U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1845 Wasp Blvd., Bldg 176
Honolulu, Hawaiʻi 96818
(808) 725-5000 · Fax: (808) 725-5215

August 26, 2022

Rear Admiral Jeffrey J. Kilian, Commander
Naval Facilities Engineering Command Pacific
258 Makalapa Drive, Suite 100
Joint Base Pearl Harbor-Hickam, HI 96860-3134

Re: NMFS Essential Fish Habitat Conservation Recommendations for the Pearl Harbor Naval Shipyard Dry Dock and Waterfront Production Facility Project at Joint Base Pearl Harbor-Hickam, Oʻahu, Hawaiʻi.

Admiral,

The National Marine Fisheries Service, Pacific Islands Regional Office (NMFS), received the Naval Facilities Engineering Systems Command, Pacific (hereafter, Navy) essential fish habitat (EFH) consultation initiation request, EFH Assessment (EFHA), and associated appendices on June 24, 2022 for the Pearl Harbor Naval Shipyard Dry Dock and Waterfront Production Facility Project at Joint Base Pearl Harbor-Hickam (JBPHH) on Oʻahu, Hawaiʻi. This project is part of the Navy's Shipyard Infrastructure Optimization Program (SIOP), and hereafter we refer to this project as SIOP. After reviewing your EFHA, all related appendices, and your additional information response, uncertainty and unaddressed adverse effects remain. We have applied the precautionary principle and recommend additional mitigation and monitoring. We have provided EFH conservation recommendations pursuant to the EFH provisions within Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA; as described by 50 CFR 600.920). Adherence to these conservation recommendations would help you ensure that these unaddressed adverse effects are avoided, minimized, offset for, or otherwise mitigated.

ACTION SUMMARY, CONCERNS, AND CONSERVATION RECOMMENDATIONS

Proposed Action

The Navy is proposing to replace Dry Dock 3 (DD3), install a new uncovered dry dock west of DD3 called Dry Dock 5 (DD5), and install a new Waterfront Production Facility (WPF) at the former

DD3 site. Select example project activities include: dredge and fill; installing a revetment, barge moorings, concrete piles, piers, bulkheads, and ramps; using vessels to transport crew and construction supplies (daily for months to years); and mitigation activities including installation of silt curtains, water quality monitoring, and habitat restoration. This work requires in-water activities with heavy equipment at: Waipio Peninsula (WP) to support dredging, installation of temporary structures, and dewatering and construction staging; Pearl City Peninsula (PCP) for construction staging and installation of temporary structures (e.g., pier and bulkhead); Ford Island (FI) for crew parking, construction staging, and installation of barge/vessel moorings along the east; Iroquois Point (IP) for construction crew parking; and Upper Middle Loch (UML) for barge storage. In-water project activities will take 65 months (in-water work will be approximately 36 months) to complete; dredging will occur 24 hours per day, 7 days per week, for 15 months. Land-side construction may take up to 36 more months to complete, for a total length of 5 to 8 years.

Environmental Stressors

The work activities will cause stress to the marine ecosystem from: physical damage to the benthos (including corals; from dredging, fill, and potential unexploded ordnance), sedimentation, turbidity, nutrient loading, chemical contamination, introduction and/or spread of invasive species, noise, shading, hypoxia, and artificial light.

Adverse Effects and Environmental Injury

27,731.19 m^2 of coral and benthic communities will be unavoidably lost in the action areas. This includes the unavoidable loss of 3,162 corals, and 17,940 m^2 and 56,160 m^2 of hard and soft bottom habitats, respectively.

Mitigation

<u>Avoidance:</u> The Navy will utilize a suite of best management practices (BMPs) to avoid potential adverse effects to the water column and substrate EFH.

<u>Minimization:</u> A suite of BMPs, including silt curtains for sedimentation and turbidity control, has been proposed. To minimize adverse effects to corals, the Navy is proposing to relocate approximately 150 corals to a restoration site at the south end of FI. This is the same site that the Navy will be restoring to offset the unavoidable loss of corals.

<u>Offset:</u> The Navy has used a Habitat Equivalency Analysis (HEA) to calculate habitat restoration area estimates to offset the loss of approximately 3,000 corals, the successional filter feeding community, and other hard bottom habitat (i.e., ecosystem services and function). Based on the Navy's marine surveys, the HEA analysis estimates 1,705.97 m^2 of replacement habitat is required to offset the loss of corals, and 29,226.33 m^2 of habitat is required to offset the loss of benthic habitat. This offset will be achieved through aquatic invasive species (AIS; the soft coral *Unomia stolonifera* and the algae *Gracilaria salicornia*) removal to offset the temporary and permanent loss of benthic

community (includes successional filter feeding community, etc.) and harbor floor EFH. To offset the loss of corals, the Navy is proposing to stabilize/and or add approximately 1,600 m^2 of submerged habitat along the southern edge of Ford Island, including installation of limestone boulders, where necessary, to enhance rugosity. To offset the loss of other benthic habitat (i.e., the 29,226.33 m^2 value), the Navy proposes AIS removal over an approximate 37,000 m^2 area to restore hard bottom habitat, which represents approximately 30% more area than the HEA calculates.

NMFS Concerns

Our concerns about the proposed activities and the proposed mitigation are listed below:

1. The Navy has not provided a detailed water quality monitoring plan in the EFHA. NMFS is concerned that the frequency of water quality monitoring may be insufficient to detect real-time exceedances and adaptively manage, particularly during dredging. Higher frequency, real-time monitoring with sensors during dredging could be helpful to ensure that potential exceedances are detected.

   Rationale: We understand that the 401 Water Quality Certification (WQC) application is in progress but will not be completed until at least October. In past consultations with the Navy and other agencies, we have provided recommendations on water quality monitoring to be considered for inclusion in the 401 WQC application and Applicable Monitoring and Assessment Plan (AMAP), the latter of which details the sampling regime and frequency of water quality measurements that will be collected. Without an AMAP or detailed description of a water quality monitoring plan, it is difficult for us to know what the Navy is proposing and how our concerns may overlap. The State of Hawaiʻi, Department of Health (DOH), AMAP Guidelines indicate that, depending on the phasing of dredging (we do not presently know this information), discrete water quality samples could only be collected three times per week to two times per month. Such a schedule could potentially increase the possibility of missing exceedances, given: a) the uncertainty of whether real-time data will be collected, and b) that discrete samples like Total Suspended Solids will likely take 1 to 2 days to analyze and report. By the time the discrete sample is analyzed, the exceedance may have already occurred without any contingency or action to fix the problem.

2. Given the short-term duration of the plume models in the EFHA (30 days maximum) relative to the extent of proposed dredging (all day every day for 15 months), NMFS is concerned about potential sedimentation and turbidity impacts from proposed activities at restoration sites and areas of high coral cover near the entrance to Pearl Harbor. The Navy has not included nor proposed potential details related to monitoring for sedimentation rates and turbidity at restoration sites nor areas of high coral cover. Inclusion of these monitoring parameters at these sites would help to understand ecosystem dynamics, inform adaptive management, and help to achieve effective offset unless adequate circulation and plume models indicate it is not required.

3. NMFS is concerned that Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) dredging activities may adversely affect SIOP activities. NMFS understands that the CERCLA dredging will occur before SIOP activities, and we appreciate that confirmation and clarification. There is a very small chance, however, of the resuspension of sediment with polychlorinated biphenyls (PCBs) into the SIOP footprint. Since we are unsure of the CERCLA water quality monitoring plan and specific activities, it would be helpful to have a better understanding of these plans, either through general discussions or information sharing.

4. NMFS is concerned about the justification for the 15% HEA pre-injury service level for the Harbor Floor; it may not be based on the best assumptions. NMFS interprets the justification to indicate that the Harbor Floor service is degrading over time in part due to Navy activities. Restoration would therefore seem to need to strive to restore the system back to the historic baseline from years past; more and more habitat would need restoration to compensate. NMFS is not suggesting that the Navy should be restoring the habitat to the historical baseline of decades past; it likely is not even feasible or practicable. NMFS is simply requesting further coordination between with the Navy, separate from this consultation, to identify the best process of determining pre-injury service levels, to get a mutually agreed-upon justification.

   The Navy is proposing to restore 30% more bottom habitat than the HEA calculates (i.e., for removal of invasive species), which would be equivalent to an approximately 35% pre-injury service; what the Navy has proposed is sufficient, and appreciated, for this specific project. However, our acceptance of this value is unique to this consultation and is not precedent setting.

5. NMFS is unsure of how much habitat restoration the Navy is proposing to offset the loss of corals. The HEA calculates approximately 1,705 m^2, but the Navy proposes both 1,600 m^2 and then 1,700 m^2 of habitat restoration on page 189 of the EFHA. The 1,600 m^2 value is less than the approximately 1,705 calculated by the HEA. NMFS requests clarity and confirmation of the true value that the Navy is proposing. NMFS is also concerned that the total area to restore may need to be greater than 1,705 m^2 to ensure an effective offset (see justification below); we are open to further discussions to find a resolution. The Navy has added approximately 30% more habitat restoration for the areas of AIS removal, presumable because it is out-of-kind offset. The habitat restoration at FI is also partly out-of-kind offset (i.e., restoring habitat to replace lost corals). If the Navy added 30% to the 1,705 m^2 value calculated by the HEA, the total value would be approximately 2,217 m^2 of habitat restoration. This would raise the potential that restoration would ensure sufficient lift into the future, and would also be proportional to the proposed additional lift for habitat restoration that would be achieved through AIS removal. NMFS recommends additional area be restored and is proposing further discussions to determine a potential agreed-upon estimate.

   <u>Scientific Justification:</u> It would be scientifically justifiable to restore, monitor, and maintain a greater amount of area at FI to ensure effective offset. In coral reef ecosystems, it is very difficult

to define coral reef area units that are similar between reef sites (US Coral Reef Task Force 2016). While approximately 3,000 corals will be unavoidably lost, the habitat and surrounding geomorphology and biological cover varies somewhat from action site to action site. In addition, what is being proposed is partial out-of-kind offset (i.e., bottom habitat restoration for loss of corals), for which additional lift/restoration is recommended by the Coral Reef Task Force (US Coral Reef Task Force 2016). While the Navy expects the southwest end of FI to be a reasonable restoration site, all benthic locations at action sites differ from one another in rugosity and three dimensional complexity. Given that: 1) Pearl Harbor has many anthropogenic impacts contributing to baseline water quality and benthic geomorphological and biological cover (i.e., sedimentation); 2) the proposed activities do not include water quality monitoring at restoration sites, and therefore the activities may adversely (and additive to the baseline) affect water quality and benthic geomorphological and biological cover at these sites (i.e., from downfield sedimentation and turbidity); 3) the nearshore coral reef ecosystem is expected to continue to rapidly change in the future (i.e., short- and long-term variability in temperature, water quality, etc.); and 4) this site has the potential to provide ecological lift if restored, monitored and maintained over the long-term, it is scientifically justifiable and consistent with best practices (Coral Reef Task Force 2016) to restore more habitat now in an attempt to ensure effective offset and preserve and create additional future ecosystem function.

6. NMFS is concerned about the success, methods, and achieving the ultimate objective of AIS removal (both the soft coral *U. stolonifera* and the algae *G. salicornia*). Removal of these AIS may cause secondary spread due to fragmentation, and additional efforts may be needed. Any details of the plans for specific years would be helpful to discuss, if that would be possible for the Navy to share.

7. NMFS has been made aware of the potential presence of algal balls near the FI restoration site; we are not certain of the specific proximity to proposed coral transplantation sites. We are concerned about the potential for this algae to spread to the coral transplantation locations and smother the transplants and habitat, thereby reducing the success of minimization and offset. Initial information suggests that the algal balls are found at the seaplane ramps near or within the coral relocation restoration site; confirmation would be helpful. The presence and potential spread of algal balls may be a threat to the recovery and long-term viability of translocated corals if the algae outcompete coral transplants.

EFH Conservation Recommendations (pursuant to 50 CFR 600.920)

Conservation Recommendation 1: The Navy should share with NMFS a more detailed description of the proposed water quality monitoring plan. NMFS recommends that higher frequency sampling during dredging be included to ensure that potential exceedances are detected, allowing implementation of appropriate contingencies and stop-work activities. The Navy should continue coordinating with NMFS during the development of the SIOP Water Quality Monitoring Plan prior to its completion so that our concerns about the frequency of sample collection and real-time sampling can be considered for inclusion in the 401 WQC AMAP. It is not our intent to hinder the Navy's 401 WQC application and/or timeline.

Conservation Recommendation 2: The Navy should monitor sedimentation rates and turbidity levels at restoration sites and at areas of high coral cover in the entrance channel of Pearl Harbor. This will ensure that dredging activities do not inadvertently damage downfield coral resources and restoration sites, in the absence of longer-term circulation and plume models. NMFS is ready and willing to continue coordination to identify and achieve an agreed upon approach.

Conservation Recommendation 3: The Navy should ensure that potential contamination from the CERCLA dredging activities does not contaminate any SIOP action areas. The Navy should share the CERCLA Water Quality Monitoring Plan with NMFS, or provide an overview discussion to NMFS better understand how avoidance and/or minimization of CERCLA contamination at SIOP areas would be achieved and adaptively managed. NMFS is ready and willing to further coordinate.

Conservation Recommendation 4: Separate from this consultation, the Navy should work with NMFS to form a working group to develop an agreed-upon process for determining HEA pre-injury service values for utilization under the EFH regulatory framework. NMFS is ready and willing to continue coordination to identify and achieve an agreed upon approach.

Conservation Recommendation 5: The Navy should implement the HEA calculation of approximately 1,705 m^2 for restoration at FI, and add up to an additional 30% (e.g., 1.3:1.0; total of approximately 2,217 m^2) to be restored. This would be consistent with general guidance from the Coral Reef Task Force to provide additional mitigation for out-of-kind replacement of lost corals, and would be approximately proportional to the proposed additional habitat restoration (37,000 m^2 versus 29,226 m^2 as calculated by the HEA) that would be achieved through AIS removal.

Conservation Recommendation 6: The Navy should develop a more detailed eradication and control plan for the removal of the soft coral *U. stolonifera* and share it with NMFS for review. NMFS is ready and willing to assist the Navy and further coordinate.

Conservation Recommendation 7: The Navy should share with NMFS a more detailed description of the proposed method(s) of *G. salicornia* removal. The description should consider method(s) to minimize fragmentation and secondary spread. NMFS is ready and willing to assist the Navy and further coordinate.

Conservation Recommendation 8: The Navy should confirm the presence/absence of algal balls at the Ford Island seaplane ramp near the proposed restoration site. If present, and to improve the habitat to help ensure more effective minimization and offset, the Navy should develop and share with NMFS an implementable containment plan. This would help to achieve effective minimization and offset.

Conservation Recommendation 9: NMFS respectfully requests that Navy share the draft final coral relocation plan with us for review prior to initiating the proposed coral relocation activities. NMFS looks forward to the opportunity to provide additional expertise and potential comments.

Conclusion

NMFS greatly appreciates the opportunity to be a Cooperating Agency, and the Navy's efforts to comply with the EFH provisions of the MSA. Our concerns are related to uncertainty in planning details for water quality monitoring, restoration methods and monitoring, and the HEA offset calculation. We have provided EFH conservation recommendations that when implemented, along with the Navy-proposed mitigation, will ensure that potential adverse effects are further mitigated.

Please be advised that regulations (Section 305(b)(4)(B)) to implement the EFH provisions of the Magnuson-Stevens Act require that federal action agencies provide a written response to this letter within 30 days of its receipt; a preliminary response is acceptable if more time is needed. The final response must include a description of measures to be required to avoid, mitigate, or offset the adverse effects of the proposed activities. If the response is inconsistent with our EFH conservation recommendations, an explanation of the reason for not implementing the recommendations must be provided at least 10 days prior to final approval of the activities.

NMFS is committed to providing continued cooperation and subject matter technical expertise to the Navy in order to achieve the project goals and comply with the EFH provisions of the MSA. Please do not hesitate to contact Stuart Goldberg at stuart.goldberg@noaa.gov to request further technical assistance.

Sincerely,

Gerald Davis
Assistant Regional Administrator
NMFS Pacific Islands Regional Office
Habitat Conservation Division

cc by e-mail:
Malia Chow, NMFS
David Delaney, NMFS
Michelle Bejder, Navy
Sean Hanser, Navy

(Page Intentionally Left Blank)

REMAINDER OF EFH CONSERVATION RECOMMENDATIONS LETTER

Consultation History

On November 30, 2021, the Navy requested pre-consultation technical assistance to review the 70% draft of their EFHA. NMFS provided comments and concerns on December 28, 2021. On June 24, 2022, the Navy requested to initiate this consultation. NMFS requested additional information on July 18, 2022, which the Navy provided on July 27, 2022. The Navy's response included an agreed-upon extension of consultation completion from August 23, 2022 to August 31, 2022. The Navy's EFHA includes a table (see Table 1 of EFHA) list of the pre-consultation meetings and dates amongst all cooperating agencies, including NMFS.

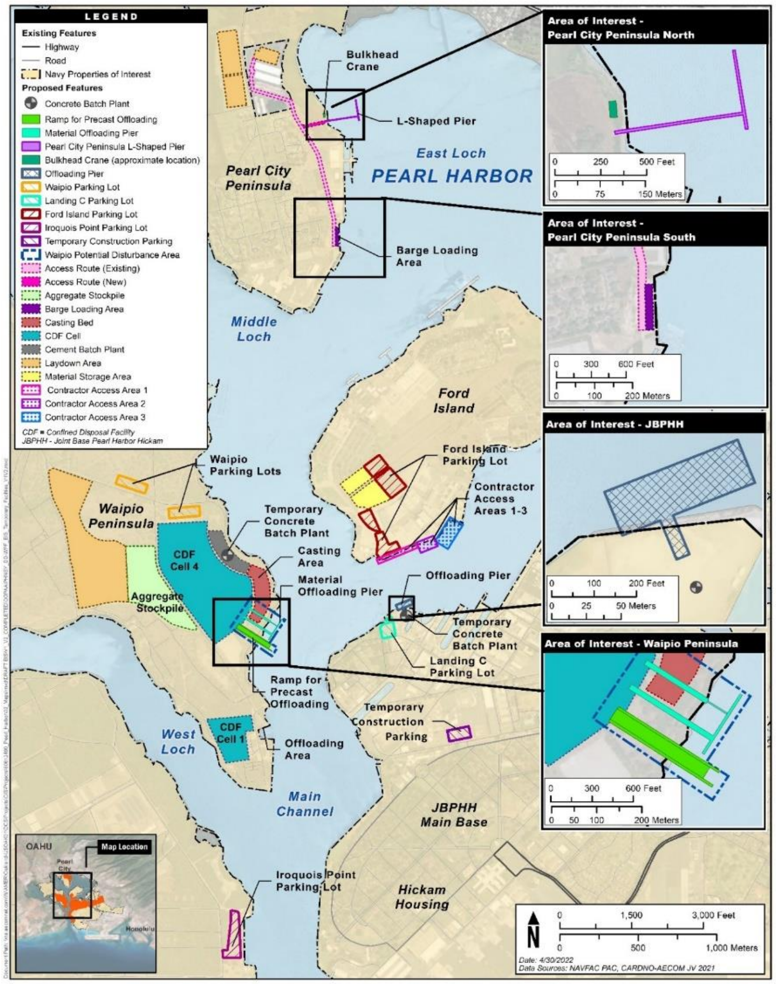

Figure 1. Constructions support facilities for the proposed action (*Source: NAVFAC 2021).*

Project Activities

This section consists of a broad overview of the proposed action; a more specific description can be found in the Enclosure at the end of this letter. The Navy proposes to replace DD3, to construct a WPF, and to construct other ancillary facilities at Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility (PHNSY and IMF) located at JBPHH. Construction-related actions include dredging, creating fast land (i.e., land above the high water line) by fill, installing temporary and new permanent in-water structures, upgrading or replacing existing in-water structures, demolishing existing upland structures, and constructing new upland facilities required to support extensive periodic maintenance of fast attack submarines. The purpose of this document is to evaluate the potential effects of constructing and operating the replacement dry dock and WPF on EFH.

The proposed action also includes building a WPF at PHNSY and IMF, including permanent ancillary facilities such as new power and utilities. The new WPF will be built on the site of DD3 and will service both DD5 and Dry Dock #2 (DD2). Construction and operation of DD5 and the WPF would occur in two distinct stages: Stage 1 comprises construction of an uncovered DD5 occurring first; followed by Stage 2 that includes the construction of the WPF. Five areas on JBPHH will be used to complete the proposed action (see Figure 1):

1) The PHNSY and IMF is where the permanent facility for servicing submarines will be built and some support elements for the DD and WPF, such as power and water lines, will extend to other parts of the base. A concrete batch plant, a pier for unloading materials, and construction crew parking will be temporarily established at PHNSY and IMF.

2) The WP site will be used as an area for dewatering and processing dredged material, staging and storing construction materials, fabricating concrete elements of DD5, construction crew parking, and a loading dock for materials and personnel going to the PHNSY and IMF construction site. Temporary structures, such as piers and a boat ramp that will be in place for several years will be built on the Main Channel shoreline of WP.

3) The PCP site will be used as an area for staging and storing construction materials, construction crew parking, and a loading dock for materials and personnel going to the PHNSY and IMF construction site. Temporary structures, such as a pier and a bulkhead for loading barges, that will be in place for several years will be built on the east shoreline of PCP.

4) The FI site will be used for construction crew parking and for staging and storing construction materials. The existing seaplane ramp would be used to load construction personnel for ferrying back and forth to the PHNSY and IMF construction site. In addition, wharf S369 on the southeast side of FI will be used to store barges during the in-water construction. Note: The Southern End Ford Island (SEFI) used to describe survey areas only.

5) The IP site on the western shoreline of the Main Channel east of Ewa Beach will be used for construction crew parking. A ferry would pick up construction personnel at the Explosive Ordnance Disposal (EOD) Small Boat Landing and move them to the PHNSY and IMF construction site.

6) The UML area will be used to store barges throughout the proposed action, with up to 48 barges using the existing mooring buoys that currently support the Naval Sea Systems Command (NAVSEA) inactive ship program. The UML currently supports inactive ship storage and some training activities, and the UML shoreline is relatively natural and undeveloped, with the exception of two piers at NAVSEA Inactive Ships On-site Maintenance Office.

Construction materials would be procured from on-island and off-island locations, and would be delivered by truck and/or barge to the four primary staging and laydown areas: the PHNSY and IMF, the WP, the PCP, and FI. However, with the exception of one open-ocean vessel trip to deliver the caisson, no other specifically-designated vessel deliveries will be required for the construction materials or equipment required in the proposed action. Materials would then move within JBPHH from these staging and laydown areas to the construction site. In-water activities such as dredging, pile driving or other construction actions will only occur at the PHNSY and IMF, the WP, and the PCP. The FI and IP landings would be used in the same manner in which they are used on a daily basis. Temporary structures would be in place for several years, but they would eventually be removed. In some cases, structures will be built for making DD5, removed, built again when construction of the WPF is executed, and removed again after that construction project is completed. Of the locations listed above, the following description of the action will describe the elements of the proposed action for each location separately. The IP will not be discussed except to provide information on the number of projected vessel trips that will be needed to transport personnel to and from the ramp or pier at those locations.

The proposed action described in the Navy's EFHA includes a description of the conceptual maximum extent for project footprints, temporary facilities, and laydown areas. These designs were conceived by a design contractor that considered construction methods and space that could be required for the project. Not yet under contract, separate construction contractors will each build DD5, the WPF, and their associated elements. Once awarded, the construction contractor will be able to identify efficiencies and other specific methods for accomplishing the design contractor's plans, which may or may not alter the footprint of support facilities, number of temporary structures, and laydown area.

Essential Fish Habitat

Effective March 11, 2019, the Western Pacific Fisheries Management Council (WPFMC) amended the Fishery Ecosystem Plans (FEP) for American Samoa, the Mariana Archipelago, and the Hawaiʻi Archipelago to reclassify thousands of Management Unit Species (MUS) as ecosystem component species. Under the changes, the number of MUS in the Hawaiʻi Archipelago was reduced to four (e.g., Bottomfish, Crustaceans, Precious Corals, and Pelagics); however, EFH designations largely remained the same. Currently in the Hawaiʻi Archipelago, the marine water column from the surface to a depth of 1,000 m from shoreline to the outer boundary of the Exclusive Economic Zone (200 nautical miles), and the seafloor from the shoreline out to a depth of 700 m around each of the Hawaiian Islands, have been designated as EFH. In Pearl Harbor, EFH is designated for the following MUS and life stages: eggs, larvae, juveniles, and adults of Bottomfish MUS (BMUS); eggs, larvae, juveniles, and adults of Crustacean MUS; and eggs, larvae, juveniles, and adults of Pelagic MUS (PMUS). Specific types of habitat considered as EFH include coral reef, patch reefs, hard substrate, artificial substrate, seagrass beds, soft substrate, mangrove, lagoon, estuarine, surge zone, deep-slope terraces and pelagic/open ocean.

While the Coral Reef Ecosystem MUS no longer exists, benthic substrate and habitat forming EFH (e.g., corals and seagrass, including corals growing on artificial substrate) remains designated in the nearshore coral reef ecosystem—including that in Pearl Harbor—for shallow stock complexes of Bottomfish (e.g., Uku: *Aprion virescens*) and Crustaceans (e.g., Kona crab; *Ranina ranina*) MUS. Specifically, the WPFMC has determined that EFH designated for the Hawaiʻi Bottomfish shallow stock complex (i.e., Uku) includes benthic or benthopelagic zones, including all bottom habitats, in depths from the surface to 240 m bounded by the official US baseline and 240 m isobaths. The WPFMC has also determined that benthic EFH designated for Hawaiʻi Crustaceans MUS (e.g., Kona crab) includes all of the bottom habitat from the shoreline to a depth of 100 m.

As a point of clarification, NMFS implements EFH designations as per their descriptions within FEPs and any relevant amendments. We do not litigate EFH designations during individual consultations based on historical information or recent species survey assessments gathered as part of an individual consultation. Rather, we follow the EFH designations that the WPFMC has determined. EFH designations can be refined and changed/updated with appropriate levels of scientific information through an MSA-defined process that is adhered to by the WPFMC, and coordinated with NMFS regional offices and science centers.

Baseline Condition

Located on the central south shore of Oʻahu, Hawaiʻi, Pearl Harbor is a large, coastal-plain estuary divided into three lochs that are remnant, drowned river valleys (Stearns 1985; Carlquist 1970). All lochs are joined together by a main entrance channel that connects the harbor with the open ocean. Since the beginning of the 20th century, Pearl Harbor has served as the primary location for US Naval operations in the Pacific and contains berthing and maintenance facilities (including piers, pilings, quay walls, and other shoreline hardscape structures constructed to support vessels of all sizes), which transformed not only the natural shoreline, but also the bathymetry when most of the flat harbor floor (HF) was dredged to accommodate deep-draft ship traffic (Dollar and Brock 2000). As the largest, landlocked estuarine body of water in Hawaiʻi, Pearl Harbor has a surface area of 8.1 square miles (21 km^2) and about 36 miles (58 km) of shoreline (Dollar and Brock 2000). Hydrographic survey data from 2016 reported an average water depth of 10.63 m (35.0 ft) throughout the harbor. Below we cover the baseline conditions for the action areas.

PHNSY and IMF: Substrate classification was ground-truthed in surveys that followed bathymetric data collection. Analysis of the bathymetric figures showed that the PHNSY and IMF survey area largely consisted of relatively flat and soft substrate in the dredged channel at water depths of 40–50 ft. There are numerous drag or scour furrows in the soft sediment. There is mixed hard bottom, or high relief, high rugosity substrates present directly offshore of DD3, and offshore and west of Bulkhead 1461 along the shoreline to Landing C (Neyland et al. 2020).

This survey area consisted of six prominent benthic strata types: HF, sloping bottom (SB), dredge cut (DC), coral patch (CP), pilings (PL), and marine railway (RR). The total area surveyed in the PHNSY and IMF included coral cover of 61.08 m^2 (657.46 ft^2). The survey estimated a total of 2,733 corals in the project footprint, and of these corals, 2,602 (20.65 m^2 [222.27 ft^2]) coral colonies are <10 cm in size (Neyland et al. 2020). There is a coral reef of the endemic finger coral, *Porites compressa*. These colonies generally consisted of a circular perimeter with a flattened top. The total area of the patch was approximately 33.0 m^2 (355 ft^2). Also present at this site are the following corals: *Leptastrea purpurea*, *Montipora capitata*, *M. patula*, *Pocillopora damicornis, Porites lobata, and P. compressa* (Neyland et al. 2020).

WP: Analysis of the bathymetric figures show that the WP survey area consisted of flat and soft substrate in the dredged channel at depths of 40–45 ft. This survey area was bound by a steep dredge cut that rises to a 100–200 ft wide bench along the shoreline. Bathymetry was not collected on the bench because water depths were too shallow for vessel navigation. The dredge cut is classified as natural (as opposed to artificial substrate) high relief with slopes greater than 30 degrees. Numerous drag or scour furrows are evident in the soft sediment directly offshore of Nevada Point. Other notable features, located in the southern end of the survey area, include a pipe trench and a 250 ft wide by 250 ft long inlet cut into the shoreline. This inlet has a moored barge acting as a wharf and is an active construction staging area, primarily for maintenance dredging and the CERCLA Pearl Harbor sediments remediation activities. The inlet depth measured 20–25 ft. and boulders and debris are evident on the seafloor (Neyland et al. 2020).

This survey area consisted of four prominent benthic strata types: HF, SB, DC, and SF. The total area surveyed in WP included coral cover of 8.40 m^2 (90.42 ft^2). The survey estimated a total of 703 corals in the project footprint, and of these corals, 690 (6.48 m^2 [69.75 ft^2]) coral colonies are <10 cm in size (Neyland et al. 2020). The following corals were detected at this site: *L. purpurea*, *M. capitata*, *M. patula,* and *P. damicornis.*

PCP: Upper East Loch off the PCP was surveyed in 2020 using single beam sonar. Analysis of the PCP bathymetric data show that the PCP survey area largely consisted of a shallow bank area (silt and clay), and flat harbor floor. Smaller portions of the area consisted of riprap shoreline (mixed rock and unconsolidated material) and the sloping dredge cut wall (Neyland et al. 2020). Since the habitats are so similar, the riprap shoreline, shallow bank and sloping bottom are conceptually considered as one strata type.

This survey area consisted of four prominent benthic strata types: HF, SB, DC, and wharf structures. The total area surveyed in PCP included coral cover of 5.65 m^2 (60.82 ft^2). The survey estimated a total of 7 corals in the project footprint, and of these corals, 6 (0.05 m^2 [0.59 ft^2]) coral colonies are <10 cm in size (Neyland et al. 2020). The following corals were detected at this site: *L. purpurea, P. damicornis,* and *P. compressa.*

SEFI: The SEFI survey area extends approximately 4,000 ft around the southern tip of Ford Island. Analysis of the bathymetric figures show that the SEFI area consisted of flat harbor floor (accumulated silty sand sediment), dredge cut wall, sloping bottom and a submerged nearshore shelf (mix of sand, coral rubble and shell hash). Macroalgae and sponges were the dominant biotic cover throughout this habitat. An additional area of FI was assessed in a reconnaissance survey in April 2022 by the Naval Facilities Engineering Systems Command (NAVFAC) Pacific (PAC) Marine Resources team, revealing the majority of the area east of the historic seaplane ramp consists of soft harbor floor in front of or under existing seawalls and pier-supported structures. The area of interest for pile clusters in the proposed action falls in Front of Foxtrot 1 Pier, and would not be attached to the pier. The soft bottom habitat would be where the footprint of the pile clusters would be situated.

This survey area is characterized by a relatively flat dredge basin with soft substrate at a depth of 40 to 45 ft (12 to 14 m). The dredge basin is bounded by a steep DC. Along the southwestern part of the SEFI survey area, the shoreline is embayed and there is a relatively wide, flat SF that was too shallow for vessel navigation during the field effort. In Front of Foxtrot 1 Pier at Ford Island, the habitat is entirely the HF. Although there are man-made structures on the shoreline of Ford Island at that location, the proposed action will not affect or be attached to those structures.

The total area surveyed in SEFI included coral cover of 32.63 m^2 (351.23 ft^2). The survey estimated a total of 2,417 corals on natural surfaces in the project footprint, and of these corals, 2,310 (18.14 m^2 [195.26 ft^2]) coral colonies are <10 cm in size (Neyland et al. 2020). The following corals were detected at this site: *L. purpurea, M. capitata, M. patula, P. damicornis,* and *P. compressa.*

IP: At the time the surveys specific to support the SIOP project were contracted (2020), neither the IP nor UML were part of the project area. However, both had been surveyed during the years before (2017-2019), and some habitat data are available. The IP area consisted of three regions on the west side of the Pearl Harbor main channel: the northernmost region extends 650 ft. (198 m) along the shoreline directly offshore of IP; the central region is offshore of the IP Boat Landing; and the southernmost region extends 820 ft (250 m) across the entrance of the lagoon just north of Hammer Point. Analysis of the IP rapid assessment survey shows that in the north end of the survey area, the benthic habitat consists of limestone platform reef covered in rubble and shell hash, the central region consists of soft sediment, and the southern end offshore of the entrance to the Lagoon consists of silty sand. In 2019, the Navy conducted benthic surveys in support of the JBPHH Integrated Natural Resources Management Plan and not specifically for the proposed action. From these survey results at IP, *L. purpurea*, *M. capitata*, and *P. damicornis* were the only species of hard corals observed, all of which were classified as rare. Most coral colonies in this area were small, isolated colonies less than 0.6 ft (18 cm) in diameter (NAVFAC PAC 2020). During the rapid assessment survey of IP, 260 images were cataloged from screenshots of GoPro, Inc. videos. Of these images, 84% did not include any corals, 15% included one species, and 1% included two species. Analysis of the images showed that *M. capitata* occurred in 14% of the images while *L. purpurea* and *P. meandrina* each occurred in 1.5%. Other size-frequency data for the corals in this area are not available at this time.

UML: The UML survey area starts on the east shore of the Waipio Peninsula west of the submarine degaussing facility, at the junction of East and Middle Loch, and extends approximately 2,920 m^2 to the northern most part of the loch. About three quarters of the west shore of the Pearl City Peninsula, up to the military housing, was also included in the UML survey. Resources in UML were documented in late 2019. The nearshore zone consisted of a gently sloping shelf that terminated in a steep dredge cut that extended to the harbor floor. In 2018, benthic biological surveys were conducted to determine the presence and extent of seagrass and corals within that footprint, along the perimeter, and on the adjacent shoreline margins surrounding the UML. No seagrass or hard coral areas were found in the basin of UML. Within the basin, the seafloor was almost 100% silt and the only hard substrates were pieces of moorings or debris. The basin is low reflectivity (of sonar signals), essentially featureless, flat silty seafloor with moorings and debris interspersed throughout. No seagrass or hard coral were found along the perimeter of UML, which is a steep slope created by previous dredge cuts. Seagrass and hard coral were uncommon, sparse, and patchy on the adjacent shoreline margins surrounding UML. The only coral species observed was *L. purpurea*, and most corals were found on the western side of the Loch (Makai side). The dominant benthic biota on the shoreline margins surrounding the UML were masses of macroalgae on mud and shell hash, with infrequent rubble interspersed. Dominant macroalgae genera were *Gracilaria*, *Hypnea*, and *Caulerpa*. Numerous species of sponges were also observed where there was hard substrate. The seafloor was covered in red terrigenous mud directly off the stream mouths. Higher reflectivity anthropogenic features were found; the basin contained a large amount of debris, anchors and lines, buoys, and moorings. *Halymenia hawaiiana* was found in seven small patches on five transects. In all cases, the seagrass occurred as relatively discrete patches growing on the sediment surface, rather than with the rhizomes mostly buried in what would be considered a “meadow”. Most of the seagrass observations were near the shoreward sides of the transects, and in areas where benthic algae were not abundant. Seagrass patches were less than 35 m^2 (377 ft^2) was observed in total. The area has characteristics of a community under chronic stress, and evidence indicates turbidity is the likely driver (Department of the Navy [DON] 2018). UML was dredged in 2019 only in unconsolidated soft sediment, avoiding the extant biota.

Water Quality Monitoring

The Navy has not provided a detailed water quality monitoring plan. The Navy is in the process of submitting their application for the Clean Water Act, 401 WQC with the State of Hawai‘i, DOH. This application would yield the AMAP, which would detail the phasing, types of samples to be collected, and frequency of collection.

US Environmental Protection Agency’s Dredge Disposal Site

The South Oʻahu Ocean Dredged Material Disposal Site (SOODMDS) disposal area is located between 4 and 6 miles off the south shore of Māmala Bay, Oʻahu; it is 2.01 square miles on the shelf-slope junction in water 1,300- to 1,500-ft deep. The transit corridor has not been defined by the Navy. NMFS assumes that it will extend from the entrance channel of Pearl Harbor seaward and through increasing depths along a west/south west direction to the center of the SOODMDS. NMFS assumes that the transit corridor will assume a straight path between the harbor and ocean disposal site, with any number of paths within the corridor. The bottom terrain of the SOODMDS is a sloping plain, dropping approximately 75 m across the 2,000 m site. Native sediment is primarily silty sand. Navy surveys along the entrance of the Pearl Harbor Entrance Channel indicate the presence corals on both the eastern and western flanks of the channel; the channel floor is primarily unconsolidated sediment, consistent with information from the NOAA, National Centers for Coastal Ocean Science benthic habitat maps (see Battista et al. 2007).

Ecological Roles

The principal benthic organisms provide ecological services (e.g., water filtration and maintaining balanced nutrient concentrations) and provide physical habitat at both micro- and macro-scales. At a micro scale, the shape of benthic organisms change water movement, which can influence the settlement (McDougall 1943) and behavior of larvae and the availability of planktonic prey (Williams 1964). Sessile organisms provide refuge from predators, particularly for larvae and small sized species (Russ 1980; Sutherland 1974). Sessile organisms provide new ecological niches increasing species diversity. At a macro-scale, corals are the primary habitat builders in the coral reef ecosystem that benefit juvenile, sub-adult, and adult life stages of the MUS that utilize designated EFH. The morphology, shape, and composite features of benthic organisms can also influence feeding strategies of these MUS.

Adverse Effects

The proposed Pearl Harbor SIOP project requires in-water work that will result in substantial adverse effects to EFH, including corals. There will be the loss of hard and soft bottom habitat, corals, the successional filter feeding community, and negative impacts to water quality. Potential effects from the proposed action may result from exposure to the following environmental stressors: physical damage, sedimentation, nutrient loading, introduction of chemical contaminants, invasive species, reduced irradiance, noise, hypoxia, and artificial light.

The Navy expects that there will be substantial adverse effects to corals and are proposing mitigation to reduce these impacts, including coral relocation and habitat restoration. Approximately 3,162 corals (most < 10 cm), 17,940 m^2 of hard bottom substrate, and 56,160 m^2 of soft substrate will be unavoidably lost. The Navy proposes to relocate and minimize impacts to 153 corals, remove invasive species from approximately 37,000 m^2 hard bottom habitat near the entrance channel to restore substrate for potential future coral settlement, and restore 1,600 m^2 of benthic habitat at the Ford Island coral relocation site. The HEA results determined a combined 1,705.97 m^2 is recommended for offsetting the unavoidable loss of corals.

<u>Total Injured Area by Site</u>

The EFHA provides a depth of estimates for impacts by site and habitat strata. Below, we only provide the total impact and any impacts to corals.

PHNSY and IMF: Dredging and installation of the offloading pier will result in the removal of 27,775 m^2 of benthic substrate and 33 m^2 of *P. compressa* coral; a total of 1,792 corals will be affected. The portion of substrate that is hard bottom is not clear from the EFHA. Dredging will result in the loss or removal of 1,679 coral colonies occurring on natural substrates. The majority of the loss will occur from the SB strata (n = 1,439), with fewer losses occurring in the DC (n = 203) and the CP (n = 37) strata. The vast majority of the coral colonies that will be impacted (n = 1,679; 93.7 percent of total coral colonies) are <10 cm in size, although there are some notable exceptions, including the aforementioned *P. compressa* area, particularly within the CP strata. To minimize the impact from the proposed action, corals of suitable size (>10 cm) and type (non-encrusting) for translocation (n = 113) will be relocated from the natural substrates that will be impacted prior to the commencement of any construction activity. Dredging activities at PHNSY and IMF will result in the loss of approximately 5,349 m^2 (57,576 ft^2) of benthic substrate supporting sponges, 1,449 m^2 (15,597 ft^2) of benthic substrate supporting other sessile invertebrates (aside from sponges and corals), and 1,084 m^2 (11,668 ft^2) of algal habitat.

The removal of the marine railway and the pilings that support the crane maintenance pier and small support structures will affect an estimated 941 coral colonies (678 from the marine railway and 263 from the pilings). The vast majority of the coral colonies that will be impacted (n = 923; 98.1 percent of total coral colonies) are <10 cm in size or of a morphology that is not suitable for translocation. Given the amount of time these structures have been in place, this indicates that the corals either colonized the structures fairly recently or, more likely, that the structures and surrounding environment provide suboptimal conditions for coral growth and development. To minimize the impact from the proposed action, corals of suitable size (>10 cm) and type (non-encrusting) for translocation (n = 18) will be relocated from the artificial structures prior to the commencement of any construction activity.

Demolition of the artificial structures at the PHNSY and IMF will result in the loss of approximately 136 m^2 (1,464 ft^2) of habitat currently supporting sponges, 5 m^2 (59 ft^2) of habitat currently supporting sessile invertebrates other than corals and sponges, and 24 m^2 (258 ft^2) of habitat currently supporting algae.

The most substantial of the new in-water structures being constructed at PHNSY and IMF would be the new rock revetment wall located on the western side of DD5. This structure will consist of 95,000 cubic yards (CY) (76,632 m^3) of cleaned rock laid at a slope from the top of the shoreline to the seafloor and occupying an area of 10,766 m^2 (115,887 ft^2).

In addition to the rock revetment, a temporary offloading pier will also be constructed to the west of DD5. The pier will be approximately 3,841 m^2 (41,347 ft^2) in size and will fit entirely on top of the rock revetment. As this pier will be installed after the construction of the rock revetment, no additional site preparation or impacts to the benthic environment are anticipated. The pier will be an open pile-supported pier allowing water circulation beneath. The pier is only intended to support DD5 construction; it will be removed at the completion of the construction phase of the project.

WP: The WP project area contains four prominent benthic strata types: flat HF, SF, SB, and DC. Activities from dredging and ramp replacement would result in the loss of 19,006 m^2 of bottom substrate. Dredging activities, if they occur to the maximum extent, will result in the loss of approximately 2,363 m^2 (25,435 ft^2) of benthic habitat supporting sponges, 14 m^2 (151 ft^2) of benthic habitat supporting other sessile invertebrates, and about 4,768 m^2 (51,322 ft^2) of benthic habitat supporting algae. Approximately 350 corals would be affected. The majority of the loss will occur from the SB strata (n = 281), with fewer losses occurring in the DC (n = 19) and the SF (n = 51) strata. Similar to PHNSY and IMP, the vast majority of the coral colonies that will be impacted (n = 338; 98.0 percent of total coral colonies) are <10 cm in size, although there are some notable exceptions of corals up to approximately 40 to 80 mm in size found predominantly within the SB strata, and a single specimen occurring in the DC strata. To minimize the impact from the proposed action, corals of suitable size (>10 cm) and type (non-encrusting) for translocation (n = 7) will be relocated from the natural substrates that will be impacted prior to the commencement of any construction activity.

At the ramp, approximately 7,017 m^2 (75,527 ft^2) would be covered and inaccessible for the duration of the construction phase of the project (65 months). Of this, 6,906 m^2 (74,333 ft^2) would be previously dredged, should dredging be deemed necessary. An additional 3,989 m^2 (42,937 ft^2) of previously undredged habitat would be impacted by the placement of the ramp, although most of this area is composed of the HF stratum (2,431 m^2 [26,167 ft^2]). The impact to the remaining 1,588 m^2 (17,093 ft^2) of previously undredged SB and DC strata would result in the loss of approximately 353 coral colonies. The majority of the loss will occur from the SB strata (n = 350), with fewer losses occurring in the DC (n = 3) strata. Similar to PHNSY and IMF, the vast majority of the coral colonies that will be impacted (n = 347; 98.3 percent of total coral colonies) are less than 10 cm. To minimize the impact from the proposed action, corals of suitable size (>10 cm) and type (non-encrusting) for translocation (n = 6) will be relocated from the natural substrates that will be impacted prior to the commencement of any construction activity. The ramp will have long-term adverse effects.

The finger piers would shade 3,167 m^2 (34,094 ft^2) reducing potential of any coral growth. Piles will occupy a combined footprint of 385 m^2 (4,144 ft^2). This is an overly conservative estimate as only a fraction of the piles will be driven in the water. As the piles would be in place for up to 65 months, there would be a reduction in the amount of EFH in the form of benthic substrate within the immediate footprint of each of the piles until such time as the piles are removed. Shading of the seafloor under the material loading pier and the gantry crane finger piers would typically discourage the growth of vegetation and coral. Overall the finger piers would have long-term adverse effects.

PCP: There are four habitat strata types: flat HF, SB “shallow bank”, DC, and wharf structures. Dredging will remove a small number of corals and the successional filter feeding community. Dredging activities at PCP will result in the loss of approximately 591 m^2 (6,361 ft^2) of benthic habitat supporting sponges, 446 m^2 (4,790 ft^2) of benthic habitat supporting other sessile invertebrates, 1,107 m^2 (11,916 ft^2) of benthic habitat supporting turf algae, and 1,452 m^2 (15,629 ft^2) of benthic habitat supporting all other algae. Dredging activities that may potentially occur at PCP will result in the loss of a total of only seven coral colonies restricted to the sloping bottom strata, all but one being <10 cm in size, which will be relocated.

The temporary L-shaped pier at PCP would consist of 41, 36-inch steel piles that would be installed during construction. Only 16 of the piles would be installed outside of the dredge footprint resulting in the long-term loss (65 months) of benthic habitat serving as EFH in the SB strata (10.5 m^2 [113 ft^2]) within the immediate footprint of the piles.

SEFI: This site consists of HF, SB, SF, and Artificial Substrate including a concrete platform and pilings. The only construction-related activity that may result in a minor loss of EFH at SEFI is the construction of the Contractor Access #3 for temporary barge mooring and storage, which consists of creating up to seven pile clusters made up of five to 18 precast concrete pilings each. All of the impacts will be to the HF stratum and will, therefore, have minimal impacts to any living biota and no impacts to coral. To be conservative, the estimated area of impact is based on pile clusters consisting of 18 pilings each with an additional 3-m buffer area of assumed disturbance around each of the clusters. As a result, it is assumed that up to 25,247 m^2 (271,756 ft^2) of the flat HF stratum will be temporarily converted to artificial structure for the duration of the construction phase (i.e., 65 months). Following the construction phase, all of the pile clusters will be removed, returning the habitat back to soft substrate and allowing it to recover back to its pre-disturbance state over a short period of time.

Stressors

Physical Damage/Removal (physical stressor): Complete removal of the benthic successional community (including filter feeders) living mostly in soft and or unconsolidated substrate may reduce larval connectivity through habitat fragmentation and the loss of brood stock (Hughes et al. 2005). Removal would also adversely affect the quality of substrate and water column EFH by reducing sediment bioturbation, the flow of water, and likely the balance of both dissolved and particulate nutrients and organic matter (Petersen and Riisgård 1992; Randløv and Riisgård 1979) until the community recovers to pre-dredge levels.

Physical damage to sessile organisms, including corals from dredging activities, results in breakage or dislocation (i.e., mortality), but can also result in sub-lethal tissue abrasion. Corals, which are primarily responsible for the structural complexity of coral reefs, are particularly vulnerable to physical damage because their slow-growing carbonate skeleton is relatively brittle and their polyps are easily damaged. In general, lobate, encrusting, and other massive colony morphologies tend to withstand breakage better than foliose, table, plating, and branching morphologies; more fragile forms tend to have higher growth rates (Rützler 2001). Reduction of topographic complexity in the habitats of the coral reef ecosystem reduces biodiversity and productivity (Alvarez-Filip et al. 2009).

Sedimentation (pollution stressor): Suspended sediment from dredging and excavation, installation of revetment materials, anchoring, pile driving and other activities can elicit short- and long-term responses from aquatic organisms depending on the quantity, quality, and duration of suspended sediment exposure (Kjelland et al. 2015). Coral reef organisms are easily smothered by sediment and can experience both physiological and lethal responses to concentrations below 10 milligrams (mg)/cm^2/day and 10 mg/Liter (L) (Tuttle et al. 2020). Adverse effects from deposited sediment can occur as low as 1 mg/cm^2/day for larvae and 4.9 mg/cm^2/day for adult tissue (Tuttle et al. 2020). Suspended sediment levels of 10 mg/L can lead to reduced growth rates and levels of 3.2 mg/L can cause bleaching and tissue mortality (Tuttle et al. 2020), although corals show considerable interspecific variability. Sedimentation can also reduce photosynthetic rates (Philipp and Fabricius 2003), disrupt polyp gas exchange, inhibit nutrient acquisition (Richmond 1996), cause tissue damage, reduce recruitment success (Hodgson 1990; Gilmour 1999), and increase metabolic costs due to enhanced mucus production (Telesnicki and Goldberg 1995).

Nutrient Loading (pollution stressor): Nutrient loading may occur due to the dredging of sediments and continued development, hardening, and urbanization of the associated nearby watersheds. Coral reef ecosystems thrive in oligotrophic (i.e., nutrient-poor) waters (D'Elia and Wiebe 1990), and nutrient enrichment has been shown to negatively affect coral reef ecosystems (Pastorok and Bilyard 1985; Stambler et al. 1991; Dubinsky and Stambler 1996). Adverse effects of nutrient enrichment vary by coral species, type of nutrient input, and the history of the exposed individuals or population. Growth rates of macroalgae are constrained by nutrient limitation and herbivore grazing, thereby preventing algae from overgrowing and killing corals under normal conditions (Carpenter 1986; Lewis 1986; Birkeland 1988; Hay 1991; Littler et al. 1991; Lapointe 1997). Exposure to elevated nutrients can cause a shift to an assemblage dominated by algae (Lapointe 1997; Edinger et al. 2000; Dudgeon et al. 2010). Eutrophication has been reported to cause subtle physiological changes in parameters such as coral growth, skeletal tensile strength, reproduction (Stambler et al. 1991; Bucher and Harrison 2002; Cox and Ward 2002; Dunn et al. 2012), and suppressed calcification rates (Kinsey and Davies 1979; Marubini and Davies 1996). Corals exposed to elevated nutrients often show lower larvae and planula production, impaired planula settlement, decreased gonadal index and fertilization rates, and higher rates of irregular embryos and hermaphroditism (Koop et al. 2001; Loya et al. 2001). Nutrient enrichment has been implicated in reduced ability to withstand disease (Bruno et al. 2003; Voss and Richardson 2006; Harvell et al. 2007) and may increase susceptibility to temperature stress, thereby increasing the chances of bleaching (Wiedenmann et al. 2012).

Chemical Contamination (pollution stressor): Chemical pollutants can have a variety of lethal and sublethal effects on habitat-forming marine organisms, including alteration of growth, interference with reproduction, disruption of metabolic processes, and changes in behavior. These adverse effects can cascade through ecosystems, altering species composition and ecosystem functions and services. Some pollutants are environmentally persistent and can take years or even decades to biodegrade, and others can bioaccumulate and biomagnify through the food chain, eventually posing a direct threat to human health. Many contaminants readily attach to sediment particles and are transported into the ocean where they become entrained in the bottom sediment of estuaries, reefs, and potentially deeper ocean ecosystems. Once trapped in sediment pore water, they can continue to flux into the overlying water column, creating a persistent source of contamination long after the initial input has ended, especially in the sediment of many industrialized bays and watersheds.

Dredging can release contaminants trapped in layers of accumulated sediment and pore water at concentrated levels, sometimes referred to as "black water." Petroleum contamination can adversely affect coral, with results including mortality, inhibition of reproduction, reduced calcium deposition, alteration of physiological processes, tissue loss, and reduced carbon fixation (Turner and Renegar 2017).

Sediment grain size is one of the main factors governing heavy metal contamination in the particulate fraction (Yao et al. 2015). The concentration of heavy metals can increase with decreasing particle size because the soil character of smaller particle size fractions (i.e., clays and silt) bind more contaminants due to the presence of minerals, organic matter, and oxides (Semlali et al. 2001; Cai et al. 2002; Ljung et al. 2006; Yao et al. 2015).

Invasive Species (biological stressor): Introduced species are organisms that have been moved, intentionally or unintentionally, into areas where they do not naturally occur. Species can be introduced to new biogeographies, typically via transport on vessel hulls or in ballast water, such as those that may be used in the proposed dredging operations. Invasive species rapidly increase in abundance to the point that they come to dominate their new environment, creating adverse ecological effects to other species of the ecosystem and the functions and services it may provide (Goldberg and Wilkinson 2004). Nearly 500 introduced species have been identified in Hawaiʻi (Randall 1987; Diaz and Rosenberg 1995 Coles and Eldredge 2002; Carlton and Eldredge 2009). Invasive species can decrease species diversity, change trophic structure, and diminish physical structure, but adverse effects are highly variable and species-specific.

Irradiance (environmental stressor): Staging of the mechanical dredge barge platform, scow, tugs, support vessels, piers, and installation of turbidity curtains for extended time periods (i.e., weeks to months) will temporarily reduce light attenuation through the water column, varying spatially as the sun transits its daily arc. Turbidity from dredging without full-length turbidity curtains may adversely affect water column and benthic EFH, including corals, by decreasing water clarity and smothering, respectively. Reduced irradiance generally can reduce photosynthetic rates of seagrass and corals (Josselyn et al. 1986; Richmond 1993), mask coral spawning cues, and reduce coral fecundity (Erftemeijer et al. 2012). When this stress is acute, photosynthetic organisms receive less energy for carbon fixation, potentially impairing a host of metabolic processes at the individual scale.

Noise (environmental stressor): Dredging will expose individual habitat-forming marine organisms to sound and vibratory stressors. Behavioral changes can occur, resulting in animals leaving feeding or reproduction grounds (Slabbekoorn et al. 2010) or becoming more susceptible to mortality through decreased predator-avoidance responses (Simpson et al. 2016). Less intense but chronic noise, such as that produced by continuous boating, can cause a general increase in background noise over a large area. Although not likely to kill organisms, chronic noise can mask biologically important sounds and alter the natural soundscape, cause hearing loss, and/or have an adverse effect on an organism's stress levels and immune system. Corals exposed to enhanced anthropogenic noise, including that from vessel engines, may have disrupted settlement of their planulae (Lecchini et al. 2018).

Hypoxia (environmental stressor): Dredging often releases pore water from accumulated sediments, which is oxygen-poor (Erftemeijer et al. 2012). The condition of low dissolved oxygen is known as hypoxia, while the complete absence of oxygen is called anoxia. When dissolved oxygen concentrations decline below the point that sustains most marine life (i.e., 2-3 mg/L), growth and feeding of marine animals is reduced. If low oxygen conditions persist, individual fitness can become compromised (Baden et al. 1990a; Baden et al. 1990b; Forbes and Lopez 1990; Das and Stickle 1994; Petersen and Pihl 1995; Brown 1997; Wu 2002). Hypoxic conditions can also increase embryo failure and larval mortality (Wang and Widdows 1991; Baker and Mann 1992; Keckeis et al. 1996; Wu et al. 2003). Crustaceans and fish appear to be particularly susceptible to hypoxic conditions, and mollusks and non-coral cnidarians appear most tolerant (Vaquer-Sunyer and Duarte 2008). Avoidance of hypoxic conditions can make organisms more vulnerable to predation (Johnson et al. 1984; Diaz et al. 1992; Pihl et al. 1992; Nilsson and Rosenberg 1994; Hervant et al. 1996; Sandberg et al. 1996; Sandberg 1997; Abrahams et al. 2007; Altieri 2008; Bertrand et al. 2008;). At a population and ecosystem scale, sensitive species may be eliminated in hypoxic areas, thereby causing changes in species composition of benthic, fish, and phytoplankton assemblages. Decreases in species diversity and species richness are well documented in hypoxic areas, and changes to food web structure and functional groups have also been reported in areas with low oxygen availability (Brown 1997; Altieri 2008).

Artificial Light (environmental stressor): Emerging research suggests that light pollution can cause delayed gametogenesis and unsynchronized gamete release in some species of corals (Ayalon et al. 2021). The proposed project expects to utilize light during nighttime activities and the new production facility will be lit at night for the extent of its functional duration.

Applicant-proposed Avoidance and Minimization Measures

BMPs will be implemented to avoid and minimize impacts to the marine environment. The following BMPs would be implemented:

- All anchors (e.g., for vessels and silt curtains) are set on hard or soft, sandy bottom void of corals and seagrass, and that chosen anchor locations take into consideration damage that could occur from the anchor chain if the vessel swings due to currents or tides. All barge and anchor system (e.g. anchors, chains, moorings, etc.) shall be properly installed to avoid damaging bottom habitat. Systems will be inspected daily and monitored over time to assess the integrity and potential damages. If practicable, all intertidal work will be conducted at low and/or slack tides.
- A Stormwater Pollution Prevention Plan (SWPPP) will be developed by the construction contractor, once selected, to reduce on-site erosion and off-site sedimentation. The SWPPP will

include, at a minimum, Silt socks, filter fabric, or an approved equivalent will be used around all topside construction located near waters of the US.

- A plan to prevent trash and debris from entering the marine environment during the Project. The plan will be implemented throughout construction of the Project.
- An oil spill contingency plan to control and clean spilled petroleum products and other toxic materials. The plan will be implemented throughout construction of the Project.
    - Oil or other hazardous substances will be prevented from seeping into the ground or entering any drainage inlet or local bodies of water.
    - When applicable, all temporary fuel oil or petroleum storage tanks will be surrounded with a temporary berm of sufficient size and strength to contain the contents of the tanks (plus 10% freeboard for precipitation) in the event of an accidental release.
    - Fueling of Project-related vehicles and equipment will take place at least 50 ft. (15.2 m) away from the water and within a containment area, preferably over an impervious surface. With respect to equipment (e.g., crane on the barge) that cannot be fueled on land, spill prevention booms will be employed to contain potential spills. All fuel spilled will be cleaned immediately.
- Lubricants and excess oil will be disposed of in accordance with applicable federal, territory, and local regulations, laws, ordinances, and permits.
- Appropriate materials to contain and clean potential spills will be stored at the work site and be readily available.
- All Project-related materials and equipment placed in the water will be free of pollutants.
- Pre-work inspections of heavy equipment for cleanliness and leaks will be conducted daily, with all heavy equipment operations postponed or halted until leaks are repaired and equipment is cleaned.
- A temporary floating debris boom will be installed around all work located below the high tide line. The location of the boom will shift as in-water work shifts during Project phasing.
- Turbidity and siltation from project-related work shall be minimized and contained through the appropriate use of erosion control practices, effective silt containment devices, and the curtailment of work during adverse weather and tidal/flow conditions.
    - During all in-water or over-water work, silt curtains will completely enclose the work area to the maximum extent practicable. Silt containment devices will isolate and contain the in-water work area and prevent turbid water from flowing outside the curtain limits.
    - Silt curtains will be monitored for damage, dislocation, or gaps, and immediately repaired where any such damage or issues are detected.
    - Installment of silt curtains around the project footprint shall be closely monitored. Once installed, silt curtains shall be deployed until the visible turbidity plume has dissipated.
    - If a plume is observed outside of the silt curtains, corrective action will be taken immediately. The Project Manager will inform the Action Proponent immediately if a plume is observed.
- As practicable, work will be conducted during calm sea states with work stoppages during high surf, winds, and currents. In the event of approaching foul weather (i.e., tropical storms and

hurricanes), equipment will be either removed from the Project site or adequately secured. Hurricane season in the Pacific is from 1 June to 30 November, however tropical storms can and do occur year round. Hawaiʻi utilizes the National Weather System's warning and watch advisories, and Navy Region Hawaiʻi adheres to the following Condition of Readiness (COR) Levels to forecast destructive force winds (50 mph):

- COR V: Lowest condition of hurricane readiness; destructive force winds are not expected.
- COR IV: first condition of heightened hurricane readiness; within 72 hours.
- COR III: within 48 hours.
- COR II: within 24 hours.
- COR I: within 12 hours.

In order to provide 48 hours leeway preparation, work activities will immediately begin the appropriate removal and/or securement of all in water equipment, vessels and barges once a COR III is triggered. Once post storm activities permit a safe assessment of equipment and conditions of the project sites, as feasible, that will be evaluated for a safe return to work providing reports of any additional adverse storm impacts.

- The portions of the equipment that enter the water will be clean and free of pollutants, including AIS. All vessels and equipment (including barges and dredging equipment) will be free from fouling organisms before entering Hawaii's coastal waters. A biofouling management plan will be developed for all vessels entering Hawaii waters.
- The Project Manager and the heavy equipment operator will perform daily pre-work equipment inspections for cleanliness and leaks. All heavy equipment operations will be postponed or halted should a leak be detected, and will not proceed until the leak is repaired and equipment cleaned.
- Prior to commencing in-water work, the Navy, contractor, or other shall ensure that all contracted vessels and barges complete an AIS risk assessment that meets the biosecurity standards defined by the Navy and the State of Hawaiʻi.
- For all in-water activities that require staging materials in the marine environment and/or be supported by divers (e.g. removing the marine railway, etc.), the Navy will ensure that these activities avoid any unnecessary contact with marine organisms and that divers also avoid exposing corals directly or indirectly to toxicopathological agents.
- The Navy and NMFS will be notified immediately in the event a vessel is grounded and/or abandoned during the proposed action. Depending on the action, vessels will wait at a safe distance in deeper waters after deploying personnel overboard to avoid anchoring.
- Established moorings will be used to the greatest extent practicable.
- Anchors will be routinely monitored for slippage by the vessel crew and watch will be maintained when personnel are onboard.
- During in-water pile driving activities, a soft start procedure would be used for impact pile driving at the beginning of each day's in-water pile driving activity or anytime that pile driving has ceased for more than 30 minutes. The soft start is an approach used to provide a warning

pulse from the pile driver so that animals in the proximity have a chance to leave the area prior to the pile driver operating at full capacity, thereby exposing fewer animals to loud underwater sounds. The contractor shall provide an initial set of strikes from the impact hammer at reduced energy, followed by a 30-second waiting period, followed by two subsequent sets of strikes.

- If practical, vibratory hammering and/or the use of a cap shall be used to minimize the impact of noise on marine species. Where feasible, measures shall be implemented that attenuate the sound or minimize impacts to aquatic resources during pile installation.
- When practicable, environmental clamshell buckets shall be utilized for mechanical dredging.
- It shall be ensured that all concrete grout, cement, and sealant used are non-toxic and non-hazardous to aquatic organisms.
- In order to reduce the introduction of Invasive Species:
    - Prior to mobilizing, it shall be ensured that all activities and construction equipment, ballast, and vessel hulls do not pose a risk of introducing new invasive species and shall not increase abundance of those invasive species present at the project location.
- Floating work platforms shall be oriented to minimize shading organisms on natural and artificial substrates to the greatest extent practicable. This may occur by allowing for the path of the sun to cross perpendicular to the length of the platform to reduce the duration of shading, thereby allowing light into areas under barges and work platforms.
- During DD5 operation, the following BMPs will be implemented to protect water quality during dry dock evolutions:
    - There will be no discharge of oils, fuels, or chemicals to surface waters, or onto land where there is a potential for re-entry into surface waters. Fuel hoses, oil drums, oil or fuel transfer valves, fittings, etc., will be checked regularly for leaks. Materials will be maintained and stored properly to prevent spills.
    - No cleaning chemicals or solvents will be discharged to ground or surface waters.
    - Dry docks will be swept to a broom clean condition and inspected prior to flooding.
    - Third-party inspection of dry dock cleaning will occur prior to flooding; this includes inspecting the dock for general cleanliness and inspecting the dry dock for any debris or materials that may become dislodged due to flooding.
    - Prior to flooding, Environmental Staff inspects the dock for general cleanliness and the Docking Officer and Dockmaster inspect the dock for debris and anything that may become dislodged due to flooding, (i.e., deteriorated concrete or piping along the dry dock walls).
    - Minimize caisson off period, to the extent practicable.
    - Routine maintenance and checks of all bubble screens.
    - Routine inspection, at least annually, to ensure dry dock sumps and outfalls are cleaned (i.e., sediment removal), as necessary.
- The following BMPs will avoid or minimize entrainment:
    - To minimize entry of fish into the dry dock, an air curtain shall be used around the dry dock to prevent entrainment of fish resulting from entering the dry dock; and

- ○ The air curtain will be permanently installed within the dry dock near or within the caisson seat to minimize the number of marine species entering the dry dock.
- ○ If any marine species is entrained, shipyard staff will immediately contact the JBPHH NR Manager.

<u>Water Quality Monitoring Plan</u>
The Navy has not provided a detailed water quality monitoring plan to NMFS and is in the process of completing the 401 WQC Application with the State of Hawaiʻi DOH. Therefore, the Navy's water quality monitoring plan is presently unclear. However, in previous dredging consultations, the Navy has used a combination of visual and quantitative real time water quality/turbidity monitoring before, during, and after dredging in Pearl Harbor to ensure that exceedances are detected in near real-time.

Cumulative Effects

Considering that many adverse effects in marine ecosystems have long durations due to slow ecosystem recovery (e.g., corals), activities proposed today could result in significant and irreversible damage to EFH in coming decades. In addition, individual adverse effects (stressors) often interact in ways that increase the combined magnitude of adverse effects, by acting synergistically (Brown 1997; Negri and Hoogenboom 2011). A cumulative effects analysis must consider the changes to the marine environment that are expected to occur under our current climate trajectory. For example, elevated seawater temperatures can cause coral bleaching, but the temperature threshold at which coral bleaching occurs is lowered under elevated nutrient conditions (Wooldridge 2009; Wooldridge et al. 2012). In another example, nutrient enrichment combined with large-scale physical damage can increase the probability of a shift in dominance from coral to algae, known as a "phase-shift."

Crain et al. (2008) reviewed over 200 studies examining cumulative effects for multiple stressors in intertidal and nearshore marine ecosystems to elucidate general patterns in cumulative stressor effects. The cumulative effects of any two stressors were distributed among all interaction types, with 26% being additive, (i.e., no interaction), 36% synergistic, and 38% antagonistic. In 62% of all cases, interactions between stressors resulted in an adverse effect on the species or ecosystem that was at least additive. In cases where a third stressor was considered, over two-thirds of the interactions became more negative, and the number of synergistic interactions increased to 66% of the cases. Of all the potential two-way combinations of stressor interactions possible for the proposed Honolulu Harbor maintenance dredging project, increased nutrients interact most additively and/or synergistically with other stressors from the action itself (i.e., sedimentation, contaminants), and also with stressors that will result from climate change (i.e., sea-level rise, ocean acidification, ocean warming). Thus, any activity or set of activities that significantly increases the negative effects of three or more stressors should be closely examined for adverse effects on EFH.

Other areas and projects are likely planned for dredging in Pearl Harbor, including the past, on-going, and future activities of the Navy, such as dredging and harbor maintenance with potential expansions. Effectively, the EFH throughout Pearl Harbor and its entrance channel will continue to be impaired by harbor maintenance activities. Unless adequate offset for adverse effects to the baseline condition of EFH have been previously proposed by the Navy and maintained in perpetuity through the regulatory framework, cumulative effects must be iteratively considered. Therefore, unaddressed adverse effects become additive without offset, and the baseline for cumulative effects begins when EFH is defined through regulation.

Recovery Potential

Recovery of benthic communities that have been exposed to broad lethal stressors can take years for individuals to recruit back to affected areas and grow to previous sizes and abundances (Diaz and Rosenberg 1995). However, acute exposures that are only lethal to individual members of a population within a community, or exposures with only sub-lethal effects, recover more quickly. Mobile organisms typically migrate out of affected areas, returning after the stress has abated (Rosenberg 1976). Recovery rates are highly variable by species, and calcareous organisms (e.g., corals) recover more slowly. Recovery from physical damage can be slow, often on the order of years to decades (Rogers and Garrison 2001). In general, recovery rates for major taxa found in the yours dredging footprints decreases from relatively fast for the successional benthic community (six to eight months), to slow for seagrass (years due to uncertainty in light attenuation, deepening of channel, and long distances between live beds and seeds) and hard corals (tens of years). Restoration and recovery of the ecological functions and services that bioturbators and filter feeders provide depends on the number of recruits present in and nearby the impacted area (Pearson and Rosenberg 1978; Rosenberg 2001; Thrush and Whitlatch 2001). Literature reviews (Newell et al. 1998) suggest that most benthic successional marine communities requires at least 6-8 months to recover back to initial levels after removal; however, recovery of successional communities can occur on timescales of one to two months after dredging (Newell et al. 1998).

In Hawaiʻi, the growth rate of most small sessile invertebrates (e.g., barnacles, bryozoans, serpulid worms) is most rapid just following recruitment. For example, *Balanus amphitrite* matures between 30-60 days, at approximately 15 mm in diameter, and matures up to 22 to 26 mm in diameter (Edmondson and Ingram 1939). Sponges reproduce sexually (broadcast spawning) and asexually. Without considering shrinkage, predation, or partial die-off, which can produce negative growth rates; reported growth rates of sponges vary from zero to several cm/yr. Fast growing zooxanthellae-bearing encrusting clionaids (*e.g., Cliona varians* and C. *caribbaea)* may spread as much as 13 cm/yr, while excavating their substratum to depths of 10 mm or more (Aerts and Kooistra 1999; Rützler 2001). The fastest growing species, *Desmapsamma anchorata*, reportedly overgrows its substratum at a mean rate of 80 cm linear growth a year (Aerts et al. 1999). Loose fragments of many sponges can reattach to rock rapidly, although heavily damaged sponges regenerate more slowly than slightly injured specimens (Schmahl 1990). Oysters usually reach maturity in one year, and they are protandric broadcast spawners. Bivalve growth is limited by food availability.

Sea urchin growth rate, including juveniles (Westbrook et al. 2015), can be rapid and is driven by population density, food availability, and abundance (Levitan 1988). Bacolod and Dy (1986) used size-frequency data and estimated that *Tripneustes gratilla* growth rates (measured as an increase in test diameter) ranged from approximately 4 to 12 mm per month; their modeling effort suggested that maximum test diameters of approximately 105 mm may be achieved by one and one half years of age. Tobol (1987) observed that reproductive maturity can be reached in individuals larger than 40 mm in test diameter.

Corals have multiple modes of reproduction; some release viable larvae after internal brooding, while others are broadcast spawners. Minton (2013) reports average growth rates for select coral species found in the Main Hawaiian Islands and the proposed action areas: *M. capitata* = 16.1 mm/yr (encrusting) to 24.5 mm/yr (branching), *P. lobata* = 11.4 mm/yr, *P. compressa* = 28.0 mm/yr, and *P. damicornis* = 12.0 mm/yr. *L. purpurea* growth rates in Guam studies averaged 6.75 mm/yr (Minton 2013). In addition, growth rates may be slower until a certain size is attained (Kolinski 2004; 2007). Recovery can be hampered by loose rubble (Dollar 1982; Raymundo et al. 2007), which is often generated by the pulverizing of fragile coral morphologies, such as branching or foliose forms. It will take tens of years for the corals directly (i.e., those lost to physical damage) or indirectly lost (i.e., those potentially lost to sedimentation and turbidity) to dredging and removal in the action area to recover naturally.

Proposed Mitigation

Avoidance: Many of the BMPs listed above contribute to avoidance. High quality survey information assisted with activity planning and shifting activities. The Navy conducted baseline benthic surveys in the primary Action Areas which included a total of 102,279.86 m^2 (1,109,589.74 ft^2 [39,256.8 m^2 PHNSY and IMF; 30,244.14 m^2 at the WP; and 32,778.92 m^2 at the PCP]). Based on these survey results, design engineers shifted the footprint of the temporary structures at the WP south to avoid impacts to the dredge cut wall habitats that contained notable habitat complexity and structure. Also, at the PCP, a concrete bulkhead (i.e. an elevated concrete pad) was redesigned so that the structure, if built, will not be in the water. The revised structure design will avoid impacts to the marine environment and EFH.

Minimization: Effects from the proposed action will be minimized by implementing BMPs and natural resource management actions. Navy engineers minimized impacts to EFH on the harbor floor by redesigning multiple aspects of the project, such as changes to methods of construction and construction footprints and BMPs to diminish the size of the impacts to the marine environment. In addition, the Navy will move coral suitable for translocation and other invertebrates from the action area to the Ford Island mitigation/restoration site. This site was selected based on its proximity and similarity to the marine environment in which the coral is currently living (e.g., similar water depth, sedimentation levels, etc.). The receiving site will be managed so that the effects of relocation are minimized to the maximum extent practicable and that the moved fauna may establish and grow with reduced stress from environmental pressures (such as algal growth). Management steps will include taking actions to reduce potential impacts from human activities to the area.

The proposed action included revisions that minimized the potential impacts to EFH by reducing the impacts in certain areas. At PCP, the footprint for a temporary pier that may be built for loading vessels with construction supplies was moved south and away from both a nearby wetland and the sloping bottom habitat in the water adjacent to the wetland. The L-shaped pier was re-designed to extend out to part of the loch where dredging had previously made the bathymetry deeper to accommodate vessels. Although some dredging around the L-shaped pier may be required, the dredged footprint was reduced significantly, because a channel will not be needed to get to the pier, and the area of the pier is smaller, thus requiring less dredging around the pier and minimizing impacts to EFH. Additionally, much less wetland and EFH (reduced from 98,654 m^2 [1,061,900 ft^2] to 32,956 m^2 [354,735 ft^2]) will be affected by the pier and crane footprint than was originally conceived.

In addition, the Navy proposes to translocate corals to minimize impacts. Baseline benthic surveys identified 3,162 corals throughout the Action Area footprints, and this included about 3,009 colonies that are not candidates for translocation (Neyland et al. 2020). Some corals have a growth form too delicate or size too small to move. The Navy used the following criteria to estimate the number and area of appropriate candidates for coral translocation:

a. All encrusting corals (i.e., *L. purpurea*) were considered unavoidably lost because they have a growth form that is difficult to translocate, are typically very small, and provide limited ecological services and function.

b. The benthic survey reports presented coral data as size frequency data. Size frequencies of each coral colony were documented as <10 cm, 10-20 cm, 20-40 cm, 40-80 cm, 80-160 cm and >160 cm. All corals less than 10 cm, regardless of species, were considered a loss due to their inability to survive during mitigation efforts

c. To estimate morphology more conservatively, general colony surface area was generated using three different formulas, depending on coral morphology:

1. Mounding: $A = 2\pi r^2 * T$ [with π being rounded to 3.14 and T = total colonies]
2. Encrusting: $A = 2\pi r^2 * T$ [with π being rounded to 3.14 and T = total colonies]
3. Branching: $A = 2\pi r^2 + 2\pi^2 * T$ [with π being rounded to 3.14 and T = total colonies].

d. An estimated 25% loss for translocated corals (*M. capitata, M. patula, P. compressa, and P. lobata*) was anticipated due to the inevitability that not all corals will survive due to movement, placement, etc. Translocating coral can encounter a variety of challenges, including (but not limited to) stress from detaching and transporting colonies and variable environmental conditions between donor and receptor sites.

e. Additionally, an estimated 50% loss of translocated branching corals (*P. damicornis*) was conservatively anticipated due to branching morphology being more fragile and susceptible to movement and placement challenges.

f. Lost coral colonies includes all corals not translocated (encrusting and < 10cm) + 25% loss of 4 coral species (listed above) + 50% loss of *P. damicornis*

g. Translocated coral colonies = 75% survival of 4 coral species (listed above) + 50% survival of *P. damicornis.*

h. % coral cover = total coral cover (m^2) / total OM area (m^2) from survey report.

i. Extrapolated injured area units = total coral cover (m^2) * total project footprint.

The Navy will strive to minimize loss of the estimated 153 corals that are expected to be good candidates for translocation by moving as many as possible to a restored habitat on the southwest end of FI, which is located about a half a mile to the northeast of the WP project site and less than a half a mile west of the primary PHNSY site. The baseline benthic surveys (Neyland et al. 2020) identified a well-developed and complex coral habitat within 3–15 m (10–49 ft.) around the sloping southwest edge of FI. An approximately 6,070 m^2 area adjacent to the fringing reef at FI is predominantly composed of rock rubble and sand-covered bottom from dredging and anthropogenic activities that precluded natural coral recruitment and consolidation.

Based on some of the Navy's coral translocation events in Guam (e.g., mitigation for the Lima Wharf maintenance dredge and X-ray Wharf repairs; see below), the Navy expects that 75% of three translocated coral species (*P. compressa*, *M. capitata* and *M. patula*) and half (50%) of translocated *P. damicornis* will survive, with only partial mortality and within two years after translocation. In the case of the delicate morphology forms, colony movement may be attempted, but some damage in process is expected and will be tolerated. Thus, the Navy accepts the risk that corals may be unavoidably lost during translocation. From the PHNSY site, 131 colonies will be translocated to FI with approximately 50–75% expected to survive (depending on morphology). From the WP site, at least 15 to 20 colonies will be translocated to FI. From the PCP site, one colony will be translocated to FI. Overall, EFH will benefit from the approximately 50–75% (i.e., approximately 78-128 of the 153 total corals) that are expected to survive and grow after translocation.

At the coral recipient site, translocated corals require additional habitat management to minimize adverse effects from translocation and to ensure coral survival. The Navy will monitor and maintain the receiving site periodically to remove algae that may be competing with corals and to reattach corals that may have become detached but still have living tissue. The Navy expects that coral with partial mortality may recover and grow if given improved habitat conditions. Algae removal (an aspect of which is explained below under offset) will be prioritized for areas with translocated coral, while other areas in the vicinity of the coral transplants may be cleared of algae overgrowth, if feasible. The Navy has documented successful coral translocation in Guam for the Lima Wharf and X-Ray Wharf projects, where survival rates were approximately 83% (still ongoing) and >90%, respectively. For the X-Ray Wharf project, 91% of relocated corals showed an increase in maximum total length.

Offset: The most notable ecosystem functional loss to EFH from the proposed action is the removal (temporary and permanent) of the invertebrate community and habitat complexity at the project sites, which allows for recruitment, refuge, and prey source habitat for BMUS and PMUS species. Based on the recent biological survey analysis (Neyland et al. 2020), the total area of coral and benthic community that are functioning collectively as EFH in all of the Action Areas and are expected to be unavoidably lost is estimated to be 27,731.19 m^2 (298,495 ft^2).

The Navy will seek to offset unavoidably lost function and services provided by coral and other benthic biota through two mitigation actions: 1) habitat conversion and ecological uplift at the Ford Island mitigation/restoration site where the corals will be moved for minimization purposes (see above); and 2) the removal of AIS. The Ford Island mitigation site is currently sloping bottom habitat degraded from wartime use, prior dredging activities, and invasive species. However, habitat conditions at the site will be improved to increase the survival of translocated corals and to promote the natural establishment of a coral and benthic invertebrate community in and around the mitigation site (i.e., out-of-kind). The Navy will additionally seek to offset unavoidable lost function and services through habitat restoration at mitigation sites that have been heavily impacted by AIS. Establishment of AIS at mitigation sites affect benthic habitat, having caused a complete change in biodiversity and a shift to algal and AIS dominated substrate. The Navy will improve conditions at mitigation sites through the removal of AIS and maintenance of native benthic assemblages within mitigation sites that have become dominated by the introduced soft coral *U. stolonifera* and the introduced *G. salicornia*.

Habitat Restoration at FI: Habitat restoration will complement and synergize with the proposed coral translocation minimization. Restoration is intended to make the site more suitable EFH as a coral reef habitat for the coral transplants, as well as for additional marine species that could recruit there. In addition, the Navy will strive to move other beneficial invertebrates to mitigation sites, as feasible. By restoring sites at FI, the Navy will be performing habitat translocation from the invertebrate community in a channel with high-levels of vessel traffic and movement to an improved site where coral naturally occurs nearby. Federally managed fish stocks (i.e., MUS) should benefit from the restored environment because prey can recruit and seek refuge there.

For the proposed action and the expected adverse effects, the Navy performed multiple HEAs using *Visual_HEA* software to determine the amount of compensatory restoration required to provide equivalent replacement of lost ecosystem services and function (Kohler and Dodge 2006; Pioch et al. 2017). The parameters used in the HEA analysis estimated 1,705.97 m^2 (18,362.91 ft^2) of replacement habitat to offset the loss of corals, and 29,226.33 m^2 (314,589.60 ft^2) of habitat restoration through AIS removal to offset the temporary and permanent loss of benthic community and harbor floor EFH. The coral, artificial structures, harbor floor, and benthic community HEA analyses included values for the pre-injury functions and services at action areas based on the baseline benthic survey report (Neyland et al. 2020), which is the best available scientific information. The Navy's calculation to offset the temporary and permanent loss of benthic community and harbor floor EFH applied a 15% pre-injury service level. A 25% and 35% pre-injury service level would have required approximately 33,873 m² and 37,940 m² of restoration via AIS removal.

The Navy notes that the percent cover used for analysis of corals and benthic communities is limited in its three-dimensional evaluation of habitat, and attempted to use conservative area formulas described previously. The largest initial loss of habitat is to small corals (<10 cm) and the encrusting corals that provide only nominal EFH functions and services for MUS species in terms of places for prey fish to recruit and seek refuge. The Navy has therefore taken multiple, conservative measures to compensate for habitat complexity and rugosity in its analysis for offset mitigation.

Based on the HEA calculations, the Navy will perform the following offset mitigation steps at FI (note that measurements and quantities are approximate due to irregularities of surfaces and variability in natural systems) to compensate for the functions and services that will be unavoidably lost from the permanent removal of corals:

- Remove anthropogenic debris scattered within the restoration area prior to stabilization.
- Stabilize approximately 1,600 m^2 of the substrate to:
    - reduce the rubble mobility on top of the mound
    - create a consistent, stable surface to which marine fauna may attach and thrive.
- Where necessary, increase rugosity and habitat complexity by placing locally-sourced, limestone boulders (or similar structures) on the newly-stabilized area on benthic seafloor at FI (above). The use of this substrate was based on the successful coral translocation completed for compensatory mitigation of Naval Base Guam X-ray Wharf repairs, Apra Harbor, in 2015.
    - The Navy expects to procure limestone boulders or similar structure of appropriate size for the proposed habitat restoration. If feasible, the use of boulders with an "elongated cube shape" with an average exposed surface area (does not include bottom surface) of 3.32 m^2 would be used. The actual number of boulders utilized will be dependent upon final boulder sizes and will vary due to limits and imprecision in quarrying techniques.
    - Also, the Navy will optimize boulder placement and stability by working with coastal engineers to determine best methods to withstand current and wave stresses.
- Based on their attachment and growth morphologies, attach transplanted corals to boulders as well as the stabilized substrate.
- Establish a reference baseline site and conduct subsequent monitoring surveys of existing coral communities adjacent to the restoration site.
- Monitor (i.e., quantify and assess the resource conditions) fish and benthic community at the restoration site at predetermined intervals over two years after translocation (e.g., three monitoring events occurring at the time of completed translocation, 12 and 24 months thereafter).

- After each monitoring event, provide a status report to NMFS on the condition of coral, algae, and fish at the restoration site and conditions of translocated corals.
- Manage macroalgae and competing invertebrate populations that threaten to overgrow transplanted corals (including "weeding" and removing algae, sponges, competing invertebrates, etc. at 3-6 month intervals up to two years after translocation).
- Design restoration and translocation plans to ensure optimal and available habitat to receive future coral transplants from other Navy projects that seek to avoid and minimize adverse effects to corals and EFH.

The above minimization actions will ensure that the translocated coral at the recipient sites will have the greatest chances for survival. Once translocation is complete, the recipient site will have new living coral colonies, with all expected to persist and grow when properly managed. Additionally, with the execution of the above offset actions, the Navy expects to stabilize and/or add approximately 1,600 to 1,705 m^2 (final value is unclear from EFHA) of improved restoration habitat as HEAs offset for the unavoidable loss of corals. The Navy conservatively anticipated 25-50% of translocated colonies that do not survive will be compensated for in the offset analysis. If all 25-50% are dead, then these colonies will still be able to provide dead coral cover that is not considered as part of the offset.

Aquatic Invasive Species Removal: AIS are a major threat to marine ecosystems, and are responsible for damage worth millions of dollars to vital and important Hawaiian coral reefs as a result of diminished fisheries and lowered property values. AIS removal will complement the coral translocation and habitat restoration at FI, while the removal and maintenance of *U. stolonifera* near Bishop Point will improve degraded marine resources and compensate for unavoidable loss of EFH ecosystem functions and services from the benthic community and harbor floor.

Gorilla ogo, an algae, has been classified as invasive by the State of Hawaiʻi Division of Aquatic Resources (HI-DAR 2021), and occurs in dense mats in shallow nearshore areas throughout Pearl Harbor. It out-competes other native algae species for available substrate, and is considered one of the most serious threats to benthic organisms within Pearl Harbor, spreading rapidly since 2005 and killing substantial coral communities and degrading productive fish habitat (NAVFAC Navy Region Hawaii 2011). *U. stolonifera* is a soft coral known to out-compete native benthic invertebrates by dispersing along shallow reefs, overgrowing any hard substrate (including corals and seagrass), leading to a decrease in species diversity of the benthic communities (Ruiz-Allais *et al*. 2021), thus causing severe ecological damage. During Pearl Harbor benthic surveys, a patch of *U. stolonifera* was discovered near Bishop Point in an area 1,000 ft. by 400 ft. (approximately 37,000 m^2). More specifically, this AIS coral was identified near Piers A5 and A6 and at depths between 40 and 50 ft. (12 and 15 m) on the slope, leading to the channel floor and on hard surface on the channel floor itself. These biological invasions dramatically impact reef ecosystems, causing a complete change in biodiversity and a shift from coral to algae-dominated reefs. Removal of these two AIS in the mitigation sites will improve the marine environment in Pearl Harbor as a feasible offset mitigation option for improving degraded marine resources and compensating for unavoidable loss of EFH ecosystem functions and services.

The Navy proposes to eradicate, monitor, and control the following AIS: the *U. stolonifera* at Bishop Point, and gorilla ogo from the coral recipient/habitat restoration site at FI. Together, these mitigation actions will offset the unavoidable loss of ecosystem functions and services from the permanent and temporary removal of the benthic community, which the HEA estimated would require 29,226.33 m^2 (314,589.60 ft^2) of replacement habitat. AIS removal may be possible with a variety of methods to control AIS, which may include (but is not limited to) a combination of reduced nitrification, manual control (e.g., the super-sucker, a large marine vacuum mounted on a barge and operated by the Nature Conservancy of Hawaiʻi to remove the gorilla ogo), and natural predator species translocations (e.g., sea urchins). For example, gorilla ogo was successfully removed from Kāneʻohe Bay, demonstrating the effectiveness of the 'super sucker.' Also, the addition of native sea urchins as a natural predator has been able to manage the removal areas in Kāneʻohe Bay long-term and without additional, large-scale removal efforts. In the 2011 JBPHH Integrated Natural Resource Management Plan (INRMP), a feasibility study and pilot project is identified as a Navy priority to attempt different control techniques. The 2011 JBPHH INRMP (NAVFAC Navy Region Hawaiʻi 2011) also called for the potential deployment of the "super sucker" into Pearl Harbor to control areas where gorilla ogo formed a thick, impenetrable mat. Based on the size of the AIS and the potential removal methods available, the Navy estimates that each AIS removal events will require scientific divers (e.g. contracted through scientific consultancies, the Nature Conservancy or State of Hawaiʻi DAR) about 1–2 weeks to complete, and that up to five total removal events may be required over the next 2–3 years, thus ensuring the complete removal of AIS in these areas. Furthermore, the areas cleared of AIS will require monitoring to document and to ensure recovery of the benthic community. Monitoring the health of the benthic communities and fish habitat shall continue on a periodic basis and will be contracted to scientific divers (such as those listed above) to monitor and to maintain the successful removal of AIS. Monitoring will include control sites just outside the AIS removal sites. Maintenance actions may include (but is not limited to) periodic removal of the invasive species to prevent its competition with hard corals. Monitoring the removal areas will occur at one and two years after removal to confirm successful elimination.

Finally, data from monitoring and maintenance surveys will confirm and validate that the Navy's offset mitigation efforts of removing AIS will improve the benthic communities at these sites, and as described in the HEA. If control sites fail naturally due to external environmental factors (e.g., climate change, storms, anthropogenic damage, etc.), monitoring would document these factors and confirm that the Navy is not responsible for these potential failures. Also, if the AIS removal is not successful, monitoring will document the detrimental environmental factors that were beyond and unrelated to the Navy's mitigation effort, and will calculate exact levels of unsuccessful mitigation. In the unlikely event of unsuccessful AIS removal, the Navy will engage with NMFS to discuss the results and plan appropriate action.

References Cited

Abrahams MV, Mangel M, Hedges K. 2007. Predator–prey interactions and changing environments: Who benefits? Philosophical Transactions of the Royal Society B: Biological Sciences. 362(1487):2095.

Aerts L, Kooistra D. 1999. Ecological strategy and competitive ability in the excavating reef sponge *Anthosigmella varians* [Ph.D]. [Amsterdam]: University of Amsterdam.

Aerts L, Scheffers S, Gomez R. 1999. Ecological strategies and competitive ability in the excavating reef sponge *Anthosigmella varians*. [The Netherlands]: University of Amsterdam.

Altieri AH. 2008. Dead zones enhance key fisheries species by providing predation refuge. Ecology. 89(10):2808-2818.

Alvarez-Filip L, Dulvy NK, Gill JA, Côté IM, Watkinson AR. 2009. Flattening of Caribbean coral reefs: Region-wide declines in architectural complexity. Proceedings of the Royal Society B: Biological Sciences. 276(1669):3019-3025.

Ayalon I, Rosenberg Y, Benichou JI, Campos CL, Sayco SL, Nada MA, Baquiran JI, Ligson CA, Avisar D, Conaco C, Kuechly HU. 2021. Coral gametogenesis collapse under artificial light pollution. Current Biology. 31(2):413-9.

Bacolod P, Dy D. 1986. Growth, recruitment pattern and mortality rate of the sea urchin, *Tripneustes gratilla linnaeus*. Phillipine Scientist. 23:1-14.

Baden SP, Loo L-O, Pihl L, Rosenberg R. 1990a. Effects of eutrophication on benthic communities including fish. Ambio. 19:113-122.

Baden SP, Pihl L, Rosenberg R. 1990b. Effects of oxygen depletion on the ecology, blood physiology and fishery of the norway lobster *Nephrops norvegicus*. Marine Ecology Progress Series. 67(2):141-155.

Baker SM, Mann R. 1992. Effects of hypoxia and anoxia on larval settlement, juvenile growth, and juvenile survival of the oyster *Crassostrea virginica*. Biological Bulletin. 182(2):265-269.

Battista TA, Costa BM, Anderson SM. 2007. Shallow-water benthic habitats of the main eight Hawaiian islands. Noaa technical memorandum NOS NCCOS. 2007;61.

Bertrand A, Gerlotto F, Bertrand S, Gutiérrez M, Alza L, Chipollini A, Díaz E, Espinoza P, Ledesma J, Quesquén R et al. 2008. Schooling behaviour and environmental forcing in relation to anchoveta distribution: An analysis across multiple spatial scales. Progress in Oceanography. 79(2):264-277.

Birkeland C. 1988. Geographic comparisons of coral-reef community processes. Proceedings of the Sixth International Coral Reef Symposium.

Brown B. 1997. Disturbances to reefs in recent times. In: Birkeland C, editor. Life and death of coral reefs. Kluwer Academic Publishers. p. 354-370.

Bruno JF, Petes LE, Drew Harvell C, Hettinger A. 2003. Nutrient enrichment can increase the severity of coral diseases. 6(12):1056-1061.

Bucher DJ, Harrison PL. 2002. Growth response of the reef coral *Acropora longicyathus* to elevated inorganic nutrients: Do responses to nutrients vary among coral taxa. Proceedings of the 9th International Coral Reef Symposium, Bali. 1:443-448.

Cai Y, Cabrera JC, Georgiadis M, Jayachandran K. 2002. Assessment of arsenic mobility in the soils of some golf courses in south Florida. Science of The Total Environment. 291(1):123-134.

Carlquist SJ. 1970. Hawaii, a Natural History; Geology, Climate, Native Flora and Fauna Above the Shoreline. Garden city, New York, Natural History Press.

Carlton JT, Eldredge LG. 2009. Marine bioinvasions of Hawai'i: The introduced and cryptogenic marine and estuarine animals and plants of the Hawaiian archipelago. Honolulu, Hawai'i: Bernice P. Bishop Museum.

Carpenter RC. 1986. Partitioning herbivory and its effects on coral reef algal communities. 56(4):345-364.

Coles S, Eldredge LG. 2002. Nonindigenous species introductions on coral reefs: A need for information. Pacific Science. 56(2):191-209.

Cox EF, Ward S. 2002. Impact of elevated ammonium on reproduction in two Hawaiian scleractinian corals with different life history patterns. Marine Pollution Bulletin. 44(11):1230-1235.

Crain CM, Kroeker K, Halpern BS. 2008. Interactive and cumulative effects of multiple stressors in marine ecosystems. Ecological Letters. 11:1304-1315.

D'Elia C, Wiebe W. 1990. Biogeochemical nutrient cycles in coral-reef ecosystems. In 'Ecosystems of the World vol. 25'(ed. Z. Dubinsky.) pp. 49–74. Elsevier: Amsterdam.

Das T, Stickle WBJMB. 1994. Detection and avoidance of hypoxic water by juvenile *Callinectes sapidus* and *C. Similis*. Marine Biology. 120(4):593-600.

DON Region Hawaii. 2018. Explosives Safety Submission for Maintenance Dredging Operations at Piers B4-B26, M1-M4, S1-S8, and H1-H4, Joint Base Pearl Harbor-Hickam, Oahu, Hawaii - Amendment 1. 47 pages.

Diaz RJ, Neubauer RJ, Schaffner LC, Pihl L, Baden SP. 1992. Continuous monitoring of dissolved oxygen in an estuary experiencing periodic hypoxia and the effect of hypoxia on macrobenthos and fish. In: Vollenweider RA, Marchetti R, Viviani R, editors. Marine coastal eutrophication. Amsterdam: Elsevier. p. 1055-1068.

Diaz RJ, Rosenberg R. 1995. Marine benthic hypoxia: A review of its ecological effects and the behavioural responses of benthic macrofauna. Oceanography and Marine Biology: An Annual Review. 33:245-203.

Dollar SJ. 1982. Wave stress and coral community structure in Hawaii. Coral Reefs. 1(2):71-81.

Dollar S and Brock S. 2000. Pearl Harbor Integrated Natural Resources Management Plan. Marine and Fisheries Resources. Prepared by Marine Research Consultants and Environmental Assessment Co. Prepared for Helber, Hastert and Fee. pp. 43

Duarte CM, Terrados J, Agawin NSR, Fortes MD, Bach S, Kenworthy WJ. 1997. Response of a mixed Philippine seagrass meadow to experimental burial. Marine Ecology Progress Series. 147:285-294.

Dubinsky Z, Stambler N. 1996. Marine pollution and coral reefs. Global Change Biology. 2(6):511-526.
Dudgeon SR, Aronson RB, Bruno JF, Precht WF. 2010. Phase shifts and stable states on coral reefs. Marine Ecology Progress Series. 413:201-216.
Dunn JG, Sammarco PW, LaFleur G. 2012. Effects of phosphate on growth and skeletal density in the scleractinian coral *Acropora muricata*: A controlled experimental approach. Journal of Experimental Marine Biology and Ecology. 411:34-44.
Edinger EN, Limmon GV, Jompa J, Widjatmoko W, Heikoop JM, Risk MJ. 2000. Normal coral growth rates on dying reefs: Are coral growth rates good indicators of reef health? Marine Pollution Bulletin. 40(5):404-425.
Edmondson C, Ingram W. 1939. Fouling organisms in Hawaii. Hawaii: Bernice P. Bishop Museum.
Erftemeijer PL, Riegl B, Hoeksema BW, Todd PA. 2012. Environmental impacts of dredging and other sediment disturbances on corals: A review. Marine Pollution Bulletin. 64(9):1737-1765.
Erftemeijer PLA, Robin Lewis RR. 2006. Environmental impacts of dredging on seagrasses: A review. Marine Pollution Bulletin. 52(12):1553-1572.
Forbes TL, Lopez GR. 1990. The effect of food concentration, body size, and environmental oxygen tension on the growth of the deposit-feeding polycheate, capitella species 1. 35(7):1535-1544.
Gilmour J. 1999. Experimental investigation into the effects of suspended sediment on fertilisation, larval survival and settlement in a scleractinian coral. Marine Biology. 135(3):451-462.
Goldberg J, Wilkinson C. 2004. Global threats to coral reefs: Coral bleaching, global climate change, disease, predator plagues and invasive species. Status of Coral Reefs of the World. 2004:67-92.
Harvell D, Jordán-Dahlgren E, Merkel S, Rosenberg E, Raymundo L, Smith G, Weil E, Willis B. 2007. Coral disease, environmental drivers, and the balance between coral and microbial associates. Oceanography. 20:172-195.
HI-DAR. 2021. Department of Land and Natural Resources. Aquatic Invasive Species. Gorilla Ogo (Gracilaria salicornia). Retrieved 8 June 2022, from https://dlnr.hawaii.gov/ais/invasivealgae/gracilaria-salicornia.
Hay ME. 1991. Fish-seaweed interactions on coral reefs: Effects of herbivorous fishes and adaptations of their prey. The Ecology of Fishes on Coral Reefs. San Diego: Academic Press. p. 96-119.
Hervant F, Mathieu J, Garin D, Freminet A. 1996. Behavioral, ventilatory, and metabolic responses of the hypogean amphipod *Niphargus virei* and the epigean isopod *Asellus aquaticus* to severe hypoxia and subsequent recovery. Physiological Zoology. 69(6):1277-1300.
Hodgson G. 1990. Tetracycline reduces sedimentation damage to corals. Marine Biology. 104(3):493-496.
Hughes TP, Bellwood DR, Folke C, Steneck RS, Wilson J. 2005. New paradigms for supporting the resilience of marine ecosystems. Trends in Ecology and Evolution. 20(7):380-386.

Johnson MA, Macaulay MC, Biggs DC. 1984. Respiration and excretion within a mass aggregation of *Euphausia superba*: Implications for krill distribution. Journal of Crustacean Biology. 4(5):174-184.

Josselyn M, Fonseca M, Niesen T, Larson R. 1986. Biomass, production and decomposition of a deep water seagrass, *Jalophila decipiens ostenf*. Aquatic Botany. 25:47-61.

Keckeis H, Bauer-Nemeschkal E, Kamler E. 1996. Effects of reduced oxygen level on the mortality and hatching rate of Chondrostoma nasus embryos. 49(3):430-440.

Kjelland ME, Woodley CM, Swannack TM, Smith DL. 2015. A review of the potential effects of suspended sediment on fishes: potential dredging-related physiological, behavioral, and transgenerational implications. Environmental Systems and Decisions 35:334-50.

Kinsey DW, Davies PJ. 1979. Effects of elevated nitrogen and phosphorus on coral reef growth. 24(5):935-940.

Kohler KE, Dodge RE. 2006. Visual_HEA: Habitat Equivalency Analysis software to calculate compensatory restoration following natural resource injury. National Coral Reef Institute, Nova Southeastern University Oceanographic Center.

Kolinski SP. 2004. Sexual reproduction and the early life history of *Montipora capitata* in Kaneohe Bay, Oahu, Hawaii. [Honolulu]: University of Hawaii.

Kolinski SP. 2007. Recovery projections for scleractinian corals injured in the M/V Cape Flattery incident, Oahu, Hawaii. Honolulu: NOAA. NOAA Technical Document.

Koop K, Booth D, Broadbent A, Brodie J, Bucher D, Capone D, Coll J, Dennison W, Erdmann M, Harrison P et al. 2001. Encore: The effect of nutrient enrichment on coral reefs. Synthesis of results and conclusions. Marine Pollution Bulletin. 42(2):91-120.

Lapointe BE. 1997. Nutrient thresholds for bottom-up control of macroalgal blooms on coral reefs in Jamaica and southeast Florida. 42(5part2):1119-1131.

Lecchini D, Bertucci F, Gache C, Khalife A, Besson M, Roux N, Berthe C, Singh S, Parmentier E, Nugues MM, Brooker RM. Boat noise prevents soundscape-based habitat selection by coral planulae. Scientific reports. 2018 Jun 18;8(1):9283.

Levitan DR. 1988. Density-dependent size regulation and negative growth in the sea urchin *Diadema antillarum philippi*. Oecologia. 76(4):627-629.

Lewis SM. 1986. The role of herbivorous fishes in the organization of a Caribbean reef community. 56(3):183-200.

Littler MM, Littler DS, Titlyanov EA. 1991. Comparisons of n- and p-limited productivity between high granitic islands versus low carbonate atolls in the Seychelles Archipelago: A test of the relative-dominance paradigm. Coral Reefs. 10(4):199-209.

Ljung K, Selinus O, Otabbong E, Berglund M. 2006. Metal and arsenic distribution in soil particle sizes relevant to soil ingestion by children. Applied Geochemistry. 21(9):1613-1624.

Llanso RJ, Diaz RJ. 1994. Tolerance to low dissolved oxygen by the tubicolous polychaete *Loimia medusa*. Journal of the Marine Biological Association of the United Kingdom. 74(1):143-148.

Loya Y, Sakai K, Yamazato K, Nakano Y, Sambali H, van Woesik R. 2001. Coral bleaching: The winners and the losers. 4(2):122-131.

Marubini F, Davies PS. 1996. Nitrate increases zooxanthellae population density and reduces skeletogenesis in corals. Marine Biology. 127(2):319-328.

McDougall KD. 1943. Sessile marine invertebrates of Beaufort, North Carolina: A study of settlement, growth, and seasonal fluctuations among pile-dwelling organisms. Ecological Monographs. 13(3):321-374.

Minton D. 2013. Review of growth rates for Indo-Pacific corals final report. National Oceanic and Atmospheric Administration Pacific Islands Regional Office.

NAVFAC Navy Region Hawaii. 2011. Final Integrated Natural Resource Management Plan Joint Base Pearl Harbor-Hickam, Pearl Harbor Naval Complex, Naval Magazine Pearl Harbor Lualualei and West Loch Branches, Naval Computer and Telecommunications Area Master Station Pacific Wahiawa, Naval Radio Transmitter Facility Lualualei, Navy-retained Lands at Kalaeloa, and Hickam Air Force Base, O‘ahu, State of Hawai‘i. Prepared by Naval Facilities Engineering Command Pacific and Helber Hastert and Fee Planners, Inc., for Commander, Navy Region Hawaii. September 2011. 711 pages.

NAVFAC PAC. 2020. Final Report, Water Quality Monitoring and Reporting for the Studies of the Benthic Structure and Marine Resources of the Main Pearl Harbor Shipping Channel: Phase II. Prepared by TEC-AECOM JV. Submitted to: NAVFAC Pacific for Commander, Navy Region Hawaii. 74 pp.

Negri AP, Hoogenboom MO. 2011. Water contamination reduces the tolerance of coral larvae to thermal stress. PLoS One. 6(5):e19703.

Newell R, Seiderer L, Hitchcock D. 1998. The impact of dredging works in coastal waters: A review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. Oceanography and Marine Biology: An Annual Review. 36:127-178.

Neyland J, Delaney D, Dollar S, Millan A, Peltier S, Ericksen M, Agustin A. 2020. Focused Biological Surveys of Pearl Harbor Naval Shipyard, Pearl Harbor, Hawaii. Prepared by CARDNO GS - AECOM PACIFIC Joint Venture. Submitted to: Naval Facilities Engineering Systems Command Pacific for Commander, Navy Region Hawaii. October 2020.

Nilsson HC, Rosenberg R. 1994. Hypoxic response of two marine benthic communities. Marine Ecology Progress Series. 115(3):209-217.

Pastorok RA, Bilyard GR. 1985. Effects of sewage pollution on coral-reef communities. Marine Ecology Progress Series. 21(1/2):175-189.

Pearson T, Rosenberg R. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanography and Marine Biology: An Annual Review. 16:229-311.

Petersen JK, Pihl L. 1995. Responses to hypoxia of plaice, *Pleuronectes platessa*, and dab, Limanda limanda, in the south-east Kattegat: Distribution and growth. Environmental Biology of Fishes. 43(3):311-321.

Petersen JK, Riisgård H. 1992. Filtration capacity of the ascidian Ciona intestinalis and its grazing impact in a shallow fjord. Marine Ecology Progress Series. 88(1):9-17.

Philipp E, Fabricius K. 2003. Photophysiological stress in scleractinian corals in response to short-term sedimentation. Journal of Experimental Marine Biology and Ecology. 287(1):57-78.
Pihl L, Baden SP, Diaz RJ, Schaffner LC. 1992. Hypoxia-induced structural changes in the diet of bottom-feeding fish and crustacea. Marine Biology. 112(3):349-361.
Pioch S, Johnston MW, Vaissière AC, Berger F, Jacob C, Dodge R. 2017. An update of the Visual HEA software to improve the implementation of the Habitat Equivalency Analysis method. Ecological Engineering.
Randall JE. 1987. Introductions of marine fishes to the Hawaiian islands. Bulletin of Marine Science. 41(2):490-502.
Randløv A, Riisgård HU. 1979. Efficiency of particle retention and filtration rate in four species of ascidians. Marine Ecology Progress Series 1:55-59.
Raymundo LJ, Maypa AP, Gomez ED, Cadiz P. 2007. Can dynamite-blasted reefs recover? A novel, low-tech approach to stimulating natural recovery in fish and coral populations. Marine Pollution Bulletin. 54(7):1009-1019.
Richmond RH. 1993. Effects of coastal runoff on coral reproduction. Proceedings of the Colloquium on Global Aspects of Coral Reefs: Health, Hazards, and History.360-364.
Richmond RH. 1996. Effects of coastal runoff on coral reproduction. Biological Conservation. 76(2):360-364.
Rogers CS, Garrison VH. 2001. Ten years after the crime: Lasting effects of damage from a cruise ship anchor on a coral reef in St. John, US Virgin Islands. Bulletin of Marine Science. 69(2):793-803.
Rosenberg R. 1976. Benthic fauna dynamics during succession following pollution abatement in a Swedish estuary. Oikos. 27:414-427.
Rosenberg R. 2001. Marine benthic faunal successional stages and related sedimentary activity. Scientia Marina. 65(S2):107-119.
Ruiz-Allais JP, Benayahu Y, Lasso-Alcalá OM. 2021. The invasive octocoral Unomia stolonifera (Alcyonacea, Xeniidae) is dominating the benthos in the Southeastern Caribbean Sea. Memoria de la Fundación La Salle de Ciencias Naturales. 79(187):63-80.
Russ GR. 1980. Effects of predation by fishes, competition, and structural complexity of the substratum on the establishment of a marine epifaunal community. Journal of Experimental Marine Biology and Ecology. 42(1):55-69.
Rützler K. 2001. Exploring neptune's gardens: From landlubber to reef biologist. Washington, D.C.: National Museum of Natural History, Smithsonian Institution.
Sandberg E. 1997. Does oxygen deficiency modify the functional response of *Saduria entomon* (isopoda) to *Bathyporeia pilosa* (amphipoda)? Marine Biology. 129(3):499-504.
Sandberg E, Tallqvist M, Bonsdorff E. 1996. The effects of reduced oxygen content on predation and siphon cropping by the brown shrimp, *Crangon crangon*. 17(1-3):411-423.
Schmahl G. 1990. Community structure and ecology of sponges associated with four southern Florida coral reefs. New Perspectives in Sponge Biology'(Ed K Rützler) pp.376-383.

Semlali RM, van Oort F, Denaix L, Loubet M. 2001. Estimating distributions of endogenous and exogenous pb in soils by using Pb isotopic ratios. Environmental Science and Technology. 35(21):4180-4188.

Simpson SD, Radford AN, Nedelec SL, Ferrari MC, Chivers DP, McCormick MI, Meekan MG. 2016. Anthropogenic noise increases fish mortality by predation. Nature Communications. 7:ncomms10544.

Slabbekoorn H, Bouton N, van Opzeeland I, Coers A, ten Cate C, Popper AN. 2010. A noisy spring: The impact of globally rising underwater sound levels on fish. Trends in Ecology and Evolution. 25(7):419-427.

Smith JE, Hunter CL, Conklin EJ, Most R, Sauvage T, Squair C, and Smith CM. 2004. Ecology of the invasive red alga Gracilaria salicornia (Rhodophyta) on Oʻahu, Hawaiʻi. Pacific science, 58(2), pp.325-343.

Stambler N, Popper N, Dubinsky Z, Stimson J. 1991. Effects of nutrient enrichment and water motion on the coral *Pocillopora damicornis*. Pacific Science. 45(3):299-307.

Stearns, H. T. 1985. Geology of the State of Hawaii. Palo Alto, California, Pacific Books.

Sutherland JP. 1974. Multiple stable points in natural communities. The American Naturalist. 108(964):859-873.

Telesnicki GJ, Goldberg WM. 1995. Effects of turbidity on the photosynthesis and respiration of two south Florida reef coral species. Bulletin of Marine Science. 57(2):527-539.

Thrush SF, Whitlatch RB. 2001. Recovery dynamics in benthic communities: Balancing detail with simplification. In: Reise K, editor. Ecological comparisons of sedimentary shores. Berlin, Heidelberg: Springer Berlin Heidelberg. p. 297-316.

Tobol R. 1987. Population structure patterns of a common red sea echinoid (*Tripneustes gratula elatensis*) au - dafni, j. Israel Journal of Zoology. 34(3-4):191-204.

Turner NR, Renegar DA. 2017. Petroleum hydrocarbon toxicity to corals: A review. Marine Pollution Bulletin. 119(2):1-16.

Tuttle LJ, Donahue MJ. 2020. Thresholds for Sediment Stress on Corals: A Systematic Review and meta-analysis. Prepared for NOAA Fisheries, Pacific Islands Regional Office, Habitat Conservation Division by the University of Hawaiʻi at Manoa, Hawaiʻi Institute of Marine Biology.

US Coral Reef Task Force. 2016. Handbook on Coral Reef Impacts: Avoidance, Minimization, Compensatory Mitigation, and Restoration. Prepared by: US Coral Reef Task Force Coral Injury and Mitigation Working Group, December 2016. 152 pp.

Vaquer-Sunyer R, Duarte CM. 2008. Thresholds of hypoxia for marine biodiversity. Proceedings of the National Academy of Sciences. 105(40):15452.

Voss JD, Richardson LLJCR. 2006. Nutrient enrichment enhances black band disease progression in corals. 25(4):569-576.

Wang WX, Widdows J. 1991. Physiological responses of mussel larvae "*Mytilus edulis*" to environmental hypoxia and anoxia. Marine Ecology Progress Series. 70(3):223-236.

Westbrook CE, Ringang RR, Cantero SMA, Toonen RJ. 2015. Survivorship and feeding preferences among size classes of outplanted sea urchins, *Tripneustes gratilla*, and possible use as biocontrol for invasive alien algae. PeerJ. 3:e1235.

Wiedenmann J, D'Angelo C, Smith EG, Hunt AN, Legiret F-E, Postle AD, Achterberg EP. 2012. Nutrient enrichment can increase the susceptibility of reef corals to bleaching. Nature Climate Change. 3:160.

Williams LG. 1964. Possible relationships between plankton-diatom species numbers and water-quality estimates. Ecology. 45(4):809-823.

Wooldridge SA. 2009. Water quality and coral bleaching thresholds: Formalising the linkage for the inshore reefs of the Great Barrier Reef, Australia. Marine Pollution Bulletin. 58(5):745-751.

Wooldridge SA, Done TJ, Thomas CR, Gordon II, Marshall PA, Jones RN. 2012. Safeguarding coastal coral communities on the central Great Barrier Reef (Australia) against climate change: Realizable local and global actions. Climatic Change. 112(3-4):945-961.

Wu RSS. 2002. Hypoxia: From molecular responses to ecosystem responses. Marine Pollution Bulletin. 45(1):35-45.

Wu RSS, Zhou BS, Randall DJ, Woo NYS, Lam PKS. 2003. Aquatic hypoxia is an endocrine disruptor and impairs fish reproduction. Environmental Science and Technology. 37(6):1137-1141.

Yao Q, Wang X, Jian H, Chen H, Yu Z. 2015. Characterization of the particle size fraction associated with heavy metals in suspended sediments of the Yellow River. International Journal of Environmental Research and Public Health. 12(6).

Enclosure: Detailed Project Activities

Construction of Dry Dock 5 and Associated Facilities

PHNSY and IMF is on the south shore of East Loch and the east side of the Main Channel of Pearl Harbor at JBPHH (Figure 1). DD5 and the WPF will be inside a controlled industrial area (CIA) on PHNSY and IMF, which is surrounded by a security fence and access is allowed only for approved personnel. Elements of the proposed action that would occur at or near PHNSY and IMF include construction and operation of DD5, a WPF, auxiliary facilities, a weight-handling system (cranes), a retaining wall, quay walls, a new crane maintenance area, a rock revetment, lighting, and upgraded utilities for operational demands.

In-water Construction Activities

Construction of the replacement dry dock would take approximately 65 months and be organized into four parts: (1) mobilization, demolition, installation of dry dock shoring walls, and dredging; (2) placing concrete in the water (precast and tremie [i.e., refers to a water-tight, funnel-like device to deposit concrete directly into the water]); (3) construction of the quay walls and placement of the caisson; and (4) land facility work. The activities discussed below are dredging, demolition of the marine railway, fill, construction of shoreline structures (quay wall, rock revetment), pile driving, and concrete work. The only upland material to be removed will be portions of the marine railway and the footprint for the southern end of the dry dock. Sediment conditions are described through borings, bathymetry profiles, and sub-bottom imagery. Most of the waterside area is included in the Pearl Harbor Sediments CERCLA program; therefore, sediment chemistry is available for surface (i.e., top 1.8 m [6 ft]) sediments. The proposed project phasing is listed below (not all items will progress in series, some may be conducted in parallel):

- Demolish marine railway, particularly the southernmost 182.9 m (600 ft).
- Dredge munitions and explosives of concern (MEC) in accessible areas.
- Backfill southernmost portion of marine railway.
- Demolish marine railway, particularly the northernmost 91.4 m (300 ft).
- Install/pile drive combi-walls around dry dock footprint.
- Dredge remaining MEC once combi-walls are in place.
- Dredge native material in dry dock footprint to design elevation.
- Construct/pile drive quay walls.
- Dredge DD5 entrance channel.
- Construct rock revetment.
- Place backfill around dry dock.

Marine Railway and Crane Maintenance Pier Demolition

The marine railway (including rail structure and pile caps) and crane maintenance pier will be removed to accommodate filling and construction activities. The railway is constructed of iron crane rails (partitioned into square sections) and concrete pile caps that run the length of the railway. Under the pile caps are timber piles that reach 6.1 to 18.2 m (20 to 60 ft) down into the substrate. Some wood piles in the shallower part of the marine railway slope would need to be removed, but piles would be left in place where they do not conflict with construction and fill can be placed on top of them. Contractors will excavate around the pile caps and cut off piles that would remain in place. Crane rails and pile caps are partially buried in soft surface sediment with the potential for MEC. Also, a crane maintenance pier that is east of the marine railway and a small platform and pier will be demolished prior to dredging. The wooden fender piles and the line of 45.7 cm (18 inch) square concrete piles that are on the west side of the crane maintenance pier will be completely removed. The concrete piles that are entirely on dry land will also be removed. The eastern row of concrete piles will not be removed, but the concrete column and pile caps on top of the piles will be removed. The concrete footing for the east side of the crane maintenance pier will be removed, but wooden piles that are in the water will not be removed but cut off at the mudline. Finally, the small platform and pier east of the crane maintenance pier will be entirely removed. A mooring dolphin and walkway at the DD3 quay wall along the west face of DD3 would be demolished to allow for construction of the new quay wall located east of DD5. Deteriorated timber fender piles at the DD3 quay wall would be demolished and replaced with new precast concrete fender piles.

Dredging

Dredging would be required to create new depth for DD5 and the DD5 entrance channel that provides access for vessels to the new dry dock. Dredging would be conducted in areas planned for fill that require removal of soft material or debris to meet geotechnical requirements. Also, the excavated material will be re-used onsite as much as possible. However, within the project boundary for DD5, all areas of soft sediments have been determined to have the potential for MEC. To limit work in the presence of MEC to the extent practical, the project will maximize removal of soft sediment with the potential for MEC prior to subsequent in-water construction activities. Soft sediment/MEC material will be left in place in backfill areas where dredging is not required to facilitate construction. In addition, a temporary shoring wall will be installed around the perimeter of the dry dock footprint to reduce dredge and backfill volumes and facilitate dry dock wall construction. Soft surface sediment with the potential for MEC will be removed in the footprint of the shoring walls to accommodate installation and reduce risk of encountering MEC during construction. Once the shoring walls are installed, bulk removal of soft surface sediments will be conducted first to remove the MEC hazard, followed by dredging of the underlying native sediments down to design depth.

The majority of the dredge footprint at PHNSY and IMF is within one of the CERCLA dredge boundaries for the Pearl Harbor Sediments Site (NAVAC PAC 2020). The CERCLA program identified remedial activities for the surface soft sediment layer at various locations within Pearl

Harbor. The activities include removal (dredging), capping, adding activated carbon, or monitored natural recovery. Within the CERCLA footprint is a smaller area close to DD3 that will be managed following Toxic Substances Control Act (TSCA) procedures because it has the potential to contain hazardous levels of polychlorinated biphenyls (PCBs). The estimated volume is approximately 150 CY (115 m^3). The Navy is planning on dredging any CERCLA sediment within the footprint for DD5 prior to commencing dredging for this proposed action.

Construction dredging quantities for PHNSY and IMF, including over-dredge, construction dredging at DD5 would be performed to a depth of 19.4 m (63.5 ft) below Mean Low Water within the DD5 footprint. Areas around the DD5 footprint would not be dredged as deep as inside the footprint, because they need to only be cleared down to suitably stable substrate. The estimated volume of soft material with the potential for MEC at DD5 is 66,300 yd^3 (50,700 m^3). There is a low potential for MEC at PCP and a moderate to high potential for MEC at WP.

Once soft sediment with potential to contain MEC is removed, the safety zones would be removed. Dredge materials would be screened for contaminants and MEC after placement in the CDF cells at WP. An entrance channel to DD5 for incoming submarines measuring 100 ft (30.5 m) wide by approximately 300 ft (91.4 m) long would be dredged to a depth of -45.8 ft (14 m) below MSL (-45.0 ft mean lower low water [MLLW]), plus 2 ft (0.6 m) allowable over-dredge.

Some fast land at PHNSY and IMF will need to be excavated to accommodate the length of DD5 and to remove land that has been determined to be geo-technically unsound to support the facilities planned for the site. Some areas of shoreline east and west of the proposed DD5 site will need to be excavated prior to fill because the substrate does not meet geotechnical standards required. The duration of dredging and excavation activity at PHNSY and IMF is projected to occur for up to 24 hours/day, 7 days/week for approximately 15 months (the period of MEC dredging will be an exception to that schedule and occur continuously at night). There could be periods of non-dredge activity during the 15 months. During operation of DD5, dredging for maintenance would occur as needed to remove any accumulated soft sediment, which is expected to occur only every 10 to 20 years. The following equipment may be required to complete the dredging actions, based on the scope of the work, likely bidders, equipment availability, and past project experience: clamshell dredge, excavator, backhoe dredge, off-loader/conveyor, scow(s), flat barge(s), tug(s), survey vessel(s), crew boat(s), and support equipment.

The off-loader/conveyor will likely be mechanical, but could potentially be hydraulic if return water can be managed without impacting adjacent stockpiles or interfering with material processing and dewatering. A silt curtain would be used to the maximum extent practicable to protect marine species and/or habitat from sediment particles. If a visible plume occurs outside of the 300 ft. (90.1 m) radius, the contractor shall stop dredging and evaluate the cause of the problem. The contractor will resume dredging only after corrective measures are completed and the problem is resolved. The material in Pearl Harbor to be dredged or removed is primarily silt, silty sand, consolidated marine sediments, stiff clayey silt, and mud. There will be no discharge of dredged material into the harbor or on land during the off-loading and transportation of the dredged material. The scows will not be loaded beyond a level that may cause overflow of effluent into any of the waters surrounding the dredge area, mooring location or in transit to the disposal site. If a plume is observed outside the silt curtain, any dredging practice or procedure causing unnecessary water column turbidity will be discontinued, and corrective action taken immediately. No dredged materials will be placed back into the marine environment in Pearl Harbor. There will be no dumping of partial or full buckets of material back into the work area or washing material into the water. There will be no dredging below project depth, and subsequent redistribution of sediment by any means. Prior to most dredging operations in Pearl Harbor, the contractor typically "rakes" the dredge areas and removes debris encountered by swinging the bucket from side-to-side to sweep and level-off the target area before dredging, and then determines if there are any objects in the targeted area. If large and/or unusual objects are found within the target area, the contractor will remove them prior to beginning dredging. Normal debris may be removed during the dredging process and from the water. Disposal of non-dredge material debris will be the responsibility of the contractor and shall be outside the limits of government property. Dredged material will be measured by CY (in place) by means of sounding before and after dredging. Over-depth dredging will be allowable only up to 2 ft (0.6 m) and will not exceed the sampling depth of 2 ft (0.6 m) beyond the project depth.

Dredge Spoils Handling

The following section provides an outline for how the various types of sediments are to be managed during dredge spoils handling and placement. Soft sediment/MEC has prescriptive requirements that must be adhered to, and all soft sediment/MEC will be processed for MEC at the CDF prior to re-use or disposal. "Native" sediments underlying the soft sediment/MEC layer are expected to be of suitable quality for re-use within the project site or for ocean disposal, with a portion requiring processing to reduce particle size prior to placement. Dredge spoils would be offloaded at either the existing offloading site at WP or proposed temporary pier at WP. At WP, CDF Cell #1 and/or #4 will be utilized for dewatering and processing dredge spoils with the potential to contain MEC. Materials will be segregated at the CDF to prevent mixing. Other CERCLA material and non-CERCLA material will be processed and stored separately. CERCLA sediment will be disposed of at the PVT Landfill on island once all MEC has been removed. Currently, the two CDFs for this project have other material in them. As the Navy manages these materials, the capacity will be updated. All material found to be suitable for unconfined disposal may be placed at the US EPA's SOODMDS. This may require material processing to ensure any sizing requirements for the native material and removal of any MEC for the soft sediment/MEC material. It is assumed that as much as 91,000 CY (69.6 m^3) of the native material is coarse grain, coral sands material with coral rubble less than 3 inches (7.6 cm) in diameter. Future reuse and/or disposal methods would depend upon the sediment characterization. Material deemed suitable for beneficial reuse may be used as fill material. Approximately 40,000 CY (30,582 m^3) of the native material is a dense coralline material that will require processing prior to placement at SOODMDS to meet environmental requirements. This activity may take place at CDF Cell #4. These larger rocks of coralline material will be managed on site to the greatest extent practicable. The construction plan assumes 10,000 CY (7,646 m^3) of the 40,000 CY (30,582 m^3) would be placed adjacent to the rock dike area.

Pile Driving

Pile driving using pre-drilling, vibratory, or impact methods would be required for installation of DD5 and the construction support facilities at WP, PCP, and FI and would be accomplished through pile drivers operating from land, barges, or on-water platforms. Pile driving activity would occur during daylight hours in the following time frames:

- At DD5, 10 hours per day, 6 days per week, for approximately 14 months (but could extend longer if unusual driving conditions are encountered).
- At WP, 10 hours per day, 6 days per week, for 3-4 months.
- At PCP, 10 hours per day, 6 days per week, for 2-3 months.
- At SEFI, 10 hours per day, 6 days per week, for 2-3 months.

With the proposed action including two support/laydown sites and one central construction site at PHNSY and IMF, it is possible that in-water sounds from pile driving, dredging, and drilling could occur simultaneously at the same site or between sites. The support sites at WP and PCP are expected to be constructed before much of the primary work is accomplished at DD5, especially the pile driving, since the structures that would be made are necessary to move material and supplies to the construction site. Even though that is the case, some preparation of the DD5 site will start immediately which can include demolishing buildings and dredging the site. It is possible some construction activities will occur simultaneously, such as pile driving at WP and dredging at PHNSY and IMF.

Following completion of construction activities for DD5, piles used for construction support facilities would be removed (extracted) using vibratory methods. Extraction would require up to approximately 25 days at PHNSY and IMF, 56 days at WP, and 46 days at PCP. Each day would include a maximum of 10 hours. A portion of piles used to provide structural stability during construction of DD5 would also be removed, requiring up to approximately 107 days. A realistic scenario is that more than one pile-driving rig will be driving piles at the same site at the same time. The aggressive schedule for constructing DD5 and the fact that the two sides of the dry dock are separated by about 100 ft (30.5 m) would be conducive to two cranes operating pile driving hammers at the same time.

Anchor Walls: One pair of anchor walls is located immediately behind the quay wall on both east and west sides and will be driven in-water. The H-piles of the quay walls are attached to the anchor walls using tie rods. The anchor wall acts as a “deadman” or stationary anchor that resists movement and helps maintain the integrity of the quay wall or dry dock shoring walls.

Temporary Trestles: They are steel pipe piles that will be driven in-water. They will temporarily support the pile driving rigs that will drive the H-piles for the shoring walls for DD5. The trestles will be removed after the fill goes into place.

Temporary Offloading Pier: This is a standard pile supported pier that will be constructed on top of the south half of rock revetment. The offloading pier will be extracted after the dry dock has been built and may be rebuilt and removed again for the WPF construction.

Fill Activity

The grade elevation surrounding DD5 would be raised from 7 ft (2.1 m) to 11 ft (3.4 m) above MSL to account for flooding and long-term sea level rise. To achieve this elevation and establish a consistent grade, structural fill will be used to fill the area around the DD5 walls and the peninsula west of DD5. To bring elevation to pre-sub-base backfill (approximately +6.0 ft. [1.8 m] MSL), the total quantity of in-water fill is estimated at 265,000 CY (185,800 m^3) and will include the permanent loss of approximately 7.8 acres (0.03 km^2) of marine waters in PHNSY and IMF due to the permanent addition of fill during the construction of DD5. Additionally, the proposed action will include the long-term loss of 0.6 acres (0.002 km^2) of marine waters at WP as a result of the installation and removal of construction support facilities (i.e., extend beyond the Pearl Harbor coastline and into the water).

Rock Revetment

A rock revetment structure will be constructed to protect the backfill along the western flank of DD5. The revetment structure is currently under design. The slope will be 1.75:1. The top elevation is +12.0 ft (3.7 m) MSL. The rock sizing at the revetment considers waves, currents, and wake and propeller wash (e.g., tug and navy vessels). The recommended median rock size is 1 ton (2,000 lbs), assuming the riprap armor has a typical, wider distribution of gradation. If the source of rock riprap has a uniform distribution of gradation, the median mass drops to 0.5 ton (1,000 lbs). Two basic designs are under consideration. Both options would utilize quarry run material (12-inch minus) as the core stone, with armor stone placed on top and on the outside to protect against erosion.

Concrete Work

DD5 floor would be constructed using both tremie concrete (i.e., concrete that is poured under water) and precast sections. Tremie concrete would be placed using a gravity-fed hopper through a vertical pipe that extends from above the water surface to the underwater floor. Underwater concrete could also be placed by pumping from a pump placed above water through a hose to the placement location in the floor. Precast concrete sections would be placed using a construction crane and flotation tanks to control the buoyancy of the precast units. Introduction of tremie concrete to the marine environment with construction of DD5 walls could impact pH, total suspended solids (TSS), and turbidity. However, a cofferdam would be installed to control spill over to the marine environment. Only marine grade concrete shall be used. No lime, chemicals or other toxic or harmful materials related to non-marine grade concrete will be permitted to be discharged to surface waters. All concrete grout, cement, and sealant will be non-toxic and non-hazardous to marine organisms. The dry dock walls would be constructed in the dry after dewatering the dry dock basin.

Temporary Cofferdam

A temporary cofferdam will consist of a cantilevered north wall, braced east and west walls, and a tremie concrete cutoff plug, and will be constructed after the dredging has been completed and all the precast concrete dry dock monoliths have been floated-in and set in place. The service life of the temporary cofferdam will be limited to the period of construction. The cofferdam will be constructed by first driving the king pile combi-wall into the ground along the entire alignment, tying into the permanent dry dock cofferdam. The existing grade will be then dredged on the inboard side of the cofferdam down to final grade. Tremie concrete infill will be placed in the voids within the cofferdam, and initial seals will be installed in the two corners of the cofferdam. After the tremie concrete cutoff plug has reached its specified design strength, the DD5 work area will be dewatered. Steel bulkheads will then be installed at the two corners of the cofferdam, and tremie concrete infill will be placed to create final seals at these corners.

Caisson

D5 would be equipped with a caisson measuring approximately 118 ft x 57 ft x 22 ft (approximately 36 m x 17 m x 7 m) at the DD5 entrance. The caisson would be a formed-welded, steel plate assembly that will provide a watertight seal, allowing the dry dock to be emptied and flooded with seawater as required for operations. Flooding of DD5 would be done using pumps and flood-through tubes within the caisson, providing superflood capability inside DD5. The caisson will be delivered to the project site via a special, heavy-lift vessel. While not yet determined, the caisson transit may potentially involve a single transoceanic vessel crossing expected to occur from Norfolk, Virginia to Oʻahu, Hawaiʻi in order to deliver the DD5 caisson. When not in use, the caisson would be moored along the quay wall adjacent to the DD5 entrance. The design life for the caisson is 50 years.

Workforce Transportation

During construction, the Navy is considering five workforce transportation options, each with varying levels of traffic delays. Of these five options, three options involve a contractor-operated ferry to shuttle workers to and from PHNSY and IMF from three different areas:

1. IP Route and Ferry Transport: Temporary single-passenger vehicle parking for up to 500 vehicles at IP; Ferry pick up at EOD Small Boat Landing and drop at existing pier at Landing C or Degaussing Small Boat Landing.
2. WP Route and Ferry Transport: Temporary single-passenger vehicle parking for up to 500 vehicles at WP; bus pick up at temporary parking lot at WP and shuttle to material offloading pier; ferry transport to existing pier at Landing C.
3. FI and Ferry Transport: Temporary single-passenger vehicle parking for approximately 500 vehicles at FI (two sites being considered); ferry pick-up at sea plane ramp and transported to Landing C or directly to DD5 construction site.

All options above estimate that two ferries would be required for each shift: one ferry with an approximate 50-person capacity; and the other with an approximate 140-person capacity. Personnel would procure their own transportation to and from the designated parking lot. Ferry operations would last for the duration of construction of DD5 (65 months) and the WPF (42 months).

Climate Change

The proposed action was designed with specific climate change risks for this property, including sea level change (SLC). DD5 will be located within a 100-year flood plain, and mitigation is being planned based on best available government data for this site. Design solutions will mitigate the impact of SLC on the building function and occupants, consistent with mission criticality. In 2019, the National Geodetic Survey adjusted the benchmark elevations in the project vicinity based on the MSL in epoch 1983-2011 at the Honolulu tide station (NOAA Station ID: 1612340). The adjustment was mainly due to SLC. Since all the data around the site are based on the pre-1983 tidal data (including the topographic survey, SIOP and Geographic Information System data), the pre-1983 data are still useful and were selected by the Navy's design team for the proposed action, thus ensuring that tidal data will be consistent between this proposed action. The Department of Defense Regional Sea Level (DSRL) database (v 3.0; October 2020) provides the statistics of Regionalized Extreme Water Levels, which include effects of the astronomical tide and storm surge. The DSRL also provided regionalized sea level changes (RSLCs) at year 2035, 2065, and 2100 for five global SLC scenarios. The RSLCs combine the site-specific adjustments with the global SLC value. Furthermore, the proposed action was designed with consideration for tsunami risks and is compliant with standards established in Minimum Design Loads and Associated Criteria for Building and Other Structures ASCE 7-16 (2016). Structures of Tsunami Risk Category III and IV will be designed for the effects of maximum considered tsunami (MCT), with a 2,475-year average return period. A site-specific tsunami modeling and energy grade line (EGL) analysis was performed following the guidance provided in ASCE 7-16 to estimate the MCT conditions at the dry dock site. Four water levels were simulated, including current MHW and three RSLC conditions. Therefore, based on (but not limited to) the data summarized above, several aspects of the proposed action were designed with multiple SLC and tsunami considerations. Key project elevations for the DD5 coping, DD5 deck, quay wall deck, and buildings have been determined from analysis performed by coastal and structural engineers considering UFC requirements, shipyard operations, flood elevations, Flood Insurance Rate Maps, and SLC for various scenarios and storm recurrence intervals. All mechanical/electrical equipment required for operation is located above MHHW plus the DRSL medium estimate of SLC. Long-term erosion effects were considered in the construction and maintenance dredging, pile driving, fill, and rock revetment and quay wall construction, all of which could alter bathymetry or disturb sub-surface geology and marine sediments. Quay walls will be designed as anchored bulkhead walls tied back to deadman structures to retain lateral load from the fill and any surcharge or load applied to the deck slab. All materials used for the quay wall will be designed for a 100-year service-life, which is defined as the time until major repairs are required.

Also, the proposed action will create a hardened shoreline of man-made structure (DD5) and the rock revetment, which is designed to eliminate erosion of the shoreline.

Dry Dock 5 Operations

DD5 must be capable of operating 365 days/year and 24 hours/day. Therefore, operation of DD5 during periods of darkness would require facility lighting. DD5 would use both pole-mounted flood lights and wall fixtures to illuminate the work area. No additional lighting would be added to the temporary security fence. Utility galleries and the mechanical utility tunnels would be illuminated by wall-mounted fixtures. Outdoor lighting would include directional louvres to minimize light scatter in marine environments and avoid attracting seabirds A new portal crane maintenance area would be located south of DD5 (between DD5 and DD4), to the east of Cushing Street. The existing portal crane track between DD3 and DD4 would be realigned to allow space for a switchback return to DD5. A new portal crane track to the west of DD5 would connect via a new switch into the existing rail DD4, and a new crane maintenance track would run to the east of the realigned existing rail between Ingersoll Avenue and Seabee Way. The portal crane maintenance area would be occupied by permanent or temporary structures such as storage containers, vision towers, and maintenance facilities.

Utilities: New electrical and mechanical utilities would serve the operational demands of DD5, including submarines docked at DD5. Most utilities would connect to existing utilities in areas adjacent to DD5; electrical power routes and mechanical utilities that would extend outside of that area are discussed below. New fiberoptic and telecommunications lines would be located along route options being considered for electrical transmission.

For electric utilities, the uncovered DD5 would have an operational peak load of up to approximately 8.0 (+/- 2) megawatts (MW). Power supply would be generated by Hawaiian Electric Company and distributed to a new substation constructed adjacent to the existing Hawaiian Electric Company substation, located south of Central Avenue, via two new 46-kilovolt (kV) feeders from Makalapa Substation. This Substation would have a footprint of approximately 26,540 ft^2 (2,466 m^2). The Hawaiian Electric Company substation would have a footprint of approximately 86,179 $ft.^2$ (8,006 m^2). Dual 11.5 kV feeders would serve DD5 and auxiliary facilities.

Exterior lighting is required in five different areas for DD5, including the dry dock itself, the area surrounding the dry dock, security fencing, the waterfront approach, and the streets. The areas around the dry dock areas are considered “Work Areas,” and illumination requirements are provided in the US Dept. of Labor Occupational Health and Safety Standards for Shipyard Employment (29 CFR 1915.82, UFC 3-530-01 Paragraph 6-3.5.1 and UFC 4-212-10). The method for illumination of the DD5 area includes high mast lighting utilizing LED lighting fixtures that comply with the ratings for fully shielded and glare U0/G2. A pole height of 60 ft has been selected with a 6-fixture pole top array to provide the required level of illumination while minimizing glare. For the security fence, engineers selected a pole height of 30 ft., and calculations indicated a spacing of approximately 100 ft on center will provide the required level of illumination while minimizing glare. Also, the crane maintenance area will be illuminated to allow for maintenance work on the cranes, and pole heights in this area will be limited to 30 ft.

Mechanical utilities include the dewatering and drainage system, sanitary wastewater, industrial wastewater, potable water, saltwater and auxiliary seawater closed loop, chilled water, compressed air, nitrogen, and shore chilled water.

Dewatering and Drainage System: Dewatering DD5 will occur via a drainage tunnel to the pumphouse wet well. Sand traps between the drainage trenches in the dry dock floor and the drainage grates would collect debris and fine material prior to the water entering the drainage tunnel. From the wet well, the main dewatering pumps would lift the water to an elevation above the coping elevation (11.83 ft [3.6 m] above MSL) and discharge into a gravity-based culvert that passes through the rock revetment to the harbor. The discharge culvert conveys water pumped from the pumphouse wet well to Pearl Harbor, and its upland end is fed from utilidors extending from the wet well (i.e., beneath the pumphouse), while its waterside end daylights into Pearl Harbor below the lowest observed water level. Water that would be pumped to the harbor would only be water that flooded the dry dock when a submarine entered the dry dock. Water that collects in the dry dock after it is dewatered will be processed through the existing Navy WWTP.

Saltwater: Saltwater would be used for dockside (outside of vessel) fire protection and flushing/backup cooling for the submarines docked at DD5. When needed, anticipated saltwater flow rate for dockside fire protection would be approximately 1,000 gpm at 60 psi, and flushing/backup cooling would be approximately 950 gpm at 150 psi supply and 40 psi minimum.

Industrial Wastewater: Industrial wastewater would be collected and sent to the Navy WWTP, if needed, prior to discharge to the sanitary sewer. Direct discharge to the sanitary sewer would be allowed if no pretreatment was necessary.

Vessel Cooling: Vessel cooling would be accomplished through closed cycle cooling, whereby the heat load to be rejected is transferred from the process fluid (the fluid being cooled) to the ambient air through a heat exchanger such as a coil or evaporative cooling tower. The heat exchanger serves to isolate the process fluid from the outside air, keeping it clean and containment free in a closed loop.

Waste Disposal: The DD5 would rely on portable electric-powered equipment (with diesel backup) to handle bilge and oily waste from docked submarines. Waste regulated under the Resource Conservation and Recovery Act (RCRA) would be transported by truck to a central accumulation area for assessment, testing, packaging, and disposal. Hazardous waste, including waste not covered by RCRA, and used oil would be delivered by truck to Navy's industrial wastewater treatment plant for assessment, testing, packaging, and proper disposal in compliance with applicable regulations and protocols.

Sewage: Sewage will be handled by connecting into the existing wastewater system and treated at the Navy WWTP. Containment basins would be provided for any potential leakage. The existing building that houses shipyard sanitary sewer pumps would be upgraded to accommodate the additional flow from DD5. An additional capacity of 200 gpm would be added to the pumping station through the replacement of both pumps in the building. Transfer of service to the new sewage pumphouse will be done after the new construction and line upgrades are accepted, after which the old pumphouse will be demolished.

Stormwater Management: The proposed action is expected to result in increased peak stormwater runoff due to the increased impervious area from new pavement and increased efficiency of stormwater drainage (e.g., number of storm drain inlets and grading). During construction, erosion and sediment control measures would be implemented in areas where they are required. Potential impacts to stormwater from landside construction activities would be mitigated through the use of construction BMPs designed to treat runoff from the construction areas. Additional site-specific BMPs would be identified in the Stormwater Pollution Prevention Plan, and any construction water quality permits that are needed would be secured. The new stormwater collection system is evaluated in accordance with the City and County of Honolulu Storm Drainage Standards (August 2017), and the increase in runoff would be captured and allowed to infiltrate to the maximum extent practicable, with use of retention basins, gravel, and infiltration trenches. The newly-constructed underground stormwater system would intercept and collect the stormwater flow via trench drains and surface inlets. New drainage management areas would be established, each with separate discharge outlets to the harbor. Stormwater systems would use treatment devices to mitigate impact of outfall flow into the harbor. The new stormwater system would also relieve the existing stormwater systems of DD3 and DD4 because the crane maintenance area would be regraded to flow to the new outfalls. Stormwater runoff collected within the dry dock inherently mixes with seepage water and industrial uses and cannot be separated. This includes stormwater runoff that has made contact within a 15 ft (4.5 m) boundary of the dock, the first 15 mm (0.5 in) of rainwater to reach this boundary, and any wastewater from hydroblast and hydrotest operations, all of which would be captured and transferred to the BWTS for storage and treatment prior to discharging through the landside wastewater system (i.e., untreated stormwater runoff from DD5 would not be discharged into Pearl Harbor except during extreme storm events.

Once appropriate National Pollutant Discharge Elimination System permit conditions are met, the oil-water separator effluent would be combined intermittently with cooling water (blowdown) and discharged to the Navy wastewater system. The Navy WWTP accepts both domestic (household) and industrial wastewater. Furthermore, all proposed dry dock site stormwater systems will be treated by a manufactured treatment device (MTD) prior to discharging via a proposed outlet into Pearl Harbor for surface water quality (SWQ) purposes. An MTD will also be installed near the DD3 outfall to improve the SWQ of the existing drainage system. An infiltration trench will be utilized on the south side of the Portal Crane Maintenance Area. Three infiltration basins will be utilized at the northwest side of the DD5. The proposed action reclaims land area from Pearl Harbor, leading to an increase in impervious areas and an anticipated increase in peak flow stormwater runoff. The increase in runoff will be captured and infiltrated to the maximum extent technically feasible. Grass areas to the south of the revetment and south of the Portal Crane Maintenance Area are utilized to increase pervious area.

Basin Water Treatment System: Normal seepage, storm, and process water that accumulates inside of DD5 would be collected in floor drains and conveyed to the pump well where drainage pumps would discharge to the BWTS. The trench drain conveyance is sized for a 100-year, 24-hour storm event. The combined basin water basis of design flow is 463,150 gallons per day (gpd). During high-flow events, if the BWTS storage tank reaches high levels, the dewatering pumps would be used to discharge excess water via the outfall to Pearl Harbor. Normal seepage, storm, and process water that accumulates inside of DD5 would be collected and directed to the BWTS for treatment and disposal via one of two discharge options. Wastewater collected in the BWTS storage tank will be treated using oil/water separators for reduction of oil and grease, and disc filtration for reduction of TSS prior to discharge to the sanitary sewer. Inside the dry dock, industry standard BMPs would minimize TSS and contaminants from being discharged during dewatering.

Maintenance: Operation of DD5 under Stage 1 would require periodic cleaning and maintenance dredging in front of DD5. Maintenance dredging for DD5 would occur every 10-20 years. The steel caisson would be subject to routine inspection and maintenance activities. Cleaning and disposal of sediment deposited in the sump, drainage tunnels, filters, and sand trap would occur to support operation of DD5. Significant maintenance overhauls would be scheduled every 10-20 years. As part of the significant maintenance overhauls, corrosion protection coatings would be reapplied as needed to the surfaces of the caisson exposed to seawater, and the aluminum anodes that comprise the caisson cathodic protection system would be replaced. Corrosion protection coatings would be reapplied as needed to surfaces of the quay wall exposed to seawater.

Construction of Operation of Waterfront Production Facility

The Navy proposes to build a WPF between DD5 and DD2 on top of the location that is currently DD3. After DD3's last commitment to service a submarine in 2023, it will be decommissioned. To build the WPF, DD3 would need to be demolished (which entails building a concrete wall in front of the dry dock area), followed by dewatering, and filling the facility. The WPF construction will occur sometime after DD5 is complete and operational. The WPF will be built on ground that is the same elevation as the deck plate of DD5 (11.0 ft [3.4 m] above MSL). A new, approximately 235,000-ft^2 (21,832-m^2), three-story WPF would be constructed and operated east of DD5, serving both DD2 and DD5. The WPF would operate 24 hours per day, 7 days per week, and 365 days per year. Stormwater and basin water would be managed in the same way as during the DD5 construction. In-water work includes installation of construction support facilities at WP and PCP and a precast concrete wall at the opening of DD3. Pile driving activity would occur during daylight hours (up to 10 hours per day and 6 days per week) for different duration: WP (3 to 4 months), PCP (2 to 3 months) and FI (2 to 3 months). The temporary offloading piers that were constructed for making DD5 are expected to be constructed again to support the WPF construction. The same pile driving and extraction parameters would apply to the reconstructed pier. Construction support facilities would be removed following construction of the WPF. The only new in-water construction necessary for the WPF is the concrete wall at the opening of DD3. The concrete wall would cover and seal the opening of DD3 such that work associated with demolition and fill of DD3 would occur under dry conditions.

Construction Support Facilities

Construction support facilities would be located at PHNSY and IMF, WP, PCP, FI, and IP. Potential parking at WP, FI, and IP is associated with workforce transportation options. Construction support facilities would be operational for the duration of Stage 1 construction (65 months), after which they would be removed. Landside areas of temporary disturbance would be restored by passive restoration, meaning areas would be restored through natural succession after the construction period ceased. Landside areas do not include any areas deemed jurisdictional waters of the United States (WOTUS), including wetlands. Construction of the project would also require use of new and existing barge moorings. New moorings would be anchored to the bottom substrate and would vary in size based on ocean bottom conditions and barge size. Barge size is estimated at approximately 8,750 square feet (813 m^2) on average. Moorings will be installed from a barge crane utilizing divers to inspect seabed to determine an acceptable location for each mooring.

Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility

A new but temporary material offloading pier will be constructed in the area over the new rock revetment to the west of DD5. As this pier will be installed after the construction of the rock revetment, no additional site preparation or impacts to the marine environment are anticipated. The pier will be an open, pile-supported pier that will allow water circulation beneath.

<u>Pile Driving:</u> Pile driving using vibratory, impact, or pre-drilling methods would be required for installation of the temporary offloading pier at PHNSY and IMF. Pile driving activity would require multiple barges with installation equipment. Pile driving operations will occur for 6 days/week and for approximately 10 hours/day during daylight hours only for 3 to 4 months. Construction support facilities would be operational for the duration of DD5 construction (65 months), after which they would be removed.

Waipio Peninsula

WP is expected to be a key location of construction support facilities. It may be the site of a concrete batch plant and a casting area for precast concrete sections for DD5 as well as the location where dredge material will be dewatered and processed. Several temporary in-water structures have been designed for the purpose of loading and offloading materials, pre-cast concrete elements, and dredge spoils.

<u>Material Loading Pier:</u> The temporary loading pier would be a pile-supported pier with two access piers from the land that lead to a long pier positioned parallel to the Pearl Harbor Main Channel. This structure is intended to service barges and delivery ships for transport of dredge spoils and construction materials on and off the WP and will be removed after DD5 is complete. The part of

the pier parallel to the main channel will be positioned close enough to deep water and the edge of the DC to forego requiring dredging to make the pier accessible.

Ramp and Gantry Crane Pier: These two temporary structures have been designed for moving large pre-cast concrete and will be removed after DD5 is complete. One or the other structure may be built if the construction contractor chooses to manufacture precast concrete parts for DD5 on WP. These structures are not supported by piles and will be constructed on a foundation, the material of which is unconfirmed at this time and will be determined by contractors.

Dredging: Dredging could also be necessary to provide adequate draft for vessels to access temporary facilities at WP. For more information about the likely dredging methods, see above. Dredging at WP is projected to occur for 24 hours/day, 7 days/week for approximately 2 months.

Pile Driving: Pile driving using vibratory, impact, or drilling methods would be required for installation of temporary structures at WP. Pile driving activity would require multiple barges with installation equipment. Pile driving operations will occur for 6 days/week and for approximately 10 hours/day during daylight hours only for 3 to 4 months. Construction support facilities would be operational for the duration of DD5 construction (65 months), after which they would be removed.

Pearl City Peninsula

PCP is the location of a staging and storage area for construction materials. Its functions will be secondary to WP, which is the primary site of storing, staging, and processing construction materials. Plans for establishing support facilities at PCP may be executed in part or may not be executed at all if the construction contractor realizes efficiencies or offers alternatives for producing or storing materials that are not located at JBPHH. A temporary pier that affects marine resources has been conceptually designed.

L-shaped Pier: The temporary L-shaped Pier would be a pile-supported structure jutting east from the land that makes a 90 degree turn above the northwest corner of the DC in upper East Loch. Vessels that will be loaded from the crane on the bulkhead and directly from the pier will dock at the L-shaped Pier. A small amount of dredging may be required to provide access around the pier for the vessels, but the dredge footprint has been minimized through placement of the pier reaching out to the previously dredged footprint.

Dredging: Some dredging may be necessary if the L-shaped Pier is built in order to provide access around the entire end of the pier. The dredging would occur for 24 hours/day, 7 days/week for approximately 2 months. Dredging would only occur as needed to remove any accumulated soft sediment for maintenance during operations.

Pile Driving: Pile driving using vibratory, impact, or drilling methods would be required for installation of the temporary structures at PCP. Pile driving activity would require multiple barges with installation equipment. Pile driving operations will occur for 6 days/week and for approximately 10 hours/day during daylight hours only for 2 to 3 months. Construction support facilities would be operational for the duration of DD5 construction (65 months), after which they would be removed.

Ford Island

The construction support facilities at FI include the use of existing structures and areas for material storage, work force parking, and contractor access via small boat landings. In addition, up to seven temporary pile clusters will be installed to support construction activities and removed when the proposed action is completed. Two pile clusters will support each set of barges, and approximately 6 to 12 barges may be moored overnight for the storage of dredged sediment and construction materials. Longer stays are anticipated but will be based on weather and construction progress. The number and size of pile clusters are dependent on contractor needs and equipment sizes and will be determined after the construction contract is awarded (March 2023).

<u>Pile Driving:</u> Up to 7 pile clusters will be installed temporarily at southeast FI to allow for temporary mooring of barges during in-water construction for the proposed action. Each cluster may comprise 5-18 pre-cast, concrete piles (20-in [9.1-cm] diameter) driven by pre-drilling methods and impact pile driving. The total size of each cluster may be up to 20 ft (6.1 m) in diameter. Pile driving activity would require multiple barges with installation equipment and may occur for 6 days/week and for approximately 10 hours/day during daylight hours only for 2-3 months. Construction support facilities would be operational for the duration of DD5 construction (65 months), after which they would be removed.

<u>Barge Mooring:</u> For the duration of the proposed action (i.e., 65 months), up to 50 barges will be used to transport and store materials, thus requiring overnight moorings. Various locations throughout Pearl Harbor (both existing and new) have been carefully selected. Each barge is estimated to have an average overwater coverage of 175 ft x 50 ft (53.3 m x 15.2 m), ranging from the smallest barge size of 110 ft x 35 ft (33.5 m x 10.7 m) to the largest size of 200 ft x 75 ft (61.0 m x 22.9 m). For the new moorings in Middle Loch, a contractor might use as a typical mooring setup for recreational boats and sailboats, but with heavier and larger components (e.g., 5,000 to 10,000 kg [11,023 to 22,046 lb]). However, due to different anchor types, ocean conditions, and different barge designs, the contractor may elect to deploy a different style of mooring system, such as a mushroom anchor or block, a drag anchor or a Stevshark anchor. The final mooring layout will be based on a 360-degree barge swing and depend on wind direction, so that each moored barge will be able to act in a full swing without hitting other moored barges. It is anticipated that the moorings will be installed from a barge crane while utilizing divers to inspect the seabed to determine an acceptable location for each mooring. The new moorings will be installed within the first 6 to 12 months from construction notice to proceed. The proposed locations for these new moorings are void of flora and/or fauna in the marine environment. No coral species are growing and/or are present. No sea grasses are growing and/or are present. And thus, no biological resources are expected to be impacted by this action. The existing benthic habitat will be minimally affected, based on the short construction duration, and the proposed small, focused work area on the seafloor.

The overall impact to the ecosystem in these locations will be negligible. Moreover, impacts to EFH will be minimized and avoided through the implementation of the following BMPs. There will be no further impact analysis from this action.

Construction Schedule and Phasing for Dry Dock 5 and the Waterfront Production Facility

Construction of the dry dock would take approximately 65 months from start to finish. Some overlap between constructing DD5 and the WPF could be expected, although it is also possible a gap in time could occur between the construction of the two facilities. Construction of the WPF would take approximately 42 months from start to finish. Funding for DD5 and the WPF will be allocated separately. Congressional approval for the funding the WPF is not yet established and will not be for several more years.