


**Prepared by**

**The Port Angeles Harbor**

**Natural Resource Trustee Council**

# August 2013

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## I. INTRODUCTIONS, AUTHORITIES, AND DELEGATIONS

This document is a preassessment screen (PAS), prepared pursuant to 43 CFR Part 11, for the Port Angeles Harbor Site (Harbor) in Port Angeles, Washington. The site is more fully described in Section II (A) below.

This PAS was undertaken to determine whether it is appropriate to conduct natural resource damage assessment pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 U.S.C. §§ 9601 *et seq.*, as amended; the Oil Pollution Act of 1990 (OPA), 33 U.S.C. §§ 2701 *et seq.*; and the Clean Water Act (CWA), 33 U.S.C. §§ 1251 *et seq.*; and the Model Toxics Control Act (MTCA), RCW Chapter 70.105D. Specifically, this PAS addresses whether the regulatory criteria found in the CERCLA regulations at 43 C.F.R. § 11.23(e) for a natural resource damage assessment have been met:

1) *A discharge of oil or release of hazardous substance has occurred.*

2) *Natural resources for which a State or Federal agency or Indian Tribe may assert trusteeship under CERCLA have been or are likely to have been adversely affected by the discharge or release.*

3) *The quantity and concentration of the discharged oil or released hazardous substances is sufficient to potentially cause injury to those natural resources.*

4) *Data sufficient to pursue an assessment are readily available or likely to be obtained at reasonable cost.*

5) *Response actions from remedial activities carried out or planned do not or will not sufficiently remedy the injury to natural resources without further action.*

This PAS has been prepared in accordance with 43 CFR § 11.23(e) by members of the Port Angeles Harbor Natural Resource Trustee Council (Trustees). The Trustees are the Secretary of the United States Department of Commerce, acting through the National Oceanic and Atmospheric Administration (NOAA); the Secretary of the United States Department of the Interior (USDOI), acting through the U.S. Fish and Wildlife Service (USFWS); the State of Washington Department of Ecology (Ecology); the Lower Elwha Klallam Tribe (Lower Elwha); the Port Gamble S' Klallam Tribe (Port Gamble); and the Jamestown S' Klallam Tribe (Jamestown). Collectively, pursuant to 42 U.S.C. §9607(f) (CERCLA Section 107 (f)) and 40 C.F.R. 300.600 (Section 300.600 of the National Contingency Plan), these entities are trustees for all of the natural resources in the environment potentially injured by releases from and into the Harbor.

## II. INFORMATION ON THE SITE

### A. Background and History

#### 1. Natural History

The Harbor is located on the northern coast of Washington's Olympic Peninsula on the Strait of Juan de Fuca (**Figure 1**). The peninsula is bordered by the Strait of Juan de Fuca to the north, the eastern Pacific Ocean to the west, and Hood Canal/Puget Sound to the east. Protected from storms from the Pacific Ocean by the 2.5-mile-long arm of Ediz Hook, the harbor was home to two aboriginal Klallam fishing villages and continues to provide safe harbor for commercial ships, fishing vessels, and pleasure craft. Several surface streams drain into the Harbor, including Tumwater; Valley; Peabody; Morse; and Ennis Creek. Ennis Creek, which drains a significantly-sized area, is a snow fed stream with its headwaters located in Olympic National Park.

The city of Port Angeles (City) includes approximately 26 miles of marine shoreline. Port Angeles Harbor is considered the largest natural deepwater harbor on the west coast of the United States, with depths exceeding 90 feet near the eastern end. The Harbor has many commercial and industrial facilities along its shoreline.

#### 2. Cultural History

The forested area surrounding the Harbor was a fishing community inhabited by two major Klallam Native American villages. These two villages, Tse-whit-zen and I'e'nis ("Ennis"), were built along the shore of the Harbor, and the latter along the creek that shares its name. Klallam Indians also inhabited what is now the area surrounding Hollywood Beach and made broad use of the natural resources in the area (Oldham 2007). Klallam villages were party to the 1855 Treaty of Point No Point in which they reserved fishing rights at all usual and accustomed grounds and stations. Over time, the Klallam Indians coalesced into the three distinct federally recognized tribes that exist today: Lower Elwha, Jamestown, and Port Gamble. Klallam Indians inhabited sites on Port Angeles Harbor into the 1930s, when they were relocated to other lands. The federal court in *United States vs. Washington* has determined that the usual and accustomed treaty fishing grounds of all three Klallam tribes includes Port Angeles Harbor.

Historians estimate that the protected Harbor has been inhabited for over 2,700 years and during the last 400 years the Harbor was shared by the two Klallam villages. The Tse-whit-zen village was located at the base of Ediz Hook near the lagoon. Archeological studies in 2004 located the remains of six longhouses in the village which was surrounded by a stockade. The I'e'nis village was located on the east side of Ennis Creek and was also surrounded by a stockade.

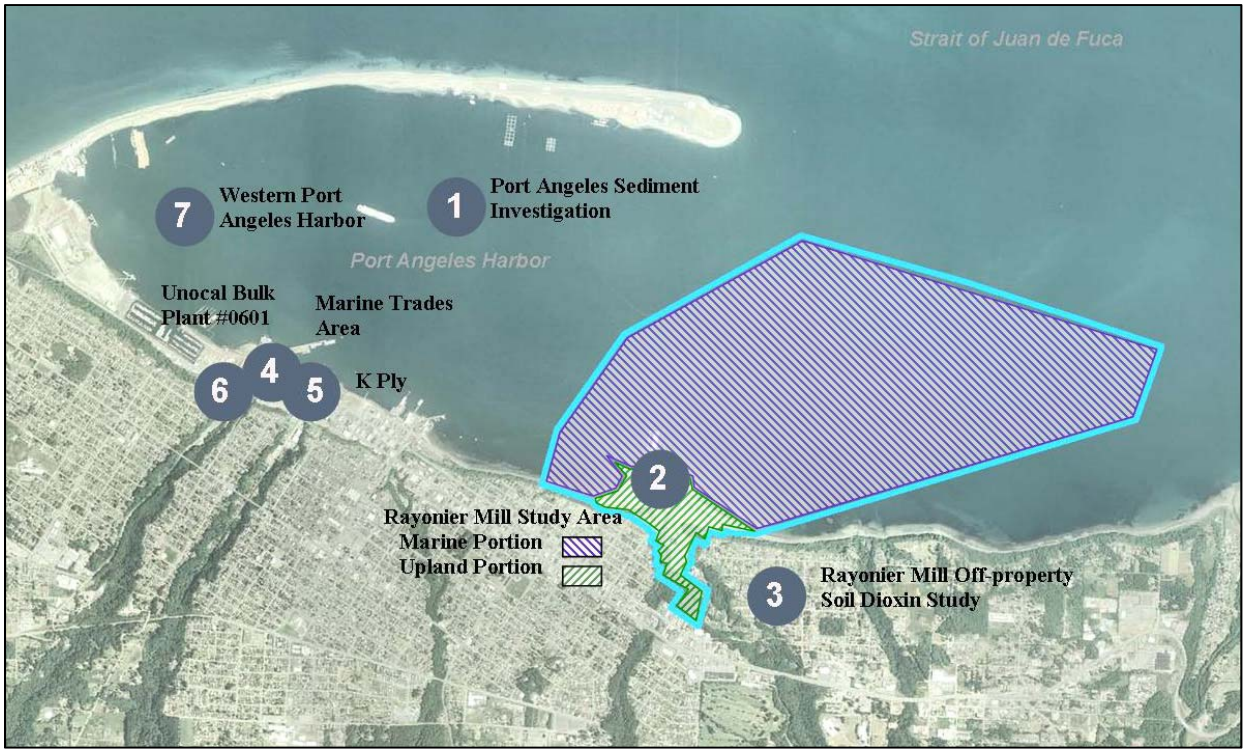



**Figure 1**. Map of Port Angeles Harbor showing Ecology work

Klallam Indians often traveled to areas of seasonal resource gathering and established temporary campsites for collecting and processing resources (Gunther 1927). When an extended stay was expected the temporary shelters were replaced with shelters constructed of cedar planks.

The marine resources utilized during these stays included harbor seals (*Phoca vitulina*), sea otters (*Enhydra lutris*), several salmonid species (*Oncorhynchus spp*.), Pacific Halibut (*Hippoglossus stenolepsis*), Lingcod (*Ophiodon elongatus*), True cods (*Gadus spp*.), rockfish (*Sebastes spp*.), Pacific herring, (*Clupea pallasii*), Surf smelt (*Hypomesus pretiosus*), Pacific sand lance (*Ammodytes hexapterus*), Dungeness crab (*Cancer magister*), shellfish such as littleneck clams (*Protothaca staminea*), butter clams (*Saxidomus giganteus*), Horse clams (*Tresus sp*.), heart cockles (*Clinicardium nuttallii*), and bent nose clams (*Macoma nasuta*). Salmon was a primary resource for early inhabitants (Oldham 2007, Wilt and Roulette 2001).

3. Current and Historic Port Angeles Harbor Industry

Over the past century, the Harbor has been used by a number of industries including saw mills and plywood manufacturing, pulp and paper production, marine

shipping/transportation, boat building and refurbishing, petroleum bulk fuel facilities, marinas, and commercial fishing. Since the early 1900s, pulp and paper mills have comprised a dominant portion of Port Angeles' industrial sector. Treated and untreated mill process effluents were commonly discharged into the Harbor from wood product sources and have been identified as significant sources of constituents of potential concern (COPCs) to marine sediments.

Historically, industrial development occurred in three distinct areas of the Harbor, herein referred to as the eastern Harbor, the central Harbor, and the western Harbor. Releases of hazardous substances, and the potential liability or responsibility of parties for those releases is discussed in Section II.D of this PAS.

*a) Eastern Port Angeles Harbor*

Facilities and operations associated with the eastern Harbor include a pulp and paper mill, discharge systems for stormwater, process wastewater, wastewater treatment and combined sewer overflows.

The U.S. Army constructed a spruce mill adjacent to Ennis Creek during World War I, but it was never put into production. In 1929, the Olympic Forest Product Company dismantled the spruce mill and built a pulp and paper mill in its place. The mill used a chlorine-based bleaching process and hog fuel burning using salt-laden wood. Extensive wood rafting was employed by the facility. The mill operated from 1930 until 1997. Rayonier, Inc. (Rayonier) owned and operated it from 1937 to 1997 when paper production ceased and the company began dismantling the site (Oldham, 2007).

*b) Central Port Angeles Harbor*

Facilities and operations associated with the central Harbor include marine terminals, petroleum bulk storage and transport, plywood manufacturing, and discharge systems for stormwater, process wastewater, and combined sewer overflows.

The Port of Port Angeles (Port) was organized in 1922 by the voters of Clallam County. In Port Angeles Harbor, the Port currently operates a full-service port with three deep-water marine terminals (Terminals 1, 3, and 7), a terminal for ferry service, other industrial activities, and Boat Haven marina. The marina encompasses 16.1 acres and provides permanent and temporary moorage space for over 500 boats. The adjacent boat yard and commercial businesses provide repair, retrofit, haul-out, and charter services, as well as bait shops and restaurants. Terminal 5 has served as a log yard and wood chip export facility and Terminal 7 has served as a wood chip export facility. A general public boat launch is located west of the marina along the Harbor waterfront. The ferry terminal, located north of downtown, provides space for ferries, as well as other smaller commercial and recreational vessels.

The Marine Trades Area (MTA) refers to an area east of Tumwater Creek where mostly marine-related businesses are located.

Petroleum storage and transport businesses have historically operated and are currently operating along the Port Angeles waterfront. Eight petroleum bulk plant and terminal facilities have operated in the central Harbor. Five major facilities closed in the early 1980s. Chevron operated two bulk plants near the central industrial waterfront, the first of which opened in 1922 and later became Unocal. The second plant (currently Pettit Oil) is a part of the MTA, along with former bulk plants owned by Arco, Standard Oil, and Phillips 66. BP America, Inc., currently operates a bulk fuel facility on the western edge of Ediz Hook.

The former Pen-Ply/K-Ply plywood mill was located along the central southern shoreline of the Harbor, and operated from 1941 until 2011. The facility operated historical log-booming areas in the Harbor and a hog fuel boiler burning salt-laden wood. The mill rafted wood and used a log pond that has since been filled in. The mill was operated by Peninsula Plywood Corp. (Pen-Ply) from 1941-1971. It was owned by ITT Rayonier from 1971 to 1989. In 1989 the property was purchased by the Klukwan Forest Products Company (K-Ply) and operated until 2007. The mill reopened for 22 months in 2010 and 2011 under the Peninsula Plywood Group, LLC (Pen-Ply).

*c) Western Port Angeles Harbor*

Facilities and operations associated with the western Harbor have included pulp and boxboard production, lumber and plywood manufacturing, wood chips storage, paper production, and discharge systems such as those associated with stormwater, process wastewater, and combined sewer overflows.

The Fibreboard Corporation (Fibreboard) pulp and boxboard mill was located west of the Boat Haven marina and operated from 1919 to 1970. The facility was originally operated by Crescent Boxboard Co. and later by Fibreboard. The facility used a bleached sulfite process with a hog fuel boiler that used salt-laden wood as fuel.

The Merrill & Ring (M&R) wood product facility operated from 1955 to 1988 as a lumber and plywood mill and a wood treatment facility with extensive log booming operations in the Harbor. During this time, the property on which the mill was located was also used for storing wood chips. In the 1970s, M&R also purchased land and the dock from Fibreboard after the Fiberboard mill closed.

In 1919, the Washington Pulp and Paper Corporation constructed a pulp mill at the base of Ediz Hook. The mill was later operated by Crown Zellerbach. The mill began production of newsprint and paper in 1921. The mill used a zinc hydrosulfite bleaching

process, sulfite and mechanical pulping processes, and operated a hog fuel boiler burning salt-laden wood. Extensive wood rafts were part of the operation. The sulfite pulping process was shut down in 1964 and the mill switched to a sodium hydrosulfite bleaching process in 1977. Wastewater discharge was moved outside of the hook in the 1960's. The mill was operated by Crown Zellerbach until 1986 when it was purchased by the James River Corporation. The James River Corporation merged with the Fort Howard Corporation and Crown Zellerbach to form the Fort James Corporation. Georgia-Pacific Corporation (G-P) acquired the Fort James Corporation in 2000. The mill changed ownership again in 1988 when it was purchased by Daishowa America, which later merged with Nippon Paper Industries USA, Co. Ltd. (NPIUSA). NPIUSA currently operates the mill. As part of current operations logs are rafted and stored along the near shore at the west end of the Harbor. Currently the mill uses a mechincal pulping process with bleach added in the form of sodium bisulfate, sodium hydrosulfite or hydrogen peroxide.

B. Biological Resources

The Harbor is a diverse marine environment with a variety of marine habitats (e.g., intertidal, subtidal, open water) and organism groups (e.g., benthos, fish, and marine mammals). The sources and pathways by which COPCs enter the Harbor, and their adverse effects, have been documented in several recent studies of the Harbor.

1. Birds and Mammals

A wide diversity of marine bird and mammal species live in and around the waters of Port Angeles Harbor. There are 59 species of sea birds that regularly inhabit Puget Sound, and 37 species that are rarely seen (Sedgley et al. 2011). While dozens of marine bird and mammal species are ephemeral or seasonal occupants of the Harbor, numerous species are year round residents within Port Angeles Harbor. These include harbor seal (*Phoca vitulina*), river otter (*Lontra canadensis*), double-crested cormorant (*Phalacrocorax auritus*), California sea lion (*Zalophus californianus*), black oystercatcher (*Haematopus bachmani*) , rhinoceros auklet (*Cerorhinca monocerata*), pelagic cormorant (*Phalacrocorax pelagicus*), glaucus-winged gull (*Larus glaucescens*), and pigeon guillemot (*Cepphus columba*). Steller sea lion (*Eumetopias jubatus*) and Northern elephant seal (*Mirounga angustirostris*) also inhabit the Strait of Juan de Fuca and have been seen within Port Angeles Harbor.

2. Fish and Shellfish

Fish species that have been present in the Harbor include Chinook (*Oncorhynchus tshawytscha*), pink (*Oncorhynchus gorbuscha*), and chum (*Oncorhynchus keta*) salmon, Pacific herring, (*Clupea pallasii*), Pacific sand lance (*Ammodytes hexapterus*), flatfish,

greenling (*Hexagrammos sp*.), Pacific halibut (Hippoglossus stenolepis), rockfish (*Sebastes spp.*), and lingcod (*Ophiodon elongates*). Commercial fisheries in the Harbor are now limited to the large salmon fish pens owned by Sea Farms, located in the central inner portion of Ediz Hook. Sport fishing in the Harbor has been a historical pastime of the residents in Port Angeles. Recent preliminary Harbor fish characterization data suggest healthy numbers of juvenile salmonids, forage fish, flatfish, and pelagic fish are present (Fresh, K.L., NOAA, Pers. Comm. March 3, 2008, in E&E 2008b).

Most of the nearshore areas in industrial sections of the Harbor provide poor salmonid habitat, while eastern Ediz Hook and the beaches near the Hollywood Beach area and east of Rayonier provide better potential habitat (Pentec Environmental 2001). Sport fishing for salmon, lingcod, Pacific halibut (*Hippoglossus stenolepis*), rockfish, and greenling (*Hexagrammos sp*.) is a viable and productive component of the Port Angeles economy (City of Port Angeles 1989). Tribal treaty subsistence fishing has been significantly impacted due to sediment contamination in the Harbor. Lower Elwha closed its commercial treaty fishery for Dungeness crab in Port Angeles Harbor in March 2007, and issued a health advisory for bottom fish, in response to the release of the Marine Remedial Investigation (Malcolm Pirnie 2007a). This study showed significantly elevated levels of polychlorinated biphenyls (PCBs) and dioxins found in Dungeness crab and horse clam tissue. Jamestown and Port Gamble also closed fisheries in Port Angeles Harbor. In May 2007, Clallam County Department of Health (CCDH) issued a public health advisory against consuming Dungeness crab, clams, and bottom fish. This was followed by a similar advisory by the Washington State Department of Health (WDOH).

Studies on Harbor clam populations in the 1970's found viable populations of commercially important and non-commercial clams and concluded that the Harbor had all the requirements necessary for sustainable clam populations (Bishop & Devitt 1970 and Goodwin & Westley 1969). Those clam surveys found that beach areas near Rayonier had only pollutant tolerant species and very low diversity, while the Ediz Hook area had higher species diversity and included the presence of other macroorganisms (annelids, crustaceans). A geoduck tract was also identified in the vicinity of the Hollywood Beach area in the central nearshore Harbor (Goodwin 1973). This tract is currently listed as a non-commercial bed (WDFW 2008). Recreational and commercial shellfish harvesting for geoduck and other clam species is closed in the Harbor due to pollution by various sources (WDOH 2008a). Shrimp and Dungeness crab are important commercial and fishery resources of the Harbor, although there have been recent advisories against the consumption of crabs, and recommendations limiting the consumption of rockfish, due to high levels of PCBs and dioxins found by the Rayonier Remedial Investigation study (CCHD 2007, Shaffer 2001, and WDOH 2008b).

C. Endangered Species

Federally-listed species under the Endangered Species Act are known to visit and reside in the Harbor area. These species including Chinook salmon, steelhead, and recently-sighted bull trout (Beirne, M., Lower Elwha Klallam Tribe, Pers. Comm. 2012). Other species that transit through the area include humpback whale, resident killer whale, leatherback sea turtle (*Dermochelys coriacea*), marbled murrelet, and Steller sea lion.

1. Chinook Salmon

Chinook salmon (*Oncorhynchus tshawytscha*) is listed as a threatened species in the Puget Sound watershed under the Endangered Species Act. Historically the Harbor area was an important juvenile rearing habitat for numerous populations of Chinook salmon primarily from the Elwha River. The construction of the Elwha Dam in 1913 created an absolute barrier to upstream passage of anadromous fish in the Elwha River and limited the habitat available to all anadromous species to the lower 4.9 miles of the river. Glines Canyon Dam was constructed upstream from the Elwha Dam in 1927 at river mile 13.1. As a result of the dams, summer water temperatures increased causing high incidence of disease, parasites, and fish mortality (NPS 1996).

In September 2011 removal of the two dams commenced. As of March 1, 2013, the Elwha Dam had been completely removed and only 30% remained of Glines Canyon Dam. In 2010 the Washington Department of Fish and Wildlife (WDFW) constructed a weir at river mile 3.7 to collect biological information on anadromous species before, during, and after dam removal. Over the 30 day period (September-October), 461 Chinook salmon were collected (Mayer et. al. 2011). Port Angeles Harbor thus continues to provide important rearing habitat for juvenile Chinook populations. Juvenile Chinook have been collected in annual beach seining activities off the former A-frame site and from along the shoreline adjacent to the eastern boundary of the Rayonier property (Fresh, K.L., NOAA, Pers. Comm. 2012).

2. Bull Trout

Coastal-Puget Sound bull trout (*Salvelinus confluentus*) are listed as a threatened species under the Endangered Species Act (USFWS 1999). The anadromous form of bull trout is unique to the Coastal Puget Sound region within their distribution in the conterminous United States (Ardren et al. 2011). Puget Sound populations include both resident and migratory forms. The Port Angeles Harbor assessment area is part of the Puget Sound Management Unit for bull trout (USFWS 2004).

Within the Harbor area, estuarine migration corridors and rearing habitats are important for the anadromous life-history type of bull trout. Functional estuarine and nearshore habitats are not only critical to anadromous bull trout for foraging and

migration (WDFW et al. 1997; Goetz et al. 2004), but also to their prey species (e.g., herring, surf smelt, sand lance) for spawning, rearing, and migration (WDFW 2000; BMSL et al. 2001). Bull trout are frequently observed in the Elwha River, which provides spawning habitat in close proximity to the Harbor. Within the Elwha River bull trout display two life histories, either residing in the river as a resident or migrating to the ocean (NPS 1996). Prior to dam removal activities, surveys conducted by the Olympic National Park found three discrete areas with fairly high abundance of bull trout (Brenkman, S., NPS, Pers Comm. 2012). These included the headwaters, upstream of Mills Reservoir and immediately below Elwha Dam. The deconstruction of the Elwha and Glines Canyon Dams that started in 2012 will increase the habitat available to all anadromous species of fish in the river. Following dam removal these populations will be able to reestablish their historic migration patterns and life history patterns. As the bull trout population expands they will likely increasingly utilize habitats in the Harbor for migration and rearing.

Unlike most Pacific salmon species, bull trout are iteroparous (survive over multiple spawning seasons) and may make multiple migrations to and from nearshore waters of Puget Sound as part of their life history (Hayes et al. 2012). Bull trout also have more specific habitat requirements than most other salmonids, especially the need for cold water (Rieman and McIntyre 1993). Therefore, they may be at higher exposure risk than Chinook because of greater sensitivity to temperature increases and possibly contaminants from stormwater runoff, and because of more frequent or increased exposure to contaminants over their lifetime.

3. Steelhead

Steelhead (*Oncorhynchus mykiss*) in Puget Sound, including the Elwha River, were listed as a threatened species in May 2007. Adult steelhead enter the Elwha River almost year round and have a variable life history. Summer run fish enter the river from April to September and may reside for up to six months prior to spawning in spring. Winter steelhead runs enter the river from November to June and spawn in the spring or early summer. The Elwha population of steelhead has been heavily impacted by dam construction. Small populations of steelhead still reside in the Harbor streams, primarily Ennis Creek. Severe habitat degradation and fish passage problems have reduced steelhead in Lee, Peabody and Tumwater Creeks to remnant levels.

4. Steller Sea Lion

The Steller sea lion (*Eumetopias jubatus*), also known as the northern sea lion, is an endangered species of sea lion in the northern Pacific. Populations in the north Pacific have declined by 70-80 percent since the 1970's; as a result the northeastern Pacific population was listed as endangered in 1997. Steller sea lions are regularly seen in the Strait of Juan de Fuca, including along the shorelines of the North Olympic Peninsula.

5. Killer Whale

In May 2003, NOAA designated the Eastern North Pacific Southern Resident stock of killer whales (*Orcinus orca*) in Puget Sound as depleted under the Marine Mammal Protection Act. Soon after NOAA released the proposed Marine Mammal Protection Act conservation plan for Puget Sound killer whales, the agency listed these orcas under the Endangered Species Act. Southern resident killer whales identified as J, K and L pods, reside for part of the year in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound, especially during the spring, summer and fall. The J pod contains approximately 18 whales, the K pod 16 whales, and the L pod 46 whales. Pods regularly visit coastal sites off Washington and Vancouver Island and are known to travel as far south as central California and as far north as the Queen Charlotte Islands. Orcas enter Puget Sound between June and October as they hunt the salmon runs. (Balcomb and Goebal 1976; Balcomb et al.1982; Olesiuk et al. 1990; Forney et al. 1999, 2000; Dahlheim et al. 2000). Winter movements and distribution are poorly understood for the population.

6. Humpback Whale

Humpback whales (*Megaptera novaeangliae*) were listed as endangered when the Endangered Species Act was passed in 1973. Though rarely seen in Puget Sound, a juvenile was reported off Vashon Island in the central sound in 2008 and another in the Strait of Juan de Fuca in 2011.

7. Leatherback Sea Turtle

Leatherback Sea Turtles *(Dermochelys coriacea)* were listed as an endangered species in June 1970. They are rarely seen in Puget Sound but are occasionally sighted feeding in the Strait of Juan de Fuca and on the Washington coast. In 2012, NOAA designated 41,914 square miles of Pacific Ocean along California, Oregon and Washington as critical habitat (NOAA 2012).

8. Marbled Murrelet

Marbled Murrelet *(Brachyramphus marmoratus)* was listed as a threatened species in Washington in September 1992 (USFWS 1997). They feed on fish and invertebrates in open water, generally within two miles of shore. Preferred prey items include species associated with the Harbor discussed previously, including Pacific herring, Pacific sand lance, and juvenile salmonids. Some of the highest densities of foraging marbled murrelets within Puget Sound have been observed in the vicinity of the Harbor and Ediz Hook. In early July of 2013, six pairs of marbled murrelets with juveniles were seen fishing in the Harbor (Striplin, P. Ecology, Pers. Comm. August 15, 2013). While there is no critical habitat in marine waters for the marbled murrelet, critical habitat is listed in the Olympic National Forest, 6 miles away.

D. Discharges of Hazardous Substances

1. Hazardous Substances Discharged

The Harbor has received contaminant inputs from multiple sources, including industrial activities. Discharges and releases of hazardous substances into the Harbor have resulted from industrial and municipal processes since the early 1900s. Hazardous substances released to the Harbor include, but are not limited to, the following chemicals (reported by name):

- Polychlorinated biphenyls (PCBs), including various Aroclor and other mixtures.
- Dioxins and furans, including 2,3,7,8-tetrachlorodibenzo-p-dioxin and 2,3,7,8-tetrachlorodibenzofuran.
- Organochlorine pesticides and related transformation products, including DDT, DDD, DDE, heptachlor, and dieldrin.
- High and low molecular weight polyaromatic hydrocarbons (PAHs).
- Metals, including mercury, cadmium, zinc, and arsenic.
- Semi-volatile organic compounds such as bis (2-ethylhexyl) phthalate, other phthalate esters, and pentachlorophenol, and other phenols.
- Volatile organic compounds such as benzene.
- Other compounds such as perchlorate, herbicides, and organic solvents.
- Antifouling agents such as tributyltin and other butyltins.
- Sulfide and ammonia.

2. Known Discharges and Potentially Liable/Responsible Parties

Numerous terrestrial and aquatic studies have been conducted on and around the Harbor with the goal of identifying areas that have been affected by industrial activity and that require remedial action. These studies found COPCs exceeding MTCA cleanup levels in terrestrial environments and the Sediment Quality Standards (SQSs) in the aquatic environment. As a result of these studies, Ecology identified the Harbor as a priority cleanup and restoration site under the Puget Sound Initiative Program (E&E 2008). Ecology's Toxics Cleanup Program is responsible for overseeing source control, cleanup, and restoration of the Harbor area.

In 2008 Ecology initiated a sediment characterization study in the Harbor (**Figure 1**). The study resulted in a Sediment Investigation Report (SIR) (E&E 2012) and a Supplemental Data Evaluation (SDE) (NewFields 2012). With the release of the SIR and SDE Report, Ecology is identifying sources, establishing preliminary sediment cleanup objectives, and

identifing potentaily liable parties (PLPs) to move forward in the clean-up process under the State's MTCA. Ecology identified Rayonier and the Washington State Department of Natural Resources (WDNR) as PLPs for the Rayonier Mill cleanup Site and the City, Port, NPIUSA, G-P, M&R, and WDNR as PLPs for the Western Port Angeles Harbor cleanup Site. Whether Owens Corning is successor to the liabilities of Fibreboard for releases of hazardous substances that occurred during Fibreboard's ownership and operation of its Port Angeles mill is still being investigated. At the same time, with the establishment of the Port Angeles Harbor Natural Resource Trustee Council under CERCLA and other natural resources damages laws, the Trustees have been reviewing Ecology's listing of PLPs to determine whether these entities, and any others, should also be treated as Potentially Responsible Parties (PRPs) for the purpose of proceeding with natural resource damages claims.

*a) Rayonier Properties, LLC*

A sulfite mill operated at the mouth of Ennis Creek from 1930 to 1997. Beginning in 1937, Rayonier operated the mill, including hog fuel boilers in which bark, wood chips, and spent sulfite waste liquor were burned as fuel.

The Rayonier mill ceased operating in 1997 and dismantling activities were completed in 1999. After mill closure, the EPA initiated the Rayonier Pulp Mill Expanded Site Investigation (ESI) to determine whether the site should be recommended for the National Priorities List (NPL) under CERCLA (E&E 1998 and 1999). The ESI involved collecting surface and subsurface soil, freshwater and marine sediment, groundwater, surface water, and marine shellfish tissue samples from onsite and marine areas. The ESI found chemical concentrations from mill operations at levels of concern in onsite soil, surface water (Ennis Creek), groundwater, and Harbor marine sediments (E&E 1998 and 1999). Onsite locations contained elevated concentrations of metals, semivolatile organic compounds (SVOCs), dioxin/furans, phthalates, and PCBs (Windward 2013). Based on these results the EPA determined that the site was eligible for inclusion on the CERCLA National Priorities List. As a result of inter-governmental consultations, the State of Washington, EPA, and the Lower Elwha entered into a Deferral Agreement in 2000 allowing Ecology to oversee the cleanup subject to certain conditions.

Subsequent investigations by Rayonier confirmed the presence of chemicals exceeding state criteria and standards (Foster Wheeler 2002, Malcolm Pirnie 2005, 2007a, 2007b, 2007c, Integral 2006). An Ecology investigation in 2008-2012 documented chemical contaminants above state criteria in surface and subsurface sediment near the former Rayonier mill and throughout the Harbor (E&E 2012 and NewFields 2012). There were also failures in bioassays indicating toxicity in surface sediment samples. Data from these investigations were used to evaluate ecological and human health risk and results indicated the highest risk is to subsistence fishers in the Harbor (E&E 2012).

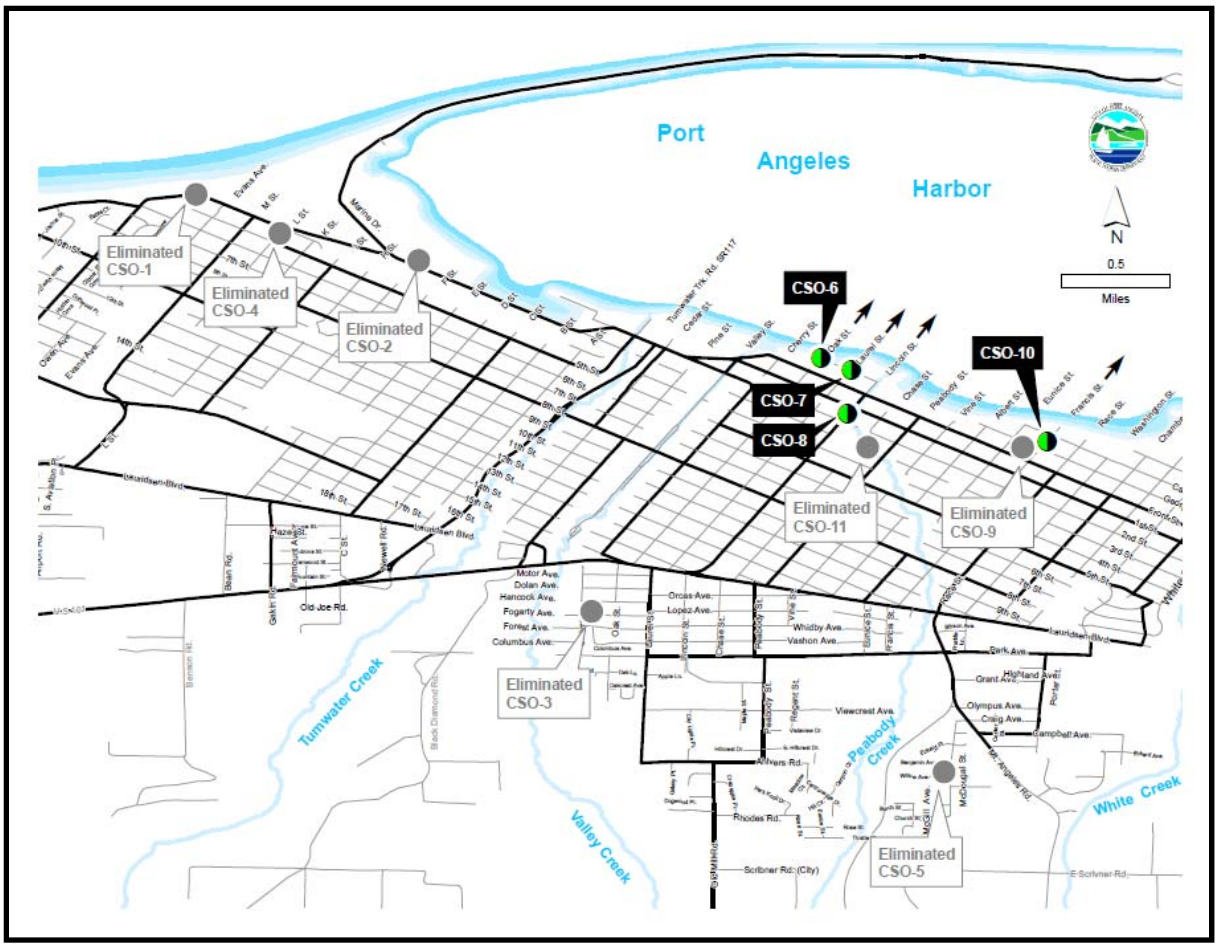



**Figure 2.** Map of the City of Port Angeles stormwater and CSO system.

*b) City of Port Angeles*

Combined Sewer Overflows (CSOs) are discharges of untreated wastewater and stormwater released during periods of heavy rainfall. At one time, the City maintained and/or operated 11 CSO discharge points, a treatment plant, and a deep water outfall near the Rayonier Mill property, all draining into Port Angeles Harbor. The wastewater treatment plant (WWTP) began operating in 1969 and since that time has occasionally discharged untreated effluent into the Harbor. In 2006, the plant inadvertently released 6 to 8 million gallons of sewage into the Harbor. This resulted in Clallam County Health Department closing all beaches harbor-wide (CCHD 2006).

As of 2008, seven of the CSO discharge points have been eliminated. During peak storm events, the sewer overflow is routed to Port Angeles Harbor through four remaining CSO discharge points From 2003-2006, CSO discharges occurred on an average of 64

times (CPAPWD 2006). The City received several NPDES permit violations for total suspended solids (TSS) in July and October 2007 (Herrera 2010).

The City also has a stormwater system operating under a NPDES permit. The stormwater outfalls are located along the waterfront in the following areas: Boat Haven marina, Boat Launch and Standard Oil Pier/Port Terminals 1 and 3, K-Ply area, Landings Pier, and the area in front of the Red Lion Inn. Ecology's SIR (E&E 2012) and SDE (NewFields 2012) did not identify any surface sediment samples adjacent to stormwater outfalls with COPCs above SMS (WAC 173-204). However, pesticides were found in a subsurface sediment sample taken near the CSO discharge point 6 adjacent to the ferry terminal (**Figure 2**).

NPDES sediment monitoring at the CSO discharge points has found that several COPCs exceeded SQS and Cleanup Screening Level (CSL) criteria in the 1996 and 2004 surveys. These include bis (2-ethylhexyl) phthalate and PCBs which exceeded the SQS at four stations; three stations exceeded the SQS near the main outfall and one at the CSO near Francis Street (CSO-10, Herrera 2010). In 2004, mercury exceeded the CSL and 1, 4-dichlorobenzene, and benzo(g,h,i)perylene exceeded the SQS criteria at a station near the Railroad Ave & Laurel Street CSO (CSO-7) and butyl benzyl phthalate exceeded the SQS near the Francis Street CSO (CSO-10).

Amphipod, juvenile polychaete, and larval sediment bioassays were conducted as part of the 2004 survey with no exceedances in SMS criteria. In the 2010 survey, two stations were sampled near the City's CSO discharge points where the CSL criterion was exceeded for bis(2-ethylhexyl)phthalate at one station and at the second the SQS criteria were exceeded for phenanthrene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, indeno(1,2,3-c,d)pyrene and fluoranthene. Both samples were analyzed for 10-day amphipod, larval development, and juvenile polychaete toxicity testing for comparison to SMS biological criteria, and results indicated that the larval test at one station exceeded the SQS criteria.

*c) Port of Port Angeles*

The Port is a current or past owner or operator of several facilities along the southern shore of the Harbor and released or disposed of hazardous substances, as defined under MTCA. Operations or practices associated with these facilities may have resulted in releases of hazardous substances to the Harbor that have come to be located in sediments. Port-owned properties include the locations of the former Fibreboard and M&R mills. The Port also operates Boat Haven marina where hazardous substances have come to be located. The Port has leased and currently leases aquatic lands to facilitate Port operations where contamination has come to be located.

The SIR and SDE confirmed that COPCs in sediments were consistent with practices that occurred at Port leased state-owned aquatic lands. Sediment immediately offshore of the M&R facility, Terminal 5, and the Fibreboard facility contained dioxin concentrations above background levels. Mercury, cadmium, and zinc were also found at concentrations exceeding the SMS criteria offshore of the M&R and Terminal 5 facilities. In a 2005 survey offshore of the M&R, Fibreboard, and the NPIUSA facilities, Anchor LLC reported several stations with high concentrations of total PCBs and dioxins/furans above SQS and proposed sediment standards for dioxins (Anchor 2005).

Offshore sediments also contain large amounts of wood waste. While wood debris may not be toxic at low concentrations, its presence depletes oxygen at the sediment-water interface and leads to the creation of hydrogen sulfide and ammonia. These compounds have been found to be toxic in sediment toxicity tests. As a greater amount of wood debris and hydrogen sulfide accumulates or is produced, the sediment becomes anoxic and filamentous bacteria can dominate the community. In addition to creating potential hypoxic/anoxic conditions, resin acids and guaiacol compounds leach out from wood debris. Resin acids (abietic and dehydroabietic acids) were found in areas with large amounts of wood debris during the Ecology sediment investigation. These two resin acids have been shown to be toxic in laboratory toxicity tests (Peng and Roberts 2000). Extensive wood debris can also smother aquatic habitat and animals, causing a break in the food chain.

*d) Fibreboard Corporation*

The Fibreboard mill was located west of the Boat Haven marina and operated from 1917 into the 1970s. The facility originally operated under the name Crescent Boxboard Co. and was later changed to Fibreboard. The company operated a bleached sulfite pulp and boxboard mill with a hog fuel boiler (USDOI 1967). Two to five former outfalls discharged fiber process waste water and cooling water (Exponent 2008, Shea et al. 1981). Arsenic, cadmium, as well as dioxin/furan toxic equivalency (TEQ) concentrations were found to exceed background in offshore sediments. The offshore area was also historically used for log rafting and storage.

*e) Merrill & Ring*

The M&R mill was located just south of the NPIUSA facility adjacent to the NPIUSA lagoon at 1608 Marine View Drive. M&R operated from 1955 to 1988 as a lumber and plywood mill and a wood treatment facility. At that time, the property was also used for storing wood chips. Localized spills of pentachlorophenol from wood treatment operations resulted in soil and groundwater contamination (CH2M Hill 1989). The highest concentration of dioxins/furans found during the SIR were located immediately offshore of the property (E&E 2012, NewFields 2012). Concentrations of mercury, cadmium, and zinc measured offshore of the facility exceeded SQS and CSL criteria. As

with other facilities in the inner Harbor area, large amounts of wood debris were found in offshore sediments.

*f) Nippon Paper Industries USA Co., Ltd.*

The NPIUSA mill is located at 1902 Marine Drive. Sampling conducted by Anchor, LLC (2005) at three locations found mercury at concentrations just below the SQS. In 2008, surface sediment samples were collected from 12 locations, nine of which were in the Harbor and three of which were from the onsite lagoon (Exponent, 2008). Results indicated that pulp wood waste was concentrated in the inner Harbor area and ranges from four to seven feet deep. All measured concentrations of cadmium, mercury and zinc from the inner Harbor and lagoon areas exceeded SQS and CSL criteria. High concentrations of zinc and cadmium were reported as a result from the zinc hydrosulfate process used at the mill. Dioxin/furan TEQ concentrations were also highest in the lagoon and inner Harbor area.

The SIR and SDE confirmed that COCs have been found in sediment in areas immediately offshore of the NPIUSA facility. Sediment immediately offshore of the facility contained the highest dioxin concentration in the Harbor and heavy metals (cadmium, mercury, zinc) at concentrations exceeding SMS criteria. Operations at this facility have led to the buildup of large amounts of wood waste in offshore sediment. While wood debris may not be independently toxic, its presence depletes oxygen at the sediment-water interface and deteriorates, creating hydrogen sulfide and ammonia by-products. These compounds have been found to be toxic in sediment toxicity tests.

*g) Georgia-Pacific Corporation*

Crown Zellerbach and James River Corporation were former owners and/or operators at the NPIUSA site from 1928 through 1998. In 2000, G-P acquired Fort James Corporation, which was a successor corporation to Crown Zellerbach and James River Corporation. A zinc hydrosulfite process was used at the mill prior to 1977. The mechanical pulping process required the use of biocides for slime control. Fiber-bearing waste and other process effluent were discharged through multiple outfalls directly into the Harbor and the lagoon until the late 1960s when the process effluent outfall was moved outside of Ediz Hook. Other outfalls continued to discharge stormwater to the Harbor and the lagoon through the 1980s.

The investigative reports discussed above for NPIUSA identified areas of marine sediment that exceed applicable state criteria for sediment and the protection of the environment on and adjacent to the NPIUSA site.

*h) Washington Department of Natural Resources*

WDNR, as the owner of aquatic lands in the state, is responsible for managing those lands for the benefit of Washington residents. WDNR currently manages several leases in the Harbor, most for log rafting purposes. These lease lands currently contain dioxins, heavy metals, and organic compounds, many of which were found at concentrations above SMS criteria. In addition to high concentrations of chemicals of concern, these lease lands contain large amounts of wood debris which can be deleterious to benthic communities.

3. Damages Excluded from Liability under CERCLA

Title 43 CFR Part 11.24(b) notes certain damages are excluded from liability under CERCLA, such as damages resulting from a discharge or release that was specifically identified as an irreversible and irretrievable commitment of natural resources in an environmental assessment, damages from a release that occurred wholly before enactment of CERCLA, or damages resulting from other federally-permitted activities as defined in Section 101(10) of CERCLA. In the Harbor area, releases have occurred that have the potential to cause or continue to cause injury and damages that are not excluded from liability under CERCLA. No environmental impact statement or similar environmental analysis has ever identified an irretrievable or irreversible commitment of natural resources at this site. Moreover, continuing non-permitted releases still occur and are also potential sources resulting in injury to natural resources and natural resource damages.

Aside from discharges permitted under the NPDES, there are no other known concerns relative to 43 CFR Part 11.24(b) warranting exclusion from liability under CERCLA, the Oil Pollution Act, or the Clean Water Act. Any injuries that may have resulted exclusively from specific NPDES releases, or other releases found to be under exclusion during the remedial investigations or injury assessments, will be considered further during the damage assessment process.

## III. PRELIMINARY IDENTIFICATION OF RESOURCES AT RISK

A. Preliminary Identification of Pathways

Natural resources in the Harbor are exposed to COPCs via pathways including atmospheric release and deposition, industrial wastewater discharge, groundwater, surface water, log storage, and sediment.

1. Atmospheric Pathways

Atmospheric release of COPC was primarily through the burning of salt laden wood in hog fuel boilers. In addition to emissions from stacks, ash from the boilers was occasionally stockpiled in open areas for later disposal and some was dispersed through wind action. Hog fuel boilers were operated by Fibreboard, Rayonier, Pen-Ply Co., and NPIUSA.

2. Industrial/Municipal Wastewater Pathways

Industrial and municipal wastewater discharges are located mainly along the south shoreline. The largest discharges were operated by Rayonier via a deepwater outfall through which as much as 39 million gallons per day of wastewater were discharged to the outer Harbor. Prior to construction of a treatment plant and deepwater outfall, Rayonier's process wastewater and stormwater were discharged through five nearshore outfalls until 1972.

The City operates several facilities along the Harbor. The wastewater treatment plant is located near the Rayonier site and has one deepwater outfall discharge point that began discharging in 1969 (E&E 2008). The plant had occasional untreated effluent discharges to the Harbor (Ecology 1976).

The City also has an extensive stormwater system operating under an NPDES permit that drains approximately 10,000 ac (4,047 ha) of the Harbor watershed. Major stormwater outfalls are dispersed along the waterfront in the following areas: Boat Haven Marina, Boat Launch and Standard Oil Pier/Port Terminals 1 and 3, K-Ply area, Landings Pier, and the area in front of the Hollywood Beach area.

Historically, there were eleven CSOs that discharged untreated sewer and stormwater into the Harbor. Currently, four CSOs remain, discharging into the Harbor during heavy storms. CSO discharges have occurred on an average of 64 times per year during the period 2003 and 2006 (E&E 2008).

The Lagoon, located just south of the NPIUSA facility, was used for the storage of process water and hog fuel ash and is connected to the Harbor through a tidally influenced narrow outlet.

3. Log Storage Pathways

Log rafting and storage facilities were used for the housing of logs prior to their use in saw mills, for pulping or as fuel for hog fuel boilers. Whole logs and debris from these logs can sink to the sea floor and over time cause hypoxic or anoxic conditions. Facilities that stored or currently store logs or where debris has been located in the Harbor

include but are not limited to Fibreboard, Port, Rayonier, PenPly/K-Ply , Foss Maritime Company, G-P, M&R, and NPIUSA.

WDNR currently manages 25 leases within the Harbor, twelve of which are leased by companies expressly for log booming operations. NPIUSA leases four aquatic areas in the western end of the Harbor along Ediz Hook.

4. Sediment Pathways

Sediment contamination has occurred and been documented in Port Angeles Harbor (E&E 2012, Ecology 2012, Malcolm Pirnie 2007a, 2007b, E&E 1998). Atmospheric deposition, surface and creek water runoff, and discharges from pulp mills and municipal wastewater facilities has contributed to sediment contamination. Sediment in the Harbor is both a sink for and source of contaminants. COPCs, depending on their solubility, can partition between water and sediment. Thus, COPCs have the potential to enter food webs, leading to risks to ecological receptors (Shea 1981). Biological resources including marine plants, benthic community infauna and epifauna, fish, piscivorous birds and wildlife can be exposed to COPCs through absorption, ingestion, or dermal contact.

B. Exposed Areas

Contaminated sediments occur within the Harbor. Spatial gradients of contaminant concentrations in sediment extend from the nearshore in the western Harbor, from the former Rayonier mill location, and from outfall locations. Generally, higher concentrations are located closer to areas of industrial activity and can be characterized as localized areas with relatively high chemical concentrations separated by larger areas with lower chemical concentrations.

C. Estimates of Concentrations

1. Benthic Community

Sediment toxicity tests were conducted as part of the Ecology SIR. Three tests were conducted at 59 stations in the Harbor and surrounding the Rayonier mill location. These tests included the acute 10-day amphipod test using *Eohaustorius estuaries*; the acute larval echinoderm test using *Dendraster excentricus*; and the chronic juvenile polychaete test using *Neanthes arenaceodentata*. Results indicated that 29 stations failed the SQS criteria and 12 also exceeded the CSL criteria (**Table 3**). The majority of these failures were from the acute larval echinoderm test using *Dendraster excentricus*. Station ED04A failed the CSL criteria for both the amphipod and the larval echinoderm test. A total of 17 stations failed the SQS criteria for larval echinoderm test and 12 failed the CSL. There was a relatively strong relationship between ammonia and amphipod

mortality ($r^2$= 0.87) and a weaker relationship between the larval echinoderm test and percent fines ($r^2$=0.63).

2. Sediment

Sediments are the primary sink for COPCs originating from urban and industrial activities on or in proximity to the Harbor. The distribution of COPCs has been described in Ecology's SIR and SDE reports (E&E 2012, NewFields 2012). Concentrations of arsenic, mercury, zinc, cadmium, carcinogenic PAHs, and several phenolic compounds were found at levels above sediment management criteria and lowest apparent effects thresholds, indicating these compounds may be adversely affecting biological communities in contact with sediments (**Tables 3** and **4**).

Marine sediments showed gradients of dioxin/furan concentrations in relation to industrial/urban areas, with the highest levels located around the Rayonier mill site and in the western Harbor. Lower concentrations were found in the deeper waters toward Ediz Hook. Nearly all sediment samples had elevated concentrations of SVOCs, metals, PCBs, pesticides, and volatile organic compounds (VOCs). Samples from Ennis Creek had elevated levels of dioxins/furans, phthalates, chromium, and carbon disulfide (E&E 2012, Malcolm Pirnie 2007a). Marine biota tissue samples contained elevated concentrations of metals and dioxins/furans at all Harbor stations. Crab samples had elevated PCBs and dioxins/furans, while geoduck (*Panopea spp.*) showed elevated levels of dioxins/furans and mercury (E&E 2012, Malcolm Pirnie 2007a, 2007b, WDOH 2005).

NPIUSA conducted sediment sampling in the western Harbor log booming area adjacent to their facility (approximately 85.7 acres) (Anchor 2005). The study found a high density of submerged logs in the east central and southwestern portions of the lease parcel. Sediment chemistry indicated no exceedances of SMS criteria for metals, although mercury concentrations in the southwestern sample were slightly elevated.

NPIUSA conducted a sediment survey to characterize baseline conditions in a WDNR lease area in the western Harbor adjacent to their facility (WDNR Lease areas 22-077766 & 20-012614) (Exponent 2008). Results indicated the highest metals concentrations were in the western Harbor and in the lagoon area. Cadmium, mercury, and zinc concentration in the lease area was greater than the SMS sediment impact zone maximum standards (Exponent 2008). PAHs, phthalates, and PCBs were below SMS criteria, however dioxin/furan concentrations, and TEQs were higher in the lease area than in the Lagoon area (Exponent 2008).

The extent of wood debris in the Harbor was investigated in 1999 (SAIC 1999). The survey used a sediment profile imaging/plane view camera system to map the distribution of wood debris both in the sediment column and on the surface. This study identified approximately 500 acres of Harbor bottom, primarily in near-shore log

booming areas, where wood debris is present. Study results indicated that benthic habitat was degraded in these areas. The highest wood pulp accumulation (greater than 20 cm thick) was measured near the current NPIUSA facility. Sedimentary methane, sulfides, ammonia and bacterial mats were present in some of these areas indicating oxygen is not diffusing into the sediment as measured by the redox-potential discontinuity.

D. Potentially Affected Resources

The Port Angeles Harbor Trustees collectively have trusteeship over all natural resources that have been exposed to hazardous substances within the Harbor. The natural resources affected or potentially affected from releases or discharges of contaminants include, but are not limited to:

- Aquatic-dependent mammals such as gray whale, seal, sea lion, mink and river otter and species they depend on as prey items
- Migratory birds, including osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucocephalus*), assorted waterfowl, great blue heron (*Ardea herodias*), spotted sandpiper (*Actitis macularius*) and other shorebirds, cliff swallow (*Petrochelidon pyrrhonota*), belted kingfisher (*Megaceryle alcyon*), and other species
- Threatened and endangered species, including Chinook salmon, marbled murrelet, and Coastal-Puget Sound bull trout
- Anadromous and resident finfish
- Shellfish
- Reptiles and amphibians
- Aquatic invertebrates
- Aquatic plants
- Wetland and upland habitats
- Groundwater
- Surface water

The services that are provided by these natural resources include, but are not limited to, the following:

- Habitat for trust resources, including food, shelter, breeding, foraging, and rearing areas, and other factors essential for survival
- Recreational and subsistence fishing
- Non-consumptive uses such as wildlife viewing and photography and other outdoor recreation activities
- Primary and secondary contact activities such as swimming and boating
- Cultural, ceremonial, spiritual, and religious use
- Traditional foods

- Other lost human use

Because of the central role that sediments and the sediment-based biological community play in the assessment area, the Trustees anticipate evaluating the potential loss of natural resources in terms of affected habitat, rather than numbers of individual species impacted. For example, Habitat Equivalency Analysis or similar type of injury analysis could be performed to estimate injury to trust resources and the amount of habitat restoration needed to compensate for the injury from the release of hazardous substances.

## IV. PREASSESSMENT SCREEN CRITERIA

Five criteria must be met before continuing past the preassessment phase to a full natural resource damage assessment. These criteria, and the ways in which they have been met in the case of Port Angeles Harbor, are as follows:

1. ***A discharge of oil or a release of a hazardous substance has occurred.***

    a. The release of quantities of COPCs into the Harbor, as documented in this preassessment, has occurred including metals (As, Hg, Cd, and Zn), PCBs, PAHs, phenols, and phthalates causing sediment contamination above SMS criteria.
    b. The burning of salt-laden logs and other wood debris in hog fuel boilers and the release of air emissions or ash through direct deposit, effluent, or stormwater runoff after surface deposition, has led to the wide distribution of dioxins and furans above background levels throughout the Harbor.
    c. The storage of logs and the release of sawdust and wood pulp to the Harbor have caused hypoxic and anoxic sediment in areas of the Harbor floor. These conditions cause the production of sulfides and ammonia which leads to toxicity in sediment bioassays.

2. ***Natural resources for which the Federal, State, or Tribal agency may assert trusteeship under MTCA/CERCLA have been or are likely to have been adversely affected by the discharge or release.***

    a. Natural resources, over which the Trustees have trusteeship, have been and are continuing to be adversely impacted. Data indicate degraded benthic communities; loss of fish and shellfish stocks from usual and accustomed fishing grounds; and the loss of nursery habitat.
    b. Chemical analysis of fish and shellfish tissue samples from the Harbor has identified metals, dioxin/furans, PCBs, and PAHs at detectable levels. The presence of these compounds in fish and shellfish may lead to greater

concentrations in higher trophic levels including piscivorous birds, seals/sea lions, and other marine mammals.

3. ***The quantity and concentration of the discharged oil or released hazardous substance is sufficient to potentially cause injury, as that term is used in this part, to those natural resources.***

    a. Sediment samples from the Harbor area contain hazardous substances at concentrations greater than Washington State standards and Federal guidelines that are known to cause injury in benthic organisms, fish, shellfish, birds and other resources.
    b. Deposits of wood debris in areas of the Harbor are sufficient to cause benthic habitat degradation due to the physical smothering. This also leads to the production of substances such as ammonia, hydrogen sulfide, and extreme cases methane.

4. ***Data sufficient to pursue an assessment are readily available or likely to be obtained at reasonable cost.***

    Numerous studies in the Harbor have contributed to a large dataset of information on conditions in the Harbor. It appears sufficient data currently exists from past studies in the Harbor to pursue a cost-effective natural resource damage assessment. Further studies may be needed to quantify injury and service losses for some resources outlined in this preassessment.

5. ***Response actions if any, carried out or planned do not or will not sufficiently remedy the injury to natural resources without further action.***

    Any previous remedial actions in the Harbor have not sufficiently remedied the injury to natural resources.

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TABLES

**Table 1**. Constituents of Potential Concern[a] based on sediment chemical comparisons to the WA SMS and on results from the ecological risk assessments.

| | |
|---|---|
| Arsenic | Acenaphthene |
| Cadmium | Phenanthrene |
| Mercury | Butyl Benzyl Phthalate |
| Zinc | Bis (2-Ethylhexyl) Phthalate |
| 2-Methylphenol | DDT |
| 4-Methylphenol | 4,4-DDD |
| 2,4-Dimethyl Phenol | 4,4-DDE |
| Pentachlorophenol | Alpha BHC |
| Phenol | Beta BHC |
| Fluoranthene | Lindane |
| cPAH TEQ | Dioxins/Furans TEQ |
| 2-Methylnaphthalene | Total PCBs (Sum of Aroclors) |
| Naphthalene | Total PCBs (Sum of Congeners) |
| Fluorene | Wood Debris [(1)] |

[(1)]Wood debris, while not a COPC, can be included under the WA SMS Other Deleterious Substance category. The large amounts of this material in portions of the Harbor deplete the sediment of dissolved oxygen leading to hypoxic and anoxic conditions which can significantly affect benthic community structure. Further, wood debris leaches resin acids and guaiacol compounds, some of which are highly toxic to marine organisms.

**Table 2.** Surface Sediment metals that Exceeded SMS Chemical and Bioassay Criteria. (Source Newfields 2012).

| Region | Location | Study | Arsenic | Cadmium | Mercury | Zinc | Bioassay Result | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | SQS = 57 CSL = 93 | SQS = 5.1 CSL = 6.7 | SQS = 0.41 CSL = 0.59 | SQS = 410 CSL = 960 | Larval Development | Amphipod Mortality | Polychaete Growth |
| | | | (mg/Kg) | | | | | | |
| Lagoon | LA01A | E & E 2012 | – | 5.90 | 0.45 | – | na | na | na |
| | LA02A | E & E 2012 | – | – | 0.59 | – | Fail | Pass | Pass |
| | LA03A | E & E 2012 | – | – | 0.59 | – | na | na | na |
| | LA01A-01 | Exponent 2008 | – | 6.4 | 0.57 | – | na | na | na |
| | LA02A-01 | Exponent 2008 | – | 7.6 | 0.59 | – | na | na | na |
| | LA03A-01 | Exponent 2008 | – | 5.7 | 0.59 | – | na | na | na |
| | NPI-L1-01 | Exponent 2008 | – | 6.0 | 0.61 | 411 | na | na | na |
| Inner Harbor | IH01A | E & E 2012 | – | 7.4 | 3.50 | 1600 | Pass | Pass | Pass |
| | IH02A | E & E 2012 | 69.0 | – | 1.30 | 460 | Fail | Pass | Pass |
| | IE09A | E & E 2012 | – | – | 1.20 | 860 | Fail | Pass | Pass |
| | IE13A | E & E 2012 | – | – | 1.90 | 610 | na | na | na |
| | IE16A | E & E 2012 | – | – | 1.30 | – | na | na | na |
| | NPI-PA1-01 | Exponent 2008 | – | – | 0.54 | – | na | na | na |
| | NPI-PA2-01 | Exponent 2008 | – | – | 0.43 | – | na | na | na |
| | NPI-PA3-01 | Exponent 2008 | – | 8.1 | 1.49 | 1660 | na | na | na |
| | NPI-PA4-01 | Exponent 2008 | – | 6.9 | 2.65 | 1330 | na | na | na |
| | NPI-PA6-01 | Exponent 2008 | – | – | 1.26 | – | na | na | na |
| | NPI-PA8-01 | Exponent 2008 | – | – | 0.67 | – | na | na | na |
| | NPI-PA9-01 | Exponent 2008 | – | – | 1.10 | – | na | na | na |
| | NPI-PA10-01 | Exponent 2008 | – | – | 0.66 | – | na | na | na |
| Rayonier | R05LP-06 | Malcolm Pirnie 2007a | – | – | 0.43 | – | Pass | Pass | Pass |

Key:
Exceeds SQS criteria
Exceeds CSL criteria
– = concentration below SMS criteria

Key:
Passed SMS criteria
Failed SQS criteria
Failed CSL criteria
na = not analyzed

**Table 3.** Surface Sediment Organic COPCs that Exceeded SMS/LAET Chemical and Bioassay Criteria. (Source Newfields 2012).

| Region | Location | Study | TOC | SMS Exceedances | | | | | | | LAET Exceedances | | | Bioassay Results | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Bis(2-ethylhexyl) phthalate | PCBs, Sum of Aroclors | PCBs, Sum of Congeners | 2,4-Dimethylphenol | 2-Methyl phenol | 4-Methyl phenol | Phenol | PCBs, Sum of Congeners | Butyl benzyl phthalate | Fluoranthene | Larval Development | Amphipod Mortality | Polychaete Growth |
| | | | | SQS = 47 CSL = 78 | SQS = 12 CSL = 65 | SQS = 12 CSL = 65 | SQS = 29 CSL = 29 | SQS = 63 CSL = 63 | SQS = 670 CSL = 670 | SQS = 420 CSL = 1200 | LAET = 130 2LAET = 1000 | LAET = 63 2LAET = 900 | LAET = 1700 2LAET = 2500 | | | |
| | | | wt% | mg/Kg OC | | | µg/Kg | | | | µg/Kg | | | | | |
| Lagoon | LA03A | E & E 2012 | 9.2 | – | – | – | – | – | – | – | – | 73 | – | na | na | na |
| Inner Harbor | MA01A | E & E 2012 | 1.1 | 49.6 | – | – | – | – | – | – | – | – | – | Fail | Pass | Pass |
| | MA03A | E & E 2012 | 4.0 | – | – | – | – | – | – | 610 | – | – | – | na | na | na |
| | MA04A | E & E 2012 | 8.5 | – | – | – | – | – | – | 740 | – | 670 | – | na | na | na |
| | WP-01-SS | Malcolm Pirnie 2007b | 4.7 | – | – | – | – | – | – | – | 372 | – | – | na | na | na |
| | WP-02-SS | Malcolm Pirnie 2007b | 10.0 | – | – | – | – | – | – | – | 219 | – | – | na | na | na |
| | WP-03-SS | Malcolm Pirnie 2007b | 3.7 | – | – | – | – | – | – | – | 173 | – | – | na | na | na |
| | WP-04-SS | Malcolm Pirnie 2007b | 5.6 | – | – | – | – | – | – | – | 148 | – | – | na | na | na |
| | WP-11-SS | Malcolm Pirnie 2007b | 6.8 | – | – | – | – | – | – | – | 2930 | – | – | na | na | na |
| Rayonier | R05IT-07 | Malcolm Pirnie 2007a | 24.6 | – | – | – | – | – | 1700 | – | – | – | – | na | na | na |
| | R05LP-03 | Malcolm Pirnie 2007a | 4.0 | 67.2 | – | – | – | – | – | – | – | – | – | Pass | Pass | Pass |
| | R05LP-06 | Malcolm Pirnie 2007a | 18.5 | – | – | – | 54 | 200 | 1300 | – | – | – | – | Pass | Pass | Pass |
| | R05LP-10 | Malcolm Pirnie 2007a | 10.0 | – | – | – | – | – | – | 480 | – | – | – | Fail | Fail | Fail |
| | R05LP-13 | Malcolm Pirnie 2007a | 14.4 | – | – | – | – | – | 820 | – | – | – | – | Fail | Fail | Pass |
| | R05LP-16 | Malcolm Pirnie 2007a | 16.5 | – | – | – | – | – | 840 | – | – | – | – | Fail | Pass | Pass |
| | R05LP-18 | Malcolm Pirnie 2007a | 23.3 | – | – | – | – | – | – | – | – | – | 3100 | Fail | Pass | Fail |
| | R05LP-20 | Malcolm Pirnie 2007a | 13.5 | – | – | – | – | – | 11000 | – | – | – | – | Pass | Pass | Pass |
| | R05MD-02 | Malcolm Pirnie 2007a | 15.0 | – | – | – | – | – | 690 | – | – | – | – | Pass | Pass | Pass |
| | R05MD-04 | Malcolm Pirnie 2007a | 1.1 | – | 17.6 | – | – | – | – | – | – | – | – | Pass | Pass | Pass |
| | R05MD-12 | Malcolm Pirnie 2007a | 1.9 | – | – | – | – | – | 1400 | – | – | – | – | Pass | Pass | Pass |
| | MD-14-SS | Malcolm Pirnie 2007b | 1.3 | – | – | 16.9 | – | – | – | – | – | – | – | na | na | na |
| | MD-18-SS | Malcolm Pirnie 2007b | 4.1 | – | – | – | – | – | – | – | 352 | – | – | na | na | na |
| | MD-23-SS | Malcolm Pirnie 2007b | 0.8 | – | – | 19.7 | – | – | – | – | – | – | – | na | na | na |
| | LP-03-SS | Malcolm Pirnie 2007b | 11.9 | – | – | – | – | – | – | – | 152 | – | – | na | na | na |
| | LP-04-SS | Malcolm Pirnie 2007b | 8.3 | – | – | – | – | – | – | – | 155 | – | – | na | na | na |
| | LP-08-SS | Malcolm Pirnie 2007b | 21.2 | – | – | – | – | – | – | – | 200 | – | – | na | na | na |
| | ED04A | E & E 2012 | 5.1 | – | – | – | – | – | 41000 | – | – | – | – | Fail | Fail | Pass |
| | MD04A | E & E 2012 | 2.2 | – | – | – | – | – | – | 760 | – | – | – | na | na | na |

Key:

> 3.5% TOC

Exceeds SQS/LAET criteria

Exceeds CSL/2LAET criteria

– = concentration below SMS criteria

Key:

Passed SMS criteria

Failed SQS criteria

Failed CSL criteria

na = not analyzed

**Table 4.** Subsurface Sediment Organic COPCs that Exceeded SMS or LAET Chemical Criteria. (Source Newfields 2012).

| Region | Location | Depth Interval (cm) | Study | TOC | SMS Exceedances | | | | | | | | | | | LAET Exceedances | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cadmium | Mercury | Zinc | PCBs, Sum of Aroclors | 2-Methyl-naphthalene | Acenaphthene | Dibenzo-furan | Fluorene | Naphthalene | Phenanthrene | Total LPAH | 4-Methyl phenol | PCBs, Sum of Aroclors | Butyl benzyl phthalate | Bis(2-ethylhexyl) phthalate | 4,4'-DDD | 4,4'-DDE |
| | | | | | SQS = 5.1 CSL = 6.7 | SQS = 0.41 CSL = 0.59 | SQS= 410 CSL= 960 | SQS = 12 CSL = 65 | SQS = 38 CSL = 64 | SQS = 16 CSL = 57 | SQS= 15 CSL= 58 | SQS = 23 CSL = 79 | SQS = 99 CSL = 170 | SQS = 100 CSL = 480 | SQS = 370 CSL = 780 | SQS = 670 CSL = 670 | LAET= 130 2LAET = 1000 | LAET = 63 2LAET = 900 | LAET = 1300 2LAET = 1900 | LAET = 16 2LAET = 43 | LAET = 9 2LAET = 15 |
| | | | | wt% | mg/Kg | | | mg/Kg OC | | | | | | | | µg/Kg | µg/Kg | | | | |
| Lagoon | NPI-L2-SC-01 | 94 -124 | Exponent 2008 | 11.3 | 7.7 | 0.7 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Inner Harbor | IE05B | 30 - 61 | E & E 2012 | 11.7 | – | 0.86 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | IE09B | 91 - 122 | E & E 2012 | 78.5 | – | – | – | – | – | – | – | – | – | – | – | – | – | 91 | – | – | – |
| | IH02B | 30 - 61 | E & E 2012 | 23.1 | 12 | 8.9 | 1900 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | IH06B | 30 - 61 | E & E 2012 | 4.9 | – | 0.53 | – | – | – | – | – | – | – | – | – | – | – | – | 2800 | – | – |
| | NPI-PA4-SC-01 | 30 - 74 | Exponent 2008 | 28.7 | – | – | 2010 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | MA02C | 12 - 24 | E & E 2012 | 3.5 | – | 0.5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Ferry Terminal | FT04C | 36 - 48 | E & E 2012 | 2.4 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 65 | 14 |
| Rayonier | EC03B | 6 - 12 | E & E 2012 | 2.3 | – | – | – | 13.5 | – | 47.8 | 24.8 | 40.0 | – | 117.0 | – | 690 | – | – | – | – | – |
| | EC03C | 12 - 24 | E & E 2012 | 2.8 | – | – | – | 14.7 | 107.9 | 176.3 | 97.1 | 147.5 | 226.6 | 348.9 | 925 | – | – | – | – | – | – |
| | ED05B | 30 - 61 | E & E 2012 | 3.7 | – | – | – | – | – | – | – | – | – | – | – | – | 250 | – | – | – | – |
| | R05LP-09 | 6 - 76 | Malcolm Pirnie 2007a | 34.4 | – | – | – | – | – | – | – | – | – | – | – | – | 170 | – | – | – | – |
| | R05LP-13 | 9 - 45 | Malcolm Pirnie 2007a | 22.7 | – | – | – | – | – | – | – | – | – | – | – | – | 260 | – | – | – | – |
| | R05LP-20 | 9 - 56 | Malcolm Pirnie 2007a | 23.9 | – | – | – | – | – | – | – | – | – | – | – | – | 380 | – | – | – | – |

Key:

> 3.5% TOC

Exceeds SQS/LAET criteria

Exceeds CSL/2LAET criteria

– = concentration below SMS criteria