Proposed Plan

Pearl Harbor Sediment Remediation
Joint Base Pearl Harbor-Hickam, Oahu, Hawaii

February 2016

U.S. NAVY ANNOUNCES A PROPOSED PLAN

The U.S. Navy invites the public to review and comment on this **Proposed Plan (PP)** for the remediation of the Pearl Harbor Sediment site at **Joint Base Pearl Harbor-Hickam (JBPHH)** (*Figure 1*). The Navy has completed its investigation of the site, identified the nature, extent, and risks associated with contaminated sediments, and developed a plan for remediation. The Navy proposes a combination of focused dredging, **Enhanced Natural Recovery (ENR)**, treatment with **Activated Carbon (AC)**, and **Monitored Natural Recovery (MNR)** as the preferred cleanup alternative for the site. Detailed information on the development, comparative analysis, and selection of the preferred remedy is presented in the Pearl Harbor Sediment **Feasibility Study (FS)** (*DON 2015*). **Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)** five-year reviews and long-term monitoring will verify that the remedy continues to protect human health and the environment.

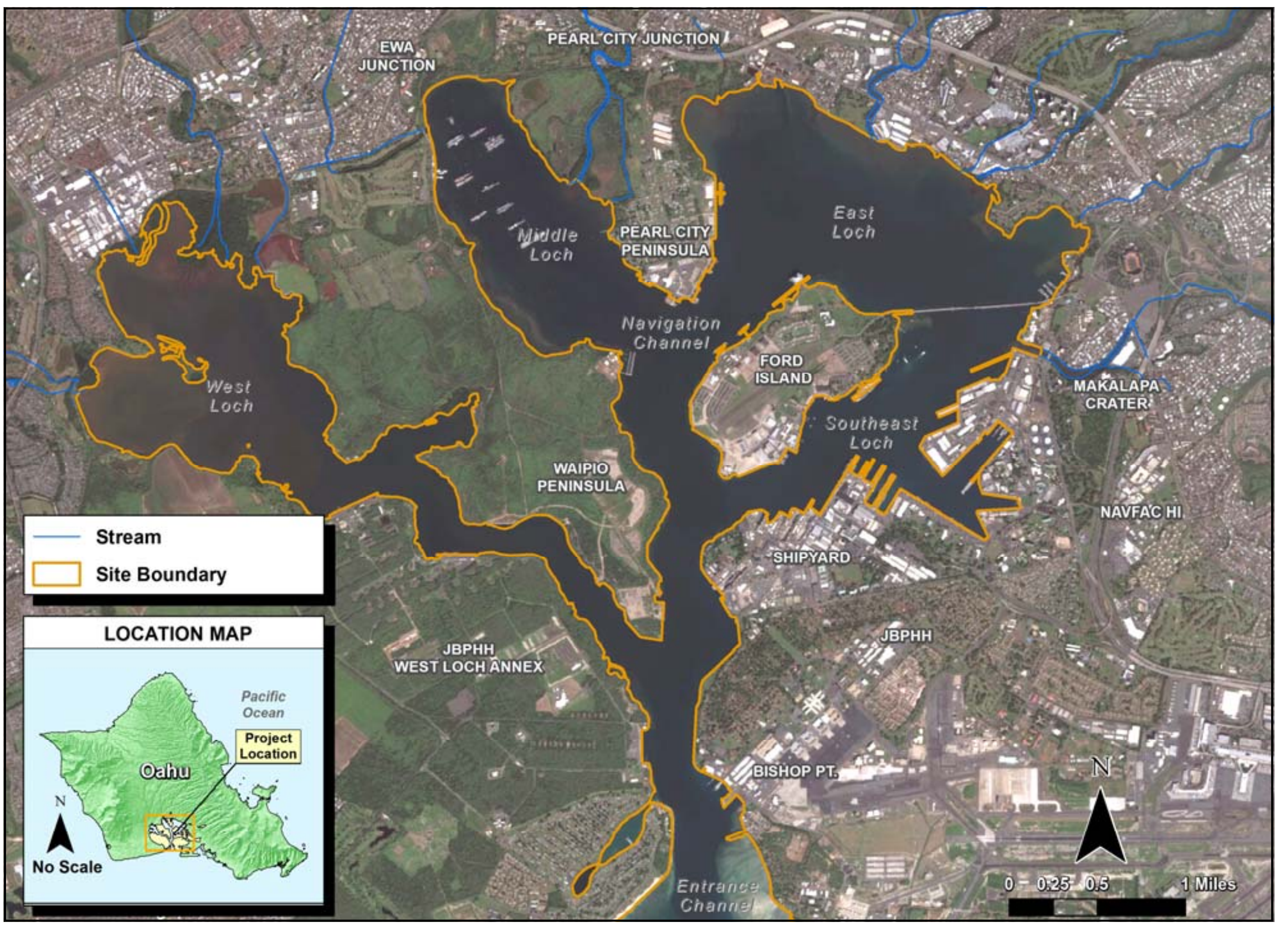

Figure 1: Pearl Harbor Sediment Site Map

Public Comment Period
February 1 to March 1, 2016

Public Meeting
February 10, 2016, 7 p.m.
Aiea Elementary School

INTRODUCTION

This PP summarizes the background and characteristics of the Pearl Harbor Sediment site; explains the findings of human health and ecological risk assessments; and discusses the cleanup objectives, remedial alternatives, and the preferred remedies for the site. Detailed site information is provided in the reports referenced at the end of this PP. The Navy issues the PP to invite public involvement in the process of selecting the site remedy and to fulfill the requirements of CERCLA §117(a) and the **National Contingency Plan (NCP)** §300.430(f)(2).

This site is listed on the **U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL)** of sites where known or threatened releases of hazardous substances, pollutants, or contaminants have occurred. It was listed in October 1992, and identified by EPA Identification Number HI4170090076. Under CERCLA, the Navy is responsible for the investigation and cleanup of contamination resulting from its past operations. The **Hawaii Department of Health (HDOH)** and EPA Region 9 have reviewed the Navy's investigation results and concur with the conclusions and recommendations for the site.

The Navy encourages all interested parties to review and comment on this PP. Comments received from the community members are valuable in helping the Navy select and finalize the remedy for the site.

SITE BACKGROUND

The Pearl Harbor Sediment site extends over approximately 5,000 acres of submerged land in the Pearl Harbor estuary, in the south-central portion of Oahu, Hawaii (*Figure 1*). The Navy owns and controls access to

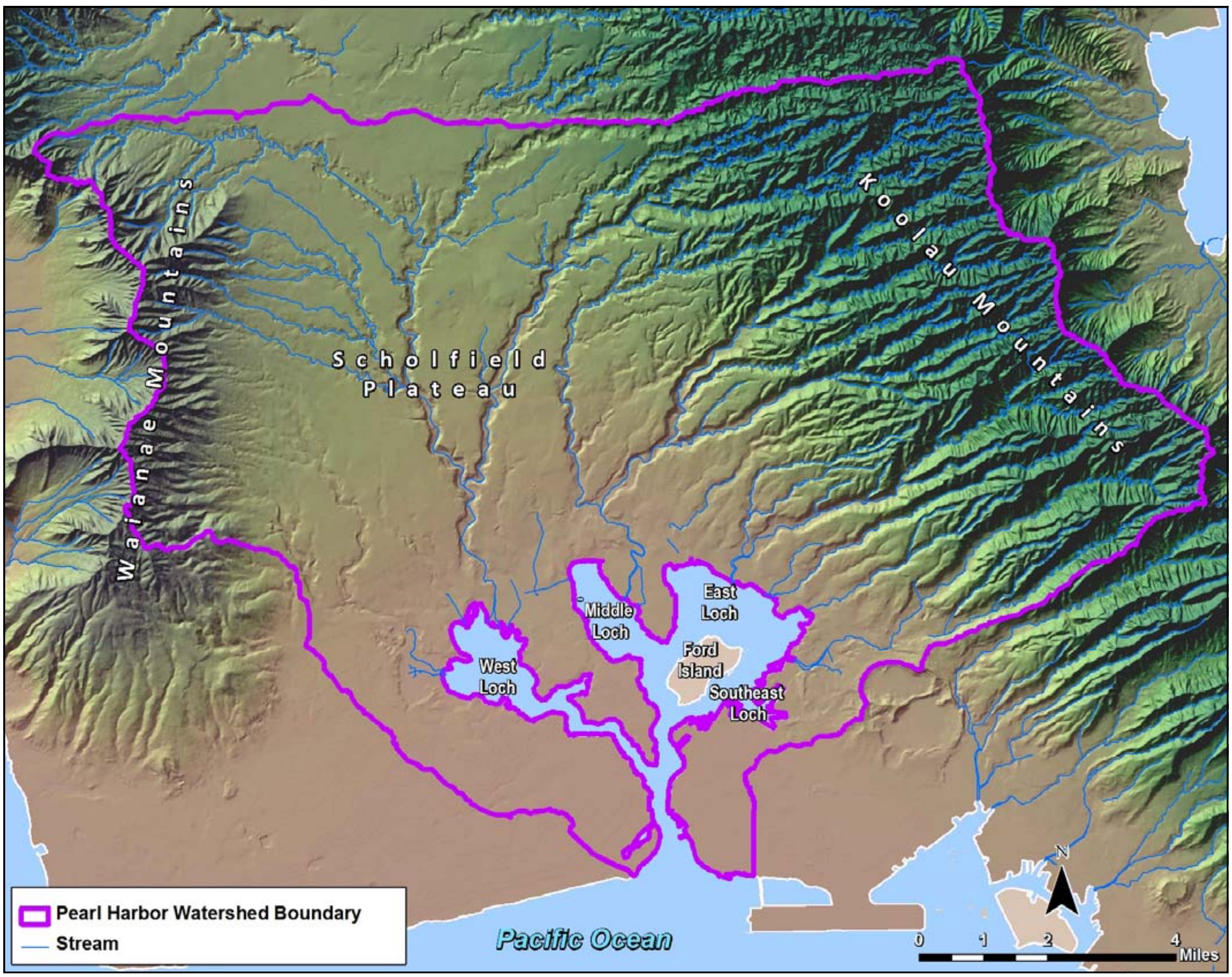

Figure 2: Pearl Harbor Watershed

all submerged lands in Pearl Harbor (*Photo 1*), and fishing is restricted to a catch-and-release program at specific locations within the harbor. The harbor is a natural trap, or sink, for sediments and chemicals discharged with surface water runoff from approximately 110 square miles of watershed, or 20 percent of Oahu's land surface (*Figure 2*).

Previous environmental investigations at the site have shown that there is sediment contamination within Pearl Harbor that can be attributed to both Navy and non-Navy sources. After the site's listing on the NPL, the Navy initiated a **Remedial Investigation (RI)** of Pearl Harbor sediments in 1996 (*DON 2007*). The RI included sampling and laboratory analysis of sediment (*Photo 2*) and tissue from representative species to identify the types of chemicals in Pearl Harbor sediments and organisms, quantify the chemical concentrations, evaluate sediment toxicity, assess potential risks to human health and the environment associated with the sediments and organisms, and evaluate the nature and extent of contamination in sediments that may pose unacceptable risk to human health or the environment. The RI conducted an extensive analysis of 243 chemicals in sediment and tissues of representative species and identified the following **chemicals of potential concern (COPCs)** that could adversely affect human health or the environment:

- Metals (antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc)
- Polynuclear aromatic hydrocarbons
- **Polychlorinated biphenyls (PCBs)**
- Dioxins/furans
- **2-(2-Methyl-4-chlorophenoxy)propionic acid (MCPP**, a chlorinated herbicide)
- **2,4,6-Trinitrotoluene (TNT)**

A 2002 pilot study for the EPA Environmental Monitoring and Assessment Program found chromium, copper, mercury, nickel, and selenium concentrations exceeding the 1996 Pearl Harbor RI screening criteria. The 2002 data indicated that concentrations of total PCBs, total **dichlorodiphenyltrichloroethane (DDT)**, antimony, arsenic, cadmium, lead, silver, and zinc in sediment decreased in certain areas of Pearl Harbor compared to the 1996 RI results.

The Navy initiated a Pearl Harbor Sediment RI Addendum in 2009 (*DON 2013*) to further characterize

Photo 1: Aerial View of Joint Base Pearl Harbor-Hickam

Photo 2: Vibracore Sediment Sampler Being Deployed

the nature and extent of contamination in the harbor before proceeding with a FS. The RI Addendum established and investigated ten distinct areas of the harbor as **Decision Units (DUs)** (*Figure 3*), and evaluated each DU using a decision process based on multiple lines of evidence provided by data collected during the RI and RI Addendum. A sediment transport study conducted as part of the RI Addendum indicated that sediments in the harbor tend to build up rather than be eroded.

An overall decrease in chemical concentrations in sediment and fish tissue at the site was observed in the 2009 RI Addendum samples compared to the 1996 RI samples. Based on data and information collected during the RI Addendum, the following COPCs were identified for Pearl Harbor sediments:

- Metals (antimony, cadmium, copper, lead, mercury, silver, and zinc)
- Total PCBs
- Chlorinated pesticides (dieldrin and endosulfan)

Arsenic, chromium, nickel, selenium, total DDT, total chlordane, total benzene hexachloride, and total endrin were eliminated as COPCs because they were not detected at concentrations above the screening criteria. TNT was eliminated because it is most likely safe for human health and the environment, based on low bioaccumulation potential, high degradation potential, and relatively low human health and ecological risks. MCPP was also eliminated as a COPC because the risk to human health and the environment calculated in the RI was overestimated due to the limited number of MCPP detections reported for the 1996 sediment and fish tissue samples.

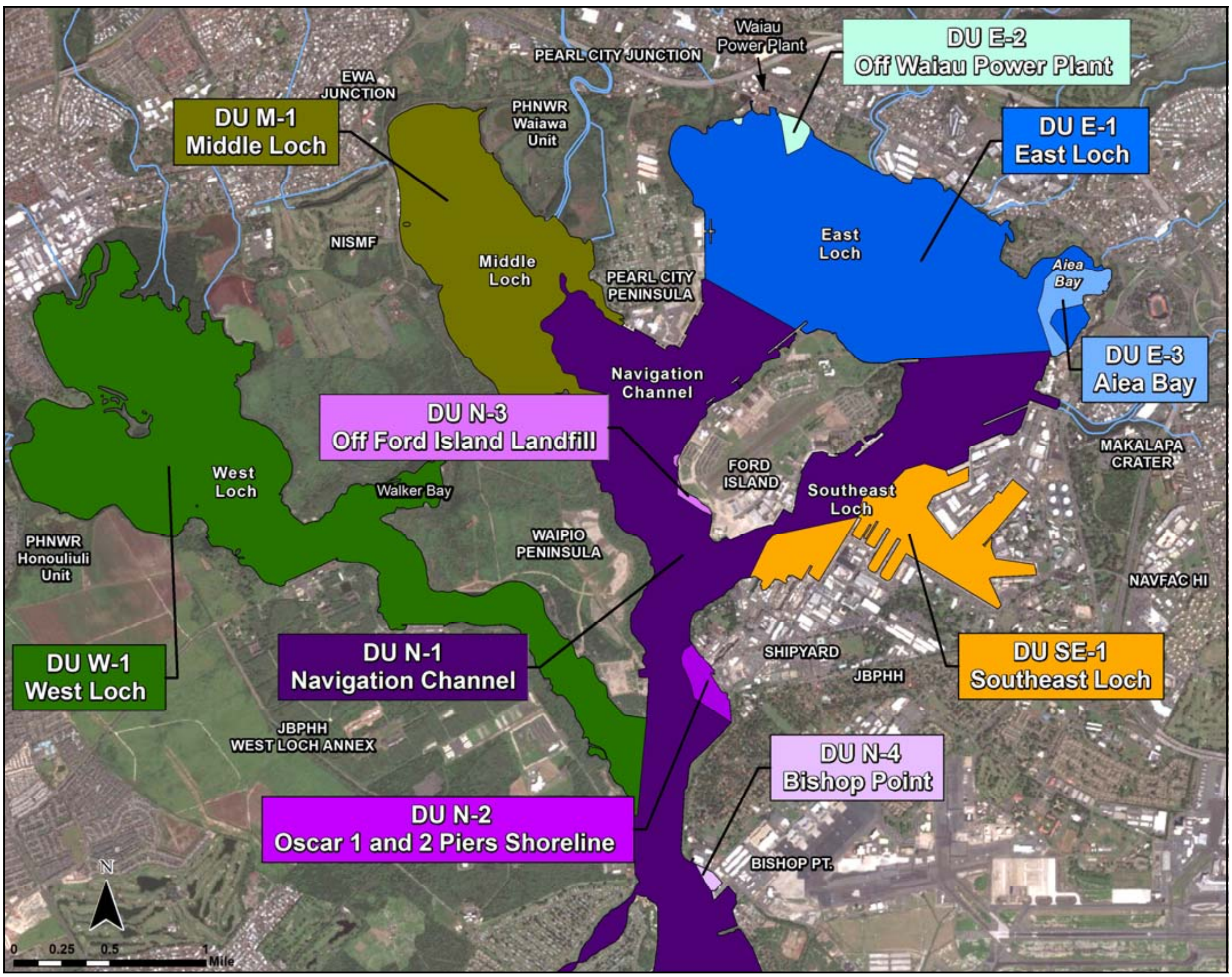

Figure 3: Pear Harbor Sediment Decision Unit Boundaries

The RI Addendum recommended the following DUs for **No Active Remediation (NAR)** (*Figure 4*) because the analytical data indicated that chemical concentrations in sediments in these areas do not pose unacceptable risk to people or the environment:

- N-1 (Majority of Navigation Channel)
- W-1 (West Loch)
- M-1 (Middle Loch)
- E-1 (Majority of East Loch)

The remaining six DUs (*Figure 4*) were recommended for further evaluation in the FS because sediments in these DUs contain concentrations of metals (antimony, cadmium, copper, lead, mercury, silver, and zinc), total PCBs, and chlorinated pesticides (dieldrin and total endosulfan) that could potentially threaten human health or the environment.

Several areas of the harbor were also recommended for evaluation of long-term fish monitoring based on exceedances of screening criteria for PCBs and dioxins/furans in in fish tissue (*Figure 4*).

The Navy initiated the Pearl Harbor Sediment FS in 2012 (*DON 2015*). A FS investigation collected additional data and information to refine the extent of contamination in the six DUs (*Figure 4*) identified for further evaluation. The investigation confirmed the list of COPCs to include six metals (antimony, cadmium, copper, lead, mercury, and zinc) and total PCBs. These seven chemicals represent the sediment **chemicals of concern (COCs)** to be remediated at the site. The FS investigation also evaluated ongoing sources of chemicals released to Pearl Harbor. The FS identified, evaluated, and recommended remedial alternatives for protecting human health and ecological receptors potentially exposed to chemicals in the impacted sediments. Evidence for ongoing natural

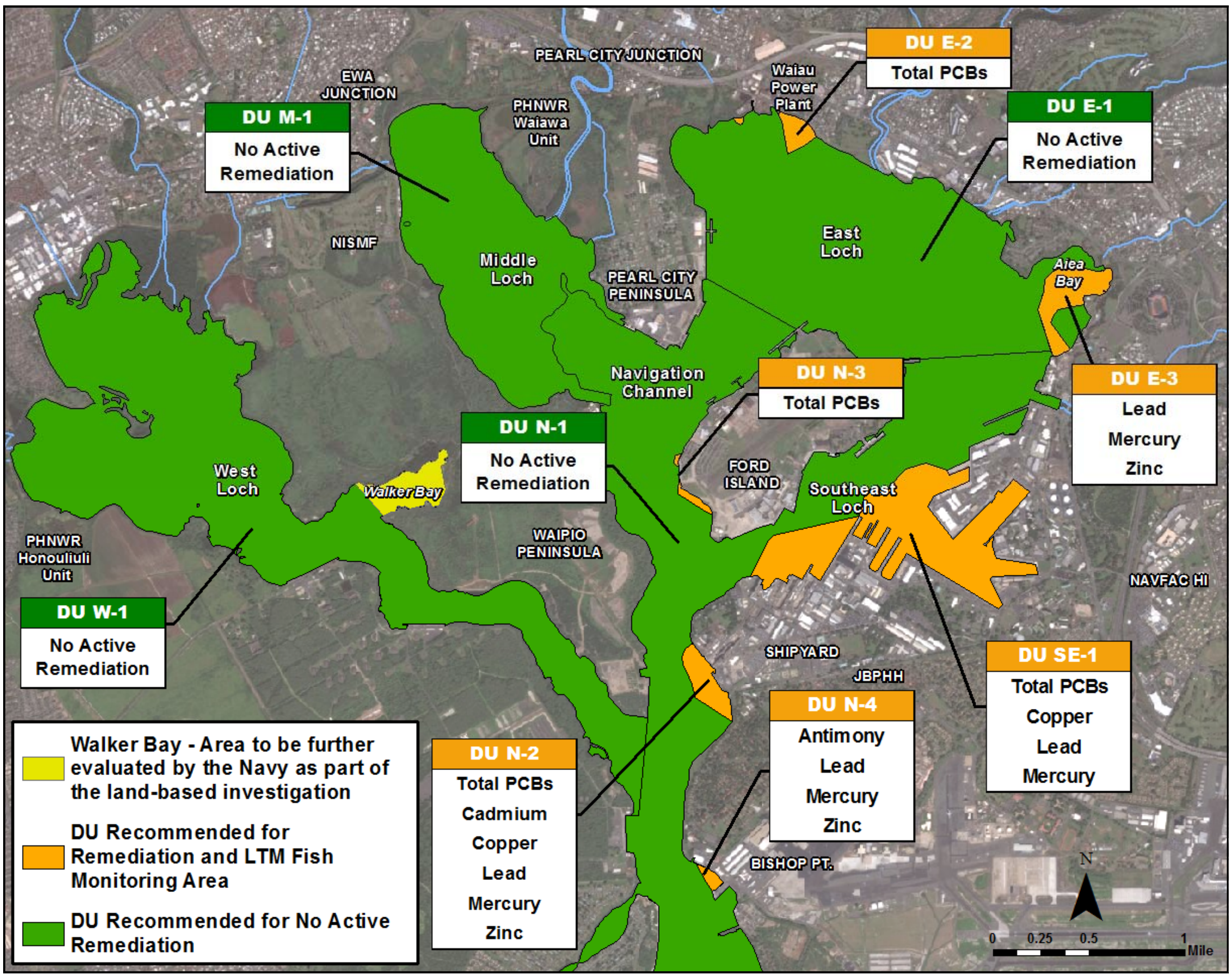

Figure 4: Areas and COCs Recommended for Remediation of Sediment

recovery at the site presented in the FS report, based on the RI, RI Addendum, FS, and other investigations, includes ongoing deposition of clean sediment and an overall harbor-wide decrease in COC concentrations in sediment and fish tissue.

SITE CHARACTERISTICS

Pearl Harbor is a natural estuary extending over approximately 5,000 acres (8 square miles) on the south-central coast of Oahu, Hawaii. The Pearl Harbor basin is a drowned river system (*Figure 2*), with several tributaries that form the three main lochs (West, Middle, and East). These lochs together with Southeast Loch and a dredged central navigation channel join at the entrance channel that opens to the Pacific Ocean in the south. Most of the land area surrounding the harbor, including approximately 75 percent of the harbor shoreline, is occupied by JBPHH.

Pearl Harbor sediments provide habitat for many types of marine life such as crabs and fish (*Photo 3*) that live on or near the bottom of the harbor and are part of the food web for many waterbird species and humans. The harbor area is generally characterized by high biological complexity and productivity. The only in-water protected marine species sighted within Pearl Harbor during a 2006 study was the threatened green sea turtle (*Chelonia mydas*), which is likely to enter and transit through Pearl Harbor occasionally (*Smith et al. 2006*).

Photo 3: Bandtail goatfish (weke pueo, weke pahulu [Upeneus taeniopterus])

The Pearl Harbor shoreline includes several wetlands, primarily the Pearl Harbor National Wildlife Refuge**,** which includes two units: the Waiawa Unit, on the northeastern shore of Middle Loch, and the Honouliuli Unit, on the western shore of West Loch (*Figure 3*). Both units provide habitat for several bird species, including four endangered, endemic waterbirds. The Hawaiian black-necked stilt (*Himantopus mexicanus knudseni*) (*Photo 4*) and the Hawaiian coot (*Fulica alai*) are the two most abundant endangered waterbirds in the wildlife refuge units. The Hawaiian common moorhen (*Gallinula chloropus sandvicensis*) and Hawaiian duck (*Anas wyvilliana*) also inhabit the units (*NAVFAC Pacific and HHF 2011*). Risk to representative species was assessed as part of the RI.

Photo 4: Hawaiian stilt (ae'o [Himantopus mexicanus knudsen])

<u>*Nature and Extent of Contamination:*</u> The nature and extent of contamination at the site have been established and refined based on the RI, RI Addendum, and FS investigations. The following six Pearl Harbor Sediment DUs have been identified (*Figure 4*) for remediation of sediments based on presence of DU-specific COCs at concentrations that might be harmful to human health or the environment:

- **DU SE-1 (Southeast Loch):** copper, lead, mercury, total PCBs
- **DU N-2 (Oscar 1 and 2 Piers Shoreline):** cadmium, copper, lead, mercury, zinc, total PCBs
- **DU N-3 (Off Ford Island Landfill and Camel Refurbishing Area):** total PCBs
- **DU N-4 (Bishop Point):** antimony, lead, mercury, zinc
- **DU E-2 (Off Waiau Power Plant):** total PCBs
- **DU E-3 (Aiea Bay):** lead, mercury, zinc

Most of the contamination is located within DU SE-1 (Southeast Loch), where there are localized areas with relatively high contaminant concentrations adjacent to piers and broader areas with relatively lower contaminant concentrations. PCBs represent the most widely distributed COC at the site and have the highest potential for posing harmful effects to human health and the environment. Sources of PCBs at the site include both past activities at Navy sites along the shoreline and releases from a non-Navy source identified as the Hawaiian Electric Company Waiau Generating Station, on the northeast shoreline of East Loch (DU E-2) (*Figure 3*).

Results from the 2009 RI Addendum and additional sampling conducted in 2012 indicate that the presence of elevated dioxin/furan concentrations in sediments and fish tissue near the shoreline of Walker Bay in West Loch (*Figure 3*) is likely attributable to contaminated soils at the adjacent Oahu Sugar Former Pesticide Mixing site. The Navy will, therefore, address long-term fish monitoring and source control at Walker Bay as part of the Oahu Sugar site investigation.

SCOPE/ROLE OF RESPONSE ACTION

Remedial alternatives specific to each DU were developed and evaluated based on the unique physical, chemical, and biological characteristics of each of the six DUs (*Figure 4*). The remedial technologies selected as components of the remedy for each DU incorporated the ongoing natural recovery through implementation of ENR, in-place treatment with AC amendment, and MNR. ENR includes placement of a thin layer of clean material (such as sand) to mix with the surface sediment and accelerate the rate of ongoing natural recovery. It is expected that remediation will be performed concurrently for all DUs, and, therefore, will include a mix of remedial construction activities for dredging, ENR, AC amendment, and monitoring for MNR. Coordinating these activities with maintenance dredging of the harbor's navigation channels will be crucial to optimizing the efficiency of the remedial efforts.

Four Pearl Harbor Sediment DUs have been identified for NAR (*Figure 3*): DU W-1 (West Loch), DU M-1 (Middle Loch), DU E-1 (Majority of East Loch), and DU N-1 (Majority of Navigation Channel). These DUs present no unacceptable risk to human health and the environment based on the RI Addendum results. However, as part of the site remedy, a minimum of one round of sediment and fish tissue sampling, and analysis will be conducted to confirm that the NAR DUs continue to pose no unacceptable risk to human health or ecological receptors, and that the observed trend of stable or decreasing COC levels in surface sediments is ongoing.

SUMMARY OF SITE RISKS

The risks to human health and the environment posed by contaminated sediments have been evaluated in the RI, RI Addendum, and FS investigations. The entire site is currently owned and operated by the Navy, and it is reasonably anticipated that the future use of the site will continue to be restricted for Navy use with limited public access to certain shoreline areas. The Navy recognizes its responsibility as stewards of the environment. It is the Navy's current judgment that the Preferred Alternative identified in this PP is necessary to protect public health or welfare and the environment from actual or threatened releases of hazardous substances into the environment.

Human Health Risks

The **Human Health Risk Assessment (HHRA)** identified the exposure pathways of potential concern for human health in Pearl Harbor as consumption of fish and crab, and direct contact with sediment and surface water (*DON 2007*). The potential risks from exposure to COPCs in sediment and surface water were shown to be much lower than risks associated with exposure to COPCs through consumption of fish or crab tissue caught from the harbor. In addition, the potential risk from consuming fish is greater than the potential risk from consuming crab; therefore, addressing the potential risk from consuming fish should also protect human health from the potential risk from consuming crabs.

PCBs, antimony, and copper have been identified as COCs for human health based on excess lifetime cancer risk greater than 1 in 100,000 for carcinogenic chemicals, or a hazard quotient greater than 1 for non-carcinogenic effects. For excess lifetime cancer risk, total PCBs are the risk driver, with an excess cancer risk of 3 in 100,000 for the adult residential scenario and 2 in 10,000 for the adult subsistence scenario. Antimony, copper, and total PCBs were identified as risk drivers for the non-cancer hazards. The total non-cancer hazard index due to antimony, copper, and total PCB exposure via ingestion of fish tissue exceeded the target hazard quotient of 1 for the adult residential (total PCBs: 1.8), child residential (total PCBs: 3.2), adult subsistence (antimony: 1.2; total PCBs: 12), and child subsistence (antimony: 2.1; copper: 1.6; total PCBs: 20) scenarios.

Baseline Ecological Risk Assessment (BERA)

The ecological risk assessment identified four groups of marine life as ecological receptors, and identified representative species for each group:

- Invertebrates living in sediment (burrowing shrimp)
- Invertebrates living on sediment (blue-clawed stone crab)
- Bottomfish (bandtail goatfish [*Photo 3*] and tilapia)
- Waterbirds (Hawaiian stilt [*Photo 4*], Hawaiian coot, black-crowned night heron, wandering tattler, and sooty tern)

The principal exposure routes of concern are: (1) direct contact and ingestion of chemicals in or on sediment and dissolved in sediment porewater by organisms living in or on the sediment surface (e.g., benthic and epibenthic invertebrates) and (2) exposure of higher-trophic-level organisms (e.g., fish and waterbirds) to chemicals that bioaccumulate in the tissues of organisms lower on the food chain.

The BERA identified potentially unacceptable risk to the following ecological receptors: invertebrates living in sediment (copper, lead, zinc, and total PCBs); invertebrates living on sediment (copper, lead, and zinc); bottomfish (cadmium, copper, lead, mercury, zinc, and total PCBs); and waterbirds (copper, lead, mercury, and total PCBs). The risk to bottomfish is higher compared to other ecological receptors, and therefore bottomfish were selected as the representative ecological receptors for the site. Bandtail goatfish (*Photo 3*) was selected as the fish species that best represents the link between sediment and fish tissue contamination due to their relatively small home range and long life span.

REMEDIAL ACTION OBJECTIVES

Three **Remedial Action Objectives (RAOs)** were developed for the Pearl Harbor Sediment site: one for protection of human health and two for protection of ecological receptors:

- RAO 1: Reduce human health risks associated with the consumption of harbor fish and shellfish by reducing COC concentrations in surface sediments to protective levels.
- RAO 2: Reduce direct contact risks to sediment-associated fish from exposure to COCs by reducing concentrations of COCs in surface sediments to protective levels.
- RAO 3: Reduce risks to waterbirds that forage in shallow waters in Pearl Harbor from exposure to COCs by reducing concentrations of COCs in surface sediments to protective levels.

The RAOs are expected to be achieved when the surface-area-weighted average concentrations of COCs in sediments within each DU meet the site-specific sediment **Preliminary Remediation Goals (PRGs).** PRGs are site-specific sediment concentration thresholds used to measure the success of a cleanup alternative in meeting the RAOs. PRGs were developed for each COC based on the risk-based concentrations developed in the human health and ecological risk assessments, site-specific background concentrations for metals, and the HDOH Fish Advisory Level (for PCBs) (*HDOH 2012*). The site-specific sediment PRG selected for each COC is set at the lowest of the risk-based criteria for a particular COC, unless the criterion is below the background concentration threshold established for that COC. Because the metal COCs are naturally occurring in Hawaii, the sediment PRGs for metals are set to background concentrations to identify concentrations that represent contamination from human activities. Sediment PRGs for each metal COC are listed below:

- *Antimony:* 8.4 **milligrams per kilogram (mg/kg)**
- *Cadmium:* 3.2 mg/kg
- *Copper:* 214 mg/kg
- *Lead:* 119 mg/kg
- *Mercury:* 0.71 mg/kg
- *Zinc:* 330 mg/kg

For PCBs, the sediment PRGs are 110 **micrograms per kilogram (µg/kg)** for areas with water depths less than or equal to 6 feet, and 170 µg/kg for areas with water depths greater than 6 feet. The more conservative sediment PRG is selected in order to protect waterbirds that wade in shallow waters (*Photo 4*), where they could directly contact contaminated sediments. The PCB sediment PRG for areas deeper than 6 feet was developed to reduce human health risk via the fish consumption pathway. The deep water sediment PRG of 170 µg/kg corresponds to a fish tissue fillet concentration of 190 µg/kg (wet weight fillet) that is based on the HDOH fish advisory level for limited fish consumption of up to one 4-ounce (113-gram) serving per month. The HDOH advisory for PCBs (*HDOH 2012*) considers the unique health benefits associated with fish consumption. The advisory protocol is based on the non-cancer endpoint to allow consumers to enjoy the numerous health benefits of eating fish. Additionally, because the entire site is restricted for Navy use, public access restrictions to the waters of Pearl Harbor severely limit fishing opportunities.

SUMMARY AND EVALUATION OF REMEDIAL ALTERNATIVES

Summary of Remedial Alternatives

Remedial technologies were screened to identify **General Response Actions (GRAs)** and process options that could serve as components of remedial alternatives for Pearl Harbor sediments. GRAs are broad categories of remedial actions such as containment, treatment, or removal; process options are alternatives for ancillary technologies that may be used to implement the GRAs.

Through this process, a total of 13 remedial technologies were identified and evaluated to determine those that should be retained to develop the most feasible remedial alternatives for each of the six DUs (*Figure 4*). The retained remedial alternatives were initially screened for effectiveness, implementability, and cost in accordance with EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (*EPA 1988*).

Evaluation of Remedial Alternatives

The remedial alternatives developed for each DU were evaluated in the FS using the two threshold, five balancing, and two modifying criteria (*Table 1*) specified by the NCP (*40 CFR 300.430[e][a][iii]*) and EPA guidance for conducting a RI/FS under CERCLA (*EPA 1988*). Community acceptance will be evaluated in the **Record of Decision (ROD)** based on comments received on the PP (*EPA 1999*).

This section presents the alternatives for each DU and compares the relative performance of each alternative with respect to the nine NCP criteria to identify the most appropriate remedy for the Pearl Harbor Sediment site. Detailed evaluation of the response action alternatives and the rationale for recommending the alternatives as the selected remedy is presented in the Final FS (*DON 2015*).

RAO 3 is not applicable to DUs SE-1, N-2, N-3, and N-4 due to deep water conditions (i.e., water depth greater than 6 feet). Site-wide costs for mobilization and demobilization and long-term remedial goal monitoring are incorporated into costs for DU SE-1.

Table 1: The Nine NCP Criteria

Criterion	Considerations
Threshold Criteria	
1. Overall Protectiveness of Public Health/Environment	Protection from unacceptable risks posed by hazardous substances, pollutants, or contaminants
2. Compliance with **Applicable or Relevant and Appropriate Requirements (ARARs)**	Compliance with requirements under federal, state, and local environmental laws
Primary Balancing Criteria	
3. Long-Term Effectiveness and Permanence	Continued protection of human health and the environment after completion of the remedy
4. Reduction of Toxicity, Mobility, or Volume through Treatment	Permanent or significant reduction of the toxicity, mobility, or volume of constituents through treatment
5. Short-Term Effectiveness	Protection of human health and the environment during implementation of the remedy
6. Implementability	Technical and administrative feasibility and availability of services and materials
7. Cost	Capital and **annual operations and maintenance (O&M)** costs and their net present value
Modifying Criteria	
8. State Acceptance	EPA and HDOH have concurred with preferred remedial alternatives presented in the FS
9. Community Acceptance	Community participation, input, and support

DU SE-1 (Southeast Loch)

Summary of Retained Remedial Alternatives for DU SE-1 (Southeast Loch)

- *Alternative 1: No Action.* The no action alternative is required by CERCLA to establish a baseline for comparison to other remedial alternatives. The no action alternative assumes that site conditions will be left in their current state and does not include **Institutional Controls (ICs)**, monitoring, and potential contingency actions to reduce risk or ensure achievement of RAOs. RAOs 1 and 2 may not be achieved under the no action alternative; however, based on natural recovery estimates, RAOs 1 and 2 could be potentially achieved in approximately 30 years and 10 years, respectively. The total cost is $0.

- *Alternative 2: MNR with Continued Maintenance Dredging.* The MNR alternative relies on ongoing natural processes that effectively reduce COC concentrations with long-term monitoring to achieve RAOs within 30 years. RAO 1 would be achieved in approximately 30 years, and RAO 2 would be achieved in approximately 10 years. The capital cost is $0 and O&M is estimated at $10 million, for a total estimated cost of $10 million.
- *Alternative 3: Dredging.* The dredging alternative involves the removal of 1.2 million **cubic yards (yd^3)** of surface sediment containing high concentrations of COCs by mechanical or hydraulic dredging processes over 149 acres. Dredged sediment would be disposed of in either the ocean (i.e., the South Oahu Ocean Dredged Material Disposal Site), a confined aquatic disposal site in Pearl Harbor, an on-island landfill, or an off-island landfill, depending on the COC concentrations. A thin (6-inch) layer of clean sand would be placed in the dredged areas to cover residual contamination. In-place treatment with AC amendment would be used to remediate sediments in 13 acres of under-pier areas. RAOs 1 and 2 would be achieved after remedial construction is complete (approximately 3 years). The capital cost is estimated at $467 million and O&M is estimated at $3 million, for a total estimated cost of $470 million. Because of the history of military operations in the harbor, munitions may be encountered during dredging. Dredging operations may need to be modified to mitigate potential explosive hazards. The estimated costs for all alternatives with dredging as a component accounts for the potential cost of mitigating explosive hazards by assuming a higher-than-recommended percentage of construction capital costs and scope contingency.
- *Alternative 5: ENR.* The ENR alternative consists of placing a relatively thin (6-inch) layer of clean sand to enhance and accelerate ongoing natural recovery processes over 149 acres. Approximately 13 acres of under-pier areas would be remediated by in-place treatment with AC amendment. RAOs 1 and 2 would be achieved in approximately 10 years. The capital cost is estimated at $68 million and O&M is estimated at $8 million, for a total estimated cost of $76 million.
- *Alternative 8: Focused Capping and Partial Dredging with ENR.* This alternative combines isolation capping (3-foot-thick layer of clean sand) of sediments containing high COC concentrations (35 acres) with partial dredging of sediments (23 acres, 320,000 yd^3), and ENR for sediments with moderate concentrations (91 acres). Dredged sediment would be disposed of in either the ocean, a confined aquatic disposal site in Pearl Harbor, an on-island landfill, or an off-island landfill, depending on the COC concentrations. Approximately 13 acres of under-pier areas would be remediated by treatment with AC amendment. RAOs 1 and 2 would be achieved after remedial construction is complete (approximately 1 year). The capital cost is estimated at $202 million and O&M is estimated at $8 million, for a total estimated cost of $210 million.
- *Alternative 10: Focused Capping and Partial Dredging with ENR and MNR.* This alternative would implement isolation capping for sediments with high COC concentrations (21 acres) with partial dredging of sediments (16 acres, 220,000 yd^3), along with ENR (42 acres) and MNR (70 acres) for sediments with lower concentrations. Dredged sediment would be disposed of in either the ocean, a confined aquatic disposal site in Pearl Harbor, an on-island landfill, or an off-island landfill, depending on the COC concentrations. Approximately 13 acres of under-pier areas would be remediated by in-place treatment with AC amendment. RAOs 1 and 2 would be achieved in approximately 10 years. The capital cost is estimated at $133 million and O&M is estimated at $7 million, for a total estimated cost of $140 million.
- *Alternative 12: Focused Capping and Partial Dredging with ENR, AC, and MNR.* This alternative would implement isolation capping for sediments with high COC concentrations (2 acres) with partial dredging of sediments (3 acres, 28,000 yd^3), along with ENR (32 acres) and MNR (117 acres) for sediments with lower COC concentrations. Dredged sediment would be disposed of in either the ocean, a confined aquatic disposal site in Pearl Harbor, an on-island landfill, or an off-island landfill, depending on the COC concentrations. Approximately 34 acres of over-water areas and 8 acres of under-pier areas would be remediated by in-place treatment with AC amendment. RAOs 1 and 2 would be achieved in approximately 20 years. The capital cost is estimated at $42 million and O&M is estimated at $7 million, for a total estimated cost of $49 million.

- *Alternative 13: Focused Dredging with ENR, AC, and MNR.* This alternative combines dredging for sediments with higher COC concentrations (5 acres, 36,000 yd^3) and placement of a thin layer of clean sand over dredge residuals. Dredged sediment would be disposed of in either the ocean, a confined aquatic disposal site in Pearl Harbor, an on-island landfill, or an off-island landfill, depending on the COC concentrations. ENR (32 acres) and MNR (117 acres) would be implemented for sediments with lower COC concentrations. Approximately 34 acres of over-water areas and 8 acres of under-pier areas would be remediated by in-place treatment with AC amendment. RAOs 1 and 2 would be achieved in approximately 20 years. The capital cost is estimated at $41 million and O&M is estimated at $6 million, for a total estimated cost of $47 million.

Evaluation of Retained Remedial Alternatives for DU SE-1 (Southeast Loch)

1. **Overall Protection of Human Health and the Environment.** The performance of the remedial alternatives for Overall Protection is split between those alternatives that rely more on natural recovery (Alternatives 1, 2, 5, 10, 12, and 13) and those that rely less on natural recovery (Alternatives 3 and 8) to achieve the RAOs. The challenges to natural recovery in DU SE-1 include an active maintenance dredging program, relatively high COC concentrations in surface sediment, and source control. Alternative 1 does not address any of these challenges. Alternative 2 includes ICs and adaptive management, which reduce risks to human health in the short term and provide a mechanism for contingency remediation in the future. Alternatives 5, 10, 12, and 13 significantly reduce COC concentrations in sediment immediately after remedial construction is completed, and isolate or treat hotspots with high COC concentrations. Alternative 3 does not rely on natural recovery; however, it significantly reduces risk immediately after remedial construction is completed. Alternative 8 includes a natural recovery component, but only for areas with lower COC concentrations in surface sediment.
2. **Compliance with ARARs.** Alternative 1 does not comply with ARARs because it does not include ICs, monitoring, or contingency actions to meet RAOs. The other alternatives comply with ARARs by achieving RAOs through a combination of active remediation, ICs, natural recovery, and/or adaptive management.
3. **Long-Term Effectiveness and Permanence.** Uncontrolled sources pose a risk to the long-term effectiveness and permanence of any remedy; therefore, a source control strategy will be implemented along with the sediment remedy. Alternatives 1 and 2 leave subsurface sediment with elevated COC concentrations in place, where it could be potentially exposed in the future, and rely heavily on seafood consumption advisories for protection of human health. Alternative 5 includes active remediation, but leaves buried contamination on site under thin layers of clean sediment and limits reliance on seafood consumption advisories. Alternatives 10, 12, and 13 include capping of the highest concentrations (with partial removal of hotspots to gain clearance in navigation areas) and/or include treatment with AC amendment to limit bioavailability of COCs, specifically PCBs, and limit reliance on seafood consumption advisories. Alternatives 3 and 8 remove sediment with high COC concentrations or isolate it under engineered caps, and minimize the need for seafood consumption advisories.
4. **Reduction of Toxicity, Mobility, or Volume through Treatment.** Alternatives 1, 2, and 5 do not meet this criterion. Alternatives 3, 8, and 10 would not include treatment unless the dredged material is treated prior to disposal. Alternatives 12 and 13 involve placement of AC amendment that reduces toxicity and mobility of the COCs by binding contaminants and limiting bioavailability.
5. **Short-Term Effectiveness.** Alternative 3 includes high construction-related impacts to the environment, society, and economy, but would require a relatively short period to achieve the RAOs. Alternative 1 does not create construction-related impacts but would not achieve the RAOs. Alternative 2 does not create construction-related impacts to the environment, society, and economy, but requires 30 years to achieve RAOs. Construction-related impacts are relatively low or moderate for Alternatives 5, 8, 10, 12, and 13; however, these alternatives would require extended periods (10–20 years) to achieve RAOs.
6. **Implementability.** Alternative 1 is readily implementable. Alternative 2 uses natural processes to aid remediation, thus limiting requirements for

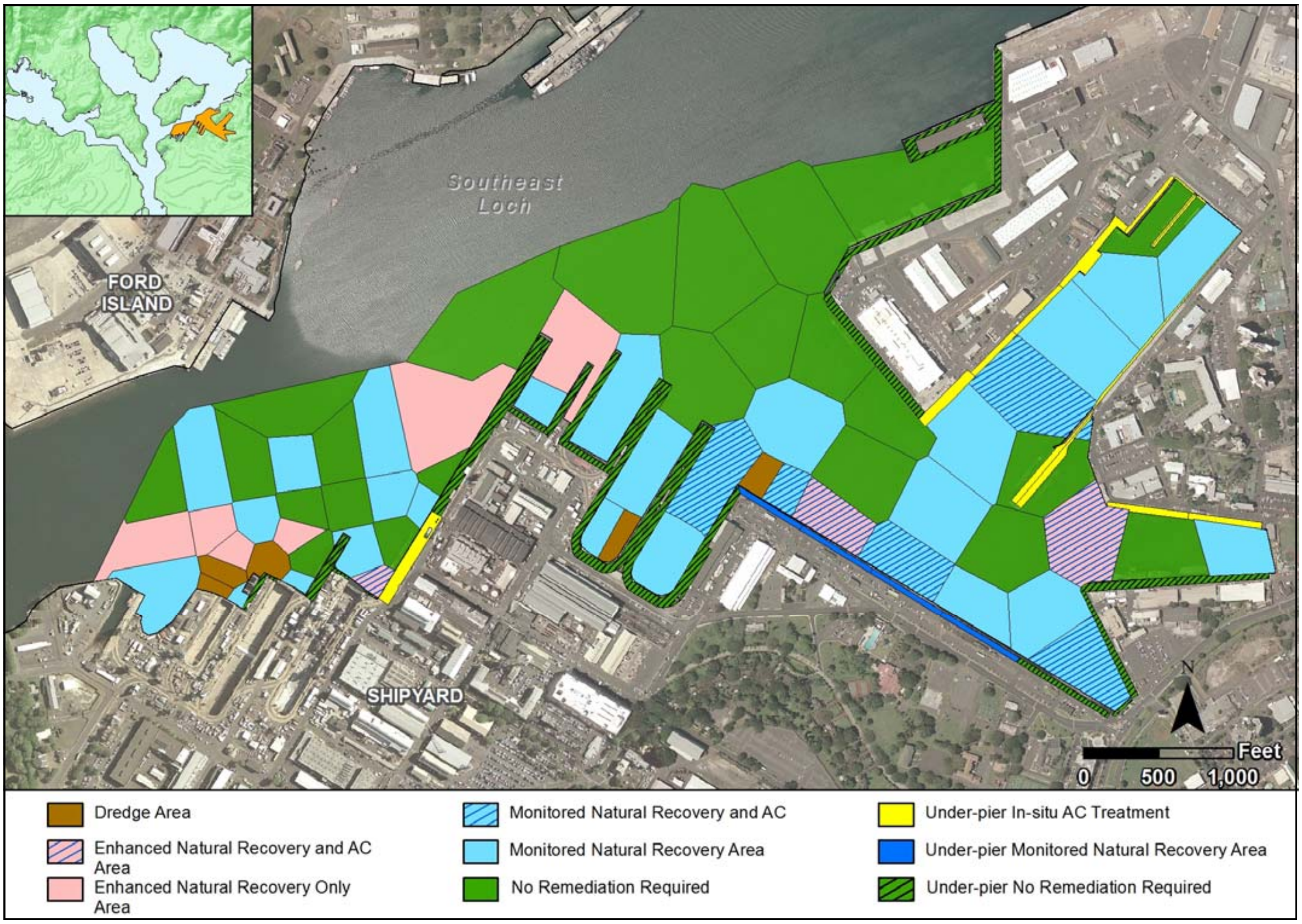

Figure 5: Preferred Remedial Alternative for DU SE-1 (Southeast Loch), Alternative 13 (Focused Dredging with ENR, AC, and MNR)

sediment removal or material placement. Alternative 3 involves removal and disposal of large volumes of sediment and constructability challenges for deep sediments along the piers. Alternatives 8, 10, and 12 present moderate challenges during construction. Alternatives 5 and 13 present fewer challenges during construction, based on the requirements for dredging and/or placement of material in the harbor.

7. **Cost.** Estimated costs range up to $470 million, with a significant degree of uncertainty based on the method of disposal, explosives safety requirements for dredging, and the source of capping or ENR material. Costs do not include upland remediation or additional source control.

The evaluation identified Alternative 13: Focused Dredging with ENR, AC, and MNR *(Figure 5)* as the preferred alternative for DU SE-1 (Southeast Loch).

DU N-2 (Oscar 1 and 3 Piers Shoreline)

Summary of Retained Remedial Alternatives for DU N-2 (Oscar 1 and 3 Piers Shoreline)

- *Alternative 1: No Action.* The no action alternative assumes that site conditions will be left in their current state and does not include ICs, monitoring, and potential contingency actions to reduce risk or ensure achievement of RAOs. RAOs 1 and 2 may not be achieved; however, based on natural recovery estimates, RAO 1 could be potentially achieved in approximately 20 years, and RAO 2 could be potentially achieved immediately. The total cost is $0.
- *Alternative 2: MNR with Continued Maintenance Dredging.* The MNR alternative relies on ongoing natural processes that effectively reduce COC concentrations with long-term monitoring to achieve PRGs within 20 years. MNR would be applied to 24 acres of surface sediment, and would be coordinated with

the Navy's current maintenance dredging program. RAO 1 would be achieved in approximately 20 years, and RAO 2 would be achieved immediately. The capital cost is $0 and O&M is estimated at $1 million, for a total estimated cost of $1 million.

- *Alternative 3: Dredging.* The dredging alternative involves the removal of sediments containing high concentrations of COCs by mechanical or hydraulic dredging processes (16 acres, 150,000 yd^3) and placement of a 6-inch layer of clean sand over approximately 50 percent of the dredged areas to cover the dredge residuals. Dredged sediment would be disposed of in either the ocean, a confined aquatic disposal site in Pearl Harbor, an on-island landfill, or an off-island landfill, depending on the COC concentrations. In-place treatment with AC amendment would be applied to approximately 0.7 acre of under-pier areas. RAOs 1 and 2 would be achieved after remedial construction is complete (5 months). The capital cost is estimated at $59.9 million and O&M is estimated at $0.1 million, for a total estimated cost of $60 million.
- *Alternative 8: Focused Dredging with MNR.* This alternative combines dredging for sediments with high COC concentrations (3 acres, 29,000 yd^3) and placement of a 6-inch layer of clean sand to cover dredge residuals. Dredged sediment would be disposed of in either the ocean, a confined aquatic disposal site in Pearl Harbor, an on-island landfill, or an off-island landfill, depending on the COC concentrations. MNR would be implemented over 12 acres for sediments with lower concentrations. RAOs 1 and 2 would be achieved in approximately 10 years. The capital cost is estimated at $12 million and O&M is estimated at $1 million, for a total estimated cost of $13 million.
- *Alternative 10: ENR and MNR.* The ENR alternative consists of placing a 6-inch layer of clean material or AC amendment over 3 acres to enhance and accelerate ongoing natural recovery processes. MNR would be implemented for sediments with lower COC concentrations (12 acres), and in-place treatment with AC amendment would be applied to approximately 0.7 acre of under-pier areas. RAO 1 would be achieved in approximately 10 years, and RAO 2 would be achieved after remedial construction is complete. The capital cost is estimated at $1.9 million and O&M is estimated at $0.6 million, for a total estimated cost of $2.5 million.

Evaluation of Retained Remedial Alternatives for DU N-2 (Oscar 1 and 3 Piers Shoreline)

1. **Overall Protection of Human Health and the Environment.** The performance of the remedial alternatives for Overall Protection is split between the alternatives that rely more on natural recovery to achieve PRGs (Alternatives 1, 2, 8, and 10) and an alternative that relies less on natural recovery (Alternative 3). However, in contrast to other DUs, DU N-2 has much lower COC concentrations, thus improving the viability of the alternatives that incorporate natural recovery. Alternative 1 does not meet this criterion because it does not include ICs, monitoring, or contingency actions. Alternatives 2, 8, and 10 rely on natural recovery, but include ICs, monitoring, and contingency actions to reduce risks and ensure that RAOs are met in the long term. Alternative 3 achieves significant reduction in COC concentrations immediately after remedial construction is completed.
2. **Compliance with ARARs.** Alternative 1 does not comply with ARARs because it does not include ICs, monitoring, or contingency actions to meet remediation targets. The other alternatives comply with ARARs by achieving RAOs through a combination of active remediation, ICs, natural recovery, and/or adaptive management.
3. **Long-Term Effectiveness and Permanence.** Alternatives 1 and 2 leave subsurface sediment with elevated COC concentrations in place, where it could be potentially exposed in the future, and rely heavily on seafood consumption advisories for protection of human health. Alternative 10 leaves sediment with high COC concentrations on site, but also includes in-place treatment of sediments in the under-pier areas and relies less on seafood consumption advisories. Alternatives 3 and 8 remove most of the more impacted sediment from the harbor and rely less on seafood consumption advisories.
4. **Reduction of Toxicity, Mobility, or Volume through Treatment.** Alternatives 1, 2, and 10 do not meet this criterion. Alternatives 3 and 8 do not include treatment unless the dredged material is treated prior to disposal. Treatment amendments reduce the toxicity and mobility of the COCs by limiting bioavailability and preventing transport in both the dissolved and solid phases.
5. **Short-Term Effectiveness.** Alternative 1 does not create construction-related impacts but would

not achieve the RAOs. Alternative 3 would quickly achieve the RAOs, but includes high construction-related impacts. Alternative 2 does not create impacts, but would require 20 years to achieve RAOs. Alternatives 8 and 10 would achieve RAOs in 10 years with minimal impacts.

6. **Implementability.** Alternative 1 is simple and readily implementable. Alternative 2 uses natural processes to aid remediation, thus limiting requirements for sediment removal and material placement. Alternative 3 involves removal and disposal of large volumes of sediments from areas where recontamination is likely to occur if ongoing contaminant sources are not controlled prior to or during the remedial construction. Alternatives 8 and 10 use natural sediment remediation processes with limited material placement or sediment removal.

7. **Cost.** Estimated costs range up to $60 million to complete the in-water sediment remedies, and do not include costs for upland remediation or source control measures. The major cost uncertainties are the method for dredged material disposal, explosives safety requirements for dredging, and the source of material for capping or ENR remedies.

The evaluation identified Alternative 10: ENR and MNR as the preferred alternative for DU N-2 (Oscar 1 and 2 Piers Shoreline) (*Figure 6*).

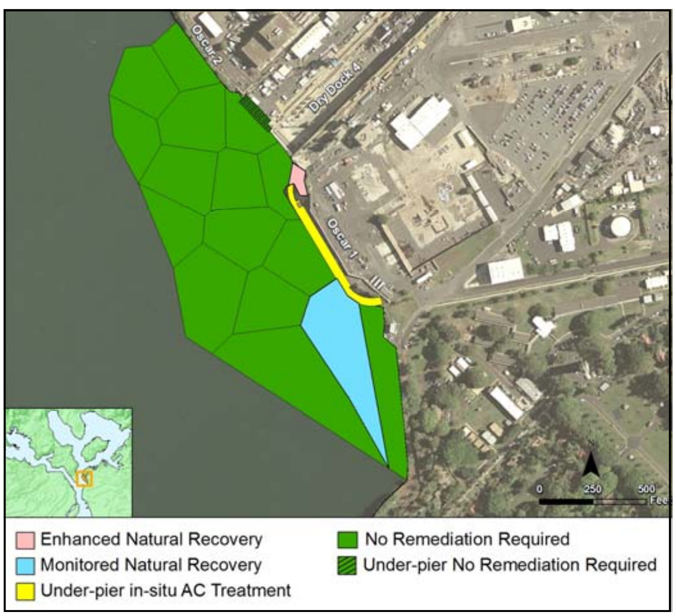

Figure 6: Preferred Remedial Alternative for DU N-2 (Oscar 1 and 2 Piers Shoreline), Alternative 10 (ENR with MNR)

DU N-3 (Off Ford Island Landfill and Camel Refurbishing Area)

Summary of Retained Remedial Alternatives for DU N-3 (Off Ford Island Landfill and Camel Refurbishing Area)

- *Alternative 1: No Action.* The no action alternative assumes site conditions will be left in their current state and does not include ICs, monitoring, and potential contingency actions to reduce risk or ensure achievement of RAOs. RAOs 1 and 2 may not be achieved; however, based on natural recovery estimates, RAOs 1 and 2 could potentially be achieved in approximately 10 years. The total cost is $0.
- *Alternative 2: MNR.* The MNR alternative relies on ongoing natural processes that effectively reduce COC concentrations with long-term monitoring to achieve PRGs within 10 years. MNR would be implemented over 4.5 acres of surface sediment. RAO 1 would be achieved in approximately 10 years, and RAO 2 would be achieved immediately. The capital cost is $0 and O&M is estimated at $180K, for a total estimated cost of $180K.
- *Alternative 3: Dredging.* The dredging alternative involves the removal of sediments containing high concentrations of COCs (0.6 acre, 1,500 yd^3) and placement of a 6-inch layer of clean sand to cover dredge residuals. Dredged sediment would be disposed of in either the ocean, a confined aquatic disposal site in Pearl Harbor, or an on-island landfill, depending on the COC concentrations. RAOs 1 and 2 would be achieved after remedial construction is complete (< 1 month). The capital cost is estimated at $633K and O&M is estimated at $17K, for a total estimated cost of $650K.
- *Alternative 4: ENR.* The ENR alternative consists of placing a 6-inch layer of clean sand to enhance and accelerate ongoing natural recovery processes over 0.6 acre. RAOs 1 and 2 would be achieved after remedial construction is complete. The capital cost is estimated at $224K and O&M is estimated at $46K, for a total estimated cost of $270K.
- *Alternative 5: Capping.* The capping alternative implements isolation capping of sediments containing high COC concentrations over 0.6 acre. RAOs 1 and 2 would be achieved after remedial construction is complete (< 1 month). The capital cost is estimated at $540K and O&M is estimated at $40K, for a total estimated cost of $580K.

Evaluation of Retained Remedial Alternatives for DU N-3 (Off Ford Island Landfill and Camel Refurbishing Area)

1. **Overall Protection of Human Health and the Environment.** The performance of the remedial alternatives for Overall Protection is split between the alternatives that rely more on natural recovery to achieve RAOs (Alternatives 1 and 2) and the alternatives that rely less on natural recovery (Alternatives 3, 4, and 5). Alternative 1 does not meet this criterion because it does not include ICs, monitoring, or contingency actions. Alternative 2 relies on natural recovery, but includes ICs, monitoring, and contingency actions to reduce risks over the recovery period and ensure that the RAOs are met in the long term. Alternatives 3, 4, and 5 would achieve RAOs immediately after remedial construction is completed.
2. **Compliance with ARARs.** Alternative 1 does not comply with ARARs because it does not include ICs, monitoring, or contingency actions to meet remediation targets. The other alternatives comply with ARARs by achieving RAOs through a combination of active remediation, ICs, natural recovery, and/or adaptive management.
3. **Long-Term Effectiveness and Permanence.** Alternatives 1 and 2 have a high potential for future exposure of subsurface sediment contamination and rely heavily on seafood consumption advisories for protection of human health. Alternative 4 includes engineering controls and relies less on seafood consumption advisories. Alternatives 3 and 5 remove the contaminated sediment or provide an engineered cap to isolate and protect it from future disturbance, and limit the need for seafood consumption advisories.
4. **Reduction of Toxicity, Mobility, or Volume through Treatment.** Alternatives 1, 2, 4, and 5 do not meet this criterion. Alternative 3 does not include treatment unless the dredged material is treated prior to disposal. Treatment amendments reduce the toxicity and mobility of the COCs by limiting bioavailability and preventing transport in both the dissolved and solid phases.
5. **Short-Term Effectiveness.** Although Alternative 1 does not create impacts, it would not achieve RAOs. Alternatives 3 and 5 would quickly achieve the RAOs and have additional short-term impacts related to dredge residuals, but this would be mitigated by placement of clean sand material imported to the site. Alternative 2 does not create construction-related impacts, but would require 10 years to achieve RAOs. Alternative 4 would achieve RAOs after remedial construction is complete, with relatively low construction and energy impacts.
6. **Implementability.** Alternative 1 is simple and readily implementable. Alternatives 2 and 4 use natural processes to aid remediation, thus limiting requirements for sediment removal and material placement. Alternatives 3 and 5 involve removal or placement of moderate volumes of sediment or cap materials, have moderate potential for localized recontamination after remediation due to ongoing lateral sources (including one large storm drain), and would require coordination with other entities before beginning remediation.
7. **Cost.** Estimated costs range up to $650K to complete the in-water sediment remedies, and do not include costs for upland remediation or source control. The two major cost uncertainties are the method for dredged material disposal and the source of material for capping or ENR remediation.

The evaluation identified Alternative 4: ENR as the preferred alternative for DU N-3 (Off Ford Island Landfill and Camel Refurbishing Area) (*Figure 7*).

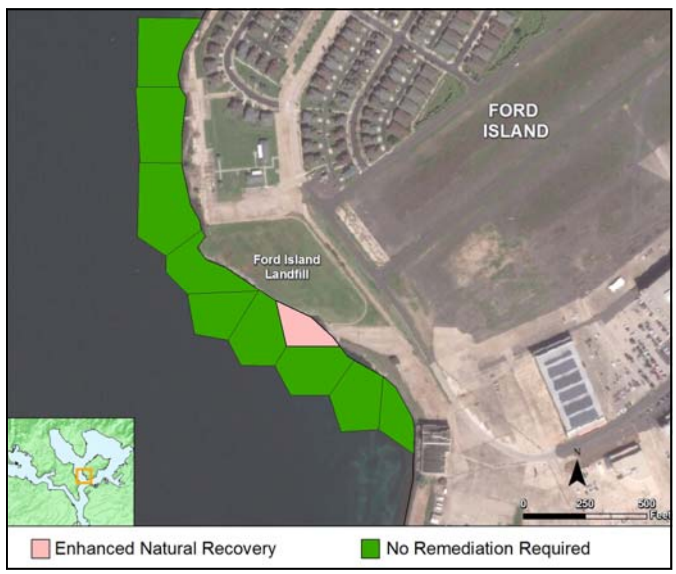

Figure 7: Preferred Remedial Alternative for DU N-3 (Off Ford Island Landfill and Camel Refurbishing Area), Alternative 4 (ENR)

DU N-4 (Bishop Point)

Summary of Retained Remedial Alternatives for DU N-4 (Bishop Point)

- *Alternative 1: No Action.* The no action alternative assumes that site conditions will be left in their current state and does not include ICs, monitoring, and potential contingency actions to reduce risk or ensure achievement of RAOs. RAOs 1 and 2 may not be achieved; however, based on natural recovery estimates, RAO 1 could potentially be achieved immediately and RAO 2 could potentially be achieved in approximately 30 years. The total cost is $0.
- *Alternative 2: MNR with Continued Maintenance Dredging.* The MNR alternative relies on ongoing natural processes that effectively reduce COC concentrations with long-term monitoring. MNR would be applied to 4.3 acres of surface sediment, and would be coordinated with the Navy's current maintenance dredging program. RAO 1 would be achieved immediately, and RAO 2 would be achieved in approximately 30 years. The capital cost is $0 and O&M is estimated at $260K, for a total estimated cost of $260K.
- *Alternative 3: Dredging.* The dredging alternative involves the removal of sediments containing high concentrations of COCs (2.7 acres, 13,000 yd^3) and placement of a 6-inch layer of clean sand to cover dredge residuals. Dredged sediment would be disposed of in either the ocean, a confined aquatic disposal site in Pearl Harbor, or on-island landfill, depending on the COC concentrations. RAO 1 and 2 would be achieved after remedial construction is complete (< 1 month). The capital cost is estimated at $5.3 million and O&M is estimated at $0.1 million, for a total estimated cost of $5.4 million.
- *Alternative 4: ENR.* The ENR alternative consists of placing a 6-inch layer of clean sand to enhance and accelerate ongoing natural recovery processes over 2.7 acres. RAO 1 would be achieved after remedial construction is complete, and RAO 2 would be achieved in approximately 20 years. The capital cost is estimated at $1 million and O&M is estimated at $0.2 million, for a total estimated cost of $1.2 million.
- *Alternative 6: Focused Dredging with MNR.* This alternative combines dredging for sediments with high COC concentrations (2.7 acres, 9,100 yd^3) and MNR. Dredged sediment would be disposed of in either the ocean, a confined aquatic disposal site in Pearl Harbor, or an on-island landfill, depending on the COC concentrations. RAOs 1 and 2 would be achieved following construction. The capital cost is estimated at $3.85 million and O&M is estimated at $50K, for a total estimated cost of $3.9 million.

Evaluation of Retained Remedial Alternatives for DU N-4 (Bishop Point)

1. **Overall Protection of Human Health and the Environment.** The performance of the remedial alternatives for Overall Protection is split between the alternatives that rely more on natural recovery to achieve PRGs (Alternatives 1, 2, 4, and 6) and the alternative that relies less on natural recovery (Alternative 3). Alternative 1 (no action) does not meet this criterion because it does not include ICs, monitoring, or contingency actions. Alternatives 2, 4, and 6 rely on natural recovery, but include ICs, monitoring, and contingency actions to reduce risks and ensure that RAOs are met in the long term. Alternative 3 (dredging) reduces risk immediately after remedial construction is completed.
2. **Compliance with ARARs.** Alternative 1 does not comply with ARARs because it does not include ICs, monitoring, or contingency actions to meet remediation targets. The other alternatives comply with ARARs by achieving RAOs through a combination of active remediation, ICs, natural recovery, and/or adaptive management.
3. **Long-Term Effectiveness and Permanence.** Alternatives 1 and 2 leave subsurface sediment with elevated COC concentrations in place, where it could be potentially exposed in the future, and rely heavily on seafood consumption advisories for protection of human health. Alternatives 4 and 6 leave impacted subsurface sediment in place but address it with engineering controls (placement of a thin clean fill layer or remove sediments with highest COC concentrations). Alternative 3 removes the contaminated sediment and limits the need for seafood consumption advisories.
4. **Reduction of Toxicity, Mobility, or Volume through Treatment.** Alternatives 1, 2, and 4 do not meet this criterion. Alternatives 3 and 6 do not include treatment unless the dredged material is treated prior to disposal. Treatment amendments reduce the toxicity and mobility of the COCs by limiting bioavailability and

preventing transport in both the dissolved and solid phases.

5. **Short-Term Effectiveness.** Although Alternative 1 does not create impacts, it would not achieve the RAOs. Although Alternative 2 has no construction-related impacts, it would require 10 years to achieve RAOs. Alternatives 3 and 6 would quickly achieve the RAOs, but includes high construction-related impacts. Alternative 4 would achieve RAOs in 20 and 10 years with moderate construction-related impacts.
6. **Implementability.** Alternative 1 is simple and readily implementable. Alternative 2 uses natural processes to aid remediation, thus limiting requirements for sediment removal or material placement. Alternative 3 involves removal and disposal of sediment from areas where recontamination is likely to occur if ongoing contaminant sources are not controlled prior to or during the implementation. Alternatives 4 and 6 use natural sediment remediation processes with limited material placement or sediment removal.
7. **Cost.** Estimated costs range up to $5.4 million and do not include costs for upland remediation or source control. The two major cost uncertainties are the method for dredged material disposal and the source of material for capping or ENR remediation.

The evaluation identified Alternative 4: ENR as the preferred alternative for DU N-4 (Bishop Point) (*Figure 8*).

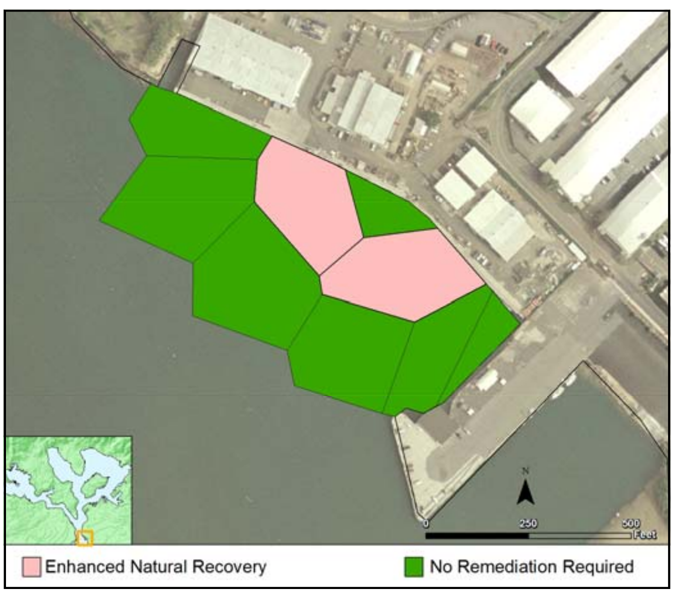

Figure 8: Preferred Remedial Alternative for DU N-4 (Bishop Point), Alternative 4 (ENR)

DU E-2 (Off Waiau Power Plant)

Summary of Retained Remedial Alternatives for DU E-2 (Off Waiau Power Plant)

- *Alternative 1: No Action.* The no action alternative assumes that site conditions will be left in their current state and does not include ICs, monitoring, and potential contingency actions to reduce risk or ensure achievement of RAOs. RAOs 1, 2, and 3 may not be achieved; however, based on natural recovery estimates, all RAOs could potentially be achieved within 30 years. The total cost is $0.
- *Alternative 2: MNR.* The MNR alternative relies on ongoing natural processes that effectively reduce COC concentrations with long-term monitoring. MNR would be implemented over 11.1 acres of surface sediment. RAOs 1, 2, and 3 would be potentially achieved in approximately 30 years, 20 years, and 30 years, respectively. The capital cost is $0 and O&M is estimated at $580K, for a total estimated cost of $580K.
- *Alternative 7: Focused Capping with ENR.* This alternative combines capping of sediments containing high COC concentrations (4.8 acres) and ENR (3.9 acres) for sediments with lower concentrations. RAOs 1, 2, and 3 would be achieved after remedial construction is complete (< 1 month). The capital cost is estimated at $5.7 million and O&M is estimated at $0.5 million, for a total estimated cost of $6.2 million.
- *Alternative 8: Focused Dredging with MNR.* This alternative combines dredging for sediments with high COC concentrations (4.8 acres, 12,000 yd^3) with MNR for sediments with lower concentrations (3.9 acres). Dredged sediment would be disposed of in either the ocean, a confined aquatic disposal site in Pearl Harbor, an on-island landfill, or an off-island landfill, depending on the COC concentrations. RAOs 1 and 3 would be achieved in approximately 10 years, and RAO 2 would be achieved immediately (< 1 month). The capital cost is estimated at $5.0 million and O&M is estimated at $0.2 million, for a total estimated cost of $5.2 million.
- *Alternative 9: Focused Capping with ENR and MNR.* This alternative combines capping of sediments containing high COC concentrations (3.2 acres), ENR (1.6 acres) and MNR (3.9 acres) for sediments with lower concentrations. RAOs 1 and 3 would be achieved in approximately

10 years, and RAO 2 would be achieved after remedial construction is complete (< 1 month). The capital cost is estimated at $3.4 million and O&M is estimated at $0.5 million, for a total estimated cost of $3.9 million.

Evaluation of Retained Remedial Alternatives for DU E-2 (Off Waiau Power Plant)

1. **Overall Protection of Human Health and the Environment.** In contrast to DUs SE-1, N-2, and N-3, DU E-2 is not subject to maintenance dredging, thus improving the overall and long-term protectiveness of alternatives that incorporate natural recovery. Alternative 1 does not meet this criterion because it does not include ICs, monitoring, or contingency actions. Alternatives 8 and 9 rely on natural recovery for sediments with relatively low concentrations, and therefore would significantly reduce COC concentrations immediately after construction is completed to achieve RAOs within a relatively short period. Alternative 7 would achieve RAOs immediately after construction.
2. **Compliance with ARARs.** Alternative 1 does not comply with ARARs because it does not include ICs, monitoring, or contingency actions to meet remediation targets. The other alternatives comply with ARARs by achieving RAOs through a combination of active remediation, ICs, natural recovery, and/or adaptive management.
3. **Long-Term Effectiveness and Permanence.** Alternatives 1 and 2 leave subsurface sediment with elevated COC concentrations in place, where it could be potentially exposed in the future, and rely heavily on seafood consumption advisories for protection of human health. Alternatives 7 and 9 leave contaminated sediment place and isolate it under engineered caps. Alternative 8 removes contaminated sediment and minimize the need for seafood consumption advisories.
4. **Reduction of Toxicity, Mobility, or Volume through Treatment.** Alternatives 1, 2, 7, and 9 do not meet this criterion. Alternative 8 does not include treatment unless the dredged material is treated prior to disposal. Treatment amendments reduce the toxicity and mobility of the COCs by limiting bioavailability and preventing transport in both the dissolved and solid phases.
5. **Short-Term Effectiveness.** Although Alternative 1 does not create impacts, it would not achieve the RAOs. Alternative 2 does not create construction-related impacts, but would require 30 years to achieve RAOs. Alternatives 8 and 9 have relatively low construction-related impacts; however, these alternatives would require 10 years to achieve RAOs. Alternative 7 would achieve RAOs after remedial construction is completed but does create moderate construction-related impacts.
6. **Implementability.** Alternative 1 is readily implementable. Alternative 2 uses natural processes to aid remediation, thus limiting requirements for sediment removal or material placement. Alternatives 7 and 9 are relatively straightforward to implement; however, the design may involve armored caps due to periodic discharges from the power plant's cooling outfall. Alternative 8 requires removal and disposal of a relatively small volume of material, with low to moderate probability of recontamination near the outfall.
7. **Cost.** Estimated costs range up to $6.2 million to complete the in-water sediment remedy, and do not include costs for upland remediation or source control. The two major cost uncertainties are the method for dredged material disposal and the source of material for capping or ENR remediation.

The evaluation identified Alternative 8: Focused Dredging with MNR as the preferred alternative for DU E-2 (Off Waiau Power Plant) (*Figure 9*).

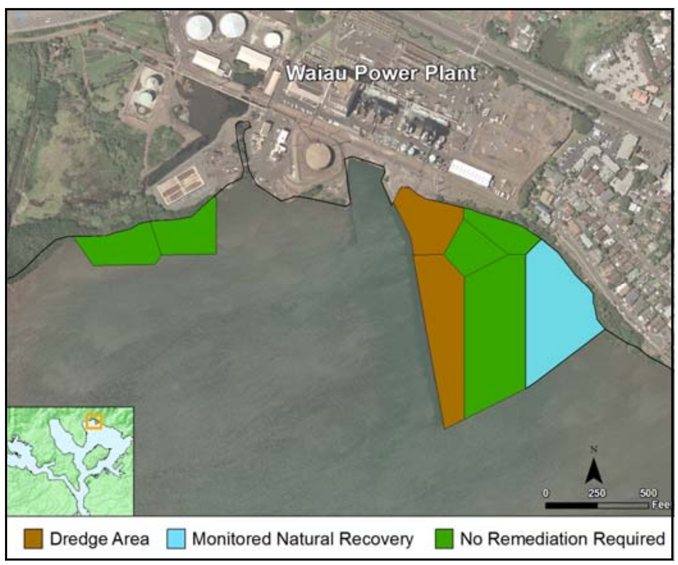

Figure 9: Preferred Remedial Alternative for DU E-2 (Off Waiau Power Plant), Alternative 8 (Focused Dredging with MNR)

DU E-3 (Aiea Bay)

Summary of Retained Remedial Alternatives for DU E-3 (Aiea Bay)

- *Alternative 1: No Action.* The no action alternative is required by CERCLA to establish a baseline for comparison to other remedial alternatives. The no action alternative assumes that site conditions will be left in their current state and does not include ICs, monitoring, and potential contingency actions to reduce risk or ensure achievement of RAOs. RAOs 1 and 2 may not be achieved; however, based on natural recovery estimates, RAOs 1 and 2 would potentially be achieved immediately. The total cost is $0.
- *Alternative 2: MNR.* The MNR alternative relies on ongoing natural processes that effectively reduce COC concentrations with long-term monitoring to achieve PRGs within 10 years. MNR would be implemented over 73.5 acres of surface sediment. RAOs 1 and 2 would be achieved immediately. The capital cost is $0 and O&M is estimated at $2.4 million, for a total estimated cost of $2.4 million.
- *Alternative 5: ENR.* The ENR alternative consists of placing a relatively thin (6-inch) layer of clean sand to enhance and accelerate ongoing natural recovery processes over 30 acres. RAOs 1 and 2 would be achieved after remedial construction is complete (< 1 month). The capital cost is estimated at $11 million and O&M is estimated at $1 million, for a total estimated cost of $12 million.
- *Alternative 6: Capping.* The capping alternative implements isolation capping of sediments containing high COC concentrations over 30 acres. RAOs 1 and 2 would be achieved after remedial construction is complete (1 year). The capital cost is estimated at $27 million and O&M is estimated at $1 million, for a total estimated cost of $28 million.

Evaluation of Retained Remedial Alternatives for DU E-3 (Aiea Bay)

1. **Overall Protection of Human Health and the Environment.** Alternative 1 does not meet this criterion because it does not include ICs, monitoring, or contingency actions. Alternative 2 relies on natural recovery but includes ICs, monitoring, and contingency actions to reduce risks and ensure that RAOs are met in the long term. Alternatives 5 and 6 reduce risk after remedial construction is completed, and isolate or treat areas with high COC concentrations.
2. **Compliance with ARARs.** Alternative 1 does not comply with ARARs because it does not include ICs, monitoring, or contingency actions to meet remediation targets. The other alternatives comply with ARARs by achieving RAOs through a combination of active remediation, ICs, natural recovery, and/or adaptive management.
3. **Long-Term Effectiveness and Permanence.** Alternatives 1 and 2 leave subsurface sediment with elevated COC concentrations in place, where it could potentially be exposed in the future, and rely heavily on seafood consumption advisories for protection of human health. Alternative 5 includes active remediation, but leaves buried contamination on site under thin layers of clean sediment and limits reliance on seafood consumption advisories. Alternative 6 isolates the contaminated sediment under engineered caps and minimizes the need for seafood consumption advisories.
4. **Reduction of Toxicity, Mobility, or Volume through Treatment.** None of the alternatives meets this criterion because they do not include treatment.
5. **Short-Term Effectiveness.** Although Alternative 1 does not create impacts, it would not achieve RAOs. Alternative 2 does not create construction-related impacts, but would require 10 years to achieve RAOs. Alternatives 5 and 6 have relatively low or moderate impacts, and RAOs would be achieved after remedial construction is completed.
6. **Implementability.** Alternative 1 is simple and readily implementable. Alternatives 2 and 5 use natural processes to aid remediation, thus limiting requirements for sediment removal or material placement. Alternative 6 is relatively straight-forward to implement; however, the design requires attention to cap material specifications (carbon or reactive material content) and location-specific conditions such as currents and groundwater flux.
7. **Cost.** Estimates range up to $28 million to complete the in-water sediment remedy, and do not include costs for upland remediation or source control. The major cost uncertainty is the source of material for capping or ENR remediation.

The evaluation identified Alternative 2: MNR as the preferred alternative for DU E-3 (Aiea Bay) (*Figure 10*).

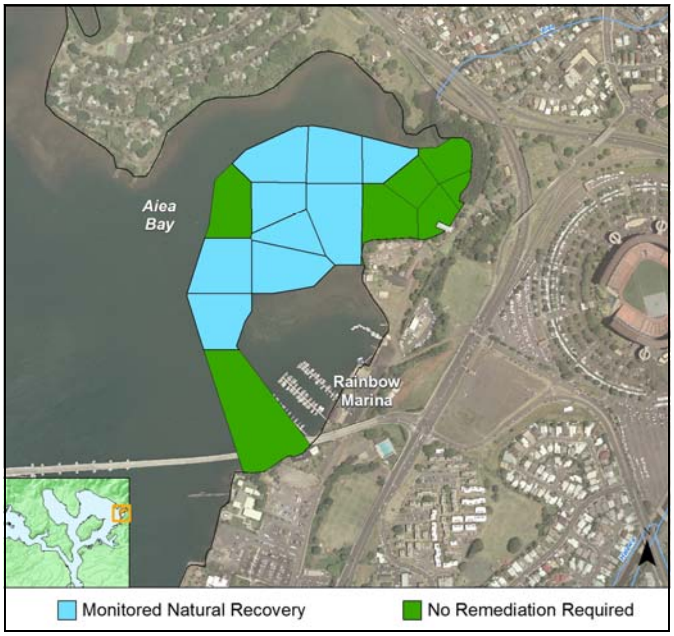

Figure 10: Preferred Remedial Alternative for DU E-3 (Aiea Bay), Alternative 8 (MNR)

PREFERRED ALTERNATIVE

The preferred remedial alternatives for remediating sediment in the six active-remediation DUs at the site are summarized as follows (*Figure 11*):

- **DU SE-1 (Southeast Loch):**
  Alternative 13: Focused Dredging with ENR, AC, and MNR. This alternative will substantially reduce COC concentrations immediately by removing sediments with high COC concentrations, enhance the rate of natural recovery of sediments with moderate COC concentrations, and reduce the remaining risk by limiting bioavailability of COCs in sediment through the use of AC amendment during the natural recovery period. This combination of technologies costs relatively less compared to the other alternatives; minimizes construction-related impacts to the environment, society, and economy) compared to other alternatives; and reduces risk to achieve the RAOs within a reasonable period (20 years) through natural recovery.
- **DU N-2 (Oscar 1 and 2 Piers Shoreline):**
  Alternative 10: ENR with MNR. This alternative is readily implementable to reduce risk to human health and the environment by enhancing the rate of natural recovery of sediments with moderate COC concentrations to achieve the RAOs within a relatively short period (10 years). This alternative is a sustainable, cost-effective remedy with minimal construction-related impacts to the environment.
- **DU N-3 (Off Ford Island Landfill and Camel Refurbishing Area):**
  Alternative 4: ENR. This alternative is a readily implementable, cost-effective remedy that will reduce risk to achieve the RAOs immediately following implementation, while minimizing construction-related impacts to the environment.
- **DU N-4 (Bishop Point):**
  Alternative 4: ENR. This alternative is a highly implementable, cost-effective remedy that will reduce risk and achieve the RAOs within a relatively short period (20 years) following implementation. There is minimal impact from construction to the environment from this alternative compared to the other alternatives.
- **DU E-2 (Off Waiau Power Plant):**
  Alternative 8: Focused Dredging with MNR. This alternative will substantially reduce risk to human health and the environment immediately by removing sediments with high COC concentrations. This alternative also relies on natural recovery to reduce sediment COC concentrations and achieve the RAOs within a relatively short period (10 years) following implementation, thus minimizing construction-related impacts to the environment, society, and economy.
- **DU E-3 (Aiea Bay):**
  Alternative 2: MNR. This alternative is a low-cost and highly implementable remedy with minimal impact to the environment, society, and economy because no construction-related activities are required to address the relatively low risk presented by COCs in sediments within this DU.

These remedial alternatives are also projected to achieve the PCB fish tissue target concentration of 190 µg/kg wet weight for fish fillets within the 10 to 20-year natural recovery period following completion of remedy construction. The fish tissue target is based on the HDOH (*2012*) fish advisory level for limited fish consumption. EPA and HDOH have concurred with the preferred alternatives presented in this PP.

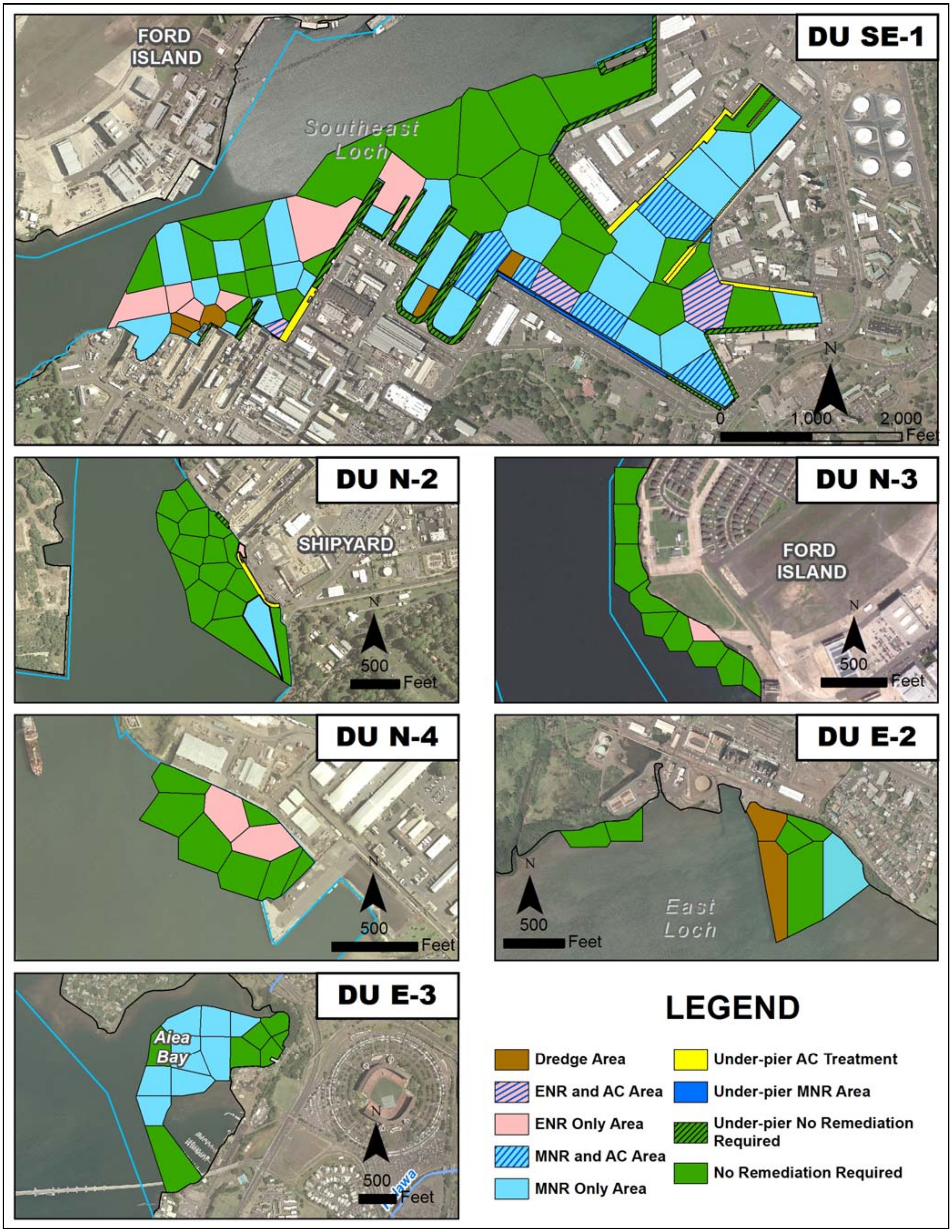

Figure 11: Preferred Alternatives Recommended as the Remedies for Pearl Harbor Sediment DUs

GLOSSARY

Activated Carbon (AC): A remedial technology that includes placement of activated carbon amendment to treat contaminated sediments in place by reducing the bioavailability of certain types of contaminants to receptors.

Administrative Record: Collection of documents that form the basis for selection of a response action at a CERCLA site.

Applicable or Relevant and Appropriate Requirements (ARARs): Requirements, including cleanup standards, standards of control, and other substantive environmental protection requirements and criteria for hazardous substances, as specified under Federal and state laws and regulations, that must be met when complying with CERCLA and the Superfund Amendments and Reauthorization Act.

Baseline Ecological Risk Assessment (BERA): A study that evaluates the site-specific likelihood, nature, and extent of adverse effects in ecological receptors exposed to chemicals of potential concern in a study area. A BERA includes exposure and toxicity assessments, risk characterization, and uncertainty analysis.

Chemical of Potential Concern (COPC) and Chemical of Concern (COC): A chemical that is potentially related to the site and has been characterized by data of sufficient quality for use in a quantitative risk assessment. A COPC becomes a COC when the chemical occurs at a concentration that poses an unacceptable threat to human health and the environment (source: EPA Glossary). For the Pearl Harbor Sediment site, COPCs were established in the RI phase, and COCs were refined from the list of COPCs in the FS stage and carried forward for evaluation of remedial alternatives.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA): Also known as Superfund, CERCLA is the federal law that regulates the environmental investigation and cleanup of sites that could endanger public health, welfare, or the environment.

Enhanced Natural Recovery (ENR): Remediation that involves placing a clean sand layer to mix with the contaminated sediment to enhance the rate of ongoing natural processes to reduce risks from sediments.

Feasibility Study (FS): Analysis of the practicability of a proposal; e.g., a description and analysis of potential cleanup alternatives for a site such as one on the National Priorities List. The feasibility study usually recommends selection of a cost-effective alternative. It usually starts as soon as the remedial investigation is underway; together, they are commonly referred to as the "RI/FS" (source: EPA Glossary).

Hazard Ranking System (HRS): A scoring system used by EPA to assess the relative threat associated with actual or potential releases of hazardous substances. The HRS is the primary screening tool for determining whether a site is to be included on the NPL.

Human Health/Ecological Risk Assessment (HHRA/ERA): Qualitative/quantitative evaluation of the risk posed to human health and the environment by the actual or potential presence or release of hazardous substances, pollutants, or contaminants (source: EPA Glossary).

Institutional Control (IC): An administrative or legal mechanism designed to protect public health and the environment from residual contamination at environmental restoration sites. For example, land use restrictions imposed by the property owner in a property deed would limit access to or use of the property.

Monitored Natural Recovery (MNR): Remediation that involves leaving sediments in place and relying on ongoing natural processes such as accumulation of clean sediment to reduce risks.

National Oil and Hazardous Substances Contingency Plan (NCP): The federal regulation that guides determination of the sites to be corrected under both the Superfund program and the program to prevent or control spills into surface waters or elsewhere.

National Priorities List (NPL): EPA's list of the most serious hazardous waste sites identified for possible long-term remedial action under Superfund. The list is based primarily on the score a site receives from the Hazard Ranking System.

Polychlorinated Biphenyls (PCBs): A group of toxic, persistent chemicals formerly used in electrical transformers and capacitors for insulating purposes and in gas pipeline systems as lubricants. The sale and new use of these chemicals were banned by law in 1979.

Preliminary Remediation Goal (PRG): A goal for evaluating and cleaning up contaminated sites. A risk-based concentration intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements.

Remedial Action Objectives (RAOs): Medium-specific or area-specific goals for protection of human health and the environment, used to guide remedial alternative development, evaluation, and selection. RAOs are derived from the baseline risk assessments, and address the site-specific chemicals, exposure pathways, and receptors.

Record of Decision (ROD): A public document prepared for NPL sites that documents the final remedial response action decision and certifies that the selected remedy complies with CERCLA. It contains a summary of site conditions, selected remedy, remedial action objectives, and the rationale for selecting the remedy.

Remedial Investigation (RI): An in-depth study designed to gather data needed to define the nature and extent of contamination at a CERCLA site, establish site cleanup criteria, identify preliminary alternatives for remedial action, and support technical and cost analyses of alternatives. The RI is sometimes accompanied by a feasibility study.

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COMMUNITY PARTICIPATION

The Navy encourages the public to gain a comprehensive understanding of the site and the activities that have been conducted there. Community members and regulatory agencies have provided input through periodic Restoration Advisory Board meetings and by reviewing and commenting on written reports and documents.

The Navy has provided information to the community through public meetings, distribution of nine fact sheets, posting site reports and related documents in the information repository for the site (see below), and announcements published in the *Honolulu Star-Advertiser* on January 24, 2016.

WHAT'S NEXT

The Navy encourages all interested parties to review this PP. Comments received from community members are valuable in helping the Navy select the final remedy for this site. Based on new information or public comments, the Navy may revise the proposed final remedy.

After carefully considering all comments received during the public comment period, the Navy will select a final remedy for the Pearl Harbor Sediment site, in coordination with the EPA and HDOH. The selected final remedy for the Pearl Harbor Sediment site will be presented in a ROD. *Figure 12* depicts the CERCLA process and the upcoming steps in that process.

CERCLA Process — What's Next?

Initial Assessment Study	Remedial Investigation & Addendum	Feasibility Study	Proposed Plan & Public Comments	Record of Decision
1983	1996–2013	2012–2015	2016	2016–2017
Complete	Complete	Complete	To Be Completed	To Be Completed
The Initial Assessment Study evaluated site-related threats to human health and the environment and recommended no further action. However, as new information became available, the EPA requested further action.	The RI evaluated the results of previous studies, collected comprehensive sediment and tissue data, assessed potential risks to human health and the environment, and recommended further action for certain areas of the harbor.	The FS evaluated the effectiveness, feasibility, and cost of cleanup for various alternatives to make the site safe for human and environmental receptors in the long term.	The PP outlines the actions taken and recommends a remedial alternative selected as the remedy for the site. The PP provides an opportunity for the public to comment on the proposed remedy.	The ROD will document the remedy selected for the site. The Navy will consider public comments in selecting the remedy and will respond to them in writing as part of the ROD.

Figure 12: CERCLA Process and What's Next in the Process

There are two ways for you to provide your comments during the 30-day public comment period:

1. Send written comments to:

   COMMANDING OFFICER
   NAVFAC HAWAII
   ATTN: D. EMSLEY CODE 09PAO
   400 MARSHALL ROAD
   JBPHH HI 96860-3139

   Phone: 808-471-7300
   Fax: 808-474-5479
   Email: denise.emsley@navy.mil

2. Provide your comments during the public meeting. A court reporter will be present to record comments.

Public Comment Period:
February 1 to March 1, 2016

REGULATORY PARTNERS

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For More Information:
All site-related documents are available for review at the Navy information repositories established at the Pearl City Public Library and University of Hawaii's Hamilton Library, and the Administrative Record at Joint Base Pearl Harbor-Hickam.