sediment from overwater structures currently and formerly located in the AOI.
- Releases from upland historical site operations that migrated via stormwater or groundwater transport. Petroleum products, antifreeze, various oils and lubricants, boiler treatment chemicals, anti-sapstain mixtures (which contained PCP until approximately 1986), inks, and paints and solvents were used and/or stored during historical sawmill operations. A trough is present in the planer/wood treatment building. It is unknown how this feature functioned. This data gap will be addressed during the upland RI.
- Wood-fired boilers and two wood-refuse burners identified at the Site. Operation of this equipment may be associated with dioxin formation; the historical disposition of boiler ash at the site is unknown (PES, 2010).
- Historically, PCB-containing equipment supporting site operations was present. All PCB-containing transformers and light ballasts were removed from the site between 1990 and 2001, and USEPA identified no other PCB-containing equipment at the site in 2006 (PES, 2010).
- Background sources (further described below), including stormwater discharge to Shannon Slough.
- Accumulations of woodwaste from historical sawmill operations, including the chip loader and various processes in the Former Mill Area. Impacts from woodwaste include the

physical presence of the woodwaste, decreased dissolved oxygen concentrations in sediment, and increased concentrations of woodwaste decomposition products, such as sulfides, ammonia, and phenols, that can cause or contribute to toxicity.

4.2 Background Sources

In addition to former mill-related sources, upstream or ubiquitous sources of chemicals and deleterious substances have the potential to impact sediments. The Chehalis River has a long history of industrial activity that could result in the release of contaminants and wood debris similar to what has been observed at the AOI. Shannon Slough, which discharges to the Chehalis River, receives considerable stormwater input from roads and neighborhoods upgradient of the Site. Further, persistent organic pollutants such as dioxins, PCBs, and PAHs are known to be widespread in the environment.

Dioxins and PAHs can result from both natural and anthropogenic sources. The area around the Site is an urban environment where industrial activity has been conducted and a city has been established for over 100 years. In urban areas vehicle emissions, back-yard trash burning, structure fires, stormwater runoff, and other common events and activities can generate these chemicals (USEPA, 2006). Therefore, low levels are commonly present in sediment because of natural and/or non-point anthropogenic activities.

PCBs are a class of persistent, bioaccumulative, and toxic compounds that historically had a wide range of uses, including electrical transformers, hydraulic systems, lubricants, surface coatings, adhesives, plasticizers, inks, insulating materials, pesticides, and consumer products (Ecology, 2014b). In the Puget Sound, surface runoff is the largest pathway to aquatic environments, followed by wastewater treatment plants and air deposition. PCBs are ubiquitous throughout the natural environment, including sediment, and are found in animal tissue throughout the food chain.

Metals, including mercury, are naturally occurring elements in the environment and can be concentrated by human activities. The distribution of naturally occurring metals is controlled by geologic processes that occur across different physiographic regions. Metals are commonly transferred to the marine environment from sewage treatment facilities, atmospheric deposition, and continental weathering.

4.3 Fate and Transport of Contaminants

The primary potential contaminant transport mechanisms operating at the AOI are deposition to sediment from former facility operations, outfall discharge to sediments, stormwater runoff to sediments, atmospheric deposition to sediments, sediment erosion caused by waves, erosion of sediment caused by propeller wash, water current sediment erosion, and food chain transfer originating from impacted media.

Former facility operations are described in Section 2.4. Potential mechanisms of contaminant transport to the AOI include stormwater flow from uplands (i.e., in the Former Mill upland area surrounding the pocket beach) to surface water and sediment. Stormwater discharges to AOI sediments have the potential to transfer contaminants to areas adjacent to stormwater outfalls at the

pocket beach and Shannon Slough, as well as through overland flow. Upstream runoff from residential, highway, and other properties may be impacting Shannon Slough.

Groundwater likely discharges to the Chehalis River (see Section 4.2). Groundwater discharge to surface water is therefore considered a complete transport pathway.

In sediments, physical transport of contaminants can be upward (advection/diffusion, ebullition), downward (advection/diffusion, burial), or lateral (resuspension/deposition). Bioturbation caused by benthic organisms can further displace or mix contaminants. In water, contaminants can move by the same advective and diffusive forces operating in the sediment, either via sorption to/from sediments resuspended by currents or scour events or via bioturbation (e.g., releases from sediment to the water column). The relative importance of the above processes will vary, depending on the chemical and physical properties of a released contaminant. The properties of sediment and the dynamics of groundwater flow also shape contaminant fate and transport. The most significant site-specific transport mechanisms are discussed further below.

A number of processes, including water flow, wave erosion, and propeller wash, have the potential to impact sediment transport in the Chehalis River. Since this reach of the Chehalis River is tidally influenced, some sediment resuspension likely occurs during the ebb and flood of the tides. While wind waves may be a mechanism for erosion in the Chehalis River, these waves are likely to be a less significant transport mechanism than the larger wakes from passing vessels. Portions of the AOI in the Chehalis River are potentially vulnerable to erosion from propeller wash where vessels may operate now or in the future. Sediment resuspension and redistribution due to river and wave energy inputs is not expected to be a significant transport mechanism closer to shore in the pocket beach and beach areas, where presence of fines indicates a depositional environment. This will be further evaluated as part of this RI.

4.4 Potential Human Health Exposure Scenarios

The primary purpose of the human health CSM is to identify potential receptor groups and to describe pathways by which those populations may be exposed to Property-related chemicals in the environment (USEPA, 1989). Populations that may be exposed to contaminants at a site and pathways by which these populations may come into contact with contaminants are identified. A complete pathway requires:

- A source and mechanism for release of constituents
- A transport or retention medium
- A potential environmental contact (exposure point) with the affected medium
- An exposure route at the exposure point

The CSM presented below shows potentially significant pathways and receptors under current and reasonable future scenarios. The evaluation focuses on the most important factors that may cause possible exposures.

The GHHSA staff currently occupy the office building and use other structures remaining on the Site. Public use and access to the Sites upland portion are currently limited. The Site upland portion is proposed for future use as the homeport for the *Lady Washington* and *Hawaiian Chieftain* tall ships as part of a new maritime heritage facility called Weyerhaeuser Sawmill Aberdeen/Seaport Landing Site. Users would include the public and staff who work at the facility. The Chehalis River is frequented by industrial marine users, fishers, and recreationists.

The principal human receptors who have the potential to contact AOI media are further described below. As noted above, the CSM will be refined as part of RI activities as additional information regarding river uses is obtained.

Property users—Current and future users of the upland areas, such as occupational workers and public visitors, may come into contact with the soils. Occupational workers may come into contact with the Chehalis River while maintaining the area. Future visitors may come into contact with the soils while touring and exploring the Weyerhaeuser Sawmill Aberdeen/Seaport Landing Site. While these groups may also come into direct contact with sediment and surface water, the exposure is anticipated to be occasional and incidental. However, because development plans for the Site will evolve over time and the exposure of users to nearshore sediment and surface water may change over time, the exposure scenarios are considered potentially complete.

Recreationists—The water recreation scenario includes assorted beach and water activities, including activities related to operation of personal watercraft. Individuals may come into contact with sediment and surface water while operating vessels; however, adult exposure is expected to be generally limited to contact with sediment and surface water while entering and exiting the water. Swimming is not a common activity in the area, given boat traffic and dangerous currents; any limited swimming that does occur likely is significantly limited in duration and frequency, given Aberdeen weather conditions. Because of the strongly hydrophobic nature of the COIs, exposure via surface water is not expected to be a significant pathway. However, children may be exposed to sediment through direct contact if playing in nearshore beach areas. Current and reasonably likely future recreational use is not expected to change significantly in the foreseeable future.

Fishers—Areas at the Site are in the QIN's usual and accustomed tribal fishing area. Fishers generally angle by boat, using hook and line and/or large nets. The shoreline is not conducive to shore fishing. Fishers may include adults and children. Fish are caught for personal consumption by sport fishermen and tribes during permitted times of the year. Because of the strongly hydrophobic nature of the COIs, exposure to fishers via surface water is not expected to be a significant pathway. The primary exposure pathway for potential fishers is consumption of aquatic biota. Other exposure pathways relevant to fishers could include contact with sediment during net fishing or harvesting shellfish.

Further coordination with the QIN is needed, and additional information on current fishing and harvesting uses will be obtained as part of the RI.

4.5 Potential Ecological Receptors

Water-dependent ecological receptors, including plants, benthic invertebrates, fish (piscivorous, omnivorous, and benthivorous), piscivorous mammals, and piscivorous raptors are the primary potential ecological receptors.

Relevant exposure media for ecological receptors include sediment and fish tissue (for receptors at higher trophic levels). Plants, benthic invertebrates, fish, birds, and mammals may all be exposed to chemicals present in sediment. Specifically, plants and benthic invertebrates may be exposed to chemicals through direct contact with and uptake from sediment; fish may be exposed to chemicals through direct contact with sediment and ingestion of food that has accumulated contaminants. Birds and mammals may be exposed to chemicals through incidental ingestion of sediment and consumption of food that has accumulated contaminants. Although birds and mammals may have some dermal exposure to chemicals in sediment, this exposure route is considered insignificant because of external protection such as fur and feathers.

5 SCOPE OF WORK

This section describes the objectives and scope of work for the site assessment. The field investigations will be conducted in general accordance with the methods and protocol described in the SAP (Appendix B).

5.1 Remedial Investigation Objectives

Remedial investigation objectives are outlined in Table 1-1. Briefly the main data collection objectives for this RIWP are:

- Refine the lateral and vertical extent of subsurface sediment chemical contamination.
- Refine the lateral and vertical extent of woodwaste in sediment.
- Refine the lateral extent of surface sediment chemical contamination.
- Characterize toxicity of sediment/woodwaste to benthic receptors using bioassays.
- Characterize sediments using the toxicity characteristic leaching protocol (TCLP) to inform potential waste disposal considerations.
- Characterize sediment deposition rates using radioisotope analysis to evaluate whether in-water areas are erosional or depositional.

Other objectives related to informing site conditions that would inform additional remedial design considerations and site uses are summarized in Table 1-1.

5.2 Sampling Strategy

5.2.1 General Sampling Approach

Woodwaste is known to be associated with impacts to aquatic biota and the lateral extent within the AOI requires further delineation. Subsurface samples using Vibracore will be collected first to define the woodwaste extent, primarily in areas not previously assessed. Cores will be visually inspected for woodwaste along a transect; cores will be collected moving away from the shore or potential woodwaste source until significant woodwaste is no longer observed. At each woodwaste investigations area, a minimum of one sample for analysis of parameters related to woodwaste impacts will be collected, if significant woodwaste is observed. In addition, chemistry samples for SMS chemicals and conventionals may be opportunistically collected from the cores if impacted intervals are observed (e.g., staining, presence of sheen, etc.).

SMS chemistry and conventionals subsurface sediment samples will also be collected at areas where previous sampling showed contamination was unbounded, or prior sampling was constrained to shallow depths (e.g., less than 2.5 feet below mudline). TCLP samples to inform waste disposal considerations will be collected at several subsurface locations, including locations where presence of woodwaste is known.

Surface sediment chemistry samples and bioassay samples will be collected once subsurface sediment sampling is complete. Co-located discrete surface sediment chemistry and bioassays will be collected. In addition, composite background samples for chemistry will be collected in the Shannon Slough and upstream of the AOI. These background locations are not considered part of the AOI as Site-related impacts are not expected in these areas. Samples will generally be collected from a vessel, unless more easily obtained on foot (e.g., nearshore locations during low tide).

Collection of subsurface (Vibracore) data prior to surface sampling is proposed since the spatial extent of woodwaste observed during the subsurface sampling effort may be used to modify the locations where collection of surface sediment bioassays is currently proposed. For example, if an area with significant woodwaste that is not currently proposed for bioassay analysis is observed during subsurface sampling, additional collection of sediments for bioassays may be considered. Any modifications to the proposed bioassay sampling regime will be coordinated with Ecology.

More specifics related to each of the sampling objectives are provided below.

5.2.2 Woodwaste

Subsurface sediment cores will be collected from a boat operated by Research Support Services, Inc. using a Vibracore sampler. This procedure is further described in the SAP. Sediment cores will be collected for woodwaste evaluation at locations where previous investigations have not yet defined the lateral and/or vertical extent of woodwaste. Eight woodwaste sampling areas (SE-01 through -08) are proposed in Figure 5-1, along with proposed general directions of sampling transects; a minimum of one sample will be collected in these areas. Two of these woodwaste sampling areas (SE-07 and SE-08) were selected within the previous woodwaste investigation area, at locations where discrete

woodwaste samples have not previously been collected (see MFA, 2019). Cores will be collected every 50 to 100 feet, along the direction indicated (moving away from the shore or potential woodwaste source) until significant woodwaste is no longer observed. In addition, four specific locations (SE-09 through -12) for woodwaste assessment are identified; at these locations no more than one sample will be obtained.

Significant woodwaste is defined as 25 percent by volume, or more. Woodwaste volume will be determined in the field by an MFA environmental scientist or geologist. Subsurface sediment cores will be visually inspected for the presence and vertical extent of woodwaste impacts; wet sieving will be conducted to ensure finer-grained woodwaste is observed, if present. Each core will initially be advanced to a maximum of 8 ft bml, or refusal. If woodwaste is observed at the maximum depth observed in those cores, additional cores may be advanced to a maximum of 15 feet below mudline, or refusal, to characterize the lower depth of woodwaste. At least one sample from one core from each woodwaste sampling area will be analyzed for woodwaste/conventional chemical analyses (Table 1-1). Sediment and woodwaste characteristics for each core collected will be logged as described in the SAP. In addition, sediment samples to determine porewater sulfides will be obtained at seven locations as specified in the SAP. Sulfides are associated with woodwaste degradation. Porewater sulfides are considered to best represent the biologically available fraction of sulfides and therefore will help inform associated toxicity to receptors.

5.2.3 Subsurface Sediment

Subsurface cores will be collected for chemistry analysis at four locations where previous investigations observed chemical concentrations exceeding screening criteria in the deepest sediment sample collected at that location, or are identified as an area with data gaps. These are four of the 12 woodwaste sampling locations described in Section 5.2.2 (SE-09 through -12; see Figure 5-1). Cores will be collected by advancing the vibracore to 8 ft bml, or until refusal. Intervals will be taken at least every two feet. One interval from each core's midpoint will be initially submitted for SMS chemical and conventionals analyses, listed in Table 1-1, while the remaining intervals will be initially archived. Chemical analyses will be conducted by subcontracted analytical laboratories. Subsurface sediment sampling procedures and proposed chemical analyses are described further in the SAP (Appendix B).

5.2.4 Surface Sediment

Surface sediment samples will be collected at locations where previous investigations have not yet defined the lateral extent of chemical contamination exceeding screening criteria. Surface samples will also be collected at locations for which bioassay analysis is proposed. Surface sediment samples will be collected to 10 centimeters below mudline, to most accurately capture the chemical and biological conditions in the layer of sediment that has the highest potential for exposure to benthic organisms. Locations where surface sediment will be collected are proposed in Figure 5-2. Surface sediment samples will be collected as outlined in the SAP. Samples will be submitted for chemical analyses and for marine bioassays to characterize aquatic toxicity.

Surface samples will consist of discrete samples, except for sample locations SE-21 and SE-22. These are composite samples that will be collected to characterize average urban background conditions near

the Site. These locations are upstream of the chip loader in the Chehalis River and upstream of any inputs from Site activities in Shannon Slough (Figure 5-2).

Surface sediment sampling procedures are described further in the SAP (Appendix B).

5.2.5 Bioassays

Bioassays will be performed on surface sediment samples to assess potential ecological toxicity of woodwaste and/or chemical contamination in surface sediment. Marine bioassays will be conducted by EcoAnalysts, Inc., in accordance with current guidance from the US Army Corps of Engineers Seattle Corps User Manual and SCUM II (USACE 2018; Ecology 2017). It is anticipated that water is brackish, between approximately 5 to 15 parts per thousand porewater salinity. Marine bioassay procedures, which include use of marine species maintained at water salinity of approximately 20 parts per thousand, have been recommended by the contract laboratory to best characterize conditions representative of the Site. This is consistent with guidance provided by Ecology (2017).

Locations where surface sediment will be collected for bioassays are proposed in Figure 5-2 and described above in Section 5.2.4. Surface sediment samples collected for chemical analysis will be directly co-located with samples submitted for bioassays. This will enable direct comparison of toxicity results observed in bioassays to chemistry data. Bioassay locations representative of a range of woodwaste presence were selected (i.e., ranging from areas known to be impacts with many feet of woodwaste to areas with no suspected woodwaste). These locations also span areas with both SMS chemicals exceedances and no SMS chemical exceedances. Therefore, the proposed locations are anticipated to inform toxicity to benthic organisms at the AOI. Parameters that have been shown to correlate with benthic response to woodwaste and are indicators of woodwaste impacts (i.e., total organic carbon, sulfides, ammonia, etc.) will also be collected (Table 1-1). Additional bioassay locations may be added opportunistically based on observations of woodwaste in the field during subsurface sediment sampling, if determined in coordination with Ecology.

Porewater salinity and pH analysis will be conducted as part of the bioassay testing to inform current conditions for these parameters at multiple locations.

Discrete samples will be collected for analysis. Reference sediment for bioassays will be obtained by EcoAnalysts from a Puget Sound location previously established to show typical background conditions (i.e., is not impacted by chemical contamination). The location is also anticipated to show a similar sediment grain size distribution as observed in the Chehalis River. Bioassay sampling and analysis procedures are described further in the SAP (Appendix B).

5.2.6 Waste Characterization

A subset of the subsurface sediment cores will be submitted for TCLP analysis for lead and mercury (Figure 5-1). This information will be used to help characterize sediment that could be removed from the site as waste for disposal during future remedial action(s). TCLP results will be compared with the appropriate RCRA criteria to determine whether waste would quality as characteristic hazardous waste, or not. These locations are shown in Figure 5-1 and include areas that are anticipated or known to be

both less and more impacted. Samples will be collected from the mid-point of the core, unless an interval that appears visually more impacted is observed.

5.2.7 Radioisotope Analysis

Radioisotope analysis of sediment cores will be used to help characterize sediment deposition rates and stability of sediments in the nearshore area of the Chehalis River offshore of the Site. Two sediment cores will be collected for radioisotope analysis (Figure 5-1). Sediment cores for radioisotope analysis will be collected using the same procedures used for other subsurface sediment cores, described in the SAP and above in Sections 5.3.2 and 5.3.3. The core sections will first be analyzed for radioisotopes to characterize sedimentation rates, bioturbation/mixing depths, and sediment stability:

- Lead-210 – a naturally occurring isotope with a half-life of 22 years
- Cesium-137 – a marker of nuclear weapons releases in the early 1960s
- Radium-226

Samples will be collected in areas that are most likely to potentially require remedial action, and represent an area near the pocket beach as well as typical nearshore environment for the Site. This will maximize the utility of radioisotope data to inform future remedial decisions. Proposed sample locations are shown in Figure 5-1. These data will be used to better understand the rate of sediment deposition, and will help inform the feasibility and potential success of various remedial options. Radioisotope analysis will be conducted by Flett Research and is further described in the SAP (Appendix B).

5.2.8 Additional Evaluations

Pilings in the vicinity of the Shannon Slough mouth will be visually assessed for creosote. If necessary, pilings will be penetrated with a handheld drill to determine presence of creosote.

Consideration was given to using diffusive gradients in thin-films (DGT) passive samplers to sample the bioavailable fraction of sulfide in sediment porewater. Sampling the bioavailable fraction of contaminants is a more accurate measure of the contamination that is available to cause biological effects to benthic or aquatic organisms (Paulik and Anderson, 2018). Communications with the creators of this tool, DGT Research[3], revealed that accurately interpreting the data provided by the DGT samplers would require developing a project-specific calibration of the DGT samplers. This calibration would require access to a project-specific laboratory and flat-bed scanner. This is outside the current scope of this RIWP. Passive sampling with DGT for sulfide in porewater may be considered further in a future investigation, but it is not included in this RIWP.

[3] https://www.dgtresearch.com/product/lsph-loaded-dgt-device-for-sulphide-in-sediment/

5.2.9 Cultural Resources

An Inadvertent Discovery Plan was developed for the Site which outlines procedures to perform in the event of discovering archaeological materials or human remains, in accordance with state and federal laws (Appendix D). In addition, field staff received cultural resources training on September 19, 2019 from Cultural Resource Consultants, LLC. The training focused on identification of native versus fill sediments, to help inform appropriate actions in the event modern or historic items are encountered.

5.3 Data Evaluation

Data obtained as part of the RI activities will be evaluated as described in this section. Sediment screening levels protective of ecological receptors and human health are identified for comparison with sediment chemistry data obtained. Sediment background conditions reflecting natural and/or regional sources are also considered in the screening level development, consistent with recommendations and guidance provided in Ecology (2017). Bioassay results, using procedures outlined in Ecology (2017), and parameters typically associated with woodwaste toxicity to benthics will also be used to inform potential risks.

5.3.1 Risk-based Benthic Criteria

Washington SMS marine and freshwater benthic criteria are appropriate for low-salinity (brackish) sediments and were developed from regional databases that included a broad suite of metals and organic compounds concentrations, as well as toxicity data for a variety of different tests and endpoints (Ecology, 2017).

The marine criteria were developed using the Apparent Effects Threshold (AET) approach. AETs were calculated separately based on biological testing toxicity and associated endpoints, with the lowest AET informing the SCO criteria representing a no-adverse-effects level for benthic communities, including no acute or chronic adverse direct toxicity effects. The second lowest AET informs the CSL criteria representing a minimum-adverse-effects level for benthic communities. The SMS marine SCO and CSL values are based on dry weight (dw) AETs for metals and polar organic compounds and on AETs normalized to TOC for nonpolar organics (WAC 173-204-562). At sample locations where the TOC content is outside the range considered normal (i.e., 0.5 to 3.5 percent) it is recommended that nonpolar organics not be organic carbon-normalized (OC). It is recommended instead that the sample dw concentrations be compared with the dw AETs for nonpolar organics, as provided in Ecology (2017).

The freshwater criteria were developed using the Floating Percentile Method which is a multivariate statistical approach that iteratively reduces predictive errors among all chemicals at once. This method results in chemical concentrations that maximize reliability of the criteria to predict toxicity, and reduces incorrect predictions of toxicity. The lowest FPM value is set at the SCO and the second-lowest at the CSL.

Consistent with the above, the AOI sediment data will be compared with the applicable SCO and CSL (dw or OC) values to determine the potential for adverse effects to benthic receptors.

5.3.2 Sediment Bioaccumulation Evaluation

Developing site-specific risk-based CULs for human fish consumption, or ecological bioaccumulation risk pathways for bioaccumulative chemicals, can require site-specific sediment and tissue data to calculate a biota-sediment accumulation factor. No such data are available for the site and even when site-specific data are available, risk-based screening levels for fish consumption are often below natural or regional background levels or below laboratory practical quantitation limits (PQLs), regardless of the exposure assumptions. In these situations, Ecology recommends using regional or natural background sediment concentrations to evaluate significantly bioaccumulative chemicals (Ecology, 2017), assuming these concentrations are lower than PQLs.

To evaluate nearby background concentrations of these compounds, existing Chehalis River sediment data collected within 1 mile of the AOI were previously queried from Ecology's EIM database as part of the previous Study Area Investigation; 33 samples were identified, at 27 locations and concentrations are summarized the Study Area Investigation (MFA, 2019). The evaluation presented in the Study Area Investigation showed that diffuse background sources, such as atmospheric deposition or stormwater, may affect Site sediments. These data, background data to be collected as part of the proposed RI activities, PQLs, as well as qualitative evaluations will be considered for setting of cleanup levels and/or addressing human health and ecological bioaccumulative pathways determined to be potentially complete.

5.3.3 Sediment Direct Contact and Incidental Ingestion

Human sediment direct contact and incidental ingestion screening levels for bioaccumulative contaminants are often above background levels (Ecology, 2017) and this section describes the development of screening levels protective of a hypothetical recreationist exposed to sediments via direct contact and incidental ingestion. While exposure to sediments under current and future scenarios is anticipated to be occasional and incidental (see Section 4.4), development plans for the Site may evolve over time, and the exposure scenario is considered potentially complete. Specifically, the current evaluation accounts for a child's exposure to sediment while playing on the beach. Potential exposure to fishers through incidental ingestion or through direct contact while harvesting fish or shellfish is not evaluated at this time. All applicable pathways will be considered as part of RI reporting.

Sediment direct contact and incidental ingestion screening levels are developed for widespread bioaccumulative chemicals (PCBs, dioxins, and cPAHs) that are typically above natural background (Ecology, 2017) and are listed as persistent bioaccumulative toxins (WAC-173-333-310). Bioaccumulative chemicals have the potential to result in adverse effects as a result of repeated, long-term exposure. Models for deriving screening levels were developed for these chemical classes, using chemical-specific model parameters; results are provided in MFA (2019). The screening levels protective of the child beach play scenario for cancer effects were calculated consistent with WAC 173-340-740 equation 740-5 and Equation 9-1 in Ecology (2017), using exposure parameters from Table 9-1 from Ecology (2017). Most of the screening levels were adopted from Table 9-2 presented

in Ecology (2017); screening levels for PCBs[4] were developed using toxicity values from the CLARC database using the same approach where:

$$SL_C = \frac{ARLc * BW * AT}{EF * ED[(IR * AB * SFo)/10^6\ mg/kg) + (SA * AF * ABS * SFd)/10^6\ mg/kg)]}$$

where:

SL_C is the sediment screening level for recreationists (mg/kg);

ARL_C is the acceptable risk level for individual carcinogens (unitless, $1*10^{-6}$);

BW is the body weight over the exposure duration (16 kg);

AT is the averaging time (75 years, or equivalently 23,375 days);

EF is the exposure frequency (41 days);

ED is the exposure duration (six years);

IR is the sediment ingestion rate (200 mg/day);

AB is the gastrointestinal absorption factor (unitless, chemical-specific);

SFo is the oral cancer potency factor ($[mg/kg\text{-}day]^{-1}$, chemical-specific);

GI is the gastrointestinal absorption conversion factor (unitless, chemical-specific);

SA is the dermal surface area (2,200 square centimeters);

AF is the adherence factor (0.2 mg/ square centimeters/day);

ABS is the dermal absorption fraction (unitless, chemical-specific); and

SFd is the dermal cancer potency factor ($[mg/kg\text{-}day]^{-1}$, derived as SFo/GI).

The resulting screening level is 3,100 ug/kg for total PCBs, protective against cancer effects. Screening levels adopted from Ecology (2017) are 100 pg/g for dioxin TEQ, and 850 ug/kg cPAH TEQ, protective against cancer effects. In addition, Ecology (2017) provides a screening level of 64 mg/kg for mercury (as methylmercury), based on noncancer effects.

Note that for PCBs, dioxins, and cPAHs, the noncancer-effects screening levels are higher (i.e., are less protective) than the cancer-effects screening levels (Ecology, 2017). The values derived above are therefore protective against both the cancer and noncancer endpoints. All model parameters are based on Ecology (2017) recommendations, and the screening levels are expected to be protective for a reasonable maximum exposure scenario of child beach play. Note that comparing a total mercury concentration to a methylmercury screening level will err on the side of being overly protective; this comparison assumes that 100 percent of the total mercury measured is in the form of methyl mercury, which is typically not the case.

[4] Ecology (2017) evaluates PCBs as congeners. Congener data are unavailable for the site, and the toxicity factor for PCBs as Aroclors from the CLARC database was applied.

5.3.4 Woodwaste Evaluation

Bioassay results represent the primary line of evidence for evaluation of whether woodwaste is related to benthic toxicity. In addition, surface sediment samples that were previously analyzed for conventional parameters, in concert with the bioassay results, may also be used to help inform whether buried woodwaste is expected to adversely affect benthics.

Woodwaste evaluations conducted at other sites have demonstrated that sediment parameters, such as total solids, total volatile solids, pH, and TOC, can be correlated with bioassay toxicity results. Conventional sediment parameters will also be collected at the chemistry and bioassay locations proposed for this RI (see Figure 5-2; Table 1-1), as well as woodwaste presence and volume in sediments. If one or more parameters are significantly correlated with bioassay results, these findings may be used to predict toxicity at other locations.

In addition, woodwaste scoring using conventional parameters, along with other chemical analytes, including phenol, ammonia, and sulfide, may be used to score locations according to Table A-3 of the draft DNR guidance (Integral, 2011) as an additional line of evidence if needed (MFA, 2019). Woodwaste scores will be tallied based on sediment parameter values and can result in determinations ranging from "Low Concern" to "High Concern."

6 PROJECT MANAGEMENT PLAN

6.1 Project Organization

Project management for implementation of this work plan, including planning, coordination sampling, documentation, and reporting tasks, will be undertaken by MFA. All project work will be supervised by a Washington-registered geologist employed at MFA. MFA will use subcontractors for various activities, including sediment sampling and laboratory services. Stakeholders and contractors involved with this project are listed below.

Project Management and Property Owner
Grays Harbor Historical Seaport Authority
500 North Custer Street
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(360) 532-8611
Contact: Brandi Bednarik, Director

Technical Consultant Project Management
MFA
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(971) 713-3579
Contact: Phil Wiescher, PhD

Subcontracted Services
Research Support Services, Inc.
321 NE High School Road, Suite D3/563
Bainbridge Island, Washington 98110
(206) 550-5202
Contact: Eric Parker

Apex Laboratories, LLC
12232 SW Garden Place
Tigard, Oregon 97223
(503) 718-2323
Contact: Philip Nerenberg

EcoAnalysts, Inc.
4770 NE View Dr. / PO Box 216
Port Gamble, Washington 98364
(360) 297-6040 x6045
Contact: Brian Hester

Flett Research, Ltd.
440 DeSalaberry Avenue
Winnipeg, Manitoba, Canada R2L 0Y7
(204) 667-2505
Contact: Robert Flett, Ph.D.

6.2 Schedule

The following is the anticipated schedule:

Task	Start Date	Completion
Complete RI work plan	NA.	September - October 2019
Fieldwork	Following Ecology approval of the RI work plan. Time frame includes fieldwork and laboratory analyses and appropriate follow-up analysis.	September - October 2019
Draft remedial investigation report	After completion of fieldwork and receipt of final data packages.	January 2020
Final remedial investigation report	Receipt of Ecology comments on draft remedial investigation report.	March 2020
Draft feasibility study report	After completion of remedial investigation report.	April 2020
Final feasibility study report	Receipt of Ecology comments on draft feasibility study report.	May 2020
Draft interim cleanup action plan	After completion of feasibility study report.	June 2020

The time frames for the work to be performed may change, based on changes to the scope of work and issues involving site access, and subject to subcontractor availability and Ecology approval.

LIMITATIONS

The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

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TABLE

Table 1-1
Data Objectives for In-Water Sampling
Weyerhaeuser Sawmill Aberdeen/Seaport Landing Site

Data Category	Data Objective	Data need	Approach	Analyses	Criteria	Type of samples	Sampling Strategy
Surface sediment	Delineate lateral extent of surface sediment impacts	Risk associated with surface sediment & woodwaste; sediment and water conditions	Boat + pneumatic power grab sampler	Metals, TPH-Dx/Gx, SVOCs, PCB aroclors, TVS, sulfide, ammonia, TOC, total solids, pH, salinity, grain size, dioxins[a]	SMS screening criteria for sediment - SCO/CSL	14 discrete samples; 2 four-point composites for area background.	Locations target areas where surface sediment chemistry data was previously lacking and/or are co-located with bioassy locations.
		Risk associated with surface sediment & woodwaste		Three marine bioassays: 10-Day Acute Sediment Toxicity Test with Marine Amphipods, Puget Sound Estuary Protocols (PSEP) Chronic Larval Sediment Toxicity Test, and the 20-Day Chronic Growth and Survival Test with *Neanthes arenaceodentata*	Comparison with reference bioassay (Puget Sound). SMS criteria and approach to determine potential for toxicity.	9 discrete samples.	Locations target a range of woodwaste and chemical conditions observed.

Table 1-1
Data Objectives for In-Water Sampling
Weyerhaeuser Sawmill Aberdeen/Seaport Landing Site

Data Category	Data Objective	Data need	Approach	Analyses	Criteria	Type of samples	Sampling Strategy
Subsurface sediment	Delineate vertical extent of chemical contamination in sediment	Refine vertical extent (locations with unknown conditions)	Boat + vibracore	Metals, TPH-Dx/Gx, SVOCs, PCB aroclors, TVS, sulfide, ammonia, TOC, total solids, grain size[a]	SMS screening criteria for sediment - SCO/CSL	4 discrete samples; additional opportunistic samples may be collected based on field observations.[b]	Locations chosen where previous chemistry data exceeded SMS critieria at the maximum subsurface depth collected and/or where subsurface chemistry data was not previously collected.
	Waste characterization	How will waste need to be disposed of after potential dredging?		TCLP analysis for Pb and Hg	RCRA criteria	4 discrete samples.	Locations target areas where dredging could be included in a potential remedy.
Woodwaste	Refine vertical (top and bottom) and lateral extent of woodwaste	Where does woodwaste end (vertically and laterally) offshore of site?		Woodwaste visual inspection at targeted locations and along transects[c]	Results will be used to refine woodwaste extents.	8 woodwaste transects and targeted subsurface locations.[d]	Locations where woodwaste was previously not assessed or areas with incomplete coverage in previously assessed areas.

Table 1-1
Data Objectives for In-Water Sampling
Weyerhaeuser Sawmill Aberdeen/Seaport Landing Site

Data Category	Data Objective	Data need	Approach	Analyses	Criteria	Type of samples	Sampling Strategy
Woodwaste	Delineate chemical conditions associated with woodwaste impacts	Risk associated with subsurface woodwaste	Boat + vibracore	Woodwaste indicator (TVS, sulfide, ammonia, TOC, total solids) analysis if significant woodwaste (>25%) is present	Parameters will be used for potential correlation with bioassay results and woodwaste scoring as needed.	12 subsurface locations (8 woodwaste investigation area plus 4 targeted subsurface locations); additional opportunistic woodwaste indicator samples may be collected from subsurface woodwaste transects based on field observations.	Locations target edges of areas where woodwaste was previously observed or areas with poor spatial coverage in previously assessed areas.
Radioisotope Data	Sediment deposition rates and stability	How fast does sediment deposit offshore of the site?		Lead-210, Radium-226, Cesium-137	Pb-210 data will be used to generate model(s) to estimate age of sediment in core(s). Ra-226 and Cs-137 data will be used to validate Pb-210 model(s).	2 eight foot cores (sectioned)	Locations target areas where potential remedial actions could be implemented in sediment, and represent the Pocket Beach area and typical nearshore conditions.
Site conditions	Piling composition; hydrology/ hydraulic evaluations; presence of underwater pilings; sediment physical characteristics; etc.	Multiple	Pilings in the vicinity of the Shannon Slough mouth will be visually assessed (i.e., using drill) for creosote. Additional work may be conducted as described under a separate work plan and/or as part of feasibility or engineering studies.				
Site uses	Define site uses to inform human health risk assessment	How do people use site? Do people collect clams, other shellfish, or resident species in this area?	Coordination with Quinault Indian Nation and Seaport Authority to obtain this information.				

Table 1-1
Data Objectives for In-Water Sampling
Weyerhaeuser Sawmill Aberdeen/Seaport Landing Site

NOTES:

[a] A subset of these analyses is identified for some sample locations, as described in the sampling and analysis plan.

[b] Core collection for one sample location (SE-09) will depend on sampling vessel access.

[c] Visual inspection includes wet sieving of sediments, as needed.

[d] Core samples will be collected along transect until significant woodwaste is no longer observed.

SCO = Sediment Cleanup Objective.

CSL= Cleanup Screening Level.

SMS = Sediment Management Standards.

FS = Feasibility Study.

SVOCs = semivolatile organic compounds.

TVS = total volatile solids.

TOC = total organic carbon.

TCLP = toxicity characteristic leaching procedure.

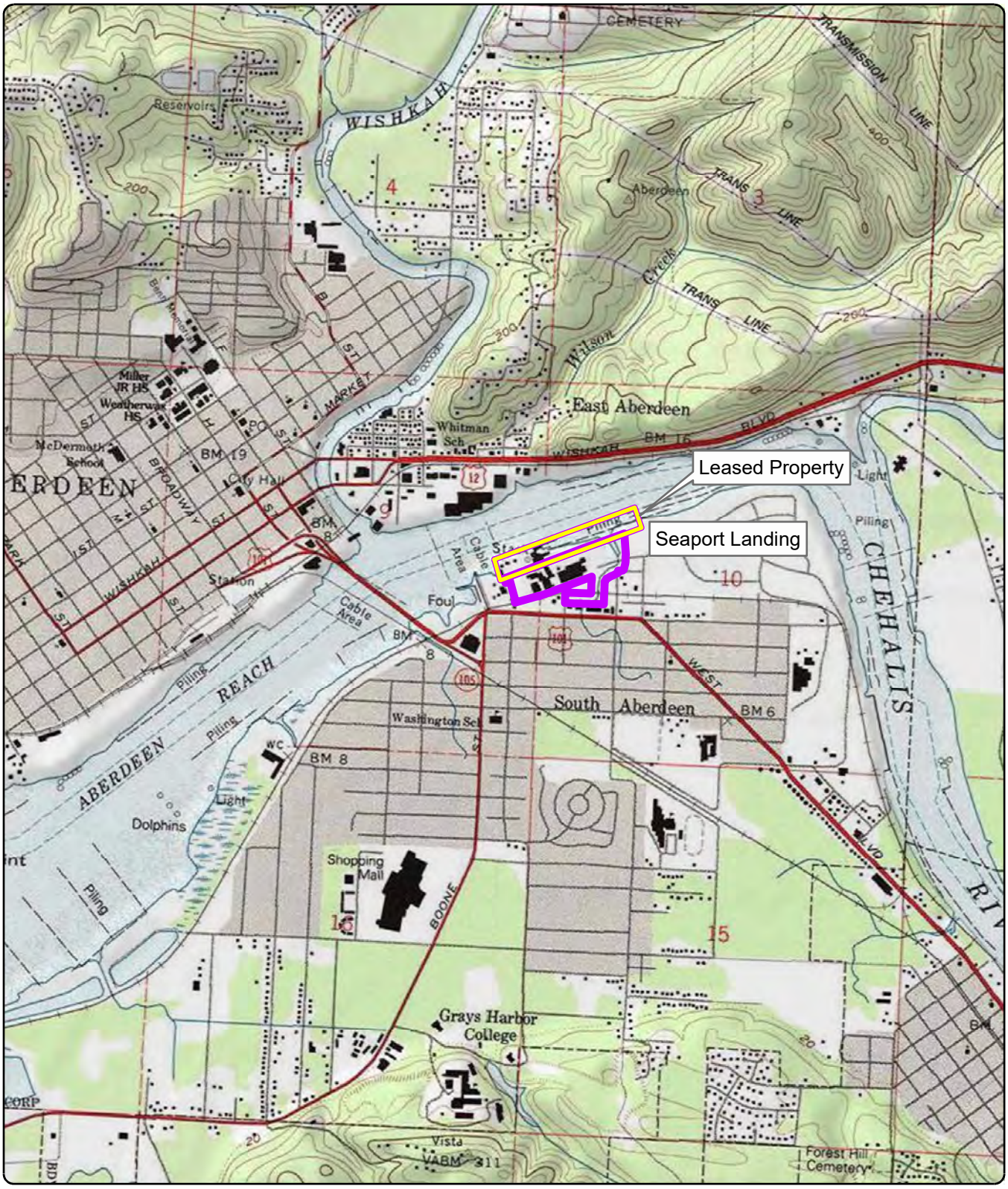
RCRA = Resource Conservation and Recovery Act.

PCBs = polychlorinated biphenyls.

TPH-Gx = total petroleum hydrocarbons - gasoline range.

TPH-Dx = total petroleum hydrocarbons - diesel range.

FIGURES



Site Address: 500 North Custer Street, Aberdeen, Washington
Source: US Geological Survey (1990) 7.5-minute topographic quadrangle: Aberdeen
Section 9 & 10, Township 17 North, Range 9 West

Approximate Aquatic Lease Area

Seaport Authority Property

Figure 1-1
Property Location
Aberdeen, Washington

0 1,000 2,000
Feet

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Path: X:\1044.02.01-02 Grays Harbor Seaport Authority\Projects\Seaport_Landing_RI_FS\Fig1-1_Property Location_MJ.mxd
Print Date: 1/4/2017
Approved By: M. Novak
Produced By: mjosef
Project: 0863.01.05

Source: Aerial photograph obtained from Esri ArcGIS Online; parcels and roads obtained from Grays Harbor County; harbor lines obtained from Washington Dept. of Natural Resources.

Produced by Maul Foster & Alongi, Inc.

Legend

Approximate Aquatic Lease Areas (with Lease Number)

- *Pakonen Boatyard*
- *Seaport Authority*
- Pakonen Boatyard
- Seaport Authority (Seaport Landing site)
- In-water Area of Investigation
- Inner Harbor Line
- Outer Harbor Line

Notes:

1. Areas of property ownership have been generalized based on taxlot information obtained from the County and a purchase sale agreement for the Seaport Authority property, and should be considered approximate.
2. Aquatic lease areas were digitized from print maps of the Aberdeen tidelands dated Mar. 22, 2001 and Jan. 15, 1907 on file with the Office of the Commissioner of Public Lands in Olympia, Washington, and should be considered approximate.

Aberdeen South Waterfront
Tideland Lease Areas with Lease Numbers

Aberdeen, Washington

0 100 200
Feet

Chehalis River

Wharf Area
Former Boiler
Pocket Beach Area
Wood Oil Tank
Former Mill Area
Intertidal Area
Tidelands and Beach Area
Shannon Slough
Lumber Shed
Powerhouse
Transformer
Former Oil House
Compressor Building
Chip Area Blower Building
Spray Room
Former Wigwam Burner
Chip Lift Truck
Diesel AST
Former Kilns
Maintenance Shop
Fuel & Chemical Storage Building
Small Log Mill
Oil Tank & Chemical Storage Shed
Planer Building
Pee Wee Mill
Storage Shed
Main Shipping Shed
Generator Shed & Diesel AST
Water Treatment System
Steam Cleaning Facility
N. Boone St.
Aberdeen Pad Transformer
Guard Shack UST
W. Curtis St.
101
Water Tank
Office
Guard Shed
Curtis St.

Source:
Aerial photograph obtained from Esri ArcGIS Online.
Parcels and roads obtained from Grays Harbor County.
Harbor lines obtained from Washington Dept. of Natural Resources.
Former features from Level I Environmental Site Assessment,
PES Environmental; August 13, 2010.

Legend

- Former Mill
- Former Wharf Extension
- Existing Buildings/Features
- Former Buildings/Features
- Inner Harbor Line
- Outer Harbor Line
- Seaport Authority Property
- Leased Property Area

Figure 1-3
Historical and Current Property Features
Aberdeen, Washington

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GRAYS HARBOR HISTORICAL SEAPORT

0 100 200
Feet

Source: Aerial photograph obtained from Esri ArcGIS Online; parcels and roads obtained from Grays Harbor County; harbor lines obtained from Washington Dept. of Natural Resources.

- Approximate Aquatic Lease Area
- Seaport Authority Property
- Former Mill
- Former Wharf Extension
- J Catch Basin
-) Oil/Water Separator
- P Outfall
- Drain Pipe (with flow direction)

Study

- (1998 Sediment Samples
- (2011 Sediment Samples
- (2013 Sediment Samples
- (2015 Upland Samples
- (2015 Sediment Samples
- Composite Sample Locations

Notes:
1. GHHSA = Grays Harbor Historical Seaport Authority.
2. Aquatic lease areas were digitized from print maps of Aberdeen tidelands dated Mar. 22, 2001 and Jan. 15, 1907 on file with the Office of the Commissioner of Public Lands in Olympia, Washington, and should be considered approximate.

Figure 2-1
Sample Locations
Aberdeen, Washington

0 100 200
Feet

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Path: X:\1044.02.01-02 Grays Harbor Seaport Authority\Projects\Seaport_Landing_RI_FS\Fig2-1_SampleLocationsLabeled_03_20190820_ST.mxd
Print Date: 8/20/2019
Approved By: mstringer
Produced By: sturner
Project: 0863.01.01-02

Notes:
1. GHHSA = Grays Harbor Historical Seaport Authority.
2. Aquatic lease areas were digitized from print maps of Aberdeen tidelands dated Mar. 22, 2001 and Jan. 15, 1907 on file with the Office of the Commissioner of Public Lands in Olympia, Washington, and should be considered approximate.
3. TPH exceedance is of Model Toxics Control Act Method A Cleanup Level.
4. Surface is sediment collected in the top 10 centimeters (0 to 0.33 feet below the mudeline).
5. TEQ = toxicity equivalence quotient

Source: Aerial photograph obtained from Esri ArcGIS Online; parcels and roads obtained from Grays Harbor County; harbor lines obtained from Washington Dept. of Natural Resources.

- Appoximate Aquatic Lease Area
- Seaport Authority
- Former Mill
- Former Wharf Extension
- # Historical Surface Sample Location (PES Phase II, April 2011)
- Composite Surface Sample

Surface Sediment Sample Locations

- No Exceedances
- ± No Exceedances - Not Analyzed for TPH
- SCO Exceedance
- SCO and CSL Exceedance

Composite Surface Sediment Sample Locations

- # No Exceedances - Not Analyzed for TPH
- # No Exceedances - Not Analyzed for Dioxin TEQ
- # No Exceedances - Not Analyzed for Dioxin TEQ or TPH
- # SCO Exceedance

Figure 2-2
Previous Sediment Management Standard Exceedances
Aberdeen, Washington

0 75 150
Feet

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Path: X:\1044.02.01-02 Grays Harbor Seaport Authority\Projects\Seaport_Landing_RI_FS\Fig2_2_SedimentManagementStandardExceedances_20190821_ST.mxd
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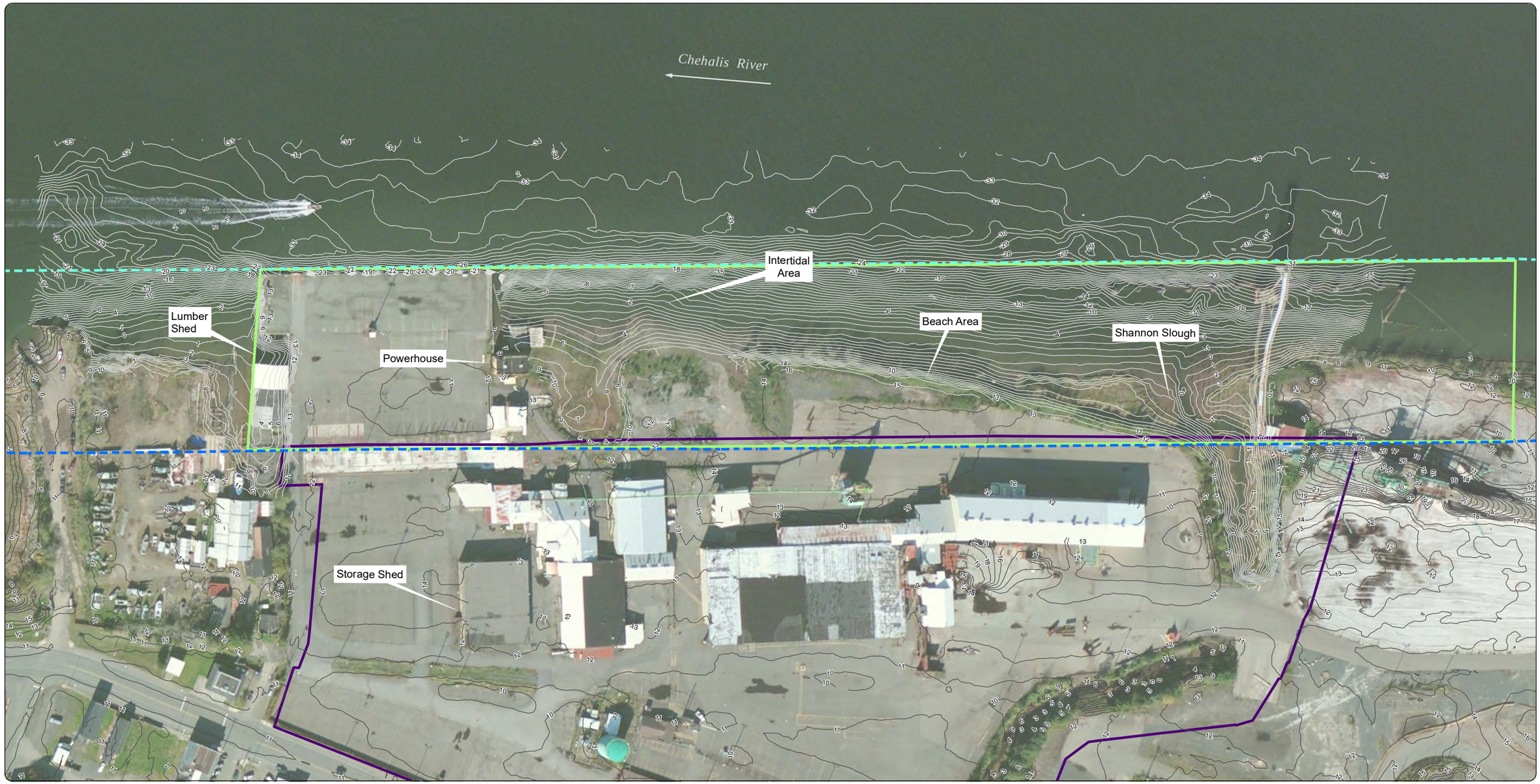
Approved By: mstringer
Produced By: sturner
Project: 1044.02.01-05



Source:
Bathymetric survey performed in 2016.
LiDAR survey performed in 2009.
Aerial photograph obtained from Esri ArcGIS Online.
Parcels and roads obtained from Grays Harbor County.
Shorelines boundaries are approximate and derived from Sanborn maps.
Harbor lines obtained from Washington Dept. of Natural Resources.
Former features from Level I Environmental Site Assessment,
PES Environmental; August 13, 2010.

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Legend

- Inner Harbor Line
- Outer Harbor Line
- Approximate Aquatic Lease Area
- One Foot Contour Bathymetry (NAVD88)
- One Foot Contour LiDAR (NAVD88)

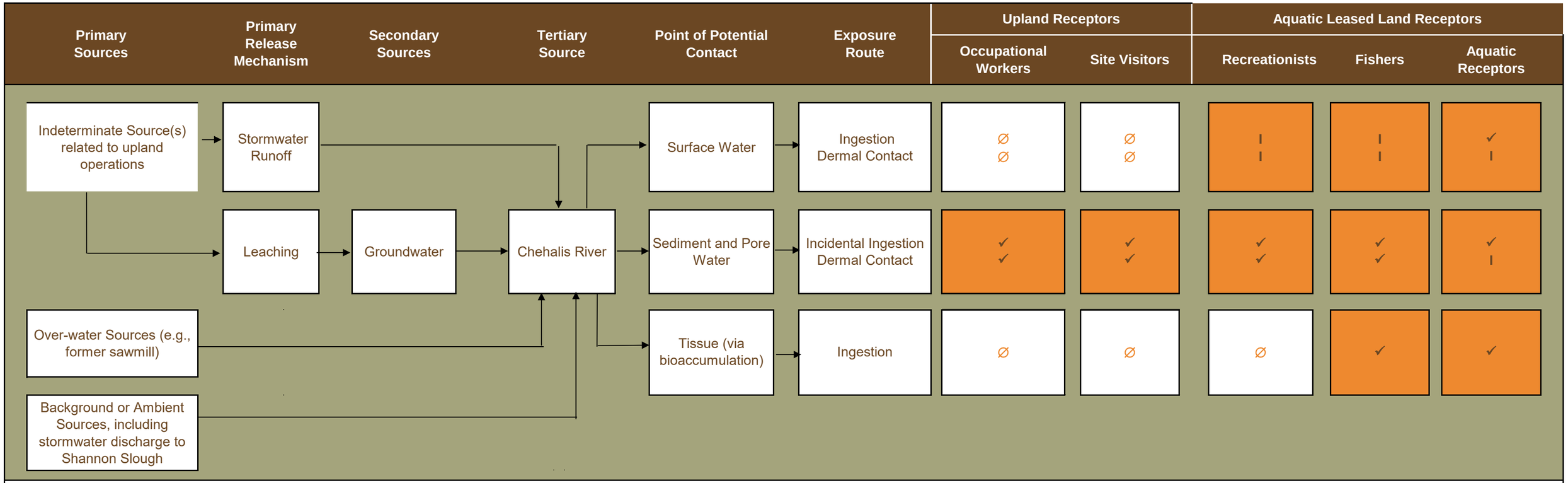
Figure 3-1
Bathymetry and Topography

Aberdeen, Washington

GRAYS HARBOR HISTORICAL SEAPORT

0 100 200
Feet

Figure 4-1
Conceptual Site Model
Seaport Landing Aquatic Land Lease
Aberdeen, Washington



Notes:

Primary pathway →
Potentially Complete exposure route ✓
Incomplete exposure route ∅
Insignificant exposure route I

Aquatic receptors include aquatic plants, benthic invertebrates, fish, and piscivorous birds and mammals.

Source: Aerial photograph obtained from Esri ArcGIS Online; parcels and roads obtained from Grays Harbor County; harbor lines obtained from Washington Dept. of Natural Resources.

Proposed Woodwaste Sample Area

Proposed Woodwaste, Subsurface Sediment, and TCLP Sample

Seaport Authority Property

Approximate Aquatic Lease Area

Proposed Sediment Sampling for Radioisotope Analysis

Former Mill

Former Wharf Extension

Edge of Previous Woodwaste Investigation

Previously Defined Extent of Woodwaste

Not Included in Previous Woodwaste Investigation

Figure 5-1
Proposed Subsurface Sediment Sampling Locations
Aberdeen, Washington

GRAYS HARBOR HISTORICAL SEAPORT

0 75 150
Feet

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Print Date: 9/19/2019
Approved By: mstringer
Produced By: abixby
Project: 1044.02.01-05

Notes:
1. Aquatic lease areas were digitized from print maps of Aberdeen tidelands dated Mar. 22, 2001 and Jan. 15, 1907 on file with the Office of the Commissioner of Public Lands in Olympia, Washington, and should be considered approximate.
2. Surface is sediment collected in the top 10 centimeters (0 to 0.33 feet below the mudeline).

Source: Aerial photograph obtained from Esri ArcGIS Online; parcels and roads obtained from Grays Harbor County; harbor lines obtained from Washington Dept. of Natural Resources.

Sample Type
- Proposed Chemistry
- Proposed Chemistry and Bioassay
- Proposed Woodwaste Chemistry Only
- Proposed Composite Sediment Chemistry Sample for Background
- Appoximate Aquatic Lease Area
- Seaport Authority
- Former Mill
- Former Wharf Extension

Figure 5-2
Proposed Surface Sediment Sampling Locations
Aberdeen, Washington

GRAYS HARBOR HISTORICAL SEAPORT

0 75 150
Feet

MAUL FOSTER ALONGI
p. 971 544 2139 | www.maulfoster.com

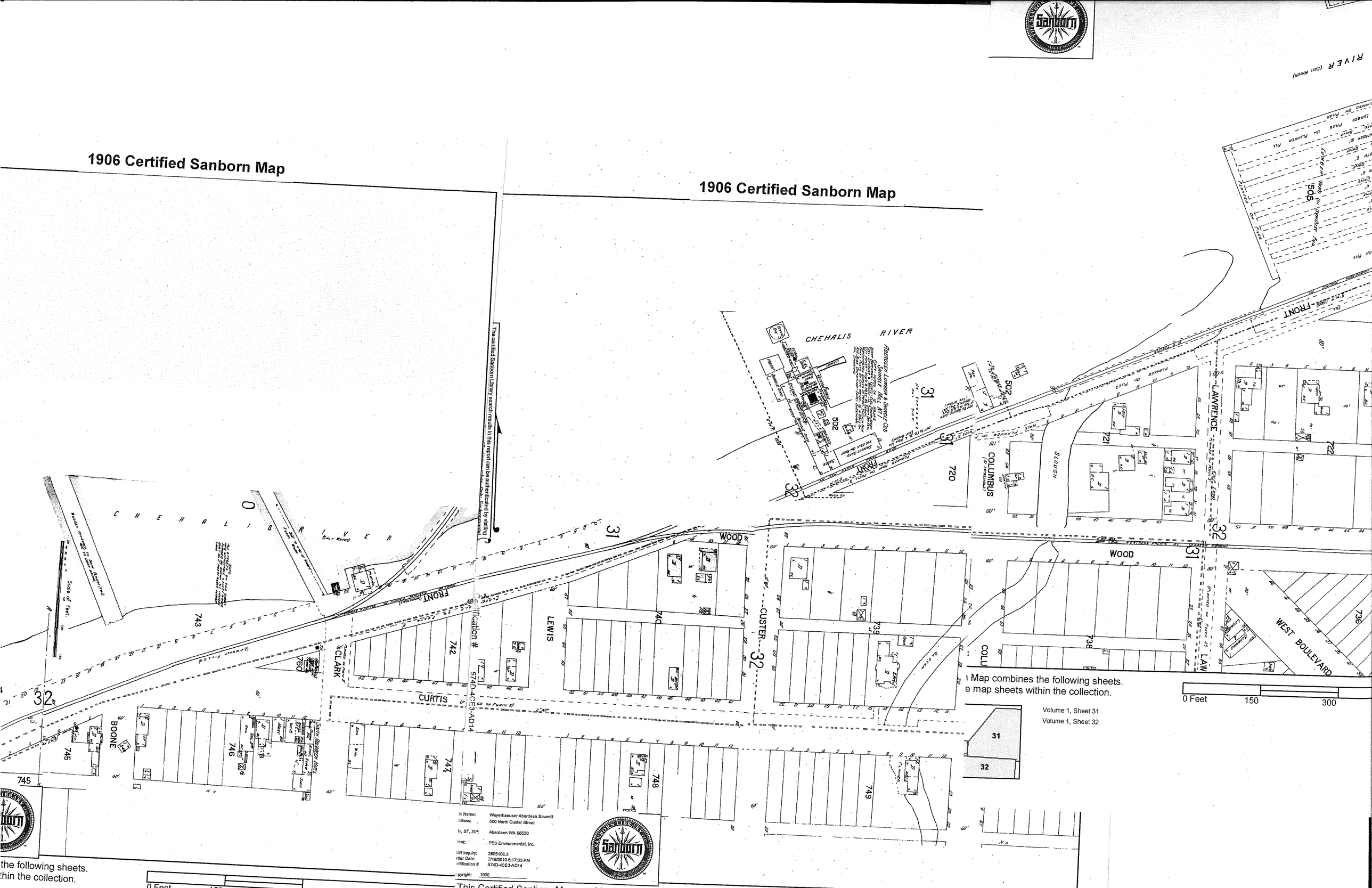
Project: 1044.02.01-05 Produced By: sturner Approved By: bpaulik Print Date: 9/20/2019 Path: X:\1044.02.01-02 Grays Harbor Seaport Authority\Projects\Tidelands R1\Work Plan\Fig1-D_Proposed Bioassay and Composite Surface Sample Locations_20190821.mxd

APPENDIX A

SANBORN MAPS

1906 Certified Sanborn Map

1906 Certified Sanborn Map



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Address: 500 North Custer Street
City, ST, ZIP: Aberdeen WA 98520
Client: PES Environmental, Inc.
SDR Inquiry: 2805106.3
Order Date: 7/16/2010 5:17:03 PM
Certification # 574D-4CE3-AD14
Copyright: 1906

Map combines the following sheets.
e map sheets within the collection.

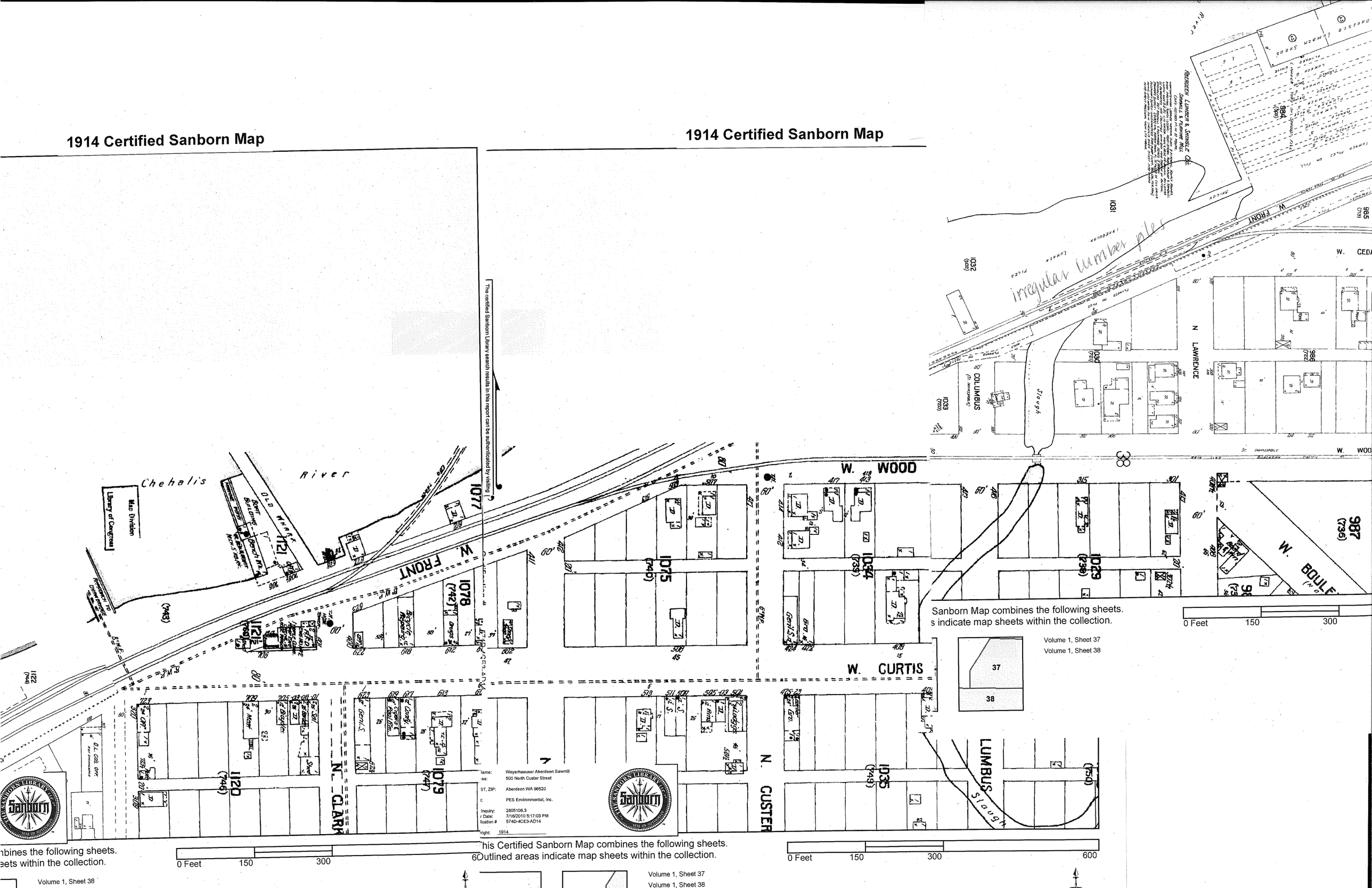
Volume 1, Sheet 31
Volume 1, Sheet 32

0 Feet 150 300

the following sheets.
hin the collection.

This Certified Sanborn Map

1914 Certified Sanborn Map



This Certified Sanborn Map combines the following sheets.
Outlined areas indicate map sheets within the collection.

Volume 1, Sheet 37
Volume 1, Sheet 38

Sanborn Map combines the following sheets.
s indicate map sheets within the collection.

Volume 1, Sheet 37
Volume 1, Sheet 38

1914 Certified Sanborn Map

This Certified Sanborn Map combines the following sheets.
Outlined areas indicate map sheets within the collection.

Volume 1, Sheet 37
Volume 1, Sheet 38

1928 Certified Sanborn Map

Site Name:	Aquatic Lands Enhancement
Address:	500 North Custer Street
City, ST, ZIP:	Aberdeen WA 98520
Client:	PES Environmental, Inc.
EDR Inquiry:	2798202.3
Order Date:	6/22/2010 11:57:39 AM
Certification #	0D28-4C72-80D8
Copyright:	1928

Sanborn Map combines the following sheets.
s indicate map sheets within the collection.

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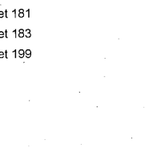
Volume 1, Sheet 198
Volume 1, Sheet 199

Sanborn Map combines the following sheets.
s indicate map sheets within the collection.



Volume 1, Sheet 181
Volume 1, Sheet 183
Volume 1, Sheet 199

0 Feet 150 300

0 Feet 150

1948 Certified Sanborn Map

1948 Certified Sanborn Map

1948 Certified Sanborn Map

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Address: 500 North Custer Street
City, ST, ZIP: Aberdeen WA 98520
Client: PES Environmental, Inc.
EDR Inquiry: 2798202.3
Order Date: 6/22/2010 11:57:39 AM
Certification #: 0D28-4C72-80D8
Copyright: 1948

Site Name: Aquatic Lands Lease
Address: 500 North Custer Street
City, ST, ZIP: Aberdeen WA 98520
Client: PES Environmental, Inc.
EDR Inquiry: 2798202.3
Order Date: 6/22/2010 11:57:39 AM
Certification #: 0D28-4C72-80D8
Copyright: 1948

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Certification # 0D28-4C72-80D8

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Volume 1, Sheet 199

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Volume 1, Sheet 181
Volume 1, Sheet 198

0 Feet 150 300 600

0 Feet 150 300

1989 Certified Sanborn Map

1989 Certified Sanborn Map

Certification # 574D-4CE3-AD14

Site Name: Weyerhaeuser Aberdeen Sawmill
Address: 500 North Custer Street
City, ST, ZIP: Aberdeen WA 98520
Client: PES Environmental, Inc.
EDR Inquiry: 2805106.3
Order Date: 7/16/2010 5:17:03 PM
Certification #: 574D-4CE3-AD14
Copyright: 1989

This Certified Sanborn Map combines the following sheets.
Outlined areas indicate map sheets within the collection.

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APPENDIX B

SAMPLING AND ANALYSIS PLAN

IN-WATER SAMPLING AND ANALYSIS PLAN

WEYERHAEUSER SAWMILL ABERDEEN/SEAPORT LANDING SITE
FACILITY SITE ID 1126, CLEANUP SITE ID 4987, AGREED ORDER ID 11225

Prepared for

GRAYS HARBOR HISTORICAL SEPAORT AUTHORITY

500 North Custer Street, Aberdeen, WA 98520

IN-WATER SAMPLING AND ANALYSIS PLAN

November 4, 2019

Project No. 1044.02.14

MAUL FOSTER ALONGI

Prepared by

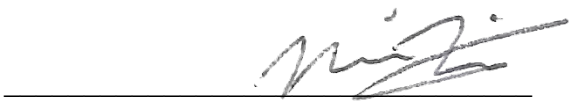
Maul Foster & Alongi, Inc.

2815 2nd Avenue, Suite 540, Seattle, WA 98121

IN-WATER SAMPLING AND ANALYSIS PLAN
WEYERHAEUSER SAWMILL ABERDEEN/SEAPORT LANDING SITE
FACILITY SITE ID 1126, CLEANUP SITE ID 4987, AGREED ORDER ID 11225

The material and data in this plan were prepared under the supervision and direction of the undersigned.

MAUL FOSTER & ALONGI, INC.



Phil Wiescher, Ph.D.
Senior Environmental Scientist

CONTENTS

TABLES AND ILLUSTRATIONS

TABLES

ACRONYMS AND ABBREVIATIONS

bml	below mudline
CFR	Code of Federal Regulations
cm	centimeter(s)
COC	chain of custody
DGPS	differential global positioning system
DMMP	Dredged Material Management Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
LCS	laboratory control sample
MFA	Maul Foster & Alongi, Inc.
the Port	Port of Ridgefield
PSEP	Puget Sound Estuary Program
QA	quality assurance
QC	quality control
RIWP	remedial investigation work plan
SAP	sampling and analysis plan
TOC	total organic carbon
USEPA	U.S. Environmental Protection Agency

1 INTRODUCTION

On behalf of Grays Harbor Historical Seaport Authority (GHHSA), Maul Foster & Alongi, Inc. (MFA) has prepared this sampling and analysis plan (SAP) for remedial investigation activities to be conducted within the in-water portion of the Weyerhaeuser Sawmill Aberdeen/Seaport Landing site, which is located 500 North Custer Street in Aberdeen, Washington, adjacent to the Chehalis River (see Figure 1-1 of remedial investigation work plan [RIWP]).

Additional information about project background and objective is provided in the RIWP. This SAP specifies field and analytical methods, including quality assurance (QA) and quality control (QC) requirements.

2 SAMPLE PROGRAM DESIGN

Samples of surface and subsurface sediment will be collected and submitted for chemical analysis, bioassays, and radioisotope analysis as described in the following sections. The overall sample program is summarized in Table B1. Associated information is provided in Table B2 (sample analyses and preservation, Table B3 (quality control procedures), and Table B4 (sample quality control limits).

The following procedures will be used for handling sediment:

- Samplers will wear clean, disposable gloves while collecting samples. Gloves will be changed between sampling locations.
- Field activities and conditions and sampling data (e.g., sample description) will be recorded in a field notebook. Any deviations from the sampling protocol will be noted on field records and will be brought to the attention of the project manager. General sediment observations, such as description of surface materials, soil type, odors, and any staining or discoloration will be recorded, consistent with the Unified Soil Classification System (includes soil type, density/consistency of soil, color).
- Samples will be placed in laboratory provided containers, either directly after sampling for discrete samples or after homogenization for composited samples. Samples will be labeled, stored in iced shipping containers with chain-of-custody (COC) documentation, and transported to the appropriate contract laboratories for analysis.

2.1 Subsurface sediment chemistry sampling

2.1.1 Sediment core advancement

A vibracore will be deployed and advanced up to 8 feet below mudline (bml), or until refusal, to collect sediment cores from the proposed subsurface sediment sampling locations shown on RIWP Figure 5-1 for chemistry analysis. Each core will be collected with the widest diameter sampling tube available (e.g., 2-, 3- or 4-inch inner diameter, as practicable). The visual appearance of each core (grain size, color, organic matter, odors, etc.) will be described and recovery will be logged. Subsurface samples will be collected in 2-foot intervals, unless significant changes in lithology are observed that require more frequent sampling.

Subsurface sediment core collection will be performed as follows:

- The sampling vessel will navigate to the target position as described in Section 2.6. The GPS position will be recorded from the vessel when the vibracore first rests on the sediment surface.
- The vibracore will be advanced without power (under its own weight), then vibration will be applied until the core tube is advanced to the target depth or to refusal.
- After a brief pause, the core tube will be extracted from the sediment, using only the minimum vibratory power needed for extraction.

The core will be accepted, rejected, or stored on the vessel pending one additional drive attempts. Field protocols are outlined below:

- Percent recovery is calculated by dividing the height of the recovered sediment by the penetration depth. A minimum of 75 percent recovery is targeted.
- If the core was not able to penetrate to target depth a second attempt will be made. If similar core refusal is met, consideration will be made as to whether the target depth is achievable. If it is determined to be unachievable, then a description of sediments encountered, and potential causes of refusal will be recorded.
- Core intervals will not be corrected for under recovery. Best professional judgment will be used to stop the core sampler from collecting material before significant sediment compaction would occur.

The core will be inspected for the following acceptance criteria:

- Overlying water is present, and the sediment surface is intact.
- The core has 75 percent target recovery versus penetration (or document why recovery is less after two attempts).
- The core tube is in good condition (not excessively bent).
- The core appears representative of surrounding area.

- Target penetration depth has been achieved or bedrock is encountered. If the target depth is not reached because of cobbles, debris, refusal, or other difficult coring conditions, an additional core will be attempted as described in the contingency plan. Contingency plan procedures are discussed below.

If samples cannot be collected at a proposed sampling location because of substrate or other field conditions, no more than two attempts will be made to relocate the core within a 50-foot radius of the planned location if accessible. If not accessible (i.e., under a structure/vessel, shallow water depth), then the target radius will be increased for sample collection (e.g., 125 feet). The best (percent recovery) of the attempts made at each location will be retained and processed.

After core acceptance, water will be carefully decanted from the top of the core tube to minimize sediment disturbance. Cores may be cut into segments for handling and storage. Core tubes will be capped and inscribed on the sidewalls with core and segment identification and "up" arrow.

Actual core penetration will be determined using a tape measure attached to the Vibracore head. The core will be driven a minimum of one foot deeper than the lower boundary of intended depth or until refusal. The tape will be used to measure total core length by comparing the start and end measurements of a tape. After the coring equipment is safely onboard the vessel, the core liner with the intact core inside will be extruded. Recovery will be determined by comparing the penetration with the height of the material in the extracted core.

2.1.2 Subsurface sediment sampling from cores

The subsurface sediment cores for chemistry analysis will be processed on the vessel, as described below:

- The core tube will be split open longitudinally to preserve the material stratigraphy inside, using a table saw, handheld circular saw, radial saw, shearing tool, X-ACTO® knife (if liner used), or similar device; and
- A photoionization detector (PID) with 10.6-electron volt lamp will be used for prescreening of each core. As soon as the core is split open, the PID monitor will be held in the ambient air space just above the open core and slowly moved down the core from top to bottom. PID readings will be recorded in the field notebook.
- Headspace screening will be conducted for each sample. Head space screening will involve the following:
  - A small representative sample will be collected from each sample interval to be screened, using a decontaminated sampling spoon. The material will be placed in a resealable plastic bag or glass jar with a septum lid.
  - The bag or jar will be tightly sealed (the jar with aluminum foil and plastic lid with septum opening), and the material will be allowed to warm at least to the ambient temperature (>32 degrees Fahrenheit). The sample will be allowed to sit for at least ten to no more than 60 minutes to allow headspace concentrations to develop and will be shaken periodically for at least 30 seconds.

  - The PID probe tip will be inserted into the container within the headspace, with care taken to avoid taking sediment or moisture into the probe.
  - The highest reading (excluding possible erratic readings) on the meter will be recorded for the sample.
- Cores will be photographed prior to sampling. The sample ID, date, and orientation of the core will be included in each photograph.
- The visual appearance of the sediment cores will be described following the Unified Soil Classification System (includes soil type, density/consistency of soil, color).
- Subsurface sample intervals will be 2 feet unless field conditions indicate otherwise (e.g., a change in lithology, odor, sheen). Intervals will be collected more frequently if changes are observed in the core are observed more frequently than every 2 feet.
- After the cores have been described and the sample intervals have been determined, sediment will be collected within the determined sample interval, homogenized until uniform in color and texture, and placed into appropriate sample containers for laboratory analysis (see Table B2). Samples collected for the analysis of potentially volatile chemicals (e.g., total sulfides, ammonia) will be placed in appropriate sample containers immediately after retrieval to minimize volatilization.

Core lithology, PID readings, sample identifications, and sample depth intervals will be recorded in field notes.

2.1.3 Field observations

While on the vessel, personnel will record the following core collection data in field notes and on a boring log form, included as Appendix B3:

- Date/time. Local date and time when the vibracoring began at each location.
- Total Drive Length. Core tube length and the depth of the core tube penetration into the subsurface.
- Recovered Length. Thickness of the sediment column retained in the core tube before sectioning and removal of the core catcher.
- Sediment Observation. Average grain size, color, notable odors, debris, and distinct color change in shallow sediments (apparent redox potential discontinuity depth). Visual descriptions will follow the Unified Soil Classification System (includes soil type, density/consistency of soil, color).

2.1.4 Analyses

After processing, samples will be placed in laboratory-supplied containers and then transported in coolers on ice (at 0 to 6°C) to the analytical laboratory. One interval from the midpoint of one subsurface sediment core at each subsurface sediment chemistry sampling location will be initially analyzed for the analytes listed in Table B1 for chemistry and TCLP characterization. TCLP samples

may be collected from a different interval, if a significantly more impacted interval is visually determined. The remaining intervals from each core will be archived for potential future analysis.

2.2 Woodwaste assessment procedures

Subsurface sediment cores will be collected in woodwaste investigation areas along transects as shown in Figure 5-1 of the RIWP. Woodwaste sampling areas were selected in areas where woodwaste was not previously evaluated. Two woodwaste sampling areas (SE-07 and SE-08) were selected within the previous woodwaste investigation area, at locations where data density was poor. Cores will be collected along transects, spaced approximately 50 to 100 feet apart, until significant woodwaste is no longer observed in a core. Cores will be collected using the Vibracore and initially advanced up to 8 feet below bml, or until refusal. If woodwaste is observed at 8 feet bml, an additional core may be collected up to 15 feet bml to better characterize the depth of woodwaste in sediment at that location.

Each core will be visually inspected to better characterize woodwaste depth and type (Ecology 2013; Ecology, 2017). After sediment cores are collected, the core will be cut open for visual inspection on the sampling vessel. Wet sieving of sediments will be conducted to determine if finer-grained woodwaste is present. Woodwaste lenses or layers will be identified if present and their depths will be recorded. Any significant visual or textural differences between sediment layers will be noted to assess the amount of woodwaste and to provide information on sediment deposition. Close attention will be paid to distinct layers, to ensure accurate evaluation of the boundary between woodwaste and the undisturbed native sediment. If distinct layers are not obvious, additional core intervals may be visually examined at a 1-foot vertical intervals. Assessing the cores at 1-foot intervals provides a much more accurate estimate for potential wood volume needing removal than core assessment at 2-foot intervals (Ecology 2013).

Subsurface sediment core collection for woodwaste investigation will be performed as follows:

- The sampling vessel will navigate to the start position shown in Table B1 and as described in Section 2.6. The GPS position will be recorded when the vibracore first rests on the sediment surface. Subsequent locations (as needed) along the transect will be navigated to by navigating 50 to 100 feet towards the target position shown in Table B1, and the position will be recorded when the vibracore first rests on the sediment surface.
- The vibracore will be advanced without power (under its own weight), then vibration will be applied until the core tube is advanced to the target depth or to refusal.
- After a brief pause, the core tube will be extracted from the sediment, using only the minimum vibratory power needed for extraction.
- Percent recovery is calculated by dividing the height of the recovered sediment by the penetration depth. A minimum of 75 percent recovery is required (or document why recovery is less).
- If the core was not able to penetrate to target depth a second attempt will be made. If similar core refusal is met, consideration will be made as to whether the target depth is

achievable. If it is determined to be unachievable, then a description of sediments encountered, and potential causes of refusal will be recorded.

- Core intervals will not be corrected for under recovery. Best professional judgment will be used to stop the core sampler from collecting material before significant sediment compaction would occur.
- Acceptance criteria for evaluation include: overlying water is present, and the sediment surface is intact; the core tube is in good condition (not excessively bent); and the core appears representative of surrounding area.
- If it is determined that significant woodwaste (greater than 25 percent) is present in the bottom 1-foot interval of the core collected up to 8 feet bml, then a second core will be collected up to 15 feet bml and evaluated.
- If samples cannot be collected at a proposed sampling location because of substrate or other field conditions, the core will be relocated within a 50-foot radius of the planned location if accessible. If not accessible (i.e., under a structure/vessel, shallow water depth), then the target radius will be increased for sample collection (e.g., 125 feet).
- Core penetration will be determined using a tape measure attached to the Vibracore head. The tape will be used to measure total core length by comparing the start and end measurements of a tape. Recovery will be determined by comparing the penetration with the height of the material in the extracted core.
- Cores will be photographed prior to sampling. The sample ID, date, and orientation of the core will be included in each photograph.
- Field observations will be recorded as described in section 2.1.3.

Woodwaste chemistry analysis (see Table B2) will be conducted for a minimum of one interval from one core from each woodwaste sample area, and one sample will be collected from each discrete woodwaste sample identified (for a total of 12 samples, see RIWP Figure 5-2), assuming significant woodwaste (greater than 25 percent by volume) is present. If multiple cores have been collected in a woodwaste sample area, the woodwaste chemistry sample will be obtained from the core that shows the most significant woodwaste impacts closest to the top (i.e., closest to sediment surface) to best represent conditions biological receptors would be most likely exposed to. If significantly more woodwaste is observed at greater depths, additional chemistry sample(s) may be collected from those intervals. Sample procedures outlined in section 2.1.2 and 2.1.3 will be followed for woodwaste chemistry cores.

2.3 Surface sediment sampling procedure

2.3.1 Surface grab sample collection

Discrete surface sediment will be collected for discrete or composite analysis from a boat pneumatic power grab sampling device or by wading. Surface sediment samples will be collected to a depth of 10 centimeter (cm) bml using a pneumatic power grab sampling device that collects an area of

approximately 0.2 m^2. The speed of the grab sampler's descent will be controlled to minimize disturbance of the sediment. The speed of ascent will also be controlled to minimize loss of sediment from washout. The sediment sample will be inspected upon retrieval to ensure that the grab sampler was completely closed and retained all sediment, including any surficial fines.

After the sampler is secured on the boat, the sediment sample will be inspected carefully before determining if the sample is acceptable. Each grab sample will be inspected to ensure the following:

- Jaws of the sampler closed completely.
- Grab sampling device did not over penetrate. Sediment should not be coming through the upper door of the device.
- That target sampling depth (10cm) was achieved.
- Overlying water is present.
- The sediment surface is relatively flat with no winnowing.

If sample recovery is poor, then the sample will be discarded and resampled within a few feet of the original location.

2.3.2 Surface sediment sampling from grab samples

2.3.2.1 Discrete surface sediment sampling

At locations shown in the RIWP Figure 5-2, discrete surface sediment samples will be collected and submitted individually for analysis. After the sediment has been photographed and characterized it will be removed from the grab sampler using a stainless-steel spoon and placed in a decontaminated stainless-steel bowl. Sediments in direct contact with the grab sampler will not be collected for analysis. Discrete samples will be placed directly into sample collection jars. Additional sediment will be collected from each discrete sampling location where composited samples are needed. This additional sediment will be composited in a stainless steel bowl (or equivalent) and homogenized using clean tools (e.g., stainless steel spoon). Samples collected for the analysis of potentially volatile chemicals (e.g., total sulfides, ammonia) will be placed in appropriate sample containers immediately after retrieval to minimize volatilization. Table B2 shows analyses to be conducted.

2.3.2.2 Composite surface sediment sampling

Discrete surface sediment samples will be composited for analysis at the background surface sampling locations (RIWP Figure 5-2). At these locations, surface sediment from the four discrete sampling locations will be composited in a clean stainless steel vessel (e.g., bowl). Composited sediment will be homogenized using stainless steel tools (e.g., spoon), yielding a composite made of sediment from the four discrete sampling locations in that area prior to collection and submittal for analysis. At each location where sediment will be composited, discrete samples will also be archived for potential future analysis. Table B2 shows analyses to be conducted.

2.3.2.3 Porewater sampling

Samples to determine porewater sulfides will be obtained at seven locations specified in Table B2. Bulk sediment samples will be collected and immediately placed in a container (Table B2). Once received by the laboratory, porewater will be extracted from the bulk sediment and then preserved with zinc acetate prior to analysis.

2.3.3 Field observations

When a sample is determined to be acceptable, the overlying water will be removed and then a photograph of the grab surface will be taken. Notes will be taken to characterize the sediment (i.e. color, odor, sediment texture, presence of debris, presence of sheen, distinct color change in shallow sediments [apparent redox potential discontinuity depth], presence of woodwaste, etc.). Visual description will follow the Unified Soil Classification System.

2.3.4 Analyses

After homogenization, sediment from this composite will be placed into laboratory provided containers and stored on ice (at 0 to 6°C) until submitted to laboratories for analysis. Surface sediment samples will be analyzed for the analytes shown in Table B2.

2.4 Bioassay sampling procedures

Discrete surface sediment samples will be collected for bioassay analysis as described in Section 2.3. At locations where bioassays are proposed, a separate five-liter aliquot of the surface sediment sample will be placed in a poly bag provided by EcoAnalysts, Inc. If needed, the pneumatic power grab sampler will be advanced multiple times to yield sufficient volume. This bag will be stored on ice (at 0 to 6°C) until it is submitted to EcoAnalysts for bioassay analysis.

As is outlined in SCUM II, acute and chronic ecological toxicity testing will be performed to assess the effects of sediment contamination on benthic organisms. These data will be used as a primary line of evidence to assess potential adverse effects related to chemical contamination and/or the presence of woodwaste in sediment. Bioassays evaluate the toxicity of sediment to the benthic community more holistically than screening individual chemicals against screening criteria (Ecology 2017). Specifically, bioassays account for bioavailability of contaminants to benthic organisms, other-than-additive effects of chemical mixtures in sediments, and toxicity of non-chemical stressors such as woodwaste (Ecology 2017). Bioassay testing will be conducted by EcoAnalysts, Inc. as described in their standard operating procedures (Appendix B1). Briefly, samples will be analyzed via three bioassays: 10-Day Acute Sediment Toxicity Test with Marine Amphipods, Puget Sound Estuary Protocols (PSEP) Chronic Larval Sediment Toxicity Test, and the 20-Day Chronic Growth and Survival Test with *Neanthes arenaceodentata*. Bioassays will be conducted following PSEP 1995 methodologies with modifications specified in SCUM II and/or the USACE Seattle Corps User Manual (USACE 2018; Ecology 2017).

Three reference sediment samples for bioassay control testing will be collected by EcoAnalysts from Carr Inlet in Puget Sound, Washington. The actual locations of the reference stations will be selected to closely match the grain size characteristics of the sampled material test sediments. The reference sediment samples are tested concurrently with each bioassay and this reference sample is used to estimate non-treatment effects due to grain size. All reference sediments will be analyzed for total solids, total organic carbon, bulk ammonia, total sulfides, and grain size.

2.5 Radioisotope sampling and analysis procedure

Two sediment cores will be collected for radioisotope analysis (RIWP Figure 5-1). Each core will be collected using a vibracore, with the widest diameter sampling tube available (e.g., 2-, 3- or 4-inch inner diameter, as practicable). Cores will be collected to 8-feet bml, or to the depth where refusal is observed using the same procedures identified in Section 2.1.1. Each core will be sectioned every 1 cm in the top 20 cm below mudline (bml), every 2 cm from 20-40 cm bml, and in 5 cm increments below 40 cm bml, as determined in coordination with Flett Research. Samples will be collected in clean, heavy-walled, water-tight polypropylene jars provided to MFA by Flett Research. Effort will be made to retain water from the core slices will be retained in sample jars to ensure accurate characterization of the bulk density of the cores.

After core collection and sectioning, samples will be submitted to Flett Research, Ltd. for radioisotope analysis of the cores. The complete approach to radioisotope analysis will be developed collaboratively between scientists from Flett Research and MFA and will be informed by the core composition and recovery, as well as by preliminary Pb-210 data for each core (Appendix B2). The general radiosotope analysis procedure for each sediment core is described below. Specifics of the radioisotope analytical methodologies are described in the Radioisotope Method Summary provided by Flett Research, Ltd. (Appendix B2).

For each sediment core, the first step will be to analyze seven sections, spread along the core length, for Pb-210. Flett Research scientists will use their professional judgement to choose these seven sections for each core. This data will be used to determine the basic profile shape of Pb-210. Additional sections along the length of the core will be analyzed as the Pb-210 profile dictates. In total 15—20 sections along the length of each core will generally be analyzed for Pb-210. In order to positively determine the Pb-210 background level(s), two or more Ra-226 measurements will be made for each sediment core. After Pb-210 and Ra-226 analyses are completed, 8—15 Cs-137 analyses may be used to validate the Pb-210 model(s) for each core. Radioisotope modeling data can be used to make inferences about sedimentation rates in the river offshore of the site.

2.6 Positioning

A differential global positioning system (DGPS) will be used to locate the sampling position for each proposed location provided in Table B1. Sampling locations will be determined to an accuracy of ±3 meters. Horizontal coordinates will be referenced to the Washington South State Plane HARN (NAD83). Effort will be made to collect sediment from each location; however, some locations may remain inaccessible. Samples may be field adjusted and will be collected as close as possible to the

intended sample location. The DGPS will be used to record each location that has been field adjusted. Locations may be accessed by boat or by foot (e.g., locations adjacent to the shoreline).

2.7 Nomenclature

Sediment samples will each be labeled an "SE" prefix to indicate a sediment sample, a number to delineate the sampling location, followed by a number to indicate the depth of the sample, in feet. For example, a sediment core collected from 3.0 to 5.0 feet deep at location 01 would have the sample name of SE-01-3.0-5.0. A composited sample will be given the modifier "-COM" in the sample name. For instance, a composited surface sediment sample collected to 10 cm deep (or equivalently 0.33 feet) at location 01 would have the sample name of SE-01-0-0.33-COM. Each discrete sample will be given a unique letter at the end of the sample name. For instance, a discrete surface sediment sample collected to 10 cm deep at location 01 would have the sample name of SE-01-0-0.33-A.

2.8 Equipment Decontamination

Nondisposable and non-dedicated sampling equipment that comes in direct contact with the sample (e.g., scoops, bowls) will be decontaminated before use for each sample, according to the following procedure:

- Distilled-water rinse
- Wash with scrub brush and Alconox™ soap and distilled water solution
- Distilled-water rinse
- Methanol solution rinse (1:1 solution with distilled water)
- Final distilled-water rinse

The sampling tube or grab sampler will be decontaminated before use for each incremental sampling methodology replicate according to the following procedure:

- Rinse with site (river) water
- Wash with scrub brush and Alconox soap and distilled water solution
- Rinse with distilled water

The thoroughness of equipment decontamination will be verified by collection and analysis of equipment rinsate samples. Liquid generated by decontamination will be properly handled, according to procedures specified in Section 3.5.

2.9 Management of Investigation-Derived Waste

Any unused sediment will be returned to the water. Decontamination fluids will be collected and stored in sealed plastic buckets and disposed of through a permitted service provider. Personal protective equipment will be disposed of in a sanitary landfill.

2.10 Field QA/QC Samples

QC samples will be collected to ensure that field samples and quantitative field measurements are representative of the media collected. The field QA/QC sample summary is provided in Table B3 and is as follows:

- **Equipment Rinsate Blanks—**To ensure that decontamination procedures are sufficient, an equipment rinsate blank will be collected when nondedicated equipment is used. Equipment rinsate blanks will be collected by passing laboratory-provided deionized/distilled water through or over sampling equipment and will be submitted for chemical analyses. The rinsate blank results will be evaluated during data quality review.
- **Field Replicates—**Field replicates will be collected to measure sampling and laboratory precision. Field duplicate results will be evaluated during data quality review.

2.11 Work Documentation

Accurate recordkeeping will be maintained throughout the field sampling effort. A field notebook will be prepared documenting the following information:

- Name(s) of the person(s) collecting samples
- Sampling vessel and field staff
- A record of site health and safety meetings and updates
- Weather conditions
- Date and time of collection of each sample
- Representative photographs with sample location ID
- Gross characteristics of the sample, such as organic matter, biota, debris, and sheen
- Physical soil description of the sample consistent with the Unified Soil Classification System (includes soil type, density/consistency of soil, and color). See boring log in Appendix B3.
- Description of material selectively removed from the sample before filling of containers for chemical analysis (e.g., gravel, wood debris)
- Any deviation from the Ecology-approved SAP

2.12 Sample Containers, Preservation, and Transport

Sample container, preservations, and holding-time requirements are summarized in Table B2. All sediment chemistry samples will be collected in glass jars. Each sample will have an adhesive plastic or waterproof paper label affixed to the container and will be labeled at the time of collection. Samples will be uniquely identified with a sample identification that, at a minimum, specifies sample name,

sample location, and sample date/time. Sample containers, sample coolers, and packing materials will be supplied by the laboratory. The laboratory will maintain documentation certifying the cleanliness of containers provided. The samples will be stored in iced coolers at 4° $\pm$ 2 Celsius unless otherwise noted in Table B2.

2.13 Sample Custody, Packaging, and Shipping

Sample custody will be tracked from point of origin through final analysis and disposal, using a COC form, which will be filled out with the appropriate sample and analytical information as soon as possible after samples are collected. For purposes of this work, custody will be defined as follows:

- In plain view of MFA field representatives
- Inside a cooler that is in plain view of MFA field representatives
- Inside any locked space such as a cooler, locker, car, or truck to which the MFA field representatives have the only available key(s)

After sample containers have been filled, they will be packed on ice in coolers and then transported to the laboratory in iced shipping containers (with a custody seal affixed).

COC procedures will begin in the field and will track delivery of the samples to the laboratories. Specific procedures are as follows:

- Samples will be packaged and shipped in accordance with U.S. Department of Transportation regulations as specified in 49 Code of Federal Regulations (CFR) 173.6 and 49 CFR 173.24.
- Individual sample containers will be packed to prevent breakage.
- A sealed envelope containing COC forms will be enclosed in a plastic bag inside the cooler.
- Signed and dated COC seals will be placed on all coolers before shipping.

Upon transfer of samples to the laboratory, the COC form will be signed by the persons transferring custody of the coolers. Upon receipt of samples at the laboratory, the shipping container seal will be broken, and the condition of the samples will be recorded by the receiver. Copies of the COC will be included in laboratory reports and data validation memoranda.

2.14 Field Instrumentation

Staff or subcontractors responsible for navigation will confirm proper operation of the navigation equipment daily. This verification may consist of internal diagnostics or visiting a location with known coordinates to confirm the coordinates indicated by the navigation system. No other field equipment requires calibration. Any issues will be noted in the field notebook and corrected before sampling operations continue.

3 LABORATORY MEASUREMENTS AND PROCEDURES

3.1 Laboratory Test Methods and Reporting Limits

Chemical testing will be conducted using the analytical methods and detection limits presented in Table B4. A laboratory that can achieve detection limits lower than those required by the associated USEPA method will be selected. Samples will be maintained according to the appropriate holding times and temperatures for each analysis.

3.2 Laboratory Instrumentation

Laboratory QA/QC will be maintained through the use of standard USEPA methods, based on USEPA test methods for evaluating solid waste, physical/chemical methods (also known as SW-846) requirements, as amended (USEPA, 1986). Table B4 presents the data quality objectives, while Table B3 summarizes general laboratory QA/QC procedures. The laboratory will also meet QA/QC requirements specified in the 2010 Dredged Material Management Program (DMMP) clarification paper (Hoffman and Fox, 2010). If the laboratory does not meet QA/QC acceptance limits, particularly if estimated maximum potential concentration qualifiers are anticipated, MFA will be contacted and corrective actions consistent with DMMP requirements will be taken (Hoffman and Fox, 2010).

3.2.1 Preventive Maintenance

Preventive maintenance of laboratory equipment will be the responsibility of the laboratory personnel and analysts. This maintenance includes routine care and cleaning of instruments, and inspection and monitoring of carrier gases, solvents, and glassware used in analyses. The preventive-maintenance approach for specific equipment will follow the manufacturers' specifications and good laboratory practices.

Precision and accuracy data will be examined for trends and excursions beyond control limits to determine evidence of instrument malfunction. Maintenance will be performed when an instrument begins to change, as indicated by the degradation of peak resolution, shift in calibration curves, decrease in sensitivity, or failure to meet any of the QC criteria.

3.2.2 Laboratory QA/QC Checks

QC samples and procedures verify that an instrument is calibrated properly and remains in calibration throughout the analytical sequence, and that the sample preparation procedures have been effective and have not introduced contaminants into the samples. Additional QC samples are used to identify and quantify positive or negative interference caused by the sample matrix. The following laboratory QC procedures are required for most analytical procedures and are summarized in Table B3:

- **Calibration Verification—**Initial calibration of instruments will be performed at the start of the project or sample run, as required, and when any ongoing calibration does not meet control criteria. The number of points used in the initial calibration is defined in the analytical method. To track instrument performance, continuing calibration will be performed as specified in the analytical method. If a continuing calibration does not meet control limits, analysis of project samples will be suspended until the source of the control failure is either eliminated or reduced to within control specifications. Any project samples analyzed while the instrument was outside control limits will be reanalyzed.
- **Method Blanks—**Method blanks are used to assess possible laboratory contamination of samples associated with all stages of preparation and analysis of samples and extracts. The laboratory will not apply blank corrections to the original data. A minimum of one method blank will be analyzed for every sample extraction group, or one for every 20 samples, whichever is more frequent.
- **Laboratory Control Samples (LCSs)—**LCSs are fortified with target analytes to provide information on analysis accuracy. Analyses of LCSs will be performed by the lab at a frequency that satisfies the analytical method requirements.
- **Laboratory Duplicates—**Laboratory duplicates are used to assess laboratory batch precision associated with all stages of preparation and analysis of samples and extracts. Laboratory duplicates will be analyzed according to method frequency requirements.
- **Surrogate Spike Compounds—**Surrogate spikes are used to evaluate the recovery of an analyte from individual samples. All project samples to be analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analysis method, i.e., carbon-13 labeled internal standards for the dioxin method. Recoveries determined using these surrogate compounds will be reported by the laboratory; however, the laboratory will not correct sample results using these recoveries.

3.3 Data Reduction, Validation, and Reporting

The analytical laboratory will submit analytical data packages that include laboratory QA/QC results to permit independent and conclusive determination of data quality. Data quality will be determined by MFA, using the data evaluation procedures described in this section. The results of the MFA evaluation will be used to determine if the project data quality objectives have been met.

3.3.1 Field Data Reduction

Daily internal QC checks will be performed for field activities. Checks will consist of reviewing field notes and field activity memoranda to confirm that the specified measurements and procedures are being used. The need for corrective action will be assessed on an ongoing basis, in consultation with the project manager.

3.3.2 Laboratory Evaluation

Initial data reduction, evaluation, and reporting at the analytical laboratory will be carried out as described in USEPA SW-846 manuals for organic and inorganic analyses (USEPA, 1986), as appropriate. Additional laboratory data qualifiers may be defined and reported to further explain the laboratory's QC concerns about a particular sample result. All additional data qualifiers will be defined in the laboratory's case narrative report associated with each case.

3.3.3 Data Deliverables

Laboratory data deliverables are listed below. Electronic deliverables will contain the same data that are presented in the hard copy report.

- Transmittal cover letter
- Case narrative
- Analytical results
- COC documentation
- Surrogate recoveries
- Method blank results
- LCS results
- Laboratory duplicate results

3.3.4 Data QA/QC Review

MFA will evaluate the laboratory data for precision, completeness, accuracy, and compliance with the analytical method. Dioxin data will be reported consistent with recent dioxin data treatment guidance (Ecology, 2017). The data review will include an assessment of laboratory performance criteria and will be consistent with the USEPA national functional guidelines (USEPA, 2017a; USEPA, 2017b). Results of the data review will be provided as a memorandum to be included with the data report and lab result sheets. Ecology will be notified before development of the data review memorandum if laboratory results indicate any significant data quality issues.

Data qualifiers, as defined by the USEPA, are used to classify sample data according to their conformance to QC requirements. The most common qualifiers are listed below:

- J—Estimate, qualitatively correct but quantitatively suspect
- R—Reject, data not suitable for any purpose
- U—Not detected at a specified reporting limit

Poor surrogate recovery, blank contamination, or calibration problems, among other things, can cause the sample data to be qualified. Whenever sample data are qualified, the reasons for the qualification will be stated in the data evaluation report.

QC criteria not defined in the guidelines for evaluating analytical data are adopted, where appropriate, from the analytical method.

The following information will be reviewed during data evaluation, as applicable:

- Sampling locations and blind sample numbers
- Sampling dates
- Requested analysis
- COC documentation
- Sample preservation
- Holding times
- Method blanks
- Surrogate recoveries
- Laboratory duplicates (if analyzed)
- Field replicates
- Field blanks
- LCSs
- Method reporting limits above requested levels
- Any additional comments or difficulties reported by the laboratory
- Overall assessment

The results of the data evaluation review will be summarized for each data package. Data qualifiers will be assigned to sample results on the basis of USEPA guidelines, as applicable.

3.3.5 Data Management and Reduction

MFA uses EQuIS environmental data management software to manage all laboratory data. The laboratory will provide the analytical results in electronic EQuIS-deliverable format. Following data evaluation, data qualifiers and analytical results will be entered into MFA's EQuIS database as well as into Ecology's Environmental Information Management (EIM) database. Consistent with Washington Administrative Code 173-340-840(5) and Ecology Toxics Cleanup Program Policy 840 (Data Submittal Requirements), data will be submitted simultaneously in both written and electronic formats.

Data may be reduced to summarize particular data sets and to aid interpretation of the results. Statistical analyses may also be applied to results. Data reduction QC checks will be performed on all hand-entered data, any calculations, and any data graphically displayed. Data may be further reduced and managed using one or more of the following computer software applications:

- Microsoft Excel® (spreadsheet)
- EQuIS (database)
- Ecology's EIM (database)

- AutoCad and/or Arc GIS (graphics)
- USEPA ProUCL (statistical software)

4 REPORTING

Ecology will be notified in writing at least two weeks before monitoring activities begin. A data report will be prepared and submitted to Ecology within 30 days of receipt and validation of all analytical data. Data will be submitted to Ecology's EIM data system at the same time the final report is submitted. The data report will include a brief summary of data collection procedures (noting, in particular, deviations from this SAP); sampling locations; summary of field notes; analytical results; a data validation memorandum; and data interpretation. Data interpretation will focus on the following

- Evaluation of surface and subsurface sediment concentrations relative to screening levels.
- Comparison of sediment chemistry data to co-located bioassay data.
- Evaluation of woodwaste observations and chemistry data.
- Evaluation of bioassay results relative to typical chemical parameters associated with woodwaste toxicity.
- Evaluation of TCLP results relative to applicable RCRA criteria.
- Interpretation of radioisotope results as an indicator of sediment deposition rates.

LIMITATIONS

The services undertaken in completing this plan were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This plan is solely for the use and information of our client unless otherwise noted. Any reliance on this plan by a third party is at such party's sole risk.

Opinions and recommendations contained in this plan apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this plan.

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TABLES

MAUL FOSTER ALONGI

Table B1
Sample Summary
Seaport Landing Tidelands Remedial Investigation Workplan

Location	X Coordinates	Y Coordinates	Sample Interval	Type	SMS Chemistry	Woodwaste Chemistry	SMS Chemistry Archive	Sediment Description	Grainsize	Bioassay	Porewater pH & salinity	Porewater sulfides	TCLP	Radioisotope
SE-01a (Start)	46.97444108	-123.797476	1 foot interval closest to surface with significant woodwaste	Woodwaste transect at 50 to 100 foot intervals	Opportunistic, as needed	1+	1+	1+	--	--	--	--	--	--
SE-01x (Target Direction)	46.97474725	-123.7958364												
SE-02a (Start)	46.97451979	-123.7981529	1 foot interval closest to surface with significant woodwaste	Woodwaste transect at 50 to 100 foot intervals	Opportunistic, as needed	1+	1+	1+	--	--	--	--	--	--
SE-02x (Target Direction)	46.97497297	-123.7966047												
SE-03a (Start)	46.97439956	-123.7994243	1 foot interval closest to surface with significant woodwaste	Woodwaste transect at 50 to 100 foot intervals	Opportunistic, as needed	1+	1+	1+	--	--	--	--	--	--
SE-03x (Target Direction)	46.97483952	-123.7978425												
SE-04a (Start)	46.97535662	-123.7959265	1 foot interval closest to surface with significant woodwaste	Woodwaste transect at 50 to 100 foot intervals	Opportunistic, as needed	1+	1+	1+	--	--	--	--	--	--
SE-04x (Target Direction)	46.97621446	-123.795572												
SE-05a (Start)	46.97529858	-123.7954432	1 foot interval closest to surface with significant woodwaste	Woodwaste transect at 50 to 100 foot intervals	Opportunistic, as needed	1+	1+	1+	--	--	--	--	--	--
SE-05x (Target Direction)	46.97497159	-123.7942377												
SE-06a (Start)	46.97499624	-123.795902	1 foot interval closest to surface with significant woodwaste	Woodwaste transect at 50 to 100 foot intervals	Opportunistic, as needed	1+	1+	1+	--	--	--	--	--	--
SE-06x (Target Direction)	46.97534806	-123.7974329												
SE-07a (Start)	46.97359055	-123.8000223	1 foot interval closest to surface with significant woodwaste	Woodwaste transect at 50 to 100 foot intervals	Opportunistic, as needed	1+	1+	1+	--	--	--	--	--	--
SE-07x (Target Direction)	46.97460766	-123.8008759												
SE-08a (Start)	46.97411458	-123.7992839	1 foot interval closest to surface with significant woodwaste	Woodwaste transect at 50 to 100 foot intervals	Opportunistic, as needed	1+	1+	1+	--	--	--	--	--	1
SE-08x (Target Direction)	46.97456763	-123.7977114												
SE-09	46.97428462	-123.795395	3-5 feet[a]	Subsurface Targeted	Standard list	1	3	1	1	--	1	--	Hg and Pb	--
SE-10	46.97364373	-123.79979	3-5 feet[a]	Subsurface Targeted	Standard list+TPH-Gx	1	3	1	1	--	1	--	Hg and Pb	--
SE-11	46.97352052	-123.799717	3-5 feet[a]	Subsurface Targeted	Standard list+TPH-Gx	1	3	1	1	--	1	--	Hg and Pb	--
SE-12	46.97391173	-123.7999954	3-5 feet[a]	Subsurface Targeted	Standard list	1	3	1	1	--	1	--	Hg and Pb	1
SE-13	46.97374072	-123.800282	0-0.33 feet	Surface	Standard list+Duplicate	1+Duplicate	--	1+Duplicate	1	1	1	--	--	--
SE-14	46.97362128	-123.7999958	0-0.33 feet	Surface	Standard list+dioxin	1	--	1	1	--	1	1	--	--
SE-15	46.97406155	-123.7993792	0-0.33 feet	Surface	Standard list	1	--	1	1	1	1	--	--	--
SE-16	46.97436014	-123.7986805	0-0.33 feet	Surface	Standard list	1	--	1	1	1	1	1	--	--
SE-17	46.9743013	-123.7975781	0-0.33 feet	Surface	Standard list	1	--	1	1	1	1	--	--	--
SE-18	46.97455036	-123.7975798	0-0.33 feet	Surface	Standard list	1	--	1	1	1	1	1	--	--
SE-19	46.97524465	-123.7957023	0-0.33 feet	Surface	Standard list	1	--	1	1	1	1	--	--	--
SE-20	46.9742391	-123.7952796	0-0.33 feet	Surface	Standard list	1	--	1	1	1	1	1	--	--
SE-21	46.97571169	-123.7935234	0-0.33 feet	Surface Composite (Background)	Standard list+dioxin	1	1	1	--	--	1	--	--	--
	46.97586189	-123.7936385					1							
	46.97578931	-123.7935797					1							
	46.97563406	-123.7934672					1							
SE-22	46.97278163	-123.7960448	0-0.33 feet	Surface Composite (Background)	Standard list+dioxin	1	1	1	--	--	1	--	--	--
	46.97261819	-123.796043					1							
	46.97255249	-123.7960507					1							
	46.97270748	-123.7960402					1							
SE-23	46.97395521	-123.7999834	0-0.33 feet	Surface	Standard list	1	--	1	1	--	1	--	--	--
SE-24	46.97384374	-123.7999094	0-0.33 feet	Surface	Standard list	1	--	1	1	1	1	1	--	--

MAUL FOSTER ALONGI

Table B1
Sample Summary
Seaport Landing Tidelands Remedial Investigation Workplan

Location	X Coordinates	Y Coordinates	Sample Interval	Type	SMS Chemistry	Woodwaste Chemistry	SMS Chemistry Archive	Sediment Description	Grainsize	Bioassay	Porewater pH & salinity	Porewater sulfides	TCLP	Radioisotope
SE-25	46.97372659	-123.7998245	0-0.33 feet	Surface	Standard list	1	--	1	1	--	1	--	--	--
SE-26	46.97360569	-123.7997505	0-0.33 feet	Surface	Standard list+TPH-Gx	1	--	1	1	1	1	1	--	--
SE-27	46.97394061	-123.7992915	0-0.33 feet	Surface	Standard list	1	--	1	1	--	1	--	--	--
SE-28	46.97448161	-123.7962432	0-0.33 feet	Surface	--	1	1	1	--	--	1	1	--	--

Notes:

[a] A 2 foot interval that includes the midpoint of the core retrieved will be analyzed; 3-5 foot is based on assumption that 8 foot core is retreived. Other 2 foot intervals from the core will be archived for potential analysis.

1+ = A minimum of one sample from one core along the transect will be analyzed, assuming significant woodwaste is present. Additional samples from additional cores may be analyzed as determined in the field.

Coordinate system is NAD 1983 State Plane Washington South.

Hg = mercury.

Pb = lead.

Standard list = metals, semivolatile organic compounds, polychlorinated biphenyls, TPH-Dx, total organic carbon.

Woodwaste Chemistry = total volatile soilds, sulfide, ammonia, total solids, total oragnic carbon.

MAUL FOSTER ALONGI

Table B2
Sample Preservation and Containers
Seaport Landing Tidelands Remedial Investigation Workplan

Sampling Type	Analysis	Method	Container	Preservative	Holding Time at 0 to 6 °C	Holding Time at -18 °C
Surface Sediment	Metals (As, Cd, Cr, Cu, Pb, Ni, Se, Ag, Zn)	USEPA 6020A	16 oz glass	0 to 6 degrees C	6 months	2 years
	Mercury	USEPA 7471B			28 days	28 days
	Diesel- and Residual-Range Hydrocarbons	NWTPH-Dx (silica gel cleanup)			14 days	1 year
	SVOCs	USEPA 8270D			14 days	1 year
	PCB Aroclors	USEPA 8082A			14 days	1 year
	Ammonia as Nitrogen	Plumb, 1981/SM 4500-NH3			7 days	Do not freeze
	Total Organic Carbon	USEPA 9060A			14 days	6 months
	Total Solids	PSEP, 1986/SM 2540G			14 days	6 months
	Gasoline-Range Hydrocarbons	USEPA 5035A/NWTPH-Gx	5035 kit	5035 kit/0 to 6 degrees C	14 days	Do not freeze
	Total Volatile Solids	PSEP, 1986	4 oz glass	0 to 6 degrees C	14 days	6 months
	Sulfide	PSEP/SM 4500-S	4 oz glass, no headspace	Zn Acetate/0 to 6 degrees C	7 days	Do not freeze
	Porewater Sulfide	PSEP/SM 4500-S	16 oz glass	Zn Acetate/0 to 6 degrees C [(a)]	7 days [(a)]	Do not freeze
	Grain Size	PSEP, 1986/ASTM D422	16 oz glass	NA	6 months	Do not freeze
	Archive	NA	16 oz glass	0 to 6 degrees C	--	--
Surface Sediment Bioassays	Marine Bioassay	PSEP, 1986 [(b)]	Poly bag	0 to 6 degrees C	14 days	Do not freeze
	Archive (Co-Located)	NA	Poly bag	0 to 6 degrees C	--	--

MAUL FOSTER ALONGI

Table B2
Sample Preservation and Containers
Seaport Landing Tidelands Remedial Investigation Workplan

Sampling Type	Analysis	Method	Container	Preservative	Holding Time at 0 to 6 °C	Holding Time at -18 °C
Subsurface Sediment	Metals (As, Cd, Cr, Cu, Pb, Ni, Se, Ag, Zn)	USEPA 6020A	16 oz glass	0 to 6 degrees C	6 months	2 years
	Mercury	USEPA 7471B			28 days	28 days
	Diesel- and Residual-Range Hydrocarbons	NWTPH-Dx (silica gel cleanup)			14 days	1 year
	SVOCs	USEPA 8270D			14 days	1 year
	PCB Aroclors	USEPA 8082A			14 days	1 year
	Ammonia as Nitrogen	Plumb, 1981/SM 4500-NH3			7 days	Do not freeze
	Total Organic Carbon	USEPA 9060A			14 days	6 months
	Total Solids	PSEP, 1986/SM 2540G			14 days	6 months
	Gasoline-Range Hydrocarbons	USEPA 5035A/NWTPH-Gx	5035 kit	5035 kit/0 to 6 degrees C	14 days	Do not freeze
	Total Volatile Solids	PSEP, 1986	4 oz amber glass	0 to 6 degrees C	14 days	6 months
	Sulfide	PSEP/SM 4500-S	4 oz glass, no headspace	Zn Acetate/0 to 6 degrees C	7 days	Do not freeze
	Grain Size	PSEP, 1986/ASTM D422	16 oz glass	0 to 6 degrees C	6 months	Do not freeze
	Archive	NA	16 oz glass	0 to 6 degrees C	--	--
Waste Characterization	TCLP (Pb and Hg)	USEPA 1311/6020A/7471B	16 oz glass	0 to 6 degrees C	6 months	Do not freeze

MAUL FOSTER ALONGI

Table B2
Sample Preservation and Containers
Seaport Landing Tidelands Remedial Investigation Workplan

Sampling Type	Analysis	Method	Container	Preservative	Holding Time at 0 to 6 °C	Holding Time at -18 °C
Woodwaste Investigation Areas	Total Volatile Solids	PSEP, 1986	4 oz amber glass	0 to 6 degrees C	14 days	1 year
	Sulfide	PSEP/SM 4500-S	4 oz glass, no headspace	0 to 6 degrees C	7 days	Do not freeze
	Ammonia as Nitrogen	Plumb, 1981/SM 4500-NH3	8 oz glass	0 to 6 degrees C	7 days	Do not freeze
	Total Organic Carbon	USEPA 9060A			14 days	6 months
	Total Solids	PSEP, 1986/SM 2540G			14 days	6 months
Radioisotopes	Radioisotope Analysis (Lead-210, Radium-226, Cesium-137)	Flett Research Analytical Methods	Polypropylene jars	NA	NA	NA

NOTES:

ASTM = ASTM International.

°C = degrees Celsius.

Comp = composite sample.

NA = not applicable.

NWTPH = northwest total petroleum hydrocarbon.

oz = ounces.

PAH = polycyclic aromatic hydrocarbon.

PCB = polychlorinated biphenyl.

PSEP = Puget Sound Estuary Program.

SM = Standard Methods for the Examination of Water and Wastewater.

SVOC = semivolatile organic compound.

TBD = to be determined.

USEPA = US Environmental Protection Agency.

[a] Preservation noted is required following extraction of porewater in the laboratory; holding time applies once porewater has been extracted and preserved.

[b] Three-species PSEP suite will be conducted (including embryo-larval development, 10-day amphipod, and 20-day polycheate tests).

Table B3
Quality Control Sample Summary
Seaport Landing Tidelands Remedial Investigation Workplan

Quality Control Check Sample	Frequency
Equipment Rinsate Blanks	One per every twenty samples (or fewer) collected with non-dedicated and non-disposable equipment.
Field Duplicate Samples	One
Method Blanks	Each analytical batch of samples for every 20 (or fewer) samples received
Laboratory Control Sample	Each analytical batch of samples for every 20 (or fewer) samples received
Laboratory Duplicate Sample	Each analytical batch of samples for every 20 (or fewer) samples received
Matrix Spike/Matrix Spike Duplicate	Each analytical batch of samples for every 20 (or fewer) samples received
Surrogate Spiking	Added to all project and QC samples (for organic analyses only)

NOTES:

QC = quality control.

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Table B4
Sediment Sampling Quality Control Limits
Seaport Landing Tidelands Remedial Investigation Workplan

Analyte	Method	SMS Marine Sediment Criteria			Reporting Limits[c,d]			MS/MSD Accuracy (%)	MS/MSD RPD Precision(%)	LCS/LCSD Accuracy (%)	LCS/LCSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Completeness (%)
		SCO	CSL	Units	MDL	PQL	Units						
Metals, Total													
Arsenic	USEPA 6020A	57	93	mg/kg-dw	0.481	0.962	mg/kg-ww	75-125	40	80-120	20	40	90
Cadmium	USEPA 6020A	5.1	6.7	mg/kg-dw	0.0962	0.192	mg/kg-ww	75-125	40	80-120	20	40	90
Chromium	USEPA 6020A	260	270	mg/kg-dw	0.481	0.962	mg/kg-ww	75-125	40	80-120	20	40	90
Copper	USEPA 6020A	390	390	mg/kg-dw	1.92	3.85	mg/kg-ww	75-125	40	80-120	20	40	90
Lead	USEPA 6020A	450	530	mg/kg-dw	0.0962	0.192	mg/kg-ww	75-125	40	80-120	20	40	90
Mercury	USEPA 7471B	0.41	0.59	mg/kg-dw	0.0385	0.0769	mg/kg-ww	75-125	40	80-120	20	40	90
Nickel	USEPA 6020A	--	--	--	0.481	0.962	mg/kg-ww	75-125	40	80-120	20	40	90
Selenium	USEPA 6020A	--	--	--	0.481	0.962	mg/kg-ww	75-125	40	80-120	20	40	90
Silver	USEPA 6020A	6.1	6.1	mg/kg-dw	0.0962	0.192	mg/kg-ww	75-125	40	80-120	20	40	90
Zinc	USEPA 6020A	410	960	mg/kg-dw	1.92	3.85	mg/kg-ww	75-125	40	80-120	20	40	90
Metals, TCLP													
Lead	USEPA 1311/6020A	--	--	--	--	0.05	mg/L	50-150	40	80-120	20	40	90
Mercury	USEPA 1311/7470A	--	--	--	--	0.007	mg/L	50-150	40	80-120	20	40	90
TPH													
Diesel Range Hydrocarbons	NWTPH-Dx	--	--	--	8.33	25	mg/kg-ww	50-150	20	76-115	20	30	90
Lube Oil Range Hydrocarbons	NWTPH-Dx	--	--	--	16.7	50	mg/kg-ww	--	--	--	--	30	90
Gasoline Range Hydrocarbons	NWTPH-Gx	--	--	--	1.67	3.33	mg/kg-ww	50-150	20	80-120	20	30	90
PCB Aroclors													
Aroclor 1016	USEPA 8082A	--	--	--	0.14	5	mg/kg-ww	70-130	20	70-140	20	--	90
Aroclor 1232	USEPA 8082A	--	--	--	0.103	5	mg/kg-ww	70-130	20	82-122	20	--	90
Aroclor 1242	USEPA 8082A	--	--	--	0.155	5	mg/kg-ww	70-130	20	78-138	20	--	90
Aroclor 1248	USEPA 8082A	--	--	--	0.125	5	mg/kg-ww	70-130	20	70-164	20	--	90
Aroclor 1254	USEPA 8082A	--	--	--	0.171	5	mg/kg-ww	70-130	20	72-134	20	--	90
Aroclor 1260	USEPA 8082A	--	--	--	0.128	5	mg/kg-ww	70-130	20	76-134	20	--	90
Total PCBs	USEPA 8082A/Calculation	12	65	mg/kg-OC	--	--	mg/kg-ww	--	--	--	--	--	--
Dioxins/Furans													
1,2,3,4,6,7,8-HpCDD	USEPA 1613B	--	--	--	0.14	5	ng/kg-ww	70-130	20	70-140	20	--	90
1,2,3,4,6,7,8-HpCDF	USEPA 1613B	--	--	--	0.103	5	ng/kg-ww	70-130	20	82-122	20	--	90
1,2,3,4,7,8,9-HpCDF	USEPA 1613B	--	--	--	0.155	5	ng/kg-ww	70-130	20	78-138	20	--	90
1,2,3,4,7,8-HxCDD	USEPA 1613B	--	--	--	0.125	5	ng/kg-ww	70-130	20	70-164	20	--	90
1,2,3,4,7,8-HxCDF	USEPA 1613B	--	--	--	0.171	5	ng/kg-ww	70-130	20	72-134	20	--	90
1,2,3,6,7,8-HxCDD	USEPA 1613B	--	--	--	0.128	5	ng/kg-ww	70-130	20	76-134	20	--	90
1,2,3,6,7,8-HxCDF	USEPA 1613B	--	--	--	0.176	5	ng/kg-ww	70-130	20	84-130	20	--	90
1,2,3,7,8,9-HxCDD	USEPA 1613B	--	--	--	0.131	5	ng/kg-ww	70-130	20	64-162	20	--	90
1,2,3,7,8,9-HxCDF	USEPA 1613B	--	--	--	0.24	5	ng/kg-ww	70-130	20	78-130	20	--	90
1,2,3,7,8-PeCDD	USEPA 1613B	--	--	--	0.121	5	ng/kg-ww	70-130	20	70-142	20	--	90
1,2,3,7,8-PeCDF	USEPA 1613B	--	--	--	0.095	5	ng/kg-ww	70-130	20	80-134	20	--	90
2,3,4,6,7,8-HxCDF	USEPA 1613B	--	--	--	0.183	5	ng/kg-ww	70-130	20	70-156	20	--	90
2,3,4,7,8-PeCDF	USEPA 1613B	--	--	--	0.0812	5	ng/kg-ww	70-130	20	68-160	20	--	90
2,3,7,8-TCDD	USEPA 1613B	--	--	--	0.0884	1	ng/kg-ww	70-130	20	67-158	20	--	90

Table B4
Sediment Sampling Quality Control Limits
Seaport Landing Tidelands Remedial Investigation Workplan

Analyte	Method	SMS Marine Sediment Criteria			Reporting Limits[c,d]			MS/MSD Accuracy (%)	MS/MSD RPD Precision(%)	LCS/LCSD Accuracy (%)	LCS/LCSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Completeness (%)
		SCO	CSL	Units	MDL	PQL	Units						
2,3,7,8-TCDF	USEPA 1613B	--	--	--	0.094	1	ng/kg-ww	70-130	20	75-158	20	--	90
OCDD	USEPA 1613B	--	--	--	0.183	10	ng/kg-ww	70-130	20	78-144	20	--	90
OCDF	USEPA 1613B	--	--	--	0.179	10	ng/kg-ww	70-130	20	63-170	20	--	90
Conventionals													
Total Volatile Solids	PSEP, 1986	--	--	--	--[a]	--[a]	mg/kg-ww	50-150	35	60-135	30	--	90
Sulfide	Plumb, 1981/USEPA 9034/9030/SM 4500-S2	--	--	--	0.38	0.5	mg/kg-ww	--	--	80-120	20	25	90
Ammonia as Nitrogen	Plumb, 1981/SM 4500-NH3	--	--	--	0.05	0.1	mg/kg-ww	75-125	20	80-120	20	25	90
Total Organic Carbon	USEPA 9060A	--	--	--	--	200	mg/kg-ww	--	--	90-110	--	20	90
Total solids	PSEP, 1986/SM 2540G	--	--	--	--	1.0	%	--	--	--	--	10	90
Grain Size													
Gravel	PSEP, 1986/ASTM D422	--	--	--	--	0.01	%	--	--	--	--	--	90
Coarse Sand	PSEP, 1986/ASTM D422	--	--	--	--	0.01	%	--	--	--	--	--	90
Medium Sand	PSEP, 1986/ASTM D422	--	--	--	--	0.01	%	--	--	--	--	--	90
Fine Sand	PSEP, 1986/ASTM D422	--	--	--	--	0.01	%	--	--	--	--	--	90
Silt	PSEP, 1986/ASTM D422	--	--	--	--	0.01	%	--	--	--	--	--	90
Clay	PSEP, 1986/ASTM D422	--	--	--	--	0.01	%	--	--	--	--	--	90
Marine Bioassay													
Puget Sound Estuary Protocols (PSEP) Chronic Larval Sediment Toxicity Test	PSEP, 1985-Modified	--	--	--	NA	NA	NA	--	--	--	--	--	90
10-Day Acute Sediment Toxicity Test with Marine Amphipods	PSEP, 1985-Modified	--	--	--	NA	NA	NA	--	--	--	--	--	90
20-Day Chronic Growth and Survival Test with *Neanthes arenaceodentata*	PSEP, 1985-Modified	--	--	--	NA	NA	NA	--	--	--	--	--	90
Radioisotope Analysis													
Lead-210	Flett Research Analytical Methods	--	--	--	0.05 DPM Po-210/g based on 0.5 g of dry sample[a]	--	--	--	--	--	--	--	90
Cesium-137	Flett Research Analytical Methods	--	--	--	0.3 DPM/g based on 9g of dry sample	--	--	--	--	--	--	--	90
Radium-226	Flett Research Analytical Methods	--	--	--	0.5 DPM Rn-222/g based on 0.5g of dry sample[b]	--	--	--	--	--	--	--	90

Table B4
Sediment Sampling Quality Control Limits
Seaport Landing Tidelands Remedial Investigation Workplan

Analyte	Method	SMS Marine Sediment Criteria			Reporting Limits[c,d]			MS/MSD Accuracy (%)	MS/MSD RPD Precision(%)	LCS/LCSD Accuracy (%)	LCS/LCSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Completeness (%)
		SCO	CSL	Units	MDL	PQL	Units						
SVOCs													
1,2,4-Trichlorobenzene	USEPA 8270D	0.81	1.8	mg/kg-OC	0.00312	0.00625	mg/kg-ww	34-120	30	34-120	30	30	90
1,2-Dichlorobenzene	USEPA 8270D	2.3	2.3	mg/kg-OC	0.00312	0.00625	mg/kg-ww	33-120	30	33-120	30	30	90
1,4-Dichlorobenzene	USEPA 8270D	3.1	9	mg/kg-OC	0.00312	0.00625	mg/kg-ww	31-120	30	31-120	30	30	90
2,4-Dimethylphenol	USEPA 8270D	0.029	0.029	mg/kg-dw	0.00625	0.0125	mg/kg-ww	30-127	30	30-127	30	30	90
2-Methylnaphthalene	USEPA 8270D	38	64	mg/kg-OC	0.0025	0.005	mg/kg-ww	38-122	30	38-122	30	30	90
2-Methylphenol	USEPA 8270D	0.67	0.67	mg/kg-dw	0.00312	0.00625	mg/kg-ww	32-122	30	32-122	30	30	90
3- & 4-Methylphenol (m,p-Cresol)	USEPA 8270D	0.26	2	mg/kg-dw	0.00312	0.00625	mg/kg-ww	34-120	30	34-120	30	30	90
Acenaphthene	USEPA 8270D	16	57	mg/kg-OC	0.00125	0.0025	mg/kg-ww	40-122	30	40-122	30	30	90
Acenaphthylene	USEPA 8270D	66	66	mg/kg-OC	0.00125	0.0025	mg/kg-ww	32-132	30	32-132	30	30	90
Anthracene	USEPA 8270D	220	1200	mg/kg-OC	0.00125	0.0025	mg/kg-ww	47-123	30	47-123	30	30	90
Benzo(a)anthracene	USEPA 8270D	110	270	mg/kg-OC	0.00125	0.0025	mg/kg-ww	49-126	30	49-126	30	30	90
Benzo(a)pyrene	USEPA 8270D	99	210	mg/kg-OC	0.00187	0.00375	mg/kg-ww	45-129	30	45-129	30	30	90
Benzo(ghi)perylene	USEPA 8270D	31	78	mg/kg-OC	0.00125	0.0025	mg/kg-ww	43-134	30	43-134	30	30	90
Benzoic acid	USEPA 8270D	0.65	0.65	mg/kg-dw	0.157	0.312	mg/kg-ww	5-140	30	5-140	30	30	90
Benzyl alcohol	USEPA 8270D	0.057	0.073	mg/kg-dw	0.00625	0.0125	mg/kg-ww	29-122	30	29-122	30	30	90
Bis(2-ethylhexyl)phthalate	USEPA 8270D	47	78	mg/kg-OC	0.0187	0.0375	mg/kg-ww	51-133	30	60-121	30	30	90
Butylbenzylphthalate	USEPA 8270D	4.9	64	mg/kg-OC	0.0125	0.025	mg/kg-ww	48-132	30	48-132	30	30	90
Chrysene	USEPA 8270D	110	460	mg/kg-OC	0.00125	0.0025	mg/kg-ww	50-124	30	50-124	30	30	90
Dibenzo(a,h)anthracene	USEPA 8270D	12	33	mg/kg-OC	0.00125	0.0025	mg/kg-ww	45-134	30	45-134	30	30	90
Dibenzofuran	USEPA 8270D	15	58	mg/kg-OC	0.00125	0.0025	mg/kg-ww	44-120	30	44-120	30	30	90
Diethyl phthalate	USEPA 8270D	61	110	mg/kg-OC	0.0125	0.025	mg/kg-ww	50-124	30	50-124	30	30	90
Dimethyl phthalate	USEPA 8270D	53	53	mg/kg-OC	0.0125	0.025	mg/kg-ww	48-124	30	48-124	30	30	90
Di-n-butyl phthalate	USEPA 8270D	220	1700	mg/kg-OC	0.0125	0.025	mg/kg-ww	51-128	30	51-128	30	30	90
Di-n-octyl phthalate	USEPA 8270D	58	4500	mg/kg-OC	0.0125	0.025	mg/kg-ww	44-140	30	44-140	30	30	90
Fluoranthene	USEPA 8270D	160	1200	mg/kg-OC	0.00125	0.0025	mg/kg-ww	50-127	30	50-127	30	30	90
Fluorene	USEPA 8270D	23	79	mg/kg-OC	0.00125	0.0025	mg/kg-ww	43-125	30	43-125	30	30	90
Hexachlorobenzene	USEPA 8270D	0.38	2.3	mg/kg-OC	0.00125	0.0025	mg/kg-ww	44-122	30	44-122	30	30	90
Hexachlorobutadiene	USEPA 8270D	3.9	6.2	mg/kg-OC	0.00312	0.00625	mg/kg-ww	32-123	30	32-123	30	30	90
Indeno(1,2,3-cd)pyrene	USEPA 8270D	34	88	mg/kg-OC	0.00125	0.0025	mg/kg-ww	45-133	30	45-133	30	30	90
Naphthalene	USEPA 8270D	99	170	mg/kg-OC	0.0025	0.005	mg/kg-ww	35-123	30	35-123	30	30	90
N-Nitrosodiphenylamine	USEPA 8270D	11	11	mg/kg-OC	0.00312	0.00625	mg/kg-ww	38-127	30	38-127	30	30	90
Pentachlorophenol	USEPA 8270D	0.36	0.69	mg/kg-dw	0.0125	0.025	mg/kg-ww	25-133	30	25-133	30	30	90
Phenanthrene	USEPA 8270D	100	480	mg/kg-OC	0.00125	0.0025	mg/kg-ww	50-121	30	50-121	30	30	90
Phenol	USEPA 8270D	0.42	1.2	mg/kg-dw	0.0025	0.005	mg/kg-ww	34-120	30	34-120	30	30	90
Pyrene	USEPA 8270D	1000	1400	mg/kg-OC	0.00125	0.0025	mg/kg-ww	47-127	30	47-127	30	30	90
Total Benzofluoranthenes	USEPA 8270D/Calculation	230	450	mg/kg-OC	--	--	--	--	--	--	--	--	--
Total LPAH	USEPA 8270D/Calculation	370	780	mg/kg-OC	--	--	--	--	--	--	--	--	--
Total HPAH	USEPA 8270D/Calculation	960	5300	mg/kg-OC	--	--	--	--	--	--	--	--	--

Table B4
Sediment Sampling Quality Control Limits
Seaport Landing Tidelands Remedial Investigation Workplan

NOTES:

MS/MSD, LCS/LCSD and laboratory duplicate accuracy and/or precision criteria may be performance-based and updated by the laboratory.

-- = not applicable or no value available.

% = percent.

ASTM = ASTM International.

cPAHs = carcinogenic polycyclic aromatic hydrocarbons.

CSL = cleanup screening level.

DPM = disintegrations per minute.

LCS = laboratory control sample.

LCSD = laboratory control sample duplicate.

MDL = method detection limit.

mg/kg-dw = milligrams per kilogram, dry-weight.

mg/kg-OC = milligrams per kilogram, organic carbon normalized.

mg/kg-ww = milligrams per kilogram, wet-weight.

mg/L = milligrams per liter.

MS = matrix spike.

MSD = matrix spike duplicate.

PAHs = polycyclic aromatic hydrocarbons.

PCBs = polychlorinated biphenyls.

PQL = project quantitation limit.

PSEP = Puget Sound Estuary Protocols.

RPD = relative percent difference.

SA = surface sediment investigation area.

SM = Standard Methods for the Examination of Water and Wastewater.

SS = subsurface sediment investigation area.

SVOCs = semivolatile organic compounds.

TCLP = toxicity characteristic leaching procedure.

TPH = total petroleum hydrocarbons.

USEPA = U.S. Environmental Protection Agency.

WW = woodwaste investigation area.

[a]Lead-210 activity is determined by measurement of its granddaughter, Polonium-210 (Po-210), which is in secular equilibrium with Pb-210 within 2 years of Pb-210 deposition.

[b]Radium-226 (Ra-226) activity is determined by measurement of Radon-222 (Rn-222) emanation.

[c]Reporting limits are listed in wet weight and screening criteria are listed in dry weight.

[d]Reporting limits are estimated based on previous work conducted by the analytical labs, and are subject to change for this project.

APPENDIX B1

BIOASSAY STANDARD OPERATING PROCEDURES

1.0 SCOPE

This test determines the short term, adverse effects of potentially contaminated sediment on marine amphipods. Sediment toxicity testing will be conducted according to procedures outlined in **Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments (1995)**, including modifications from the Sediment Management Annual Review Meeting (SMARM) clarification papers. Other references include **USACE/USEPA (1991) (OTM)** and **USACE/USEPA (1998) (ITM)** (for dredged sediments), **ASTM E 1367**, and **EPA/600/R-94/025**.

2.0 SUMMARY OF TEST

2.1 Approach

Table 1. Conditions for Performing 10-Day Solid Phase Toxicity Testing on Marine Amphipods

Test type	Static Non-renewal*
Test duration	10 Day
Lighting	Ambient and Constant
Test chamber size	1-L glass beaker
Test sediment depth	2 cm (~175 mL)
Test solution volume	775 mL (Chamber Vol. up to 950 mL)
Renewal of test solution	None*
No. of organisms per chamber	20
No. of replicates per treatment	5 test replicates 2 sacrificial chambers (one being the water quality surrogate) recommended minimum
Feeding	None
Test solution aeration	Trickle-flow (sufficient to maintain DO levels above 60% saturation)

* Static renewal, intermittent flow or continuous flow tests may be used where it is necessary to maintain water quality parameters, e.g., dissolved oxygen (DO) or ammonia.

2.2 Physical Requirements

Table 2. Species Specific Test Condition Summaries

Species	*Ampelisca abdita*	*Rhepoxynius abronius*	*Eohaustorius estuaries*	*Leptocheirus plumulosus*[5]
Life Stage Tested	Immature amphipods	Mature amphipods 3-5 mm, mixed sexes	Mature amphipods 3-5 mm, mixed sexes	Mature amphipods 2-4 mm, mixed sexes
Feeding	Will not be fed	Will not be fed	Will not be fed	Will not be fed
Temperature (°C)	20 ± 1	15 ± 1	15 ± 1	25 ± 2
Salinity (ppt)	28 ± 1	28 ± 1	28 ± 1 or ambient[4]	20 ± 2
pH	7-9	7-9	7-9	7-9
DO (≥ 60% Saturation)	4.6 mg/L	5.1 mg/L	5.1 mg/L	4.4 mg/L
Grain Size [1]	> 60% fines (> 20% clay fraction)[2]	< 60% fines	0 – 99.4% silt-clay; Provided clay fraction < 20%[2]	< 70% fines, <70% sand
Total Ammonia (mg/L, pH 7.7)	< 30	< 30	< 60	< 60
Un-ionized Ammonia (mg/L, pH 7.7)	< 0.4	< 0.4	< 0.8	< 0.8
Sulfides	N/A[3]	N/A[3]	N/A[3]	N/A[3]

[1] Grain size distributions are recommended guidelines and should not be considered absolute criteria. Species selection generally includes discussion with regulatory agencies and share holders and can be chosen exclusive from grain size characteristics (i.e. comparison to historical data with same species, species availability, etc.)
[2] SMARM clarification paper: 10/20/99
[3] Specific guidance for sulfide sensitivities have not been well established.
[4] Test salinity for *E. estuarius* may be conducted at the interstitial salinity (ambient) of the test sediments. The target test salinity should be approved by the client or regulatory agency, and will vary agency depending upon the objectives of the testing program.
[5] Direct guidance for *L. plumulosus* is not given under PSEP guidelines; however, test conditions are similar to that of *E. estuarius* and described in other guidance documents (EPA 1991, 1994).

3.0 TEST ORGANISM

The test organism should be selected based on availability, sensitivity to test materials, tolerance to ecological conditions, ecological importance, and ease of handling in the laboratory. Ideally, organisms with wide geographical distribution should be selected so test results can be compared among laboratories with similar organisms. Test conditions for each amphipod species are summarized in Tables 1 and 2.

Table 3. Test Organism Suppliers

Species	*Ampelisca abdita*	*Rhepoxynius abronius*	*Eohaustorius estuaries*	*Leptocheirus plumulosus*
Life Stage Tested	Immature amphipods, or mature females only	Mature amphipods 3-5 mm, mixed sexes	Mature amphipods 3-5 mm, mixed sexes	Mature amphipods 3-5 mm, mixed sexes
Sources	John Brezina and Associates, Dillon Beach, CA; Aquatic Research Organisms, Hampton, NH;	Doug Henderson, Puget Sound Organisms; John Brezina and Associates, Dillon Beach, CA	Northwest Aquatic Sciences, Newport, OR	Aquatic BioSystems, Fort Collins, CO; Aquatic Research Organisms, Hampton, NH;

3.1 Test Organism Care

Records will be kept, including the date and location collected, feeding regime, and sediment characteristics.

Holding time for amphipods is standardized to between 2 and 10 days.

4.0 TEST SUBSTANCE

The test sediments will be labeled, properly stored, and tracked by internal chain-of-custody procedures throughout its tenure at the facility. The sediments will not be heated, filtered, distilled, frozen, or otherwise altered without prior written consent by the Client. The test substance is stored at 0 – 6 °C in the dark, in a secure and distinct storage area. Containers should also have as little air as possible over the sediment or be stored with nitrogen gas in the overlying head space.

Test sediments should not be sieved prior to testing unless there is potential concern of similar species, competitors, or predators. Native sediments should always be sieved to remove amphipods from the material to be used as the Control treatment. A 0.5 mm sieve is sufficient to remove the amphipods and sediments should only be dry sieved (manually pushed through the sieve) using only the water present in the sample. These procedures can be performed prior to test set-up and stored under the conditions described above.

5.0 EQUIPMENT

5.1 Instrumentation/Equipment

Microprocessor-controlled recorder, and a digital thermometer
Light meter
DO meter and probe
Salinity meter and probe
pH meter and probe
Ammonia probe meter and ancillary supplies
Microbalance capable of measuring weights to the nearest 0.0001 mg
Environmental test chamber or water bath capable of maintaining test temperature within 1ºC
1 L and 250 mL test chambers
Clean filtered seawater
Deionized water
Pipets
Camel hair brushes
Miscellaneous labware (wash bottles, tally counters, culture bowls, etc.)
500 µm stainless steel sieves
Holding cups (food grade plastic is acceptable)
Stir plate and teflon stir bars
Centrifuge for collecting pore water

5.2 Apparatus

5.2.1 Test Area

The test area consists of a water bath or temperature controlled room with constant monitoring of test temperature and appropriate illumination. The facility will be well ventilated and free of fumes.

5.2.2 Lighting

Overhead lighting will be ambient and continuous (24-hour).

5.2.3 Test Chambers

l-L glass jars with a l0-cm internal diameter, covered with a petri dish.

6.0 PROCEDURE

6.1 Preparation

6.1.1 Labware Preparation

Labware is described as any plastic or glass material used in the laboratory that will come into contact with any of the test substances or organisms in this evaluation. Labware must be cleaned prior to use. Labware will first be soaked in tap or deionized water then scrubbed with a brush on all surfaces using non-phosphate detergent in. Alconox® is a widely used established brand of detergent used in laboratory applications. The clean materials will then be rinsed three times with running deionized water. Labware will then be allowed to soak in a 10% hydrochloric acid bath and afterwards rinsed three times with deionized water. Glass labware with also receive a solvent rinse with reagent grade acetone, and finally rinsed three times with deionized water. Some plastic labware is not resistant to solvents and may be damaged by acetone. Plastic labware such as Teflon can receive a solvent rinse, but all other plastics should be investigated prior to solvent rinsing.

6.1.2 Dilution Water Preparation

Natural seawater will be obtained from North Hood Canal, sand filtered, and filtered to 0.45µm. Seawater will be adjusted as necessary to maintain a target test salinity. Salinity should be lowered with the addition of high purity deionized water or increased with the addition of bioassay grade sea salts or brine.

6.1.3 Test Organism Acclimation

For acclimation, amphipods will be held in control sediment with salinity adjusted dilution water. Gentle aeration will be provided for the duration of the acclimation period. Two to three days are sufficient for acclimation to the test conditions. Organisms may be fed a slurry of ground alfalfa or Tetramin™ if held for an extended period.

Amphipods in holding containers will be checked daily before the initiation of a test. Individuals that emerge from the sediment and appear dead or unhealthy will be discarded. If greater than 10% of the amphipods die or appear unhealthy during 48 hours preceding the test, the health of the batch of organisms should be evaluated for use in the proposed testing. This may include an additional day of holding to determine if mortalities or abnormal behavior are due to shipping or acclimation stress, and not indicative of an overly sensitive population.

6.2 Primary Task

6.2.1 Pre-Test Analyses

Prior to test initiation, and preferably as soon as sediments are received at the testing facility, pore water should be collected from a homogenized sample from each sediment treatment (including reference and controls). This sample should be analyzed for interstitial salinity, ammonia, and sulfides. The parameters listed in Table 3 are recommendations based upon the tolerance of each species. If conditions within the sediment are outside the tolerance ranges, the project manager and/or client should be notified and possible corrective actions discussed. The most common corrective action involves test chamber overlying water renewal or purging to bring test conditions with tolerance ranges. These procedures are described further in Section 6.2.3.

Table 4. Species Specific Test Condition Summaries

Species	*Ampelisca abdita*	*Rhepoxynius abronius*	*Eohaustorius estuarius*	*Leptocheirus plumulosus*[2]
Total Ammonia (mg/L, pH 7.7)	< 30	< 30	< 60	< 60
Un-ionized Ammonia (mg/L, pH 7.7)	< 0.4	< 0.4	< 0.8	< 0.8
Sulfides	N/A[1]	N/A[1]	N/A[1]	N/A[1]

[1] Specific guidance for sulfide sensitivities have not been well established.
[2] Direct guidance for *L. plumulosus* is not given under PSEP guidelines; however, test conditions are similar to that of *E. estuarius* and described in other guidance documents (EPA 1991, 1994).

6.2.2 Test Sediment Addition

Test sediment will be prepared using glassware cleaned according to Section 6.1.1, pre-cleaned glassware of a disposable nature, or non-toxic food grade plastic. All test chambers should be labeled accordingly with corresponding random number positions. After setup, the test chambers are distributed throughout the testing area based upon their position numbers. All 5 treatment replicates, including the corresponding Water Quality Surrogate (see Section 6.2.3), should be included in the randomized test matrix.

If necessary, sieving of the control sediment and/or test treatments will be performed (see Section 4.0). On the day before the test begins, each test sediment sample will be thoroughly homogenized within its storage container, and an aliquot added to a test chamber depth of 2 cm.

The sediment within the test chamber will be settled by tapping the test chamber against the side of the hand. Prepared seawater is gently added up to the 950-mL level (about 775 mL). A solid disk attached to a rod is placed inside the chamber to limit the suspension of the sediment into the water column by diffusing the water down the inside of the test chamber. The disc should be maintained just above the water surface as the

test chamber is filled. The sample is left overnight with gentle aeration to allow suspended particles to settle and equilibrium to be established between sediment and overlying water before the amphipods are added.

6.2.3 Sample Adjustments

If the water quality conditions in the test chamber are not suitable to support the selected amphipod species, it may be necessary to adjust those conditions to within tolerance limits. The two most common parameters which may require attention include interstitial salinity and ammonia. Water quality conditions (exclusive of contaminants) should be within the tolerance limits of the test species to remove the impact of their interference on the determination of toxic effects. Depending upon the program, manipulations to the test treatments may be performed to correct any deviations. Unfortunately, these manipulations may also alter the level of contaminants through purging or alter their available chemical state (salinity or pH change). Best professional judgment must be employed when deciding to manipulate the sample treatments and should always involve discussion with the client or regulatory agency. If manipulations are performed to the test treatments, the associated Control and Reference sediment should be treated in the same manner.

Generally, adjustments to the interstitial salinity of the sediments are not desirable. Exceptions to this may be sediments with very low interstitial salinities that are destined for open ocean disposal (~32-35 ppt). Salinity may be adjusted by replacing the overlying water within the test chambers with water of salinity equal to, or slightly greater than (or slightly less than if lowering), the target test salinity. The test chamber water should be removed through siphoning or pumping the water out to a level just above the test sediment. Care should be taken not to remove any sediment during this process. Prepared seawater is gently added up to the 950-mL level. A solid disk attached to a rod is place inside the chamber to limit the suspension of the sediment into the water column by diffusing the water down the inside of the test chamber. The disc should be maintained just above the water surface as the test chamber is filled.

For sediments with pore water ammonia concentrations exceeding those values listed in Table 4, purging may be required to bring the test chambers conditions within acceptable limits. In most cases this should be determined in the pre-test pore water analyses (Section 6.2.1). General procedures for purging of the test chambers are described in further detail in the SMARM clarification paper “Ammonia and Amphipod Toxicity Testing” (SMARM clarification paper: 06/15/02). Additional sacrificial surrogate chambers should be created to monitor pore water ammonia levels during the acclimation process. Overlying water exchanges are conducted in the same manner as the overlying water renewal for salinity adjustment described above. Purging should be conducted twice daily until the pore water ammonia concentrations are below the threshold values. Pore water ammonia levels should be monitored every 1-3 days during the purging process. Overlying ammonia levels should also be measured as part of the monitoring procedure as it gives an estimate of ammonia reduction without the breakdown of a surrogate

chamber. Once the pore water ammonia has been reduced below the threshold values, purging should be terminated and the testing period can commence. Depending upon the program, purging may or may not be continued after test initiation. It may be possible in highly biogenic sediment that ammonia may increase again over the course of the test if renewals are discontinued.

6.2.4 Reference Toxicity Test

During this 96-hour toxicity test with marine amphipods and a test substance, five concentrations of a reference substance (ammonium chloride) with 10 test organisms will be used to assess the health of the test organisms. Three test chambers per reference concentration may be used. One concentration will be the 96-hour LC_{50}. The other four concentrations will be selected to bracket the LC_{50}. The LC_{50} values will be compared with historical data from definitive bioassays with the reference substance. The results of the 96-hour mortality, determined during this study, will be reported and used in combination with control mortality to characterize the health of the test organisms. Table 5 summarizes the test conditions for conducting a 96-hour water-only reference toxicant test.

Table 5. Conditions for Performing 4-Day Water-Only Reference Testing on Marine Amphipods

Test type	Static Non-renewal
Test duration	4 Day
Lighting	Dark and Constant[1]
Test chamber size	250-mL glass beaker (minimum)
Test solution volume	200-mL (minimum)
Renewal of test solution	None
No. of organisms per chamber	10 recommended (minimum of 5)
No. of replicates per treatment	3
Feeding	None
Test solution aeration	None unless needed to maintain DO levels above 60% saturation

[1] In the absence of sediment, amphipods will continue to attempt to bury into the bottom of the chamber. Keeping the amphipods in the dark will lessen this digging behavior thus reducing undue stress on the test organisms.

The results of the ammonia reference-toxicant may be compared to the ammonia concentrations observed within the test samples to assist in correlating any ammonia related effects within a specific batch of organisms. Table 6 summarizes the published threshold ammonia concentrations for each species.

Table 6. Threshold sediment interstitial ammonia levels for triggering ammonia reference toxicant tests.

Interstitial Ammonia (mg/L @ pH 7.7)	*Ampelisca abdita*	*Rhepoxinius abronius*	*Eohaustroius estuarius*	*Leptocheirus plumulosus* [1]
Total	>15	>15	>30	>30
Unionized	>0.2	>0.2	>0.4	>0.2

[1] Direct guidance for *L. plumulosus* is not given under PSEP guidelines; however, test conditions are similar to that of *E. estuarius* and described in other guidance documents (EPA 1991, 1994).

6.2.3 Reference and Control Sediment

During this l0-day toxicity test with marine amphipods on project sediment(s), reference sediment(s) will be used to provide a site-specific basis for comparison of potentially toxic and non-toxic conditions. Control sediment, collected during amphipod collection at the same site, will be used to determine the condition of the amphipods.

6.2.5 Water Quality

During routine test observations, a daily record of test room or water bath temperatures and test chamber aeration should be made.

In order to limit the impact of disturbance on the test organisms, all water quality measurements during the testing procedure will be performed in a surrogate water quality only chamber. In addition to the five test treatment replicates, a minimum of three additional surrogate chambers should also be tested; one for use as a water quality surrogate (WQS), and two to be utilized at test initiation and termination for pore water analyses. Surrogate chambers should be treated in the same manner as the test replicates. This includes randomization among the test treatments and addition of test animals. Additional pre-test surrogate chambers may also be required to monitor pore water salinity, ammonia, or sulfide manipulations.

After one day of acclimation after sediment and overlying water layering (test day 0), an initial set of water quality parameters will be measured in the overlying water of the WQS for each test treatment. The water quality parameters include temperature, dissolved oxygen (DO), pH, salinity, total ammonia, and total sulfides. In addition, a surrogate replicate from each test treatment will be sacrificed in order to extract pore water via centrifugation for subsequent analysis of ammonia and sulfides. Prior to test initiation, these initial water quality measurements must be reviewed to ensure that they are within the testing parameters. Test initiation should be postponed until any deviations are addressed and corrected.
On test days 1 through 9, temperature, DO, pH, and salinity will be measured in the water quality surrogate chamber of each treatment. At test termination (test day 10) the full suite of measurements will be repeated as on day 0.

6.2.6 Test Organism Addition

Amphipods are sieved from the holding sediment (500 µm sieve) and transferred to a sorting tray containing water of the holding temperature and salinity. Active, healthy amphipods are randomly selected from the sorting tray and sequentially distributed among dishes containing approximately 15 mL of dilution seawater until each dish contains 5 individuals. Prior to addition to the test chambers, the number of organisms is verified by recounting the individuals within the dish as well as confirming health and appearance. Unacceptable amphipods are discarded and replaced prior to introduction.

Twenty animals (4 dishes of 5 animals each) are then added to the randomly positioned test chambers. Addition should occur with minimal disruption of the sediment by gently pouring the water and amphipods from the sorting dishes into the test chamber. Any amphipods remaining in the dish should be gently washed into the test chamber. After addition, the test chamber is marked to confirm organism addition, recovered, and aeration restored. Any amphipods that do not bury within 15 minutes will be removed and replaced (*Ampelisca abdita* should be allowed one hour for burial).

6.2.5 Test Initiation

The test is initiated when the test organisms are distributed to each test chamber.

6.2.6 Test Observations

Notes are made on sediment appearance and unusual conditions. This can include fungal and algal growth. The number of amphipods that have emerged from the sediment, either floating on the water surface or lying on top of the sediment is recorded. Amphipods that are floating on the surface can be released from the surface tension by dropping a small drop of water (from the test chamber) with a pipette. Care must be taken not to cross-contaminate beakers. Dead animals either on the water or sediment surface are not removed during the exposure period. A list of observation types and their corresponding codes are detailed in Table 7.

Table 7. Observation Key for Recording Test Observations

Normal	N
No Burrows	NB
Body on surface (mortality). Can indicate a corpse or a molt.	M
Emergence (actively swimming in water column, or walking on sediment surface; not burrowing)	E
Growth. Indicative of fungal, algal, or bacterial mats	G
No Air Flow	D
Floating on surface. Animals caught in surface tension of water.	FOS
Water too cloudy/turbid for observation	TC

6.3 Post-task

The bioassay is terminated on day 10. After final observations are performed, the contents of each test chamber are sieved through a 0.5-mm sieve. A gentle spray of seawater is used to wash the sediment through the sieve. Material retained on the sieve is transferred to a clean sorting vessel containing seawater of a similar salinity and temperature as the test. The numbers of live and dead amphipods are recorded. An amphipod is considered alive if there is any sign of movement (e.g., pleopod twitching or response to gentle prodding). Recoveries may not equal 20 due to the decomposition of dead animals through the test. Although not commonly conducted, there is also a procedure for evaluating the ability of the amphipods (excluding *A. abdita*) to rebury into Control sediment. This sublethal endpoint is discussed in further detail in PSEP 1995.

Results Needed:

- Percent mortality for each treatment
- Mean water quality values by treatment
- LC_{50} and 95% confidence limits (for ref. tox.)
- Reburial

In screening tests, the responses of amphipods in collected test sediments are compared to control and reference site sediments.

6.4 Reporting

The report may include, but will not be limited to, the following:

- Name and address of the laboratory conducting the study, and dates on which the study was initiated and completed.
- The name of the Study Director, other scientists or professionals, and supervisory personnel involved in the study.
- Objectives as stated in the protocol.
- A description of the methods used.

- Transformations, calculations, or operations performed on the data, a summary and analysis of the data, and a statement of the conclusion drawn from the analysis.
- The test substance identified by code number and the date each sample was used.
- The number of organisms used in the study.
- Concentrations of exposure and exposure method.
- Any circumstances that may have affected the quality or integrity of the data, including deviations from test protocols or Standard Operating Procedures.
- The location where raw data and the final report will be stored.
- Additions or corrections to a final report will be in the form of an amendment by the Study Director. The amendment will clearly identify that part of the final report that is being altered and the reason(s) for the alteration(s). The amendment will be signed and dated by the Study Director.

The master copy of the final report will be signed and dated by the Study Director.

7.0 HEALTH AND SAFETY CONSIDERATIONS

Proper laboratory protection, including lab hood or ventilation system, lab coat, closed-toe shoes, gloves and safety glasses, is required when working with chemicals and unprocessed samples.

Refer to the Port Gamble Laboratory's Chemical Hygiene Plan and Health and Safety Plan at S:\Health and Safety for procedures to ensure safe operation in the laboratory and for contingency plans in the event of an accident or emergency.

For specific chemical health and safety information, refer to the Safety Data Sheet log.

8.0 PERSONNEL

Any laboratory personnel demonstrating competence with this method may perform the procedure.

9.0 QUALITY ASSURANCE REQUIREMENTS (ACCEPTANCE CRITERIA)

This study will be conducted according to the Standard Operating Procedures of the Port Gamble Laboratory which are in effect during the time the study is being performed. In the case where there is a conflict between the other SOPs and this protocol, the protocol will be the definitive procedure.

Usually tests would be unacceptable if the following conditions occurred:

- More than 10% of the organisms die in the Control treatment.

Test data will need to be evaluated and qualified if:

- All test chambers were not identical.
- Treatments were not randomly assigned to test chambers.
- Test organisms were not randomly or impartially distributed to test chambers.
- All test animals were not from the same population, were not all of the same species, or were not of acceptable quality.
- Reference sediment and controls were not included in the test.
- Amphipods were maintained in the laboratory for less than two days or greater than ten days, unless the effect of prolonged maintenance in the laboratory has been shown to have no significant effect on sensitivity.
- Temperature, DO, pH, salinity, and ammonia were not measured, or were not within acceptable range.
- Test organisms were not acclimated at the test temperature and salinity at least 24 hours before they were placed in test chambers.
- Aeration to the test chamber was off for an extended time such that the DO levels dropped below acceptable limits and was associated with mortality.
- Response criteria were not monitored in a blind fashion.

10.0 REFERENCE DOCUMENTS

Puget Sound Water Quality Authority. Revised July 1995. “Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments.” Prepared for U.S. EPA Region 10, Office of Puget Sound. Seattle, W A.

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Norberg-King, T.J. 1998. An interpolation estimate for chronic toxicity: The Icp approach. Technical Report 05-88, National Effluent Toxicity Assessment Center, Environmental Research Laboratory, U.S. Environmental Protection Agency, Duluth, Minnesota.

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11.0 APPENDIX OF CHANGE

- 08/20/15 Changed test organism acclimation section to reflect a 10% mortality threshold in assessing the organism's health

- 05/23/16 Added "uncontrolled" statement to SOP and updated Health and Safety section

- 05/09/17 Updated health and safety information, removed branding, added review documentation section. Added "proprietary information" statement to footer.

12.0 DOCUMENT REVIEW

Acknowledgement below indicates that the individuals have read and understood the concepts summarized in this document.

Name	Signature	Date

1.0 SCOPE

To evaluate the chronic toxicity of marine sediments Sediment testing will be conducted as defined in **Dinnel and Stober (1995), Standard Methods (APHA 1985), ASTM (1989)**, and **Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments (1995)**.

2.0 SUMMARY OF TEST

2.1 Approach

Number of samples	≥ 1
Number of replicates per test sediment	5
Number of controls	1
Number of replicates per control	5
Number of reference sediments	1
Number of replicates per reference sediment	5
Test chambers	1 L glass beaker or comparable wide mouth glass jar (10 cm internal diameter)
Test sediment volume	18 g of sediment per container
Overlying water	900 mL of 28‰ salinity, clean, filtered, seawater with a maximum holding time of 2 days
Renewal of overlying water	None
Number of test organisms per chamber	20,000-40,000 embryos for Bivalves, 25,000 embryos for Echinoderms
Type of biological observations	Survival, Development
Times of biological observations	Post test
Type of physical observations	Room or bath temperature continuous, light daily
Types of water quality analyses	DO, temperature, salinity, pH; ammonia and sulfides (Program Dependent)
Times of water quality samples	DO, temperature, salinity, and pH measured in a surrogate test chamber daily. Ammonia and total sulfide samples taken at the beginning and end of the test.
Aeration	Gentle aeration is applied to all chambers if Dissolved Oxygen levels fall below 6.0 mg/L.
Sediment holding time	Samples must be stored in the dark at 4 ± 2 º C with no headspace or headspace filled with nitrogen gas.

2.2 Physical Requirements

Species	*Dendraster excentricus*	*Strongylocentrotus purpuratus*	*Mytilus galloprovincialis*	*Crassostrea gigas*
DO (mg/L)*	> 4.8	> 4.8	> 4.8	> 4.6
Temperature (°C)	15 ± 1	15 ± 1	16 ± 1	20 ± 1
Salinity (ppt)	28 ± 1	28 ± 1	28 ± 1	28 ± 1
pH	Ambient	Ambient	Ambient	Ambient
Lighting	14 hours light : 10 hours dark at 50-100 foot-candles	14 hours light : 10 hours dark at 50-100 foot-candles	14 hours light : 10 hours dark at 50-100 foot-candles	14 hours light : 10 hours dark at 50-100 foot-candles
Ammonia	< 0.14 mg/L unionized	< 0.14 mg/L unionized	< 0.13 mg/L unionized	< 0.13 mg/L unionized
Aeration	Gentle, if D.O. falls below 6.0 mg/L	Gentle, if D.O. falls below 6.0 mg/L	Gentle, if D.O. falls below 6.0 mg/L	Gentle, if D.O. falls below 6.0 mg/L

*60 percent saturation at 15ºC and 28 ppt.

2.3 Biological Requirements

Feeding None
Life stage Larval Stage used within 2 hours of fertilization depending on test species.

3.0 TEST ORGANISM

The test organism should be selected based on availability, sensitivity to test materials, tolerance to ecological conditions, ecological importance, and ease of handling in the laboratory. Ideally, organisms with wide geographical distribution should be selected so test results can be compared among laboratories with similar organisms. The organisms for this protocol are *D. excentricus, S. purpuratus, M. galloprovincialis,* and *C. gigas*.

3.1 Test Organism Specifications

Species:	*Dendraster excentricus*	*Strongylocentrotus purpuratus*	*Mytilus galloprovincialis*	*Crassostrea gigas*
Age:	Larval Stage used within 2 hours of fertilization	Larval Stage used within 2 hours of fertilization	Larval Stage used within 2 hours of fertilization	Larval Stage used within 2 hours of fertilization
Source:	In-house collection; Aquatic Toxicology Support, Bremerton, WA; Dave Gutoff, San Diego, CA	Dave Gutoff, San Diego, CA; In-house collection; Aquatic Toxicology Support, Bremerton, WA	Taylor Shellfish, Shelton, WA; Aquatic Research Organisms, Hampton, NH	In-house collection; Taylor Shellfish, Shelton, WA; Aquatic Toxicology Support, Bremerton, WA

3.2 Test Organism Care

Records of the stock shipments will be kept, including original source, feeding regime, and holding water characteristics

4.0 TEST SUBSTANCE

The test substance will be labeled, properly stored, and tracked by internal chain-of-custody procedures throughout its tenure at the Port Gamble Laboratory. The test substance will not be heated, filtered, distilled, frozen, or otherwise altered without prior written consent by the Client.
The test substance is stored at 0 - 6°C in a secure and distinct storage area.

5.0 EQUIPMENT

5.1 Instrumentation/Equipment

Microprocessor-controlled recorder, and a digital thermometer
Light meter
DO meter and probe
Salinity meter and probe
pH meter and probe
Ammonia probe meter and ancillary supplies
Method of measuring total sulfides
1 L test chambers
Clean filtered seawater
Pipets

Miscellaneous labware (wash bottles, tally counters, culture bowls, etc.)
Centrifuge for collecting pore water
20 mL Scintillation or 25 mL shell vials
Syringe (to inject KCl into echinoderms) with 18-22 gauge needle
Pasteur pipets and bulbs
Ice bath or refrigerator
Compound microscope
Neubauer hemocytometer
Sedgwick-Rafter (or equivalent) counting cell (1 mL)
Small siphon hose (2ft. long, 3/16 - 1/4 in diameter)
Laboratory timer
Controlled temperature water bath or room
100-mL graduated cylinder
Perforated plunger

5.2 Reagents

0.5 M KCl
5% Buffered formalin
Copper sulfate
10% hydrochloric acid
Acetone
5% buffered formalin

5.3 Apparatus

5.3.1 Test Area

The test area consists of a room with constant temperature and appropriate illumination. The facility will be well ventilated and free of fumes.

5.3.2 Lighting

Continuous overhead lighting will be at 50-100 foot-candles (550-1050 Lux).

5.3.3 Test Chambers

l-L glass chambers
20 mL glass scintillation or 25 mL glass shell vials

6.0 PROCEDURE

Prior to use, all glassware and plasticware will be thoroughly cleaned.

6.1 Preparation

6.1.1 Glassware Preparation

Glassware will first be soaked in deionized water then scrubbed with a brush on all surfaces using non-phosphate detergent in deionized water. Glassware will be rinsed three times with running deionized water. Glassware will then be rinsed in 10% hydrochloric acid, rinsed three times with deionized water, rinsed once with reagent grade acetone, and finally rinsed three times with deionized water.

6.1.2 Dilution Water Preparation

Filtered seawater collected from North Hood Canal will be diluted to 28 ± 1 ppt salinity using deionized water. Seawater will be held for a maximum of 2 days.

6.1.3 Test Organism Acclimation

Stock cultures will be acclimated in the same dilution water and at the same temperature as in the test procedures. Short-term culture logs will be maintained throughout the holding period.

6.2 Primary Task

6.2.1 Test Sediment Addition

Test sediment will be prepared using glassware cleaned according to Section 6.1.1, pre-cleaned glassware of a disposable nature, or non-toxic food grade plastic.

Eighteen grams of reference or test sediment is added to each chamber. 900 mL of filtered seawater (28 ppt salinity) is added to each test chamber. Two control series are prepared consisting of clean seawater without sediment. One series is used as a duplicate control in order to monitor embryo development. The sediments are suspended by vigorously shaking for 10 seconds. Test chambers will be randomized, and the mixture will be allowed to settle for four hours prior to embryo induction.

6.2.2 Reference Toxicant Test

Concurrent with this toxicity test, five concentrations of a reference substance are used to assess the health of the test organisms. Three replicates per reference concentration will be used. Five concentrations will be selected to bracket the 48-hour LC_{50}. The LC_{50} values will be compared with historical data from definitive bioassays. The results of this survival and development test, conducted during this study, will be reported and used in combination with control survival and development to characterize the health of the test organisms.

6.2.3 Test Organism Spawning and Addition

To collect gametes for testing with bivalve species, the adult organisms are placed in clean seawater and acclimated to the target test salinity (test dependant) and temperature (16°C for *Mytilus* and 20°C for *Crassostrea*) for approximately 20 minutes. The water bath temperature is then increased 5°C over a period of 15 minutes. Bivalves are maintained at this elevated temperature and monitored for spawning individuals. Spawning animals are removed from the water bath and placed in individual containers with seawater. Gametes from at least two males and two females are used to initiate the test. Once sufficient eggs and sperm had been collected, the eggs are screened though 60-µm mesh to remove any detritus or feces and a homogenized sperm solution added to the egg solutions. Egg-sperm solutions are periodically homogenized with a perforated plunger during the fertilization process. Approximately one hour after fertilization, embryo solutions are checked for fertilization and cell division. Only those embryo stocks with >90% cell division are used to initiate the tests. Density of the embryo stock solution is determined by counting the number of embryos in a subsample of stock solution. For bivalve species, approximately 20,000 - 40,000 embryos will be added to test chambers within 2 hours of fertilization.

To collect gametes required for testing echinoderm species, spawning is induced in the adult organisms by the injection of 0.5 to 1.0 mL of 0.5 M KCl into the coelemic cavity through the perisotomal membrane. The injection is performed while the adult animal is out of water. Females will release orange (*S. purpuratus*) or purple (*D. excentricus*) eggs and males of both species will release cream-colored sperm. Once release has been initiated, each adult is inverted over a 50 to 100 mL beaker with filtered seawater at 15 degrees Celsius and gametes are allowed to accumulate for approximately 15 minutes. Once sufficient eggs and sperm had been collected, the eggs are transferred to a larger beaker with cold filtered seawater and a homogenized sperm solution (taken from several males) is added to the egg solutions. Egg-sperm solutions are periodically homogenized with a perforated plunger during the fertilization process. Approximately one half-hour after fertilization, embryo solutions are checked for fertilization. Only those embryo stocks with >90% fertilization are used to initiate the tests. Density of the embryo stock solution is determined by counting the number of embryos in a subsample of stock solution.

Approximately 25,000 embryos will be added to test chambers within 2 hours of fertilization.

The test is initiated by randomly allocating an aliquot of the embryo stock solution into each test chamber four hours after sediments are shaken and within two hours of egg fertilization. Embryos are held in suspension during initiation using a perforated plunger. The test chambers are covered and incubated for 48 hours or longer under the conditions specified in Section 2.2.

For embryos/larvae test, a perforated plunger is used to mix the embryos/larvae at the test initiation. Approximately 25,000 echinoderm or 20,000-30,000 bivalve embryos will be added to test chambers within 2 hours of fertilization.

In order to determine the initial embryo concentration, five 10-mL samples should be collected from the control culture and preserved using l-mL 5% buffered formalin.

6.2.4 Test Initiation

The test is initiated when the first organism enters a test chamber.

6.2.5 Test Substance Renewal

No test substance renewals are required by this protocol.

6.2.6 Test Measurements

Water Quality. All probes will be cleaned thoroughly before initial use. Data collection will be performed on each samples respective surrogate chamber and recorded. The probes will be rinsed with de-ionized water between each sample. DO, temperature, salinity, and pH will be measured from the overlying water in the surrogate chamber daily. Ammonia and total sulfides should be measured in the overlaying water at least at the beginning of the test.

Biological. Larvae will be scored for normal development according to ASTM guidelines.

6.2.7 Test Termination

For echinoderm species, the test is terminated at 48 hours or when greater than 90% of the embryos in the duplicate seawater control have reached normal development (whichever is later and within 96 hours). For bivalve species, the test is terminated at 48 hours or when greater than 95% of the embryos in the duplicate seawater control have reached normal development (whichever is later and within 60 hours).

The water and the larvae overlying the settled sediment in each container are carefully mixed in order to suspend larvae and prevent disturbance of the sediment. The overlying water and larvae are then placed into a clean, l-L beaker. The water is then mixed, and three l0-mL aliquots of the sample are removed and placed into 20-mL scintillation vials or shell vials. The contents of each vial are preserved with 1.0-mL of 5% buffered formalin, and the caps are securely replaced on the vials.

Preserved samples are examined on Sedgwick-Rafter cells (if using scintillation vials) or in the shell vials. Normal and abnormal larvae are counted to determine the percent normal development. In addition, percent survival is determined using the appropriate method outlined in **Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments (1995)**.

6.3 Post-task

- PSEP 1995 Recommendations:

Calculate the percent mortality for each replicate:

Mortality = 100 x (l-(No. of surviving test larvae / No. of control larvae))

Calculate the percent abnormality for each replicate:

Abnormality = 100 x (l-(No. of abnormal larvae / No. of normal and abnormal survivors))

Calculate the combined larval mortality/abnormality:

Combined larval mortality/abnormality = 100 x (l-(No. of surviving normal larvae / No. of embryos inoculated))

- Conventional endpoint calculations typically reported for PSEP testing programs:

Endpoint Calculation	Sample Type	
	Control	Reference and Project
Proportion Normal	No. of surviving normal larvae / No. of normal and abnormal survivors	
Proportion Survival	No. of normal and abnormal survivors / No. of embryos inoculated	
Normal Survivorship (Combined Proportion Normal)	No. of surviving normal larvae / No. of embryos inoculated	No. of surviving normal larvae / Mean No. normal in the Control

Results Needed:

- Individual replicate, mean, and standard deviation values for percent survival/mortality, percent normality/abnormality, and combined larval mortality/abnormality
- Plot of dose-response curve at test termination (48 or 72 hours)
- LC_{50} value for mortality, EC_{50} value for abnormality
- 95% confidence limits of LC_{50} value and EC_{50} value
- Tables showing biological, chemical, and physical data

6.3.1 Method

LC_{50} and EC_{50} values and 95% confidence limits will be determined using a computer approach published by Norberg-King (1988) of the U.S. EPA and a commercial statistic software program. The Inhibition Concentration percentage, or ICp, approach to calculating point estimates of toxicity (i.e., LC_{50} and EC_{50}) is based upon a monotonic smoothing technique of biological response versus concentration. Bootstrapped estimates of mean response at each concentration allow for distribution-free estimates of standard error and confidence intervals. The result is a nonparametric statistical test that requires no assumptions of normality or homogeneous variance and is robust enough to accommodate a wide variety of biological responses.

6.4 Reporting

The report may include, but will not be limited to, the following:

- Name and address of the laboratory conducting the study, and dates on which the study was initiated and completed.
- The name of the Study Director, other scientists or professionals, and supervisory personnel involved in the study.
- Objectives as stated in the protocol.
- A description of the methods used.
- Information regarding organisms used.
- All water quality measurements.
- Transformations, calculations, or operations performed on the data, a summary and analysis of the data, and a statement of the conclusion drawn from the analysis.
- The test substance identified by code number and the date each sample was used.
- The number of organisms used in the study.
- Concentrations of exposure and exposure method.

- Any circumstances that may have affected the quality or integrity of the data, including deviations from test protocols or Standard Operating Procedures.
- The location where raw data and the final report will be stored.
- Additions or corrections to a final report will be in the form of an amendment by the Study Director. The amendment will clearly identify that part of the final report that is being altered and the reason(s) for the alteration(s). The amendment will be signed and dated by the Study Director.

The master copy of the final report will be signed and dated by the Study Director.

7.0 HEALTH AND SAFETY CONSIDERATIONS

Proper laboratory protection, including lab hood or ventilation system, lab coat, closed-toe shoes, gloves and safety glasses, is required when working with chemicals and unprocessed samples.

Refer to the Port Gamble Laboratory's Health and Safety Plan at S:\Health and Safety for procedures to ensure safe operation in the laboratory and for contingency plans in the event of an accident or emergency.

For specific chemical health and safety information, refer to the Safety Data Sheet log.

8.0 PERSONNEL

Any laboratory personnel demonstrating competence with this method may perform the procedure.

9.0 QUALITY ASSURANCE REQUIREMENTS (ACCEPTANCE CRITERIA)

This study will be conducted according to the Standard Operating Procedures which are in effect during the time the study is being performed. In the case where there is a conflict between the other SOPs and this protocol, the protocol will be the definitive procedure.

Test acceptability criteria are:

- ≥ 90% survival of embryos introduced into control test chambers.
- ≥ 70% of embryos demonstrate normal development in the control.

10.0 REFERENCE DOCUMENTS

Dinnel, P.A., J.M. Link, and Q.J. Stober. 1987. Improved methodology for a sea urchin sperm cell bioassay for marine waters. *Arch. Env. Cont. Toxicol.* 16:23-32.

Chapman, G.A., et al. 1995. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms, 1st edition. U.S. EPA Environmental Monitoring Systems Laboratory, Cincinnati, Ohio, EPA/600/R-95/136.

Sediment Management Annual Review Meeting Clarification Paper. Warner, L.C. "Reporting Ammonia LC_{50} Data for Larval and Amphipod Bioassays". October 3, 2001.

Sediment Management Annual Review Meeting Clarification Paper. Kendall, D. "Sediment Larval Test Species Recommended for Toxicity Testing by The DMMP Program". October 17, 2005.

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PTI Environmental Services. 1991. Draft Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments. Prepared for U.S. EPA, PTI Contract C744-12.

Puget Sound Water Quality Authority. Revised July 1995. Recommended Guideline for Conducting Laboratory Bioassays on Puget Sound Sediments. Prepared for U.S. EPA Region 10, Office of Puget Sound, Seattle, WA.

11.0 APPENDIX OF CHANGE

- 04/28/16 Updated logo

- 05/26/16 Added “uncontrolled” statement to SOP and updated Health and Safety section

- 05/09/17 Updated health and safety information, removed branding, added review documentation section. Added “proprietary information” statement to footer. Updated organism suppliers. Added the use of shell vials as an alternative to scintillation vials. Removed reference toxicant and retesting time frames from test acceptability criteria in section 9.0. Added clarification papers from Seattle USACE DMMO. Updated post-task calculation options.

12.0 DOCUMENT REVIEW

Acknowledgement below indicates that the individuals have read and understood the concepts summarized in this document.

Name	Signature	Date

1.0 SCOPE

To determine the chronic toxicity of marine sediments on the marine polychaete *Neanthes arenaceodentata*. Sediment toxicity testing will be conducted according to guidelines presented in **ASTM E1611**, **Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments (1995)**, and the various updates presented during the Annual Sediment Management Review meetings (SMARM).

2.0 SUMMARY OF TEST

Table 1 Test Condition Summary

Sample storage conditions	4°C, dark minimal head space
Recommended Sediment Holding Time:	≤8 weeks (56 days)
Test Species	***Neanthes arenaceodentata***
Age class	Juvenile (2-3 weeks post-emergence)
Test Procedures	ASTM, PSEP 1995 with SMARM revisions
Regulatory program	SMS, DMMP, or other as mandated by the associated program
Test type/duration	20-Day static renewal
Test chamber	1-Liter glass beaker or jar
Exposure volume	175 mL (2cm) sediment/ 775 mL water
Replicates per treatment	5 + 2 surrogate chambers (one used for WQ measurements throughout the test)
Control / Diluent water	North Hood Canal, sand filtered
Test Lighting	Continuous
Aeration	Continuous from test initiation: 100 bubbles per minute
Test temperature	Recommended: 20 ± 1 °C
Test Salinity	Recommended: 28 ± 2 ppt
Test dissolved oxygen	Recommended: > 4.6 mg/L (60% saturation @ 20°C and 28 ppt salinity)[1]
Test pH	Recommended: 7 – 9 [2]
Organisms/replicate	5
Feeding	40 mg/jar every other day (8mg/ind every other day)
Water renewal	Water renewed every third day (1/3 volume of exposure chamber)

[1] PSEP guidance is not specific on dissolved oxygen limits. The value of 60% saturation is based on ASTM 2006.
[2] pH is monitored as a water quality parameter. There are generally no control limits for pH; however measurements of pH may be useful in interpreting results (Ecology 2003).

2.2 Physical Requirements

DO	>4.6 mg/L (60% Saturation)
Temperature	20 ± 1°C
Salinity	28 ± 2 ppt (PSEP); 28 – 36 ppt (ASTM)
pH	7.0 - 9.0
Lighting	Continuous ambient light at approximately 50-100 foot-candles (550-1050 lux)

2.3 Biological Requirements

Feeding	Organisms will be fed ground TetraMin® on an every-other-day basis. The amount of food provided will be approximately 8 mg (dry weight) per juvenile *N. arenaceodentata*
Life stage	Juvenile worms (2-3 weeks, 0.25-1.0 mg),

3.0 TEST ORGANISM

The test organism should be selected based on availability, sensitivity to test materials, tolerance to ecological conditions, ecological importance, and ease of handling in the laboratory. Ideally, organisms with wide geographical distribution should be selected so test results can be compared among laboratories with similar organisms. The organism for this protocol is *Neanthes arenaceodentata*.

3.1 Test Organism Specifications

Species:	*Neanthes arenaceodentata*
Source:	Aquatic Toxicology Support, Bremerton, WA
Age:	Juvenile Worms (2-3 weeks, 0.25-1.0 mg), laboratory cultured

4.0 TEST SUBSTANCE

The test substance will be labeled, properly stored, and tracked by internal chain-of-custody procedures throughout its tenure at the Port Gamble Laboratory. The test substance will not be heated, filtered, distilled, frozen, or otherwise altered without prior written consent by the Client. The test substance is stored at 0 - 6°C in a secure and distinct storage area.

5.0 EQUIPMENT

5.1 Instrumentation/Equipment

Thermometer
Light meter
DO meter and probe
Salinity meter and probe
pH meter and probe
Ammonia probe meter and ancillary supplies
Microbalance capable of measuring weights to the nearest 0.0001 g
Environmental test chamber or water bath capable of maintaining 20 ± 1°C
1000 mL test chambers
Clean filtered seawater
Deionized water
Pipets
Brushes
Miscellaneous labware (wash bottles, tally counters, culture bowls, etc.)
500 µm stainless steel sieves
Aluminum weigh boats
Holding cups (food grade plastic is acceptable)
Stir plate and teflon stir bars
Finely ground TetraMin®
Centrifuge and centrifuge Teflon® tubes for collecting pore water
Drying oven capable of maintaining 60°C
Muffle furnace capable of 550°C
Desiccator

5.2 Apparatus

5.2.1 Test Area

The test area consists of a water bath or a room with constant temperature and appropriate illumination. The facility will be well ventilated and free of fumes.

5.2.2 Lighting

Continuous overhead lighting will be at 50-100 foot-candles (550-1050 Lux).

5.2.3 Test Chambers

1000 mL glass beakers with a 10 cm internal diameter covered with a petri dish.

6.0 PROCEDURE

6.1 Preparation

6.1.1 Labware Preparation

Labware is described as any plastic or glass material used in the laboratory that will come into contact with any of the test substances or organisms in this evaluation. Labware must be cleaned prior to use. Labware will first be soaked in deionized water then scrubbed with a brush on all surfaces using non-phosphate detergent in deionized water. Alconox® is a widely used established brand of detergent used in laboratory applications. The clean materials will then be rinsed three times with running deionized water. Labware will then be allowed to soak in a 10% hydrochloric acid bath and afterwards rinsed three times with deionized water. Glass labware will also receive a solvent rinse with reagent grade acetone, and finally rinsed three times with deionized water. Some plastic labware is not resistant to solvents and may be damaged by acetone. Plastic labware such as Teflon can receive a solvent rinse, but all other plastics should be investigated prior to solvent rinsing.

6.1.2 Dilution Water Preparation

Natural seawater will be obtained from North Hood Canal, sand filtered, and filtered to 0.45µm. Seawater will be adjusted as necessary to maintain a target test salinity. Salinity should be lowered with the addition of high purity deionized water or increased with the addition of bioassay grade sea salts or brine.

6.1.3 Test Organism Care and Acclimation

Upon receipt, salinity and temperature of water in shipping containers should be measured. If salinity is more than 2 ppt different from the target test salinity of 28 ppt then the salinity should be adjusted (no more than 3 ppt daily). If salinity is outside the range of 15 to 35 ppt, then test animals may be possibly stressed and the supplier should be notified to provide a new batch of test organisms. Temperature should be allowed to equilibrate to test temperature prior to removing animals from shipping containers. If temperature of shipping containers is outside the range of 15 to 25°C then a new batch of test organisms may be required. Animals should be held for at least 24 hours prior to testing and may be fed during holding period.

If animal health is suspect upon receipt (e.g. over 10% of number received dead, animals behaving strangely or diseased), notify the laboratory manager who will assess whether to notify the supplier and order replacements. If more than 10% of the organisms die in the 48h prior to testing, the entire batch is discarded, and a new batch is ordered. If the acclimation process is repeated with a new group of test organisms and excessive mortality occurs, an alternative source of dilution water should be used.

6.2 Primary Task

6.2.1 Test Sediment Addition

Test sediment will be prepared using labware cleaned according to Section 6.1.1, pre-cleaned labware of a disposable nature, or non-toxic food grade plastic.

If pre-sieving of sediment is required to exclude large material or potential predators they may be press sieved (no water) through a clean stainless steel sieve (2 mm mesh).

One day prior to test initiation test sediment, reference, and control sediment should be added to the test chambers. Sediment should be thoroughly homogenized prior to addition to the test chambers. A subsample should be analyzed for pore water ammonia. Approximately 2 cm of sediment should be added to each of the 5 replicate containers and applicable surrogate chambers. Once sediment has been added, clean filtered seawater should be added up to the 950-mL mark at a salinity of 28 ppt. Water should be added to ensure minimal disturbance of test sediments. Test chambers should be aerated at approximately 100 bubbles/minute under test temperature and photoperiod regime. The system should be left overnight with gentle aeration to allow suspended particles to settle and an equilibrium to be established between sediment and overlying water before the organisms are added.

6.2.2 Reference and Control Sediment Test

During this 20-day toxicity test with *Neanthes arenaceodentata* and a test sediment, a reference substance will be used to provide a site-specific basis for comparison of potentially toxic and non-toxic conditions.

6.2.3 Test Organism Addition

For test initiation, worms should be selected at random from a large culture dish(es) that contains all of the shipped animals. Animals should be added in order of replicate number, not treatment, to ensure an equal distribution of selected animals across treatments (i.e., so that animals selected initially aren't all in a single treatment and animals selected at the end aren't all in a single treatment). Transfer of animals to the test chambers is accomplished by gently drawing one worm into the wide end of a Pasteur pipette and adding the organism directly to the test chamber just above the water’s surface to prevent cross-contamination. The number of animals added will be tracked by a cell counter operated by the person adding the worms. As animals are added to the test chamber, test chambers should be marked. Test chambers should be observed within one hour of addition. Worms demonstrating non-burrowing behavior may be replaced, if the observer believes the behavior results from factors other than sediment toxicity.

During test initiation, five worms should be assigned to an additional 3 holding cups for initial calculated individual weight measurements. Worms for these measurements should be selected at random from the culture dish and should be collected at regular intervals during initiation of the test so as not bias the initial size measurements.

6.2.4 Test Initiation

The test is initiated when test organisms are distributed completely to each test chamber.

To make initial weight measurements, individual animals should be gently scooped onto a small brush, rinsed briefly in deionized water, blotted dry on a Kimwipe and transferred onto a pre dried, pre weighed, pre marked (number etched into pan prior to pre weighing) aluminum pan (2x2 cm piece of aluminum foil). All five worms from one holding cup should be placed onto a foil weigh boat. Fold pans over to prevent loss of animals over the course of drying. Oven dry worms and pans at 60°C for 24 hours prior to weighing. Remove pans/worms from the oven and place in a desiccator for approximately 1 hour to cool to room temperature. All weight measurements must be made on a balance that can be measured to the nearest 0.01 mg.

An initial ash-free dry weight (AFDW) measurement may also be desired on the worms if this endpoint is included in the final test weight determinations. After obtaining the dry weight data, each of the weigh boats is then dried in a muffle furnace heated to 550°C for 2 hours in order to determine ashed weights. The ashed boats are again weighed to 0.01 mg and the ashed weight is subtracted from the dry weight to calculate the AFDW.

6.2.5 Test Maintenance

Feed worms every 48 hours. TetraMin® should be provided at approximately 8 mg (dry weight) per juvenile *Neanthes* (40 mg per test chamber).

Overlying water should be renewed every three days (total of six renewals). Approximately one third of the overlying water volume should be exchanged at each renewal.

6.2.6 Test Measurements

Data are recorded on data sheets.

Water Quality. A daily record of test room or water bath temperatures and test chamber aeration should be made. Water quality measurement should be made prior to renewals. Record temperature, salinity, dissolved oxygen, and pH in one randomly selected test chamber per treatment or a designated water quality surrogate chamber.

Biological. Response criteria indicating toxicity of test sediment include mortality, sublethal and chronic effects. A sublethal effect is the emergence from highly toxic sediment during the course of the test. Chronic effects are monitored by comparing the differences in dry weight or AFDW between test sediments and reference sediments (or control treatment when appropriate). Response criteria will be monitored in a "blind" fashion, that is, the observer will have no knowledge of the treatment of the sediment in the test chambers.

Mortality. At test termination (Day 20), all sediment from each individual chamber should be sieved through a 500 µm sieve to collect surviving organisms. Gently rinse sediment through sieve using 26 - 30 ppt salinity seawater. Gently remove animals from the sieve using a camel hair brush taking care not to damage the animal. Once removed, the animal should be placed into a labeled holding container containing clean filtered seawater (26 - 30 ppt) at room temperature. Record whether animal recovered from each test chamber is surviving, dead, or missing (for purposed of calculations all missing animals are assumed to be dead).

Growth (Dry Weight). Growth is measured by the dry weight of the surviving test worms within a replicate. The results are compared with the weight of the worms at the beginning of the test and with the control(s) and the test concentrations of sediment. Each surviving animal is removed from its holding cup, rinsed briefly in deionized water (< 5 seconds) blotted dry on a Kimwipe, and then placed onto a pre dried, pre weighed, pre labeled weigh boat. The aluminum foil boat should be folded over to prevent the loss of the animal during drying. Note weigh boats should be handled with forceps only. Oven dry animals at 60°C for 24 hours, remove animals and boats from oven and allow to come to room temperature in a desiccator prior to weighing on a microbalance to the nearest 0.01 mg. Subtract boat weight from total weight to obtain measured dry weight value of surviving worms.

Growth Modification (Ash-Free Dry Weight). The purpose of this modification is to account for the weight of sediment contained in the gut of the worms during the drying process. Worms reared under similar conditions and life history, but exposed to different grain size sediment, may express significantly different dry weights due to the contribution of heavier gut material of the worms maintained in sandy (heavier particles) sediment. This discrepancy has the potential to lead to Type II errors, where significant differences are found between test treatments, when none actually exist. The procedure below is a tool to estimate the actual contribution of gut content to the overall weight of the animals. A procedure defined as “ashing” is employed to heat the worm tissue at high temperatures until all that is left behind is solid inorganic material.

At the termination of the 20-day survival and growth test, sediment from each test chamber is sieved through a 0.5-mm screen and all recovered polychaetes are transferred into a plastic cup. Survival is recorded and worms are rinsed with deionized water and placed in pre-ashed, pre-weighed aluminum boats and dried in a gravimetric

oven at 60°C for at least 24 hours. Each weigh-boat is removed from the oven, cooled in a desiccator for approximately 30 minutes, and then weighed on an analytical microbalance to 0.01 mg. Each of the weigh boats is then dried in a muffle furnace heated to 550°C for 2 hours in order to determine ashed weights. The ashed boats are again weighed to 0.01 mg and the ashed weight is subtracted from the dry weight to calculate the AFDW. Both the dry weight and the AFDW are used to determine individual worm weight and growth rates.

The 20-day average individual dry weight (or AFWD) in each exposure chamber is recorded and the mean and standard deviation calculated for each treatment.

6.3 Post-task

Results Needed:

- Percent mortality for each treatment
- Mean dry weight per individual for each treatment
- Ash-Free dry weight (AFDW) per individual for each treatment (program specific, if desired)
- Mean water quality values by treatment
- LC_{50} and 95% confidence limits (for ref. tox.)
- Tables showing biological, chemical, and physical data

In screening tests, the responses of worms in collected test sediments are compared to control and reference site sediments.

6.4 Reporting

The report may include, but will not be limited to, the following:

- Name and address of the laboratory conducting the study, and dates on which the study was initiated and completed.
- The name of the Study Director, other scientists or professionals, and supervisory personnel involved in the study.
- Objectives as stated in the protocol.
- A description of the methods used.
- Transformations, calculations, or operations performed on the data, a summary and analysis of the data, and a statement of the conclusion drawn from the analysis.
- The test substance identified by code number and the date each sample was used.

- The number of organisms used in the study.
- Concentrations of exposure and exposure method.
- Any circumstances that may have affected the quality or integrity of the data, including deviations from test protocols or Standard Operating Procedures.
- The location where raw data and the final report will be stored.
- Additions or corrections to a final report will be in the form of an amendment by the Study Director. The amendment will clearly identify that part of the final report that is being altered and the reason(s) for the alteration(s). The amendment will be signed and dated by the Study Director.

The master copy of the final report will be signed and dated by the Study Director.

7.0 HEALTH AND SAFETY CONSIDERATIONS

Proper laboratory protection, including lab hood or ventilation system, lab coat, closed-toe shoes, gloves and safety glasses, is required when working with chemicals and unprocessed samples.

Refer to the Port Gamble Laboratory's Health and Safety Plan at S:\Health and Safety for procedures to ensure safe operation in the laboratory and for contingency plans in the event of an accident or emergency.

For specific chemical health and safety information, refer to the Safety Data Sheet log.

8.0 PERSONNEL

Any laboratory personnel demonstrating competence with this method may perform the procedure.

9.0 QUALITY ASSURANCE REQUIREMENTS (ACCEPTANCE CRITERIA)

This study will be conducted according to the Standard Operating Procedures which are in effect during the time the study is being performed. In the case where there is a conflict between the other SOPs and this protocol, the protocol will be the definitive procedure.

Usually tests would be unacceptable if one or more of the following occurred:

- More than 10% of the control organisms die.
- All test chambers were not identical.

- Treatments were not randomly assigned to test chambers.
- Test organisms were not randomly or impartially distributed to test chambers.
- All test animals were not from the same population, were not all of the same species, or were not of acceptable quality.
- Reference sediment and controls were not included in the test.
- Temperature, DO, pH, salinity, and ammonia were not measured, or were not within acceptable range.
- Aeration to the test chamber was off for an extended time such that the DO levels dropped to less than 4.6 mg/L.
- Response criteria were not monitored in a blind fashion.

10.0 REFERENCE DOCUMENTS

ASTM. 2012. Guide for conducting Sediment Toxicity Test with Marine and Estuarine Polychaetous Annelids. Standard Guide #E-1611-00(Reapproved 2007). American Society for Testing and Materials, Philadelphia, P A.

Puget Sound Water Quality Authority. Revised July 1995. “Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments.” Prepared for U.S. EPA Region 10, Office of Puget Sound. Seattle, W A.

11.0 APPENDIX OF CHANGE

- 08/20/15 Hand-written change to reflect criteria: if >5% mortality 48hrs preceding test, organisms should be replaced

- 11/12/15 Updated logo, corrected microbalance to nearest gram, and changed test organism acclimation section to reflect a 10% mortality threshold when assessing the organism’s health during rounds

- 05/23/16 Added “uncontrolled” statement to SOP footer and updated Health and Safety section

- 05/09/17 Updated health and safety information, removed branding, added review documentation section. Added “proprietary information” statement in footer. Updated information on animal health upon receipt in section 6.1.3.

12.0 DOCUMENT REVIEW

Acknowledgement below indicates that the individuals have read and understood the concepts summarized in this document.

Name	Signature	Date

APPENDIX B2

RADIOISOTOPE METHOD SUMMARY

Flett Research Ltd.
440 DeSalaberry Ave.
Winnipeg, MB

Document ID: A05100-9
Version: 1
Date: March 5, 2018

Summary of Pb-210, Ra-226, Cs-137 and Be-7 Methods

Lead-210 (Pb-210)

At Flett Lead-210 activity is determined by measurement of its granddaughter, Polonium-210 (Po-210), which is in secular equilibrium with Pb-210 within 2 years of Pb-210 deposition. The method is a modification of procedures described by Eakins and Morrison (1978) and Flynn (1968).

Po-210 in dry sediment, soil or peat samples is solubilized by acid digestion and then plated onto silver planchets for detection by alpha spectrometry. Po-210 recovery is determined by spiking with a known activity of Po-209 tracer.

Method Detection Limits:	0.05 DPM Po-210/g based on 0.5 g of dry sample 0.1 DPM Po-210/g based on 0.25 g of dry sample
MDLs are expressed at the 95% confidence level and can vary slightly depending upon the amount of sample, detector and recovery efficiency of each sample. Counting period is 60 000 seconds. If clean up by distillation is required the MDL is 0.2 DPM/g for a 0.5g sample.	

Cesium-137 (Cs-137) and Be-7

Our method for the non-destructive measurement of gamma-ray emitting radionuclides in sediment, soil and peat is modified from the Environmental Measurements Laboratories method HASL-300 Method Ga-01-R.

Dry samples, which can be highly variable in density, are compressed into pancakes of uniform diameter and relatively similar density. Cs-137 activity is determined by counting gamma-ray emissions at 661.6KeV that are emitted in 85.2% of the decays for 80 000 seconds on a coaxial HPGe detector. Be-7 would usually be measured concurrently with Cs-137 in the same sample and by the same detector. Be-7 is most easily measured by counting the gamma emissions at 477 KeV that are emitted in 10.3 % of the decays.

Method Detection Limits for Cs-137:	0.3 DPM/g based on 9g of dry sample. 0.1 DPM/g based on 32g of dry sample
Be-7:	3 DPM/g based on 9g of dry sample 0.8 DPM/g based on 36g of dry sample
MDLs are expressed at the 95% confidence level and vary with the amount of sample counted. Counting period is 80 000 seconds.	

Radium-226 (Ra-226)

At Flett Radium-226 (Ra-226) activity is determined by measurement of Radon-222 (Rn-222) emanation. The procedure is modified from that of Mathieu et al. (1988).

Dry sediment, soil and peat samples undergo acid digestion to solubilize Ra-226. The digest is placed into a glass vessel, sparged with helium to remove preexisting radon, and then sealed to allow Rn-222 and its daughters to accumulate. After at least 11 days the vessel is again purged and the ingrown radon is collected onto a cold charcoal trap and then transferred into a Lucus scintillation cell. Radon activity is counted for 60 000 seconds by alpha scintillation spectrometry.

Method Detection Limits:	0.5 DPM Rn-222/g based on 0.5g of dry sample 0.1 DPM Rn-222/g based on 2g of dry sample
MDLs are expressed at the 95% confidence level and vary with the amount of sample counted. Counting period is 60 000 seconds.	

References

Appleby, P.G. and F. Oldfield, 1978. The calculation of Lead-210 dates assuming a constant rate of supply of unsupported Pb-210 to the sediment Catena 5: 1-8

Blais, Jules M., Jacob Kalff, R. Jack Cornett & R. Douglas Evans. 1995. Evaluation of Pb-210 dating in lake sediments using stable Pb, Ambrosia pollen, and Cs-137. J. Paleolimnol. 13: 169 – 178.

Eakins, J.D. and R.T. Morrison. 1978. A new procedure for the determination of Lead-210 in lake and marine sediments. International Journal of Applied Radiation and Isotopes. 29: 531 - 536.

Environmental Measurements Laboratory, US Department of Energy – HASL-300 Method Ga-01-R Gamma Emitters in the Environment by Energy, HASL EML Procedures Manual, 28th Edition, February 1997.
Flynn, W.W. 1968. The determination of low levels of Polonium-210 in environmental materials. Anal. Chim. Acta . 43: 221 – 227.

Mathieu, G.G., P.E. Biscaye, R.A. Lupton and D.E. Hammond. System for measurement of 222Rn at low levels in natural waters. 1988. Health Physics 55: 989 - 992.

APPENDIX B3

BORING LOG FORM

MAUL FOSTER ALONGI

Boring/Well No.: ____________

Site: ____________

Location: ____________

Project #: ____________

Boring Log Form

Drill Rig		MFA Staff:		Hole Dia:		Total Depth:	
Drilling Co.:			Water Level:		WLE Note:		
Start Date:		End Date:	Water Level:		WLE Note:		
Notes:							

Completion	Sample			Soil Type:		Color:	
	Top:	Time:	Depth:	Top:	Fines:	Moisture:	
	Length:			Bottom:	Sand:	PID:	
	Type:	Sample ID		Soil Class:	Gravel:	Line Type:	
	% Recov:			Trace:		Impacts:	
				Notes:			
	Top:	Time:	Depth:	Soil Type:		Color:	
	Length:			Top:	Fines:	Moisture:	
	Type:	Sample ID		Bottom:	Sand:	PID:	
	% Recov:			Soil Class:	Gravel:	Line Type:	
				Trace:		Impacts:	
				Notes:			
	Top:	Time:	Depth:	Soil Type:		Color:	
	Length:			Top:	Fines:	Moisture:	
	Type:	Sample ID		Bottom:	Sand:	PID:	
	% Recov:			Soil Class:	Gravel:	Line Type:	
				Trace:		Impacts:	
				Notes:			
	Top:	Time:	Depth:	Soil Type:		Color:	
	Length:			Top:	Fines:	Moisture:	
	Type:	Sample ID		Bottom:	Sand:	PID:	
	% Recov:			Soil Class:	Gravel:	Line Type:	
				Trace:		Impacts:	
				Notes:			
	Top:	Time:	Depth:	Soil Type:		Color:	
	Length:			Top:	Fines:	Moisture:	
	Type:	Sample ID		Bottom:	Sand:	PID:	
	% Recov:			Soil Class:	Gravel:	Line Type:	
				Trace:		Impacts:	
				Notes:			
	Top:	Time:	Depth:	Soil Type:		Color:	
	Length:			Top:	Fines:	Moisture:	
	Type:	Sample ID		Bottom:	Sand:	PID:	
	% Recov:			Soil Class:	Gravel:	Line Type:	
				Trace:		Impacts:	
				Notes:			
	Top:	Time:	Depth:	Soil Type:		Color:	
	Length:			Top:	Fines:	Moisture:	
	Type:	Sample ID		Bottom:	Sand:	PID:	
	% Recov:			Soil Class:	Gravel:	Line Type:	
				Trace:		Impacts:	
				Notes:			
Borehole Notes:							

APPENDIX C

HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

WEYERHAEUSER SAWMILL ABERDEEN/SEAPORT LANDING
500 NORTH CUSTER STREET
ABERDEEN, WASHINGTON

Prepared for
GRAYS HARBOR HISTORICAL SEAPORT AUTHORITY
November 4, 2019
Project No. 1044.02.14

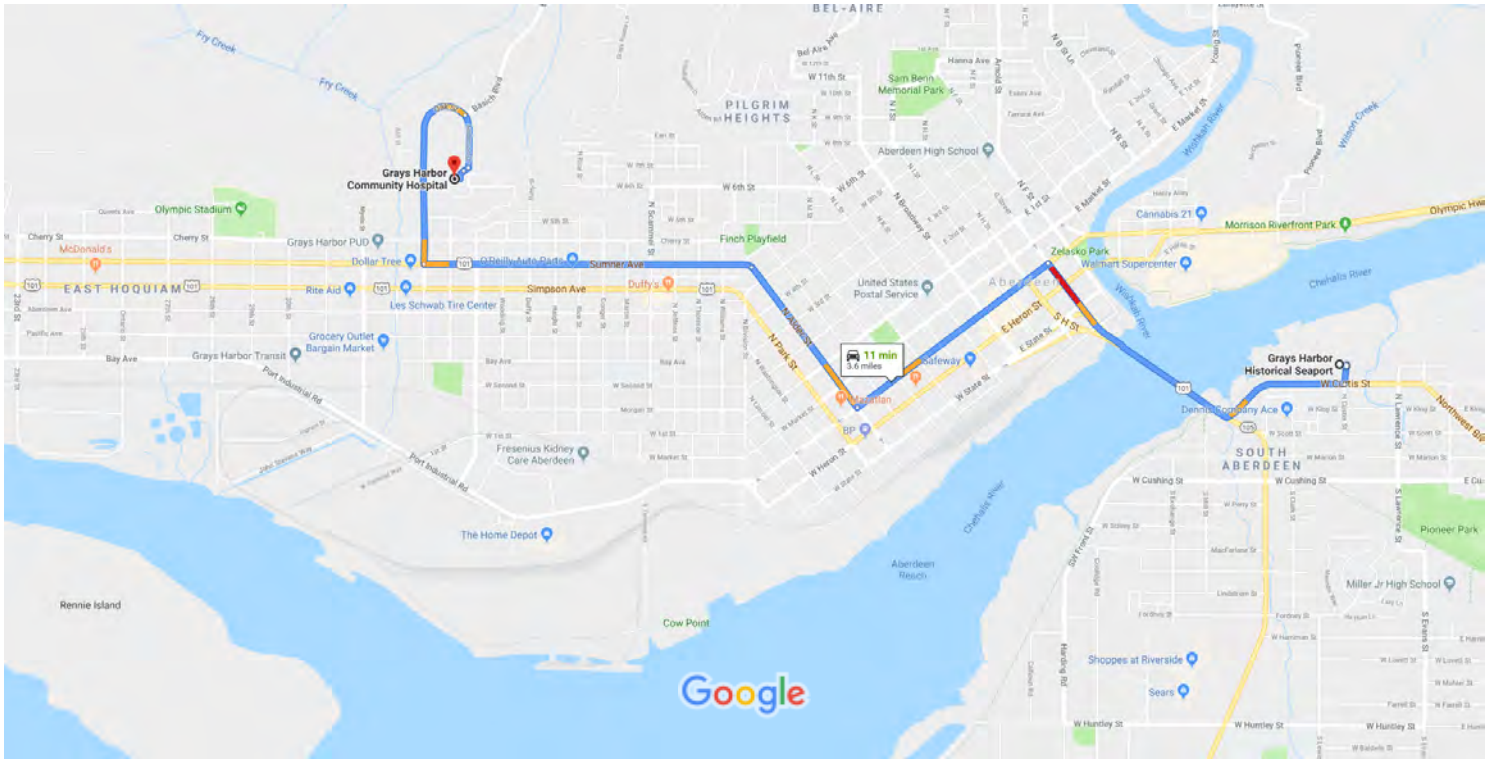
MAUL FOSTER ALONGI

Prepared by
Maul Foster & Alongi, Inc.
2815 2nd Avenue, Suite 540, Seattle, WA 98121

Google Maps

Grays Harbor Historical Seaport to Grays Harbor Community Hospital

Drive 3.6 miles, 11 min



Map data ©2019 Google 1000 ft

Grays Harbor Historical Seaport

500 N Custer St, Aberdeen, WA 98520

1. Head south on N Custer St toward W Curtis St

24 s (259 ft)

Continue on US-101 N. Take Sumner Ave to Oak St

8 min (2.9 mi)

2. Turn right onto US-101 N/W Curtis St
   Continue to follow US-101 N

1.0 mi

3. Turn left onto E Wishkah St

0.6 mi

4. Turn right onto S Alder St

0.5 mi

5. S Alder St turns slightly left and becomes Sumner Ave

0.9 mi

Continue on Oak St to your destination

2 min (0.7 mi)

6. Turn right onto Oak St

0.5 mi

7. Continue straight onto Anderson Dr

0.1 mi

8. Turn right

82 ft

9. Continue straight

Destination will be on the right

128 ft

Grays Harbor Community Hospital

915 Anderson Dr, Aberdeen, WA 98520

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

HEALTH AND SAFETY PLAN

SEAPORT LANDING SITE
500 NORTH CUSTER STREET
ABERDEEN, WASHINGTON

The material and data in this plan were prepared under the supervision and direction of the undersigned.

MAUL FOSTER & ALONGI, INC.

Meaghan Pollock, GIT
Staff Geologist

Emily Hess, LG
Project Geologist

CONTENTS

CONTENTS (CONTINUED)

1 NEAREST HOSPITAL/EMERGENCY MEDICAL CENTER

1.1 Nearest Hospital

Grays Harbor Community Hospital
915 Anderson Drive
Aberdeen, Washington 98520

Phone: (360)532-8330

Distance: 3.6 miles (mi)

Travel Time: 11 minutes

1.2 Route to Hospital from Site

See map on first page of this document.

1.2.1 Driving Directions to Hospital from Site

1. Head south on North Custer Street toward West Curtis Street (259 feet [ft])
2. Turn right onto US-101 North/West Curtis Street (1.0 mi)
3. Turn left onto East Wishkah Street (0.6 mi)
4. Turn right onto South Alder Street (0.5 mi)
5. South Alder Street turns slightly left and becomes Sumner Avenue (0.9 mi)
6. Turn right onto Oak Street (0.5 mi)
7. Continue straight onto Anderson Drive (0.1 mi)
8. Turn right (82 ft)
9. Continue straight (128 ft). Destination will be on the right.

1.3 Emergency Phone Numbers

Ambulance, Police, Fire	**Dial 911**
Emily Hess Project Manager	Phone: (360)433-0244 Cell: (360)980-2497
Michael Stringer Project Director	Phone: (206)858-7617 Cell: (206)498-9147
Emily Curtis Health and Safety Coordinator (HSC)	Phone: (503)501-5233 Cell: (503)410-1524

2 PLAN SUMMARY

This health and safety plan (HASP) was developed to describe the procedures and practices necessary for protecting the health and safety of Maul Foster & Alongi, Inc. (MFA) employees conducting activities at the Weyerhaeuser Sawmill Aberdeen/Seaport Landing site (the Site). Other employers, including contractors and subcontractors, are expected to develop and implement their own HASPs to manage the health and safety of their personnel.

MFA personnel conducting activities at the Site are responsible for understanding and adhering to this HASP. Before fieldwork begins, a site safety officer (SSO) who is familiar with health and safety procedures and with the Site will be designated by the on-site personnel. Safety deficiencies should be immediately communicated to the SSO and, if necessary, to MFA's HSC.

All contractors and subcontractors have the primary responsibility for the safety of their own personnel on the Site. All personnel on the Site have "stop work" authority if they observe conditions that they believe create an imminent danger.

If MFA employees work on the Site for more than a year, this HASP will be reviewed at least annually. The plan will be updated as necessary to ensure that it reflects the known hazards, conditions, and requirements associated with the Site.

MFA personnel who will be working on the Site are required to read and understand this HASP. MFA personnel entering the work area must sign the Personnel Acknowledgment Sheet (Section 16), certifying that they have read and that they understand this HASP and agree to abide by it.

3 KEY PROJECT PERSONNEL

Name	Responsibility
Michael Stringer	Project Director
Emily Hess	Project Manager/Field Personnel
Kyle Roslund	Field Personnel
Meaghan Pollock	Field Personnel
Blair Paulik	Field Personnel
Emily Curtis	HSC

4 SITE DESCRIPTION AND BACKGROUND

4.1 Type of Site

The Site is located north of Curtis Street along the Chehalis River in Aberdeen, Washington. The Site is comprised of a 0.9-acre tax parcel (parcel number 029901100501); a 9.27-acre tax parcel (parcel number 029901100100); two 1.04-acre tax parcels (parcel numbers 027400400000, 027600300101); a 1.39-acre tax parcel (parcel number 027401900000); a 3.96-acre tax parcel (parcel number 029901000101); a 1.74-acre tax parcel (parcel number 027400300100); three 0.14-acre tax parcels (parcel numbers 027400301700, 027400200700, 027400200900); a 1.33-acre tax parcel (parcel number 027400200100); a 0.66-acre tax parcel (parcel number 027601800700); a 1.29-acre tax parcel (parcel number 027600800101); a 0.95-acre tax parcel (parcel number 027400100000); a 0.15-acre tax parcel (parcel number 027600900101); and the tidelands between the Site and the Chehalis River.

4.2 Building/Structures

On-site buildings and structures related to former sawmill operations consist of a small log mill, "Pee Wee" mill, main shipping shed, steam cleaning facility, fuel and chemical storage building, maintenance shop, planer building, compressor building, former oil house, lumber shed, storage shed, office, guard shack, generator shed, wharf, two diesel aboveground storage tanks, and an underground storage tank.

4.3 Topography

Topography of the Site is generally flat with a slight slope to the north toward the adjacent Chehalis River.

4.4 General Geologic/Hydrologic Setting

The Site and vicinity are located within the alluvial plain of the Chehalis River. The Site and vicinity have been mapped as artificial fill and recent alluvium. Alluvium deposits, according to well logs from resource protection wells in the area, consist of sands, silts, silty sands, and clayey silts that are at least 60-ft thick. Artificial fill is comprised of silty sand gravel and gravel. Boring logs also indicate that sandstone was encountered below the alluvium.

Depth to water in the vicinity ranges from 5 to 6 ft below ground surface. Based on geologic logs from previous environmental investigations, groundwater flow in the area is generally to the northwest; however, flow direction and gradient may be tidally affected.

4.5 Site Status

The Site is currently zoned light industrial, and several former sawmill-related buildings are extant. Much of the surface of the Site is paved with asphalt.

4.6 General Site History

The operational history of the Site is detailed in an environmental site assessment.[1] Before 1900, sawmills operated on the Site, on both the uplands and leased tidelands portion of the Site. Since the early 1890s, the South Aberdeen waterfront has been developed for commercial and industrial use. In the late 1890s, the Aberdeen Lumber sawmill was constructed on the upland property with logs rafted along the shoreline to feed the mill. The Aberdeen Lumber sawmill was later sold, becoming the Schafer Brothers Lumber and Door Company Mill #4. The business expanded and so did its footprint. Schafer Brothers later sold the Site to Simpson Timber Company.

Weyerhaeuser acquired the Site in 1955 and operated several sawmills and associated support facilities through January 2009, when the mill known as the Small Log Sawmill was permanently closed. Until the mid-1960s, raw logs were brought to the Site in log rafts on the Chehalis River and tied up to pilings in the river in front of the mill known as the Big Mill. After the mid-1960s, raw logs were brought to the Site by truck and staged on log decks at various locations in and adjacent to the Site. The Big Mill was originally configured to manufacture shingles and slats for housing construction. During World War II, the Big Mill was converted to manufacture ship keels for the war effort. The precursor to the Small Log Mill was added in 1972; small log mill operations were performed in the upland portion of the Site outside of the leased property. The last upgrade to the Small Log Mill took place in 2003. In 2006, the Big Mill and attached finger pier were closed; the associated structures were removed from the Site between 2006 and 2008. This area is now known as the Former Mill Area. The Site continued to operate the Small Log Mill into early 2009. The Grays Harbor Historical Seaport Authority acquired the uplands portion of the Site on March 29, 2013. Currently, there are no active wood-product manufacturing operations at the Site.

[1] PES. 2010. Level I Environmental Site Assessment, Weyerhaeuser NR Company, Aberdeen Sawmill, 500 N. Custer Street, Aberdeen, WA. Prepared by PES Environmental, Inc. August 13.

5 HAZARD EVALUATION

5.1 Site Tasks and Operations

MFA has completed job hazard analyses (JHAs) for specific tasks that likely could be completed on the Site, depending on the scope of work. These tasks are provided in Appendix A. The following list generally summarizes planned tasks and operations:

- General work near heavy equipment
- Work in and around excavations
- Working around structurally hazardous areas
- Collecting soil and groundwater samples
- Collecting sediment samples
- Collecting soil vapor, indoor air, outdoor air, and subslab vapor samples
- Collecting asbestos and lead samples
- Working over water from boats and/or docks

The control measures that field personnel must use to eliminate or minimize these hazards, such as air monitoring, personal protective equipment (PPE), and decontamination procedures, are detailed in the JHAs and in subsequent sections of this plan.

5.2 Chemical Hazard Evaluation

Chemicals of potential concern (COPCs) for the Site are summarized in Appendix B. Action levels and associated controls are specified in Appendix C.

5.3 Physical Hazards

The specific physical hazards and associated controls for work on the Site are described in Appendix A, JHAs.

6 HEALTH AND SAFETY TRAINING

MFA personnel working on site and who could be exposed to COPCs will have completed training consistent with the hazardous waste operations and emergency response requirements in 29 Code of Federal Regulations (CFR) 1910.120(e). The training will include:

- Identity of site safety and health personnel

- Safety and health hazards identified on the Site
- Proper use of required PPE
- Safe work practices required on the Site, e.g., fall protection, confined space entry procedures, hot work permits, general safety rules
- Safe use of engineering controls and equipment on the Site
- Medical surveillance requirements, including the recognition of signs and symptoms that might indicate overexposure to hazards
- The site emergency response plan/spill containment plan

The HSC will oversee training for site personnel. Training records, including an outline, sign-offs, and competency records, will be maintained by the HSC.

7 SAFETY EQUIPMENT

7.1 Personal Protective Equipment

PPE must be worn by individuals on the Site to protect against physical hazards. PPE required on the Site is modified Level D, which consists of:

- Type 1 hard hat
- High-visibility vest
- Work boots
- Safety glasses with side shields
- Nitrile gloves or equivalent when handling known or potentially impacted media
- Work gloves (if handling materials that might have sharp edges, protrusions, or splinters)

Additional PPE may be necessary for specific tasks with additional hazards. The SSO will be responsible for designating additional PPE for specific tasks. Depending on the activity, additional PPE may include:

- Hearing protection (during high-noise tasks)
- Chemical-resistant clothing, e.g., Tyvek® coveralls
- Chemical-resistant boots
- Chemical-resistant goggles
- Chemical-resistant gloves
- Faceshield
- Respiratory protection

Additional PPE may be required if workers discover unexpected contamination. Characteristics of unexpected contamination could include unusual odors, discolored media, a visible sheen, etc. The SSO and, if necessary, the HSC will be contacted as soon as possible after the discovery of unexpected contamination, and the SSO and/or the HSC will determine the need for additional controls and/or training.

PPE used at the Site must meet the requirements of recognized consensus standards (e.g., American National Standards Institute, National Institute for Occupational Safety and Health [NIOSH]), and respiratory protection shall comply with the requirements set forth in 29 CFR 1910.134.

Project personnel are not permitted to reduce the level of specified PPE without approval from the SSO or the HSC.

7.2 Safety Equipment

The SSO will be responsible for ensuring that the following safety equipment is available on site and is properly inspected and maintained:

- Soap and water for decontamination
- Caution tape, traffic cones, and/or barriers
- First-aid kit
- Fire extinguisher
- Fluids for hydration, e.g., drinking water or sports drink

7.3 Air Monitoring Equipment

The following air monitoring equipment will be available to identify site conditions that may require additional controls:

- Photoionization detector

See Appendix C for specified action levels and followup actions.

7.4 Communications Equipment

MFA personnel should have a mobile phone or a radio available in case of emergency.

8 DECONTAMINATION PROCEDURES

8.1 Partial Decontamination Procedures

MFA employees will implement the following partial decontamination procedures when exiting the exclusion zone but remaining on the Site:

- Wash and rinse boots and outer gloves in containers in the contamination-reduction zone.
- Inspect Tyvek® suit for stains, rips, or tears. If suit is contaminated and is to be used again, full decontamination will be performed as described in Section 8.2. If the suit is damaged, it should not be reused.
- Remove outer gloves. Inspect and discard in a container labeled for disposable items if ripped or damaged.
- Remove respirator, if worn, and clean with premoistened alcohol wipes. Discard used cartridges at the frequency dictated by the SSO.
- Wash hands and face with soap and water.

8.2 Full Decontamination Procedures

MFA employees will follow the full decontamination procedures listed below when exiting the exclusion zone and leaving the Site, e.g., at the end of the work shift:

- Wash and rinse boots and outer gloves in containers in the contamination-reduction zone.
- Remove outer gloves and Tyvek® suit and deposit in a container labeled for disposable items.
- Remove respirator and discard used cartridges at the frequency dictated by the SSO.
- Wash and rinse respirator in a "respirators only" decontamination container.
- Remove work boots and put on street shoes. Place work boots in a plastic bag or container for later reuse.
- Remove inner gloves and deposit in a container labeled for disposable items.
- Wash hands and face with soap and water.
- Shower as soon after the work shift as practicable.

9 MEDICAL SURVEILLANCE

MFA will ensure that its employees who meet the following criteria are enrolled in a medical surveillance program consistent with 29 CFR 1910.120(f):

- The employees are, or may be, exposed to hazardous substances or health hazards at or above established permissible exposure limits for 30 or more days per year.
- The employees are required to wear a respirator for 30 or more days per year.

MFA employees who exhibit signs or symptoms consistent with overexposure to site contaminants will be offered medical surveillance consistent with Washington Administrative Code 296-843-21005.

MFA will ensure that its employees who are authorized to wear respirators are medically evaluated consistent with the respiratory protection standard (29 CFR 1910.134). The HSC or administrative designee (e.g., human resources manager) will maintain medical evaluation records.

10 AIR MONITORING

Based on site conditions, air monitoring is not anticipated; however, air monitoring equipment will be available in case workers encounter conditions that indicate the presence of unexpected contamination, such as unusual odors, discolored media, or a visible sheen. If such conditions are discovered, workers will exit the area and contact the SSO and, as needed, the HSC. If necessary, MFA will use the air monitoring equipment to evaluate the conditions and determine if additional controls and/or training are required. Action levels and followup actions are provided in Appendix C.

Air monitoring, if conducted, must be performed by individuals familiar with the calibration, use, and care of the required instruments. Measurements shall be documented, and the records should include the following information:

- The name of the person conducting the measurements
- The identity of workers, if any, who have exposure indicated by measurement result
- Information about the instrument, e.g., type, make, model, serial number
- The location of the measurement
- The measurement date and start/stop time

- Conditions represented by the measurement, including applicable activities, work practices, weather conditions, site conditions, and controls in place
- Measurement results
- Other relevant observations or notes

10.1 Air Monitoring Action Levels

If air monitoring is conducted, the results will be compared to the action levels provided in Appendix C. The air monitoring action levels are established to comply with OSHA Permissible Exposure Levels, American Conference of Governmental Industrial Hygienists threshold limit values, and NIOSH recommendations for the chemicals that may be encountered on the Site. The action levels are also adjusted for the relative response of common PIDs to motor-fuel vapors.

10.2 Explosion Hazard Action Levels

MFA employees working on site will take measurements when working near known or suspected sources of explosive gases or vapors. The instrument alarm should be set to sound at 10 percent of the lower explosive limit. When measurements exceed this level, MFA employees on site will:

1. Extinguish ignition sources and shut down powered equipment in the work area.
2. Move personnel at least 100 ft away from the work area.
3. Contact the SSO and the HSC.
4. At the instruction of the HSC and after waiting 15 minutes for explosive gases to dissipate, the SSO may use the combustible gas meter to approach the worksite to measure combustible gases in the work area. The SSO shall not enter (or allow any personnel to enter) any area where the combustible gas meter readings exceed the explosivity action level, nor shall the SSO approach if there is a potential for fire or explosion.
5. The SSO may authorize personnel to reenter the work area after the source of the combustible gases has been identified and controlled.

10.3 Instrument Calibrations

Instruments shall be calibrated consistent with manufacturers' recommendations. Calibrations shall be coordinated by the SSO. Calibration and monitoring records shall be maintained by the SSO and/or the project manager.

11 SITE CONTROL MEASURES

Access to the Site will be controlled as part of the site preparation. Control measures may include fencing, gates, and signs limiting access to everyone except authorized personnel. Work zones and contaminant reduction zones will be designated by the SSO.

MFA requires the "buddy system" if personnel conduct operations that may involve exposure to site hazards. The buddy system may involve working with non-MFA personnel.

12 EMERGENCY RESPONSE / SPILL CONTAINMENT / CONFINED SPACE

MFA employees on site will follow the emergency response, spill response, and confined space procedures described in the MFA Health and Safety Manual. Incidents will be documented on the incident report form included with Appendix D.

13 PRE-ENTRY BRIEFING

MFA employees on site will conduct pre-entry briefings, e.g., tailgate meetings, before starting work on the Site and/or as the scope of work changes throughout the project to ensure that employees are familiar with the HASP and that the plan is being followed. Attendance and discussion topics will be documented on sign-in sheets, which will be maintained by the SSO. A tailgate safety meeting checklist is included as Appendix E.

14 PERIODIC EVALUATION

The project manager or designee will evaluate the effectiveness of this HASP. As part of the evaluation, the project manager or designee will track ongoing health and safety feedback from field personnel working on the project. This feedback will be reviewed and incorporated into either immediate or annual updates of the HASP. HASPs will be reviewed and updated at least annually. Updating the plan as necessary ensures that it reflects the known hazards, conditions, and requirements associated with the Site. MFA will maintain periodic evaluation records and will track all HASP revisions.

15 SAFE WORK PRACTICES

The following safe work practices are provided to supplement the other information included with this HASP:

1. Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of materials is prohibited in areas with potentially contaminated materials.
2. Field personnel will, whenever practicable, remain upwind of drilling rigs, open excavations, and other site-disturbing activities.
3. Subsurface work shall not be performed at any location until the area has been confirmed by a utility-locator firm to be free of underground utilities or other obstructions.

16 ACKNOWLEDGMENT

MFA cannot guarantee the health or safety of any person entering the Site. Because of the potentially hazardous nature of visits to active sites, it is not possible to discover, evaluate, and provide protection against all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at the Site. The health and safety guidelines in this plan were prepared specifically for the Site and should not be used on any other site without prior evaluation by trained health and safety personnel.

MFA personnel who will work at the Site are to read, understand, and agree to comply with the specific practices and guidelines described in this HASP regarding field safety and health hazards.

This HASP has been developed for the exclusive use of MFA personnel. MFA may make this plan available for review by contracted or subcontracted personnel for information only. This plan does not cover the activities performed by employees of any other employer on the Site. All contracted or subcontracted personnel are responsible for implementing their own health and safety program, including generating and using their own plan.

I have read and I understand this HASP and all attachments, and agree to comply with the requirements described herein:

Name	Title	Date

APPENDIX A

JOB HAZARD ANALYSES

Job Hazard Analysis (JHA)

Task/Operation: Asbestos and Lead-Based Paint Sampling	
Project Number: 1044.02.14	**Location Where Task/Operation Performed:** Seaport Landing, Aberdeen, Washington
Date Prepared: 4/29/2019	**Employee Preparing this JHA:** Meaghan Pollock
Date Reviewed: 5/1/2019	**Employee Reviewing and Certifying this JHA:** Emily Hess

Job/Task Description

Employees will conduct sampling for asbestos-containing materials (ACM) and lead-based paint.

Physical Hazards

Name of Physical Hazard	Source of Hazard/Risk	Hazard/Risk Mitigation
Bodily harm or death	Possible fall from heights.	Stay a safe distance from edges of buildings, floor openings, and structurally hazardous areas. Signs, cones, barrier tape, or equivalent methods will be used to mark edges and floor openings.
Bodily harm	Potentially violent transients occupying vacant buildings.	Do not engage with transients. Contact site security and/or the local police to remove transients before accessing area.
Eye injury	Debris and spills.	Wear eye protection with side shields.
Respiratory	Building materials.	ACM, lead-based paint, and mold have been found in the buildings. Use respirator with high-efficiency particulate air filters when working around abatement areas.
Injuries caused by improper lifting	Equipment, sample coolers.	Use proper bending/lifting techniques by bending and lifting with legs and not with back. Do not twist at the waist when turning core samplers or other devices. Use buddy system for heavy objects.
Accidents with equipment/tools	Sample collection equipment/tools.	Use an equipment checklist to verify that you have the appropriate equipment/tools for your tasks. Consult appropriate JHAs. Stow tools in vehicle properly; use appropriate cases and bags. Secure equipment in vehicle with netting or straps; do not leave loose. Loose equipment can cause property damage or injuries to others or yourself.

Task/Operation: Asbestos and Lead-Based Paint Sampling		
Biological/Chemical/Radiological Hazards		
Biological—mold	Dilapidated building materials.	Avoid areas containing mold, if practicable. Employees who enter areas where mold is disturbed must use a respirator and, if necessary, Tyvek® suits or similar.
Chemical	Personnel performing tasks may come into direct contact with contaminant-containing material.	If necessary, see Chemicals of Potential Concern Table for applicable chemical hazards. Wear the appropriate personal protective equipment (PPE), including nitrile gloves or similar, during sampling to prevent direct contact with contaminant-containing material. Use of a half-face respirator may be necessary.
Biological—radiation	Portable x-ray fluorescence (XRF) device.	The analyst should undergo proper training for safely operating the XRF instrument and radiation training before using the instrument in the field.
Additional Control Measures and Guidance		
Engineering Controls: No engineering controls specified.		
General Safe-Work Practices and Guidance: • Avoid areas containing mold, if practicable. • Follow protocols for radiation safety provided in the XRF instrument operator's manual. • Triple-rinse sampling equipment using distilled or deionized water and alconox soap for first rinse, and distilled water for second and third rinses. • Clean materials between locations at the site to avoid cross-contamination. • Do not bring equipment back to the office without proper decontamination.		
PPE: Respirator (if necessary), hard hat, work boots, high-visibility vest, safety glasses with side shields, nitrile gloves or equivalent.		

Job Hazard Analysis (JHA)

Task/Operation: Sediment Sampling	
Project Number: 1044.02.14	**Location/Site where Task/Operation Performed:** Seaport Landing, Aberdeen, Washington
Date Prepared: 4/29/2019	**Employee Preparing this JHA:** Meaghan Pollock
Date Reviewed: 5/1/2019	**Employee Reviewing and Certifying this JHA:** Emily Hess

Job/Task Description

Employees will conduct sediment sampling. This will require occasional work near potentially contaminated media.

Physical Hazards

Physical Hazard/Risk	Source of Hazard/Risk	Hazard/Risk Mitigation
Drowning	Entering body of water where work is being conducted.	Wear a personal floatation device.
Eye injury	Debris (e.g., sediment) coming into contact with eyes.	Wear eye protection with side shields.
Injuries caused by improper lifting	Equipment, core sampler, sample coolers.	Use proper bending/lifting techniques by bending and lifting with legs and not with back. Do not twist at the waist when turning the core sampler. Use buddy system for heavy objects.
Accidents with equipment/tools	Sample collection equipment/tools.	Verify you have the appropriate equipment/tools for tasks. Use equipment/tools only as intended by the manufacturer. Stow all tools in vehicle properly; use appropriate cases and bags. Secure equipment in vehicle with netting or straps—do not leave loose.

Biological/Chemical Hazards

Biological/Chemical Risk	Source of Hazard/Risk	Hazard/Risk Mitigation
Chemical	Personnel performing tasks may come into direct contact with contaminated materials in the sediment.	If necessary, see Chemical Hazards Summary Table for applicable chemical hazards. Wear appropriate personal protective equipment (PPE), including nitrile gloves, during sampling to prevent direct contact with contaminants in sediment.
Biological—animals	Biting or stinging insects and spiders.	When necessary, use bug repellent.

Additional Control Measures and Guidance

Engineering Controls: No engineering controls specified.

Chemical or Biological Concerns Specific to this JHA: None.

Task/Operation: Sediment Sampling
General Safe-Work Practices and Guidance: • Triple-rinse sampling equipment using distilled or deionized water and alconox for first rinse, and distilled water for second and third rinses. • Always clean materials between locations at the site to avoid cross-contamination. • Do not take equipment from the site without first properly decontaminating said equipment. • Do not eat or drink in the immediate area where sampling is being conducted. • Wash hands and face before eating or drinking. • Dispose of used nitrile gloves in an appropriate container. • Always carry a cellular phone while working in remote areas.
PPE: Hard hat, work boots, high-visibility vest, personal flotation device, safety glasses with side shields, nitrile gloves, and hearing protection if sampling using a drill-rig or around heavy equipment.

Job Hazard Analysis (JHA)

Task/Operation: Soil and Groundwater Sampling		
Project Number: 1044.02.14	**Location/Site Where Task/Operation Performed:** Seaport Landing, Aberdeen, Washington	
Date Prepared: 4/29/2019 **Date Reviewed:** 5/1/2019	**Employee Preparing this JHA:** Meaghan Pollock **Employee Reviewing and Certifying this JHA:** Emily Hess	
Job/Task Description		
Employees will conduct soil and groundwater sampling. This will require occasional work near potentially contaminated media.		
Physical Hazards		
Physical Hazard/Risk	**Source of Hazard/Risk**	**Hazard/Risk Mitigation**
Heat/cold/sunburn	Weather.	Wear sunscreen on exposed skin. Stop work if an employee feels symptoms of dehydration, overheating, or heat stroke. Move to a shaded area and consume water. During cold conditions, wear adequate clothing to reduce the potential for hypothermia.
Eye injury	Construction debris and splashes (e.g., soil, water) coming into contact with eyes.	Wear eye protection with side shields.
Physical stress	Heavy lifting of equipment and bailing water.	Use proper lifting techniques, and take breaks and rest as needed.
Accidents with equipment/tools	Sample-collection equipment/tools.	Only use appropriate equipment for its intended use. Secure equipment in vehicle with netting or straps—do not leave loose.
Biological/Chemical Hazards		
Biological/Chemical Risk	**Source of Hazard/Risk**	**Hazard/Risk Mitigation**
Chemical	Personnel performing tasks may come into direct contact with contaminated materials in the soil and/or groundwater.	If necessary, see Chemical Hazards Summary Table for applicable chemical hazards. Wear appropriate personal protective equipment (PPE), including nitrile gloves and safety glasses, during sampling to prevent direct contact with contaminants in soil and/or groundwater.
Biological—animals	Biting or stinging insects, spiders, snakes, and livestock.	When necessary, use bug repellent. Use snake chaps or shin guards when grass is above the ankle. Use a bar to clear spiders and/or snakes from objects and/or vegetation.

Task/Operation: Soil and Groundwater Sampling
Additional Control Measures and Guidance
Engineering Controls: No engineering controls specified.
General Safe-Work Practices and Guidance: • Do not eat or drink in the immediate area where sampling is being conducted. • Wash hands and face before eating or drinking. • Dispose of used nitrile gloves in an appropriate container. • Avoid working with breathing zone directly above the opening of the well casing. When possible, work upwind of the well casing. • If work is conducted in or near traffic areas, wear high visibility vests. Use cones, flagging, or other devices to mark out the work area. • Always carry a cellular phone while working in remote areas. • Avoid direct contact with soil and groundwater.
PPE: Hard hat, work boots, high-visibility vest, safety glasses with side shields, and disposable nitrile gloves.

Job Hazard Analysis (JHA)

Task/Operation: Soil Vapor, Outdoor Air, Indoor Air, and Subslab Vapor Sampling	
Project Number: 1044.02.14	**Location/Site where Task/Operation Performed:** Seaport Landing, Aberdeen, Washington
Date Prepared: 5/1/2019	**Employee Preparing this JHA:** Meaghan Pollock
Date Reviewed: 5/1/2019	**Employee Reviewing and Certifying this JHA:** Emily Hess

Job/Task Description

Employees will conduct work such as soil vapor, outdoor air, indoor air, and subslab vapor sampling. This will require occasional work near potentially contaminated media and compressed gas.

Physical Hazards

Hazard/Risk	Source of Hazard/Risk	Hazard/Risk Mitigation
Asphyxiation	Helium gas.	Do not place head inside Helium shroud.
Eye injury	Construction debris coming into contact with eyes.	Wear eye protection with side shields.
Physical stress	Heavy lifting of sampling equipment, compressed gas cylinders, sample coolers; kneeling on hard or gravel surfaces.	Use proper bending/lifting techniques by bending and lifting with legs and not with back. Do not twist at the waist when turning. Use buddy system for heavy objects. Use knee pads or kneeling pad. Take breaks and rest as needed.
Accidents with equipment/tools	Sample-collection equipment/tools.	Verify you have the appropriate equipment/tools for your tasks. Use equipment/tools as intended by the manufacturer. Stow all tools in vehicle properly and use appropriate cases and bags. Secure equipment (including compressed gas cylinders) in vehicle with netting, straps, and/or chains—do not leave loose, doing so can cause property damage or serious injuries to others or yourself.
Noise	Roto-hammer.	Wear proper ear protection.

Biological and Chemical Hazards

Hazard/Risk	Source of Hazard/Risk	Hazard/Risk Mitigation
Chemical	None specific to this JHA. Chemical hazards related to the site are described in the Chemical Hazards Summary Table.	None.
Biological—animals	Stinging insects, spiders, and snakes.	Use bug repellent as necessary. Use snake chaps or shin guards when grass is above the ankle. Use a bar to clear out objects and/or vegetation, as well as spiders and/or snakes (do not use your hands or feet).

Additional Control Measures and Guidance

Engineering Controls: No engineering controls specified.

Task/Operation: Soil Vapor, Outdoor Air, Indoor Air, and Subslab Vapor Sampling
General Safe-Work Practices and Guidance: • Always wear nitrile gloves when handling samples and sampling equipment. • Do not eat or drink in the immediate area where sampling is conducted. • Wash hands and face before eating or drinking. • Used nitrile gloves should be disposed of in a container labeled for disposable items. • Secure compressed gas cylinder appropriately during transport and use. • Attach regulator and hose to compressed gas cylinder in appropriate manner. • Grasp or secure hose when in use—do not allow to whip. • Employees should use caution when working around rodent droppings. If possible, use Shop-Vac® to remove rodent droppings before commencing work. • Secure equipment in vehicle with netting or straps; do not leave loose.
Personal Protective Equipment: Hard hat (if overhead hazard is present); work boots (if working near heavy equipment); high-visibility vest; safety glasses; disposable nitrile gloves; and hearing protection (i.e., ear plugs or ear muffs) as needed.

Job Hazard Analysis (JHA)

Task/Operation: Working around Excavations		
Project Number: 1044.02.14		**Location/Site where Task/Operation Performed:** Seaport Landing, Aberdeen, Washington
Date Prepared: 4/1/2019	**Employee Preparing this JHA:** Meaghan Pollock	
Date Reviewed: 5/1/2019	**Employee Reviewing and Certifying this JHA:** Emily Hess	

Job/Task Description
Employees will conduct work around excavations, such as excavation backfill and drilling oversight.

Physical Hazards		
Hazard/Risk	**Source of Hazard/Risk**	**Hazard/Risk Mitigation**
Bodily harm or death	Possible to fall into open excavation from heights.	Stay a safe distance from excavation area. Signs, cones, barrier tape, or other equivalent methods will be used to mark open excavations.
Eye injury	Construction debris (e.g., soil) coming into contact with eyes.	Wear eye protection with side shields.
Head injury	Possible to fall into open excavation from heights.	Stay a safe distance from excavation area. Signs, cones, barrier tape, or other equivalent methods will be used to mark open excavations.

Biological and Chemical Hazards		
Hazard/Risk	**Source of Hazard/Risk**	**Hazard/Risk Mitigation**
Chemical	None specific to this JHA, unless contact made with contaminated materials.	If necessary, see Chemical Hazards Summary Table for applicable chemical hazards.
Biological	No unique source of biological hazards warranting specific controls.	None.

Additional Control Measures and Guidance
Engineering Controls: No engineering controls specified.
General Safe-Work Practices and Guidance: Personnel will stay out of excavation areas at all times. If heavy equipment is being operated, the JHA for working around heavy equipment will be referenced. Signs, cones, barrier tape, or other equivalent methods will be used to mark open excavations, if feasible. Any work that must be conducted near excavations will be conducted using a buddy system.
Personal Protective Equipment: Hard hat; work boots; high-visibility vest; safety glasses with side shields; hearing protection (i.e., ear plugs or ear muffs); and nitrile gloves if handling potentially impacted media.

Job Hazard Analysis (JHA)

Task/Operation: Working Around Structurally Hazardous Areas	
Project Number: 1044.02.14	**Location Where Task/Operation Performed:** Seaport Landing, Aberdeen, Washington
Date Prepared: 4/29/2019 **Date Reviewed:** 5/1/2019	**Employee Preparing this JHA:** Meaghan Pollock **Employee Reviewing and Certifying this JHA:** Emily Hess

Job/Task Description

Employees will conduct sampling for asbestos-containing materials and lead-based paint. This will require occasional work near structurally hazardous areas.

Physical Hazards

Name of Physical Hazard	Source of Hazard/Risk	Hazard/Risk Mitigation
Bodily harm or death	Possible to fall from heights.	Stay a safe distance from structurally hazardous areas. Signs, cones, barrier tape, or equivalent methods will be used to mark structurally hazardous areas.
Eye injury	Debris coming into contact with eyes.	Wear eye protection with side shields.
Head injury	Possible to fall from heights.	Stay a safe distance from structurally hazardous areas. Signs, cones, barrier tape, or equivalent methods will be used to mark structurally hazardous areas.

Biological/Chemical Hazards

Biological	No unique source of biological hazards warranting specific controls.	None.
Chemical	None specific to this JHA, unless contact made with contaminated materials.	If necessary, see Chemicals of Potential Concern Table for applicable chemical hazards.

Additional Control Measures and Guidance

Engineering Controls: No engineering controls specified.

General Safe-Work Practices and Guidance: Personnel will stay away from structurally hazardous areas at all times. Signs, cones, barrier tape, or equivalent methods will be used to mark structurally hazardous areas, if feasible. Use the buddy system for any work that must be conducted near structurally hazardous areas.

Personal Protective Equipment: Hard hat, work boots, high-visibility vest, safety glasses with side shields, and nitrile gloves or equivalent if handling potentially impacted media.

Job Hazard Analysis (JHA)

Task/Operation: Working Near Heavy Equipment	
Project Number: 1044.02.14	**Location/Site Where Task/Operation Performed:** Seaport Landing, Aberdeen, Washington
Date Prepared: 4/29/2019	**Employee Preparing this JHA:** Meaghan Pollock
Date Reviewed: 5/1/2019	**Employee Reviewing and Certifying this JHA:** Emily Hess

Job/Task Description

Employees will conduct work around heavy equipment during investigations at the site. This will require occasionally working near drill rigs and other heavy equipment.

Physical Hazards

Hazard/Risk	Source of Hazard/Risk	Hazard/Risk Mitigation
Bodily harm or death	Heavy equipment operating on site creates a potential for site workers to be struck, crushed, or impacted by moving parts.	Stay a safe distance from equipment and maintain eye contact with equipment operators. Wear a safety vest for enhanced visibility.
Eye injury	Construction debris (e.g., soil) coming into contact with eyes.	Wear eye protection with side shields.
Head injury	Heavy equipment and/or tools impacting the head.	Wear a hard hat.
Penetration of feet	Sharp objects that could be stepped on; large objects falling on feet.	Wear steel-toe boots with steel shank.
Hearing loss	Noise generated by heavy equipment/machinery.	Wear hearing protection such as ear plugs or ear muffs.
Injury to bystanders	Pedestrians in the locality of work.	Use cones and caution tape to cordon off the immediate work area. Watch for and escort pedestrians away from work area. Pause work if necessary.
Hand injury	Pinch points.	Wear protective gloves whenever possible. Avoid placing hands near operating equipment.

Biological and Chemical Hazards

Hazard/Risk	Source of Hazard/Risk	Hazard/Risk Mitigation
None	None specific to this JHA. Chemical hazards related to the site are described in the Chemical Hazards Summary Table.	None.

Additional Control Measures and Guidance

Engineering Controls: No engineering controls specified.

Chemical or Biological Concerns Specific to this JHA: None.

General Safe-Work Practices and Guidance:

- Personnel should stay upwind and out of the impact area of heavy equipment, if feasible.
- Cones, barrier tape, or other equivalent methods will be used to establish the impact area, if feasible.
- Work conducted in the impact area must be coordinated with the equipment operator using pre-established methods of communication, such as direct eye contact, hand signals, and/or verbal communication.

Personal Protective Equipment: Hard hat; steel-toe work boots with steel shank; high-visibility safety vest or outer garment; safety glasses with side shields; nitrile gloves; and hearing protection, i.e., ear plugs or ear muffs.

Job Hazard Analysis (JHA)

Task/Operation: Working over Water from Boats and Docks	
Project Number: 1044.02.14	**Location/Site where Task/Operation Performed:** Seaport Landing, Aberdeen, Washington
Date Prepared: 4/29/2019	**Employee Preparing this JHA:** Meaghan Pollock
Date Reviewed: 5/1/2019	**Employee Reviewing and Certifying this JHA:** Emily Hess

Job/Task Description

Employees will conduct work near (on a bank), in (wading), or over (boat) water, which can be dangerous.

Physical Hazards

Hazard/Risk	Source of Hazard/Risk	Hazard/Risk Mitigation
Drowning	Entering body of water where work is being conducted.	Wear a personal flotation device (PFD).

Biological and Chemical Hazards

Hazard/Risk	Source of Hazard/Risk	Hazard/Risk Mitigation
None	None specific to this JHA. Chemical hazards related to the site are described in the Chemical Hazards Summary Table.	None.

Additional Control Measures and Guidance

Engineering Controls: No engineering controls specified.

General Safe-Work Practices and Guidance:

- At least one extra PFD will be kept on hand in case one becomes damaged.
- Suitable rescue equipment, for example, a lifebelt or lifeline, is to be in position and deemed serviceable before activities begin.
- The boat will be boarded, loaded, and unloaded from a dry and stable location.
- The site supervisor or designee is to make regular and frequent checks on number of personnel working.
- Any work over water is to be carried out by a minimum of two persons; no lone workers are permitted.
- Special care must be taken in fog, snow, or rain; extra checks will be made by the site supervisor under these conditions.
- In a small utility boat, keep weight towards the middle, both fore and aft and side to side.
- If you see waves approaching, take them on the bow.
- Do not overload the boat.
- A secondary means of propulsion should be available (oars or paddle).

Personal Protective Equipment: United States Coast Guard–approved PFD must be used. The PFDs will be inspected daily for defects or chemical damage before use.

APPENDIX B

CHEMICALS OF POTENTIAL CONCERN

Table B-1
Chemical Hazards
Seaport Landing Upland Remedial Investigation Workplan

	OSHA PEL (TWA)	ACGIH TLV (TWA)	NIOSH IDLH	LEL (%)	IP (eV)	Other Hazard
TPH						
Gasoline-Range Organics (TPH-G)	NA	300 ppm	NA	1.4	NA	C, E, F, P
Diesel-Range Organics (TPH-D)	NA	100 mg/m^3	NA	NA	NA	E, F, P
Residual-Range Organics (TPH-O)	NA	NA	NA	NA	NA	E, F, P
VOCs						
1,1-Dichloroethane	100 ppm	100 ppm	3000 ppm	5.4	11.06	--
1,2-Dichloroethane	50 ppm	NE	50 ppm	6.2	11.05	--
cis-1,2-Dichloroethene	200 ppm	NE	1000 ppm	5.6	9.32	P
Tetrachloroethene	100 ppm	25 ppm	150 ppm	NA	9.32	C
Trichloroethylene	100 ppm	300 ppm	1,000 ppm	NA	9.45	C, P
Vinyl chloride	1 ppm	5 ppm	NA	3.6	9.99	C, F
PAHs						
Anthracene	0.2 mg/m^3	0.2 mg/m^3	80 mg/m^3	0.6	NA	F, P
Acenaphthene	NE	NE	NE	0.6	NA	F, P
Acenaphthylene	NE	NE	NE	NA	NA	F, P
Benzo(a)anthracene	NE	NE	NE	NA	NA	C, P
Benzo(a)pyrene	0.2 mg/m^3	0.2 mg/m^3	80 mg/m^3	NA	NA	C, P
Benzo(b)fluoranthene	NE	NE	NE	NA	NA	C, P
Benzo(g,h,i)perylene	NE	NE	NE	NA	NA	P
Benzo(k)fluoranthene	NE	NE	NE	NA	NA	C, P
Chrysene	0.2 mg/m^3	0.2 mg/m^3	80 mg/m^3	NA	7.59	C, P
Dibenz(a,h)anthracene	NE	NE	NE	NA	NA	C, P
Fluoranthene	NE	NE	NE	NA	NA	SC, P
Fluorene	NE	NE	NE	NA	NA	--
Indeno(1,2,3-cd)pyrene	NE	NE	NE	NA	NA	SC
Naphthalene	10 ppm	10 ppm	250 ppm	0.9	8.12	SC, E, F, P
Phenanthrene	0.2 mg/m^3	0.2 mg/m^3	80 mg/m^3	NA	NA	--
Pyrene	0.2 mg/m^3	0.2 mg/m^3	80 mg/m^3	NA	NA	P
1-Methylnaphthalene	NE	0.5 ppm	NE	NA	NA	SC, E, F, P
2-Methylnaphthalene	NE	0.5 ppm	NE	NA	NA	SC, E, F, P
Remaining PAH constituents	NA	NA	NA	NA	NA	NA
Metals						
Arsenic	0.01 mg/m^3	0.01 mg/m^3	5 mg/m^3	NA	NA	C, P
Barium	0.5 mg/m^3	0.5 mg/m^3	NE	NA	NA	R, P
Cadmium	0.0050 mg/m^3	0.002 mg/m^3	9 mg/m^3	NA	NA	C
Chromium	1 mg/m^3	0.5 mg/m^3	250 mg/m^3	NA	NA	R, P
Chromium (VI)	0.001 mg/m^3	0.05 mg/m^3	15 mg/m^3	NA	NA	R, C
Lead	0.05 mg/m^3	0.05 mg/m^3	100 mg/m^3	NA	NA	C, P
Mercury	0.1 mg/m^3	0.01 mg/m^3	2 mg/m^3	NA	NA	R, P
Selenium	0.2 mg/m^3	0.2 mg/m^3	1 mg/m^3	NA	NA	R, P
Silver	0.01 mg/m^3	0.1 mg/m^3	10 mg/m^3	NA	NA	R, P

Table B-1
Chemical Hazards
Seaport Landing Upland Remedial Investigation Workplan

	OSHA PEL (TWA)	ACGIH TLV (TWA)	NIOSH IDLH	LEL (%)	IP (eV)	Other Hazard
Additional						
Asbestos	0.1 fiber/cc	0.1 fiber/cc	NE	NA	NA	C
Benzene	1 ppm	5 ppm	500 ppm	1.2	9.24	F, C, P, R
Ethylbenzene	100 ppm	125 ppm	800 ppm	0.8	8.76	F, P
Pentachlorophenol	0.5 mg/m^3	1.5 mg/m^3	2.5 mg/m^3	NA	NA	C, P
Polychlorinated biphenyls	0.5 mg/m^3	1 mg/m^3	5 mg/m^3	NA	NA	C
Toluene	100 ppm	150 ppm	500 ppm	1.1	8.82	E, F, P, R
Xylenes	100 ppm	150 ppm	900 ppm	0.9	8.44–8.56	F, P

NOTES:

IDLH values taken from http://www.cdc.gov/niosh/idlh/intridl4.html.

-- = not applicable.

ACGIH = American Conference of Governmental Industrial Hygienists®.

C = carcinogen.

cc = cubic centimeter.

E = explosive.

F = flammable.

IDLH = immediately dangerous to life and health.

IP (eV) = ionization potential.

LEL = lower explosive limit.

mg/m^3 = milligrams per cubic meter.

NA = not available.

NE = not established.

NIOSH = National Institute for Occupational Safety and Health.

OSHA = Occupational Safety and Health Administration.

P = poison.

PAH = polycyclic aromatic hydrocarbon.

PEL = permissible exposure level.

ppm = parts per million.

R = reactive.

SC = suspected carcinogen.

TLV = threshold limit value.

TPH = total petroleum hydrocarbons.

TWA = time-weighted average.

VOC = volatile organic compound.

APPENDIX C

AIR MONITORING ACTION LEVELS

Air Monitoring Procedures and Toxicity Action Levels

Instrument	Action Level	Initial Action	Followup Action
FID or PID[a]	Detection of **1 ppm** (above ambient) or greater in breathing zone **sustained for two minutes.**	Dräger tube test for **benzene**. If **1 ppm benzene** detected with Dräger tube, upgrade to level C.	Ventilate area, always work upwind.
Dräger tube test (benzene)	Over **1 ppm benzene sustained** in breathing zone.	After upgrade to Level C, continue to monitor breathing zone with Dräger tube. If **10 ppm or greater benzene**, leave exclusion zone. Return only if levels decrease to below 10 ppm.	Ventilate area, always work upwind.
FID or PID[a]	Detection of 10 ppm (above ambient) in breathing zone **and determined not to be benzene.**	Upgrade to Level C and continue to monitor breathing zone with Dräger tube. **If 50 ppm, leave exclusion zone**. Return only if levels decrease to below 50 ppm.	Ventilate area, always work upwind.
CGI[b]	At or above 10% of the LEL.	Cease activities; turn off all potential sources of ignition. Evacuate.	Determine source of flammable vapors.
Dust Meter	0.05 milligrams per cubic meter of air.	Dust suppression, e.g., misting.	Adjust operations.

NOTES:

CGI = combustible gas indicator.

FID = flame ionization detector.

LEL = lower explosive limit.

PID = photoionization detector.

ppm = parts per million.

[a]Some PIDs do not work in high (e.g., greater than 90%) humidity or rainy weather. Under these atmospheric conditions, only PIDs certified for use in high humidity should be used.

[b]See Section 10.2 of the Health and Safety Plan (to which this table is attached) for complete explosion hazard action levels.

APPENDIX D

INCIDENT REPORT FORM

MAUL FOSTER & ALONGI, INC.
HEALTH & SAFETY INCIDENT REPORT

THIS REPORT MUST BE COMPLETED IN FULL AND SUBMITTED WITHIN 24 HOURS TO THE MFA HEALTH AND SAFETY COORDINATOR

Project Name: _____

Project Number: _____

Date of Incident: _____

Time of Incident: _____

Location: _____

Type of Incident (Check all applicable items)

- ☐ Illness
- ☐ Injury
- ☐ Property Damage
- ☐ Health & Safety Infraction
- ☐ Fire, Explosion, Flash
- ☐ Unexpected Exposure
- ☐ Vehicular Accident
- ☐ Electric Shock
- ☐ Near Miss
- ☐ Other (describe): _____

DESCRIPTION OF INCIDENT

(Describe what happened and the possible cause of the incident. Identify individual(s) involved, witnesses, and their affiliations. Describe emergency or corrective action taken. Attach additional sheets, drawings, or photographs as needed.)

_____

_____

_____

_____

_____

_____

_____

_____

INCIDENT REPORTER

_____	_____	_____
PRINT NAME	SIGNATURE	DATE

Site Safety Officer must deliver this report to the Health & Safety Coordinator within 24 hours. Reviewed by:

_____	_____	_____
PRINT NAME MFA Health & Safety Coordinator	SIGNATURE MFA Health & Safety Coordinator	DATE

APPENDIX E

TAILGATE SAFETY MEETING CHECKLIST

Tailgate Safety Meeting Checklist

MAUL FOSTER ALONGI

Client Name:	
Project No.:	
Communicated By:	
Date:	

Yes	NA	Information Reviewed
☐	☐	Emergency Procedures and Site Evacuation Routes
☐	☐	Route to Hospital
☐	☐	HASP Review and Location
☐	☐	Key Project Personnel
☐	☐	Emergency Phone Numbers
☐	☐	Stop Work Authority
☐	☐	General Site Description/History and Chemical Hazards
☐	☐	For Active Sites—Site Activities and Vehicular/Equipment Traffic
☐	☐	Site-Specific Physical Hazards
☐	☐	Required Personal Protective Equipment
☐	☐	Available Safety Equipment and Location
☐	☐	Daily Scope of Work (Reference JHAs as applicable)
☐	☐	Decontamination Procedures
☐	☐	Identify Work Zones, Exclusion Zones, and Decontamination Zones
☐	☐	Hazardous Atmospheres
☐	☐	Air Monitoring Equipment and Procedures
☐	☐	Identify Potential Site-Specific Slip, Trip, and Fall Hazards
☐	☐	Dust and Vapor Control
☐	☐	Confined Space(s)
☐	☐	Open Pits and Excavation
☐	☐	Extreme Temperatures
☐	☐	Incident Reporting
☐	☐	Other: _____

Suggestions to Improve H&S Practices

Attendees		
Name	Signature	Company
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		

APPENDIX D

INADVERTENT DISCOVERY PLAN

DEPARTMENT OF ECOLOGY
State of Washington

PLAN AND PROCEDURES FOR THE UNANTICIPATED DISCOVERY OF CULTURAL RESOURCES AND HUMAN SKELETAL REMAINS[1]

PROJECT TITLE: Seaport Landing Environmental Assessment Project (Aberdeen Sawmill)

COUNTY WASHINGTON: Grays Harbor

Section, Township, Range: Section 10, Township 17, Range 09W

1. INTRODUCTION

The following Inadvertent Discovery Plan (IDP) outlines procedures to perform in the event of discovering archaeological materials or human remains, in accordance with state and federal laws.

2. RECOGNIZING CULTURAL RESOURCES

A cultural resource discovery could be prehistoric or historic. Examples include:

a. An accumulation of shell, burned rocks, or other food related materials.

b. Bones or small pieces of bone.

c. An area of charcoal or very dark stained soil with artifacts.

d. Stone tools or waste flakes (i.e. an arrowhead. or stone chips).

e. Clusters of tin cans or bottles, logging or agricultural equipment that appears to be older than 50 years.

f. Buried railroad tracks, decking, or other industrial materials.

When in doubt, assume the material is a cultural resource.

3. ON-SITE RESPONSIBILITIES

STEP 1: *Stop Work*. If any employee, contractor or subcontractor believes that he or she has uncovered a cultural resource at any point in the project, all work must stop immediately. Notify the appropriate party(s). Leave the surrounding area untouched, and provide a demarcation adequate to provide the total security, protection, and integrity of the discovery. The discovery location must be secured at all times by a temporary fence or other onsite security.

STEP 2: *Notify Archaeological Monitor or Licensed Archaeologist*. If there is an Archaeological Monitor for the project, notify that person. If there is a monitoring plan in place, the monitor will follow the outlined procedure.

[1] If you need this document in a format for the visually impaired, call Water Quality Reception at Ecology, (360) 407-6600. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

STEP 3: *Notify the Project Manager* of this project and contact the Ecology Staff Project Manager, or other applicable contacts:

Maul Foster & Alongi Project Manager: Name: Emily Hess Phone: 360-980-2497 Email: ehess@maulfoster.com	Ecology Staff Project Manager Name: Tom Middleton Phone: (360) 407-7263 Email: tmid461@ecy.wa.gov

Assigned Alternates:

Maul Foster & Alongi Assigned Project Manager Alternate: Name: Michael Stringer Phone: 206-498-9147 Email: mstringer@maulfoster.com	Ecology Cultural Resource Specialist (Alternate): Name: Amy Hargrove Phone: 360-407-6262 email: Amy.Hargrove@ecy.wa.gov
Cultural Resource Consultant Senior Staff: Name: Margaret Berger Phone: 206-979-3652 Email: margaret@crcwa.com	

The Project Manager or applicable staff will make all calls and necessary notifications. **If human remains are encountered**, treat them with dignity and respect at all times. Cover the remains with a tarp or other materials (not soil or rocks) for temporary protection and to shield them from being photographed. **Do not call 911 or speak with the media. Do not take pictures unless directed to do so by DAHP. See Section 5.**

4. FURTHER CONTACTS AND CONSULTATION

A. **Project Manager's Responsibilities**:

- *Protect Find*: The Project Manager is responsible for taking appropriate steps to protect the discovery site. All work will stop immediately in a surrounding area adequate to provide for the complete security of location, protection, and integrity of the resource. Vehicles, equipment, and unauthorized personnel will not be permitted to traverse the discovery site. Work in the immediate area will not resume until treatment of the discovery has been completed following provisions for treating archaeological/cultural material as set forth in this document.

- *Direct Construction Elsewhere on-Site*: The Project Manager may direct construction away from cultural resources to work in other areas prior to contacting the concerned parties.

- *Contact Senior Staff*: If the Senior Staff person has not yet been contacted, the Project Manager must do so.

B. **Senior Staff Responsibilities**:

- *Identify Find*: The Senior Staff (or a delegated Cultural Resource Specialist), will ensure that a qualified professional archaeologist examines the area to determine if there is an archaeological find.

- If it is determined not to be of archaeological, historical, or human remains, work may proceed with no further delay.

- If it is determined to be an archaeological find, the Senior Staff or Cultural Resource Specialist will continue with all notifications.

- If the find may be human remains or funerary objects, the Senior Staff or Cultural Resource Specialist will ensure that a qualified physical anthropologist examines the find. **If it is determined to be human remains, the procedure described in Section 5 will be followed.**

- *Notify DAHP*: The Senior Staff (or a delegated Cultural Resource Specialist) will contact the involved federal agencies (if any) and the Washington Department of Archaeology and Historic Preservation (DAHP).

- *Notify Tribes*: If the discovery may be of interest to Native American Tribes, the DAHP and Ecology Supervisor or Coordinator will coordinate with the interested and/or affected tribes. At the request of Quinault Indian Nation, if testing begins to reach intact sediments and extends vertically beyond the depth of fill materials, the Quinault Indian Nation will be notified and will have the opportunity to re-evaluate the need to have an archaeological monitor.

General Contacts

Federal Agencies:	**State Agencies**:
Agency: Name Title Number Email	Agency: Name Title Number: Email

Department of Archaeology and Historic Preservation:

Dr. Allyson Brooks State Historic Preservation Officer 360-586-3066 Assigned Alternate:	Rob Whitlam, Ph.D. Staff Archaeologist 360-586-3050 Assigned Alternate:

The DAHP or appropriate Ecology Staff will contact the interested and affected Tribes for a specific project.

Tribes consulted on this project are:

Tribe Quinault Indian Nation	Tribe Confederated Tribes of the Chehalis Reservation
Name Naomi Brandenfels	Name Dan Penn
Title Archeologist	Title Acting THPO
Phone 360-276-8211x7309	Phone 360-709-1747
Email naomi.brandenfels@quinault.org	Email dpenn@chehalistribe.org
Copy Dave Bingaman (dbingaman@quinault.org)	

Further Activities

- Archaeological discoveries will be documented as described in Section 6.
- Construction in the discovery area may resume as described in Section 7.

5. SPECIAL PROCEDURES FOR THE DISCOVERY OF HUMAN SKELETAL MATERIAL

Any human skeletal remains, regardless of antiquity or ethnic origin, will at all times be treated with dignity and respect. Do not take photographs by any means, unless you are pre-approved to do so.
If the project occurs on federal lands or receives federal funding (e.g., national forest or park, military reservation) the provisions of the Native American Graves Protection and Repatriation Act of 1990 apply, and the responsible federal agency will follow its provisions. Note that state highways that cross federal lands are on an easement and are not owned by the state.

If the project occurs on non-federal lands, the Project Manager will comply with applicable state and federal laws, and the following procedure:

A. **In all cases you must notify a law enforcement agency or Medical Examiner/Coroner's Office**:

In addition to the actions described in Sections 3 and 4, the Project Manager will immediately notify the local law enforcement agency or medical examiner/coroner's office.

The Medical Examiner/Coroner (with assistance of law enforcement personnel) will determine if the remains are human, whether the discovery site constitutes a crime scene, and will then notify DAHP.

Grays Harbor County Coroner (360) 537-6139
1006 N H St, Aberdeen, WA 98520

B. Aberdeen Police Department 360-533-8765 **Participate in Consultation**:

Per RCW 27.44.055, RCW 68.50, and RCW 68.60, DAHP will have jurisdiction over non-forensic human remains. Ecology staff will participate in consultation.

C. **Further Activities**:

- Documentation of human skeletal remains and funerary objects will be agreed upon through the consultation process described in RCW 27.44.055, RCW 68.50, and RCW 68.60.

- When consultation and documentation activities are complete, construction in the discovery area may resume as described in Section 7.

6. DOCUMENTATION OF ARCHAEOLOGICAL MATERIALS

Archaeological deposits discovered during construction will be assumed eligible for inclusion in the National Register of Historic Places under Criterion D until a formal Determination of Eligibility is made.

Project staff will ensure the proper documentation and field assessment will be made of any discovered cultural resources in cooperation with all parties: the federal agencies (if any), DAHP, Ecology, affected tribes, and a contracted consultant (if any).

All prehistoric and historic cultural material discovered during project construction will be recorded by a professional archaeologist on a cultural resource site or isolate form using standard and approved techniques. Site overviews, features, and artifacts will be photographed; stratigraphic profiles and soil/sediment descriptions will be prepared for minimal subsurface exposures. Discovery locations will be documented on scaled site plans and site location maps.

Cultural features, horizons and artifacts detected in buried sediments may require further evaluation using hand-dug test units. Units may be dug in controlled fashion to expose features, collect samples from undisturbed contexts, or to interpret complex stratigraphy. A test excavation unit or small trench might also be used to determine if an intact occupation surface is present. Test units will be used only when necessary to gather information on the nature, extent, and integrity of subsurface cultural deposits to evaluate the site's significance. Excavations will be conducted using state-of-the-art techniques for controlling provenience, and the chronology of ownership, custody and location recorded with precision.

Spatial information, depth of excavation levels, natural and cultural stratigraphy, presence or absence of cultural material, and depth to sterile soil, regolith, or bedrock will be recorded for each probe on a standard form. Test excavation units will be recorded on unit-level forms, which include plan maps for each excavated level, and material type, number, and vertical provenience (depth below surface and stratum association where applicable) for all artifacts recovered from the level. A stratigraphic profile will be drawn for at least one wall of each test excavation unit.

Sediments excavated for purposes of cultural resources investigation will be screened through 1/8-inch mesh, unless soil conditions warrant ¼-inch mesh.

All prehistoric and historic artifacts collected from the surface and from probes and excavation units will be analyzed, catalogued, and temporarily curated. Ultimate disposition of cultural materials will be determined in consultation with the federal agencies (if any), DAHP, Ecology and the affected tribes.

Within 90 days of concluding fieldwork, a technical report describing any and all monitoring and resultant archaeological excavations will be provided to the Project Manager, who will forward the report for review and delivery to Ecology, the federal agencies (if any), DAHP, and the affected tribe(s).

If assessment activity exposes human remains (burials, isolated teeth, or bones), the process described in Section 5 will be followed.

7. PROCEEDING WITH WORK

Work outside the discovery location may continue while documentation and assessment of the cultural resources proceed. A professional archaeologist must determine the boundaries of the discovery location. In consultation with Ecology, DAHP and any affected tribes, the Project Manager will determine the appropriate level of documentation

and treatment of the resource. If there is a federal nexus, Section 106 consultation and associated federal laws will make the final determinations about treatment and documentation.

Work may continue at the discovery location only after the process outlined in this plan is followed and the Project Manager, DAHP, any affected tribes, Ecology (and the federal agencies, if any) determine that compliance with state and federal law is complete.

8. RECIPIENT/PROJECT PARTNER RESPONSIBILITY

The Project Recipient/Project Partner is responsible for developing an IDP. The IDP must be immediately available onsite, be implemented to address any discovery, and be available by request by any party. The Project Manager and staff will review the IDP during a project kickoff or pre-construction meeting.

We recommend that you print images in color for accuracy.

Implement the IDP / UDP if …

You see chipped stone artifacts.

- Glass-like material
- Angular
- “Unusual” material for area
- “Unusual” shape
- Regularity of flaking
- Variability of size

Implement the IDP / UDP if …

You see ground or pecked stone artifacts.

- Striations or scratching
- Unusual or unnatural shapes
- Unusual stone
- Etching
- Perforations
- Pecking
- Regularity in modifications
- Variability of size, function, and complexity

Implement the IDP / UDP if …

You see bone or shell artifacts.

- Often smooth
- Unusual shape
- Carved
- Often pointed if used as a tool
- Often wedge shaped like a "shoehorn"

Bone Awls from Oregon and Bone Wedge from California

Implement the IDP / UDP if …

You see bone or shell artifacts.

- Often smooth
- Unusual shape
- Perforated
- Variability of size

Implement the IDP / UDP if …

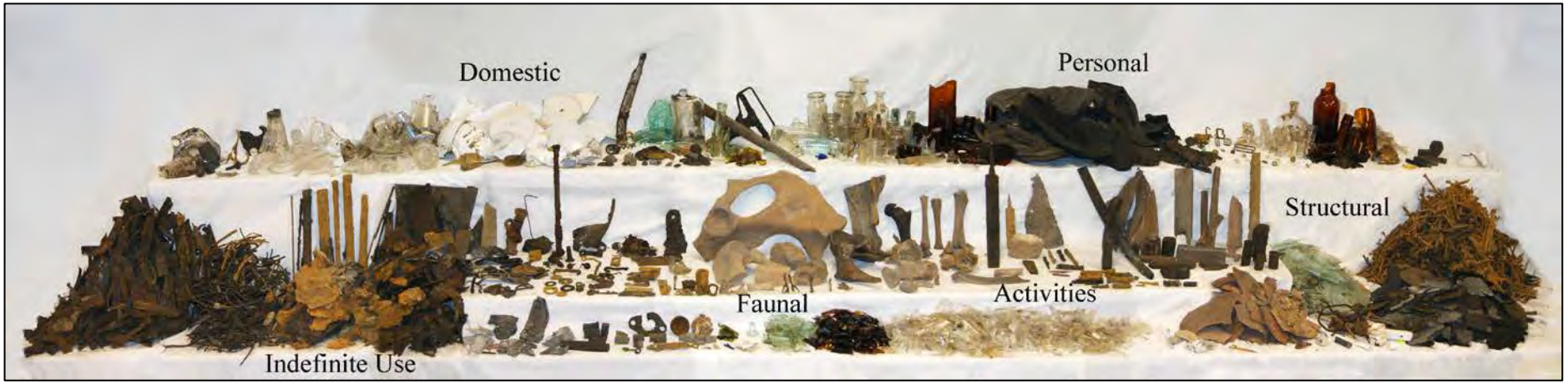
You see fiber or wood artifacts.

- Wet environments needed for preservation
- Variability of size, function, and complexity
- Rare

Artifacts from Mud Bay, Olympia, Washington

Implement the IDP / UDP if …

You see historic period artifacts.



Artifacts from Downtown Seattle, Alaskan Way Viaduct (Upper Left and Lower) and Unknown Site (Upper Right)

Implement the IDP / UDP if …

You see strange, different or interesting looking dirt, rocks, or

- Human activities leave traces in the ground that may or may not have artifacts associated with them
- “Unusual” accumulations of rock (especially fire-cracked rock)
- “Unusual” shaped accumulations of rock (e.g., similar to a fire ring)
- Charcoal or charcoal-stained soils
- Oxidized or burnt-looking soils
- Accumulations of shell
- Accumulations of bones or artifacts
- Look for the “unusual” or out of place (e.g., rock piles or accumulations in areas with few rock)

Implement the IDP / UDP if …

You see strange, different or interesting looking dirt, rocks, or

- "Unusual" accumulations of rock (especially fire-cracked rock)
- "Unusual" shaped accumulations of rock (e.g., similar to a fire ring)
- Look for the "unusual" or out of place (e.g., rock piles or accumulations in areas with few rock)

Site on Muckleshoot Indian Reservation, near WSDOT ROW along SR 164

Implement the IDP / UDP if …

You see strange, different or interesting looking dirt, rocks, or

- Often have a layered or “layer cake” appearance
- Often associated with black or blackish soil
- Often have very crushed and compacted shells

Implement the IDP / UDP if …

You see historic foundations or buried structures.