DRAFT INTERGRATED DETAILED PROJECT REPORT AND ENVIRONMENTAL ASSESSMENT

PIER 70: CENTRAL BASIN
CAP 107 NAVIGATION IMPROVEMENT PROJECT

Prepared by:
US Army Corps of Engineers
San Francisco District
and
HydroPlan LLC

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Executive Summary

1 Study Information

The purpose of this report is to recommend a plan to address navigation requirements in the Port of San Francisco (Port) Pier 70 Shipyard Central Basin (Central Basin). The shipyard is located at Potrero Point on the eastern waterfront of San Francisco, California. The Port, the non-Federal sponsor (NFS), requested assistance from the U.S. Army Corps of Engineers (USACE) to provide and maintain access for deep-draft vessels to the shipyard at Pier 70.

This report was prepared under the Continuing Authorities Program (CAP) because Central Basin meets the definition of a small navigation project under Section 107 of the River and Harbor Act of 1960.

2 Problem

The existing depth of the Central Basin approach is inefficient and, in many cases, impeding access in and out of the Pier 70 Shipyard. The condition is expected to worsen in the future with increased shoaling. The situation incurs increased transportation costs and delays to users, as well as excludes certain large classes of vessels.

The Pier 70 Shipyard has two drydocks used for service, specialized repair, and emergency repair of deep-draft vessels. Drydock #2 is 900 feet long, 150 feet wide and has a 56,600-ton lift capacity. The entire drydock can be lowered into the water in order to allow the ships to enter and exit from the Bay. Shipyards with drydocks of similar capabilities are located in San Diego, California and Portland, Oregon. The draft restriction of the Central Basin Approach area forces vessels in the region that could be repaired at the Port of San Francisco to travel outside of the region for repair, including to docks located in Guam and Hawaii. The Pier 70 Shipyard has in the past taken in emergency repair jobs. If access to Drydock #2 is not maintained, then deep–draft government or commercial ships needing emergency repairs in the San Francisco Bay region would need to travel to Portland, Oregon, at minimum.

Inability to access the shipyard efficiently poses an environmental risk (e.g., oil spills from deep draft commercial vessels) if emergency repairs cannot be done locally. As an illustration, the Cosco Busan was repaired at the Pier 70 Shipyard, which was less than two nautical miles away from the location of the accident. If it had been necessary for the Cosco Busan to travel further for repairs, environmental oil spill damages and clean up and remediation costs would likely have been much more significant.

The Pier 70 Shipyard is over 100 years old, one of the first shipyards on the west coast, and provides well-paid jobs to an available labor force of over 1,300. Without a deeper, more reliable Central Basin approach, there could be a reduction in the local labor force, or loss of the entire labor force, should the shipyard close.

3 Planning Objectives

The planning objectives and their metrics are as follows:

1. Reduce transportation costs and user delays for commercial and U.S. government deep-draft vessels in accessing repair and service facilities at the Pier 70 Shipyard.

   Metric: Travel time and cost for likely future users of the shipyard.

2. Increase access to the specialized repair and service facilities at the Pier 70 Shipyard.

   Metric: Number of different vessels able to access the shipyard drydocks and piers and the number of hours per day that the docks/piers are accessible for different classes of vessels.

3. Improve safety and decrease risk to vessels and operators in approaching the Central Basin Shipyard.

   Metric: Draft clearance for each vessel class likely to use the shipyard and clearance conformance with minimum safety requirements, where they exist.

4 Plans Considered and Evaluated

Measures to meet the planning objectives were identified, evaluated, and screened. General screening criteria include effectiveness, completeness, environmental acceptability, and project benefits and costs. Retained measures were combined into a preliminary array of fifteen alternative plans for Federal action. The final array of alternatives consisted of three action alternatives and the No Action alternative. These are:

Alternative 1) 30 feet (ft) Mean Lower Low Water (MLLW) depth + Non-structural measures + SF-DODS only placement

A 30 ft (MLLW) deep basin would accommodate 90 percent of the vessels that are currently using or expected to use the shipyard in a more effective basis. All of the dredged material would be disposed of in the deep ocean at the San Francisco Deep Ocean Disposal Site (SF-DODS). In addition, the non-structural measures of lightering, and use of favorable tides would continue to be practiced as needed by vessels entering the dry docks to ensure they have safe under keel

Alternative 4) 30 ft MLLW depth + Non-structural measures + SF-11 + Montezuma placement

Alternative 4 would provide the same level of access to the shipyard as Alternative 1. Under this scenario, roughly 73 percent of the dredged material would be placed at the Montezuma Wetland Restoration Project (MWRP; an upland beneficial reuse site), but the associated high cost would need to be offset to meet USACE NED criteria of maximizing net NED benefits by placing the remainder of suitable material in-Bay (roughly 27 percent). In addition, the non-structural measures of lightering, and use of favorable tides would continue to be practiced as needed by vessels entering the dry docks to ensure they have safe under keel clearance.

Alternative 6) 32 ft MLLW depth + Non-structural measures + SF-DODS only placement

A 32 ft (MLLW) basin would allow 95 percent of the of the current and expected vessel classes (those analyzed in the economic analysis) to access the shipyard on a more effective basis. All of the dredged material would be disposed of at SF-DODS. In addition, the non-structural measures of lightering, and use of favorable tides would continue to be practiced as needed by vessels entering the dry docks to ensure they have safe under keel clearance.

Alternative 16) No Action Plan (Future Without-Project Condition)

Under this plan, no Federal action would be taken. Depths currently range from 11 to deeper than 40 feet, with a median depth of roughly 24 feet. Future without-project depths, under the assumption of no sea level change, are projected to be 27.3 feet in 2016, 24.8 feet in 2021, 22.3 feet in 2026, 19.8 feet in 2031, and 17.3 feet in 2036. The shipyard is expected to close between 2022 and 2026 under this scenario. The future without project depths were used in comparing the No Action Alternative to other alternatives.

5 NED Evaluation

Alternative	1	4	**6**	16
Dredge Depth (MLLW)	30 ft	30 ft	**32 ft**	No Action
Placement Site	SF-DODS	MWRP and SF-11	**SF-DODS**	N/A
Present Value Benefits	$72,820,000	$72,820,000	**$82,450,000**	$0
Average Annual Benefits	$2,900,000	$2,900,000	**$3,280,000**	$0
Present Value Costs	$51,240,000	$53,180,000	**$49,850,000**	$0
Average Annual Costs	$2,040,000	$2,120,000	**$2,000,000**	$0
Benefit to Cost Ratio	1.4	1.4	**1.7**	0
Net Annual NED Benefits	$860,000	$780,000	**$1,300,000**	$0
Note: All benefit and cost estimates are rounded to nearest $10,000.				

6 Recommended Plan

The Proposed Action (Alternative 6) will involve dredging the Central Basin approach area to a depth of 32 feet MLLW plus 2 feet of overdepth and placing all of dredged material at SFDODS. Approximately 237,700 CY of material (including the 2 feet of overdepth) would be dredged.

Alternative 6 is the plan that maximizes net NED benefits and is the Recommended Plan (Proposed Action).

Dredging under the Proposed Action would most likely use a mechanical clamshell dredge plant with tugboats and scows. The mechanical clamshell dredge plant comprises of a large work barge with a large crane mounted on the deck of the barge. The crane has a boom that is long enough to extend out beyond the end of the work barge in any direction and is able to swivel 360 degrees on its mount. A large clamshell bucket is attached to a series of cables at the end of the boom that allows the bucket to be raised and lowered into the water. The cables also open and close the bucket as it is filled with sediment and then emptied into scows. The scows are open barges that can carry large quantities of sediment while they are towed with tugboats to and from the placement site. Based on cost estimates derived using the Corps of Engineers Dredge Estimating Program (CEDEP), the Proposed Action would involve one 21 CY clamshell bucket, three 3,000 horsepower (HP) tugboats, and four 4,000 CY scows to transport the dredged material to SF-DODS.

Under the Proposed Action, full scows will be towed to SF-DODS to place dredged material. SF-DODS is located in the Pacific Ocean, approximately 55 nautical miles west of the Golden Gate Bridge and approximately 71 nautical miles from the Central Basin. Once at SF-DODS, the actual release of dredged material from the scow is completed in a matter of minutes by opening the doors at the base of the scow and allowing the material to enter the water.

Dredging associated with the Proposed Action is expected to take place during the established environmental work windows for dredging in SF Bay, which open annually on June 1 and close on November 30. Dredging will begin at the western most end of the proposed Central basin dredging footprint and progress easterly to the end of the footprint. Given the proposed dredging equipment and distance between the Central Basin and SF-DODS, the daily production under the Proposed Action would be approximately 5,200 CY/day. It is expected that the dredging contractor will be working 24-hours per day, 7-days a week on the project. At this rate, the Proposed Action would take an estimated 1.4 months to complete. It is expected that construction would occur in the 2017 environmental work window.

The NFS portion of the costs of General Navigation Features (GNF) is 25 percent of construction costs with an additional 10 percent payed over 30 years after construction.

7 Environmental Impacts

No significant environmental impacts were identified for the Proposed Action (Alternative 6) in comparison with the No Action alternative. The Pier 70 Shipyard has existed for over 100 years. The Port has previously performed opportunistic sporadic dredging in Central Basin four times in the last forty years. Deepening to 32 feet is not expected to significantly increase shoaling or affect Threatened and Endangered species. Placement of the dredged material from initial construction will take place at the San Francisco Deep Ocean Disposal Site SF-DODS. SF-DODS is a monitored and permitted dredged material disposal site. After initial construction is completed, material dredged periodically as part of USACE Operations and Maintenance will be disposed of at the least cost, permitted site or sites in accordance with all applicable regulations. There are no known cultural resource sites in the Proposed Project footprint.

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(*required by NEPA)

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Acronyms and Abbreviations

APE ....Area of Potential Effect

BAE ....BAE Systems

Basin Plan ....San Francisco Bay Basin Water Quality Control Plan

BCDC..........................San Francisco Bay Conservation and Development Commission

Central Basin ....Central Basin Approach Area at the Pier 70 Shipyard

CEQ............................Council on Environmental Quality

CAP ....Continuing Authorities Program

CAR ............................U.S. Fish and Wildlife Coordination Act Report

C.C.R. ....California Code of Regulations

CDFW.........................California Department of Fish and Wildlife

CEDEP ....Corps of Engineers Dredge Estimating Program

CERCLA ....Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. § 9601 *et seq*

CESA ....California Endangered Species Act

C.F.R. ....United States Code of Federal Regulations

CRRP ....Cullinan Ranch Tidal Restoration Project

CWA...........................Federal Water Pollution Control Act Amendments of 1972, also known as

Clean Water Act

CZMA..........................Coastal Zone Management Act of 1972

D&I ....Design and Implementation Phase of a CAP Project

DMMO.........................San Francisco Bay Dredged Material Management Office

DOT ....United States Department of Transportation

DPR.............................Detailed Project Report

EA ....Environmental Assessment

EEZ..............................Exclusive Economic Zone

EIR ....Environmental Impact Report

EIS...............................Environmental Impact Statement

ER ....Engineering Regulation

ESA ....Federal Endangered Species Act

FCSA ....Federal Cost Sharing Agreement

FWCA..........................U.S. Fish and Wildlife Coordination Act

GNF.............................General Navigation Feature

HQUSACE....................USACE Headquarters

kAmP ....thousand amperes of power

LERR............................lands, easements, rights-of-way and relocations

LOA ....length overall

LTMS...........................San Francisco Bay Long Term Management Strategy for the Placement of Dredged Material

MARAD.......................Maritime Administration

MLLW ....mean lower low water

Montezuma................Montezuma Wetland Restoration Project

MPRSA........................Marine Protection, Research, and Sanctuaries Act, also called the Ocean Dumping Act

MSC ....Major Subordinate Command

MWRP ....Montezuma Wetland Restoration Project

NED.............................National Economic Development

NEPA...........................National Environmental Policy Act

NFS ....Non-Federal Sponsor

NMFS..........................National Marine Fisheries Service, often referred to as the NOAA Fisheries Service

NMSC..........................Naval Military Sealift Command

NOAA..........................National Oceanic and Atmospheric Administration

O&M...........................Operations and Maintenance

PMP ....Project Management Plan

Port............................Port of San Francisco
Porter-Cologne Act.....Porter-Cologne Water Quality Control Act of 1969
PPA ....Project Partnership Agreement
Puglia..........................Puglia Engineering, Inc.
SF-11...........................Alcatraz placement site
SF-DODS ....San Francisco Deep Ocean Disposal Site
SFRWQCB ....San Francisco Bay Regional Water Quality Control Board
Shipyard ....Pier 70 Shipyard
SPD ....USACE South Pacific Division
T-AKE ....Naval Military Sealift Command's Lewis & Clark-class dry cargo & munitions ship
T-AOE ....Naval Military Sealift Command's Supply-class fast combat support ship
TSP..............................Tentatively Selected Plan
USACE.........................United States Army Corps of Engineers
U.S.C. ....Code of Laws of the United States of America
USEPA.........................United States Environmental Protection Agency
USFWS........................United States Fish and Wildlife Service
WRRDA.......................Water Resources Reform and Development Act
WQC ....Water Quality Certification

DRAFT INTEGRATED DETAILED PROJECT REPORT AND ENVIRONMENTAL ASSESSMENT

PIER 70: CENTRAL BASIN
CAP 107 NAVIGATION IMPROVEMENT PROJECT

This document constitutes a Detailed Project Report (DPR) that describes the plan formulation process, including the evaluation of alternatives and the Tentatively Selected Plan (TSP) with an integrated Environmental Assessment (EA). This EA is written in compliance with the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. § 4321 *et seq*), as amended, the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the NEPA (40 C.F.R. § 1500-1508), and U.S. Army Corps of Engineers (USACE) Planning Regulations (Engineering Regulation (ER) 200-2-2). The EA presents an evaluation of the potential impacts associated with the proposed project alternatives. The recommended format of an Environmental Impact Statement (EIS)/EA is provided in 40 C.F.R. § 1502.10 and has been integrated into this DPR. The titles of sections required by NEPA as part of the EA are marked with asterisk to show how the recommended plan meets the requirements of both U.S. Army Corps of Engineers Plan Formulation Policy and NEPA.

1 Introduction to the Study

1.1 Project Location, Congressional District, and Description.

The Port of San Francisco (Port) is the non-Federal sponsor and its facilities are located on the northern and eastern shores of the City and County of San Francisco, California (***Figure 1***). The study area consists of the Central Basin Approach Area (Central Basin) at the Pier 70 Shipyard (shipyard) and is located at Potrero Point on the eastern waterfront of San Francisco, in the San Francisco Bay (roughly San Francisco Assessor's Block 4046, Lot 002). Central Basin is approximately 1.5 miles south of the San Francisco—Oakland Bay Bridge (Interstate 80) and is located at roughly latitude 37.76511 and longitude -122.38247. The project is located in California Congressional District 12, represented by Congresswoman Nancy Pelosi, as well as by California Senators Barbara Boxer and Diane Feinstein.

Potential dredged material placement sites that were considered for this study include:

1. Alcatraz Placement Site (SF-11),
2. Cullinan Ranch Tidal Restoration Project (CRRP),
3. Montezuma Wetland Restoration Project (Montezuma or MWRP), and
4. San Francisco Deep Ocean Disposal Site (SF-DODS), located in the Pacific Ocean approximately 55 nautical miles west of the Golden Gate Bridge and about 71 nautical miles from the Central Basin proposed dredge footprint.

Other potential placement sites were considered during the planning process, but were screened from further consideration.

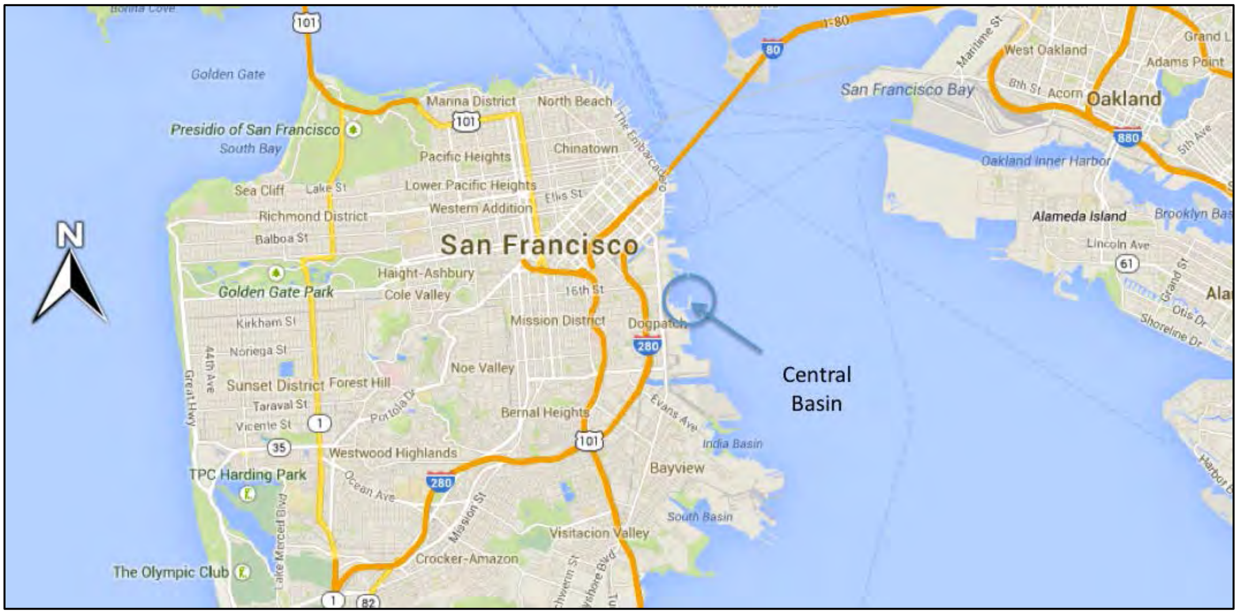

Figure 1. Location of Study Area, Central Basin in the Port of San Francisco, California (Source: Google)

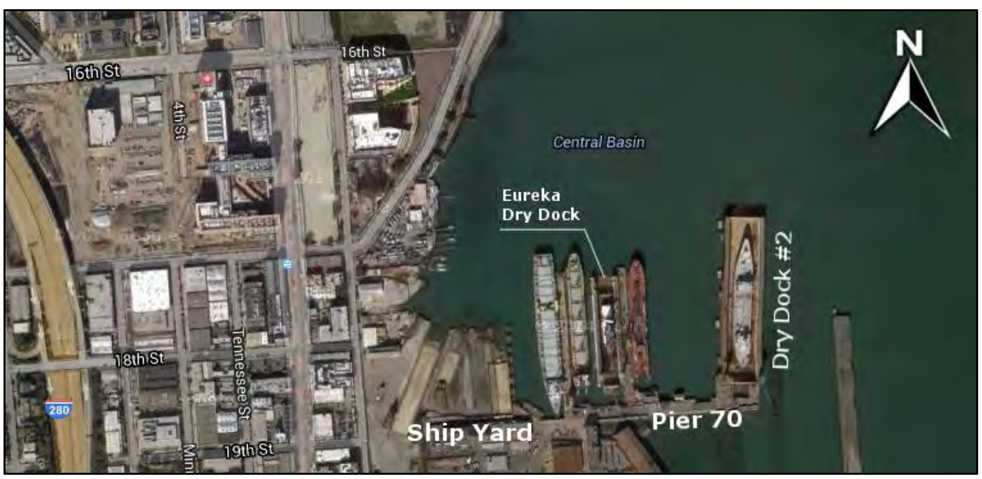

Figure 2. Satellite Aerial of Central Basin and Pier 70 Shipyard, San Francisco (Source: Google)

The Pier 70 Shipyard shown in ***Figure 2*** features two drydocks, full pier-side facilities, and an available labor force in excess of 1,300, as well as a number of machine and engineering firms. The Port of San Francisco owns the real property and primary equipment for ship repair, such as the drydocks and cranes, which are currently leased to Puglia Engineering, Inc. (Puglia). Puglia offers full-service ship repair for commercial and government vessels and can accommodate post-Panamax class ships. The entire drydock can be lowered into the water in order to allow the ships to enter and exit from the Bay. This active commercial harbor processed 1,088,272 tons of cargo in calendar year 2011. The Port offers a full range of marine terminal services, such as handling of bulk and general cargo, heavy lift services, stevedoring, and storage—both ground and covered. ***Figures 3 through 8*** show Pier 70 and its facilities.

Figure 3. Entrance to Drydock at Pier 70

Figure 4. A ship in drydock, on reinforced pilings for hull maintenance and repairs.

Figure 5. Pier side facilities at Pier 70 store ships before or after repairs.

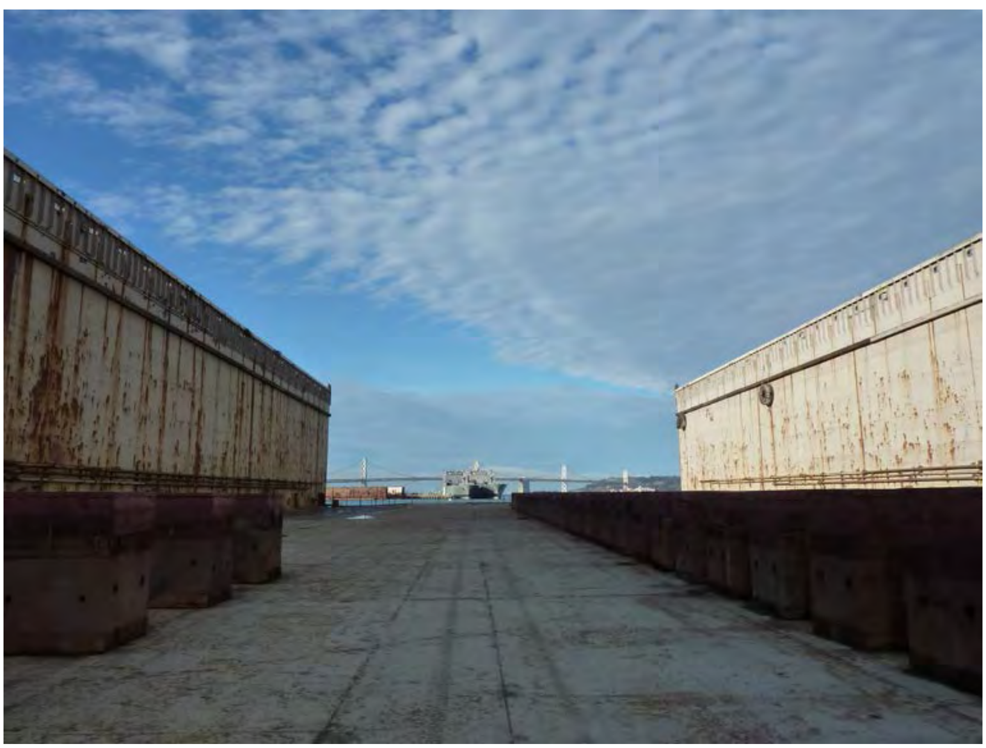

Figure 6. Drydock #2, pictured empty facing north, with the San Francisco-Oakland Bay Bridge and large ship in the bay beyond.

Figure 7. Drydock #2 pictured empty, facing south, with wood and steel pilings used to support ships.

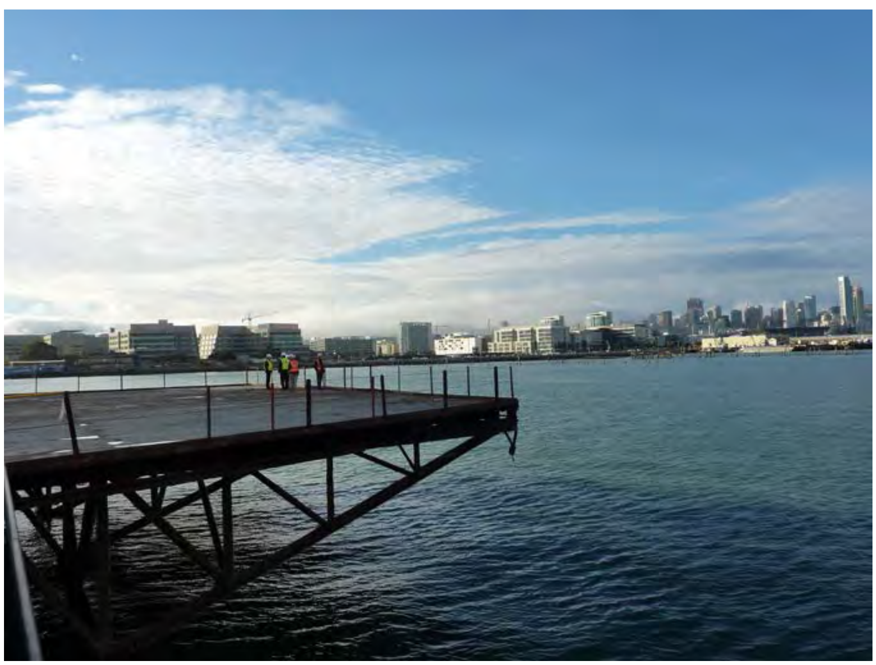

Figure 8. The approach to the Pier 70 Shipyard viewed from the edge of Drydock #2 looking out onto Central Basin. The areas between and directly in front of the piers and drydocks are deeper than most of Central Basin.

1.2 Background on the Pier 70 Shipyard

The Pier 70 Shipyard has been active and integral to western U.S. industry for well over 100 years. It has operated under different names and ownership, but ships have been built in the area around Potrero Point as far back as the Gold Rush. In fact, the first steel ships on the Pacific were built at this historic shipyard, which is the oldest working civilian shipyard in the U.S. (Wilson, 2014).

Figure 9. Boatyard at Potrero Point, ca 1870. (Source: Eadweard Muybridge/Bancroft Library and Pier70SF.org)

Once part of the pasturage for Mission Dolores and DeHaro ranch, the area attracted the shipyard because of its deep-water access, inexpensive land, and suitable distance from the more populated and quickly growing city of San Francisco (Wilson, 2014). The cape of land was filled and flattened over the decades to make it larger and accommodate roughly half a dozen major manufacturing and utility companies. One such company, the Pacific Rolling Mill, was the first significant steel and iron mill in the west and produced specialized parts, including parts for San Francisco’s famous cable cars. Potrero Point, along with Pier 70, was a significant contributor to the national economy, military and labor history of the U.S. From 1862 to 1872, John North operated his shipyard, North’s Ship Yard, at Potrero Point, where he built high quality boats (***Figure 9***). In the 1880s, large-scale steel shipbuilding was added to the operations at historic Pier 70, in addition to small boatbuilding and repairs. George Kneass and Sons was a significant boatbuilding company at this time and their shed is still standing, just north of Pier 70. Union Iron Works operated at the site starting in 1883 and built many historically significant vessels, including Admiral Dewey’s flagship of the Spanish-American War, the U.S.S. Olympia (***Figures 10 and 11***). The Olympia still exists and can be seen at a ship museum in Philadelphia. It is the oldest steel ship in the world.

Bethlehem Steel Corporation purchased the shipyard in 1905 for $1 million, worth roughly $27 billion in 2015. Shortly after the purchase, the 1906 San Francisco Earthquake hit, which damaged the plant considerably and destroyed the hydraulic drydock, a huge loss for the company. From 1910 until World War I, however, Bethlehem Steel invested in major improvements to the shipyard, and was among the most prolific ship producers during the war, launching three destroyers per month on average, and producing 18 submarines. During World War II, roughly 10,000 workers were employed at the shipyard, working three shifts a day. Bethlehem's Potrero yard produced 72 vessels and repaired over 2,500 navy and commercial craft during World War II.

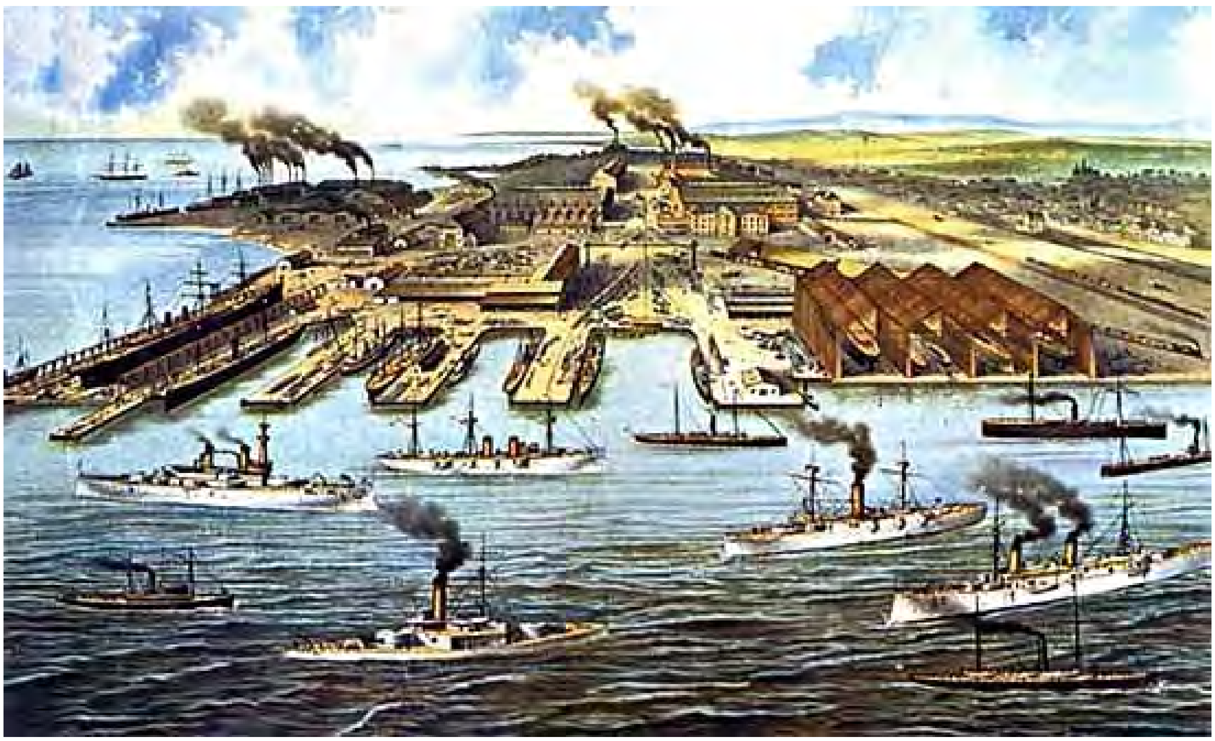

Figure 10. Union Iron Works, early 1900s. Some of the naval ships pictured were built here. (Source: San Francisco Maritime Museum Library and Pier70sf.org)

After World War II, shipbuilding declined—the last ship built was in 1965. Large barges continued to be built, however, into the seventies and ship repair continued as well. By the late 1970s, the oldest active civilian shipyard in the U.S. stopped building vessels entirely because the declining U.S. shipping industry could no longer support it.

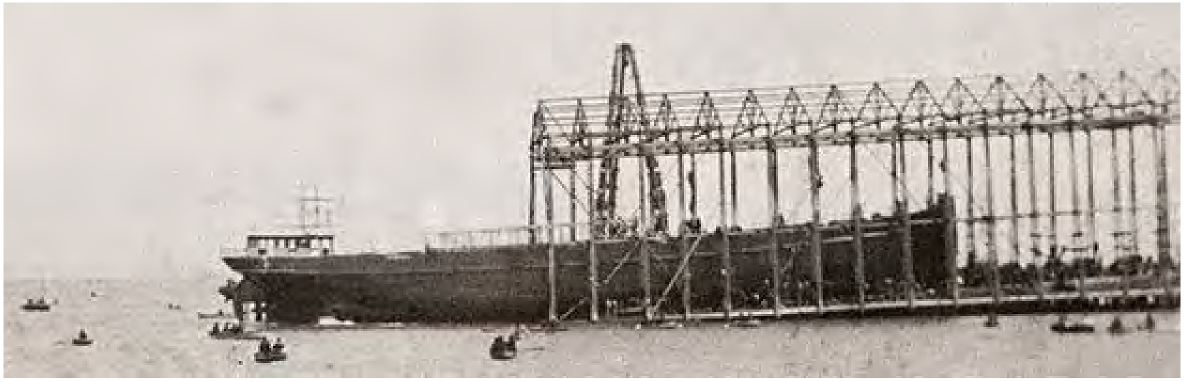

Figure 11. Launching of the Arago, the first ship built by Union Iron Works, 1885. (Source: San Francisco Maritime Museum Library and Pier70SF.org)

In 1982, the City of San Francisco purchased the Potrero yard property for one dollar. Since acquisition of the shipyard, the Port has had seven lessee companies operate there. Today, Puglia Engineering, Inc. (Puglia) operates on the Pier 70 land, piers, and drydocks that they lease from the Port of San Francisco. The current 30-year lease was signed in December 1987 with Southwest Marine, Inc., which has since changed name and ownership a number of times due to a series of bankruptcies and acquisitions. BAE Systems became the leaseholder in 2005, and recently sold their lease in 2016 to Puglia through the latest of these acquisitions. As they operate it now, the Pier 70 Shipyard is one of the largest repair facilities on the west coast. Pier 70 facilities can handle almost any kind of ship, including very large cruise ships. The available labor force for the facility is roughly 1,300; however, roughly 220-300 ship workers are employed here on an average working day and over 420 are employed when the shipyard is busy. Much of the historical buildings used to support the shipyard in the past are still standing. The Port of San Francisco has been active in seeking new uses for the buildings, in order to revitalize the area and restore these historic resources.

1.3 Dredging History and Related Studies

Central Basin has not been included in any previous Federal study or completed project. The main shipping channel that enters San Francisco Bay and passes under the Golden Gate Bridge, before heading inland and north to Sacramento and Stockton, is federally maintained. However, the channel that vessels take to access Central Basin and Pier 70 lies in San Francisco Harbor, south of the federally maintained channel and no request for Federal participation in Central Basin had been submitted until the Port of San Francisco did so for this study.

The River and Harbor Acts of 1927, 1930, 1935, and 1968 authorized dredging to remove rocks and shoals from specific sections of the waterfront along the San Francisco Bay and the main ship channel approach outside the Golden Gate Bridge. However, the Central Basin study area was not part of these authorized projects.

The Port, sometimes in partnership with BAE or predecessor lessees, has conducted sporadic dredging on focused parts of Central Basin to varying depths since 1984 to allow access to

Central Basin Pier 70 Dry Dock facilities. Puglia is responsible for maintenance of their leasehold area, which includes dredging the area between and just in front of docks and piers to the required depths for operation. These depths vary from about 21 feet mean lower low water (MLLW) by Pier 3, to deeper than 50 feet MLLW by Drydock #2. Puglia needs sufficient depth there in order to lower the drydock down when ships are entering and exiting the dock.

Central Basin does not have a designated or marked deep draft ship channel and is not maintained. In the past 40 years, a total of four sporadic dredging episodes have occurred to facilitate access to Central Basin Pier 70 Dry Dock facilities (***Table 1***).

Table 1. Central Basin Dredging History

Year(s)	Quantity Dredged (cubic yards, cy)	Permit Holder	Depth Dredged To
1984/1985	108,000	Port of San Francisco	Unknown
1989/1990	76,000	Port of San Francisco	32 ft. MLLW
1999/2000	199,411[1]	Port of San Francisco	28 ft. MLLW, plus 2 ft. overdepth in most, but not all of the basin.
2011	89,474	BAE Systems	30 ft. MLLW, plus 2 ft. overdepth

Despite sporadic dredging episodes, shoaling has caused limited depths over time in Central Basin. Prior to the 2011 dredging, Central Basin had a limiting depth of approximately 24 to 29 feet MLLW, which limited operations at the primary Pier 70 drydock, Drydock #2. Even though Central Basin is the second largest drydock in the Pacific west coast, the limiting depths of Central Basin currently restrict access to ships that can be repaired at Pier 70.

In the summer of 2011, the Port and BAE, faced with depth limitations that threatened the viability of continued operations, undertook a one-time opportunistic dredging episode in Central Basin to 30 ft MLLW, plus two feet of allowable overdepth. According to Port representatives, both the 1999/2000 and the 2011 dredge were the result of Federal involvement. For the first episode in 1999/2000, the Port of San Francisco received Federal Emergency Management Agency funds as a result of the Loma Prieta earthquake event of 1989. The second episode occurred in 2011 as a "stop gap" measure waiting for the current USACE CAP Section 107 study to conclude. Subsequently, neither the Port nor Puglia Engineering, Inc. intend to continue dredging Central Basin in this manner without Federal participation.

[1] The survey document shows this number, but a subsequent table on Maintenance Dredging History from the Master Sampling and Analysis Plan notes that 119,411 cy was removed during this episode. This is believed to be a typographical mistake in the table.

In 2011, approximately 90,000 cubic yards of sediment was dredged with placement at both the San Francisco Deep Ocean Disposal Site (SF-DODS) and the Alcatraz placement site (SF-11, located in San Francisco Bay). These are the only two placement sites that have been used for Central Basin dredged materials throughout its dredging history of four dredging episodes over the last thirty years. Since the 2011 dredging, Central Basin has continued to shoal and now has depths of approximately 16 to 32 ft MLLW.

Prior to the Port's purchase of what is now the Pier 70 Shipyard in 1982, Central Basin was privately maintained. There are limited to no records surviving on the dredging completed during the World War I and II periods when the site was operated by Bethlehem Steel and its predecessors. One Bethlehem Steel plan from 1945 shows planned depths of 26 feet MLLW in the western part of Central Basin and 34 feet MLLW in the center of Central Basin. No Federal study or project has been completed or begun on Central Basin until now.

Pier 70 Redevelopment Project

The Port of San Francisco is also pursuing an adjacent redevelopment project for the inactive lots of old buildings at Pier 70, called the Forest City Site and Historic Core (see ***Figure 12***). While this project is adjacent to the active shipyard and one of its stated goals is to help preserve the long-term viability of the ship repair industry, it is a wholly separate project from the CAP 107 Navigation Improvement Study at Central Basin. As shown in ***Figure 12***, the ship repair yard that Puglia currently operates is in blue, and the redevelopment site, called Forest City Site, is outlined in yellow.

Figure 12. Forest City Redevelopment Site, alongside active ship repair facility. (Source: pier70sf.com)

The Port intends to use infill development to reconnect Pier 70 with the Central Waterfront, while rehabilitating Pier 70's historic buildings and creating a variety of amenities and useable spaces aimed at promoting local economic development.

Planned spaces include arts and creative spaces, middle and working class housing, light manufacturing, local retail, and nine acres of waterfront parks. The project also plans to rehabilitate roughly 250,000 square feet of historic buildings.

California Environmental Quality Act (CEQA) review and continuing community engagement is currently taking place as the design is refined and the first phase of construction is set to begin in 2017 and last 10 to 15 years. The separate Pier 70 Redevelopment Project is not expected to affect a potential navigation or deepening project at Central Basin. All work at Central Basin is in-water work and is targeted for 2017. The Redevelopment Construction would begin in 2017 and would occur on land adjacent to the Shipyard.

1.4 Study Sponsor

The non-Federal sponsor (NFS) is the City and County of San Francisco acting by and through the Port of San Francisco. On 1 October 2009, the Port submitted a signed Letter of Intent to cost share the Central Basin Pier 70 study. The Port reiterated its interest in partnering with USACE in a subsequent letter dated 29 April 2013. The Federal Cost Sharing Agreement (FCSA) was signed on 21 June 2013 and the Project Management Plan (PMP) was signed shortly thereafter on 2 July 2013.

1.5 Purpose and Need*

The statements below convey the NEPA purpose and need for the proposed action as required by the CEQ's Regulations for Implementing the Procedural Provisions of the NEPA (40 C.F.R. § 1502.13).

The United States Army Corps of Engineers (USACE) proposes to dredge the Central Basin at Pier 70 to an increased depth and place the dredged material at a permitted site.

The purpose of the proposed action is to reduce the negative economic impacts of shoaling in the Central Basin at Pier 70 to allow vessels to safely and efficiently access the Pier 70 Shipyard without the use of high tide. The existing depth of the Central Basin approach does not allow for the efficient operation and accommodation of the existing vessel fleet that calls on the Pier 70 Shipyard for maintenance and repair. The limited channel depth causes the Naval Military Sealift Command (NMSC) in conjunction with the U.S. Coast Guard to place restrictions on vessel transit in to the Central Basin to ensure vessel and crewmember safety. In turn, these restrictions lead to tidal delays, maneuvering difficulties, and ultimately bar access to ships – resulting in economic inefficiencies that translate to costs to the national economy.

The Proposed Action is necessary to:

- Reduce transportation costs and user delays for use of the repair and service facilities at the Pier 70 Shipyard;
- Increase access to the specialized repair and service facilities at the Pier 70 Shipyard; and,
- Improve safety and decrease risk to vessels and operators in approaching the Central Basin Shipyard.

This action would reduce economic inefficiencies and safety impediments incurred by the existing vessel fleet that calls on the Pier 70 Shipyard for maintenance and repair as well as provide access for larger class of vessels that are not able to access Pier 70 under the without-project condition.

1.6 Study Authority and Scope

This study is being conducted under the authority of Section 107 of the River and Harbor Act of 1960 (Pub. L. No. 86-645, 33 U.S.C. 577), as amended, which authorizes USACE to study, adopt, construct and maintain navigation improvement projects without additional project specific congressional legislation, using the same procedures and policies that apply to projects authorized by Congress. The Federal share of initial implementation costs for any one project may not exceed $10 million in accordance with current cost limits authorized by Section 1030 of the Water Resources Reform and Development Act (WRRDA) of 2014 (Pub. L. No. 113-121 [128 Stat. 1193]). WRRDA 2014 was signed into law June 13, 2014 and implementation guidance was issued December 3, 2014 (USACE, 2014a).

Section 107 of the 1960 River and Harbor Act is one of the ten legislative authorities under which USACE is authorized to plan, design, and construct certain types of water resources projects that are of limited scope and complexity, without additional and specific congressional authorization. These authorities are called the Continuing Authorities Program (CAP) when referred to as a group.

CAP projects differ from General Investigation projects because:

- They are typically quicker to implement (usually 3 years from study to construction);
- CAP projects do not need additional Congressional authorization for individual projects;
- They are limited in scope, geographic area and complexity;
- They have a Federal cost limit determined by the specific project authority—in this case $10,000,000;

- They have a Feasibility Report or Detailed Project Report (DPR) with delegated approval by the Major Subordinate Command (MSC) Commander, in this case the South Pacific Division (SPD) Commander;
- Typically, the Federal Cost Sharing Agreement (FCSA) is approved or executed by the District Commander. The Project Partnership Agreement (PPA), on the other hand, will be approved at USACE Headquarters (HQUSACE) and the Assistant Secretary of the Army for Civil Works (ASA(CW)) level because an official model CAP Section 107 PPA has not been developed or published;

There are only two phases in CAP projects: Feasibility and Design & Implementation (D&I).

1.7 Cost Sharing

The initial $100,000 of Federal funding is used to execute the FCSA. After that, CAP Section 107 projects are cost shared 50/50 during the Feasibility Phase between the non-Federal Sponsor and USACE. The non-Federal Sponsor is responsible for lands, easements, rights-of-way and relocations (LERR) and 25 percent of General Navigation Features (GNF)[2]. The sponsor must contribute an additional 10% of the cost of the GNF over no more than 30 years, which is reduced by the value of creditable LERR. For a CAP 107 project, the total limit on Federal spending on the project is $10 million.

[2] General Navigation Features are channels, jetties or breakwaters, locks and dams, basins of water areas for vessel maneuvering, turning, passing, mooring or anchoring incidental to transit of the channels and locks (ER 1105-2-100 USACE 2000).

2 Existing Conditions

The existing condition was analyzed in order to help identify problems and objectives and lay the groundwork for analyzing potential impacts to and benefits from the various alternatives. Areas that have greater import on the decision-making and planning process are discussed in more detail, and background data and added detail is provided in appendices or by reference. This section describes the existing navigation conditions, the role that Pier 70 plays for emergency repairs, the shipyard condition, as well as tides, waves, sediment chemistry and sediment transport. The environmental and historical resources present are also described herein.

2.1 Overview of Existing Environmental Conditions and Affected Environment*

2.1.1 Overview of Affected Environment

The Project is located in San Francisco Bay. San Francisco Bay is a shallow estuary that drains water from approximately 40 percent of California. Water from the Sacramento and San Joaquin River watersheds passes through the Bay to the Pacific Ocean. San Francisco Bay is characterized by wide shallow areas flanking a central natural deep water channel. The deep channel is a remnant of the ancient drowned river valley that constitutes San Francisco Bay. Portions of the natural deep water channel (former river alignment) have been deepened further to support deep draft vessel navigation.

Shallow water reclamation by infilling along the margins has reduced the original Bay from approximately 700 square miles to its present size of approximately 400 square miles. The central portion of the San Francisco Bay has an average depth of 43 feet MLLW. The northern and southern areas have an average depth of 15 to 17 feet MLLW, respectively. The Bay's deepest waters lie at the Golden Gate where depths exceed 360 feet (University of Rhode Island and USEPA 2015). San Francisco Bay is commonly divided into four areas: Suisun Bay, North Bay (or San Pablo Bay), Central Bay, and South Bay. ***Figure 13*** shows the approximate basin boundaries for the four sub-bays. The Central Bay is the deepest portion of the Bay; the North Bay (San Pablo Bay) is the shallowest. The main part of the Bay measures 3 to 12 miles wide east-to-west and somewhere between 48 miles and 60 miles north-to-south. It is the largest Pacific estuary in the Americas.

The detailed description of the affected environment and impact assessment is provided in ***Chapter 6.***

Figure 13. Sub-bays of San Francisco Bay.

2.1.2 Project Location

The Project is primarily located within Central San Francisco Bay; SF-DODS is located in the Pacific Ocean approximately 55 miles west of the Golden Gate Bridge. To the west of the Bay are the hills of the San Francisco and Marin peninsulas; to the east lie the Richmond, Berkeley, and Hayward-Fremont Hills; to the south are the San Benito and Santa Clara Valleys; and to the north are San Pablo Bay and the Napa and Sonoma Valleys. Substantial portions of San Francisco Bay shoreline have been converted to urban, transportation, agricultural, and industrial uses; nonetheless, many areas of the Bay retain their natural character and contain mudflats and tidal marshes, and other sensitive habitat.

The project area consists of one dredging location (Central Basin), three placement sites (SF-11, MWRP, and SF-DODS), and the waters connecting these sites. MWRP is a beneficial reuse site that would use dredged sediment to aid the restoration of tidal salt marsh habitat (wetland reuse). SF-DODS is an offshore placement site. SF-11 is an in-Bay placement site. ***Figure 14*** shows the dredging locations and San Francisco Bay placement sites. The only Project feature that is outside of ***Figure 14*** is SF-DODS, which is shown in ***Figure 15*.** MWRP is located in the Napa River Estuary just north of San Pablo Bay and the eastern margin of Suisun Bay near the confluence of Suisun Bay and the Sacramento-San Joaquin River Delta, respectively (***Figure 14***). The dredging location and beneficial reuse placement site are located along the shoreline, and are either in or adjacent to sensitive habitat, as described below. Typical habitats at and in the vicinity of the beneficial reuse site include open water, mudflat, and tidal marsh.

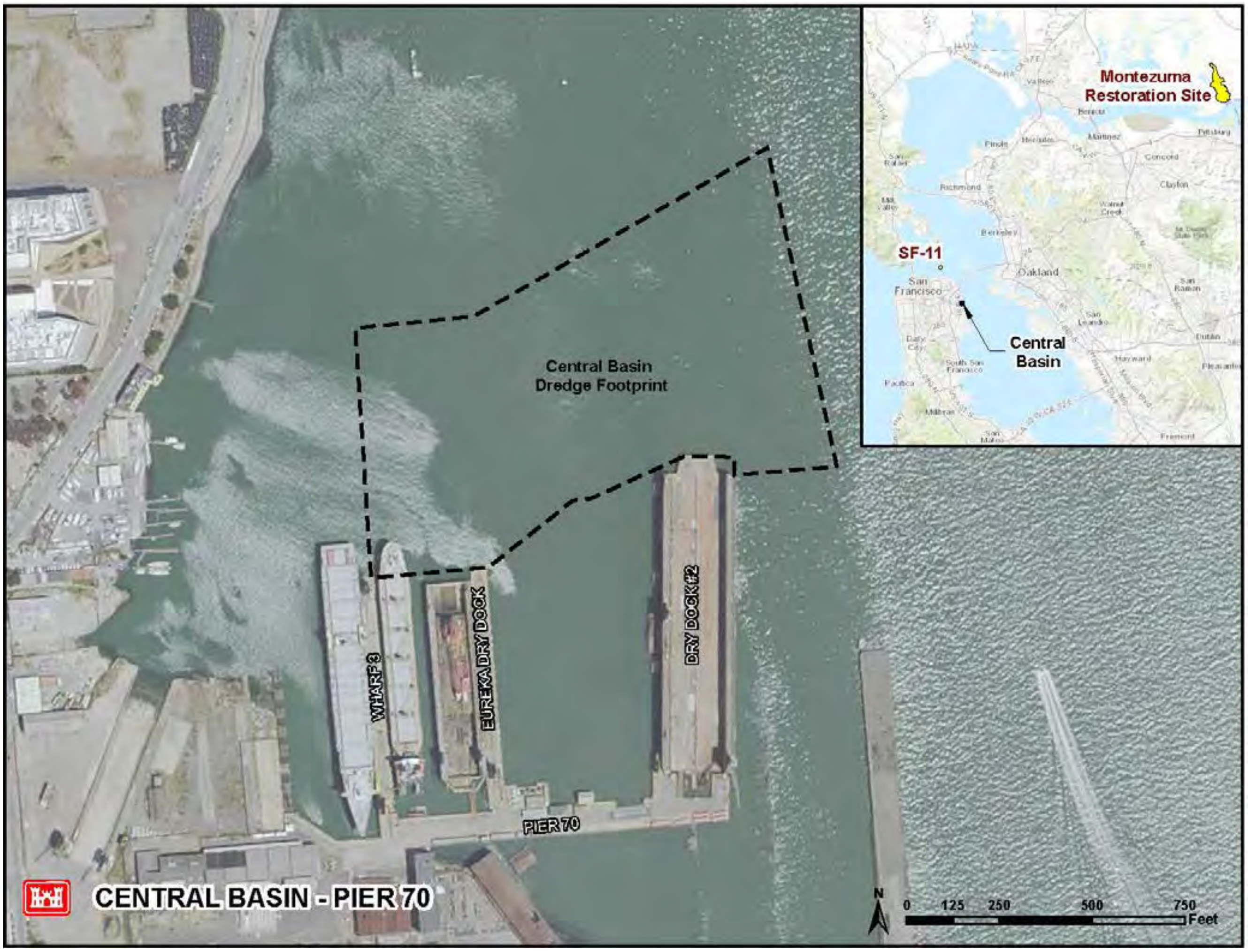

Figure 14. Dredging Location and San Francisco Bay Placement Sites.

Figure 15. Location of SF-DODS.

2.2 Existing Shipyard Conditions

The Pier 70 Shipyard operates within a land area of 14.4 acres and leasehold water area of 17.4 acres (includes dredged areas beneath drydocks, but not Central Basin), and has world class facilities and capabilities. Portland, San Diego, Victoria, and Pier 70 are the only facilities on west coast that can accommodate post-Panamax vessels, i.e. vessels that are too large to go through Panama Canal, which can take up to 106 feet in width. If not serviced on the west coast, post-Panamax vessels must go around South America to yards in the Caribbean or to the Far East to reach comparable facilities.

Drydock and Berths

- *Drydock #2*: 54,000 long tons NAVSEA certified cubic lift capacity—900 feet length overall (LOA) x 150 feet interior wingwall clearance.
- The Pier 70 Shipyard has two piers and two berths, up to 700 feet LOA – each with shore side power & shore side crane support.

High Capacity Shore side Power

As of October 2012, the Port of San Francisco activated and began operating a high capacity shore side power system capable of delivering up to 8,000 amperes of power (8kAmP) to any ships serviced in Drydock #2 or alongside Puglia's static berths. Clean hydroelectric power can now be supplied at a high voltage level required by the new generation and classes of commercial cruise and U.S. military ships such as the Military Sealift Command's T-AKE (Lewis & Clark-class dry cargo & munitions ship) and T-AOE (Supply-class fast combat support ship). This makes the Pier 70 Shipyard the only shipyard on the U.S. West Coast that can handle U.S. Military T-AKE or T-AOE ships. The Pier 70 Shipyard operates the second largest capacity lift floating drydock dedicated to ship repair in America's West Coast—Drydock #2. The yard has crane capacity to 60 mtons, with four wingwall cranes supporting the drydocks directly, and two shore side whirly cranes supporting the work berths.

2.3 Existing Navigation Conditions

Soundings of Central Basin surveyed in October 2014 are shown in ***Figure 16***. The Eureka Drydock is immediately to the west of Pier 4 indicated in ***Figure 16***.

2.3.1 Drydock #2 and Pier 4

The T-AKE and T-AOE ships arriving at the shipyard are serviced at Drydock #2 and Pier 4. As shown on ***Figure 16***, the northern-most portion of the approach directly in front of Drydock #2 was about 26.8 ft MLLW. The approach to Drydock #2 ranged from 26.8 ft MLLW at the northern most edge of the dredging area, to over 40 feet MLLW close to Drydock #2. The center of the approach to Drydock #2 was 30 ft MLLW.

In October 2014, the center of the basin, between Drydock #2 and Pier 4, was generally 30 ft below MLLW. This area is transited by the largest ships serviced at the shipyard as they are moved into position for repairs at Pier 4.

Oftentimes, the shipyard must work with the ship's crew to shift contents from one or several tanks to other tanks in the ship to manipulate draft while in the yard. This entails removing a full tank (oil, sewage, ballast, etc.) from the ship and putting it in barges or somewhere else on the ship in order to inspect a tank for leaks or coating failure or to make repairs/modifications. Once the tank work is completed, it will be cleaned and the materials will be pumped back in. Working this way keeps the yard from completing projects in multiple tanks at one time leading to operational delays to the ship.

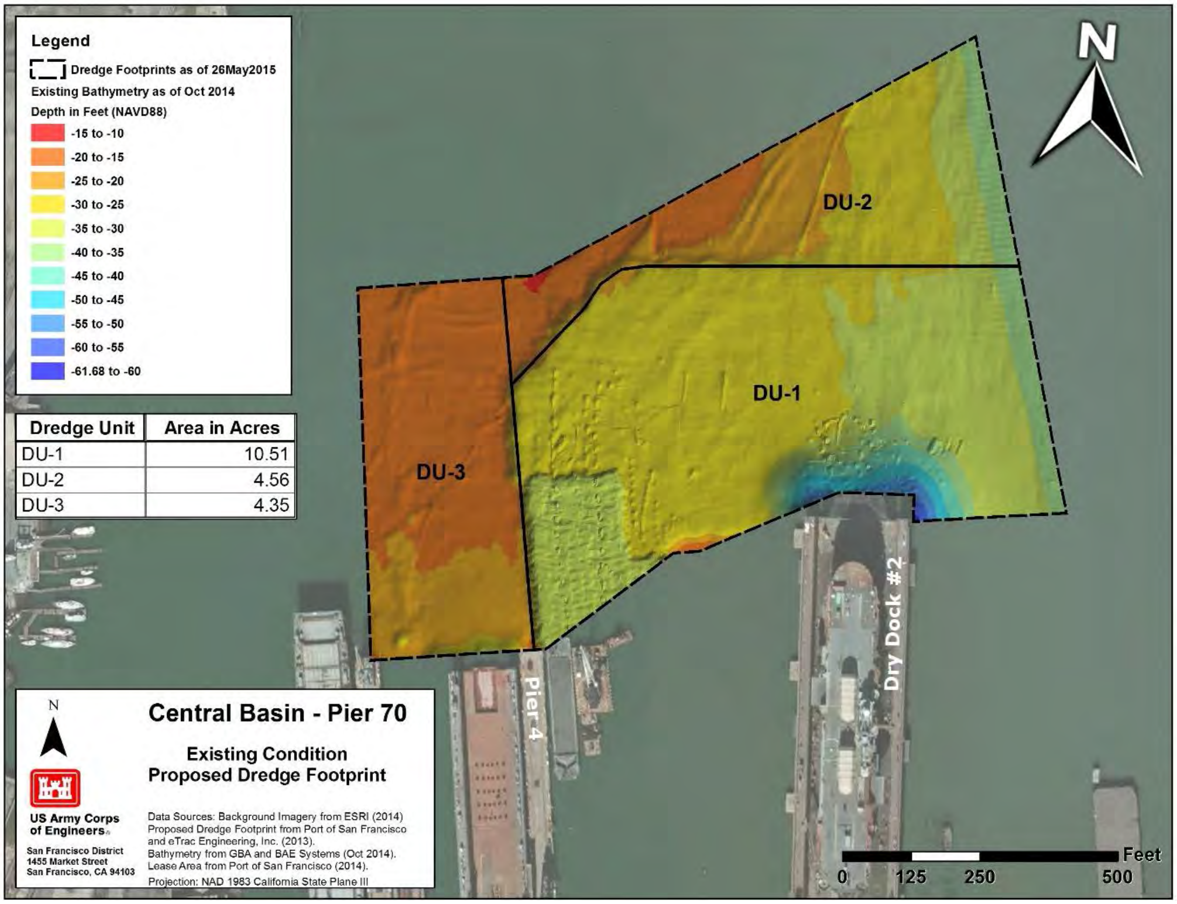

Figure 16. Existing Bathymetry (October 2014) of Central Basin, in proposed dredge footprint (as of May 2015).

2.3.2 Ship Maneuverability

Any portions of the dredging footprint shown in ***Figure 16*** that are shallower than 30 ft MLLW could pose a hazard to T-AKE and T-AOE ships entering or leaving Drydock #2 and Pier 4. The October 2014 hydrographic survey (***Figure 16***) indicated some sloughing or shoaling occurred along the northern edge of Central Basin. The survey recorded a depth of 16 ft MLLW at the point of inflection of the northern boundary of the dredging footprint near DU-1 and DU-3 (Dredge units shown in ***Figure 16***).

As ships enter Central Basin from the main shipping channel, they need room to turn so that they can line up with the drydock or pier they are entering and either back in, which is preferred as this allows greater access to the ship from the pier, or head in bow first. The yard handles ships up to 980 feet long. To accommodate T-AKE and T-AOE ships ideally, the dredging footprint of the approach to Drydock #2 would extend north into Central Basin, plus a margin of safety of about 50 feet of maneuvering room. A sketch of this area is shown in ***Figure 17***.

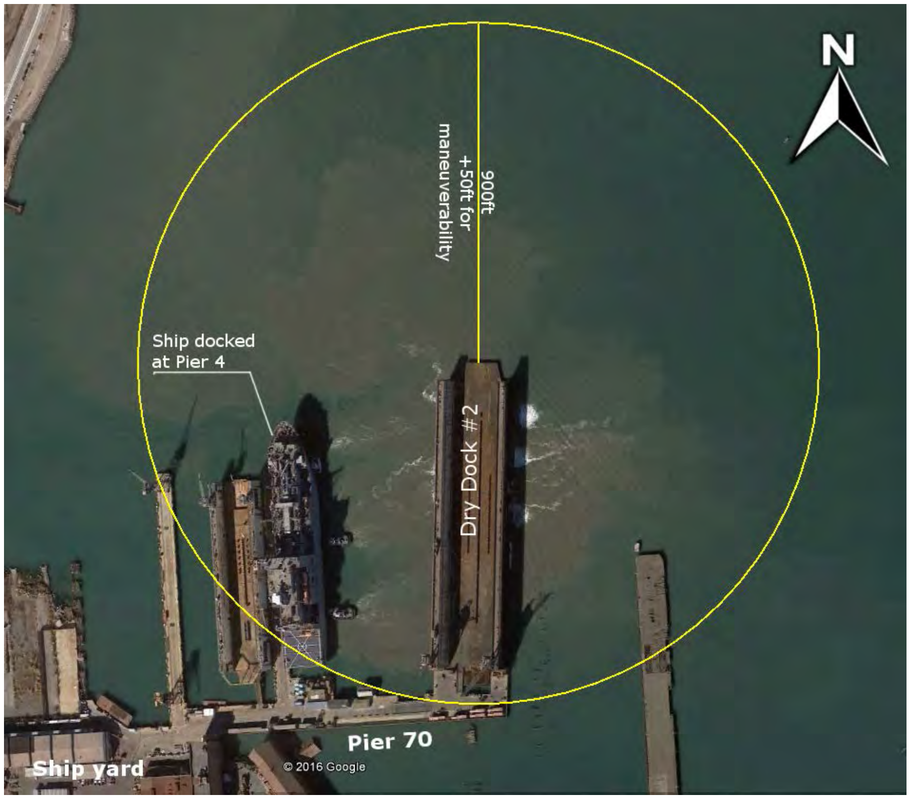

Figure 17. Ideal limit of dredged approach to Drydock #2.

Tugboats operated by the San Francisco Bar Pilots accompany the ships accessing the shipyard docks (San Francisco Bar Pilots Association 2016). As an example, ***Figure 18*** shows a large ship being pushed into place at Pier 4 by tugboats. The tugboats need a minimum draft of 20 feet and must operate in the area between the ships and the limits of the Central Basin dredge footprint to keep the ships from running aground. To maneuver the ships the tugboat operators must have some working room to overcome currents, wind and waves and, ideally, there should be room to provide a margin for error.

The existing footprint of dredging in Central Basin is a result of balancing the costs in consideration with the need to provide for safe maneuverability of deep draft ships. Due to maneuverability requirements, the controlling depth of the entrance channel and turning basin at Central Basin is approximately 27 feet MLLW.

Table 2 presents depth requirements (ship draft plus required under keel clearance) for each vessel class and whether they can use high tides to improve drydock access. Under keel clearance requirements vary by owner/operator. Commercial ships require one to two feet of under keel clearance, depending on tide and weather. The Military Sealift Command (NMSC) is part of the Navy. As a government operator, NMSC's standard practices require a 3 feet under keel clearance at mean low water. Both NMSC and Coast Guard vessels cannot use tide as a consideration of a channel's depth when accessing a drydock.

Figure 18. Tug Boats Maneuvering a Ship into Place alongside Pier 4.

At current depths, most of the ships accessing the Pier 70 Shipyard are tide restricted, and some are not able to utilize the shipyard at all due to inadequate depths. ***Table 2*** includes specifics on some of the ships that would be likely to utilize the Pier 70 Shipyard, if feasible.

Table 2. Depth Requirements for Likely Users of Pier 70 Shipyard, by Vessel Class.

Commercial Ships:	Unable to Come in at Current Depths	Needed Facility Depth (Expected Arrival Draft + UKC in feet) Minimum/Maximum	Legally permitted to use tide for entry?
Cruise		26/30	Yes
Articulating tug/barge combo (ATB)		21/21	Yes
Tanker		24/24	Yes
Container Ship		27/27	Yes
Other		24/27	Yes
Military Sealift Ships:	**Unable to Come in at Current Depths**	**Needed Facility Depth (Expected Arrival Draft + UKC in feet)**	**Legally permitted to use tide for entry?**
T-AOE	√	33	No
T-AH	√	31	No
T-AO	√	30	No
T-AKR	√	30	No
T-AKE/T-AK	√	29.17	No
T-AS		20	No
T-ARS		20	No
T-ATF		17	No
JHSV		14	No
Maritime Administration Ships:	**Unable to Come in at Current Depths**	**Needed Facility Depth (Expected Arrival Draft + UKC in feet)**	**Legally permitted to use tide for entry?**
Small MARAD		27	Yes
Large MARAD	√	32	Yes
U.S. Coast Guard:	**Unable to Come in at Current Depths**	**Needed Facility Depth (Expected Arrival Draft + UKC in feet)**	**Legally permitted to use tide for entry?**
Seagoing Buoy Tender		20	No
National Security Cutter		22	No
High Endurance Cutter		17	No
Polar Class Icebreaker	√	29	No

2.3.3 Tides

Due to the location and topography of the Bay, twice a month at full or new moons, the water surface elevation in Central Basin falls to MLLW or below (up to 2 feet). Since MLLW is the mean of the lowest low tides for the local tidal datum, it is to be expected that an extreme low tide will be below the MLLW mark. This is an additional challenge in accommodating and maneuvering ships with large drafts into the Shipyard drydocks or piers. In these cases, operators will opt to come in on slack water, because maneuverability is safer when there is less current.

The draft of ships accessing the shipyard is usually less than the current project condition (see ***Table 2).*** Usually the ships have no cargo and minimum fuel. However, the shipyard also does unscheduled emergency work, as described in ***Section 2.1***, and the ships are at their operating draft. When ships are depth restricted, operators must wait for a favorable tide, pump off fuel, or seek repairs elsewhere. The resulting delays and costs affect National Economic Development (NED).

While Commercial ships use high tides to meet under keel clearance requirements to safely transit the channel, military ships cannot consider high tides because they must be able to leave the shipyard under any tidal conditions. The Maritime Administration (MARAD), which is part of the United States Department of Transportation (DOT), and the Coast Guard, which is part of the United States Department of Homeland Security during peacetimes and the Navy during wartimes, both have ships that cannot access Central Basin at current depths. Therefore, the depth at MLLW is the determining depth of whether a military ship can be serviced at the Central Basin shipyard.

The cost of these delays and potential NED benefit of deepening the basin have been analyzed and are presented in ***Section 5***. Though not part of the NED analysis, extra costs in material and labor are incurred in the existing condition.

2.3.4 Waves

Long period ocean swell does not propagate to the Central Basin area due to the distance from the Golden Gate and orientation of the shoreline (URS/AGS Joint Venture 2012). As a result, Central Basin is subject to generally small and short period waves generated by local winds over the San Francisco Bay. Wind-wave growth and transformation modeling with SWAN suggests that a wind event with a return period of 100 years may produce wave heights of up to 5 to 6 feet in the eastern section of Central Basin (Coast & Harbor Engineering 2014). However, this modeling exercise assumed that the Wharf 8 and Puglia facilities did not limit wave penetration to Central Basin, and therefore the extreme wave heights in Central Basin may be less than suggested by the modeling.

2.3.5 Sedimentation

Central Basin is relatively sheltered from the stronger tidal currents. MORPHO model simulations (Coast & Harbor Engineering, 2014) suggest that currents rapidly decrease in strength (to < 1 foot /second) toward the western section of Central Basin. As a result, most of the proposed dredge footprint is subject to considerable sediment deposition.

The shoaling analysis (see ***Appendix C.a***) estimated the background shoaling rate based on the measured net bathymetric changes between June 2013 and January 2014 hydrographic surveys and simulations of sedimentation with a three dimensional hydrodynamic, wind wave, and sediment transport model (Delta Modeling Associates, Inc., 2015).

In the existing conditions, the shoaling in Central Basin is estimated as 0.5 ft/year, based on the hydrographic surveys performed seven months apart. The sediment transport model estimated shoaling of 1.0 ft/year for existing, wet year, conditions. The sedimentation rate in wet years is generally higher than in dry years because more hydrologic inputs to the Bay (runoff) bring more sediment. The potential effect of wet year's sedimentation increases are accounted for in the cost contingency of the cost risk analysis.

The eastern side of Central Basin, close to Drydock #2, is generally deeper with less, or slower, shoaling. The basin becomes shallower westward towards the shore and shoaling increases. Sediment modeling showed that the shoaling was not uniformly distributed throughout the footprint, with the greatest shoaling (up to 1 foot) concentrated in the western section of the footprint last dredged by BAE Systems in 2011.

2.3.6 Depth Limitations

The existing depth of the Central Basin approach is inefficient and, in many cases, impeding access in and out of the Pier 70 Shipyard. Shoaling is expected to continue over time, resulting in increased transportation costs and delays to users, as well as excludes certain large classes of vessels. The length and lifting capacity of Drydock #2 can accommodate larger vessels that have drafts to 35 feet, while the approach to the repair berths is currently restricted to approximately 29 feet MLLW for docking a ship with three feet under keel clearance. However, this area is expected to continue to shoal at an average rate of half a foot per year.

Vessels in the region that, except for the draft restriction of the approach, could be repaired at the Port of San Francisco are forced to travel outside of the region for repair, including to docks located in Guam and Hawaii. In addition to being more costly to access for ships home ported closer to San Francisco, alternate facilities have other barriers to access that further increase delays and inefficiencies for users. BAE Honolulu at Pearl Harbor lacks exclusive control and rights to drydocks, which can cause delays.

The National Steel and Shipbuilding in San Diego has a drydock, graving dock, and yard that is dedicated mostly to shipbuilding and does not have adequate capacity to perform efficient repairs for military and coast guard ships home ported on the west coast. This is due in part to the high utilization by Navy ships repaired at their own facility. The graving dock in San Diego has a lifting capacity of 30,000 long tons, compared to 54,600 long ton lifting capacity at Drydock #2 in San Francisco.

The NMSC recently disqualified Pier 70 for two potential ship repairs, as technically unsatisfactory to accommodate their vessels safely because of the constraining depth of Central Basin. Many ships, including the five emergency repair jobs listed in ***Section 2.1*** from a 9-month period, are not being bid at Pier 70 for this same reason. This problem only stands to get worse as shoaling continues.

2.4 Emergency Repair Work

Section 1.2, Background on the Pier 70 Shipyard, presented the history of the shipyard and its existing status as an important ship repair facility. In addition to planned maintenance and repairs, the shipyard is valuable in its capacity and potential to perform emergency repairs.

The San Francisco Bay is the inlet through which many highly trafficked Ports are reached, including the Port of Oakland, Sacramento, Stockton, Redwood City, and San Francisco. According to the Marine Exchange, there are about 3,200 to 3,500 ship movements (in/out) a year. When there are emergencies, such as leaking oil tankers, or container ships taking on water, etc., the Pier 70 Shipyard is the closest repair facility to these ports on the west coast capable of handling such large ships. The next closest shipyard with similar capabilities is San Diego, which is 455 nautical miles away (NOAA 2012). However, the drydocks in San Diego are often unavailable as the Navy owns, operates, and usually fully utilizes them.

The next closest repair facility of similar capability is in Portland, Oregon, 652 nautical miles away. In the past, during emergencies where deep draft ships cannot traverse Central Basin or travel to other shipyards, emergency repair jobs have been completed at the Port of San Francisco's Pier 80. Pier 80 is a working cargo terminal near the main ship channel, roughly one mile away from Pier 70. The Port of San Francisco maintains Pier 80 at 40 ft MLLW. However, since the drydock facilities, cranes, forklifts, workers, security services, and equipment are all located at Pier 70, working out of Pier 80 is costly and is only used during emergencies. The following emergency jobs have been conducted at Pier 80:

- Winter D (February/14): Large container ship that needed to trim the ship to get the bow thruster out of the water for a repair. The aft draft of this vessel was 33 feet.
- Oregon Voyager (March/13): Loaded tanker that needed to change out a deep well pump. The draft of this vessel was 35 feet. This job was done at Pier 80 using a mobile crane.

Sometimes the high cost of repairing deeper draft ships at Pier 80 makes it preferable to go elsewhere for repairs. To users, this travel equates to transportation costs and further loss of profitable operation. The following recent repair work was unable to come to the Pier 70 Shipyard because shallow depths did not allow for the maintenance of required three foot under keel depth. These are listed as 'technically unacceptable':

- USNS Yukon – Jan/2014: technically unacceptable because of water depth
- USNS Guadalupe – Aug/2013: technically unacceptable because of water depth

The above vessels needing repair went to Portland, Seattle, or Victoria in Canada.

Aside from increased costs of transportation and extended delays, there also may be environmental consequences caused by the need for ships to go to shipyards in San Diego, Portland, Seattle, or Canada. In the case of leaking oil tankers, additional travel would be damaging to the environment and cleanup of spilled oil would have further reaching economic consequences.

As an illustration, the Cosco Busan, which crashed into the San Francisco – Oakland Bay Bridge in 2007, resulted in damaging oil spills into the San Francisco Bay and beyond. The Cosco Busan was repaired at the Pier 70 Shipyard, which was less than two nautical miles away from the location of the accident. If it had been necessary for the Cosco Busan to travel further for repairs, environmental oil spill damages and economic clean up and remediation costs would likely have been much more significant.

The Pier 70 Shipyard is regularly called on to participate in Table Top marine disaster drills held by the USCG and other maritime stakeholders. In these drills, the yard is considered an asset and main option for minimizing the environmental impact of potential waterborne casualties.

2.5 Historic and Cultural Resources

The shipyard and its history are rich in historic cultural resources, as described in ***Section 1.3***, Background on the Pier 70 Shipyard. However, since the proposed alternatives at Central Basin would all occur in the water, none of the historic buildings or properties in the shipyard will be affected. The District's historical record of past dredging in Central Basin contains previous environmental reviews and project documents over the past 20 plus years and the records of the current operations that lease the Port facilities. No encounter with submerged cultural resources during dredging operations is identified in any of these documents, nor in the literature and database review performed for the Area of Potential Effect (APE)[3]. Therefore, it is a reasonable, tentative, conclusion that no historic properties are present in the APE. Submerged cultural resources would not likely have survived in the existing shipping channels.

Additionally, an archaeologist surveyed a potential beach-disposal area for cultural resources and the results were negative. Lastly, none of the plotted locations of known shipwrecks fall within the area of the considered disposal sites.

The cultural resources assessment thus concluded that there is little potential for historic properties to be adversely affected by the dredging, and that no historic properties will be adversely affected by disposal activities.

[3] The APE is defined as the geographic area of a Federal undertaking within which adverse effects in the character or use of a historic property would occur from the project.

3 Problems, Opportunities, and Objectives

In the early planning stages, the problems and opportunities are defined and used to determine appropriate objectives for the project. This section describes the problems and opportunities, as assessed by the CAP 107 study, as well as the goals and objectives of the project. An assessment was also made of the planning constraints and considerations. Finally, a projection of what is likely to occur if no Federal action is taken is also discussed.

3.1 Problems

Based on the existing conditions given in Section 2, the following problems have been identified:

1) The existing depth of the Central Basin approach is inefficient for access in and out of the Pier 70 Shipyard and is expected to cause increased transportation costs and delays to users, as well as exclude certain large classes of vessels now and in the future.

2) Pier 70 Shipyard is also a repair facility that has in the past taken in emergency repair jobs. Inability to access the repair facility efficiently also poses an environmental safety hazard (e.g., oil spills from deep draft commercial vessels).

3) Future shoaling will worsen the operational conditions in the Central Basin, causing additional adverse impacts.

3.2 Opportunities

The following opportunities were identified:

1) Increase navigation safety and efficiency

2) Enable more use of Pier 70 Shipyard by increasing the number of vessels and improving operational flexibility

3) Increase the space available for maneuvering vessels with draft requirements of up to roughly 35 feet MLLW to fully utilize the large capacity of Drydock #2

4) Reduce the negative impacts of shoaling in Central Basin

5) Support quick and efficient disaster, accident, and spill response

6) Support the Long Term Management Strategy (LTMS) goals for dredge material placement by maximizing beneficial reuse of dredged material

3.3 Planning Objectives

The planning objectives guide the plan formulation process and serve to help assess an alternative's effectiveness during evaluation.

Navigation is one of the primary missions of USACE's Civil Works program. The USACE objective in navigation planning is to contribute to national economic development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED (NED benefits) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

The national objective is a general statement and is not specific enough for direct use in plan formulation. The water and related land resource problems and opportunities identified in this study are refined and stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes in the without project conditions. All objectives will be evaluated based on the USACE period of analysis, which is defined as 50 years, starting at base year of project completion.

Project specific planning objectives were developed based on the problems and opportunities described above.

1. Reduce transportation costs and user delays for commercial and U.S. government deep-draft vessels in accessing repair and service facilities at the Pier 70 Shipyard.

   Metric: Travel time and cost for likely future users of the shipyard.

2. Increase access to the specialized repair and service facilities at the Pier 70 Shipyard.

   Metric: Number of different vessels able to access the shipyard drydocks and piers and the number of hours per day that the docks/piers are accessible for different classes of vessels.

3. Improve safety and decrease risk to vessels and operators in approaching the Central Basin Shipyard.

   Metric: Draft clearance for each vessel class likely to use the shipyard and clearance conformance with minimum safety requirements, where they exist.

3.4 Planning Considerations and Constraints

The following planning constraints and considerations were identified during the early planning stages as items that should be considered during the development of measures and alternatives, as well as their evaluation.

3.4.1 CAP 107 Authority Funding Limitations

A CAP 107 authority is limited in scope and cost. Under this authority, actions can be made to adopt, construct, and maintain navigation improvements that provide NED benefits. Federal cost share is limited to $10 million, including the feasibility study, design, and implementation/construction costs. The NFS pays 50 percent of the feasibility study costs after the initial $100,000 of Federal funding. After the study, USACE pays a percentage of the Construction costs and 100 percent of the Operations and Maintenance costs. The NFS will contribute 25 percent of the General Navigation Features (GNF) for channels with depths between 20 and 45 feet. The NFS is responsible for an additional 10 percent of GNF over 30 years, which may be reduced by any creditable lands, easements, rights-of-way and relocations.

3.4.2 Environmental Regulations and Impacts

No potential adverse environmental impacts have been identified (see ***Section 6***, Environmental Effects). In the event that oysters, eelgrass, or any other sensitive benthic habitats are found, USACE would work with the National Marine Fisheries Service (NMFS, also known as NOAA Fisheries) and the California Department of Fish and Wildlife (CDFW) to minimize impacts to the population to comply with the Magnuson-Stevens Fishery Conservation and Management Act[4].

The project is required under the Endangered Species Act not to jeopardize the continued existence of threatened or endangered species or to destroy or adversely modify their habitat. Non-Federal interests have dredged the Central Basin project footprint in the past. Construction and annual maintenance dredging by USACE must occur within the work window defined through agency consultation and wildlife lifecycles.

A description of the requirements and compliance activities associated with these and other Federal and State regulations is documented in ***Section 10***, Compliance with Applicable Laws, Policies, and Plans.

3.4.3 San Francisco Bay Long Term Management Strategy for the Placement of Dredged (LTMS) Planning Context

LTMS goals and objectives were considered during the plan formulation process.

The LTMS program was formed in the 1990s in response to the public's growing concern over the potential direct, indirect and cumulative effects of dredging and dredged material disposal activities on the already stressed resources of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. The 50-year LTMS program comprises state and Federal regulatory agencies with primary authority to review and permit dredging and disposal activities in the San Francisco Bay Area. Participating agencies include the United States Environmental Protection Agency (USEPA), San Francisco Bay Regional Water Quality Control Board (SFRWQCB), San Francisco Bay Conservation and Development Commission (BCDC), California State Lands Commission, and USACE.

Formal implementation of the LTMS began in 2001 with the adoption of the LTMS Management Plan. The Management Plan was preceded by an extensive 8-year Federal and state planning

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[4] The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established a requirement to describe and identify "essential fish habitat" (EFH) in each Federal fishery management plan. NOAA Fisheries Service issued EFH regulations in January 2002. EFH is defined in the Magnuson-Stevens Act as "*...those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.*"

effort that culminated in the LTMS Final EIS/Environmental Impact Report (EIR) in October 1998. The environmentally preferred alternative identified in the LTMS Final EIS/EIR includes beneficial reuse of at least 40 percent of material dredged in the San Francisco Bay region, no more than 40 percent placement at SF-DODS, and no more than 20 percent placement at in-Bay sites. The Management Plan was based on average annual dredged material disposal volumes from 1991 through 1999. The 2001 LTMS Management Plan called for reversing the historic practice of disposing 80 percent or more of all material dredged from San Francisco Bay at in-Bay disposal sites, and requires that at least 80 percent of all dredged material be placed at beneficial reuse sites, upland, or at ocean disposal sites, with only limited volumes of material being placed in-Bay. Over the life of the LTMS, the selected alternative aims to:

- Maintain, in an economically and environmentally sound manner, those channels necessary for navigation in San Francisco Bay, and eliminate unnecessary dredging activities;
- Conduct dredged material disposal in the most environmentally sound manner;
- Maximize the use of dredged material as a resource; and
- Maintain the cooperative permitting framework for dredging and disposal applications.

The LTMS program itself does not change or grant any agency new authorities and that the laws described in ***Section 10***, Compliance with Applicable Laws, Policies, and Plans, are the basis for agency jurisdiction over dredging and dredged material placement.

3.4.4 Water Quality Control Plan for the San Francisco Basin (Basin Plan)

The Basin Plan is the primary document used by the SFRWQCB for the regulation of in-Bay dredging. The Basin Plan was most recently approved by the state Office of Administrative Law on 20 March 2015; and Section 4.20.7 states its policies toward dredging as: "*The goal of the policies below is to reduce in-bay disposal volumes to approximately 20% of recent historical dredging volumes, to about 1 million cubic yards per year.*" The Basin Plan implements the LTMS Management Plan by setting a long-term overall target for in-Bay disposal of dredged material at designated disposal sites, which is evaluated on both an annual basis and every three years. It also adopts the guidelines contained in the Inland Testing Manual (USEPA and USACE, 1998) and local implementation procedures developed through the Dredged Material Management Office (DMMO) as the appropriate framework for evaluating the suitability of dredged material for disposal at in-Bay disposal sites, and providing revised permit conditions to reflect requirements of the resource agencies (California Department of Fish and Wildlife, United States Fish and Wildlife Service, and NMFS). The USACE will address consistency of the Central Basin dredging action with the water quality objectives and beneficial uses adopted in the Basin Plan to the maximum extent practicable through the Section 401 Water Quality Certification (WQC) process.

3.4.5 San Francisco Bay Plan

The BCDC regulates dredging and dredged material placement in San Francisco Bay. Under authority of the state McAteer-Petris Act of 1965, BCDC prepared the San Francisco Bay Plan; and in 1968, adopted regulations and policies regarding dredging and placement in San Francisco Bay. The San Francisco Bay Plan dredging policies implement the LTMS findings through the inclusion of policies that reduce in-Bay disposal, maximize beneficial reuse, and an allocation strategy to reduce in-Bay disposal. The BCDC is also the state coastal zone management agency pursuant to the Federal Coastal Zone Management Act (CZMA) for the San Francisco Bay segment of the California coastal zone. Under the Federal consistency provisions of the CZMA, Federal projects need to be determined to be consistent with the state's coastal zone management program and policies to the maximum extent practicable (16 U.S.C. § 1456).

The lead Federal agency makes the consistency determination, and seeks concurrence from the CZMA managing agency, which has the ability to concur, condition the project to find consistency, or object to the project. The BCDC's law and policies are the basis for its federally approved state coastal management program for San Francisco Bay. Dredging and placement projects must be consistent with all Bay Plan policies, to the maximum extent practicable, and USACE requests BCDC's concurrence on USACE's consistency determination prior to commencing dredging activities. The USACE's evaluation of discharges (i.e., placement) of dredged material in San Francisco Bay and ocean placement sites and compliance with Section 404 and 401 of the Clean Water Act (CWA), the Marine Protection, Research, and Sanctuaries Act (MPRSA), and the CZMA is guided by the LTMS Program, and other plans and policies described in the detailed project report.

3.4.6 Compliance with Local Land Use Plans

Pier 70 is within the City of San Francisco and subject to city planning and zoning laws.

3.4.7 Standard for Dredged Material Disposal

The USACE Engineer Regulations (ER 1105-2-100) provide that the preferred alternative must be the least costly plan that is consistent with environmental statutes, as set forth in the National Economic Development (NED) Plan for new work projects. Compliance with the ocean dumping criteria of the MPRSA and with the CWA Section 404(b)(1) Guidelines (40 C.F.R. § 230) is a controlling factor used by the USACE in determining the environmental acceptability of disposal alternatives.

3.4.8 Period of Analysis, Base Year, and Planning Horizon

Section 9 of the "Economic and Environmental Principles for Water and Related Land Resources Implementation Studies" (Figure 1-1 in USACE, 2000) requires that the period of analysis to be the same for each alternative plan studied, but does not specify the actual number of years for the period of analysis. Section 2-4j of the Planning Guidance Notebook (USACE, 2000) lists 3 criteria to determine the number of years for the period of analysis: "The period of analysis shall be the time required for implementation plus the lesser of: (1) the period of time over which any alternative plan would have significant beneficial or adverse effects, (2) a period not to exceed 50-years except for major multiple purpose reservoir projects, or, (3) a period not to exceed 100 years for major multiple purpose reservoir projects." Based upon these criteria, a period of analysis of 50 years was selected for this study. In addition, a base year needs to be established for the project from which the 50-year period of analysis will begin. The year 2016 was chosen as the base year for this study. While the period of analysis for this study was selected as 50 years (primarily for economic purposes), there are other aspects of the study requiring a longer planning horizon. Both ER 1110-2-8159 (USACE 1997) and ETL 1110-2-1 (USACE 2014b) suggest using a longer planning horizon for service life and sea level change respectively. Therefore, based on Section 1.1 b. of ETL 1110-2-1, a 100-year planning horizon was used for this study.

3.5 Policy Considerations for Multiple Interested Federal Agencies

A policy question arose as to whether the presence and measurement of benefits accruing primarily or exclusively to another Federal Agency, specifically a Federal military organization, presented a situation that could preclude USACE financial participation in a Navigation project. A policy and Planning Guidance Letter search on who pays for Navigation improvement projects where there are other Federal agencies benefiting has turned up the following results: USACE participation and cost-share requirements are determined by ownership of the property (pier, port, shoreline, etc.) and not the measurement of benefits or to specifically whom the benefits accrue. The USACE should be able to cost share on both study and construction if an economically justifiable plan is recommended. Though various Federal agencies that use the Pier 70 Shipyard will benefit from decreased transportation costs and increased safety and efficiency, the property and facilities are municipally owned and thus Federal beneficiaries are not required to cost-share on incremental benefits. The Pier 70 Shipyard does not have restrictive conditions such that a single property owner or user will enjoy exclusive current and future benefits. Additionally, there are commercial users of the Shipyard in addition to Federal Agencies. Relevant examples where similar situations have occurred include Port Hueneme and San Diego Harbor.

3.6 Future Without Project Conditions.

The Future Without Project Condition (FWOP) is the characterization of what can reasonably be expected to occur in the future if no Federal project is undertaken. In some cases, other events or actions may be reasonably expected to intervene to alleviate some of the problems, in other cases, deteriorating trends may cause problems to worsen over time. The FWOP requires assumptions about the future that are uncertain and thus there is always uncertainty in the FWOP description.

Costs and benefits of the action alternatives are compared against the FWOP. The FWOP takes into account how conditions can be expected to change over time. Such changes may have large impacts on the costs and benefits of inaction or action on the part of the Federal government.

In the case of Central Basin, the Port has requested Federal assistance in deepening and establishing a Federal deep draft navigation channel at Central Basin. Though the Port has conducted sporadic dredging activities in Central Basin (i.e. only four times over the last 40-years), they have not been able to do so consistently nor effectively. Neither the Port, nor any other party has a legal obligation to maintain Central Basin. Given the above circumstances, it is expected that no further dredging of Central Basin will take place under the without-project condition. Therefore, the future without project condition assumes that the shipyard would close between 2022 and 2026.

3.6.1 Future Without Project Depth and Navigation Condition

The FWOP depth was projected using the mean depths in the proposed dredging footprint calculated from hydrographic surveys conducted from November 2010 to January 2014, plus the background shoaling rate. The proposed dredging footprint covers a significantly larger area with a greater variation in depth than the presently utilized channel.

The mean depth within the proposed dredging footprint was 27.3 feet MLLW over the course of the five surveys included in the analysis. The greatest depths ranged to just below 60 feet MLLW and were found adjacent to Drydock 2. The shallowest depths were found along the northern and western edges of the proposed dredging footprint, including a broad area with depths of less than 20 feet MLLW and a minimum depth of 14.3 feet MLLW.

The shoaling analysis (Delta Modeling Associates, Inc. 2015) is presented in ***Appendix C.a***. The shoaling analysis estimated a net shoaling rate of 16,000 cubic yards per year, with the greatest shoaling (up to 1 foot) concentrated in the western section of the footprint last dredged by BAE Systems in 2011. There was also some modest erosion in the northeastern section of the footprint, and widely scattered areas of little to no bathymetric change. In wet hydrologic conditions, the shoaling rate was nearly double that of the rate during very dry conditions, suggesting significant year-to-year variations. The long-term shoaling rate estimate assumes a uniform decrease of depth due to sediment accumulation over the entire footprint of half a foot per year. In a wet year, this could increase to 1 foot per year.

However, the higher shoaling rate is associated with wet hydrologic conditions that do not occur every wet season, and it is likely that shoaling rates will decrease over the long-term as previously deepened areas fill and approach the same depth as surrounding bathymetry. Therefore, a shoaling rate of half a foot per year was used to determine the future without project depth. The future without project depth predicts an approximate 10-foot decrease in depth over the course of 20 years, with a mean depth approaching 17 feet MLLW, not including sea level rise (***Table 3***).

Table 3. Future Without Project Condition Depth (2016 to 2036) in Central Basin

Year	2016	2021	2026	2031	2036
Mean Depth (feet MLLW)	27.3	24.8	22.3	19.8	17.3

The Maritime Administration (MARAD), which is part of the Department of Transportation (DOT) and the Coast Guard, which is part of the Department of Homeland Security during peacetimes and the Navy during wartimes, both have ships that cannot cross Central Basin at projected future depths. Navigation conditions in Central Basin are already unsafe for some vessels to enter the shipyard and are expected to worsen, until the shipyard is no longer able to operate.

The USACE San Francisco District economist and the USACE Deep Draft Navigation Planning Center of Expertise economist did an informal sensitivity analysis to determine whether the project would be economically justified assuming two scenarios: 1) no future Non-Federal Sponsor dredging activities, and 2) Non-Federal Sponsor maintenance to its current depth of approximately 27 feet MLLW. The result of these calculations led the economists to determine that there is Federal interest in dredging this channel to 32 feet MLLW under either scenario. The first scenario of no future Non-Federal Sponsor dredging activities was then selected for use as the future without project condition throughout this report.

3.6.2 Future Shipyard Use

Based on the projected without project depths, the Port estimates that the shipyard would not be viable after 2021. If ship movements were limited to positive tides, one could add 5 to 6 feet to the 24.8 depth to give about 30 feet of depth in Central Basin. After 2021, possible repairs would be limited to smaller vessels, but there is not enough volume in that market for a sustainable business plan. Therefore, the future without project condition assumes that the shipyard would close between 2022 and 2026.

3.6.3 Sea Level Change

Potential relative Sea Level Change (SLC) at Central Basin from 1992 to 2116 ranges from 0.82 feet (“low” rate) to 6.52 feet (“high” rate). The “low” rate is linear with a steady increase of 0.0066 feet per year throughout the planning horizon. This SLCrate implies that there has been 0.16 feet of relative SLC from the middle point of the last NTDE in 1992 to 2016. In the case of the “intermediate” and “high” SLC scenarios, the rates considerably accelerate after approximately 2050, when the “high” rate yields a SLC rate of over 0.5 foot per decade. It can be anticipated that sea level change will slightly increase channel depth over the 20 years following construction, with a maximum potential increase in depth of approximately 1 foot under the “high” rate.

For the purpose of the economic analysis, the FWOP depth was projected out 20 years for a no sea level change scenario and the three SLC rates. The shoaling rate of 0.5 feet per year would yield an approximate 10 foot decrease in depth over the course of 20 years (see ***Table 4***), with a mean depth approaching 17 feet (MLLW) by 2036. The impacts of sea level change over the course of 20 years is likely to be relatively minor, with the high rate potentially offsetting the anticipated shoaling by only 1 foot or so. The potential effect of the High Rate is accounted for in the cost contingency of the Cost Risk Analysis (CRA).

Table 4. Central Basin Future Without-Project Channel Depths – in feet below MLLW

Year	No Sea Level Change	Low Rate (Historical)	Intermediate Rate (NRC I)	High Rate (NRC III)
2016	**27.3**			
2021	24.8	24.8	24.9	25.0
2026	22.3	22.4	22.5	22.8
2031	19.8	19.9	20.1	20.5
2036	17.3	17.4	17.7	18.3

4 Alternative Plans

Alternative plans were formulated to address the problems identified in Chapter 3, meet the purpose and need for the project, fulfill project objectives, and work within identified constraints. Each alternative is composed of actions or measures to allow vessels increased access to Pier 70 through non-structural measures and/or structural (i.e., channel deepening) measures, and measures for placement of dredged material.

This chapter describes management measures, the rationale for retaining or not retaining these management measures in a preliminary screening process, and how retained measures were combined to form a focused array of alternatives carried forward for further evaluation.

4.1 Nonstructural Measures

Non-structural management measures are actions that do not require physical changes to infrastructure, but instead focus on changes in patterns or methods of use. The following nonstructural measures were developed and evaluated.

4.1.1 Relocate shipyard to Pier 80 or other suitably accessible location.

Instead of deepening the approach to Pier 70, relocation would involve moving the ship repair infrastructure and facilities to another more accessible location nearby, such as Pier 80.

Not Retained: Moving the drydocks to Pier 80 would be cost prohibitive. The preliminary cost estimate for relocation to Pier 80 is between $16 and 20 million. Additionally, Pier 80 is an active cargo terminal and it is unlikely that it could accommodate the full range of Shipyard activities currently provided. No other suitable locations were identified for relocation.

4.1.2 Lightering

Lightering is the process of removing cargo before calling at a port or repair facility in order to reduce its arrival draft. Lightering typically takes place in dedicated anchorage locations.

Retained: This measure is already in practice and is part of the existing condition and No Action Alternative, but it may also still be necessary in some situations. However, alternatives should significantly reduce the need for lightering. During emergencies, such as a ship leaking oil, this measure carries great risk and cost because it can cause delays while oil is leaking into the Bay. Therefore, relying too heavily on lightering, as well as use of favorable tides is not a well-suited measure for emergencies. Measures like these, which cause delays, can increase safety risk in emergencies.

4.1.3 Use of favorable tides

High tides occur twice daily in San Francisco Bay, approximately 12 hours apart. Incoming and outgoing vessels may wait until high tide to have sufficient available draft to cross through Central Basin.

Retained: Ships with the deepest draft requirements and which are are permitted to use tides may still need to use favorable tides to meet their safety requirements.

4.1.4 Daylight Transit Only

Improve safety by restricting transit of Central Basin to daylight hours only. Deepening such that ships are no longer tide restricted, would complement this measure.

Not Retained: Though the goal of increasing access during daylight hours remains, this measure was not retained for further analysis because in some situations it may be impractical or less safe to wait for daylight in order to traverse Central Basin. Nighttime transit does not negatively affect the safety of operations at Central Basin. The shipyard is equipped with lighting that is used when necessary to improve visibility for safe operations. Furthermore, there are times when nighttime conditions are safer than day. For instance, due to more favorable wind conditions at night. This measure is not effective and has been screened out.

4.2 Structural Measures

The following structural measures were developed and evaluated.

4.2.1 Deepen Central Basin to 30 feet, 32 feet, or 35 feet.

Deepening Central Basin is the primary structural measure under consideration. Navy protocols require a depth of 35 feet to bring all classes of Naval vessel into the shipyard.

Incremental depths were developed for economic analysis based on the current vessel draft requirements of likely users. Each incremental depth also includes two feet of overdepth, one of which is paid.

Retained: Economic analysis of shipping patterns and projections of likely future use will help identify the optimal depth for Central Basin.

4.2.2 Dredge a wider footprint towards the shore in Central Basin.

The existing depths in Central Basin vary greatly and this can cause significant shoaling in some areas where sediments from shallower areas slough into the dredged deeper areas. This measure was developed based on the assumption that dredging a wider footprint may ameliorate some of this shoaling and reduce future maintenance dredging requirements. For this measure, the additional area considered to expand the footprint was the shallower area towards the shore.

Not Retained: The shoaling analysis included in the Coastal Engineering Appendix demonstrates that increasing the dredging footprint by an additional 18 percent would not reduce future operations and maintenance (O&M) quantities or costs (see ***Appendix C.a***, Coastal Engineering, for more information).

4.3 Dredged Material Placement Measures

A comprehensive range of sites was considered for dredged material disposal/placement. Many placement sites were excluded from consideration because they would not be available to accept dredged materials at the time this project would be implemented. Ravenswood Pond

Complex, Eden Landing Pond Complex, Alviso Pond complex, Bay Farm Borrow Pit, and Passive in-Bay disposal were not retained for further consideration because:

- **Ravenswood Pond Complex**: This site is currently permitted and available. However, its remaining capacity is only about 300,000 cy. Cost for placement of dredged material would be prohibitive. Ravenswood is within the Don Edwards National Wildlife Sanctuary and includes sensitive habitat. There are a number of natural channels that must be protected. Dredged material would have to be dredged with clamshells, loaded onto barges, off-loaded from the barges into a re-handling area and dried to reduce moisture content to sufficiently to prevent free moisture when the material is loaded into trucks. The material would then be trucked to the site for precise placement. The multiple handling steps and inefficient transport process significantly escalates project costs.
- **Eden Landing Pond Complex, Alviso Pond complex, Bay Farm Borrow Pit**: These sites were screened out because they are not currently permitted for placement of dredged material and it is uncertain whether they would be available for construction.
- **Passive in-Bay disposal**: This is a new and promising concept that would consist of placing dredged material in the bay in locations where natural dispersal processes would move it to renourish subsided coastal wetlands. Passive disposal is still being rigorously studied as the "LTMS Strategic Placement study" by resource agencies and USACE and is expected to take 3 to 5 years to complete. The study would not be completed nor permitted by the time this project is scheduled for construction. Previous studies by USACE [Bever & MacWilliams, 2013; Bever & MacWilliams, 2014] indicate that this method is very site specific, with the potential for success much greater in the South Bay than in the North Bay. Additional studies of the Central Basin site and coordination with regulatory agencies would be needed before this method may be considered a viable option. This measure was eliminated from further consideration due to its infeasibility and high uncertainty. However, future O&M in Central Basin could consider it if it were to become a reality.

In 2015, the Port of San Francisco in partnership with USACE conducted two sampling and testing events of material proposed to be dredged at Central Basin to determine the suitability of the material for placement at available sites; and, therefore, determine the feasibility of considered placement measures. The Dredged Material Management Office (DMMO) determines the suitable placement sites for dredged material upon review of sediment testing results for all USACE projects. The DMMO is a joint program composed of USACE, USEPA, BCDC, SFRWQCB, and the State Lands Commission. Participating agencies include CDFW, NMFS, and the United States Fish and Wildlife Service (USFWS). The DMMO agencies use the requirements listed in the *Ocean Testing Manual* (USEPA and USACE, 1991), *Inland Testing Manual* (USEPA and USACE, 1998), and *Guidelines for Implementing the Inland Testing manual within the San Francisco Bay Region* (USACE, 2001).

Samples were collected throughout the entire proposed dredge footprint in April 2015 and samples were collected only in two dredge units in November 2015. The analytical results for each sampling event are detailed in the following documents (***Appendix D***):

- *Central Basin Supplemental Sampling Results Technical Memorandum*, dated January 4, 2016.
- *Port of San Francisco Central Basin Sediment Characterization Report*, dated August 25, 2015, and revised on September 28, 2015.

As a result of the sampling and testing conducted by the Port of San Francisco and USACE, the DMMO determined that roughly a quarter of the material is suitable for in-Bay placement, and all of the material is suitable for placement as foundation material at MWRP or at SF-DODS.

Descriptions of the remaining placement measures, are provided below. The placement sites carried forward for further consideration in this section are already permitted, and/or sites for which the site owners have completed environmental review.

4.3.1 Deep Ocean Disposal

SF-DODS is located in the Pacific Ocean approximately 55 nautical miles west of the Golden Gate Bridge and about 71 nautical miles from the proposed dredge footprint at Central Basin (***Figure 15***). The total size of SF-DODS is 6.5 square nautical miles, with the disposal area in a 600-meter radius circle at the center of the site. The site was established in 1994 and is managed by the USEPA. SF-DODS is authorized to receive up to 4.8 million CY of dredged material per year. There are no tipping fees or unloading costs associated with the site. Site users, however, are responsible for a volume-based *pro rata* share of annual site monitoring costs, which typically totals approximately $500,000 per year. Annual monitoring by USACE has shown that past disposal at SF-DODS has occurred without causing significant impacts to the ocean and the marine biology in and around SF-DODS (USACE, 2016).

SF-DODS can accommodate material from Central Basin that cannot be placed in San Francisco Bay due to elevated concentrations of various constituents relative San Francisco Bay ambient concentrations. Therefore, the LTMS EIS/EIR determined disposal at SF-DODS to be environmentally superior to disposal of the same material at the traditional unconfined disposal sites in the more sensitive San Francisco Bay and Delta Estuary.

<u>Retained:</u> SF-DODS is retained as a potential disposal option that would be environmentally acceptable.

In a memorandum for record from the DMMO dated April 8, 2016, the DMMO concluded that all the material proposed to be dredged at Central Basin is suitable for placement at SF-DODS.

4.3.2 Upland Beneficial Reuse

The Montezuma Wetlands Restoration Project (MWRP) is a privately owned and operated site that began accepting material in July 2003. The owner/operator is Montezuma Wetlands LLC. MWRP has a remaining capacity of 12 million CY. The site is approximately 1,800 acres adjacent to Montezuma Slough in Solano County, located north of the New York slough inland from San Francisco (***Figure 14***). Dredged material brought here is beneficially reused to restore and create wetlands. The site has capacity for material for many years. Montezuma has all required permits, and may accept both "cover" and "foundation" quality material (as defined in the SFRWQCB's Order No. R2-2010-0108). Cover material has stricter suitability thresholds while foundation material can accommodate elevated concentrations of constituents in sediment.

The site has deep-water access, as well as a docking area for dredged material off-loading equipment. The offloader can accommodate most dredged material transport scows with 1,000 CY or greater capacity, but the operator does not guarantee complete offloading of flat-bottom scows or scows with capacity less than 1,000 CY. Pocket scows are not allowed at MWRP.

The tipping fee per cubic yard, which includes the unloading and subsequent sediment management costs, has been negotiable and varies with the size of the project and suitability/contamination levels of the materials. Placing dredged material as cover at beneficial re-use upland sites for restoration purposes requires clean material and an offloader. Montezuma is the only upland site available at this time that has an offloader.

<u>Retained:</u> Preliminary results from Central Basin sediment testing showed that there is no material suitable for placement as cover material, but roughly half of the dredge units appeared to meet the criteria for placement at Montezuma as foundation material (NewFields, 2015). In a memorandum for record from the DMMO dated April 8, 2016, the DMMO concluded that all the material proposed to be dredged at Central Basin is suitable for placement as foundation material at MWRP. Therefore, placement at Montezuma as foundation material was retained as a measure.

The Cullinan Ranch Tidal Restoration Project (Cullinan Ranch) is a 1,575-acre wetland restoration site that is part of the San Pablo Bay National Wildlife Refuge and is located in western Solano County near the City of Vallejo. It is a beneficial reuse site and is currently permitted and available. A non-profit organization, Ducks Unlimited, operates the site in partnership with USFWS for the purpose of increasing habitat for salt marsh harvest mouse and Ridgway's rail by restoring diked baylands to historic tidal marsh conditions. Cullinan Ranch is permitted to restore approximately 290 acres of tidal marsh habitat approximately 2.8 million cubic yards of dredged material. The project permits also include two locations for offloading facilities in the Napa River, north and south of the mouth of the confluence with Dutchman Slough, which will accommodate deep draft barges.

The site will charge a tipping fee to cover the costs of providing an off-loader and subsequent site and sediment management costs, similar to MWRP. The site is expected to be available until 2020.

Not Retained: Cullinan Ranch was screened out because concentrations of polychlorinated biphenyls (PCBs) and other analytes exceed the Cullinan Ranch acceptability criteria dictated by the SFRWQCB's waste discharge requirements for the site (Order No. R2-2010-0108). Therefore, the material proposed for dredging at Central Basin is not suitable for placement at Cullinan Ranch. Cullinan Ranch lacks an offloader that can place the Central Basin material in an efficient and timely manner and, currently, there are no plans for Cullinan Ranch to build or receive this type of offloader. Furthermore, Cullinan Ranch was screened out because the funding limits for CAP 107 make building an offloader cost prohibitive.

4.3.3 In-Bay Placement – Alactraz Placement Site (SF-11)

The Alcatraz Placement Site (SF-11) is a 1,000-foot-radius circular area, approximately 40 to 70 feet deep, approximately 0.3 mile south of Alcatraz Island in the Central San Francisco Bay (***Figure 14***). Since at least 1972, SF-11 has been the most heavily used placement site in San Francisco Bay. Placement is currently regulated at a maximum of 400,000 CY per month from October to April; and 300,000 CY per month from May to September.

Other in-Bay placement sites were considered including the San Francisco Bar Channel Placement Site (SF-8), Carquinez Strait placement site (SF-9), San Pablo Bay placement site (SF-10), Suisun Bay placement site (SF-16), and Ocean Beach placement site (SF-17). Among other reasons, these sites were not retained primarily because they are much farther from Central Basin than SF-11.

Retained: Sediment testing indicates that a little over a quarter of the material is suitable for in-Bay disposal (76,660 CY of the 296,180 total CY at a project depth of 35 feet MLLW). Any alternative that proposes utilizing in-Bay disposal cannot exceed 83,580 CY due to suitability constraints. In-Bay disposal retained as a measure to be combined with other placement measures.

4.4 Measures Carried Forward for Alternatives

The measures that were carried through the alternative formulation and screening are presented in ***Table 5***.

Table 5. Management Measures that were carried forward for further consideration.

Non-structural Measures
Lightering
Use of favorable tides
Structural Measures
Deepen to 30 feet
Deepen to 32 feet
Deepen to 35 feet
Placement Measures
SF-DODS Ocean Disposal
Upland Beneficial Reuse at Montezuma Wetland Restoration Project\
In-Bay Disposal at SF-11

4.5 Initial Array Formulation and Screening

The structural and placement measures in ***Table 5*** were combined into the initial array of 15 alternatives. Sediment testing helped to determine the suitability of the material in different dredge units and at different depths (***Appendix D***). This information was used to formulate the placement scenarios and perform initial screening., Approximately one quarter of the material in Central Basin is suitable for placement in-Bay, all is suitable for SF-DODS, and all is suitable for placement as foundation material at Montezuma. None of the material is suitable for placement as cover material at Montezuma. The array of alternatives were created based on this suitability determination.Alternatives that propose disposal of material at Montezuma as cover material were not considered in the initial array.

Under SF-DODS only and Montezuma only placement alternatives, all material dredged during construction (new work material) would be hauled to and placed at one of these sites. The Montezuma alternatives would be expected to enjoy strong public and regulatory agency support, as they would be a clear attempt to meet the LTMS objective of increasing beneficial reuse of dredge material. While placement of 100 percent of the new work material at Montezuma Wetlands Restoration Site would desirable for environmental reasons, it was expected to be much more expensive than disposal at SF-DODS because of tipping fees.

In alternatives that considered a placement at both SF-DODS and SF-11, approximately three quarters of the new work material would go to SF-DODS and the remainder would be placed at SF-11. These alternatives were expected to have the least cost when compared with other alternatives of equal depth since SF-11 is much closer to Central Basin.

Alternatives that considered placing material at both Montezuma and SF-11 considered three quarters of new work material going to Montezuma and the remainder going to SF-11. Including placement at SF-11 in combination with placement at Montezuma was expected to reduce costs in comparison with placement at only Montezuma. Use of in-Bay placement sites by USACE is generally reserved for only material dredged during annual maintenance episodes. However, it was assumed that there would be support from regulatory agencies for using some in-Bay capacity in order to offset costs of sending material to Montezuma for wetland restoration.

The final placement measure of placing some of the new work material at SF-DODS, SF-11 and Montezuma considered placing about two thirds at SF-DODS, a quarter at SF-11 and the remainder at Montezuma. These alternatives attempted to reduce the costs while still placing some material at Montezuma.

The initial round of screening was performed based on the following criteria.

1. The in-Bay placement of dredged materials listed in RWQCB's Order No. R2-2015-0023 and the Basin Plan are for USACAE O&M dredging projects. Any alternatives that propose placement at SF-11 in combination with placement at SF-DODS were screened out of the final array in order to maintain in-Bay placement capacity for USACE O&M dredging projects.
2. The USACE Engineer Regulations (ER 1105-2-100) requires that the preferred alternative be the plan that maximizes net National Economic Development (NED) benefits and is consistent with environmental statutes, as set forth in the NED Plan for new work projects. Upland beneficial reuse would normally be cost-prohibitive for a project of this size—especially for material that is not suitable for cover. However, beneficial reuse of dredged material is preferred among the LTMS agencies, so it was proposed to combine some in-Bay placement to offset the cost of beneficial reuse to meet the requirements of ER 1105-2-100.

Each alternative in the final array consisted of a different combination of the structural measures and placement measures listed in ***Table 5***, plus all three of the non-structural measures. ***Table 6*** summarizes the initial array of alternatives considered and whether and why each was not retained. Following the initial screening, cost estimates were determined for the remaining alternatives.

An alternative with placement at MWRP and SF-11 is retained for further analysis. This placement site combination was proposed to offset the prohibitively high cost of beneficial reuse. Although the existing USACE O&M dredging projects use the full in-Bay placement capacity, the opportunity to provide material for upland beneficial reuse may make this alternative preferable to the LTMS agencies. With the approval of the LTMS Program Managers, the site could potentially be used for a small amount of material to off-set the cost of using upland beneficial reuse sites, if the cost of using them results in a favorable Benefits/Costs Ratio and meets ER 1105-2-100 criteria for the NED plan. Thus, the MWRP and SF-11 placement alternative is retained for further analysis.

Following screening, three alternative plans were selected for further consideration.

Table 6. Initial Array of Alternatives

Alt #	Depth (ft MLLW)	Dredge Placement Site(s)	Quantity (cy)	% Total Dredged Material	Total Project Cost	Retained	Reason for screening
1	**30 ft**	**SF-DODS**	**162,070**	**100**	**$7,811,000**	**Yes**	**Retained as potential LPP**
2	30 ft	Montezuma	162,070	100%	$11,786,000	No	Not NED nor LPP. Exceeds CAP $10M limit on Federal contribution.
3	30 ft	SF-DODS SF-11	117,660 44,410	73% 27%	$7,613,000	No	Limits in-Bay disposal capacity for existing USACE O&M dredging projects
4	**30 ft**	**Montezuma** SF-11	**117,660** 44,410	**73%** 27%	**$9,742,000**	**Yes**	**Retained for beneficial use consideration** (this alternative will require coordination to avoid phasing and capacity issues at SF-11).
5	30 ft	SF-DODS Montezuma SF-11	116,030 1,630 44,410	72% 1% 27%	$7,811,000	No	Limits on in-Bay disposal capacity for existing USACE O&M dredging projects
6	**32-feet**	**SF-DODS**	**212,120**	**100%**	**$8,971,000**	**Yes**	
7	32-feet	Montezuma	212,120	100%	$14,444,000	No	Not NED nor LPP. Exceeds CAP $10M limit on Federal contribution.
8	32-feet	SF-DODS SF-11	155,300 56,820	73% 27%	$8,441,000	No	Limits on in-Bay disposal capacity for existing USACE O&M dredging projects
9	32-feet	Montezuma SF-11	155,300 56,820	73% 27%	$11,819,000	No	Not NED nor LPP. Also does not meet volume limit on in-Bay disposal capacity.
10	32-feet	SF-DODS Montezuma SF-11	146,730 8,570 56,820	69% 4% 27%	$8,971,000	No	Limits on in-Bay disposal capacity for existing USACE O&M dredging projects
11	35-feet	SF-DODS	296,200	100%	$10,992,000	No	Not NED nor LPP. Exceeds CAP $10M limit on Federal contribution.
12	35-feet	Montezuma	296,200	100%	$18,912,000	No	Not NED nor LPP. Exceeds CAP $10M limit on Federal contribution.
13	35-feet	SF-DODS	219,520	74%	$10,134,000	No	

Alt #	Depth (ft MLLW)	Dredge Placement Site(s)	Quantity (cy)	% Total Dredged Material	Total Project Cost	Retained	Reason for screening
		SF-11	76,660	26%			Limits on in-Bay disposal capacity for existing USACE O&M dredging projects. Not NED nor LPP, exceeds CAP $10M limit on Federal contribution.
14	35-feet	Montezuma SF-11	219,520 76,660	74% 26%	$15,383,000	No	Not NED nor LPP. Exceeds CAP $10M limit on Federal contribution.
15	35-feet	SF-DODS Montezuma SF-11	199,785 19,735 76,660	67% 7% 26%	$10,992,000	No	Not NED nor LPP. Also does not meet limits on in-Bay disposal capacity. Exceeds CAP $10M limit on Federal contribution.
16	**No Action**	**N/A**	**N/A**	**N/A**		**Yes**	

4.6 Final Array of Alternatives

Four alternative plans were retained in a final array for further consideration:

Alternative 1) 30 ft MLLW foot depth + Non-structural measures (lightering, and use of favorable tides)+ SF-DODS only placement

Alternative 4) 30 foot depth + Non-structural measures (lightering, and use of favorable tides) + SF-11 + Montezuma placement

Alternative 6) 32 foot depth + Non-structural measures (lightering, and use of favorable tides) + SF-DODS only placement

Alternative 16) No Action Plan (Future Without-Project Condition)

4.6.1 Proposed Action: Alternative 6

Alternative 6 would involve dredging the three proposed dredge units (DUs) in the Central Basin approach area to a depth of 32 feet MLLW plus 2 feet of overdepth and placing all of dredged material at SF-DODS. Approximately 237,700 CY of material (including the 2 feet of overdepth) would be dredged. A depth of 32 ft would allow 95 percent of the likely vessel classes (those analyzed in the economic analysis) to come in to the shipyard. Dredging under the Proposed Action would most likely use a mechanical clamshell dredge plant with tugboats and scows as illustrated in ***Figure 19***. The mechanical clamshell dredge plant (***Figure 19***) is made up of a large work barge with a large crane mounted on the deck of the barge. The crane has a boom that is long enough to extend out beyond the end of the work barge in any direction and is able to swivel 360 degrees on its mount. A large clamshell bucket is attached to a series of cables at the end of the boom, which allows the bucket to be raised and lowered into the water. The cables also open and close the bucket as it is filled with sediment and then emptied into scows. The scows are open barges that can carry large quantities of sediment while they are towed with tugboats to and from the disposal site. The Proposed Action is expected to be executed with one 21 CY clamshell bucket, three 3,000 horsepower (HP) tugboats, and four 4,000 CY scows to transport the dredged material to SF-DODS (***Appendix C.c***, Civil Design Appendix).

The dredge plant barge has two or three spuds, which are long vertical pipes that are driven with hydraulic pumps into the bay bottom to hold the dredge still while it is digging. The dredge will anchor itself in place and the crane will begin digging in a series of arcs extending out and away from the work barge while the clamshell bucket digs down to the intended depth. The scows that are to be filled with sediment are tied to the side of the dredge plant. As soon as one scow is filled and hauled away, another scow is maneuvered into place alongside the dredge and the digging continues. The digging will begin near the dredge and will progress away from the dredge until the crane boom has been extended out to its maximum length. After the furthest arc has been completed down to the desired depth, the spuds will be lifted out of the bay mud and the dredge plant will be repositioned to the next area to be dredged using small tender tugboats. The spuds will then be lowered to stabilize the dredge and digging will begin again. This relocation operation requires approximately 1-hour to complete. On average, the mechanical clamshell dredge plant for this project will need to be relocated approximately every 2.5 to 3 hours. Under these conditions, the clamshell dredge is expected to dig an average of 190,000 square feet (4.5 acres) per day.

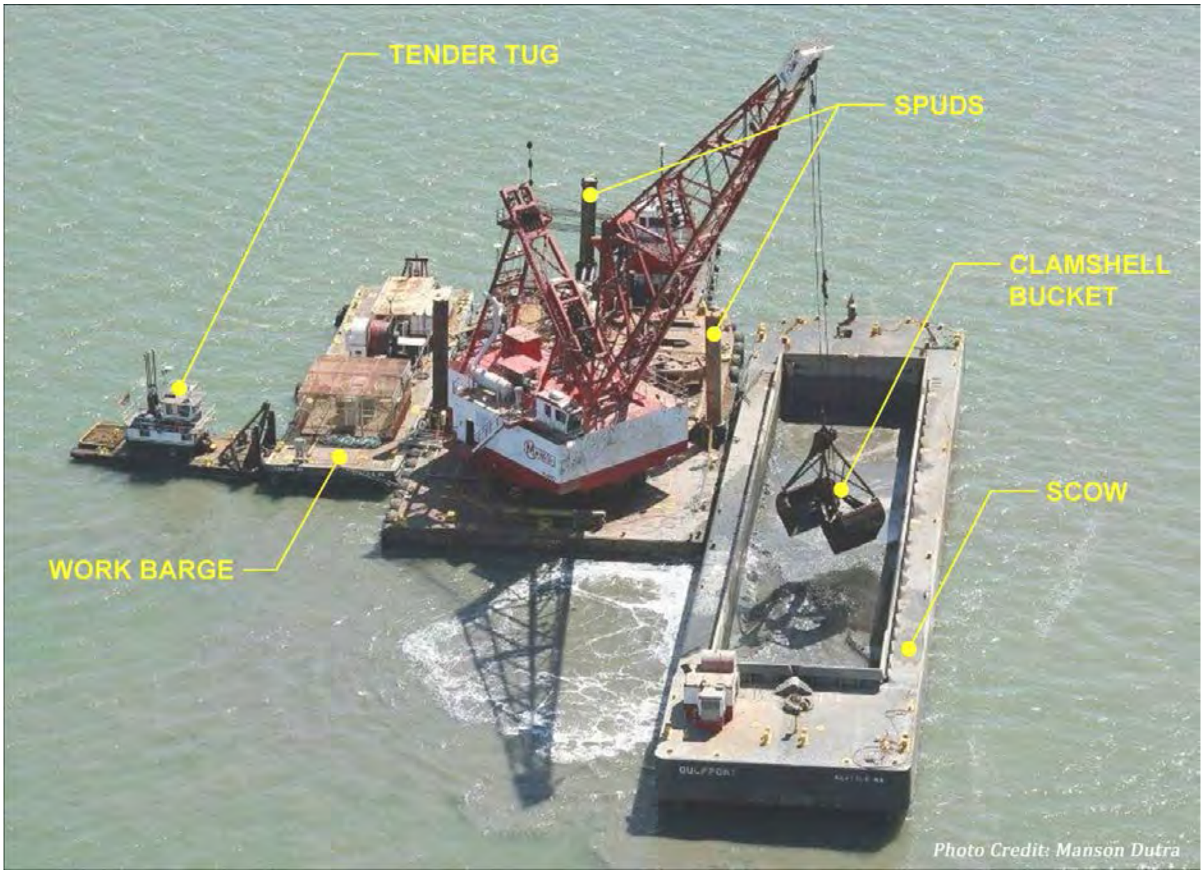

Figure 19. Typical Clamshell Dredge Plant with Scow and Tugboat.

Under the Proposed Action, full scows will be towed to SF-DODS to place dredged material. SF-DODS is described in ***Section 4.3.1***. It is located in the Pacific Ocean, approximately 48 nautical miles west of the Golden Gate Bridge and approximately 60 nautical miles from the Central Basin. Once at SF-DODS, the actual release of dredged material from the scow is completed in a matter of minutes by opening the doors at the base of the scow and allowing the material to enter the water (***Figure 20***).

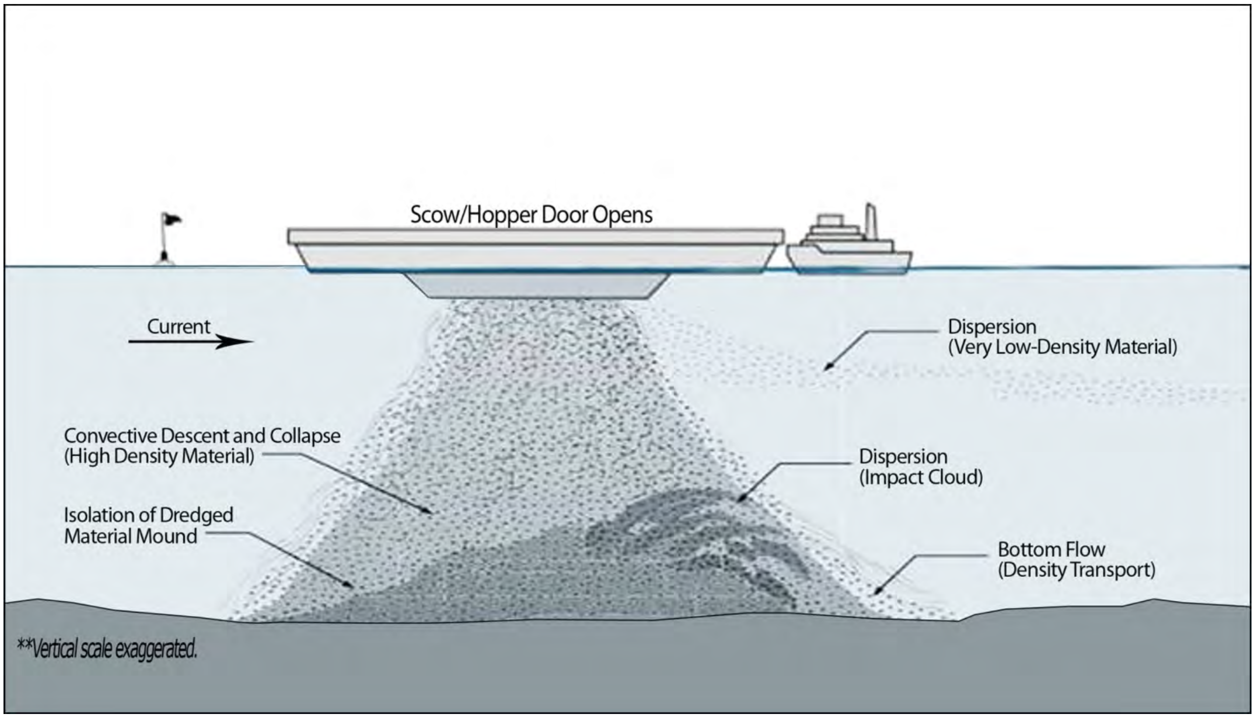

Figure 20. Conceptual Drawing of a Bottom Release Scow Depositing Material at an Aquatic Placement Site.

Dredging associated with the Proposed Action is expected to take place during the established environmental work windows for dredging in SF Bay, between June 1 and November 30 in any year. Dredging will begin at the western most end of the proposed Central basin dredging footprint and progress easterly to the end of the footprint. Given the proposed dredging equipment and distance between the Central Basin and SF-DODS, the daily production under the Proposed Action would be approximately 5,200 CY/day (***Appendix C.c*** Civil Design Appendix). It is expected that the dredging contractor will be working 24-hours per day, 7-days a week on the project. At this rate, the Proposed Action would take an estimated 1.4 months to complete (***Appendix C.c,*** Civil Design Appendix). In addition, the non-structural measures of lightering, and use of favorable tides would continue to be practiced as needed by vessels entering the dry docks to ensure they have safe under keel clearance.

4.6.2 Alternative 1

Alternative 1 is similar to the Alternative 6 but would involve dredging the Central Basin approach area to a depth of 30 feet MLLW plus 2 feet of overdepth. Approximately 185,000 CY of material would be dredged (including 2 feet of overdepth) and all of the material would be placed at SF-DODS. A 30 ft MLLW foot plan would accommodate 90 percent of the current classes of vessels that are likely to use the shipyard.

The dredging operation under Alternative 1 would involve the same type, quantity, and operation of dredge equipment as described for the Proposed Action and the same placement site. Thus, this alternative is expected to have the same production rate of approximately 5,200

CY/day. Alternative 1 would follow the same project timing (within established environmental work windows), work plan (dredging west to east across the proposed footprint), and schedule (24hours a day, 7days a week) as the Proposed Action. However, given the reduced quantity of material to be dredged, this alternative would take approximately 1.0 month to complete (***Appendix C.c*** Civil Design Appendix). In addition, the non-structural measures of lightering, and use of favorable tides would continue to be practiced as needed by vessels entering the dry docks to ensure they have safe under keel clearance.

4.6.3 Alternative 4

Like Alternative 1, Alternative 4 would involve dredging the Central Basin approach area to a depth of 30 feet MLLW plus 2 feet of overdepth. Alternative 4 would provide the same level of access to the shipyard as Alternative 1. However, under this alternative material would be placed at both the SF-11 in-Bay and Montezuma Wetlands Restoration Project placement sites instead of SF-DODS. Approximately 185,000 CY of material would be dredged (including 2 feet of overdepth) and 73 percent (135,050 CY) would be taken to MWRP with the remainder (49,950 CY; 27 percent) going to SF-11.

The dredging operation under Alternative 4 would involve the same size mechanical clamshell dredged plant that would be used under the Proposed Action (and Alternative 1) as well as the same number of scows. However, the tug boats would be smaller (1,800 HP) because the working conditions in the protected waters of the San Francisco Bay are much less severe. Full scows would be towed to MWRP or SF-11. These placement sites are described in ***Sections 4.3.2*** and ***4.3.3***, respectively.

The MWRP site uses an offloader (Liberty) to remove dredged sediment from scows and pumps the sediment into the MWRP site cells (***Figure 21***); the offloader is approximately 52 nautical miles from the Central Basin. After a scow is delivered to the offloader, it will be tied up to the Liberty's mooring system, so that the offloader snorkel can remove material from the scow. The snorkel simultaneously injects water into the scow to further slurry the material and then sucks the material out of the scow and pumps it into the designated cells within the MWRP site. It takes approximately 2-hours to empty a 4,000 CY scow filled with the type of sediment that will be dredged from Central Basin. The total time for each scow trip to the offloader, including unloading the scow and returning the scow to the dredge area is approximately 15 hours for the Central Basin dredging. Given the proposed dredging equipment and distance to the placement site, the estimated daily production rate for placement at MWRP is 5,900 CY/day (***Appendix C.c*** Civil Design Appendix).

Figure 21. Liberty Offloader Unloading a Scow.

The haul distance from the Central Basin to the SF-11 placement site is approximately 3 miles. The dredged material is placed in the same manner as deep ocean disposal and requires only a matter of minutes. Given the proposed dredging equipment and distance to the placement site, the estimated daily production rate for placement at SF-11 is 12,300 CY/day (***Appendix C.c*** Civil Design Appendix).

Alternative 4 would follow the same project timing (within established environmental work windows), work plan (dredging west to east across the proposed footprint), and schedule (24hours a day, 7days a week) as the Proposed Action (and Alternative 1). Given the estimated material quantities to be taken to each placement site and the aforementioned daily production rates for placement at those sites, alternative 4 would approximately 0.8 months to complete (approximately 0.1 month for placement of the estimated quantity at SF-11 and 0.7 months for placement of the estimated quantity at MWRP) (***Appendix C.c*** Civil Design Appendix). In addition, the non-structural measures of lightering, and use of favorable tides would continue to be practiced as needed by vessels entering the dry docks to ensure they have safe under keel clearance.

4.6.4 No Action Alternative: Alternative 16

Analysis of the No Action Alternative is required under NEPA to provide a comparative baseline against which other alternatives can be evaluated. Under the No Action Alternative there would be no dredging in the Central Basin approach area of Pier 70 and no associated transport and placement of material at a placement site. While taking no action would eliminate the potential for effects associated with dredging, transport, and placement of material from the Central Basin approach area, it would also result in increasingly unsafe navigation conditions for vessels attempting to use the Central Basin drydock facilities. Because the FWOP condition for this feasibility study assumes that no dredging of Central Basin will take place in absence of a Federal project, the No Action Alternative and FWOP condition in this case are equivalent. ***Section 3.6*** and ***Appendix C.a*** (Coastal Engineering Appendix) of this DPR describes the expected without project (No Action) conditions in terms of future shoaling, depth, and shipyard operations in the Central Basin approach area. In the absence of dredging, USACE estimates there would be a 10-foot decrease in depth over the course of 20 years, with a mean depth in the approach area reaching approximately 17 feet by 2036, and that shipyard operations would no longer be viable after 2021. The decrease in mean depth would create increasingly unsafe navigation conditions for vessels and require many of those needing repair to use alternative drydocks, the closest of which are in San Diego, California (455 nautical miles away) or Portland, Oregon (652 nautical miles away). Requiring ships to travel this distance for service could pose a safety risk, cause economic losses, and result in additional greenhouse gas emissions from vessel travel.

5 Evaluation of Alternatives

5.1 Planning Criteria

Four specific screening criteria are evaluated in Corps water resource studies: completeness, effectiveness, efficiency, and acceptability. ***Table 7*** summarizes the evaluation of the alternative plans against the planning criteria as described below.

1) Effectiveness.

Effectiveness is the extent to which an alternative plan achieves the planning objectives. Alternative plans that clearly make little or no contribution to the planning objectives should be dropped from consideration.

2) Efficiency

Efficiency is a measure of the cost effectiveness and economic optimization of the plan expressed in net benefits. Benefits can be both monetary and non-monetary. Alternative plans that provided little benefit relative to cost should be dropped from consideration.

- Net Benefits (the average annual benefits minus the average annual costs)
- Benefit to cost ratio (average annual benefits divided by average annual costs)

3) Acceptability

Acceptability is a measure of the alternative plans' consistency with applicable Federal laws, regulations, and policies. In other words, acceptability means a measure or plan is technically, environmentally, economically, and socially feasible.

4) Completeness

- Completeness is a determination of the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities.

5.2 The Four Principles and Guidelines (P&G) Accounts

Four accounts are used to evaluate and display of effects of alternative plans. ***Table 7*** summarizes the evaluation of the alternative plans relative to the four accounts.

National Economic Development (NED): The NED account measures changes in the economic value of the national output of goods and services. The plan that maximizes the net NED benefits consistent with the Federal objective is designated as the NED plan. ***Table 8*** provides a summary of the average annual benefits and costs for the final alternatives.

Alternative 6 is the NED plan. It will reasonably maximize net annual NED benefits of 1.3 million dollars and present value benefits over a 50-year life of the project of 82.5 million dollars. Present value costs over the life of the project are roughly 49.9 million dollars, while average annual costs are 2.0 million dollars. For every dollar invested on the NED plan, the expected NED benefit-to-cost ratio is 1.7 dollars. ***Table 9*** provides a comparison by economic criteria of the final array.

A detailed description of the economic model used to evaluate the alternatives is included in ***Appendix A***. The economic model underwent both District Quality Control and Agency Technical Review prior to the TSP milestone meeting.

Environmental Quality: The EQ account evaluates non-monetary effects on significant natural and cultural resources. EQ ratings of the final alternative plans range from low to high depending on the placement scenario for each alternative.

Alternatives 1 and 6 do not include in-bay disposal of dredged material and therefore, are consistent with the goals of the LTMS. In addition, Alterative 6 reasonably maximizes net NED benefits, whereas Alternative 1 and 4 do not. However, neither alternative 1 or 6 includes beneficial reuse of the dredged material. Therefore, their EQ ratings are medium.

Alternative 4 prioritizes beneficial reuse of dredged material with 73 percent of material placed at the Montezuma Wetlands Restoration site. However, alternative 4 has a low EQ rating because it includes placement of 27% of dredged material at SF-11 (in-bay disposal) which is generally only available for disposal of maintenance dredged material.

Regional Economic Development (RED): The RED account registers changes in the distribution of regional economic activity that result from each alternative plan. It is not expected that any of the alternatives will result in a significant change in regional economics.

Other Social Effects (OSE): The OSE account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts. None of the alternatives would impact the historic use of the shipyard or surrounding area. Navigational safety would be improved by all three of the action alternatives.

Table 7. Final Array of Alternatives Comparison by Planning Criteria

Alternative	**1**	**4**	**6 NED Plan - TSP**	**16**
Depth (MLLW)	30 ft	30 ft	**32 ft**	No Action
Effectiveness: Meets project objectives	Med	Med	**High**	Low
Benefit to Cost Ratio	1.4	1.4	**1.7**	NA
Efficiency: Net Annual NED Benefits	$0.86 M	$0.78 M	**$1.30 M**	$0
Acceptability	Yes	Yes	**Yes**	Yes
Completeness: Plan includes all actions (by Corp and non-Corps entities) necessary to realize the stated outputs	Yes	Yes	**Yes**	Yes

Table 8. Evaluation of the Final Array of Alternatives by the Four P&G Accounts.

Alternative	**1**	**4**	**6 (NED Plan – TSP)**	**16**
Depth (MLLW)	30 ft	30 ft	32 ft	No Action
NED: Annual Net Benefits* and Benefit to Cost Ratio (BCR)	$860,000 BCR of 1.4	$780,000 BCR of 1.4	$1,300,000 BCR of 1.7	NA
Environmental Quality: Acceptability	Medium-low	Low	Medium-low	High
Regional Economic Development: Regional job creation	No significant Impact	No significant Impact	No significant Impact	No significant Impact
Other Social Effects: Navigational safety and maintaining historic use of shipyard	Safer/yes	Safer/yes	Safer/yes	Safe/no

Table 9. Comparison by Economic Criteria of Final Array of Alternatives.

Alt #	Dredge Depth (MLLW)	Dredge Material Disposal Location	Present Value Benefits	Average Annual Benefits	Present Value Costs	Average Annual Costs	Benefit to Cost Ratio	Net Annual NED Benefits
1	30 ft	SF-DODS	$72,820,000	$2,900,000	$51,240,000	$2,040,000	1.4	$860,000
4	30 ft	Montezuma & SF-11	$72,820,000	$2,900,000	$53,180,000	$2,120,000	1.4	$780,000
6	**32 ft**	**SF-DODS**	**$82,450,000**	**$3,280,000**	**$49,850,000**	**$2,000,000**	**1.7**	**$1,300,000**
16	No Action	None	$0	$0	$0	$0	0	$0
All benefit and cost estimates have been rounded to nearest $10,000.								

5.3 Other Planning Considerations

- *Compliance with local land use plans.* Development at Pier 70 should be consistent with the San Francisco Bay Plan policies, administered by the BCDC, the designated Coastal Zone Management Agency for San Francisco Bay. Additionally, Pier 70 is within the City of San Francisco and subject to city planning and zoning laws.
- The City of San Francisco has plans to revitalize the adjacent vacant historic lots at Pier 70. This project complements the revitalization effort. The deepening and maintenance of Central Basin is consistent with the City's stated intent to support the active shipyard in its historically significant operation and the CAP 107 project would enable continued operation past 2022.
- *Live Native Oysters, eelgrass, and benthic habitat***.** In the event that oysters, eelgrass, or benthic habitat is found, the Corps would work with NOAA Fisheries and the California Department of Fish and Wildlife to minimize impacts to the population. No significant impacts are expected.
- *Sponsor's financial capability to pay.* The sponsor's ability to pay for the project will be formally assessed during the Design and Implementation Phase when a Project Partnership Agreement (PPA) will be signed in order to establish the cost sharing agreement for this next phase. During this phase, the sponsor has signed an FCSA and has demonstrated the financial capability to pay for their portion of the study costs.

5.4 Identification of Tentatively Selected Plan

After evaluating the alternatives using the criteria laid out and agreed upon during the Alternatives IPR (held in June 2014), the team, with full support from the NFS, selected Alternative 6, the NED plan, for the TSP. The TSP proposes to deepen Central Basin to 32 ft MLLW, plus two feet overdepth and place dredged material at SF-DODS. Disposal at this site was determined using the suitability criteria of the location and the sediment chemistry and bioaccumulation test results for Central Basin to ensure suitable placement/disposal. The TSP also includes non-structural measures, as needed, of lightering, and the use of favorable tides, where appropriate to further increase access to Pier 70. Not all vessels are permitted to use tides for navigation and this has been accounted for in the economic analysis. Only those vessels that are permitted to use the tides would make use of this measure.

The TSP meets the objectives of this project. It would contribute to NED, consistent with all laws and planning requirements – contributing an estimated 2.09 million dollars in net annual NED benefits. In the FWOP condition, there will be no access to the shipyard after 2026. Currently, roughly 65 percent of vessel classes have access. The TSP would increase access to 95 percent of all vessel classes analyzed.

The objective of reducing transportation costs and user delays is also met, as evidenced by the estimated $3.28 million in average annual benefits. Safety would similarly be improved, since Pier 70 would be more accessible for emergency repairs and there would be a decreased need for lightering, a practice with some associated inherent risks. Finally, the TSP would reduce the negative impacts of shoaling through the maintenance of Central Basin every four years.

The TSP does well when evaluated for the four P&G accounts – NED, RED, EQ, and OSE. NED benefits were already discussed, but the regional economic development assessment is also very good. The shipyard currently supports between 220 and 420 union jobs, which would otherwise be lost by 2026 in the FWOP condition. Furthermore, the active shipyard likely provides ancillary economic benefit to local businesses. The EQ assessment of the TSP is 'medium-low', which is satisfactory given the available placement options in consideration of NED criteria, sediment suitability and environmental regulatory requirements., Finally, the OSE account is good, as marked by improved safety, access, and the continued operation of the historic shipyard, something that the City of San Francisco has vocally supported.

The assessment of completeness, effectiveness, efficiency, and acceptability for the TSP is also good. As previously discussed, the TSP meets all objectives and is therefore considered complete. It is effective, as measured by the $82.45 million in NED benefits over 50 years. The TSP is also efficient, with a BCR of 1.7. Finally, the TSP is acceptable, with approval from LTMS of the disposal location.

6 Environmental Effects*

This EA complies with the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. § 4321 *et seq*), as amended, the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the NEPA (40 C.F.R. § 1500-1508), and U.S. Army Corps of Engineers (USACE) Planning Regulations (Engineering Regulation (ER) 200-2-2). It presents an evaluation of the potential effects associated with the proposed dredging of the Central Basin approach area at the Pier 70 Shipyard and subsequent placement of the dredged material at SF-DODS, as well as alternatives to the Proposed Action.

6.1 Scope of Environmental Assessment

The objective of this EA is to analyze whether the Proposed Action or action alternatives would significantly affect the quality of the environment. The scope of the analysis is limited in time and space by the reasonably foreseeable direct, indirect, and cumulative impacts of the Proposed Action. Direct effects are caused by the action, and occur at the same time and place as the action (40 C.F.R. § 1508.8a) while indirect effects are caused by the action, but may occur later in time or further removed in distance (40 C.F.R. § 1508.8b). Cumulative effects "result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions" (40 C.F.R. § 1508.7).

The primary action areas for this analysis include the proposed Central Basin approach area dredging footprint, including three proposed dredge units (DUs) (***Figure 16***); the dredge material placement site (SF-DODS as well as the alternative placement sites evaluated); and waterways used for vessel transit between the dredge and placement sites. The scope of this analysis is limited to the areas associated with dredging, placement, and related surface and transit operations. This includes: the substrate, water column, and water surface in the immediate vicinity of the proposed DUs and placement sites; the water column and water surface in areas of vessel transit; the air in the immediate vicinity of the action areas and in the greater San Francisco Bay Air Basin; and the Pier 70 facilities, adjacent commercial and industrial properties, and maritime operations in the vicinity of the action areas. Indirect effects on conditions in the greater San Francisco Bay also fall within the scope of analysis in some cases. Additionally, the scope of analysis incorporates evaluation of potential cumulative impacts associated with future projects reasonably foreseeable to occur within the vicinity of the action areas as of July 2016.

6.2 Alternatives Evaluated

Section 4 of this report describes the alternative formulation and initial screening process . Non-structural (***Section 4.1***), structural (***Section 4.2***), and dredged material placement (***Section 4.3***) measures were formulated and then initially screened. Measures carried forward after initial screening (***Section 4.4***) were combined into an initial array of 15 action alternatives and a no action alternative (***Section 4.5***). The 16 alternatives were then screened based on the effectiveness, project benefits and costs, the CAP project cost limit, in-bay dredge material placement quantity limits, and dredge material placement goals listed in the LTMS Management Plan. Based on these screening criteria, four alternatives (including the No Action Alternative) were included in the Final Array of Alternatives for further analysis (***Section 4.6***) and are analyzed in this EA. The other 12 initial alternatives were eliminated from further study for the reasons described in Section 4, and thus are not analyzed in this EA.

Alternative 6 (NED Plan, TSP) is the Proposed Action (Agency-Preferred Alternative); Alternatives 1 and 4 are evaluated in this EA as alternatives to the Proposed Action; and Alternative 16 is the No Action Alternative. The other alternatives that were considered in the initial array of 16 alternatives were eliminated from further study and are not analyzed in this EA.

6.3 Affected Environment and Consequences

This section provides an assessment of the potential impacts of the Proposed Action (Alternative 6) – as well as of Alternatives 1 and 4 – in relation to the No Action Alternative. In some instances, neither the proposed action nor the action alternatives are expected to affect a given environmental resource. Such resources are identified in either the physical, biological, or human environmental sections and are not discussed further.

6.3.1 Physical Environment

6.3.1.1 *Not Applicable Physical Environment Factors*

The following environmental factors were considered in this analysis but are not applicable to the No Action Alternative, Proposed Action, and Alternatives 1 and 4 due to the nature of the project:

- Storm, wave, and erosion buffers:
  - There will be no project impacts that would expose people or structures to a significant risk of loss, injury, or death involving mudflow, inundation by tsunami, failure of a levee, or failure of a dam. The project is not near geologic or topographic conditions that would generate mudflows. The project would not involve the construction of any new structures or public use areas that result in increased risk of inundation by a tsunami. The alternatives would not involve any activities that would potentially result in the failure of a levee or dam.
- Agriculture and forestry resources,
  - There will be no project impacts that would significantly deplete agricultural and forestry resources. Due to the nature of the project, it will not involve any agriculture or forestry resources and is not located where these resources occur.
- Flood control functions:
  - There will be no project impacts that would expose people or structures to a significant risk of loss, injury, or death involving flooding, including future flood risks (sea level rise induced by climate change). The project would not place

within a 100-year flood hazard area structures that would impede or redirect flood flows which could result in increased risk of flooding. The project would not include the construction of housing. The alternatives would not involve the construction of substantial new impervious surfaces that would increase the amount of runoff, resulting in erosion or siltation, or affecting flooding on or off placement sites. .

- Aquifer recharge and base flow:
  - There would be no project impacts that would substantially deplete groundwater supplies or interfere with groundwater recharge. The alternatives would not involve excavation to depths that would affect aquifer systems or groundwater movement, and would not involve the construction of substantial new impervious surfaces that would impede groundwater recharge. Therefore, no impacts related to groundwater would occur.
- Water supplies and conservation:
  - There would be no project impacts that would substantially deplete water supplies or interfere with water conservation. The alternatives do not involve excavation that would impact water sources or utilities that deliver water to customers. Therefore, no impacts to water supplies or water conservation would occur.
- Seismicity
  - The Project Area and adjacent drydocks are not in an area at risk for liquefaction and earthquake-induced landslides (CA Dept. of Conservation, 2000). The project alternatives neither propose construction of new structures nor introduce elements that would increase potential risks related to rupture of a known earthquake fault; seismic shaking; or seismic-related ground failure, including liquefaction; or landsides. Similarly, the project alternatives are designed to be dredged to avoid activities that would cause geologic units or soils to become unstable, and potentially result in onsite or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse; this excludes minor erosion of the channel sides from sloughing that may occur after the channels are dredged. Seismic-related ground shaking cannot be prevented or predicted, but the likelihood of potential adverse effects related to seismic hazards during project construction is fairly low since strong seismic events are rare. Slope failure could occur at the dredge site as a result of a large seismic event; however, channels would be properly designed in accordance with EM 1110-2-1902 to avoid significant impacts (USACE 2003). Therefore, none of the alternatives would have impacts related to seismic risks.

The No Action Alternative, Proposed Action, and Alternatives 1 and 4 will not impact these environmental factors; therefore, these factors are not discussed in this EA.

6.3.1.1 *Geology, Soils, Mineral Resources*

The San Francisco Bay Area has a structurally controlled topography that consists primarily of north- to northwest-trending mountain ranges and intervening valleys that are characteristic of the Coast Ranges geomorphic province. San Francisco Bay is a topographic trough formed by a combination of warping and faulting, and is underlain by a down-dropped or tilted block (the Bay Block) (Olson and Zoback 1998). This trough in the Coast Ranges allows the San Joaquin and Sacramento rivers to drain to the ocean. San Francisco Bay is about 55 miles long, and from 3 to 5 miles wide. Constrictions divide San Francisco Bay into Suisun, San Pablo, and the Central and South San Francisco bays.

The geology of the San Francisco Bay Area comprised primarily of three different geologic provinces: the Salinian block, the Franciscan complex, and the Great Valley sequence. The Salinian block is west of the San Andreas Fault. To the east of the San Andreas Fault, and bounded on the east by the Hayward Fault, is the Mesozoic Franciscan complex, where Central Basin is located. The Franciscan rocks represent pieces of former oceanic crust that have accreted to North America by subduction and collision. These rocks are primarily deep marine sandstone and shale. However, chert and limestone are also found in this assemblage. To the east of the Hayward Fault is the Great Valley sequence.

The trough-like depression that underlies San Francisco Bay has been nearly filled with sediments, some of which have come from erosion of surrounding hills, and some of which consist of later marine deposits. The thickness of the various historic sediment formations varies throughout the Estuary, but they can be several hundred feet thick overall. The upper several feet of the sediment profile in most locations consists of more recently deposited marine and riverine sediments. Sediments in the Estuary fall into three categories: sandy bottoms in the channels; shell debris over a wide expanse of the South Bay (derived from remnants of oyster beds); and soft deposits (known as Bay Mud) underlying the vast expanses of shallow water. Regions of the Estuary where currents are strong, including the deep channels of San Francisco Bay and the central channels of the major rivers in the Delta, generally have coarser sediments (i.e., fine sand, sand, or gravel). Areas where current velocities are lower, such as the shallow fringes of each sub-embayment of San Francisco Bay, are covered with Bay Mud (LTMS 1998). The shallow subsurface sediments (Bay Mud) of San Francisco Bay can be divided into three units, Young Bay Mud, Bay Deposits, and Old Bay Mud.

Young Bay Mud generally consists of gray to grayish-green fine sand, silts, and silty-clays. These are more recent marine sediments that are exposed at the mudline throughout the Project Area. Thicknesses can range up to 120 feet under the Bay, thinning to less than 1 foot around the original margins of the bay. Shell fragments are sometimes found in the Young Bay Mud. With increasing depth, there is some consolidation in the Young Bay Mud clay, although it is typically not as stiff as the Old Bay Mud.

Between the Young Bay Mud and the Old Bay Mud there appears to be a horizontally variable sand unit, called Bay Deposits, that consists of fine sand. This sand unit varies in composition between silty sand and sandy clay. The unit does not consistently appear throughout the Bay Area and does not appear to be present in the Project Area.

Underlying the Young Bay Mud is a firm, stiff, dark greenish-gray silty clay that is typically a very stiff, over consolidated clay. It is markedly different from overlying Young Bay Mud. It has a greater compressive strength, includes thin sand and gravel lenses, and lacks shell fragments in the clay. The Old Bay Mud is thicker than 50 feet beneath the central part of the Bay, with a maximum thickness of more than 100 feet just east of Yerba Buena Island.

According to the most recent analytical results from 2015, the concentration of fines in the material proposed to be dredged within the Project Area is greater than 93 percent (roughly half is clay and the other half is silt), and the concentration of sand is less than seven percent (NewFields, 2015). Clay is comprised of particles from 0.001 to 0.0039 millimeters (mm) in sizeand silt is comprised of particles from 0.0039 to 0.0625 mm in size. Please see ***Appendix D*** for the full sampling and analysis report.

Young Bay Mud is a very soft, highly compressible material that can cause settlement and ground subsidence. Bay Mud is encountered within the Project Area as well as the placement sites. The potential for settlement is correlated to thickness of the Bay Mud that underlies a given location. Therefore, a new earthen or structural load constructed in an area that contains a significant thickness of Bay Mud can cause consolidation of Bay Mud, which would cause ground settlement resulting in lower ground surface elevations. The project alternatives do not propose to construct substantial new structures and would not impose any substantial earthen loads on any portion of the Project Area. Therefore, the Proposed Action will not have any impacts related to potential settlement and ground subsidence in the area.

The Proposed Action and Alternatives 1 and 4 would not require quarrying, mining, dredging, or extraction of locally important mineral resources within the Project Area, nor would implementation of these alternatives deplete any nonrenewable natural resource.

The primary mineral resource extraction activity in San Francisco Bay is sand mining for industrial and agricultural uses. There is a sand mining location near Alcatraz Island in the vicinity of SF-11; however, no impacts to sand mining are anticipated because no material would be placed outside of the boundaries of SF-11 and dredge material has been placed at SF-11 since its establishment prior to 1980, yet sand mining in the area has continued (BCDC, 2015). Project-related vessel traffic may transit near some of the sand mining locations to reach the SF-DODS, SF-11, and Montezuma placement sites, but Project-related vessel traffic would be a small fraction of the more than 130,000 annual vessel movements in San Francisco Bay (USACE & SFRWQCB, 2015). Dredging of Central Basin, and placement of dredged materials at any of the placement sites under the proposed alternatives would not adversely impact sand mining. The Project Area does not occur near and would not affect any land-based mineral resources.

The No Action Alternative, Proposed Action, and Alternatives 1 and 4 would not result in adverse impacts on mineral resources or adverse impacts related to unstable geologic resources. Potential effects of the Proposed Action and action alternatives on substrate are discussed under the "Substrate" heading below.

6.3.1.1 *Substrate, Erosion and Accretion Patterns*

Substrate within the Proposed Action area includes soft-bottom substrate such as Bay sand and mud. Under the No-action alternative, no changes to existing substrate conditions would occur. The Proposed Action has the potential to affect the soft bottom substrate. However, no significant impacts to soft-bottom substrate associated with water quality are expected as described in ***Section 6.3.1.4***, "Turbidity, suspended sediments."

Under the Proposed Action and Alternatives 1 and 4, dredging would remove sediment that has accumulated in Central Basin. The design dimensions of the channels are intended to preclude sloughing of the channel sides. Transport of dredged materials would not disturb sediments, and therefore would not result in any erosion impacts.

The potential for erosion or accretion impacts due to placement activities would be minimal. Open-water placement at SF-DODS is predominantly nondispersive (i.e., dredged materials largely remain at the placement location) and placement of Project Area sediments would have no significant erosion or accretion impacts there. Open-water placement at SF-11 is dispersive, therefore, no erosion or accretion impacts from placement of Project Area sediments are expected. The placement of dredged material at beneficial reuse and upland placement sites is managed by site operators so that substantial erosion impacts do not occur. Furthermore, at beneficial reuse sites, placement of dredged material would have beneficial impacts on soil resources by providing sediments needed to implement the site-specific intended beneficial reuse (e.g., habitat restoration, flood protection).

Under all alternatives, erosion impacts would be less than significant. The placement of dredged material at beneficial reuse sites would have beneficial impacts on soil resources.

6.3.1.2 *Surface waters, and currents, circulation and drainage patterns*

Since approximately 1850, human activities have made significant modifications to San Francisco Bay, causing changes in the patterns of circulation and sedimentation. Between 1856 and 1900, hydraulic mining in the Sierra foothills deposited several feet of sediment throughout San Francisco Bay. Starting in the 1800s, the construction of levees and dikes altered the patterns of drainage and annual flooding in the Sacramento River Delta. In addition, the placement of fill at numerous localities around the San Francisco Bay margins has dramatically altered the shoreline profile during historic time (LTMS, 1998).

The San Francisco Bay is subject to a mixed semidiurnal tidal regime, which is characterized by two unequal sets of daily highs and lows that vary in amplitude over time. Tidal amplitude also has a distinct seasonal signal along the California coast, with the largest tidal ranges typically occurring during spring tidal cycles in the late fall and winter months. As a result, the highest water levels typically occur during winter storms, and have the potential to affect the operation of critical infrastructure. This tidal exchange determines water surface levels, direction, volume of flow and salinity and influences the biological, chemical, and physical conditions of the Bay.

All portions of the project action area are within the waters of central San Francisco Bay with the exception of SF-DODS. Implementation of the Proposed Action and Alternatives 1 and 4 would remove material from the dredge footprint and place it at an approved placement site. The implementation of the analyzed alternatives will not change the amount of open surface water in the action area.

Given the frequent modifications to current and circulation from large-vessel traffic, the project alternatives would not significantly affect existing currents or circulation patterns. Dredging in the project footprint would not alter the course of any of the waterways. Dredged material placement at existing placement sites would not affect existing current and circulation patterns. Therefore, all of the alternatives evaluated, including the No Action Alternative, would have no effect on surface waters, or currents, circulation, or drainage patterns.

6.3.1.3 *Water Quality - Temperature, Salinity, and Other Parameters*

San Francisco Bay is composed of distinct hydrographic regimes (LTMS 1998): the South Bay, which extends from the Bay Bridge to the southern terminus of San Francisco Bay in San Jose; and the Central Bay, which extends from the Bay Bridge to the Richmond/San Rafael Bridge, Suisun, and San Pablo Bays, which connect the Delta and the Pacific Ocean (***Figure 22***).

The action area is located in Upper South Bay and likely has waters with similar characteristics to the Central San Francisco Bay. In this part of the Bay, tides and currents are a stronger influence than the North Bay, especially during the dryer months of the year. The Sacramento and San Joaquin rivers freshwater inflows can extend through the Central Bay and into the South Bay during wet winters. Pacific waters that are cold, saline, and low in total suspended sediment (TSS) characterize the Central Bay (USACE & SFRWQCB, 2015). The Central Bay is most similar to ocean salinity levels (32 parts per thousand).

Temperature exerts a major influence on biological activity and growth in San Francisco Bay. Temperature is also important because of its influence on water chemistry. The seasonal range of water temperature in San Francisco Bay is from about 8 degrees Celsius to about 23 degrees Celsius. At a given location, there can be small, irregular temperature changes with depth. In addition, the pH (measure of the acidity or basicity of an aqueous solution) of waters in San Francisco Bay is relatively constant and typically ranges from 7.8 to 8.2 (USACE & SFRWQCB, 2015).

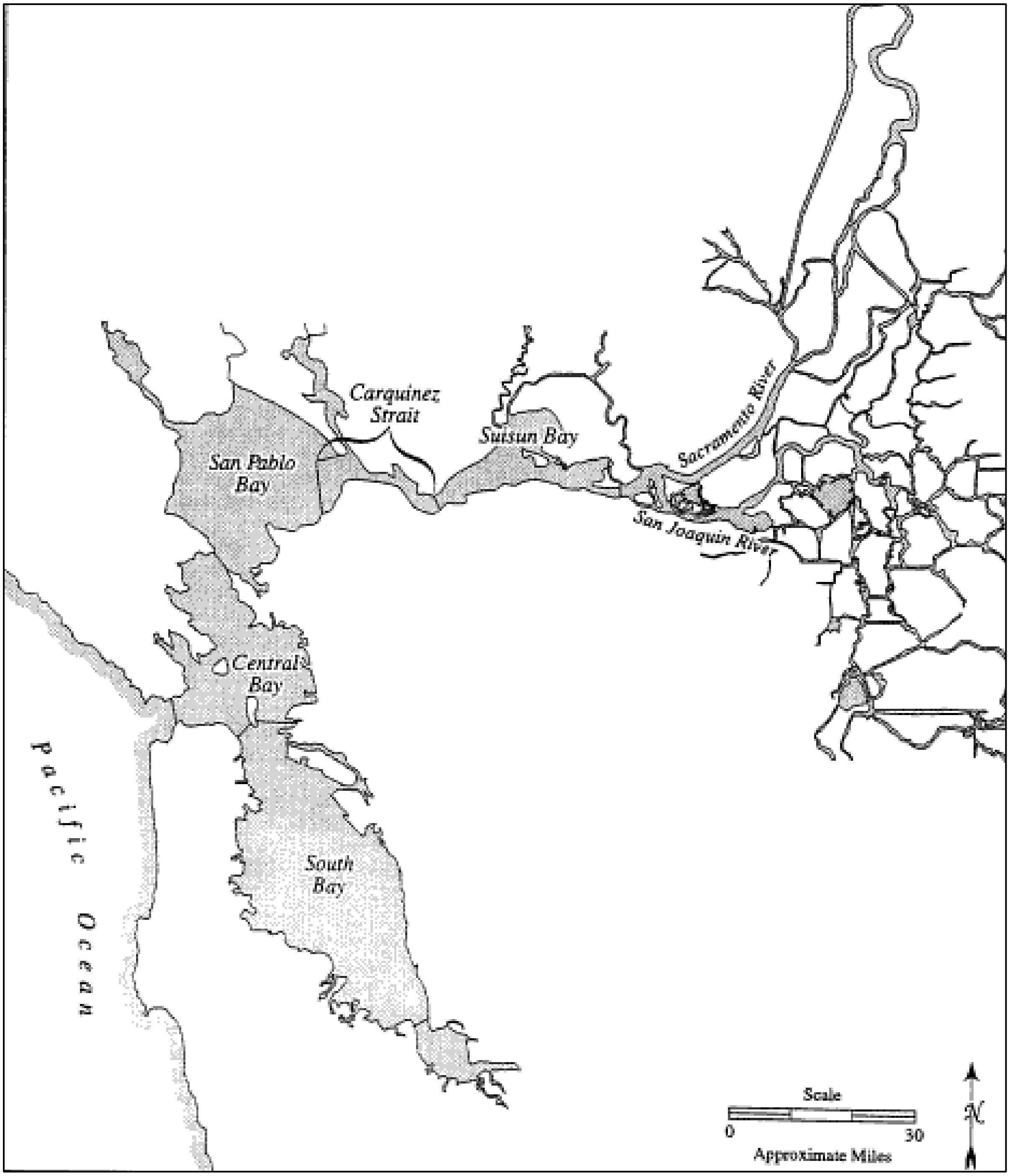

Figure 22. Subembayments of San Francisco Bay (LTMS, 1998).

The water in San Francisco Bay is generally well oxygenated. Typical concentrations of dissolved oxygen in most of San Francisco Bay range from 9 to 10 milligrams per liter (mg/L) during high periods of river flow, 7 to 9 mg/L during moderate river flow, and 6 to 9 mg/L during the late summer months, when flows are lowest (SFEI, 2008).

The Project Area includes the Pacific Ocean from San Francisco Bay to SF-DODS. The ocean is influenced by currents and counter currents as well as tides, which account for 35 to 60 percent of the current variability on the continental shelf. Tidal currents can affect the resuspension of material deposited on the seabed and dispersion of material suspended in the water column. However, currents in the vicinity of SF-DODS are generally slow, which helps to minimize the extent of sediment plumes within the water column during and immediately after sediment placement events (USACE & SFRWQCB, 2015). USEPA studies of SF-DODS have shown it is depositional (USEPA, 2010).

Offshore surface waters show a great deal of variability in temperature-salinity properties. Water discharged from San Francisco Bay into the Gulf of the Farallones has a higher temperature and lower salinity, and therefore lower density, than water in the Gulf (LTMS, 1998). Dissolved oxygen concentrations in surface waters are approximately 8 mg/L. Concentrations decline through the mixed layer, and reach minimum values of about 0.5 mg/L at a depth of 800 meters. Below 800 meters, dissolved oxygen concentrations increase to over 3 mg/L at depths greater than 2,000 meters (LTMS, 1998).

The analysis considered whether the project would substantially degrade water quality through alteration of temperature, salinity, pH, and dissolved oxygen or violate any water quality standards.

Studies have shown placement of dredged material from hopper, cutterhead, and clamshell-bucket dredges into the water column does not cause substantial short- or long-term changes in salinity, temperature, or pH (USACE 1976a; 1976b). A USACE study (USACE 1976a) found that changes in these parameters were localized and short in duration; ambient concentrations of these parameters were usually regained within 10 minutes following material release (USACE 1998).

Localized minor and temporary dissolved oxygen level reductions (1 to 2 parts per million) may occur during dredging, including barring and knockdown practices, and placement; however, the ambient conditions are shortly regained following settlement of the suspended sediment (USACE 1976a).

The movement of vessels for transport of dredged materials would not be expected to affect water temperature, salinity, pH, or dissolved oxygen.

The impacts to water quality (temperature, salinity, pH, and dissolved oxygen) from the proposed action or alternatives would be short-term and less than significant. The No Action Alternative would not disturb sediments in San Francisco Bay; therefore, the No Action Alternative would have no impact on water quality.

All placement sites being considered have been specifically permitted to accept dredged sediment. Compliance with applicable water quality regulations would ensure that potential water quality impacts would be less than significant for all placement sites.

6.3.1.4 *Water Quality – Turbidity and Suspended Sediments*

Turbidity is an optical property related to clarity of water; it causes light to be scattered and absorbed rather than transmitted in straight lines. Turbidity is caused by the presence of suspended and dissolved matter such as clay, silt, finely divided organic matter, plankton, other microscopic organisms, organic acids, and dyes. Factors affecting turbidity include shape, size, refractive index, color, and absorption spectra of particles. Turbidity is expressed in Nephelometric Turbidity Units (NTUs).

Total suspended solids, on the other hand, are a measure of the amount of dry-weight mass of non-dissolved solids suspended per unit of water (often measured in mg/L). Total suspended solids include inorganic solids (clay, silt, and sand) and organic solids (algae and detritus). Fine sediments (clay and silt) remain suspended in the water column longer than coarse sediments (sand).

Total suspended solids (TSS) levels in the Estuary vary greatly, ranging from 10 mg/L to over 100 mg/L (SFEI 2011). In general, higher TSS results in more turbid water. There is also variability in TSS concentrations, depending on the specific location in the Estuary, with shallow areas—and channels adjacent to shallow areas—having the highest suspended sediment concentrations. TSS levels vary throughout the Estuary, depending on season, tidal stage, and depth. The Central Bay generally has the lowest TSS concentrations; however, wind-driven wave action and tidal currents, as well as dredged material placement and sand mining operations, cause elevations in suspended solids concentrations throughout the water column (LTMS, 1998).

Turbidity conditions on the continental shelf near the Golden Gate are affected by seasonal and tidal flows of turbid waters from San Francisco Bay. In the vicinity of SF-DODS, the background TSS values are variable, but mean values range from 1 to 3 mg/L (LTMS, 1998).

This analysis considered whether the project would substantially degrade water quality because of increased turbidity.

Field and laboratory analyses examining the dispersion of dredged material indicate that sediment suspended during dredging either remains suspended in the upper water column at relatively low concentrations or forms high concentration suspensions that cover the bottom (Anchor 2003). Very fine material such as clay and silt has a tendency to go into suspension during the dredging process. Because the settling velocity of such fine particles is very slow, these particles remain in suspension for a longer time compared with coarse-grained particles such as sand that settle fairly quickly. The degree of turbidity or the degree of suspended sediment, therefore, largely depends on the size of the sediment particles (Anchor 2003).

Sediments in Central Basin are greater than 93 percent fines, with half comprised of silts and the other half comprised of clays (NewFields, 2015). Under all project alternatives, dredging would cause a local resuspension of sediments, and a temporary decrease in water clarity. Increased turbidity from dredging is short term, minor, and greatly diminish with distance from the activity.

Sediments become suspended during mechanical dredging from: the clamshell bucket's impact to the channel bottom; material washing from the top and side of the bucket as it passes through the water column; sediment spillage as it breaks the water surface; spillage of material during barge loading; and intentional overflow in an attempt to increase the barge's effective load (USACE & SFRWQCB, 2015). A study characterizing the spatial extent of turbidity plumes during mechanical dredging operations in Oakland Harbor (MEC Analytical Systems 2004) found that in both ebb and flood surveys, plumes were distinct above background TSS concentrations for distances up to 400 meters from the source. Ambient concentrations varied throughout the study area, but were generally less than 50 mg/L. TSS concentrations exceeding 275 mg/L were measured only in immediate proximity (within 110 meters) to the source. TSS concentrations tended to decay fairly rapidly with increasing distance. In general, TSS concentrations above 100 mg/L were distributed in small pockets that primarily flowed just above the channel bottom, but occasionally dispersed into midwater depths (MEC Analytical Systems 2004). Generally, mechanical dredges result in greater suspended sediment during dredging activities than hydraulic dredges, and therefore result in greater increases in turbidity (Anchor 2003).

A clamshell bucket will be used for all of the action alternatives considered. This means that the bucket can be opened while excavating and closed while the bucket is raised and lowered in the water. A clamshell bucket generates less turbidity than an open bucket during operations.

The sediment resuspension from dredge vessel movement is limited, and vessels movement for transport of dredged materials would not be expected to increase turbidity above ambient ranges generated by natural hydrologic processes, weather, and existing vessel traffic.

Some degree of increased turbidity will occur with placement of dredged material in any of the placement environments, and at any placement volume. In most cases, such effects would be limited to the area of the plume following placement, and would be temporary and localized.

Both computer modeling and real-time field monitoring of dredged material placement at SF-DODS have shown that sediment plumes dissipate quickly to background levels, and that this occurs entirely within the boundaries of the placement site. Because SF-DODS is a depositional site (in contrast to in-Bay sites), disposed material is not expected to re-suspend into the water column, and therefore would not continue to affect water quality after its initial placement. All of the existing in-Bay placement sites are dispersive sites in shallow, estuarine waters, so dredged material may re-suspend in the water column following initial placement. Therefore, compared to in-water placement at SF-DODS, there is greater potential for turbidity impacts to be associated with placement at any of the in-Bay sites (LTMS 1998). Impacts associated with bottom dumping of the sediment have been evaluated as part of the permitting process for SFDODS and in-Bay sites.

Placement of dredged materials at habitat restoration beneficial reuse projects (particularly wetland restoration) such as MWRP could result in a net benefit to water quality by increasing sediment retention, filtration of pollutants, and shoreline stabilization over the long term.

Impacts associated with offloader operations and the operations at the Montezuma site were analyzed as a part of the site permitting process.

The impact to water quality from the implementation of the Proposed Action or Alternatives 1 or 4 due to short-term increases in turbidity would be less than significant. Placement of dredged materials at habitat restoration beneficial reuse projects could have long-term beneficial effects on water quality.

6.3.1.5 *Air Quality*

6.3.1.5.1 *Regulatory Setting - Federal*

Federal Clean Air Act

At the Federal level, the United States Environmental Protection Agency (USEPA) has been charged with implementing national air quality programs. USEPA's air quality mandates are drawn primarily from the Federal Clean Air Act (CAA; 42 U.S.C. § 7401 *et seq*.).

The CAA required the USEPA to establish primary and secondary National Ambient Air Quality Standards (NAAQS). The CAA also required each state to prepare an air quality control plan, referred to as a State Implementation Plan (SIP). The CAA Amendments of 1990 added requirements for states with nonattainment areas to revise their SIPs to incorporate additional control measures to reduce air pollution. The SIP is periodically modified to reflect the latest emissions inventories, planning documents, and rules and regulations of the air basins, as reported by their jurisdictional agencies. USEPA has responsibility to review all state SIPs for conformity with the mandates of the CAA, and to determine whether implementation will achieve air quality goals (BAAQMD 2012a).

The Bay Area Air Quality Management District (BAAQMD) prepares plans to attain ambient air quality standards in the San Francisco Bay Area Air Basin (SFBAAB). The BAAQMD implements programs and regulations required by the CAA, CAA amendments, and the California Clean Air Act (CCAA) (BAAQMD 2012a). The clean air strategy of the BAAQMD includes preparing plans for the attainment of ambient air quality standards, adopting and enforcing rules and regulations concerning sources of air pollution, and issuing permits for stationary sources of air pollution. As part of these plans, BAAQMD developed project-level thresholds and guidance for use during the CEQA evaluation process such that projects would not violate the CAA, as discussed in more detail below.

National Environmental Policy Act

On February 18, 2010, the Council on Environmental Quality released, for public consideration and comment, draft guidance on the ways in which Federal agencies can improve their consideration of the effects of greenhouse gas (GHG) emissions and climate change in their evaluation of proposals for Federal actions under the National Environmental Policy Act (NEPA). The memorandum (CEQ, 2010) stated that if a Proposed Action would be reasonably anticipated to cause direct emissions of 25,000 metric tons or more of carbon dioxide-equivalent (CO_2e) GHG emissions on an annual basis, agencies should consider this an indication that a quantitative and qualitative assessment may be meaningful to decision makers and the public; this threshold was also included in the Council on Environmental Quality's revised guidance for analyzing GHG emissions and climate change, dated December 18, 2014. For long-term actions that have annual direct emissions of less than 25,000 metric tons of CO_2e, the Council on Environmental Quality encourages Federal agencies to consider whether the action's long-term emissions should receive similar analysis. The subsequent narrative includes analysis of the GHG emission effects of the project alternatives.

Supreme Court Ruling on California Clean Air Act Waiver

On April 2, 2007, the U.S. Supreme Court ruled that carbon dioxide (CO_2) is an air pollutant as defined under the CAA, and that the USEPA has the authority to regulate emissions of GHGs. However, there are no Federal thresholds regarding GHG emissions directly applicable to the Proposed Project. In June 2009, the USEPA granted California a waiver under the CAA, allowing the state to impose its own, stricter GHG regulations for vehicles beginning in 2009.

Please see the Thresholds of Significance Section for further discussion.

6.3.1.5.2 *Regulatory Setting - State Regulations*

The following State regulations are listed as they pertain to this project. It should however be noted that Federal projects may not be subject to local and state regulations where they exceed Federal requirements.

California Clean Air Act (CCAA)

The California Air Resources Board (CARB) is the agency responsible for coordination and oversight of state and local air pollution control programs in California, and for implementing the CCAA. The CCAA requires that all air districts in the state endeavor to achieve and maintain the California Ambient Air Quality Standards by the earliest practical date. The act specifies that districts should focus particular attention on reducing the emissions from transportation and area-wide emission sources, and provides districts with the authority to regulate indirect sources.

CARB is primarily responsible for developing and implementing air pollution control plans to achieve and maintain the NAAQS. CARB is primarily responsible for statewide pollution sources, and produces a major part of the SIP. Local air districts still provide additional strategies for sources under their jurisdiction. CARB combines these data and submits the completed SIP to the USEPA.

Other CARB duties include monitoring air quality (in conjunction with air monitoring networks maintained by air pollution control and air quality management districts); establishing the California Ambient Air Quality Standards (CAAQS), which in many cases are more stringent than the NAAQS; determining and updating area designations and maps; and setting emissions standards for new mobile sources, consumer products, small utility engines, and off-road vehicles (BAAQMD 2012a).

Executive Order S-3-05

Executive Order S-3-05 sets forth a series of target dates by which statewide GHG emissions would be progressively reduced: by 2010, reduce emissions to 2000 levels; by 2020, reduce emission to 1990 levels; and by 2050, reduce GHG emissions to 80 percent below 1990 levels. The subsequent narrative includes analysis of the GHG emission effects of the project alternatives.

Assembly Bill 32 and the California Climate Change Scoping Plan

The California Global Warming Solutions Act of 2006 and Assembly Bill (AB) 32 establish a cap on statewide GHG emissions, and set forth the regulatory framework to achieve the corresponding reduction in statewide emission levels. Under AB 32, GHG are defined as CO_2, methane (CH_4), nitrogen dioxide (N_2O), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

Pursuant to AB 32, CARB adopted a Scoping Plan in 2008, outlining measures to meet the 2020 GHG reduction limits (CARB, 2008). To meet these goals, California must reduce its GHG emissions by 30 percent below projected 2020 business-as-usual emission levels, or about 15 percent from today’s levels. The Scoping Plan estimates a reduction of 174 million metric tons of CO_2e from the transportation, energy, agriculture, forestry, and high global warming potential (GWP) sections. The subsequent narrative includes analysis of the GHG emission effects of the project alternatives.

Executive Order S-1-07

Executive Order S-1-07 established a goal of reducing the carbon intensity of transportation fuels sold in California by 10 percent by 2020. CARB determined that a Low Carbon Fuel Standard could be adopted as a discrete, early-action measure to meet the mandates in AB 32. CARB adopted the Low Carbon Fuel Standard on April 23, 2009.

Senate Bill 97

Senate Bill 97 acknowledges that climate change is an important environmental issue that requires analysis under CEQA. The bill directed the California Office of Planning and Research to prepare and develop guidelines for the feasible mitigation of GHG emissions or the effects of GHG emissions, and transmit those guidelines to the California Natural Resources Agency by July 1, 2009. The California Natural Resources Agency certified those CEQA guidelines on December 30, 2009, and they became effective March 18, 2010 (CNRA, 2012). The subsequent narrative includes analysis of the GHG emission effects of the project alternatives.

California Commercial Harbor Craft Regulations

The CARB approved the California Commercial Harbor Craft Regulations in November 2007 and approved amendments to these regulations in June 2010. The California Commercial Harbor Craft Regulations consist of two separate sections of the California Code of Regulations (C.C.R.): Low Sulfur Fuel Requirement, Emission Limits and Other Requirements for Commercial Harbor Craft (13 C.C.R. § 2299.5) and Airborne Toxic Control Measure for Commercial Harbor Craft (17 C.C.R. § 93118.5).

The Low Sulfur Fuel Requirement, Emission Limits and Other Requirements for Commercial Harbor Craft (13 C.C.R. § 2299.5) states that any person who sells, supplies, offers for sale, purchases, owns, operates, leases, charters, or rents any new or in-use diesel fueled Harbor Craft, as defined in 17 C.C.R. § 93118.5(d)(39), must comply with the low sulfur fuel use requirement in 17 C.C.R. § 93118.5(e)(1) and other requirements in 17 C.C.R. § 93118.5 when operating the craft within Regulated California Waters.

The purpose of the Airborne Toxic Control Measure for Commercial Harbor Craft regulation (17 C.C.R. § 93118.5), referred to in the Low Sulfur Fuel Requirement, Emission Limits and Other Requirements for Commercial Harbor Craft (13 C.C.R. § 2299.5), is to reduce diesel particulate matter (PM), oxides of sulfur (SOx), and oxides of nitrogen (NOx) from diesel propulsion and auxiliary engines on harbor craft that operate in “Regulated California Waters.” The Airborne Toxic Control Measure for Commercial Harbor Craft regulation (17 C.C.R. § 93118.5) applies to all tugboats and oceangoing tugboats and supersedes the requirements of 13 CCR 2299.1 and 17 CCR 93118 in their entirety.

The Airborne Toxic Control Measure for Commercial Harbor Craft regulation defines “Regulated California Waters” as:

- all California internal and estuarine waters,
- all California ports, roadsteads, and terminal facilities,
- all waters within 3 and 12 nautical miles of the California baseline (starting at the California-Oregon border and ending at the California-Mexico border at the Pacific Ocean, inclusive),
- all waters within 24 nautical miles of the California baseline (starting at the California-Oregon border to 34.43 degrees North, 121.12 degrees West, inclusive), and
- all waters within the area, not including any islands, between the California baseline and a line starting at 34.43 degrees North, 121.12 degrees West; thence to 33.50 degrees North, 118.58 degrees West; thence to 32.65 degrees North, 117.81 degrees West; and ending at the California-Mexico border at the Pacific Ocean, inclusive.

The Airborne Toxic Control Measure for Commercial Harbor Craft regulation defines “California Baseline” as “the mean lower low water line along the California coast,” as shown in this case by the National Oceanic and Atmospheric Administration (NOAA) Nautical Chart 18640, San

Francisco to Point Arena (***Appendix D***). For this project, USACE assumes that the Farallon Islands are not included as a part of the "California Baseline."

Generally, the California Commercial Harbor Craft Regulations require all commercial harbor craft owners to:

- Fuel their diesel engines with CARB diesel fuel (also known as California ultra low sulfur diesel fuel), which is defined as any diesel fuel that meets the specifications of vehicular diesel fuel as defined in 13 C.C.R. § 2281, 2284, and 2299 and 17 C.C.R. § 93116, or alternative diesel fuel as defined in 17 C.C.R. § 93118.5(d)(2),
- Install a non-resettable hour meter on each engine,
- Keep a copy of their initial 30 days of operation within California Regulated Waters and annually updated records on the vessel or in a central dockside location.

The California Commercial Harbor Craft Regulations also require that he engines on all new commercial harbor craft vessels to meet the United States Environmental Protection Agency (U.S. EPA) marine or off-road engine emission standards in effect at the time the vessel is acquired. Newly acquired engines for all in-use harbor craft to must meet the Tier 2 or Tier 3 marine or off-road standards (or Tier 4 in certain cases) in effect at the time the vessel owner/operator acquires the engine. Existing Tier 1 and earlier propulsion and auxiliary engines on in-use ferries, excursion vessels, tugboats, towboats, push boats, crew and supply vessels, and barge and dredge vessels, must meet U.S. EPA Tier 2 or Tier 3 standards in effect at the time of regulation compliance.

Therefore, the equipment used to carry out the Proposed Action, Alternative 1, or Alternative 4, will comply with the requirements of the California Commercial Harbor Craft Regulations. The USACE will commit to implementing these measures by establishing binding agreements with construction phase contractors before the start of construction. In addition, the construction phase contractors will have to provide their CARB Harbor Craft Reports to USACE to ensure compliance prior to the start of construction.

Please see the Thresholds of Significance Section for further discussion.

6.3.1.5.3 *Regulatory Setting - Regional Regulations*

Bay Area Air Quality Management District Air Quality (BAAQMD) Regulations

The BAAQMD manages air quality conditions in the SFBAAB through a comprehensive program of planning, regulation, enforcement, technical innovation, and promotion of the understanding of air quality issues. The clean air strategy of the BAAQMD includes preparing plans for the attainment of ambient air quality standards, adopting and enforcing rules and regulations concerning sources of air pollution, and issuing permits for stationary sources of air pollution. The BAAQMD also inspects stationary sources of air pollution and responds to citizen complaints; monitors ambient air quality and meteorological conditions; and implements programs and regulations required by the CAA, CAA amendments, and the CCAA (BAAQMD 2012a).

As stated above, the BAAQMD prepares plans to attain ambient air quality standards in the SFBAAB. The BAAQMD prepares ozone attainment plans for the national ozone standard, and clean air plans for the California standard, in coordination with both the Metropolitan Transportation Commissions (MTC) and the Association of Bay Area Governments. As part of these plans, BAAQMD developed project-level thresholds and guidance for use during the CEQA evaluation process.

BAAQMD CEQA Guidelines

On June 2, 2010, the BAAQMD's Board of Directors unanimously adopted thresholds of significance to assist in the review of projects under CEQA. These thresholds are designed to establish the level at which the BAAQMD believed air pollution emissions would cause significant environmental impacts under CEQA, and were posted on BAAQMD's website and included in the BAAQMD's May 2010 updated CEQA Guidelines (BAAQMD 2014b).

On March 5, 2012, the BAAQMD's Air Quality CEQA Thresholds of Significance were challenged by an order issued in *California Building Industry Association v. BAAQMD,* Alameda Superior Court Case No. RGI0548693. The order requires the BAAQMD thresholds to be subject to further environmental review. The claims made in the case concerned the CEQA impacts of adopting the thresholds (i.e., how the thresholds would affect land use development patterns), and petitioners argued that the thresholds for Health Risk Assessments encompassed issues not addressed by CEQA. On August 13, 2013, a court of appeal rejected the challenge to the BAAQMD's Air Quality CEQA Thresholds of Significance. This decision is under further appeal. The California Supreme Court is reviewing this matter and an opinion may be issued prior to the conclusion of this Environmental Assessment.

In response to the court's order, BAAQMD stated that lead agencies will need to determine appropriate air quality thresholds of significance based on substantial evidence in the record. BAAQMD has indicated that although lead agencies may rely on the May 2010 updated CEQA Guidelines for assistance in calculating air pollution emissions, obtaining information regarding the health impacts of air pollutants, and identifying potential mitigation measures, BAAQMD has been ordered to set aside the thresholds, and is no longer recommending that these thresholds be used as a general measure of a project's significant air quality impacts. Lead agencies may continue to rely on the Air District's 1999 Thresholds of Significance, and they may continue to make determinations regarding the significance of an individual project's air quality impacts based on the substantial evidence in the record for that project (BAAQMD 2014). However, as discussed in more detail below in Thresholds of Significance, the BAAQMD's significance thresholds and recommended analysis methodologies were considered but ultimately were not chosen as the Thresholds of Significance for this Proposed Project..

6.3.1.5.4 *Ambient Air Quality – San Francisco Bay Area Air Basin (SFBAAB), Climate, and Meteorology*

The project's study area is located in the San Francisco Bay Area Air Basin (SFBAAB), which encompasses San Francisco, Marin, Santa Clara, San Mateo, Napa, Contra Costa and Alameda counties, and along the southeast portion of Sonoma and the southwest portion of Solano counties. The SFBAAB covers an area of approximately 6,620 square miles including both land and water portions within the jurisdiction of the Bay Area Air Quality Management District (BAAQMD 2014a). The jurisdictional boundary of the BAAQMD is shown in ***Figure 23***. This section evaluates potential impacts to air quality in the immediate project areas and surrounding regional environment of the SFBAAB. Most of the study area is within the jurisdiction of the BAAQMD. Please note that SF-DODS is located outside of SFBAAB. BAAQMD is the primary agency responsible for air quality regulation in the nine-county SFBAAB. The environmental setting constitutes the baseline physical conditions used to determine whether implementation of the Proposed Project would cause changes in air pollutant emissions that would result in significant air quality impacts according to applicable thresholds.

The SFBAAB is characterized by complex terrain consisting of coastal mountain ranges, inland valleys, and bays, which distort normal wind flow patterns. The Coast Range splits wind flows, resulting in a western coast gap (Golden Gate) and an eastern coast gap (Carquinez Strait), which allows air to flow in and out of the SFBAAB and the Central Valley.

The air flowing in from the coast to the Central Valley, called the sea breeze, begins developing at or near ground level along the coast in late morning or early afternoon. As the day progresses, the sea breeze layer deepens and increases in velocity while spreading inland. The depth of the sea breeze depends in large part upon the height and strength of the inversion. If the inversion is low and strong (and hence stable), the flow of the sea breeze will be inhibited, and stagnant conditions are likely to result (BAAQMD, 2012a).

The climate is dominated by the strength and location of a semi-permanent, subtropical high-pressure cell. During the summer, the Pacific high-pressure cell is centered over the northeastern Pacific Ocean, resulting in stable meteorological conditions and a steady northwesterly wind flow. In the winter, the Pacific high-pressure cell weakens and shifts southward, resulting in wind flow offshore, curtailing upwelling, and causing storms. Weak inversions, coupled with moderate winds, result in low air pollution potential.

The SFBAAB is characterized by moderately wet winters and dry summers. Winter rains account for about 75 percent of the average annual rainfall. The amount of annual precipitation can vary greatly from one part of the SFBAAB to another, even within short distances. In general, total annual rainfall can reach 40 inches in the mountains, but it is often less than 16 inches in sheltered valleys (BAAQMD 2012a).

Figure 23. Jurisdictional Boundary of BAAQMD (BAAQMD 2012)

6.3.1.5.5 *Ambient Air Quality – Region of Influence*

Identifying the region of influence (ROI) for air quality requires knowledge of the types of pollutants being emitted, the emission rates and release parameters of the pollutant source (e.g., release temperature, area of release, release height), the proximity of the source to other pollutant sources, and local and regional meteorological conditions. The ROI for emissions of inert pollutants (all pollutants other than O_3 and its precursors) is generally limited to a few miles downwind from a source. Thus, for the emission of inert pollutants from project-related activities, the ROI is limited to the immediate waters, waterways, and coastal areas of the San Francisco Bay and Pacific Ocean where dredging, material transport and placement activities would take place. For upland disposal at MWRP, the ROI is limited to the transportation routes and disposal site.

The ROI for O_3 can extend much farther downwind than for inert pollutants. Ozone is a secondary pollutant formed in the atmosphere by photochemical reactions of previously emitted pollutants called "precursors." Ozone precursors are mainly the reactive organic gas (ROG) portion of volatile organic compounds (VOC) and oxides of nitrogen (NO_x). In the presence of solar radiation, the maximum effect of ROG and NO_x emissions on O_3 levels usually occurs several hours after they are emitted and many miles from the source. Ozone and O_3 precursors transported from other regions can also combine with local emissions to increase local O_3 concentrations. Therefore, the ROI for O_3 may include much of the SFBAAB.

For the project emissions analysis below, the Region of Influence is limited to the "Regulated California Waters" as defined by the California Commercial Harbor Craft Regulations, which includes all waters within 24 nautical miles of the California baseline. This ROI was chosen even though ship emissions reported in the 2014 BAAMD Emissions Inventory are based on ship activity within three nautical miles of the coastline (BAAQMD 2014a).

6.3.1.5.6 *Ambient Air Quality – Criteria Air Pollutants*

Air quality at a given location can be described by the concentrations of various pollutants in the atmosphere. Units of concentration are generally expressed in parts per million (ppm) micrograms per cubic meter (µg/m3). The significance of a pollutant concentration is determined by comparing the concentration to an appropriate Federal and/or state ambient air quality standard. The standards represent the allowable atmospheric concentrations at which the public health and welfare are protected and include a reasonable margin of safety to protect the more sensitive receptors in the population.

Federal standards, established by the EPA, are termed the National Ambient Air Quality Standards (NAAQS). The EPA designates all areas of the United States as having air quality better than (attainment) or worse than (nonattainment) the NAAQS. A nonattainment designation means that one of the primary NAAQS has been exceeded more than three discontinuous times in three years in a given area. Pollutants in an area are often designated as unclassified when there is a lack of data for EPA to form a basis of attainment status. The NAAQS for all averaging periods other than annual are defined as the maximum acceptable concentrations that may not be exceeded more than once per year. The annual NAAQS may never be exceeded.

The state standards, established by the California Air Resources Board (CARB), are termed the California Ambient Air Quality Standards (CAAQS). The CARB designates areas of the state as either in attainment or nonattainment of the CAAQS. An area is in nonattainment if the CAAQS has been exceeded more than once in 3 years. The CAAQS are defined as the maximum acceptable pollutant concentrations that are not to be equaled or exceeded, depending on the specific pollutant. The NAAQS and CAAQS are presented in ***Appendix D***.

The state and Federal standards have been adopted by BAAQMD for assessing local air quality impacts. The pollutants of main concern that are considered in this analysis include ozone (0_3), carbon monoxide (CO), nitrogen dioxide (NO2), sulfur dioxide (SO_2), particulate matter smaller than 10 microns in diameter (PM_{10}), and particulate matter smaller than 2.5 microns in diameter ($PM_{2.5}$).

Table 10 lists the state and Federal ambient air quality standards. ***Table 11*** shows the current attainment status for each criteria air pollutant in the BAAQMD. A description of each criteria pollutant is provided below.

Table 10. Relevant Federal and California Ambient Air Quality Standards.

Pollutant	Averaging Time	California Standards[1]	Federal Standards[2]	
		Concentration[3]	Primary[3,4]	Secondary[3,5]
Ozone (O_3)[6]	1-Hour	0.09 ppm (180 µg/m^3)	—	Same as Primary Standard
	8-Hour	0.070 ppm (137 µg/m^3)	0.070 ppm (137 µg/m^3)	
Respirable Particulate Matter (PM_{10})[7]	24-Hour	50 µg/m^3	150 µg/m^3	Same as Primary Standard
	Annual Arithmetic Mean	20 µg/m^3	—	
Fine Particulate Matter ($PM_{2.5}$)[7]	24-Hour	–	35 µg/m^3	Same as Primary Standard
	Annual Arithmetic Mean	12 µg/m^3	12.0 µg/m^3	15 µg/m^3
Carbon Monoxide (CO)	8-Hour	9.0 ppm (10 mg/m^3)	9 ppm (10 mg/m^3)	—
	1-Hour	20 ppm (23 mg/m^3)	35 ppm (40 mg/m^3)	
Nitrogen Dioxide(NO_2)[8]	Annual Arithmetic Mean	0.030 ppm (57 µg/m^3)	53 ppb (100 µg/m^3)	Same as Primary Standard
	1-Hour	0.18 ppm (339 µg/m^3)	100 ppb (188 µg/m^3)	—
Sulfur Dioxide (SO_2)[9]	24-Hour	0.04 ppm (105 µg/m^3)	—	—
	3-Hour	—	—	0.5 ppm (1,300 µg/m^3)
	1-Hour	0.25 ppm (655 µg/m^3)	75 ppb (196 µg/m^3)[11]	—
Lead[10,11]	30-Day Average	1.5 µg/m^3	—	—
	Calendar Quarter	—	1.5 µg/m^3	Same as Primary Standard
	Rolling 3-Month Average[9]	—	0.15 µg/m^3	
Visibility-Reducing Particles[12]	8-Hour	Extinction coefficient of 0.23 per kilometer — visibility of 10 miles or more (0.07 — 30 miles or more for Lake Tahoe). Method: Beta Attenuation and Transmittance through Filter Tape.	No Federal Standards	
Sulfates	24-Hour	25 µg/m^3		
Hydrogen Sulfide	1-Hour	0.03 ppm (42 µg/m^3)		
Vinyl Chloride[12]	24-Hour	0.01 ppm (26 µg/m^3)		

Table 10. Relevant Federal and California Ambient Air Quality Standards (Continued).

Source: California Air Resources Board (CARB), 2016b.

Notes:

1 California standards for ozone, carbon monoxide (except Lake Tahoe), sulfur dioxide (1-hour and 24-hour), nitrogen dioxide, suspended particulate matter—PM_{10}, $PM_{2.5}$, and visibility-reducing particles—are values that are not to be exceeded. All others are not to be equaled or exceeded. California ambient air quality standards are listed in the Table of Standards in Section 70200 of Title 17 of the California Code of Regulations.

2 National standards (other than ozone, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once a year. The ozone standard is attained when the fourth-highest 8-hour concentration in a year, averaged over 3 years, is equal to or less than the standard. For PM_{10}, the 24-hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m^3 is equal to or less than 1. For $PM_{2.5}$, the 24-hour standard is attained when 98 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. Contact USEPA for further clarification and current Federal policies.

3 Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based upon a reference temperature of 25 °C and a reference pressure of 760 torr. Most measurements of air quality are to be corrected to a reference temperature of 25 °C and a reference pressure of 760 torr; ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

4 National Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.

5 National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

6 On October 1, 2015, the national 8-hour ozone primary and secondary standards were lowered from 0.075 to 0.070 ppm.

7 On December 14, 2012, the national annual $PM_{2.5}$ primary standard was lowered from 15 µg/m^3 to 12.0 µg/m^3. The existing national 24-hour $PM_{2.5}$ standards (primary and secondary) were retained at 35 µg/m^3, as was the annual secondary standard of 15 µg/m^3. The existing 24-hour PM_{10} standards (primary and secondary) of 150 µg/m^3 also were retained. The form of the annual primary and secondary standards is the annual mean, averaged over 3 years.

8 To attain the 1-hour national standard, the 3-year average of the annual 98th percentile of the 1-hour daily maximum concentrations at each site must not exceed 100 ppb. Note that the national 1-hour standard is in units of parts per billion (ppb). California standards are in units of parts per million (ppm). To directly compare the national 1-hour standard to the California standards the units can be converted from ppb to ppm. In this case, the national standard of 100 ppb is identical to 0.100 ppm.

9 On June 2, 2010, a new 1-hour SO_2 standard was established and the existing 24-hour and annual primary standards were revoked. To attain the 1-hour national standard, the 3-year average of the annual 99th percentile of the 1-hour daily maximum concentrations at each site must not exceed 75 ppb. The 1971 SO_2 national standards (24-hour and annual) remain in effect until one year after an area is designated for the 2010 standard, except that in areas designated nonattainment for the 1971 standards, the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standards are approved. Note that the 1-hour national standard is in units of parts per billion (ppb). California standards are in units of parts per million (ppm). To directly compare the 1-hour national standard to the California standard the units can be converted to ppm. In this case, the national standard of 75 ppb is identical to 0.075 ppm.

10 The California Air Resources Board has identified lead and vinyl chloride as 'toxic air contaminants' with no threshold level of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.

11 The national standard for lead was revised on October 15, 2008 to a rolling 3-month average. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

12 In 1989, the ARB converted both the general statewide 10-mile visibility standard and the Lake Tahoe 30-mile visibility standard to instrumental equivalents, which are "extinction of 0.23 per kilometer" and "extinction of 0.07 per kilometer" for the statewide and Lake Tahoe Air Basin standards, respectively.

°C = degrees Celsius
µg/m^3 = micrograms per cubic meter; mg/m^3 = milligrams per cubic meter
$PM_{2.5}$ = particulate matter equal to or less than 2.5 micrometers in diameter
PM_{10} = particulate matter equal to or less than 10 micrometers in diameter ppb = parts per billion
ppm = parts per million SO_2 = sulfur dioxide
USEPA= United States Environmental Protection Agency

Table 11. Federal and State Attainment Status for the San Francisco Bay Area.

Pollutant	Averaging Time	California Attainment Status[1]	Federal Attainment Status[2,3]
Ozone	8-Hour	Nonattainment[9]	Nonattainment[4]
	1-Hour	Nonattainment	N/A[5]
Carbon Monoxide	8-Hour	Attainment	Attainment[6]
	1-Hour	Attainment	Attainment
Nitrogen Dioxide	1-Hour	Attainment	Unclassified[11]
	Annual Arithmetic Mean	N/A	Attainment
Sulfur Dioxide (SO_2)[12]	24-Hour	Attainment	Attainment
	1-Hour	Attainment	Attainment
	Annual Arithmetic Mean	N/A	Attainment
Particulate Matter (PM_{10})	Annual Arithmetic Mean	Nonattainment[7]	N/A
	24-Hour	Nonattainment	Unclassified
Particulate Matter – Fine ($PM_{2.5}$)	Annual Arithmetic Mean	Nonattainment[7]	Unclassified/Attainment[15]
	24-Hour	N/A	Nonattainment[10]
Sulfates	24-Hour	Attainment	N/A
Lead[13]	30-day Average	N/A	Attainment
	Calendar Quarter	N/A	Attainment
	Rolling 3-Month Average[14]	N/A	N/A [14]
Hydrogen Sulfide	1-Hour	Unclassified	N/A
Vinyl Chloride (chloroethene)	24-Hour	No information available	N/A
Visibility-Reducing particles[8]	8-Hour (10:00 to 18:00 PST)	Unclassified	N/A

Source: BAAQMD 2016.

Notes:

[1] California standards for ozone, carbon monoxide (except Lake Tahoe), sulfur dioxide (1-hour and 24-hour), nitrogen dioxide, suspended particulate matter – PM_{10}, and visibility reducing particles are values that are not to be exceeded. The standards for sulfates, lead, hydrogen sulfide, and vinyl chloride are not to be equaled or exceeded. If the standard is for a 1-hour, 8-hour, or 24-hour average (i.e., all standards except for lead and the PM_{10} annual standard), then some measurements may be excluded. In particular, measurements are excluded that CARB determines would occur less than once per year on the average.

[2] National standards shown are the "primary standards" designed to protect public health. National standards other than for ozone, particulates, and those based on annual averages are not to be exceeded more than once a year. The 1-hour ozone standard is attained if, during the most recent 3-year period, the average number of days per year with maximum hourly concentrations above the standard is equal to or less than one. The 8-hour ozone standard is attained when the 3-year average of the fourth highest daily concentrations is 0.075 ppm (75 ppb) or less. The 24-hour PM_{10} standard is attained when the 3-year average of the 99th percentile of monitored concentrations is less than 150 $\mu g/m^3$. The 24-hour $PM_{2.5}$ standard is attained when the 3-year average of 98th percentiles is less than 35 $\mu g/m^3$.Except for the national particulate standards, annual standards are met if the annual average falls below the standard at every site. The national annual particulate standard for PM_{10} is met if the 3-year average falls below the standard at every site. The annual $PM_{2.5}$ standard is met if the 3-year average of annual averages, spatially averaged across officially designed clusters of sites, falls below the standard.

Table 11. Federal and State Attainment Status for the San Francisco Bay Area (Continued).

[3] National air quality standards are set by USEPA at levels determined to be protective of public health, with an adequate margin of safety.

[4] On October 1, 2015, the national 8-hour ozone primary and secondary standards were lowered from 0.075 to 0.070 ppm. An area will meet the standard if the fourth-highest maximum daily 8-hour ozone concentration per year, averaged over three years, is equal to or less than 0.070 ppm. EPA will make recommendations on attainment designations by October 1, 2016, and issue final designations October 1, 2017. Nonattainment areas will have until 2020 to late 2037 to meet the health standard, with attainment dates varying based on the ozone level in the area. The current nonattainment status for the 8-hr ozone standard in the San Francisco Bay Area is "marginal" (USEPA 2016).

[5] The national 1-hour ozone standard was revoked by USEPA on June 15, 2005.

[6] In April 1998, the San Francisco Bay Area was redesignated to attainment for the national 8-hour carbon monoxide standard (see 63 FR Page 15305; https://www3.epa.gov/airquality/greenbook/cfrnrpt2.html#CO.1990.San_Francisco).

[7] In June 2002, CARB established new annual standards for $PM_{2.5}$ and PM_{10}.

[8] Statewide visibility reducing particles Standard (except Lake Tahoe Air Basin): Particles in sufficient amount to produce an extinction coefficient of 0.23 per kilometer when the relative humidity is less than 70 percent. This standard is intended to limit the frequency and severity of visibility impairment due to regional haze, and is equivalent to a 10-mile nominal visual range.

[9] The 8-hour California ozone standard was approved by the CARB on April 28, 2005 and became effective on May 17, 2006.

[10] On January 9, 2013, EPA issued a final rule to determine that the Bay Area attains the 24-hour $PM_{2.5}$ national standard. This EPA rule suspends key SIP requirements as long as monitoring data continues to show that the Bay Area attains the standard. Despite this EPA action, the Bay Area will continue to be designated as "non-attainment" for the national 24-hour $PM_{2.5}$ standard until such time as the Air District submits a "redesignation request" and a "maintenance plan" to EPA, and EPA approves the proposed redesignation. The current nonattainment status for the 24-hour $PM_{2.5}$ standard in the San Francisco Bay Area is "moderate" (USEPA 2016).

[11] To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.100 ppm (effective January 22, 2010). For Federal attainment status, please see Final Air Quality Designations for the 2010 Primary Nitrogen Dioxide (NO_2) NAAQS (February 17, 2012) in 77 FR 9532 (https://www3.epa.gov/airquality/greenbook/nndesig_info.html).

[12] On June 2, 2010, the USEPA established a new 1-hour SO2 standard, effective August 23, 2010, which is based on the 3-year average of the annual 99th percentile of 1-hour daily maximum concentrations. The existing 0.030 ppm annual and 0.14 ppm 24-hour SO2 NAAQS must continue to be used until 1 year following USEPA initial designations of the new 1-hour SO2 NAAQS. The USEPA expects to designate areas by June 2012.

[13] CARB has identified lead and vinyl chloride as 'toxic air contaminants' with no threshold level of exposure below which there are no adverse health effects determined.

[14] National lead standard, rolling 3-month average: final rule signed October 15, 2008. Final designations effective December 31, 2011.

[15] In December 2012, EPA strengthened the annual $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) from 15.0 to 12.0 micrograms per cubic meter ($\mu g/m^3$). In December 2014, EPA issued final area designations for the 2012 primary annual $PM_{2.5}$ NAAQS. Areas designated "unclassifiable/attainment" must continue to take steps to prevent their air quality from deteriorating to unhealthy levels. The effective date of this standard is April 15, 2015.

CARB = California Air Resources Board; N/A = not applicable
$\mu g/m^3$ = micrograms per cubic meter
NAAQS = National Ambient Air Quality Standards
$PM_{2.5}$ = particulate matter equal to or less than 2.5 micrometers in diameter
PM_{10} = particulate matter equal to or less than 10 micrometers in diameter
ppm = parts per million; ppb = parts per billion
PST = Pacific Standard Time
SIP = State Implementation Plan

Ozone, or smog, is not emitted directly into the environment, but is formed in the atmosphere by complex chemical reactions between reactive organic gases (ROG) and nitrogen oxides (NO_X) in the presence of sunlight. Ozone formation is greatest on warm, windless, sunny days. The main sources of NO_X and ROG, often referred to as ozone precursors, are combustion processes (including motor vehicle engines); the evaporation of solvents, paints, and fuels; and biogenic sources. Automobiles are the single largest source of ozone precursors in the SFBAAB. For ozone, the SFBAAB is classified as a nonattainment area for the state and Federal standards. For the Federal standard, the current nonattainment status for the 8-hr ozone standard in the San Francisco Bay Area is "marginal" (USEPA 2016).

Particulate matter (PM) refers to a wide range of solid or liquid particles in the atmosphere, including smoke, dust, aerosols, and metallic oxides. Respirable PM with an aerodynamic diameter of 10 micrometers or less is referred to as PM_{10}. $PM_{2.5}$ includes a subgroup of finer particles that have an aerodynamic diameter of 2.5 micrometers or less. Some PM, such as pollen, are naturally occurring. In the SFBAAB, most PM is caused by combustion, factories, construction, grading, demolition, agricultural activities, and motor vehicles. Motor vehicles are currently responsible for about half of particulates in the SFBAAB. Wood burning in fireplaces and stoves is another large source of fine particulates (BAAQMD 2012a). As indicated in ***Table 10***, the SFBAAB is classified as a nonattainment area for the state PM_{10} and $PM_{2.5}$ standards and Federal $PM_{2.5}$ standards. The current Federal nonattainment status for the 24-hour $PM_{2.5}$ standard in the San Francisco Bay Area is "moderate" (USEPA 2016).

Carbon monoxide (CO) is an odorless, colorless gas formed by the incomplete combustion of fuels. The single largest source of CO in the SFBAAB is motor vehicles. The SFBAAB is classified as an attainment area for the state and Federal CO standards.

Nitrogen dioxide (NO_2) is a reddish-brown gas that is a byproduct of combustion processes. Automobiles and industrial operations are the main sources of NO_2. NO_2 may be visible as a coloring component of a brown cloud on high pollution days, especially in conjunction with high ozone levels (BAAQMD 2012a). In 2010, the USEPA implemented a new 1-hour NO_2 standard, which is presented in ***Table 10***. The SFBAAB has been designated as an unclassified area for the new Federal NO_2 standard, but is an attainment area for the Federal annual arithmetic mean standard (BAAQMD 2016). An unclassified area is an area in which compliance with the NAAQS cannot be determined with current information.

Sulfur dioxide (SO_2) is a colorless acid gas with a pungent odor. It is produced by the combustion of sulfur-containing fuels, such as oil, coal, and diesel. As indicated in ***Table 10***, the SFBAAB is classified as an attainment area for the state and Federal SO_2 standards.

Lead is a metal found naturally in the environment, as well as in manufactured products. The major sources of lead emissions have historically been mobile and industrial sources. Because of the phase-out of leaded gasoline, metal processing is currently the primary source of lead emissions. The highest levels of lead in air are generally found near lead smelters. Other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers. As indicated in ***Table 10***, the SFBAAB is classified as an attainment area for the Federal lead standards. There is no additional state standard.

As indicated in ***Table 10***, the SFBAAB is either unclassified, or there is no information available for ambient levels of hydrogen sulfide, vinyl chloride (chloroethene), and visibility-reducing particles. There are no Federal attainment standards associated with these three pollutants.

6.3.1.5.7 *Ambient Air Quality –Baseline Air Quality and San Francisco Bay Area Air Basin Emissions*

Table 12 displays the air emissions that were estimated to have occurred within the SFBAAB in 2011. The 2014 project annual average emissions overall and from ships and boats are projections from the SFBAAB 2011 base year emission inventory and incorporate factors such as a projected increase in shipping activity. Emissions from shipping activity out to three nautical miles from the coast were included in the emissions inventory. Transportation sources are one of the largest contributors to air pollutants in the SFBAAB. Transportation sources account for approximately 48 percent of the ROG, 90 percent of the CO, 84 percent of the NO_x, 15 percent of the SO2, 18 percent of PM_{10}, and 28 percent of the $PM_{2.5}$ emitted in the SFBAAB (BAAQMD, 2014a).

Table 12. Emissions Summary – San Francisco Bay Area Air Basin.

	Particulate Matter <10 Microns (PM_{10})	**Particulate Matter <2.5 Microns ($PM_{2.5}$)**	**Reactive Organic Gases (ROG)**	**Nitrogen Oxides (NO_x)**	**Sulfur Dioxide (SO_2)**	**Carbon Monoxide (CO)**
Total 2011 Average Daily Emissions **(tons/day)**	105	45	273	316	21	1,327
2011 Annual Average Emissions Ships and Boats **(tons/day)**	2.3	2.3	17.9	27.3	1.1	87.6
Total 2014 Projected Average Daily Emissions **(tons/day)**	107	46	252	274	22	1,162
2014 Projected Annual Average Emissions Ships and Boats **(tons/day)**	2.5	2.5	17.4	26.7	0.6	88.3
Distribution of 2011 Annual Average Emissions (Percent per Major Source Category)						
Petroleum Refining Processes	0	0	2	0	3	0
Other Industrial/Commercial Processes	9	13	4	1	32	--
Organic Compounds Evaporation	--	0	24	--	--	--
Off-Road Mobile Sources*	5	12	18	28	11	32
On-Road Motor Vehicles	13	16	30	56	4	58
Consumer Products/Dust Sources/Fires	56	21	19	0	1	1
GRAND TOTAL	100	100	100	100	100	100
Source: BAAQMD 2014a *Dredging is included in this category.						

6.3.1.5.8 *Toxic Air Contaminants*

In addition to the criteria air pollutants listed above, another group of pollutants, commonly referred to as toxic air contaminants (TACs) or hazardous air pollutants, can result in health effects that can be quite severe. Industrial facilities and mobile sources are significant sources of TACs. Various common urban facilities produce TAC emissions, such as gasoline stations (benzene), hospitals (ethylene oxide), and dry cleaners (perchloroethylene). Automobile exhaust also contains TACs such as benzene and 1,3-butadiene. Most recently, diesel particulate matter (DPM) was identified as a TAC by CARB. DPM differs from other TACs in that it is not a single substance, but rather a complex mixture of hundreds of substances. BAAQMD research indicates that mobile-source emissions of DPM, benzene, and 1,3-butadiene represent a substantial portion of the ambient background risk from TACs in the SFBAAB.

Ambient standards have not been developed for TACs for a mobile sources associated with the Proposed Action (dredging and dredged material placement). Instead, the BAAQMD uses a risk-based approach to regulate TACs. In addition to monitoring criteria pollutants, both the BAAQMD and CARB operate TAC monitoring networks in the SFBAAB.

6.3.1.5.9 *Sensitive Receptors*

Sensitive receptors refer to those segments of the population most susceptible to poor air quality: children, the elderly, and those with pre-existing serious health problems affected by air quality. Examples of receptors include people at residences, schools and schoolyards, parks and playgrounds, daycare centers, nursing homes, and medical facilities.

Commercial and recreational ship traffic is an ambient air emissions source at the Federal navigation channels and throughout the study area. The Central Basin dredge footprint is located in the San Francisco Bay in an area that has been a commercial and industrial area since the early 1900s. However, there are no sensitive receptors in close proximity to the Central Basin dredge footprint (i.e., located 1,000 feet away). There are sensitive receptors in the area though, including the University of California at San Francisco (UCSF) Medical Center at Mission Bay and the UCSF Benioff Children's Hospital. Again, these medical facilities are located adjacent to an established industrial area, which includes the Central Basin dredge footprint.

6.3.1.5.10 *Global Climate Change Setting - Causes*

Global climate change is caused by anthropogenic emissions of GHGs released into the atmosphere through combustion of fossil fuels, and other GHG-producing activities such as deforestation and land use change.

GHGs play a critical role in the Earth's radiation budget by trapping infrared radiation emitted from the Earth's surface and which could have otherwise escaped to space. The "greenhouse effect" keeps the Earth's atmosphere near the surface warmer than it would be otherwise, and allows for successful habitation by humans and other forms of life.

Prominent GHGs contributing to this process include CO_2, methane (CH_4), nitrous oxide (N_2O), and fluorocarbons. Emissions of CO_2 and N_2O are byproducts of fossil fuel combustion, among other sources. CH_4, a highly potent GHG, results from off-gassing associated with agricultural practices and landfills. Fluorocarbons are commonly used in refrigeration systems.

Global warming potential (GWP) is a measure of the estimated contribution to global warming of a given mass of GHG. It is a relative scale that compares the gas in question to that of the same mass of CO_2 (whose GWP is by definition 1). For example, emitting 1 ton of CH_4 causes the same amount of global warming as emitting 25 tons of CO_2; therefore the CH_4 GWP is 25. To account for the GWP of GHGs, GHG emissions are often required to be multiplied by their

GWP and then reported as CO_2e. As such, emissions of CO_2, CH_4, and N_2O are typically converted into CO_2e by multiplying their emissions by their respective GWP.

6.3.1.5.11 *Global Climate Change Setting – Effects of Climate Change*

The combustion of fossil fuels releases carbon that has been stored underground into the active carbon cycle, thus increasing concentrations of GHGs in the atmosphere. Emissions of GHGs in excess of natural ambient concentrations are theorized to be responsible for the enhancement of the greenhouse effect, and contribute to what is termed "global warming," a trend of unnatural warming of the Earth's natural climate. Increases in these gases lead to more absorption of radiation, and warm the lower atmosphere further, thereby increasing evaporation rates and temperatures near the surface. Climate change is a global problem, and GHGs are global pollutants, unlike criteria pollutants (such as ozone, CO, and PM) and TACs, which are pollutants of regional and local concern.

Climate change could affect California's natural environment in the following ways (CEC, 2005):

- Rising sea levels along the California coastline, particularly in San Francisco and the Sacramento-San Joaquin River Delta, due to ocean expansion;
- Extreme heat conditions, such as heat waves and very high temperatures, which could last longer and become more frequent;
- An increase in heat-related human deaths and infectious diseases, and a higher risk of respiratory problems caused by deteriorating air quality;
- Reduced snow pack and stream flow in the Sierra Nevada mountains, affecting winter recreation and water supplies;
- Potential increase in the severity of winter storms, affecting peak stream flows and flooding;
- Changes in growing season conditions that could affect California agriculture, causing variations in crop quality and yield; and
- Changes in distribution of plant and wildlife species due to changes in temperature, competition of colonizing species, changes in hydrologic cycles, changes in sea levels, and other climate-related effects.

These changes in California's climate and ecosystems could occur at a time when California's population is expected to increase from approximately 37 million in 2010 to 50 million by the year 2050 (California Department of Finance 2012).

Transportation generates 37 percent of California's GHG emissions, followed by the industrial sector (24 percent), in-state electricity generation (12 percent), imported electricity generation (8 percent), agriculture and forestry (8 percent), residential (6 percent), commercial (5 percent), and other sources (<1 percent) (CARB 2016c). Sinks of CO_2 include uptake by vegetation, and dissolution into the ocean. In 2014, California generated 441 million metric tons of GHG, measured as CO_2e emissions (CARB 2016d).

6.3.1.5.12 *Thresholds of Significance Applicability Evaluation*

As mentioned above, BAAQMD's thresholds of significance as published in the May 2010 CEQA Air Quality Guidelines have been suspended by the BAAQMD until the issues identified in the court case are resolved. Because this is a Federal project that will comply with the California Commercial Harbor Craft Regulations, the results of the analysis in this Environmental Assessment was compared to thresholds listed in the Federal General Conformity regulations. This analysis considered NEPA's carbon dioxide threshold (25,000 metric tons or more of carbon dioxide-equivalent) included in the Council on Environmental Quality's revised guidance for analyzing GHG emissions and climate change, dated December 18, 2014.

The 2012 CEQA Air Quality Guidelines state that BAAQMD cannot recommend specific thresholds of significance for use by local governments at this time. In addition, the 2012 CEQA Air Quality Guidelines state that lead agencies will need to determine appropriate air quality thresholds to use for each project they review based on substantial evidence that they should include in the administrative record for the project.

Federal General Conformity Regulations (40 C.F.R. § 93 Subpart B)

General Conformity regulations implement the Section 176(c) of the Clean Air Act that prohibits federal agencies from taking actions that may cause or contribute to violations of NAAQS in an area working to attain or maintain the standards. To meet General Conformity requirements, federal entities must demonstrate that emissions from their actions will not exceed emission budgets established in a state's plan to attain or maintain the NAAQS.

In accordance with 40 C.F.R. § 93.153, a conformity determination is required for each criteria pollutant or precursor where the total of direct and indirect emissions of the criteria pollutant or precursor in a nonattainment or maintenance area caused by a Federal action would equal or exceed any of the *de minimis* levels listed in ***Table 13*** below. ***Table 13*** only shows ozone and particulate matter equal to or less than 2.5 micrometers in diameter because these are the only criteria air pollutants where the SFBAAB is in nonattainment.

According to BAAQMD's 2009 CEQA Thresholds Options and Justification Report, many air districts state that if implementation of a Proposed Project would not result in the generation of emissions that exceed applicable project-level mass emission thresholds, then the cumulative impact of the project on air quality would also be considered less than significant (BAAQMD 2009).

Based on these thresholds, the impacts would be significant if the project would:

- Conflict with or obstruct implementation of the applicable air quality plan;
- Violate any air quality standard or contribute substantially to an existing or projected air quality violation;
- Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is in nonattainment under an applicable Federal or state ambient air

quality standard (including releasing emissions that exceed quantitative thresholds for ozone precursors);

- Expose sensitive receptors to substantial pollutant concentrations; or
- Create objectionable odors affecting a substantial number of people.

The final thresholds of significance are compared to project-level emissions in ***Section 6.3.1.5.15***.

Table 13. De Minimis Emission Levels For General Conformity Determination

Pollutant	Area Type (Federal Nonattainment Category for San Francisco Bay Area Air Basin)	Tons/Year
Ozone (NO_x)	Marginal	100
Ozone (VOC)	Marginal	50
$PM_{2.5}$*	Moderate	100

Notes:
*On January 9, 2013, EPA issued a final rule to determine that the Bay Area attains the 24-hour $PM_{2.5}$ national standard. This EPA rule suspends key SIP requirements as long as monitoring data continues to show that the Bay Area attains the standard. Despite this EPA action, the Bay Area will continue to be designated as "non-attainment" for the national 24-hour $PM_{2.5}$ standard until such time as the Air District submits a "redesignation request" and a "maintenance plan" to EPA, and EPA approves the proposed redesignation. The current nonattainment status for the 24-hour $PM_{2.5}$ standard in the San Francisco Bay Area is "moderate" (USEPA 2016).
*In December 2012, EPA strengthened the annual $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) from 15.0 to 12.0 micrograms per cubic meter (μg/m^3). In December 2014, EPA issued final area designations for the 2012 primary annual $PM_{2.5}$ NAAQS. Areas designated "unclassifiable/attainment" must continue to take steps to prevent their air quality from deteriorating to unhealthy levels. The effective date of this standard is April 15, 2015.
$PM_{2.5}$ = particulate matter equal to or less than 2.5 micrometers in diameter
PM_{10} = particulate matter equal to or less than 10 micrometers in diameter

6.3.1.5.13 *Methodology*

Per the requirements of NEPA, the Proposed Project is compared to baseline conditions, which are equivalent to the conditions under the No Action/No Project Alternative. Under the No Action Alternative, no dredging or dredged material maintenance would occur; therefore, there would be no impact to air quality.

The lead agencies are using Federal thresholds for criteria air pollutants for GHGs (specifically carbon dioxide). This analysis addressed project emissions of the following air pollutants: ROG, NO_x, PM, and CO_2. These pollutants were chosen because BAAQMD is in nonattainment status for ozone (ROG and NO_x), and $PM_{2.5}$ according to ***Table 11*** and ***Table 13***.

To quantify the emissions under the Proposed Action (Alternative 6), the analysis quantitatively assessed emissions from dredging and transit operations associated with the use mechanical dredge equipment. The analysis converted calculations for emissions per unit of material dredged for each dredge equipment type to total annual pollutant emissions from dredging activities and compared them to local and Federal annual air quality pollutant thresholds (i.e., the thresholds of significance identified for the project).

6.3.1.5.14 *Data Sources*

According to the Civil Design ***Appendix C.c***, the most cost effective combination of dredging equipment for this project using the Corps of Engineers Dredge Estimating Program (CEDEP) is one mechanical dredge with a 21 CY clamshell bucket, with three 3,000 horsepower (HP) tug boats and four 4,000 CY scows for disposal at SF-DODS. Based on this configuration and a project depth of 32 feet MLLW, the total amount of time estimated to dredge with a mechanical clamshell, transport material from the Central Basin, and place at SF-DODS is 1.4 months. The daily production rate is approximately 5,200 CY/day.

The analysis identified potential air pollutant emission sources (engines/pumps) for a mechanical dredge. The analysis assumed the *Paula Lee* mechanical barge as a representative model for mechanical barge specifications; the *Paula Lee* has two different main engines, one deck engine, and four deck winch engines (USACE n.d.).

In addition, mechanical dredging operations are supported by two 3,000 HP tug boats that have one main engine each that will transport the material from Central Basin to SF-DODS. Emissions from a third 3,000 HP tug boat that is used to position the barge were also included in this analysis. In order to determine emissions for the worst case scenario, the emissions shown below include three tug boats that that will transport the material from Central Basin to SF-DODS and one tug boat that will be used to position the barge.

No tug emissions factors were available for those typically used in San Francisco Bay at the time of this analysis. Therefore, this analysis used the emissions factors for ocean-going vessels in the guidance recommended by the USEPA to estimate commercial marine emission inventory (ICF International 2009). The emissions factors were chosen based on the use of a slow-speed diesel engine and marine gas oil with a maximum of 0.10% sulfur by weight. However, California ultra low sulfur diesel that will be used in the Proposed Project per Title 17, section 93118.2 of the California Code of Regulations only contains 0.0015% sulfur. The slow-speed diesel engine was chosen because the emissions factors were more conservative than those listed for a medium speed diesel engine.

Please note that any equipment used for the Proposed Project will be required to comply with the California Commercial Habor Craft Regulations and will likely have lower emissions factors than those used for this analysis.

The dredge and tug boat specific inputs used to calculate each vessel type's emissions include engine horsepower, engine load, and barge dredging rate (i.e., amount of material dredged per pumping hour). Engine load varies depending on the activity being performed, such as pumping versus transport of pumped material. Therefore, equipment specifications and calculations for both the pumping portion of dredging activities as well as the transit portion are discussed below.

Emission factors of ROG, NO_x, PM, and CO_2 were other inputs used in the calculations of the total annual emissions for each engine. Emission factors associated with a piece of equipment could vary depending on the model year assumed. The emission factors of ROG, NO_x, PM and CO_2 used in calculations are included in ***Appendix D***; the calculations are further explained below.

6.3.1.5.15 *Calculations and Assumptions*

In determining a source's potential to emit, the worst case uncontrolled emissions rate and/or the highest emitting material and operating conditions that the source is or will be permitted to use under federally-enforceable requirements must be determined. The Proposed Action, Alternative 1, and Alternative 4 include dredging at Central Basin and dredged material placement at either SF-DODS, MWRP, or SF-11. Please see ***Table 14*** for the summary of dredge equipment and volumes for the final array of project alternatives.

Table 14. Summary of Dredge Equipment and Volumes for Alternatives Analyzed.

Alternative	Project Depth	Dredging Method	Placement Site	Estimated Project Duration	Volume of Material Dredged (Cubic Yards per Year)
No Action	N/A	No Dredging Will Occur	No Dredged Material Placement will occur	None	None
1	30' + 2' MLLW	Mechanical dredge, Four 4,000 CY scows, Three 3,000 hp tugs	SF-DODS	1.0 month	185,000
4	30' + 2' MLLW	Mechanical, Four 4,000 CY scows, Three 1,800 hp tugs	Montezuma SF-11	0.9 month	135,050 (73%) 49,950 (27%)
6 (Proposed Action)	32' + 2' MLLW	Mechanical dredge, Four 4,000 CY scows, Three 3,000 hp tugs	SF-DODS	1.4 months	237, 700
Source: Civil Design ***Appendix C.c***					

Since SF-DODS is the placement site for the Proposed Action, is the furthest from Central Basin, and has the longest project duration and project volumes, the Proposed Action emissions were chosen for analysis in this report. The use of alternative placement sites could affect the distances traveled by vessels, and therefore result in differing emission amounts. Please note that in the event that an alternate dredge type or disposal location other than SF-DODS is used, this analysis will be supplemented if emissions levels are estimated to be above those for the Proposed Action.

Under the Proposed Action, a maximum amount of 237,700 cubic yards per year of material from Central Basin would dredged by one mechanical dredge (with maneuvering assistance from one 3,000 horse power tug) from the mud line to a project depth of 32 feet MLLW. This material would be loaded onto 4,000 CY scows, and transported to the deep ocean disposal site using two 3,000 horsepower tugs. Dredged material would be disposed at SF-DODS by bottom dumping from the scows.

Using the engine specification inputs and emission factors described above, maximum pollutant emissions during annual dredging activities were calculated for the Proposed Action. The dredge equipment will operate under two scenarios: pumping and transit. Each scenario was evaluated to determine the total project emissions.

The average dredging rate for pumping activities was calculated in the Civil Design ***Appendix C.c***, in which the average amount of material dredged per day will be roughly 5,200 CY. Assuming that the dredging contractor will be working 24-hours per day, 7-days a week on this project, the *Paula Lee* was assumed to dredge, on average, 217 cubic yards per hour (***Table 15***).

The transit activities of each barge were based on the standard capacity of dredges with comparable engine sizes and an estimated average speed (10 miles per hour). The Civil Design ***Appendix C.c*** states that SF-DODS is approximately 71 nautical miles (or 82 miles) from Central Basin (one-way). In order to calculate the transport rate in cubic yards per hour, the material transported in the scow per round trip (90% of 4,000 CY scow capacity) was divided by the round trip duration (164 miles round trip at 10 mph speeds for 16.4 hours round trip). This resulted in a transit rate of 220 CY per hour. This is the transport rate that is applicable for the mechanical dredge because the dredge will always stay within the Region of Influence (***Table 15***).

It was assumed that three tugs will constantly be hauling material from Central Basin during transit activities, while one tug will always be helping to maneuver the dredge and scows at Central Basin during pumping activities. This is the worst case scenario. It is more likely that two tugs will haul material from Central Basin to SF-DODS, while one tug maneuvers the dredge and scows.

The distance considered for tug emissions during transit activities is limited to the area within the Region of Influence. Therefore, the tug will travel 34 nautical miles or 39 miles (one-way) during transit activities within the Region of Influence, which includes the haul route from Central Basin to a distance 24 nautical miles off the coast, which is defined as “Regulated California Waters” by the California Commercial Harbor Craft Regulations. To account for this, the transit rate for the tug boat during transit increased from 220 CY per hour to 462 CY per hour. In order to calculate the transport rate in cubic yards per hour, the material transported in the scow per round trip (90% of 4,000 CY scow capacity) was divided by the round trip duration (78 miles round trip at 10 mph speeds for 7.8 hours round trip). This resulted in a transit rate of 462 CY per hour.

Load factors are expressed as a percent of the vessel's total propulsion or auxiliary power. At service or cruise speed, the propulsion load factor is 83 percent (ICF International 2009); therefore, this analysis assumed that the load factor is 0.8 during transit for the tug and during pumping for the deck and deck winch motors. At lower speeds, the Propeller Law should be used to estimate ship propulsion loads. During pumping, the tug will only be used for maneuvering the dredge or scow occasionally and the mechanical dredge main engines will be burdened to dig no more than one bucket load at a time; therefore, the conservative lower limit (10 percent) of the Propeller Law was used as the load factor during pumping for the tug and during pumping and transit for the main mechanical dredge engines. Under Propeller Law, load factors as low as 2 percent are possible even though this was not used in this analysis (ICF International 2009).

Table 15. Calculation of Horsepower Hour per Cubic Yard Material Dredged.

Dredge Type	Engine	hp	Number of Engines Per Barge	Load[1]	Dredge Rate[2] (Cubic yards/hour)	Horsepower-Hour/ Cubic Yard)[1,3]
Mechanical (*Paula Lee*) - Pumping	Tug – main engine	3,000	1	0.1	217	1.38
	Main	1,200	1	0.1	217	0.55
	Main	895	1	0.1	217	0.41
	Deck	300	1	0.8	217	1.11
	Deck Winch	300	4	0.8	217	4.42
Mechanical (*Paula Lee*) - Transit	Tug – main engine	3,000	3	0.8	462	15.60
	Main	1,200	1	0.1	220	0.55
	Main	895	1	0.1	220	0.41
	Deck	300	1	0	220	0
	Deck Winch	300	4	0	220	0

Notes:

hp = horsepower

Sources: USACE n.d.; USACE 2013d. The horsepower, year and quantity of each mechanical dredge engine, except for the tugboat, were obtained from the specifications sheet for the Paula Lee. Both specification sheets were provided by USACE.

[1] Load of all engines and all tug boat specifications were provided by USACE. Zero load indicates that the activity is not part of the corresponding phase (e.g., pumping is not used in transport of material).

[2] Cubic yards per hour for pumping specifications (dredging rate) is an average rate that was calculated from data provided in a mechanical versus hydraulic dredge study provided by USACE. Cubic yards per hour for transit specifications, is an average rate based on 5,000-cubic-yard capacity for either the *Essayons* or the scow that accompanies the *Paula Lee* filled to 90 percent and a 0.9-hour round trip time.

[3] Calculation:

$$\frac{hp-hr}{CY} = (hp) * (number\ of\ engines\ per\ barge) * \frac{load}{cubic\ yards\ per\ hour}$$

To calculate emissions from dredging a specified amount of material, emission factors were converted to the units of pounds per cubic yard of dredged material. First, as shown in ***Table 15***, engine specifications along with the average dredging rate of each barge type were used to convert engine power to the units of horsepower-hour/cubic yard.

Subsequently, pounds of emissions per cubic yard of dredged material were calculated by multiplying the emission factors [grams per horsepower-hour] by [horsepower-hour/cubic yard]. ***Appendix D*** includes the conversion of emission factors from the units provided in the specification sheets to the units of pounds per cubic yard dredged material.

Finally, total emissions of each pollutant were calculated by multiplying the emissions per cubic yard dredged by the 237,700 cubic yards of material per year, as shown in ***Table 16*** below. Details calculations of emissions are provided in ***Appendix D***.

Analysis for SO_2 was not included because the area is in attainment for Federal and state ambient air quality standards (i.e., NAAQS and CAAQS) for SO_2 and therefore, BAAQMD does not have any mass emissions significance thresholds for SO_2. Furthermore, SO_2 emissions from ships were reduced significantly due to the introduction of ultra-low sulfur fuel in 2009 (BAAQMD 2014a). The use of ultra-low sulfur diesel fuel makes SO_2 emissions adequately low to be considered negligible for impact analyses.

The major sources of lead emissions have historically been from fuels in on-road motor vehicles (such as cars and trucks) and industrial sources. The major sources of lead emissions to the air today are ore and metals processing and piston-engine aircraft operating on leaded aviation gasoline. The project area is in attainment for lead based on the NAAQS and CAAQS, and BAAQMD does not have any mass emissions significance thresholds for lead. The proposed project alternatives do not include any major sources of airborne lead, and lead emissions from diesel fuel combustion are considered to be negligible.

Because SO_2 and lead emissions would be negligible, they are not further discussed in the analysis.

Table 16. Total Mass Emissions to Dredge 237,700 Cubic Yards.

Dredge Equipment Type and Activity	**Engine Type**	**(Tons/Year)**			
		ROG	**NO_X**	**PM_{10}**	**CO_2[1]**
Mechanical (*Paula Lee*) – Pumping	Tug – Main Engine	0.16	4.59	0.05	144
	Main	0.04	0.78	0.02	75
	Main	0.02	0.83	0.04	56
	Deck	0.09	1.65	0.05	149
	Deck Winch	0.23	4.29	0.15	597
Total Pumping Emissions		0.55	12.15	0.31	1,021
Mechanical (*Paula Lee*) – Transit	Tug – Main Engine	1.83	51.82	0.58	1,628
	Main	0.04	0.77	0.02	74
	Main	0.02	0.82	0.04	55
	Deck	0	0	0	0
	Deck Winch	0	0	0	0
Total Transit Emissions		1.89	53.41	0.64	1,757
Total Emissions for the Proposed Action[2]		**2.44**	**65.56**	**0.95**	**2,778**
de minimis Emission Levels (40 C.F.R. § 93.153)		50	100	100	
NEPA/CEQ Thresholds of Significance for Carbon Dioxide Equivalent					25,000
Exceeds Thresholds?		No	No	No	No

Notes:
NEPA = National Environmental Policy Act
CEQ = Council on Environmental Quality
CO_2 = carbon dioxide
N/A = not applicable
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 micrometers in diameter ROG = reactive organic gas
1. CO_2 emissions and thresholds are presented in metric tons per year.
2. This also accounts for the difference in emissions between the Proposed Action (equivalent to the maximum impact) and the No Action Alternative.

6.3.1.5.16 *Conclusions and Mitigation Measures*

Emissions associated with the dredging and transport of material under the Proposed Action are listed in ***Table 16***.

Based on the results of the total emission estimate, emissions from the Proposed Action are less than those *de minimis* levels identified in 40 C.F.R. § 93.153 (b), which means that the Proposed Action will not cause emissions increases in excess of *de minimis* levels. Therefore, USACE has determined that conducting a general conformity analysis is not required.

The potential of the emissions from the Proposed Action's activities to conflict with or obstruct BAAQMD Air Quality Plan Implementation, exceed applicable air quality standards, or contribute substantially to an air quality violation would be less than significant because total mitigated annual project emissions in tons per year are below the thresholds of significance for this project including the *de minimis* levels identified in 40 C.F.R. § 93.153 (b).

In addition, because the No Action Alternative would not result in any new emissions, the No Action Alternative would have no impact and therefore does not have potential to conflict with or obstruct BAAQMD Air Quality Plan Implementation, exceed applicable air quality standards, or contribute substantially to an air quality violation.

The USACE commits to compliance with the California Commercial Harbor Craft Regulations by establishing binding agreements with construction phase contractors before the start of construction.

Dredging and dredged material placement emissions would be temporary, intermittent, and would cease upon completion of project activities. Total estimated project emissions are shown in ***Table 16*** and ***Appendix D***.

6.3.1.6 *Hazards and Hazardous Materials*

Based on a review of potential cleanup sites in the vicinity of the project using the GeoTracker (SWRCB, 2017) and EnviroStor (DTSC, 2017) databases, there is only one cleanup site located roughly 700 feet from the proposed dredge footprint within the vicinity of the former Pier 64 (***Figure 24***).

As a result of this review and under USACE ER 1165-2-132, Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Projects, the dredged material and sediments beneath the navigable waters proposed for dredging at Central Basin do not qualify as HTRW. The dredge footprint is not within the boundaries of a site designated by USEPA or the State of California for a response action (either a removal action or a remedial action) under the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. § 9601 *et seq* (CERCLA), and the dredge footprint is not a part of a National Priority List (NPL) site under CERCLA.

The Regional Water Board adopted site cleanup requirements (Order No. R2-2005-0028) for the Pier 64 site on June 15, 2005. This Order named Atlantic Richfield Company, Chevron U.S.A. Inc., Phillips Petroleum Company, Texaco Inc., Union Oil Company of California, the City and County of San Francisco, and Ecor-SF Holdings, Inc. as responsible parties.

As part of the larger 303-acre Mission Bay Redevelopment Area in the City and County of San Francisco, the 12-acre Pier 64 site was the historical location of various bulk petroleum storage and transfer facilities, with releases that impacted soil and groundwater. Note that this site is located entirely on land, outside of the Central Basin dredge footprint.

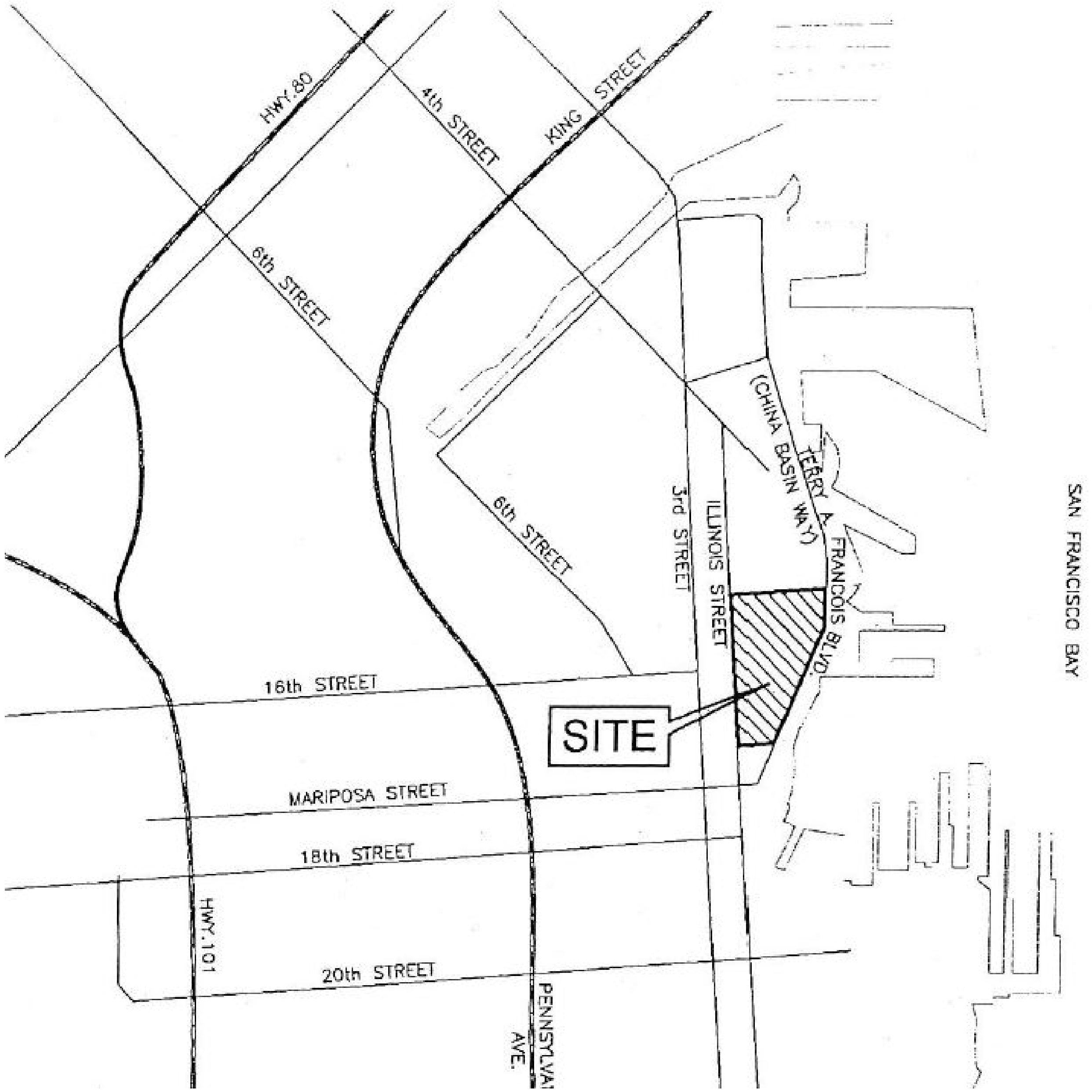

Figure 24. Pier 64 and Vicinity Map (Source: SFRWQCB Order No. R2-2005-0028)

Order No. R2-2005-0028 required the implementation of a November 19, 2004, Remedial Action Plan (RAP) proposed by Atlantic Richfield Company, Chevron U.S.A. Inc., Texaco Inc., and Union Oil Company of California (collectively the Pier 64 Group) to address the existence of separate phase petroleum hydrocarbons products at the site along the 16th Street pipeline corridor and under the majority of the footprint of the two former petroleum bulk storage facilities on both sides of 16th Street (i.e., Parcels 3892-01 and 3940-01) as well as their immediate surrounding and downgradient areas.

A subset of the dischargers (the Pier 64 Group) has completed all the tasks as set forth in the Order. Consistent with the approved RAP, approximately 200,000 tons of impacted soil were removed and disposed of offsite. Additionally, more than 15,000 feet of petroleum pipelines were either removed or grouted in place. Post-remediation groundwater monitoring has shown that the residual petroleum products have very limited impact on the groundwater beneath the site. Current groundwater conditions have met the Regional Water Board's Environmental Screening Levels. Any residual contamination poses acceptable risks to human health and the environment that can be effectively managed using the existing Mission Bay Area Risk Management Plan.

As a result, the SFRWQCB issued a new Order (Order No. R2-2014-0022) that rescinds the site cleanup requirements in Order No. R2-2005-0028.

The Proposed Action and alternatives will not affect the remediation of near by hazard sites such as Pier 64. In addition, the Pier 64 hazard site does not affect the material proposed to be dredged within Central Basin as evidenced by the recent sediment testing results. .

6.3.1.6.1 *Central Basin Sediment Suitability for Permitted Placement Sites and Analytical Test Results for Dredge Material*

Per USACE ER 1165-2-132, the dredged material and sediments beneath the navigable waters proposed for dredging in Central Basin were tested and evaluated for their suitability for disposal in accordance with the appropriate guidelines and criteria adopted pursuant to Section 404 of the Clean Water Act and Section 103 of the Marine Protection Research and Sanctuaries Act (MPRSA) and supplemented by the Corps of Engineers Management Strategy for Disposal of Dredged Material: Containment Testing and Controls (or its appropriate updated version) as cited in Title 33 Code of Federal Regulations, Section 336.1.

In general, the surficial sediments in San Francisco Bay have been deposited since industrialization began in California, and therefore may have been exposed to anthropogenic sources of pollutants. These "industrial age" sediments are likely to be encountered in Central Basin. Recent sand deposits—either riverine sand in portions of San Pablo and Suisun bays and the lower Sacramento River, or sand bars maintained by strong currents in central San Francisco Bay and the San Francisco Bar—also may be exposed to anthropogenic sources of pollutants, but typically do not accumulate significant concentrations of them. There have been several programs in San Francisco Bay that have monitored concentrations of contaminants in sediments from various embayments. Data indicate that, overall, the peripheral industrialized areas indeed have higher mean contaminant concentrations than do the central basins (LTMS, 1998).

The Port of San Francisco in partnership with USACE has conducted two sampling and testing events of material proposed to be dredged at Central Basin to determine the suitability of the material for placement at available sites. Samples were collected throughout the entire proposed dredge footprint in April 2015 and samples were collected only in two dredge units (DUs) in November 2015.

The results of the first sampling and testing event are presented in the "Port of San Francisco Central Basin Sediment Characterization Report," dated August 25, 2015 and revised September 29, 2015 (***Appendix D***). Please see ***Figures 25 and 26*** for maps of the dredge units sampled, sampling locations, and existing shoaling.

Figure 25. Upper Dredge Units and Actual Sampling Locations for Central Basin (Source: NewFields, 2015)

Figure 26. Lower Dredge Units and Actual Sampling Locations for Central Basin (Source: NewFields, 2015)

Initial sampling at Central Basin was conducted between April 13 and April 23, 2015. Nine dredge units (DUs) were characterized as follows:

- Four surface DUs (DU01A, DU02A, DU03A, and DU04A) were characterized from the mud line to 30 feet MLLW (plus two feet of allowable overdepth), and from 32 to 32.5 feet MLLW to represent the material to be left in place after dredging (Z-layer), and
- Five subsurface DUs (DU05B, DU06B, DU07B, DUOBB, DU09B) were characterized from 32 to 35 feet MLLW (plus two feet of allowable overdepth), and 37 to 37.5 feet MLLW to represent the Z-layer.

Sediment from all DUs underwent the full suite of chemical analyses and biological testing. Polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), cadmium, and mercury were detected at concentrations above Cullinan Ranch Tidal Restoration Project and Montezuma Wetland Restoration Project acceptance criteria for placement as cover (surface) material. Concentrations of chlordane and PAHs were detected above Montezuma Wetland Restoration Project acceptance criteria for placement as foundation material. A summary of the criteria exceedances is provided in ***Table 17***. However, biological testing results indicated no sediment or water column toxicity (NewFields, 2015).

Table 17. Summary of Criteria Exceedances by Dredge Unit.

	DU01A	DU02A	DU03A	DU05B	DU06B	DU07B	DU08B
EFH Bioaccumulation Trigger	Hg	Hg; PCBs		Hg, PAHs	Hg, PCBs	Hg, PAHs	Hg
RWQCB TMDL	PCBs		PCBs	Hg, PCBs		PCBs	PCBs
MWRP Surface (cover) Material	Cd, PAH, PCBs, Chlordane	Cd, Se, PCBs, Chlordane	Cd, PCBs, Chlordane	Cd, Hg, PCBs, PAHs, Chlordane	Cd, PAHs, PCBs, Chlordane	Cd, Hg, Se, PAHs, PCBs, Chlordane	Cd, PCBs
MWRP Foundation Material	Chlordane	Chlordane	Chlordane	PAHs, Chlordane		Chlordane	
2014 SF Bay Ambient (<100% fines)	Cd, Hg, PCBs	Cd, Hg, Se, Chlordane, PCBs	Cd, Chlordane, PCBs	Cd, Hg, Se, PAHs, Chlordane, PCBs	Cd, Hg, PCBs	Cd, Hg, PAHs, PCBs	Cd, Hg, Chlordane, PCBs

As a result of the first sampling event, the DMMO members determined the following in a memorandum dated September 14, 2015:

- All of the sediment is suitable for unconfined aquatic disposal at the San Francisco Deep Ocean Disposal Site.

- None of the sediment is suitable for unconfined aquatic disposal at an in-Bay disposal site or for placement as wetland cover material at the Montezuma Wetland Restoration Project site.
- The sediment characterized by composite for DU06B is suitable for placement as wetland foundation material at Montezuma.

The DMMO members (USACE, USEPA, BCDC, SFRWQCB, and the State Lands Commission) also requested that USACE conduct a Z-layer analysis within the 37 to 37.5 feet MLLW depth interval for PAHs in DU05B at that time.

Based on the suitability determination above, the material proposed to be dredged at Central Basin is not suitable for all placement at Cullinan Ranch Tidal Restoration Project and placement as cover material at the Montezuma Wetland Restoration Project because concentrations of PCBs and other analytes exceeded the acceptability criteria dictated by the RWQCB's waste discharge requirements for cover material both sites (Order No. R2-2010-0108 and Order No. R2-2012-0087). Cullinan Ranch Tidal Restoration Project only accepts cover material. Therefore, these placement alternatives were screened out.

Given the sediment characterization results listed above and the depth alternatives for the project, USACE also must ensure that the material proposed to be dredged to a project depth of 32 feet MLLW plus two feet of overdepth within Central Basin was adequately characterized. The Z-layer for this depth extends from 34 to 34.5 feet MLLW.

Because this project depth and Z-layer are in between the initial test intervals, additional chemical analyses were requested by the DMMO for select samples from DU05B and DU08B to verify that concentrations in the 32 feet to 34 feet interval are consistent with those from the previously tested 32 feet to 37 feet interval. A supplemental sampling and analysis plan (SSAP) was prepared by NewFields in a technical memorandum with the subject, "Central Basin Supplemental Sampling and Analysis," dated October 13, 2015. The SSAP proposed that if chemical concentrations from this second phase of analysis are similar to previous results, the sediments from the 32 to 34 feet MLLW layer in Central Basin will be considered suitable for disposal at SF-DODS. The DMMO determined that the SSAP was appropriate for the sediment from the interval in question in the Central Basin in a letter dated October 22, 2015.

The requested supplemental samples were collected at Central Basin in November 2015. Two DUs were characterized as follows:

- DU05B - All five individual cores from 32 to 34 feet MLLW and each Z-layer sample from 34 to 34.5 feet MLLW were analyzed for PCBs, PAHs, and chlordane.
- DU08B - Four individual cores were collected and a composite sediment sample was generated for the 32 to 34 feet MLLW depth interval and another composite sample was

generated for the 34 to 34.5 feet MLLW Z-layer depth interval. The composite samples were analyzed for PCBs only.

The results of the supplemental sampling and analysis are presented in the technical memorandum with the subject, "Central Basin Supplemental Sampling and Analysis Results," dated January 4, 2016 that was provided by NewFields (***Appendix D***). Since the DU05B and DU08B chemical concentrations are similar or lower than the results measured in the samples collected in April 2015, USACE and the Port of San Francisco concluded that additional biological testing is not warranted.

As a result of the second sampling event, the DMMO members made the following final determinations in a memorandum dated April 28, 2016:

- All the sediment characterized from dredge units DU05B and DU08B is suitable for unconfined aquatic disposal at the San Francisco Deep Ocean Disposal Site (SF-DODS).
- The sediment proposed to be dredged from dredge units DU02A and DU06B to a depth of 32 feet MLLW, plus a two-foot overdepth allowance, is suitable for disposal at an in-Bay disposal site.
- Except for dredge units 2A and 6B, none of the sediment is suitable for unconfined aquatic disposal at an in-Bay disposal site or for placement as wetland cover material at the Montezuma Wetland Restoration Project site (Montezuma).
- Additionally, to amend the memo dated September 14, 2015 (DMMO Serial Number 15-086), all sediment proposed to be dredged from the Central Basin to a depth of 32 feet MLLW, plus a two-foot overdepth allowance, is suitable for placement as wetland foundation material at Montezuma.

As USACE understands, the DMMO determined that material is suitable for placement at MWRP as wetland foundation material because the MWRP acceptance criterion for chlordane is conservatively low and the DMMO members are confident that chlordane will not leach into groundwater based on their professional judgment and experience. Despite this, MWRP may refuse to accept this material because the concentration of chlordane exceeds the material acceptability criterion listed in the MWRP Waste Discharge Requirements.

This suitability determination provides the possibility for material in dredge units 2A and 6B to be placed at MWRP as wetland cover material. However, the concentration of total chlordane in the dredge depth interval from the mudline to 30 feet MLLW plus two feet of allowable overdepth (DU 2A) exceeds the material acceptability criterion for wetland foundation material dictated by the SFRWQCB's Waste Discharge Requirements for MWRP. In addition, the concentrations of cadmium, selenium, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and chlordane in DUs 2A and 6B exceed the material acceptability criteria dictated by the San Francisco Regional Water Quality Control Board (SFRWQCB) for wetland cover material (Order No. R2-2012-0087). Please see ***Table 18*** below for the constituent concentrations and Appendix D for a full discussion of the analytical results.

Table 18. Concentrations of Analytes that Exceed MWRP Wetland Cover Acceptability Criteria for Dredge Units 02A and 06B

Analyte	Concentrations		MWRP Acceptability Criteria		SF Bay Ambient (2015 RMP Report)	SFRWQCB TMDL
	DU 2A	DU 6B	Wetland Cover	Wetland Foundation		
Cadmium (mg/kg)	1.9	2.1	0.33	9.6	0.33	-
Selenium (mg/kg)	0.7	0.5 U	0.64	1.4	0.36	-
PCBs (µg/kg)	27	28	22.7	180	18.3	29.6
PAHs (µg/kg)	2,100	3,400	3,390	44,792	4,540	-
Total Chlordane (µg/kg)	15	2 Y	2.3	4.8	0.34	-

Notes:
Concentrations highlighted in red exceed MWRP acceptance criteria for wetland cover material.
Y = non-detect with an elevated reporting limit due to chromatographic interference (equivalent to U with raised MRL)
U = non-detect at the method detection limit
*DU 02A and 06B are located in the same area, labeled in Figures 25 and 26 as DU-2. DU 02A material was collected from the mud line to 30 feet MLLW (+ 2 feet overdepth and 0.5 foot Z layer), and DU 06B material was collected from 32 feet MLLW to 35 feet MLLW (+ 2 feet overdepth and 0.5 foot Z layer).
TMDL = Total Maximum Daily Load

Despite the chlordane concentration that exceeded the MWRP foundation criterion, there was no indication of toxicity in any of the sediments. Bioaccumulation testing was conducted and tissues were tested for PCBs concentrations. The bioaccumulation data did not indicate significant uptake of PCBs in total tissue residue. Also, leachability tests were conducted for metals only (including cadmium) and these did not indicate any significant concerns. Nevertheless, since no leachability studies were conducted for chlordane, the potential mobility is not known.

Based on the sediment characterization, suitability determinations, and coordination with the DMMO agencies, all of the sediment is suitable for placement at SF-DODS and as foundation material at the Montezuma Wetland Restoration Project. Only Dredge Units 2A and 6B are also suitable for unconfined aquatic placement at an in-Bay disposal site. Because discharge of the material from Dredge Units 2A and 6B at MWRP would violate the San Francisco Regional Water Quality Control Board's (SFRWQCB) Waste Discharge Requirements for MWRP (Order No. R2-2012-0087), USACE finds that none of the material proposed to be dredged at Central Basin is suitable for placement as wetland cover material at MWRP per 40 C.F.R. Part 230.10(b)(1).

The Final Array of Alternatives for further analysis (***Section 4.6***) are consistent with these determinations.

6.3.1.6.2 *Summary*

As stated above, all of the material proposed to be dredged at Central Basin under the Proposed Action is suitable for placement either at MWRP as foundation material or SF-DODS. Some of the material is also suitable for placement in-Bay. The results of the sampling and analysis conducted by NewFields shows that none of the material proposed to be dredged qualifies as a hazardous substance or a hazardous waste. As such, impacts to water quality as a result of potential mobilization of contaminated sediments or hazardous materials release would be less than significant.

Additionally, USACE would implement BMPs and comply with water quality protection measures included as conditions to the WQC issued by the Regional Water Board and the letter of agreement issued by the BCDC for USACE's consistency determination. Adherence to these measures and BMPs would minimize the potential for water quality degradation. Vessels would be operated in compliance with all applicable regulations related to the prevention of water pollution by fuel, harmful substances, and garbage, as well as from accidental discharges. During transport, the dredged material would be secured, with precautions in place to minimize any risk of spills. Therefore, the potential for the release of hazardous substances from vessel operations during dredging, transport, and placement activities would be minimal.

As such, the No Action Alternative, Proposed Action, and Alternatives 1 and 4 would have no impact on hazards and hazardous materials.

6.3.2 Biological Environment

The following sections describe the habitats and species assemblages; special aquatic sites; and special status species/habitats associated with these action areas and identify potential effects to such resources from the Proposed Action or the action alternatives.

6.3.2.1 *Aquatic Habitat and Species*

This section first describes the aquatic habitats present in the proposed and alternative action areas and the species assemblages associated with those habitats. Then, the potential for the Proposed Action and alternatives to impacts such habitats and species is discussed.

6.3.2.1.1 *Aquatic Habitats and Species Assemblages*

Subtidal Benthic and Demersal Habitat

The benthic and demersal zones are found at the bottom of the sea. Benthic habitat includes the seafloor sediment and sub-sediment layers, while demersal habitat is the portion of the water column that is located just above, and largely influenced by, the seafloor.

Sediment within the proposed Central Basin dredging footprint is primarily (97.5%) clay, also referred to a Bay Mud, and silt. The substrate at the proposed SF-DODS placement site reflects the dredged material placed at the site. Sediment placed at SF-DODS can be of any grain size and may have levels of contaminants slightly above that of sediment disposed at in-Bay disposal sites. Although sampling conducted between 1996 and 2007 has shown that measured chemical concentrations in the sediment at SF-DODS have generally not exceeded background values found at the site prior to disposal or at a SF-DODS reference area (Germano and Associates, 2008). Alternative 4 would involve placement of material at SF-11 and MWRP. Since approximately 1972, SF-11 has been the most heavily used disposal site in San Francisco Bay, SF-11 has an allowable capacity of dredged material placement of 400,000 cubic yards from October through April, or 300,000 cubic yards from May through September. However, there is an overall in-bay placement limit of 1.25 million cubic yards per, restricts the amount of dredged material that can be placed at SF-11. Sediment placed at SF-11 is primarily consists of fine-grained materials. Material to be placed at MWRP is mixed with water from an onsite holding pond to form a slurry and pumped through a pipeline at the offloader facility into sediment placement cells onshore at the restoration area.

The grain size, depth, and position of substrate influences the organisms present in the benthic and demersal communities (SCC 2010). Such organisms may include marine worms (tunicates, oligochaetes, polychaetes), amphipods, mollusks (barnacles, mussels), crustaceans, aquatic vegetation and macroalgae and benthic and demersal fish. Many of the invertebrate species that occupy benthic habitats in San Francisco Bay are non-native species that have been introduced to the Estuary (SCC 2010). Within San Francisco Bay, recreationally important fish species that use these habitats include halibut (*Paralichthys californicus*), white sturgeon (*Acipenser transmontanus*), striped bass (*Morone saxatilis*), and leopard shark (USACE & SFRWQCB, 2015). These habitats are also used as foraging areas for marine mammals such as harbor seal and California sea lion (Zalophus californianus), and fish such as green sturgeon (Acipenser medirostris) and bat ray (Myliobatis californica) (SCC, 2010). Given its location on the continental slope, the benthic community at SF-DODS is more sparsely populated, particularly by fish and invertebrates that are adapted to the harsh conditions of the deep sea.

<u>Open Bay Pelagic Habitat</u>

The pelagic zone includes the open water at the surface and in the water column away from the bottom of the ocean (above the demersal zone). Open bay pelagic habitat can be further subdivided into “deep bay” – those portions of San Francisco Bay deeper than 18 feet below MLLW-– and “shallow bay” – those portions of San Francisco Bay between 18 feet below MLLW and MLLW (Goals Project 2000).

Depths in the proposed Central Basin dredging footprint as of 2014 ranged from greater than 30 feet MLLW in the far eastern portion of the footprint to 15 to 20 feet MLLW in the far western portion footprint. The mean depth within the footprint in 2014 was 27.1 ft MLLW. Thus, while some of the western portion of the proposed footprint constitutes shallow bay, the majority is deep bay. The SF-11 placement site associated with Alternative 4 ranges in depth from 40 to 70 feet MLLW and thus is considered deep bay. The MWRP offloader site has deep-water access for barges and thus is deep bay.

Species that occupy deep bay habitat include free-swimming invertebrates such as California Bay shrimp (*Crangon fransicorum*) and fishes such as brown rockfish (*Sebastes auriculatus*), halibut, sturgeon (*Asipenser* sp.), delta smelt, and longfin smelt (USACE & SFRWQCB, 2015).

Deep bay habitat also provides important roosting and "loafing" habitat for waterbirds and may be used by surf scoter (*Melanitta perspicillata*), scaups (*Aythya* spp.), brown pelican, and terns (*Sterna* spp.). Marine mammals, such as Pacific harbor seal, harbor porpoise, and California sea lion transit and forage in deep bay habitat, while anadromous fish, such as Chinook salmon and steelhead, use it as a migratory pathway to and from upstream spawning areas (USACE & SFRWQCB, 2015)

The shallow bay zone serves as habitat for Pacific herring, northern anchovy (*Engraulis mordax*), bat ray, and jacksmelt (*Atherinopsis californiensis*), as well as at least 40 other species of fish, crabs, and shrimp (USACE & SFRWQCB, 2015). Shallow bay habitat provides rearing habitat for juvenile halibut and sanddabs (*Citharichthys stigmaeus*), shiner perch (*Cymatogaster aggregata*), herring, and other fishes, and may also be used by migrating anadromous fish. This habitat is in the foraging depth range of many diving birds, and marine mammals such as Pacific harbor seals also forage in this depth range. Eelgrass, an ecologically important submerged aquatic vegetation (SAV), can occupy areas of this habitat type, however no eelgrass is or other SAV is known to be present in or near the proposed central basin dredging footprint (***Figure 27***).

<u>*Open Ocean Pelagic Habitat*</u>

Open ocean pelagic habitat exists at the proposed SF-DODS placement site, which is located in the open ocean on the lower continental slope and has a depth range of 8,000 to 10,000 feet (2,500 meters and 3,000 meters). SF-DODS has two basic pelagic communities: the shallow pelagic community and the deep pelagic community. The shallow pelagic community includes sea birds that forage in the open waters of the ocean, marine mammals, migratory fish, and pelagic invertebrates. The deep pelagic community includes fish and invertebrates such as squid that are adapted to deep-water conditions and marine mammals that dive to great depths while foraging.

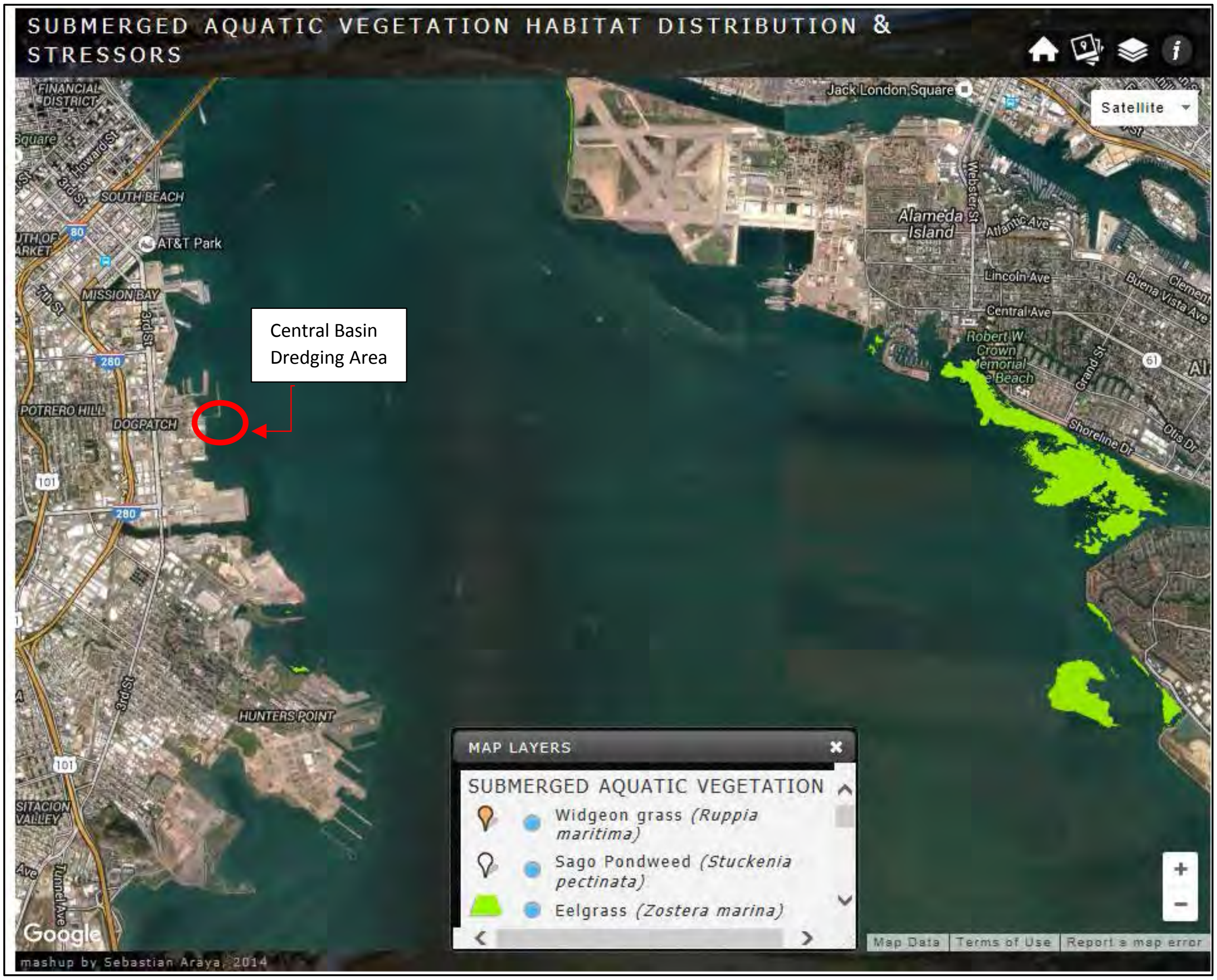

Figure 27. Submerged Vegetation Habitat in relation to the Central Basin Action Area (Red Circle).

6.3.2.1.2 *Potential Effects to Aquatic Habitats and Species*

Benthic Habitat Disturbance

Dredging associated with the Proposed Action would directly affect benthic communities through mechanical removal of benthic habitat and largely non-motile benthic organisms in the proposed dredging footprint. Organisms immediately adjacent to the dredging footprint may be also be impacted by smothering or burial from sediments re-suspended in the water column during the dredging. Similarly, benthic organisms in or immediately adjacent to aquatic placement sites would also be directly affected by burial of benthic habitat and prolonged exposure to anaerobic conditions after placement has ceased. This would result in mortality of most of the organisms in the burial footprint at the placement site; however, this would be a short-term effect because benthic habitat is quickly recolonized. While, transport of dredged material from the Central Basin to the placement site would not be expected to affect benthic habitat, repositioning the dredge plant could affect small portions of the benthic community in the proposed dredge footprint as the spud piles are removed and replaced.

Dredging and placement activities associated with the Proposed Action would result in the loss of most, if not all, benthic organisms and seafloor habitats in the proposed dredge footprint and at the placement site. However the effect would be short-term given that areas experiencing this type of disturbance are usually recolonized quickly by benthic communities (Newell et al., 1998). Newell et al. (1998) suggest that even large areas disturbed by dredging activities are generally recolonized by benthic invertebrates within 1 month to 1 year, with original abundance levels retuning within a few months to years. Benthic habitat within the proposed dredging footprint and at the SF-11 in-Bay disposal site associated with Alternative 4, recolonization would likely include non-native benthic invertebrates already present in SF Bay which harbors more non-native benthic species than any other aquatic ecosystem in North America (Cohen and Carlton, 1995). The existing benthic communities at the in-Bay disposal sites such as SF-11 are thought to have, over the years, reached an equilibrium that adjusts to the periodic disposal of dredged material (USACE & SFRWQCB, 2015). Dredge material from this project has similar physical characteristics to the material present as SF-DODS. The USACE has confirmed that placement of much greater quantities of similar material at SF-DODS has occurred without causing significant impacts to the ocean and species in and around the area (USACE, 2016).

Given that the proposed dredging and placement activities would affect only a very small proportion of extensive, similar benthic habitat throughout the Bay and open ocean; that both the proposed dredging and aquatic placement sites have a history of undergoing similar actions; and that benthic communities have been shown to recolonize rapidly from similar disturbances, the potential impacts to benthic habitat from the Proposed Action would be less than significant.

Turbidity

Clamshell dredging equipment associated with the Proposed Action would interact with sediment in the proposed dredging footprint, re-suspending it into the water column and temporarily increasing turbidity, as described in ***Section 6.3.1.4***. Increased turbidity may affect aquatic habitat and species by altering water quality, inhibiting light transmission, reducing visibility, affecting respiration (clogging gills), smothering, reducing foraging success, and altering behavior and movement patterns. Fish and other aquatic species in early life-history stages, such as the egg and larval stages, and sessile (non-motile) organisms are more sensitive to increased turbidity, as they have limited to no capability to avoid direct disturbance or water quality changes. Benthic organisms immediately adjacent to the proposed dredging footprint and placement site may be lost because of smothering or burial from suspended sediments as they settle out of the water column. Turbidity near the surface of the water column can reduce sunlight penetration, and therefore decrease phytoplankton or submerged aquatic vegetation productivity, which depend on light transmission. Motile organisms such as adult fish and marine mammals can generally avoid unsuitable conditions such as turbidity. Suspended sediments affect fish behaviors such as avoidance responses, territoriality, feeding, and homing (Wilber and Clarke 2001). Generally, bottom-dwelling fish species are the most tolerant of turbidity, and filter feeders are the most sensitive. Turbidity plumes caused by in-water placement and dredging activities have the potential to reduce food availability and foraging success for marine mammals in the local vicinity these activities by temporarily decreasing visibility or causing the relocation of mobile prey from the area. However, these species forage over large areas of San Francisco Bay and the ocean, and can be expected to avoid areas of temporarily increased turbidity, which are ephemeral in nature (LTMS 1998).

Increased turbidity effects from dredging and placement activities are short term, minor, and greatly diminished with distance from the activity. Changes in turbidity associated with the Proposed Action would be localized, small in relation to surrounding areas of similar habitat, and quickly diluted to near or within background particulate concentrations in the action areas. The Proposed Action is expected to require approximately 1.4 months to complete and any increased turbidity associated with the action would cease at its completion. While some benthic organisms and individuals in early life-history stages located immediately adjacent to the dredging and placement sites would to be lost due to smothering, areas disturbed by dredging or placement of dredged materials are quickly recolonized by benthic organisms (Newell et al. 1998). The timing of the project within the LTMS work windows would help minimize the presence of early life-stage of managed organisms. Insignificant effects to pelagic habitat or species would be expected because of the small area and limited duration of the effect, the ability of fish and marine mammals to avoid the area, and the presence of large amounts of equal or higher quality habitat in the immediate vicinities of the proposed dredging and placement sites**.** Given this, turbidity-related impacts to aquatic species and habitats from the Proposed Action would be less than significant.

<u>*Resuspension of Sediments*</u>
As described in the "Turbidity" section above, dredging and placement associated with the Proposed Action would re-suspend bottom sediments. The sediments within the proposed Central Basin dredging footprint were tested for metals, butylins, PAHs, pesticides, and PCBs in order to determine their suitability for various placement sites. Most contaminants are tightly bound in the sediments, and are not easily released during short-term resuspension (USACE & SFRWQCB, 2015). Available studies have suggested that there is little transfer of metal concentrations into the dissolved phase during dredging activities and direct toxicity by exposure to dissolved organic contaminants (pesticides, PCBs, and PAHs) in the water column is not very likely because these compounds are relatively insoluble (Jabusch et al. 2008). The "Summary of Analytical Test Results of dredge or fill material" subsection of ***Section 6.3.1*** describes the results of this testing.

Sediments at the site were found to have concentrations of some metals and PAHs above ambient concentrations found in SF Bay. All all of the material is suitable for placement at SF-

DODS or as foundation material at MWRP, and roughly a quarter of the material was determined suitable for placement in-Bay.

The sediment was also tested to determine if the compounds in the sediment could become biologically available to organisms by entering the water column or through food chain processes at the dredging or aquatic placement sites. The results of water column and benthic toxicity tests showed that none of the sediments demonstrated an acute toxicity to the organsims. In addition, bioaccumulation testing showed that overall, the bioavailability of PAHs and PCBs from Central Basin sediments was low, , similar magnitude to reference data, and below literature toxicity thresholds (***Appendix D***).

Any resuspension of sediments would be minor, localized at and around the action areas, and temporary – ceasing at the completion of dredging and placement activities. , The Proposed Action and Alternatives are constratined by the sediment suitability criteria for each placement site. Thus, potential impacts to aquatic species or habitats from suspension of contaminated sediments associated with the Proposed Action or action alternatives are expected to be less than significant.

Underwater Noise

Operational noise from the clamshell dredge equipment associated with the Proposed Action and alternatives has the potential to affect marine mammals and/or fish at or around the proposed dredge area. Clamshell dredges generate underwater noise from the winches, bucket impact with the substrate, closing and opening the bucket, and sounds associated with dumping the dredged material into the barge. The most intense sound impacts have been found to result from the bucket's impact with the substrate which can result in peak sound pressure levels (SPL) of 124 decibels (dB) approximately 150 meters from the bucket strike location (Reine et al. 2002, Dickerson et al. 2001).

The National Marine Fisheries Service (NMFS) underwater sound thresholds for impacts to marine mammals suggest that underwater noises from impulse sounds at or above 160 dB root mean square (rms) constitute harassment, while a received SPL between 180 and 190 dBrms may result in injury to cetaceans (whales, dolphins, and porpoises) and pinnipeds (seals and sea lions), respectively (Reine and Dickerson 2014). A peak SPL of 206 dB is considered injurious to fishes and a threshold of 150 dB has generally been adopted for adverse behavioral effects in fishes (SAIC 2007). In comparison, ambient underwater noise levels in areas with significant vessel traffic generally range around 130 dB_{peak} (SAIC 2007) and commercial shipping vessels can produce continuous noise in the range of 180 to 189 dB (Reine and Dickerson 2013).

The sound pressure levels produced by the impact of clamshell dredge bucket is approximately 124 dB_{peak}, which is below thresholds for injury and harassment to marine mammals, as well as thresholds for injury and adverse behavioral effects in fish species. Additionally, this noise level may be below ambient underwater sound levels around the dredging action area given the level of existing vessel traffic in the area and the sounds produced by that activity. Underwater noise produced during dredging mays still cause fleeing, the cessation of feeding, or startle responses in fish or marine mammals at the site, but the noise would be temporary and these motile species could avoid the area. As such, any potential underwater noise impacts on aquatic habitats and species from the Proposed Action or action alternatives would be less than significant.

Entrainment

Entrainment refers to the incidental removal of organisms from the aquatic environment with dredged material. In general, organisms on the dredged material or smaller organisms in the water column with limited or no swimming capabilities are most susceptible to entrainment. Dredging associated with the Proposed Action and action alternatives is expected to be accomplished with a mechanical clamshell dredge, which is a measure implemented to reduce entrainment because little water is removed along with the sediment. However, a clamshell dredge may still remove demersal fish (e.g., Pacific staghorn sculpin, Pacific sanddab) and benthic organisms that live in or on the sediment. Entrained individuals are likely to suffer injury, mortality, or be transported and released with the dredged material (potentially in unsuitable habitat).

Entrainment impacts from the Proposed Action and action alternatives would be less than significant for the following reasons:

- The Proposed Action and action alternatives would use a type of dredge to minimize entrainment;
- The timing of the project within the LTMS work windows would help minimize the presence of susceptible early life-stage individuals of special-status and commercially important species in the benthic and demersal zones during the dredging period; and,
- The risk of entrainment would be temporary and cease after the duration of the dredging activity..

Displacement

The movement and activity of dredging, transport, and placement equipment in the aquatic environment as a result of the Proposed Action or action alternatives has the potential to cause fish marine mammals to temporarily avoid the immediate dredging or placement area when work is being conducted. This may occur, for example, due to noise from dredging equipment (discussed above) or due to the physical disturbance of rapid, high-volume, placement at placement sites. Localized effects of this type have been documented around the SF-11 placement site with avoidance of the area by some fish species for 2 to 3 hours following dredged material placement events (ECORP, 2009). In addition to being temporary, these effects would be confined to the proposed dredging and placement areas and the SF Bay and open ocean contain extensive aquatic habitat of the same or higher quality to support any organisms temporarily displaced during the Proposed Action or action alternatives. Any displacement causing activities would end at the completion of the Proposed Action or action alternatives (approximately 1.4 months or less). Thus, displacement of aquatic species due to the Proposed Action or action alternatives is expected to less than significant.

Disturbance of Avian Foraging

San Francisco Bay is an important stopover for many species of migratory waterfowl in the Pacific Flyway and many bird species rest and forage in open bay habitat. The movement and activity of dredging, transport, and placement equipment in the aquatic environment as a result of the Proposed Action or action alternatives has the potential to disturb these behaviors in the project action areas. Avian species that occupy SF Bay are likely accustomed to human activity and noise, including that from vessel traffic, however, dredging and placement activities may still interrupt foraging and increase energetic costs by requiring additional flight times and/or triggering startle responses (USACE & SFRWQCB, 2015). Birds that might be found in or near the proposed dredging footprint or placement sites are mobile and could avoid the open water project activity. Impacts on foraging as a result of increased turbidity in the water column and burial of the benthic community would be short term and localized (as discussed in the applicable subsections above), and open Bay outside of the project area could provide ample alternative forage resources. Therefore, the Proposed Action and action alternatives are not expected to significantly affect avian species in the aquatic environment.

Special aquatic sites (wetlands, mudflats, coral reefs, pool and riffle areas, shallows, sanctuaries and refuges)

There are no rocky shorelines, salt marshes, tidal marshes, tidal flats, salt ponds, or other special aquatic sites within the proposed dredging footprint or the surrounding vicinity. The proposed SF-DODS placement site is approximately 6 nautical miles west of the outer boundary of the Gulf of Farallones National Marine Sanctuary and the barge route to SF-DODS is south of the Sanctuary boundary (LTMS, 1998).Transport to and placement of dredged materials at SF-DODS would not impact the Marine Sanctuary or its resources.

There are no special aquatic sites located at or in the immediate vicinity of the SF-11 placement site associated with Alternative 4. However, the MWRP placement site (***Section 4.3.2***) associated with this Alternative is a 1,800-acre upland beneficial reuse site where dredged material is used to create wetlands. The operator of the MWRP (Montezuma Wetlands, LLC) has coordinated with Federal, state, and local resource agencies and has all permits necessary for wetland restoration at the site. Placement of dredged material at this wetland restoration beneficial reuse site would provide a beneficial impact to special aquatic sites by increasing wetland habitat in the SF Bay area.

The Proposed Action, Alternative 1, and the No Action Alternative would have no effect on special aquatic sites because no such sites are at or in the immediate vicinity of the action areas associated with these alternatives. Alternative 4 would have no adverse effects on special aquatic sites but would benefit such sites by contributing to the restoration of wetland habitat around SF Bay.

6.3.2.1.3 *Summary*

The Proposed Action (Alternative 6) would involve dredging, transport, and placement of approximately 237,700 CY of material and has the potential to affect aquatic habitat and organisms in and around the proposed Central Basin dredging footprint and SF-DODs placement site through disturbance of benthic communities, increases in turbidity and suspended contaminants, underwater noise, entrainment, displacement of mobile species, or interruption of avian foraging. These activities would take place over a relatively short duration (approximately 1.4 months) and the associated effects, as described above, would have less than significant impact on aquatic habitats and species.

The effects of Alternative 1 would be of the same type as the Proposed Action but the dredging, transport, and placement activities would last for a slightly shorter duration (1.0 months). Some effects, such as benthic habitat disturbance and turbidity, could also be less severe given the reduced quantity of material to be dredged (185,000 CY). Alternative 4 would involve similar dredging-related effects to Alternative 1 (as they involve the same depth and quantity of dredging) but the activities would last for the shortest duration (approximately 0.8 months) and the impacts of aquatic placement would occur in-Bay (SF-11) and involve much less material (as the majority would go to the MWRP). Both Alternatives 1 and 4 would be expected to have a less than significant impact on aquatic habitats and species.

The No Action Alternative would involve no dredging, transport, or placement of material in the aquatic environment and thus would have no effect on its habitats or species.

6.3.2.2 *Terrestrial Habitat and Species*

Activities associated with the Proposed Action and Alternatives 1 and 4 would largely take place in the waters of SF Bay and the open ocean where no terrestrial habitat or species exist. The Farallon Islands are an important terrestrial haul-out and nesting area in the open ocean outside of SF Bay but this habitat is far from the SF-DODS these species have rarely been observed in the vicinity of the SF-DODS (LTMS 1998). No terrestrial marine mammal haul-outs or avian nesting areas are expected to be disturbed by dredging, transport, or placement activities associated with the Proposed Action or action alternatives. The potential for effects to marine mammals and waterfowl in the aquatic environment are discussed above.

While material placed in terrestrial habitat at the MWRP under Alternative 4, the sediment would be placed in an area scraped clean of all growth and habitat. Furthermore, in accordance with the project's regulatory permits for receiving and placing dredged material, the MWRP site operator is responsible for protecting habitat and species at the site. Thus, no effects to terrestrial habitat or species would be expected from the offloading of material associated with Alternative 4.

No effect on terrestrial habitat or species would result from the Proposed Action, Alternatives 1 and 4, or the No Action Alternative.

6.3.2.3 *Special Status Species and Habitats:*

This section focuses on species and habitats regulated under the Federal Endangered Species Act (ESA), the Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA), the Marine Mammal Protection Act (MMPA).

6.3.2.3.1 *Endangered, threatened, or proposed species and critical habitats*

The USACE conducted a preliminary review to investigate the potential presence of listed and proposed species and critical habitats within the action areas associated with the project. Official project species lists from the United States Fish and Wildlife Service (USFWS) Information, Planning, and Conservation (IPaC) system (USFWS 2016), National Marine Fisheries Service (NMFS) lists of protected species along the west coast of the United States (NOAA 2016) and other sources were used to generate a master list of species and habitats potentially present in the project region. The complete list is included in ***Appendix D***. The USACE evaluated the species' known ranges and habitat constraints, and those determined to have the potential to occur in the project action area (***Table 19***) are discussed further below.

No significant effects to ESA-listed species or critical habitats are expected from the Proposed Action or action alternatives. However, given the presence of critical habitat and potential for presence of listed species within the Proposed Action areas, consultation with USFWS and NMFS will be conducted by USACE prior to project implementation. This will include initial informal consultation and may include formal consultation and preparation of a Biological Assessment and Biological Opinion.

Fish

Relevant range, habitat requirements, and life history traits for the delta smelt, longfin smelt, green sturgeon, and salmonid species are described in the master list of species and habitats potentially present in the project region (***Appendix D***).

Potential effects to these fish species and their critical habitats from the Proposed Action or action alternatives would be the same as the effects to fish and aquatic habitat in general that are discussed in the "aquatic habitat and species" section above. Temporarily altered water quality (e.g. turbidity, suspended sediment) from dredging and aquatic placement activities could decrease habitat quality, reduce visibility, affect respiration (clog gills), smother eggs or larval life-stages, decrease foraging success, and/or alter behavior and movement patterns for these species. Underwater noise from operation of the clamshell dredge equipment could cause individuals of these species to flee, cease feeding, or exhibit startle responses near the proposed Central Basin dredge footprint. Similarly, movement and physical activity in the water column associated with dredging, transport, and rapid high-volume placement of material has the potential to result in these species temporarily avoiding the immediate dredging or placement area while work is conducted. Finally, dredging could cause entrainment of individuals of these species (although this is very unlikely given their mobility and the proposed use of a clamshell dredge).

Table 19. Listed Species with the Potential to Occur in the Proposed Action Areas.

Common Name	Scientific Name	Federal[1]	State[1]	Potential for Presence Within Proposed Action Areas
Fish				
Delta smelt	*Hypomesus transpacificus*	FT, CH	ST	Range includes open surface waters in the vicinity of the Montazuma Wetland Restoration Project placement site.
Longfin smelt	*Spirinchus thaleichthys*	Candidate	ST	Species is found throughout San Francisco Bay.
Southern DPS green sturgeon	*Acipenser medirostris*	FT, CH	SSC	Action areas are located within designated critical habitat.
Steelhead (Central California Coast and Central Valley ESUs)	*Oncorhynchus mykiss*	FT, CH	--	Action areas are located in designated critical habitat (for Central California Coast ESU) and both ESUs use open water areas within the Bay during migration to/from spawning grounds
Coho salmon (Central California Coast ESU)	*Oncorhynchus kisutch*	FE, CH	SE	Species may migrate through open ocean or Bay waters in action areas.
Chinook salmon (Sacramento winter-run and Central Valley spring-run ESUs)	*Oncorhynchus tshawytscha*	Winter FE, CH Spring FT, CH	Winter SE Spring ST	Migration corridor includes waters between Golden Gate and Sacramento – San Joaquin River systems.
Marine Reptiles				
Leatherback sea turtle	*Dermochelys coriacea*	FE, CH	--	May forage in deep open ocean or Bay waters.
Green sea turtle	*Chelonia mydas*	FT	--	Generally found in waters along continental coasts. Could occur in open ocean waters in the vicinity of SF-DODS.
Loggerhead sea turtle	*Caretta caretta*	FT	--	Numerous records of individuals off the coast of California. Could occur in open ocean waters in the vicinity of SF-DODS.
Marine Mammals				
Blue whale	*Balaenoptera musculus*	FE	--	Could transit through open ocean waters at SF-DODS.
Fin whale	*Balaenoptera physalus*	FE	--	Could transit through open ocean waters at SF-DODS.
Humpback whale	*Megaptera novaeangliae*	FE		Species is a very rare visitor to the San Francisco Bay. May transit in open ocean waters around SF-DODS.
Northern Pacific Right Whale	*Eubalaena glacialis*	FE, CH		Could transit through open ocean waters at SF-DODS.
Sei Whale	*Balaenoptera borealis*	FE		Could transit through open ocean waters at SF-DODS.
Southern Resident Killer whale	*Orcinus orca*	FE, CH		Could transit through open ocean waters at SF-DODS.
Sperm whale	*Physeter catodon*	FE		Could transit through open ocean waters at SF-DODS.
Mammals				
Salt marsh harvest mouse	*Reithrodontomys raviventris*	FE	SE	Habitat and confirmed the presence of individuals at Montazuma Wetland Restoration Project.
Birds				
California least tern	*Sterna antillarium browni*	FE	SE	Species forages in marine waters of San Francisco Bay and has been documented at Montazuma Wetland Restoration Project since 2005.

[1]FT= Federal Threatened; FE= Federal Endangered; CH= Critical Habitat; ST= State Threatened; SE= State Endangered; SSC= State Species of Special Concern.

Dredging and placement activities associated with the Proposed Action and action alternatives would be conducted within the designated LTMS work windows established to avoid sensitive periods (i.e., migration periods, spawning periods) of delta smelt, steelhead, coho salmon, and Chinook salmon in SF Bay. This would minimize the likelihood that these species would be present in the Proposed Action areas during project activity. There is currently no work window approved for green sturgeon and longfin smelt and these species are presumed present in the Bay year-round. Green sturgeon spawn in the Sacramento River while longfin smelt are believed to spawn primarily in lower reaches of the Sacramento and San Joaquin rivers. Because these spawning areas are well outside the Proposed Action areas, eggs or larvae of these species would not be expected in these areas and juveniles and adults would be motile enough to avoid them.

While unlikely, if individuals of these species happen to be present near the Proposed Action areas during project activities, any potential effects would be expected to be temporary and minor (Jabusch, 2008). Underwater noise from clamshell dredging would not exceed established thresholds for injury or adverse behavioral changes; any related effects would be temporary and negligible. The potential for entrainment of these species (especially susceptible life-stages like eggs and larvae) would be negligible. Moreover, while individuals of these species may be temporarily displaced from the action areas during project activity, there is ample other aquatic habitat of equal or greater quality available in the vicinity of the action areas for foraging and transiting. Therefore, any potential impacts to these listed fish species and their critical habitats from the Proposed Action or Alternatives 1 or 4 would be less than significant. The No Action Alternative would have no effect on these species.

Sea Turtles

Sea turtles are generally pelagic species that may forage in coastal waters but are unlikely in the Bay. Leatherback turtle designated critical habitat is located along the west coast of the United States that coincides with the SF-DODs placement site and the species has the potential to occur near the Gulf of the Farallones. The Loggerhead turtle and green sea turtle may occur in the open ocean in the vicinity of SF-DODs, however, they are generally found in warmer waters. The nesting of all three species occurs in temperate waters; therefore, juveniles and eggs would not occur in the region (USACE & SFRWQCB, 2015). Because occurrence of these species is rare in the region; they are highly mobile and thus able to occupy vast open ocean, pelagic habitat outside of the SF-DODS for foraging and transit; and they nest in temperate areas; no impacts from the Proposed Action, Alternatives 1 or 4, or the No Action Alternative are expected.

Whales

Whales are generally found in deep, offshore waters and all of the species listed in ***Table 19*** may occur off the coast of California. Ranges and relevant life history traits for these species are discussed in the master list of species and habitats potentially present in the project region (***Appendix D***). These species could transit in or around the SF-DODS but are unlikely in the Bay (gray whales do enter the bay infrequently and humpback whales have been documented in the Bay extremely rarely). If such species were present at SF-DODS during placement activities, it is unlikely that the placement activities would have any significant effect on them. While strikes from vessels have the potential to impact whales, vessel traffic to and from SF-DODS under the Proposed Action or Alternative 1 would be an insignificant increase in vessel traffic coming into and out of the Golden Gate and the vessel size involved could be easily avoided by whale species. Given this, no effects to whales are expected from the Proposed Action, Alternatives 1 or 4, or the No Action Alternative.

Salt marsh harvest mouse

The salt marsh harvest mouse is a small rodent species and is restricted to salt and brackish water marshes in San Francisco Bay. Along with the No Action Alternative, the Proposed Action and Alternative 1 would not affect the salt marsh harvest mouse because the species would not be present in the proposed dredging, placement, and transport action areas associated with these alternatives. Extensive salt marsh harvest mouse habitat exists at the MWRP associated with Alternative 4, and surveys conducted between 2000 and 2009 confirmed the presence of salt marsh harvest mouse in the area (Acta Environmental 2011). However, in accordance with their permits for receiving dredged materials, site operators for MWRP are responsible for coordinating protected species issues with resources agencies, and managing the placement of dredged materials at the sites in accordance with any species protection conditions. Thus, no effects to salt marsh harvest mouse are expected from any of the evaluated alternatives.

Least Tern

In SF Bay Nesting sites for the California least tern exist at the former Naval Air Station in Alameda and the species is known to use the Middle Harbor Enhancement Area in Oakland's Middle Harbor for foraging and roosting. This species feeds primarily in shallow estuaries or lagoons where small fish are abundant. The least tern generally migrates from the San Francisco Bay Area in August and winters south of the United States. An LTMS work window for California least tern of August 1 through March 15 annually applies for actions within 1 mile of the coastline from the Berkeley Marina south to San Lorenzo Creek. While the action areas associated with the Proposed Action and action alternatives are outside of this zone, project dredging and placement would still confirm to this work window (as it coincides with work windows for many other species).

In 2005, least terns were observed at MWRP site and since then, the MWRP operator (Montezuma Wetlands, LLC) has been working with CDFW and USFWS staff to create suitable nesting habitat for the tern outside of areas of the site that would be impacted by planned restoration activities (USACE & SFRWQCB, 2015). Montezuma Wetlands, LLC coordinates with CDFW and USFWS on least tern issues and proposed dredged material placement actions for the site must first comply with the ESA, and other Federal, state, and local wildlife protection laws, before the project accepts dredged material therefore, placement of dredged material at MWRP under Alternative 4 would not be expected to affect least tern.

No effects to least tern are expected from any of the evaluated alternatives.

6.3.2.3.2 *Essential fish habitat*

Essential Fish Habitat (EFH) is defined under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) as waters and substrate necessary for spawning, breeding, feeding or growth to maturity for certain fisheries. The San Francisco Bay and open ocean areas associated with the Proposed Action and action alternatives are EFH for Pacific salmonids, coastal pelagic, and Pacific groundfish fisheries.

<u>Pacific Salmonid Fishery Management Plan (FMP)</u>

The current Pacific Salmon FMP provides management protection for natural and hatchery salmon species off the coasts of Washington, Oregon, and California. These species include Chinook (*Oncorhynchus tshawytscha*), coho (*Oncorhynchus kisutch*), pink (*Oncorhynchus gorbuscha*), and all salmon protected under the ESA except steelhead. The EFH designated for these species includes marine waters from the shoreline to the boundary of the exclusive economic zone (EEZ; 200 miles offshore) and estuarine and freshwater habitat within Washington, Oregon, California, and Idaho.

<u>Pacific Groundfish Fishery Management Plan</u>

The Pacific Coast Groundfish FMP provides protection for 83 groundfish species throughout the Pacific Coast of the United StatesDesignated EFH for Pacific Coast Groundfish includes all waters from depths less than or equal to 3,500 m to MHHW or the upriver extent of saltwater intrusion in river mouths along the coasts of Washington, Oregon, and California. The Pacific Coast Groundfish FMP describes seven habitat units that comprise pacific groundfish EFH: estuarine, rocky shelf, non-rocky shelf, canyon, continental slope and basin, neritic zone, and oceanic zone. Habitat areas of particular concern include estuary, sea grass, kelp canopy, and rocky habitats.

<u>Coastal Pelagic Fishery Management Plan</u>

The Coastal Pelagic FMP provides protection for commercial pelagic species, including four finfish: Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*), and Jack Mackerel (*Trachurus symmetricus*); market squid (*Loligo opalescens*); and various species of krill and euphausiids. The EFH for the finfish species and squid includes all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington, offshore to the limits of the EEZ where sea surface temperatures range between 50 and 78 degrees Fahrenheit. The EFH for krill extends the length of the West Coast from the shoreline to a depth of approximately 1,300 feet (USACE 2015).

Potential impacts of the Proposed Action and Alternatives 1 and 4 on EFH and EFH-managed species would be the same as those described in the “Aquatic habitat and Species” Section and would be expected to be temporary and minor. Potential impacts to a number of the salmonid species covered under the Pacific Salmon FMP are discussed in the “Endangered, threatened, or proposed species and critical habitats” section above. No habitats of particular concern to the Pacific Coast Groundfish FMP (sea grass, kelp canopy, or rocky habitats) exist in any of the proposed or alternative action areas or their immediate vicinity. As shown in ***Figure 27***, the closest Eelgrass beds are well south and across the Bay from the proposed dredging site and nearest placement site (SF-11). Native oysters (Ostrea conchaphila), which also can contribute to EFH in SF Bay, also do not occur in any of the proposed or alternative action areas.

In compliance with the MSFMCA, an EFH assessment and consultation with NMFS regarding adverse effects to EFH from the Proposed Action will be conducted before the Proposed Action is implemented to obtain EFH conservation recommendations to avoid, minimize, mitigate, or otherwise offset potential adverse effects to EFH. Given the relatively minor nature and short-duration of the anticipated effects and with implementation of any EFH conservation recommendations provided by NMFS, no significant impacts to EFH would be expected from the Proposed Action or Alternatives 1 or 4. Under the No Action Alternative, no impacts to EFH would occur.

6.3.2.3.3 *Marine mammals protected under the Marine Mammal Protection Act (MMPA)*

The most common marine mammals in SF Bay are the Pacific harbor seal, harbor porpoise (*Phocoena phocoena*), and the California sea lion (Goals Project, 1999). Other marine mammal species that have been seen occasionally in the Bay include northern elephant seal (*Mirounga angustirostris*), Steller sea lion (*Eumetopias jubatus*), northern fur seal (*Callorhinus ursinus*), and, less frequently, the southern sea otter (*Enhydra lutris*). Seventeen species of cetaceans (whales, dolphins, and porpoises) are frequently observed near the SF-DODS in the Gulf of the Farallones (USACE & SFRWQCB, 2015). Of these, Dall's porpoise (*Phocoenoides dalli*), harbor porpoise, and Pacific white-sided dolphin are common resident species. While depths at SF-DODS range from 2,500 meters to 3,000 meters, the highest densities of cetaceans occur in the continental slope waters at depths between 200 meters and 2,000 meters. The highest densities of cetaceans in the vicinity of SF-DODS occur from March through May (LTMS, 1998).

Marine mammals may occasionally be found near the action areas associated with the Proposed Action or action alternatives. Marine mammals are frequently exposed to vessel traffic, are highly mobile, and can easily avoid dredging and placement activities. Potential effects to marine mammals in general are discussed in the "Aquatic habitat and species" Section above. No significant impact is expected to these species from any of the alternatives evaluated, nor are any alternatives expected to require an IHA.

6.3.2.3.4 *Summary*

Effects from the dredging, transport, and placement of approximately 237,700 CY of material associated with the Proposed Action (Alternative 6) could potentially effect Endangered, threatened, or proposed species and critical habitats; essential fish habitat; and/or marine mammals protected under the MMPA in and around the proposed Central Basin dredging footprint and SF-DODs placement site as described above. These activities would take place over a relatively short duration (approximately 1.4 months) and the associated effects would be minor and temporary. No significant impacts to special status species and habitats would occur from the Proposed Action.

The effects of Alternative 1 would be of the same type as the Proposed Action but the dredging, transport, and placement activities would last for a slightly shorter duration (1.0 month). Some effects to special status species or habitats could be less severe given the reduced quantity of material to be dredged (185,000 CY) and the shorter project duration. Alternative 4 would involve similar dredging-related effects to Alternative 1 (as they involve the same depth and quantity of dredging) but the activities would last for the shortest duration (approximately 0.8 months) and the impacts of aquatic placement would occur in-Bay (SF-11) and involve much less material (as the majority would go to the MWRP). Both Alternatives 1 and 4 would be expected to have a less than significant impact on special status species and habitats. Alternative 4 would involve placement of material at MWRP and therefore would benefit wetlands, a special aquatic site, by contributing to restoration of this habitat.

The No Action Alternative would involve no dredging, transport, or placement of material and thus would have no adverse or beneficial effects on special status species or habitats.

6.3.3 Human Environment

6.3.3.1 *Noise*

Noise from dredging equipment such as an excavator and a dredging vessel can generate ambient (airborne) noise levels of approximately 78 to 82 A-weighted decibels (dBA; USACE & SFRWQCB, 2015). The Federal Transit Administration (FTA) guidelines for assessment of noise impacts for construction activity are commonly accepted industry standard for analysis of noise impacts and include noise thresholds of 90 and 100 dBA equivalent continuous sound level over a 1-hour period for residential and industrial land uses respectively (FTA, 2006). The proposed Central Basin dredging footprint is surrounded by active vessel docks and nearby commercial and industrial terrestrial operations that create relatively high levels of ambient noise. There are no sensitive noise receptors (e.g. residences) within 1,000 feet of the dredge footprint. Based on the noise levels generated by dredging equipment, the construction noise threshold applicable to the industrial Central Basin area would not be exceeded. Moreover, the noise generated from the clamshell mechanical dredge would be intermittent and cease at completion of the project.

The proposed SF-DODS and alternative SF-11 placement sites are over open waters with no sensitive receptors in close proximity. Short-term noise impacts may occur during placement at the alternative MWRP site, however, placement of dredged materials has occurred regularly at this location for years now, and can be considered part of the existing condition. Noise during transport of dredged materials would not be noticeable in the context of other vessel traffic in San Francisco Bay.

Given that the dredging noise would not exceed the FTA construction noise thresholds applicable for the industrial area, there are no sensitive noise receptors in close proximity, and noise from transport and placement would be negligible, the Proposed Action would have less than significant noise impacts on the human environment. Noise impacts from Alternative 1 would similar to those of the Proposed Action and less than significant, but would be slightly shorter in duration than given the shorter project duration associated with dredging to a shallower depth of 30 feet. Noise impacts from Alternative 4 would be the same as Alternative 1 in terms of dredging-related noise, but this alternative would also include some, short-term noise effects associated with terrestrial placement at MWRP. Noise impacts from Alternative 4 would still be less than significant. The No Action Alternative would have no noise-related effects.

Underwater noise effects are discussed in the "Aquatic habitat and species" sub-section of ***Section 6.3.2***.

6.3.3.2 *Recreation (boating, fisheries, other)*

The proposed dredging, transport, and placement activities would not involve the construction of recreation facilities, create demand for new recreational facilities, increase use or deterioration of existing recreational facilities. The Pier 70 - Central Basin area is a working maritime facility and not typically frequented by recreational vessels. Even with the presence of the dredge plant and associated scows and tugs, there would be sufficient room for small recreational vessels to maneuver into and out of the Central Basin area if necessary. Transportation of dredged material to the proposed and alternative placement sites via scows would create vessel traffic on the Bay, but this increase would be negligible given existing levels of traffic and would not be expected to interfere with waterborne recreation significantly. Placement of dredge material at the proposed SF-DODS would not interfere with recreational boating. Placement in-bay at SF-11 and at the MWRP offloader facility would occur at established placement sites and navigational warning markers would be used to prevent any hazard to recreational or other vessels.

No significant impacts to recreation are expected from the Proposed Action. Alternatives 1 and 4 would also have no significant impacts on recreation, but any effects from Alternative 1 would be slightly shorter in duration (1.0 months) than those of the Proposed Action (1.4 months) given the shorter project duration associated with dredging to a shallower depth of 30 feet, while any effects from Alternative 4 would be the shortest in duration (0.8 months). The No Action Alternative would have no effects on recreation.

6.3.3.3 *Navigation, Transportation, and Traffic*

The San Francisco Bay is the inlet through which many highly trafficked Ports are reached, including the Ports of Oakland, Redwood City, Richmond, Sacramento, Stockton, and San Francisco. Approximately 3,200 to 3,500 ship movements (in/ out) of the Bay take place each year. The Pier 70 Shipyard is the closest repair facility to these ports on the west coast. As described in detail in ***Sections 2.3*** and ***3.1***, shoaling has caused reduced depths in the Central Basin approach area, which impedes vessel access in and out of the Pier 70 Shipyard. At current depths, access to the Shipyard and its Drydock #2, the second largest drydock on the West Coast of the United States, is tide restricted for many vessels (i.e. they can only enter at high tide), and some are not able to utilize the shipyard at all due to inadequate depths.

The primary objective of the Proposed Action and action alternatives is to increase navigation efficiency in the Central Basin to enable more use of the Pier 70 Shipyard and its repair facilities by an increased number and type of vessels. The Proposed Action and action alternatives would increase the space available for maneuvering vessels with deep draft requirements to utilize the large capacity of Drydock #2 fully. Under the Proposed Action the proposed Central Basin dredging footprint would be dredged to a depth of 32 feet, which would allow approximately 95 percent of the likely vessel classes (those analyzed in the economic analysis) to safely enter the Pier 70 Shipyard. Under Alternatives 1 and 4, the proposed Central Basin dredging footprint would be dredged to a depth of 30 feet, allowing approximately 90 percent of likely vessel classes to utilize the Shipyard safely.

During the Proposed Action or action alternatives, the dredge plant and vessels used to transport dredge material would slightly increase vessel traffic in the SF Bay, however, given the existing level of vessel traffic in the region, this increase would have negligible effects on navigation. Additionally, safety measures would be taken to avoid any adverse effects on navigation. For example, any dredging equipment in a shipping channel would be moved out of the channel whenever Coast Guard notification of a large commercial vessel transiting the channel is received, in order to avoid navigation hazards. Similarly, transportation of dredged material to the proposed SF-DODS placement site would only be allowed when weather and sea state conditions do not interfere with safe transportation. No scow trips would be allowed to be initiated when the National Weather Service has issued a gale warning for local waters during the time period necessary to complete placement operations, or when wave heights are 16 feet or greater and the wave period is less than 30-seconds. Dredging, transport, and placement activities would comply with applicable vessel traffic and safety requirements, and navigational warning markers would be used as needed to prevent navigational hazards. Therefore, the Proposed Action and action alternatives would not cause navigational safety risks.

Given the minimal increase in vessel traffic associated with the Proposed Action and action alternatives, as well as the navigation safety measures that would be implemented as part of the project, no significant adverse effects to navigation in the Bay would result from these alternatives. Any minor effects would be temporary and would be greatest (but still insignificant) under the Proposed Action (lasting approximately 1.4 months, involving the most vessel trips for material transport, and furthest placement site), followed by Alternative 1 (lasting approximately 1.0 month, involving less vessel trips for material transport than the Prosed Action but the same placement site). Any minor navigation effects would be least under Alternative 4 (lasting approximately 0.8 months, involving the fewest vessel trips for material transport, and closest placement sites).

Moreover, given that the Proposed Action and action alternatives would increase navigation efficiency in the Central Basin and allow more vessels to safely access the Pier 70 facilities (including one of the largest drydocks on the west coast), they would have long-term beneficial impacts on navigation in the Bay. The Proposed Action would have the most beneficial impact by allowing slightly more vessel classes (95%) to access the Pier 70 facilities than would Alternatives 1 and 4 (which would each allow 90% of vessel classes), due to the different proposed depths associated with these alternatives.

While the No Action Alternative would have no effects on navigation due to vessels associated with conducting dredging and placement activities, it would result in adverse impacts on navigation in the Bay overall as existing shoaling at the site would continue and would further reduce vessels from safely accessing the Shipyard facilities. This could prevent vessels needing repair from being able to use the Pier 70 repair facilities which would increase navigational hazards in the Bay.

6.3.3.4 Aesthetics/visual impact

Aesthetic evaluations are inherently subjective, but to some observers, the aesthetics of SF Bay could be slightly degraded during dredging and placement activities due to the presence of dredge equipment and the turbidity produced. The Proposed Action and action alternatives would involve the presence of one clamshell dredge plant, three tugboats, and four scows in the Central Basin area and placement sites for the duration of the project activities. ***Figure 19*** illustrates what this equipment typically looks like. The presence of this equipment in the Central Basin would be temporary, and similar equipment is regularly present at the established placement sites associated with the Proposed Action and action alternatives. Thus, any perceived visual impacts associated with the Proposed Action and Alternatives 1 and 4 would be temporary, short in duration, and less than significant. Visual effects associated with the Proposed Action would be expected to last approximately 1.4 months, those associated with Alternative 1 would last approximately 1 month, and those associated with Alternative 4 would last approximately 0.8 months. The No Action Alternative would result in no change in aesthetics.

6.3.3.5 *Public facilities, utilities and services*

The proposed dredging and dredged material placement activities under the Proposed Action and action alternatives would not change the service population in the region (SF Bay area), and therefore would not result in changes to demand for public services (fire protection, police enforcement, school capacity), facilities (parks, libraries), or utilities (electricity, natural gas, water, trash). There is a combined sewage overflow area associated with the Mariposa Pump Station about 750 feet southwest of the action area. However, no public facilities or utilities are involved in the Proposed Action or action alternatives and none of these alternatives would necessitate the need for construction or expansion of public facilities. Therefore, all of the alternatives evaluated, including the No Action Alternative, would have no effect on public facilities, utilities, and services.

6.3.3.6 *Public health and safety*

The Pier 70 Shipyard is a repair facility that has in the past taken in emergency repair jobs such as leaking oil tankers (for example the Cosco Busan vessel that struck the Bay Bridge support pier in 2007) or ships taking on water. As discussed in ***Sections 2.3*** and ***3.1***, current shoaling in the Central Basin approach area has created conditions that prevent safe access to the repair facility for some vessels. This could also pose vessel worker and environmental safety hazards depending on the nature of a vessel's problem. The Pier 70 Shipyard is also regularly participates in Table Top marine disaster drills held by the USCG and other maritime stakeholders. In these drills, the repair facility is considered an asset and main option for minimizing potential waterborne casualties.

The Proposed Action and action alternatives would benefit public health and safety by improving navigation efficiency in the Central Basin, which would allow more vessels to safely access the Pier 70 repair facilities and ensure the sites continued ability to serve as an asset during marine disasters. Furthermore, as discussed in ***Section 6.3.3.3***, Navigation, Transportation, and Traffic, the Proposed Action and action alternatives would employ measures to avoid impacts to navigation safety from dredging, transport, and placement activities. Therefore, no adverse effects to public health and safety are would result from the Proposed Action or action alternatives. Conversely, the No Action Alternative could threaten safety by allowing the shoaling at Central Basin to continue, which would further reduce the ability of vessels to access the repair facilities and could inhibit the Pier 70 Shipyard from serving as an asset during a marine disaster.

6.3.3.7 *Hazardous and toxic materials*

Section 6.3.1.6 and ***Appendix D*** describe the impacts of the project alternatives in relation to hazards and hazardous materials. As of result of these site evaluations, the impacts to human environment as a result of potential mobilization of contaminated sediments or hazardous materials release would be less than significant under the No Action Alternative, Proposed Action, and Alternatives 1 and 4. Please see ***Section 6.3.1.6*** for more in-depth analysis.

6.3.3.8 *Energy consumption or generation*

Vessels and equipment used for dredging, transport, and placement activities would require consumption of nonrenewable energy resources as fuel. However, this consumption would be a relatively small amount compared to the annual amount of fuel consumed by vessels operating and transiting through SF Bay's ports and harbors. Alternative 4 would result in the least fuel consumption given the quantity of material dredged and distance to the placement sites. Alternative 1 would result in medium fuel consumption of the three action alternatives given that it would remove the same quantity of material as Alternative 4 but place it at a location further away. The Proposed Action would require the most fuel consumption as it would remove the most material and deliver it to the same location as Alternative 1. Despite these differences, each alternative would have negligible effects on energy consumption and generation. The No Action Alternative would have no effect on energy consumption or generation

6.3.3.9 *Cultural and historical resources*

The term cultural resource is used to describe the tangible and intangible evidence of past human behavior, which can be discerned in prehistoric and historical archaeological sites, artifacts and objects, historical buildings and structures, shipwreck sites, traditional cultural places and properties, and Native American sacred sites. The primary piece of Federal legislation that agencies commonly comply with during the planning phase of a proposed project is the National Historic Preservation Act of 1966, as amended. Section 106 of the Act requires Federal agencies to consider the effects of their projects on cultural resources that are found to be significant, which can be either for the historical or scientific information they yield, or upon which a Native American tribe places religious or cultural value.

The process to comply with Section 106 is codified in implementing regulations published by the Advisory Council on Historic Preservation (36 C.F.R. § 800). The regulations provide a set of procedures that agencies should follow to identify cultural resources situated in the Area of Potential Effects and to determine whether they are eligible for listing in the National Register of Historic Places, i.e., evaluate the resources and determine if they meet certain criteria. If determined eligible, the resource is referred to as an “historic property” in Federal terminology (see below). The Section 106 process requires the agency to give the State Historic Preservation Officer an opportunity to comment on the agency’s effort to identify historic properties, which also includes considering the views of Indian tribes and interested parties.

When historic properties are present in the Area of Potential Effects, the preferred practice is to avoid or minimize impacts through preservation measures (e.g., set aside land or redesign project features to preserve the resources). If there will be unavoidable adverse effects to an historic property, the agency develops a Historic Property Treatment Plan to resolve the adverse effects, which the consulting parties adopt by executing a Memorandum of Agreement that ensures that the agency will implement mitigation measures to document the archaeological, historical, and cultural information lost because of project construction. When human burials are present in archaeological sites, the agency must adhere to provisions of the State Public Resources Code, which requires consultation with the Native American Heritage Commission and engaging a Most Likely Descendent who may provide recommendations for treatment and disposition of the remains.

National Register of Historic Places

A property may be listed, or determined eligible for listing in, the National Register if it meets criteria for evaluation defined in 36 C.F.R. § 60.4. That is, the quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association and:

1. That are associated with events that have made a significant contribution to the broad patterns of our history, or

2. That are associated with the lives of persons significant in our past, or
3. That embody the distinctive characteristics of a type, period or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction, or
4. That have yielded, or may be likely to yield, information important in prehistory or history.

Section 2.5 and ***Appendix F*** (Cultural Resources Appendix) describe the rich historic cultural resources at the shipyard. However, since the Proposed Action and action alternatives would all occur in the water, none of the historic buildings or properties at the shipyard will be affected. No submerged cultural resources or shipwrecks are known to fall within the Central Basin area or the considered placement sites. Therefore, no effects to cultural and historic resources are expected from the Proposed Action, Alternatives 1 and 4, or the No Action Alternative.

6.3.3.9.1 *Historic monuments, parks, national seashores, wild and scenic rivers, wilderness area, research sites, etc.*

No historic monuments, national parks or seashores, wild and scenic rivers, wilderness areas, or research sites exist within or around the Central Basin dredging footprint, SF-DODS, SF-11 or the MWRP. Thus, none of these types of sites will be affected by the Proposed Action, Alternatives 1 and 4, or the No Action Alternative.

6.3.3.9.2 *Archaeological sites*

No Archeological sites are known to exist or anticipated within the Central Basin area or the considered placement sites. Therefore, no effects to archaeological sites are expected from the Proposed Action, Alternatives 1 and 4, or the No Action Alternative.

6.3.3.10 *Socio-economic Environment*

The socio-economic environment around the project site would remain unchanged under the Proposed Action, Alternatives 1 and 4, and the No Action Alternative.

6.3.3.11 *Environmental Justice*

The environmental justice conditions in San Francisco City and County would remain unchanged under the Proposed Action, Alternatives 1 and 4, and the No Action Alternative.

6.3.3.12 *Growth inducing impacts - community growth, regional growth*

As discussed under the "Navigation" subsection above, The Proposed Action, Alternative 1, and Alternative 4 would be expected to result in increased large vessel usage of the drydock at Pier 70. However, potentially increased maritime usage is not considered a growth-inducing impact on the community or region. No housing or people would be displaced because of the Proposed Action or action alternatives, and no new housing would be created. Community and regional growth in San Francisco City and County would remain unchanged under the Proposed Action, Alternatives 1 and 4, and the No Action Alternative.

6.3.3.13 Potential impacts on the implementation of other use plans, policies or controls

As described in more detail in ***Section 3.4.3***, the LTMS Management Plan was preceded by an extensive 8-year Federal and state planning effort that culminated in the LTMS Final EIS/EIR in October 1998. The environmentally preferred alternative identified in the LTMS Final EIS/EIR includes beneficial reuse of at least 40 percent of material dredged in the San Francisco Bay region, no more than 40 percent placement at SF-DODS, and no more than 20 percent placement at in-Bay sites. The Management Plan was based on average annual dredged material disposal volumes from 1991 through 1999. The Management Plan called for reversing the historic practice of disposing 80 percent or more of all material dredged from San Francisco Bay at in-Bay disposal sites, and requires that at least 80 percent of all dredged material be placed at beneficial reuse sites, upland, or at ocean disposal sites (specifically at least 40% beneficial reuse), with only limited volumes of material being placed in-Bay. The LTMS goals specify that 40 percent of dredged sediment must be targeted for beneficial reuse, 40 percent targeted for out-of-Bay placement at SF-DODS, and only 20 percent targeted for in-Bay disposal.

The aforementioned *Water Quality Control Plan for the San Francisco Basin* (Basin Plan) implements the Long Term Management Strategy (LTMS) Management Plan by setting a long-term overall target for in-Bay disposal of dredged material at designated disposal sites of 1.25 MCY (or less) per year. The Water Quality Certification for the USACE San Francisco Bay Federal Channel Maintenance Dredging Program for 2015 through 2019 issued by the SFRWQCB (Order No. R2-2015-0023) states:

> "The 1.25 MCY annual in-Bay disposal goal allocates 250,000 cy/year to 'small' dredging projects, defined in the LTMS Management Plan as those projects that generate less than 50,000 cy per year on average with a design depth of less than -12 feet MLLW, leaving the remaining 1.0 MCY of the disposal goal plus the 0.25 MCY 'contingency volume' to be split between USACE and the medium-sized maritime industry dredgers. For water quality control purposes, USACE's average in-Bay disposal volume from maintenance dredging projects for 2015 through 2019 is expected to be within 0.625 – 0.750 MCY per year (50 to 60 percent of the 1.0 MCY in-Bay disposal goal plus the 0.25 MCY contingency volume it shares with other dredgers). The total not to exceed in-Bay disposal volume for this Order is 3.5 MCY (calculated as 0.7 MCY times five years). Further action by the Water Board will be required for in-Bay disposal in excess of this quantity."

Because the only placement site is SF-DODS for the Proposed Action (Alternative 6), this alternative does not meet LTMS goals for beneficial reuse. Because SF-11 is not included as a placement site for this alternative, implementation of the Proposed Action does satisfy LTMS goals and Basin Plan requirements for in-Bay placement.

Since Alternative 1 only includes placement at MWRP, this alternative meets LTMS goals for beneficial reuse and in-Bay placement and satisfies Basin Plan requirements.

Implementation of Alternative 4 would include placement of 73% of material at MWRP and 27% of material at SF-11. This alternative does not strictly meet any of the LTMS goals but it would satisfy Basin Plan requirements as long as the prescribed in-Bay placement limits are not exceeded.

The Proposed Action and Alternatives 1 and 4 satisfy all applicable Federal, state, and local laws and regulations. The implementation of these project alternatives will have a less than significant impact on other agencies' ability to implement other use plans, policies, or controls.

Under the No Action Alternative, dredging and placement of material would not occur; therefore, the No Action Alternative is not subject to the aforementioned policies and will have no impact on the implementation of other use plans, policies, or controls.

6.3.3.14 *Irreversible changes, irretrievable commitment of resources*

The Proposed Action and action alternatives include the use of dredging vessels and equipment, which consume fossil fuels to operate. Consuming fossil fuels would be considered an irretrievable commitment of resources but the amount consumed under these alternatives would be minor and less than significant. Dredging and placement activities are not considered an irreversible change or irretrievable commitment of resources as the processes that cause sediment deposition in the Bay would remain unaltered and the material would remain within the aquatic or wetland environments that are part of the sediment cycle. Thus, no significant irreversible changes or irretrievable commitment of resources would occur under the Proposed Action or action alternatives. Use of fossil fuels would be greatest under the Proposed Action given the amount of material to be dredged and transported and least under Alternative 4 given the reduced amount of material and the closer location of the placement sites. The no-action alternative would not involve any changes or commitment of resources.

6.3.3.15 *Not Applicable Human Environment Factors:*

The following environmental factors were considered in this analysis but are not applicable to the No Action Alternative, Proposed Action, and Alternatives 1 and 4 due to the nature of the project:

- Land use classification
    - There will be no project impacts that would significantly change the land use classification of the surrounding area. Currently, the surrounding area is used for commercial and industrial purposes. Implementation of the No Action Alternative and Proposed Action alone will not significantly affect the future land use to warrant specific new zoning of the area.
- Prime and unique farmland
    - The project alternatives do not present an opportunity to use the Central Basin dredge footprint as farmland.

6.3.4 Cumulative Effects

6.3.4.1 *Activities that occurred on-site historically:*

Sections 1.2, ***1.3*** and ***2.5*** of this report describe past activities at the Central Basin site while ***Sections 2.1*** through ***2.4*** describe current activities at the site. ***Sections 4.3.1***, ***4.3.2***, and ***4.3.3*** describe the historic and current use at SF-DODS, MWRP, and SF-11, respectively.

6.3.4.2 *Activities likely to occur within the foreseeable future:*

Operations of the shipyard and dry docks will continue as described in ***Sections 2.1*** through ***2.4*** and ***Section 3.6***.

Maintenance dredging of Central Basin will be required every 4 years to maintain the project depth (See: ***Appendix B***, Cost Engineering Appendix, and ***Appendix C.c***, Civil Design Appendix). Maintenance dredging would include the estimated 2-ft (4-yrs of shoaling) of required dredging volume plus overdepth. ***Table 20*** shows the estimated future O&M dredging volumes that would be expected every 4 years under the Proposed Action (32+1 depth) verses Alternatives 1 and 4 (30+1 Depth).

Table 20. Estimated and Future O&M Volumes.

Alternative Depth MLLW (Ft)	Ave. Annual Volume (CY)	Estimated Annual Increase (%)	Future Estimated Annual O&M Total (CY)	Estimated Depth of Shoaling (Ft)
30+1	31,500	57	48,000	0.5
32+1	31,500	33.3	42,000	0.3

The proposed SF-DODS Placement Site and the alternative SF-11 and MWRP sites are expected to continue to be used as placement sites in the future. However, at some point in the future, it is foreseeable that the MWRP would have the material needed to complete the wetland restoration and would no longer accept material for placement. Wetland restoration at the site would be completed and the site would be left to function as wetland habitat.

6.3.4.3 *Contextual relationship between the Proposed Action, historic, and foreseeable future actions at the project site*

In the context of the past and foreseeable future actions in the vicinity of the proposed and alternative action areas, the Proposed Action or Alternatives 1 or 4 would not have significant adverse cumulative effects. The effects of future O&M dredging would be similar to those described in this EA but reduced in magnitude given the much smaller volume of material and thus reduced time and equipment that would be necessary. Based on the estimates in ***Table 20***, the Proposed Action would have a slightly reduced future O&M dredging volume (42,000 CY) than Alternatives 1 and 4 (48,000 CY), and thus slightly less future effects related to O&M. The Proposed Action and action alternatives would have continued beneficial effects on navigation and public safety by facilitating safe vessel access to the Pier 70 repair facilities.

6.3.5 Relationship between Local Short-term Uses of the Environment and Long-term Productivity

The dredging, transport, and placement of material associated with the Proposed Action and action alternatives would result in short-term impacts on sediments, water quality, air quality, aquatic habitats and species, navigation, noise and aesthetics. These potential effects are described in detail in the sections above and would minor, localized, and generally end with the completion of dredging, transport, and placement activities. Any potential effects would be minimized by implementing the standard practices and mitigation measures discussed in the specific resource sections.

The Proposed Action or action alternatives would have no significant, adverse effects or cumulative impacts on the physical, biological, or human environment. Moreover, the Proposed Action and action alternatives would have long-term beneficial impacts to navigation and safety in terms of removing the shoaled sediment that presents a navigational hazard at the Central Basin and limits access to the Pier 70 repair facilities. Alternative 4 would also have a long term beneficial impact by contributing to the restoration of wetland habitat around SF Bay.

Therefore, none of the action alternatives would be expected to have an adverse effect on the long-term productivity of the environment.

6.3.6 Determination and Statement of Findings

The Proposed Action (Alternative 6) and action alternatives (Alternatives 1 and 4) would provide a means to meet the primary project objective of increasing navigation efficiency in the Central Basin to allow more vessels to safely access the Pier 70 facilities, including one of the largest drydocks on the west coast. The USACE has determined that no significant direct, indirect, or cumulative adverse impacts to the physical, biological, or human environment would occur from the Proposed Action or action alternatives. Differences in effects between the alternatives are described in the specific resource sections.

This report is accompanied by a draft Finding of No Significant Impact (FONSI) for the tentatively selected plan (Proposed Action - Alternative 6), in ***Appendix D*** . The FONSI will be signed once all environmental compliance permits are acquired and any public or agency comments on this assessment have been evaluated and incorporated.

7 Tentatively Selected Plan: Implementation Considerations

The USACE's evaluation of all four alternatives included in this EA in the context of environmental criteria, as well as planning, economic, and engineering criteria, and other considerations is presented in ***Section 5***. The tentatively selected plan is the NEPA Proposed Action (Alternative 6). The study process has investigated conditions at Central Basin that should be considered during Design and Implementation (D&I). Design considerations include hydrologic and hydraulic considerations, such as shoaling and sea level change, geotechnical recommendations for cut slope, as well as civil design considerations. Real estate requirements have been assessed and presented, as well as considerations for construction – including schedule and cost sharing. Finally, considerations for the O&M, including monitoring and adaptive management, are presented, as well as the responsibilities of the NFS.

7.1 Design Considerations

The following considerations should be incorporated into the design during PED.

7.1.1 Hydrologic/Hydraulic Considerations

7.1.1.1 *Shoaling*

Numerical modeling (see ***Appendix C.a***, Coastal Engineering Appendix) suggested that shoaling rates would generally increase with increasing project depth. In general, a wet hydrologic year is expected to result in more sedimentation due to more sediment inputs to the San Francisco Bay. Dry hydrologic years would have lower shoaling rates.

Modeling performed to predict future sedimentation, or shoaling, rates in Central Basin, included simulation of the effects of wind, waves, tides, hydrologic inputs, bathymetry and hydrodynamic circulation on sedimentation. For simulation of each alternative, the initial bathymetry of Central Basin was set at a constant depth equal to the alternative depth plus one foot of overdepth. Please see ***Table 21*** below for a summary of the data used to estimate the shoaling rate at Central Basin.

Table 21. Data Used to Estimate the Shoaling Rate in Central Basin (Source: Delta Modeling Associates, 2015).

Simulated Project Depth + Overdepth (ft below MLLW)	Water Year Type	Water Years	Shoaling Rate (yd^3/yr)
32 + 1	Dry	2008	37,500
	Wet	2006	42,000

Simulations under wet hydrologic conditions (water year 2006) indicated that the shoaling rate for a 32 ft MLLW project depth would be 42,000 cy/yr. The simulations were able to show that shoaling was not equally distributed throughout all areas of the Central Basin project footprint, and the simulated pattern of shoaling was similar to the shoaling observed in historic, sequential, hydrographic surveys. The shoaling rate is much lower in the deeper areas of the project footprint, to the east of the Basin and north of Drydock #2, than in the western section of the Basin, to the northwest of the Pier 4.

The layer of accumulated sediment on the western side of the Basin is expected to be thicker than on the eastern side. As discussed in ***Section 2.3.2***, Ship Maneuverability, the area northwest of Pier 4 must be included in the project footprint to provide for a margin of safety for San Francisco Bar Pilots tugboats. Bar Pilots tugboats must be able to move these large ships into position along Pier 4 and in doing so must counteract wind and waves that may push the ships westward during maneuvering.

The numerical modeling to predict expected shoaling rates under with-project conditions is discussed in more detail in ***Appendix C.a***.

7.1.1.2 *Sea Level Change*

The potential of sea level change (SLC) to affect Central Basin and Pier 70 was analyzed and discussed in ***Appendix C.a***. The conclusion is that, overall, the projected SLC is expected to have minimal impacts on the project, given that all of the alternatives only involve deepening of a navigation channel. As in the case of other similar deepening projects, such as the Lake Worth Inlet (USACE 2014c), it is expected that SLC will slightly reduce the required maintenance dredging for each of the alternatives provided that there are no increased sediment inputs into the project area. SLC will also increase the amount of time the channel is accessible during extreme low water events, which could also provide an additional economic benefit. It is very unlikely that SLC will have any impact on dredged material placement operations.

SLC is also unlikely to have significant impacts on drydock operations as the 1% AEP extreme high water level under all SLC scenarios is projected to remain below the critical performance threshold elevation for drydock infrastructure. However, the 1% AEP extreme high water level under the "high" rate will be within 1 foot of the Pier 70 deck elevation by 2060, and SLC could start to pose a problem just beyond the 50-year planning horizon.

Furthermore, the Port of San Francisco and its tenant (Puglia Engineering, Inc.) do not anticipate any significant impacts from SLC on operations at the drydock facilities, as the mooring of the drydock will accommodate increased water surface elevation to allow for increased float height.

7.1.2 Geotechnical Considerations

No geotechnical investigation was conducted for this study. Geologic stratigraphy was extrapolated from past environmental sampling efforts and local/regional mapping of the San Francisco Bay. Geotechnical material properties were estimated using established strength parameters for Bay Mud and engineering judgment. More information can be found in the Geotechnical Engineering ***Appendix C.b***, but a brief summary of the geotechnical considerations for the project is provided here.

7.1.2.1 *Geologic Setting and Stratigraphy*

The Central Basin is located along the western shore of the San Francisco Bay. Subsurface geology along the western bay margin is typically soft silty clay (Young Bay Mud) overlying stiff to hard silt, clay, and fine sand (Old Bay Mud). The interface of Young and Old Bay Mud is occasionally marked by a thin (< 5 ft) layer of marine deposits that may include coarse-grained sands, shell fragments, and/or fine gravel. Bedrock in the project area is greater than 100 feet below the mudline.

The project is in a high seismicity area. Principal sources of seismic loading are the San Andreas Fault (~8 miles west) and Hayward Fault (10 miles east). Peak horizontal ground accelerations of approximately 0.4 to 0.5 g have a 10 percent chance of exceedance in 50 years.

Subsurface stratigraphy was estimated using past environmental sampling efforts and local/regional mapping of the San Francisco Bay. Environmental sampling targeted characterization of maintenance dredge material (i.e. above 32 ft MLLW) and potential future deepening to the current permitted depth (i.e. above 40 ft MLLW). Explorations were advanced with a standard electric vibracore that reached target depths with no reported difficult driving or refusal. Soils encountered included silts, silty clays, and clayey silt; typical composition of Young Bay Mud.

In general, stable cut slope inclination varies from 3H:1V to 5H:1V. Shallower side slopes appear to be function of dredging extents and natural bathymetry, rather than the strength of slope and foundation soils. Section 6 is cut adjacent to the drydock area and shows a stable cut slope that is slightly steeper than 2H:1V below 40 ft MLLW. It was judged that the transition from soft Young Bad Mud to stiff Old Bay Mud is approximately 45 ft MLLW based on the steeper cut slopes.

EM 1110-2-1902 generally requires a long-term factor of safety (FOS) of 1.5 but permits an FOS of 1.3 or less in slopes where consequences of failure are low. An FOS of 1.4 was assumed to be a reasonable value for feasibility level analyses of a “low consequence” slope. The analyses results demonstrated that cut slopes of 2H:1V and shallower can be expected to perform satisfactory for the average slope height (i.e. 18 ft). However, results suggest that a 3H:1V inclination may be required for the highest cut slopes. Overall, drained conditions governed slope stability for all cut slope inclinations.

7.1.2.2 *Cut Slope Recommendations*

Cut slopes for the Central Basin project should be assumed to be 3H:1V based on preliminary slope stability analyses. The analyses showed that inclinations steeper than 3H:1V may be stable in localized reaches where the cut slope height is ~15 ft or less. However, these reaches are likely limited to less than one-quarter of the basin border being considered.

Seismic analyses have not been performed during feasibility because the impacts to the project are considered low. The 3H:1V cut slopes are likely to be resilient to seismically induced slope failures. Light to moderate shaking will have a negligible impact to slope stability, however, very strong shaking may generate localized sloughing along the project cut slopes. Resultant sloughing is unlikely to "run-out" into the basin or to limit the controlling depth more than normal deposition of sediment.

The deepening of the Central Basin is unlikely to affect the foundations of existing infrastructure on the southern border of the study area. Existing mudline depths adjacent to these structures are maintained to depths greater than or equal to 35 ft MLLW. The existing infrastructure to the west and north of the study footprint is greater than 300 ft from the Central Basin. The potential for negative impacts to existing infrastructure should be confirmed during preconstruction engineering and design (PED).

Diggability is likely to be consistent between the existing mudline and the full depth (35 feet) of the array of alternatives. Dredging equipment can be appropriately selected and scaled to meet environmental, disposal, or other technical criteria. Stiffer Old Bay Mud that would potentially require a specific dredge plant configuration is highly unlikely to be encountered at depths less than 35 ft MLLW. A review of historical aerial photographs and documents provided by the Port of San Francisco suggest there is no decommissioned/demolished infrastructure within the study area that would require specialized equipment to remove.

7.1.3 Civil Design Considerations

After consultation with the Port of San Francisco (see Utility Survey Letter from the Port in ***Appendix G***), as well as review of the existing dredge permits for Central Basin, the team is reasonably assured that there are no utilities within the dredging footprint. No physical utility survey will be conducted and this decision has been documented in the risk register.

The Central Basin project footprint boundaries were chosen to accommodate the full range of vessel classes that currently use and could use Central Basin to access the shipyard. Therefore, a ship simulation study was deemed unnecessary for this project, since the boundaries of Central Basin were determined to be adequate for the vessels using the area, and the cost of the ship simulation study would be very large relative to the total study cost and funding limit for CAP 107.

The Pier 70 Central Basin side slopes of 3H: 1V were determined appropriate for the feasibility phase, as discussed in ***Section 7.1.2***, Geotechnical Considerations. Soundings were taken by a fathometer and are based on the Mean Lower Low Water (MLLW) datum. The plane grids and coordinates are based on the Lambert projection, NAD 83 California Zone 3. Based on a hydrographic survey from October 2014, the project footprint of approximately 97,000 yd^2 was sub-divided into four areas or dredge units. ***Table 22*** shows the estimated central basin volumes to dredge to the Proposed Project depth.

Table 22. Estimated Central Basin Volumes.

Depth (feet below MLLW)	Volume (CY)	1-foot Paid Overdepth (CY)	1-foot Non-Paid Overdepth (CY)	Total (CY)
32	186,500	25,600	25,600	237,700

More information on Civil Design can be found in ***Appendix C.c***, Civil Design.

7.2 Construction Considerations

To minimize potential environmental effects associated with the project, detailed project plans would be developed prior to construction and all standard best practices, including environmental protection and safety practices, would be incorporated into the project.

Prior to the start of construction activities, the USACE would require the construction contractor to develop the following plans:

- Stormwater pollution prevention plan (SWPPP)
- Health and safety plan
- Spill prevention and response plan
- Oil transfer plan
- Waste management plan
- Traffic control plan (if needed)
- Air quality management plan
- Cultural resources protection plan

Appropriate implementation of best practices would significantly reduce the potential for environmental impacts and safety concerns. The following best practices will be incorporated into the project as applicable.

- Air Quality/GHGs
    - Maintain equipment according to manufacturers' specifications.
    - Use diesel oxidation catalysts and catalyzed diesel particulate traps where feasible.
    - Restrict idling of construction equipment (excluding clamshell dredge) to a maximum of five minutes when not in use.
- Navigation safety:
    - Notification of near-by public landowners: Near-by owners of public lands would be notified of proposed dredging and placement activities in the vicinity of their properties to ensure that they are able to notify users of their property regarding the construction activities and the need to proceed with caution. Near-by public landowners would be encouraged to post signs informing the public about the construction activities. USACE would provide signage to the public landowners as requested.
    - Notification to nearby marinas: The contractor would be required to notify the nearby marinas of the proposed dredging and placement work, and provide them with the schedule to ensure that recreational vessel users are aware of the need for safe navigation around the dredge.

  - During dredging and disposal activities, navigational warning markers, lighting, and aids to navigation would continue to be used as needed to prevent navigational hazards from the dredging and offloading equipment.
  - Notice(s) to mariners for dredging activities and location: a notice to mariners would be issued requesting mariners to proceed with caution and/or to proceed at no wake speed as required to ensure the safety of both the dredging operation and the transiting vessel.
- Vessel Wake Management:
  - Tugs and other vessels that could cause scour of the channel banks would be required to transit within the center of the channel when feasible, and to reduce vessel speeds when operating near sensitive habitat.
- Protection oflisted fish species and marine mammals:
  - .
  - The USACE would implement a worker education program for listed fish species and marine mammals that could be adversely impacted by project activities. The program would include a presentation to all workers on biology, general behavior, distribution and habitat needs, sensitivity to human activities, legal protection status, and project-specific protective measures. Workers would also be provided with written materials containing this information.
- Construction staging:
  - The temporary construction staging area would be located on an impervious surface and located away from areas that could make it susceptible to damaging waves. The staging area would comply with the Port's storm water discharge permit and BMPs. Any liquids or other materials at the staging area that could spill or runoff during storm events would be located in a bermed area or an area equipped with other types of secondary containment. All materials brought to the Port and not immediately transferred to the dredge or other equipment must be stored within the staging area.
- Spill prevention and response for routine hazardous materials use and for fueling:
  - The contractor would be required to maintain adequate spill response materials at the dredge and/or work site, and train all workers in proper spill response.
  - Catch pans or drop cloths would be used under all equipment utilizing fluids.
  - All fuel would be kept in double containment systems with positive shut-off values at the nozzles.
  - All fuel transfer hoses would be drained completely before being disconnected.
  - All dredge engines would be equipped with fuel spill catching skirts; petroleum-fueled dredge engines that are not equipped with fuel spill catching skirts would not be allowed.
  - Dredging would stop immediately following any fuel or hazardous waste leaks or spills, and cleanup actions would be implemented.

- o All chemicals used in an aquatic environment would be approved for use in that environment.

7.3 Real Estate Considerations

Navigation Servitude will apply. Credit will not be afforded for lands that are available to the project through exercise of the navigation servitude.

In addition, NFS will not be eligible for credit for placement/disposal sites as it is a permitted site in the ocean. Any costs associated with disposal have been captured under construction costs and not a LERRD.

However, a temporary work area easement will be required. The dredging contractor will need a place to park their trailer, which is their temporary office while they are working on the project. The USACE requires space in the trailer so the Construction staff can perform their QA duties. The NFS will provide an estimated 15,000 square feet of sponsor owned land for the purposes of a trailer and temporary parking spaces. Please see Appendix E for further information.

7.4 Operation, Maintenance, Repair, Rehabilitation, and Replacement Cost Considerations

As discussed in ***Section 7.1.1.1***, numerical modeling results suggest a general increase in sedimentation with increasing project depth resulting in an increase in future maintenance dredging (***Table 23)***.

Table 23. Estimated Future Operations and Maintenance Volume.

Depth (ft below MLLW)	Ave. Annual Volume (CY)	Estimated Annual Increase from existing conditions (%)	Future Estimated Annual O&M Total (CY)
(32 + 1)	31,500	33.3	42,000

In an annual maintenance dredging scenario, mobilization and demobilization costs predominate as a relatively small amount of unconsolidated sediment will have accumulated. The small amount of sediment accumulated in one year would be a relatively thin and inconsistently distributed layer of sediment and would be a challenge to the practical accuracy of dredging. Prior to maintenance dredging, bathymetry must be surveyed and sediments must be sampled to determine the amount of material to suitable to be placed at available placement sites in any given year. The priority of dredging Central Basin would need to be assessed more frequently in relation to other higher traffic Federal channels in the San Francisco Bay.

In scenarios with longer intervals between maintenance dredging episodes, the costs and challenges associated with an annual maintenance cycle are reduced. A thicker layer of sediment is more easily dredged. The reduction in costs must be weighed against the reduction in benefits due to restricted access to the shipyard.

An analysis of costs for alternative maintenance dredging frequencies found that the most cost effective maintenance cycle is a 4-year cycle. Cost estimates assumed that O&M dredging would be performed every four years and all dredged material will be disposed at the current Federal Standard in-Bay disposal near Alcatraz Island, SF-11.

7.5 Cost Apportionment

Table 24 provides the project cost apportionment through the Operations and Maintenance phase of the project.

Table 24. Project Cost Apportionment.

FEASIBILITY PHASE	Project Cost Items	Federal Cost Apportionment	Non-Federal Cost Apportionment
Feasibility Study			
Initial $100K Feasibility Study Cost at 100% Federal [Federal Interest Determination (FID) and Project Management Plan (PMP) & Feasibility Cost Sharing Agreement (FCSA)]	$100,000	$100,000	$0
Detailed Project Report (DPR) (50% Federal / 50% Non-Federal)	$1,280,000	$640,000	$640,000
Subtotal Feasibility Study Cost	$1,380,000	$740,000	$640,000
DESIGN AND IMPLEMENTATION (D&I) PHASE TSP (NED Plan) Project First Cost			
General Navigation Features (GNF)- Channel Modification 32' MLLW (75% Federal / 25% Non-Federal)[1]	$8,971,000	$6,728,250	$2,242,750
Environmental Mitigation (75% Federal / 25% Non-Federal)	$0	$0	$0
LERRs (100% Non-Federal)	$0	$0	$0
Subtotal Project First Cost	$8,971,000	$6,728,250	$2,242,750
Additional Project Implementation Requirements and Cost Adjustments			
Local Service Facilities (100% Non-Federal)	$0	$0	$0
Additional 10% of General Navigation Features (GNF) (see Sec. 101(a)(2) of WRDA 1986)[3]	$897,100	$0	$897,100
Subtotal Additional Project Implementation Requirements and Cost Adjustments	TBD	$0	$0
TOTAL	$11,248,100	$7,468,250	$ 3,139,850
Aids to Navigation[2]	$60,000	$60,000	$0
Annual O&M (100% Federal)[4]	$410,000	$410,000	$0

[1]Includes Mob/Demob, PED, & S&A.

Constant across all alternatives without effect on plan selection. This paid in full by the U.S. Coast Guard.

[3] The additional 10% of GNF is payable over a 30-year period.

[4]Assumes a 4-year maintenance cycle

7.6 Non Federal Sponsor Requirements

Prior to implementation, the non-Federal sponsor shall agree to:

a. Provide, during the periods of design and construction, funds necessary to make its total contribution for commercial navigation equal to:

   - 25 percent of the cost of design and construction of the General Navigation Features (GNFs).

b. Provide all lands, easement, and rights-of-way (LERR), including those necessary for the borrowing of material and placement of dredged or excavated material, and perform or assure performance of all relocations, including utility relocations, all as determined by the government to be necessary for the construction or operation and maintenance of the GNFs;

c. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the GNFs an additional amount equal to 10 percent of the total cost of construction of GNFs less the amount of credit afforded by the Government for the value of the LER and relocations, including utility relocations, provided by the non-Federal sponsor for the GNFs. If the amount of credit afforded by the Government for the value of LER, and relocations, including utility relocations, provided by the non-Federal sponsor equals or exceeds 10 percent of the total cost of construction of the GNFs, the non-Federal sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to an refund for the value of LER and relocations, including utility relocations in excess of 10 percent of the total costs of construction of the GNFs;

d. Provide, operate, and maintain, at no cost to the Government, the local service facilities in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Government;

e. In the case where the GNF footprint, or a portion of the footprint, is deepened to a depth greater than 32 feet MLLW plus 1 foot of paid overdepth, provide 50 percent of the incremental increase in the estimated 4-year operation and maintenance cycle cost that the Government determines would be incurred based on a project depth of 32 feet;

f. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating and maintaining the GNFs;

g. Hold and save the United States free from all damages arising from the construction or operation and maintenance of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors;

h. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of three years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 C.F.R.§ 33.20;

i. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601– 9675, that may exist in, on, or under LER that the Federal Government determines to be necessary for the construction or operation and maintenance of the GNFs. However, for lands, easements, or rights-of-way that the Federal Government determines to be subject to the Navigation Servitude, only the Federal Government shall perform such investigation unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

j. Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under LER that the Federal Government determines to be necessary for the construction or operation and maintenance of the project;

k. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA;

l. Comply with Section 221 of PL 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. § 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. § 2211(e)) which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

m. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, PL 91-646, as amended, (42 U.S.C. § 4601-4655) and the Uniform Regulations contained in 49 C.F.R. § 24, in acquiring lands, easements, and rights-of-way, necessary for construction, operation and maintenance of the project including those necessary for relocations, the borrowing of material, or the placement of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

n. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, PL 88-352 (42 U.S.C. § 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including but not limited to, 40 U.S.C. § 3141-3148 and 40 U.S.C. § 3701-3708 (revising, codifying and enacting without substantive changes the provision of the Davis-Bacon Act (formerly 40 U.S.C. § 276a *et seq*.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. § 327 *et seq*.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. § 276c);

o. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation that are in excess of 1 percent of the total amount authorized to be appropriated for the project; and

p. Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal sponsor's obligations for the project costs unless the Federal agency providing the Federal portion of such funds verifies in writing that such funds are authorized to be used to carry out the project.

q. Accomplish all removals determined necessary by the Federal Government other than those removals specifically assigned to the Federal Government.

r. Mitigation monitoring during construction and post construction shall be cost shared between the Federal government and non-Federal sponsor, 75 percent and 25 percent, respectively.

8 Coordination, Public Views, and Comments*

There are two public advisory groups focused on Pier 70: the Maritime Commerce Advisory Committee (MCAC), which is aimed at Maritime users, and the Southern Waterfront Advisory Committee (SWAC). Other local stakeholders include local businesses who benefit from the shipyard, as well as community-based groups like neighbors, environmental groups and Environmental Justice Groups. The 11 unions that supply labor at the shipyard are also stakeholders.

The following is a list of unions currently active at BAE Systems San Francisco Ship Repair (as of February 2014), which is now owned by Puglia Engineering, Inc.:

1. Boilermaker-Blacksmith, Lodge 549 (Welders, Shipfitters, Riggers, Firewatch)
2. Brotherhood Carpenters & Joiners of America, Local #2236 (Carpenters, Lagger, Dock)
3. Sheet Metal Workers', Local #104 (Sheet Metal)
4. Auto, Marine & Special Painter Local #1176 (Painters, Blasters)
5. Operating Engineers', Local #3 (Crane Operator)
6. Machinists Lodge #1414 (Machinist, Warehouse, ToolRoom)
7. Pipefitters. Local #38 (Pipefitter)
8. I.B.E.W., Local #6 (Electrician)
9. Shipyard & Marine Shop Laborers (Laborers, Firewatch)
10. Retail Delivery Drivers, Driver-Salesmen and Helpers, Local 2785 (Teamster Driver)
11. Bay Cities Metal Trades Council

9 List of Preparers and Organizations and Persons Consulted*

Name	Title/Organization	Role
Main Report		
Eli Brossell & Daria Mazey	Project Manager/Water Resources Planner – HydroPlan LLC	Lead Preparers (DPR)
Roxanne Grillo	Environmental Planner – USACE	Lead Preparer (EA)
Tessa Beach	Environmental Planner – USACE	Support (EA)
Craig Conner	Planner – USACE	Support (DPR)
Russell Reed	Senior Water Resources Planner – HydroPlan LLC	Support
Paula Gagnon	Natural Resources Specialist – HydroPlan LLC	Support
Lewis Hornung	Project Manager – HydroPlan LLC	Support
Al Paniccia	Project Manager—USACE	Support (schedule and cost sharing information)
Bill Dunbar	General Manager—BAE Systems	Consulted
Dennis Deisinger	Business Development Manager—BAE Systems	Consulted
Appendix A: Economics		
Emily Morrison	Economist—USACE	Lead Preparer
Arden Sansom	Economist – USACE	Consulted
Appendix B: Cost Estimate		
Sherman Fong	Cost Engineer—USACE	Lead Preparer
Matt Young	Cost Engineer—USACE	Support
Appendix C: Engineering		
James Zoulas	Coastal Engineer —USACE	Lead Preparer (Water Resources)
Nicholas Malasavage	Geotechnical Engineer—USACE	Lead Preparer (Geotech. Eng.)
Dave Doak	Civil Design—USACE	Lead Preparer (Civil Design)
Aaron Bever	Civil Engineer – Delta Modeling Associates	Co Preparer (Shoaling Analysis)
Michael MacWilliams	Civil Engineer – Delta Modeling Associates	Co Preparer (Shoaling Analysis)
Appendix D: Environmental		
Roxanne Grillo	Physical Scientist-USACE	Lead Preparer
Tessa Beach	Physical Scientist-USACE	Support
Appendix E: Real Estate		
Bonievee Delapaz	Real Estate Specialist—USACE	Lead Preparer (Real Estate)
Crystal Ramos	Real Estate Specialist—USACE	Support (Real Estate)
Appendix F: Cultural Resources		
Kathleen Ungvarsky	Archaeologist—USACE	Lead Preparer
Richard Stradford	Archaeologist—USACE	Support (Cultural Resources)
Appendix G: Project Documentation		
Daley Dunham (Former Liaison was Jay Ach)	Project Liaison—Port of San Francisco	Point of Contact/Lead Preparer
Christine Boudreau	Project Liaison—Boudreau and Associates for the Port of San Francisco	Point of Contact

10 Compliance with Applicable Laws, Policies, and Plans

Implementation of the TSP requires compliance with applicable Federal, state and local statutes and policies pertaining to dredging and dredged material placement activities, and protection of aquatic and terrestrial resources. Some of these laws require the USACE to obtain permits, certifications, or approvals from other agencies before taking action. The following section describes the key Federal and state laws applicable to the TSP and for which permits or certifications are required. This section also discusses the status of coordination with the issuing agencies and progress made toward compliance with the relevant laws and regulations.

10.1 Federal Laws

10.1.1 National Environmental Policy Act (NEPA)

The USACE dredging and dredged material placement activities come under the jurisdiction of the National Environmental Policy Act (NEPA). Under NEPA, Federal agencies must consider the environmental consequences of proposed major Federal actions. The spirit and intent of NEPA is to protect and enhance the environment through well-informed Federal decisions, based on sound science. NEPA is premised on the assumption that providing timely information to the decision maker and the public about the potential environmental consequences of proposed actions would improve the quality of Federal decisions. Thus, the NEPA process includes the systematic evaluation of potential environmental consequences expected to result from implementing a proposed action. The CEQ sets forth regulations implementing NEPA.

Status: The Environmental Assessment (EA) integrated into this document is intended to fulfill the requirements of NEPA (42 U.S.C. § 4321 *et seq.*), the CEQ regulations (40 C.F.R. § 1500-1508), and USACE Procedures for Implementing NEPA (Engineer Regulation 200-2-2). A draft Finding of No Significant Impact (FONSI) for the tentatively selected plan is included in ***Appendix D***. The FONSI will be signed once all environmental compliance permits are acquired and any public or agency comments of the EA have been evaluated and incorporated.

10.1.2 Marine Protection, Research, and Sanctuaries Act (MRPSA)

The primary Federal environmental statute governing transportation of dredged material to the ocean for the purpose of disposal is the Marine Protection, Research, and Sanctuaries Act (MPRSA), also called the Ocean Dumping Act (Public Law 92-532). Section 103 of the MPRSA authorizes USACE to issue permits, subject to United States Environmental Protection Agency (USEPA) concurrence or waiver, for dumping dredged materials into the ocean waters. It requires public notice, opportunity for public hearings, compliance with criteria developed by the USEPA (unless a waiver is granted), and the use of designated sites whenever feasible. Although USACE does not issue itself permits, USACE and USEPA apply these standards to USACE projects as well.

Status: After the release of the draft report, USACE will seek concurrence from USEPA regarding placement of dredged material at SF-DODS as a part of the Proposed Action under MPRSA. A Section 103 evaluation was conducted on the TSP, and is included in ***Appendix D***. The

USACE will request that USEPA review the evaluation along with the EA to ensure that discharge of fill material would comply with the MPRSA guidelines.

10.1.3 Clean Air Act (CAA)

The USEPA, in conjunction with the U.S. Department of Transportation (DOT), established the General Conformity Rule on 30 November 1993. The rule implements the Clean Air Act (CAA) conformity provision, which requires Federal agencies to identify, analyze, and quantify emission impacts of an action and mandates that the Federal government not engage, support, or provide financial assistance for licensing or permitting, or approve any activity not conforming to an approved CAA implementation plan.

Status: The Proposed Action will not cause emissions increases in excess of *de minimis* levels for pollutants or adversely affect air quality. Air emissions associated with the Proposed Action will be temporary and all equipment used to the project will be in compliance with the California Commercial Harbor Craft Regulations. Therefore, USACE has determined that conducting a general conformity analysis is not required. The Air Quality portion of the EA is found in ***Section 6.3.1.5*** of this report.

10.1.4 Clean Water Act (CWA), Section 401 Water Quality Certification

The primary federal environmental statute governing the discharge of dredged or fill material into waters of the United States (inland of and including the territorial sea) is the Federal Water Pollution Control Act Amendments of 1972, also called the Clean Water Act (CWA). The Federal CWA (33 U.S.C. § 1251 *et seq.*) allows states to set standards to protect water quality. It established the basic structure for regulating discharges of pollutants into waters of the U.S. and gives the USEPA the authority to implement pollution control programs The objective of the Federal CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters.

Specific sections of the CWA control discharge of pollutants and wastes into marine and aquatic environments. Under Section 401 of the CWA, water quality certification (WQC) is required for any activity that requires a federal permit or license, and that may result in discharge into navigable waters.

In some states, such as California, the USEPA has delegated authority to regulate the CWA to state agencies. The Porter-Cologne Water Quality Control Act of 1969 (Porter-Cologne Act), and associated regulations found in California Code of Regulations Title 23, establish a comprehensive program for the protection of water quality and the beneficial uses of waters of the state. It addresses both point and nonpoint source discharges, to both surface and ground waters. It also provides for the adoption of water quality control plans to designate beneficial uses of water, set water quality objectives to protect beneficial uses, and provide for a program to achieve those objectives. The plans may include prohibitions against the discharges of waste or certain types of waste, in specified areas or under specified conditions.

The San Francisco Bay Basin Water Quality Control Plan (Basin Plan) is the San Francisco Bay Regional Water Board's master water quality control planning document. The SFRWQCB administers Section 401 of the CWA and either issues or denies Water Quality Certifications (WQCs) based on an assessment of the Proposed Action’s compliance with Federal water quality standards and the Basin Plan. WQCs typically include project-specific requirements established by the SFRWQCB to ensure attainment of water quality standards.

Status: The USACE must obtain a 401 WQC when the action places dredged material into navigable waters. The CWA defines navigable waters as waters of the U.S. including the territorial seas (33 U.S.C. § 1362(7)). SF-DODS is located in the contiguous zone, outside of the territorial seas (NOAA, 2016a). All dredged material will be placed at SF-DODS under the Proposed Action. Therefore, USACE has determined that no WQC is required for this action per 33 C.F.R. § 336.2(c).

10.1.5 Clean Water Act (CWA), Section 404

The goal of Section 404(b)(1) Guidelines of the CWA (Guidelines) is “to restore and maintain, the chemical, physical, and biological integrity of waters of the United States (waters of the US) through the control of discharges of dredged or fill material.” The regulations set forth in 40 C.F.R. § 230 are the substantive criteria issued by the USEPA, used in evaluating discharges of dredged of fill material in to waters of the US. The 404(b)(1) guidelines provide regulations outlining measures to avoid, minimize and compensate for impacts. They also specify “no discharge of dredged or fill material shall be permitted if there is a practical alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences” (40 C.F.R. § 230.10[a]).

Section 404 of the CWA requires that a permit be obtained from the USACE when an action will result in the discharge of dredged or fill material into wetlands and waters of the U.S. Under Section 404, the USACE regulates such discharges and issues individual and/or general permits for these activities, and the U.S. Environmental Protection Agency has oversight authority. Section 404(b)(1) of the CWA establishes procedures for the evaluation of permits for discharge of dredged or fill material into waters of the U.S. Guidelines (40 C.F.R. §230) were promulgated specifically pursuant to Section 404(b)(1) of the Act. The Section 404(b)(1) Guidelines govern, in part, the issuance of permits by USACE. In situations where USACE is proposing work that involves discharge of dredged or fill material into waters of the United States, USACE must comply with the requirements of the Section 404(b)(1) Guidelines, although it does not issue itself permits.

Status: Since the TSP is to place all of the dredged material at SF-DODS, no dredged material will be placed in waters of the U.S. Therefore, no 404(b)(1) analysis is required for this action.

10.1.6 Coastal Zone Management Act (CZMA)

The CZMA of 1972 and the subsequent eight amendments (16 U.S.C. § 1451-1456), administered by the NOAA's Office of Ocean and Coastal Resource Management, provides for management of the nation's coastal resources through a state and Federal partnership. Under the Federal consistency provisions of the CZMA, Federal projects such as those involving dredging and dredged material placement must be carried out in a manner consistent with the state's coastal zone management program and policies to the maximum extent practicable (16 U.S.C. § 1456). This determination is made by the lead Federal agency, and concurrence is requested from the state or local agency responsible for implementing the CZMA.

In California, pursuant to the McAteer-Petris Act, the San Francisco Bay Conservation and Development Commission (BCDC) is the state's coastal zone management agency responsible for issuing consistency determinations under the CZMA for San Francisco Bay. The San Francisco Bay Plan is BCDC's policy document specifying goals, objectives, and policies for BCDC jurisdictional areas.

Status: The USACE will prepare a Consistency Determination for the Proposed Action and submit documentation of compliance with applicable chapters of the CZMA to BCDC after release of the draft report. Once a Consistency Notification is issued by BCDC, USACE will comply, to the maximum extent practicable, with its conditions to ensure that the Proposed Action is consistent with the policies of the San Francisco Bay Plan.

10.1.7 Endangered Species Act

Section 7 of the Federal Endangered Species Act (ESA; 16 U.S.C. § 1531-1544) outlines the procedures for federal interagency cooperation to conserve federally listed species and designated critical habitats. The ESA provides a program for conserving threatened and endangered plants and animals, and the habitats in which they are found. It is designed to protect critically imperiled species from extinction. The ESA is administered by USFWS and NMFS. In general, NMFS is responsible for protection of ESA-listed marine species and anadromous fishes, while other species are under USFWS jurisdiction.

Section 7(a)(2) states that each federal agency shall, in consultation with the Secretary, ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. In fulfilling these requirements, each agency must use the best scientific and commercial data available. This section of the Act defines the consultation process, which is further developed in regulations promulgated at 50 C.F.R. § 402. By consulting with USFWS and NMFS before initiating projects, agencies review their actions to determine if those actions could adversely affect listed species or their habitat. Through consultation, USFWS and NMFS work with Federal agencies to help design their programs and projects to conserve listed and proposed species. The agencies then prepare a Biological Opinion, which often includes conditions, reasonable and prudent alternatives, and protection/mitigation measures that must be completed if the project is implemented.

Status: An inventory of listed and proposed endangered, threatened, candidate, and other special status species that may occur in the action area is provided in ***Appendix D***. The USACE has been coordinating with USFWS and NMFS through informal meetings and discussions. An ESA Section 7 informal consultation letter will be prepared and appended to this report. The letter will include the USACE's determination of the listed species that are not likely to be adversely affected by the Proposed Action. Informal Section 7 Consultation will be initiated following the release of the draft report.

10.1.8 Fish and Wildlife Coordination Act (FWCA)

The FWCA ensures that fish and wildlife receive consideration equal to that of other project features from projects that are constructed, licensed, or permitted by Federal agencies. The FWCA requires Federal agencies that construct water resource development projects to consult with USFWS, NMFS, and the applicable state fish and wildlife agency (CDFW) regarding the project's impacts on fish and wildlife and measures to mitigate those impacts.

Status: The Proposed Project is designed to minimize impacts to fish, wildlife, and existing habitat. We received a draft Coordination Act Report (CAR) from USFWS in mid-December 2016, due to the number of CARs currently requested by USACE San Francisco and Sacramento Districts. Please see ***Appendix D*** for the full text of the draft CAR. The final CAR will be included in the final Integrated Detailed Project Report and Environmental Assessment.

10.1.9 Magnuson-Stevens Fishery Conservation and Management Act

Sections 305(b)(1)(D) and 305(b)(2-4) of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) establishes a management system for national marine and estuarine fishery resources. This legislation mandates the identification, conservation, and enhancement of Essential Fish Habitat (EFH), which is defined as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity," for all managed species. Federal agencies consult with NMFS on proposed actions that may adversely affect EFH. The main purpose of the EFH provisions of the Act is to avoid loss of fisheries due to disturbance and degradation of the fisheries habitat.

Status: An EFH Assessment will be prepared and appended to the final Integrated Detailed Project Report and Environmental Assessment. The NMFS is expected to issue EFH Conservation Recommendations to avoid, minimize, mitigate, or otherwise offset any identified adverse effects of the project. The Central Basin project will be in full compliance with this Act once a response is provided to the EFH conservation recommendations.

10.1.10 Marine Mammal Protection Act (16 U.S.C. § 1361 *et seq*)

The Marine Mammal Protection Act (16 U.S.C. § 1361-1421h) makes it unlawful to take or import any marine mammals and/or their products. Section 101(a)(5)(D) of the act requires an incidental harassment authorization (IHA) be issued for activities other than commercial fishing that may injure (Level A) or harass by causing disruption of migration, breathing, nursing, breeding, feeding, or sheltering behavioral patterns (Level B) small numbers of marine mammals.

As described in ***Section 6.3.2***, the project alternatives are not expected to result in impacts to marine mammals that would require an incidental harassment permit.

10.1.11 Migratory Bird Treaty Act (16 U.S.C. § 703-711)
The Proposed Action is not expected to significantly impact avian species in the aquatic environment. Any impacts to avian species would be minor and temporary.

10.1.12 National Marine Sanctuaries Act (16 U.S.C. § 1431 *et seq*)
Placement of dredged materials would not impact the Gulf of Farallones National Marine Sanctuary if placement takes place at SF-DODS; the barge route is south of the Sanctuary boundary to preclude scow spillage in the special aquatic site.

10.1.13 Rivers and Harbors Act
Section 10 of the Rivers and Harbors Act (33 U.S.C. § 401 *et seq.*) requires authorization from the USACE for the construction of any structure in, or over any navigable water of the U.S., including the excavation/dredging or deposition of material in these water or any obstruction or alteration in a "navigable water."

Status: The USACE does not issue itself Section 10 permits, however, it may issue a Section 10 permit to the non-Federal sponsor, if required. The USACE will ensure compliance with Section 10 before completion of the NEPA process, if applicable.

10.1.14 Cultural Resources
The following is a list of regulations pertaining to the effect of the Proposed Action on Cultural Resources:

- National Historic Preservation Act (16 U.S.C. § 470 and 36 C.F.R. § 800): Protection of Historic Properties
- Executive Order 11593: Protection and Enhancement of the Cultural Environment
- Archaeological and Historic Preservation Act of 1974, (16 U.S.C. § 469 *et seq*.)
- Federal Water Project Recreation Act (16 U.S.C. § 4601 *et seq*.)
- Abandoned Shipwreck Act of 1987, (43 U.S.C. § 2101 *et seq*.)
- Submerged Lands Act, (Public Law 82-3167; 43 U.S.C. § 1301 *et seq*.)

Status: Since the Proposed Action would occur in the water, none of the historic buildings or properties at the shipyard will be affected. No submerged cultural resources or shipwrecks are known to fall within the Central Basin area or the considered placement sites. No historic monuments, national parks or seashores, wild and scenic rivers, wilderness areas, or research sites exist within or around the Central Basin dredging footprint or SF-DODS. No Archeological sites are known to exist or anticipated within the Central Basin area or the considered placement sites.

10.2 State Laws

10.2.1 California Environmental Policy Act (CEQA)

The CEQA was closely modeled on NEPA and requires public agencies to consider and disclose to the public the environmental implications of proposed actions. CEQA applies to all discretionary activities that are proposed or approved by California public agencies, including state, regional, county, and local agencies, unless an exemption applies. Unlike NEPA, CEQA imposes an obligation to implement measures or project alternatives to avoid or mitigate significant adverse environmental effects, when feasible. When avoiding or mitigating significant environmental impacts of a Proposed Project is not feasible, CEQA requires that agencies either disapprove of the project, or prepare a written statement of the overriding considerations with approval of such project. Under the direction of CEQA, the California Natural Resources Agency has adopted regulations, known as the Guidelines for Implementation of the CEQA (CEQA Guidelines, California Code of Regulations Title 14, Section 15000 *et seq*.), which provide detailed procedures that agencies must follow to implement the law.

Status: While this document is not intended to fulfill the specific requirements of CEQA and the CEQA Guidelines (as a Federal agency, USACE is not required to comply with CEQA) state regulations have been considered in the formulation and selection of the Proposed Action.

10.2.2 California Endangered Species Act (CESA)

The CESA (California Fish and Game Code 2050-2116) operates in a similar fashion to the Federal ESA, but is administered by CDFW. Certain species that are federally listed may not be listed on the CESA or vice-versa, or may have a different listing status. Similar to the Federal ESA, CESA and the Native Plant Protection Act authorize CDFW to designate, protect, and regulate the taking of protected species in the State of California. Section 2080 of the California Fish and Game Code prohibits the taking of state listed plants and animals. CEQA lead agencies considering the approval of Proposed Projects that may adversely affect state-listed threatened or endangered species must consult with CDFW as a trustee agency. There has been no clear and explicit waiver of Federal sovereignty with respect to CESA. Accordingly, as a Federal agency, USACE does not seek incidental take authorization or other authorization under CESA. However, the SFRWQCB considers the CESA when issuing WQC. Their review considers rare and endangered species, as protected by the Basin Plan in the beneficial uses protecting Preservation of Rare and Endangered Species, and Fish Migration.

Status: This document analyzes impacts to state listed species. No significant effects to listed species or critical habitats are expected from the Proposed Action.

11 Recommendations

I concur with the findings presented in this report. The recommended plan developed is technically sound, economically justified, and socially and environmentally acceptable.

The work proposed is within the existing authority. I recommend that the plan selected herein, deepening the Central Basin approach to the Pier 70 Shipyard at the Port of San Francisco to a depth of 32 ft MLLW, be implemented under the CAP 107 authority.

- The total estimated construction cost of the project is $8,971,000.
- The average annual costs were determined to be $1,189,000 and average annual benefits were $3,281,000, with a benefit to cost ratio of 2.76 to 1. Average annual net benefits are $2,092,000.

The recommended plan conforms to the essential elements of the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies and complies with other Administration and legislative policies and guidelines on project development. If the project were to receive funds for Federal implementation, it would be implemented subject to the cost sharing, financing, and other applicable requirements of Federal law and policy for navigation projects including WRDA 1986, as amended; and would be implemented with such modifications, as the Chief of Engineers deems advisable within his discretionary authority. Aids to navigation are to be funded by the U.S. Coast Guard. Federal implementation is contingent upon the non-Federal sponsor agreeing to comply with applicable Federal laws and policies.

The information contained herein reflects the information available at this time and current departmental policies concerning formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works program or the perspective of higher review levels within the executive branch. Consequently, the recommendations may be modified before it is submitted to the Congress as a proposal for authorization and implementation funding. However, prior to submittal to the Congress, the State of California, the Port of San Francisco (the non-Federal sponsor), interested Federal agencies and other parties will be advised of any significant modifications and will be afforded an opportunity to comment further.

____________________ ___________________________

Date

John C. Morrow
Lieutenant Colonel, US Army
District Engineer

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Appendix A:

Economics

Central Basin CAP 107
Navigation Improvements
Economics Appendix A

San Francisco, California

March 2017

U.S. Army Corps
of Engineers

San Francisco District

CENTRAL BASIN CAP 107 NAVIGATION IMPROVEMENTS
ECONOMICS APPENDIX A
SAN FRANCISCO, CALIFORNIA

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I. INTRODUCTION

This document presents the economic evaluation performed as part of the Central Basin Continuing Authority Program (CAP) 107 feasibility study. The economic evaluation estimates the National Economic Development (NED) benefits associated with each project alternative. NED benefits are contributions to National Economic Development that increase the value of the national output of goods and services. The Federal planning objective is to maximize the total net annual NED benefits consistent with protection of the environment.[1] NED is the primary basis for Federal investment in water resource projects and is measured in average annual equivalent terms.

The US Army Corps of Engineers (USACE) San Francisco and Alaska Districts, along with the Deep Draft Navigation Planning Center of Expertise (DDN-PCX) performed the economic analysis contained in this document.

According to the Institute for Water Resources (IWR) NED Manual for Deep Draft Navigation (IWR Report 10-R-4), "benefits of deep draft navigation projects are derived mainly for transportation cost savings, or higher net income to commodity users or producers during the economic period of analysis." In this case the benefits are expected to accrue primarily from a reduction in transportation costs for vessels that require repair and maintenance services along the US West Coast. Any change in the revenue or profit of the various ship repair companies is considered a regional transfer and is not included in the estimate of NED benefits.

A. Study Purpose and Scope

The purpose of this study is to evaluate the feasibility of providing improved navigation in the Central Basin channel at the Port of San Francisco.

Potential navigation improvements include deepening the existing non-Federal Central Basin channel to allow continued vessel calls to the ship yard and dry docks located at the nearby Pier 70. Additional channel depth will allow a sustained or additional level of vessel calls to the ship yard, which represents a transportation cost savings for some classes of vessels. In the without-project condition, Central Basin is expected to continue to shoal, which will reduce the number of vessels able to use the adjacent ship yard and dry dock.

B. Document Layout

This document first describes the existing conditions including a description of the study area, navigation problems, and more detailed information about use of the channel and vessel operations. The next sections use the existing condition data to forecast both the future without- and with-project condition vessel traffic and operations. These sections also describe

[1] Principles and Guidelines, March 1986.

the transportation cost calculations methodology and summarize the results of those calculations. Subsequent sections describe the alternatives and the costs of each. Finally, alternatives are evaluated and compared based on their NED benefits. Section II describes the existing conditions including a description of the study area, navigation problems and more detailed information about use of the channel and vessel operations. The following section explains the assumptions related to the future without project condition, including the expected vessel usage of the Central Basin channel in the absence of Federal navigation improvements. This section also explains the transportation cost calculation methodology and presents the results of these calculations for the future without project condition. Section III describes the future with project condition description of project alternatives and future with project vessel transportation costs.

The following section presents project benefits, which are reflected by transportation cost savings. Section IV presents the costs of each alternative plan and Section V compares the alternative plans on a net annual NED basis and identifies the NED plan which maximizes net annual benefits.

II. EXISTING CONDITIONS

This section describes the existing navigation conditions at Central Basin and details of the vessel fleet and operations.

A. Study Area

The study area is the Central Basin channel, located near Pier 70 at the Port of San Francisco. Central Basin is located near the eastern shore of the City of San Francisco, approximately 1.5 miles south of the San Francisco-Oakland Bay Bridge. Central Basin is not a federally-authorized or maintained project. The River and Harbor Acts of 1927, 1930, 1965, and 1968 authorized specific sections of the waterfront and main ship channel approach outside the Golden Gate Bridge. Figure 1 shows the vicinity of Central Basin.

Figure 1. Central Basin vicinity map

Source: ©Google Earth 2015, with citation added by USACE

Figure 2 shows the Federally-maintained San Francisco Main Ship (Bar) Channel entrance to San Francisco Bay Harbor. The Main Ship Channel is located approximately five miles west of the Golden Gate Bridge in the waters leading to San Francisco Bay. Project Operations and Maintenance (O&M) provides for annual maintenance dredging to be performed on the San Francisco Man Ship (Bar) Channel to attain a 55 foot project depth at Mean Lower Low Water (MLLW). This critical channel, which is the gateway to San Francisco Bay, is 2,000 feet wide by 16,000 feet long. Infrequent maintenance dredging of various other channels within the Port of San Francisco may also be performed. This includes Islais Creek Shoal, Presidio Shoal, and Black Point Shoal, each of which have an authorized project depth of 40 feet MLLW, and San Francisco Airport Channel which has an authorized project depth of 10 feet MLLW. Rock Pinnacles, which include Blossom Rock, Rincon Reef Rock, Arch Rock, Harding Rock, and Shag Rocks all have authorized depths of 35 feet MLLW."

Figure 2. San Francisco Bay Harbor Main Ship Channel

Source: USACE San Francisco District (http://www.spn.usace.army.mil/Missions/ProjectsandPrograms/ProjectsbyCategory/ProjectsforNavigableWaterways/SanFranciscoBayHarbor.aspx)

1. Existing Facilities and Infrastructure

Adjacent to the Central Basin channel and Pier 70 at the port is a ship yard. The land for the ship yard is owned by the non-Federal sponsor, the Port of San Francisco, and is currently leased and operated by BAE Systems.[2] This yard is known as the BAE Systems San Francisco Ship Repair, but is referred in this document simply as the ship yard.

[2] BAE Systems recently sold their lease to Puglia, Engineering, Inc. (Puglia). Puglia will continue operate in an equivalent manner as BAE Systems and offer equivalent full-service ship repair for commercial and government vessels, accommodate post-Panamax class, and provide the equivalent skilled labor force.

The ship yard facility offers full-service ship repair for commercial and government vessels and can accommodate post-Panamax class ships. The ship yard features two floating drydocks, full pier side facilities, an available labor force in excess of 1,300, and a number of machine and engineering firms. Dry dock #2 is currently one of the largest dry docks on the west coast of the United States, at a length of 900-feet, width of 150-feet, and a lift capacity of 56,600 tons. The Eureka dry dock at the San Francisco ship yard is 528-feet long, 90-feet wide, with a lift capacity of 14,500 tons. The ship yard also has two piers totaling 2,557 feet.[3]

Figure 3. Central Basin channel area and BAE Systems San Francisco Ship Repair dry docks

Source: ©Google Earth 2015, with citations added by USACE

Note: The Central Basin channel area shown on this map is for illustration only. Detailed project footprints should be consulted for a representation of the precise dredging area.

2. Channel Depth and Historical Non-Federal Dredging

BAE Systems, the leaseholder of the ship yard at Pier 70, is responsible for dredging of their ship berths and underneath the dry docks. Dry dock #2 can accommodate vessel drafts of up to 35-feet, which requires BAE Systems to maintain a water depth of approximately 60-feet. This depth is necessary so that the floating dry dock can be lowered underneath a ship and then the ship can be floated above the water. This process of loading a vessel onto a dry dock can take 12 to 16 hours.

[3] BAE Systems San Francisco Ship Repair. http://www.baesystems.com/product/BAES_021148/bae-systems-ship-repair---san-francisco;baeSessionId=_14J0BmgQSgPF2mmy5GeAoL4ILp4gU1uzAZyC7UYOT24Smo-OXnT!1136537573?_afrLoop=1410434284450000&_afrWindowMode=0&_afrWindowId=null#!%40%40%3F_afrWindowId%3Dnull%26_afrLoop%3D1410434284450000%26_afrWindowMode%3D0%26_adf.ctrl-state%3Dadbb5g3te_4

The Central Basin channel which leads to the ship yard has not been included as part of a Federal study or a previously authorized Federal navigation project. As of the spring of 2015, the Port and BAE Systems reported that the depth of Central Basin is approximately -27-feet Mean Lower Low Water (MLLW). Under existing conditions, Central Basin naturally shoals which reduces the usable channel depth. The Port of San Francisco, sometimes in partnership with BAE Systems or previous ship yard leaseholders, has conducted infrequent sporadic dredging activities at Central Basin. See Table 1. Prior to the Port's purchase of the ship yard in 1982, Central Basin may have been privately maintained; however, dredging records are unavailable.

Table 1. Central Basin Historical non-Federal Dredging

Year(s)	Quantity Dredged (cubic yards)	Permit Holder	Dredge Depth (in feet below MLLW)
1984/1985	108,000	Port of San Francisco	Unknown
1989/1990	76,000	Port of San Francisco	32
1999/2000	199,411	Port of San Francisco	28 (plus 2-feet over-dredge)
2011	89,474	BAE Systems	30 (plus 2-feet over-dredge)

The Port and BAE Systems have stated that these dredging events were conducted on an emergency basis in order to maintain the functionality of the ship yard. Also, Central Basin has not been dredged to an effective footprint as large as described for this project.

According to Port representatives, both the 1999/2000 and the 2011 dredge were a result of Federal involvement. The first being funded by Federal Emergency Management Agency funds as a result of the Loma Prieta earthquake event of 1989. And the second due as a "stop gap" measure waiting for the current USACE CAP Section 107 study to conclude. Subsequently, both the Port and BAE Systems state that they do not have the ability, or the financial capability to perform regular effective dredging in order to maintain Central Basin at a usable depth in the future.

B. Navigation Problems

The problem statement developed for this study is:

> *Historically, the depth of the Central Basin has resulted in greater costs to maintain and repair some government and commercial vessels. In many cases, the existing depth of the Central Basin approach impedes access in and out of the Pier 70 ship yard. The condition is expected to worsen in the future without project condition as siltation continues to occur. The situation incurs increased transportation costs and delays to users, as well as excludes certain classes of vessels.*

Additional information on the study's problems and opportunities is available in the main report. The remainder of this section provides some detail on the navigation problems, particularly those relevant to the economic analysis.

The Port of San Francisco requested that a navigation study be conducted to address navigation challenges resulting from inadequate depth of the Central Basin at the approach to the dry docks at Pier 70. The Port of San Francisco conducted sporadic emergency spot dredging in 2011, which temporarily improved operational conditions. The Port of San Francisco has requested Federal assistance under CAP 107 to deepen and establish a new Federal navigation channel.

The lack of depth in the Central Basin is not just a problem for the Port or San Francisco and its tenant. The draft constraint affects the ability of military and commercial vessels to undergo scheduled maintenance or emergency repairs at the facility. According to a Navy contracting officer for the Military Sealift Command (MSC), the lack of depth in the Central Basin is “a constant problem”. In some cases, the lack of depth in the basin reduces even further the very small number of companies that can compete for West Coast repair, maintenance, or overhaul solicitations. According to the Navy official, in some instances, if the Port of San Francisco facility is found to be “technically unacceptable” due to the draft constraint in the basin, there may only be a single bidder for the job. Not only does this typically result in an increase in the cost of the job itself (monopoly situation), but it reduces scheduling flexibility and often increases the cost of transporting the vessel to the repair facility due to longer distances between the vessel location and the repair location.

Shoaling of Central Basin reduces the usable depth of the entrance channel and therefore vessel access to the ship yard.

Under existing conditions, Dry Dock #2 is one of only two dry docks on the West Coast of the United States which can accommodate large government vessels, including Military Sealift Command (MSC) and Maritime Administration (MARAD) ships.

Currently, the controlling depth of the entrance channel and turning basin at Central Basin is approximately -27-feet mean lower low water (MLLW). Based on shoaling of the channel, the depth is expected to continue to reduce over the 50-year period of analysis (the assumptions associated with the future without project condition will be addressed in subsequent sections of this report). Ships calling at Central Basin require an underkeel clearance of two to three feet. In addition, some government vessels cannot use tide as a consideration of a channel’s depth when accessing a dry dock. These factors all contribute to the expectation that the decreasing depth of Central Basin will reduce the number of vessels able to utilize the channel to access the BAE Systems dry dock.

For many of these vessels, if they are unable to use the dry dock at the Port of San Francisco, their next nearest option for vessel repair and maintenance is a dry dock in Portland, Oregon. Additional alternative dry docks of sufficient size are available in Honolulu, Hawaii and Guam. Travel to an alternate dry dock facility represents additional travel costs for some vessels, which could be avoided with a deeper channel at Central Basin. This is the basis of NED benefits.

The theory underlying the Central Basin analysis is that shoaling at Central Basin will reduce the channel depth and thereby restrict vessel access to the adjacent BAE Systems San Francisco ship yard. This reduced vessel access means that the number of accessible dry docks will be reduced – to only one alternative facility on the US West Coast for some types of vessels. If vessels cannot use the dry dock at San Francisco, their only choice may be to transit to Portland or dry docks in the Pacific, which may be cost prohibitive. For some vessel classes and some vessel itineraries, this represents additional travel costs which could be avoided with a deeper channel at Central Basin.

A key point is that increased depth at Central Basin would allow for increased opportunities for vessels to use the San Francisco ship yard, but does not necessarily mean that BAE Systems will be awarded the contract. However, if a vessels does use the BAE Systems dry dock, it may represent a travel cost savings and a benefit to the Nation, depending on the vessel itinerary.

Shoaling of Central Basin reduces the usable depth of the channel and therefore vessel access to the ship yard. There are two dry docks at the BAE Systems San Francisco ship yard: Eureka and Dry Dock #2. Dry dock #2 at the BAE Systems ship yard is currently the second largest on the West Coast of the United States and serves as an important facility for repair and maintenance of commercial and government vessels. Under existing conditions, the dry dock at the San Francisco ship yard is one of only two dry docks on the US West Coast of the United States which can accommodate large government vessels, including Military Sealift Command (MSC) and Maritime Administration (MARAD) ships. Currently, the controlling depth of the entrance channel and turning basin at Central Basin is approximately -27-feet mean lower low water (MLLW). Shoaling estimates from San Francisco District engineering forecast that the controlling depth of Central Basin will be reduced to only -17.3 feet MLLW during the 50-year period of analysis. Ships calling at Central Basin require an underkeel clearance of two to three feet. In addition, some government vessels cannot use tide as a consideration of a channel's depth when accessing a dry dock. These factors all contribute to the expectation that the decreasing depth of Central Basin will reduce the number of vessels able to utilize the channel to access the BAE Systems dry dock.

For many of these vessels, if they are unable to use the dry dock at the Port of San Francisco, their next nearest option for vessel repair and maintenance is a dry dock in Portland, Oregon. Additional alternative dry docks of sufficient size are available in Honolulu, Hawaii and Guam. Travel to an alternate dry dock facility represents additional travel costs for some vessels, which could be avoided with a deeper channel at Central Basin. This is the basis for NED benefits.

C. Existing Vessel Fleet

1. Fleet Specifications/Description

Vessel data provided by BAE Systems was first broken down into broad categories such as US Coast Guard Vessels, Commercial Cruise Ships, MARAD Vessels, and MSC Vessels. Then, vessels were classified into more detailed subgroups, or "classes" based upon similarity of characteristics, with particular attention to anticipated arrival draft at Central Basin. This will be the primary factor in determining vessel use of the Central Basin in future project conditions.

a. Government Vessels

United States Coast Guard Vessels

US Coast Guard (USCG) Vessels									
	Vessel Name	Hull ID	LOA (ft)	Beam (ft)	Design Draft (ft)	Displacement (units)	DWT	Flag	Vessel Class
	USCGC Healy	WAGB 20	420	82	29	16000		US	Icebreaker
	USCGC Polar Sea	WAGB 11	399	83.5	28	13194		US	Polar Class Icebreaker
	USCGC Polar Star	WAGB 10	399	83.5	28	13194		US	Polar Class Icebreaker
	USCGC Bertholf	WMSL 750	418	54	21	4306		US	National Security Cutter
	USCGC Stratton	WMSL 752	418	54	21	4306		US	National Security Cutter
	USCGC Waesche	WMSL 751	418	54	21	4306		US	National Security Cutter
	USCGC Boutwell	WHEC 719	378	43	16	3300		US	High Endurance Cutter
	USCGC Mellon	WHEC 717	378	43	16	3300		US	High Endurance Cutter
	USCGC Midgett	WHEC 726	378	43	16	3300		US	High Endurance Cutter
	USCGC Morgenthau	WHEC 722	378	43	16	3300		US	High Endurance Cutter
	USCGC Munro	WHEC 724	378	43	16	3300		US	High Endurance Cutter
	USCGC Rush	WHEC 723	378	43	16	3300		US	High Endurance Cutter
	USCGC Sherman	WHEC 720	378	43	16	3300		US	High Endurance Cutter
	USCGC Alex Haley	WMEC 39	282	50	15	3000		US	Medium Endurance Cutter
	USCGC Aspen	WLB 208	225	46	13	2000		US	Seagoing Buoy Tender
	USCGC Kukui	WLB 203	225	46	13	2000		US	Seagoing Buoy Tender

Vessel Class Name	LOA (ft)	Beam (ft)	Anticipated arrival draft (ft)	UKC (ft)	
Seagoing Buoy Tender	225	46	18	2	*Anticipated arrival depth based on minimum facility depths from solicitation
National Security Cutter	418	54	20	2	*Anticipated arrival depth based on minimum facility depths from solicitation
High Endurance Cutter	378	43	15.33	2	
Polar Class Icebreaker	400	84	27	2	*Includes icebreaker and polar class icebreaker

Note: Anticipated arrival draft information is based on Federal government contract solicitation data, accessed on the Fed Biz Opps website (fbo.gov). Data is summarized here, with more details presented on the "Historical gov't drydock info tab".

Military Sealift Command (MSC) Vessels

Military Sealift Command (MSC) Vessels										
Vsl Class Code	**Vessel Name**	**Hull ID**	**Vessel Type (from MSC)**	**LOA (ft)**	**Beam (ft)**	**Homeport (from Naval**	**Fleet**	**Max**	**Draft Limit**	**DWT (MT)**
T-AOE	Bridge	T-AOE 10	Fast Combat Support	754	107	Bremerton, WA		40	41	27272
	Rainier	T-AOE 7	Fast Combat Support	754	107		Pacific	40	41	27272
T-AH	Mercy	T-AH 19	Hospital	894	106	Oakland, CA		33		40504
T-AO	John Ericsson	T-AO 194	Fleet Replenishment Oiler	677.5	97.5		Pacific			28304
	Guadalupe	T-AO 200	Fleet Replenishment Oiler	677.5	97.5		Pacific	35	35	28304
	Henry J. Kaiser	T-AO 187	Fleet Replenishment Oiler	677.5	97.5	Diego Garcia, British Te	Pacific	35	35	28304
	Pecos	T-AO 197	Fleet Replenishment Oiler	677.5	97.5		Pacific	35	35	28304
	Yukon	T-AO 202	Fleet Replenishment Oiler	677.5	97.5		Pacific	35	35	28304
T-AKR	Brittin	T-AKR 305	Large, Medium-Speed, RO/RO	950	106		Atlantic (Gulf)	34		25752
	Bob Hope	T-AKR 300	Large, Medium-Speed, RO/RO	950	106		Pacific	34		24103
	Mendonca	T-AKR 303	Large, Medium-Speed, RO/RO	950	106		Atlantic (Gulf)	34		24103
T-AKE	Amelia Earhart	T-AKE 6	Dry Cargo/Ammunition	689	106		Pacific	30	31	14887
	Carl Brashear	T-AKE 7	Dry Cargo/Ammunition	689	106		Pacific	30	31	14887
	Cesar Chavez	T-AKE 14	Dry Cargo/Ammunition	689	106			30	31	14887
	Charles Drew	T-AKE 10	Dry Cargo/Ammunition	689	106		Pacific	30	31	14887
	Matthew Perry	T-AKE 9	Dry Cargo/Ammunition	689	106	San Diego, CA	Pacific	30	31	14887
	Richard E. Byrd	T-AKE 4	Dry Cargo/Ammunition	689	106		Pacific	30	31	14887
	Wally Schirra	T-AKE 8	Dry Cargo/Ammunition	689	106	San Diego, CA	Atlantic	30	31	14887
	Washington Chambers	T-AKE 11	Dry Cargo/Ammunition	689	106		Pacific	30	31	14887
	Alan Shepard	T-AKE 3	Dry Cargo/Ammunition	689	106		Pacific	30	31	14887
T-AK	2nd LT John P. Bobo	T-AK 3008	Maritime Prepositioning Force Contain	673.2	105.5		Atlantic	30		24061
T-AS	USS Emory S. Land	AS 39	Submarine Tender	644	85	Diego Garcia, British Territory		26	29	
	USS Frank Cable	AS 40	Submarine Tender	644	85	Guam, Mariana Islands		26	29	
T-ARS	Salvor	T-ARS 52	Rescue and Salvage	225	51	Pearl Harbor, HI	Pacific	17	18	618
T-ATF	Navajo	T-ATF 169	Fleet Ocean Tug	226	42		Pacific	15	15	556
	Sioux	T-ATF 171	Fleet Ocean Tug	226	42		Pacific	15	15	556
JHSV	Fall River	JHSV 4	Joint High-Speed Transport	338	93.5			13		9154
	Millinocket	JHSV 3	Joint High-Speed Transport	338	93.5			13		

Summary

Vsl Class Code	Vessel Type (from MSC)	Anticipated Arrival Draft (ft)	
T-AOE	Fast Combat Support	29.71	
T-AH	Hospital	28	
T-AO	Fleet Replenishment Oiler	27	
T-AKR	Large, Medium-Speed, RO/	27	**Assume same arrival draft as T-AO due to similar max navigational draft.
T-AKE	Dry Cargo/Ammunition	26.17	
T-AK	Maritime Prepositioning Fc	26.17	**Assume same arrival draft as T-AKE class due to other similar dimensions
T-AS	Submarine Tender	17	
T-ARS	Rescue and Salvage	17	
T-ATF	Fleet Ocean Tug	14	
JHSV	Joint High-Speed Transport	11	

Note: Anticipated arrival draft information is from Federal government contract information, available on Fed Biz Opps (fbo.gov). This data is presented in columns N and O above and summarized in this table. In this case, the maximum anticipated arriva

Military Sealift Command (MSC) Vessels

Vsl Class Code	Vessel Name	Hull ID	Vessel Type (from MSC)	LOA (ft)	Beam (ft)	Homeport (from Naval	Fleet	Max	Draft Limit	DWT (MT)
T-AOE	Bridge	T-AOE 4	Fast Combat Support	376.835848	76.46733616	Bremerton, WA		15.9	20.17459998	1641
	Rainier	T-AOE 1	Fast Combat Support	360.2709324	75.29976625		Pacific	15.1	19.41239773	587
T-AH	Mercy	T-AH 20	Hospital	343.7060168	74.13219635	Oakland, CA		14.3	18.65019548	-467
				327.1411012	72.96462644			13.5	17.88799323	-1521
T-AO	John Ericsson	T-AO 194	Fleet Replenishment Oiler	310.5761856	71.79705653		Pacific	12.7	17.12579098	-2575
	Guadalupe	T-AO 200	Fleet Replenishment Oiler	294.01127	70.62948662		Pacific	11.9	16.36358873	-3629
	Henry J. Kaiser	T-AO 187	Fleet Replenishment Oiler	277.4463544	69.46191672	Diego Garcia, British Te	Pacific	11.1	15.60138648	-4683
	Pecos	T-AO 197	Fleet Replenishment Oiler	260.8814388	68.29434681		Pacific	10.3	14.83918423	-5737
	Utilizing assumptions from above and vessel characteristics to classify vessels.									

Notes & Data Sources:

Vessel characteristics (through DWT - column K) are from MSC websites and Naval Vessel Register.

Vessel minimum and arrival draft information is based on Federal government contract information for specific vessels, available from Fed Biz Opps (fbo.gov).

Vessels selected for analysis by comparing notes from conversation with MSC (recent and that conducted by Mark Bierman) with projected drydockings from the POSF & BAE.

Maritime Administration (MARAD) Vessels

Maritime Administration (MARAD) Vessels

Vessel Name	Type	Division	Hull #	Year Built	Design	Homeport	Status	Vessel Type	Location	LOA (ft)	Beam (ft)	Draft Summer	Total DWT S	Total DWT Summer R
PACIFIC COLLECTOR	Retention - Other	Pacific	T-AGS29	1970	S3-M-MA153c	Portland, OR	Other Agency Use	Missile Defense Agency - Missil	Portland, OR	393.6	54	18.3	1212	1,231.45
GOLDEN BEAR	Retention - Passeng	Pacific	T-AGS39	1971	S4-M-MA154a	Vallejo, CA	School Ship	Training ship	Vallejo, CA	499.8	72	30.1	6483	6,587.03
Curtiss	RRF - Break Bulk	Pacific	T-AVB 4	1969	C5-S-78a	San Diego, CA	RRF	T-AVB Class - Aviation Support	San Diego, CA	602	90	30	15694	15,945.84
Cape Orlando	RRF - RO/RO	Pacific	AKR2044	1981	Dsl/Sweden	Alameda, CA	RRF	Cape O Class Ro-Ro	Alameda, CA	635.3	91.9	30.2	20404	20,731.42
PACIFIC TRACKER	Retention - Other	Pacific	MA #144	1965	S6-S-MA60e	Portland, OR	Other Agency Use	Missile Defense Agency - Missil	Portland, OR	665.7	75	27.8	5031	5,111.73
Gem State	RRF - Crane Ship	Pacific	T-ACS 2	1966	C6-S-MA1qd	Alameda, CA	RRF	T-ACS - Crane Ship	Alameda, CA	668.6	76	33.3	16175	16,434.56
Grand Canyon State	RRF - Crane Ship	Pacific	T-ACS 3	1965	C6-S-MA1qd	Alameda, CA	RRF	T-ACS - Crane Ship	Alameda, CA	668.6	76	33.3	16175	16,434.56
Keystone State	RRF - Crane Ship	Pacific	T-ACS 1	1966	C6-S-MA1qd	Alameda, CA	RRF	T-ACS - Crane Ship	Alameda, CA	668.6	76	33.3	16175	16,434.56
Cape Inscription	RRF - RO/RO	Pacific	AKR5076	1976	C7-S-95a	Long Beach, CA	RRF	Cape I Class Ro-RO	Long Beach, CA	684.8	102	34	19955	20,275.22
Cape Intrepid	RRF - RO/RO	Pacific	T-AKR11	1976	C7-S-95a	Tacoma, WA	RRF	Cape I Class Ro-RO	Tacoma, WA	684.8	102	34	19955	20,275.22
Cape Isabel	RRF - RO/RO	Pacific	AKR5062	1976	C7-S-95a	Long Beach, CA	RRF	Cape I Class Ro-RO	Long Beach, CA	684.8	102	34	19955	20,275.22
Cape Island	RRF - RO/RO	Pacific	T-AKR10	1977	C7-S-95a	Tacoma, WA	RRF	Cape I Class Ro-RO	Tacoma, WA	684.8	102	34	19955	20,275.22
ADM WM.M. Callaghan	RRF - RO/RO	Pacific	AKR1001	1967	Gas Turbine	Alameda, CA	RRF	RO-RO	Alameda, CA	694.3	92	29.1	13500	13,716.63
Petersburg	RRF - Tanker	Gulf	AOT9101	1963	Stm/50k	San Francisco, CA	RRF	OPDS Class - Tanker	Alameda, CA	736.3	102	39.3	49905	50,705.82
Cape Henry	RRF - RO/RO	Pacific	AKR5067	1979	G2-Dsl/Japan	Alameda, CA	RRF	Cape H Class Ro-Ro	Alameda, CA	749.7	105.8	35.5	31929	32,441.36
Cape Horn	RRF - RO/RO	Pacific	AKR5068	1979	G2-Dsl/N	San Francisco, CA	RRF	Cape H Class Ro-Ro	San Francisco, CA	749.7	105.8	35.5	31929	32,441.36
Cape Hudson	RRF - RO/RO	Pacific	AKR5066	1979	G2-Dsl/N	San Francisco, CA	RRF	Cape H Class Ro-Ro	San Francisco, CA	749.7	105.8	35.5	31929	32,441.36
Cape Mohican	RRF - Barge Ship	Pacific	AKR5065	1973	C8-S-82a	Alameda, CA	RRF	Cape M Class - SeaBee	Alameda, CA	873.8	105.8	39.1	38410	39,026.36
Algol (AKR-287)	RRF - RO/RO	Pacific	T-AKR 287	1972	Navy Cargo	Alameda, CA	RRF	Fast Sealift Ship (FSS) Ro-Ro	Alameda, CA	946.1	105.5	36.7	25248	25,653.15
CAPELLA (AKR-293)	RRF - RO/RO	Pacific	T-AKR 293	1972	Navy Cargo	Alameda, CA	RRF	Fast Sealift Ship (FSS) Ro-Ro	Alameda, CA	946.1	105.5	36.8	25406	25,813.69

Vessel Classes for analysis	LOA (ft)		Beam (ft)		Expected Arrival Draft (ft)	
	Min	Max	Min	Max	Min	Max
Small MARAD (<700' LOA)	393.6	694.3	54	102	18.3	29
Large MARAD (>700' LOA)	736.3	946.1	102	105.8	25	29

Note: Relatively small number of MARAD vessels in potential list of "biddable" vessels, so vessels were classified more broadly.

Note: Expected arrival drafts are based upon input from a MARAD contracting official.

Notes & Data Sources:

Data gathered and cross-referenced from MARAD website, MARAD vessel specification brochure, and Naval Vessel Register website.

Selected fleet of vessels (listed) cross-referenced from vessel database provided by POSF & BAE. The selected vessels from those lists correspond to MARAD vessels based on the West Coast and excludes those based on East Coast or in the Gulf.

Information from MARAD contracting specialist Kathryn Rato confirmed that these are the vessels which would use dry docks on the West Coast (based on their homeport/layberth locations).

Ms. Rato also stated typical arrival drafts at a dry dock for these vessels range from 25 to 29-feet.

b. Commercial Vessels

BAE Systems provided only vessel names and not unique identifiers (such as IMO numbers), or other specific characteristics. First, each vessel name was researched online to find IMO numbers and vessel characteristics. This initial research was sent to BAE Systems for their verification of each vessel. This verification is important to ensuring the correct vessel data is utilized for vessel projections, operating costs, and other similar information.

Exact vessel bids are only available for a short time (6 years) over the 50-year period of analysis. So this analysis utilizes vessel operations information for these specific vessels to determine generalizing assumptions which appropriately categorize the characteristics of the fleets on which BAE Systems plans to bid in the future.

Cruise										
	Vessel Name	**IMO**	**Ship Type**	**Flag**	**Current draft (ft)**	**Length (ft)**	**Beam (ft)**	**Draft (ft)**	**DWT**	**S**
	AMSTERDAM	9188037	Passenger (	Netherlands	26.57480315	777.5590551	104.9868766	26.6	7327	
	CARNIVAL INSPIRATION	9087489	Passenger (	Bahamas	26.24671916	859.5800525	104.9868766	25.8	7180	
	NCL STAR	9195157	Passenger (	Bahamas	28.2152231	964.5669291	104.9868766	26.9	7500	
	CARNIVAL SIRIT	9188647	Passenger (	Malta		862.8608924	104.9868766	26.3	7200	
	CARNIVAL PRIDE	9223954	Passenger (	Panama	26.90288714	862.8608924	104.9868766	26.3	7200	
	CARNIVAL MIRACLE	9237357	Passenger (	Panama	26.90288714	862.8608924	104.9868766	25.6	7089	
	CARNIVAL IMAGINATION	9053878	Passenger (	Bahamas	26.90288714	859.5800525	104.9868766	25.8	7180	
	NCL SUN	9218131	Passenger (	Bahamas	26.90288714	853.0183727	104.9868766	27.0	7100	
	CARNIVAL SPLENDOR	9333163	Passenger (	Panama	27.23097113	951.4435696	118.1102362	27.2	11843	
	GOLDEN PRINCESS	9192351	Passenger (	Bermuda	28.2152231	951.4435696	118.1102362	27.9	8418	
	GRAND PRINCESS	9104005	Passenger (	Bermuda	28.2152231	823.4908136	118.1102362	27.9	8418	
	STAR PRINCESS	9192363	Passenger (	Bermuda	27.88713911	951.4435696	118.1102362	27.7	10852	
	CROWN PRINCESS	9293399	Passenger (	Bermuda	28.54330709	803.8057743	118.1102362	27.9	13294	
	NCLJEWEL	9304045	Passenger (	Bahamas	27.88713911	964.5669291	104.9868766	28.2	7500	
Notes & Data Sources:						778	104.9868766			
Vessel names provided by BAE - expected vessels requiring dry dock 2015-2020.						882				
Vessel characteristics from vesselfinder.com and from cruise company websites, as available						965	104.9868766			
Vessel characteristics verified by BAE personnel, including expected arrival draft at drydock.							104.9868766			
Typical schedule and sailing draft information also gathered in NNOMPEAS.							118.1102362			

Tankers

Vessel Name	IMO	Ship Type	Flag	Current draft (ft)	Length (ft)	Beam (ft)	Draft (ft)	DWT
EMPIRE STATE	9408126	Chemical/oil products tanker	USA		600	105		48635
EVERGREEN STATE	9408138	Chemical/oil products tanker	USA		600	105		48641
GOLDEN ARROW	5036676	Chemical/oil products tanker	Liberia					39235
KODIAK	6419966	Chemical/oil products tanker						91161
OREGON VOYAGER	9144914	Chemical/oil products tanker	USA	35.43307087	591	105	40	45671
PINE GALAXY	9272682	Chemical/oil products tanker	Bahamas	31.167979	463	79	31	19997
FLORIDA VOYAGER	9118630	Crude oil tanker	USA	26.90288714	571	105	22	46094

Notes & Data Sources:

Vessel names provided by BAE - expected vessels requiring dry dock 2015-2020.

Vessel characteristics from vesselfinder.com and from vessel company websites, as available.

Container Ship

Vessel Name	IMO	Ship Type	Flag	Current draft (ft)	Length (ft)	Beam (ft)	Draft (ft)	DWT	S
DOLE ECUADOR	8513479	Container ship	Bahamas		561	89			
HORIZON CONSUMER	7224306	Container ship	USA	29.52755906	676	95	34	25651	
MATSONIA	7334204	Container ship	USA	22.96587927	702	105	28	22501	
SS KAUAI	7802718	Container ship	USA	26.90288714	676	95	34	26350	

Notes & Data Sources:	Vessel Flag	Number
Vessel names provided by BAE - expected vessels requiring dry	Foreign	1
Vessel characteristics from vesselfinder.com and from vessel cc	US	3
	Total	4

Other Vessel Types

Vessel Name	IMO	Ship Type	Flag	Current draft (ft)	Length (ft)	Beam (ft)	Draft (ft)	DWT
DUBLIN SEA	9492684	Pusher tug	USA	20.7	131.2	42.7	22.0	448
R/V MARCUS LANGSETH	9010137	Research vessel	USA	19.7	236.2	55.8	19.4	1547
MARJORIE C	9619684	RO/RO Cargo ship	USA	27.9	689.0	105.0		24750
CSL TECUMSEH	9600994	Self discharging bulk carrier	Bahamas	26.9	751.3	105.0		71319
RT HON PAUL E MARTIN	9600970	Self Discharging Bulk Carrier Par	Bahamas	30.5	749.8	105.8	44.3	71405.3
JEAN ANNE	9233167	Vehicles Carrier	USA	27.6	577.4	101.7	28.7	12561

Summary of Commercial Vessel Characteristics:

Commercial Vessels	LOA (ft)		Beam (ft)		Expected Arrival Draft (ft)		Underkeel Clearance (ft)
	Min	Max	Min	Max	Min	Max	
Cruise	778	965	105	118	24	28.2	2
ATB	512	587	74	78	19	19	2
Tanker	463	600	79	105	22	22	2
Container	561	702	89	105	25	25	2
Other	577	751	102	106	19	25	2

2. Existing Condition Dry Dock Bids/Calls – Vessel Fleet

The basis for vessel travel cost calculations is first an understanding of the potential fleet of vessels which may require dry dock services along the US West Coast. BAE Systems provided estimates of their planned vessel bids over the next six years. The potential vessel fleet includes both government and commercial vessels. Government vessels include those from the Military Sealift Command (MSC), United States Coast Guard (USCG), and Maritime Administration (MARAD). The potential fleet and frequency of dry docking for government vessels was also verified with contracting officials from these agencies.

Commercial vessels include cruise ships, articulating tugs and barges (ATBs), tankers, container ships, and various other bulk cargo and roll-on/roll-off (RORO) carriers. Based on the data provided, this analysis first developed projections of the potential vessel fleets on which BAE Systems plans to bid over the project period of analysis (specific numbers are not provided in this context in order to protect BAE's commercially sensitive data).

The existing condition level of vessel dry dock services is based on data provided by BAE Systems regarding the vessels on which they expect to bid for dry dock services at their San Francisco ship yard for the years 2015 through 2020. These projections by BAE Systems assume that Central Basin will be dredged to a depth to allow access for these vessels – that is, BAE Systems has not altered the vessels on which they plan to bid based upon the projected depth constraints of Central Basin in the future without any dredging.

Baseline estimates of the number of vessels on which BAE Systems will bid is based on the average of the 2015 through 2020 data provided by the company. Using the average of six years as a baseline serves to reduce the variability in year-to-year forecasting.

Details on Federal government contract actions, including government vessel drydocking solicitations and awards, are available on the Fed Biz Opps website. Due to availability of information, this does not represent a complete record of all government vessel drydockings, but instead provides important data such as patterns of arrival draft at ship yards, frequency of dry dock use, and which dry docks were used. This information is only available for US Coast Guard and MSC vessels.

a. Military Sealift Command Ships

Contracting officials report that the depth of Central Basin is critical to repairs of MSC ships. The BAE Systems San Francisco ship yard is only one of two facilities on the West Coast which can accommodate larger ship classes. Continued shoaling at Central Basin will force MSC vessels to seek alternate dry dock facilities.

b. US Coast Guard Vessels

After reviewing the records of historical drydockings for USCG vessels, many of these vessels are geographically restricted to using dry docks close to their homeports. The vessels listed in BAE Systems' documents as "biddable" are homeported in either Seattle, Washington; Alameda, California; San Diego, California; Honolulu, Hawaii; Kodiak, Alaska; or San Francisco, California.

The largest of the USCG vessels are icebreakers, national security cutters and high endurance cutters. These large vessels are typically not homeported in San Francisco, and are geographically restricted to a maximum of 200 miles from their homeport. This means that they would not be eligible to use BAE Systems San Francisco ship yard. In addition, one of the deepest-drafting classes of USCG vessels, the Polar Class icebreaker has utilized Mare Island Dry dock in recent years. This dry dock is located just across San Francisco Bay from the BAE Systems dry docks. Other, smaller classes of USCG vessels have used the dry docks at the Bay Ship & Yacht Co., in Alameda, California, which is also located in the San Francisco Bay region.

In summary, some USCG vessels would be prevented from using BAE Systems San Francisco ship yard due to geographic restrictions in their solicitations, and nearly all other classes of vessels can use existing dry docks in the San Francisco Bay area. Considering these factors, USCG vessels would not benefit from significant travel cost savings based solely upon the provision of a deeper channel at Central Basin. These vessels are not included in detailed travel cost analyses.

This assumption is not intended to imply that USCG vessels will not use the BAE Systems San Francisco ship yard in the future; only that navigation improvements at Central Basin will not result in travel cost savings for these vessels.

c. MARAD Vessels

MARAD contracting officials report that BAE Systems San Francisco ship yard is a bidder on some of their West Coast vessel repair and maintenance contracts. At this time, the depth of Central Basin has not been an issue for MARAD vessels.

D. Vessel Operations

Additional information regarding typical vessel operations was then gathered to form the basis for travel cost calculations and estimates of how each type of vessel would be able to access the ship yard in future conditions.

An important consideration for this study is that vessel traffic in the Central Basin channel is based on the need for vessel repair at the dry dock. There are no commodity transfers associated with these dry dock calls. So this analysis will not present information related to commodities or shipping practices, including commodity transfer or vessel immersion rates.

1. Underkeel Clearance

Rules regarding underkeel clearance requirements for non-commercial vessels were obtained from Federal contracting documents. Commercial vessel underkeel requirements are based on BAE info and verification with NNOMPEAS. Ships calling at Central Basin require an underkeel clearance of two to three feet.

For government vessels, expected arrival drafts and underkeel clearances were researched in contract solicitation documents, and verified during interviews with contracting officials. Per contracting documents, MSC vessels require underkeel clearance of 3-feet. According to data provided by a MARAD contracting official, MARAD ships require underkeel clearances of 2- to 3-feet.

For commercial vessels, arrival drafts are based upon a combination of input from BAE Systems officials and comparison with NNOMPEAS data, as available.

2. Sailing Draft

In this case, vessel **sailing draft** refers to the anticipated **arrival draft** at a dry dock. Vessels typically arrive at a dry dock for scheduled repair and maintenance at less than their sailing draft because the vessel is unloaded or has de-ballasted to reduce draft. Vessels which require dry docks for vessel repair in the event of emergency may come in at deeper drafts, since the vessel could be loaded more fully at the time of the emergency incident.

This analysis focuses on scheduled vessel repair services as estimating the frequency and location of vessels when they require emergency repair is beyond the scope of this study.

a. Government Vessels

Arrival drafts for government vessels are based upon a combination of internet research, interviews with agencies, and information provided by BAE Systems.

Military Sealift Command. MSC vessels have arrival drafts at the dry dock ranging from 29.7 feet to 11 feet, depending on the class of vessel. The largest vessel classes of MSC vessels are Fast Combat Support (T-AOE), Hospital ships (T-AH), Fleet Replenishment Oilers (T-AO), Large RORO (T-AKR), Dry Cargo/Ammunition (T-AKE), and Maritime Prepositioning Force Container ships (T-AK), with typical arrival drafts of 29.7-, 28-, 27-, 27-, 26.2-, and 26.2-feet, respectively. Smaller MSC vessel classes include Submarine Tenders (T-AS), Rescue and Salvage (T-ARS), Fleet Ocean Tugs (T-ATF), and Joint High Speed Transport ships (JHSV), with typical arrival drafts ranging from 11- to 17-feet.

MARAD. According to data provided by a MARAD contracting official, MARAD ships typically arrive at a dry dock drafting between 25- and 29-feet.

b. Commercial Vessels

Commercial vessel arrival drafts are based upon input from BAE Systems in comparison with typical sailing draft information researched in the USACE National Navigation Operation & Management Performance Evaluation and Assessment System (NNOMPEAS) database[4].

BAE Systems provided information about the expected arrival drafts for vessel to their dry docks. This analysis gathered NNOMPEAS data (as available) on specific ship itineraries over a three-year period to verify typical sailing draft information.

[4] NNOMPEAS is a database maintained by USACE Institute for Water Resources and tracks vessel transit, sailing draft, and other pertinent data for deep draft navigation analyses.

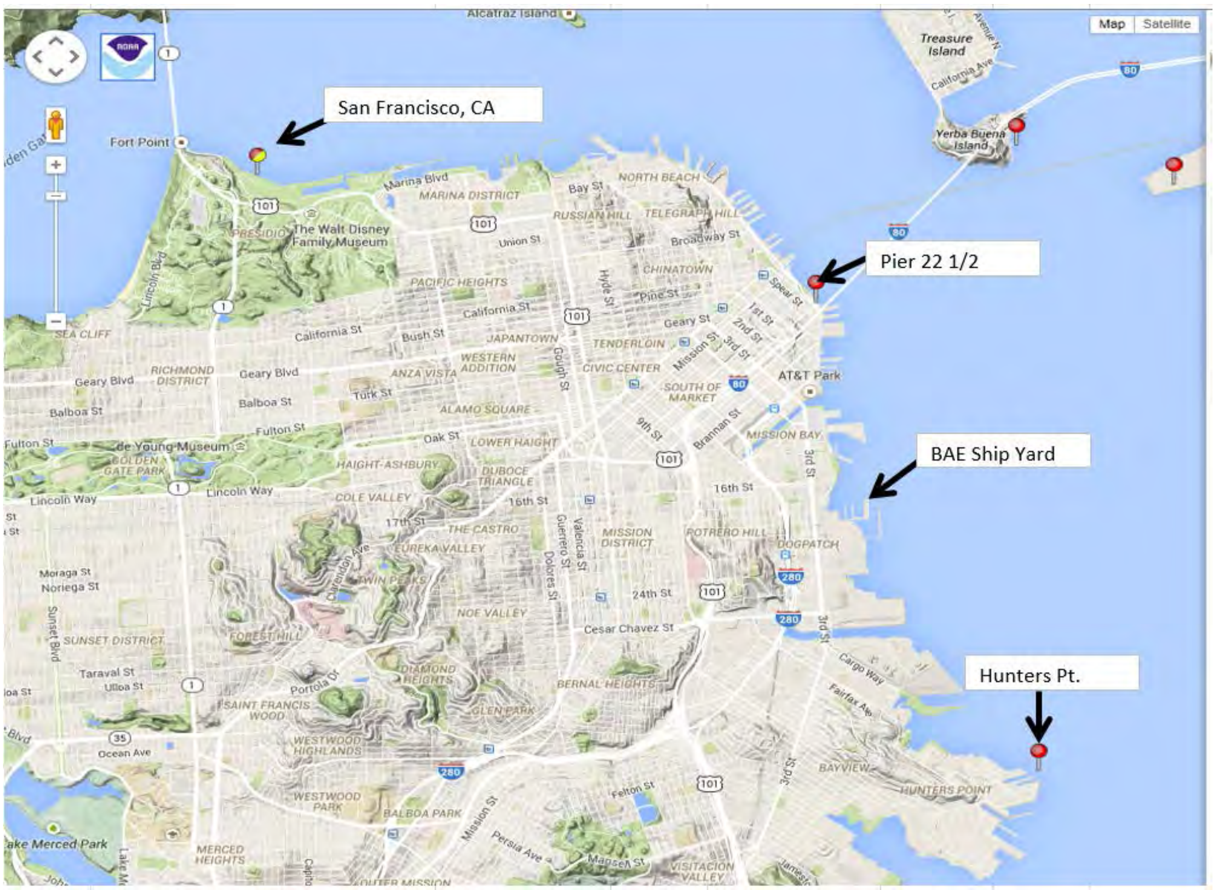
Summary of expected arrival drafts and underkeel clearance requirements, by vessel class

Vessel Classes for analysis:	Expected arrival draft (ft)	Underkeel Clearance (ft)	Total depth (arrival draft + UKC)
Government Vessels			
MSC			
T-AOE	29.7	3	32.7
T-AH	28	3	31
T-AO/T-AKR	27	3	30
T-AO/T-AKR	27	3	30
T-AKE/T-AK	26.2	3	29.2
T-AS/T-ARS	17	3	20
T-AS/T-ARS	17	3	20
T-ATF	14	3	17
JHSV	11	3	14
Coast Guard			
Seagoing Buoy Tender	18	2	20
National Security Cutter	20	2	22
High Endurance Cutter	15.33	2	17.33
Polar Class Icebreaker	27	2	29
MARAD			
Small MARAD	25	2	27
Large MARAD	29	3	32

	Anticipated Arrival Draft		Underkeel	Total depth	
Commercial Vessels	**Min**	**Max**	**Clearance (ft)**	**Min**	**Max**
Cruise	24	28.2	2	26	30.2
ATB	19	19	2	21	21
Tanker	22	22	2	24	24
Container Ship	25	25	2	27	27
Other	19	25	2	21	27

3. Tidal Considerations

Tidal ranges at Central Basin are included in this analysis. Tidal information Tide information for San Francisco Bay is presented beginning in the following figures and tables. The BAE Systems ship yard is between two NOAA tide stations: Pier 22 ½ and Hunters Point. This analysis utilizes the average of the tide ranges from these two stations resulting in a tide of 4.775 feet. This is consistent with anecdotal information provided by BAE Systems which suggests there is an approximately a 5-foot tide range at the ship yard.



NOAA Tide info:

	Station Name (Benchmark sheets)	Station Number
	San Francisco, CA	9414290
	Pier 22 1/2, San Francisco, CA	9414317
	Hunters Point, SF Bay, CA	9414358

Tide Level	San Francisco, CA
MHHW	5.84
MHW	5.23
MTL	3.18
MSL	3.12
NGVD29	2.64
MLW	1.14
MLLW	0
NAVD88	-0.08

Tide Level	Pier 22 1/2
MHHW	6.26
MHW	5.63
MTL	3.38
MSL	3.26
NGVD29	2.76
MLW	1.12
NAVD88	0.04
MLLW	0
Mean Tide range	4.51
Mean Tide Level	3.375

Tide Level	Hunters Point
MHHW	6.8
MHW	6.18
MTL	3.66
MSL	3.56
NGVD29	3.53
MLW	1.14
NAVD88	0.84
MLLW	0
Mean Tide range	5.04
Mean Tide Level	3.66

Expected tide range, BAE ship yard (ft)

MHHW	Mean Tide Range	Mean Tide Level
6.53	4.775	3.5175

Values equal to the average of Pier 22 1/2 and Hunters Point

This analysis utilizes the Mean Tide Range.

Vessel classes and Tide

In addition to considerations of channel depth and underkeel clearance, some government vessels cannot use tide as a consideration of a channel's depth when accessing a dry dock.

USCG dry docking specifications:

"Water depth. Ensure that water depth is sufficient at the pier to allow the vessel's lowest underwater appendage to clear the bottom by at least two feet at: (1) ordinary low water mark on non-tidal rivers, (2) at all tide conditions predicted during the availability for tidal rivers and other navigable waterways."

MSC: Per MSC Contracting Officer Henry Bijak, MSC vessels must be able to arrive and depart the facility at all tidal conditions. Facility depth needs are based on MLLW.

MARAD: Per MARAD Contracting specialist, MARAD vessel clearances can include tide - does not have to be accessible at any tidal condition.

Commercial: Per info from BAE, tide is used for consideration of available depth for commercial vessel calls.

Tide summary by vessel class

Vessel Classes for analysis:	Can use tide?
Government Vessels	
MSC	
T-AOE	No
T-AH	No
T-AO/T-AKR	No
T-AO/T-AKR	No
T-AKE/T-AK	No
T-AS/T-ARS	No
T-AS/T-ARS	No
T-ATF	No
JHSV	No
Coast Guard	
Seagoing Buoy Tender	No
National Security Cutter	No
High Endurance Cutter	No
Polar Class Icebreaker	No
MARAD	
Small MARAD	Yes
Large MARAD	Yes
Commercial Vessels	
Cruise	Yes
ATB	Yes
Tanker	Yes
Container Ship	Yes
Other	Yes

4. Vessel Speeds

MSC and MARAD vessel speeds are based upon vessel specifications found during online research. The speeds at which MSC ships travel were gathered from online research of vessel specifications. MARAD vessel speeds were gathered from online vessel specifications.

For commercial vessels, some data was available from online AIS data from vesselfinder.com. However, this data was limited and was not associated with a specific itinerary, so may not be representative of typical vessel transits. To address the uncertainty with that data, this analysis uses an extrapolation of the service speed by vessel class as presented in the Institute for Water Resources (IWR) published Vessel Operating Cost (VOC) data.

Commercial vessel speeds are based upon IWR's published deep draft VOCs by specific vessel type. Some Automated Identification System (AIS) data was available online regarding vessel speeds. But these data points were limited and may not accurately represent vessel transits, so data available from IWR was utilized.

This analysis only considers vessel speeds at-sea. Vessel operations in port (approach to the dry dock) are not considered in this analysis as they are assumed to be similar regardless of the dry dock facility used. In addition, there is no evidence to suggest that there are in-port delays associated with the reduced depth of Central Basin. This analysis focuses on the benefits associated with reducing vessel travel time by allowing for continued use of BAE Systems' dry dock facilities.

Vessel Speed Summary

MSC Vessels

Vessel Type	Flag	Vessel Speeds (knots)		
		Max	Min	Average
T-AOE	US	25	25	25.0
T-AH	US			17.0
T-AO/T-AKR	US	24	20	22.0
T-AO/T-AKR	US	24	20	22.0
T-AKE/T-AK	US	20	17.7	18.9
T-AS/T-ARS	US	20	14	17.0
T-AS/T-ARS	US	20	14	17.0
T-ATF	US	14.5	14.5	14.5
JHSV	US	35	35	35.0

Source: MSC online vessel specifications.

MARAD Vessels

Vessel Type	Flag	Vessel Speeds (knots)		
		Max	Min	Average
Small MARAD	US	21.30	17.00	18.36
Large MARAD	US	27.00	13.50	19.50

Source: MARAD vessel specifications from MARAD website and Naval Vessel Reg

Vessel Type	Flag	Vessel Speeds (knots)		
		Max	Min	Average
Cruise	Foreign	27.17	21.14	22.45
General Cargo	US	16.13	15.43	15.83
Chemical Tanker	US	15.03	14.91	14.98
Chemical Tanker	Foreign	16.71	13.90	15.09
Container Ship	US	19.95	19.62	19.82
"Other Vessels" - General Carg	US	15.67	13.45	14.31
"Other Vessels" - General Carg	Foreign			19.93

E. Alternate Dry Docks and Travel Distances

In addition to assumptions regarding vessel itineraries, knowledge of alternate available dry docks is necessary for travel cost calculations. Government vessel dry docking solicitations revealed which West Coast and Pacific dry docks are frequently used. Additional internet research supplemented the range of dry docks in this region. The largest dry docks on the US West Coast are BAE Systems ship yard in San Francisco, Vigor Marine, LLC yard in Portland, Oregon, and the General Dynamics Nassco ship yard in San Diego, California. Dry dock #2 in San Francisco is 900-feet in length and can lift post-Panamax cruise ships. The Vigor Marine ship yard in Portland has four dry docks, the largest of which is 960-feet in length by 186-feet wide. The other dry docks in Portland are 661-, 598-, and 329-feet in length. The General Dynamics San Diego ship yard has two inclined building ways, each 950-feet long, a 1,000-foot long graving dock, and an 820-foot long floating dry dock. However, MSC reports that the San Diego ship yard is exclusively used for long-term Navy vessel ship-building and repair contracts and is not considered a viable alternative to San Francisco or Portland.

There is a 1,060-foot long dry dock at the Pearl Harbor Naval ship yard in Honolulu, Hawaii. MSC reports similar restrictions at this ship yard – that it is most often used as a facility for Navy ships. In addition, MSC reports that the ship yards available in both Honolulu and Guam are not considered for MSC contracts due to the additional travel distance and time.

BAE Systems also has a ship yard in San Diego, California with an existing 528-foot long floating dry dock. Recent news releases by BAE Systems show that the company is planning to construct an additional dry dock in San Diego. This new dry dock would be one of the largest on the West Coast at 950-feet in length and could accommodate the same types of vessels as the existing Portland and San Francisco ship yards. After consultation with representatives from BAE Systems, as well as the MSC and MARAD, it is not clear whether the San Diego ship yard would be used for commercial vessel solicitations or would be used as an exclusively Naval ship yard and not be eligible for additional contracts. Based on this data, the new BAE Systems San Diego dry dock is not considered in the array of potential alternate dry docks for large vessels in the future without project condition.

There are several additional dry docks located in the Seattle and Tacoma regions of Washington. These include the Vigor Marine ship yard in Tacoma with a 389-foot drydock. Also, Vigor Marine has a ship yard in Seattle with three dry docks ranging from 500- to 552-feet long. Foss Maritime has a ship yard in Seattle with three dry docks: two at 220-feet long and one 108-feet long. The Lake Union Drydock company has two dry docks at 420- and 200-feet long. Puglia Engineering, Inc. has two dry docks in Bellingham, Washington measuring 460- and 389-feet long.

There are also ship yards in Ketchikan and Seward, Alaska. The Vigor Marine ship yard in Ketchikan has two dry docks measuring 460- and 225-feet. And the Vigor Marine ship yard in Seward has a 350-foot long synchrolift.

In the San Francisco Bay area, there are ship yards at both Mare Island and Alameda. The Mare Island Dry Dock LLC has two concrete graving docks measuring 720- and 680-feet long. The Bay Ship and Yacht Company in Alameda has one dry dock capable of accommodating vessels up to 390-feet in length.

There are dry docks on the US West Coast which are considered viable alternatives to the San Francisco ship yard.

Many of these alternate dry docks were listed on Federal contract solicitations. Other information was gathered from online research.

Interviews with MSC contracting officials revealed that MSC vessel dry docking procedures are unique from other Naval vessels. Navy vessels typically use the Naval ship yards in San Diego and Honolulu, while MSC vessels are required to use commercial facilities. Based on the size of some MSC vessels, the only dry docks currently available for their use are the Vigor Marine facility in Portland, Oregon, and the BAE Systems San Francisco ship yard. Since Naval ship yards are often booked with long-term Naval vessel maintenance contracts, MSC does not consider them to be a viable alternative for their vessel drydockings.

1. Vessel Routes

An important consideration in determining vessel transit costs is an understanding of the routes that vessels transit – both prior to and after calling at a ship yard or dry dock facility. This analysis utilized available data to summarize the typical routes transited by each class of vessel before and after a visit to a dry dock.

As with other input data, this analysis makes probabilistic assumptions regarding the likelihood of a vessel route (starting and ending location) by vessel class.

a. MSC Vessels

Route data for MSC vessels is based upon the reference cities from contract solicitations. MSC vessel contract solicitations often include a reference city from which each vessel will be based prior to using a ship yard.

MSC vessel contracts also indicate the starting location of a vessel prior to utilizing a dry dock. On the West Coast, MSC ship contracts listed starting cities of San Diego, CA, the Puget Sound region of Washington, Guam, or Honolulu, Hawaii. MSC contracting personnel stated that ships most likely to use the San Francisco dry docks are typically based in San Diego, CA or Bremerton, WA.

b. MARAD Vessels

MARAD vessel routes are based upon each vessel's homeport. This is based upon interviews with a MARAD contracting official who stated that MARAD vessels typically transit to and from their homeport or layberth location before and after visiting a dry dock.

The majority of MARAD vessels are homeported in Alameda or San Francisco, California. Some vessels are homeported in Portland, Oregon, San Diego, California, Long Beach, California, and Tacoma, Washington.

c. Commercial Vessels

Commercial vessel transit information is based upon available ship itineraries from NNOMPEAS and available data from vessel operators' websites. NNOMPEAS ship itineraries were compared to available information on vessel websites to determine general vessel routes, by type of vessel.

d. Cruise Ships

Typical cruise ship routes were determined by examining historical ship itineraries available in NNOMPEAS data and expected future cruise schedules available via online research (www.cruisemapper.com and cruise ship websites). These cruise itineraries inform both the starting location or prior port to using a dry dock and the ending location, or the next port after using a dry dock. Ten of the 14 cruise ship itineraries examined are West Coast cruises typically transiting along the West Coast including Los Angeles, San Francisco, and Seattle voyages. Since these vessels are transiting in the vicinity of all West Coast dry docks, it is difficult to assume any travel cost savings. A generalizing assumption is that these vessels have a starting location in San Francisco and an ending location equal to the dry dock used. This assumption will eliminate travel cost savings.

Three of the other four cruise ships have itineraries operating from Long Beach, California, to Mexico. These vessels may experience additional travel costs if they had to utilize a dry dock facility farther north than San Francisco and then travel back to Long Beach to maintain its itinerary. Therefore, this analysis assumes that both the prior and next ports for these vessels are Long Beach. The final cruise ship is listed as operating only on the East Coast. A simplifying assumption for this analysis is that this vessel also operates on the Long Beach to Mexico route as it is also a Carnival ship. This vessel's starting and ending location is set to Long Beach.

e. ATBs

For Articulating Tug & Barge vessels (ATBs), based on NNOMPEAS itineraries, these vessels primarily transit between Vancouver, Canada and the Puget Sound region in Washington State. Based on this information, if these vessels were to utilize the BAE Systems San Francisco ship yard, it would be an increased travel distance compared to repair facilities in the Pacific Northwest. Additional data on these vessels will show that they are not among the potentially benefitting fleet due to their typical sailing draft and the size of the vessel which would allow them to utilize other dry docks in the San Francisco Bay region.

f. Tankers

Ship itineraries for tankers also show that tankers primarily transit on the US West Coast, including port calls in LA/Long Beach, Richmond Harbor, CA, the Puget Sound region, Portland, and some calls to Alaska, Hawaii, and Guam. Given that these vessels frequently transit in the vicinity of alternate ship yards, they are not assumed to benefit from travel cost savings from being able to use the BAE Systems San Francisco ship yard.

g. Container Ships

The container ships listed on BAE's information had more varied itineraries. Two of the four ships transit along the West Coast including from the San Francisco Bay area to the Pacific Northwest. One vessel transits between Long Beach, California and Honolulu, Hawaii and another transits between San Diego, California, and Central and South America. Container ships already transiting along the West Coast of the US are not expected to benefit. However, the two ships transiting between southern California and Hawaii or South America could face additional travel costs if they had to use a dry dock farther north than San Francisco. These vessels' starting and ending ports are set to represent their typical transits.

h. Other Vessel Types

In terms of "other" vessel types, two vessels were eliminated from consideration because they are small vessels which would not be size-constrained entering Central Basin regardless of channel depth, and could also use alternate dry docks in the San Francisco Bay area. Of the remaining vessels, on transits between San Francisco and Western Canadian ports while the others transit between Southern California and Pacific islands. Starting and ending locations for these vessels have been set accordingly.

III. FUTURE WITHOUT PROJECT CONDITION

This section details the assumptions regarding the vessel fleet and operations in the future without-project condition. Assumptions are based upon the best available information and are appropriate for the level of detail needed for a CAP study.

Calculating vessel transportation costs in both the future without- and with-project conditions is based on a number of factors, including: the fleet of vessels on which BAE Systems will bid for dry dock services, the expected arrival draft and underkeel clearance requirements of these vessels, the vessel ports of call or typical itineraries, the expected depth of the Central Basin channel in the future, tidal data, alternative dry docks along the US West Coast, vessel speeds, and vessel operating costs. Another important consideration is that dry dock services (especially for government vessels) are typically solicited on a contract basis. So navigation improvements providing additional depth at Central Basin will allow BAE Systems to be eligible for more contract awards, but does not necessarily mean that they will be successful bidder on those contracts.

Put another way, any time a vessel that could be repaired in San Francisco has to go to an alternate dry dock facility as a result of a draft constraint at Central Basin, there is a potential NED impact. But consideration must be given that the number of vessels that would actually be repaired at San Francisco is a subset of those that could be repaired there. The precise number of these vessels in a given year is highly variable given the various uncertainties involved. The Central Basin economics analysis addresses the uncertainty associated with these assumptions by utilizing a probabilistic analysis and iterations of transportation cost calculations to arrive at more risk-informed transportation cost calculations and plan selection.

A. Facilities and Infrastructure

-Based upon interviews with both the Port and BAE representatives, there are no expected changes to shore-side facilities. Importantly, this means no expected change in dry dock capacity, which will drive assumptions about the future fleet and calls to the dry dock.

B. Channel Depth

In the future without project condition, this analysis assumes that there will be no dredging by either the Port of San Francisco or their leaseholder at Pier 70. This means that Central Basin will be allowed to shoal naturally over the period of analysis. This assumption has been verified by both the Port and BAE Systems. San Francisco District engineering staff provided estimates of the depth of Central Basin in the future without project condition at 5-year intervals. These intervals represent the analysis years for which transportation costs are calculated. Transportation costs are interpolated for the intervening years and all projections are held constant at 20-years after the base year.

Shoaling estimates from San Francisco District engineering forecast that the controlling depth of Central Basin will be reduced to only -17.3 feet MLLW during the 50-year period of analysis.[5]

San Francisco District (SPN) engineering staff developed estimates of the expected channel depths at 5-year intervals based upon historical shoaling rates. Projections are held constant after 20 years past the base year. The expected future without project condition is that neither the Port of San Francisco, nor their leaseholder at the ship yard will dredge Central Basin and it will be allowed to naturally shoal. This assumption has been confirmed by both of these entities. BAE Systems has stated that based on the depth assumptions, their ship yard will likely no longer be profitable at depths shallower than 24.8 feet and would be forced to close between 2021 and 2026.

Under the future without-project condition it is expected that Commercial Cruise Ships and Large Maritime Administration (MARAD) Vessels will no longer be able to access Pier 70 by year 2021. Container Ships, Small MARAD Vessels, and Military Sealift Command (MSC) T-AS (Submarine Tender) and T-ARS (Rescue/Salvage) Vessels will no longer be able to access Pier 70 by year 2026, but would gain access under with-project conditions.

The following MSC vessel classes are currently precluded access to Pier 70 due to without-project depth restrictions: T-AH (Hospital), T-AO (Fleet Replenishment Oiler) T-AKR (Large, Medium-Speed, RO/RO), T-AKE (Dry Cargo/Ammunition), and T-AK (Maritime Prepositioning Force Container, RO/RO and MLP). These vessel classes would be able to access Pier 70 under with-project conditions.

The PDT investigated the implications of this assumption and found that the dry dock infrastructure is too expensive to relocate to a channel with greater depth and that the Port of San Francisco would not be able to attract a different ship yard leaseholder with those reduced depths. So the ship yard at Pier 70 would no longer be operational after this point.

[5] USACE San Francisco District economist and the USACE Deep Draft Navigation economist performed an informal sensitivity analysis to determine whether the project would be economically justified assuming two scenarios: 1) no future Non-Federal Sponsor dredging activities, and 2) Non-Federal Sponsor maintenance to its current depth of approximately 27 feet MLLW. The result of these calculations led the economists to determine that there is Federal interest in dredging this channel to 32 feet MLLW under either scenario. The first scenario of no future Non-Federal Sponsor dredging activities was then selected for use as the future without project condition throughout this economic analysis.

Table 2 summarizes the future without-project condition channel depths through the 50-year period of analysis.

Table 2. Central Basin Future Without-Project Channel Depths – in feet below MLLW

Year	Future Without Project
2016	27.3
2021	24.8
2026	22.3
2031	19.8
2036	17.3
2041	17.3
2046	17.3
2051	17.3
2056	17.3
2061	17.3
2066	17.3

C. Vessel Fleet

The basis for vessel travel cost calculations is first an understanding of the potential fleet of vessels which may require dry dock services along the US West Coast.

The future vessel fleet is based upon projecting the number of vessels on which BAE Systems will bid for dry dock repairs. This analysis forecasts the number of vessel bids, rather than the number of bids won by BAE Systems, because the expected number of bids over 20 years can be forecasted based on the information provided by BAE Systems. Attempting to further forecast bids won would introduce another level of uncertainty into the analysis. Additional description of how vessels were selected to use a particular ship yard will be discussed in the transportation cost methodology.

Using six years of predicted vessel bids serves to eliminate the variability in year-to-year forecasting. The data shows that BAE Systems plans to bid on an average of 32 vessels each year.

a. Fleet Forecast Methodology

This analysis first attempted to take a simplistic approach to forecasting the future level of vessel bids, by examining the probability of bid by vessel type, based on the six-year average. This probability represents the likelihoods that BAE Systems will bid upon that class of vessel in a given year. A simplistic forecast method would be to multiply the expected probability of vessel bids by the total number of expected bids to derive the fleet mix by vessel type. The problem with this method is that given the number of vessel classes compared to total vessel bids, some classes will not be represented, based on their low probability and the need to round predictions to the nearest whole vessel.

(An important note is that this analysis assumes that the baseline level of vessel bids is representative of the expected number of annual bids over the 50-year period of analysis. As there are no plans for expansion of the ship yard, this analysis assumes that the capacity of the ship yard will remain constant.)

To address this issue and the uncertainty associated with predicting the number of bids by vessel class in each year, this analysis uses a slightly more complicated probabilistic approach. This approach relies upon using the cumulative probability of each class of vessel (averaged over the six years available), Excel's random number generator, and a nested "if" statement equation in Excel.

The cumulative probability of each vessel class bid is equal to the cumulative sums of the probabilities calculated by vessel class. Excel's random number generator returns an evenly distributed random number greater than or equal to 0 and less than or equal to 1. The final step is to utilize a nested "if" statement formula with inputs of cumulative probability and random numbers to randomly assign the expected fleet of "biddable" vessels in a given year.

Utilizing the even distribution of the random number generator, in combination with the weighted cumulative percentages of each vessel type, and the iterative nature of the "if" statement in Excel ensures an appropriate distribution and selection of vessel types. To further address the uncertainty associated with selecting vessel types in each year, this analysis utilizes 10 iterations of potential biddable vessels for each analysis year.

To address the uncertainty associated with forecasting these vessel bids (the potential vessel fleet), this analysis developed various iterations of potential vessel fleets for calculation.

b. Commercial Ships

Exact vessel bids are only available for a short time (6 years) over the 50-year period of analysis. So this analysis utilizes vessel operations information for these specific vessels to determine generalizing assumptions which appropriately categorize the characteristics of the fleets on which BAE Systems will bid in the future.

D. Vessel Operations

Additional information regarding typical vessel operations was then gathered to form the basis for travel cost calculations and estimates of how each type of vessel would be able to access the ship yard in future conditions. In general, these vessel operating assumptions are utilized for both the future without- and with-project conditions. For example, underkeel clearances and expected vessel starting locations prior to accessing a dry dock are not expected to change with navigation improvements at Central Basin. More details about these assumptions will be presented in subsequent sections.

A combination of interviews with vessel operators and online research provided the majority of data for government vessels. The website Fed Biz Opps[6] provides a significant level of information on historical government contract actions, including vessel dry docking. Data gathered from searches on Fed Biz Opps was utilized to inform assumptions about typical arrival draft at a dry dock, underkeel clearance requirements, vessel routes, tidal requirements, and use of alternative dry dock facilities. Data on Fed Biz Opps was only available for MSC and USCG vessels. Data for MARAD vessels was gathered from MARAD’s website and interviews with MARAD contracting officials.

E. Alternate Dry Docks and Travel Distances

In general, the availability of alternate dry dock facilities is the same as presented in the existing conditions section.

Recent news articles show that BAE Systems is planning to construct an additional dry dock at their ship yard in San Diego. This new San Diego dry dock would be one of the largest on the West Coast and could accommodate the same types of vessels as the existing Portland and San Francisco ship yards. After consultation with representatives from BAE Systems, as well as the MSC and MARAD, it is not clear whether the San Diego ship yard would be used for commercial vessels or would be used as a Naval ship yard and not be eligible for other

[6] https://www.fbo.gov/

commercial vessel contracts. Based on this data, the new BAE Systems San Diego dry dock is not considered in the array of potential alternate dry docks for large vessels in the future project conditions.

Determinations were made on which dry docks can be used by each vessel class in future conditions. These assumptions are based upon comparison of vessel and dry dock dimensions. In the future without project condition, the San Francisco dry dock is not considered a viable dry dock option.

In the future without project condition, potential biddable vessels for BAE Systems are assigned to an alternative dry dock based on a comparison of the dimensions of the vessel and the dry dock. In the case of some large vessels, the only available alternative facility is in Portland, Oregon. In other cases, there are various possible alternative facilities. In these instances, the probability of using any one facility is used to select a dry dock for travel cost calculations. This is done in recognition that vessels will use a dry dock based on a contract and selection, so the exact facility used for each vessel in each year is unknown. If a class of vessel can use the dry docks at the BAE Systems San Francisco ship yard in the future without project condition (in consideration of assumptions of facility depths), it is not considered a potentially benefitting vessel and detailed travel costs are not calculated.

F. Transportation Cost Modeling Methodology

Typically, the software program HarborSym is used to calculate transportation costs and economic benefits of deep draft navigation studies (channel deepening and widening). The program is currently the only tool approved and certified for use by USACE to estimate benefits for these projects. The program is a data intensive model which is not necessarily well-suited for a smaller-scale feasibility study, such as that conducted for a CAP 107 project. In addition, HarborSym is used partially to calculate in-port transportation costs associated with vessel docking and commodity transfers. These factors are not appropriate for analysis for the Central Basin feasibility study. Vessels do not access the dry docks at Central Basin, or any other ship yard, for the purpose of commodity transfers.

For these reasons, the study team, in coordination with the DDN-PCX determined that HarborSym was not an appropriate tool for this study. Instead, transportation costs and NED benefits are calculated in a spreadsheet model. Per the Director of Civil Works' Policy Memorandum #1 (Continuing Authority Program Planning Process Improvements dated January 19, 2011), "Approval of planning models under EC 1105-2-412 is not required for CAP projects. MSC commanders remain responsible for assuring the quality of the analyses used in these projects. ATR will be used to ensure that models and analyses are compliant with Corps policy, theoretically sound, computationally accurate, transparent, described to address any limitations of the model or its use, and documented in study reports."

The Central Basin benefits model was developed by the Alaska District in consultation with the San Francisco District and the DDN-PCX. The San Francisco District completed District Quality Control (DQC) of the model on June 19, 2015. Agency Technical Review (ATR) of the model was coordinated through the DDN-PCX and completed on July 6, 2015.

San Francisco District engineering staff provided controlling depth estimates for Central Basin in the without project condition at 5-year intervals. Controlling depths vary based on the estimated shoaling rates of the channel. The channel depth was held constant after 20 years past the base year to reduce the effects of uncertainty in forecasting. These 5-year intervals represent the analysis years for which transportation costs are calculated. Transportation costs are interpolated between each analysis year and held constant after 20 year past the base year.

The probabilistic method of addressing uncertainty of input data, as described in previous sections, is used throughout the Central Basin model. This method involves cumulative probability, random number generators, nested "if" statement formulas, and iterations of the same calculations used to derive average costs.

Based on the variance in some input data, there is a high level of variability in modeling results. To address this variability, transportation costs are based on the average of 100 iterations. Calculations were conducted by running the 10 iteration model (presented on the previous worksheets) 10 separate times.

The Central Basin benefits model uses probabilistic calculations and the average of many iterations to address the uncertainty associated with vessel transits.

The model represents a system of waterborne transit of commercial and government vessels transiting to dry dock facilities. The model focuses on identifying the transportation characteristics of these vessels as well as the likelihood that they will use a particular dry dock. The model uses this system and assumptions to calculate transportation costs in the future without project condition, assuming the San Francisco ship yard is inaccessible and the various future with project conditions, assuming various channel depths. Transportation cost savings for these vessels represent NED benefits.

G. Future Without-Project Transportation Costs

Present value and average annual calculations are based upon a 50-year project period of analysis and a Federal Fiscal Year (FY) 2016 discount rate of 3.125 percent.[7]

Future without-project vessel transportation costs are calculated by combining the previous assumptions related to vessel transit and the without-project condition fleet.

First, assumptions are made regarding the probability of starting location by each class of vessel. Next, probabilities are used to estimate which dry dock facility will be used by each vessel class in the future-without project condition. These alternate dry docks do not include BAE Systems San Francisco ship yard as it is unavailable to the impacted vessel classes. The next port to which a vessel calls after using a dry dock is based upon the previous assumptions

[7] The FY2017 Federal discount rate decreased 3.125% to 2.875%. The lower discount rate will have a positive effect on net benefits and benefit-to-cost ratios (BCRs). Applying the FY17 discount rate will not affect the determination of the NED plan. The FY17 discount rate will be applied in the Final Economic Appendix.

regarding vessel routes. All of this information is combined to determine the total travel distance for each vessel class.

Vessel operating costs are dependent upon the flag of the vessel – either foreign or US-flagged.

For depths in each future condition and analysis year, it is determined whether each class of vessel will be able to transit Central Basin in consideration of channel depth, vessel sailing draft, underkeel clearance, and tide, where applicable.

If a class of vessel can transit Central Basin in the future without project condition for a particular analysis year, it is not considered a "benefitting vessel" for that year, and its travel costs are not considered. Only those vessels which are expected to be depth constrained entering Central Basin are considered for detailed travel costs, as these are the vessels which would be forced to use alternate facilities and may accrue additional travel costs.

All of the above assumptions are then combined to calculate estimates of vessel transportation costs in the future without project condition. For each analysis year, there are 10 iterations of potential vessel fleets on which BAE Systems will bid and would potentially benefit from navigation improvements at Central Basin. Each iteration of vessel fleets is then combined with the probabilistic assumptions regarding vessel routes and alternative dry dock used to determine the total round-trip travel distance by vessel. Travel distance is then combined with vessel speed and VOCs to estimate the total travel cost per vessel. The total travel costs for each iteration are then averaged to arrive at a future without project cost for that analysis year.

The following table summarizes the future without project transportation costs for the vessels which could benefit from navigation improvements at Central Basin. Note that costs are calculated at five-year intervals, are interpolated in the intervening years, and all projections and costs are held constant after 20 years past the base year.

		FWOP				
	Iteration	**2017**	**2021**	**2026**	**2031**	**2036**
Results	Average of 100 iterations	$15,583,718	$18,862,970	$21,589,313	$22,670,756	$22,840,291

IV. FUTURE WITH PROJECT CONDITION

Introduction

A. Alternatives Considered—Channel Depths

The future with project condition considers dredging Central Basin to three alternative depths: 30-, 32- and 35-feet.

The future with project channel depths are equal to each alternative's depth: Alternative 1 at -30-feet MLLW, Alternative 2 at -32-feet, and Alternative 3 at -35-feet. In the future with-project condition, the Central Basin channel will be maintained to its authorized depth.

Table 3. Central Basin Future With-Project Channel Depths – in feet below MLLW

Year	Future With Project		
	Alternative 1	Alternative 2	Alternative 3
2016	30	32	35
2021	30	32	35
2026	30	32	35
2031	30	32	35
2036	30	32	35
2041	30	32	35
2046	30	32	35
2051	30	32	35
2056	30	32	35
2061	30	32	35
2066	30	32	35

This analysis considers which vessel classes will be able to use the Central Basin channel in each future with-project condition. Determinations are based upon each scenario's depth, tide, and each vessel class's arrival draft and underkeel clearance requirements.

B. Vessel Fleet

The future without- and future with-project conditions use the same fleet of benefitting vessels. This fleet is based upon the assumptions as described previously to determine their ability to use the channel in the future.

As previously discussed, under the future without-project condition it is expected that Commercial Cruise Ships and Large Maritime Administration (MARAD) Vessels will no longer be able to access Pier 70 by year 2021. Container Ships, Small MARAD Vessels, and Military Sealift Command (MSC) T-AS (Submarine Tender) and T-ARS (Rescue/Salvage) Vessels will no longer be able to access Pier 70 by year 2026, but would gain access under with-project conditions.

The following MSC vessel classes are currently precluded access to Pier 70 due to without-project depth restrictions: T-AH (Hospital), T-AO (Fleet Replenishment Oiler) T-AKR (Large, Medium-Speed, RO/RO), T-AKE (Dry Cargo/Ammunition), and T-AK (Maritime Prepositioning Force Container, RO/RO and MLP). These vessel classes would be able to access Pier 70 under with-project conditions.

C. Alternative Dry Docks and Travel Distances

Determinations were made on which dry docks can be used by each vessel class in future conditions. For each alternative in the future with project condition, the BAE Systems San Francisco dry docks are considered only if alternative depths would allow for transit of each class of vessel.

Future with-project dry dock selections include San Francisco for the vessels which are able to call there for each alternative.

In the future with-project condition, the same assumptions as in the future without-project condition are made regarding the probability of vessel use of a dry dock. The difference is that the BAE Systems San Francisco ship yard is added to the array of potential facilities. So, large vessels now are eligible for dry docking at either Portland or San Francisco. Probabilistic assumptions are again used to assign a vessel to a dry dock, in recognition that because BAE Systems ship yard is now eligible to win additional contracts does not mean that they will absolutely win the bid or contract.

D. Future With-Project Transportation Costs

The general method to calculate transportation costs is the same as in the future without-project condition. More specifically, the same input data is used regarding vessel fleet and other pertinent factors to ensure consistent calculations.

The primary difference between the future without- and with-project conditions, is the inclusion of the BAE Systems San Francisco ship yard as a potential dry dock location in the with-project condition. Since this analysis considers the fleet of vessels on which BAE Systems will bid, the future with-project condition implies that vessels could use the ship yard, but not necessarily that they would use it. Increased depth of Central Basin would allow the BAE Systems ship yard to be considered in vessel dry dock contract solicitations, but does not guarantee that they will win the contract.

The same calculation procedure is followed as was used for future without-project transportation costs. The primary difference is that future with project condition costs considers the BAE Systems San Francisco ship yard in the array of potential dry docks. This facility represents a shorter round-trip travel distance for some vessels, resulting in lower levels of total future with project transit costs.

30 ft Channel				
2017	2021	2026	2031	2036
$13,535,340	$15,620,920	$18,557,902	$19,002,506	$20,108,982

32 ft Channel				
2017	2021	2026	2031	2036
$13,680,459	$15,387,711	$18,044,676	$18,961,315	$19,511,323

35 ft Channel				
2017	2021	2026	2031	2036
$14,231,017	$15,952,894	$18,050,316	$18,650,454	$19,528,426

Note: The cumulative probabilistic methodology, including random number generator that was utilized to forecast the fleet mix concluded with results that hold vessel transportation costs constant at with-project depths of 32’ MLLW and 35” MLLW.

The next table summarizes the net present value and average annual calculations for the future with-project condition, by alternative. Calculations are again based upon a 50-year project period of analysis and a Federal fiscal year 2016 discount rate of 3.125 percent[8].

[8] The FY2017 Federal discount rate decreased 3.125% to 2.875%. The lower discount rate will have a positive effect on net benefits and benefit-to-cost ratios (BCRs). Applying the FY17 discount rate will not affect the determination of the NED plan. The FY17 discount rate will be applied in the Final Economic Appendix.

Future Without Project Transportation Costs	
FY2016 Discount Rate	3.125%
Period of Analysis	50
Capital Recovery Factor	0.040

Future Without Project Condition Summary:

	Net Present Value	Average Annual
Future Without Project	$534,684,225	$21,276,665
Total	**$534,684,225**	**$21,276,665**
QC		$21,276,665

Future Without Project Condition, NPV Calcs.

Year	Year	PV Factor	FWOP Transport Costs	Total Present Value
2017	1	0.970	$15,583,718	$15,111,484
2018	2	0.940	$16,239,568	$15,270,264
2019	3	0.912	$16,895,419	$15,405,545
2020	4	0.884	$17,551,269	$15,518,605
2021	5	0.857	$18,862,970	$16,172,988
2022	6	0.831	$19,317,360	$16,060,683
2023	7	0.806	$19,771,751	$15,940,333
2024	8	0.782	$20,226,141	$15,812,529
2025	9	0.758	$20,680,532	$15,677,834
2026	10	0.735	$21,589,313	$15,870,814
2027	11	0.713	$21,769,553	$15,518,364
2028	12	0.691	$21,949,794	$15,172,701
2029	13	0.670	$22,130,034	$14,833,737
2030	14	0.650	$22,310,275	$14,501,384
2031	15	0.630	$22,670,756	$14,289,156
2032	16	0.611	$22,699,012	$13,873,421
2033	17	0.593	$22,727,268	$13,469,761
2034	18	0.575	$22,755,524	$13,077,825
2035	19	0.557	$22,783,780	$12,697,274
2036	20	0.540	$22,840,291	$12,343,048
2037	21	0.524	$22,840,291	$11,969,016

- Transportation costs held constant and appropriately discounted after 20 yrs

V. PROJECT BENEFITS

NED benefits for Central Basin are the transportation cost savings for vessels which could use the San Francisco ship yard instead of alternate facilities. Benefits are equal to future without project transportation costs minus future with project costs.

The source of NED benefits is the travel cost savings for some vessels now able to use the San Francisco ship yard. This analysis uses probabilistic assumptions and iterative calculations to estimate the average travel costs and savings. These methods are employed to address the inherent uncertainty present in many vessel operating variables and that the San Francisco ship yard may not win additional bids simply because of a deeper channel.

Net Present Values:

Future With Project Transportation Costs		
FY2016 Discount Rate	3.125%	
Period of Analysis	50	
Capital Recovery Factor	0.040	
Future With Project Condition Summary:		
	Net Present Value	**Average Annual**
Alternative 1 - 30-feet	$461,866,628	$18,379,038
Alternative 2 - 32-feet	$452,232,796	$17,995,679
Alternative 3 - 35-feet	$455,085,556	$18,109,199

Benefits:

Transportation Cost Savings - Benefits		
FY2015 Discount Rate	3.125%	
Period of Analysis	50	
Capital Recovery Factor	0.040	
Benefits Summary:		
	Net Present Value	**Average Annual**
Alternative 1 - 30-feet	$72,817,596	$2,897,627
Alternative 2 - 32-feet	$82,451,428	$3,280,986
Alternative 3 - 35-feet	$79,598,669	$3,167,466

- Benefits are shown here as falling between 32-feet and 35-feet. This results from the probabilistic and independent structure of the model routing ships to the port for repairs. In the benefit-cost analysis displayed at the end of this appendix, the benefit numbers are held constant for the 32-feet plan. Conversely, if the 35-feet numbers had been used, none of the alternatives would fall below unity nor change the relative ranking of all of the alternatives.

VI. PROJECT COSTS

Cost estimates were provided by the San Francisco Cost Engineering section.

At this time, each alternative has four potential dredge disposal scenarios. The analysis uses the costs for all dredge disposal scenarios, but this will be refined as a final decision is made regarding dredge material disposal.

Cost estimates for Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) were provided by San Francisco District Cost Engineering.

Total NED costs for each alternative include construction costs, interest during construction (IDC), and annualized operations and maintenance.

Construction cost estimates, construction timing, and costs for Operations, Maintenance, Repair Replacement, and Rehabilitation (OMRR&R) were provided by the San Francisco District cost estimating section. This OMRR&R requirements are the same for all project alternatives.

Aids to Navigation have recently been estimated at $60,000. Aids to Navigation costs are a relatively small insignificant amount that is also a constant across alternatives and will not affect economic justification nor determination of the NED plan. This item will be included with the cost estimate Final Economic Appendix.

Construction costs are based upon dredging Central Basin to each alternative depth. NED costs also include Interest During Construction (IDC), which considers construction cost and construction length. The duration of construction for each alternative was provided by the San Francisco District Cost estimating section.

The next tables summarize the costs of each alternative. At this time, the final dredge disposal location is being selected, so each alternative includes four possible dredge placement sites for the 30-ft Channel Alternative and two possible dredge placement sites for the 32-ft and 35-ft Channel Alternatives. Composite placement sites that included SF11 for 32-ft and 35-ft Channel Alternatives were not carried forward in the final array due to ensuring that in-bay capacity is maintained for efficient placement for USACE O&M dredging projects, sediment suitability issues, and environmental regulation requirements and considerations.

Table 4. Cost Summary, 30-ft Channel

Alternative	30-ft Channel			
Dredge Disposal[9]	SF-DODS	Montezuma	Montezuma and SF-11	SF-DODS, Montezuma and SF-11
Construction Cost	$7,810,000	$11,790,000	$9,740,000	$7,810,000
IDC	$12,000	$14,000	$10,000	$9,000
Total NED Cost	$7,822,000	$11,804,000	$9,750,000	$7,819,000
Annual NED Cost	$311,000	$470,000	$388,000	$311,000
PV OMRR&R	$43,427,300	$42,427,300	$42,427,300	$42,427,300
Avg. Ann. OMRR&R	$1,728,100	$1,728,100	1,728,100	1,728,100
Total, PV	$51,242,700	$55,238,400	$53,178,000	$51,242,700
Average Annual Cost	$2,039,100	$2,198,100	$2,116,100	$2,039,100

Table 5. Cost Summary, 32-ft Channel

Alternative	32-ft Channel	
Dredge Disposal[5]	SF-DODS	Montezuma
Construction Cost	$8,970,000	$14,440,000
IDC	$17,000	$22,000
Total NED Cost	$8,987,000	$14,462,000
Annual NED Cost	$358,000	$575,000
PV OMRR&R	$40,854,000	$40,854,000
Avg. Ann. OMRR&R	$1,625,700	$1,625,700
Total, PV	$49, 850,500	$55,303,800
Average Annual Cost	$1,983,700	$2,200,700

[9] Dredge Disposal column headings indicate only where the new work construction dredged material will be placed, but all OMRR&R dredged material will be placed in-bay at the SF-11 disposal site.

Table 6. Cost Summary, 35-ft Channel

Alternative	35-ft Channel	
Dredge Disposal[10]	**SF-DODS**	**Montezuma**
Construction Cost	$10,990,000	$18,910,000
IDC	$30,000	$40,000
Total NED Cost	$11,020,000	$18,950,000
Annual NED Cost	$439,000	$754,000
PV OMRR&R	$44,963,000	$44,963,000
Avg. Ann. OMRR&R	$1,789,200	$1,789,200
Total, PV	$55,995,000	$63,911,000
Average Annual Cost	$2,228,200	$2,543,200

[10] Dredge Disposal column headings indicate only where the new work construction dredged material will be placed, but all OMRR&R dredged material will be placed in-bay at the SF-11 disposal site.

VII. SUMMARY OF BENEFITS AND COSTS

This section summarizes project benefits and costs and identifies the NED plan.

Alternative plans are compared based on their net annual NED benefits: equal to average annual benefits minus average annual costs. The plan which maximizes net annual NED benefits is the NED plan.

Table 7 summarizes the benefits and costs associated with each alternative and dredge disposal location and presents Net Annual NED benefits and benefit-cost ratios. Based on these calculations, the Tentatively Selected Plan (TSP) is the 32-feet Channel Alternative with dredge material placement site at SF-DODS. The TSP is the NED Plan and reasonably maximizes net annual NED benefits of $1.3 million and a benefit-cost ratio of 1.7.

Table 7. Central Basin Benefits, Costs, and Alternative Comparison

Alternative Channel Depth	Dredge Disposal	Present Value Benefits	Average Annual Benefits	Present Value Costs	Average Annual Costs	Benefit to Cost Ratio	Net Annual NED Benefits	Rank by Net NED Benefits
30-feet	SF-DODS	$72,818,000	$2,898,000	$51,242,700	$2,039,100	1.4	$859,000	4
30-feet	Montezuma	$72,818,000	$2,898,000	$55,238,400	$2,198,100	1.3	$700,000	8
30-feet	Montezuma and SF-11	$72,818,000	$2,898,000	$53,178,000	$2,116,100	1.4	$782,000	6
30-feet	SF-DODS, Montezuma and SF-11	$72,818,000	$2,898,000	$51,242,700	$2,039,100	1.4	$859,000	5
32-feet	**SF-DODS**	**$82,451,000**	**$3,281,000**	**$49,850,500**	**$1,983,700**	**1.7**	**$1,297,000**	**1**
32-feet	Montezuma	$82,451,000	$3,281,000	$55,303,800	$2,200,700	1.5	$1,080,000	2
35-feet	SF-DODS	$82,451,000	$3,281,000	$55,995,000	$2,228,200	1.5	$1,053,000	3
35-feet	Montezuma	$82,451,000	$3,281,000	$63,911,000	$2,543,200	1.3	$738,000	7

Notes:

- Present value and average annual calculations are based on a 50-year period of analysis and a Federal fiscal year 2015 discount rate of 3.375 percent (Note: The FY2017 Federal discount rate decreased 3.125% to 2.875%. The lower discount rate will have a positive effect on net benefits and benefit-to-cost ratios (BCRs). Applying the FY17 discount rate will not affect the determination of the NED plan. The FY17 discount rate will be applied in the Final Economic Appendix).
- OMRR&R costs for this analysis are placeholders at this time and will be updated once finalized. OMRR&R costs include maintenance dredging of Central Basin on a 4-year dredge cycle, with dredge disposal at SF-11. These costs are the same for all alternatives.
- The 30-feet Channel with exclusive placement at SF-DODS was ranked above the 30-feet Channel Alternative with a composite placement site at SF-DODS, Montezuma, and SF-11 due to unquantified potential costs and challenges associated with construction contract administration, ensuring that in-bay capacity is maintained for efficient placement for USACE O&M dredging projects, sediment suitability issues, and environmental regulation requirements and considerations.

Appendix B:

Cost Engineering Report

BASIS OF ESTIMATE
PIER 70: CENTRAL BASIN
CAP 107 NAVIGATION IMPROVEMENT PROJECT
CALIFORNIA

INTRODUCTION
Reference materials used to prepare the Current Working Estimates (CWEs) for Tentative Select Plan (TSP) and alternatives cost estimates along with the basis for the estimates and any applicable facts and/or assumptions impacting the CWEs are documented below.

REFERENCE(S)

- *Report Synopsis, Pier 70 Central Basin Continuing Authorities Program Section 107 Navigation Improvement Project Tentatively Selected Plan Milestone (20 April 2016)*
- *Corps of Engineering Dredging Programs (CEDEP) for clamshell operation and pumping operation.*
- *Hypack Quantity Takeoffs.*
- *Future O&M takeoffs.*
- *Cost Risk Analysis (CRA).*
- *Array of Alternatives Cost Table.*

PROJECT DESCRIPTION
The alternative evaluations for the TSP considered channel depths of -30, -32 and -35 feet plus 1 foot allowable paid over-depth and an additional 1 foot allowable un-paid over-depth. Disposal site options are SF-DODS, Montezuma, and combinations mentioned to SF-11. It is anticipated that this work will be accomplished within 2 months. All dredging, material transportation and material placement shall be in accordance with the project plans, specifications, permits, regulatory guidance and applicable contract clauses.

BASIS/FACTS/ASSUMPTIONS
- Parametric dredging cost estimates was developed using the CEDEP program. A single 21 CY clamshell dredge, 3 - 4000cy dump scow.
- Mobilization and Demobilization of required clamshell dredge, dump scow, and miscellaneous. support equipment was based on hauling from Seattle, Washington. Additional mobilization and demobilization was included for every additional dredge season needed to complete the dredging work.
- Tipping fee for Montezuma ($30/CY) for material considered challenged.
- There are no Real Estate required.
- CRA was prepared with participation from project team members resulted with contingencies for each alternative.

EFFECTIVE PRICE LEVEL
Cost Estimates Effective Price Level is October 1, 2015.

CONSTRUCTION WINDOW
Due to endangered species, the dredging window begins June 1st to November 30th each year.

OVERTIME
Work will be completed using two 12 hour shifts 7 days a week.

ACQUISITION PLAN
The acquisition is unknown at this time, however, the estimates prepared assumed IFB competitive bidding.

CONSTRUCTION METHOD
Typical clamshell dredging is standard. No special construction technologies are required for the job.

EQUIPMENT /LABOR AVAILABILITY AND DISTANCE TRAVELED
The project is located in San Francisco, California. All labor and equipment is assumed available within a 1010 miles radius (Tacoma, WA) in order to allow for fair competition.

ENVIRONMENTAL CONCERNS
No special environmental concerns beyond those stated in the basis/facts/assumptions and Construction Window.

LABOR RATES
The labor used are from the 2016 Davis-Bacon wage rates for San Francisco, California.

Appendix C:

Engineering

Central Basin CAP 107
Navigation Improvements
Coastal Engineering Appendix C.a

San Francisco, California

March 2017

**U.S. Army Corps
of Engineers**

San Francisco District

CONTENTS

FIGURES

TABLES

I. **INTRODUCTION**

This document presents the coastal engineering evaluation performed as part of the Central Basin Continuing Authority Program (CAP) 107 feasibility study. The purpose of this study is to evaluate the feasibility of Federal investment in deep draft navigation improvements for commercial shipping in the Central Basin of the Port of San Francisco, California (Figure 1). These improvements include deepening the existing non-Federal Central Basin channel to allow continued vessel access to the ship yard and dry docks at Pier 70.

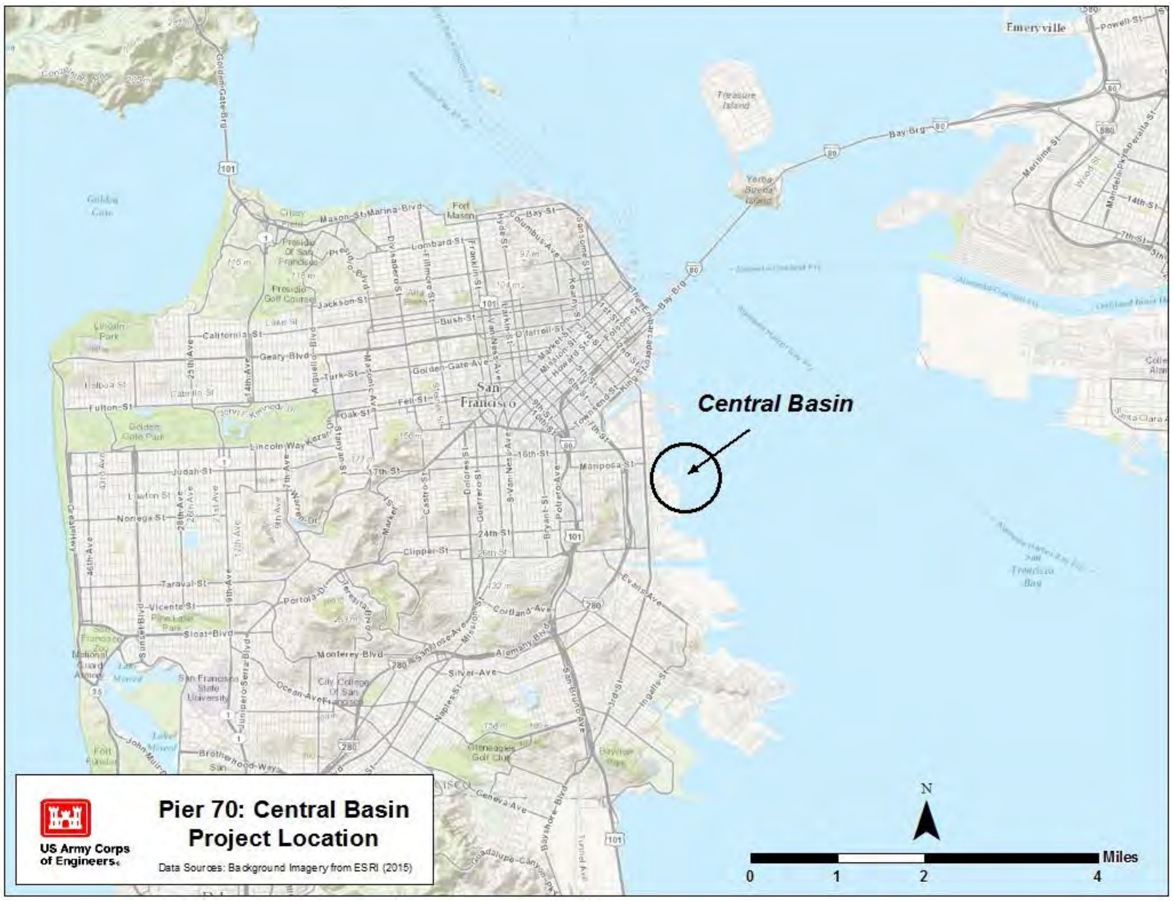


Figure 1. Central Basin vicinity map

The coastal engineering evaluation was conducted by SPN staff with numerical modeling support from a contractor, Delta Modeling Associates. The evaluation includes a review of previous work in the study area, description of existing physical conditions, and determination of future without-project (FWOP) and with project conditions with respect to channel depth.

II. **PURPOSE**

The purpose of this evaluation is to establish the FWOP and future with project conditions necessary to support economic and other planning analyses. The economic analysis required a time series of projected FWOP depths over a 20 year period from an assumed construction date of 2016. These FWOP depths were developed based on a number of assumptions regarding natural processes and human interventions, and this evaluation includes a discussion of these assumptions. The other important planning consideration was the potential impact of sea level change (SLC) on future project performance, and this evaluation includes an analysis of potential SLC impacts over the next 100 years.

This evaluation also serves the purpose of describing the physical processes that will govern the FWOP and future with project depth and navigation conditions in the study area. An understanding of these processes and the associated inherent future uncertainty serves as the basis for completing a risk informed evaluation of future navigation conditions. This is particularly important with respect to predicted shoaling rates in the proposed dredging footprint. As a result, this evaluation employed a variety of techniques, including numerical modeling by a USACE-sponsored contractor (Delta Modeling Associates, **Attachment A)** to quantify how different future conditions (e.g., deepening) may impact shoaling rates.

III. BACKGROUND

The Central Basin study area encompasses a navigation channel, which connects the deeper waters of San Francisco Bay to two dry dock ship repair facilities (Figure 2). The non-Federal Sponsor of the study, the Port of San Francisco (Port), has requested that USACE investigate the feasibility of dredging an approximately 20 acre footprint to a depth of 35 feet relative to the Mean Lower Low Water (MLLW) Datum. The Port has indicated that this footprint size and configuration is necessary to accommodate operations at Dry Dock #2, which include parking ships in an adjacent area prior to entering the dry dock.

The proposed dredging footprint has not been subject to routine maintenance dredging, and most of the proposed footprint is at a depth of least several feet above 35 feet MLLW. However, the Port and one of their tenants, BAE Systems, has performed some dredging in smaller sections of the proposed footprint in order to facilitate access to Dry Dock #2. This dredging has been very limited in scope, with the most recent dredging episode limited to a depth of 30 feet MLLW over a considerably smaller footprint of 6.4 acres.

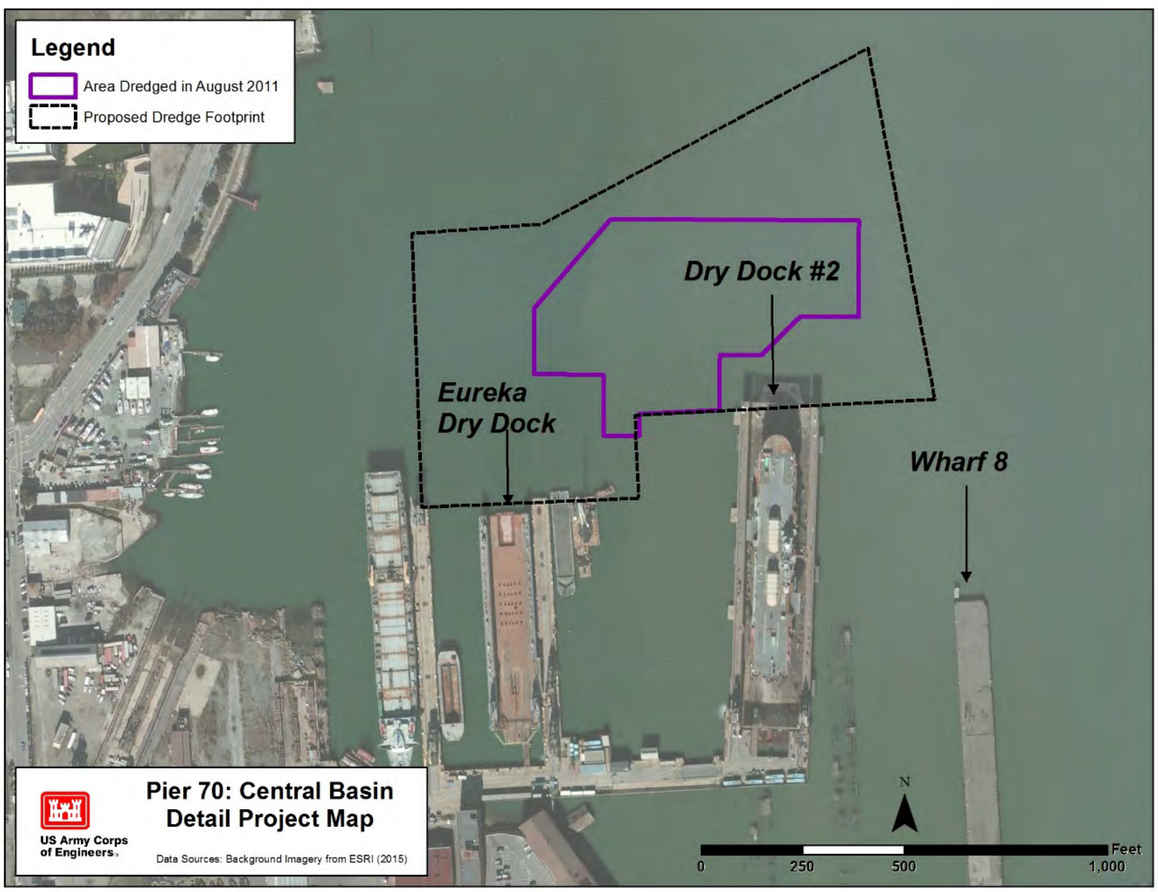


Figure 2. Detail Central Basin study area map

IV. PRIOR REPORTS AND DATASETS

The Central Basin study was initiated with a Federal Interest Determination (FID) in 2010 (USACE, 2010). The FID included a brief discussion of the impacts of the limiting depth (24 feet MLLW as of 2010) on vessel access to Dry Dock #2. The FID also states that shoaling is expected to cause deterioration of navigation conditions, but does not provide a quantitative estimate of shoaling rates. In addition, the FID indicates that USACE has not prepared any other reports regarding Central Basin prior to 2010.

The Port of San Francisco has sponsored a number of studies and data collection efforts that provide relevant information for the Central Basin study area. The primary study of interest is a coastal engineering analysis that was performed to support of development of design concepts for remediation (capping) of contaminated sediments near the shoreline of Crane Cove (Coast & Harbor Engineering, 2014). The coastal engineering analysis also included evaluations of the impacts of three proposed actions on shoaling in the Central Basin, including the removal of Wharf 8, construction of Crane Cove Park Beach, and deepening the proposed footprint to a depth of 35 feet MLLW with 2 feet of overdepth. The removal of Wharf 8 and the construction of Crane Cove Beach have implications for the FWOP condition and are discussed in the **Future Without-Project Condition** chapter.

The above coastal engineering analysis was conducted (unbeknownst to USACE staff at the time) concurrently with the USACE-sponsored numerical modeling (Delta Modeling Associates, 2015). As a result, there is some overlap between the two reports, with both groups utilizing numerical models to predict changes shoaling due to channel deepening.

The Port of San Francisco and its primary tenant at Pier 70 have also sponsored a series of hydrographic surveys in the study area. Surveys have been conducted on a yearly (or more frequent) basis since at least 2010, and include both single beam and higher resolution multibeam datasets. Five of these datasets were utilized to derive mean depths in the proposed dredging footprint, and these depths, along with shoaling rates and sea level change, were used to inform the FWOP depth. A more detailed description of the bathymetric datasets used in the FWOP analysis is presented in the **Future Without-Project Condition** chapter.

The Port of San Francisco Sea Level Rise and Adaptation Study (URS/AGS Joint Venture, 2012) is also of interest, as it includes modeled Total Water Levels (TWLs) along the waterfront just north of the study area at Pier 54. These TWLs were computed for a 1 percent chance exceedance (100 year) event, and can inform the evaluation of the future performance of critical project infrastructure such as pier decks under both FWOP and with project conditions. The National Oceanic and Atmospheric Administration (NOAA) *NOAA Digital Coast Sea Level Riser Viewer* also provides a method for visualizing how different sea level change scenarios could impact critical project infrastructure (NOAA, 2016), and is further discussed in the **Future With Project Condition** chapter.

V. EXISTING CONDITIONS

A. Physical Characteristics

Central Basin is located approximately 2 miles south of the San Francisco-Oakland Bay Bridge on the western edge of San Francisco Bay (Figure 3). As a result, the setting of the study area has been shaped by a number of physical processes that operate on varying timescales throughout the San Francisco Bay.

1. Tides

The San Francisco Bay is subject to a mixed semidiurnal tidal regime, which is characterized by two unequal sets of daily highs and lows that vary in amplitude over time. Tidal amplitude also has a distinct seasonal signal along the California coast, with the largest tidal ranges typically occurring during spring tidal cycles in the late fall and winter months (Figure 4). As a result, the highest water levels typically occur during winter storms (see **Total Water Level** section), and have the potential to impact the operation of critical project infrastructure.

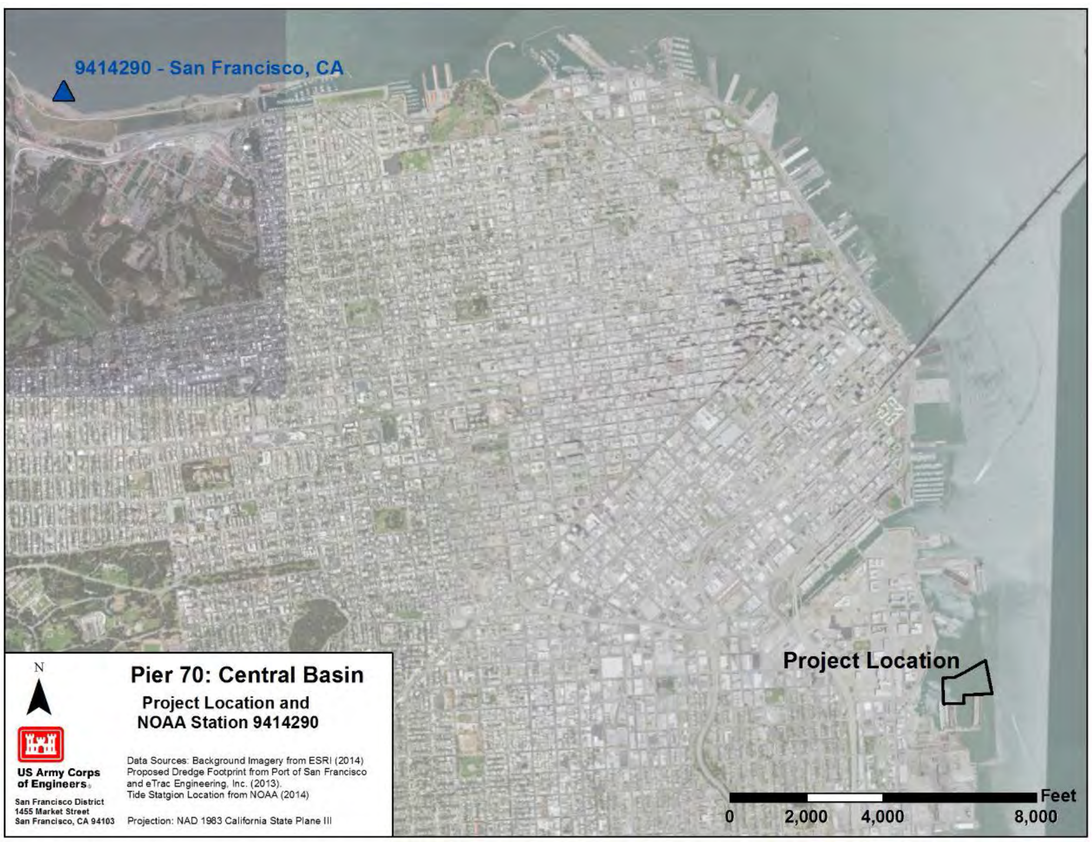


Figure 3. Locations of Central Basin study area and San Francisco tide station (9141290)

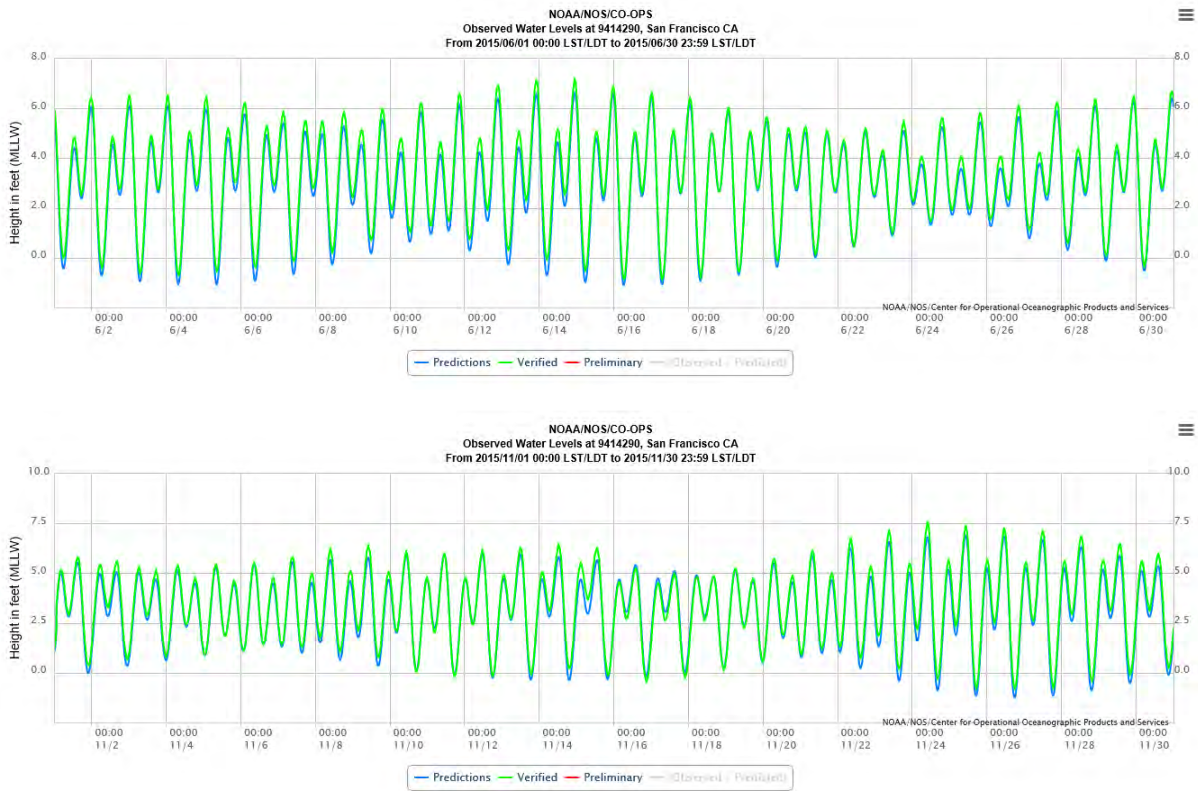


Figure 4. Observed water levels at the San Francisco tide station (9414290) in June and Nov 2015.

While this study utilizes water level data from the NOAA San Francisco tide station, (Figure 3; Table 1), it should also be noted that the Port has established a network of tidal benchmarks on Port property (Table 2). This network includes a benchmark (EE-09) which was used by the Port to define the relationship between MLLW and NAVD88 in the Central Basin project area. The NAVD88 elevation at benchmark EE-09 was established by direct (differential) leveling from City and County of San Francisco Benchmarks, and the vertical datum transformation to MLLW was completed using NOAA VDatum. As a result, this analysis is based on the assumption that MLLW is 0.17 feet below NAVD88 in the project area. However, no additional tidal datums were established at EE-09 (Mueller, per comm., 2015), and all additional tidal datums cited in this sea level change analysis are from the San Francisco tide station.

Table 1: Tidal datums at NOAA Gauge 9414290 relative to Mean Lower-Low Water (MLLW)

Datum	Description	Feet
Maximum	Highest Observed Water Level (01/27/ 1983)	8.66
MHHW	Mean Higher-High Water	5.84
MHW	Mean High Water	5.23
MTL	Mean Tide Level	3.18
MSL	Mean Sea Level	3.12
MLW	Mean Low Water	1.13
MLLW	Mean Lower Low Water	0
NAVD88	North American Vertical Datum of 1988	-0.06
Minimum	Lowest Observed Water Level (12/17/1933)	-2.88

Table 2: Datum conversions for tidal benchmarks established by Towill Inc for the Port of San Francisco

BM Designation	Horizontal Datum	Projection	Northing (Y)	Easting (X)	NAVD88	MLLW	Vertical Units
EE-09	NAD83(1992)	CA Zone 3	2106154.93	6017004.64	11.49	11.66	U.S. Survey Feet

(Source: Port of San Francisco and eTrac, Inc)

2. Waves

Long period ocean swell does not propagate to the Central Basin area due to the distance from the Golden Gate and orientation of the shoreline (URS/AGS Joint Venture, 2012). As a result, Central Basin is subject to generally small and short period waves generated by local winds over the San Francisco Bay. Wind-wave growth and transformation modeling with SWAN suggests that a wind event with a return period of 100 years may produce wave heights of up to 5 to 6 feet in the eastern section of Central Basin (Coast & Harbor Engineering, 2014; Figure 5). However, this modeling exercise assumed that the Wharf 8 and BAE facilities did not limit wave penetration to Central Basin, and therefore the extreme wave heights in Central Basin may be less than suggested by the modeling.

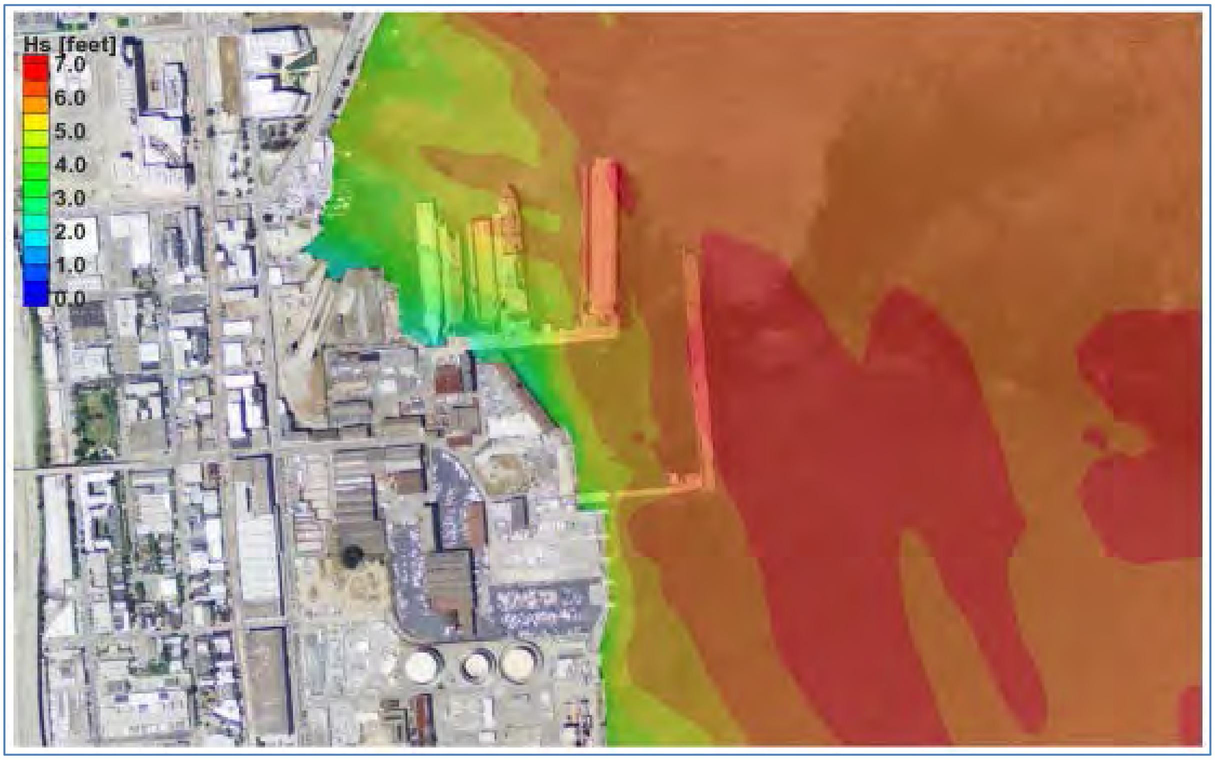


Figure 5. 100-Yr significant wave heights at Central Basin (Source: Coast & Harbor Engineering, 2014)

3. Total Water Level

The Total Water Level (TWL) includes the overall effects of tides and atmospheric conditions (Still Water Level [SWL]) combined with wave runup. SWL is typically reflected in water levels recorded at tide gauges and can be several feet lower than TWL along shorelines subjected to large waves. While TWL has not been computed in the immediate vicinity of Central Basin, the Port's Sea Level Rise and Adaptation Study (URS/AGS Joint Venture, 2012) does include TWL computations in an area near Pier 54, which is approximately 0.25 miles north of Central Basin (Figure 6). The 100-year TWL for this location is 12.50 feet MLLW, which is nearly four feet higher than the highest observed water level (8.55 feet MLLW, relative to Central Basin) at the San Francisco tide station. While the TWL at Central Basin is likely to be somewhat different than the one computed at Pier 54, the TWL at Pier 54 suggests that wave runup may add at least a couple of feet to the SWL at Central Basin.

Figure 6. Locations were TWLs were calculated relative to Central Basin. Note that Point 20 is located approximately 0.25 miles north of Central Basin (Source: URS/AGS Joint Venture, 2012)

4. Sea Level Change

Records from tide gauges have shown that the shoreline of San Francisco Bay has been subject to relative sea level change (SLC). The San Francisco tide station (9414290,) has continuously recorded water levels for 113 years, which yields a relative historical SLC of 2.01 mm/yr (0.00659 ft/yr). There is also a NOAA tide station located across central San Francisco Bay at a similar distance from the project at Alameda (9414750). However, this station has a shorter period of record (75 years) and a lower historical SLC rate of 0.82 mm/yr (0.00269 ft/yr). As a result, this study used the San Francisco tide station to characterize SLC at Central Basin.

USACE policy (ER 1100-2-8162) states that alternatives must be formulated and evaluated for the entire range of SLC rates represented by three scenarios of “low”, “intermediate”, and “high” SLC rates (Figure 7). The “low” SLC rate is represented by historic rate of SLC at the project site, and was derived from records at the San Francisco tide station (9414290). The “intermediate” and “high” rates are estimated using the modified National Research Council

(NRC) Curves I and III and corrections based on local vertical land movement. The NRC Curves assume a global mean sea level (GMSL) change of 1.7 mm/yr (0.0056 ft/yr) with varying degrees of SLC acceleration for the two curves. A more detailed discussion of the sea level change analysis methods and implications for FWOP conditions is presented in the **Future Without-Project Condition** chapter.

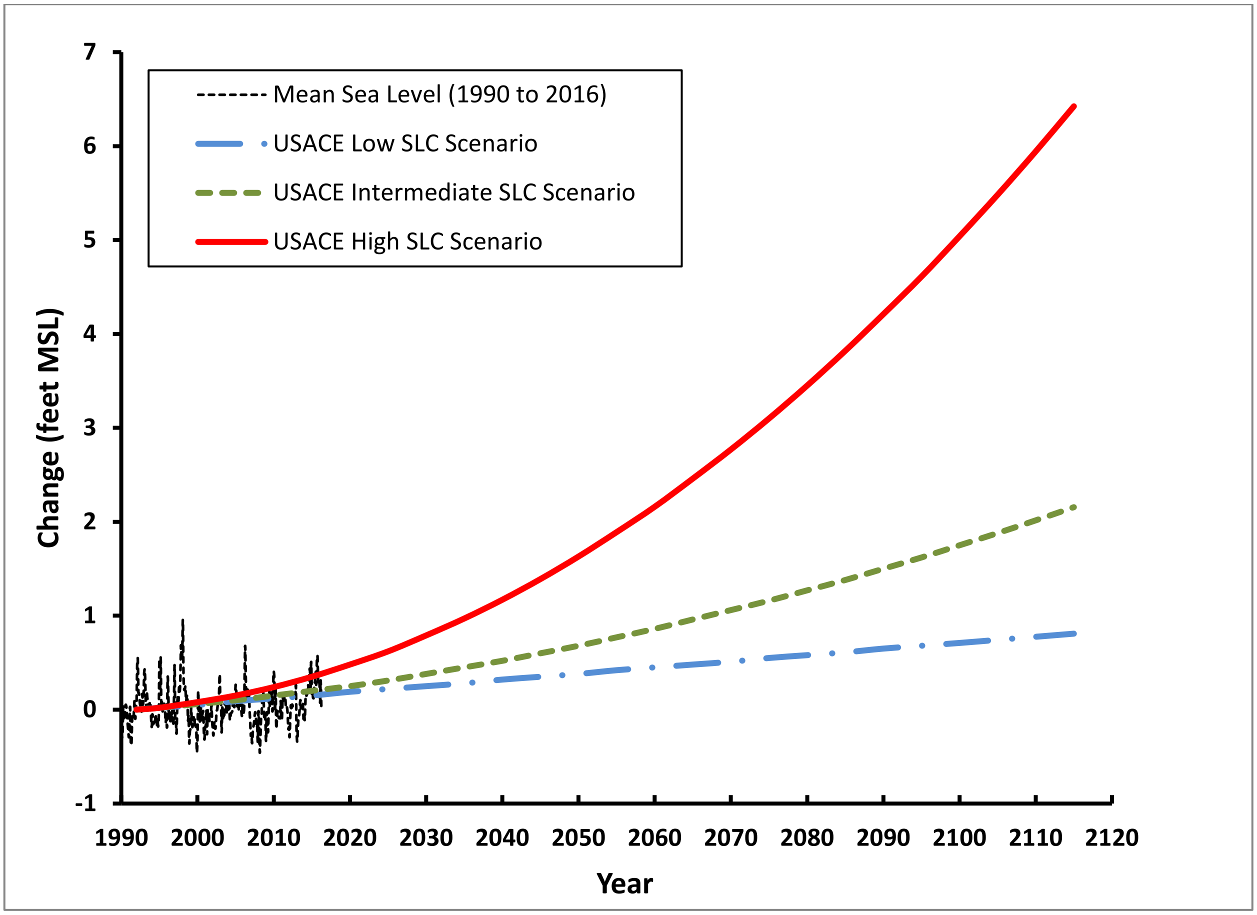


Figure 7. Projections of relative SLC from 1992 to 2116 based on the USACE "low", "intermediate", and "high" rates (Source: USACE *Sea-Level Change Curve Calculator* and NOAA, 2016).

5. Currents and Sediment Transport

The San Francisco Bay is subject to considerable spatial and temporal variations in currents. In the central San Francisco Bay, currents are primarily influenced by tidal fluctuations with currents reversing in response to the flood and ebb of the tides. Central Basin is relatively sheltered from the stronger tidal currents, with MORPHO model simulations (Coast & Harbor Engineering, 2014) suggesting that currents rapidly decrease in strength (to < 1 foot /second) toward the western section of Central Basin. As a result, most of the proposed dredge footprint in the central basin is subject to considerable sediment deposition, which can be observed in the series of bathymetric surveys discussed in the Future Without-Project Condition chapter.

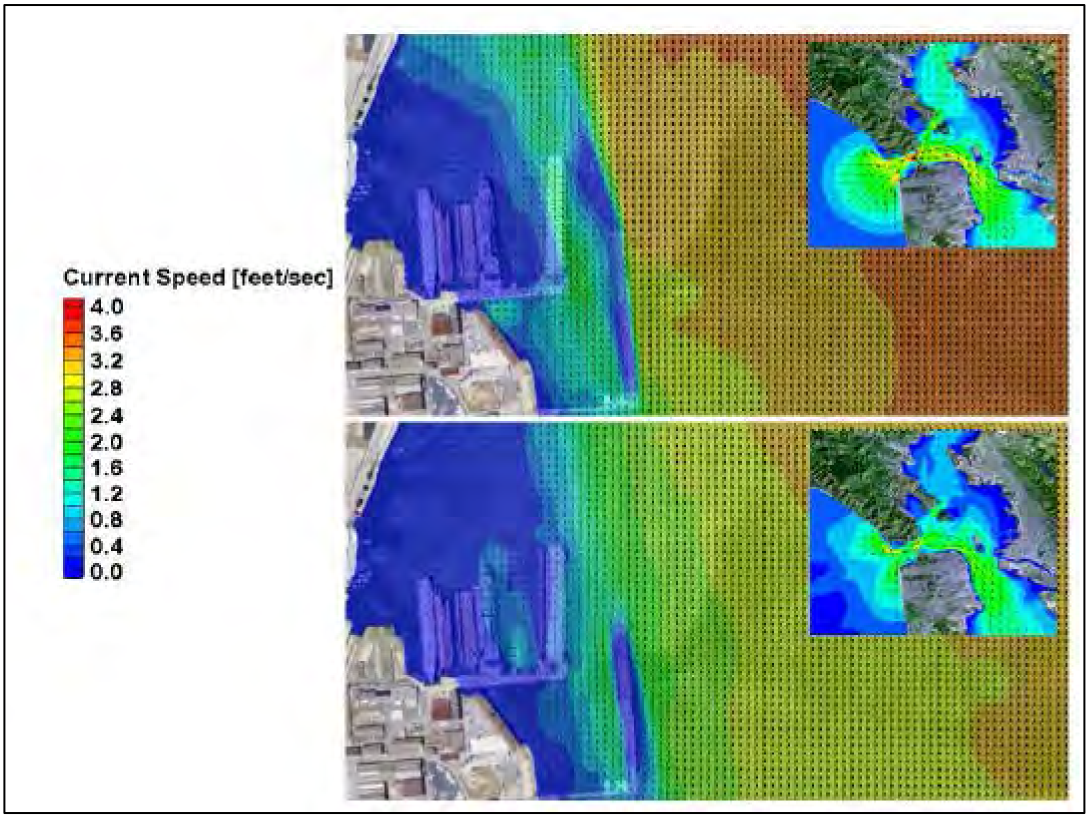


Figure 8. Typical current speeds and directions during peak ebb and (top) and flood (bottom) tidal forcing (Source: Coast & Harbor Engineering, 2014).

6. Vicinity Bathymetry

Central Basin is located along the western edge of San Francisco Bay, which is marked by a relatively abrupt transition from relatively deep to shallow water. The far eastern section of the proposed dredging footprint is characterized by depths greater than 30 feet MLLW, and will likely require little in the way of dredging (Figure 9). However, the central and western section of the footprint encompass large areas with depths of less than 30 feet MLLW, with the minimum depths (15 to 20 feet MLLW) in the far western section of the proposed footprint. This area in the far western section of the proposed footprint did not appear to have been maintained during the latest (BAE-funded) dredging episode in 2011, whereas the central section of the footprint was clearly dredged to a depth of at least 28 feet MLLW. It should also be note that BAE Systems routinely maintains the area under Dry Dock #2 to a depth of 60 to 65 feet MLLW.

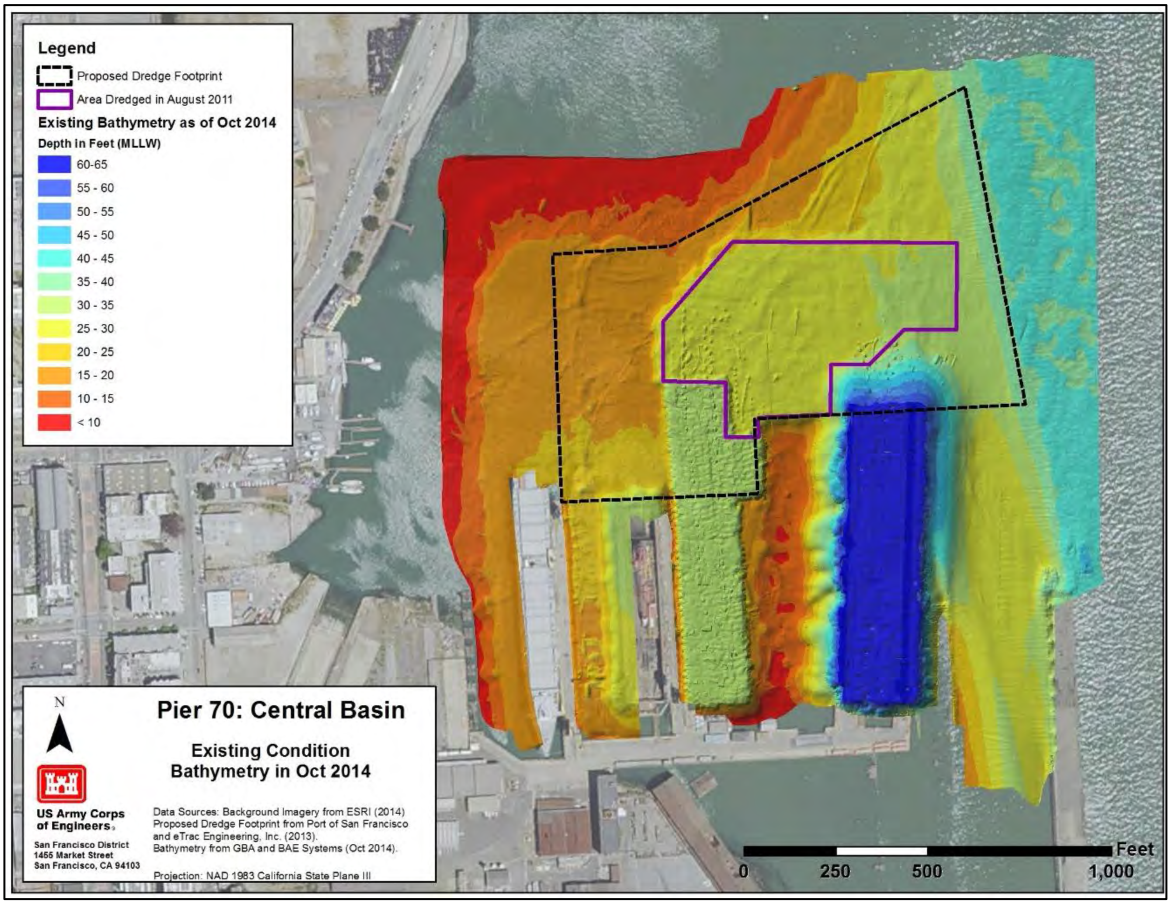


Figure 9. Existing bathymetry as on October 2014 in the study area

VI. FUTURE WITHOUT-PROJECT CONDITION

This section details the assumptions, methods, and findings regarding the FWOP depth in study area. The FWOP depth was projected out 20 years from an assumed construction date of 2016 at the request of the project economist. The FWOP depth takes into account predicted shoaling and the impacts of sea level change (SLC), but does not assume any future deepening or maintenance dredging of the proposed project footprint by the non-Federal sponsor (Port).

A. Assumptions and Methods

The key assumptions and methods utilized to determine the FWOP depth are described below.

1. Key Assumptions

The starting depth for the FWOP was derived from a series of 5 hydrographic surveys from 2010 to 2014. This time period included one relatively limited (BAE Systems-funded) dredging episode in 2011, under the assumption that the staring depth should account for this activity. The FWOP depth over the 20 years following 2016 was developed under the assumption that the Port would not sponsor any dredging in Central Basin in the future. This assumption was made at the direction of Planning and the project team, and is discussed in detail in the main body of the Detailed Project Report.

The FWOP condition also accounted for two actions that are likely to be undertaken by the Port in the immediate study area. These actions include removal of Wharf 8 (Figure 2) and construction of a beach at Crane Cove (Crane Cove Park Beach), and previous work by another party (Coast & Harbor Engineering, 2014) has already evaluated the impacts of these actions on hydrodynamic conditions and shoaling. As a result, the FWOP utilizes findings from this report to characterize the impacts of these two actions.

The background shoaling rate over the period of 20 years following 2016 was developed based on the assumption of a uniform shoaling rate over the FWOP analysis period. The reasoning for this assumption is further described in the **Impacts of Shoaling** section in this chapter.

2. Methods

a. Bathymetric Analysis

GIS software was utilized to derive mean depths of the proposed dredging footprints from a series of 5 hydrographic survey datasets from November 2010 to January 2014. This time period was selected as the hydrographic survey datasets were readily available, and it covers a recent dredging episode in August 2011. Four of the hydrographic surveys were conducted by a contractor to BAE Systems, Inc. (Gahagan Bryant Associates, Inc. [GBA]) with a single beam echo sounder along survey lines spaced at approximate 50 foot intervals. The May-June 2013 survey was conducted by a contractor to the Port of San Francisco (eTrac Engineering, Inc.) with multibeam sonar, and provides a significantly higher resolution depiction of bathymetry. In addition, AutoCAD files depicting the proposed dredging footprint, previously dredged areas, and lease areas were obtained from eTrac Engineering, GBA, and the Port of San Francisco, respectively.

The hydrographic survey datasets used in the mean depth analysis were originally provided as xyz files, which depicted horizontal coordinates (x and y) and depths (z) associated with soundings. All horizontal coordinates were referenced to the North American Datum (NAD) 1983 State Plane California Zone III coordinate system, and all depths were referenced to the mean lower-low water (MLLW) datum. It should be noted that the MLLW datum was based on Benchmark "EE09", which was established by Towill Inc. under the direction of the Port of San Francisco (Ach, 2014). The xyz files were then converted to txt files, which were imported into ESRI ArcGIS 10.1, where the data points and associated depth data were plotted on a map using the "Display XY Data" tool. These data point layers were then exported as GIS feature classes, which were subsequently edited (e.g., combined) to ensure that all survey points associated with each respective survey matched the original charts (PDF format) provided by the contractors.

The GIS feature classes where then used to create triangular irregular network (TIN) surfaces for each survey, which were clipped with the proposed dredging footprint. The proposed dredging footprint did not include the area currently leased by BAE Systems (per Port of San Francisco, 2012), the expanded area (DU-4), or two areas where there was insufficient survey coverage to accurately characterize depth (**Figure 1**). The TIN surfaces were then converted to raster files (cell size of 1 foot), which provided the depth statistics (mean, maximum, minimum, and standard deviation) that are reported in **Table 1**.

The June 2013 and January 2014 hydrographic survey datasets (xyz format) were also provided to the 3-D modeling contractor (Delta Modeling Associates), who processed the datasets into 1 meter resolution digital elevation models (DEMs). The contractor then computed the net shoaling rate by summing the change in seabed elevation (bathymetry) from June 2013 to January 2014 in each DEM cell, including cells that experienced erosion. The results of the contractor's net shoaling rate computation were then validated by USACE staff using the above described rasters depicting the June 2013 and January 2014 bathymetric surfaces.

b. Numerical Modeling

The contractor used a 3-D hydrodynamic, wind wave, and sediment transport model to simulate the amount of shoaling that could be expected to occur during a year (2006) characterized by wet hydrologic conditions, which are typically associated with significantly higher shoaling rates. The model was also utilized to evaluate how shoaling rates vary with project depths and the expanded dredging footprint (including DU-4). This 3-D model coupled the UnTRIM Bay-Delta model, the SWAN wave model, and the SediMorph sediment transport and seabed morphology model, and a detailed description of the models are provided in Delta Modeling Associates (2015).

c. Sea Level Change Analysis

This analysis utilized the USACE *Sea-Level Change Curve Calculator* (USACE, 2015) along with associated sea level change rate equations to compute the three SLC rates for the 124 year period from 1992 to 2016. The *Sea-Level Change Curve Calculator* This time period was selected to include a 100 year time period following an assumed construction date of 2016, and to account for SLC from the middle point (1992) of the last National Tidal Datum Epoch (NTDE) to 2016. It was necessary to account SLC for the period from 1992 to 2016 because the tidal datums utilized in this analysis were based on the last NTDE.

B. Channel Depth

1. Present Channel Depth

The mean depth within the proposed dredge footprint which excluded DU-4 ranged from -26.0 feet in November 2010 to -28.1 feet in November 2011, *with a mean of 27.3 feet MLLW over the course of the 5 surveys* (**Table 1**). The greatest depths were found adjacent to the main dry dock, where depths ranged down to just below 60 feet MLLW. The shallowest depths were found along the northern and western edges of the proposed dredging footprint, including a broad area with depths of less than 20 feet MLLW. However, areas that had been dredged in August 2011 (outline in blue in **Figure 1**) were considerably deeper (25 to 35 feet MLLW) than the shallow areas to the west and north.

Table 3. **Depths in proposed Central Basin dredge footprint (not including DU-4) from 2010 to 2014. Note that all depths are referenced to Mean Lower Low Water (MLLW).**

Survey Date	Mean Depth (ft)	Maximum Depth (ft)	Minimum Depth (ft)	Standard Deviation (ft)
Nov 2010	26.0	57.3	17.1	6.5
Nov 2011	28.1	59.6	16.0	6.3
Aug 2012	27.7	60.2	15.1	6.3
Jun 2013	27.4	61.4	14.3	6.4
Jan 2014	27.1	60.9	14.3	6.4
Mean	**27.3**	**59.9**	**15.4**	**6.4**

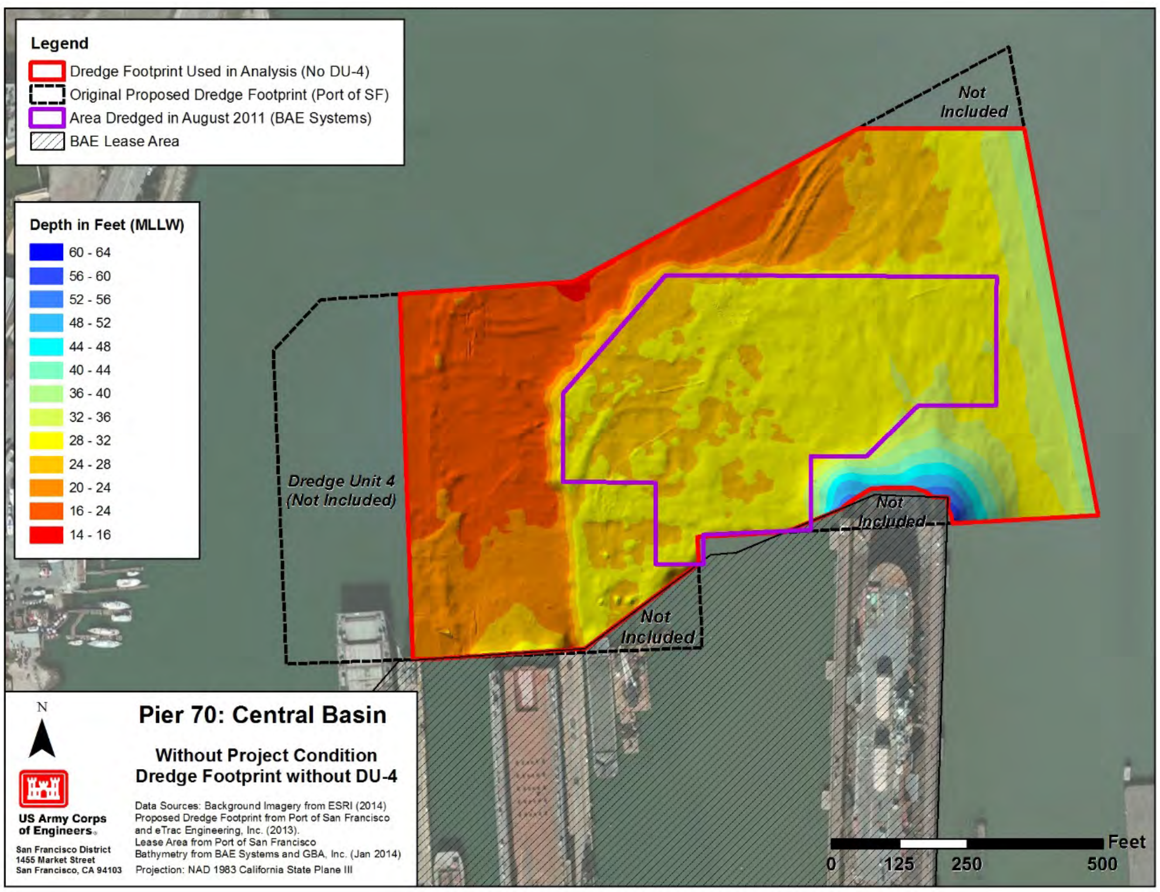


Figure 10 Bathymetry as of January 2014 and the proposed dredge footprint without DU-4

2. Impacts of Shoaling

The contractor (Delta Modeling Associates) estimated that the net shoaling rate from Jun 2013 to Jan 2014 in the footprint excluding DU-4 was approximately 16,000 cubic yards per year. This estimate was validated by USACE, which computed a net shoaling rate of 15,500 cubic yards per year. The shoaling was not uniformly distributed throughout the footprint, with the greatest shoaling (up to 1 foot) concentrated in the western section of the footprint last dredged by BAE Systems in 2011 (Figure 11, Figure 12). There was also some modest erosion in the northeastern section of the footprint, and widely scattered areas of little to no bathymetric change. The 3-D numerical modeling predicted a net shoaling rate of 31,500 cubic yards per year during a year (2006) characterized by wet hydrologic conditions (Figure 13). This rate was nearly double the rate measured during the very dry conditions from June 2013 to January 2014, and suggests that there can be significant year-to-year variations in shoaling rates.

In order to estimate a long-term shoaling rate over the entire footprint (excluding DU-4), it was necessary to assume the mean depth would decrease at a rate equal to the thickness of sediment that would accumulate if the sediment were to be distributed uniformly over the entire footprint. Thus, if it is assumed that 16,000 cubic yards (432,000 cubic feet) of material will be uniformly distributed over the section of the footprint where the two surveys overlapped (area ~ 827,000 square feet), this will translate into a thickness of approximately 0.5 feet. In the case of a shoaling rate of 31,500 cubic yards per year, this would translate into a decrease in depth of approximately 1 foot per year.

The Coast & Harbor Engineering report (2014) also produced similar findings regarding the shoaling rate in Central Basin. The report found that the immediate vicinity of the proposed dredging footprint experienced shoaling rates ranging from 1 to 8 inches per year from 1999 to 2013, with the highest shoaling rates (8 inches per year) were concentrated in the zone (3) that essentially overlaps the western section of the proposed dredging footprint (Figure 14).

The report also suggested that the removal of Wharf 8 would result in a redistribution of shoaling farther west into Central Basin and south into the dry dock areas. The shoaling rates would increase in the western section of the proposed dredge footprint (DUs 2 and 3) from 8 to 9 inches per year to 9 to 10 inches per year, and decrease in the eastern section (DU-1) by 69 percent from nearly 5 inches per year to 1.5 inches per year. However, the magnitude of the predicted decrease in shoaling in the eastern section of the dredge footprint (3.5 inches per year) falls within the 6 inch (0.5 foot) range of uncertainty associated with hydrologic conditions. Thus, it can be assumed that assumed that the decrease in shoaling in this section would have a minimal impact on future O&M dredging requirements under FWOP project conditions. It should also be noted that the report modeling found that the construction of

Crane Cove Park Beach would not have a notable impact on shoaling rates in the proposed dredge footprint.

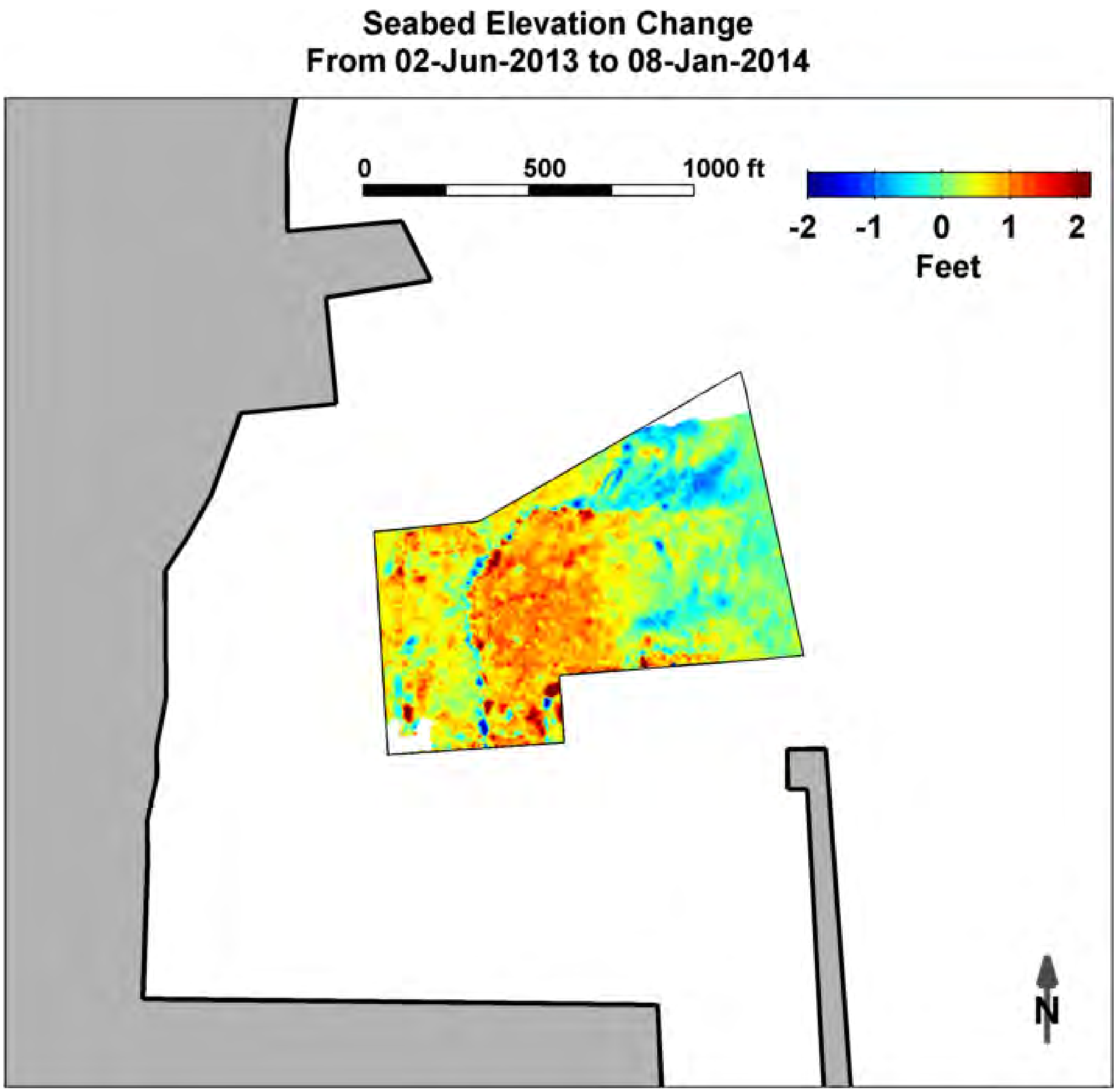


Figure 11. Change in bathymetry within Central Basin (DUs 1, 2, and 3) between June 2013 and Jan 2014 (Delta Modeling Associates, 2015)

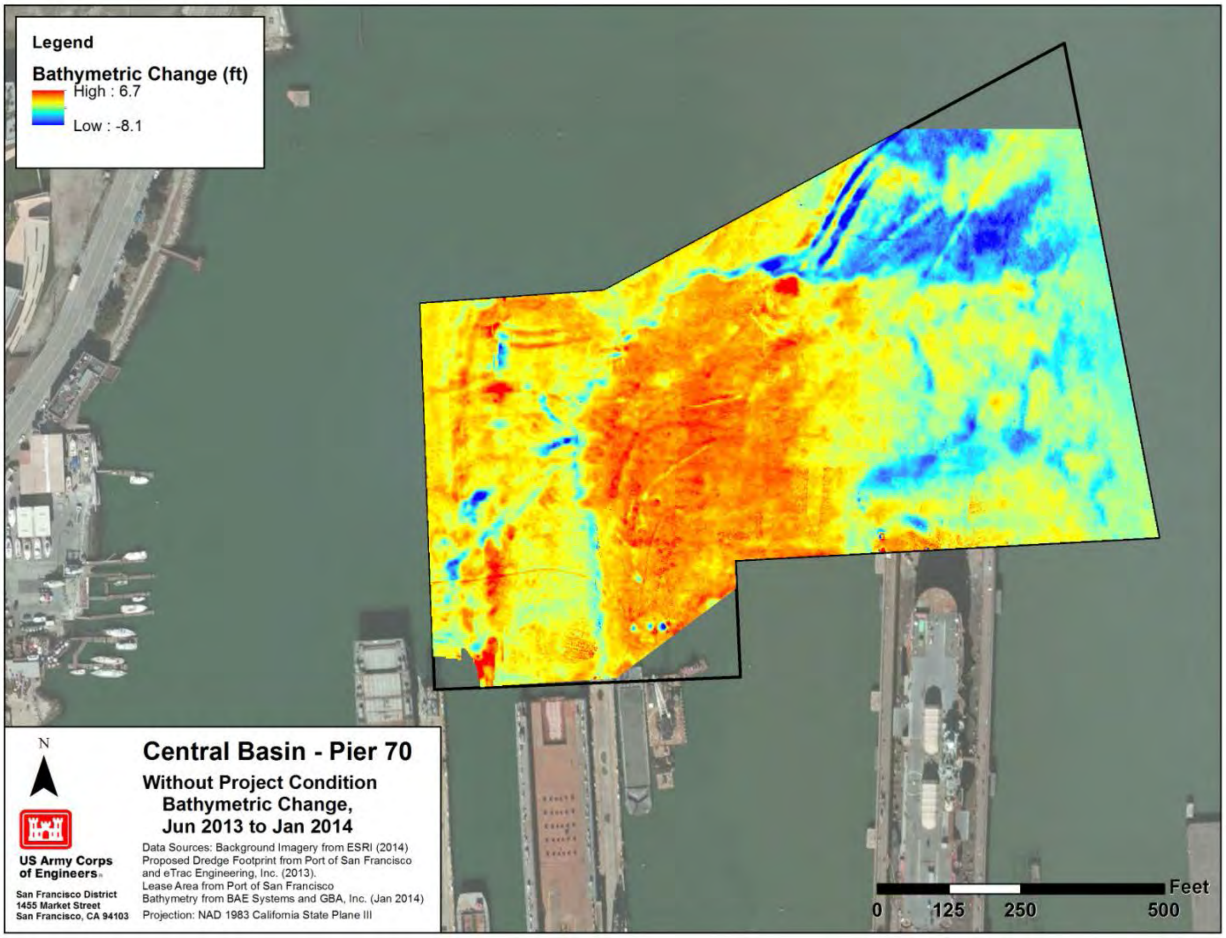


Figure 12 Change in bathymetry computed by USACE. Note that the raster surfaces used in this validation were higher resolution than the DEMs developed by Delta Modeling Associates.

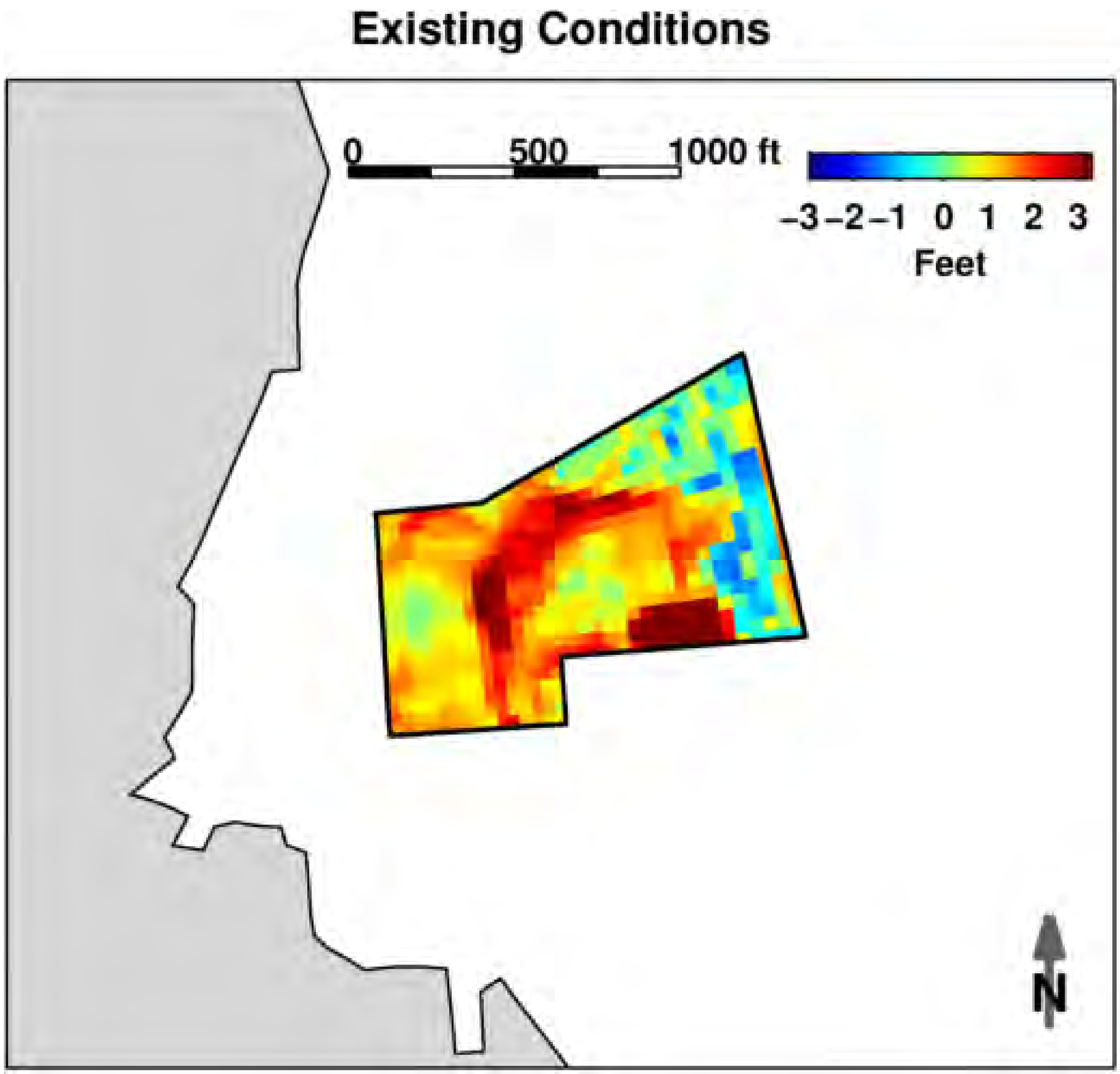


Figure 13. Sediment deposition thickness in Central Basin during a wet water year (2006) for the existing conditions (without project condition) scenario (Delta Modeling Associates, 2015).

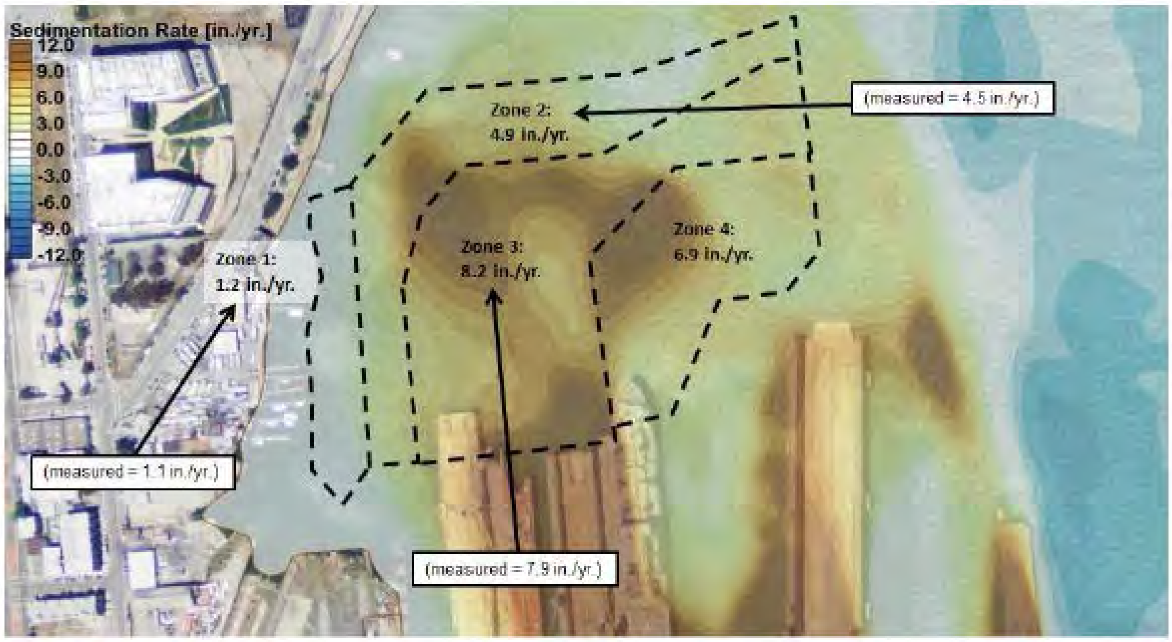


Figure 14. Model predicted and measured shoaling rates (Source: Coast & Harbor Engineering, 2014)

The above findings suggest that the proposed Central Basin dredging footprint will decrease in depth at a rate of 0.5 feet to 1.0 feet per year. However, the higher rate of shoaling (1.0 feet) is associated with wet hydrologic conditions that do not occur every wet season, and it is likely that shoaling rates will decrease over the long-term as previously deepened areas fill and approach the same depth as surrounding bathymetry. Therefore, a more conservative shoaling rate of 0.5 feet per year was applied to determine the FWOP depth.

3. Sea Level Change

Potential relative SLC at Central Basin from 1992 to 2116 ranges from 0.82 feet ("low" rate) to 6.52 feet ("high" rate). The "low" rate is linear with a steady increase of 0.0066 feet per year throughout the planning horizon. It should be noted that this rate implies that there has been 0.16 feet of relative SLC from the middle point of the last NTDE in 1992 to 2016. In the case of the "intermediate" and "high" SLC scenarios, the rates considerably accelerate after approximately 2050, when the "high" rate yields a SLC rates of over 0.5 foot per decade (Table 4). As shown in Table 4, it can be anticipated that sea level change will slightly increase channel depth over the 20 years following construction, with a maximum potential increase in depth of approximately 1 foot under the "high" rate.

Table 4. Estimated relative SLC (ft) for the three USACE rates at Central Basin from 1992 to 2016 based on a historical rate of 0.00659 ft/yr at the San Francisco Tide Station (9414290)(Source: USACE *Sea-Level Change Curve Calculator*).

YEAR	LOW (HISTORICAL)	INTERMEDIATE (NRC I)	HIGH (NRC III)
1992	0	0	0
2000	0.05	0.06	0.08
2010	0.12	0.15	0.24
2016	**0.16**	**0.21**	**0.37**
2020	0.19	0.25	0.48
2030	0.25	0.38	0.79
2040	0.32	0.52	1.17
2050	0.38	0.68	1.63
2060	0.45	0.86	2.16
2070	0.51	1.06	2.77
2080	0.58	1.27	3.45
2090	0.65	1.5	4.21
2100	0.71	1.75	5.04
2110	0.78	2.02	5.94
2116	**0.82**	**2.18**	**6.52**

4. Future Without-Project Condition Depth

For the purpose of the economic analysis, the FWOP depth was projected out 20 years for a no sea level change scenario and the three USACE rates. The shoaling rate of 0.5 feet per year would yield an approximate 10 foot decrease in depth over the course of 20 years **(Table 2)**, with a mean depth approaching 17 feet (MLLW) by 2036. The impacts of sea level change over the course of 20 years is likely to be relatively minor, with the high rate potentially offsetting the anticipated shoaling by only 1 foot or so.

Table 5. Central Basin Future Without-Project Channel Depths – in feet below MLLW

YEAR	NO SEA LEVEL CHANGE	LOW RATE (HISTORICAL)	INTERMEDIATE RATE (NRC I)	HIGH RATE (NRC III)
2016	**27.3**			
2021	24.8	24.8	24.9	25.0
2026	22.3	22.4	22.5	22.8
2031	19.8	19.9	20.1	20.5
2036	17.3	17.4	17.7	18.3

VII. FUTURE WITH PROJECT CONDITION

The future with project condition evaluation included analysis of the impacts of deepening on shoaling rates, and an assessment of the future performance of the channel and critical infrastructure potential sea level change.

A. Alternatives and Methods

1. Alternatives

The future with project condition evaluation included deepening alternatives of 30, 32, and 35 feet MLLW. Preliminary economic analysis indicated that the NED (National Economic Development Plan) depth would likely be 32 feet MLLW, and the assessment of potential future impacts of SLC was adjusted accordingly.

2. Methods

a. Numerical Modeling

The contractor to USACE (Delta Modeling Associates) also utilized the 3-D model (see Future Without-Project Condition chapter) to simulate the impacts of deepening the channel to 30, 32 and 35 feet MLLW. The simulated deepening was accomplished by altering the bathymetric grid to include uniform deepening to the given depth over the proposed dredging footprint.

b. Sea Level Change

The USACE *Sea-Level Change Curve Calculator* also provided tidal datums and extreme water levels for a number of annual exceedance probabilities (AEPs)(Figure 15, Figure 16). The extreme water levels served as a baseline for comparing the impacts of SLC under the different rates to critical performance thresholds (depths and elevations) for project elements. The critical performance threshold for channel performance involves channel depth during extreme low water conditions. Thus, the 50% AEP extreme low water level was utilized to evaluate how the three SLC rates would impact channel performance. The primary critical performance threshold for dry dock infrastructure involves access to said infrastructure via the Pier 70 deck, with the Pier 70 deck elevation serving as this threshold. As a result, the 1% AEP extreme high water level was used to assess the potential impacts to access to the Pier 70 Ship Repair facility under the three SLC rates.

There are also several sites being evaluated for placement of dredged material from Central Basin including both aquatic and upland sites. The primary aquatic site under consideration is the San Francisco Deep Ocean Disposal Site (SF-DODS) which is located approximately 55 miles west of the Golden Gate. There is also the possibility that some material may be taken to the Alcatraz Disposal Site (SF 11) located in the San Francisco Bay adjacent to Alcatraz Island. In the case of aquatic disposal at both of these sites, it is very unlikely that sea level change will have any impact on dredged material placement operations, and thus there are no critical performance thresholds. The potential upland site, Montezuma Wetlands, is an active tidal wetland restoration project where it is anticipated that tidal waters will routinely inundate the site, and it is likely that the project will accommodate some degree of SLC. However, specific design information was not available for this site at the time of writing, and therefore no critical performance thresholds were identified for this site.

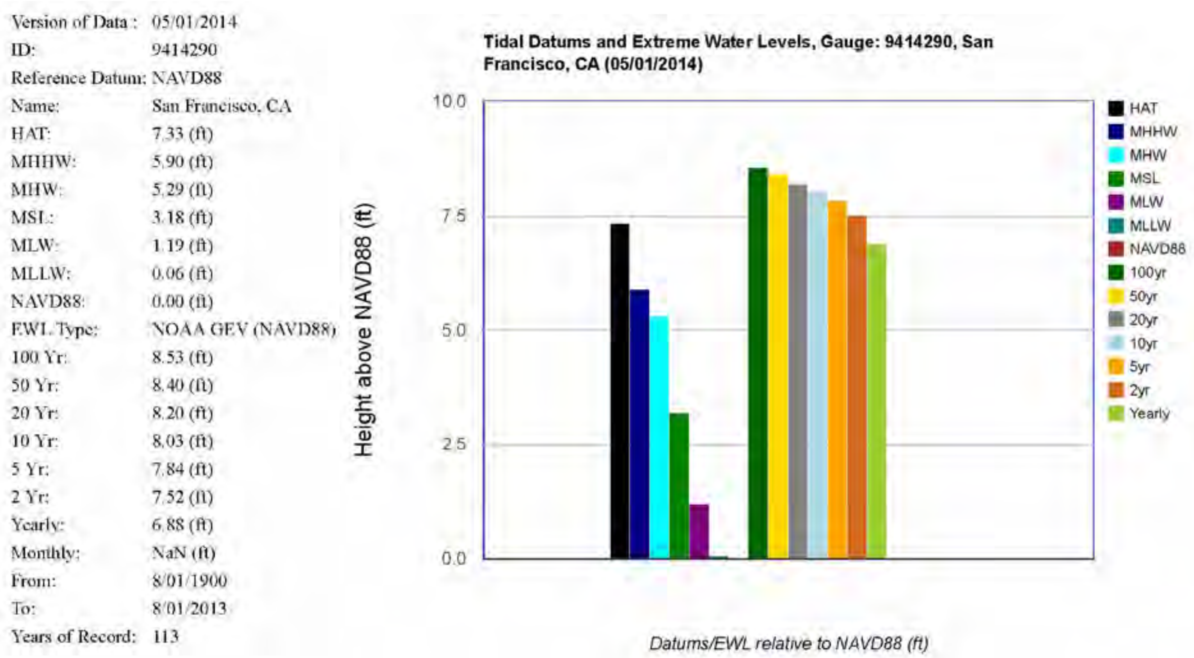


Figure 15. Tidal datums and extreme high water levels at NOAA Gauge 9414290 relative to the North American Vertical Datum of 1988 (NAVD88).

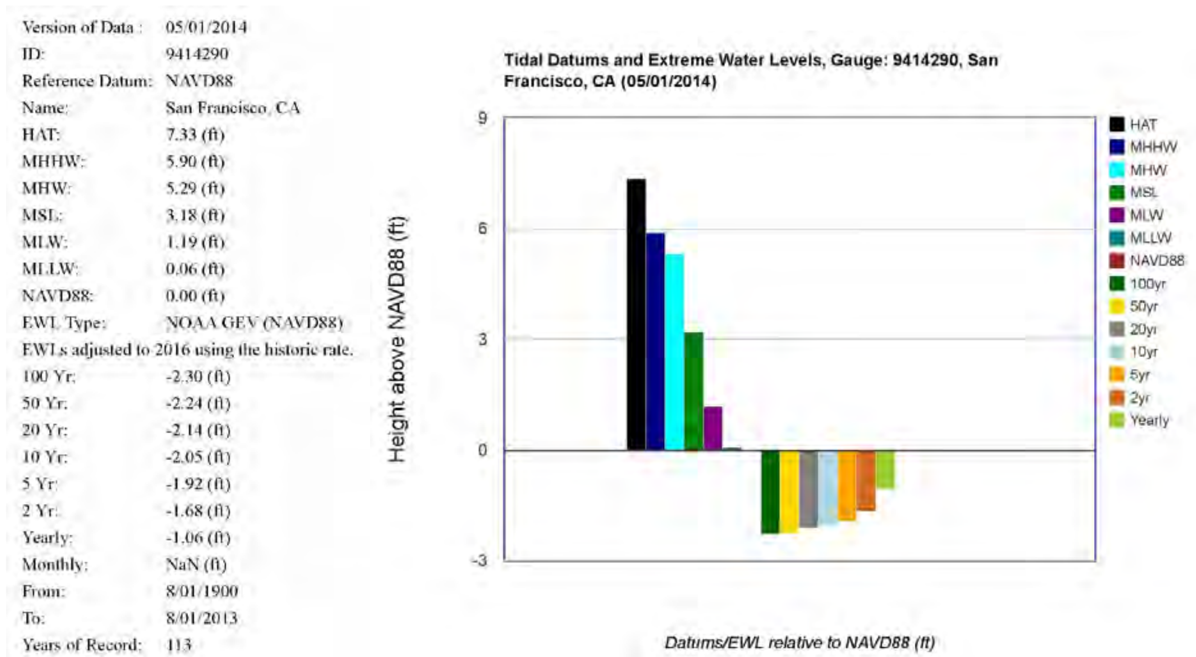


Figure 16. Tidal datums and extreme low water levels at NOAA Gauge 9414290 relative to the North American Vertical Datum of 1988 (NAVD88).

B. Channel Depth

1. Future Shoaling Rates

The numerical modeling suggests that shoaling rates will generally increase with increasing project depth, with deepening to 35 feet MLLW increasing the shoaling rate on the order of 5,000 to 10,000 cubic yards per year (**Table 6**). This would translate into an average deposition of approximately 1.3 to 1.7 feet of sediment per year in the deepened sections of the channel (**Table 7** and **Table 8**). The implications of the predicted shoaling on operations and maintenance (O&M) dredging requirements are discussed in detail in the **Civil Design Appendix**.

However, simulations under wet hydrologic conditions (water year 2006) indicated that the shoaling rate would be slightly higher (48,000 cy/yr) at a project depth of 30 foot MLLW than at 32 feet MLLW (42,000 cy/yr). Delta Modeling Associates (2015) suggested that this somewhat unexpected result can be explained by “the channel bathymetry in the 30 ft MLLW project depth interacting differently with the water flow in the main Central Bay channel than the bathymetry in 32 ft MLLW project depth during the very wet portion of the 2006 water year”. However, the results under all hydrologic scenarios suggest that deepening to 35 feet MLLW will likely increase shoaling rates.

Table 6. Scenario matrix used to estimate the shoaling rate in Central Basin under varying project depths (Source: Delta Modeling Associates, 2015)

Scenario	Channel Project Depth + Overdepth [ft MLLW]	Water Year Types	Water Years	Major Results
Existing Conditions	Variable Bathymetry	Wet	2006	1. Predicted sedimentation rate under existing conditions was reasonable based on the available data. 2. Estimated sedimentation rate of 16,000 to 31,500 yd^3 yr^{-1} under existing conditions, dependent on hydrologic conditions.
CB.1	30 + 1	Critical and Wet	2008 and 2006	1. Sedimentation rates were predicted to generally increase with increasing project depth. 2. 48,000 to 49,500 yd^3 yr^{-1} for a 30 ft MLLW project depth. 3. 42,000 to 49,500 yd^3 yr^{-1} for a 32 ft MLLW project depth. 4. 51,500 to 55,500 yd^3 yr^{-1} for a 35 ft MLLW project depth.
CB.2	32 + 1			
CB.3	35 + 1			
Expanded Footprint	35 +1			1. Predicted sedimentation rate increased by about 11% to 17% as a result of expanding the Central Basin footprint.

Table 7. Predicted average sediment depositional thickness in each dredging unit (DU) during water year 2006 (Source: Delta Modeling Associates, 2015))

Scenario	Project Depth + Overdepth [ft MLLW]	Year [Duration]	Average Deposition Thickness [feet]			
			DU-1	DU-2	DU-3	All
CB.1	30 + 1	2006 [1 yr]	1.1	1.7	2.2	1.5
CB.2	32 + 1		0.9	1.3	2.5	1.3
CB.3	35 + 1		0.9	1.7	3.2	1.6

Table 8. Predicted average sediment depositional thickness in each dredging unit (DU) during water year 2006 (Source: Delta Modeling Associates, 2015))

Scenario	Project Depth + Overdepth [ft MLLW]	Year [Duration]	Average Deposition Thickness [feet]			
			DU-1	DU-2	DU-3	All
CB.1	30 + 1	2008 [1 yr]	1.5	1.5	1.6	1.5
CB.2	32 + 1		1.6	1.3	1.6	1.5
CB.3	35 + 1		1.8	1.4	1.9	1.7

2. Impacts of Sea Level Change

The evaluation of the performance of the channel under the NED (National Economic Development Plan) depth (32 feet, MLLW) indicates that channel depth during extreme low water level conditions is expected to increase under all three SLC rates. In the case of the 50% AEP extreme low water level, the “low” SLC rate will only result in a minor (less than 1 foot) increase in channel depth by 2116 (Figure 5). The full NED design channel depth could be available during the 50% AEP extreme low water level event by approximately 2100 in the case of the “intermediate” SLC scenario, and by 2055 in the case of the “high” SLC scenario.

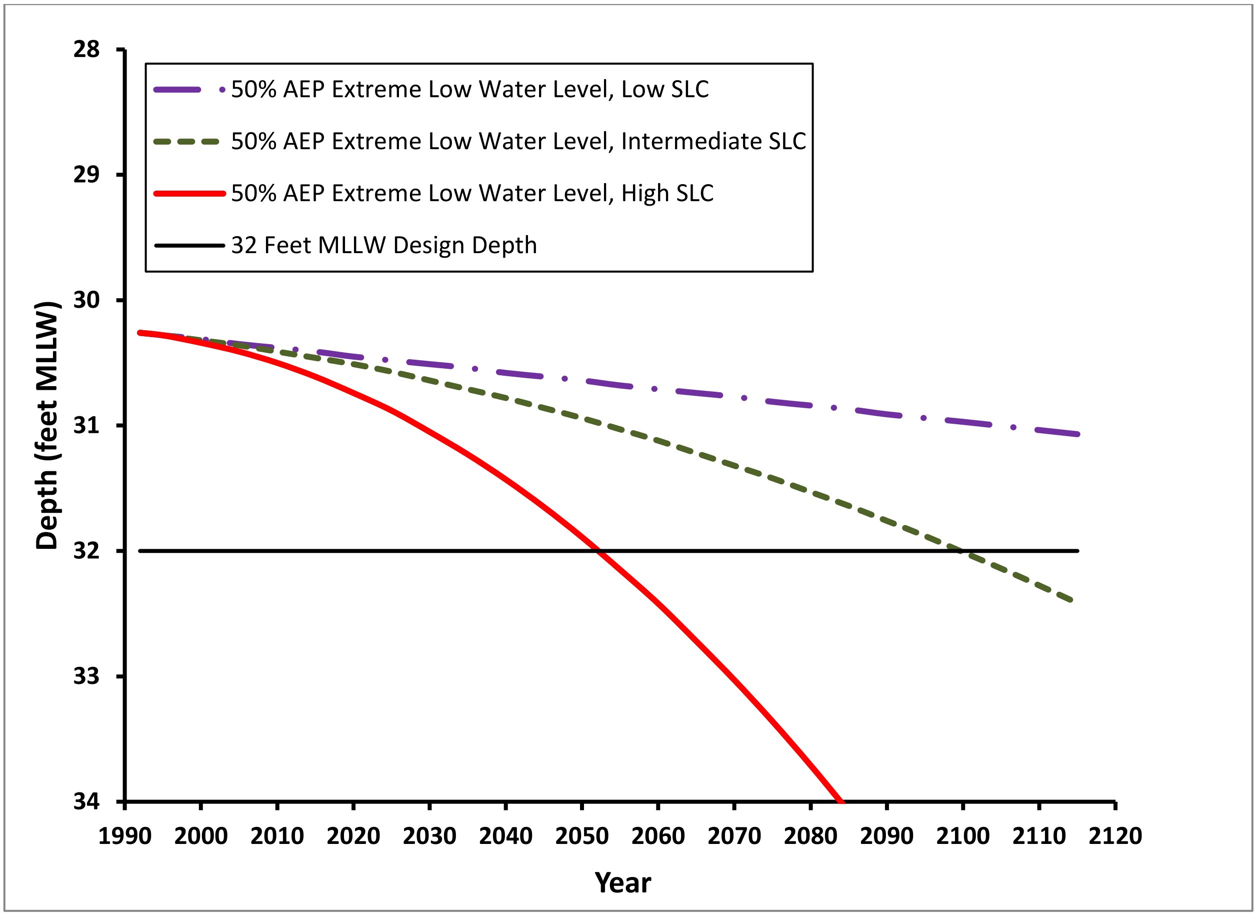


Figure 17. Evaluation of NED channel design depth (32 feet, MLLW) against 50% AEP extreme low water level.

C. Facilities and Infrastructure

1. Impacts of Sea Level Change

The 1% AEP extreme high water level is expected to remain below the Pier 70 deck (11.46 ft, MLLW) and associated infrastructure (12 ft, MLLW) under all three SLC scenarios for at least 50 years after construction in 2016 (Figure 6). However, the 1% AEP extreme high water level under the "high" rate is projected to reach the Pier 70 deck by 2070 and start to directly impact dry dock infrastructure by 2077. In addition, modeling results from the Port of San Francisco Sea Level Rise and Adaptation Study (URS/AGS Joint Venture, 2012) indicates that the 100-year total water level (TWL) under existing conditions at a nearby location (south of Pier 54) is 12.50 ft, MLLW, which is 1 foot higher than the Pier 70 deck elevation. While this study did not compute TWLs in the immediate Central Basin project area, it does suggest that extreme TWLs in this area of San Francisco Bay will exceed the extreme values derived from the San Francisco tide station.

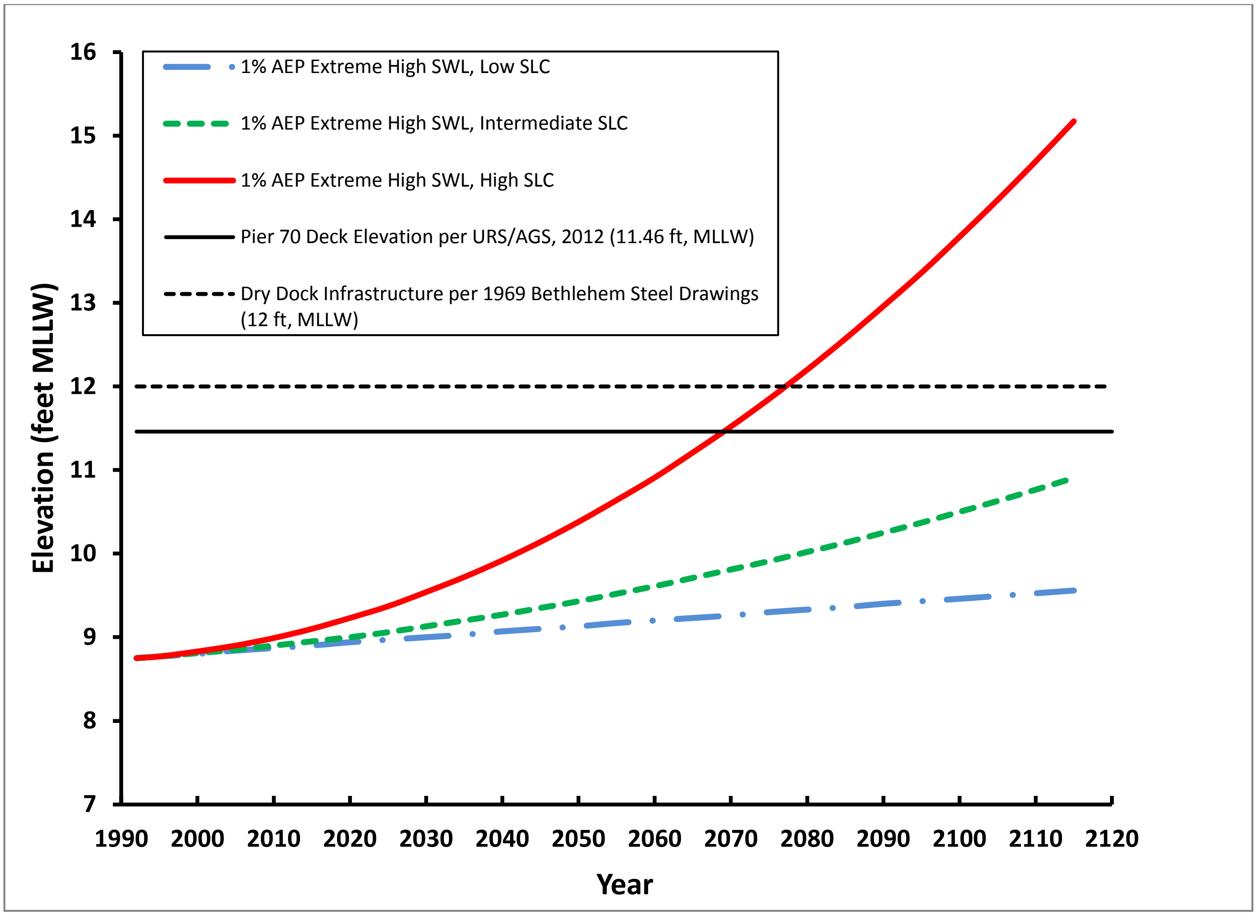


Figure 18. Critical performance threshold (deck elevation) for the Pier 70 Ship Repair facility

SLC is also unlikely to have significant impacts on dry dock operations over the next 50 years as the 1% AEP extreme high water level under all SLC scenarios is projected to remain below the critical performance threshold elevation for dry dock infrastructure. SLC could start to impact dry dock operations by around 2070 under the “high” scenario with the impact becoming more significant as the SLC rate accelerates after 2070. However, the Port of San Francisco and its tenant (BAE Systems, Inc.) do not anticipate any significant impacts from SLC on operations at the dry dock facilities, as the mooring of the dry dock will accommodate increased water surface elevation to allow for increased float height (C. Boudreau, pers comm., 2015; S. Halvax, pers comm., 2015). Furthermore, a review of projected sea level inundation with the NOAA Sea Level Rise (SLR) Viewer (Figure 7) is consistent with the conclusion that SLC impacts will remain minimal for at least 50 years after construction. Figure 7 suggests that the decks and infrastructure will not be inundated under a SLR scenario (2 feet) comparable to the amount of relative SLC projected to occur around 2060 under the “high” rate.

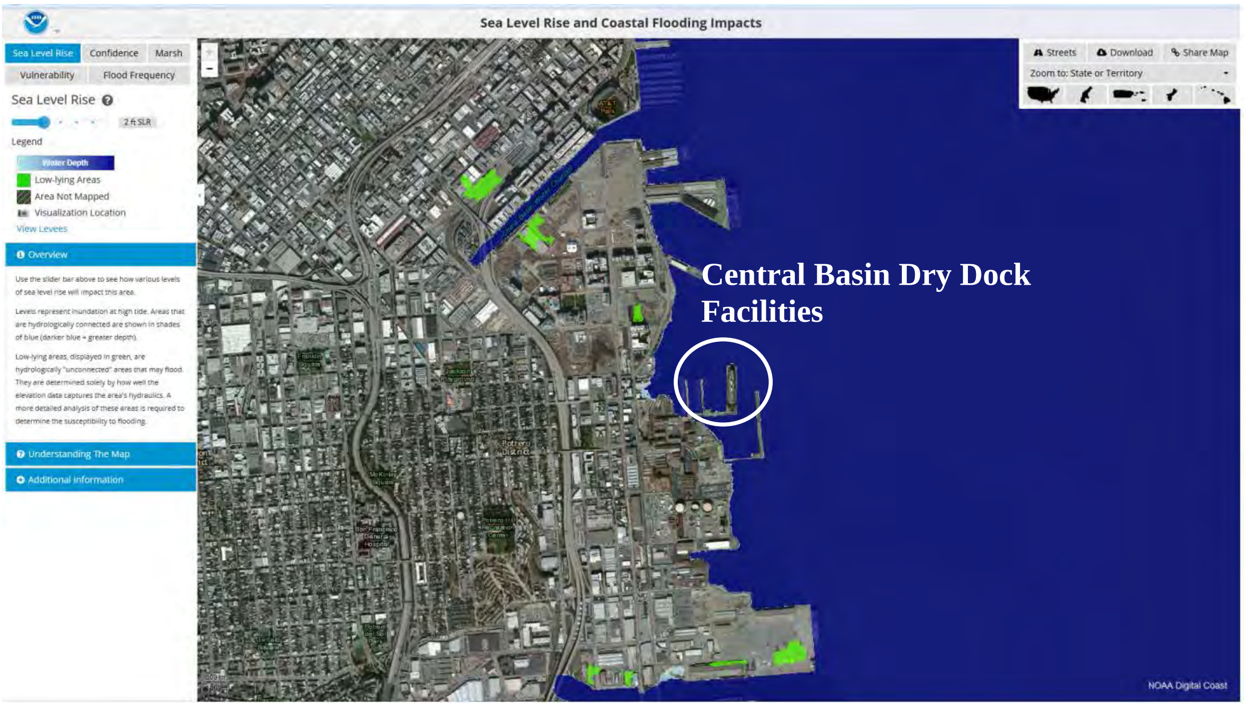


Figure 19. Map of potential impacts of 2 feet of relative SLR (based on MHHW) in the Central Basin project area (Source: NOAA Digital Coast Sea Level Riser Viewer, http://coast.noaa.gov/slr/)

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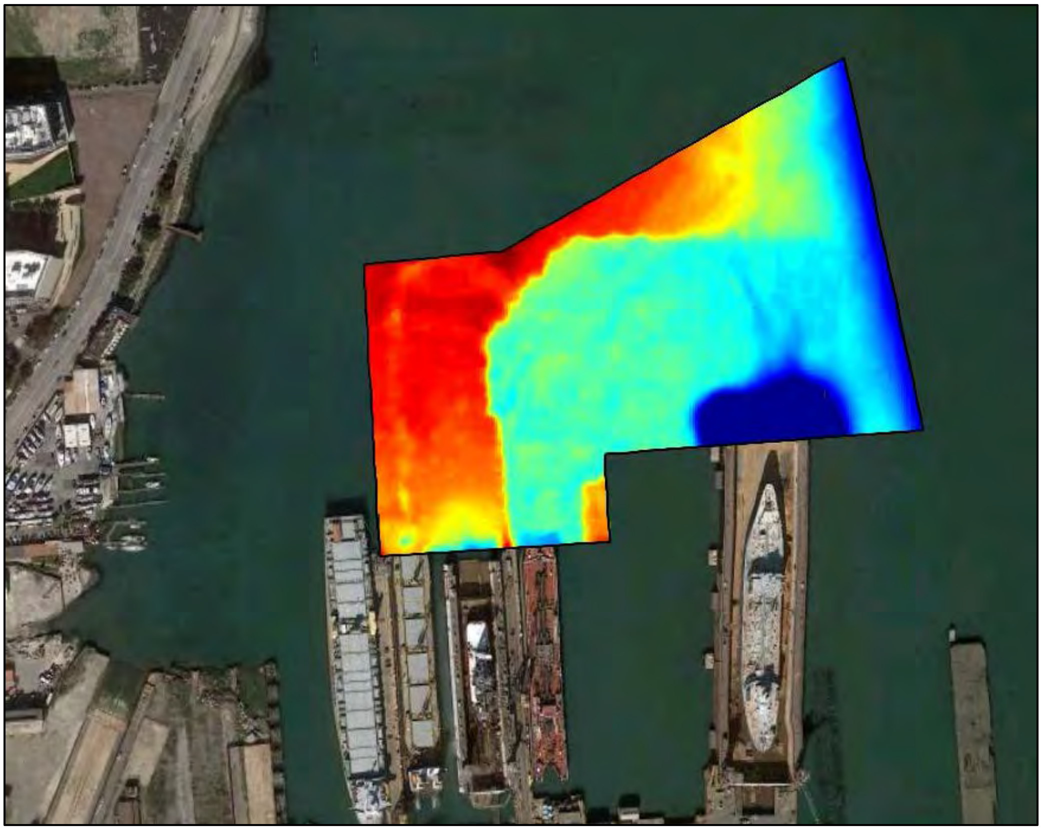
IX. ATTACHEMENT A: HYDRODYNAMIC MODELING REPORT

Report starts on next page.

Central San Francisco Bay 3-D Sediment Transport Modeling

Analysis of the Effect of Project Depth on Sedimentation Rates in Central Basin



FINAL REPORT

Prepared For:

U.S. Army Corps of Engineers
San Francisco District
1455 Market Street
San Francisco, CA 94103

Prepared By:

Delta Modeling Associates, Inc.

DELTA MODELING ASSOCIATES

FINAL REPORT
March 30, 2015

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Executive Summary

This study was conducted for the United States Army Corps of Engineers (USACE) San Francisco District to investigate the sedimentation rate in the Central Basin navigation channel (Central Basin) as part of the "Central San Francisco Bay 3-D Sediment Transport Modeling" project. A three-dimensional (3-D) hydrodynamic, wind wave, and sediment transport model was applied to estimate shoaling rates in Central Basin for existing conditions, three project depths, and two dredging footprints under both wet and dry conditions. To this end, the Unstructured Tidal, Residual, Intertidal & Mudflat (UnTRIM) Bay-Delta model (MacWilliams et al. 2007, 2008, 2009, 2015) coupled with the Simulating WAves Nearshore (SWAN) wave model (SWAN Team 2009a) and the SediMorph sediment transport model (BAW 2005) were used to simulate 3-D hydrodynamics, wind waves, and sediment transport in San Francisco Bay and the Sacramento-San Joaquin Delta region with a focus on sediment transport in the Central Bay and deposition in Central Basin. The numerical simulations were combined with the limited available data to predict the sedimentation rate in Central Basin. The predicted annual sedimentation rates are equivalent to the predicted annual dredging requirements necessary to maintain the design depth in Central Basin.

Based on two available hydrographic surveys, a shoaling rate in Central Basin under existing conditions was estimated to be about 16,000 cubic yards per year ($yd^3\ yr^{-1}$). However, this estimate was based on only about seven months of sedimentation and is considered only an order of magnitude estimate of the sedimentation rate under very dry hydrologic conditions because the surveys spanned a period with very little rain and very little river inflow to San Francisco Bay and the Sacramento-San Joaquin Delta. A model simulation using the existing bathymetric conditions in Central Basin predicted a sedimentation rate of about 31,500 $yd^3\ yr^{-1}$ during a wet hydrologic year (2006). Based on previous work in Oakland Harbor Channel, also in the Central Bay, the sedimentation rate can vary by a factor of two as a result of interannual variability in sediment transport (Delta Modeling Associates 2015). The comparison of the hydrosurvey-derived and model-predicted sedimentation rates indicates the model is predicting reasonable deposition rates, which are within the range of what would be expected based on the limited available data and accounting for possible interannual variability. These analyses suggest an annual sedimentation rate of between 16,000 and 31,500 $yd^3\ yr^{-1}$ in Central Basin under existing conditions, depending on the annual hydrologic conditions. This estimate takes into account the effects of interannual variability in the Bay-wide sediment transport and also includes some uncertainty that is inherent when comparing the results from hydrosurvey data to numerical model results. However, it is expected the sedimentation rate would be higher if all of Central Basin was deepened to the project depth. Under existing conditions only about 30% of Central Basin is deeper than 30 ft MLLW and about 17% is shallower than 20 ft MLLW.

Three scenarios were used to estimate how the sedimentation rate in Central Basin was affected by increasing the project depth (Table E-1). These three scenarios examined project depths of 30 feet (ft) mean lower low water (MLLW), 32 ft MLLW, and 35 ft MLLW. All of these project depths included an additional 1 ft of overdepth. Both water year 2008 and water year

2006 were simulated to incorporate possible interannual variability in the analysis. Water years span from October 1 of the previous calendar year to September 30, such that water year 2006 spans from October 1, 2005 to September 30, 2006. This designation allows for all of the precipitation over the "wet season" to be included in a single water year (rather than two calendar years). Water years in California are classified in five categories ranging from critical (driest), dry, below normal, above normal, and wet (wettest) based on inflows to the Sacramento-San Joaquin Delta. Water year 2008 was classified as a critical water year. Simulations during water year 2006, which was classified as a wet water year, examined a period with higher outflow from the Sacramento-San Joaquin Delta.

Simulations of existing conditions bathymetry, three different project depths, and two different water year types indicated that the sedimentation rate in Central Basin will generally increase as a result of increasing the Central Basin project depth. During the simulated critical water year of 2008, the sedimentation rate was predicted to be about 49,500 yd^3 yr^{-1} with a 30 ft MLLW project depth. This sedimentation rate was predicted to remain nearly the same at 49,500 yd^3 yr^{-1} as a result of deepening from 30 ft MLLW to 32 ft MLLW. The sedimentation rate was predicted to increase by about 12% to 55,500 yd^3 yr^{-1} as a result of deepening from 30 ft MLLW to 35 ft MLLW.

During the simulated wet water year of 2006, the model predicted the sedimentation rate will increase in each of the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios relative to the existing conditions. However, the model predicted the sedimentation rate in the 30 ft MLLW scenario to be higher than the sedimentation rate in the 32 ft MLLW scenario during the wet water year of 2006. Analysis suggested the prediction of a higher sedimentation rate in the 30 ft MLLW scenario than the 32 ft MLLW scenario resulted from the channel bathymetry in the 30 ft MLLW project depth interacting differently with the water flow in the main Central Bay channel than the bathymetry in 32 ft MLLW project depth during the very wet portion of the 2006 water year. During the simulated wet year of 2006 the sedimentation rate was predicted to be about 48,000 yd^3 yr^{-1} for the 30 ft MLLW project depth. The sedimentation rate was predicted to be 42,000 yd^3 yr^{-1} for the 32 ft MLLW project depth, which is less than was predicted for the 30 ft MLLW project depth. The sedimentation rate was predicted to increase by about 23% to 51,500 yd^3 yr^{-1} as a result of deepening to a 35 ft MLLW project depth, relative to the 32 ft MLLW scenario. The predicted 51,500 yd^3 yr^{-1} is an increase of about 7% relative to the 48,000 yd^3 yr^{-1} predicted for the 30 ft MLLW scenario. The interannual variability in the sedimentation rate was predicted to lower in Central Basin than was predicted in the Oakland Harbor Channel (Delta Modeling Associates 2015).

A fifth scenario was used to evaluate the increase in the sedimentation rate associated with an expanded footprint of the dredged area of Central Basin. A 35 ft MLLW project depth was used for this scenario. This scenario was also simulated using both the critical year of 2008 and the wet year of 2006. Expanding the footprint of Central Basin by about 18% by including dredging unit 4 (DU-4) in the dredged area was predicted to increase the sedimentation rate and the annual dredging requirements relative to predictions using the existing channel area of DU-1, DU-2, and DU-3. For the critical year of 2008, the sedimentation rate was predicted to increase by about 11% to 61,500 yd^3 yr^{-1} in the Expanded Footprint scenario relative to the 35 ft MLLW scenario that did not include DU-4. For the wet year of 2006 the sedimentation rate was predicted to increase by about 17% to 60,500 $yd^3 yr^{-1}$ in the Expanded Footprint scenario relative to the 35 ft MLLW scenario that did not include DU-4.

The predicted annual depositional thicknesses were up to one to five feet in some portions of Central Basin for each of the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios. These depositional thicknesses caused shoaling to above the project depths over large portions of Central Basin during the simulations. Both the predicted and the hydrosurvey derived sediment depositional patterns showed less sedimentation toward the eastern side of Central Basin adjacent to the naturally deeper Central Bay.

Table E-1 Scenario matrix used to estimate the shoaling rate in Central Basin under varying project depths.

Scenario	Channel Project Depth + Overdepth [ft MLLW]	Water Year Types	Water Years	Major Results
Existing Conditions	Variable Bathymetry	Wet	2006	1. Predicted sedimentation rate under existing conditions was reasonable based on the available data. 2. Estimated sedimentation rate of 16,000 to 31,500 $yd^3 yr^{-1}$ under existing conditions, dependent on hydrologic conditions.
CB.1	30 + 1	Critical and Wet	2008 and 2006	1. Sedimentation rates were predicted to generally increase with increasing project depth. 2. 48,000 to 49,500 $yd^3 yr^{-1}$ for a 30 ft MLLW project depth. 3. 42,000 to 49,500 $yd^3 yr^{-1}$ for a 32 ft MLLW project depth. 4. 51,500 to 55,500 $yd^3 yr^{-1}$ for a 35 ft MLLW project depth.
CB.2	32 + 1			
CB.3	35 + 1			
Expanded Footprint	35 +1			1. Predicted sedimentation rate increased by about 11% to 17% as a result of expanding the Central Basin footprint.

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Abbreviations

3-D	Three-Dimensional
BAAQMD	Bay Area Air Quality Management District
BAW	Bundesanstalt für Wasserbau (German Federal Waterways Engineering and Research Institute)
CCWD	Contra Costa Water District
CIMIS	California Irrigation Management Information System
DEM	Digital Elevation Model
DICU	Delta Island Consumptive Use
DU	Dredging Unit
DWR	Department of Water Resources
GLS	Generic Length Scale
LTMS	Long Term Management Strategy
MLLW	Mean Lower Low Water
NAVD 88	North American Vertical Datum of 1988
NED	National Economic Development
NOAA	National Oceanic & Atmospheric Administration
O&M	Operations & Maintenance
SFPORTS	San Francisco Physical Oceanographic Real-Time System
SWAN	Simulating WAves Nearshore
TRIM	Tidal, Residual, Intertidal & Mudflat Model
UnTRIM	Unstructured Tidal, Residual, Intertidal & Mudflat Model
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

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1. Introduction

This report documents the three-dimensional (3-D) hydrodynamic, wind wave, and sediment transport model that was applied to investigate the shoaling rate in the Central Basin navigation channel (Central Basin). A description of estimating a sediment deposition rate in Central Basin from two hydrographic surveys is also provided. This report is divided into six sections and one appendix:

- **Section 1. Introduction.** This section provides a summary of the scope and organization of the report.

- **Section 2. Central Basin Sediment Transport Modeling Overview.** This section provides a brief overview of the project study area, project approach, and project objectives.

- **Section 3. Numerical Model Descriptions.** This section provides brief descriptions of the Unstructured Tidal, Residual, Intertidal & Mudflat (UnTRIM) hydrodynamic model, the UnTRIM Bay-Delta model, the Simulated WAves Nearshore (SWAN) wave model and the SediMorph seabed morphology model.

- **Section 4. Hydrographic Survey Data for Sediment Volume Change.** This section uses two bathymetric surveys to estimate a shoaling rate in Central Basin.

- **Section 5. Influence of Project Depth and Channel Area on Shoaling.** This section examines how proposed deepening of Central Basin will influence the sedimentation rate in Central Basin. Section 5 also examines the change in the sedimentation rate associated with expanding the dredged footprint of Central Basin.

- **Section 6. Summary and Conclusions.** This section presents a brief summary of the work conducted for this study and provides the primary conclusions drawn from this analysis.

- **Appendix A. Data Sources, Assumptions, and Limitations of the Coupled Modeling System.** This appendix summarizes the model boundary conditions, details some of the major assumptions inherent in the numerical modeling effort, and outlines the limitations that arise as a result of these assumptions.

2. Central Basin Sediment Transport Modeling Overview

This project was conducted for the United States Army Corps of Engineers (USACE) San Francisco District to investigate the sedimentation rate in Central Basin. This project used an existing three-dimensional hydrodynamic, wind wave, and sediment transport modeling system to estimate sediment transport. The objectives of the project were to:

1. Estimate the incremental increase in the sedimentation rate in Central Basin associated with deepening the existing conditions channel to 30 feet (ft) mean lower low water (MLLW) and then from 30 ft MLLW to 32 ft MLLW and from 30 ft MLLW to 35 ft MLLW project depths.

2. Estimate the sedimentation rate associated with an expanded dredging footprint of Central Basin at the depth identified by the USACE National Economic Development (NED) plan. Because the NED depth had not been selected at the time the modeling was conducted, a conservative approach was taken where the expanded footprint was evaluated using the deepest considered project depth, 35 ft MLLW.

The UnTRIM Bay-Delta model (MacWilliams et al. 2008, 2009) was applied together with the SWAN (SWAN Team 2009a) wave model and the SediMorph sediment transport and seabed morphology model (BAW 2005), as a fully-coupled hydrodynamic-wave-sediment transport model. This coupled model has been used in previous studies to evaluate sediment transport processes in the San Francisco Estuary (MacWilliams et al. 2012; Bever and MacWilliams 2013, 2014; Delta Modeling Associates 2014a, 2015). The model was previously calibrated and verified by Delta Modeling Associates (2015) using observations of suspended sediment concentration in Central San Francisco Bay (Central Bay) and observed sediment deposition within Oakland Harbor Channel. In this Central Basin study the previously validated model was applied to estimate the sedimentation rate in Central Basin under existing conditions, conditions with the channel fully dredged to the project depth of 30 ft MLLW, and to evaluate how proposed channel deepening and expanding would influence the sedimentation rate in the channel.

2.1 Project Study Area

The San Francisco Estuary includes the South Bay, Central Bay, San Pablo Bay, Carquinez Strait, Suisun Bay, and the Sacramento-San Joaquin Delta (Figure 2-1). Including the Sacramento-San Joaquin Delta region is very important when studying San Francisco Bay as it has historically been one of the largest sediment sources to San Francisco Bay. The study area for the purpose of this computer modeling work included all of San Francisco Bay and the Sacramento-San Joaquin Delta region. The focus of the study, however, was on Central Bay and specifically the western side in the vicinity of Central Basin (Figure 2-2). Central Basin is subdivided into three dredging units (DU), with DU-1, DU-2, and DU-3 encompassing the entire existing Central Basin footprint. A fourth area (DU-4) has been proposed as an expanded footprint of Central Basin to improve access to additional berths.

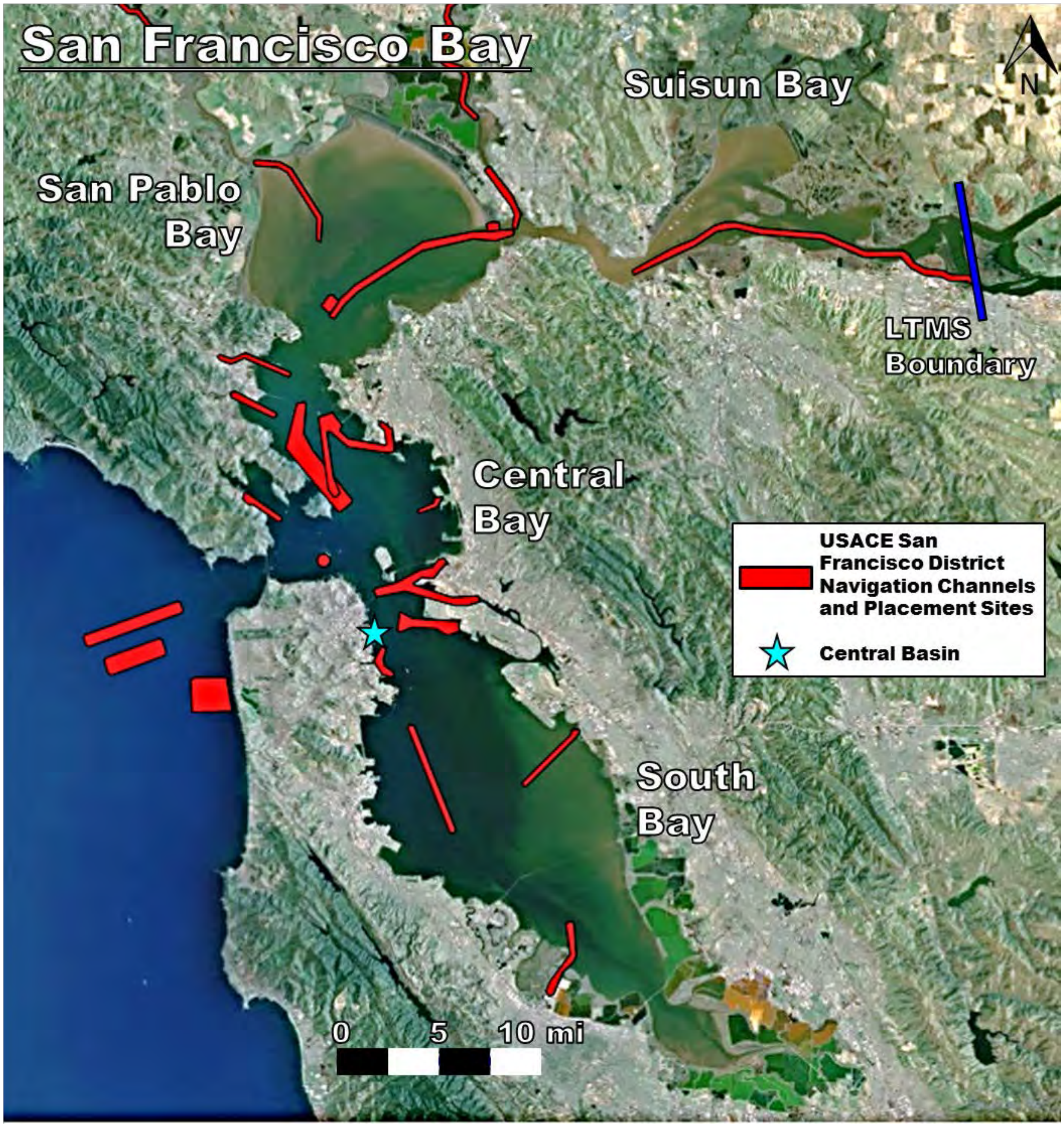

Figure 2-1 San Francisco Bay, USACE San Francisco District navigation channels and dredged material placement sites, and the Long Term Management Strategy (LTMS) eastern boundary. The location of Central Basin is marked with a blue star.

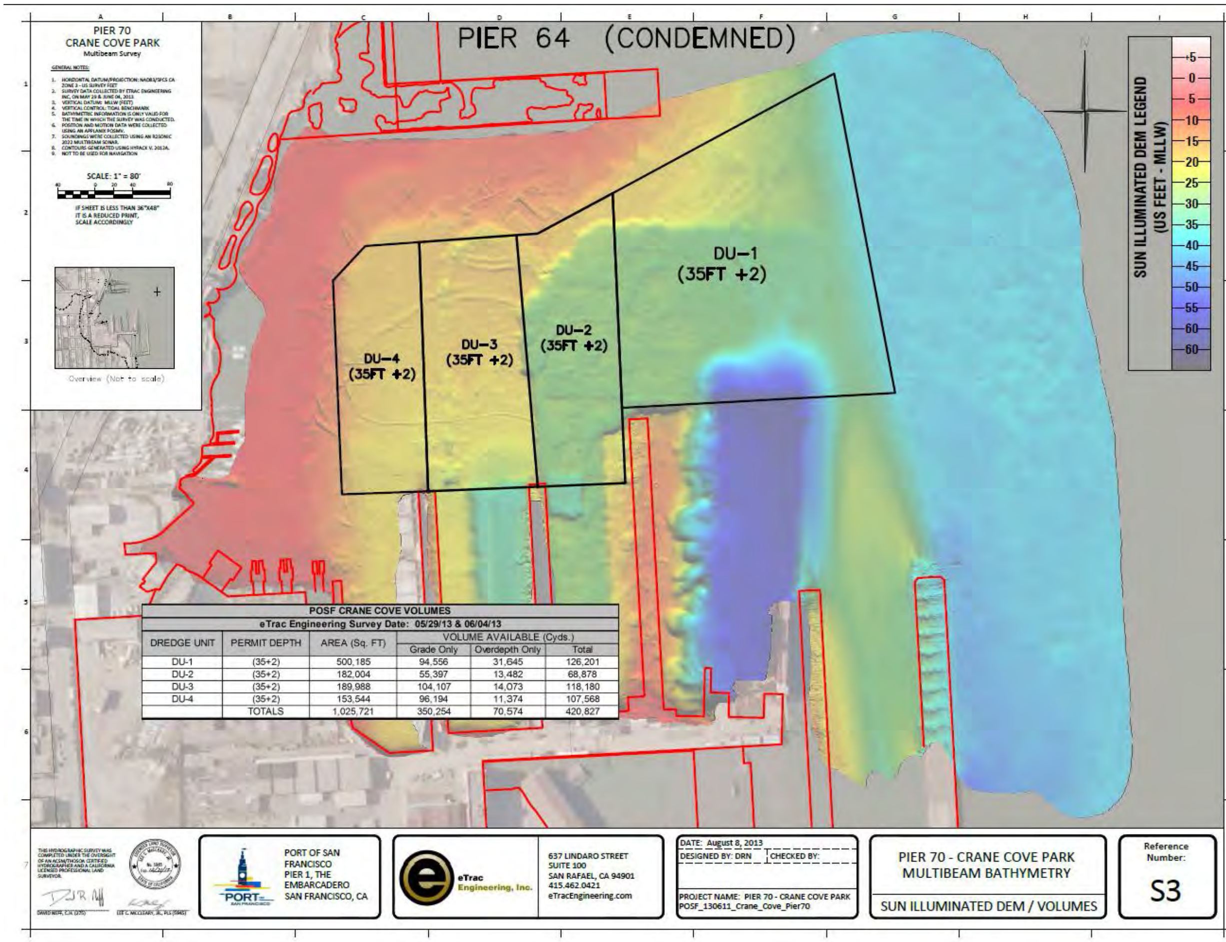

Figure 2-2 Central Basin (DU-1, DU-2, and DU-3) on the eastern side of the Central Bay and the proposed expanded footprint (DU-4). Figure from the Port of San Francisco.

2.2 Modeling Approach

Hydrodynamics, waves, and sediment transport were simulated throughout San Francisco Bay and the Sacramento-San Joaquin Delta by the UnTRIM Bay-Delta model (MacWilliams et al. 2008, 2009, 2015) together with the SWAN (SWAN Team 2009a) wave model and the SediMorph sediment transport and seabed morphology model (BAW 2005). Descriptions of the UnTRIM Bay-Delta model, the SWAN wave model, and the SediMorph sediment transport model are provided in Section 3. The coupled modeling system was used to simulate the sediment transport throughout the Bay-Delta system and the resulting deposition in Central Basin. In this way the modeling system directly predicts the volume of sediment deposited in Central Basin and the resulting dredging requirements.

The calibration and validation of both the UnTRIM Bay-Delta model and the coupled hydrodynamic, wave, and sediment transport modeling system have already been well-documented in previous studies (e.g., MacWilliams et al. 2007, 2008, 2009, 2015; Bever and MacWilliams 2014; Delta Modeling Associates 2014a, 2015). The model setup used for this study was validated for sediment deposition in Oakland Harbor Channel (Delta Modeling Associates 2015). Due to the lack of an extensive hydrographic survey data set to use for further validating model predictions of deposition in Central Basin, neither further calibration nor extensive validation was performed for this study. However, two hydrographic surveys were available for use in estimating an order of magnitude sedimentation rate in Central Basin. Model predictions of depositional volume in Central Basin were compared to this single data-based estimate to give an order of magnitude estimate of the model's validity for application in Central Basin.

The two primary objectives of this project were to estimate the incremental change in the sedimentation rate in Central Basin under the existing conditions bathymetry and 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW project depths, and to estimate the change in the sedimentation rate associated with expanding the footprint of Central Basin. These objectives were achieved through a combination of analysis of hydrographic survey data and numerical simulations. The approach used entailed:

- Estimating an order of magnitude sediment accretion rate using data from two hydrographic surveys (Section 4);
- Using the numerical model to estimate sedimentation rates in Central Basin under existing conditions and three project depths and to evaluate the incremental changes to the sedimentation rate resulting from proposed deepening from 30 ft MLLW to 32 ft MLLW and from 30 ft MLLW to 35 ft MLLW (Section 5);
- Using the numerical model to predict the sedimentation rate associated with an expanded dredging footprint at a 35 ft MLLW project depth and comparing to the scenario with the existing Central Basin footprint (Section 5).

A brief summary of these steps is provided below.

2.2.1 Estimate a Data-Based Sediment Accretion Rate in Central Basin

Hydrographic survey data of the bathymetry in Central Basin were used to derive an estimate of the annual net sediment depositional volume. The hydrosurvey derived sedimentation rate is considered an order of magnitude estimate of the sedimentation rate in Central Basin because of the limited duration between the hydrographic surveys and because the data only spanned extremely dry hydrologic conditions during which there was very little rain and very little freshwater inflow to San Francisco Bay and the Sacramento-San Joaquin Delta. This basic estimate of the sedimentation rate was also used to validate that the model predicted the correct order of magnitude depositional volume in Central Basin. A more quantitative validation of sedimentation rates was not possible because hydrosurvey data were not available for the two time periods simulated for this study.

2.2.2 Influence of Project Depth on Sedimentation Rates

This application entailed applying the coupled UnTRIM-SWAN-SediMorph Bay-Delta model to estimate incremental changes to the Operations and Maintenance (O&M) dredging needs at Central Basin as a result of proposed project deepening. The purpose of this application was to estimate the sedimentation rate in Central Basin and determine how proposed deepening of Central Basin will impact the amount of dredging required to maintain the project at the project depth. To this end, three model scenarios were conducted that allowed for the estimation of the sedimentation rate in Central Basin under existing conditions and with 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW project depths.

2.2.3 Influence of Increased Channel Footprint on Sedimentation Rates

The coupled UnTRIM-SWAN-SediMorph Bay-Delta model was also used to evaluate how an expanded footprint of Central Basin would influence the sedimentation rate and dredging requirements. An additional scenario was conducted using a 35 ft MLLW project depth with the addition of DU-4 to the dredged Central Basin (Figure 2-2). Adding DU-4 to the dredged channel footprint increases the area of Central Basin by about 18%. The comparison of the scenarios with the channel dredged to 35 ft MLLW using the existing footprint and using the expanded footprint allowed for the examination of how expanding the footprint of Central Basin will impact the sedimentation rate.

3. Numerical Model Descriptions

The UnTRIM Bay-Delta model (MacWilliams et al. 2008, 2009, 2015) was applied together with the SWAN (SWAN Team 2009a) wave model and the SediMorph sediment transport and seabed morphology model (BAW 2005), as a fully-coupled hydrodynamic-wave-sediment transport model. Abbreviated backgrounds of the three models are provided, along with citations to full descriptions of the numerical models, model coupling, and previous applications. Validation of the coupled modeling system, including validation of the coupling of the models and initial wave and sediment transport results within San Francisco Bay is presented in MacWilliams et al. (2012), Bever and MacWilliams (2013, 2014), and Delta Modeling Associates (2014a, 2015). Appendix A provides more detail on the model forcing and boundary conditions and presents some of the main areas of uncertainty within the numerical models.

3.1 UnTRIM Model Description

The hydrodynamic model used in this technical study is the three-dimensional hydrodynamic model UnTRIM (Casulli and Zanolli 2002). A complete description of the governing equations, numerical discretization, and numerical properties of UnTRIM are described in Casulli and Zanolli (2002, 2005), Casulli (1999), and Casulli and Walters (2000).

The UnTRIM model solves the three-dimensional Navier-Stokes equations on an unstructured grid in the horizontal plane. The boundaries between vertical layers are at fixed elevations, and cell heights can be varied vertically to provide increased resolution near the surface or other vertical locations. Volume conservation is satisfied by a volume integration of the incompressible continuity equation, and the free-surface is calculated by integrating the continuity equation over the depth, and using a kinematic condition at the free-surface as described in Casulli (1990). The numerical method allows full wetting and drying of cells in the vertical and horizontal directions. The governing equations are discretized using a finite difference – finite volume algorithm and solved using a semi-implicit method. Discretization of the governing equations and model boundary conditions are presented in detail by Casulli and Zanolli (2002). All details and numerical properties of this state-of-the-art three-dimensional model are well-documented in peer reviewed literature (Casulli and Zanolli 2002, 2005).

3.1.1 Turbulence Model

The turbulence closure model used in the present study is a two-equation model comprised of a turbulent kinetic energy equation and a generic length-scale equation. The parameters of the generic length-scale (GLS) equation are chosen to yield the k-ε closure (Umlauf and Burchard 2003). The Kantha and Clayson (1994) quasi-equilibrium stability functions are used. All parameter values used in the k-ε closure are identical to those used by Warner et al. (2005), including the minimum eddy diffusivity and eddy viscosity values which were 5×10^{-6} m^2/s. The numerical method used to solve the equations of the turbulence closure is a semi-implicit method that results in tridiagonal positive-definite matrices in the water column of each grid cell and ensures that the turbulent variables remain positive (Deleersnijder et al. 1997).

3.1.2 Previous Applications of the TRIM and UnTRIM Hydrodynamic Models

The Tidal, Residual, Intertidal & Mudflat (TRIM) 3-D model (Casulli and Cheng 1992) and the UnTRIM model have been applied previously to San Francisco Bay (Cheng and Casulli 2002; MacWilliams and Cheng 2007; MacWilliams and Gross 2007; MacWilliams et al. 2007, 2008). The TRIM3-D model (Casulli and Cattani 1994) which follows a similar numerical approach on structured horizontal grids has been widely applied in San Francisco Bay (e.g., Cheng et al. 1993; Cheng and Casulli 1996; Gross et al. 1999, 2006), and a 2D version, TRIM2D, is used in the San Francisco Bay Physical Oceanographic Real-Time System, SFPORTS (URL: http://sfports.wr.usgs.gov/sfports) (Cheng and Smith 1998). Thus, the UnTRIM numerical approach has been well-tested in San Francisco Bay, and is very well suited to perform the types of analysis used in this study.

3.1.3 UnTRIM Bay-Delta Hydrodynamic Model

The UnTRIM San Francisco Bay-Delta model (UnTRIM Bay-Delta model) is a three-dimensional hydrodynamic model of San Francisco Bay and the Sacramento-San Joaquin Delta, which has been developed using the UnTRIM hydrodynamic model (MacWilliams et al., 2007, 2008, 2009, 2015). The UnTRIM Bay-Delta model extends from the Pacific Ocean through the entire Sacramento-San Joaquin Delta (Figure 3-1). The UnTRIM Bay-Delta model takes advantage of the grid flexibility allowed in an unstructured mesh by gradually varying grid cell sizes, beginning with large grid cells in the Pacific Ocean and gradually transitioning to finer grid resolution in the smaller channels of the Sacramento-San Joaquin Delta. This approach offers significant advantages both in terms of numerical efficiency and accuracy, and allows for local grid refinement for detailed analysis of local hydrodynamics, while still incorporating the overall hydrodynamics of the larger estuary in a single model. The UnTRIM Bay-Delta hydrodynamic model has been calibrated using water level, flow, and salinity data collected in San Francisco Bay and the Sacramento-San Joaquin Delta (MacWilliams et al. 2008, 2009, 2015). Predicted water levels were compared to observed water levels at National Oceanic & Atmospheric Administration (NOAA) and Department of Water Resources (DWR) stations in San Francisco Bay, and DWR and United States Geological Survey (USGS) flow and stage monitoring stations in the Sacramento-San Joaquin Delta.

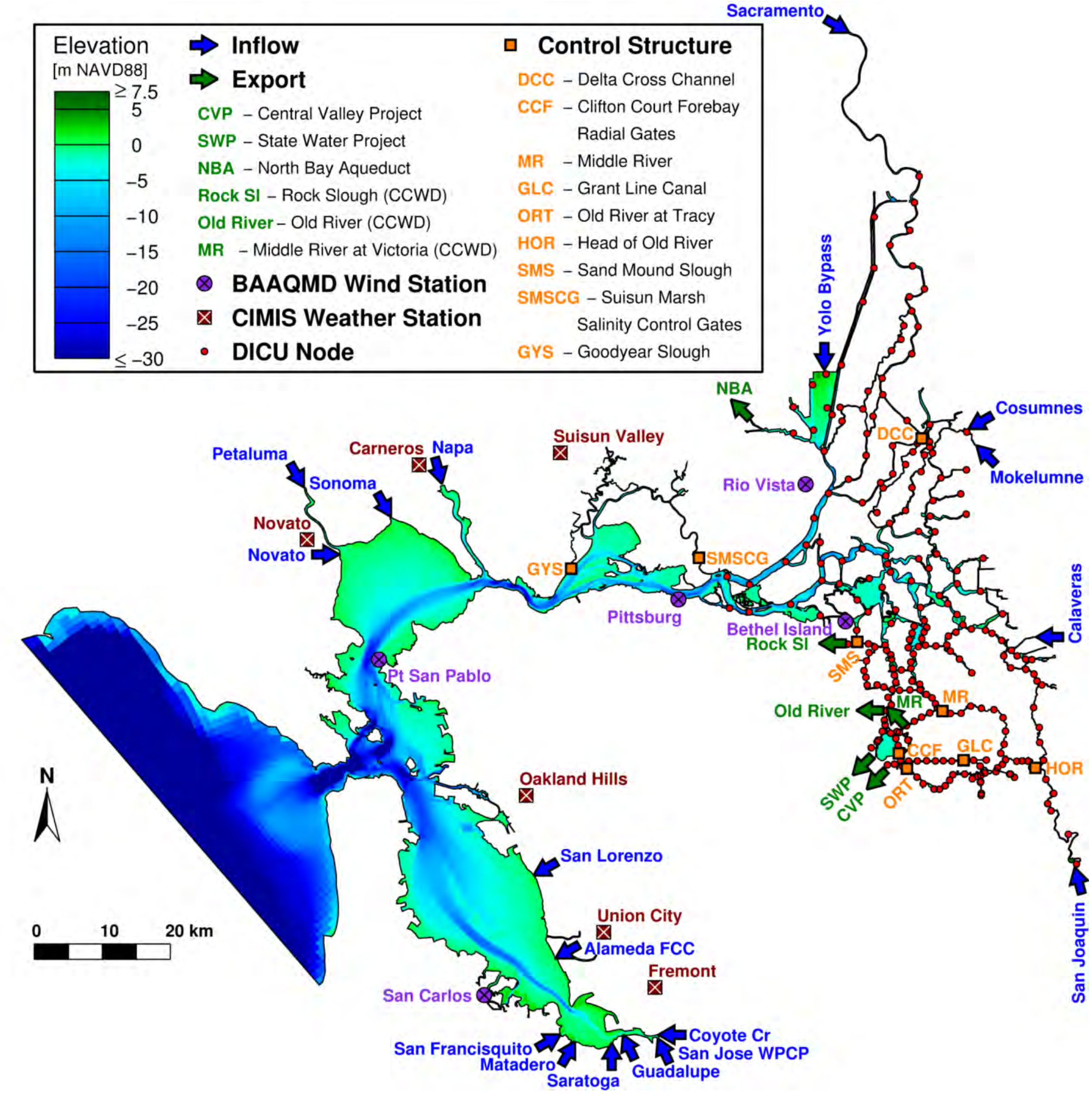

Figure 3-1 UnTRIM San Francisco Bay-Delta model domain, bathymetry, and locations of model boundary conditions which include inflows, export facilities, wind stations from the Bay Area Air Quality Management District (BAAQMD), evaporation and precipitation from the California Irrigation Management System (CIMIS) weather stations, Delta Island Consumptive Use (DICU), and flow control structures. CCWD stands for Contra Costa Water District.

3.2 SWAN Model Description

Wind wave properties must be estimated in order to accurately calculate bottom stress in SediMorph for the sediment transport calculations. In the approach documented here, the wind wave properties are predicted by the SWAN model (SWAN Team 2009a). SWAN supports the use of unstructured grids (Zijlema 2010) allowing fairly straight-forward application with UnTRIM. A one way “coupling” of SWAN and UnTRIM has been implemented in which information is written by UnTRIM for use in SWAN. After each SWAN wave prediction is complete, the significant wave height, peak wave period, and wave direction are passed back to UnTRIM to be used by SediMorph to calculate bottom shear stress.

3.2.1 SWAN Overview

The SWAN model (SWAN Team 2009a) is a widely used model for predicting wind wave properties in coastal areas (e.g., Funakoshi et al. 2008). SWAN "represents the effects of spatial propagation, refraction, shoaling, generation, dissipation and nonlinear wave-wave interactions" (SWAN Team 2009b) on wind waves. Therefore, SWAN can estimate the wind waves in coastal regions with variable bathymetry and ambient currents. SWAN can also accommodate spatial variability in bottom friction parameters and wind velocity. SWAN is a freely available model developed at Delft University of Technology (SWAN Team 2009a).

The SWAN options used for this project were in most cases the default values. As such the model included wind generated waves, whitecapping, wave refraction, quadruplet wave-wave interactions, and wave breaking. A Madsen et al. (1988) bottom friction formulation was used based on the seabed grain size provided by UnTRIM. SWAN also included the influence of the UnTRIM current velocities in the wave calculations. A method from Rogers et al. (2003) to reduce the artificial reduction of lower frequencies by dissipation was included. A functionality to limit the wave turning from refraction based on the Courant-Friedrichs-Lewy (CFL) condition was included based on Dietrich et al. (2013) to limit unreasonably large wave periods near steep bathymetric gradients.

3.2.2 Previous Applications

SWAN has been widely applied in many settings, including estuaries. Published applications of SWAN in the San Francisco Estuary include studies of wind waves in South San Francisco Bay by Bricker (2003) and Bricker et al. (2005). Bricker et al. (2005) found that the representation of wave breaking and refraction are important capabilities of SWAN. In contrast, an approach using analytical equations, documented by Inagaki et al. (2001), which does not represent effects of wave breaking and refraction, provided substantially different estimates of wave properties at the study site near Coyote Point (Bricker et al. 2005). Zimmerman et al. (2008) applied SWAN to study wind waves near Hunter's Point and predicted significant wave height accurately during periods with strong winds. van Der Wegen (2010) applied SWAN in morphological modeling of San Pablo Bay. Bever and MacWilliams (2013) used the coupled UnTRIM-SWAN-SediMorph model to investigate wave dynamics across the San Pablo Bay shoals. SWAN wave predictions were also used in the South Bay sediment transport modeling of Bever and MacWilliams (2014).

3.3 SediMorph Model Description

The seabed morphologic model SediMorph was originally developed by the German Federal Waterways Engineering and Research Institute (BAW) in Hamburg (BAW-Hamburg). SediMorph is currently being used and developed in a framework of several hydraulic research institutes

(Weilbeer 2005). The SediMorph model is used with several different hydrodynamic models at BAW, including UnTRIM (Casulli and Zanolli 2002, 2005) and TELEMAC (Electricité de France 2000). For the current study, the SediMorph module is coupled to the UnTRIM Bay-Delta model to allow for sediment transport and seabed morphological change calculations in San Francisco Bay.

3.3.1 SediMorph Overview

The primary purpose of the SediMorph module is to compute the sedimentological processes at the alluvial bed of a free-surface flow, including (Weilbeer 2005):

- The roughness of the bed resulting from grain and form roughness (ripples and/or dunes);
- The bottom shear stress as a result of roughness, flow, and waves;
- Bed load transport rates (fractioned);
- Erosion and deposition rates (fractioned);
- Bed evolution;
- Sediment distributions within multiple seabed layers.

A full description of the model capabilities of SediMorph and the validation of the SediMorph model is presented by BAW (2005). The physics modeled in SediMorph are described in detail by Malcherek (2001). A full description of the governing equations for the SediMorph model is presented by BAW (2005). A full description of the numerical setup of the SediMorph model as used in the UnTRIM-SWAN-SediMorph modeling system is presented in Bever and MacWilliams (2014).

3.3.2 Treatment of the Sediment Bed

SediMorph is designed to use the same horizontal computational mesh as the UnTRIM hydrodynamic model. In the vertical, the SediMorph module allows for evolution of the bed elevation above a pre-defined rigid layer in each cell. Above the rigid layer, SediMorph includes multiple seabed layers and an exchange layer. Only sediment in the seabed to the thickness of the thin surface exchange layer is available for sediment resuspension during any one time step. Figure 3-2 shows the horizontal and vertical grid structure of the UnTRIM and SediMorph models and provides a schematic representation of the location of the sediment transport processes within the model grid structures.

SediMorph allows for the use of multiple seabed layers that can help the model armor the seabed, or keep deposited yet easily erodible fine sediment at the surface. With the use of multiple seabed layers, sediment is eroded or deposited into layers at the sediment water interface that have a set maximum thickness (~1.7 centimeters (cm) in this modeling work). These layers can be winnowed of fine sediment creating an armored sediment bed or store easily erodible fine sediment that was deposited for later resuspension. Physically, these layers behave like a surface mixed layer, where the deposited sediment is mixed within a thin layer at the surface without being mixed within the entire sediment bed, and then remains near the sediment surface for later resuspension. When one seabed layer fills up with sediment through deposition, subsequent sediment deposition is then added to the layer above. Conversely, when the thickness of the upper seabed layer is less than the thickness of the exchange layer, the upper layer is mixed with the layer below and is considered eroded away. The thickness of the exchange layer between the seabed and the water column is dictated by the seabed grain size and the bed shear stress, and only sediment within this layer is available for sediment mobilization during any one time-step. The exchange layer thickness is calculated similarly to that from Harris and Wiberg (1997) using,

If $\tau_b > \tau_C$ $$ELT = \frac{\tau_b}{\tau_C} D_{90}(1 - P)$$

otherwise $$ELT = D_{90}(1 - P)$$

where *ELT* is the exchange layer thickness, τ_b is the bed shear stress, τ_C is the critical Shields shear stress using the grain size of the 50th percentile, D_{90} is the grain size of the 90th percentile sediment and *P* is the porosity of the exchange layer.

SediMorph runs concurrently with UnTRIM, and uses the hydrodynamics and wave properties in the calculation of seabed shear stress, which feeds into the sediment erosion and bedload calculations. In the shear stress calculations the Nikuradse and ripple roughnesses at each grid cell are used to allow for a spatially varying roughness.

SediMorph allows for the use of multiple sediment classes, and these classes are considered well mixed within any single seabed layer. A single porosity value is specified for the entire seabed within the model. All sediment classes are used in their relative proportions within a layer in the calculation of bulk seabed properties, such as determining the average grain size. For sediment deposition and erosion, however, all the sediment classes are treated individually within a seabed layer. If the shear stress is above the critical shear stress of any given sediment class then that class can be eroded from the surface exchange layer according to Ariathuria and Arulanandan (1978). Also, the sediment density of each sediment class is used with the single porosity value to determine the deposition and erosion thickness (from the calculated deposited or eroded sediment mass) of each sediment class individually. These thicknesses are summed and combined with the bedload transport based on Meyer-Peter and Müller (1948) to calculate the net seabed deposition or erosion, dependent on each sediment class eroded from the layer or deposited from the overlying water column.

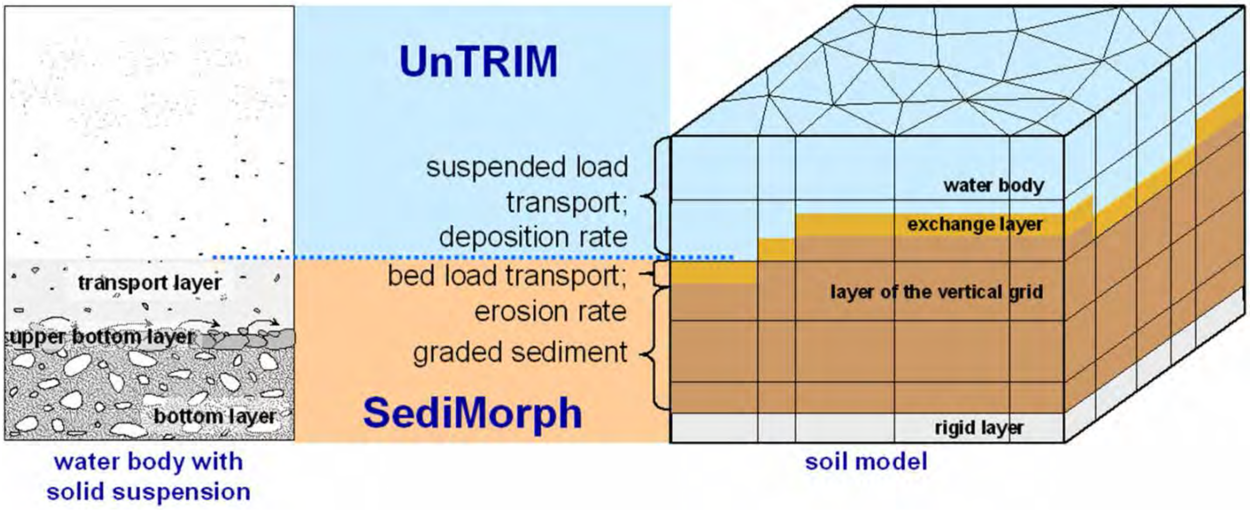

Figure 3-2 Horizontal and vertical grid structure of the UnTRIM and SediMorph models (right); schematic (left) and process list (middle) show the location of the sediment transport processes within the model grid structures (Source: BAW).

3.3.3 Sediment Transport Modeling Setup

To limit the number of grain classes within the model, the continuously varying grain size distribution within the real world was here simplified to represent the most dominant constituents, as has previously been done in three-dimensional sediment transport modeling of San Francisco Bay (Ganju and Schoellhamer 2009; van der Wegen et al. 2011; Bever and MacWilliams 2013). Increasing the number of sediment classes within the modeled grain size distribution increases the complexity of the calibration because of the increased number of tunable parameters and increases the run time of each model simulation. Sediment transport calculations for this project included four sediment classes, each with different particle size, settling velocity, critical shear stress, density, and erosion rate parameter (Table 3.3-1). The four sediment classes were chosen to represent the dominant constituents in the real (in-situ) San Francisco Bay grain size distribution, and were single particle silt**,** flocculated silts and clays called "flocs", sand, and gravel. The final sediment class parameters shown in Table 3.3-1 were determined as described in Bever and MacWilliams (2014).

Table 3.3-1 Sediment grain class parameters.

Sediment class	**Settling Velocity (mm s^{-1})**	**Critical Shear Stress (Pa)**	**Diameter**	**Density (kg m^{-3})**	**Erosion Rate Parameter (kg m^{-2} s^{-1})**
Silt	0.0774	0.0275	11 µm	2650	3.5×10^{-5}
Flocculated Silt and Clay	2.25	0.15	200 µm	1300	5×10^{-5}
Sand	23	0.19	250 µm	2650	5×10^{-5}
Gravel	NA	NA	8 mm	2650	NA

Observed surface grain size distributions were used to generate a realistic initial sediment bed for the entire San Francisco Bay-Delta system. Grain size distribution data was compiled from a USACE Long Term Management Strategy (LTMS) report (Pratt et al. 1994), the dbSEABED west coast surface grain size distribution database (Jenkins 2010), the USGS sand provenance study (Barnard et al. 2013), and the Delta sediment grain size study (S. Wright, Pers. Comm. 2012). The method presented in Bever and MacWilliams (2013, 2014) was used with over 1300 surface grain size distributions to generate the initial sediment bed (Figure 3-3). A porosity of 70% was specified for the seabed based on the calibration of the model. This porosity value is used throughout the Bay-Delta system in the model and is reasonable given that it is near the average of values reported for the San Francisco Bay in Caffrey (1995) of about 65%.

Suspended sediment was supplied through river input to the Sacramento-San Joaquin Delta, the North Bay, and the South Bay. Sediment was supplied to the Delta by the Sacramento, San Joaquin, Cosumnes, and Mokelumne Rivers and the Yolo Bypass as described in Bever and MacWilliams (2013, 2014), representing nearly 100% of the sediment inflow to the delta (Wright and Schoellhamer 2005). Sediment was supplied to the South Bay by Alameda Creek, San Lorenzo Creek, Coyote Creek, and the Guadalupe River as described in Bever and MacWilliams (2013, 2014). Sediment was supplied to the North Bay by the Napa River in the same manner as the South Bay tributaries. Sediment was not supplied by other South Bay or North Bay tributaries because of a lack of the available data needed to specify the inflow suspended sediment concentrations.

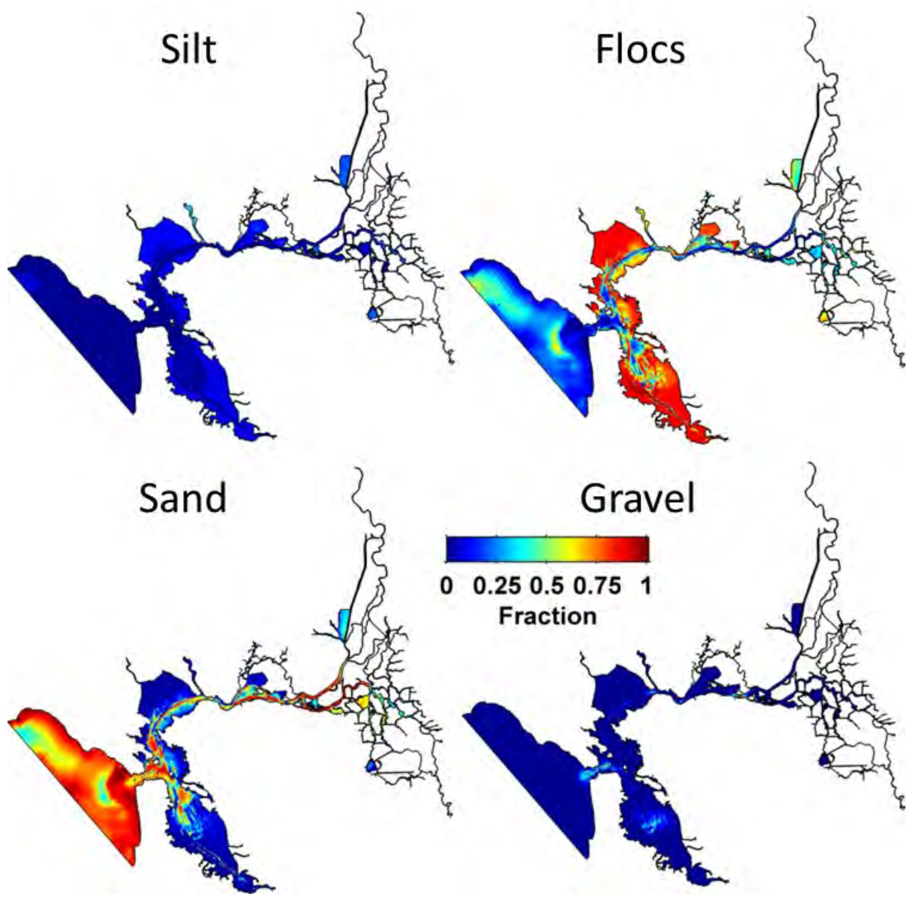

Figure 3-3 The fraction of each sediment class making up the initial sediment bed.

3.3.4 Previous Applications

The SediMorph model has been used for a wide range of applications at the German Federal Waterways Engineering and Research Institute (BAW). Initial applications used in the validation of the SediMorph model are presented by BAW (2005). Weilbeer (2005) presents the simulation of sediment transport processes in the Ems-Dollard estuary using UnTRIM-SediMorph. Kahlfeld and Schüttrumpf (2006) applied the UnTRIM-SediMorph model to evaluate the potential morphodynamic impacts of the proposed construction of a container port in the Jade-Weser estuary. Sohrmann and Weilbeer (2006) used the UnTRIM-SediMorph model to evaluate the effect of channel deepening on sediment transport in the Elbe estuary using data from repeated bathymetric surveys spanning 30 years of channel deepening. Additional applications at BAW include the simulation of dredged material placement. SediMorph has also been used with UnTRIM and SWAN to simulate dredged material dispersal in North San Francisco Bay (MacWilliams et al. 2012) and sediment fluxes between the channel and shoals in San Pablo Bay (Bever and MacWilliams 2013). Bever and MacWilliams (2014) used the coupled UnTRIM-SWAN-SediMorph modeling system to determine the fate of dredged material and investigate if open water placements can potentially be used to augment mudflat and marsh sedimentation. The coupled modeling system has also been used to evaluate the effects of increasing project depth and of different water year types on the sedimentation rate in Oakland Harbor Channel (Delta Modeling Associates 2015). A similar application examining the effect of increasing project depth on sedimentation in Redwood City Harbor Channel has also been conducted (Delta Modeling Associates 2014b). These applications demonstrate the suitability of the SediMorph model for the types of applications proposed as part of this study (Section 2.2).

3.4 Overview of UnTRIM-SWAN-SediMorph Coupling

The UnTRIM Bay-Delta model (MacWilliams et al. 2008, 2009, 2015) was applied together with the SWAN (SWAN Team 2009a) wave model and the SediMorph sediment transport and seabed morphology model, as a fully-coupled hydrodynamic-wave-sediment transport model. This overview provides a brief description of how the model coupling is performed and what role each model plays in the coupled modeling system. In this modeling system UnTRIM calculates the flow, water level, salinity, sediment advection, sediment settling, and sediment mixing. SWAN calculates the temporally and spatially varying waves needed for accurate predictions of sediment resuspension in the presence of wind waves. SediMorph calculates the seabed shear stress, erosion and deposition of sediment, bedload transport, the seabed morphologic change, and keeps track of the sedimentological properties within the seabed. The seabed shear stress for sediment resuspension is calculated in SediMorph to include the wave properties and spatially-varying roughness from the time-varying grain size distribution of the surface of the seabed. The model bathymetry in each grid cell is adjusted each time step to account for erosion and deposition and any morphologic change of the seabed. The validation of the coupled modeling system, including validation of the coupling of the models and initial wave and sediment transport results within San Francisco Bay is presented in MacWilliams et al. (2012) and Bever and MacWilliams (2014).

The UnTRIM, SWAN, and SediMorph models run concurrently and pass information between one another to create a fully three-dimensional hydrodynamic, wave, and sediment transport modeling framework. The model coupling is performed such that UnTRIM can run either as a standalone hydrodynamic model, coupled to SWAN, coupled to SediMorph, or coupled to SWAN and SediMorph, giving freedom to use only the portion of the coupled modeling system that is necessary for any specific modeling objective. In this framework the SWAN executable is called by the main UnTRIM program at specified intervals, while UnTRIM and SediMorph are compiled as a single executable and communicate every time-step (every 90 s). SWAN runs in stationary 2D mode and uses a hot restart from the previous SWAN output as the initial conditions for the subsequent SWAN time step. Through the writing and reading of text files, UnTRIM passes to SWAN the:

- Grid geometry;
- Bathymetry;
- Wind velocity;
- Depth-averaged currents;
- Nikuradse bottom friction coefficient.

Because the unstructured version of SWAN only does computations on triangular meshes, each UnTRIM quadrilateral is decomposed into two SWAN triangles prior to writing grid geometry and any other information for SWAN. However, the nodes remain identical between the quadrilateral cells and the resulting triangles, and SWAN calculations are made at the grid nodes. SWAN returns to UnTRIM the:

- Significant wave height;
- Peak wave period;
- Peak wave direction.

UnTRIM and SediMorph run on identical grids, and because they are compiled as a single executable, UnTRIM and SediMorph do not require the reading and writing of files to pass information. SediMorph uses the currents, waves, and suspended sediment concentration from UnTRIM to calculate the seabed shear stress and the deposition and erosion fluxes, and then passes the net flux between the seabed and the water column back to UnTRIM for use in updating the suspended sediment concentration. SediMorph also calculates the bedload sediment transport and adjusts the bed elevation to account for erosion, deposition, and bedload within each grid cell. SediMorph then updates the fractions of each sediment class within the seabed. In this way the morphologic change of the seabed is calculated at every time-step and feeds back into the hydrodynamic calculations. Also, the bottom orbital velocity for shear stress calculations is calculated in the SediMorph sediment transport routines based on the provided wave properties, and thus the wave influence on seabed shear stress is impacted by the water depth at each time step. The suspended sediment advection, mixing, and settling are calculated in UnTRIM, which incorporates the suspended sediment concentration in the equation of state following Warner et al. (2008).

4. Hydrographic Survey Data for Sediment Volume Change

Two hydrographic surveys of the bathymetry in and around Central Basin were provided by the Port of San Francisco. The hydrosurvey data were used to estimate an order of magnitude sedimentation rate in Central Basin under existing conditions. This estimated sedimentation rate was considered an order of magnitude estimate of the sedimentation rate in Central Basin because of the limited duration between surveys and because the data only spanned extremely dry hydrologic conditions. The sedimentation rate derived from this analysis was also used to assess whether the model predicted sedimentation rates in Central Basin were reasonable.

4.1 Hydrographic Survey Bathymetric Data

The first hydrographic survey was conducted on May 29 and June 4, 2013 and the second on January 8, 2014. For purposes of calculating the sedimentation rate, the date of the first survey was set as midway between the two survey dates (June 2, 2013) for the analysis (Figure 4.2-1). These two surveys spanned 220 days during very dry hydrologic conditions. The hydrographic surveys of Central Basin provided locations in State Plane feet and the depth of the seabed below MLLW in and around Central Basin as individual location and depth soundings. The survey data were further processed onto a 1 m Digital Elevation Model (DEM) in MLLW and Universal Transverse Mercator (UTM) to allow for the direct comparison of each hydrographic survey during analysis. All bathymetric data outside of Central Basin were disregarded to prevent sediment erosion or deposition outside of the channel from influencing the shoaling analysis.

4.2 Sediment Volume Change in Central Basin

The hydrographic surveys were used to estimate the change in the sediment volume in Central Basin through time by comparing the change in water depth between the successive surveys (Figure 4.2-2). The calculation used the processed bathymetric data in MLLW which were converted into a 1 m DEM as described in Section 4.1. The area of each DEM cell was multiplied by the change in the seabed elevation and then the depositional or erosional volume in each DEM cell was summed over Central Basin to determine the total net volume of sediment change. This analysis estimated a sedimentation rate of about 16,000 cubic yards per year (yd^3 yr^{-1}) in Central Basin under existing conditions. However the existing depth is less than the current project depth of 30 ft MLLW over much of Central Basin, particularly in DU-3 (Figure 4.2-1). In the existing conditions only about 30% of Central Basin was deeper than 30 ft MLLW and about 17% was shallower than 20 ft MLLW.

Using periodic hydrosurveys to calculate the sediment volume change was suggested by Trawle (1981) to be a relatively accurate way of estimating the shoaling rate within dredged channels. However, Trawle (1981) also states the necessity of capturing a wide range of environmental conditions when estimating shoaling rates from hydrosurvey data to average out seasonal time scale fluctuations in sedimentation and to account for possible interannual variability. Since the available hydrosurveys of Central Basin only spanned an extremely dry period of limited freshwater and sediment supply from the Delta and were limited to only two surveys, this estimate of 16,000 yd^3 yr^{-1} should be considered an order of magnitude estimate. Over longer time periods it is expected the sedimentation rate will be higher than this 16,000 yd^3 yr^{-1} estimate because deposition rates around Central Bay tend to be higher as the sediment supply from the Delta increases (i.e. Delta Modeling Associates 2015).

The hydrographic surveys were also used to identify areas of Central Basin that underwent sediment deposition and areas that experienced relatively little change or erosion. The eastern side of DU-1 (see Figure 2-2 for a map of DUs) predominantly showed areas of little sedimentation or erosion (negative elevation change) between the two hydrosurveys, while the western side of DU-1 and DU-2 were predominantly depositional (positive elevation change, Figure 4.2-2). The relatively little deposition in DU-3 compared to DU-2 is a product of DU-3 being significantly shallower than the project depth in the existing bathymetry (Figure 4.2-1). A small area of deposition occurred on the southern end of DU-1, indicating increased sedimentation that resulted in infilling of the dredged dry-dock slip.

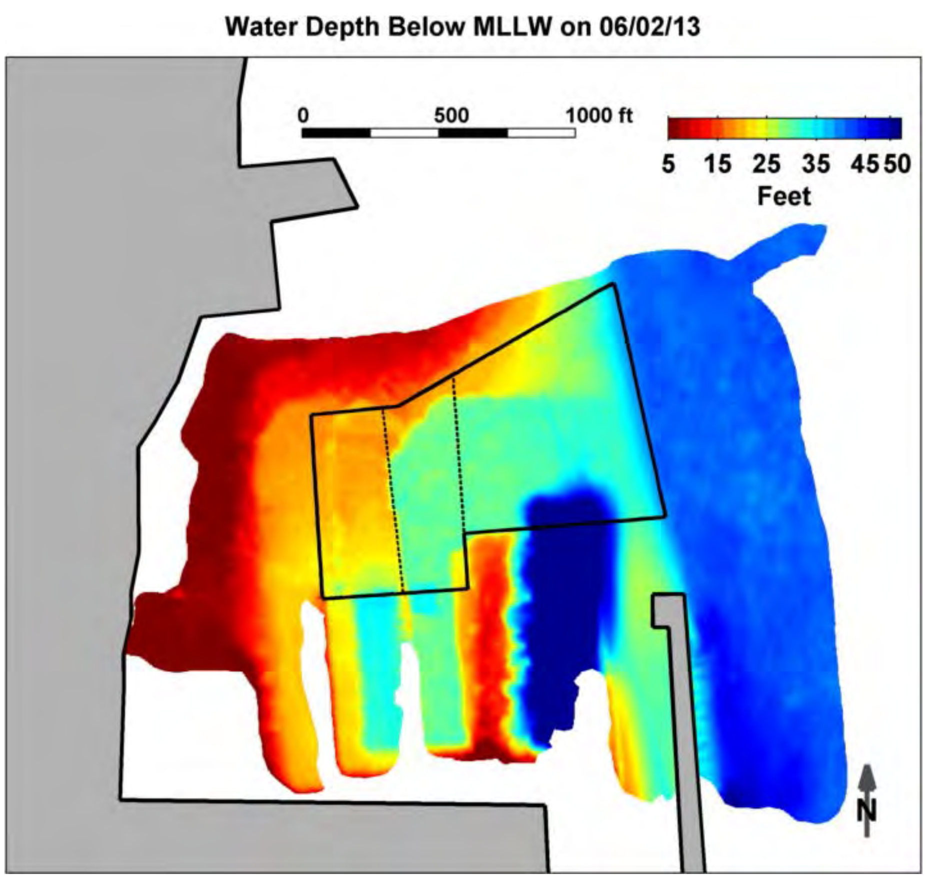

Figure 4.2-1 The hydrosurvey bathymetric data in and around Central Basin on June 2, 2013.

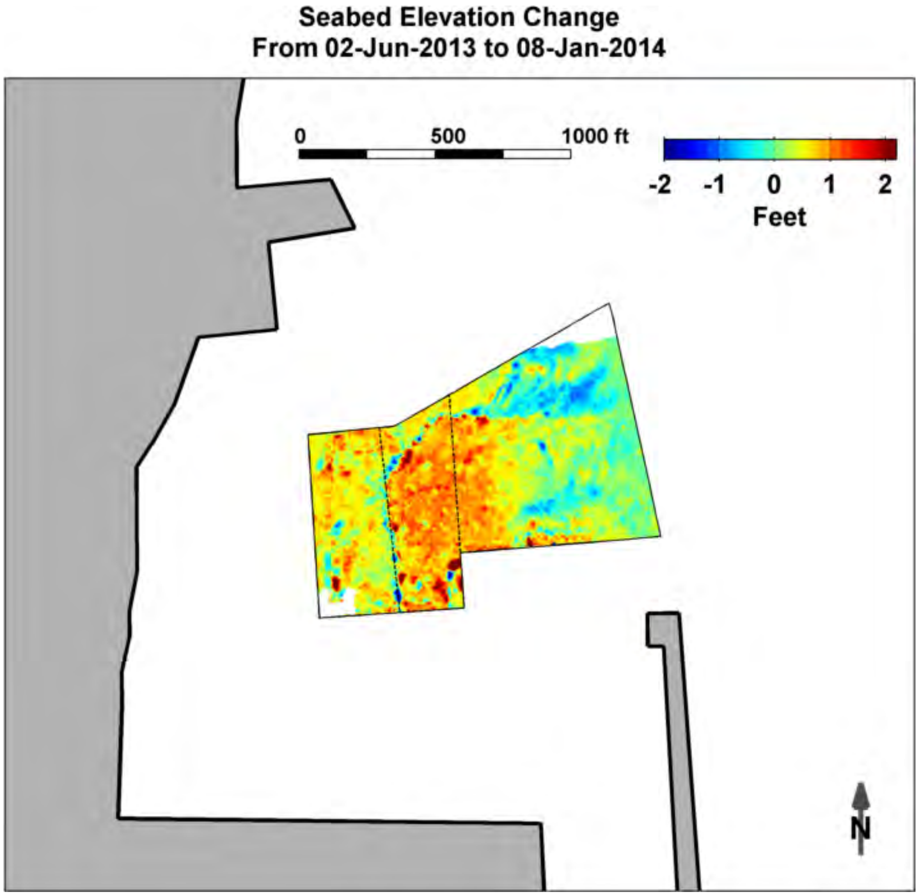

Figure 4.2-2 The change in the seabed elevation within Central Basin (DU-1, DU-2, and DU-3) between June 2, 2013 and January 8, 2014. White areas inside Central Basin represent areas where the two hydrosurveys did not overlap and were not used in the shoaling analysis. Positive change represents sediment deposition and negative change represents erosion.

5. Influence of Project Depth and Channel Area on Shoaling

Numerical simulations of hydrodynamics, waves, and sediment transport were used to investigate the effects of proposed deepening of Central Basin on the sedimentation rate in the channel. One scenario was used to predict the sedimentation rate under existing conditions. Three scenarios were used to estimate how the sedimentation rate in Central Basin would be changed by deepening from 30 ft MLLW to 32 ft MLLW and from 30 ft MLLW to 35 ft MLLW. This analysis showed that increasing project depth generally increased sedimentation in Central Basin. A fifth scenario was used to determine the change in the sedimentation rate and annual dredging requirements associated with expanding the dredged area of Central Basin (adding area of DU-4) with a 35 ft MLLW project depth. The model predicted an increase in the sedimentation rate resulting from expanding the dredged footprint of Central Basin.

5.1 Project Depth Overview

This analysis used sets of model scenarios that were combined to produce a scenario set in which only a single variable was changed within each set. Varying only a single variable within the set of scenarios allowed for the determination of how that single variable effected the model predictions. For example, to determine how the depth of Central Basin affected the sedimentation rate, nearly identical model simulations were conducted using identical hydrological forcing, such that only the bathymetry in Central Basin was changed between scenarios. In this way the meteorological boundary conditions were identical between the scenarios and the only thing that changed was the channel bathymetry. These scenarios then allowed for the examination of how changing the Central Basin project depth influenced the sedimentation rate, because everything was consistent between the scenarios except the project depth. Thus, any differences in the predicted sedimentation rate between the modeled scenarios can be attributed solely to differences in the scenario's channel bathymetry. This approach was identical to that used to estimate the effects of historic deepening of Oakland Harbor Channel from 42 ft MLLW to 46 ft MLLW to 50 ft MLLW on the sedimentation in the channel (Delta Modeling Associates 2015).

The sediment depositional volumes in Central Basin are presented as a sedimentation rate in cubic yards per year and represent the net change in the sediment volume in the channel. These sedimentation rates correspond to the annual dredging requirements that would be needed to maintain the depth of Central Basin at the project depth plus one foot of overdepth. Figures show the sedimentation rate in thousands of cubic yards per year.

5.2 Description of Model Scenarios

The Central Basin region of the UnTRIM Bay-Delta model grid was refined to directly resolve Central Basin (Figure 5.2-1, Table 5.2-1). While the grid cells in the open Central Bay were on the order of 200x250 m or larger, the grid cells in Central Basin were refined to about 10x10 m. The hydrosurvey data were converted from MLLW to NAVD88 for use in specifying bathymetry for the UnTRIM Bay-Delta model using a constant offset provided by the Port of San Francisco of 0.17 ft. Bathymetry in the vicinity of Central Basin was set as the existing conditions based on the hydrosurvey from June 2013 because this survey provided more spatial coverage than the survey in January 2014. For the existing conditions scenario the bathymetry in Central Basin (DU-1, DU-2, and DU-3) was also set based on the hydrosurvey data from June of 2013 (Figure 4.2-1, Table 5.2-2). For the project depth scenarios the bathymetry in Central Basin was set as the deeper of the existing conditions from the June of 2013 hydrosurvey or the project depth plus one foot of overdepth (Figure 5.2-2). The project depths considered were 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW (Table 5.2-2). The total Central Basin depths used in these scenarios included the one foot of overdepth and were 31 ft MLLW, 33 ft MLLW, and 36 ft MLLW. These project depths resulted in deepening of up to about 20 ft relative to the existing conditions (Figure 5.2-3). The deepening relative to the existing conditions was not uniform throughout Central Basin because the existing conditions have a large degree of bathymetric variability in the Central Basin footprint. The southeast corner of Central Basin is relatively deep in the existing conditions and for the 30 ft MLLW scenario no deepening of this region was required. The project depths plus one foot of overdepth in MLLW were converted to NAVD88 for use in the UnTRIM Bay-Delta model using a conversion of 0.17 ft provided by the Port of San Francisco. A 3:1 side slope for the edge of the Central Basin footprint was used to set the bathymetry immediately adjacent to Central Basin.

A fifth scenario was conducted with the bathymetry, model forcing, and boundary conditions specified exactly as described above and used a 35 ft MLLW project depth (Table 5.2-2). However, this fifth scenario included an expanded footprint of the dredged Central Basin. The footprint of Central Basin was expanded to also include DU-4 (Figure 5.2-1). Including DU-4 in the dredged footprint increased the area of Central Basin by about 18% relative to the scenarios only considering DU-1, DU-2, and DU-3 (Table 5.2-1). This Expanded Footprint scenario was compared to the original 35 ft MLLW scenario (CB.3) to determine the change in the sedimentation rate and annual dredging requirements associated with expanding the footprint of Central Basin.

Scenarios were modeled using the hydrologic conditions from two different water years, water years 2008 and 2006. The existing conditions scenario was only simulated using the 2006 water year, and was used as an order of magnitude validation of the predicted net sediment volume change in Central Basin. The scenarios investigating the influence of increasing the project depth and expanding the dredged footprint on the sedimentation rate were simulated using both the 2008 and the 2006 water years. Water years span from October 1 of the previous calendar year to September 30, such that water year 2006 spans from October 1, 2005 to September 30, 2006. This designation allows for all of the precipitation over the “wet season” to be included in a single water year (rather than two calendar years). Water years in California are classified in five categories ranging from critical (driest), dry, below normal, above normal, and wet (wettest) based on inflows to the Sacramento-San Joaquin Delta. Water year 2008 was classified as a critical water year (CDEC 2014). Simulations during water year 2006, which was classified as a wet water year (CDEC 2014), examined a period with higher outflow from the Sacramento-San Joaquin Delta.

Modeling the existing conditions bathymetry allowed for an order of magnitude validation of the model predicted sedimentation rate relative to the estimate derived from the hydrosurvey data (Section 4). This simple validation was facilitated by the existing conditions bathymetry being based on the hydrosurvey data from June of 2013 that was used in Section 4 to estimate a data-derived sedimentation rate. As a result the bathymetry used in the existing conditions scenario was as close as possible both to the current bathymetry of Central Basin and to the Central Basin bathymetry used to estimate a sedimentation rate in Section 4. However, neither the length of time used to calculate the data-derived and predicted sedimentation rates nor the years in which the sedimentation rates were calculated were the same. As a result, quantitative assessment of the accuracy of the predicted sedimentation rate is not possible with the data that were available.

Table 5.2-1 The area of each dredging unit after incorporating Central Basin into the numerical model grid.

Dredging Unit	DU-1	DU-2	DU-3	DU-4
Area [yd^2]	55,584	20,159	21,097	17,044

Table 5.2-2 The scenario matrix used to validate the sediment depositional volume in Central Basin, to evaluate the effect of deepening of the project depth on sedimentation, and to evaluate the effect of expanding the dredged footprint of Central Basin on sedimentation.

<table>
<tr><th>Scenario</th><th>Channel Project Depth + Overdepth [ft MLLW]</th><th>Water Year Type</th><th>Water Years</th><th>Short Name</th><th>Notes</th></tr>
<tr><td>Existing Conditions</td><td>Variable Bathymetry</td><td>Wet</td><td>2006</td><td>Existing Conditions</td><td>Bathymetry set using June of 2013 hydrosurvey data.</td></tr>
<tr><td>CB.1</td><td>30 + 1</td><td rowspan="4">Critical and Wet</td><td rowspan="4">2008 and 2006</td><td>30 ft MLLW</td><td rowspan="3">Channel bathymetry set as deeper of existing conditions or project depth plus 1 ft overdepth.</td></tr>
<tr><td>CB.2</td><td>32 + 1</td><td>32 ft MLLW</td></tr>
<tr><td>CB.3</td><td>35 + 1</td><td>35 ft MLLW</td></tr>
<tr><td>Expanded Footprint</td><td>35 + 1</td><td>Expanded Footprint</td><td>Dredged footprint includes DU-4.</td></tr>
</table>

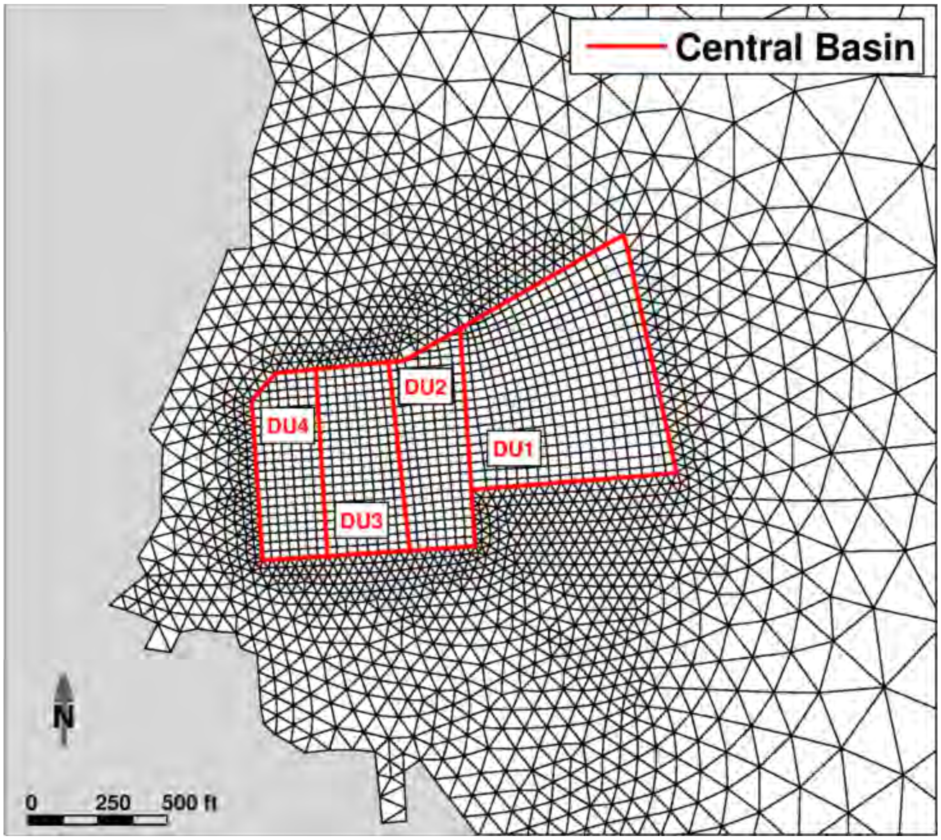

Figure 5.2-1 The numerical model grid in the vicinity of Central Basin. Central Basin DU-1, DU-2, DU-3, and the proposed expanded footprint (DU-4) are outlined in red.

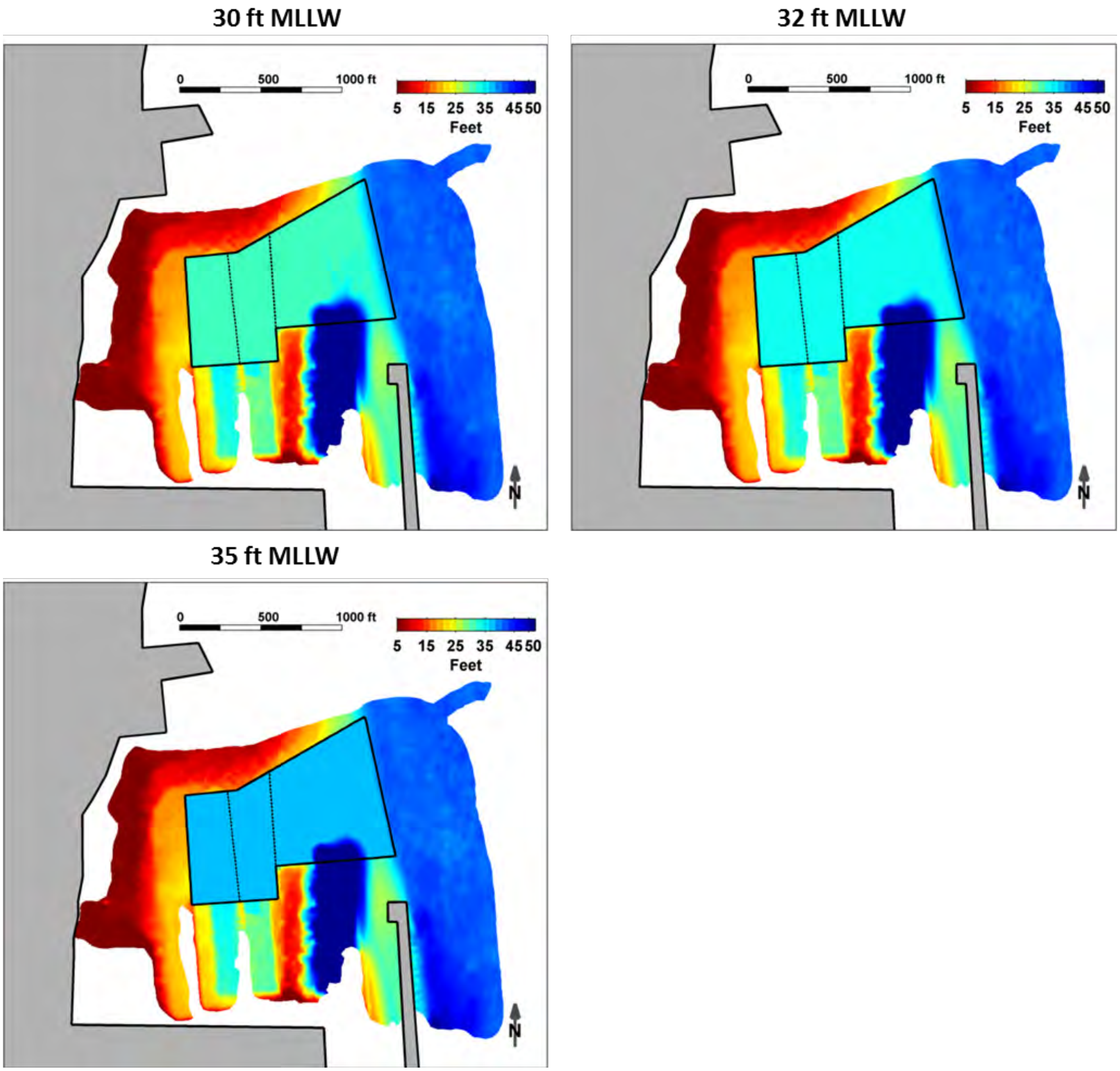

Figure 5.2-2 The bathymetry used to generate the depths for the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenario model grids. Areas inside Central Basin were set as the deeper of the hydrosurvey data or the project depth plus one foot of overdepth.

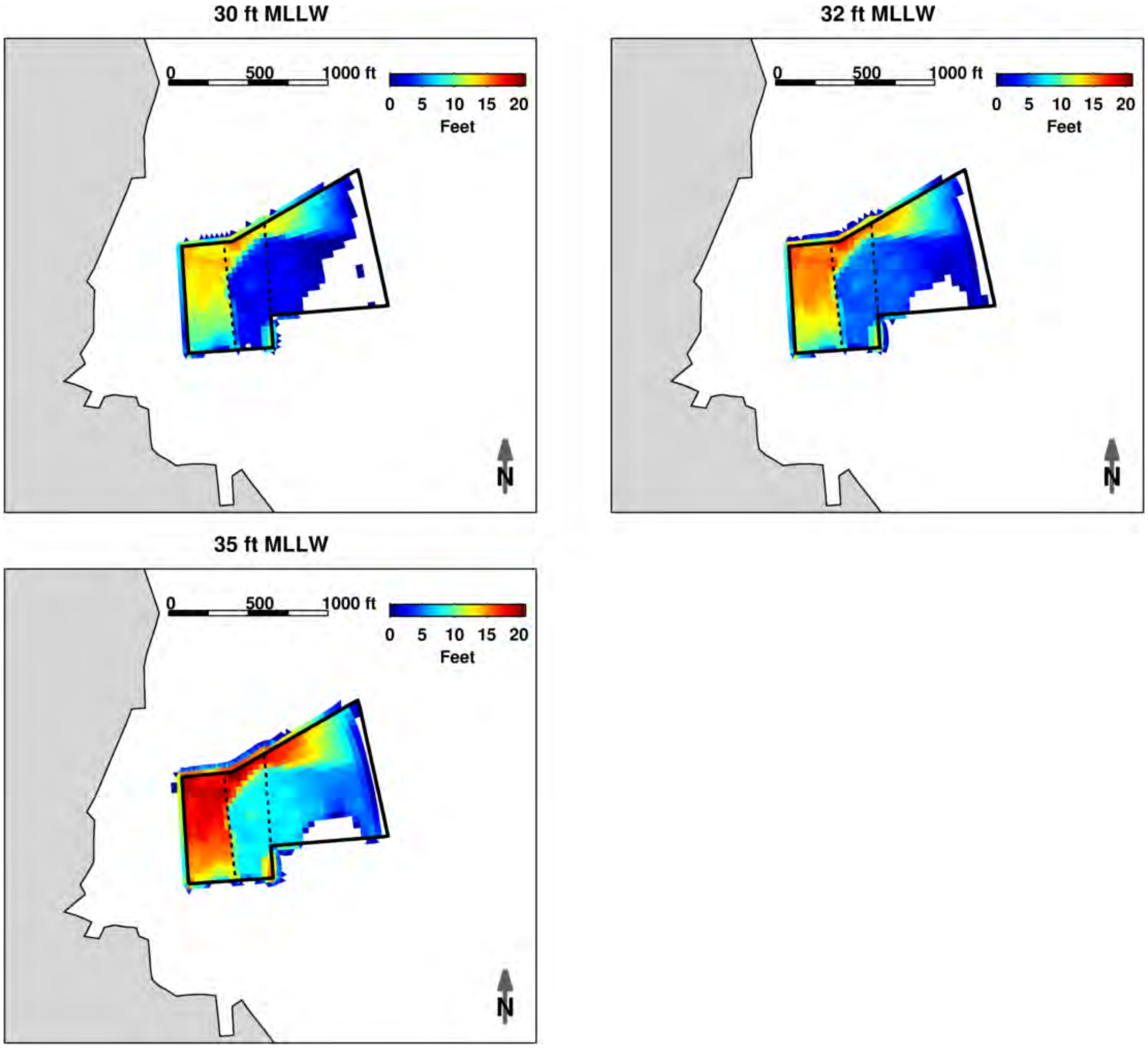

Figure 5.2-3 The amount deepened from the existing conditions model grid to the project depth plus one foot of overdepth scenario grids. White areas represent no deepening, which is especially apparent in the southeast corner under the 30 ft MLLW scenario. Deepened regions outside the Central Basin footprint indicate deepening due to the 3:1 channel side slopes.

5.3 Validation of the Predicted Sedimentation Rate

The existing conditions scenario modeled the wet year of 2006 to determine the predicted sedimentation rate for comparison with the sedimentation rate estimated from the hydrosurvey data. It is expected the predicted sedimentation rate during a wet period should be greater than the observed rate during a very dry period. Based on previous work in Oakland Harbor Channel, also in the Central Bay, the sedimentation rate can vary by a factor of 2 as a result of interannual variability in sediment transport (Delta Modeling Associates 2015). The predicted sedimentation rate under existing conditions during a wet year was 31,500 $yd^3\ yr^{-1}$ (Figure 5.3-1), which is within the range of expected values after accounting for possible interannual variability in the sedimentation that occurs in other channels (e.g., Oakland Harbor, Delta Modeling Associates 2015). This indicates that the model is appropriate for investigating how increasing the Central Basin project depth would affect the sedimentation rate. The combination of the data-derived and model predicted sedimentation rates suggest that the sedimentation rate in Central Basin is between 16,000 yd^3 yr^{-1} and 31,500 yd^3 yr^{-1} under existing conditions, depending on the hydrologic conditions.

The predicted depositional pattern under existing conditions showed little change or erosion on the eastern side near the main Central Bay channel and increasing thicknesses toward the west (Figure 5.3-2). The deposition was predicted to be lower in the shallow western portion (Figure 5.3-2) that appears to have not been dredged during the last dredging episode (Figure 4.2-1). This predicted depositional pattern qualitatively matched that seen in the hydrosurvey data (Figures 4.2-2 and 5.3-2). The existing conditions scenario showed more sediment deposition than the hydrosurvey data. Thicker sediment deposits in the model predictions than the hydrosurvey data are expected since the modeled scenario spanned a longer length of time during a much wetter period than the period during which the hydrosurvey data were analyzed.

The lack of a model validation simulation spanning the same time period as the hydrosurvey data leads to increased uncertainty in the absolute value of predicted sedimentation rates than would be present with a model validation period spanning the period when the hydrosurvey data were collected. The predicted sedimentation rate under existing conditions was 15,500 yd^3 yr^{-1} greater than the rate estimated from the hydrosurvey data. However, the amount of this difference attributable to different lengths of time used to calculate the predicted and hydrosurvey derived rates, attributable to wet versus very dry hydrologic conditions, or attributable to error in the model predictions cannot be quantified. The error in the predicted sedimentation rate is believed to be less than 15,500 yd^3 yr^{-1} because of previous work suggesting the sedimentation rate during a wet year should be greater than the hydrosurvey derived rate during very dry conditions (Delta Modeling Associates 2015). The validation does not provide any information on whether the model predictions were too low for the simulated time period. The uncertainty when comparing scenarios is less than the uncertainty in the absolute values of the sedimentation rates. The uncertainty when comparing multiple scenarios was estimated using a sensitivity test where the model forcing and boundary conditions were held constant but other aspects of the numerical setup were varied. The uncertainty when comparing scenarios was estimated to be about 1,000 yd^3 yr^{-1} to 1,500 yd^3 yr^{-1}, an order of magnitude lower than the estimated maximum absolute value error.

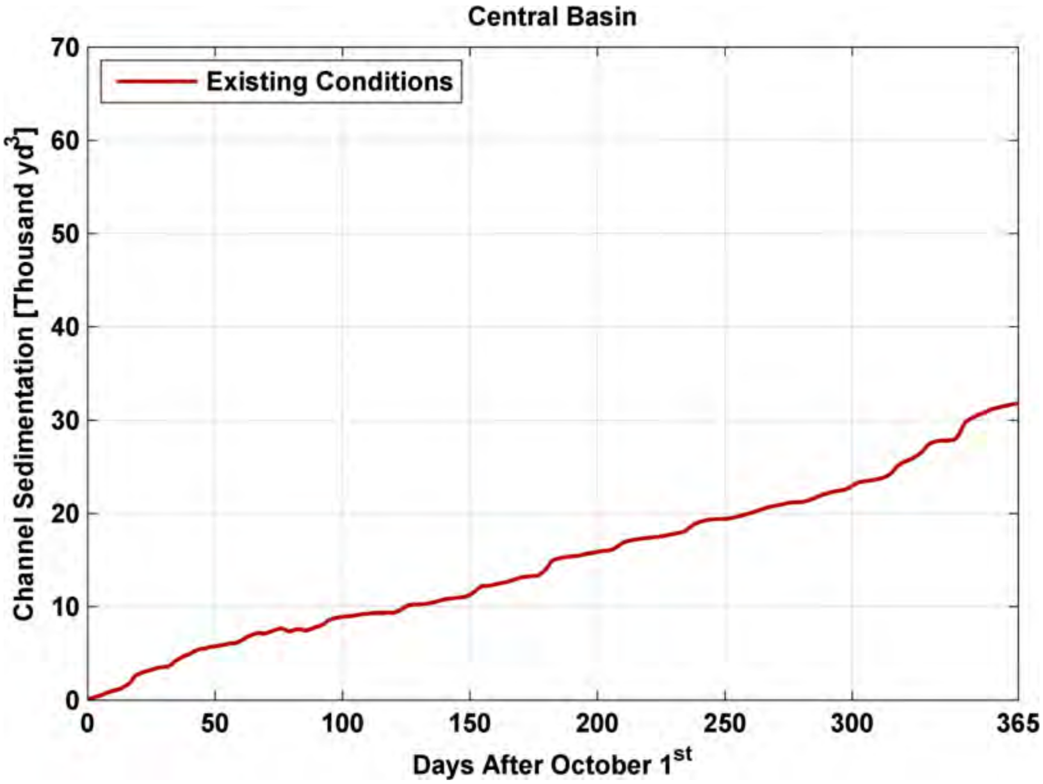

Figure 5.3-1 The predicted volume of sediment deposited in Central Basin during a wet water year for the existing conditions scenario.

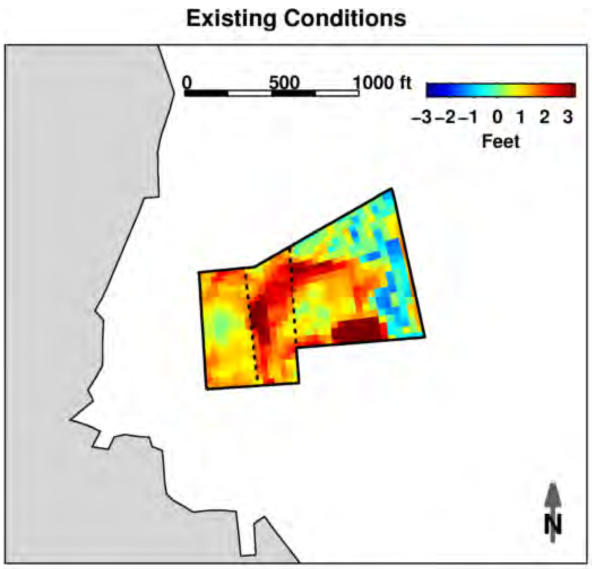

Figure 5.3-2 Sediment deposition thickness in Central Basin during a wet water year for the existing conditions scenario. The area of increased depositional thickness in the south of DU-1 is the deeper dry-dock slip.

5.4 Influence of Project Depth on the Sedimentation

The influence of increasing the project depth from 30 ft MLLW to 32 ft MLLW and from 30 ft MLLW to 35 ft MLLW was evaluated separately for a one year period during the critical 2008 water year and a one year period during the wet 2006 water year.

5.4.1 Critical Water Year: 2008

During the critical water year of 2008 the model predicted an increase in the sedimentation rate with increased depth of Central Basin (Figure 5.4-1, Table 5.4-1). The model predicted a sedimentation rate of 49,500 yd^3 yr^{-1} for the 30 ft MLLW project depth. The sedimentation rate was predicted to remain nearly the same at 49,500 yd^3 yr^{-1} as a result of deepening from 30 ft MLLW to 32 ft MLLW. The sedimentation rate was predicted to increase by about 12% to 55,500 yd^3 yr^{-1} as a result of deepening from 30 ft MLLW to 35 ft MLLW.

All three of the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios showed sediment deposition thicknesses from one to three feet over part of Central Basin after the one year simulation (Figure 5.4-2). The large difference in depth between the dredged channel and the surrounding mudflats acted as a barrier for the transport of sediment up and out of Central Basin onto the shallower mudflats and resulted in sediment deposition near the base of the side slopes. This resulted in the thickest deposition near the edges of the dredged channel. Higher deposition rates were predicted in the portion of the deeper dry-dock slip that extended into DU-1. The difference in depth between the deeper dry-dock slip and the project depths lead to a large amount of sediment trapping in the dry-dock slip.

The eastern side of DU-1 was predicted to be erosional or have minimal deposition for all three project depths simulated (Figure 5.4-2). The 30 ft MLLW scenario was predicted to have the most erosion of the eastern side of DU-1. The erosion was increased in the 30 ft MLLW scenario relative to the 32 ft MLLW and the 35 ft MLLW scenarios because of different interactions of the three channel bathymetries with the hydrodynamics in the Central Bay channel to the east. The southeast corner of DU-1 was deeper in the existing bathymetry than the 30 ft MLLW project depth and was not deepened in the scenario (Figure 5.2-3). Not deepening the southeast corner of the 30 ft MLLW scenario resulted in a sloping seabed that more strongly impinged on the local currents and increased the shear stress in the southeastern region of DU-1 in the 30 ft MLLW scenario, relative to the other scenarios (Figure 5.4-3). It appears that the impinging on the currents also slightly reduced the flow of water into Central Basin, which promoted a decreased seabed shear stress in the middle and western portion of Central Basin (Figure 5.4-3) and thicker and more uniform deposition in DU-1 (Figure 5.4-2) for the 30 ft MLLW scenario than in the other scenarios. Additional survey data and further analysis would be required to better understand the mechanisms responsible for this result.

The average depositional thickness in each dredging unit was predicted to increase from DU-1 to DU-3 for each of the three project depth scenarios (Table 5.4-2). This increase in average depositional thickness indicates that the depositional volume per square yard of dredging unit area increased from east to west in Central Basin.

Table 5.4-1 The predicted sedimentation rate in each dredging unit of Central Basin and the complete Central Basin during water year 2008.

Scenario	Project Depth + Overdepth [ft MLLW]	Year [Duration]	Annual Shoaling Rate in Dredging Units [yd^3/yr]			
			DU-1	DU-2	DU-3	All
CB.1	30 + 1	2008 [1 yr]	28,000	10,000	11,500	49,500
CB.2	32 + 1		29,500	9,000	11,000	49,500
CB.3	35 + 1		32,500	9,500	13,500	55,500

Table 5.4-2 The predicted average depositional thickness in each dredging unit of Central Basin and the complete Central Basin during water year 2008.

Scenario	Project Depth + Overdepth [ft MLLW]	Year [Duration]	Average Deposition Thickness [feet]			
			DU-1	DU-2	DU-3	All
CB.1	30 + 1	2008 [1 yr]	1.5	1.5	1.6	1.5
CB.2	32 + 1		1.6	1.3	1.6	1.5
CB.3	35 + 1		1.8	1.4	1.9	1.7

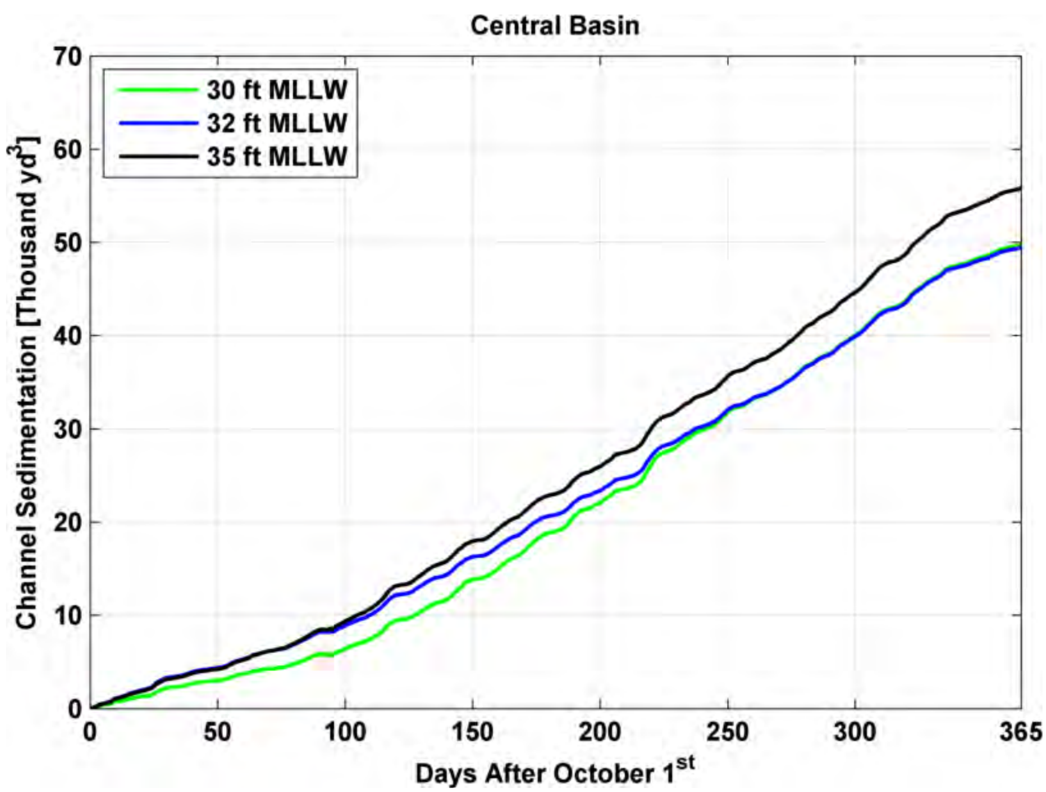

Figure 5.4-1 The predicted volume of sediment deposited in Central Basin during a critical water year (2008) for the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios.

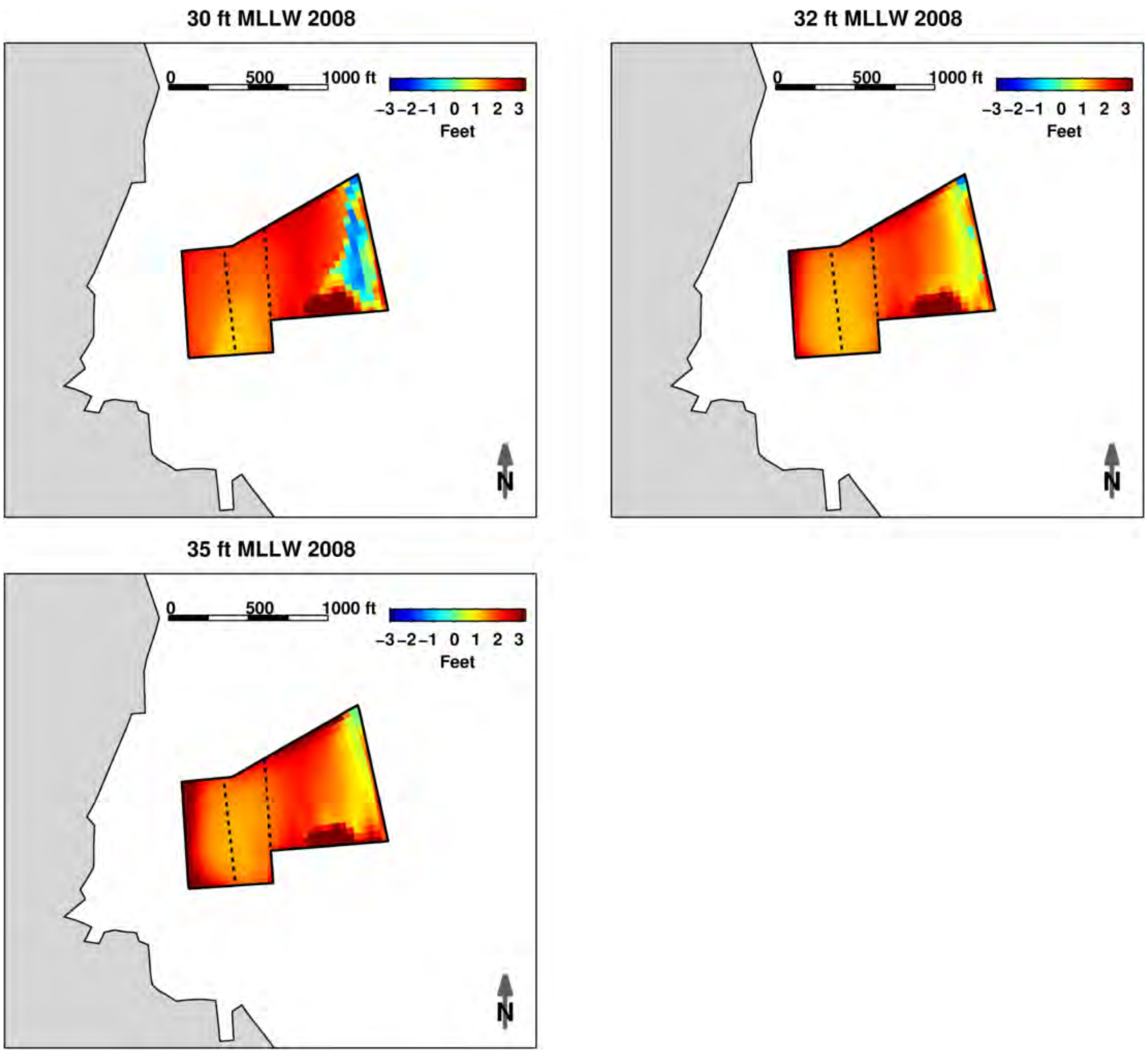

Figure 5.4-2 Sediment deposition thickness in Central Basin during a critical water year (2008) for the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios. The area of increased depositional thickness in the south of DU-1 is the deeper dry-dock slip.

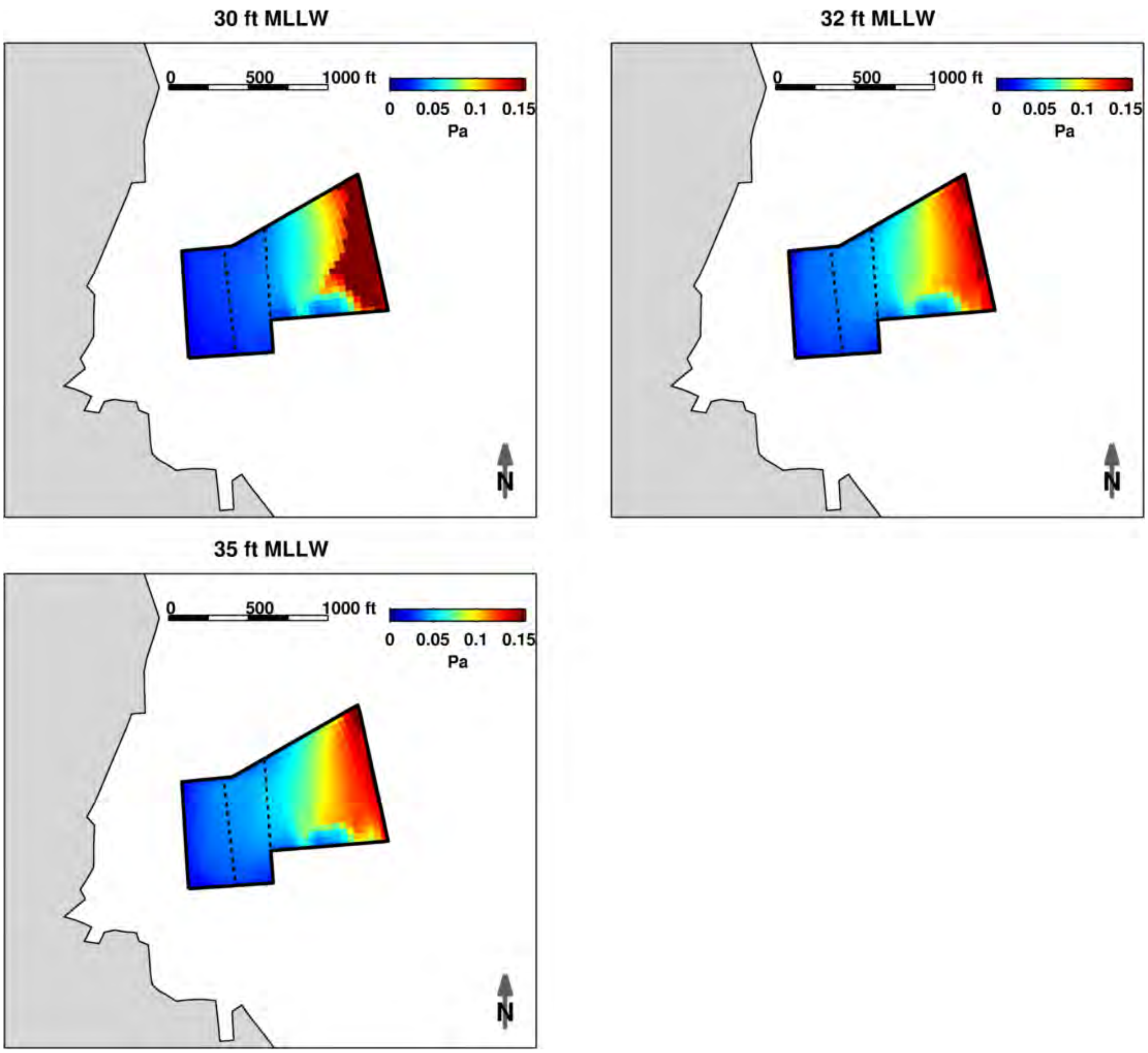

Figure 5.4-3 The time-averaged seabed shear stress in Central Basin over the critical water year (2008) for the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios.

5.4.2 Wet Water Year: 2006

During the wet water year of 2006 the model predicted a general increase in sedimentation with increased project depth of Central Basin, however, there were predicted deviations about this general trend. The predicted sedimentation rates for the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios were all higher than under the existing conditions. The deepest project depth (35 ft MLLW) was predicted to have the highest sedimentation rate over the one year period (Table 5.4-3). However, the 30 ft MLLW scenario was predicted to have a higher sedimentation rate than the 32 ft MLLW scenario during the wet year (Figure 5.4-4, Table 5.4-3). The increase in the sedimentation in the 30 ft MLLW scenario was most pronounced in DU-1, where the 30 ft MLLW scenario had a higher predicted sedimentation rate than both the 32 ft MLLW and the 35 ft MLLW scenarios. This increase in the sedimentation rate in DU-1 with the 30 ft MLLW project depth compared to the 32 ft MLLW and 35 ft MLLW project depths was likely caused by different interactions of the Central Basin depth with the local hydrodynamics, particularly during the very wet portion of the year. As also explained in Section 5.4.1, the southeast corner of DU-1 was deeper in the existing conditions than the 30 ft MLLW project depth and was therefore not deepened in the 30 ft MLLW scenario (Figure 5.2-3). Not deepening the southeast corner in the 30 ft MLLW scenario resulted in a sloping seabed in the southeast corner of DU-1 that more strongly impinged on the local currents and increased the shear stress in the southeastern region of DU-1 in the 30 ft MLLW scenario relative to the 32 ft MLLW and 35 ft MLLW scenarios (Figure 5.4-3). The impinging on the currents also likely slightly reduced the flow of water into Central Basin, which promoted a decreased seabed shear stress over the middle and western portion of Central Basin (Figure 5.4-3) and thicker and more uniform deposition in DU-1 (Figure 5.4-5) for the 30 ft MLLW scenario than in the other scenarios.

The model predictions for the wet year of 2006 were further analyzed by examining the sedimentation rate over only the relatively dry portions of the water year (October-December 2005 and June-September 2006) for comparison with the results from the critical year of 2008. This analysis showed that the predicted sedimentation rate during the relatively dry portion of the water year was typically higher in both the 32 ft MLLW and the 35 ft MLLW project depth scenarios than the 30 ft MLLW scenario (Figure 5.4-6). This expected relative increase in the sedimentation rates with increased project depth during the relatively dry portions of the 2006 water year is consistent with the results from the 2008 simulations. When analyzing only the relatively dry portions of the wet 2006 water year the 32 ft MLLW scenario was predicted to only increase the sedimentation rate relative to the 30 ft MLLW scenario by about 3% (1,500 yd^3 yr^{-1}). This change in the sedimentation rate between scenarios is close to the overall uncertainty when comparing two scenarios, and these two scenarios were considered to have nearly the same predicted sedimentation rates over the relatively dry periods of the simulated water year. This analysis suggests the different interactions between the project depths and the Central Bay hydrodynamics may have resulted in the higher predicted sedimentation rate in the wet period with the 30 ft MLLW project depth. The predicted sedimentation rate in the 30 ft MLLW scenario during the wet period is higher than for both the 32 ft MLLW and 35 ft MLLW scenarios (Figure 5.4-6, Table 5.4-4).

When including the wet period of 2006 in the analysis, the model predicted a sedimentation rate of 48,000 yd^3 yr^{-1} for the 30 ft MLLW project depth. The sedimentation rate was predicted to be 42,000 yd^3 yr^{-1} for the 32 ft MLLW project depth, which was less than predicted for the 30 ft MLLW project depth. The 35 ft MLLW scenario was predicted to increase the sedimentation rate by 23% to 51,500 yd^3 yr^{-1} relative to the 32 ft MLLW scenario. The 51,500 yd^3 yr^{-1} sedimentation rate is an increase of 7% relative to the 48,000 yd^3 yr^{-1} sedimentation rate.

The average depositional thickness was predicted to increase from DU-1 to DU-2 to DU-3 in each of the three project depth scenarios (Table 5.4-5). This increase in average depositional thickness indicates that the depositional volume per square yard of dredging unit area increased from east to west in Central Basin. The sediment depositional patterns for the wet water year of 2006 (Figure 5.4-5) were predicted to be similar to those for the critical water year of 2008 (Figure 5.4-2). The predicted deposition thickness for the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios were in excess of three feet over in some portions of central Basin after the one year simulation spanning the wet 2006 water year (Figure 5.4-5). The thickest deposition was near the edges of the dredged project footprint, with deposition predicted to exceed three to four feet on the western side of DU-3 in the 32 ft MLLW and 35 ft MLLW scenarios. The portion of the deeper dry-dock slip that extended into DU-1 was predicted to be very depositional. The eastern side of DU-1 was predicted to be erosional or have little change in all three of the scenarios. The mechanisms behind this prediction are explained above and in Section 5.4.1.

Table 5.4-3 The predicted sedimentation rate in each dredging unit of Central Basin and the complete Central Basin during water year 2006.

Scenario	Project Depth + Overdepth [ft MLLW]	Year [Duration]	Annual Shoaling Rate in Dredging Units [yd^3/yr]			
			DU-1	DU-2	DU-3	All
CB.1	30 + 1	2006 [1 yr]	21,000	11,500	15,500	48,000
CB.2	32 + 1		16,000	8,500	17,500	42,000
CB.3	35 + 1		17,500	11,500	22,500	51,500

Table 5.4-4 The predicted sedimentation rate in each dredging unit of Central Basin and the complete Central Basin during the dry and wet portions of water year 2006. These time periods encompassed October 1st through December 30th, 2005 (dry), December 30th, 2005 through May 31st, 2006 (wet), and June 1st through September 30th, 2006 (dry).

Scenario	Project Depth + Overdepth [ft MLLW]	Conditions [Duration]	Annual Shoaling Rate in Dredging Units [yd^3/yr]			
			DU-1	DU-2	DU-3	All
CB.1	30 + 1	Dry [90 days]	24,500	12,000	17,000	53,500
CB.2	32 + 1		26,500	11,000	14,500	52,000
CB.3	35 + 1		29,000	12,000	19,000	60,000
CB.1	30 + 1	Wet [153 days]	18,000	12,000	16,500	46,500
CB.2	32 + 1		5,500	6,500	19,000	31,000
CB.3	35 + 1		6,000	11,000	26,500	43,500
CB.1	30 + 1	Dry [122 Days]	22,500	10,500	12,500	45,500
CB.2	32 + 1		21,000	9,500	18,000	48,500
CB.3	35 + 1		23,500	12,000	20,000	55,500

Table 5.4-5 The predicted average depositional thickness in each dredging unit of Central Basin and the complete Central Basin during water year 2006.

Scenario	Project Depth + Overdepth [ft MLLW]	Year [Duration]	Average Deposition Thickness [feet]			
			DU-1	DU-2	DU-3	All
CB.1	30 + 1	2006 [1 yr]	1.1	1.7	2.2	1.5
CB.2	32 + 1		0.9	1.3	2.5	1.3
CB.3	35 + 1		0.9	1.7	3.2	1.6

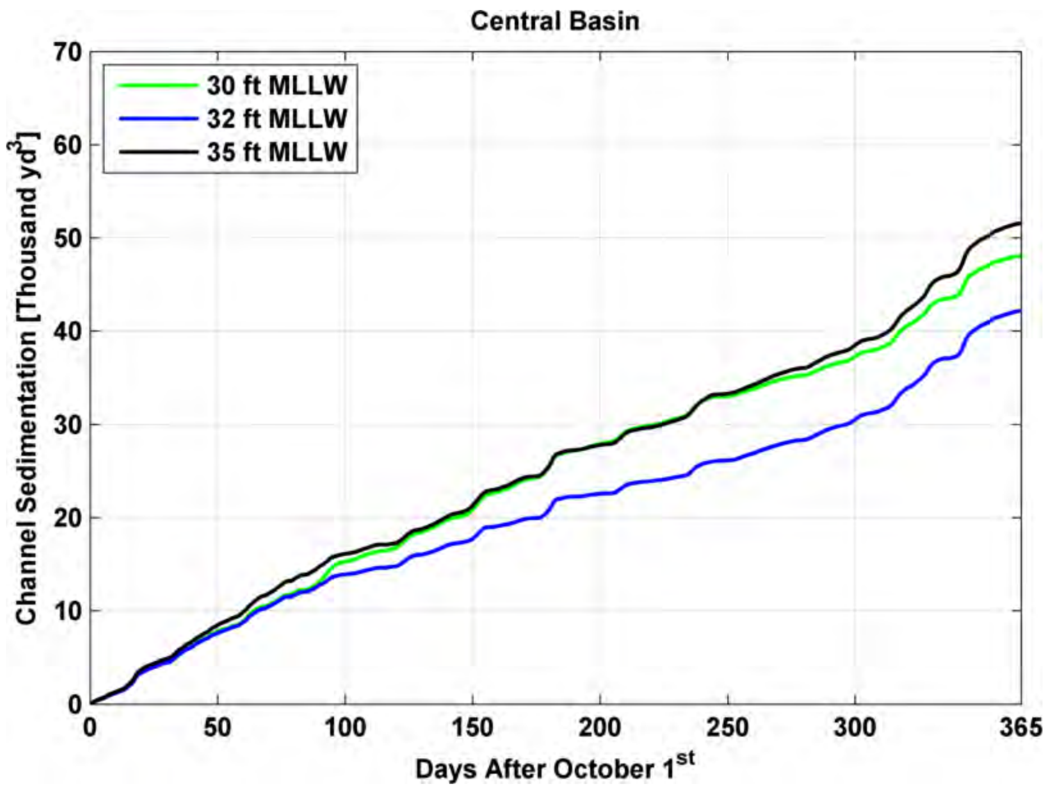

Figure 5.4-4 The predicted volume of sediment deposited in Central Basin during a wet water year (2006) for the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios.

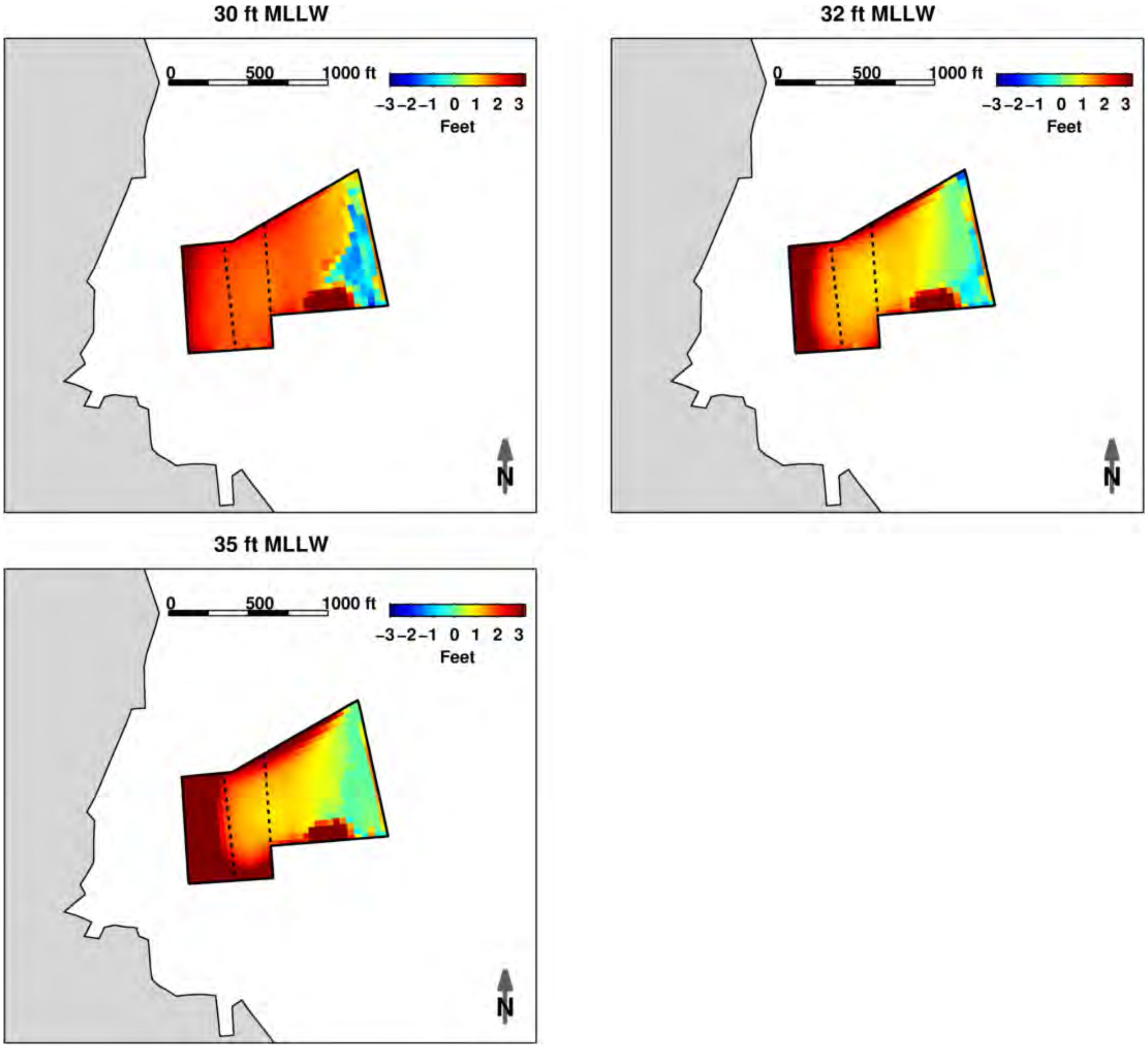

Figure 5.4-5 Sediment deposition thickness in Central Basin during a wet water year (2006) for the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios. The area of increased depositional thickness in the south of DU-1 is the deeper dry-dock slip.

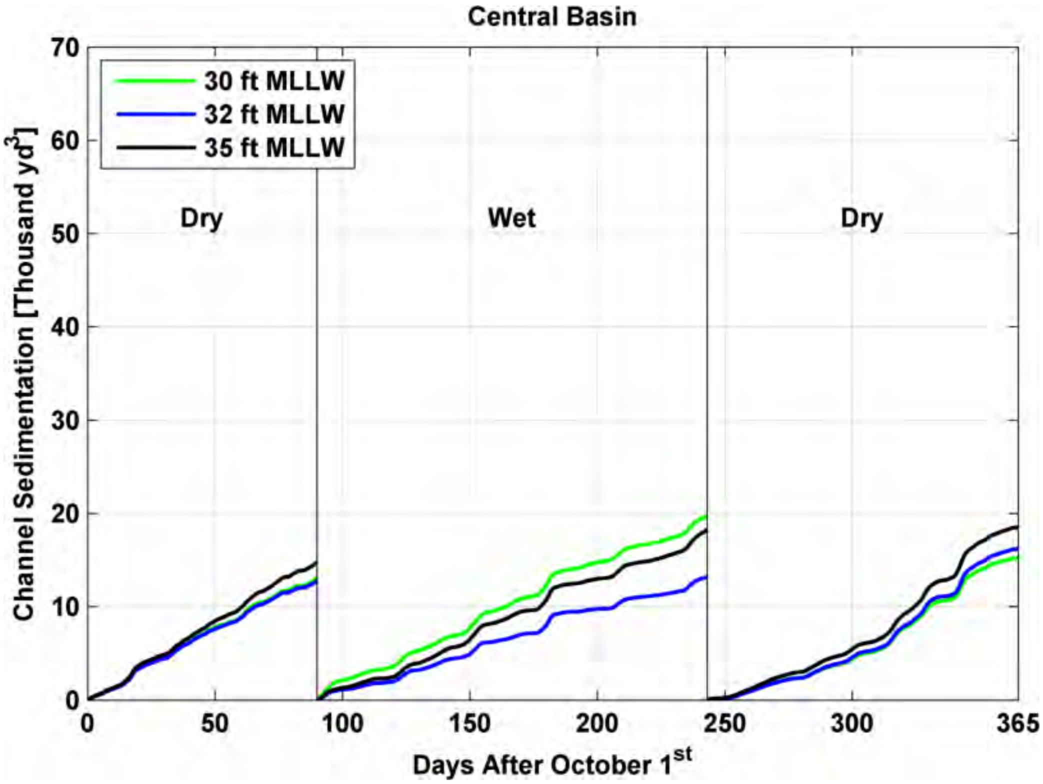

Figure 5.4-6 The predicted volume of sediment deposited in Central Basin during the dry and wet periods of a wet water year (2006) for the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios.

5.5 Influence of Increased Channel Area on the Sedimentation Rate

The model predicted an increase in the sedimentation rate in Central Basin resulting from expanding the dredged footprint of the channel. For the critical year of 2008 the sedimentation rate was predicted to increase by about 11% to 61,500 yd^3 yr^{-1} in the Expanded Footprint scenario relative to the 35 ft MLLW scenario (Table 5.5-1). For the wet year of 2006 the sedimentation rate was predicted to increase by about 17% to 60,500 yd^3 yr^{-1} in the Expanded Footprint scenario relative to the 35 ft MLLW scenario. However, the sedimentation was not predicted to increase in each of the dredging units uniformly. The sedimentation was predicted to remain the same or decrease in dredging units one through three in the Expanded Footprint scenario because the sediment was transported farther toward the west than in the 35 ft MLLW scenario that did not include DU-4. Much of the sediment that was deposited near the western edge of the dredged project footprint in DU-3 in the 35 ft MLLW scenario was transported further west and was deposited in DU-4 in the Expanded Footprint scenario (Figures 5.5-1 and 5.5-2). This sediment that bypassed DU-3 in the Expanded Footprint scenario was still deposited along the edge of the dredged project, except the edge of the project footprint was along DU-4 in the Expanded Footprint scenario.

Table 5.5-1 The predicted sedimentation rate in each dredging unit of Central Basin and the complete Central Basin during water years 2008 and 2006. DU-4 was only included in this analysis for the Expanded Footprint scenario.

Scenario	Project Depth + Overdepth [ft MLLW]	Year [Duration]	Annual Shoaling Rate in Dredging Units [yd³/yr]				
			DU-1	DU-2	DU-3	DU-4	All
CB.3	35 + 1	2008 [1 yr]	32,500	9,500	13,500	n/a*	55,500
Expanded Footprint	35 + 1		32,000	9,000	9,000	11,500	61,500
CB.3	35 + 1	2006 [1 yr]	17,500	11,500	22,500	n/a*	51,500
Expanded Footprint	35 + 1		14,500	10,000	16,500	19,500	60,500

* n/a stands for not applicable.

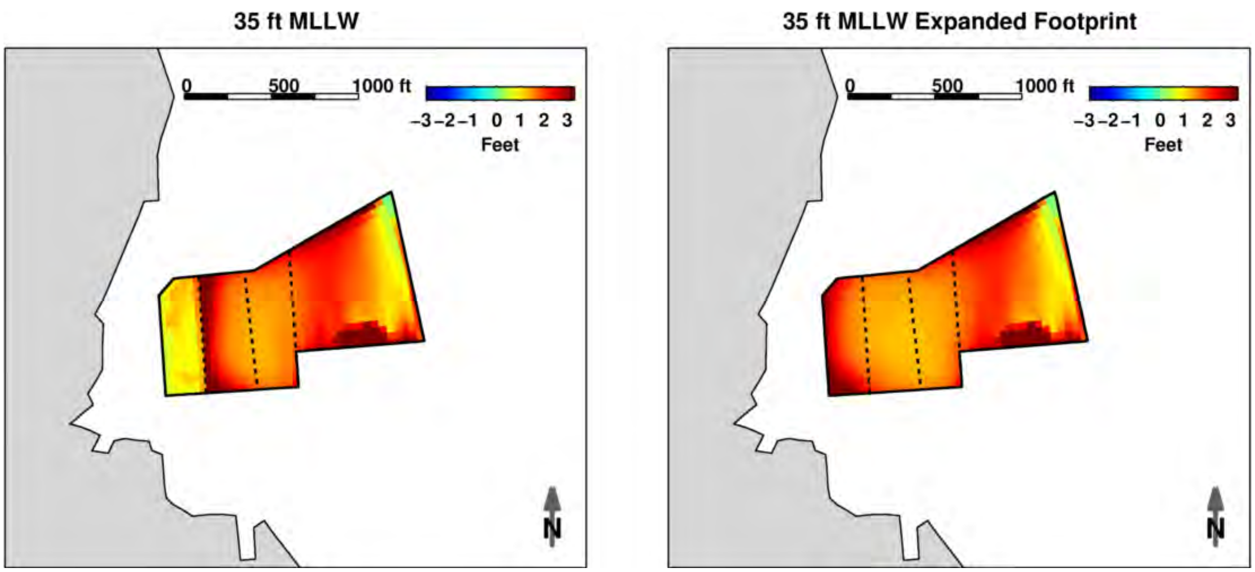

Figure 5.5-1 Sediment deposition thickness in Central Basin over a critical water year (2008) for the 35 ft MLLW (left) and Expanded Footprint (right) scenarios. The larger eastern region represents DU-1, DU-2, and DU-3, while the smaller western region is DU-4. DU-4 was only used to calculate the sedimentation rate in the Expanded Footprint scenario.

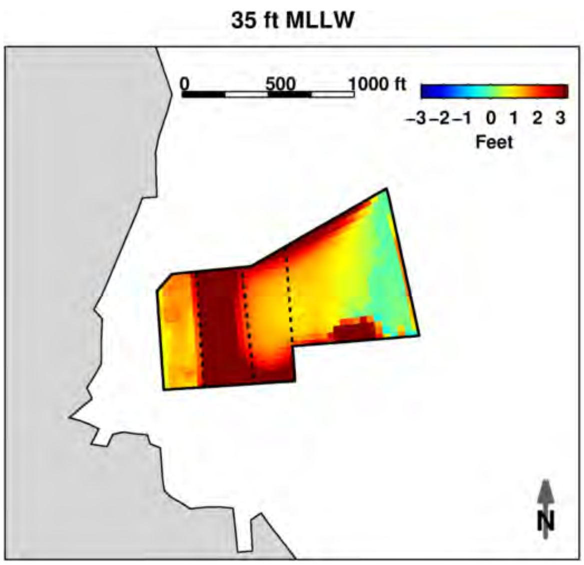

Figure 5.5-2 Sediment deposition thickness in Central Basin during a wet water year (2006) for the 35 ft MLLW (left) and Expanded Footprint (right) scenarios. The larger eastern region represents DU-1, DU-2, and DU-3, while the smaller western region is DU-4. DU-4 was only used to calculate the sedimentation rate in the Expanded Footprint scenario.

5.6 Summary of Central Basin Sedimentation Rates

The sedimentation rate in Central Basin was generally predicted to increase as the project depth of Central Basin was increased from the existing conditions to the 35 ft MLLW project depth. The sedimentation rate was also predicted to increase when the area of the dredged footprint was expanded to include DU-4. The interannual variability in the sedimentation rate was predicted to be lower in Central Basin than was predicted in the Oakland Harbor Channel (Delta Modeling Associates 2015). The complexity of the predicted sedimentation rates as a function of project depth combined with the interannual variability precluded the development of a simple relationship relating the project depth to the sedimentation rate. Table 5.6-1 summarizes the sedimentation rates estimated from the hydrosurvey data and predicted by the model for each of the analyzed water years, channel bathymetries, and dredging footprints.

Table 5.6-1 The hydrosurvey derived and model predicted sedimentation rates for the complete Central Basin under each of the channel configurations and time periods examined. N/A indicates the channel configuration and project depth combination was not examined.

Channel Area	Channel Project Depth + Overdepth [ft MLLW]	Annual Shoaling Rate [yd^3/yr] and Analysis Time Period		
		Water Year 2006 (Predicted)	Water Year 2008 (Predicted)	June 2013 to January 2014 (Hydrosurvey)
DU-1, DU-2, and DU-3	Existing Conditions	31,500	N/A	16,000
	30+1	48,000	49,500	N/A
	32+1	42,000	49,500	N/A
	35+1	51,500	55,500	N/A
Expanded Footprint	35+1	60,500	61,500	N/A

6. Summary and Conclusions

This report documents the results of the Central Basin study conducted as part of the "Central Bay 3-D Sediment Transport Modeling" project. Central Basin has infilled significantly over the last ten years, restricting access to piers and dry-docks. Hydrographic surveys of Central Basin bathymetry and numerical model results from the coupled UnTRIM-SWAN-SediMorph Bay-Delta model were used to predict the sedimentation rate in Central Basin under various project depths. Emphasis was placed on determining how deepening project depths incrementally affect the sedimentation rate and annual dredging requirements in Central Basin. The increasing sedimentation rate associated with expanding the Central Basin footprint was also evaluated.

Two hydrographic surveys of the Central Basin bathymetry were used to estimate a shoaling rate on the order of about 16,000 yd^3 yr^{-1} under existing conditions. However, this estimate was based on only about seven months of sedimentation during very dry hydrologic conditions, and as such is considered only an order of magnitude estimate of the sedimentation rate under very dry hydrologic conditions. A model simulation using the existing conditions of Central Basin predicted a sedimentation rate of about 31,500 yd^3 yr^{-1} during a wet hydrologic year. Based on previous work in Oakland Harbor Channel, also in the Central Bay, the sedimentation rate can vary by a factor of 2 as a result of interannual variability in sediment transport. This indicates the predicted sedimentation rate was within the range of expected values based on the limited data available and accounting for interannual variability. The model also predicted the depositional and erosional patterns observed in the hydrosurvey data, with erosion or little change in the eastern portion of Central Basin, increased depositional thickness in the western portion of the dredged project footprint, and reduced depositional thicknesses in the relatively undredged most western portion of the project footprint. The combination of model validations for the Central Basin and Oakland Harbor studies indicate the model is suitable for examining changes in sedimentation in Central Basin resulting from deepening the project depth and from expanding the dredged footprint. Together, the hydrosurvey estimates and the model predictions suggest annual sedimentation rates between about 16,000 yd^3 yr^{-1} and 31,500 yd^3 yr^{-1} under existing conditions, depending on the hydrologic conditions.

Simulations of the existing conditions bathymetry and 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW project depths during two different water year types predicted the sedimentation rate in Central Basin to generally increase as a result of deepening the Central Basin project depth. Since even the 30 ft MLLW scenario entails significant deepening relative to the existing conditions (see Figure 5.2-3), the predicted sedimentation rates for the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios were higher than the sedimentation rate under existing conditions. During the simulated critical water year of 2008, the sedimentation rate was predicted to be about 49,500 yd^3 yr^{-1} with a 30 ft MLLW project depth. This sedimentation rate was predicted remain nearly the same at about 49,500 yd^3 yr^{-1} as a result of deepening from 30 ft MLLW to 32 ft MLLW. The sedimentation rate was predicted to increase by about 12% to 55,500 yd^3 yr^{-1} as a result of deepening from 30 ft MLLW to 35 ft MLLW.

During the simulated wet water year of 2006, the model predicted the sedimentation rate to increase in each of the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios relative to the existing conditions. However, the model predicted the sedimentation rate in the 30 ft MLLW scenario to be higher than the sedimentation rate in the 32 ft MLLW scenario during the wet water year of 2006. Analysis suggested the prediction of a higher sedimentation rate in the 30 ft MLLW scenario than the 32 ft MLLW scenario resulted from the model predicting different interactions of the channel bathymetry with the hydrodynamics of the Central Bay that increased the predicted sedimentation under the 30 ft MLLW project depth relative to the 32 ft MLLW project depth during the very wet portion of the 2006 water year. During the simulated wet year of 2006, the sedimentation rate was predicted to be about 48,000 $yd^3\ yr^{-1}$ for the 30 ft MLLW project depth. During this same year, the sedimentation rate was predicted to be 42,000 $yd^3\ yr^{-1}$ for the 32 ft MLLW project depth, which is lower than was predicted for the 30 ft MLLW project depth. The sedimentation rate was predicted to increase by about 23% to 51,500 $yd^3\ yr^{-1}$ as a result of deepening to a 35 ft MLLW project depth, relative to the 32 ft MLLW scenario. The predicted 51,500 $yd^3\ yr^{-1}$ is an increase of about 7% relative to the 48,000 $yd^3\ yr^{-1}$ predicted for the 30 ft MLLW scenario.

Expanding the footprint of Central Basin that is dredged to a 35 ft MLLW project depth by including dredging unit 4 (DU-4) in the dredged area was predicted to increase the sedimentation rate and the annual dredging requirements relative to predictions using only DU-1 through DU-3. For the critical year of 2008 the sedimentation rate was predicted to increase by about 11% to 61,500 $yd^3\ yr^{-1}$ in the Expanded Footprint scenario relative to the 35 ft MLLW scenario. For the wet year of 2006 the sedimentation rate was predicted to increase by about 17% to 60,500 $yd^3\ yr^{-1}$ in the Expanded Footprint scenario relative to the 35 ft MLLW scenario. Increasing the area of the dredged project footprint was predicted to slightly decrease the sedimentation in DU-1 through DU-3 because the hydrodynamics acted to transport the sediment farther toward the west than in the original 35 ft MLLW scenario that did not include DU-4.

The predicted annual depositional thicknesses were up to one to five feet in some portions of Central Basin for each of the 30 ft MLLW, 32 ft MLLW, and 35 ft MLLW scenarios. These depositional thicknesses caused shoaling to above the project depths over large portions of Central Basin during the simulations. Both the predictions and the hydrosurvey derived sediment depositional patterns showed less sedimentation toward the eastern side of Central Basin adjacent to the naturally deeper Central Bay, and more deposition along the western edge of the deepened portion of Central Basin. This suggests a two level project depth of 35 ft MLLW near the Central Bay channel reducing to 30 ft MLLW approaching and in DU-2 and DU-3 may maximize access to the eastern dry-dock slip while minimizing the increased sedimentation and increased dredging requirements that were predicted to accompany the 35 ft MLLW project depth. However, this multi-depth project approach was not directly evaluated as part of this analysis.

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Appendix A: Data Sources, Assumptions, and Limitations of the Coupled Modeling System

This appendix briefly describes the data sources used to develop the model boundary conditions for the UnTRIM Bay-Delta model. Some of the major assumptions inherent in the numerical modeling of hydrodynamics, waves, and sediment transport and the resulting limitations that influence the model results are also discussed.

A.1 Data Sources Used Within the UnTRIM Bay-Delta Model

Detailed descriptions of the boundary conditions and the data used to develop the boundary conditions for the UnTRIM Bay-Delta model, the SWAN wave model, and the SediMorph seabed and sediment transport model, along with the coupling methods for the hydrodynamic, wave, and sediment transport modeling system, are presented in MacWilliams et al. (2015) and Bever and MacWilliams (2013). This appendix presents a summary of the model boundary conditions and data sources used in the coupled UnTRIM-SWAN-SediMorph Bay-Delta model that can be used as a quick reference (Figure A-1, Table A-1), while the previously mentioned references should be consulted for detailed descriptions.

The UnTRIM Bay-Delta model grid was developed with varying grid resolution along the axis of the estuary as necessary to resolve the bathymetric variability, with smaller grid cells used in narrower channels and in regions of complex bathymetry. The bathymetry was incorporated into the model using the highest resolution data that were available at any location (MacWilliams et al. 2015). The observed water level at the NOAA San Francisco tide station (9414290) was used to force the tidal water level at the open boundary. The open boundary salinity was set using daily salinity observations from the Farallon Islands, approximately 20 km west of the open boundary (SCCOOS 2012). The initial salinity field in the Bay was specified based on vertical salinity profiles collected by the USGS at 38 stations along the axis of the estuary (USGS 2013b) and in the Delta by interpolating from continuous monitoring stations (CDEC 2013). At the bottom boundary the roughness coefficient Z_0 was specified according to the elevation of each grid cell edge following the approach used by Cheng et al. (1993), Gross et al. (2010), and MacWilliams and Gross (2013), with higher roughness coefficients in shallower and higher elevation areas.

River inflows to the model included tributaries to the Bay and Delta and discharges from water pollution control plants (Figure A-1). Daily water exports were also specified at six locations. Hourly wind data was specified for six subregions of the Bay-Delta based on observations from the Bay Area Air Quality Management District (BAAQMD). Evaporation and precipitation in the Bay was set based on hourly data from the California Irrigation Management Information System (CIMIS), while evaporation and precipitation in the Delta were included in the Delta Island Consumptive Use (DICU). Monthly estimates of DICU (CDWR 1995) were used to specify the seepage, agricultural diversions, return flows and return flow salinity within the Delta. Nine control gates and temporary barriers in the Delta were incorporated into the model to represent the effects of these gates and barriers on flow and transport in the Delta (Figure A-1). For each control structure, the seasonal timing of the installation, removal, and associated culvert and gate operations were specified (MacWilliams et al. 2009; MacWilliams and Gross 2013).

Sediment transport calculations included four sediment classes, each with different particle size, settling velocity, critical shear stress, density and erosion rate parameter. The four sediment classes were chosen to represent the dominant constituents in the real San Francisco Bay grain size distribution, and were single particle silt**,** flocculated silts and clays called “flocs”, sand, and gravel, with characteristics based on data from San Francisco Bay (Kineke and Sternberg 1989; Sea Engineering 2008; Smith and Friedrichs 2011). Observed surface grain size distributions were used to generate a realistic initial sediment bed for the entire San Francisco Bay-Delta system. Grain size distribution data were compiled from a USACE Long Term Management Strategy report (Pratt et al. 1994), the dbSEABED west coast surface grain size distribution database (Jenkins 2010), the USGS sand provenance study (Barnard et al. 2013) and the Delta sediment grain size study (S. Wright, Pers. Comm. 2012). Suspended sediment was supplied through river input to the Sacramento-San Joaquin Delta, the North Bay and the South Bay. Sediment was supplied to the Delta by five tributaries representing nearly 100% of the sediment inflow to the delta (Wright and Schoellhamer 2005). Sediment was supplied to the North Bay by one tributary and to the South Bay by four tributaries. Suspended sediment concentrations were set based on time series concentrations from the USGS (T. Morgan-King, Pers. Comm. 2013), daily concentrations from the USGS (2013a), or rating curves (Wright and Schoellhamer 2005), depending on data availability.

The SWAN wave calculations used the same model grid and bathymetry as the UnTRIM hydrodynamic model, except that the quadrilaterals in the UnTRIM grid were converted to triangles, as explained in Bever and MacWilliams (2013). The wind was the same as that used in the hydrodynamic model and the bottom roughness was the Nikuradse roughness based on the roughness from the hydrodynamic model.

Table A-1 Summary of data sources used for model boundary conditions.

	Boundary Condition / Forcing	**Description / Sources**
UnTRIM Initial Conditions	Bathymetry	High-resolution bathymetric data from several sources
	Navigation channel alignments in the grid	Provided by the USACE (Central Basin was provided by the Port of San Francisco)
	Salinity	Based on USGS water quality sampling in the Bay (USGS 2013b) and interpolated using continuous monitoring stations in the Delta (CDEC 2013)
Hydrodynamic Forcing	Tidal forcing	Six minute from NOAA San Francisco tide station (9414290)
	Open boundary salinity	Daily salinity at Farallon Islands (SCCOOS 2012)
	Inflows	Daily using DAYFLOW (CDWR 1986, 2013) for Delta tributaries and USGS data (USGS 2013a) for Bay tributaries
	Exports	Daily from DAYFLOW (CDWR 1986, 2013) and the California Data Exchange Center (CDEC 2013)
	DICU	Monthly based on the Delta Island Consumptive Use Model (CDWR 1995)
	Flow control structures	Seasonally nine Delta control structures (see MacWilliams et al. 2009)
	Evaporation / precipitation	Hourly data from California Irrigation Management Information System (CIMIS)
	Wind	Hourly data from Bay Area Air Quality Management District (BAAQMD)
	Seabed roughness	Elevation dependent Z_0 ranging from 0.001 mm to 1.0 cm
Sediment	Sediment settling velocity, critical shear stress, diameter, and erosion rate	Based on data in San Francisco Bay from Kineke and Sternberg (1989), Sea Engineering (2008), Smith and Friedrichs (2011)
	Seabed grain size distribution	Based on surface grain size distributions from the USGS (Barnard et al. 2013; S. Wright, Pers. Comm. 2012), USACE (Pratt et al. 1994) and dbSEABED database (Jenkins 2010)
	Inflow suspended sediment concentration	Daily based on USGS time series observations, USGS daily measurements, or rating curves, based on data availability.
Waves	Bathymetry	Same as the hydrodynamic model
	Wind	Same as the hydrodynamic model
	Bottom roughness	Nikuradse roughness based on the roughness used in the hydrodynamic model

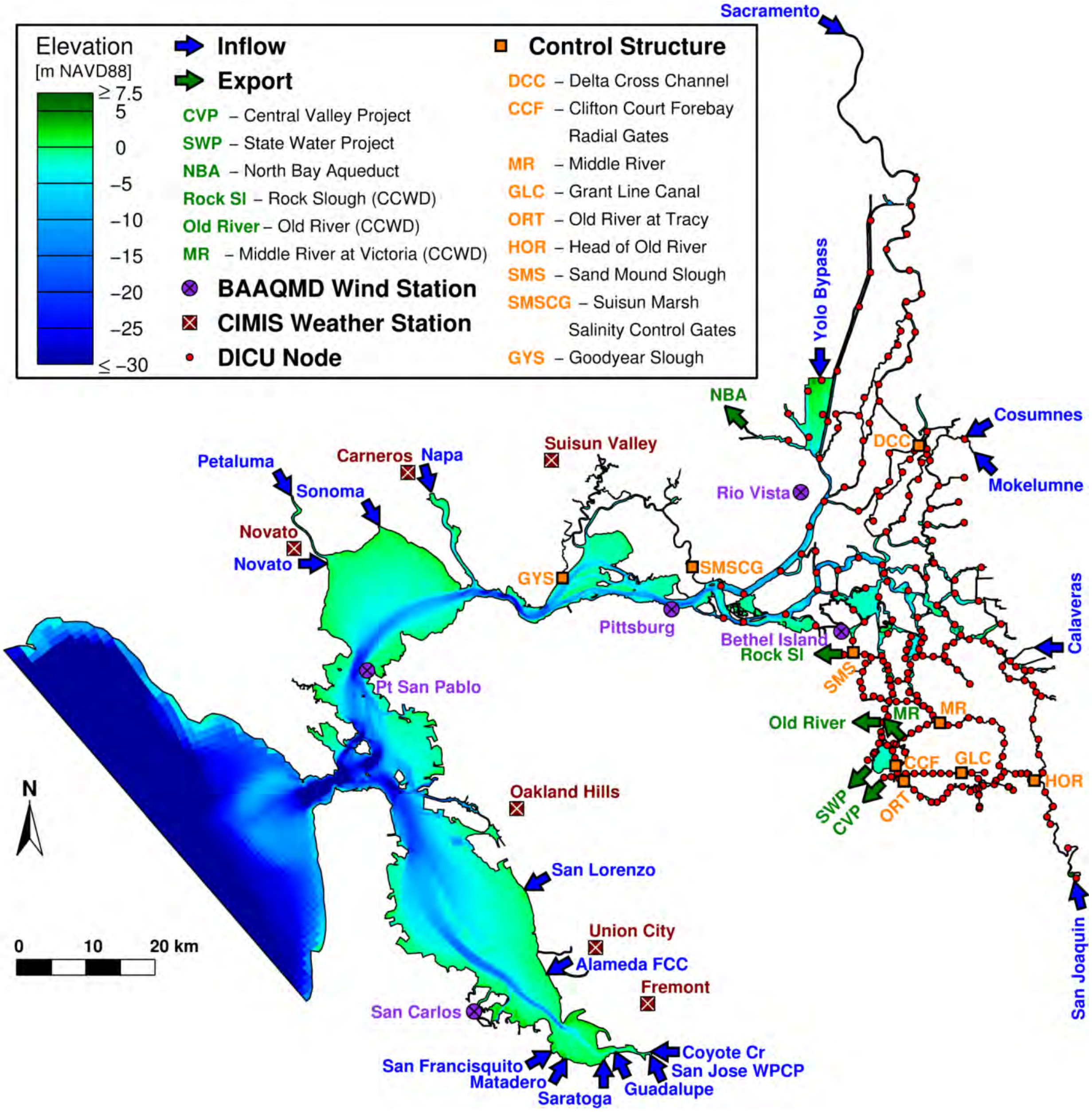

Figure A-1 UnTRIM San Francisco Bay-Delta model domain, bathymetry, and locations of model boundary conditions which include inflows, export facilities, wind stations from the Bay Area Air Quality Management District (BAAQMD), evaporation and precipitation from the California Irrigation Management System (CIMIS) weather stations, Delta Island Consumptive Use (DICU), and flow control structures. CCWD stands for Contra Costa Water District. See Table A-1 for more information.

A.2 UnTRIM Numerical Model Uncertainty

As discussed in Section 3.1, the TRIM and UnTRIM models have been widely used in San Francisco Bay, and numerous detailed model calibrations have been performed (e.g., Cheng et al. 1993; Gross and Schaaf & Wheeler 2003; Gross et al. 2006; MacWilliams and Cheng 2007; MacWilliams and Gross 2007; MacWilliams et al. 2008, 2009, 2015). Due to this extensive history of application, these models are the best established three-dimensional models of San Francisco Bay.

The equations governing fluid motion and salt transport, representing conservation of water volume, momentum and salt mass, are well established, but cannot be solved analytically for complex geometry and boundary conditions. Therefore numerical models are used to give approximate solutions to these governing equations. Many decisions are made in constructing and applying numerical models. The governing equations are first chosen to represent the appropriate physical processes in one, two, or three-dimensions and at the appropriate time scale. Then these governing equations that describe fluid motion and salt transport in a continuum are discretized giving rise to a set of algebraic equations. The resulting discretized algebraic equations must be solved, often requiring the use of an iterative matrix solver. The discretization and matrix solution must be developed carefully to yield a numerical scheme that is consistent with the governing equations, stable and efficient. To apply the models, the bathymetric grid, boundary conditions, initial conditions and several model parameters must be chosen. The accuracy of the model application depends on the appropriate choice of these inputs, including site-specific parameters, the numerical scheme for solving the governing equations, and the associated choice of time step and grid size.

The three-dimensional model applied in this project provides a more detailed description of fluid motion in San Francisco Bay than depth-averaged or one-dimensional models. The UnTRIM model, like almost all large scale hydrodynamic models, averages over the turbulent time scale to describe tidal time scale motions. The resulting three-dimensional hydrodynamic models represent the effect of turbulent motions as small scale mixing of momentum and salt, parameterized by eddy viscosity and eddy diffusivity coefficients, respectively. These turbulent mixing coefficients are estimated from the tidal flow properties (velocity and density) by "turbulence closure" models embedded within the three-dimensional models. Three-dimensional models estimate the variability in velocity and salinity in all dimensions and through the tidal cycle, and therefore provide a detailed description of hydrodynamics and salinity. However, several sources of uncertainty are inherent in the application of these three-dimensional models:

- Spatial resolution/computational speed – the spatial resolution of the bathymetry of the model domain, and velocity and salinity distributions, is limited by the large computational expense associated with high-resolution models. The description of the Bay-Delta bathymetry is improved by the use of a flexible unstructured grid, with coarser grid resolution used in the open bay portions of the grid and increasing grid resolution within the project study area to optimize computational efficiency. The computational speed of the Bay-Delta model roughly scales with the number of grid cells. For example, halving of the horizontal resolution of the model would lead to four times as many three-dimensional grid cells and an implementation that takes roughly four times the computation time, making general system wide reductions in grid resolution infeasible and showcasing the benefit of using grid refinement approaching study regions.
- Bathymetric data – limited spatial coverage and accuracy of bathymetric data can be a substantial source of uncertainty. Converting all data to a uniform vertical datum and

horizontal datum can lead to some error. In particular, LiDAR data may have substantial errors in vertical datum and removing vegetation from the dataset can be difficult. In the present application, bathymetric data from multiple sources were merged to develop the model bathymetry.

- Bottom roughness – the UnTRIM model requires bottom friction coefficients to parameterize the resistance to flow at solid boundaries. These parameters are specified and adjusted in model calibration. The roughness values used in the present application have been applied in several recent applications (e.g., MacWilliams et al. 2007, 2008, 2009, 2015).
- Turbulence closure – the effect of turbulent motions on the tidal time scale motions is parameterized by a turbulence closure (Section 3.1.1), as is done in other 3-D hydrodynamic numerical models of similar spatial and temporal scale as the UnTRIM Bay-Delta model (e.g., Warner et al. 2005; Wang et al. 2011). While many turbulence closures are available (e.g., Warner et al., 2005), this is an ongoing area of research and, particularly in stratified settings, the effect of turbulence on tidal flows and salinity is not easy to estimate accurately. Different turbulence closures may give significantly different results in stratified settings (e.g., Stacey 1996).
- Numerical errors – a numerical method approximates the governing equations to some level of accuracy. The mathematical properties of the numerical method of the TRIM and UnTRIM models are well understood due to detailed mathematical analysis presented in several peer reviewed publications. While the stability and conservation properties of the method are ideal, a remaining source of error in the numerical method is some limited numerical diffusion of momentum, which may cause some damping of tidal propagation.
- Boundary conditions and initial conditions – The salinity in San Francisco Bay varies laterally (e.g., Huzzey et al. 1990) but this lateral variability cannot be described by existing observations. In addition, only limited observations are available to describe the vertical distribution of salinity. Therefore, lateral and vertical salinity distributions must be achieved by interpolation and extrapolation from the limited observations to obtain initial salinity fields. Inflows to the estuary are also quite uncertain in several regions due to un-gauged portions of watersheds and uncertainty in estimates of outflows and diversions in the Sacramento-San Joaquin Delta.

Though additional potential sources of uncertainty can be identified, the largest sources of uncertainty for hydrodynamic predictions are the accuracy and resolution of available bathymetry and the grid resolution used to represent this bathymetry in the model. This study makes use of the best available high resolution bathymetric data, especially in Central and South Bays and around the study area, and the highest computationally practical grid resolution throughout the domain. However, many of the available bathymetric data sets in other portions of the San Francisco Bay are fairly old and they required vertical and or horizontal coordinate transformations for the grid used in this project. Additionally, the most recent bathymetry for the Delta does not include many in-channel islands and other subtidal areas that are subject to flooding at high water, particularly during spring tide.

The uncertainty in Delta outflows can also be a substantial source of uncertainty in predicting salinity intrusion during summer conditions, particularly when consumptive use within the Delta (which is only known approximately) is typically the same order of magnitude as Delta tributary flows. The current application makes use of monthly Delta Island Consumptive Use (DICU) estimates from DWR. However, because these estimates of diversions and return flows and salinities are approximate, they may not be representative of actual consumptive use in a particular year. This uncertainty would impact the accuracy of net Delta outflows predicted at the flow monitoring stations in the western Delta, when compared to observed flows, and would thereby influence salinity intrusion into the Western Delta during summer conditions. This uncertainty in Delta outflow may also influence the accuracy of sediment transport calculations.

A.3 SWAN Numerical Model Uncertainty

SWAN is a state-of-the-art and full featured spectral wave model. However, several simplifications and limitations are associated with this model. Wave-induced currents are not computed by SWAN. Because a phase-decoupled approach is used, SWAN “does not properly handle diffraction in harbors or in front of reflecting obstacles” (SWAN Team 2009b). Some additional uncertainty is introduced by interpolation of UnTRIM parameters and variables from side and cell center locations to node locations for use by SWAN. However, in practical SWAN applications the uncertainty is likely to be driven primarily by the limited accuracy of input parameters such as wind velocity, bottom friction, and bathymetry.

A.4 SediMorph Numerical Model Uncertainty

Significant uncertainty exists in the prediction of sediment transport. This uncertainty results from the complexity of representing sediment physics, the limited data available to characterize heterogeneous bed sediment and inflow sediment properties in a dynamic environment, and the difficulty in the specification of representative sediment parameters, such as settling velocity, critical shear stress, and erosion rate. Erosion and deposition processes are also highly sensitive both to the specified sediment parameters, and to the calculated bed shear stress, which in turn is sensitive to the selection or calculation of appropriate bed roughness parameters. Effective bed roughness is influenced by the grain size distribution of the bed material, and bed forms such as ripples and dunes, and can also vary significantly in both space and time.

A.5 Sediment Transport Modeling Assumptions and Limitations

The interaction of tides, winds, waves, and sediments results in complex physical processes which need to be simplified and parameterized in order to be represented in a numerical model. As a result, the numerical simulation of sediment transport processes requires some simplifying assumptions which can influence the accuracy of the model predictions. The interpretation of the model results must therefore take into account how these assumptions influence both the model predictions and any conclusions drawn from the model predictions. This section outlines the major assumptions and simplifications that were made in the development of the UnTRIM-SWAN-SediMorph coupled modeling system used in this study, and discusses how these simplifying assumptions may affect the interpretation of the model results.

The major simplifications made in this application were the partitioning of the full range of sediment sizes in the Bay to a discrete set of sediment classes with constant sediment parameters, assuming a single sediment class to represent flocculated particles rather than modeling the aggregation and disaggregation of sediment particles, and the treatment of sediment material in the seabed. Each of these simplifying assumptions is discussed below.

SediMorph allows for multiple sediment classes, each with different settling velocity, critical shear stress, erosion rate parameter, diameter, and density. In the simulations presented in this report the mud fraction was partitioned between the silt and floc sediment classes. The sediment properties for the four modeled sediment classes were selected to represent single particles of silt (silt), aggregated clay and silt particles which behave as flocculated particles (flocs), coarser material (sand), and gravel bedload (gravel). The characteristics of the “flocs” sediment class were set based on field observations of flocs within San Pablo Bay by Kineke and Sternberg (1989), from observations of the size and settling velocity of flocs in the plume from a suction hopper dredge in San Francisco Bay by Smith and Friedrichs (2011), from data on sediment mass eroded from the top of cores collected in San Pablo Bay by Sea Engineering (2008), and through comparison of modeled and observed time-series suspended sediment concentrations within San Francisco Bay. However, in reality flocs continuously undergo aggregation and disaggregation due to physical and biological changes in the water (Mikkelson et al., 2006), such as changes to turbulence and the Kolmogrov microscale, varying suspended sediment concentrations, compaction of the seabed and subsequent resuspension, sediment interaction with biofilms, and incorporation into fecal pellets (some examples in Eisma 1986; Hill and McCave 2001; Fugate and Friedrichs 2003). These processes are extremely complex and are not easily incorporated into a numerical model. Previous sediment modeling studies in San Francisco Bay (e.g., Schoellhamer et al. 2008; Ganju and Schoellhamer 2009; van der Wegen et al. 2011; Bever and MacWilliams 2013, 2014) have also made a similar simplifying assumption by specifying a sediment class with characteristics representing flocculated material but assuming that mass is not aggregated or disaggregated between sediment classes. This simplification potentially leads to decreased peak suspended sediment concentrations during energetic periods and faster settling of the sediment from the water column because large flocs are not broken into smaller flocs or constituent particles. The simplification may also lead to an underestimation of the amount of sediment transported out of a channel onto the mudflats, because flocs may be disaggregated during high tidal flows into smaller particles that are more easily transported out of the channel.

Since bed consolidation is not currently represented in the model, the model may over predict the transport distance of the sediment and the sediment depositional thicknesses and volumes. With bed consolidation, some sediment would consolidate during neap tide periods and be harder to erode the following spring tide. Neglecting bed consolidation may lead to increased suspended sediment concentrations at the start of spring tides in the model predictions, because the sediment deposited in the model during neap tides does not consolidate and is easily erodible as the currents start to increase approaching spring tides. Without seabed consolidation the model also does not dewater or compact the seabed, which would reduce the depositional thicknesses and volumes over time. On a spring-neap time scale compaction likely only negligibly affects model predictions of depositional thicknesses because of the relatively small depositional and erosional thicknesses undergoing compaction. However, on longer time scales with thicker deposition compaction could affect model predictions of depositional thickness and the feedbacks on the hydrodynamics. This lack of compaction and dewatering is mostly counteracted by tuning the seabed porosity based on the estimates of sediment depositional volume and thickness in USACE navigation channels based on hydrosurvey data so the modeled thicknesses and volumes agree with the hydrosurvey estimates. However, additional data are needed to more fully validate predictions of sediment fluxes and morphologic change outside of the ship channels.

The complexity inherent in sediment transport modeling detailed above results in the accuracy of sediment transport predictions based on numeric skill metrics such as those used by MacWilliams et al. (2015) being lower for comparisons of suspended sediment concentrations than is typical for modeling of salinity or water level. This is especially true when considering simulations such as those in this report that span a year or more in length and simulate the transport of sediment over large distances from upstream portions of freshwater rivers through the entire San Francisco Estuary and into the Pacific Ocean. However, when the comparisons between observed and predicted suspended sediment concentrations indicate the model is predicting a similar magnitude of concentration as the observations, captures the seasonal and spatial trends, and captures the observed tidal time-scale variations and along-estuary spatial structure, this suggests that the model is capturing the primary physical processes responsible for sediment transport in the system.

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Geotechnical Appendix C.b

Pier 70: Central Basin

March 2017

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1.0 INTRODUCTION

The Central Basin study area is located on the eastern waterfront of the City of San Francisco (i.e. western shore of San Francisco Bay). The Central Basin is approximately 1.5 miles south of the San Francisco - Oakland Bay Bridge. Potential project alternatives are focused on dredging depth; with the deepest being -35 ft MLLW. The footprint of the study area within Central Basin is shown in Figure 1. Existing mudline elevations typically vary from -10 to -30 ft MLLW depending on the location in the basin.

The following sections summarize geotechnical conditions and recommendations for use in determining the preferred project alternative. No geotechnical investigation was conducted as a part of this work. Geologic stratigraphy was extrapolated from past environmental sampling efforts and local/regional mapping of the San Francisco Bay. Geotechnical material properties were estimated using established strength parameters for Bay Mud and engineering judgment.

2.0 GEOLOGIC SETTING AND STRATIGRAPHY

The Central Basin is located along the western shore of the San Francisco Bay. Subsurface geology along the western bay margin is typically soft silty clay (Young Bay Mud) overlying stiff to hard silt, clay, and fine sand (Old Bay Mud). The interface of Young and Old Bay Mud is occasionally marked by a thin (< 5 ft) layer of marine deposits that may include coarse grained sands, shell fragments, and/or fine gravel. Bedrock in the project area is greater than 100 feet below the mudline.

The project is in a high seismicity area. Principal sources of seismic loading are the San Andreas Fault (~8 miles west) and Hayward Fault (~10 miles east). Peak horizontal ground accelerations of approximately 0.4 to 0.5 g have a 10 percent chance of exceedance in 50 years.

Subsurface stratigraphy was estimated using past environmental sampling efforts and local/regional mapping of the San Francisco Bay. Environmental sampling targeted characterization of maintenance dredge material (i.e. above -32 ft MLLW) and potential future deepening to the current permitted depth (i.e. above -40 ft MLLW). Explorations were advanced with a standard electric vibracore that reached target depths with no reported difficult driving or refusal. Soils encountered included silts, silty clays, and clayey silt; typical composition of Young Bay Mud.

Historical bathymetric surveys of the Central Basin from 1999 to 2014 were reviewed. Digital survey data from the 2011 post-dredge survey was available and used to plot typical cut slopes from the edges of the dredged footprint that were used in the geotechnical analysis. The location of selected cross sections are shown in Figure 1 and plotted in Figure 2. In general, stable cut slope inclination varies from 3H:1V to 5H:1V. Shallower side slopes appear to be a function of dredging extents and natural bathymetry, rather than the strength of slope and foundation soils. Section 6 is cut adjacent to the dry dock area and shows a stable cut slope that is slightly steeper than 2H:1V below -40 ft MLLW. It was judged that the transition from soft Young Bad Mud to stiff Old Bay Mud is below approximately -45 ft MLLW based on the steeper cut slopes.

3.0 GEOTECHNICAL ANALYSIS

The analyses were performed in accordance with EM 1110-2-1902 Engineering and Design, Slope Stability. Preliminary slope stability analyses were completed to evaluate the static stability of cut slopes for the undrained (short-term) and drained (long-term) condition. Material properties estimated using established values [i.e. Bonaparte and Mitchell (1979)] for Bay Mud and engineering judgment. Unit weight and shear strength values used in the analyses are shown in Table 1.

Table 1: Material properties for slope stability analysis.

Material	Saturated Unit Weight (lb/ft^3)	Drained		Undrained	
		Friction (degrees)	Cohesion (lb/ft^2)	Friction (degrees)	Cohesion (lb/ft^2)
Young Bay Mud	90	30	5	22	50
Old Bay Mud	115		1,000		1,400

Slope stability analyses considered a series of cut slope inclinations with a constant cut slope toe at -35 ft MLLW (i.e. the deepest project alternative). The top of the cut slope was held constant at -17 ft MLLW and is representative of existing cut slopes, and the average cut slope along the western and northern border of the Central Basin post-deepening. An additional configuration with a 25 ft cut slope at a 3H:1V inclination was analyzed to capture the likely tallest cut slope (post-deepening) along the western border. The geometry and results of the slope stability analyses are shown in Figure 3 through Figure 6. Resultant factors of safety (FOS) are summarized in Table 2.

Table 2: Resultant factor of safety for static slope stability analyses.

Slope Inclination (H:V)	Height of Cut Slope (ft)	Factor of Safety	
		Drained	Undrained
3:1	25	1.45	1.77
	18	2.03	2.45
2:1		1.40	1.92
1:1		0.80	1.34

EM 1110-2-1902 generally requires a long-term FOS of 1.5 but permits an FOS of 1.3 or less in slopes where consequences of failure are low. A factor of safety of 1.4 was assumed to be a reasonable value for feasibility level analyses of a “low consequence” slope. The analyses results demonstrated that cut slopes of 2H:1V and shallower can be expected to perform satisfactory for the average slope height (i.e. 18 ft) . However, the analyes suggest that a 3H:1V inclination may be required for the highest cut slopes.

Overall, drained conditions governed (i.e. lower factor of safety) slope stability for all cut slope inclinations.

4.0 RECOMMENDATIONS

Cut slopes for the Central Basin project should be assumed to be 3H:1V based on preliminary slope stability analyses. The analyses showed that inclinations steeper than 3H:1V may be stable in localized reaches where the cut slope height is ~15 ft or less. However, these reaches are likely limited to less than one-quarter of the basin border being considered.

Seismic analyses have not been performed during feasibility because the impacts to the project are considered low. The 3H:1V cut slopes are likely to be resilient to seismically induced slope failures. Moderate shaking will have a negligible impact to slope stability, however, very strong shaking may generate localized sloughing along the project cut slopes. Resultant sloughing is unlikely to "run-out" into the basin or to limit the controlling depth more than normal deposition of sediment.

The deepening of the Central Basin is unlikely to impact the foundations of existing infrastructure on the southern border of the study area. Existing mudline depths adjacent to these structures are maintained to depths greater than or equal to -35 ft MLLW. The existing infrastructure to the west and north of the study footprint is greater than 300 ft from the Central Basin. The potential for negative impacts to existing infrastructure should be confirmed during preconstruction engineering and design (PED).

Diggability is likely to be consistent between the existing mudline and the full depth (-35 feet) of the array of alternatives. Dredging equipment can be appropriately selected and scaled to meet environmental, disposal, or other technical criteria. Stiffer Old Bay Mud that would potentially require a different dredge plant configuration is highly unlikely to be encountered at depths less than -35 ft MLLW. A review of historical aerial photographs and documents provided by the Port of San Francisco suggest there is no decommissioned/demolished infrastructure within the study area that would require specialized equipment to remove.

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August 2011; Pre-Dredge Survey

September 2011; Post-Dredge Survey
November 2011; Condition Survey
June 2013; Condition Survey
January 2014; Condition Survey

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USACE (2003), “EM 1110-2-1902: Engineering and Design, Slope Stability.

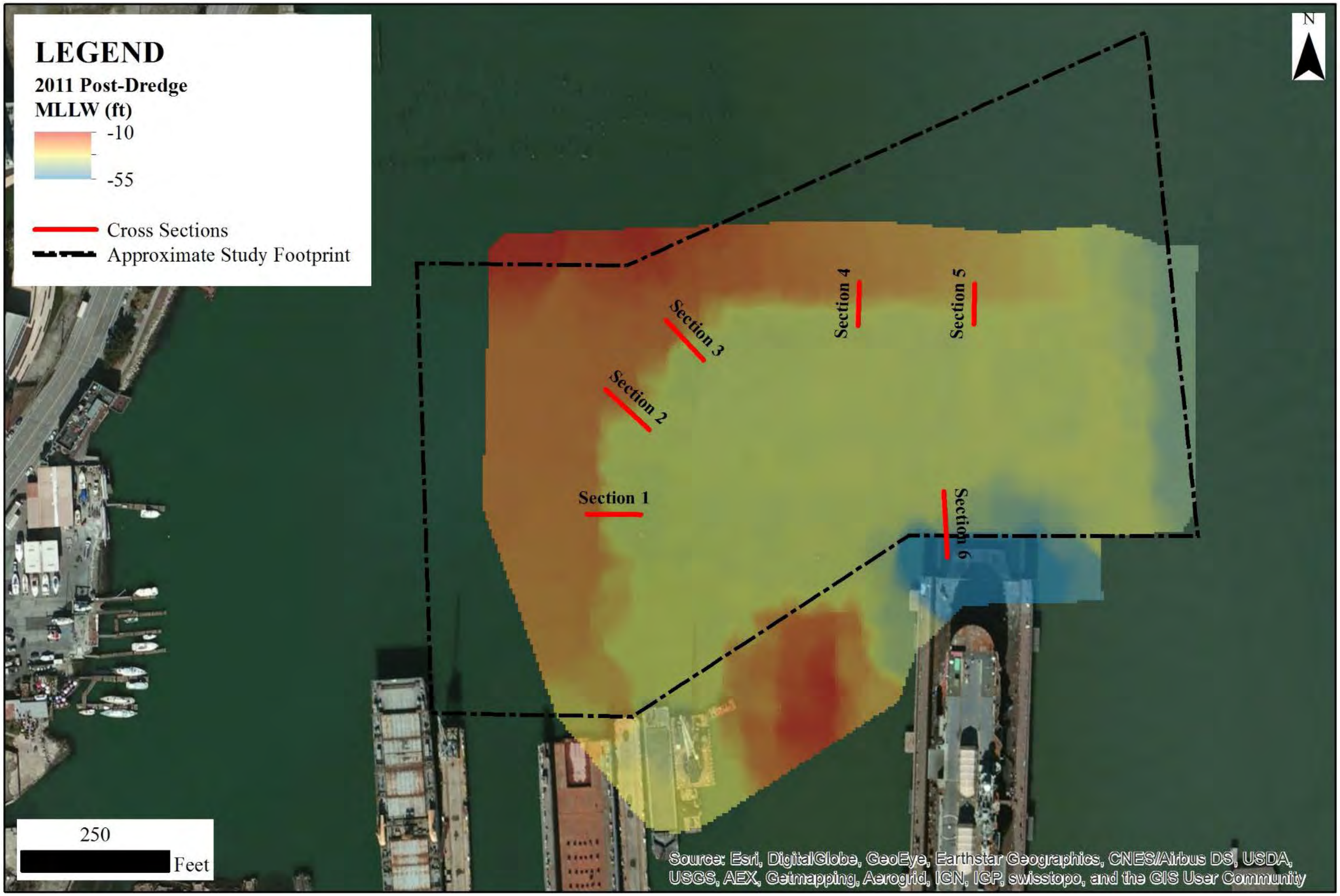

Figure 1: Central Basin study area, recent bathmetry, and cross section location.

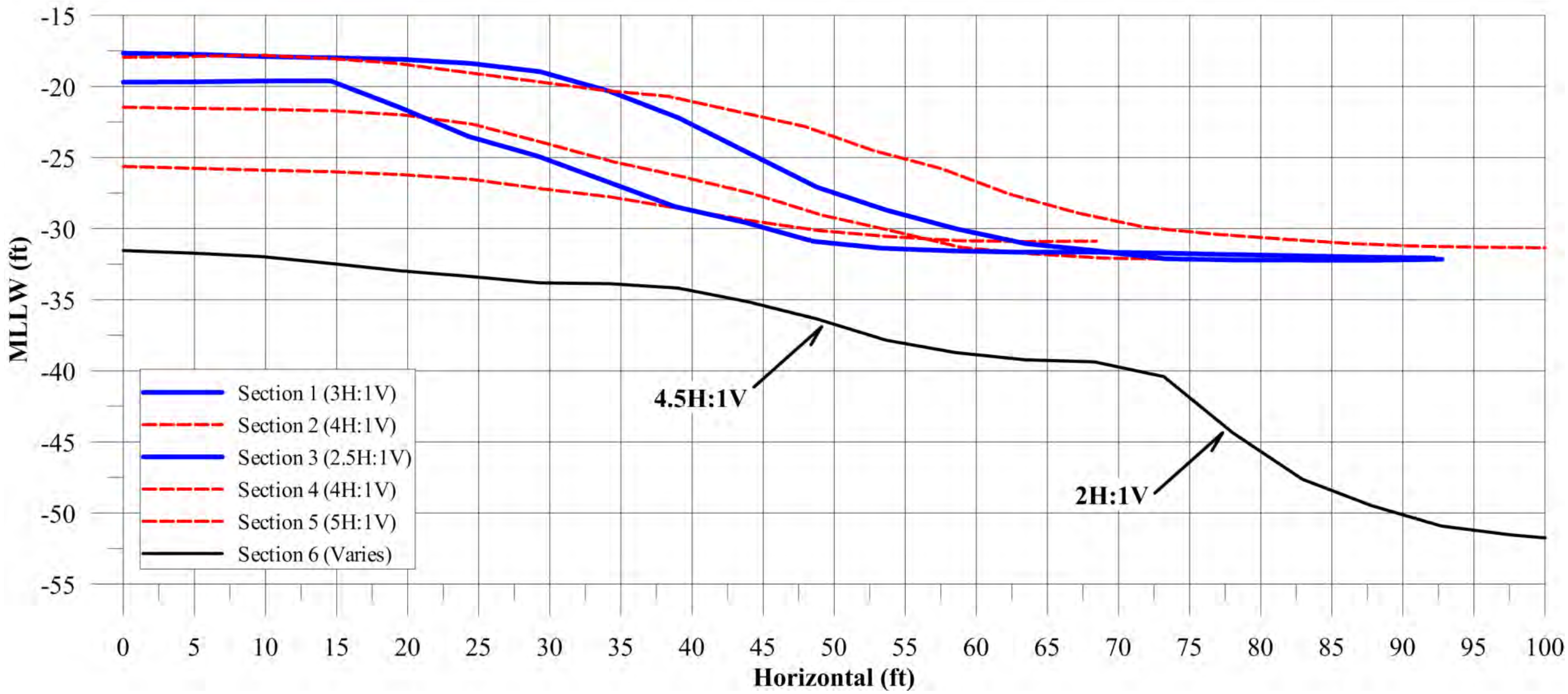

Figure 2: Typical cross-section bathymetry from a 2011 post-dredging survey.

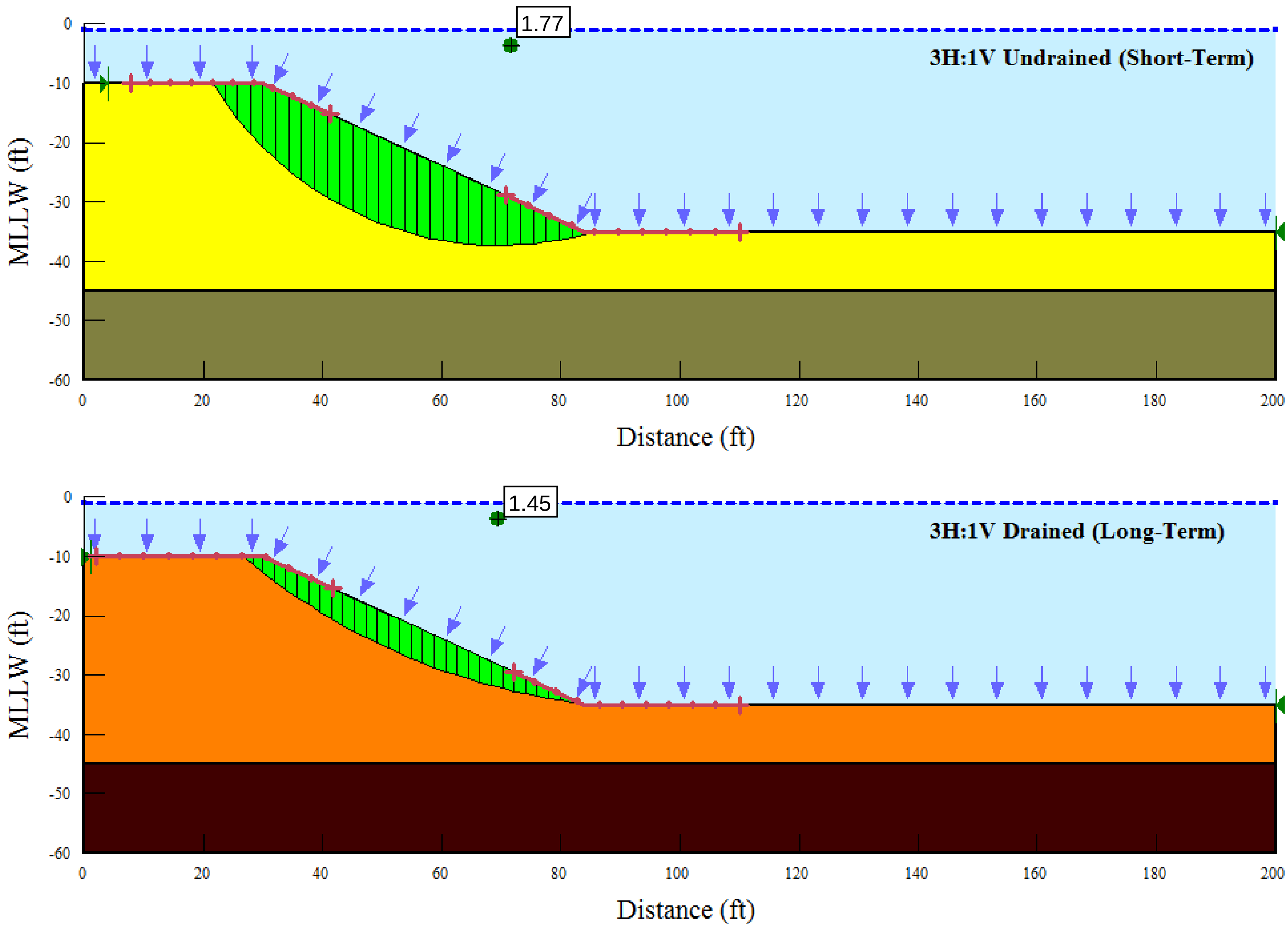

Figure 3: Static slope stability analysis results for the highest slope in the 3H:1V configuration .

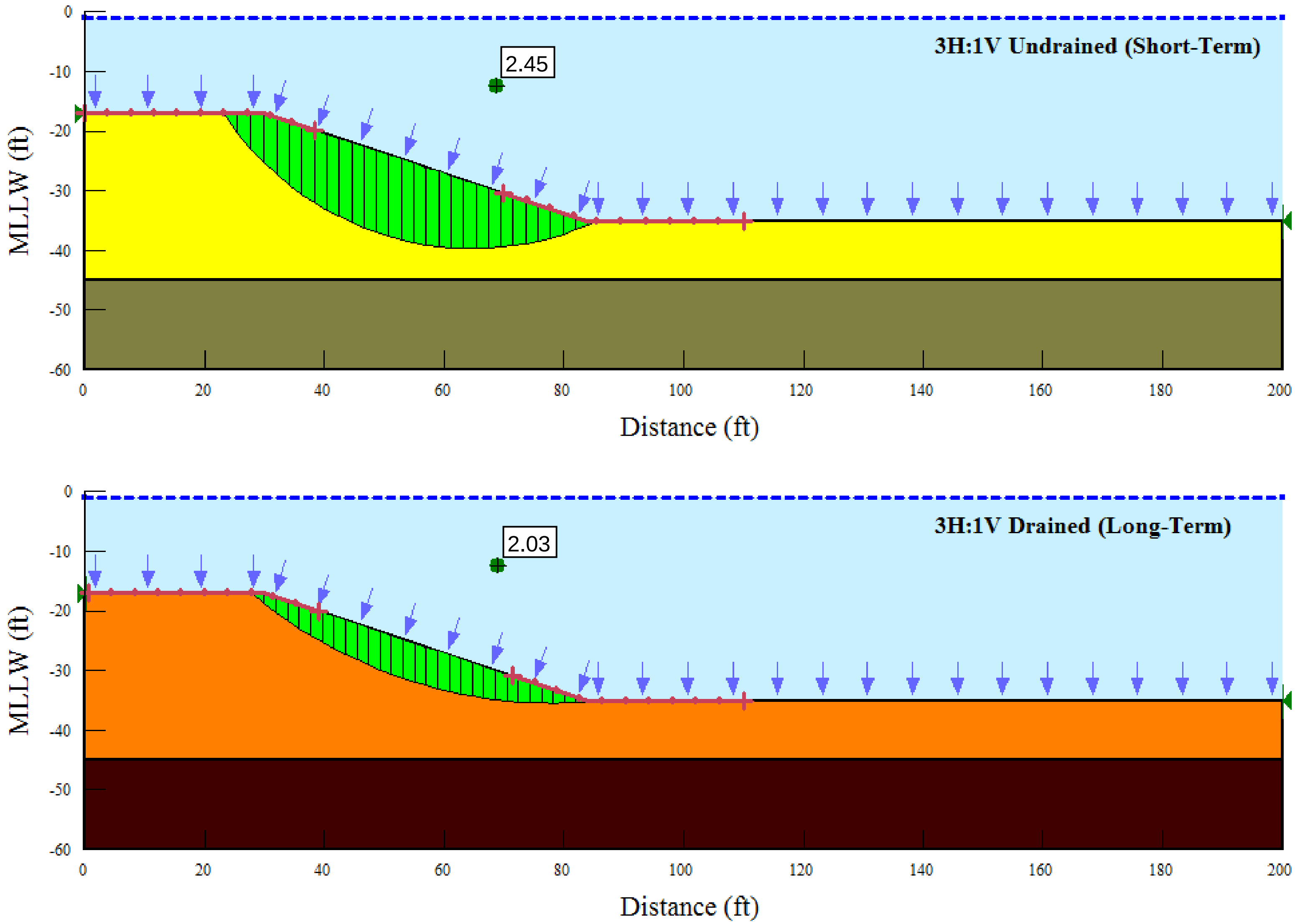

Figure 4: Static slope stability analysis results for 3H:1V cut slope.

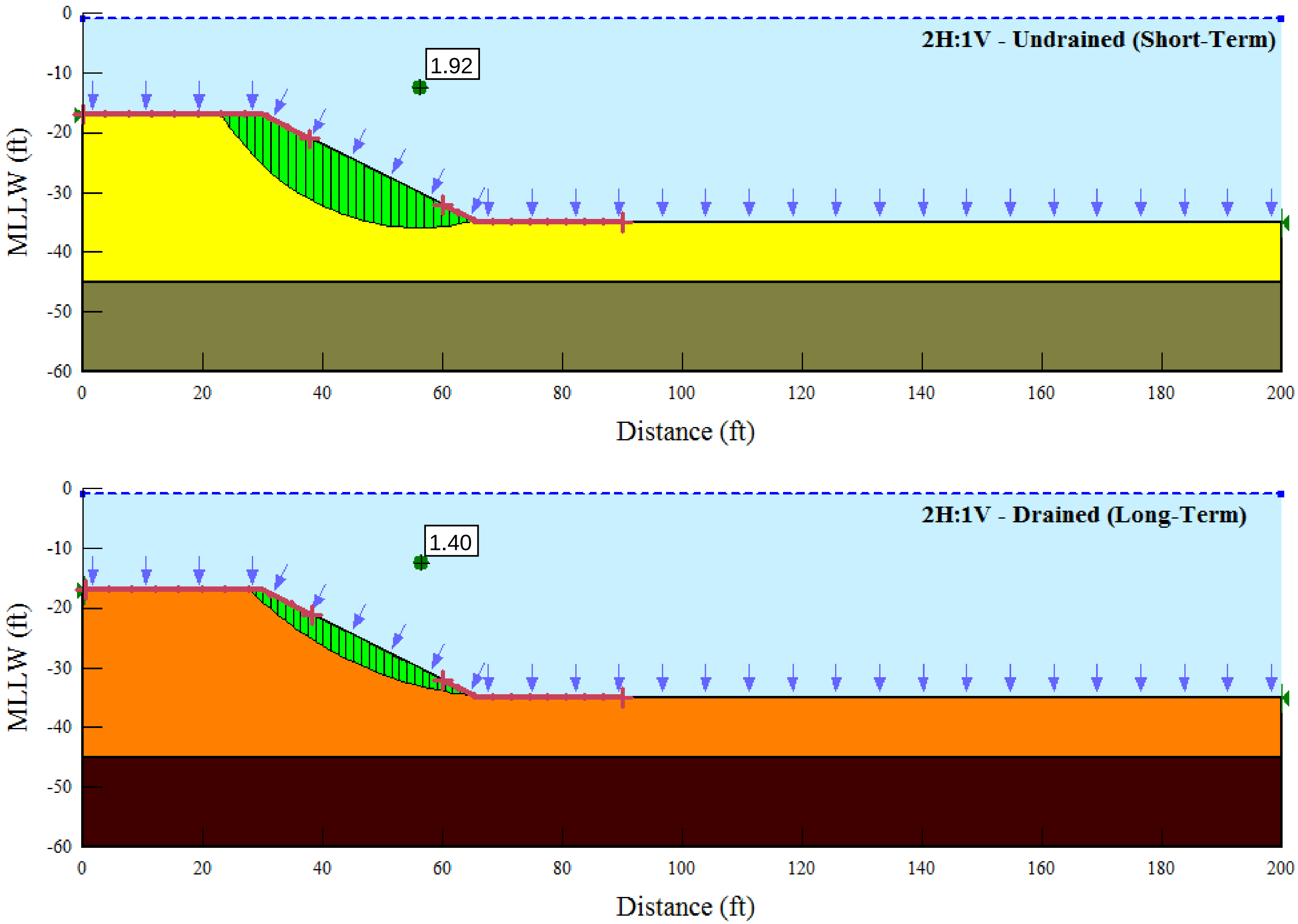

Figure 5: Static slope stability analysis results for 2H:1V cut slope.

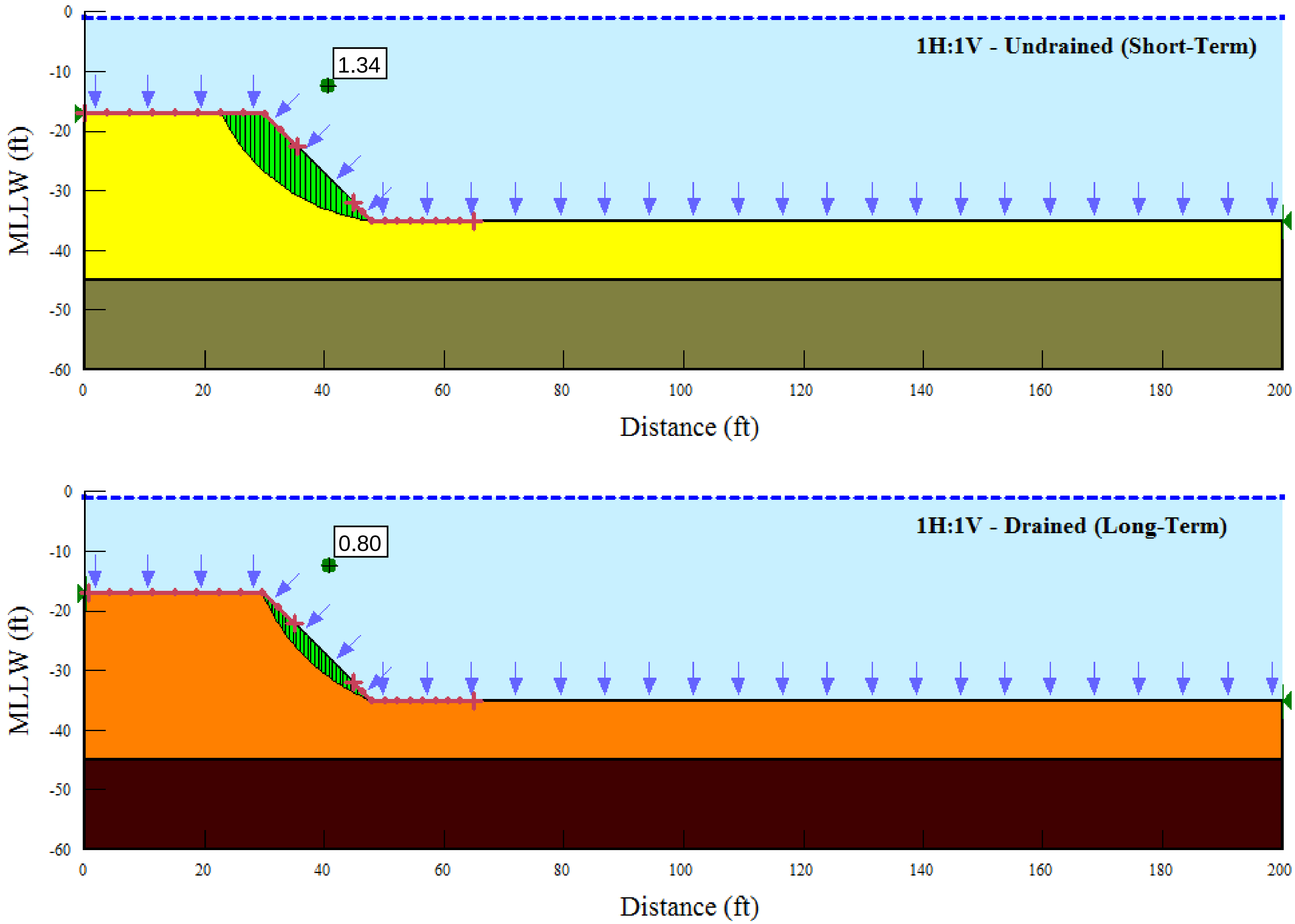

Figure 6: Static slope stability analysis results for 1H:1V cut slope.

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Pier 70: Central Basin CAP 107, California, Navigation Improvement Feasibility Study

Civil Design Appendix C.c

Final Draft

March 2017

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1.0 Purpose of Appendix

This appendix summarizes the Central Basin Pier 70 design criteria and the dredged material placement sites required to support the planning and Federal interest determination of a civil works navigation project in the Pier 70 Central Basin. This project is referred to as the "Pier 70 Central Basin, California, Navigation Improvement Feasibility Study", or more generically as the "study" or "study area" in this report. This report will serve as an appendix to the study's integrated feasibility study and environmental impact statement report.

2.0 Background

This study is being conducted under the authority of Section 107 of the River and Harbor Act of 1960 (Pub. L. No. 86-645, 33 U.S.C. 577), as amended, which authorizes the Corps to study, adopt, construct and maintain navigation improvement projects without additional project specific congressional legislation, using the same procedures and policies that apply to congressionally authorized projects.

The Port of San Francisco (Port) is located on the northern and eastern shores of the City and County of San Francisco, California. The study area (*Figure 1*), Central Basin Approach Area at the Pier 70 Shipyard (Central Basin and shipyard, respectively), is located at Potrero Point on the eastern waterfront of San Francisco, in the San Francisco Bay. Central Basin is approximately 1.5 miles south of the San Francisco—Oakland Bay Bridge.

Central Basin is the in-bay approach to the shipyard at the Port of San Francisco's Pier 70. The Pier 70 Shipyard features two dry docks and full pier-side facilities, as well as a number of machine and engineering firms. The Port of San Francisco owns the real property and primary equipment for ship repair, such as the dry docks and cranes, and currently leases such equipment to BAE Systems (BAE). BAE offers full-service ship repair for commercial and government vessels and can accommodate post-Panamax class ships, including cruise ships, tankers, container ships, and more. This active commercial harbor processed 1,088,272 tons of cargo in calendar year 2011. The Port offers a full range of marine terminal services, such as handling of bulk and general cargo, heavy lift services, stevedoring, and storage—both ground and covered.

Figure 1 – Study Area

3.0 Central Basin

The Pier 70 Central Basin (*Figure 2*) is located in San Francisco and consists of three dredging sectors or dredging units (DUs). The dredged material from all of the dredging units were determined to be suitable for disposal at the San Francisco Deep Ocean Disposal Site (SF-DODS) pending the additional bioaccumulation testing. Except for dredging unit (DU) 1, the dredged material from all the dredging units are suitable to be used as non-cover material for the Montezuma Wetlands Restoration site. However, none of the dredged material has been determined to be suitable as cover material for the Montezuma Wetlands Restoration site due to the presence of polychlorobiphenyls (PCBs). The dredged sediment also does not meet the acceptance criteria for the Cullinan Ranch beneficial use upland site. Therefore, Cullinan Ranch will not be evaluated in this feasibility study.

A ship simulation study is required for USACE Deepening Projects and is normally conducted during the feasibility phase. With consideration for the total funding limit for a CAP project and the fact that a ship simulation study represents a large percentage of the design phase cost for this project, it was decided not to conduct a ship simulation study. However, the San Francisco Bar Pilots (Pilots) reviewed the proposed configuration of the Central Basin as well as consideration of the alternative depths, and provided their assessment in a letter to the Corps in June 2016. The letter stated the proposed Central Basin boundaries appear to be adequate for the design vessels that will be using it, based on conversations with the Pilots who will be piloting the vessels into and out of the area. The proposed configuration of the Central Basin was established by BAE Systems as the minimum area needed to safely maneuver the expected vessels in and out of the repair facility. The Pilots have reviewed the configuration and have agreed in concept to the proposed configuration. Therefore, the risk associated with not performing a ship simulation study was considered low.

Figure 2 below shows the existing bathymetry of the Central Basin in October 2014 as well as the preliminary configuration of the three DUs.

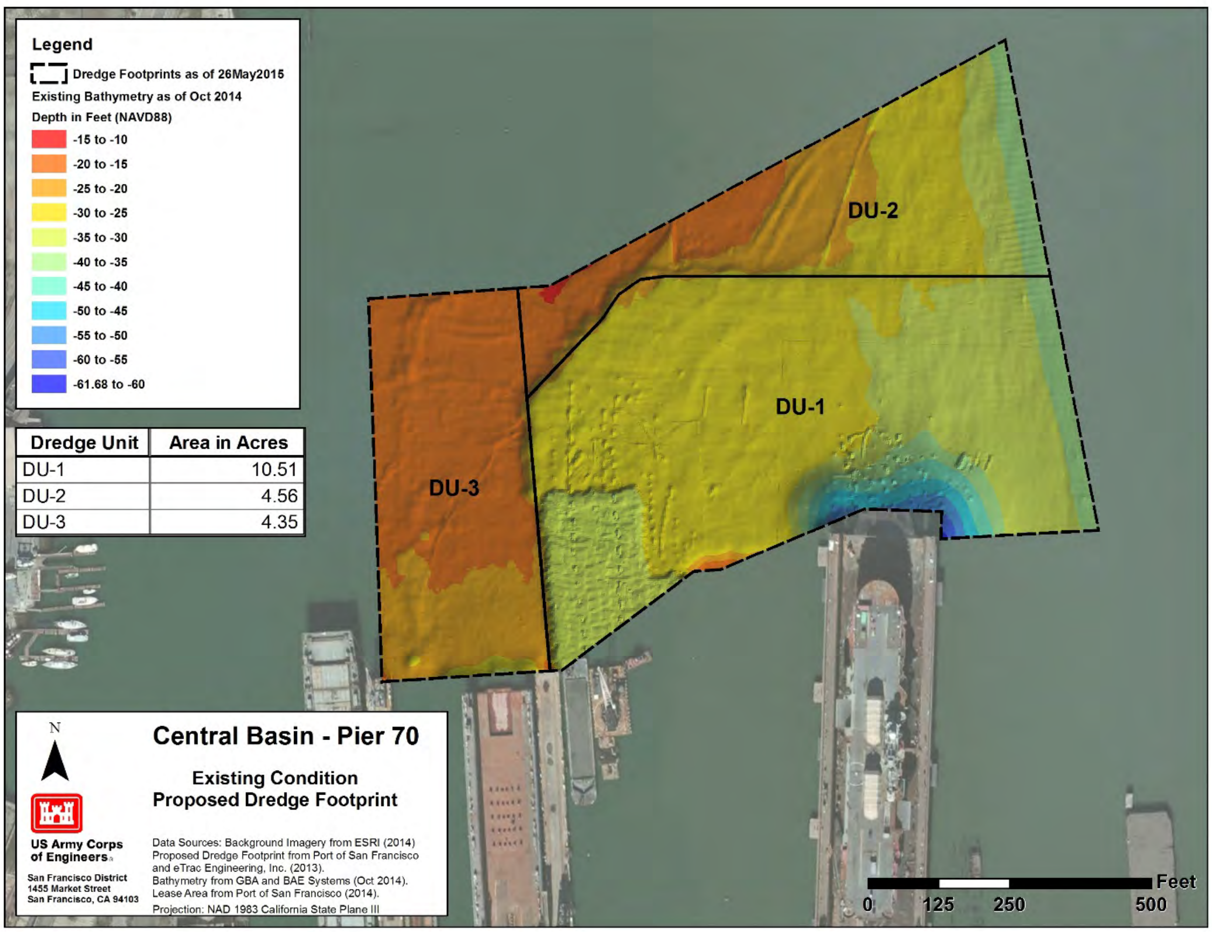

Figure 2 – Proposed DUs and Bathymetry as of January 2014

The boundary of the Pier 70 Central Basin project footprint will have side slopes that will transition from the project's dredged depths to the existing bathymetry that surrounds the central basin. The preliminary design includes side slopes of 3H: 1V, which were determined appropriate based on the physical characteristics of the sampled sediment from the Central Basin. The details of the geotechnical analysis are included in the Geotechnical Appendix.

3.1 Estimated Deepening Volumes

The estimated dredge quantities for the Central Basin alternative depths are calculated with Hypack hydrographic survey software. The estimated dredged material quantities for the Central Basin are summarized in *Table 1* and represent the sum total of all three dredge units for each alternative depth. The hydrographic survey soundings were taken with multi-beam survey equipment and are based on the mean lower, low water (MLLW) datum, NAVD 88. The plane grids and coordinates are based on the Lambert projection, NAD 83 California Zone 3.

Table 1- Estimated Central Basin Volumes

Alternative Depth MLLW (feet)	Volume (CY)	1-foot Paid Overdepth (CY)	1-foot Non-Paid Overdepth (CY)	Total (CY)
30	140,000	22,500	22,500	185,000
32	186,500	25,600	25,600	237,700
35	267,500	29,000	29,000	325,500

3.2 Estimated Future Operations & Maintenance (O&M) Volumes

The without project analysis of the effect of project depth on sedimentation rates in Central Basin was performed in March 2015 and is enclosed in the Coastal Engineering Appendix. The without project average annual shoal rate for the Central Basin is approximately 16,000 cubic yards (CY)/year in a dry year and approximately 31,500 CY/year in a wet year. These shoaling rates equate to a decrease in depth of approximately 0.5-ft/year and 1-ft/year, respectively. A second analysis was performed to determine future shoaling rates for the three alternative depths. The analysis used a 3-D sediment transportation model to predict shoaling rates for the three alternative depths and for 2-year, 3-year, and 4-year maintenance cycles. The future with project annual shoaling rates for a wet year were predicted to increase by approximately 57 percent for the 30-ft alternative, 33 percent for the 32-ft alternative, and 64 percent for the 35-ft alternative. These figures are represented in *Table 2* and include 2-feet of overdepth. As seen in the predicted shoal distribution figures in the Coastal Engineering Appendix, the sediment is not evenly distributed throughout the project footprint. In general, the shoaled sediment is thicker at the edges of the footprint and thinner in the middle areas. Also, normal ship activity within the basin will continue to disturb the sediment and cause the sediment to collect in areas where the water is relatively calm at the edges of the footprint.

The Sediment Transport Analysis also evaluated whether expanding the project footprint to the east, represented by DU-4 in *Figure 3* below, would lessen the expected increase in the annual sediment shoaling rate due to deepening the existing footprint. Deepening a relatively small footprint in an otherwise stable geomorphic system typically results in an increase in future maintenance dredging. However, the shoaling analysis included in the Coastal Engineering Appendix demonstrates that increasing the dredging footprint by an additional 18 percent does not reduce future O&M quantities. Therefore, the alternative to expand the Central Basin footprint with DU-4 was not retained.

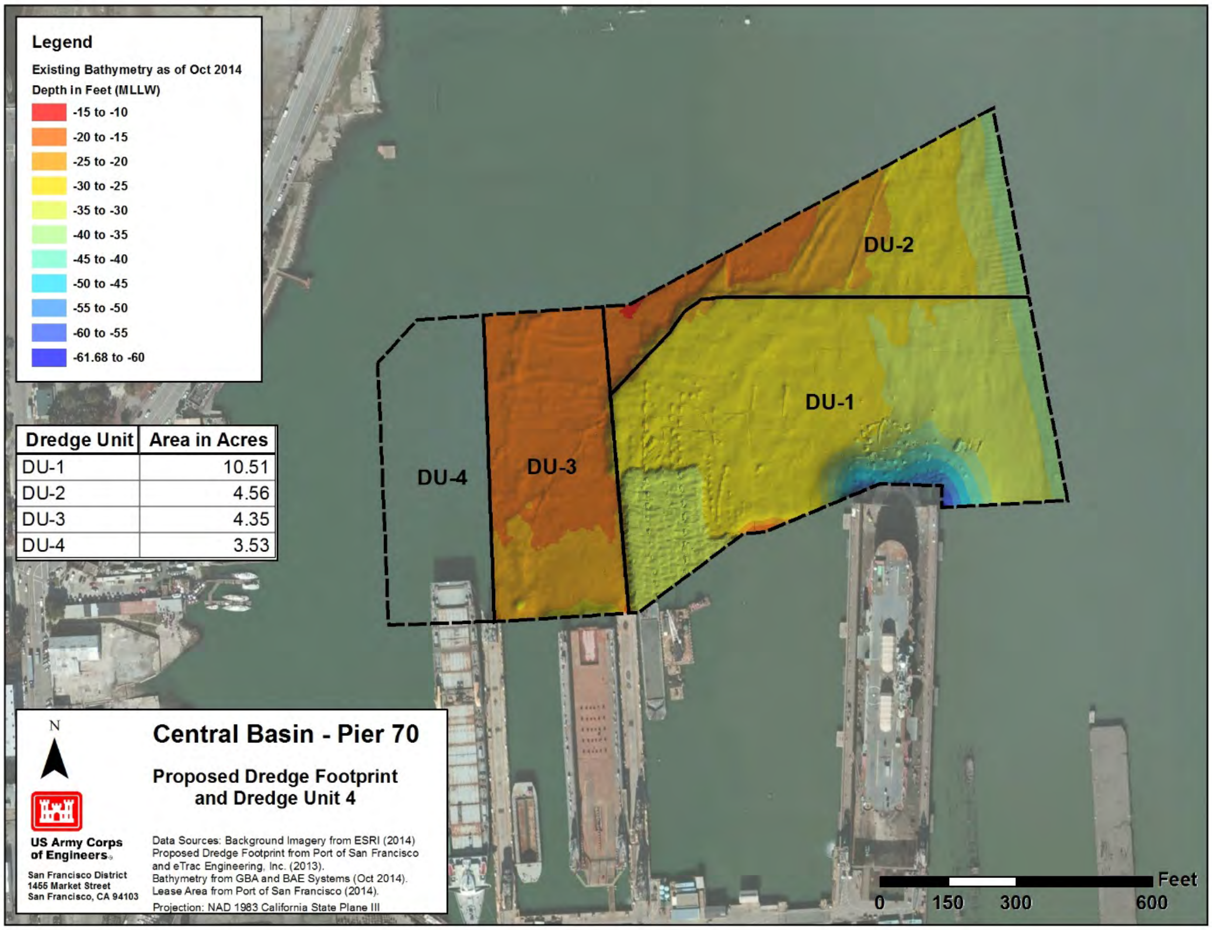

Figure 3- Proposed DUs and Bathymetry from October 2014

The cost analysis of the maintenance dredging cycles in the Cost Appendix indicated the most cost effective maintenance cycle in terms of unit price is a 4-year cycle. Although the unit prices and estimated dredge volumes for each cycle vary considerably, the overall effect on the total cost of each maintenance cycle does not vary more than 8 percent for in-bay disposal and 11 percent for SF-DODS disposal regardless of the length of the cycle. The majority of the savings is associated with the fact that there is only one mobilization/demobilization cost for each cycle, so the annualized maintenance cost is reduced the longer the maintenance cycle is. Therefore, since the predicted average depth of shoaling across the project footprint each year is approximately 0.5-ft, regardless of depth, and taking into account that the depth of shoaling will be thinner at areas of ship activity within the project footprint, the recommended maintenance cycle is 4 years. It is assumed that future maintenance dredging material will continue to be disposed at the current in-bay site near Alcatraz Island, SF-11. The maintenance dredging contract will include the estimated 2-ft (4-yrs of shoaling) of required dredging volume plus 1-ft of paid overdepth volume for a total of 3-ft of paid dredging volume.

Table 2- Estimated Future O&M Volumes

Alternative Depth Plus Overdepth MLLW (Ft)	Ave. Annual Volume (CY)	Estimated Annual Increase (%)	Future Estimated Annual O&M Total (CY)	Estimated Depth of Shoaling (Ft)
30+1	31,500	57	48,000	0.5
32+1	31,500	33.3	42,000	0.3
35+1	31,500	64	51,500	0.6

4.0 Dredging Equipment

There are three types of dredge plants that could be utilized for this project, mechanical clamshell, hydraulic cutterhead pipeline, and hydraulic hopper.

4.1 Clamshell Dredge Plant

The mechanical clamshell dredge plant (*Figure 4*) is made up of a large work barge with a large crane mounted on the deck of the barge. The crane has a boom that is long enough to extend out beyond the end of the work barge in any direction and is able to swivel 360 degrees on its mount. A large clamshell bucket is attached to the end of a series of cables at the end of the boom, which allows the bucket to be raised and lowered into the water. The cables also open and close the bucket as it is filled with sediment and then emptied into scows. The scows are open barges that can carry large quantities of sediment while they are towed with tug boats to and from the disposal site. The dredge plant barge has two or three spuds, which are long vertical pipes that are driven with hydraulic pumps into the bay bottom to anchor the dredge while it is digging. Once anchored, the crane will begin digging in a series of arcs extending out and away from the work barge while the clamshell bucket digs down to the desired depth. The scows that are to be filled with sediment are tied to the side of the dredge plant. As soon as one scow is filled and hauled away, another scow is maneuvered into place alongside the dredge and the digging continues. The digging will begin near the dredge and will progress away from the dredge until the crane boom has been extended out to its maximum length. After the farthest arc has been completed down to the desired depth, the spuds will be lifted out of the bay mud and the dredge plant will be repositioned by small tender tug boats to the next area to be dredged. The spuds will then be lowered to stabilize the dredge and digging will begin again. This relocation operation requires approximately one hour to complete. On average, the mechanical clamshell dredge plant for this project will need to be relocated approximately every 2.5 to 3 hours. The contractor is also required to move all of their dredging equipment out of the shipping channel whenever they are notified by the Coast Guard that a large commercial vessel is going to be transiting the channel, so they do not create a navigation hazard. These delays each typically take one hour out of the daily production. The dredging contractor will be working 24-hours per day, 7-days a week on this project.

Depending on the number of similar delays, the dredge will dig an average of 190,000 square feet (4.5 acres) per 24-hour day. The estimated duration for construction for the three alternative depths using a mechanical clamshell dredge plant are presented in *Table 3* below. The construction duration estimates for disposal at SF-11 is based on the available volumes of material that are suitable for in-bay disposal for each alternative depth. The construction duration estimates for disposal at SF-DODS and MWRP are based on the total estimated volumes of dredged material for each alternative depth.

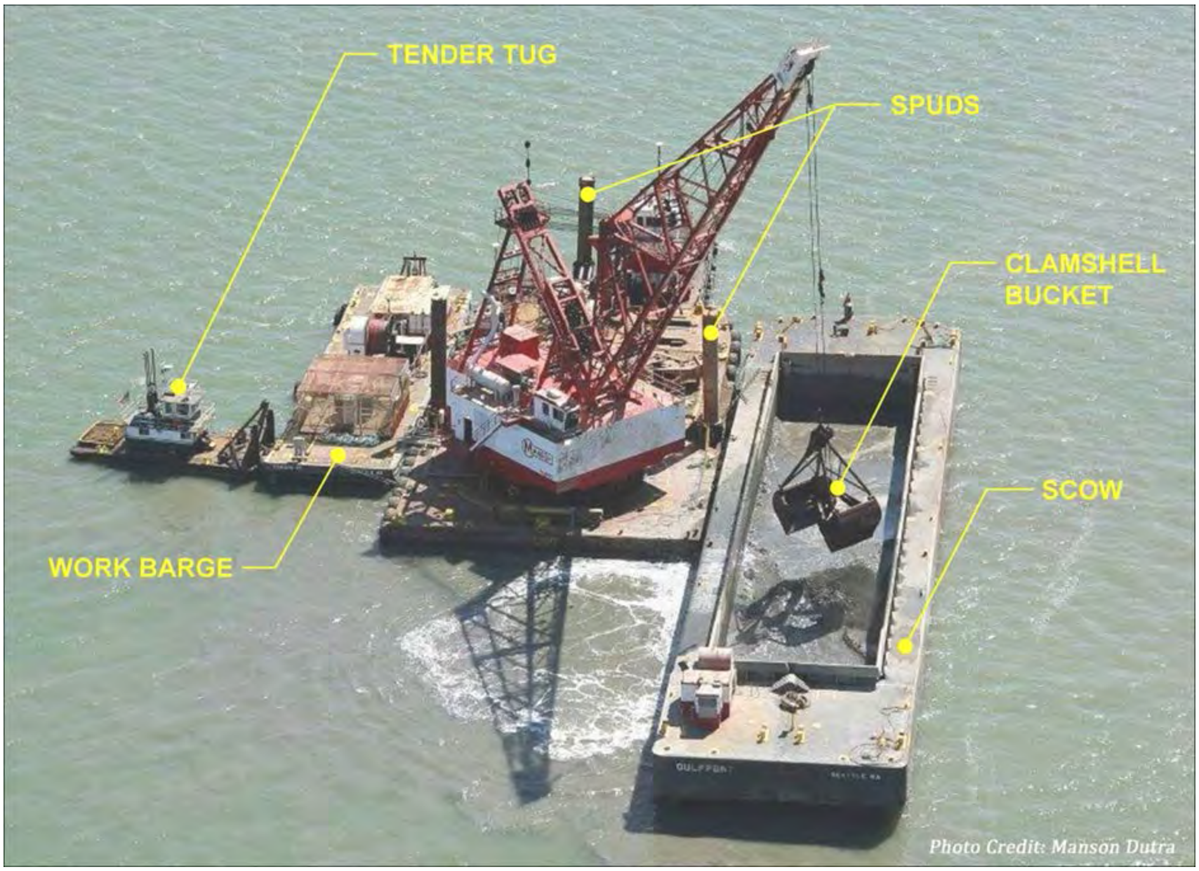

Figure 4- Typical Clamshell Dredge Plant and Scow

4.2 Hydraulic Cutterhead Pipeline Dredge Plant

A hydraulic cutterhead dredge is a barge-type vessel with onboard pump(s), two spuds, a walking spud, and a working spud, and a cutterhead attached to a pipeline. The spuds, which are long steel poles, are hydraulically driven into the channel bottom and act as anchors while the cutterhead sweeps back and forth across the channel bottom. *Figure 5* shows a typical hydraulic cutterhead dredge. *Figure 6* shows a schematic of a hydraulic cutterhead dredge plant. The cutterhead is generally attached to a pipeline at the front (bow) of the vessel and the pipeline is attached to a “ladder”, or boom, that lowers the cutterhead to the bottom of the channel and raises it back up when the dredge needs to be repositioned. The pipeline generally runs the length of the dredge’s platform, providing an open pipeline at the back (stern) of the dredge. Semi-flexible pipeline sections are added to the dredge’s open pipeline, transporting the dredge sediment to the designated placement site. The number of additional pipe sections needed depends on the distance from the dredge to the placement site. The semi-flexible pipeline can either be submerged or floating. Support vessels, “tender tugs”, move and position the pipeline, as needed. The spuds can both be on the back (stern), one on each side, or one in the front and one on the back.

Figure 5- Typical Hydraulic Cutterhead Dredge Plant

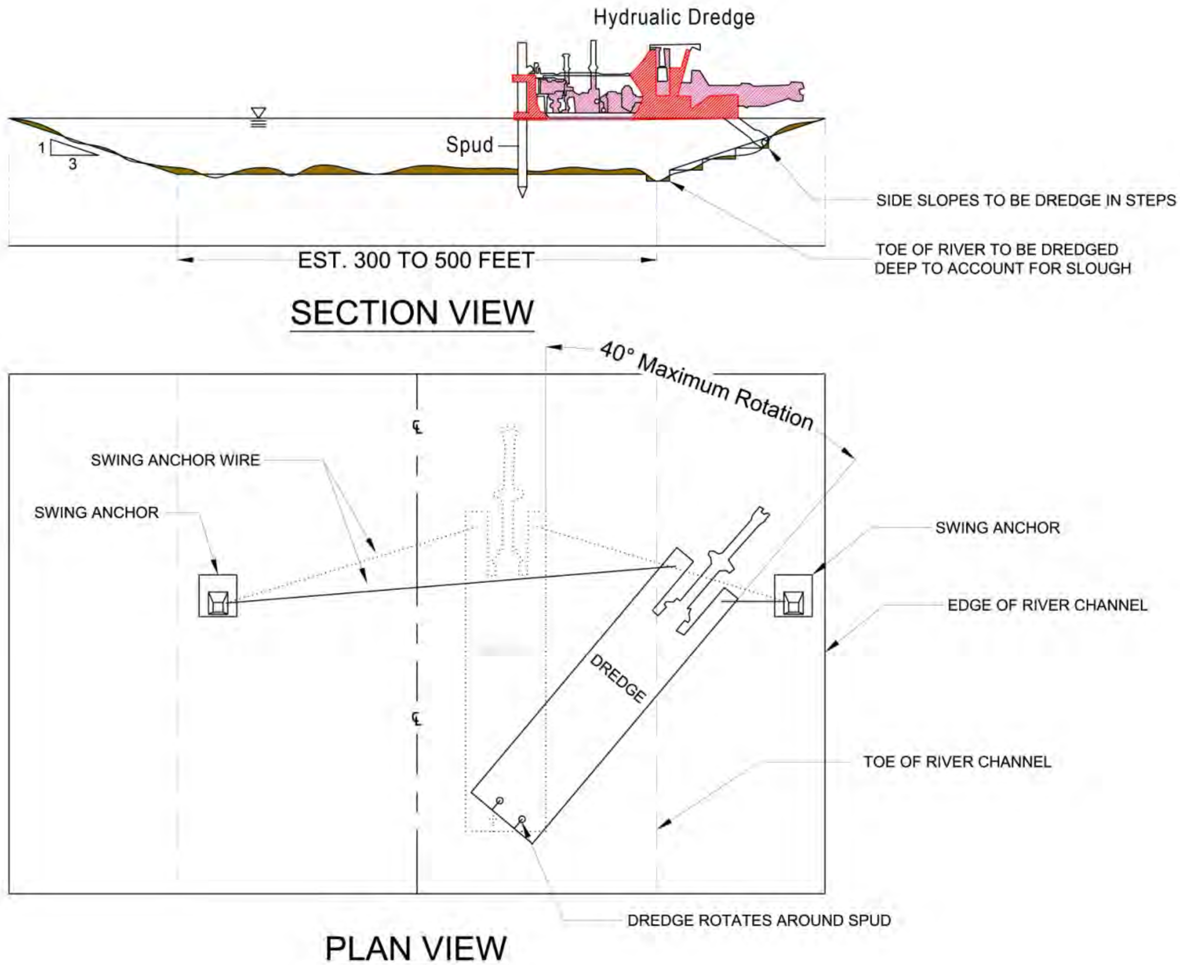

Figure 6- Schematic of a Hydraulic Cutterhead Dredge Plant

Once the dredge is positioned, the pipeline and cutterhead is lowered to the bottom of the channel by the ladder. The cutterhead slowly starts to rotate, at about 30 revolutions per minute, breaking up the sediment. The vacuum created by the large onboard pumps draws sediment slurry—comprised of approximately 80–90 percent water and 10–20 percent sediment—through the cutterhead, into and through the pipeline in the dredge barge's hull, through the attached semi-flexible pipeline, and is pumped through the length of the pipeline where it is placed at the designated placement site. The cutterhead moves laterally back and forth across the river bottom by pulling itself towards each of the two swing anchors via the anchor wires. The swing anchors are also hydraulically driven into the channel bottom to provide a stable platform to pull against. As the dredge plant progresses up the channel and is roughly even with the swing anchors, dredging activities cease while the swing anchors are then relocated approximately 100-feet ahead of the dredge plant and the dredging process repeats. Depending on the distance from the dredge plant to the placement site, additional pumps may be used along the pipeline to keep the sediment moving in the pipeline. These pumps are called booster pumps and are generally needed every 2.5 miles or 13,000 feet. The pumps onboard the dredge plant, are powered by diesel engines and can pump sediment as far as 3 miles before additional booster pumps are needed to pump the sediment further.

The dredge continues to remove sediment from the channel by slowly moving from side to side in a sweeping arc using the swing anchor. The shaping and spacing of cutter teeth varies, depending on the type of material being dredge. When cutting hard material, the cutterhead is only effective swinging in one direction, the ‘cutting swing’. The cutterhead teeth are at the wrong cutting angle when dredging during the ‘return swing’, or the opposite direction as the cutting swing.

4.3 Hydraulic Hopper Dredge Plant

In general, a hopper dredge (*Figure 7*) is a diesel-powered ship with a cargo hold that collects dredged sediment. On one side, or both sides of the ship, a drag arm is attached to the ship’s hull that extends down into the water to the channel bottom. Each drag arm has a drag head attached at the end that scrapes the channel bottom and collects sediment. Each drag arm also has a pump that creates a vacuum that lifts sediment from the channel bottom through the drag head and drag arm and into the ship’s cargo hold, or hopper bin where the sediment is collected. When the hopper is full, the ship transports the sediment to an aquatic disposal site where the material will be released from the bottom of the ship. In contrast to other hydraulic dredges, hopper dredges trail the suction piece (drag arm) behind the vessel where other hydraulic dredges push the suction in front of the vessel. Hopper dredges usually have to make several passes in order to remove all of the sediment in the project footprint. Hopper dredges are also not classified by discharge size, but by hopper capacity: small (500 – 2,000 CY), medium (2,000 – 6,000 CY), and large (> 6,000 CY). Hoppers are generally used when material needs to be moved a long distance and it is not feasible to pipe the material. When the slurry is deposited in the hopper, the sediments are given room to settle and excess water is allowed to drain out of the hopper back into the water.

Some hopper dredges have the ability to pump sediment directly from their bins, typically at the bow of the vessel through an on-board booster pump to a beach nourishment site (*Figure 8*), or through a pipeline to an upland site. This allows the hopper dredge to function as a mobile offloader facility. The efficiency of this arrangement is dependent on the distance from the dredge area to the upland site, as well as how far the material must be pumped from the hopper to the upland site.

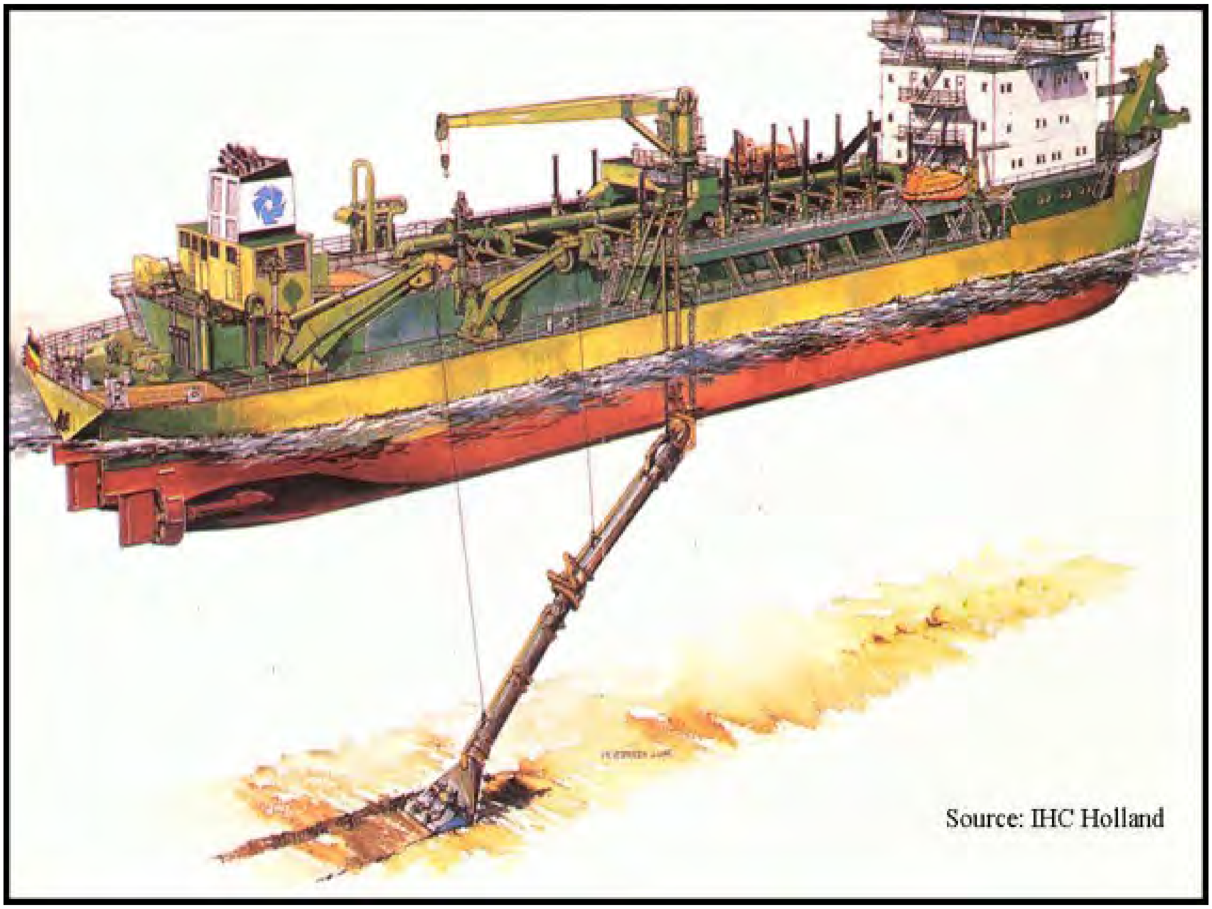

Figure 7- Hydraulic Hopper Dredge Plant

Figure 8- Hopper Dredge with Pump-Off Capability

5.0 Dredged Material Placement Sites

There are three dredged material placement sites that were evaluated to determine which site, or sites, in combination with appropriate dredge plants, would provide the most cost effective method for dredging the Central Basin footprint and transporting the dredged sediment to its final disposition. The three sites, Montezuma Wetland Restoration Site (MWRP), San Francisco Deep Ocean Disposal Site (SF-DODS), and Alcatraz (SF-11) are shown in *Figure 9* and described in the following.

Figure 9- Dredged Material Disposal Sites

5.1 Montezuma Wetland Restoration Site

Montezuma Wetlands Restoration Project (MWRP) is a privately owned and ongoing restoration effort (*Figure 9*). MWRP accepts both wetland cover and wetland non-cover (foundation) quality material from new work and maintenance projects. This site is currently accepting sediment and has an off-loader in place and operating. The project site comprises approximately 2,400 acres at the eastern edge of Suisun Marsh, approximately 17 miles southeast of Fairfield, California.

Ground elevations at the site have subsided up to 10 feet since its tidal marshlands were diked and drained for agricultural purposes more than 100 years ago. All site preparation, monitoring, and reporting is handled by the MWRP, which charges a tipping fee for accepting dredged sediment. The tipping fee includes use of the offloader and the site has capacity for approximately 15 million cubic yards. The MWRP site is also responsible for the cost of managing the sediment and water quality once the sediment is pumped into the MWRP site.

The MWRP site uses an offloader (*Figure 10*) to remove dredged sediment from scows and pumps the sediment into the MWRP site cells. For a dredging operation that includes a mechanical dredge plant (clamshell bucket) operation, it is anticipated that the dredging contractor will determine the optimal number and size of scows and tug boats to use to maximize efficiency and minimize cost based on the equipment that they will be using. The Corps has estimated that four 4,000 CY scows and three 1,800

HP tug boats are likely to be used for placement at the MWRP site. The haul distance from the Central Basin project dredge area to the MWRP offloader (Liberty) is approximately 52 miles. After the scow is delivered to the offloader, it will be tied up to the Liberty's mooring system, so that the offloader snorkel can remove material from the scow. The snorkel simultaneously injects water into the scow to create a slurry and pumps it into the designated cells within the MWRP site. It takes approximately 2 hours to empty a 4,000 CY scow filled with the type of sediment that will be dredged from the Central Basin. The dredging contractor will attempt to time the emptying of a scow with the arrival of the next filled scow so the tug boat can return the empty scow to the dredge area immediately. The tug boats will be traveling at a maximum speed of approximately 7 knots (8 mph) to and from the offloader. The total time for each scow trip to the offloader, including unloading the scow and returning the scow to the dredge area is approximately 15 hours for the Central Basin dredging. The MWRP offloader facility operates on the same schedule as the dredging contractor, 24-hours per day, 7-days a week. It is estimated that the offloader will actually be working a total of approximately 10-hours per day over a 24-hour period.

As shown in *Table 1*, the total amount of time estimated to dredge with a mechanical clamshell, transport material from the Central Basin and place at the MWRP site for the 30-ft alternative is approximately 0.7 months, 1.2 months for the 32-ft alternative, and 1.7 months for the 35-ft alternative. The daily dredging production rate is approximately 5,900 CY/day.

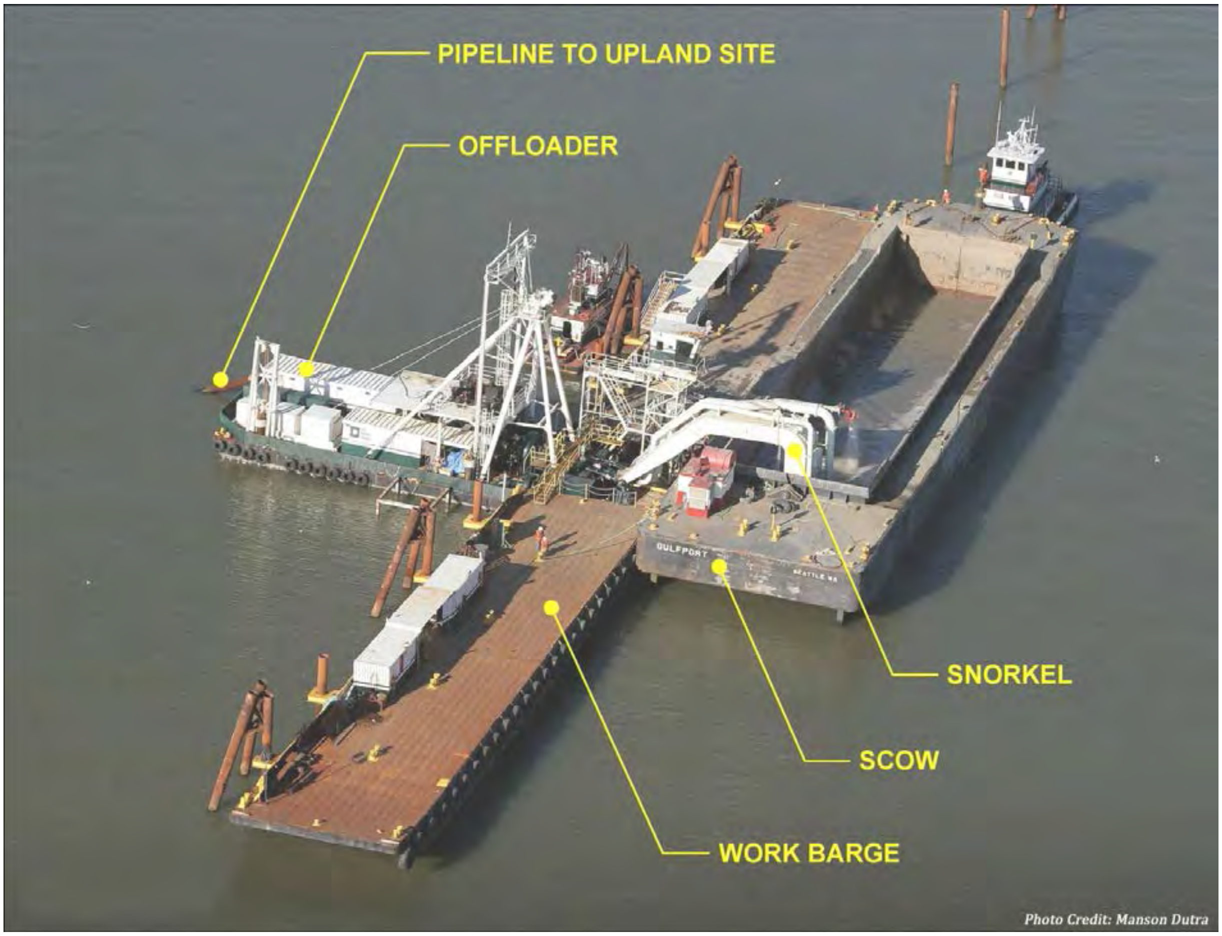

Figure 10- Offloader Liberty Unloading a Scow

5.2 San Francisco Deep Ocean Disposal Site (SF-DODS)

SF-DODS is located in the Pacific Ocean, approximately 55 nautical miles west of the Golden Gate Bridge (*Figure 9*). The site is approximately 71 nautical miles from the Central Basin. The site was established in 1994 by the Long Term Management Strategy (LTMS) agencies, and is managed by the Environmental Protection Agency.

Dredged material is not allowed be leaked or spilled from the scows during transit to the SF-DODS. Transportation of dredged material to the SF-DODS can only be allowed when weather and sea state conditions do not interfere with safe transportation and do not create risk of spillage, leak, or other loss of dredged material in transit to the SF-DODS. No scow trips are allowed to be initiated when the National Weather Service has issued a gale warning for local waters during the time period necessary to complete dumping operations, or when wave heights are 16 feet or greater, and the wave period is less than 30-seconds.

The dredged material is released from the bottom of the scow (*Figure 11*) in a matter of minutes. As shown in *Table 1*, the total amount of time estimated to dredge with a mechanical clamshell, transport material from the Central Basin, and place at the SF-DODS for the 30-ft alternative is approximately 1.0

months, 1.4 months for the 32-ft alternative, and 1.9 months for the 35-ft alternative. The daily dredging production rate is approximately 5,200 CY/day for all three alternative depths.

The cost estimates for dredging and disposal at SF-DODS indicate the same size mechanical clamshell dredged plant that would be used to place material at MWRP would also be used for disposal at SF-DODS. The number of scows and tugboats would also remain the same but, the tug boats would be increased to 3,000 HP because the open ocean working conditions are much more demanding than the protected waters of the San Francisco Bay and the San Pablo Bay.

5.3 Alcatraz Disposal Site, SF-11

SF-11 is located in the San Francisco Bay approximately 0.3 miles south of Alcatraz Island (*Figure 9*). It is a designated dispersive dredge material disposal site used primarily for maintenance dredging material. SF–11 is a circular area with a 1,000-ft radius. The maximum amounts of dredged material allowed to be disposed at SF-11 are 400,000 CY/month from October to April and 300,000 CY/month from May to September.

The haul distance from the Central Basin project dredge area to SF-11 is 3 miles, and as with deep ocean disposal, the actual release of dredged material from the scow is completed in a matter of minutes. As shown in *Table 1*, the total amount of time estimated to dredge with a mechanical clamshell, transport the total available amount of dredged material for each alternative depth that is suitable for in-bay disposal from the Central Basin, and place at the SF-11 disposal site for the 30-ft alternative is approximately 1 month, 1.5 months for the 32-ft alternative, and 2 months for the 35-ft alternative. *Figure 11* shows a typical aquatic disposal operation.

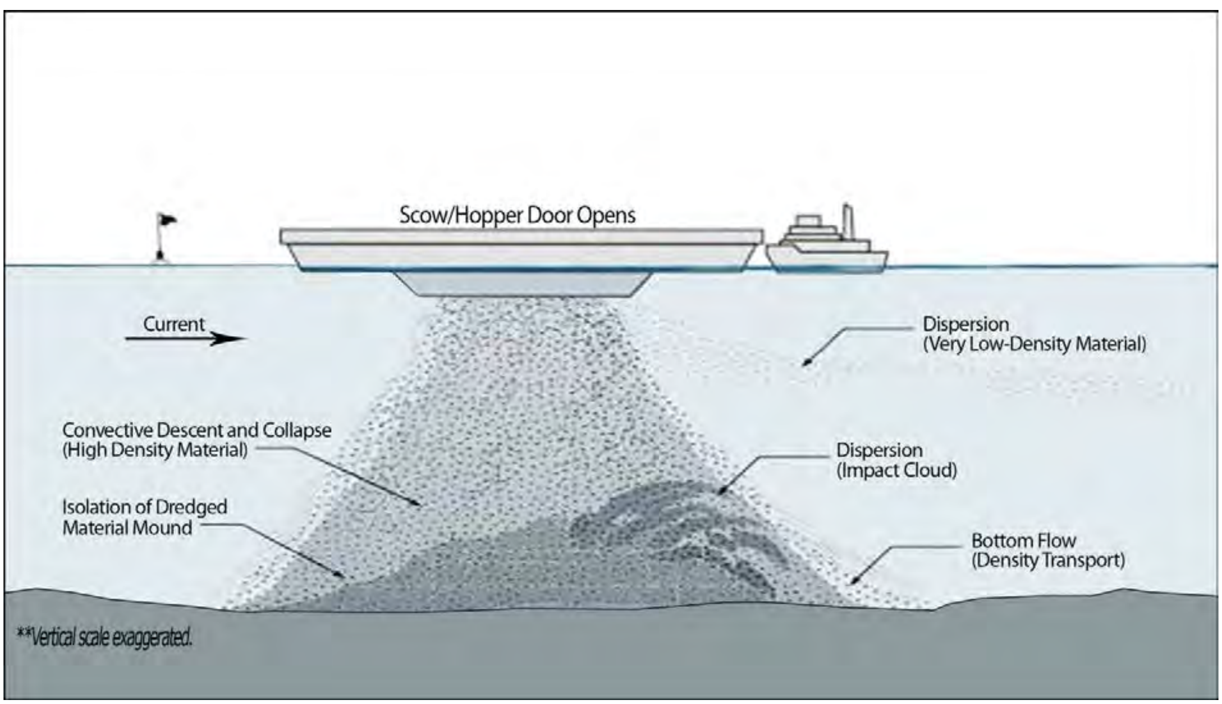

Figure 11- Bottom Dump Scow at Aquatic Disposal Site

5.4 Environmental Constraints and Work Windows

The LTMS Program does not currently allow dredged material from a deepening project to be disposed at any of the San Francisco in-bay disposal sites. However, an additional alternative was considered that included a combination of beneficial use upland placement and in-bay placement in proportional quantities that would be equivalent in cost to an all-SF-DODS disposal quantity alternative. In-bay disposal is far less expensive than beneficial use upland placement primarily because it does not require the dredged material to be double handled, such as with an offloader facility, and there is no additional cost for managing the sediment at the site after it has been placed. Also the in-bay disposal sites are typically much closer to the dredge areas, so there is a lower transportation cost. Only the material in DU-1 (*Figure 2*) was found to be suitable for in-bay disposal. *Table 4* presents the percentages of available suitable in-bay material for each alternative depth.

Table 3- Estimated In-Bay/Beneficial Use Upland Disposal

Alternative Depth	Suitable In-Bay Vol. (CY)	Beneficial Use Vol. (CY)	Total Vol. (CY)	Percent In-Bay of Total Vol. (%)
30-ft	44,400	117,700	162,100	27.4
32-ft	56,800	155,300	212,100	26.8
35-ft	67,700	219,500	287,200	23.4

As demonstrated in Table 5 of the TSP Report Synopsis, in order for the cost of an in-bay/beneficial use combination disposal site alternative to be competitive with the SF-DODS disposal site alternative, there would have to be a higher percentage of available dredged material that is suitable for in-bay disposal. This premise is in conflict with the LTMS goals for limiting in-bay disposal to not more than 20 percent of the total volume of dredged material. Therefore, the combination disposal site alternative was not retained.

Dredging cannot begin before the environmental work window opens on June 1 in any year. The environmental work window closes on November 30 for this project. The work windows were established to protect sensitive life stages of special status fish which use both channels. Currently, the project proposes to dredge within the work windows for all three alternative depths.

6.0 Dredge Plant Determination

Preliminary cost estimates for dredging, hauling, and placement of dredged material indicate that the most likely dredge plant that will be used for this project is a mechanical clamshell dredge with tug boats and scows (*Figure 4*). This assumption is based on the cost estimating results using the Corps of Engineers Dredge Estimating Program (CEDEP). The estimated volumes that were entered into the

CEDEP software include all of the material that is in the project footprint at the time of the survey, and include 1-ft of paid overdepth.

The CEDEP estimates assumes that there will not be a separate maintenance dredging episode prior to the start of the deepening dredging. This assumption will make the dredging more efficient and cost effective because it provides a better “bank height”, or thickness of material. The CEDEP program takes into account the proximity of the dredge areas to the current array of permitted placement sites that can accept the dredged material, the size of the area to be dredged, the depth and thickness of the material to be dredged, and the type of material to be dredged.

The sediment sampling and testing results for the material in the Central Basin footprint indicate that all of the sediment is suitable for disposal at SF-DODS. The sediment in DU-2, DU-3, and a portion of DU-1 (*Figure 2*) is suitable as non-cover material at the MWRP site. The results also indicate the remaining sediment in DU-1 is suitable for aquatic in-bay disposal.

The cost to place non-cover material at the MWRP site includes a tipping fee of $30/CY to offload, manage and monitor the non-cover quality material at the site. The total cost to dredge, haul, and place material at MWRP is approximately 51 percent more than the total cost to dredge, haul, and dispose at SF-DODS. Therefore the alternative for upland disposal at MWRP was not competitive.

The hydraulic pipe dredge alternative was not evaluated because the nearest placement site that is permitted to receive non-cover dredged material is the MWRP site, which is located more than 50 miles from the Central Basin project footprint. Typically, when the pumping distance approaches 10 miles, the cost to dredge with a hydraulic cutterhead pipe dredge begins to exceed the cost to mechanically dredge and dispose at the same disposal site. Likewise, since the LTMS does not allow “new work”, or deepening material to be disposed at the in-bay disposal sites, the hopper dredge also becomes less cost effective than mechanical clamshell dredging when the haul distance to the disposal site exceeds 20 miles. The haul distances from the Central Basin to SF-DODS and MWRP both exceed 50 miles, so a hopper dredge plant operation was not evaluated for this project.

Based on the current hydrographic surveys, estimated quantities for all three alternative depths, and the sampling and testing results of the sediment characteristics, CEDEP identified the most cost effective combination of clamshell dredging equipment for this project is: one 21 CY clamshell bucket with either three 3,000-horsepower (HP) tug boats and four 4,000 CY scows for disposal at SF-DODS, or three 1,800-HP tug boats and four 4,000 CY scows to haul the dredged material to the Montezuma site. As shown in the Cost Appendix, CEDEP has also determined that the most cost-effective disposal site is SF-DODS.

Table 4- Estimated Construction Duration - Clamshell Dredge Plant

Placement Site	Production Rate (CY/day)	-30 feet Duration (months)	-32 feet Duration (months)	-35 feet Duration (months)
SF-DODS	5,200	1.0	1.4	1.9
SF-11	12,300	0.1	0.15	0.2
MWRP	5,900	0.9	1.2	1.7

7.0 References

U.S Army Corps of Engineers, San Francisco District (2016) Pier 70: Central Basin CAP 107 Navigation Improvement Geotechnical Appendix June 2016

U.S Army Corps of Engineers, San Francisco District (2016) Pier 70: Central Basin Coastal CAP 107 Navigation Improvement Engineering Appendix May 2016

U.S Army Corps of Engineers, San Francisco District (2016) Pier 70: Central Basin CAP 107 Navigation Improvement Cost Appendix December 2015

Letter, San Francisco Bar Pilots to USACE, San Francisco District, dated 3 June 2016

Appendix D:

Environmental

Draft Finding of No Significant Impact (FONSI)

(33 C.F.R. pt. 230-325)

Pier 70: Central Basin Continuing Authorities Program Section 107 Navigation Improvement Project San Francisco, San Francisco County, California

1. **Action:** The United States Army Corps of Engineers, San Francisco District, proposes to dredge the three proposed dredge units (19.42 acres) in the Central Basin Approach Area at the Pier 70 Shipyard to a depth of 32 feet MLLW plus 2 feet of overdepth and place all of dredged material at SF-DODS to reduce the negative impacts of shoaling in the Central Basin at Pier 70 and allow vessels to safely and efficiently access the Pier 70 Shipyard without the use of high tide.

2. **Factors Considered:** Factors considered for this FONSI were direct, indirect, and cumulative impacts to air and water quality, aquatic and terrestrial habitat, biological resources, endangered/threatened species, recreation and public facilities/services, transportation and traffic, noise, aesthetics, public health and safety, hazardous and toxic material, land use, and cultural, archeological, and historic resources.

3. **Conclusion:** Based on a review of the information incorporated in the Environmental Assessment, including views of the United States Army Corps of Engineers, the general public, and resource agencies having special expertise or jurisdiction by law, USACE concludes the proposed activity would not significantly affect the quality of the physical biological, and human environment. In addition, avoidance, minimization, and mitigation measures are proposed to further support this determination. Therefore, pursuant to the provisions of the National Environmental Policy Act of 1969, the preparation of an additional Environmental Impact Statement will not be required.

Approved by:

___________________________ ___________________________

John C. Morrow
Lieutenant Colonel, U.S. Army
District Engineer

Date

Appendix D: Environmental – Air Quality Calculations

Table D-1 Estimation of Dredging Rate for Mechanical Dredge														
Dredge Rate	Pumping Day													Average
	1	2	3	4	5	6	7	8	9	10	11	12	13	
Paula Lee Data Amount Dredged[1,] (Cubic	448	224	276	NA	NA	NA	NA	NA	NA	286	195	167	202	257[2, 3]

[1] Source: U.S. Army Corp of Engineers, San Francisco District, February 2014 *"Comparison of Mechanical and Hopper Dredging Operations in San Francisco Bay."* These rates were derived from data collected during dredging at Richmond Harbor and placement at a site 4.5 miles away.

[2] The daily production rate for a mechanical dredge to dredge material from Central Basin with placement at SF-DODS listed in the Civil Design Appendix is 5,200 CY/day (or roughly 217 CY per hour). The production rate of 217 CY per hour will be used in this analysis.

[3] This analysis will be supplemented in the event that an alternate dredge type or disposal location is used.

Notes:

NA = not applicable

Table D-2 Estimation of Dredging Duration with Placement at SF-DODS using a Mechanical Dredge Based on 237,700 Cubic Yards Total Dredged Material		
Dredge Equipment Type	Total Pumping Hours	Total Pumping Days (based on 24 hours/day)
Mechanical[1]	1104	46

[1] – The production rate was used for a mechanical dredge to dredge material from Central Basin with placement at SF-DODS, which is 5,200 CY/day (or roughly 217 CY per hour) as listed in the Civil Engineering Appendix.

Table D-3
Calculation of Engine Usage per Amount of Dredged Material

Dredge Equipment Specifications									
Dredge Equipment Type	**Activity**	**Engine Type**	**Engine Size (hp)**	**Number of Engines**	**Rate or Capacity[3] (CY/hr)**	**Load Factor**	**Model Year**	**Engine Size Data source**	**Calculated Power Rate (hp-hr/CY)**
Mechanical (Paula Lee)	Pumping (Dredging)	Tug – main engine[1]	3000	1	217[2]	0.1	N/A	USACE Civil Design Appendix	1.38
		Main	1200	1	217[2]	0.1	2007	USACE spec sheet	0.55
		Main	895	1	217[2]	0.1	2002	USACE spec sheet	0.41
		Deck	300	1	217[2]	0.8	2004	USACE spec sheet	1.11
		Deck Winch	300	4	217[2]	0.8	2007	USACE spec sheet	4.42
Mechanical (Paula Lee[1])	Transit (Dredged Material Placement)	Tug – main engine[1]	3000	3	462	0.8	N/A	USACE Civil Design Appendix	15.60
		Main	1200	1	220	0.1	2007	USACE spec sheet	0.55
		Main	895	1	220	0.1	2002	USACE spec sheet	0.41
		Deck	300	1	220	0	2004	USACE spec sheet	0.00
		Deck Winch	300	4	220	0	2007	USACE spec sheet	0.00

Notes: CY = cubic yard, CY/hr – cubic yards per hour, hp = horsepower, hp-hr/CY = horsepower hour per cubic yard, mph = miles per hour

1 The Civil Design Appendix states that one mechanical dredge with a 21 cubic yard bucket, three 3,000 horsepower (HP) tug boats and four 4,000 CY scows is the most effective combination of dredging equipment. This analysis focuses on the worst case scenario, which assumes that three 3,000 HP tug boats will constantly be in transit to SF-DODS, while one 3,000 HP work tug will assist the mechanical dredge at Central Basin.

2 The daily production rate for a mechanical dredge to dredge material from Central Basin with placement at SF-DODS listed in the Civil Design Appendix is 5,200 CY/day (or roughly 217 CY per hour). The production rate of 217 CY per hour will be used in this analysis. Please see Table D-1 above for further explanation.

3 The mechanical dredge will always stay in the Region of Influence. The distance considered for tug emissions during transit activities is limited to the area within the Region of Influence. Therefore, the tug will travel 39 miles (one-way) during transit activities within the Region of Influence, which includes the haul route from Central Basin to a distance of 24 nautical miles off the coast. Estimation of transport rates (cubic yards per hour) for the mechanical dredge and tug are presented in the following tables:

Estimation of Transport Capacity/Rate for Mechanical Dredge		
Speed	10	mph
Distance to SF-DODS*	82	Miles (one-way)
Round trip duration	16.4	hr
Size	4000	CY
Fill to level (% of capacity)	90%	
Material / round trip	3600	CY
Transport rate	220	CY/hr
* Distance from Central Basin to SF-DODS: 82 miles (71 nautical miles) per Civil Design Appendix.		
Transport rate = (Material/round trip) / (Round trip duration)		

Estimation of Transport Capacity/Rate for Tug		
Speed	10	mph
Distance to SF-DODS	82	Miles (one-way)
Round trip duration	16.4	hrs
Distance within Regulated CA Waters*	39	Miles (one-way)
Round trip duration within Reg. CA Waters	7.8	hrs
Size	4000	CY
Fill to level (% of capacity)	90%	
Material / round trip	3600	CY
Transport rate	462	CY/hr
* Distance includes the distance from Central Basin to the CA Baseline is 10 nautical miles plus 24 additional nautical miles (Regulated CA Waters) = 34 nautical miles or 39 miles		
Transport rate = (Material/round trip) / (Round trip duration within Regulated California Waters only) = 3600 CY / 7.8 hrs		

Table D-4 Calculation of Emission Factors

Dredge Equipment Specifications			Available Emission Factors[1]				Emission Factors (g/hp-hr) [1,2]				
Dredge Equipment Type	Activity	Engine Type	CO (g/kW-hr)	NO_X + ROG[2] (g/kW-hr)	NO_X + ROG[3] (g/hp-hr)	PM (g/kW-hr)	ROG	CO	NO_X	PM_{10}	CO_2
Mechanical (Paula Lee)	Pumping	Tug – main engine	—	—	—	—	0.45	1.04	12.68	0.14	439
		Main	—	—	5.70	—	0.3	1.6	5.4	0.13	568
		Main	—	—	—	—	0.2	2.0	7.7	0.36	568
		Deck	—	—	6.00	—	0.3	1.4	5.7	0.17	568
		Deck Winch	—	—	3.90	—	0.2	2.1	3.7	0.13	568
Mechanical (Paula Lee)	Transit	Tug – main engine	—	—	—	—	0.45	1.04	12.68	0.14	439
		Main	—	—	5.70	—	0.3	1.6	5.4	0.13	568
		Main	—	—	—	—	0.2	2.0	7.7	0.36	568
		Deck	—	—	6.00	—	0.3	1.4	5.7	0.17	568
		Deck Winch	—	—	3.90	—	0.2	2.1	3.7	0.13	568

Notes:

1 Source: United States Army Corps of Engineers (USACE), n.d. Specification sheets for the *Paula Lee* dredge. Provided by USACE San Francisco District.

2 Emissions factors were not available for tugs that typically operate within San Francisco Bay at the time of the analysis. Therefore, the emissions factors for a slow-speed diesel engine and marine gas oil with a maximum of 0.10% sulfur by weight listed in the guidance recommended by the USEPA to estimate commercial marine emission inventory were used for the tug (ICF International, 2009). California ultra low diesel fuel has 0.0015% sulfur content.

3 The mixture consists of 95 percent NO_X and 5 percent ROG.

CO = carbon monoxide
CO_2 = carbon dioxide
g/hp-hr = grams per horsepower hour
g/kW-hr = grams per kilowatt hour
NO_X = nitrogen oxides
PM = particulate matter
ROG = reactive organic gas

Table D-5
Calculation of Air Pollutants Emission Rates from Dredging Activities (pounds/cubic yard)

Dredge Equipment Specifications			Calculated Emissions (lbs/CY)[1]				
Dredge Equipment Type	**Activity**	**Engine Type**	**ROG**	**CO**	**NO_X**	**PM_{10}**	**CO_2**
Mechanical (Paula Lee)	Pumping	Tug – main engine	0.0014	0.0032	0.0386	0.0004	1.34
		Main	0.0004	0.0020	0.0066	0.0002	0.69
		Main	0.0002	0.0018	0.0070	0.0003	0.52
		Deck	0.0007	0.0034	0.0139	0.0004	1.38
		Deck Winch	0.0020	0.0205	0.0361	0.0013	5.54
Mechanical (Paula Lee)	Transit	Tug – main engine	0.0154	0.0359	0.4360	0.0049	15.10
		Main	0.0004	0.0019	0.0065	0.0002	0.68
		Main	0.0002	0.0018	0.0069	0.0003	0.51
		Deck	0	0	0	0	0
		Deck Winch	0	0	0	0	0

Notes:

1 Calculation:

$$\frac{Calculated\ Power\ Rate\ \left(\frac{hp-hr}{CY}\right) * Emission\ Factor\ \left(\frac{g}{hp-hr}\right)}{453.592\ (\frac{g}{lbs})} = Calculated\ Emissions\ (\frac{lbs}{CY})$$

CO = carbon monoxide
CO_2 = carbon dioxide
lbs/CY = pounds per cubic yard
NO_X = nitrogen oxides
PM = particulate matter
ROG = reactive organic gas

Table D-6
Calculation of Air Pollutants Emission Rates from and Placement Activities (tons/year)

Dredge Equipment Type	Activity	Engine Type	Total Pollutant Emissions during Dredging Activities — Tons/Year: ROG	CO	NO_X	PM_{10}	CO_2	Metric Tons/Year: CO_2
Mechanical (Paula Lee)	Pumping	Tug – main engine	0.16	0.38	4.59	0.05	159	144
		Main	0.04	0.23	0.78	0.02	82	75
		Main	0.02	0.22	0.83	0.04	61	56
		Deck	0.09	0.41	1.65	0.05	165	149
		Deck Winch	0.23	2.43	4.29	0.15	658	597
Total Pumping Emissions			0.55	3.67	12.15	0.31	1,126	1,021
Mechanical (Paula Lee)	Transit	Tug – main engine	1.83	4.27	51.82	0.58	1,795	1,628
		Main	0.04	0.23	0.77	0.02	81	74
		Main	0.02	0.21	0.82	0.04	61	55
		Deck	0	0	0	0	0	0
		Deck Winch	0	0	0	0	0	0
Total Transit Emissions			1.89	4.71	53.41	0.64	1937	1757
Total Emissions for the Proposed Action[1]			**2.44**	**8.38**	**65.56**	**0.95**	**3062**	**2,778**
de minimis Emission Levels (40 C.F.R. 93 § 153) – Minimum threshold for which a conformity determination must be performed			50	100	100	100	--	--
NEPA/CEQ Thresholds of Significance for Carbon Dioxide Equivalent								25,000
Do Total Mitigated Emissions Exceed Thresholds?			**No**	**No**	**No**	**No**	**No**	**No**

Notes:

1 The use of an electric-powered mechanical dredge would essentially eliminate all emissions from the mechanical dredge. Retarding injection timing by 2 degrees from the manufacturers' suggested setting would reduce NOx emissions by about 15 percent from diesel-powered equipment (USACE, 1998).

NEPA = National Environmental Policy Act
CO_2 = carbon dioxide
ROG = reactive organic gas
CEQ=Council on Environmental Quality
CO = carbon monoxide
NO_X = nitrogen oxides
PM = particulate matter

TABLE D-7
FEDERALLY LISTED, PROPOSED, AND SPECIAL CONCERN SPECIES - PIER 70: CENTRAL BASIN CAP 107 NAVIGATION IMPROVEMENT PROJECT

SPECIES NAME COMMON NAME	LISTING STATUS[1]	RANGE, HABITAT REQUIREMENTS & ADDITIONAL NOTES	POTENTIAL TO OCCUR IN ACTION AREAS
FEDERALLY LISTED, PROPOSED AND/OR FULLY PROTECTED SPECIES			
PLANTS			
Do not occur. Given that the proposed action areas involve only marine aquatic habitat and an active wetland construction site, listed terrestrial plant species were omitted from this list.			
INVERTEBRATES			
Callophrys mossii bayensis San Bruno elfin butterfly	FWS: FE CH: Proposed CA: None	The San Bruno elfin butterfly is restricted to primarily north-facing grasslands and rocky outcrops containing its larval foodplant Pacific stonecrop (*Sedum spathulifoilum*) in the fog belt of San Mateo County, California. Presence of suitable nectar plants such as *Lomatium sp*. and *Berberis pinnata* are important habitat components. The San Bruno elfin butterfly currently is known to occur only at San Bruno Mountain, Malagra Ridge, Sweeney Ridge, Whiting Ridge, and Montara Mountain in San Mateo County, California. The flight period of the San Bruno elfin butterfly is limited to the early spring, from late February to mid-April.	**Does not occur.** No suitable habitat present.
Plebejus icarioides missionensis Mission blue butterfly	FWS: FE CH: Proposed CA: None	The mission blue butterfly inhabits grasslands within the coastal fogbelt in southern Marin, San Francisco, and San Mateo counties in California that contain one or all three of its larval foodplants (*Lupinus albifrons, L. formosus, and L. variicolor*). Nectar plants are also an important habitat component for this species, and include a variety of native wildflowers and nonnative thistles. The mission blue butterfly is has a flight period that extends from late March to mid-June.	**Does not occur.** No suitable habitat present.
Speyeria callippe callippe Callippe silverspot butterfly	FWS: FE CH: Proposed CA: None	The callippe silverspot butterfly is endemic to the grassy hills surrounding San Francisco Bay. The animal occurs in grasslands with California golden violet (*Viola pedunculata*), which is its sole larval foodplant. Although this plant is found in grasslands throughout much of California, the callippe silverspot butterfly is limited to fog-influenced locations in the San Francisco Bay area. The presence of adequate nectar sources is also an essential habitat component for this species.	**Does not occur.** No suitable habitat present.
Euphydryas editha bayensis Bay Checkerspot butterfly	FWS:FT CH: Designated CA: None	The Bay Checkerspot butterfly is restricted to serpentine outcrops with thin soils that support dry native grasslands and have an abundance of its larval foodplants: *Plantago erecta* and *Orthocarpus densiflorus*.	**Does not occur.** No suitable habitat present.

TABLE D-7
FEDERALLY LISTED, PROPOSED, AND SPECIAL CONCERN SPECIES - PIER 70: CENTRAL BASIN CAP 107 NAVIGATION IMPROVEMENT PROJECT

SPECIES NAME COMMON NAME	LISTING STATUS[1]	RANGE, HABITAT REQUIREMENTS & ADDITIONAL NOTES	POTENTIAL TO OCCUR IN ACTION AREAS
Haliotis cracherodii Black Abalone	NMFS: FE CH: Designated CA: None	Black abalone inhabit rocky tidal and subtidal habitat along the coast of North America, from Point Arena, California, to Bahia Tortugas and Isla Guadalupe, Mexico. This designated critical habitat for this speces includes intertidal and subtidal rocky habitat and all waters from MHHW to a depth of 20 ft within five segments of the California coast between Del Mar Point, Sonoma County, and Palos Verdes Peninsula, near Long Beach, California. It also includes the Farallones Islands (USACE, 2015). There is no critical habitat for this species designated within San Francisco Bay. Black abalone are not found in sandy substrates, however, they are broadcast spawners and when spawning occurs, their larvae may be present in waters over both rocky and sandy bottoms (USACE, 2015). Black abalone spawn in spring and early summer (SAIC, 2007). Larvae are free-swimming for between 5 and 14 days before they settle onto hard substrate (USACE, 2015).	**Not likely to occur.** No suitable rocky habitat present. Project activities will not take place during spawning season.
Haliotis sorenseni White Abalone	NMFS: FE CH: None CA: None	White abalone range in the Pacific Ocean from Point Conception, California, down to Punta Abreojos, Mexico. The species occurs in open low and high relief rock or boulder habitat that is interspersed with sand channels usually between depths of 80-100 feet (25-30 m).	**Does not occur**. Range is in Southern California.
<u>FISH</u>			
Eucyclogobius newberryi Tidewater goby	FWS: FE CH: Designated CA: SSC	A small (4-5 cm total length) California endemic fish that inhabits brackish coastal lagoons, estuaries and marshes. Range extends from the Smith River in Del Norte County to Agua Hedionda Lagoon in San Diego County. Typically an annual species that lives for approximately 1 year. The species is restricted primarily to coastal lagoons and the brackish zone of larger estuaries. The species is generally found in water less than 1 meter (3.3 feet) deep and salinities of less than 12 parts per thousand (Swenson, 1999).	**Does not occur**. Action areas are not located within designated critical habitat. No suitable habitat present. Species is believed to have been extirpated from San Francisco Bay due to habitat loss and introduction of predatory invasive fishes (USFWS 2005).
Hypomesus transpacificus Delta smelt	FWS: FT CH: Designated CA: ST	Inhabits brackish water in the Sacramento-San Joaquin Delta. Known to range from Sacramento/San Joaquin Delta, Sacramento River as high as the confluence with the Feather River, Mokelumne River, Cache Slough, Montezuma Slough, San Pablo Bay, Suisun Bay, Suisun Marsh, Carquinez Strait, and Napa River and Marsh. Spawns in freshwater habitat from February to August in shallow water areas with submersed aquatic plants, suitable substrates and refugia. Found in open surface waters of the Delta and Suisun Bay.	**May occur.** Range and critical habitat includes open surface waters in the vicinity of the Montazuma Wetland Restoration Project placement site.

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SPECIES NAME COMMON NAME	LISTING STATUS[1]	RANGE, HABITAT REQUIREMENTS & ADDITIONAL NOTES	POTENTIAL TO OCCUR IN ACTION AREAS
Spirinchus thaleichthys Longfin smelt	NMFS: Candidate CH: None CA: ST	Longfin smelt are pelagic, estuarine fish which range from Monterey Bay northward to Hinchinbrook Island, Prince William Sound Alaska. In California, they have been commonly collected from San Francisco Bay, Eel River, Humboldt Bay and Klamath River. This species is found throughout San Francisco Bay (CDFG 2009b, undated). As they mature in the fall, adults migrate to brackish or freshwater in Suisun Bay, Montezuma Slough, and the lower reaches of the Sacramento and San Joaquin Rivers. Spawning takes place in freshwater. In April and May, juveniles are believed to migrate downstream to San Pablo Bay; juvenile longfin smelt are collected throughout the Bay during the late spring, summer and fall, and occasionally venture into the Gulf of the Farallons.	**May Occur.** Species is found throughout San Francisco Bay.
Acipenser medirostris Green sturgeon (southern DPS)	NMFS: FT CH: Designated CA: SSC	An anadromous fish that is generally found in marine waters from the Bering Sea to Ensenada, Mexico. Green sturgeon spawning populations have been found in the Sacramento-San Joaquin river system and medium-sized rivers northward. Adult green sturgeon enter the San Francisco Bay estuary and move up the Sacramento River in early spring (CDFG 2001). The green sturgeon spawning period occurs in the Sacramento River between March and June. Post-spawning adults may be present in San Francisco Bay Estuary during the spring and early summer for months prior to migrating to the ocean. Sub-adult and nonspawning adult green sturgeon use both ocean and estuarine environments for rearing, foraging, and feeding on benthic invertebrates, crustaceans, and fish (Moyle, 2002). Critical habitat has been designated for this species and includes coastal marine waters up to 60 fathoms (fm) depth from Monterey Bay north to Cape Flattery, Washington, including the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California (USFWS 2009a).	**May Occur**. Action areas are located within designated critical habitat. However, suitable spawning habitat is not present within the action areas.
Thaleichthys pacificus Pacific eulachon (Southern DPS)	NMFS: FT CH: None CA: SSC	Eulachon are native to the eastern Pacific and tributaries along the Pacific coast of North America. Eulachon are anadromous fish that spend most of their adult lives in the ocean but return to their natal freshwater streams and rivers to spawn and die. Eulachon feed primarily on plankton as well as fish eggs, insect larvae, and small crustaceans. Though evidence is scant, Eulachon may have been native to the Sacramento River and drainages within the south California Coastal to Baja California region (USFWS 2009b). The species was recorded in the Sacramento River in 2007 (USFWS 2009b) and in San Pablo Bay in 2001 (CAS, 2009).	**Not likely to occur**. Species is rarely detected in San Francisco Bay and does not breed within the Bay.

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SPECIES NAME COMMON NAME	LISTING STATUS[1]	RANGE, HABITAT REQUIREMENTS & ADDITIONAL NOTES	POTENTIAL TO OCCUR IN ACTION AREAS
Oncorhynchus kisutch Coho salmon (Central California Coast ESU)	NMFS: FE CH: Designated CA: SE	Coho salmon are restricted to coastal streams, on the west coast of North American from the northwest coast of Alaska to Santa Cruz County, California (NOAA 2005). Adults return to their stream of origin to spawn and die, usually at around three years old. Coho generally return to their natal streams between November and December. Critical habitat includes all water, substrate and adjacent riparian zones of all accessible river reaches and estuarine habitat from Punta Gorda in northern California to the San Lorenzo River, which empties into Monterey Bay at Santa Cruz. The species may be extirpated from San Francisco Bay (Leidy, et al 2005).	**May occur.** Species may migrate through opn ocean or bay waters.
Oncorhynchus tshawytscha Chinook salmon (Sacramento winter-run and Central Valley spring-run ESUs)	NMFS: FE (winter-run) FT (spring-run) CH: Designated(both) CA: SE (winter-run) ST (spring-run)	Chinook salmon are anadromous fish that spends 1-3 years in the ocean and return to perennial freshwater streams during the spring to spawn. Juveniles rear in the Sacramento and San Joaquin Rivers and tributaries throughout the year. Chinook salmon migrate through the San Francisco Bay between the Golden Gate and the Sacramento-San Joaquin River systems. The winter-run enter San Francisco Bay from November through June and spawn in the spring and summer, primarily in the Sacramento River. The Central Valley spring-run migrate. April to July and spawn in the Sacramento River Basin. Both runs are most commonly found migrating through the northern and central portions of San Francisco Bay (CDFG, 1987).	**May occur**. Migration corridor exists between Golden Gate and Sacramento – San Joaquin River systems.

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SPECIES NAME COMMON NAME	LISTING STATUS[1]	RANGE, HABITAT REQUIREMENTS & ADDITIONAL NOTES	POTENTIAL TO OCCUR IN ACTION AREAS
Oncorhynchus mykiss irideus Steelhead (Central California Coast and Central Valley ESU)	NMFS: FT CH: Designated CA: None	An anadromous fish that spends several years in the ocean; returning to freshwater rivers and tributaries to spawn. The Central California Coast Evolutionary Significant Unit (ESU) includes all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in California streams from the Russian River, Sonoma County, CA, (inclusive) to Aptos Creek, Santa Cruz County, CA, (inclusive), and the drainages of San Francisco and San Pablo Bays eastward to the Napa River (inclusive), Napa County, CA (NMFS 2011). The Central Valley ESU includes all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in the Sacramento and San Joaquin Rivers and their tributaries. Adult steelhead typically migrate from the ocean to fresh water between December and April, peaking in January and February (Fukushima and Lesh, 1998). Spawning occurs between December and March in streams in the San Francisco Bay Area. After hatching, young steelhead remain in freshwater streams for one to four years before migrating to the ocean. Juvenile steelhead migrate to the ocean from January through May, with peak migration occurring in April and May (Fukushima and Lesh, 1998). Critical Habitat for this the Central California Coast DPS is present within San Francisco Bay and specific creeks and rivers that drain directly into the Bay.	**May occur**. Action areas are located in designated critical habitat (for Central California Coast ESU) and both ESUs use open water areas within the Bay during migration to/from spawning grounds. No spawning habitat is located in or near action areas.

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SPECIES NAME COMMON NAME	LISTING STATUS[1]	RANGE, HABITAT REQUIREMENTS & ADDITIONAL NOTES	POTENTIAL TO OCCUR IN ACTION AREAS
AMPHIBIANS & REPTILES			
Rana aurora draytonii California red-legged frog	FWS: FT CH: Designated CA: SSC	A medium-sized frog that inhabits lowlands & foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation up to 1,500 meters in elevation (Stebbins 2003). Range extends from Redding to Baja California, Mexico with hybridization occurring with the California red-legged frog from the Oregon border to Marin County. Breeding occurs between November and April in standing or slow moving water at least 0.7 meters (2 ½ feet) in depth with emergent vegetation such as cattails (*Typha* spp.), tules (*Scirpus* spp.) or overhanging willows (*Salix* spp.) present (Hayes and Jennings 1988). Habitat for this species is located in several areas on the San Francisco Peninsula where suitable ponds, marshes, streams with adjacent uplands are present.	**Not likely to occur.** Project is not located within designated critical habitat. No suitable habitat present.
Dermochelys coriacea Leatherback sea turtle	FWS: FE NMFS: FE CH: Designated CA: None	Leatherback turtles utilize much of the world's marine habitat and designated Leatherback critical habitat stretches along the California Coast from Point Arena to Pont Arguello. They forage widely in deep temperate and tropical waters (> 55 ft below MLLW). Nesting only occurs in tropical and subtropical regions.	**May occur**. May forage in open ocean or open bay.
Chelonia mydas Green sea turtle (East Pacific DPS)	FWS: FT NMFS: FT CH: None CA: None	Green turtles are generally found in tropical and subtropical waters along continental coasts and islands. While they have been sighted from Baja California to southern Alaska, they most commonly occur from San Diego south (NOAA, 2015).	**May occur.** Could occur in open ocean in the vicinity of SF-DODS.
Lepidochelys olivacea Olive ridley sea turtle	FWS: FT NMFS: FT CH: None CA: None	This species of sea turtles is distributed in the tropical latitudes and are known to occur from Southern California down to Northern Chile (NOAA, 2015).	**Does not occur**. Range is in Southern California.
Caretta caretta Loggerhead sea turtle	FWS: FT NMFS: FT CH: None CA: None	Loggerheads have been reported as far north as Alaska, and as far south as Chile with numerous records off the coast of California (NOAA, 2015). Generally found in warmer waters.	**May occur**. Could occur in open ocean in the vicinity of SF-DODS.

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BIRDS:			
Charadrius alexandrinus nivosus Western snowy plover	FWS: FT CH: Designated CA: SSC	Inhabits beaches, mud flats, estuaries, salt evaporation ponds and inland river channels with banks for foraging. Breeds on sandy beaches, dunes, levees, river banks and dry salt evaporation beds along the California coastline typically in areas with minimal human disturbance. Breeding begins in March (Baicich & Harrison 2005). Federal listing applies only to the Pacific coastal population that nests within 50 miles of the Pacific Ocean on the mainland coast, peninsulas, offshore islands, bays, estuaries, or rivers of the U.S. and Baja, California.	**Not likely to occur.** No suitable habitat present.
Rallus longirostris obsoletus California clapper (Ridgeway's) rail	FWS: FE CH: None CA: SE	California clapper rail is a chicken-sized bird that inhabits tidal salt marshes around San Francisco, San Pablo, and Suisun bays.,. The species is associated with dense cordgrass (Spartina), gumplant and pickleweed for nesting, and feeds on invertebrates in open mud areas along sloughs. In the San Francisco Bay area, clapper rails breed from mid-March to August. Individuals may nest near the San Leandro Marina, in the adjacent salt marsh, and wander into or along Estudillo Canal (USACE, 2009). In addition, this species is known to be present within a tidal marsh near the San Rafael Creek Inner Canal Channel (USACE, 2011).	**Not likely to occur.** No suitable habitat present.
Sterna antillarium browni California least tern	FWS: FE CH: None CA: SE	The California least tern is the smallest tern in North America. The species migrates to California in April and remains until August; wintering takes place south of the United States. They nest in colonies on bare or sparsely vegetated sandy beaches, alkali flats, and landfills. Presently, most nesting occurs on beaches or in coastal wetlands near estuaries, bays, harbors or the ocean. Species has been recorded nesting at Alameda Naval Air Station, (EONDX #13784) and is known to use the Middle Harbor Enhancement Area in Oakland Harbor for foraging and roosting. Least terns forage over marine and bay waters and feed on small fish and invertebrates.	**May occur**. Species forages in marine waters of San Francisco Bay and has been documented at Montazuma Wetland Restoration Project since 2005.
Diomedea albatrus Short-tailed albatross	FWS: FE CH: None CA: None	Short-tailed albatross nest on steep open slopes in coastal areas. Breeding season begins in October. Birds have very rarely been sighted in the northern Pacific after breeding season ends in summer, and no landings have been reported in California.	**Not likely to occur.** No suitable habitat present. Rare occurrence of short-tailed albatross in areas south of Alaska.

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MAMMALS:			
Enhydra lutris nereis Southern sea otter	FWS: FT CH: None CA: FP	Southern (aka California) sea otters use nearshore marine environments from Ano Nuevo, San Mateo County to Point Sal, Santa Barbara County (CDFG 2009a). They require canopies of giant kelp and bull kelp for rafting and feeding (Costa, 1978). Sea otters eat a variety of marine invertebrates including urchins, crabs, clams and snails. Sea otters are considered a keystone species that protect the kelp forest, by keeping species in check that consume kelp, such as sea urchins, limpets and snails (Estes and Palmisano 1974). Otters also use kelp forests as a refuge from predation by white sharks and winter storms, and as nursery areas for females with pups (Foster and Schiel 1985).	**Not likely to occur.** Current range is south of SF Bay and individuals have very rarely been recorded in the Bay. No kelp forest habitat exists in action areas.
Reithrodontomys raviventris Salt marsh harvest mouse	FWS: FE CH: None CA: SE	The salt marsh harvest mouse is restricted to the salt and brackish water marshes in San Francisco Bay. The species lives entirely within the tidal zone, and favors pickleweed (Salicornia) as cover and forage. The species is adapted to life within the tidal zone, and can escape tidal inundation through climbing upward within the marsh vegetation, and is a good swimmer. The species can drink saltwater. Salt marsh harvest mice build ball-shaped nests within the tidal zone. Young are born from spring to fall, and breeding occurs 2-3 times per year (Reid, 2006). Two subspecies of salt marsh harvest mouse are found in San Francisco Bay (*Reithrodontomys raviventris raviventris* and *R. r. halicoetes*). R. r. raviventris is mostly restricted to southern San Francisco Bay, extending from Belmont, San Mateo County, on the San Francisco Peninsula to the Newark area in Alameda County. *R. r. halicoetes* is found in the north bay on the Marin Peninsula, through Petaluma, Napa and Suisun Bay Marshes, and in northern Contra Costa County.	**May occur**. Extensive salt marsh harvest mouse habitat exists in Phases II through IV of the Montezuma Wetlands Restoration Project (MWRP), and surveys conducted between 2000 and 2009 have confirmed the presence of salt marsh harvest mouse habitat in these areas (Acta Environmental, 2011).
Arctocephalus townsendi Guadalupe fur seal	NMFS: FT CH: None CA: None	Guadalupe fur seals are rarely observed in California, although seals are sometimes seen at the Farallon Islands and at Point Reyes. Guadalupe fur seals occupy cool, sheltered, rocky shores with bluffs, rock platforms and tidepools. The only known breeding colony is on Guadalupe Island, off the Mexican coast	**Not likely to occur**. Rare in California and suitable habitat not present in action areas.
Balaenoptera musculus Blue whale	NMFS: FE CH: None CA: None	Blue whales are known to migrate and forage along the CA coastline. Blue whales accompanied by young calves have been observed often in the Gulf of California from December through March. They migrate poleward in spring to take advantage of high zooplankton production in summer. Although blue whales are found in coastal waters, they are thought to occur further offshore than other whales.	**May occur**. Could transit through open ocean waters at SF-DODS.
Balaenoptera physalus Fin whale	NMFS: FE CH: None CA: None	Fin whales are found in deep, offshore waters of all major oceans. There is a population of Fin whales in the North Pacific and there may be resident groups of fin whales in the Gulf of California.	**May occur**. Could transit through open ocean waters at SF-DODS.

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Megaptera novaeangliae Humpback whale	FWS: FE CH: None CA: None	Humpback whales inhabit a variety of ocean habitats from the waters surrounding tropical islands to shallow waters off continental coasts. In the summer, they inhabit waters from southern California throughout the Gulf of Alaska to the southern Chukchi Sea. Humpback whales do not inhabit San Francisco Bay, though there have been rare cases of humpback whales straying into the Bay.	**May occur.** Species is a very rare visitor to the San Francisco Bay. May transit in open ocean waters at SF-DODS.
Eubalaena glacialis Northern Pacific Right whale	NMFS: FE CH: Designated CA: None	Designated critical habitat for this species falls within the Gulf of Alaska and the Bering Sea. Sightings have been reported as far south as central Baja California. The species is believed to spend the summer on high-latitude feeding grounds and migrate to more temperate waters during the winter. They primarily occur in coastal or shelf waters.	**May occur**. Could transit through open ocean waters at SF-DODS.
Balaenoptera borealis Sei whale	NMFS: FE CH: None CA: None	Sei whales occur in subtropical, temperate, and subpolar waters around the world. They are typically found in waters on the continental shelf edge and slope. They are usually observed in deeper waters of oceanic areas far from the coastline.	**May occur**. Could transit through open ocean waters at SF-DODS.
Orcinus orca Southern Resident Killer whale	NMFS: FE CH: Designated CA: None	Southern Resident Killer Whales range during the spring, summer, and fall includes the inland waterways of Washington state and the transboundary waters between the United States and Canada. In recent years, they have been regularly spotted as far south as central California during winter months.	**May occur**. Could transit through open ocean waters at SF-DODS.
Physeter catodon Sperm whale	NMFS: FE CH: None CA: None	Sperm whales are found throughout the world's oceans in deep waters between about 60° N and 60° S latitudes. Sperm whales tend to inhabit areas with a water depth of 1968 feet (600 m) or more, and are uncommon in waters less than 984 feet (300 m) deep.	**May occur**. Could transit through open ocean waters at SF-DODS.

[1] **Explanation of State and Federal Listing Codes**

Federal listing codes:
- FE Federally listed as Endangered
- FT Federally listed as Threatened
- CH Critical Habitat (Proposed or Designated)

California listing codes:
- SE State listed as Endangered
- ST State listed as Threatened
- SSC California Species of Special Concern
- FP Fully Protected

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CENTRAL BASIN SITE VISIT

Native Oyster and Eelgrass Survey

On February 11, 2014 Peter LaCivita travelled with the PDT to Pier 70 in the Port of San Francisco. The Port is pursuing a project on behalf of tenant BAE Systems to deepen the access channel to their dry dock facilities. The visit was scheduled around the time that the tide would be low. The idea was to make a preliminary determination of the presence of native oysters *Ostreola conchaphila* on the pilings and other hard surfaces of Pier 70. At the upper limit of the splash zone were the typical barnacles *Semibalanus balanoides* or possibly *Chthamalus stellatus*. Below the barnacles, any encrusting organisms were covered by so much mud that it was impossible to identify anything. It is not possible to say for sure that there are no oysters there, but the conditions are not favorable.

Because the depth in the dry dock and approach channel areas exceeds 3 meters (~10 feet) no eelgrass will present. Mapping in the 2004 *Baywide Eelgrass Inventory of San Francisco Bay* funded by Caltrans, the nearest known eelgrass patch is in Lash Lighter Basin 2 miles from the project.

Marine Protection, Research, and Sanctuaries Act (MPRSA) Section 103 Evaluation

Pier 70: Central Basin Continuing Authorities Program Section 107 Navigation Improvement Project San Francisco, San Francisco County, California

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1.0 INTRODUCTION

As a result of the Pier 70: Central Basin Continuing Authorities Program Section 107 Navigation Improvement Project plan formulation process, the U.S. Army Corps of Engineers (USACE) proposes to dredge the Central Basin Approach Area (Central Basin) and place the dredged material in ocean waters at the San Francisco Deep Ocean Disposal Site (SF-DODS).

Three statutes principally govern dredged material disposal in United States waters: the National Environmental policy Act (NEPA), the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) (33 U.S.C. § 1401-1445), also called the Ocean Dumping Act, and the Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. § 1251 et seq.), also called the Clean Water Act (CWA).

Placement of dredged or fill material within the San Francisco Bay, including the project dredge footprint, is considered to be placement within “waters of the United States” pursuant to Section 404 of the CWA. Placement of dredged material at SF-DODS is pursuant to MPRSA because SF-DODS is located in the Contiguous Zone off of the California Coast in the Pacific Ocean (NOAA, 2016).

Under Section 103 of the MPRSA (33 U.S.C. § 1413), USACE is the federal agency that decides whether to issue a permit authorizing the ocean disposal of dredged materials. In the case of federal navigation projects, USACE may implement the MPRSA directly in the USACE projects involving ocean disposal of dredged materials. USACE relies on EPA’s ocean dumping criteria when evaluating permit requests for (and implementing federal projects involving) the transportation of dredged material for the purpose of dumping it into ocean waters (40 C.F.R. § 227). MPRSA permits and federal projects involving ocean dumping of dredged material are subject to USEPA review and concurrence (USEPA, 2016).

This document provides an evaluation of Pier 70: Central Basin Continuing Authorities Program Section 107 Navigation Improvement Project’s conformance to the aforementioned regulations (40 C.F.R. § 227). Alternatives for the management of dredged material must be carefully evaluated from the standpoint of environmental acceptability and technical practicability.

2.0 DREDGING AND PLACEMENT INFORMATION

The study area consists of the Central Basin Approach Area at the Pier 70 Shipyard (shipyard) and is located at Potrero Point on the eastern waterfront of the City of San Francisco, in the San Francisco Bay. Central Basin is located approximately 1.5 miles south of the San Francisco—Oakland Bay Bridge (Interstate 80). The area is referred to as Central Basin and is adjacent to the Port of San Francisco Pier 70 industrial complex (Figure 1). The dredge footprint is located entirely within the waters of San Francisco Bay and is approximately 19.42 acres.

Central Basin provides a navigable channel to access to the second largest dry dock (Drydock #2) on the west coast of the United States. The Pier 70 Shipyard features two drydocks, full pier-side facilities, and an available labor force in excess of 1,300, as well as a number of machine and engineering firms. The Port of San Francisco owns the real property and primary equipment for ship repair, such as the drydocks and cranes, which are currently leased to Puglia Engineering, Inc. (Puglia). Puglia offers full-service ship repair for commercial and government vessels and can accommodate post-Panamax class ships. The Port offers a full range of marine terminal services, such as handling of bulk and general cargo, heavy lift services, stevedoring, and storage—both ground and covered.

The existing depth of the Central Basin approach is inefficient and, in many cases, impeding access in and out of the Pier 70 Shipyard. The condition is expected to worsen in the future with increased siltation. The situation incurs increased transportation costs and delays to users, as well as excludes certain large classes of vessels.

The length and lifting capacity of Drydock #2 enables it to accommodate and repair vessels of a size that only one other facility on the West Coast can match. While Drydock #2 can accommodate the larger vessels that have drafts to 35 feet, the approach to the repair berths is restricted to approximately 24 feet mean lower low water (MLLW). However, Central is expected to continue to shoal at an average rate of half a foot per year, which could cause current restrictions put in place by the Naval Military Sealift Command (NMSC) in conjunction with the U.S. Coast Guard to be even more limiting. To remain competitive, the shipyard needs to be able to work on larger classes of vessels. Significant shoaling in Central Basin will not accommodate future growth for the Pier 70 Shipyard or maintain current operational capacity in the future without project condition.

Vessels in the region that, except for the draft restriction of the approach, could be repaired at the Port of San Francisco are forced to travel outside of the region for repair, including to docks located in Guam and Hawaii. Shipyards with drydocks of similar capabilities are located in San Diego, California and Portland, Oregon. The Pier 70 Shipyard has in the past taken in emergency repair jobs. If access of deep–draft government or commercial ships to Drydock #2 were not maintained, then, at minimum, vessels of this size needing emergency repairs in the San Francisco Bay region would need to travel to Portland or San Diego. Inability to access the repair facility efficiently also poses an environmental safety hazard (e.g., oil spills from deep draft commercial vessels).

As described in Section 1.5 of the Draft DPR and Integrated EA, the purpose of the project is to maximize the reduction of the negative impacts of shoaling in the Central Basin at Pier 70 to allow vessels to safely and efficiently access the Pier 70 Shipyard without the use of high tide, improve safety and decrease risk to vessels and operators in approaching the Central Basin Shipyard, increase access to the specialized repair and service facilities at the Pier 70 Shipyard, and reduce transportation costs and user delays for use of the repair and service facilities at the Pier 70 Shipyard.

The subject of this evaluation is the United States Army Corps of Engineers' (USACE) proposal to dredge the Central Basin and subsequently place the dredged material at the San Francisco Deep Ocean Disposal Site (SF-DODS). The USACE identified SF-DODS as the location for placement proposed for dredged material from Central Basin because:

1) SF-DODS is designated to provide capacity for long-term management of dredged material from the San Francisco Bay region (Section 2.2),
2) SF-DODS has the capacity to accept the material (Section 2.2),
3) The material proposed to be dredged at Central Basin meets the sediment quality requirements for placement at SF-DODS (Section 4.5 and 5.0-7.0),
4) The Federal share of initial implementation costs (including all feasibility study, design, and construction costs) does not exceed $10 million in accordance with current cost limits authorized by Section 1030 of the Water Resources Reform and Development Act (WRRDA) of 2014 (Section 7.2), and
5) Dredging Central Basin to 32 feet MLLW plus two feet of allowable overdepth and placing all of the material at SF-DODS (Alternative 6) is the plan with the highest benefit to cost ratio; is the least costly plan that is consistent with environmental statutes; and, therefore, is the Proposed Action and the National Economic Development Plan (NED) (Section 7.2).

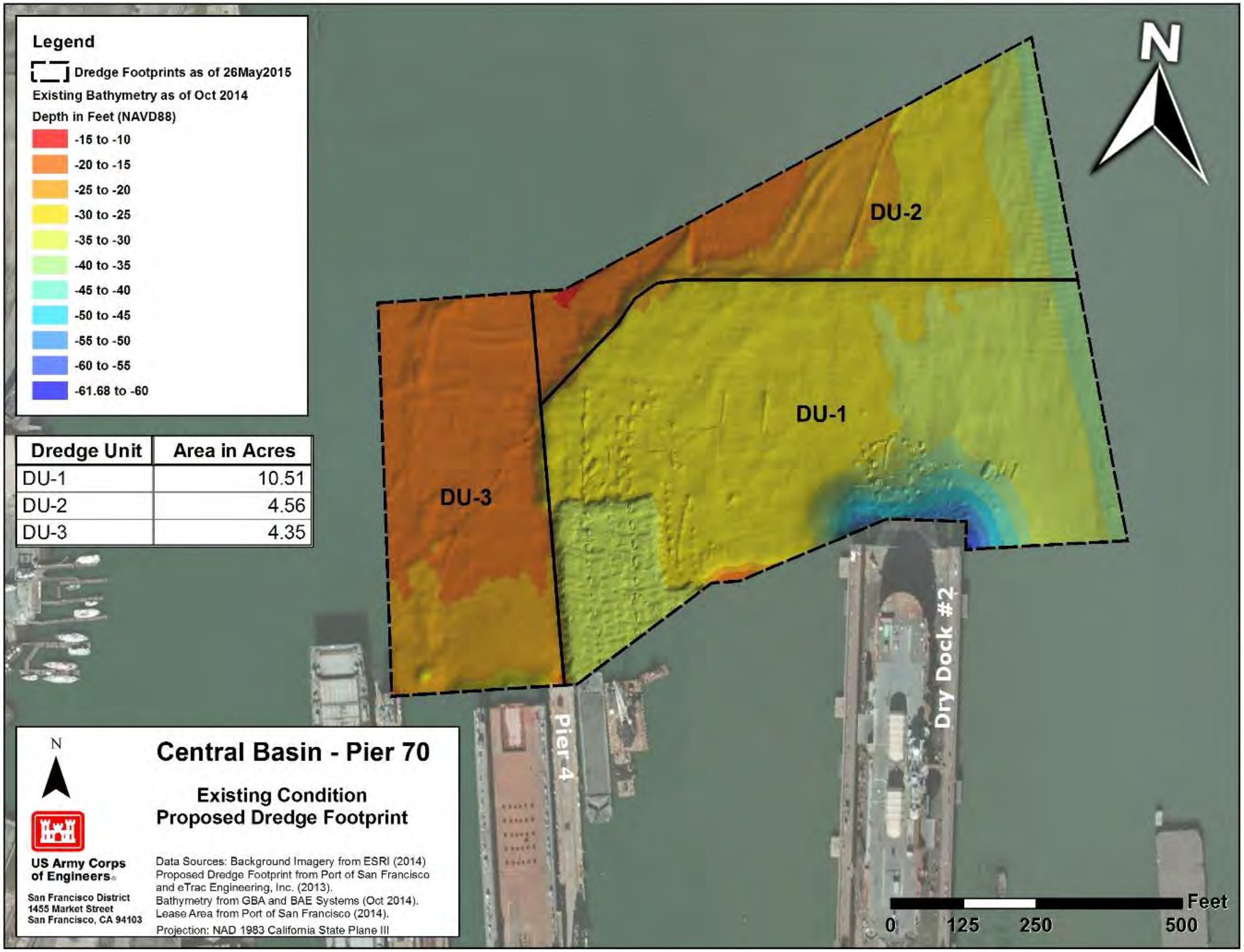

Figure 1. Proposed Dredge Footprint - Central Basin Approach Area

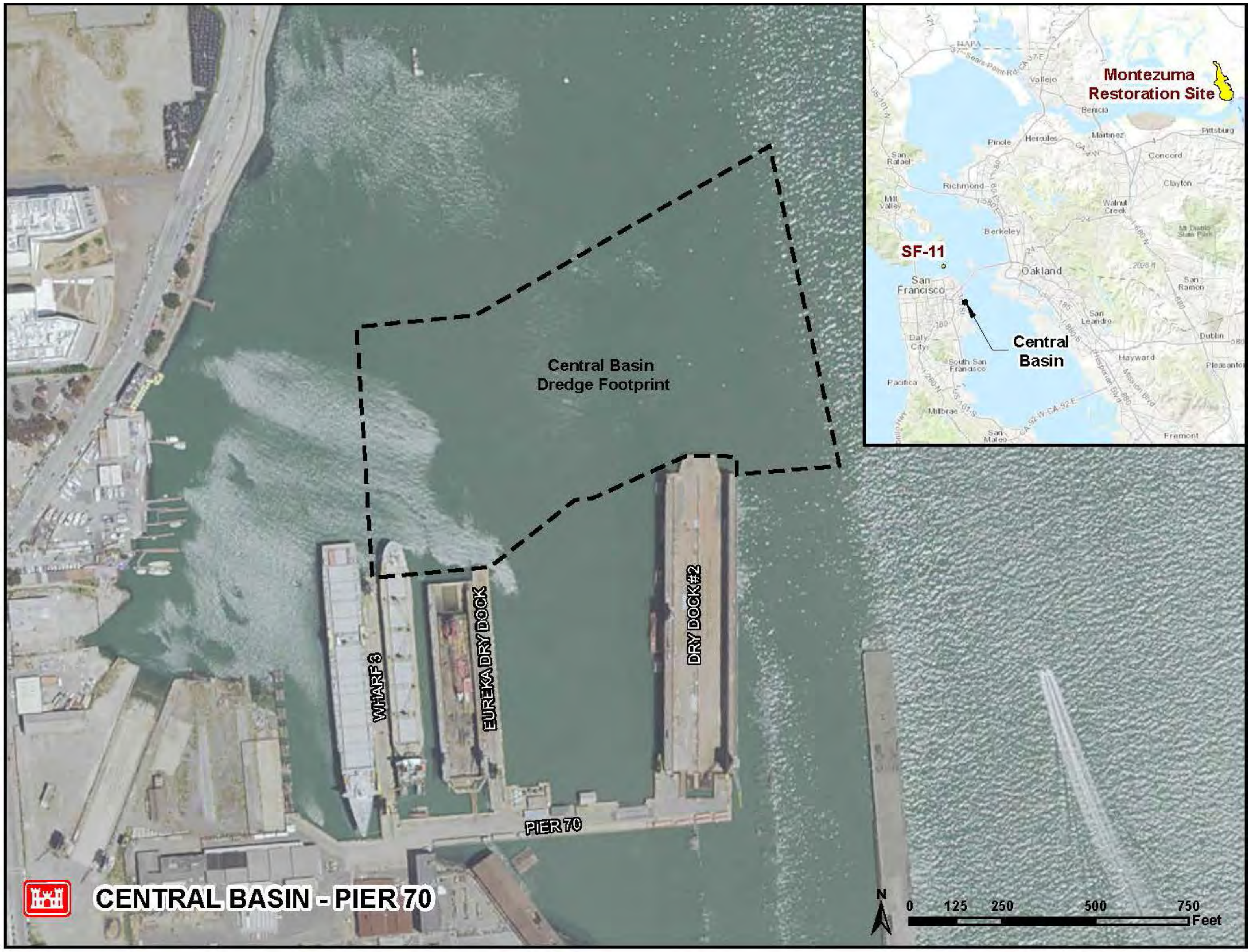

Figure 2. Central Basin Location and San Francisco Bay Placement Sites

Figure 3. Central Basin and Placement Site Locations

2.1 Description of Final Array of Project Alternatives – Dredging Location, Volume of Material to Be Dredged, and Expected Start and End of Dredging,

The Draft DPR and Integrated EA[1] evaluates in detail the potential environmental impacts of the final array of four alternatives in Section 5 of the Draft DPR and Integrated EA: the No Action Alternative (Alternative 16), the Proposed Action (Alternative 6), and two alternatives to the Proposed Action (Alternatives 1 and 4). The analysis of impacts in the Draft DPR and Integrated EA is based on the assumption that USACE will obtain the authorization and funding to implement the Proposed Action in 2017.

Please refer to Appendix C.c (Civil Design Appendix) of the Draft DPR and Integrate EA for a full discussion of the equipment, dredge volumes, placement sites and distances, production rates, and project durations for each alternative listed below.

The Central Basin dredge footprint and all placement sites considered are in the San Francisco Bay Long-Term Management Strategy (LTMS) Program Planning Area. However, the geographic scope of potential impacts of the proposed project are limited to the dredge footprint at Central Basin and transit routes to associated placement sites in and around San Francisco Bay. Please refer to Sections 1 and 4.3 of the Draft Detailed Project Report (DPR) and Integrated Environmental Assessment (EA) for the full description of the Central Basin and considered placement sites.

The dredging process involves the excavation of accumulated sediment from the channel bed. The dredged material is subsequently transported and placed at a permitted facility or location in a manner consistent with the approval conditions established by applicable regulatory agencies, after determination of suitability for placement at that site.

The proposed method of maintenance dredging includes the use of one 21 cubic yard (CY) electric mechanical dredge, three 3,000 horsepower tugs, and four 4,000 CY scows. Mechanical dredging usually involves bucket or clamshell dredges, which scoop material directly into a scow for transport to a placement site.

2.1.1 No Action Alternative (Alternative 16)

Under the No Action Alternative (Alternative 16), no Federal action would be taken. Depths currently range from 11 to deeper than 40 feet, with a median depth of roughly 24 feet. Future without-project depths are projected to be 27.3 feet in 2016, 24.8 feet in 2021, 22.3 feet in 2026, 19.8 feet in 2031, and 17.3 feet in 2036. The shipyard is expected to close between 2022 and 2026 under this scenario. Please refer to Section 3.6 of the Draft DPR and Integrated EA for a full description of the No Action Alternative.

2.1.2 Proposed Action (Alternative 6)

Under the Proposed Action (Alternative 6), the three proposed dredge units (DUs) in the Central Basin Approach Area (Figure 1) would be dredged to a depth of 32 feet mean lower low water (MLLW) plus 2 feet of overdepth and placing all of dredged material at SF-DODS. Approximately 237,700 CY of material (including the 2 feet of overdepth) would be dredged. Dredging associated with the Proposed Action is expected to take place in 2017 during the established environmental work windows for dredging in San

[1] This evaluation was prepared pursuant to USACE's compliance requirements under Section 103 of the MPRSA; therefore, only USACE's findings under the National Environmental Policy Act and other federal laws and executive orders, as presented in the Draft DPR and Integrated EA, are disclosed this MPRSA Section 103 evaluation. This MPRSA Section 103 evaluation does not present analysis completed in compliance with the California Environmental Quality Act and other state laws.

Francisco Bay, which open annually on June 1 and close on November 30. Dredging will begin at the western-most end of the proposed Central basin dredging footprint and progress easterly to the end of the footprint. It is expected that the dredging contractor will be working 24-hours per day, 7-days a week on the project. Given the proposed dredging equipment and distance between the Central Basin and SF-DODS, the daily production under the Proposed Action would be approximately 5,200 CY/day. At this rate, the Proposed Action would take an estimated 1.4 months to complete. Please refer to Section 4.6.1 of the Draft DPR and Integrated EA for a full description of the Proposed Action.

2.1.3 Alternative 1

Under Alternative 1, similarly to the Proposed Action, the three proposed DUs in the Central Basin Approach Area would be dredged to a depth of 30 feet MLLW plus 2 feet of overdepth. Approximately 185,000 CY of material would be dredged (including 2 feet of overdepth) and all of the material would be placed at SF-DODS. This alternative is expected to have the same production rate as the Proposed Action at approximately 5,200 CY/day. Alternative 1 would follow the same project timing (in 2017 within established environmental work windows), work plan (dredging west to east across the proposed footprint), and schedule (24 hours a day, 7days a week) as the Proposed Action. However, given the reduced quantity of material to be dredged, this alternative would take approximately 1.0 month to complete. Please refer to Section 4.6.2 of the Draft DPR and Integrated EA for a full description of Alternative 1.

2.1.4 Alternative 4

Under Alternative 4, like Alternative 1, the three proposed DUs in the Central Basin Approach Area would be dredged to a depth of 30 feet MLLW plus 2 feet of overdepth. However, under this alternative, material would be placed at both the Alcatraz placement site (SF-11) and the Montezuma Wetlands Restoration Project (MWRP) placement site instead of SF-DODS. Approximately 185,000 CY of material would be dredged (including 2 feet of overdepth) and 73 percent (135,050 CY) would be taken to MWRP with the remainder (49,950 CY; 27 percent) going to SF-11. The dredging operation under Alternative 4 would involve the same size mechanical clamshell dredged plant that would be used under the Proposed Action (and Alternative 1) as well as the same number of scows and tugboats, but the tug boats would be downgraded to 1,800 HP because the working conditions in the protected waters of the San Francisco Bay are much less severe than those in the open ocean where SF-DODS is located. Full scows would be towed to MWRP or SF-11. Given the proposed dredging equipment and distances to MWRP and SF-11, the estimated daily production rate for placement at MWRP is 5,900 CY/day and the estimated daily production rate for placement at SF-11 is 12,300 CY/day. Alternative 4 would follow the same project timing (in 2017 within established environmental work windows), work plan (dredging west to east across the proposed footprint), and schedule (24hours a day, 7days a week) as the Proposed Action (and Alternative 1). Given the estimated material quantities to be taken to each placement site and the aforementioned daily production rates for placement at those sites, alternative 4 would approximately 0.8 months to complete (approximately 0.1 month for placement of the estimated quantity at SF-11 and 0.7 months for placement of the estimated quantity at MWRP). Please refer to Section 4.6.3 of the Draft DPR and Integrated EA for a full description of Alternative 4.

2.2 San Francisco Deep Ocean Disposal Site (SF-DODS) – Description of Disposal Area, Placement Location, and Compliance with Site Designation Conditions

The SF-DODS is located in the Pacific Ocean approximately 55 nautical miles west of the Golden Gate Bridge (Figure 3). The total size of SF-DODS is 6.5 square nautical miles; however, its disposal area is only a 600-meter radius circle located at the center of the larger site. SF-DODS is the farthest offshore and deepest (8,200 to 9,840 feet) dredged material placement site in the United States. The site was established in 1994 by the San Francisco Bay Long Term Management Strategy agencies and is managed by the USEPA. Please see Figure 3 for the location of SF-DODS in relation to Central Basin.

The center point coordinate (NAD 83) of San Francisco Deep Ocean Disposal Site is (40 C.F.R. § 228):

Latitude: 37° 39.0' N Longitude: 123° 29.0' W

The SF-DODS is authorized to receive up to 4.8 million CY of dredged material per year. In order for a dredging project to be authorized to dispose of dredged material at the SF-DODS, sediment evaluations (including appropriate physical, chemical, and biological testing) as described in the national sediment testing manual popularly referred to as the Ocean Testing Manual (OTM) must first be conducted. However, since 2000, annual disposal at SF-DODS for all dredging projects, not just the Federal navigation channels maintained by USACE, has averaged less than one million CY per year.

A site management and monitoring plan (SMMP) for SF-DODS became effective in 1994 and was extracted from the 1994 Final Rule designating the site. The objective of the SMMP is to provide guidelines in making management decisions necessary to fulfill the mandated responsibilities to protect the marine ecosystem per 40 C.F.R. § 228(I)(3)(x). The SMMP provides monitoring guidelines to collect data that confirms whether contaminated sediments are being deposited at the SF-DODS despite extensive pre-disposal testing per 40 C.F.R. § 228(I)(3)(ix). Annual monitoring by USACE and USEPA has shown that past disposal at SF-DODS has occurred without causing significant impacts to the ocean and the marine biology in and around SF-DODS.

Split hull dump scows will be used to transport the material to the offshore disposal site and they will be equipped with Automated Scow Monitoring Systems in compliance with the USACE National Dredging Quality Management (DQM) System requirements. These systems collect, store, and transmit barge draft, location in transit, and verification data for offshore material placement. This information will be available daily and will be transmitted to USACE and USEPA (per DQM requirements), and these data will serve as quality assurance (QA) and quality control (QC) for the offshore placement activities.

3.0 EXCLUSIONARY CRITERIA FOR OCEAN PLACEMENT WITHOUT TESTING

3.1 Grain Size of Material

The most recent results of grain size analyses for Central Basin composite sediment samples ranged from 93 to 99.3 percent fines (silt and clay). Please see Figure 4 below for the grain size distribution measured in composite samples collected in 2015 and please see Section 3.0 of this document for further information.

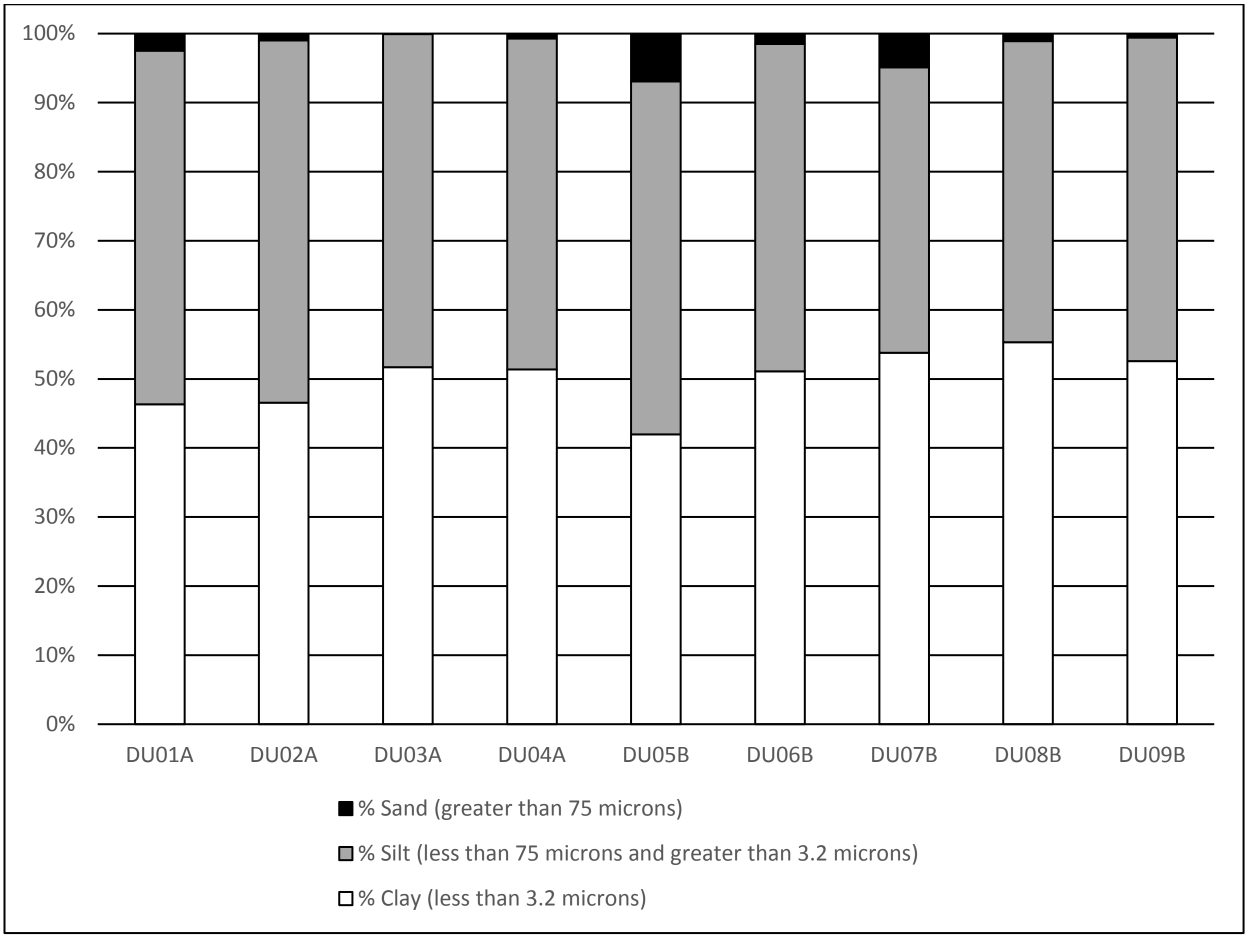

Figure 4. Grain Size Distribution in Central Basin Sediment Samples Collected in 2015

3.2 Exclusion Applicability

In accordance with 40 C.F.R. § 227.13(b), the exclusionary criteria apply to material that meets any of the following three criteria to be considered environmentally acceptable for ocean placement without further testing:

1. The dredged material is comprised predominately of sand, gravel, rock, or any other naturally occurring bottom material with particle sizes larger than silt, and the material is found in areas of high current or wave energy.

2. Dredged material is for beach nourishment or restoration and is comprised predominately of sand, gravel, or shell with particle sizes comparable with material on the receiving beaches.

3. The material proposed for placement is substantially the same as the substrate at the proposed disposal site and the site from which the material proposed for disposal is to be taken is far removed from known existing and historical sources of pollution as to provide reasonable assurance that such material has not been contaminated by such pollution.

The material proposed to be dredged at Central Basin is almost entirely comprised of silt and clay and is not located in an area of high current or wave energy; is not suitable for beach nourishment; and is not physically the same as the placement site sediments. Therefore, the proposed dredged material from Central Basin does not meet the exclusionary criteria for testing.

4.0 NEED FOR TESTING FOR OCEAN PLACEMENT

4.1 Requirement for Testing

The material proposed to be dredged within Central Basin consists primarily of a mixture of silts and clays, and does not fully meet the exclusionary criteria set forth under 40 C.F.R. § 227.13(b). Therefore, tiered testing was conducted to determine if the proposed dredge material from Central Basin meets the limiting permissible concentration (LPC) for ocean placement in accordance with 40 C.F.R. § 227.32, and the following protocols:

- *Evaluation of dredged material proposed for discharge in waters of the U.S. – Testing manual* (USEPA/USACE 1998), also known as the Inland Testing Manual or ITM, is the guidance manual for evaluating the suitability of dredged material for unconfined aquatic inland disposal.
- *Evaluation of dredged material proposed for ocean disposal – Testing manual* (USEPA/USACE 1991), also known as the Ocean Testing Manual, OTM, or Green Book, is the guidance manual for evaluating the suitability of dredged material for ocean disposal.
- *Guidelines for Implementing the Inland Testing Manual within the San Francisco Bay Region, Public Notice 01-01* (USEPA et al., 2001), also known as PN 01-01, provides guidance for the determining the dredged material testing that will be required for dredging projects proposing disposal at designated sites in waters of the U.S. within San Francisco Bay.

Both the ITM and OTM provide guidance for conducting water column toxicity, benthic toxicity, and bioaccumulation analyses. However, the ITM was developed more recently than the OTM and provides more descriptive and updated guidance for how to conduct biological tests and statistically evaluate the data (toxicity significance, LC_{50}, mixing zones, etc.). The Central Basin sampling and testing team used the tiered guidance in the OTM, but relied on the updated test methods in the ITM.

4.2 Historical Operations at Central Basin

Please Section 1.2 of the Draft DPR and Integrated EA for the full history of operations at Central Basin.

In general, the Pier 70 Shipyard has been active and integral to western U.S. industry for well over 100 years. The shipyard was founded by Risdon Iron Works in 1884, which launched from the shipyard the first steel-hulled ship built anywhere on the Pacific Rim in 1885.

Bethlehem Steel Corporation and its preceding subsidiaries acquired the shipyard from Risdon Iron Works in 1905 and operated the shipyard continuously until its sale in 1982. Shortly after the purchase, the 1906 San Francisco Earthquake hit, which damaged the plant considerably and destroyed the hydraulic drydock, a huge loss for the company. From 1910 until World War I, however, Bethlehem Steel invested in major improvements to the shipyard, and was among the most prolific ship producers during the World War I and II. During World War II, Bethlehem's Potrero yard produced 72 vessels and repaired over 2,500 navy and commercial craft.

After World War II, shipbuilding declined—the last ship built was in 1965. Large barges continued to be built, however, into the 1970s and ship repair continued as well. By the late 1970s, the oldest active civilian shipyard in the U.S. stopped building vessels entirely because the declining U.S. shipping industry could no longer support it.

In 1982, the City of San Francisco purchased the Potrero yard property for one dollar. Since acquisition of the shipyard, the Port has had seven lessee companies operate there. Today, Puglia Engineering, Inc. (Puglia) operates on the Pier 70 land, piers, and drydocks that they lease from the Port of San Francisco. The current 30-year lease was signed in December 1987 with Southwest Marine, Inc., which has since changed name and ownership a number of times due to a series of bankruptcies and acquisitions. BAE Systems became the leaseholder in 2005, and recently sold their lease in 2016 to Puglia through the latest of these acquisitions.

4.3 Dates of Previous Dredging

Central Basin has not been included in any previous Federal study or completed project. No request for Federal participation in Central Basin had been submitted until the Port of San Francisco did so for this study. The River and Harbor Acts of 1927, 1930, 1935, and 1968 authorized dredging to remove rocks and shoals from specific sections of the waterfront along the San Francisco Bay and the San Francisco Main Ship Channel approach outside the Golden Gate Bridge. However, the Central Basin study area was not part of these authorized projects.

The Port, sometimes in partnership with predecessor lessees, has dredged parts of Central Basin to varying depths since 1984. Puglia Engineering, Inc. is responsible for maintenance of their leasehold area, which includes dredging the area between and just in front of docks and piers to the required depths for operation. These depths vary from about 21 feet mean lower low water (MLLW) by Pier 3, to deeper than 50 feet MLLW by Drydock #2. Puglia needs sufficient depth there in order to lower the drydock down when ships are entering and exiting the dock.

Central Basin does not have a designated or marked deep draft ship channel and is not maintained on a regular basis. In the past 30 years, a total of four dredging episodes have occurred.

Table 1. Central Basin Dredging History

Year(s)	Quantity Dredged (cubic yards, cy)	Permit Holder	Depth Dredged To
1984/1985	108,000	Port of San Francisco	Unknown
1989/1990	76,000	Port of San Francisco	32 ft. MLLW
1999/2000	199,411[2]	Port of San Francisco	28 ft. MLLW, plus 2 ft. overdepth in most, but not all of the basin.
2011	89,474	BAE Systems	30 ft. MLLW, plus 2 ft. overdepth

In the summer of 2011, the Port and BAE Systems (the lease holder prior to Puglia), faced with depth limitations that threatened the viability of continued operations, undertook a one-time emergency spot-dredging episode in Central Basin to 30 ft MLLW, plus two feet of allowable overdepth. Approximately

[2] The survey document shows this number, but a subsequent table on Maintenance Dredging History from the Master Sampling and Analysis Plan notes that 119,411 cy was removed during this episode. This is believed to be a typographical mistake in the table.

90,000 cubic yards of sediment was dredged with placement at both the San Francisco Deep Ocean Disposal Site (SF-DODS) and the Alcatraz placement site (SF-11, located in San Francisco Bay). These are the only two placement sites that have been used for Central Basin dredged materials throughout its dredging history of four dredging episodes over the last thirty years. Since the 2011 dredging, Central Basin has continued to shoal and now has depths of approximately 16 to 32 ft MLLW.

Prior to the Port's purchase of what is now the Pier 70 Shipyard in 1982, Central Basin was privately maintained. There are limited to no records surviving on the dredging completed during the World War I and II periods when the site was operated by Bethlehem Steel and its predecessors. One Bethlehem Steel plan from 1945 shows planned depths of 26 feet MLLW in the western part of Central Basin and 34 feet MLLW in the center of Central Basin. No Federal study or project has been completed or begun on Central Basin until now.

4.4 Locations and Summary of Previous Testing

During the planning process for Central Basin, the Port of San Francisco in partnership with USACE has conducted two sampling and testing events of material proposed to be dredged at Central Basin to determine the suitability of the material for placement at available sites, such as in-Bay sites like SF-11, SF-DODS, Montezuma Wetland Restoration Project (MWRP), and Cullinan Ranch Tidal Restoration Project (CRRP). For this project, the Central Basin dredge footprint is divided into three (3) dredge units (DUs; see Figure 1). Samples were collected throughout the entire proposed dredge footprint in April 2015 and samples were collected only in two dredge units (DU05B and DU08B) in November 2015. Sediment from all DUs underwent the full suite of required chemical analyses and biological testing.

Figure 5. Upper Dredge Units and Actual Sampling Locations for Central Basin

Figure 6. Lower Dredge Units and Actual Sampling Locations for Central Basin

4.5 Results of Previous Testing

The USACE in partnership with the Port of San Francisco submitted sampling and analysis results from the material to be dredged within Central Basin to the San Francisco Bay Dredged Material Management Office (DMMO) to determine the suitability of the material to be placed at approved placement sites in and around San Francisco Bay. The suitability of the material determines technologically viable placement site options as well as the cost of dredged material placement, and therefore is a practicability consideration in this MPRSA Section 103 evaluation.

In a memorandum for the record dated April 28, 2016, DMMO determined that:

- All of the material proposed to be dredged at Central Basin is suitable for placement at SF-DODS, as wetland foundation material at the Montezuma Wetland Restoration Project (MWRP).
- The material proposed to be dredged within DU-2 (Figure 1) is suitable for placement at an in-Bay disposal site.
- Except for DU-2, none of the sediment is suitable for unconfined aquatic disposal at an in-Bay disposal site or for placement as wetland cover material at MWRP.

This suitability determination provides the possibility for DU-2 material to be placed at MWRP as wetland cover material. However, because discharge of the material proposed to be dredged in DU-2 at MWRP as wetland cover material would violate the San Francisco Regional Water Quality Control Board's (SFRWQCB) Waste Discharge Requirements for MWRP (Order No. R2-2012-0087), USACE has assumed that none of the material proposed to be dredged at Central Basin is suitable for placement as wetland cover material at MWRP per 40 C.F.R. § 230.10(b)(1).

The DU-2 concentration of total chlordane in the dredge depth interval from the mudline to 30 feet MLLW (plus two feet of allowable overdepth) exceeds the material acceptability criterion for wetland foundation material dictated by the SFRWQCB's Waste Discharge Requirements for MWRP. In addition, the concentrations of cadmium, selenium, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and chlordane exceed the material acceptability criteria for wetland cover material dictated by the aforementioned Waste Discharge Requirements for MWRP. Please see Table 2 below for the constituent concentrations. Please see Section 5.3.1.9 and Appendix D of the Draft DPR and Integrated EA for a full discussion of the sampling and analysis results and suitability determination.

Despite the chlordane concentration that exceeded the MWRP foundation criterion, there was no indication of toxicity in any of the sediments. Bioaccumulation testing was conducted and tissues were tested for PCBs concentrations. The bioaccumulation data did not indicate significant uptake of PBCs in total tissue residue. Leachability tests were conducted for metals only (including cadmium) and these did not indicate any significant concerns. Nevertheless, since no leachability studies were conducted for chlordane, the potential mobility is not known.

Based on the sediment characterization, suitability determinations, and coordination with the DMMO agencies, all of the sediment is suitable for placement at SF-DODS and as foundation material at the Montezuma Wetland Restoration Project. DU-2 only is suitable for unconfined aquatic placement at an in-Bay disposal site. None of the material is suitable for placement as cover material at the Montezuma Wetland Restoration Project. The final array of alternatives for further analysis in the Draft DPR and Integrated EA are consistent with these determinations.

Table 2. Concentrations of Analytes that Exceed MWRP Wetland Cover Acceptability Criteria for Dredge Units 02A and 06B

Analyte	Concentrations*		MWRP Acceptability Criteria		SF Bay Ambient (2015 RMP Report)	SFRWQCB TMDL
	DU 02A	DU 06B	Wetland Cover	Wetland Foundation		
Cadmium (mg/kg)	1.9	2.1	0.33	9.6	0.33	-
Selenium (mg/kg)	0.7	0.5 U	0.64	1.4	0.36	-
PCBs (µg/kg)	27	28	22.7	180	18.3	29.6
PAHs (µg/kg)	2,100	3,400	3,390	44,792	4,540	-
Total Chlordane (µg/kg)	15	2 Y	2.3	4.8	0.34	-

Notes:
Concentrations highlighted in red exceed MWRP acceptance criteria for wetland cover material.
Y = non-detect with an elevated reporting limit due to chromatographic interference (equivalent to U with raised method reporting limit)
U = non-detect at the method detection limit
*DU 02A and 06B are located in the same area, labeled in Figure 1 as DU-2. DU 02A material was collected from the mud line to 30 feet MLLW (+ 2 feet overdepth and 0.5 foot Z layer), and DU 06B material was collected from 32 feet MLLW to 35 feet MLLW (+ 2 feet overdepth and 0.5 foot Z layer).
TMDL = Total Maximum Daily Load

4.6 Recent Events Influencing Testing Results

There are no known recent events that have occurred in the vicinity of the project area immediately before or after the April 2015 and November 2015 sampling events.

5.0 WATER COLUMN DETERMINATIONS

In April 2015 through January 2016, tiered testing following protocols in the OTM, ITM, and PN 01-01 was conducted for composite samples collected from locations within the proposed dredging area. Results of the studies and a description of the sampling and chemical testing methodologies are detailed in the following documents:

- Sampling and Analysis Plan: "Port of San Francisco Central basin Sediment Characterization Sampling and Analysis Plan"(NewFields 2015a),
- Sampling and Analysis Report: "Port of San Francisco Central Basin Sediment Characterization Report," dated August 25, 2015 and revised September 29, 2015 (NewFields 2015b),
- Sampling and Analysis Plan (technical memorandum): "Central Basin Supplemental Sampling and Analysis" (NewFields 2015c), and
- Sampling and Analysis Report (technical memorandum): "Central Basin Supplemental Sampling and Analysis Results," dated January 4, 2016 (NewFields, 2016).

Sediment cores were collected from twenty-one (21) locations within Central Basin using a vibracoring system. The site water/elutriate preparation water sample was collected from the center of the Central Basin project footprint.

5.1 Sediment Testing

The results of the first sampling and testing event are presented in the "Port of San Francisco Central Basin Sediment Characterization Report," dated August 25, 2015 and revised September 29, 2015 (NewFields, 2015b). The full text of this report is included in Appendix D of the Draft Detailed Project Report (DPR) and Integrated Environmental Assessment (EA). Initial sampling at Central Basin was conducted between April 13 and April 23, 2015 to characterize nine dredge units (DUs) (Figures 5 and 6).

Please note that DU04A and DU09A were eliminated from the project footprint after sampling and testing were completed. No dredging will occur in the area represented by DU04A and DU09A in Figures 5 and 6; and therefore, the sediment characterization results are not discussed in this MPRSA Section 2013 Evaluation.

In April 2015, forty-two (42) discrete samples were collected at twenty-one (21) locations. Cores from all locations in each DU were homogenized to produce a single composite sample for chemical and conventional analyses and biological testing. The footprint of the upper DUs (A layer) matched that of the lower DUs (B layer) such that portions of each core went towards separate DUs (upper and lower), depending on the proposed dredge depth. The nine DUs were characterized as follows:

- Four surface DUs (DU01A, DU02A, DU03A, and DU04A) were characterized from the mud line to 30 feet MLLW (plus two feet of allowable overdepth), and from 32 to 32.5 feet MLLW to represent the material to be left in place after dredging (Z-layer), and
- Five subsurface DUs (DU05B, DU06B, DU07B, DU08B, DU09B) were characterized from 32 to 35 feet MLLW (plus two feet of allowable overdepth), and 37 to 37.5 feet MLLW to represent the Z-layer.

All nine composite samples were tested for physical and chemical constituents. Target analytes for the sediment testing were based on consultation with the San Francisco Bay Dredged Material Management Office (DMMO) and USACE-San Francisco District. Bulk sediments were tested for the following target constituents:

- Metals,
- Butyltins,
- Polycyclic Aromatic Hydrocarbons (PAHs),
- Pesticides, and
- Polychlorinated Biphenyls (PCBs).

In addition, the following physical analyses were conducted for the bulk sediment samples:

- Grain size determination,
- Percent total organic carbon, and
- Percent total solids.

Analytical results were compared to the SF-DODS reference database values, material acceptance criteria established in the Waste Discharge Requirements for MWRP and CRRP, San Francisco Regional Water Quality Control Board Total Maximum Daily Loads (TMDLs), and the San Francisco Bay ambient concentrations established by the San Francisco Bay Regional Monitoring Program (RMP).

Detailed results of the bulk sediment testing are provided in the “Port of San Francisco Central Basin Sediment Characterization Report" (NewFields, 2015b). Table 3 summarizes exceedances of the aforementioned screening criteria.

Table 3. Summary of Criteria Exceedances by Dredge Unit

	DU01A	DU02A	DU03A	DU05B	DU06B	DU07B	DU08B
EFH Bioaccumulation Trigger	Hg	Hg; PCBs	-	Hg, PAHs	Hg, PCBs	Hg, PAHs	Hg
RWQCB TMDL	PCBs	-	PCBs	Hg, PCBs	-	PCBs	PCBs
MWRP Surface (cover) Material	Cd, PAH, PCBs, Chlordane	Cd, Se, PCBs, Chlordane	Cd, PCBs, Chlordane	Cd, Hg, PCBs, PAHs, Chlordane	Cd, PAHs, PCBs, Chlordane	Cd, Hg, Se, PAHs, PCBs, Chlordane	Cd, PCBs
MWRP Foundation Material	Chlordane	Chlordane	Chlordane	PAHs, Chlordane	-	Chlordane	-
2014 SF Bay Ambient (<100% fines)	Cd, Hg, PCBs	Cd, Hg, Se, Chlordane, PCBs	Cd, Chlordane, PCBs	Cd, Hg, Se, PAHs, Chlordane, PCBs	Cd, Hg, PCBs	Cd, Hg, PAHs, PCBs	Cd, Hg, Chlordane, PCBs

Given the sediment characterization results listed above and the depth alternatives for the project, the Corps also must ensure that the material proposed to be dredged to a project depth of 32 feet MLLW plus two feet of overdepth within Central Basin was adequately characterized. The Z-layer for this depth extends from 34 to 34.5 feet MLLW.

Because the proposed project depth (32 feet MLLW) and Z-layer are in between the initial test intervals, additional chemical analyses were requested by the DMMO for select samples from DU05B and DU08B to verify that concentrations in the 32 feet to 34 feet interval are consistent with those from the previously tested 32 feet to 37 feet interval. The results of the second sampling and testing event are presented in the technical memorandum with the subject, "Central Basin Supplemental Sampling and Analysis Results," dated January 4, 2016 that was provided by NewFields (Appendix D of the Draft DPR and Integrated EA; NewFields, 2016).

The requested supplemental samples were collected at Central Basin in November 2015. Two DUs were characterized as follows:

- DU05B - All five individual cores from 32 to 34 feet MLLW and each Z-layer sample from 34 to 34.5 feet MLLW were analyzed for PCBs, PAHs, and chlordane.
- DU08B - Four individual cores were collected and a composite sediment sample was generated for the 32 to 34 feet MLLW depth interval and another composite sample was generated for the 34 to 34.5 feet MLLW Z-layer depth interval. The composite samples were analyzed for PCBs only.

Since the DU05B and DU08B chemical concentrations are similar or lower than the results measured in the samples collected in April 2015, the Corps and Port of San Francisco concluded that additional biological testing is not warranted. No other testing was conducted on these samples.

5.2 Water Column Elutriate Testing

Two elutriate procedures were conducted on the sediment composites collected in April 2015 from each DU, modified elutriate testing (MET) and waste water extraction testing using de-ionized water (DI-WET). Chemistry results for both tests are presented in Table 4 and are compared to the SFRWQCB daily maximum limits (DML; RWQCB 2013). Details of the elutriate analysis are provided in the "Port of San Francisco Central Basin Sediment Characterization Report," dated August 25, 2015 and revised September 29, 2015 (NewFields, 2015b).

For the MET, selenium concentrations exceeded the DML for DU01A, DU06B, DU07B, DU08B, and DU09B. Copper concentrations exceeded the DML for all but DU06B. However, the analytical laboratory had interference issues due to the high salinity of the samples. This interference resulted in elevated reporting limits of between 10-12 mg/kg for these two metals, as well as others that did not exceed the DML. Reported concentrations are generally within a factor of two of the elevated method reporting limits.

The interference issues did not occur in the freshwater DI-WET analysis. No exceedances of the DML were noted in the DI-WET samples results. Due to the analytical interference an issue involving the MET elutriates, it is recommended that the DI-WET results be used for evaluating the potential leachate from Central basin sediment composites.

Table 4. Summary of Elutriate Chemistry Results for Total and Dissolved Metals

	DML	CB-DU01A	CB-DU02A	CB-DU03A	CB-DU04A	CB-DU05B	CB-DU06B	CB-DU07B	CB-DU08B	CB-DU09B
Modified Elutriate Testing (MET) Results										
Conventionals (mg/L)										
TSS[1]	100	10.2	10.4	8.6	9.5	14	18.2	10.2	15.3	19.6
Total Metals (µg/L)										
Mercury	2.1	0.08 J	0.02 J	0.01 J	0.01 J	0.1 U	0.06 J	0.1 U	0.1 U	0.1 U
Selenium	20	20	12 J	3 J	6 J	6 J	30	40	20	20
Dissolved Metals (µg/L)										
Arsenic	69	37	32	32	32	30	5 U	8	4.5 J	4 J
Cadmium	3.9	2 U	2 U	2 U	2 U	2 U	0.5 J	0.5 J	0.5 J	0.5 J
Chromium	16	10	10	10	10	10	7 J	9 J	9 J	9 J
Copper	9.4	20	20	20	20	20	9 J	20	20	20
Lead	65	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Nickel	74	10	20	20	10	10	10 J	10	10	10
Silver	1.9	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Zinc	90	16 J	17 J	17 J	18 J	18 J	57 J	27 J	26 J	26 J

Deionized Waste Extraction Test (DI-WET) Results										
Conventionals (mg/L)										
TSS[1]	100	50.8	34	44.5	29.3	24.7	49.2	45.4	80	43.3
Total Metals (µg/L)										
Mercury	2.1	0.05 J	0.1	0.3	0.05 J	0.2	0.2	0.1	0.3	0.08 J
Selenium	20	5	4.8	4.5	4.3	5	5.2	5.3	3.5	4.5
Dissolved Metals (µg/L)										
Arsenic	69	51.4	38	44.2	30.6	27.8	28	43.5	39.6	32.2
Cadmium	3.9	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	16	0.9	1	1	1	0.9	0.9	1	0.9	1.2
Copper	9.4	2.2	2	1.9	2	1.9	2.2	1.9	2.5	1.8
Lead	65	0.2	0.2	0.1	0.2	0.3	0.3	0.2	0.4	0.2
Nickel	74	2.7	4.3	2.4	1.8	3	3	4	3.7	1.5
Silver	1.9	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	90	1.5 J	1.4 J	1.1 J	1.4 J	1.5 J	1.2 J	1.2 J	1.6 J	1 J

Notes: Exceeded Daily Maximum Limit DML: Regional Water Quality Control Board Daily Maximum Limit TSS: total suspended solids

1. The TSS threshold value of 100 mg/L represents an instantaneous maximum rather than a daily maximum limit

J-detected below the method reporting limit but above the method detection U-non-detect at the method detection

A conservative evaluation of potential water-column impacts from initial mixing during disposal of Central Basin sediments at SF-DODS was carried out using the Short Term FATE (STFATE) model (Johnson et al., 1994). Chemical concentrations in sediment composites that exceeded the TMDL guidelines (mercury, Total PAHs and Total PCBs) were modeled using STFATE to determine whether the contaminants would exceed water quality criteria when disposed at SF-DODS.

STFATE simulates the movement of the disposed material as it falls through the water column, spreads over the bottom, and is finally transported and diffused by the ambient current. The model assumes that all contaminants in the dredged material are released into the water column and become available to water-column organisms during disposal. This conservative assumption serves as a screen to reduce the evaluation effort for dredged material that will cause only minimal water-column impact during descent, which is common among large, deep-ocean disposal sites. A single dredged material placement is simulated using a typical split-hull type barge with a capacity of roughly 5,000 CY. STFATE results are then used to determine if further testing is needed to demonstrate compliance with established water quality criteria (WQC) (USACE/USEPA 1998).

The modeled water column contaminant concentrations are generated using the STFATE model and physical characteristics of the Central Basin sediment (grain size and percent solids), the physical oceanographic conditions of the SF-DODS Disposal Site, and the volume of sediment to be discharged (USEPA/USACE 1998). Disposal was simulated for samples with the highest concentrations of mercury, total PAHs, and total PCBs. The physical characteristics of sample DU05B were used to evaluate water column impacts for total PAH and mercury; and the physical characteristics of sample DU04A were used to evaluate water column impacts for total PCBs.

Maximum contaminant concentrations were evaluated for the water column outside the boundary of the disposal site *during* the 4-hr initial-mixing period, and anywhere in the marine environment *after* the 4-h initial mixing period. Under the simulated scenarios, water quality criteria for mercury, total PAHs, and total PCBs were not exceeded for disposal of Central Basin sediments at SF-DODS. Peak concentration within the site during the 4-hr initial mixing period reached 0.000026 mg/L for mercury and 0.033 mg/L total PAHs, while a 4-hr peak concentration of 0.000032 mg/L was predicted for total PCBs. The modeled contaminant concentrations and comparison to WQC are summarized in Table 4.

Sample ID	Analyte	Sediment Concentration (mg/kg)	Background Concentration in Seawater (mg/L)[a]	Marine Water Quality Criteria (mg/L)	Max Disposal Site Concentration After 4-hrs (mg/L)	Max Concentration Outside Site (mg/L)[a]
DU05B	Mercury	0.5	0.0001	0.0018[b]	0.000065	0.0001
DU05B	Total PAHs	66	0.0001	0.3[c]	0.00739	0.0001
DU04A	Total PCBs	0.042	0.0001	0.000033[d]	0.000015	0.0001

Notes:
mg/kg = milligrams per kilogram (dry weight)
mg/L = milligrams per liter
a = Background concentration estimated to be below detection level at Method Detection Limit (MDL)
b = USEPA Ambient Water Quality Criteria
c = USEPA Lower Observable Effects Levels (LOELs)
d = USEPA Tier II Secondary Acute Value

5.3 Water Column Bioassays

Mytilus galloprovincialis (mussel), *Americamysis bahia* (mysid shrimp), and *Menidia beryllina* (fish) were exposed to a standard dilution series of elutriates (100, 50, 10, and 1 percent) created from the project sediment composites. In addition, the elutriate preparation water (site water) and a laboratory control were tested in each of the water column bioassays. The mussel tests measured developmental effects to embryos, and the mysid shrimp and fish tests measured effects to organism survival. Five replicates per dilution were conducted, with ten test organisms per replicate. At the test termination, the number of survivors are counted and compared to controls to determine whether significant mortality has occurred. The test protocols are detailed in the SAP (NewFields 2015a) and the test results are listed in the "Port of San Francisco Central Basin Sediment Characterization Report," dated August 25, 2015 and revised September 29, 2015 (NewFields, 2015b). Results for water column bioassays are summarized in Tables 5, 6, and 7. All reference toxicant toxicity tests indicated that all test organisms were responding to toxic stress in a typical fashion. The water quality parameters for all tests were within the recommended water quality conditions for the bioassay.

The *Americamysis bahia* and *Menidia beryllina* tests met the QA/QC criteria for control acceptability results with a range from ≥94% survival in the Lab Control treatments (acceptability criterion ≥ 90%), indicating acceptable survival responses by the test organisms; there was ≥94% survival in the Site Water Control treatments (acceptability criterion ≥ 90%).

Table 5. Effects of Central Basin Sediment Elutriate on Americamysis bahia

Sample ID	Elutriate Treatment	Mean Survival (%)	LC_{50}
CB-DU01A	Control	100	>100%[a]
	Site Water	100	
	1%	100	
	10%	100	
	25%	100	
	50%	100	
	100%	100	
CB-DU02A	Control	100	>100%[a]
	Site Water	100	
	1%	96.0	
	10%	98.0	
	25%	98.0	
	50%	96.0	
	100%	98.0	
CB-DU03A	Control	98.0	>100%[a]
	Site Water	100.0	
	1%	96.0	
	10%	98.0	
	25%	96.0	
	50%	98.0	
	100%	98.0	
CB-DU04A	Control	100.0	>100%[a]
	Site Water	100.0	
	1%	100.0	
	10%	98.0	
	25%	96.0	
	50%	96.0	
	100%	90.0*	

Sample ID	Elutriate Treatment	Mean Survival (%)	LC_{50}
CB-DU05B	Control	100.0	>100%[a]
	Site Water	100.0	
	1%	98.0	
	10%	100.0	
	25%	98.0	
	50%	100.0	
	100%	100.0	
CB-DU06B	Control	98.0	>100%[a]
	Site Water	100.0	
	1%	98.0	
	10%	98.0	
	25%	96.0	
	50%	100.0	
	100%	94.0	
CB-DU07B	Control	94.0	>100%[a]
	Site Water	100.0	
	1%	98.0	
	10%	96.0	
	25%	98.0	
	50%	100.0	
	100%	100.0	
CB-DU08B	Control	98.0	>100%[a]
	Site Water	100.0	
	1%	98.0	
	10%	98.0	
	25%	96.0	
	50%	100.0	
	100%	100.0	
CB-DU09B	Control	96.0	>100%[a]
	Site Water	100.0	
	1%	98.0	
	10%	100.0	
	25%	96.0	
	50%	98.0	
	100%	98.0	
R-AM-H	Control	100.0	>100%[a]
	Site Water	100.0	
	1%	98.0	
	10%	100.0	
	50%	98.0	
	100%	96.0	

*The survival response at this test treatment was significantly less than the Lab Control response at $p < 0.05$.
a = Due to the absence of sufficient reductions in survival or development, the LC point estimate could not be calculated, but can be assumed to be >100% elutriate.

Table 6. Effects of Central Basin Sediment Elutriate on Menidia beryllina

Sample ID	Elutriate Treatment	Mean Survival (%)	LC_{50}
CB-DU01A	Control	100.0	>100% a
	Site	100.0	
	1%	100.0	
	10%	100.0	
	25%	100.0	
	50%	98.0	
	100%	100.0	
CB-DU02A	Control	98.0	>100% a
	Site	100.0	
	1%	100.0	
	10%	98.0	
	25%	94.0	
	50%	94.0	
	100%	100.0	
CB-DU03A	Control	100.0	>100% a
	Site	100.0	
	1%	100.0	
	10%	100.0	
	25%	98.0	
	50%	98.0	
	100%	96.0	
CB-DU04A	Control	100.0	>100% a
	Site	100.0	
	1%	100.0	
	10%	98.0	
	25%	96.0	
	50%	96.0	
	100%	90.0	
CB-DU05B	Control	100.0	>100% a
	Site	100.0	
	1%	98.0	
	10%	100.0	
	25%	98.0	
	50%	100.0	
	100%	100.0	
CB-DU06B	Control	100.0	>100% a
	Site	98.0	
	1%	100.0	
	10%	100.0	
	25%	100.0	
	50%	98.0	
	100%	100.0	
CB-DU07B	Control	100.0	>100% a
	Site	98.0	
	1%	96.0	
	10%	100.0	
	25%	100.0	
	50%	96.0	
	100%	100.0	

Sample ID	Elutriate Treatment	Mean Survival (%)	LC_{50}
CB-DU08B	Control	100.0	>100% a
	Site	100.0	
	1%	98.0	
	10%	98.0	
	25%	96.0	
	50%	100.0	
	100%	100.0	
CB-DU09B	Control	96.0	>100% a
	Site	98.0	
	1%	100.0	
	10%	98.0	
	25%	97.5	
	50%	100.0	
	100%	100.0	
R-AM-H	Control	100.0	>100% a
	Site	98.0	
	1%	100.0	
	10%	98.0	
	50%	100.0	
	100%	96.0	

a = Due to the absence of sufficient reductions in survival or development, the LC point estimate could not be calculated, but can be

The sediment elutriate toxicity test results for *Mytilus galloprovincialis* ranged from an EC_{50} of 35.4 (DU04A) to > 100% (DU05B, DU06B, DU07B, DU08B, and DU09B). There was ≥80.3% (>70% acceptability criterion) embryo survival and ≥97.5% normal development (>70% acceptability criterion), respectively, in the Lab Control treatments, indicating acceptable responses by the test organisms and meeting the QA/QC criteria for control acceptability results. The test results are summarized in Table 7.

Table 7. Effects of Central Basin Sediment Elutriate on Mytilus galloprovincialis

Sample ID	Concentration (%)	Mean Survival (%)	LC_{50}	Mean Normal Development (%)	EC_{50}
CB-DU01A	Control	90.3	58.5%	98.9	70.2%
	Site Water	84.7		99.5	
	1	88.3		98.8	
	10	83.7		98.9	
	25	79.8		99.5	
	50	85.8		98.1	
	100	0*		0*	
CB-DU02A	Control	91.4	61.6%	98.6	70.7%
	Site Water	84.7		99.5	
	1	88.0		99.2	
	10	85.2		98.6	
	25	84.5		99.3	
	50	83.4		99.1	
	100	0*		0*	
CB-DU03A	Control	84.3	63.4%	98.7	67.8%
	Site Water	84.7		99.5	
	1	87.0		97.7	
	10	88.0		98.8	
	25	85.4		98.8	
	50	74.1*		92.6*	
	100	0*		0*	
CB-DU04A	Control	80.3	35.0%	97.8	35.4%
	Site Water	84.7		99.5	
	1	88.4		98.1	
	10	88.6		99.0	
	25	84.8		98.7	
	50	0*		0*	
	100	0*		0*	
CB-DU05B	Control	87.8	>100% [a]	98.7	>100% [a]
	Site Water	84.7		99.5	
	1	87.0		98.9	
	10	87.5		99.0	
	25	86.6		99.3	
	50	87.4		99.5	
	100	82.8		100.0	
CB-DU06B	Control	91.2	>100% [a]	99.4	>100% [a]
	Site Water	82.9		95.9	
	1	86.9		99.1	
	10	92.5		99.2	
	25	85.1		99.0	
	50	88.3		99.0	
	100	84.5		98.7	

Sample ID	Concentration (%)	Mean Survival (%)	LC_{50}	Mean Normal Development (%)	EC_{50}
CB-DU07B	Control	87.6	>100% [a]	99.5	>100% [a]
	Site Water	82.9		95.9	
	1	87.2		99.6	
	10	88.5		98.8	
	25	90.8		99.5	
	50	76.5		99.3	
	100	88.4		99.3	
CB-DU08B	Control	88.4	>100% [a]	98.7	>100% [a]
	Site Water	82.9		95.9	
	1	83.9		98.7	
	10	89.9		99.4	
	25	84.1		99.5	
	50	90.8		99.3	
	100	88.6		96.7	
CB-DU09B	Control	88.6	>100% [a]	98.8	>100% [a]
	Site Water	82.9		95.9	
	1	88.5		99.8	
	10	88.8		99.4	
	25	91.4		99.3	
	50	87.2		99.1	
	100	89.9		99.8	
R-AM-H	Control	91.7	>100% [a]	97.5	>100% [a]
	Site Water	82.9		95.9	
	1	80.6		96.3	
	10	91.1		96.9	
	50	84.6		95.3	
	100	86.8		96.1	

*The survival response at this treatment was significantly less than the Lab Control response at $p < 0.05$.
a = Due to the absence of sufficient reductions in survival or development, the LC point estimate could not be calculated, but can be assumed to be >100% elutriate.

A placement site dilution model for the in-bay SF-11 was used to determine if the results of the water column bioassays would meet the water column LPC for ocean placement. This analysis is conservative because SF-11 is a much smaller site when compared to SF-DODS.

As per the ITM guidelines (USEPA et al. 2001), the median effects concentrations (EC50) values for the larval development bioassay were used to predict potential toxicity in the water column. The guidance stipulates that suspended solid concentration in the water column must not exceed 1% of the EC50 (in percent) outside the mixing zone. An EC50 value of 35.4% was reported for the *Mytilus galloprovincialis* larval development test for sample DU04A, which was the lowest among the Central Basin samples. From this result, the limiting permissible concentration (LPC) of 0.354% is the de facto water quality guideline concentration for the suspended solid concentration that must be met after dilution at the disposal site. Please note that this is also a conservative input because DU04A is no longer included in the project footprint.

The SF-11 placement site dilution model was used to simulate the initial mixing concentration of the suspended particulate phase during disposal. The model assumes that a typical barge is used for disposal (measuring 60 m x 25 m) and a receiving water dilution volume of 627,239 cubic meters based on the dimensions of the SF-11 disposal site. The results of the mixing model are presented in Table 8.

The predicted suspended solid concentration is 0.16%, which is less than the LPC of 0.354%. Under the simulated scenario, disposal of Central Basin sediments at SF-11 would not pose a toxicity risk in the water column.

Table 8. Mixing Model Results for Determining Potential Toxicity for Placement of Dredged Material at SF-11 In-Bay Placement Site

Site:	**Port of SF, Central Basin**
Species:	***M. galloprovinciallis***
Disposal Site:	**SF-11**
Mixing Zone Volume Calculation	
Depth of disposal site (m)=	15
Pi (constant)=	3.14159
Width of vessel (m)=	10
Length of vessel(m)=	25
Speed of vessel (m/s)=	0.5
Time of discharge (s)=	30
Depth of vessel (m)=	4
Mixing Zone Volume (m^3)=	627,239
Volume of Liquid Phase	
Bulk density (g/cc) =	1.3
Particle density (g/cc) =	2.6
Density of liquid phase (constant) =	1
Vol of disposal vessel (m^3)=	6,000
Liquid phase volume (m^3)=	4,875
Volume of suspended phase	
Silt (%) =	64.0
Clay (%) =	26.2
Volume of Suspended Phase (m^3)=	1,015
Projected Water Column Concentration (SP) =	0.16
Calculation of Water Column Concentration Guideline (percent SP)	
Lowest LC50 or EC50 from bioassay	35.4
LC50 or EC50 X 0.01=	0.354

6.0 BENTHIC DETERMINATIONS

6.1 Benthic Toxicity Evaluation

Whole sediment bioassays were conducted using two benthic species, *Ampleisca abdita* (amphipod) and *Neanthes arenaceodentata* (polychaete). The tests were conducted as static, non-renewal tests with 10 days of exposure to the whole sediments and overlying water and measured survival in channel sediment as compared to survival in the reference sediment. The test protocols are detailed in the SAP (NewFields 2015a) and the test results are listed in the "Port of San Francisco Central Basin Sediment Characterization Report," dated August 25, 2015 and revised September 29, 2015 (NewFields, 2015b). Results for whole sediment bioassays are summarized in Tables 9 and 10 below.

For *Ampleisca abdita, t*here was 100% survival in the Lab Control sediment (acceptability criterion: > 90%), indicating an acceptable survival response by the test organisms and meeting the QA/QC criterion. There was a slight, but statistically significant, reduction in survival in the CB-DU06B sediment. There were no significant reductions in survival in any of the remaining sediments. Results of reference toxicant toxicity tests indicated that these test organisms were responding to toxic stress in a typical fashion. All water quality parameters were within the recommended water quality conditions for the amphipod mortality bioassay.

The amphipod mortality bioassay mean survival results for *A. abdita* ranged from 90-100% and are summarized in Table 9. All of the results met the Limiting Permissible Concentration (LPC) criteria for the test. Therefore, none of the DU sediment composite samples demonstrated an acute toxic response in the amphipod *A. abdita.*

Table 9. Ampelisca abdita Survival in the Central Basin Sediments

Sediment Site	% Survival in Test Replicates					Mean % Survival	Significant Biological Effect: R-T ≥ 20%?	Statistically Less than Reference?	Exceeds LPC?
	Rep A	Rep B	Rep C	Rep D	Rep E				
Lab Control	100	100	100	100	100	100	-	-	-
R-AM-H	100	95	95	100	100	98	-	-	-
CB-DU01A	100	100	100	100	100	100	-2; No	No	No
CB-DU02A	100	100	100	100	100	100	-2; No	No	No
CB-DU03A	100	100	90	95	100	97	1; No	No	No
CB-DU04A	100	100	90	100	100	98	0; No	No	No
CB-DU05B	90	100	100	100	85	95	3; No	No	No
CB-DU06B	70	95	95	90	100	90*	8; No	No	No
CB-DU07B	100	100	90	95	100	97	1; No	No	No
CB-DU08B	100	100	90	100	100	98	0; No	No	No
CB-DU09B	95	100	90	100	100	97	1; No	No	No

*The survival response at this treatment was significantly less than the Lab Control response at $p < 0.05$.

For *Neanthes arenaceodentata*, there was 96% survival in the Lab Control sediment (acceptability criterion: > 90%), indicating an acceptable survival response by the test organisms and meeting the

QA/QC criterion. There were no significant reductions in survival in any of the site sediments. Results of reference toxicant toxicity tests indicated that these test organisms were responding to toxic stress in a typical fashion. All water quality parameters were within the recommended water quality conditions for the polychaete mortality bioassay.

The mean survival results for the *N. arenaceodentata* mortality bioassay ranged from 94 to 100% are summarized in Table 10. All of the results met the Limiting Permissible Concentration (LPC) criteria for the test. Therefore, none of the DU sediment composite samples demonstrated an acute toxic response in the polychaete *N. arenaceodentata*.

Table 10. Neanthes arenaceodentata Survival in the Central Basin Sediments

Sediment Site	% Survival in Test Replicates					Mean% Survival	Significant Biological Effect: R-T ≥ 20%?	Statistically Less than Reference?	Exceeds LPC?
	Rep A	Rep B	Rep C	Rep D	Rep E				
Lab Control	90	100	100	100	90	96			
R-AM-H	90	100	90	100	100	96			
CB-DU01A	100	100	90	100	100	98			
CB-DU02A	100	100	100	100	90	98			
CB-DU03A	100	100	100	100	100	100			
CB-DU04A	80	100	100	100	90	94			
CB-DU05B	100	100	90	100	100	98			
CB-DU06B	100	100	100	100	90	98			
CB-DU07B	100	100	100	100	100	100			
CB-DU08B	100	90	100	100	90	96			
CB-DU09B	90	100	100	90	100	96			

6.2 Benthic Bioaccumulation

Sediments from the Central Basin were evaluated in 28-day bioaccumulation studies with *Nereis virens* (polychaete) and *Macoma nasuta* (bivalve). The studies measured survival of the test organisms (Table 11) and the potential for bioaccumulation of contaminants in organism tissue as a result of exposure to Central Basin sediment samples. The bioaccumulation exposure protocols are detailed in the SAP (NewFields 2015a) and the test results are listed in the "Port of San Francisco Central Basin Sediment Characterization Report," dated August 25, 2015 and revised September 29, 2015 (NewFields, 2015b).

Each batch included five replicates from each of the nine sediment composite DUs, five replicates for the laboratory control treatment, and five replicates of the reference sediment collected from R-AM-H near SF-11. The mean percent survival for the control sediment was 98 percent for *M. nasuta* and 96 percent for *N. virens.* All test sediments for *M. nasuta* all exceeded 90 percent mean survival except for DU02A at 89 percent. All test sediments for *N. virens* equaled or exceeded 90 percent mean survival.

Table 11. Sediment Bioaccumulation Test Results with Macoma nasuta and Nereis virens

Sample ID	***Macoma nasuta***[1]		***Nereis virens***[2]	
	28-Day Mean Survival	**Standard Deviation**	**28-Day Mean Survival**	**Standard Deviation**
CB-Control	98%	2.7	96%	5.5
CB-DU01A	98%	2.7	92%	13.0
CB-DU02A	89%	4.2	96%	5.5
CB-DU03A	96%	4.2	100%	0.0
CB-DU04A	94%	4.2	92%	8.4
CB-DU05B	96%	4.2	96%	5.5
CB-DU06B	92%	7.6	96%	5.5
CB-DU07B	98%	2.7	94%	5.5
CB-DU08B	92%	4.5	98%	4.5
CB-DU09B	96%	4.2	90%	17.3
R-AM-H	94%	4.2	92%	13.0

Notes:
1. All treatments were initiated with 20 clams per replicate
2. All treatments were initiated with 10 polychaetes per replicate

6.3 Tissue Chemistry Analysis and Results

Following review of the bulk sediment data and completion of the 28-day bioaccumulation exposures, USACE-San Francisco District consulted with the DMMO agencies to determine the target constituents for tissue analysis. The DMMO requested that all of the Central Basin tissue samples be analyzed for PCB congeners due to exceedances of the in-Bay bioaccumulation threshold. PAH concentrations in sediment composites from DU05B and DU07B both exceeded the BT, however the DMMO only requested tissue analysis for DU05B. All tissue samples were also analyzed for percent lipids and total solids. In addition, a time-zero (T_0) sample considered representative of tissue concentrations prior to bioaccumulation testing was also submitted to the laboratory for analysis.

Detailed results of the tissue chemistry analysis are provided in the "Port of San Francisco Central Basin Sediment Characterization Report," dated August 25, 2015 and revised September 29, 2015 (NewFields, 2015b). The tissue chemistry results are included in Tables 12, 13, and 14.

Table 12. PCB Congeners Concentrations in Macoma Nasuta Bioaccumulation Tissue Samples

M. Nasuta	**T_0**	**Control**	**DU01A**	**DU02A**	**DU03A**	**DU04A**	**DU05B**	**DU06B**	**DU07B**	**DU08B**	**DU09B**	**R-AM-H**
Conventionals (%)												
Total Solids	12.6	12.2	11.8	11.8	11.2	12	11.3	11.6	12.3	11.7	11.8	11.3
Percent Lipids	0.488	0.485	0.488	0.473	0.449	0.526	0.414	0.421	0.572	0.366	0.462	0.43
Polychlorinated Biphenyls (µg/kg WW)												
PCB #8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #18	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #28	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #31	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #33	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #44	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #49	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #52	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #56	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #60	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #66	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #70	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #74	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #87	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #95	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #97	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #99	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #101	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #105	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #110	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #118	1 U	1 U	1 U	1 U	1 U	0.6 J	1 U	1 U	1 U	1 U	1 U	1 U
PCB #128	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #132	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #138	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.6 J	1 U
PCB #141	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #149	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 J	1 U
PCB #151	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #153	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #156	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

***M. Nasuta* Conventionals (%)**	**T_0**	**Control**	**DU01A**	**DU02A**	**DU03A**	**DU04A**	**DU05B**	**DU06B**	**DU07B**	**DU08B**	**DU09B**	**R-AM-H**
PCB #158	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #170	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #174	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #177	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #180	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #183	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #187	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #194	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #195	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #201	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #203	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total PCB*	1 U	1 U	1 U	1 U	1 U	0.6 J	1 U	1 U	1 U	1 U	1.1 J	1 U

Notes:
WW: wet weight
T_0: tissue preserved prior to bioaccumulation testing
* sum of detected 40 PCB compounds
J-detected below the method reporting limit but above the method detection
U-non-detect at the method detection

Table 13. PCB Congeners Concentrations in Nereis virens Bioaccumulation Tissue Samples

N. Virens	**T_0**	**Control**	**DU01A**	**DU02A**	**DU03A**	**DU04A**	**DU05B**	**DU06B**	**DU07B**	**DU08B**	**DU09B**	**R-AM-H**
Conventionals (%)												
Total Solids	16.2	14.6	14.8	14.8	13.2	13.5	12.8	14.2	14.6	13.9	14.4	14.5
Percent Lipids	1.35	1.18	1.23	1.21	1.1	1.02	1.01	1.16	1.12	1.12	1.17	1.24
Polychlorinated Biphenyls (µg/kg WW)												
PCB #8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #18	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #28	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #31	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #33	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #44	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #49	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #52	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #56	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #60	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #66	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #70	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #74	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #87	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #95	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #97	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #99	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #101	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #105	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #110	1 U	1 U	1 U	1 U	1 U	0.6 J	1 U	1 U	1 U	1 U	1 U	1 U
PCB #118	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #128	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #132	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #138	1.4	0.6 J	0.6 J	0.6 J	0.6 J	0.6 J	0.5 J	0.5 J	0.7 J	0.6 J	0.6 J	0.5 J
PCB #141	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #149	0.8 J	0.6 J	0.7 J	0.7 J	0.8 J	0.9 J	0.6 J	0.7 J	0.8 J	0.7 J	0.8 J	0.6 J
PCB #151	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #153	1.8	1.7	1.8	1.7	1.6	1.1	0.9 J	1.7	1.8	1.5	1.7	1.5
PCB #156	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

N. Virens **Conventionals (%)**	**T_0**	**Control**	**DU01A**	**DU02A**	**DU03A**	**DU04A**	**DU05B**	**DU06B**	**DU07B**	**DU08B**	**DU09B**	**R-AM-H**
PCB #158	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #170	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #174	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #177	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #180	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #183	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #187	0.9 J	0.7 J	0.7 J	0.7 J	0.7 J	0.8 J	0.7 J	0.7 J	0.7 J	0.9 J	0.8 J	0.7 J
PCB #194	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #195	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #201	0.6 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #203	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total PCB*	5.5	3.6	3.8	3.7	3.7	4	2.7	3.6	4	3.7	3.9	3.3

Table 14. PAHs Concentrations in Bioaccumulation Tissue Samples

	T_0	Control	DU05B	R-AM-H	T_0	Control	DU05B	R-AM-H
	Macoma nasuta				***Nereis virens***			
Conventionals (%)								
Total Solids	12.6	12.2	11.3	11.3	16.2	14.6	12.8	14.5
Percent Lipids	0.488	0.485	0.414	0.43	1.35	1.18	1.01	1.24
Polycyclic Aromatic Hydrocarbons (µg/kg WW)								
Naphthalene	5 U	5 U	5 U	5 U	3 J	4 J	5.5	3.5 J
2-Methylnaphthalene	5 U	5 U	5 U	5 U	5 U	5 U	4 J	5 U
1-Methylnaphthalene	5 U	5 U	5 U	5 U	5 U	5 U	3 J	5 U
Acenaphthylene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acenaphthene	5 U	5 U	5 U	5 U	5 U	5 U	4.5 J	5 U
Fluorene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Phenanthrene	5 U	5 U	11	5 U	5 U	5 U	2.5 J	5 U
Anthracene	5 U	5 U	3 J	5 U	5 U	5 U	5 U	5 U
Fluoranthene	3 J	4 J	11	3 J	3.5 J	5 U	2.5 J	5 U
Pyrene	5 U	4.5 J	22	3.5 J	3.5 J	5 U	4.5 J	5 U
Benzo(a)anthracene	5 U	5 U	3.5 J	5 U	5 U	5 U	5 U	5 U
Chrysene	5 U	5 U	4 J	5 U	5 U	5 U	5 U	5 U
Benzo(b)fluoranthene	5 U	5 U	3.5 J	5 U	5 U	5 U	5 U	5 U
Benzo(k)fluoranthene	5 U	5 U	1.5 J	5 U	5 U	5 U	5 U	5 U
Benzo(a)pyrene	5 U	5 U	4 J	5 U	5 U	5 U	5 U	5 U
Indeno(1,2,3-cd)pyrene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibenz(a,h)anthracene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(g,h,i)perylene	5 U	5 U	4.5 J	5 U	5 U	5 U	5 U	5 U
Perylene	5 U	5 U	3 J	5 U	48	5 U	5 U	5 U
Biphenyl	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,6-Dimethylnaphthalene	5 U	5 U	5 U	5 U	4.5 J	4 J	5.5	5 U
1-Methylphenanthrene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(e)pyrene	5 U	5 U	3.5 J	5 U	5 U	5 U	5 U	5 U
2,3,5-Trimethylnaphthalene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibenzothiophene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Total Benzofluoranthenes	9.9 U	10 U	6.6 J	10 U	10 U	10 U	10 U	10 U
Total PAH*	3 J	8.5 J	76.1 J	6.5 J	62.5	8 J	32	3.5 J

Notes:
WW: wet weight

T_0: tissue preserved prior to bioaccumulation testing

* sum of detected 25 PAH compounds

J-detected below the method reporting limit but above the method detection

U-non-detect at the method detection

6.3.1 Comparison of Tissue Concentrations to Federal Action Levels

Concentrations in Tables 12 through 14 were compared to FDA and USEPA human health guidelines. There is no FDA action level for PAH, but a concentration of 6,000 µg/kg for total PAHs is the USEPA limit considered to present risk to consumers of fish and shellfish (USEPA 2000). All DU05B total PAHs concentrations were 76.1J or 32 µg/kg, well below the USEPA consumer risk threshold. There is no FDA action level for total PCBs, but there is a tolerance level of 2,000 µg/kg. All Central Basin tissue concentrations were below this level.

The USEPA screening value for total PCBs for recreational fishers is 20 µg/kg. Total PCB concentrations in Tables 12 and 13 ranged from 2.7 to 4 µg/kg in *Nereis virens* and 0.6J to 1.1J in *Macoma nasuta*, which are below these USEPA threshold for recreational fishers. The USEPA screening value for subsistence fishers is 2.45 µg/kg. All *M. nasuta* tissues were below this value. *N. virens* tissues exceeded this value due to elevated concentrations in the organisms prior to testing (T0). The T0 concentration of total PCBs in *N. virens* was 5.5 µg/kg. However, *N.* virens should not be evaluated for human health risks as it is not a species targeted for consumption.

6.3.2 Comparison to SF-DODS Reference Database

The USEPA tracks tissue chemistry results from bioaccumulation testing conducted on sediments from the SF-DODS reference area (http://www.epa.gov/region09/water/dredging/sfdods/index.html). The reference area for SF-DODS is located approximately 20 nautical miles from the disposal site and is considered representative of natural background conditions.

Multiple rounds of bioaccumulation testing have been conducted on *M. nasuta* exposed to SF-DODS reference area sediments. Similarly, multiple rounds of testing have been conducted on polychaetes. However, only one round of testing was conducted using *N. virens* while the remainder of the polychaete tests were conducted using *Nephtys sp*. Bioaccumulation testing results from the SF-DODS reference area included the full suite of contaminants of concern including PCBs and PAH. The PAH list from the SF-DODS reference site only includes the 16 EPA priority compounds instead of the full 25 compounds analyzed as part of the Central Basin testing. Similarly, only PCB Aroclors were analyzed in the SF-DODS reference tissues while PCB congers were analyzed in the Central Basin composites. Total PCBs calculated from congener data are typically higher than that from Aroclor data.

Table 15 presents the sums of PCBs, low molecular weight PAH (LPAH), high molecular weight PAH (HPAH), and priority pollutant total PAH from Central Basin alongside the range of concentrations from the SF-DODS reference testing. *M. nasuta* PAH concentrations from DU05B exceeded the maximum from SF-DODS, but were generally within a factor of two. Total PCBs from Central Basin were within the range of concentrations from the SF-DODS reference site.

The LPAH concentration in *N. virens* tissue from Central Basin testing was 12.5 µg/kg, slightly higher than the SF-DODS reference maximum of 11 µg/kg. Both HPAH and total PAHs from Central Basin were within the SF-DODS concentration range (Table 15). Total PCB concentrations in the *N. virens* composites from Central Basin ranged from 2.7 to 4.0 µg/kg compared to non-detects in the reference tissues. As mentioned above, the T_0 *N. virens* tissue had higher concentrations PCBs prior to exposure to Central Basin sediments.

Comparison to the SF-DODS reference data indicates that bioaccumulation may have occurred for some of the PAH compounds in the tissues from DU05B. The next step is an evaluation of the bioavailability and bioaccumulation potential using the bioaccumulation factor (BAF)/biota sediment accumulation factor (BSAF) values.

Table 15. Comparison of Central Basin and SF-DODS Bioaccumulation Tissue Burdens

Analyte	DU05B	Central Basin Range	SF-DODS Reference Range
M. nasuta **(µg/kg WW)**			
Total LPAH	14 J	--	ND - 10
Total HPAH	54 J	--	ND - 26
Total PAH[1]	68 J	--	ND - 33
Total PCBs[2]	--	ND - 1.1	ND - 4.2
N. virens **(µg/kg WW)[3]**			
Total LPAH	12.5 J	--	4 - 11
Total HPAH	7 J	--	17 - 25
Total PAH[1]	19.5 J	--	21 - 36
Total PCBs[2]	--	2.7 - 4.0	ND

Notes:
ND= Non-detect
PAH = Polycyclic Aromatic Hydrocarbon
PCB = Polychlorinated biphenyl
L/H = low/high molecular weight
1. total PAH is the sum of the 16 USEPA priority pollutants
2. total PCBs is the sum of congeners for Central Basin and sum of Aroclors for SF-DODS
3. N. virens tissues were only tested in one batch.

The BAF and BSAF values represent the extent of a contaminant's uptake into tissue relative to the source sediment, and can be representative of both bioavailability and/or bioaccumulation. Bioavailability is the extent that an organism is exposed to a contaminant, while bioaccumulation is the buildup of a contaminant in an organism. Or more simply, bioavailability is the amount available for partitioning from sediment to an organism's tissue, while bioaccumulation results when a significant amount remains in the tissue.

Most PAH compounds have high octanol water partitioning coefficients (Kow), meaning they bind to organic carbon in sediments, or lipids in organisms. Depending on the type and amount of organic carbon, PAH may preferentially bind to sediment and not freely transfer to tissue (Ghosh et al. 2003). Such a scenario would limit the bioavailability of PAH. Similarly, bioaccumulation of PAH is dependent on a variety of factors. Vertebrates are capable of metabolizing PAHs which minimizes the bioaccumulation potential (Varanasi and Usha 1989). By contrast, invertebrates do not metabolize PAH to the same extent (Varanasi and Usha 1989). Therefore, the test species used in this evaluation are good indicators of bioaccumulation potential.

A BAF value is the ratio of tissue concentrations to sediment concentrations. The units for both concentrations are the same, resulting in a unitless value. The BSAF is the ratio of the lipid normalized tissue concentration over the TOC normalized sediment concentration. The magnitude of the BAF/BSAF value provides some indication of the bioavailability and/or bioaccumulation potential. A high BAF/BSAF indicates concentrations are greater in tissue than sediment and suggests that the contaminant is available for uptake from the sediment and may accumulate in higher trophic levels. A low BAF/BSAF indicates that either the contaminant is not available for uptake, or that it does not bioaccumulate.

Table 3-17 lists the BAF and BSAF values from bioaccumulation testing at DU05B and the SF-DODS reference site. Values were calculated for LPAH, HPAH, and total PAH. No TOC or lipids data were available for the SF-DODS reference samples so no BSAF value could be calculated. There were no extreme values in percent TOC or lipids at DU05B. As a result the BAF and BSAF values for DU05B are similar. The BAF values from DU05B are consistently lower than those at SF-DODS for both species. These numbers demonstrate that PAH at DU05B are minimally bioavailable and the bioaccumulation potential from these sediments is low.

Table 16. BAF and BSAF Values for Central Basin and SF-DODS Reference Sediment and Tissue Samples

Analyte	DU05B		SF-DODS Reference
	BAF	BSAF	BAF
***M. nasuta*[1]**			
LPAH	0.00070	0.0011	0.098
HPAH	0.0014	0.0021	0.31
Total PAH	0.0012	0.0018	0.20
***N. virens*[2]**			
LPAH	0.00063	0.00039	3.7
HPAH	0.00018	0.00011	1.5
Total PAH	0.00033	0.00021	2.1

Notes:
PAH = Polycyclic Aromatic Hydrocarbon
L/H = low/high molecular weight
BAF = Bioaccumulation Factor
BSAF = Biota sediment accumulation factor
1. SF-DODS reference BAF calculated from the average concentration in tissue divided by the average concentration in sediment. Maximum values were used for sediments.
2. SF-DODS reference BAF calculated from the one reported batch of *N. virens* testing.

6.3.3 Comparison of Tissue Concentrations to Tissue Residue Effects Data

While it was demonstrated in the previous section that the bioavailability and bioaccumulation potential from DU05B was minimal, the magnitude of sediment PAH concentrations in this sample resulted in *M. nasuta* concentrations approximately twice the maximum present in SF- DODS reference site tissues. These concentrations are compared to literature toxicity reference values (TRV) to demonstrate the measured tissue burdens from Central Basin are below levels of ecological concern.

Common sources of tissue effects data include:

- The USACE Environmental Residue Effects Database (ERED) http://el.erdc.usace.army.mil/ered/index.cfm
- Jarvinen and Ankley (1999)

The most common endpoint used to evaluate tissue effects was the lowest observed effects dose (LOED). If the LOED was not presented an approximation was made using an uncertainty factor (USACHPPM 2000; Leidos 2014). The most conservative values were selected for comparison to Central Basin tissues. Effects thresholds presented in Table 17 were available for *Nereis sp.* and *Mytilus edulis* as a surrogate for *M. nasuta*. TRVs were only available for select PAH compounds. None of the PAH compounds from the DU05B tissue samples (Table 14) exceeded the TRVs, indicating that risks to benthic invertebrates at the concentrations observed in bioaccumulation testing are minimal.

Table 17. Summary of Tissue Reference Values used to Evaluate Ecological Impacts

Species Name	Analyte	TRV (µg/kg ww)	Effect Class	Toxicity Measure	Species Life Stage
Mytilus edulis	Acenaphthene	1,470	Behavior	ED50	Adult
Mytilus edulis	Benzo(a)pyrene	300	Reproduction	LOED	N/A
Mytilus edulis	Fluoranthene	220	Reproduction	LOED	N/A
Mytilus edulis	Pyrene	9,450	Behavior	EC50	Adult
Nereis arenaceodentata	Phenanthrene	780	Behavior/ Growth/ Reproduction	LOED	Immature

Source: Leidos 2014
Notes:
ED50 = Effects dose
LOED = Lowest observed effects dose
TRV = Tissue reference value. All TRVs are LOEDs. ED50 values were converted to LOED using an uncertainty factor of 20.

6.3.4 Tissue Chemistry Conclusions

Concentrations of PAH accumulated by *N. virens* samples were within the range of SF-DODS reference values. PCB concentrations in *N. virens* were detected at low concentrations, compared to non-detects in the reference data. However, the PCB concentrations from the tissue composites were lower than the T_0 sample, indicating that PCBs were already present in the organisms and concentrations were reduced during their exposure period to Central Basin sediments.

Concentrations of PCBs in *M. nasuta* were nearly all non-detects with detected concentrations for three congeners below the MRL. Concentrations of PAH in *M. nasuta* were elevated above the SF-DODS reference concentrations by a factor of two. BAF/BSAF values were calculated to evaluate the possible extent of uptake or bioaccumulation. The BAF values for *M. nasuta* were orders of magnitude lower than those from the reference site indicating little uptake of PAH. Tissue results from DU05B were also compared to literature TRVs to determine if there could be toxic effects at the reported concentrations. DU05B were less than the literature values for each PAH compound evaluated.

Overall, the bioavailability of PAH and PCBs from Central Basin sediments was low, and concentrations that did accumulate in tissues during the testing period were of similar magnitude to reference data and below literature toxicity thresholds.

7.0 MPRSA SECTION 103 OCEAN DISPOSAL CRITERIA COMPLIANCE EVALUTION

Applications and authorizations for Dredged Material Permits under Section 103 of the MPRSA for the transportation of dredged material for the purpose of dumping it in ocean waters will be evaluated by the U.S. Army Corps of Engineers in accordance with the criteria set forth in part 227 and processed in accordance with 33 CFR 209.120 with special attention to §209.120(g)(17) and 33 CFR 209.145.

7.1 Compliance with 40 C.F.R. § 227 Subpart B – Environmental Impact

The following criteria were evaluated to determine that the proposed dredged material placement would not degrade the marine environment, and that the dredged material placement would not produce an unacceptable adverse effect on human health or on the ocean for other future uses.

1) The material to be dredged from the project area does not contain any of the prohibited materials listed in 40 C.F.R. § 227.5 including radioactive waste, material used in radiological, chemical or biological warfare, or persistent inert synthetic or natural materials that may float and thus interfere with legitimate uses of the ocean. In addition, the material has been sufficiently described to make this determination.
2) The material does not contain any of the constituents prohibited as other than trace contaminants listed in 40 C.F.R. § 227.6 including organohalogen compounds, mercury and mercury compounds, cadmium and cadmium compounds, oil, or known carcinogens, mutagens, or teratogens.
3) The material to be placed in SF-DODS is composed of naturally occurring sediment to be dredged from waters of the U.S. and does not meet the definition of waste materials listed in 40 C.F.R. § 227.7.
4) The material does not contain toxic waste as regulated under 40 C.F.R. § 227.8.
5) Although large quantities of dredged material are proposed for placement at SF-DODS, the site was designated with these quantities in mind and was located in an area and sized such that unacceptable impacts would not occur as described in 40 C.F.R. § 227.9.
6) The designation of SF-DODS took into account possible hazards to fishing, navigation, shorelines, and beaches. The material proposed for placement at the SF-DODS will be placed in such a manner as to not result in adverse impacts to the listed resources and as not to interfere with coastal navigation as described in 40 C.F.R. § 227.10.
7) The material proposed for placement at the SF-DODS is not required to be containerized as described in 40 C.F.R. § 227.11.
8) The dredged material does not contain any inert synthetic or natural material that may float or remain in suspension. Dredged material is natural sediment dredged from the waterways of the U.S. and is not considered to be solid waste as described in 40 C.F.R. § 227.12.

The materials to be dredged from the Central Basin dredge footprint were not considered to meet the exclusionary criteria (please see Section 2.0 of this document). Appropriate testing has been performed and is described in earlier sections of this MPRSA Section 103 Evaluation. The material has been determined to be in compliance with the requirements of 40 CFR § 227.6 and there would be no violation of marine water quality criteria after the allowance for mixing. Bioassays on the suspended particulate phase (elutriate) and solid phase (whole sediment bioassay) show that the material can be discharged so as not to exceed the LPC described in 40 CFR § 227.27(b).

7.2 Compliance with 40 C.F.R. § 227 Subpart C – Need for Ocean Placement

Subpart C states the basis on which an evaluation will be made of the need for ocean dumping, and alternatives to ocean dumping. The results of the evaluation of the following factors contribute to the determination of the need for dumping:

1) Degree of treatment useful and feasible for the waste to be dumped, and whether or not the waste material has been or will be treated to this degree before dumping;
    - The material proposed to be dredged at Central Basin is not a waste. The material meets acceptance criteria for various placement sites in and around San Francisco Bay including SF-DODS, MWRP foundation material, and partially (roughly 26%) SF-11. Therefore, the material does not require treatment prior to placement.
2) Raw materials and manufacturing or other processes resulting in the waste, and whether or not these materials or processes are essential to the provision of the applicant's goods or services, or if other less polluting materials or processes could be used;
    - The material proposed to be dredged at Central Basin is not a waste and is the result of natural sedimentation processes within San Francisco Bay.
3) The relative environmental risks, impact, and cost for ocean dumping as opposed to other feasible alternatives including but not limited to: land fill, well injection, incineration, storage, spread of material over open ground, recycling of material for reuse, additional biological, chemical, or physical treatment of intermediate or final waste streams, and irreversible or irretrievable consequences of the use of alternatives to ocean dumping.
    - Any alternatives that required double handling (e.g. stockpiling or temporary storage) of the dredged material were not considered because these alternatives are known to be substantially more expensive than placing the material at available placement sites in and around San Francisco Bay.
    - Treatment of the material is not required as explained above.
    - The primary irreversible or irretrievable consequences of the use of alternatives to ocean dumping, in this case placement at MWRP, would be an increase in air quality emissions and loss of sediment from the San Francisco Bay system. The current air quality analysis was done for placement at SF-DODS. The Region of influence for placement at SF-DODS includes the route from Central Basin to the California Baseline (10 nautical miles) then the route from the California Baseline to SF-DODS that is within Regulated California Waters (24 nautical miles) for a total transit route of 34 nautical miles one-way. The transit route from Central Basin to MWRP is 52 nautical miles all within the Region of Influence. Because the route to MWRP is longer and is completely within San Francisco Bay, emissions of NOX and particulate matter from tug boats in transit to MWRP affecting the San Francisco Bay region would be greater than the emissions in transit to SF-DODS that would affect the San Francisco Bay region. However, emissions at either site would not exceed the *de minimis* thresholds included in the General Conformity regulations (40 C.F.R. § 93.153).

7.2.1 Practicability Considerations

The act of dredging is not specifically regulated under the MPRSA; however, the placement process (i.e., the transportation of dredged material for the purpose of dumping it into ocean waters) is regulated. According to 40 CFR §227 Subpart C, "Waste treatment, improvements in processes, and alternative methods of disposal are practicable when they are available at reasonable incremental cost and energy expenditures, which need not be competitive with the costs of ocean dumping, taking into account the environmental benefits derived from such activity, including the relative adverse environmental impacts associated with the use of alternatives to ocean dumping."

7.2.2 Federal Spending Limit under the Continuing Authorities Program

One of the practicability considerations in this MPRSA Section 103 evaluation is the Federal spending limit for project implementation as a part of the Continuing Authorities Program.

This study is being conducted under the authority of Section 107 of the River and Harbor Act of 1960 (Pub. L. No. 86-645, 33 U.S.C. § 577), as amended, which authorizes the Corps to study, adopt, construct and maintain navigation improvement projects without additional project specific congressional legislation, using the same procedures and policies that apply to projects authorized by Congress. Section 107 of the 1960 River and Harbor Act is one of the ten legislative authorities under which the Corps is authorized to plan, design, and construct certain types of water resources projects that are of limited scope and complexity, without additional and specific congressional authorization. These authorities are called the Continuing Authorities Program (CAP) when referred to as a group.

Under CAP, the Federal share of initial implementation costs (including all feasibility study, design, and construction costs) for any one project may not exceed $10 million in accordance with current cost limits authorized by Section 1030 of the Water Resources Reform and Development Act (WRRDA) of 2014 (Pub. L. No. 113-121 [128 Stat. 1193]). WRRDA 2014 was signed into law June 13, 2014 and implementation guidance was issued December 3, 2014 (USACE, 2014a).

Section 101 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. § 2211), specifies the cost-sharing requirements applicable to this project. The non-Federal Sponsor is responsible for 25 percent of the initial implementation (or construction) costs.

Therefore, the construction cost of any one alternative may not exceed $10,000,000 total at a maximum, neglecting to account for feasibility costs that would lower the upper threshold to below $10,000,000. During the plan formulation and screening process, any of the 16 alternatives included in the initial array of alternatives were screened out if they exceeded the $10 million limit and are not considered practicable as a CAP project due to cost. Please refer to Table 18 below and Section 4.5 of the Draft DPR and Integrated EA for a more detailed discussion of the screening process. Bolded alternatives in Table 18 (Alternatives 1, 4, and 6) and the No Action alternative were carried forward to the final array of alternatives evaluated in the Draft DPR and Integrated EA in accordance with the National Environmental Policy Act.

7.2.3 Sediment Suitability and Cost Analysis for Approved Placement Sites

Given the results of the sediment suitability determination for the Proposed Project, USACE conducted a detailed comparison of the cost of placing the Central Basin material at MWRP as foundation material, SF-DODS, and SF-11. The study indicated that dredging Central Basin to 32 feet MLLW plus two feet of allowable overdepth and placing all of the material at SF-DODS is the plan with the highest benefit to cost ratio and therefore is the Proposed Action and the National Economic Development Plan (NED). Additionally, placing all of the material at SF-DODS to any of the three considered project depths in the study always proved to be the least cost alternative.

The USACE Engineer Regulations (ER 1105-2-100) requires that the preferred alternative be the plan that maximizes net National Economic Development (NED) benefits and is consistent with environmental statutes, as set forth in the National Economic Development Plan for new work projects (USACE, 2000). As noted in Section 5.2 of the Draft DPR and Integrated EA, the benefit to cost ratio (BCR) for the the NED Plan/Proposed Action (Alternative 6) is 2.8, which is beyond the BCRs for Alternatives 1 and 4 at 2.5 and 2.4, respectively. Upland beneficial reuse would normally be cost-prohibitive for a project of this size—especially for material that is not suitable for cover.

Recognizing these factors, Alternatives 5, 10, and 15 are included in the initial array of alternatives and the detailed cost comparison. These alternatives are:

- Alternative 5 – 30 ft MLLW foot depth + Non-structural measures (lightering and use of favorable tides) + SF-DODS (72% of material), SF-11 (27% of material), and MWRP foundation (1% of material) placement
- Alternative 10 – 32 ft MLLW foot depth + Non-structural measures (lightering and use of favorable tides) + SF-DODS (69% of material), SF-11 (27% of material), and MWRP foundation (4% of material) placement
- Alternative 15 – 35 ft MLLW foot depth + Non-structural measures (lightering and use of favorable tides) + SF-DODS (67% of material), SF-11 (26% of material), and MWRP foundation (7% of material) placement

These alternatives set the following factors as fixed to determine the amount of foundation material that can be placed at MWRP and still be cost competitive with the NED Plan or the all SF-DODS placement alternative for the same project depth:

- The total cost of Alternative 5 must not exceed the NED Plan at $8.9 million.
- The maximum amount of material suitable for in-Bay placement will be placed at SF-11 (27 percent of the total amount of Central Basin material) to offset the cost of placing foundation material at MWRP.

The results of the cost comparison show that only 7-10 percent of the material can be placed as foundation material at MWRP, while 26-27 percent of material would be placed at SF-11 and 64-66 percent of material would be placed at SF-DODS in order to compete with the all SF-DODS, least cost alternatives for each project depth. Please see Table 18 below for the cost comparison and volume breakdown for all of the alternatives included in the initial array. Please note that Table 18 only accounts for the volumes to the project depth plus one foot of paid overdepth, and does not take into account the additional foot of unpaid overdepth in its volume calculations. Please refer to Section 4.5 of the Draft DPR and Integrated EA for a more detailed discussion.

Please note that Table 18 below does not include any alternatives that propose placement at SF-11 in combination with placement at SF-DODS only. The full volume for in-Bay placement specified in the San Francisco Bay Regional Water Quality Control Board's (SFRWQCB) Order No. R2-2015-0023 is currently allocated to USACE's existing O&M dredging projects. Given the limits on in-Bay placement of dredged materials listed in SFRWQCB's Order No. R2-2015-0023 and the San Francisco Bay Basin Water Quality Control Plan, any alternatives that propose placement at SF-11 in combination with placement at SF-DODS only were not retained in the final array in order to maintain in-Bay placement capacity for USACE O&M dredging projects.

Given the increased cost of beneficial re-use of foundation material and the aforementioned fiscal constraints, alternatives that include placement at MWRP are not available at reasonable incremental cost and energy expenditures. Therefore, Alternative 4 and other alternatives that include placement at MWRP are not considered practicable with respect to cost for the initial project implementation.

Table 18. Array of Alternatives Cost Comparison

<table>
<tr><th>Alt #</th><th>Depth (feet MLLW)</th><th>Dredge Placement Site(s)</th><th>Quantity (CY)</th><th>% Total Dredged Material</th><th>Total Project Cost</th><th>Benefit to Cost Ratio</th></tr>
<tr><td>1</td><td>30 ft</td><td>SF-DODS</td><td>162,070</td><td>100</td><td>$7,811,000</td><td>1.42</td></tr>
<tr><td>2</td><td>30 ft</td><td>Montezuma</td><td>162,070</td><td>100%</td><td>$11,786,000</td><td>1.32</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">30 ft</td><td>Montezuma</td><td>117,660</td><td>73%</td><td rowspan="2">$9,742,000</td><td rowspan="2">1.37</td></tr>
<tr><td>SF-11</td><td>44,410</td><td>27%</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">30 ft</td><td>SF-DODS</td><td>106,750</td><td>66%</td><td rowspan="3">$7,811,000</td><td rowspan="3">1.42</td></tr>
<tr><td>Montezuma</td><td>10,910</td><td>7%</td></tr>
<tr><td>SF-11</td><td>44,410</td><td>27%</td></tr>
<tr><td>6</td><td>32-feet</td><td>SF-DODS</td><td>212,120</td><td>100%</td><td>$8,971,000</td><td>1.65</td></tr>
<tr><td>7</td><td>32-feet</td><td>Montezuma</td><td>212,120</td><td>100%</td><td>$14,444,000</td><td>1.49</td></tr>
<tr><td rowspan="2">9</td><td rowspan="2">32-feet</td><td>Montezuma</td><td>155,300</td><td>73%</td><td rowspan="2">$11,819,000</td><td rowspan="2">1.56</td></tr>
<tr><td>SF-11</td><td>56,820</td><td>27%</td></tr>
<tr><td rowspan="3">10</td><td rowspan="3">32-feet</td><td>SF-DODS</td><td>137,490</td><td>65%</td><td rowspan="3">$8,971,000</td><td rowspan="3">1.65</td></tr>
<tr><td>Montezuma</td><td>17,810</td><td>8%</td></tr>
<tr><td>SF-11</td><td>56,820</td><td>27%</td></tr>
<tr><td>11</td><td>35-feet</td><td>SF-DODS</td><td>296,200</td><td>100%</td><td>$10,992,000</td><td>1.47</td></tr>
<tr><td>12</td><td>35-feet</td><td>Montezuma</td><td>296,200</td><td>100%</td><td>$18,912,000</td><td>1.29</td></tr>
<tr><td rowspan="2">14</td><td rowspan="2">35-feet</td><td>Montezuma</td><td>219,520</td><td>74%</td><td rowspan="2">$15,383,000</td><td rowspan="2">1.37</td></tr>
<tr><td>SF-11</td><td>76,660</td><td>26%</td></tr>
<tr><td rowspan="3">15</td><td rowspan="3">35-feet</td><td>SF-DODS</td><td>190,470</td><td>64%</td><td rowspan="3">$10,992,000</td><td rowspan="3">1.47</td></tr>
<tr><td>Montezuma</td><td>29,050</td><td>10%</td></tr>
<tr><td>SF-11</td><td>76,660</td><td>26%</td></tr>
</table>

7.3 Compliance with 40 C.F.R. § 227 Subpart D – Impact of the Proposed Dumping on Aesthetic, Recreational, and Economic Values

The following factors have been considered in making the determination that the proposed placement at SF-DODS will not impact aesthetic, recreational, or economic values of the Pacific Ocean in the vicinity of SFDODS:

1) The San Francisco Deep Ocean Disposal Site (SF-DODS) is the deepest ocean dredged material disposal site in the United States. It is located off the Continental Shelf in approximately 8,200 to 9,800 feet (2,500 to 3,000 meters) of water, approximately 55 nautical miles offshore of San Francisco (Figure 1). The area has been used in the past for the placement of dredged material and has not resulted in negative impacts to potential recreational or commercial activities.
2) Based on past use of the area and the characteristics of the material proposed for placement, no impact to water quality is to be expected. The material will be discharged from bottom dump scows with the initial point of discharge being approximately 14 ft below the surface of the water. Based on results of the STFATE model, no applicable water quality standards will be violated by the proposed activity.
3) The material proposed for discharge contains substantial quantities of silt and clay. The point of initial discharge is below the surface of the water and because the material is somewhat consolidated, the majority of the material will be entrained into the disposal surge, which is in a downward direction because of gravity. Studies indicate that any turbidity caused by placement is restricted to the immediate vicinity of the dump scow and persists for only a short period of time.
4) Pathogenic organisms are not expected to be present in the material. However, if present they would likely be fecal coliforms that are killed by saline waters and therefore would not pose any impact to fisheries.
5) No toxic chemical constituents are present in the dredged material in concentrations suspected of affecting humans either directly or indirectly through the food chain. There are no constituents in the dredged material that would impact living marine resources of any value.

7.4 Compliance with 40 C.F.R. § 227 Subpart E – Impact of the Proposed Dumping on Other Uses of the Ocean

The proposed placement of dredged material at SF-DODS would have no long-term impact on any other uses of the ocean including, but not limited to, commercial and recreational fishing, commercial and recreational navigation, mineral exploration or development, or scientific research. Short-term impacts may occur because of the presence of the tugs and scows in the SF-DODS.

8.0 MPRSA SECTION 103 CONDITIONS

8.1 Requirements to Meet Ocean Disposal Criteria

The DMMO determined that the sediment from each Central dredging unit is suitable for placement at SF-DODS in a memorandum for the record dated April 28, 2016. No other special requirements have been designated.

8.2 Requirements of Site Designation conditions and the Site Monitoring and Management Plan (SMMP)

Site users are responsible for a volume-based *pro rata* share of annual site monitoring costs. The USACE will contribute to the share of annual site monitoring costs for the placement of material at SF-DODS in 2017.

All material placed at SF-DODS will be in accordance with the site conditions and requirements for SF-DODS listed in 40 C.F.R. § 228 and those provided by the USEPA. Prior to the start of dredging, USEPA provides standard conditions such as those listed below (USEPA, 2016a):

1) ***Prohibition on Leaking or Spilling During Transport:*** Dredged material shall not be leaked or spilled from disposal vessels during transit to the SF-DODS. Transportation of dredged material to the SF-DODS shall only be allowed when weather and sea state conditions will not interfere with safe transportation and will not create risk of spillage, leak or other loss of dredged material during transit. Disposal vessels must not be loaded beyond a level at which dredged material would be expected to be spilled in transit under anticipated sea state conditions, and in no case may disposal vessels be filled to more than 80 percent of the vessel's maximum bin or hopper volume. No disposal vessel trips shall be initiated when the National Weather Service has issued a gale warning for local waters during the time period necessary to complete dumping operations, or when wave heights are 16 feet or greater.
2) ***Prohibition on Trash and Debris; use of Grizzly:*** Only dredged material determined in advance by USEPA to be suitable for ocean disposal may be discharged at SF-DODS. Uncharacterized dredged material, vessels, trash, and other debris are prohibited from being discharged at the site. In order to exclude large trash and debris (including rocks) from being disposed at the site, before transport to SF-DODS all dredged material must be placed into scows through a steel mesh or chain "grizzly" with openings of no more than 12 inches by 12 inches. Material retained on the grizzly must be removed and disposed of separately. The USEPA may on a case-by-case basis waive the requirement to use a grizzly if they determine that trash and debris is unlikely to be present in the area to be dredged.
3) ***Independent Inspector, and Scow Certification Checklist:*** Before any disposal vessel departs for the SF-DODS, a quality control inspector must certify in writing that the vessel is not over-loaded, and otherwise meets the conditions and requirements of a Scow Certification Checklist that contains all of the substantive elements found in the example contained in the most current SMMP Implementation Manual. The USEPA and USACE must approve the proposed Scow Certification Checklist prior to the commencement of ocean disposal operations. No ocean disposal trip may be initiated until both the towing vessel captain and the inspector have signed

all relevant entries on the Scow Certification Checklist. The inspector shall provide a summary of any discrepancies or inaccuracies on the Checklist in the permittee's report to USEPA for the relevant month (see condition 10, below).

4) ***Farallon Islands Exclusion Zone:*** Disposal vessels in transit to and from the SF-DODS must remain at least three nautical miles from the Farallon Islands whenever possible. Closer approaches should occur only where the designated vessel traffic lane encroaches within 3 miles of the islands. In no case should disposal vessels leave the designated vessel traffic lane while within 3 miles of the islands, or transit north of a line extending westward from the termination of the designated vessel traffic lane while within 3 miles of the islands.
5) ***Surface Disposal Zone (SDZ):*** When dredged material is discharged within the SF-DODS, no portion of the vessel from which the materials are released (e.g. towed barge) may be further than 1,960 feet (600 meters) from the center of the disposal site at latitude 37°39'N; longitude 123°29'W. No more than one disposal vessel may be present within the SF-DODS SDZ at any time.
6) ***Disposal Vessel Instrumentation and Tracking:*** The primary tracking system for recording ocean disposal operations shall be disposal vessel- (e.g., scow-) based. Each disposal vessel shall have a primary navigation/tracking system functioning for each disposal trip, calibrated for accuracy at a minimum at the beginning of each ocean disposal project, that automatically and continually indicates and records the following information throughout transportation to, disposal at, and return from SF-DODS:
   a. position of the disposal vessel;
   b. speed and heading of the disposal vessel;
   c. fore and aft draft of the disposal vessel (sensors as near vessel centerline as possible);
   d. fore and aft bin height (top of dredged material load in the bin or hopper) (sensors as near vessel centerline as possible);
   e. time and location of each disposal event (e.g., the discharge phase).

   This system must record these data at 1-minute interval while outside the SF-DODS disposal site boundary, and at a 15-second interval while inside the SF-DODS disposal site boundary and the SDZ. The primary system must also include a real-time display, located in the wheelhouse or otherwise visible to the helmsman, showing the position of the disposal vessel relative to the boundaries of SF-DODS and its SDZ, superimposed on the appropriate NOS chart so that the operator can confirm proper position of the disposal vessel within the SDZ before discharging the dredged material.
7) ***Posting Disposal Vessel Tracking Data on the Internet:*** Within 24 hours of the completion of each disposal trip, data recorded from the primary disposal tracking system must be posted by a third party contractor to a World Wide Web (Internet) site accessible by EPA Region 9, the San Francisco District USACE, and NOAA's Gulf of the Farallones National Marine Sanctuary. The Web site must be searchable by disposal trip number and date, and at a minimum for each disposal trip it must provide a visual display of: the disposal vessel transit route to SF-DODS; the beginning and ending locations of the disposal event; and the disposal vessel draft and load level in the bin throughout the transit. The requirement for posting this information on the Web is

independent from the hard-copy reporting requirements listed in Special Conditions 10 and 12, below.

8) ***E-Mail Alerts:*** The third-party system must also generate and distribute "e-mail alerts" regarding any degree of apparent dumping outside the Surface Disposal Zone of SF-DODS ("mis-dumping"), and regarding any apparent substantial leakage/spillage or other loss of material en route to SF-DODS. Substantial leakage/spillage or other loss shall be defined as an apparent loss of draft of one foot or more between the time that the disposal vessel begins the trip to SF-DODS and the time of actual disposal. E-mail alerts for any disposal trip must be sent within 24 hours of the end of that trip to EPA Region 9, the San Francisco District USACE, the relevant National Marine Sanctuary if the event triggering the alert occurred in whole or in part within a Sanctuary boundary, and to other addressees as may be indicated by EPA or USACE on a project-specific basis.
9) ***Back-up Navigation System:*** A functioning back-up navigation system, meeting the minimum accuracy requirement listed above, must also be in place on the towing vessel (tug, if any). If the primary (disposal vessel's) navigation tracking system fails during transit, the disposal trip may continue only so long as the back-up (towing vessel's) navigation and tracking system remains operational, by placing the towing vessel in such a location that, given the compass heading and tow cable length to the scow ("lay back"), the estimated scow position would be within the Surface Disposal Zone [i.e., within 1,960 feet (600 meters) of the center of the disposal site]. In such cases the towing vessel's position, and the tow cable length and compass heading to the disposal vessel at the time of discharge, must be recorded and reported. Further disposal operations using a disposal vessel whose navigation tracking system fails must cease until the primary disposal tracking system's capabilities are restored.
10) ***Record-Keeping, and Monthly Reporting:*** In addition to the requirement in Special Condition 7, above, for posting data on the Web, the permittee shall maintain daily records (including using the approved Scow Certification Checklist) of: the amount of material dredged and loaded into barges for disposal; the location from which the material in each barge was dredged; the weather report for and sea-state conditions anticipated during the transit period; the time that each disposal vessel departs for, arrives at and returns from the SF-DODS; the exact location and time of each disposal; and the volume of material disposed at the SF-DODS during each disposal trip. The permittee shall also maintain, for each ocean disposal trip, both electronic data and printouts from the GPS-based primary disposal tracking system (or the backup navigation tracking system when appropriate) showing transit routes, disposal vessel draft readings, disposal coordinates, and the time and position of the disposal vessel when dumping was commenced and completed. These daily records shall be compiled at a minimum for each month during which ocean disposal operations occur, and provided in reports, certified accurate by the independent quality control inspector, to both EPA and USACE. For each ocean disposal trip, these reports shall include the electronic tracking and disposal vessel draft data on CD-ROM (or other media approved by USEPA and USACE), as well as hard copy reproductions of the Scow Certification Checklists and printouts listed above. The monthly reports shall include a cover letter describing any problems complying with the Ocean Disposal Special Conditions, the

cause(s) of the problems, any steps taken to rectify the problems, and whether the problems occurred on subsequent disposal trips.

11) ***24-Hour Notification Requirement for Potential Leaks or Mis-Dumps:*** The permittee shall report any anticipated, potential, or actual variances from compliance with these Ocean Disposal Special Conditions, and any additional project-specific Special Conditions, to the District Engineer and the Regional Administrator within 24 hours of discovering such a situation. If any of these compliance problems occur within the boundaries of a National Marine Sanctuary, the permittee must also report any such situation to the relevant Sanctuary office within 24 hours. A message from an operational "e-mail alert" system, as described in Special Condition 8 above, will be considered as fulfilling this 24-hour notification requirement. In addition, the permittee shall prepare and submit a detailed report of any such compliance problems on a weekly basis by noon Monday, to the District Engineer and the Regional Administrator. These reports shall describe the cause(s) of the problems, any steps taken to rectify the problems, and whether the problems occurred on subsequent disposal trips.
12) ***Project Completion Report:*** Within 60 days following the completion of ocean disposal operations, the permittee shall submit to the District Engineer and Regional Administrator a completion letter summarizing the total number of disposal trips and the overall volume (bin as well as *in-situ*) of material disposed at SF-DODS for the project, and whether any of this dredged material was excavated from outside the areas authorized for ocean disposal or was dredged deeper than authorized by the permit.
13) ***Restriction on disposal timing:*** All ocean disposal operations, including transport to and discharge at SF-DODS, must cease by midnight of November 30, 2016. No ocean disposal operations are authorized beginning December 1, 2016.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay Delta Fish and Wildlife Office
650 Capitol Mall 8th floor 8-300
Sacramento, California 95814

In Reply Refer to:
08-FBDT00-
2017-CPA-0001

DEC 21 2016

Thomas Kendall
Chief of Planning
U.S. Army Corps of Engineers
San Francisco District
1455 Market Street
San Francisco, California 94103-1398

Dear Sir:

Please find enclosed our draft Fish and Wildlife Coordination Act report for the U.S. Army Corps of Engineers' proposed Pier 70: Central Basin CAP 107 Navigation Improvement Project for your review and comment. We request that you provide comments by December 21, 2016 so we may expedite preparation of a final report.

If you have questions on this draft report, please contact Steven Schoenberg of my staff at (916) 930-5672, or at Steven_Schoenberg@fws.gov.

Sincerely,

Kaylee Allen
Field Supervisor

Enclosure

cc:
Joseph Terry, Sacramento Fish and Wildlife Office, Sacramento, California
Roxanne Grillo, San Francisco Corps of Engineers, San Francisco, California
Becky Ota, California Department of Fish and Wildlife, Belmont, California

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

DRAFT FISH AND WILDLIFE COORDINATION ACT REPORT FOR THE PIER 70: CENTRAL BASIN CAP 107 NAVIGATION PROJECT

PREPARED BY:

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PREPARED FOR:

U.S. Army Corps of Engineers
San Francisco District
San Francisco, California

December 2016

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SUMMARY

The Corps of Engineers' preferred alternative for the Pier 70: Central Basin CAP 107 Navigation Project involves deepening of a 19.4 acre area north of Pier 4 and Drydock #2 to 32 feet below Mean Lower Low Water, to improve and maintain safe access for large ships. These ships are brought to these and adjacent facilities for repair, including emergency repair work. All of the dredged material produced from this project would be disposed in the open ocean at a previously designated and approved site, the San Francisco Deep Ocean Disposal Site (SF-DODS). Non-structural measures, involving lightering, light loading, and use of favorable tides would be continued as needed. Construction of the project would improve navigation safety of all ships using the facilities, and facilitate the transport and repair of ships while reducing the risk or minimizing the consequences of spills from such vessels. Accordingly, the U.S. Fish and Wildlife Service recommends that the project be constructed as proposed. We recommend that suitable material from future maintenance dredging be considered for maximum beneficial re-use in wetland restoration.

INTRODUCTION

This document represents the United States Fish and Wildlife Service's (Service) draft Fish and Wildlife Coordination Act (FWCA) report on the U.S. Army Corps of Engineers' (Corps) Pier 70: Central Basin CAP 107 Navigation Project (project). Located on the west side of south San Francisco Bay at Potrero Point, Pier 70, with associated Pier 4, Drydock #2, and the adjacent yard, comprise an important facility which services vessels using heavily trafficked Ports in the area, including the Ports of Oakland, Sacramento, Stockton, San Francisco, and Redwood City. The project involves dredging and dredged material disposal or re-use measures to improve safe access to the pier and its facilities for ship repair. Drydock #2 is the second largest lift floating drydock in the western Americas and is the only facility with high capacity shoreside power necessary to service the largest cruise ships and military ships. Not only does this facility handle a high volume of large ships in the region, but it is also capable of responding to emergencies such as mechanical failures and leaking ships, including large oil tankers which offload to local refineries. It is also the only such facility in the region which can handle post-Panamax vessels, with comparable facilities at least 500 nautical miles away north or south.

The use of the Pier 70 facilities is limited by the depth of Central Basin, a 19.4 acre open water area just north of the pier, which is used by ships and tugboats to line up ships and maneuver into the docks or piers. Central Basin experiences significant shoaling which limits the size of boats and times of day that the facilities can be accessed. It has been sporadically dredged four times over the last 30 years, most recently in 2011 to 30 feet (ft) below Mean Lower Low Water (MLLW). The basin continues to shoal and now has depths of -16 to -32 ft MLLW, which excludes many deeper draft vessel types, both commercial vessels and government vessels in particular which are not permitted to use tide as a consideration when accessing a dock (i.e., naval Coast Guard and Military Sealift Command).

Because Pier 70 has not previously been a Federal project, there has not been prior involvement by the Service under the FWCA. The primary information considered in this report was provided by the Corps and includes a series of internal draft documents, as follows: the September 2016 Detailed Project Report and Integrated Environmental Assessment (Corps and HydroPlan 2016), a May 2016 powerpoint and June 2016 report synopsis for a revised Tentative Selected Plan (TSP) milestone phase of planning for the project, a revised sediment characterization report and associated technical memoranda (NewFields 2015 a-c), other Corps-provided information on the dredging footprint, dredging history, and physical setting, and a powerpoint on the prior TSP which preceded additional sediment sampling analysis.

DREDGING ALTERNATIVES

The Corps retained 3 alternatives (Alt) for evaluation, in addition to the no-action alternative: Alt 1- deepening to -30 ft MLLW and disposal of all dredged material at SF-DODS; Alt 4 - deepening to -30 ft MLLW and a combination of in-bay disposal at SF-11 (27%) and placement at Montezuma Wetlands (73%); Alt 6 (the TSP, or preferred alternative) - deepening to -32 ft MLLW and disposal of all dredged material at SF-DODS. The TSP was selected on the basis of a superior combination of criteria which differed between alternatives. These criteria include effectiveness to meet the project objectives, benefit-to-cost ratio, and environmental quality/acceptability. Other alternative configurations were screened out without detailed evaluation due to exceeding the cost of the $10 million Continuing Authorities Program (CAP) limit on Federal contribution, not meeting the Corps' National Economic Development (NED) "least costly" planning criterion, or exceeding limits on in-bay disposal capacity.

DREDGED MATERIAL PLACEMENT ALTERNATIVES

The three options for dredged material placement considered in the alternatives retained for evaluation are: a designated deep ocean disposal site (SF-DODS); a designated in-bay disposal site near Alcatraz Island (SF-11); and a permitted beneficial reuse site about 60 miles east of Central Basin that uses dredged material to raise elevations of a subsided site to create tidal wetlands (Montezuma Wetlands Restoration Project). These sites vary in capacity, cost, and material suitability criteria for acceptance. Other locations or options (Ravenswood, Eden Landing, Alviso Ponds, Bay Farm Borrow Pit, Cullinan Ranch, in-bay passive transport) were also considered but screened out for various reasons, either they were cost prohibitive, they were not yet permitted, the sediment samples from Central Basin exceeded acceptability criteria for these sites, or they were conceptual ideas not yet available for near term application.

Deep Ocean Disposal (SF-DODS): This is a permitted open ocean disposal site located about 50 miles west of the Golden Gate and 60 miles from Central Basin. It was designated by the U.S. Environmental Protection Agency in 1994 and can receive up to 4.8 mcy/year of dredged material. It is a nondispersive site about 8 square miles in bottom area with a 600-meter surface disposal location at its center. There are restrictions in terms of weather, transit route, and scow load, to minimize environmental impacts. The dredging method would be by clamshell and transport by bottom dump scow filled 80%. The SF-DODS would receive all of the dredged material from the proposed project under the preferred alternative.

Montezuma Wetlands: This site is a privately owned, permitted, and operational wetland restoration project site located on about 2,400 acres of moderately subsided, diked baylands at the eastern edge of Suisun Marsh. Dredged material from various projects is transported by scow and used here to raise elevations of the site so it can be opened up to tidal action to restore tidal marshlands. The owner charges for receipt of this material. The site is designed in four phases. The first phase has about 1 mcy of remaining capacity and the second phase has 4.5 mcy of additional capacity. It can accept both wetland cover and non-cover quality materials. It is roughly 60 miles from Central Basin. Material would be dredged by clamshell and transported by scow to an offloader, which would pump the material onto the site. All offloading and pump facilities are currently in place.

In-bay disposal (SF-11): This site is a location (1,000 ft radius circle at the surface) about 0.3 mile south of Alcatraz Island in Central San Francisco Bay, in waters about 40-70 ft deep. It is a dispersive site, subject to annual and monthly limits and goals established by the Regional Water Quality Control Board, and managed by Long Term Management Strategy program managers. It is about 6 miles from Central Basin.

PROPOSED PROJECT

In order to increase access to Pier 70 for a range of vessel sizes, reduce costs and transit delays, and improve safety during entry, the Corps proposes to construct the TSP (Alt 6). Under this alternative, Central Basin would be dredged as needed to a minimum of -32 ft MLLW with 2 ft of overdepth. This will involve removal of about 237,700 cubic yards of dredged material. The dredging footprint is 19.4 acres. The proposed location for placement of this dredged material is the designated ocean disposal site about 50 miles west of the Golden Gate known as SF-DODS. The project assumes continued use of the non-structural measures of lightering, light loading, and use of favorable tides, as needed. The project would take about 1.4 months of continuous work to complete, using a mechanical clamshell dredge, bottom-dumping scows, and tugboats. This work would be done in 2017 in the environmental work window for in-bay dredging from June 1 to November 30. After completion, maintenance dredging and disposal is planned on a 4 year cycle. Locations of the dredging, SF-DODS, and other alternative dredged material placement sites evaluated, are shown in Figure 1.

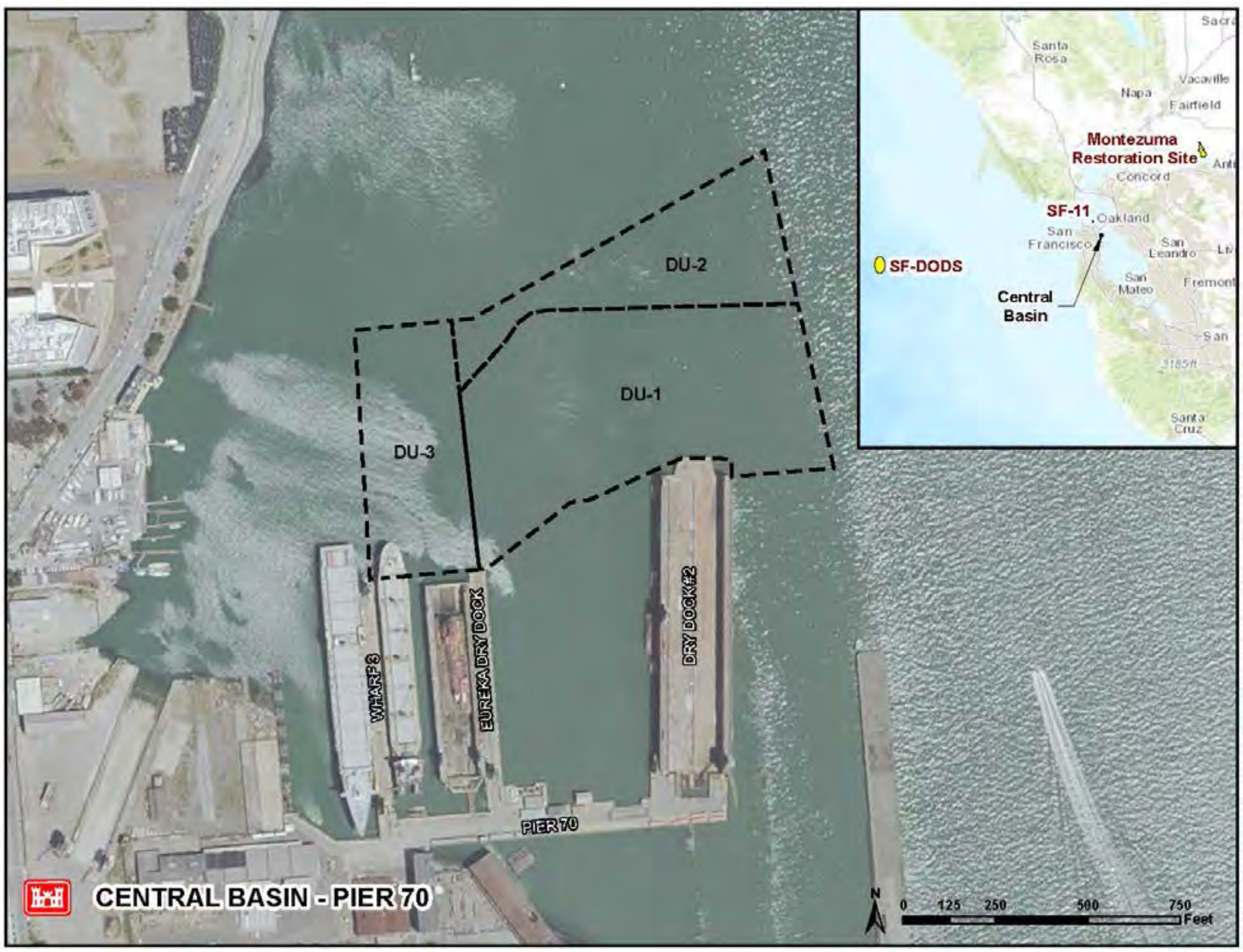

Figure 1. Location of the dredging footprint, the SF-DODS, and alternative dredged material placement sites evaluated for the Central Basin CAP 107 Navigation Improvement Project.

BIOLOGICAL RESOURCES

Dredging Location (Central Basin): Central Basin is 20-40 ft deep, and there is no eelgrass known in close proximity. We did not research specific studies for this location. However, the typical benthic community would include marine worms, amphipods, mollusks, and crustaceans, both native and non-native species. The pelagic waters would also have marine zooplankton dominated by calanoid copepods, phytoplankton, and fish species. Recreational species such as halibut, sturgeon, striped bass, and leopard shark, could occur in this location. Other smaller forage species would also be expected, with shiner and surf perch more abundant, as well as bay goby, white croaker, speckled sanddab and, seasonally, Pacific herring, which lay eggs on various natural (vegetation) or constructed submerged surfaces (including piers and jetties) present on bay margins and shallow waters.

SF-DODS: The resources of this disposal site have been discussed in detail in environmental documentation for the designation (USEPA 1993). It is 8,200 to 9,850 ft deep. The water column exhibits typical marine phytoplankton assemblages that vary with season. The benthic community includes a diverse assemblage of mostly polychaete worms and crustacean species, and a relatively low number of sea floor fish species. Various marine mammals occur in the area such as whales, dolphins, and porpoises.

Montezuma Wetlands: This site is diked, subsided up to 11 ft, and was formerly characterized as grazing land with some bare areas and wetlands in the form of ditches, saline basins, and seasonally flooded areas (Levine-Fricke 1995). Currently, phase I of the Montezuma Wetlands project is still in development and receiving dredged materials. The status of the rest of the site not yet in development is presumed to remain as predominantly upland vegetation. Within these uplands, seasonally flooded areas probably receive some winter use by wading birds and waterfowl during periods of high precipitation and extreme tides. Otherwise, the primary wildlife use of the area would be by common upland species.

SF-11(in-bay near Alcatraz Island): The 40-70 ft depth would qualify this site as deep bay habitat. Its regular use as a disposal area results in relatively fine grained surface sediment materials. The depth and location of this site would be expected to support occurrence of anadromous salmonid fish like steelhead and chinook salmon, free swimming invertebrates such as California bay shrimp, and brown rockfish, as well as halibut, sturgeon, bat ray, and marine mammals such as the Pacific harbor seal. Diving birds associated with deep water habitat like SF-11 include surf scoter, scaups, brown pelican, and terns. The frequent disposal events at this site would be expected to result in a reduced abundance of benthic invertebrate fauna and, possibly, somewhat elevated contaminant levels compared to elsewhere. Bathymetry of SF-11 is regularly mapped to monitor the extent of mounding, which can be a navigation hazard.

Listed species: There are a variety of special status species that could occur within the action area of the proposed project, but some are more likely in the disposal alternatives that are not part of the TSP. Green sturgeon, steelhead, coho salmon, chinook salmon, and longfin smelt can occur in open waters throughout the bay, including Central Basin and SF-11. Delta smelt, the salt marsh harvest mouse, and California least tern, have been confirmed to be present at

Montezuma Wetlands. Various species of listed sea turtles and whales are known, or could potentially transit through, open ocean waters at SF-DODS.

RESOURCE CATEGORIES AND MITIGATION GOALS

The Service's Mitigation Policy (Policy) (FR 46:15 January 23, 1981) provides general guidance in making recommendations to conserve fish and wildlife resources. Under the Policy, resources are assigned to one of four Resource Categories, with a mitigation goal consistent with the values provided to fish and wildlife and the rarity of that habitat (cover-type). A mitigation goal is assigned ranging from "no loss of existing habitat value" (Resource Category 1) for the most valuable kinds of habitat to "minimize loss of habitat value" (Resource Category 4) for the less valuable and most common kinds of habitat. Application of the Policy involves designating cover-types which may be affected and assigning evaluation species based on the sensitivity of those species to the project action, their role in the ecosystem, or association with Service-wide resource management issues such as conservation of anadromous fish and migratory birds. We then state the Resource Category, the rationale for that selection, and the corresponding mitigation goal.

For this project area, we have designated six basic cover-types within the project area and adjacent areas affected by the project. Due to differences in water depth and/or salinity in tidal and non-tidal ponds, there may be several more specific habitats within these cover-types, as noted below.

Open water (bay): This cover type is considered those waters within San Francisco Bay which are permanently inundated, deeper than MLLW and usually more than -18 ft MLLW. Areas affected by the project include the portions of Central Basin to be dredged, SF-11, and any sediment offloading facilities constructed in deep waters. Pelagic plankton, fish, and macroinvertebrates reside in these waters and are prey organisms for larger recreational fish, some seabirds and waterfowl. An appropriate evaluation species would be juvenile fishes. Such open waters are relatively abundant in the planning area and are not expected to be lost or permanently degraded by the proposed action. They are designated Resource Category 4, with a mitigation planning goal to minimize loss of habitat value.

Subtidal benthic (bay): This cover type includes permanently inundated, unvegetated bottom substrate deeper than MLLW, such as the portions of Central Basin to be dredged, the pipeline relocations, and any sediment offloading facilities constructed in deep waters. This cover type supports food organisms like shrimp, benthic fish, and other macroinvertebrates. Bottom dwelling fishes such as sturgeon, flatfishes such as juvenile halibut, and rays, would be appropriate evaluation species. Most such habitat affected by the proposed project is already regularly dredged. This cover type is also relatively abundant. Due to this abundance, regular disturbance, and medium value to the evaluation species, it is designated Resource Category 4, with a mitigation planning goal to minimize loss of habitat value.

Deep water column (ocean): This cover type is represented by ocean waters greater than 50 ft deep and occurs in the SF-DODS. Mesopelagic fish such as deep-sea smelt are selected as the evaluation species due to their abundance and moderate importance as food items of recreationally significant species such as rockfish. Due to the high abundance of this cover type and modest value, it is designated Resource Category 4, with a mitigation planning goal to minimize loss of habitat value.

Deep water benthos (ocean): This type of cover is the ocean bottom located at the SF-DODS. It exhibits a relatively low fish density and low biomass of epifauna. These areas are abundant and shown by monitoring to recover quickly from effects of dredged material disposal. This habitat is designated Resource Category 4, with a mitigation planning goal to minimize loss of habitat value.

Tidal emergent marsh: This cover-type includes areas which are vegetated, generally between Mean Higher High and Mean Low Water that are subject to unrestricted tidal inundation. For this project, it includes areas which could become vegetated in the future through placement of dredged material and exposure to tidal action at Montezuma Wetlands. Species composition varies with salinity and elevation with respect to mean tide level. It provides habitat for resident mammals including the listed salt marsh harvest mouse, tidal marsh birds, macroinvertebrates, and juvenile fishes. Marshes also produce and export organic matter that supports the food web throughout estuaries and bays. Evaluation species would be a marsh specialist like the marsh wren. Most historical tidal marsh in the Bay proper has been lost due to industrial salt production or coastal development and fill, while initial losses in the delta were caused by diking and conversion to agriculture. Due to this regional scarcity, importance to the ecosystem, and very high value to the evaluation species, we designate tidal emergent marsh as Resource Category 2, with a goal of no net loss of in-kind habitat value.

Upland: Upland in the project area occurs mostly as non-native annual grassland habitat on dike slopes surrounding the Montezuma Wetlands placement site. Limited portions could be temporarily affected by construction of offloading facilities or pipelines needed to deliver dredged material. Larger areas of upland on Montezuma Wetlands would be disturbed, then later restored to tidal wetlands. Upland supports common small mammals and passerine birds, many of which are non-native. The uplands at Montezuma Wetlands also contain some seasonal wetlands, where the listed California least tern has been documented foraging since 2005. A native species like the California vole would be an appropriate evaluation species. A modest area of upland adjacent to tidal emergent marsh does have value as roosting habitat for birds during high tides, and as refugium for the listed salt marsh harvest mouse during tidal flood events. Considering both the regional abundance as well as the importance of preserving some uplands near tidal habitats, we designate upland as Resource Category 4, with a mitigation goal to minimize loss of habitat value.

FUTURE WITHOUT THE PROJECT

Based on the last five bathymetric surveys, Central Basin has a mean depth of -27.3 ft MLLW in the proposed dredging footprint, with broad areas less than -20 ft MLLW and as shallow as -14.3 ft MLLW. It will continue to shoal over time, at a rate which will vary with the wetness of hydrologic conditions. Assuming mean shoaling rates, the lessee and Port have estimated that the shipyard, including Pier 70, would not be viable after 2021, when the mean depth of Central Basin reaches -24.8 ft MLLW. At this time, access would be limited to smaller vessels and the shipyard would not have enough volume to sustain the repair business. Therefore without the project, the shipyard would close around 2022-2026. Closure of the shipyard would most likely terminate maintenance dredging. Central Basin is in a relatively sheltered part of the bay, so that in the absence of dredging, there would be an estimated 10 ft decrease in depth over the next 20 years. By 2026, mean depths in Central Basin would approach -17 ft MLLW. This lack of maintenance dredging would avoid temporary disturbance of the benthic biotic community and local water column that would otherwise have occurred with maintenance dredging.

Vessels using Central Basin and operations to repair them there introduce small amounts of chemical contaminants which accumulate in the sediments. Such effects would be lessened without the project, although local inputs from urban and industrial runoff other than the shipyard would remain. Similarly, environmental quality at the preferred, ocean disposal site might be slightly higher without the project as well, because of less disturbance associated with the reduced frequency and volume of dredged material disposal derived from Central Basin. To the extent that available dredged material is limiting and this material is suitable for wetland restoration, that benefit would not occur without the project, due to closure of the shipyard.

With Pier 70 closed, ships could still be repaired but would have to travel to much more distant ports elsewhere on the west coast. This would include damaged and/or leaking ships. There may be other forms of local response to limit spills and perhaps effect limited repair, but they would not be comparable to that achievable with Pier 70 and its shipyard. The need to travel to other locations in a damaged state may pose an increased risk of further spillage and disablement along routes to other ports on the west coast or elsewhere, which could lead to environmental impact. In sum, without the project, there would be less vessel traffic in the immediate area, but a regional increase in the risk of environmental impact due to the inability to promptly respond to and repair damaged or disabled vessels.

FUTURE WITH THE PROJECT

With the project, shipping traffic would continue, with a likely increase in volume in terms of the number and variety of ships, but a reduction in transit time per visit due to the increased depth window. With Central Basin deepened, average annual shoaling rates would increase from 31,500 to 42,000 cy, or about 0.3 ft per year. Maintenance dredging on a four-year cycle would be planned and would cause modest, temporary disturbance of the benthic and water column biotic communities, and continued deposition of any contaminants associated with the ships, shipyard, urban runoff, or other local sources. These maintenance dredging episodes would likely be on the order of 1 month in duration. There are a variety of ways that biotic resources may be adversely affected by the disturbance of dredging and dredged material disposal, and the associated increase in turbidity. These mechanisms include temporary reduction in visibility, clogging of gills, burial, reduced foraging, removal of forage organisms in the substrate, displacement of mobile organisms such as fish and marine mammals to other locations, and a possibility of direct mortality through mechanical injury. These effects apply to all aquatic organisms, including fishes, invertebrates, and mammals, including any listed species which may be present.

Depending on cost, dredged material characteristics, and placement site availability, maintenance dredged material may be employed for beneficial re-use in tidal wetland restoration, or otherwise will be disposed in-bay at SF-11 or at the SF-DODS. There would be incremental benefits from beneficial reuse at tidal restoration sites, and modest impacts at SF-11 or SF-DODS within limits of the permitted uses.

DISCUSSION

For the purpose of this report, we have limited our discussion to the no-project and Corps-preferred -32 ft MLLW deepening alternative, with disposal at the SF-DODS. We recommend the Corps proceed with construction of the preferred project. The deepening will restore and sustain vital ship repair services in the region for a full range of ship sizes. This will improve regional ability to respond to emergencies and repair leaking or disabled vessels that would otherwise pose a risk to environmental resources.

Evaluation of the suitability of dredged material for use at the alternative placement sites was done by chemical analysis, biological testing, and bioaccumulation tissues, using composite samples from 9 locations, or dredging units (DUs), within Central Basin (NewFields 2015). This involved initial and supplemental testing and, on April 28, 2016, final determinations by the Dredged Materials Management Office (DMMO). The final determinations were based on the analyses as well as the professional judgment of the DMMO. According to these final determinations, all nine DUs are suitable for unconfined aquatic disposal at SF-DODS, or as foundation material (non-cover) at Montezuma Wetlands. Two DUs are suitable for unconfined aquatic disposal in-bay at SF-11 or as cover material at Montezuma Wetlands. Based on our review of the results of sediment sampling, we have no objection to the proposed disposal of all material from the initial deepening at the SF-DODS. We recommend that future dredged material derived from maintenance of this project be considered for beneficial re-use in tidal restorations to the maximum extent practicable, and to the extent deemed suitable, such as at Eden Landing, Cullinan Ranch, Montezuma Wetlands, Alviso Ponds, or other reuse sites.

Construction of the project within the June 1 - November 30 dredging window is intended to avoid and minimize impacts to listed salmon, steelhead, and sturgeon. Any other necessary measures would be determined through formal consultation with National Marine Fisheries Service and U.S. Fish and Wildlife Service, if appropriate.

CONCLUSION

The proposed Pier 70: Central Basin CAP 107 Navigation Improvement Project will have localized temporary effects on fish and wildlife resources in and near the open bay water and subtidal benthic habitat of the dredging footprint. The project will maintain the viability of the shipyard and improve its capacity to repair ships, including damaged or leaking vessels, with increased safety of maneuvering. This is expected to reduce the risk and effect of oil and chemical spills over the long term, which would benefit resources in the region. Accordingly, we recommend the Corps implement the preferred alternative as proposed, and consider future use of maintenance-generated dredged material for beneficial re-use.

RECOMMENDATIONS

We recommend that the Corps:

1. Implement the project as proposed (deepening to -32 ft MLLW, disposal at SF-DODS).

2. For dredged material generated by maintenance dredging in the future, conduct sufficient analyses to determine its suitability, and maximally use that material beneficially for tidal marsh restoration at available sites.

3. Evaluate effects of the project on listed species, initiate consultation as appropriate with the Service and National Marine Fisheries Service, and implement any additional measures determined by such consultation to be needed to minimize or offset any effects.

REFERENCES

Corps and Hydroplan [U.S. Army Corps of Engineers and HydroPlan LLC]. 2016. Draft Detailed Project Report and Integrated Environmental Assessment. Pier 70: Central Basin CAP 107 Navigation Improvement Project. Prepared by, U.S. Army Corps of Engineers, San Francisco District, and HydroPlan LLC. September 2016. Contract No. W912P7-11-D-004; Task Order No. Contract No. W912P7-11-D-004-0008. September 2016. Internal draft report. 175 pp.

Levine-Fricke. 1995. Montezuma Wetlands Project. Ecological resources mitigation and restoration plan. Submitted to U.S. Army Corps of Engineers, Regulatory Branch, in support of a permit application under Public Notice 19405E26. Emeryville, California. August 10, 1995. 75 pp + figures and appendices.

NewFields. 2015a. Port of San Francisco Central Basin Sediment Characterization Report - Revised. Prepared by NewFields, Edmonds, Washington, for Port of San Francisco, San Francisco, California. September 29 2015. 74 pp. + appendices.

_____. 2015b. Technical Memorandum. Subject: Central Basin Supplemental Sampling and Analysis. Prepared by NewFields, Edmonds, Washington. October 13, 2015. 5 pp.

_____. 2015c. Technical Memorandum. Subject: Central Basin Supplemental Sampling and Analysis Results. Prepared by NewFields, Edmonds, Washington. December 14, 2015. 6 pp.

USEPA [U.S. Environmental Protection Agency]. 1993. Final Environmental Impact Statement (EIS) for designation of a deep water ocean dredged material disposal site off San Francisco, California. August 1993. Environmental Protection Agency Region 9. San Francisco, California.

From:	Grillo, Roxanne L CIV USARMY CESPN (US)
To:	Grillo, Roxanne L CIV USARMY CESPN (US)
Subject:	FW: CEQA determination for Central Basin and PPA
Date:	Friday, March 03, 2017 7:06:02 PM

From: Dunham, Daley (PRT) [mailto:daley.dunham@sfport.com]
Sent: Tuesday, November 29, 2016 12:16 PM
To: Grillo, Roxanne L CIV USARMY CESPN (US) <Roxanne.Grillo@usace.army.mil>
Subject: [EXTERNAL] CEQA determination for Central Basin and PPA

See below.

From: Navarrete, Joy (CPC)
Sent: Tuesday, November 29, 2016 11:49 AM
To: Dunham, Daley (PRT)
Subject: RE: Draft Project Partnership Agreement Submittal - Pier 70 Central Basin Continuing Authorities Program Section 107 Navigation Improvement Project

Hi Daley-
I've reviewed all the materials for the proposed Project Partnership Agreement and determined that the project is Categorically Exempt from CEQA pursuant to Section 15304(g) "Maintenance dredging where the spoil is deposited in a spoil area authorized by all applicable state and federal regulatory agencies."

Let me know if you need anything further.

Thanks,
Joy

Joy Navarrete, Senior Environmental Planner
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103
P. 415-575-9040 F. 415-558-6409
Blockedwww.sfplanning.org

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
FEDERAL BUILDING, 2800 COTTAGE WAY, ROOM W-2605
SACRAMENTO, CA 95825
PHONE: (916)414-6600 FAX: (916)414-6713

Consultation Code: 08ESMF00-2015-SLI-0891 July 17, 2015
Event Code: 08ESMF00-2015-E-02799
Project Name: Pier 70: Central Basin CAP 107 Navigation Improvement Project

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, under the jurisdiction of the U.S. Fish and Wildlife Service (Service) that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the Service under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Please follow the link below to see if your proposed project has the potential to affect other species or their habitats under the jurisdiction of the National Marine Fisheries Service:

http://www.nwr.noaa.gov/protected_species/species_list/species_lists.html

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

The table below outlines lead FWS field offices by county and land ownership/project type. Please refer to this table when you are ready to coordinate (including requests for section 7 consultation) with the field office corresponding to your project, and send any documentation regarding your project to that corresponding office. Therefore, the lead FWS field office may not be the office listed above in the letterhead. Please visit our office's website (http://www.fws.gov/sacramento) to view a map of office jurisdictions.

Lead FWS offices by County and Ownership/Program

County	Ownership/Program	Species	Office Lead*
Alameda	Tidal wetlands/marsh adjacent to Bays	Salt marsh species, delta smelt	BDFWO
Alameda	All ownerships but tidal/estuarine	All	SFWO
Alpine	Humboldt Toiyabe National Forest	All	RFWO
Alpine	Lake Tahoe Basin Management Unit	All	RFWO
Alpine	Stanislaus National Forest	All	SFWO
Alpine	El Dorado National Forest	All	SFWO
Colusa	Mendocino National Forest	All	AFWO
Colusa	Other	All	By jurisdiction (see map)
Contra Costa	Legal Delta (Excluding ECCHCP)	All	BDFWO
Contra Costa	Antioch Dunes NWR	All	BDFWO
Contra Costa	Tidal wetlands/marsh adjacent to Bays	Salt marsh species, delta smelt	BDFWO
Contra Costa	All ownerships but tidal/estuarine	All	SFWO

El Dorado	El Dorado National Forest	All	SFWO
El Dorado	LakeTahoe Basin Management Unit		RFWO
Glenn	Mendocino National Forest	All	AFWO
Glenn	Other	All	By jurisdiction (see map)
Lake	Mendocino National Forest	All	AFWO
Lake	Other	All	By jurisdiction (see map)
Lassen	Modoc National Forest	All	KFWO
Lassen	Lassen National Forest	All	SFWO
Lassen	Toiyabe National Forest	All	RFWO
Lassen	BLM Surprise and Eagle Lake Resource Areas	All	RFWO
Lassen	BLM Alturas Resource Area	All	KFWO
Lassen	Lassen Volcanic National Park	All (includes Eagle Lake trout on all ownerships)	SFWO
Lassen	All other ownerships	All	By jurisdiction (see map)

Marin	Tidal wetlands/marsh adjacent to Bays	Salt marsh species, delta smelt	BDFWO
Marin	All ownerships but tidal/estuarine	All	SFWO
Mendocino	Russian River watershed	All	SFWO
Mendocino	All except Russian River watershed	All	AFWO
Napa	All ownerships but tidal/estuarine	All	SFWO
Napa	Tidal wetlands/marsh adjacent to San Pablo Bay	Salt marsh species, delta smelt	BDFWO
Nevada	Humboldt Toiyabe National Forest	All	RFWO
Nevada	All other ownerships	All	By jurisdiction (See map)
Placer	Lake Tahoe Basin Management Unit	All	RFWO
Placer	All other ownerships	All	SFWO
Sacramento	Legal Delta	Delta Smelt	BDFWO
Sacramento	Other	All	By jurisdiction (see map)
San Francisco	Tidal wetlands/marsh adjacent to San Francisco Bay	Salt marsh species, delta smelt	BDFWO

San Francisco	All ownerships but tidal/estuarine	All	SFWO
San Mateo	Tidal wetlands/marsh adjacent to San Francisco Bay	Salt marsh species, delta smelt	BDFWO
San Mateo	All ownerships but tidal/estuarine	All	SFWO
San Joaquin	Legal Delta excluding San Joaquin HCP	All	BDFWO
San Joaquin	Other	All	SFWO
Santa Clara	Tidal wetlands/marsh adjacent to San Francisco Bay	Salt marsh species, delta smelt	BDFWO
Santa Clara	All ownerships but tidal/estuarine	All	SFWO
Shasta	Shasta Trinity National Forest except Hat Creek Ranger District (administered by Lassen National Forest)	All	YFWO
Shasta	Hat Creek Ranger District	All	SFWO
Shasta	Bureau of Reclamation (Central Valley Project)	All	BDFWO
Shasta	Whiskeytown National Recreation Area	All	YFWO
Shasta	BLM Alturas Resource Area	All	KFWO

Shasta	Caltrans	By jurisdiction	SFWO/AFWO
Shasta	Ahjumawi Lava Springs State Park	Shasta crayfish	SFWO
Shasta	All other ownerships	All	By jurisdiction (see map)
Shasta	Natural Resource Damage Assessment, all lands	All	SFWO/BDFWO
Sierra	Humboldt Toiyabe National Forest	All	RFWO
Sierra	All other ownerships	All	SFWO
Solano	Suisun Marsh	All	BDFWO
Solano	Tidal wetlands/marsh adjacent to San Pablo Bay	Salt marsh species, delta smelt	BDFWO
Solano	All ownerships but tidal/estuarine	All	SFWO
Solano	Other	All	By jurisdiction (see map)
Sonoma	Tidal wetlands/marsh adjacent to San Pablo Bay	Salt marsh species, delta smelt	BDFWO
Sonoma	All ownerships but tidal/estuarine	All	SFWO
Tehama	Mendocino National Forest	All	AFWO
	Shasta Trinity National Forest		

Tehama	except Hat Creek Ranger District (administered by Lassen National Forest)	All	YFWO
Tehama	All other ownerships	All	By jurisdiction (see map)
Yolo	Yolo Bypass	All	BDFWO
Yolo	Other	All	By jurisdiction (see map)
All	FERC-ESA	All	By jurisdiction (see map)
All	FERC-ESA	Shasta crayfish	SFWO
All	FERC-Relicensing (non-ESA)	All	BDFWO
***Office Leads:**			
AFWO=Arcata Fish and Wildlife Office			
BDFWO=Bay Delta Fish and Wildlife Office			
KFWO=Klamath Falls Fish and Wildlife Office			
RFWO=Reno Fish and Wildlife Office			
YFWO=Yreka Fish and Wildlife Office			

Attachment

Official Species List

Provided by:

Sacramento Fish and Wildlife Office
FEDERAL BUILDING
2800 COTTAGE WAY, ROOM W-2605
SACRAMENTO, CA 95825
(916) 414-6600

Consultation Code: 08ESMF00-2015-SLI-0891
Event Code: 08ESMF00-2015-E-02799

Project Type: DREDGE / EXCAVATION

Project Name: Pier 70: Central Basin CAP 107 Navigation Improvement Project
Project Description: The Port of San Francisco is located on the northern and eastern shores of the City and County of San Francisco, CA. The study area, Central Basin Approach Area at the Pier 70 Shipyard (Central Basin and shipyard, respectively), is located at Potrero Point on the eastern waterfront of SF, in the San Francisco Bay. The project area is 19.45 acres. This feasibility study includes dredging the project area to 30, 32, and 35 feet mean lower low water. Construction is planned to begin in 2017.

Please Note: The FWS office may have modified the Project Name and/or Project Description, so it may be different from what was submitted in your previous request. If the Consultation Code matches, the FWS considers this to be the same project. Contact the office in the 'Provided by' section of your previous Official Species list if you have any questions or concerns.

Project Location Map:

Project Coordinates: MULTIPOLYGON (((-122.3803562108304 37.766080874504155, -122.38002975596505 37.76485635099314, -122.38099084245519 37.76479934693279, -122.38098901751167 37.764931474518605, -122.3814587963491 37.76493658384001, -122.38233099874391 37.764629339257674, -122.38249409097617 37.764617347609594, -122.3832835861391 37.7641274622454, -122.38437891927269 37.76405323386286, -122.38450923552337 37.7659051092937, -122.38340391263927 37.765986071631836, -122.38065955734974 37.76721868243578, -122.3803562108304 37.766080874504155)))

Project Counties: San Francisco, CA

United States Department of Interior
Fish and Wildlife Service

Project name: Pier 70: Central Basin CAP 107 Navigation Improvement Project

Endangered Species Act Species List

There are a total of 19 threatened or endangered species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

Amphibians	Status	Has Critical Habitat	Condition(s)
California red-legged frog *(Rana draytonii)* Population: Entire	Threatened	Final designated	
Birds			
California Least tern *(Sterna antillarum browni)*	Endangered		
Short-Tailed albatross *(Phoebastria (=diomedea) albatrus)* Population: Entire	Endangered		
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific coastal pop.	Threatened	Final designated	
Fishes			
Delta smelt *(Hypomesus transpacificus)* Population: Entire	Threatened	Final designated	
steelhead *(Oncorhynchus (=salmo) mykiss)*	Threatened	Final designated	

Population: Northern California DPS			
Tidewater goby *(Eucyclogobius newberryi)* Population: Entire	Endangered	Final designated	
Flowering Plants			
Marin dwarf-flax *(Hesperolinon congestum)*	Threatened		
Marsh Sandwort *(Arenaria paludicola)*	Endangered		
Presidio Manzanita *(Arctostaphylos hookeri var. ravenii)*	Endangered		
Presidio clarkia *(Clarkia franciscana)*	Endangered		
San Francisco lessingia *(Lessingia germanorum (=l.g. var. germanorum))*	Endangered		
San Francisco manzanita *(Arctostaphylos franciscana)*	Endangered	Final designated	
White-Rayed pentachaeta *(Pentachaeta bellidiflora)*	Endangered		
Insects			
Callippe Silverspot butterfly *(Speyeria callippe callippe)* Population: Entire	Endangered		
Mission Blue butterfly *(Icaricia icarioides missionensis)* Population: Entire	Endangered		
San Bruno Elfin butterfly *(Callophrys*	Endangered		

mossii bayensis) Population: Entire			
Mammals			
Salt Marsh Harvest mouse *(Reithrodontomys raviventris)* Population: U.S.A.(CA)	Endangered		
Southern Sea otter *(Enhydra lutris nereis)*	Threatened		

Critical habitats that lie within your project area

There are no critical habitats within your project area.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife
650 CAPITOL MALL, SUITE 8-300
SACRAMENTO, CA 95814
PHONE: (916)930-5603 FAX: (916)930-5654
URL: kim_squires@fws.gov

Consultation Code: 08FBDT00-2016-SLI-0197 July 16, 2016
Event Code: 08FBDT00-2016-E-00140
Project Name: Pier 70: Central Basin CAP 107 Navigation Improvement Project - SF-11 Disposal Site

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

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We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment

Official Species List

Provided by:

San Francisco Bay-Delta Fish and Wildlife
650 CAPITOL MALL
SUITE 8-300
SACRAMENTO, CA 95814
(916) 930-5603
http://kim_squires@fws.gov

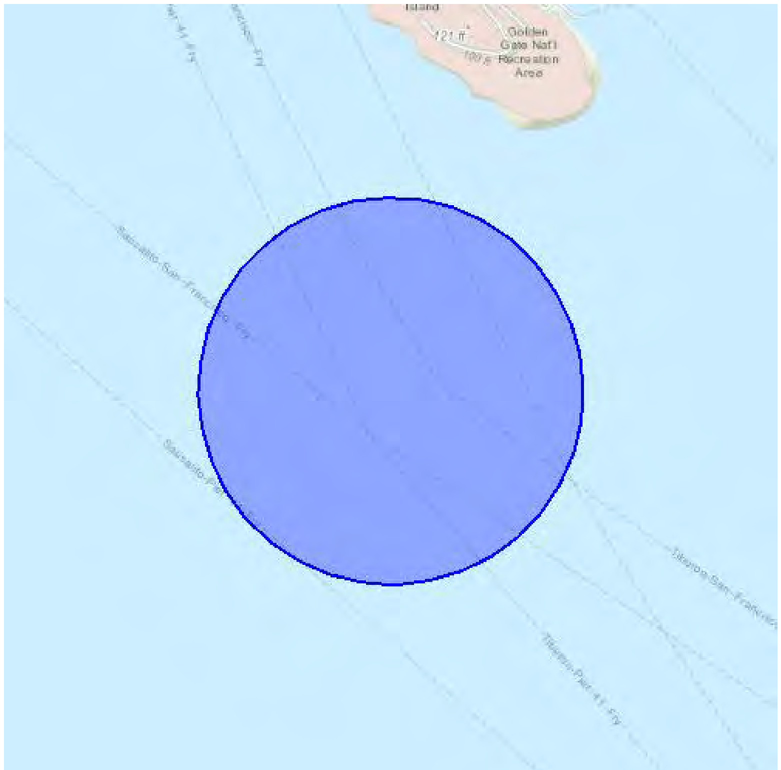
Consultation Code: 08FBDT00-2016-SLI-0197
Event Code: 08FBDT00-2016-E-00140

Project Type: DREDGE / EXCAVATION

Project Name: Pier 70: Central Basin CAP 107 Navigation Improvement Project - SF-11 Disposal Site
Project Description: This feasibility study includes dredging the Central Basin Approach Area at the Pier 70 Shipyard to 30 or 32 feet mean lower low water and placement of the material at an authorized placement site. The site associated with this species list is the SF-11 (Alcatraz) placement site. Construction is planned to begin in 2017.

Please Note: The FWS office may have modified the Project Name and/or Project Description, so it may be different from what was submitted in your previous request. If the Consultation Code matches, the FWS considers this to be the same project. Contact the office in the 'Provided by' section of your previous Official Species list if you have any questions or concerns.

Project Location Map:



Project Coordinates: The coordinates are too numerous to display here.

Project Counties: San Francisco, CA

Endangered Species Act Species List

There are a total of 18 threatened or endangered species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

Amphibians	**Status**	**Has Critical Habitat**	**Condition(s)**
California red-legged frog *(Rana draytonii)* Population: Entire	Threatened	Final designated	
Birds			
California Clapper rail *(Rallus longirostris obsoletus)* Population: Entire	Endangered		
California Least tern *(Sterna antillarum browni)*	Endangered		
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific coastal pop.	Threatened	Final designated	
Fishes			
Delta smelt *(Hypomesus transpacificus)* Population: Entire	Threatened	Final designated	
steelhead *(Oncorhynchus (=salmo) mykiss)*	Threatened	Final designated	

Population: Northern California DPS			
Flowering Plants			
Franciscan manzanita *(Arctostaphylos franciscana)*	Endangered	Final designated	
Marsh Sandwort *(Arenaria paludicola)*	Endangered		
Presidio Manzanita *(Arctostaphylos hookeri var. ravenii)*	Endangered		
Presidio clarkia *(Clarkia franciscana)*	Endangered		
San Francisco lessingia *(Lessingia germanorum (=l.g. var. germanorum))*	Endangered		
Sonoma sunshine *(Blennosperma bakeri)*	Endangered		
Insects			
Bay Checkerspot butterfly *(Euphydryas editha bayensis)* Population: Entire	Threatened	Final designated	
Callippe Silverspot butterfly *(Speyeria callippe callippe)* Population: Entire	Endangered		
Mission Blue butterfly *(Icaricia icarioides missionensis)* Population: Entire	Endangered		
San Bruno Elfin butterfly *(Callophrys mossii bayensis)* Population: Entire	Endangered		

Mammals			
Salt Marsh Harvest mouse *(Reithrodontomys raviventris)* Population: wherever found	Endangered		
Southern Sea otter *(Enhydra lutris nereis)*	Threatened		

Critical habitats that lie within your project area

There are no critical habitats within your project area.

DREDGED MATERIAL MANAGEMENT OFFICE

MEMORANDUM FOR THE RECORD

TO: Roxanne Grillo, Brian Mulvey, Al Paniccia

DATE: September 14, 2015

FROM: Rob Lawrence; Chair, Dredged Material Management Office

SUBJECT: USACE Central Basin Dredging; Test Results; DMMO Serial Number: 15-086

At the meeting on September 2, 2015, the Dredged Material Management Office (DMMO) completed its review of the document of the test results prepared by NewFields entitled, "Port of San Francisco Central Basin Sediment Characterization Report," dated August 25, 2015. The results are for a volume of approximately 420,580 cubic yards (cy) of sediment proposed to be dredged from the Port of San Francisco Central Basin (Central Basin) as follows:

Dredge Units DU01A, DU02A, DU03A, and DU04A: approximately 248,125 cy dredged to a design depth -30 feet mean lower low water (MLLW) plus a 2-foot overdepth allowance from an approximately 23.6-acre footprint; and,

Dredge Units DU05B, DU06B, DU07B, DU08B, and DU09B: approximately 172,455 cy dredged to a design depth -35 feet MLLW plus a 2-foot overdepth allowance from an approximately 23.6-acre footprint.

The Central Basin is located near Pier 70 along the eastern waterfront in the city and county of San Francisco, California.

The members of the DMMO have determined the following for the sediment from the Central Basin as characterized in the above document:

1. All the sediment is suitable for unconfined aquatic disposal at the San Francisco Deep Ocean Disposal Site.

2. None of the sediment is suitable for unconfined aquatic disposal at an in-Bay disposal site or for placement as wetland cover material at the Montezuma Wetland Restoration Project site (Montezuma).

3. The sediment characterized by composite 6B is suitable for placement as wetland foundation material at Montezuma.

The DMMO members request that USACE conduct a z-layer analysis for polycyclic aromatic hydrocarbons (PAHs) in the dredge unit characterized by composite 5B. The results of that analysis are to be provided to the DMMO for review.

Please note that this memorandum does not constitute an authorization to proceed with your dredge project. You must first obtain all appropriate authorizations and provide all appropriate notifications.

Respectfully,

Robert J. Lawrence
Chair, Dredged Material Management Office

Copies Furnished:

Ms. Christine Boudreau, Boudreau Associates, San Francisco, CA
USACE, San Francisco, CA (Jessica Burton Evans)
USEPA, San Francisco, CA (Jennifer Siu)
BCDC, San Francisco, CA (Brenda Goeden)
RWQCB, Oakland, CA (Beth Christian)
SLC, Sacramento, CA (Al Franzoia)
CDFW, Santa Rosa, CA (Arn Aarreberg)
NOAA Fisheries, Santa Rosa, CA (Sara Azat)

DREDGED MATERIAL MANAGEMENT OFFICE

MEMORANDUM FOR THE RECORD

TO: Roxanne Grillo, Al Paniccia, Jessica Burton Evans

DATE: October 22, 2015

FROM: Rob Lawrence, Chair, Dredged Material Management Office

SUBJECT: USACE Central Basin Dredging; Supplemental Sampling and Analysis Plan; DMMO Serial Number: 15-098

At its October 21, 2015 meeting, the Dredged Material Management Office (DMMO) reviewed the supplemental sampling and analysis plan (SSAP) for the testing of a sediment interval of -32 feet mean lower low water (MLLW) to -34 feet MLLW, plus a 6-inch z-layer, in the Central Basin. Due to elevated levels of polycyclic aromatic hydrocarbons, polychlorinated biphenyls and chlordane, the DMMO requested the supplemental characterization of this interval in two dredge units (DU05B and DU08B) from a previous characterization in order to make a suitability determination for the placement of this sediment at the San Francisco Deep Ocean Disposal Site. The SSAP was in a Technical Memorandum prepared by New Fields, with the subject, "Central Basin Supplemental Sampling and Analysis," dated October 13, 2015. The Central Basin is located near Pier 70 along the San Francisco waterfront in the city and county of San Francisco, California.

The members of the DMMO have determined that the SSAP is appropriate for the sediment from the interval in question in the Central Basin, as proposed in the above Technical Memorandum.

Please note that this memorandum does not constitute an authorization to proceed with your dredge project. You must first obtain all appropriate authorizations and provide all appropriate notifications.

Respectfully,

Robert J. Lawrence
Chair, Dredged Material Management Office

DREDGED MATERIAL MANAGEMENT OFFICE

MEMORANDUM FOR THE RECORD

TO: Roxanne Grillo, Jessica Burton Evans, Al Paniccia

DATE: April 28, 2016

FROM: Rob Lawrence; Chair, Dredged Material Management Office

SUBJECT: USACE Central Basin Dredging; Test Results; DMMO Serial Number: 16-020

At the meeting on January 13, 2016, the Dredged Material Management Office (DMMO) completed its review of the Technical Memorandum of the specific chemistry test results, prepared by NewFields with the subject, "Central Basin Supplemental Sampling and Analysis Results," dated January 4, 2016. The results are for tests for polycyclic aromatic hydrocarbons, polychlorinated biphenyls and chlordane in the sediment layer from -32 feet mean lower low water (MLLW) to -34 feet MLLW (plus a one-half foot z-layer to -34.5 feet MLLW) in dredge units DU05B and DU08B.

At a meeting on January 27, 2016, the DMMO considered a request for a suitability determination for in-Bay disposal of sediment from dredge units DU02A and DU06B to a depth of -32 feet MLLW, plus a two-foot overdredge allowance. That request was made in a letter from Ms. Jessica Burton Evans (USACE) to Mr. Rob Lawrence (DMMO), dated January 19, 2016.

The Central Basin is located near Pier 70 along the eastern waterfront in the city and county of San Francisco, California.

The members of the DMMO have determined the following for the sediment from the Central Basin as characterized in the above document and letter:

1. All the sediment characterized from dredge units DU05B and DU08B is suitable for unconfined aquatic disposal at the San Francisco Deep Ocean Disposal Site (SF-DODS).

2. The sediment proposed to be dredged from dredge units DU02A and DU06B to a depth of -32 feet MLLW, plus a two-foot overdredge allowance, is suitable for disposal at an in-Bay disposal site. **Be advised that this suitability determination does not indicate that disposal at an in-Bay disposal site is or will be authorized.**

3. Except for dredge units 2A and 6B, none of the sediment is suitable for unconfined aquatic disposal at an in-Bay disposal site or for placement as wetland cover material at the Montezuma Wetland Restoration Project site (Montezuma).

4. Additionally, to amend the memo dated September 14, 2015 (DMMO Serial Number 15-086), all sediment proposed to be dredged from the Central Basin to a depth of -32 feet MLLW, plus a two-foot overdredge allowance, is suitable for placement as wetland foundation material at Montezuma.

Be advised that a concurrence must be obtained from the US Environmental Protection Agency before dredged material can be disposed at SF-DODS.

Please note that this memorandum does not constitute an authorization to proceed with your dredge project. You must first obtain all appropriate authorizations and provide all appropriate notifications.

Respectfully,

Robert J. Lawrence

Robert J. Lawrence
Chair, Dredged Material Management Office

Copies Furnished:

Ms. Christine Boudreau, Boudreau Associates, San Francisco, CA
USACE, San Francisco, CA (Mark D'Avignon)
USEPA, San Francisco, CA (Brian Ross)
BCDC, San Francisco, CA (Brenda Goeden)
RWQCB, Oakland, CA (Beth Christian)
SLC, Sacramento, CA (Al Franzoia)
CDFW, Santa Rosa, CA (Arn Aarreberg)
NOAA Fisheries, Santa Rosa, CA (Sara Azat)

Port of San Francisco

Central Basin

Sediment Characterization Report

Prepared for:

PORT OF SAN FRANCISCO

Port of San Francisco
Pier 1
The Embarcadero
San Francisco, CA, 94111

Prepared by:

NewFields

NewFields
115 2nd Avenue North, Suite 100
Edmonds, Washington 98020

August 25, 2015

Table of Contents

Tables

Figures

Appendices

List of Acronyms and Abbreviations

ARI	Analytical Resources, Inc.
BAF	bioaccumulation factor
BP	bioaccumulation potential
BSAF	biota sediment accumulation factor
BT	bioaccumulation trigger
CAP	Continuing Authorities Program
COC	chain of custody
cy	cubic yard
DI	deionized
DI-WET	deionized waste extraction test
DML	daily maximum limit
DMMO	Dredged Material Management Office
DU	dredge unit
EC50	effect concentration median
EFH	Essential Fish Habitat
FDA	Food and Drug Administration
HPAH	high molecular weight PAH
ITM	Inland Testing Manual
KCl	Potassium Chloride
K_{ow}	octanol water partitioning coefficient
LC50	lethal concentration median
LOED	lowest observed effects dose
LPAH	low molecular weight PAH
LPC	limiting permissible concentration
MET	modified elutriate test
µg/kg	micrograms per kilogram
MLLW	mean lower low water
MRL	method reporting limit
MWRP	Montezuma Wetlands Restoration Project
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PN	Public Notice
Port	Port of San Francisco
PSAP	Programmatic Sampling and Analysis Plan
QA/QC	Quality Assurance and Quality Control
RMP	Regional Monitoring Program
RPD	Relative Percent Difference
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SCR	Sediment Characterization Report
SF	San Francisco
SF-DODS	San Francisco Deep Offshore Disposal Site
SFEI	San Francisco Estuary Institute
SP	solid phase
SPP	suspended particle phase
STFATE	Short Term Fate

SUAD	suitable for unconfined aquatic disposal
TMDL	total maximum daily load
TOC	total organic carbon
TRV	toxicity reference value
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WQC	water quality criteria
WW	wet weight

1 Introduction

This Sediment Characterization Report (SCR) presents the analytical chemistry and biological testing results for the sediment characterization for proposed dredging within Central Basin. NewFields conducted the work described in this SCR under contract to the Port of San Francisco (Port). The Port is the non-Federal sponsor for the Central Basin Continuing Authorities Program (CAP) 107 dredging project being planned and evaluated by the United States Army Corps of Engineers (USACE).

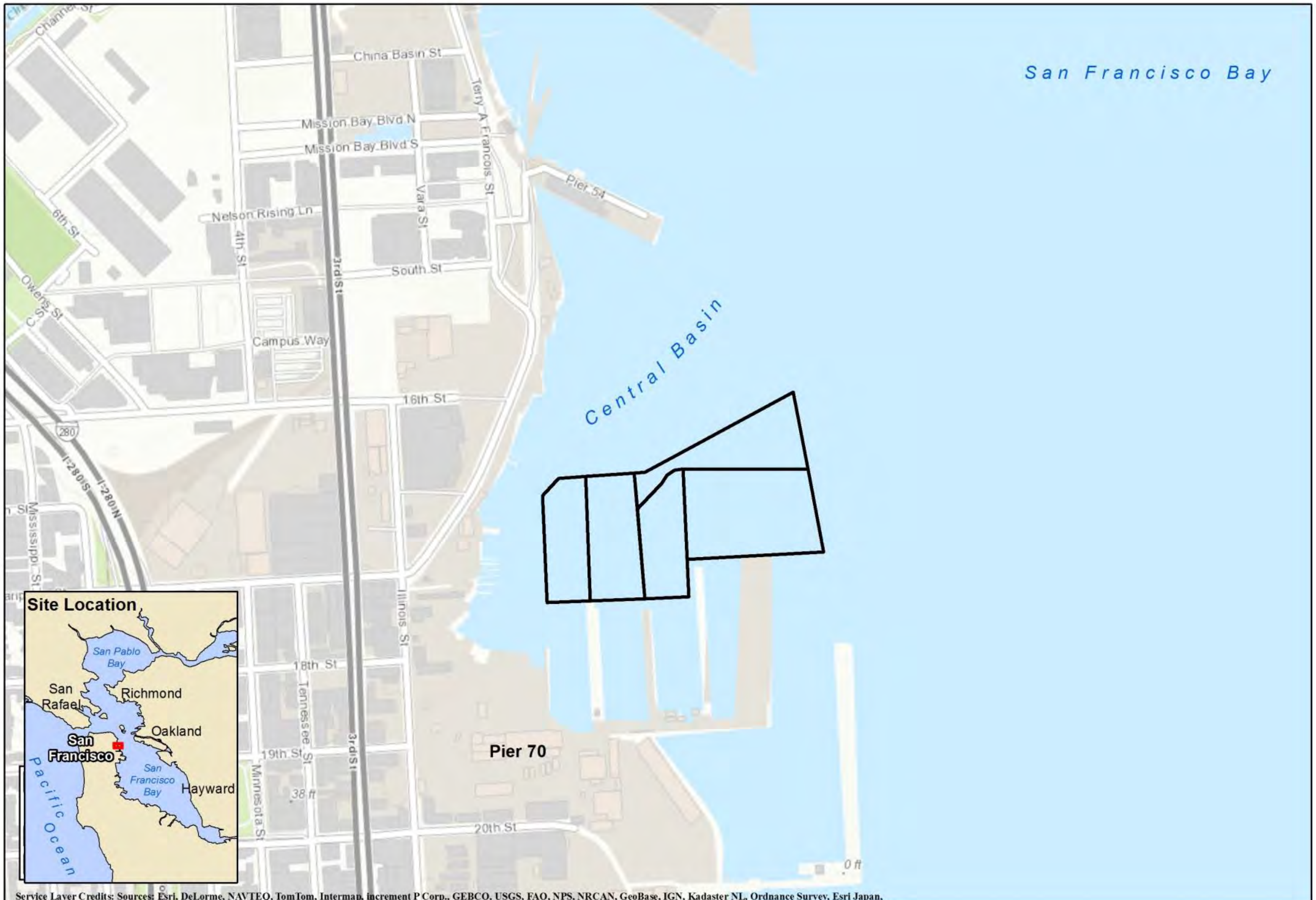
The purpose of this SCR is to document all activities associated with the collection, analysis (chemical and biological), and data results for sediment samples collected between April 13 and April 23, 2015. The document is intended to complement the Sampling and Analysis Plan (SAP; NewFields 2015), and has been prepared to meet reporting objectives presented in the Inland Testing Manual (ITM; USEPA/USACE 1998), and any guidance required by the Dredged Material Management Office (DMMO). Any deviations from the SAP will be described herein, as well as any corrective measures which were taken in accordance with quality assurance/quality control (QA/QC) objectives.

1.1 Project Description

This sediment characterization for Central Basin near Pier 70 (Figure 1-1) will support the planning process for the USACE's Pier 70 CAP107 Navigation Improvement Project that evaluates the impacts of proposed project alternatives (including potential future dredging episodes) on the environment, the local economy, and more. The Port of San Francisco conducted the sediment characterization as part of their required cost share effort for the aforementioned. The sediment characterization within these areas included two potential dredging depths ranging from -30 ft mean lower low water (MLLW; -32 ft MLLW with 2 ft allowable overdepth) or -35 ft MLLW (-37 ft MLLW with 2 ft allowable overdepth). Prior to dredging, the sediment characterization was conducted to evaluate suitability for disposal at the Alcatraz Disposal Site in San Francisco (SF) Bay, SF-11; the San Francisco Deep Ocean Disposal Site (SF-DODS); or for beneficial re-use at the Montezuma Wetlands Restoration Project (MWRP) site. The final project depth will be determined based on the results of the sediment characterization, suitability determinations, and available funding and approvals through the CAP107 process. The overall volume of sediment proposed to be dredged to -37 ft. MLLW is approximately 420,580 cubic yards (cy) from a total of nine Dredging Units (DUs). Table 1-1 summarizes the proposed dredging volumes and project depth for each DU.

Table 1-1. Proposed Maintenance Dredging Volumes

Dredging Unit	Dredging Unit Interval (MLLW)	Dredging Depth (MLLW; including 2 ft allowable overdepth)	Approximate Dredge Volume to Project Depth	Approximate Overdredge Volume	Approximate Total Dredge Volume (cubic yards)	Surface Area (Sq. ft.)	Surface Area (acres)
DU1	mudline to -30 ft	-32 ft	13,138	23,543	36,681	483,376	11.1
DU2	mudline to -30 ft	-32 ft	37,333	12,025	49,359	198,818	4.6
DU3	mudline to -30 ft	-32 ft	68,973	14,011	82,984	189,988	4.4
DU4	mudline to -30 ft	-32 ft	67,722	11,379	79,101	153,615	3.5
DU5	-32 to -35 ft	-37 ft	27,459	20,086	47,545	331,763	7.6
DU6	-32 to -35 ft	-37 ft	19,486	11,231	30,716	198,818	4.6
DU7	-32 to -35 ft	-37 ft	16,792	14,073	30,865	151,612	3.5
DU8	-32 to -35 ft	-37 ft	21,095	11,379	32,475	189,988	4.4
DU9	-32 to -35 ft	-37 ft	17,069	13,785	30,854	153,615	3.5
		Totals	289,068	131,513	420,580	2,051,593	47.1



N

Figure 1-1. Vicinity Map of Port of San Francisco Central Basin and Pier 70

0 500 1,000 2,000 Feet

2 Field Sample Collection and Processing

This section describes the sample collection and processing methods used and describes any deviations from the SAP.

2.1 Sediment Sample Collection

The sediment characterization sampling at the Central Basin was conducted between April 13 and April 23, 2015. NewFields (Edmonds, WA), with support from AEW Engineering (San Francisco, CA) and Acta Environmental (San Francisco, CA) conducted the field sampling effort, and ensured that all sediment samples were collected in accordance with the DMMO approved SAP (NewFields 2015). The sampling vessel, vibracoring equipment, navigation and positioning, and operators were provided by TEG Oceanographic Services (Santa Cruz, CA).

As per the SAP (NewFields 2015), a total of 9 DUs were delineated for characterizing the material to be dredged. Dredging was proposed to two project depths:

1) -30 feet MLLW for DU01A through DU04A (authorized depth of -32 feet MLLW including 2 feet of overdepth);

2) -35 feet MLLW for DU05B through DU09B (authorized depth of -37 feet MLLW including 2 feet of overdepth).

Nine sediment coring locations were occupied in DU01A, and five coring locations were occupied in DU05B, while four sediment coring locations were occupied in all other DUs (Figures 2-2 and 2-3). Cores from all locations in each DU were homogenized to produce a single composite sample for chemical and conventional analyses and biological testing. The footprint of the upper DUs (A layer) matched that of the lower DUs (B layer) such that portions of each core went towards separate DUs (upper and lower), depending on the proposed dredge depth. Two cores were collected at each location to ensure sufficient volume for the lower DUs (B layer). Only the first collected core was retained for the composite sample in the upper DUs, as it provided sufficient volume to conduct all required analyses.

Sediment from the mudline to -30 ft MLLW (+ 2 ft overdepth and 0.5 ft Z layer) was collected from each core to characterize the respective upper DU for each location. Sediment from -32 ft MLLW to -35 ft MLLW (+ 2 ft overdepth and 0.5 ft Z layer) was collected from each core to characterize the respective lower DU for each location.

Sediment within the project and overdepth horizons within a given DU was homogenized together for the composite sample. The Z layer samples were collected from the first core at each location and archived separately (i.e., not composited). An individual archive sample was also collected from the combined project and overdepth horizon of the first core from each sampling location.

Table 2-1 provides the actual coordinates for the sampling locations, along with the observed mudline, core penetration and core depth. Cores were collected using an electrically powered vibracore as described in the SAP and PSAP (NewFields 2015; Anchor 2003).

Reference sediments were collected from Alcatraz reference station R-AM-H. The reference sediment was used for biological test comparisons and interpretations. A stainless steel pipe dredge sampler was used to collect reference sediment.

Site water was collected to create the elutriate preparations for the water column-tests. A total of 180 liters of site water was collected on April 17, 2015 from the center of the Central Basin characterization area and delivered to the laboratory. A battery powered drum pump with polyethylene tubing was used to collect the site water samples. Both the pump and tubing were new for the project and rinsed prior to use.

2.2 Sample Processing

Sediment core samples were processed at an onshore site provided by BAE Systems in accordance with the procedures detailed in the SAP (NewFields 2015) and PSAP (Anchor 2003). A composite sample was created for each DU by combining a proportionate volume of homogenized sediment from each core or cores (to project depth plus overdepth). All composite samples were subjected to physical and chemical analyses. Biological testing was performed on all DU composite samples. Individual core samples from each location and composite samples from each DU were archived in the event that additional analysis was necessary. Z-layer samples were collected from each location and archived. All samples were placed into appropriate sample jars for physical and chemical analyses or into food-grade polyethylene bags for biological testing. A summary of the compositing scheme and testing strategy is presented in Table 2-2.

All sample containers were appropriately labeled, placed in coolers with ice, and stored until couriered delivery or shipment to the appropriate laboratory. Samples for chemical analysis were securely packed in coolers with ice and shipped overnight via FedEx to Analytical Resources, Inc. (ARI; Kelso, WA) or were hand couriered to Cel Analytical (San Francisco). Archive samples were also securely packed in coolers with ice and shipped overnight via FedEx to ARI. Upon receipt, archive samples were stored frozen. Samples for biological testing were couriered to Pacific Ecorisk (Fairfield, CA). Samples for biological testing were stored in the dark at 4 ± 2 degrees Celsius (°C) until tests was initiated. Appropriate chain-of-custody (COC) procedures were followed for all samples.

2.3 Deviations from the SAP

Deviations from the SAP occurred during the sample collection effort. Corrective actions were taken whenever possible to address the deviations in order to provide adequate information to characterize the sediment proposed to be dredged.

1. The bathymetric data used in the SAP indicated the presence of up to 4.8 feet of sediment at DU01A-C7 and 11.1 feet of sediment at DU01A-C8. BAE dredging in 2011 removed much of this accumulation. Field measured depths at these two locations were near -32 ft MLLW and -31.5 ft MLLW, respectively (Table 2-1). Only a small amount of sediment from these two locations was included in the composite for DU01A. The individual core archive sample at DU01A core 7 could not be collected due to insufficient volume in the upper DU.
2. After the initiation of field sampling, the DMMO agencies requested that two locations within DU01A/DU05B be moved and an additional location be included to address concerns relative to historical chemistry results from near this area. Location DU01A-C1 was moved southwest approximately 100 feet, location DU01A-C3 was moved south-southwest approximately 75 feet, and location DU01A-C9 was added in in the southwest corner of the DU. The final location of these samples are shown in Figures 2-1 and 2-2. Sediment collected from these DUs prior to the location adjustments was not included in the sediment composite.

Table 2-1. Actual Sample Location Coordinates and Descriptions of Collected Cores

Upper DU	Lower DU	Latitude	Longitude	Mudline Elevation (ft MLLW)	Core Collected (ft)	Depth Achieved (ft. MLLW)	Project and Overdepth (Z-Layer) Achieved
A layer	B layer	(NAD83)	(NAD83)	Core #1 / Core #2			
DU01A-C1	DU05B-C1	37.765655	-122.381157	-31.4 / -30.9	-6.5 / -7	37.9 / 37.9	Yes
DU01A-C2	DU05B-C2	37.765605	-122.382167	-26.8 / -27.2	-13 / -12	39.8 / 39.2	Yes
DU01A-C3	DU05B-C3	37.765333	-122.380575	-30.6 / -30.6	-10 / -10	40.6 / 40.6	Yes
DU01A-C4	DU05B-C4	37.764927	-122.382142	-26 / -26	-13.5 / -12	39.5 / 38	Yes
DU01A-C9	DU05B-C9	37.765008	-122.380432	-31 / -30.7	-8 / -8	39 / 38.7	Yes
DU01A-C5	DU07B-C1	37.765477	-122.382782	-25.6 / -25.9	-12 / -12	37.6 / 37.9	Yes
DU01A-C6	DU07B-C2	37.765380	-122.383293	-27.3	-12.0	39.3	Yes
DU01A-C6*	DU07B-C2*	37.765345	-122.383323	-25.6	-12.0	37.6	Yes
DU01A-C7	DU07B-C3	37.764733	-122.383187	-32.1 / -32.7	-8 / -8	40.1 / 40.7	Yes
DU01A-C8	DU07B-C4	37.764208	-122.382643	-31.4 / -31.8	-9.5 / -8	40.9 / 39.8	Yes
DU02A-C1	DU06B-C1	37.766447	-122.381613	-24.2 / -24.4	-13.3 / -13.1	37.5 / 37.5	Yes
DU02A-C2	DU06B-C2	37.766282	-122.382350	-20.2 / -21	-17.3 / -16.5	37.5 / 37.5	Yes
DU02A-C3	DU06B-C3	37.766152	-122.382772	-20.5 / -19.9	-18 / -18.5	38.5 / 38.4	Yes
DU02A-C4	DU06B-C4	37.765992	-122.383123	-21 / -21	-17.5 / -17.5	38.5 / 38.5	Yes
DU03A-C1	DU08B-C1	37.765887	-122.383658	-17.3 / -17.2	-20.2 / -20.3	37.5 / 37.5	Yes
DU03A-C2	DU08B-C2	37.765273	-122.384118	-17.1 / -16.9	-20.4 / -20.6	37.5 / 37.5	Yes
DU03A-C3	DU08B-C3	37.764780	-122.383728	-19.7 / -19.8	-17.8 / -17.7	37.5 / 37.5	Yes
DU03A-C4	DU08B-C4	37.764343	-122.384087	-20.7 / -20.7	-16.8 / -16.8	37.5 / 37.5	Yes
DU04A-C1	DU09B-C1	37.765613	-122.384897	-16.2 / -16.1	-21.3 / -21.4	37.5 / 37.5	Yes
DU04A-C2	DU09B-C2	37.765162	-122.384627	-17.8 / -17.7	-20 / -20	37.8 / 37.7	Yes
DU04A-C3	DU09B-C3	37.764492	-122.384987	-18.6 / -18.4	-19 / -19.5	37.6 / 37.9	Yes
DU04A-C4	DU09B-C4	37.764258	-122.384998	-20.3 / -20.3	-18 / -18	38.3 / 38.3	Yes
R-AM-H[1]	n/a	37.813833	-122.426167	n/a	n/a	n/a	n/a
Site Water[2]	n/a	37.764617	-122.384200	n/a	n/a	n/a	n/a

Notes: NAD =North American Datum   MLLW = mean lower low water   n/a: not applicable
Core #1 / Core #2 represent the two cores collected at each location to obtain sufficient volume;
*: The two cores at DU01A-C6/DU07B-C2 were collected from separate locations due to loss of the original second core;
1: Reference sediment collected from Alcatraz Environs
2: Site water collected for use in biological testing.

Table 2-2: Sediment Sample Compositing Scheme and Testing Strategy

Composite ID	Location ID	Chemical Testing and Archival				Biological Testing		
		Composite Sediment Chemistry Analysis	Individual Core and Z Layer Archive	Individual Core Analysis	Composite Z Layer Analysis	In-Bay Disposal Biological Tests[3]	Ocean Disposal Biological Tests[4]	Bioaccumulation Tests and Tissue Analysis[5]
CB-DU01A	DU01A-C1 DU01A-C2 DU01A-C3 DU01A-C4 DU01A-C5 DU01A-C6 DU01A-C7 DU01A-C8 DU01A-C9	Full Suite[1]	Yes[2]	No	PCBs	Yes	Yes	Yes / PCBs
CB-DU02A	DU02A-C1 DU02A-C2 DU02A-C3 DU02A-C4	Full Suite[1]	Yes	No	PCBs	Yes	Yes	Yes / PCBs
CB-DU03A	DU03A-C1 DU03A-C2 DU03A-C3 DU03A-C4	Full Suite[1]	Yes	No	PCBs	Yes	Yes	Yes / PCBs
CB-DU04A	DU04A-C1 DU04A-C2 DU04A-C3 DU04A-C4	Full Suite[1]	Yes	No	PCBs	Yes	Yes	Yes / PCBs

Table 2-2 (cont.): Sediment Sample Compositing Scheme and Testing Strategy

Composite ID	Location ID	Chemical Testing and Archival				Biological Testing		
		Composite Sediment Chemistry Analysis	Individual Core and Z Layer Archive	Individual Core Analysis	Composite Z Layer Analysis	In-Bay Disposal Biological Tests[3]	Ocean Disposal Biological Tests[4]	Bioaccumulation Tests[5]
CB-DU05B	DU05B-C1	Full Suite[1]	Yes	PAH	PCBs, PAH, Hg	Yes	Yes	Yes / PCBs, PAH
	DU05B-C2			PAH				
	DU05B-C3			PAH				
	DU05B-C4			PAH				
	DU05B-C9			PAH				
CB-DU06B	DU06B-C1	Full Suite[1]	Yes	No	PCBs	Yes	Yes	Yes / PCBs
	DU06B-C2							
	DU06B-C3							
	DU06B-C4							
CB-DU07B	DU07B-C1	Full Suite[1]	Yes	No	PCBs, PAH	Yes	Yes	Yes / PCBs
	DU07B-C2							
	DU07B-C3							
	DU07B-C4							
CB-DU08B	DU08B-C1	Full Suite[1]	Yes	No	PCBs	Yes	Yes	Yes / PCBs
	DU08B-C2							
	DU08B-C3							
	DU08B-C4							
CB-DU09B	DU09B-C1	Full Suite[1]	Yes	No	PCBs	Yes	Yes	Yes / PCBs
	DU09B-C2							
	DU09B-C3							
	DU09B-C4							

Notes: PCB: polychlorinated biphenyls PAH: polycyclic aromatic hydrocarbons Hg: mercury
1: Chemical analysis included grain size, total organic carbon, total solids, metals, PCB congeners, 25 PAH compounds, butyltins, and pesticides.
2: No archive sample was collected from core DU01A-C7 due to lack of sufficient volume.
3: Biological tests included SP amphipod mortality (*A. abdita*), SP polychaete mortality (*N. arenaceodentata*), and SPP larval development (*M. galloprovincialis*).
4: Supplemental biological tests included two water column mortality tests using fish (*M. beryllina*) and mysid shrimp (*A. bahia*).
5: Bioaccumulation testing to evaluate PCB and PAH uptake was conducted using two species, a bivalve (*M. nasuta*) and a polychaete (*N. virens*).

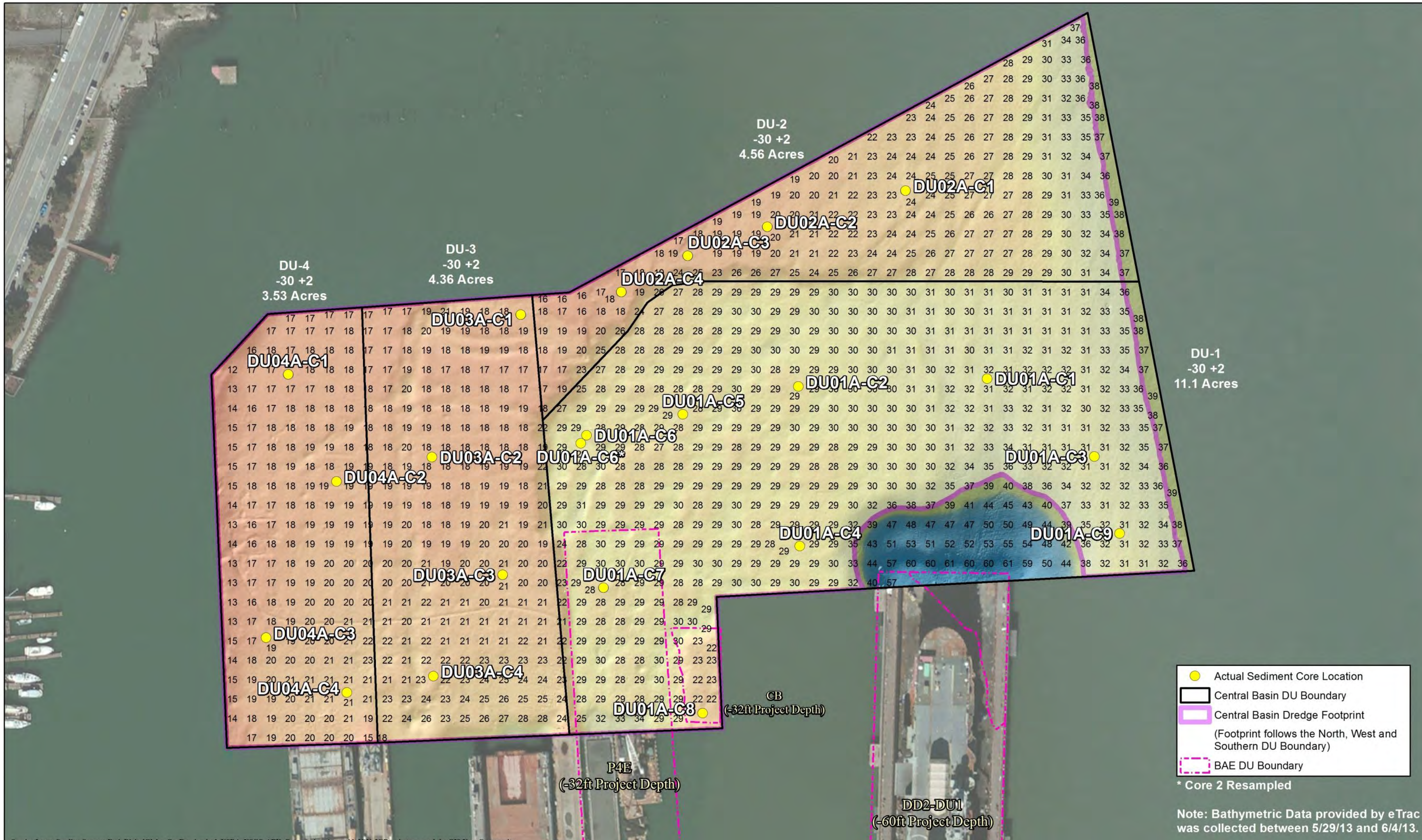


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Figure 2-1. Upper Dredge Units and Actual Sampling Locations for Central Basin

0 100 200 400 Feet

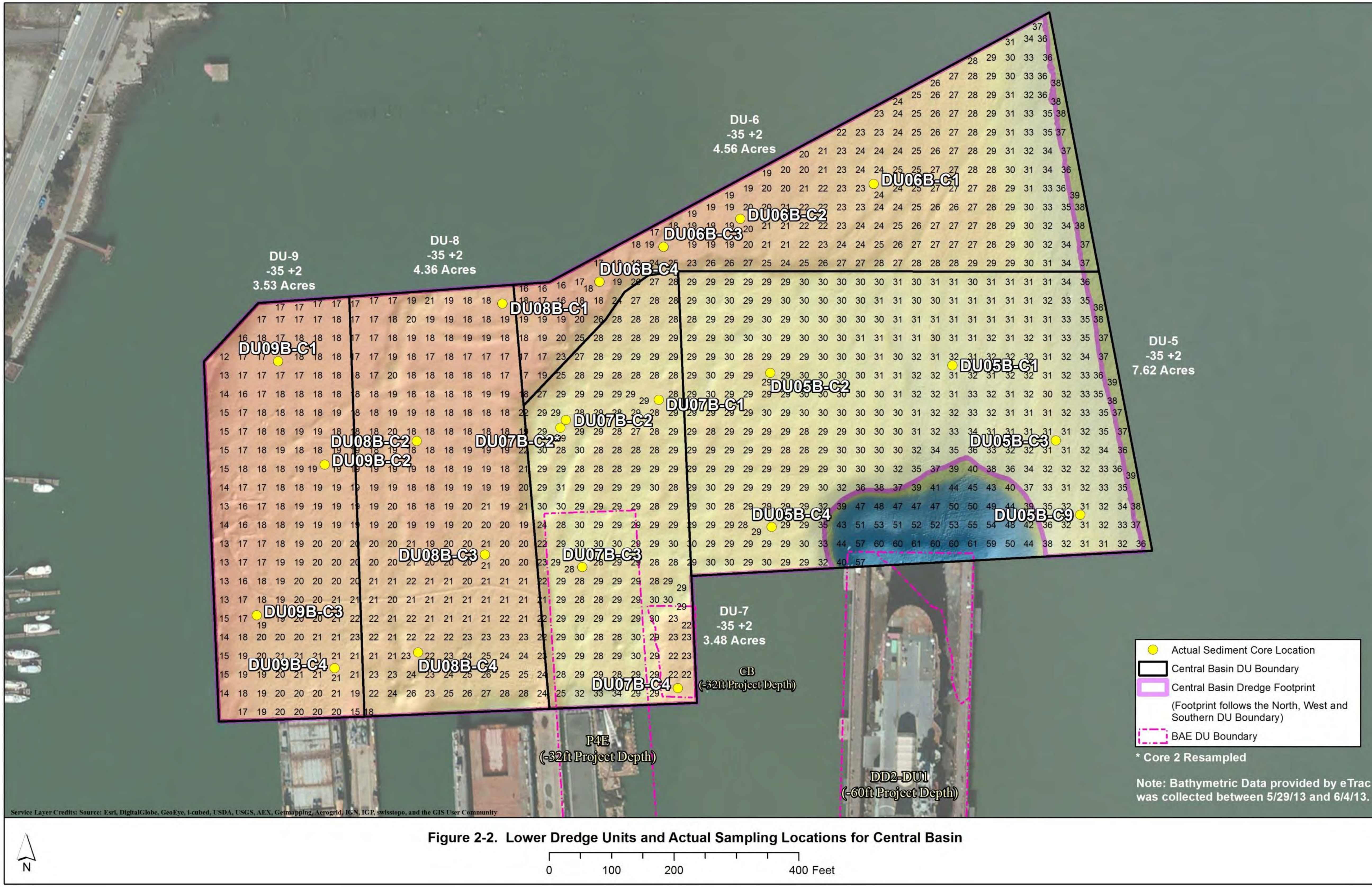

Figure 2-2. Lower Dredge Units and Actual Sampling Locations for Central Basin

3 Laboratory Results

This section summarizes the results for the analytical chemistry and biological testing laboratories. The sediment chemistry results are provided in Section 3.1. This section also includes a description of the individual core and Z layer composite samples submitted for analysis of PCBs, PAH, or mercury as requested by the DMMO agencies. The modified elutriate test (MET) and deionized waste extraction test (DI-WET) results are provided in Section 3.2. The biological testing results are summarized in Section 3.3. The tissue chemistry results from the laboratory bioaccumulation testing are presented in Section 3.3.5.

3.1 Sediment Chemistry Results

Sediment composite samples from each DU were analyzed for the physical and chemical parameters specified in Tables 5-1 to 5-3 of the SAP (NewFields 2015). The analyte list for this project was developed to provide data on potential contaminants of concern and to address testing requirements for disposal at SF-11 and SF-DODS and potential beneficial reuse at MWRP. Physical and conventional parameters included total organic carbon (TOC), total solids, and grain size; chemical analytes included metals, organotins, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides.

PAH analysis included the expanded list of 25 compounds from the Programmatic Essential Fish Habitat (EFH) consultation. PCBs included the list of 40 congeners recommended by the U.S. Environmental Protection Agency (USEPA) for dredge material evaluations, the Regional Monitoring Program (RMP) in San Francisco Bay, and for the San Francisco Bay Total Maximum Daily Loads (TMDLs).

The detailed analytical laboratory reports are provided in Appendix B on the enclosed CD.

Analytical results were compared to several thresholds relevant to San Francisco Bay Area sediments. The following criteria are listed in Table 3-1:

- The EFH bioaccumulation triggers (BT) and TMDL values are used to determine when bioaccumulation testing is necessary and whether analysis of Z layer sediments or individual core samples may be required. These thresholds are updated annually and are available through the San Francisco Estuary Institute (SFEI; http://www.sfei.org/content/dmmo-ambient-sediment-conditions). The BT and TMDL thresholds listed in Table 3-1 are effective through 2015.
- The MWRP acceptance criteria include surface and foundation thresholds for reuse of dredged material (RWQCB 2012). Surface, or cover, material is considered suitable for the marsh surface. Foundation, or noncover, material is only suitable for burial under surface sediment.

- Maximum concentrations observed from samples collected at the SF-DODS reference area are also included in Table 3-1 for comparison purposes. However, due to the number of Central Basin composite samples that exceeded these reference concentrations they are not discussed specifically in the text (http://www.epa.gov/region9/water/dredging/sfdods/refarea-db.html).

Table 3-1. Summary of Dredged Material Sediment Comparative Criteria

	EFH BT	RWQCB TMDL	MWRP Surface	MWRP Foundation	SF-DODS Reference
Conventionals					
TOC (%)					1.45
Metals (mg/kg DW)					
Arsenic			15.3	70	5.33
Cadmium			0.33	9.6	0.6
Chromium			112	370	283
Copper			68.1	270	86.3
Lead			43.2	218	26
Mercury	0.33	0.47	0.43	1.3	0.2
Nickel			112	200	238
Selenium			0.64	1.4	2.6
Silver			0.58	3.7	1
Zinc			158	410	288
Butyltins (μg/kg DW)					
Total butyltin[1]					1.3
Polycyclic Aromatic Hydrocarbons (μg/kg DW)					
Total PAHs[2]	4,500		3,390	44,792	192
Pesticides (μg/kg DW)					
Dieldrin	1.9		0.72	4.3	
Total DDTs[3]	50		7	100	2.1
Total Chlordane[4]	37		2.3	4.8	
Polychlorinated Biphenyls congeners (μg/kg DW)					
Total PCBs[5]	18	29.6	22.7	180	

Notes:
EFH BT: Essential Fish Habitat bioaccumulation trigger
RWQCB: Regional Water Quality Control Board
MWRP: Montezuma Wetlands Restoration Project
SF-DODS: San Francisco Deep Ocean Disposal Site
TOC: total organic carbon
TMDL: total maximum daily load
1. sum of detected concentrations of butyltin, dibutyltin, tributyltin, and tetrabutyltin
2. sum of detected 25 PAH compounds
3. sum of detected 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, and 2,4'-DDT, 2,4'-DDE, 2,4'-DDD, or highest non-detect value.
4. sum of detected cis-chlordane, trans-chlordane, oxy-chlordane, cis-nonachlor, and trans-nonachlor, or highest non-detect value.
5. sum of detected 40 PCB Congeners

Analytical results are presented in Table 3-2 for the target chemicals or chemical groups as well as conventional parameters. Select chemical concentrations are highlighted to denote exceedances of the threshold values in Table 3-1.

The total PCB concentrations measured in the 9 DU sediment composites ranged from 27 to 42 µg/kg, all of which exceeded the BT of 18 µg/kg. Sediments from DU01A, DU03A, DU04A, DU05B, DU07B, DU08B, and DU09B also exceeded the TMDL of 29.6 µg/kg (Table 3-2). Therefore, bioaccumulation testing tissue was analyzed for PCBs from all DU composite sediment samples and the Z layer composite samples from each of the DUs were analyzed for PCBs.

Total PAH in DU05B and DU07B exceeded the BT with concentrations of 66,000 µg/kg and 5,400 µg/kg, respectively (Table 3-2). At the request of the DMMO only bioaccumulation tissues from DU05B were analyzed for total PAH. The five individual cores from DU05B were analyzed for PAH along with the Z layer composites from DU05B and DU07B.

With the exception of DU03A, the mercury concentrations measured in the sediment composites all exceeded the BT of 0.33 mg/kg (Table 3-2). The composite from DU05B exceeded the TMDL with a concentration of 0.5 mg/kg. The DMMO no longer requires bioaccumulation testing for mercury concentrations above the BT, but supplemental chemical analysis was requested by the DMMO for the Z layer composite from DU05B.

Several target chemicals exceeded the MWRP surface and foundation thresholds. All 9 DUs had cadmium concentrations greater than the surface threshold of 0.33 mg/kg. Mercury concentrations were greater than the surface threshold in composites from DU05B and DU07B, and selenium was greater than the surface threshold in composites from DU02A and DU05B (Table 3-2).

Total PAH concentrations exceeded the surface threshold of 3,390 µg/kg in composites DU01A, DU05B, DU06B, DU07B, and DU09B. DU05B was the only sample to exceed the foundation threshold of 44,792 µg/kg for total PAH (Table 3-2). Total chlordane concentrations were higher than both the surface and foundation thresholds in composites DU02A, DU03A, DU04A, and DU05B. Total PCB concentrations exceeded the MWRP surface thresholds in all 9 DUs, but no composite samples exceeded the foundation thresholds.

A summary of analytical chemistry results for the individual cores and z-sample composites is presented in Table 3-3 for mercury and PAH and Table 3-4 for PCBs. PAH concentrations from the individual cores in DU05B were not consistent across the DU. Concentrations in cores 2 and 4 on the west side of the dry dock were below both the BT and MWRP surface thresholds. Concentrations in cores 1, 3, and 9 on the east side of the dry dock were an order of magnitude higher and were responsible for the elevated concentration in the composite. Total PAH were 53,000 µg/kg in core 1, 29,000 µg/kg in core 3, and 30,000 µg/kg in core 9 (Table 3-3).

The concentration of total PAHs from the Z layer composite sample from DU05B was 14,000 µg/kg, which was approximately one-fourth the DU composite concentration. Total PAH from the Z layer composite for DU07B was 5,400 µg/kg, the same concentration as the DU composite (Table 3-3). The concentrations from both Z layer composites exceeded the BT and MWRP surface threshold. Total mercury from the Z layer composite from DU05B was 0.49 mg/kg, essentially the same as the DU composite concentration of 0.50 (Table 3-3).

Overall, the total PCB concentrations in the Z layer composite samples were similar to or slightly lower than the concentrations in the DU composites (Table 3-4) indicating there would be little change in total PCB concentrations in surface sediments should dredging occur at either target depth. DU08B was an exception with a DU composite concentration of 34 µg/kg, and a Z layer composite concentration of 100 µg/kg.

Table 3-2: Composite Sediment Chemistry and Conventionals Results for each DU

	CB-DU01A	CB-DU02A	CB-DU03A	CB-DU04A	CB-DU05B	CB-DU06B	CB-DU07B	CB-DU08B	CB-DU09B
	4/22/15	4/20/15	4/16/15	4/15/15	4/21/15	4/20/15	4/22/15	4/16/15	4/15/15
Conventionals									
Total Solids (%)	43.3	48.3	45.8	53.4	52.5	50.8	46.8	40.8	47.8
TOC (%)	0.58	0.63	0.65	0.61	0.63	0.65	0.63	0.66	0.84
Total Sand[1]	2.5	1	0.7	0.7	6.9	1.5	4.9	1.1	0.6
Total Silt[2]	51.2	52.5	48	47.9	51.1	47.5	41.3	43.7	46.8
Total Clay[3]	46.3	46.6	51.4	51.3	41.9	51.2	53.8	55.4	52.5
Total Fines[4]	97.5	99.1	99.4	99.2	93	98.7	95.1	99.1	99.3
Metals (mg/kg DW)									
Arsenic	3.6	4.6	3.6	3.5	4.7	5.3	4.6	4.4	4.4
Cadmium	**1.6**	**1.9**	**1.8**	**1.6**	**2**	**2.1**	**1.9**	**2**	**2**
Chromium	40	47.4	49	44.4	50	52.3	47.9	51.8	53.9
Copper	18.8	23.9	24.3	22.7	27.7	29.7	28.3	31.6	33.3
Lead	10.8	13	13	12.2	15.2	15.9	15.4	16	16.5
Mercury	0.33	0.34	0.32	0.33	0.5	0.36	**0.43**	0.38	0.38
Nickel	34.7	42.2	43.6	39.9	45	47	43.4	47.6	49
Selenium	0.6	**0.7**	0.5 U	0.5	**0.8**	0.5 U	0.5 U	0.5 U	0.5 U
Silver	0.19	0.23	0.14	0.14	0.27	0.28	0.29	0.19	0.21
Zinc	50.5	61.6	63.5	58.9	66.6	70.3	65.5	74.5	74.7
Butyltins (µg/kg DW)									
Butyltin Ion	4 U	3.9 U	3.7 U	3.7 U	3.9 U	3.9 U	4 U	3.7 U	3.8 U
Dibutyltin Ion	5.6 U	5.5 U	5.2 U	5.2 U	12	5.3 J	7.7	11	13
Tributyltin Ion	3.8 U	9.7	13	2.8 J	64	33	44	59	32
Tetrabutyltin Ion	4.9 U	4.8 U	4.5 U	4.5 U	4.7 U	4.8 U	5 U	4.5 U	4.7 U
Total butyltin[5]	5.6 U	9.7	13	2.8 J	78	38.3 J	51.7	70	45
Polycyclic Aromatic Hydrocarbons (µg/kg DW)									
Naphthalene	37	38	26	37	870	45	53	35	58
2-Methylnaphthalene	27	28	16	28	440	57	65	20	68
1-Methylnaphthalene	9.3	9.6	14 U	9.3	550	20	13 J	15 U	13 J
Acenaphthylene	22	17	13 J	18	1,700	27	24	18	21
Acenaphthene	14	10	8.6 J	9.8	1,200	19	21	15	15
Fluorene	37	22	16	20	1,400	43	56	34	35
Phenanthrene	160	140	78	100	10,000	180	180	130	140

Table 3-2 (cont.): Composite Sediment Chemistry and Conventionals Results for each DU

	CB-DU01A	CB-DU02A	CB-DU03A	CB-DU04A	CB-DU05B	CB-DU06B	CB-DU07B	CB-DU08B	CB-DU09B
	4/22/15	**4/20/15**	**4/16/15**	**4/15/15**	**4/21/15**	**4/20/15**	**4/22/15**	**4/16/15**	**4/15/15**
Anthracene	110	78	43	69	4,700	110	200	100	110
Fluoranthene	360	270	190	300	7,900	360	810	370	370
Pyrene	390	280	280	340	10,000	440	820	490	610
Benzo(a)anthracene	270	120	95	140	4,400	200	360	200	210
Chrysene	420	160	110	180	5,000	250	510	270	310
Benzo(b)fluoranthene	320	120	120	190	1,900	230	380	230	260
Benzo(k)fluoranthene	160	64	58	94	1,200	120	200	120	130
Benzo(a)pyrene	400	180	170	250	4,200	310	460	280	350
Indeno(1,2,3-cd)pyrene	210	110	110	160	1,600	190	250	160	210
Dibenz(a,h)anthracene	55	21	19	29	490	37	55	32	38
Benzo(g,h,i)perylene	250	140	150	200	2,000	240	310	210	280
Perylene	140	100	100	140	750	200	220	200	240
Biphenyl	10	12	8.6 J	13	320	15	19	15	18
2,6-Dimethylnaphthalene	11	14	22	20	480	34	21	25	22
1-Methylphenanthrene	23	10	14 U	4.9 U	1,400	5 U	19	15 U	15 U
Benzo(e)pyrene	250	100	100	150	2,000	190	300	180	230
2,3,5-Trimethylnaphthalene	4.9 U	4.8 U	14 U	4.9 U	170	17	15 U	15 U	15 U
Dibenzothiophene	4.9 U	10	14 U	8.3	870	22	16	15 U	13 J
Total Benzofluoranthenes	640	250	240	370	4,600	470	780	460	510
Total PAHs[6]	**3,700**	2,100	1,700	2,500	***66,000***	**3,400**	**5,400**	3,100	**3,800**
Pesticides (µg/kg DW)									
alpha-BHC	0.49 U	4.2 Y	4.1 Y	4.1 Y	4.6 Y	0.5 U	0.48 U	4.1 Y	5.4 Y
beta-BHC	12 Y	9.1 Y	7.6 Y	7.2 Y	9.2 Y	4.7 Y	11 Y	7.3 Y	9.2 Y
delta-BHC	2.8 Y	3.7 Y	3.2 Y	1.1 Y	0.97 U	1.3 Y	1.2 Y	1.3 Y	0.61 Y
gamma-BHC (Lindane)	0.49 U	5.1 Y	2.9 Y	0.48 U	1.7 Y	2.4 Y	7.4 Y	0.49 U	0.5 U
Heptachlor	3 Y	11 Y	11 Y	12 Y	6.2 Y	7.4 Y	5.1 Y	12 Y	6.3 Y
Aldrin	2.1 Y	3.4 Y	0.49 U	0.48 U	0.97 U	0.5 U	1.9 Y	2.4 Y	2.3 Y
Heptachlor Epoxide	2.7 Y	0.98 U	0.99 U	0.97 U	1.9 U	1 U	3.9 Y	0.98 U	0.99 U
Endosulfan I	0.49 U	0.49 U	0.49 U	0.48 U	0.97 U	0.5 U	0.48 U	0.49 U	0.5 U
Dieldrin	0.98 U	0.98 U	0.99 U	0.97 U	1.9 U	1 U	0.97 U	0.98 U	0.99 U
4,4'-DDE	0.98 U	0.98 U	0.99 U	1.2	1.9 U	1.6	0.97 U	2	2.2
Endrin	1.8 Y	0.98 U	0.99 U	0.97 U	1.9 U	1 U	0.97 U	0.98 U	0.99 U

Table 3-2 (cont.): Composite Sediment Chemistry and Conventionals Results for each DU

	CB-DU01A	CB-DU02A	CB-DU03A	CB-DU04A	CB-DU05B	CB-DU06B	CB-DU07B	CB-DU08B	CB-DU09B
	4/22/15	4/20/15	4/16/15	4/15/15	4/21/15	4/20/15	4/22/15	4/16/15	4/15/15
Endosulfan II	5.6 Y	0.98 U	0.99 U	0.97 U	3.5 Y	1 U	0.97 U	0.98 U	0.99 U
4,4'-DDD	4 Y	1.6	0.99 U	1.5	1.9 U	2.1 P	0.97 U	1.6	2.9
Endosulfan Sulfate	2.3 Y	0.98 U	0.99 U	2 Y	1.9 U	2.1 Y	0.97 U	0.98 U	0.99 U
4,4'-DDT	1.4 Y	2.5 Y	1.5	3.4 Y	4.5 Y	2.2 Y	1.3 Y	2.3 Y	2.4 Y
Endrin Aldehyde	0.98 U	0.98 U	0.99 U	0.97 U	1.9 U	1 U	0.97 U	0.98 U	0.99 U
trans-Chlordane	11 Y	10 Y	15 Y	5.8 Y	27 Y	2.4 Y	5.8 Y	1.9 Y	3.5 Y
cis-Chlordane	0.6 Y	0.49 U	0.49 U	0.48 U	0.97 U	0.5 U	0.48 U	0.49 U	0.5 U
Toxaphene	24 U	24 U	25 U	24 U	48 U	25 U	24 U	24 U	25 U
2,4'-DDT	0.98 U	2.2 Y	4.3 Y	2 Y	1.9 U	1 U	0.97 U	0.98 U	0.99 U
2,4'-DDE	0.98 U	6.7 Y	1.8 Y	0.97 U	1.9 U	1 U	2.3 Y	0.98 U	1.8 Y
2,4'-DDD	3.7 Y	0.98 U	0.99 U	1.5 Y	1.9 U	1 U	3 Y	0.98 U	3.7 Y
oxy Chlordane	3.9 Y	0.98 U	0.99 U	0.97 U	1.9 U	1 U	0.97 U	0.98 U	0.99 U
cis-Nonachlor	2.2 Y	1.5 Y	2.6 Y	0.97 U	3.8 Y	1 U	2.9 Y	0.98 U	0.99 U
trans-Nonachlor	9 Y	15	12	5.6	15	1 U	7.4 Y	1.6 P	2.7
Total DDTs[7]	4 Y	1.6	1.5	2.7	4.5 Y	3.7 P	3 Y	3.6	5.1
Total Chlordane[8]	11 Y	***15***	***12***	***5.6***	***15***	2.4 Y	7.4 Y	1.6 P	**2.7**
Polychlorinated Biphenyls (µg/kg DW)									
PCB #8	0.3 J	0.3 J	0.2 J	0.2 J	1.1	0.5 J	0.5	0.8	0.4 J
PCB #18	3	2.3	2.4	1.9	1.7	2.4	3.3	1.9	1.8
PCB #28	0.5 U	0.2 J	0.3 J	0.3 J	0.3 J	0.4 J	0.3 J	0.3 J	0.4 J
PCB #31	1.5	0.9	1.1	0.8	1	1	1.3	0.8	0.8
PCB #33	0.4 J	0.4 J	0.4 J	0.3 J	0.6	0.4 J	0.5 J	0.4 J	0.7
PCB #44	0.4 J	0.3 J	0.4 J	0.5	0.6	0.5 J	0.5 J	0.5	0.5
PCB #49	0.2 J	0.3 J	0.7	0.7	0.5 J	0.5 J	0.5 J	0.6	1
PCB #52	1	1.3	0.8	1.4	1	1.3	1.6	1.6	1.6
PCB #56	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #60	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #66	0.3 J	0.4 J	0.5	0.8	0.4 J	0.4 J	0.4 J	0.5 J	0.4 J
PCB #70	0.8	0.8	1.1	1.6	0.7	0.7	0.9	1	1
PCB #74	0.4 J	0.3 J	0.4 J	0.5	0.6	0.5 J	0.5 J	0.5	0.5
PCB #87	0.2 J	0.3 J	0.7	0.7	0.5 J	0.5 J	0.5 J	0.6	1
PCB #95	1	1.3	0.8	1.4	1	1.3	1.6	1.6	1.6

Table 3-2 (cont.): Composite Sediment Chemistry and Conventionals Results for each DU

	CB-DU01A	CB-DU02A	CB-DU03A	CB-DU04A	CB-DU05B	CB-DU06B	CB-DU07B	CB-DU08B	CB-DU09B
	4/22/15	4/20/15	4/16/15	4/15/15	4/21/15	4/20/15	4/22/15	4/16/15	4/15/15
PCB #97	0.5	0.4 J	0.5	0.8	0.3 J	0.3 J	0.5 J	0.5 J	0.5 J
PCB #99	0.4 J	0.5 U	0.8	1.4	0.6	0.7	0.7	1	1.2
PCB #101	1.4	1.1	1.3	1.6	1.6	1	1.4	1.5	1.6
PCB #105	2.1	1.9	2.1	2.6	1.4	1.8	2.2	2.3	2.2
PCB #110	1.6	1.3	1.7	2.3	1.7	1.3	1.6	1.6	1.6
PCB #118	1.5	1.3	1.8	2.6	1.6	0.9	1.2	1.2	1.2
PCB #128	0.6	0.4 J	0.6	0.8	0.6	0.5	0.6	0.4 J	0.5
PCB #132	0.9	0.5 U	0.6	0.9	1	0.7	0.8	0.5	0.5
PCB #138	3.9	3.1	3.5	4.9	3.7	2.8	2.6	3.4	3.6
PCB #141	0.2 J	0.2 J	0.2 J	0.4 J	0.6	0.2 J	0.2 J	0.3 J	0.3 J
PCB #149	1.1	1.4	1.3	1.9	2.5	1.3	1.5	2	2.3
PCB #151	0.3 J	0.3 J	0.5 U	0.5 U	0.5	0.5 U	0.5 U	0.4 J	0.4 J
PCB #153	1.4	1.7	2.2	3.4	1.9	1.4	1.8	2.3	2.8
PCB #156	0.4 J	0.5 U	0.5 U	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #158	0.5 U	0.5 U	0.2 J	0.3 J	0.2 J	0.5 U	0.2 J	0.2 J	0.2 J
PCB #170	0.6	0.7	0.8	1	0.9	0.7	0.8	0.9	1.2
PCB #174	0.6	0.7	0.8	0.9	1.1	0.7	0.7	0.8	1
PCB #177	0.3 J	0.4 J	0.4 J	0.5 J	0.7	0.4 J	0.5 J	0.4 J	0.5
PCB #180	0.8	1	1.1	1.4	1.9	1.1	1.2	1.4	1.6
PCB #183	0.4 J	0.4 J	0.6	0.6	0.7	0.4 J	0.6	0.5	0.6
PCB #187	0.8	0.9	0.8	1	1.2	1	1.2	1.1	1.4
PCB #194	0.5 J	0.3 J	0.4 J	0.4 J	0.5	0.4 J	0.5 J	0.2 J	0.5
PCB #195	0.5 U	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.3 J	0.3 J	0.4 J
PCB #201	0.2 J	0.3 J	0.3 J	0.3 J	0.5	0.3 J	0.3 J	0.4 J	0.4 J
PCB #203	0.5 U	0.4 J	0.5 U	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.3 J
Total PCBs[9]	**31**	**27**	**32**	**42**	**37**	**28**	**33**	**34**	**37**

Notes: TOC: total organic carbon DW: dry weight

Comparative criteria (Table 3-1): Exceeded Bioaccumulation Trigger Exceeded TMDL **Exceeded MWRP surface (cover)** ***Exceeded MWRP foundation (non-cover)***

1. greater than 75 microns 2. greater than3.2 microns and less than 75 microns 3. less than 3.2 microns 4. Less than 75 microns

5. sum of detected concentrations of butyltin, dibutyltin, tributyltin, and tetrabutyltin 6. sum of detected 25 PAH compounds

7. sum of detected 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, and 2,4'-DDT, 2,4'-DDE, 2,4'-DDD, or highest non-detect value.

8. sum of detected cis-chlordane, trans-chlordane, oxy-chlordane, cis-nonachlor, and trans-nonachlor, or highest non-detect value. 9. sum of detected 40 PCB compounds

J-detected below the method reporting limit but above the method detection limit Y-non-detect with an elevated reporting limit due to chromatographic interference (equivalent to U with raised MRL)

U-non-detect at the method detection limit P-the analyte was detected on both columns but quantified values differed by >40% RPD with no obvious chromatographic interference

Table 3-3: Individual Core and Z-layer Composite Sediment Chemistry Results for Polycyclic Aromatic Hydrocarbons and Mercury

	CB-DU05B-C1	CB-DU05B-C2	CB-DU05B-C3	CB-DU05B-C4	CB-DU05B-C9	CB-DU05B-Z	CB-DU07B-Z
	Individual Core Analysis					Z Layer Composite	
Metals (mg/kg DW)							
Mercury	--	--	--	--	--	**0.49**	--
Polycyclic Aromatic Hydrocarbons (µg/kg DW)							
Naphthalene	370	43	320	37	390	290	45
2-Methylnaphthalene	240	42	120 J	42	190	79	40
1-Methylnaphthalene	670	12	160	11	240	62	13
Acenaphthylene	1,100	32	730	24	820	260	28
Acenaphthene	1,600	18	240	14	280	150	20
Fluorene	2,100	30	540	36	720	240	55
Phenanthrene	10,000	180	4,000	140	4,300	1,500	190
Anthracene	3,200	100	1,600	110	1,800	800	170
Fluoranthene	6,100	330	4,000	350	3,300	1,600	760
Pyrene	7,900	410	5,100	480	4,600	2,000	790
Benzo(a)anthracene	3,400	170	2,200	210	2,100	930	370
Chrysene	3,200	200	2,300	270	2,300	1,000	520
Benzo(b)fluoranthene	1,500	180	1,100	260	1,000	620	420
Benzo(k)fluoranthene	950	91	640	140	610	350	210
Benzo(a)pyrene	3,100	260	2,000	310	2,100	1,100	470
Indeno(1,2,3-cd)pyrene	1,200	160	890	180	840	500	240
Dibenz(a,h)anthracene	430	32	260	42	270	140	58
Benzo(g,h,i)perylene	1,000	190	790	140	1,000	630	290
Perylene	590	160	420	170	440	330	290
Biphenyl	300	14	86 J	14	130	52	17
2,6-Dimethylnaphthalene	560	16	130 J	15	200	69	19
1-Methylphenanthrene	1,500	29	700	21	720	300	23
Benzo(e)pyrene	1,400	150	990	190	1,000	570	310
2,3,5-Trimethylnaphthalene	210	5.8	140 U	5.3	79	35	14
Dibenzofuran	210	12	140 U	18	410	130	17
Total Benzofluoranthenes	3,600	370	2,500	540	2,400	1,400	830
Total PAH[1]	**53,000**	2,900	**29,000**	3,200	**30,000**	**14,000**	**5,400**

Notes: TOC: total organic carbon DW: dry weight
1. sum of detected 40 PAH compounds J-detected below the method reporting limit but above the method detection U-non-detect at the method detection limit
Comparative criteria (Table 3-1): Exceeded Bioaccumulation Trigger Exceeded TMDL **Exceeded MWRP surface (cover)** ***Exceeded MWRP foundation (non-cover)***

Table 3-4. Z Layer Composite Sediment Chemistry Results for Polychlorinated Biphenyls (PCBs)

	CB-DU01A-Z	CB-DU02A-Z	CB-DU03A-Z	CB-DU04A-Z	CB-DU05B-Z	CB-DU06B-Z	CB-DU07B-Z	CB-DU08B-Z	CB-DU09B-Z
Polychlorinated Biphenyls (µg/kg DW)									
PCB #8	0.9 Y	0.4 U	0.5 Y	0.4 J	1.1 Y	0.6 Y	0.6 Y	2.5	2.4 U
PCB #18	8.6	1.7	5.1	1.9	6.5	3.2	1.2	12	12 U
PCB #28	0.5 U	0.4 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5	2.4 U
PCB #31	0.5 U	0.4 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5	2.4 U
PCB #33	0.5 U	0.4 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5	2.4 U
PCB #44	0.9	0.4 U	0.4 J	0.5	1.2	0.5 J	0.4 J	2.5	2.4 J
PCB #49	0.5 U	0.4 U	0.5 U	0.5	0.6	0.5 J	0.4 J	2.5	2.4 U
PCB #52	1.4	1.1	1	1.4	2	1.6	1	2.4	2.8 U
PCB #56	0.5 U	0.4 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5	2.4 U
PCB #60	0.5 U	0.4 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5	2.4 J
PCB #66	0.2 J	0.4 U	0.2 J	0.4 J	0.4 J	0.3 J	0.4 J	2.5	2.4 U
PCB #70	0.7	0.5	0.7	0.9	1.3	0.8	0.9	1.2	1.2 U
PCB #74	0.5 U	0.4 J	0.5 U	0.5 U	1	0.5 J	0.5 U	2.5	2.4 J
PCB #87	0.5 U	0.4 U	0.5 U	0.5 J	0.8	0.5 U	0.5 U	2.5	2.4 U
PCB #95	0.4 J	0.3 J	0.6	0.8	0.9	0.6	0.8	1.1	1.4 U
PCB #97	0.5 U	0.3 J	0.5 U	0.6	1.1	0.6	0.7	2.5	2.4 U
PCB #99	0.5 J	0.5	0.6	0.9	0.9	0.8	0.7	2.5	1.2 U
PCB #101	0.5 U	0.4 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5	2 J
PCB #105	0.5	0.4 J	0.3 J	0.8	0.9	0.5	1	2.5	2.4 J
PCB #110	0.8	0.7	0.9	1.4	2.1	1.3	1.5	2.2	2 U
PCB #118	0.8	0.5	0.6	1	1.5	0.9	1	1.6	1.2 U
PCB #128	0.3 J	0.3 J	0.3 J	0.4 J	0.6	0.4 J	0.4 J	2.5	2.4
PCB #132	0.5 U	0.4 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5	2.4 U
PCB #138	2.1	0.4 U	2.3	3.3	5.6	3.4	3.2	4.3	4 J
PCB #141	0.1 J	0.4 U	0.2 J	0.3 J	0.3 J	0.2 J	0.2 J	2.5	2.4 U
PCB #149	0.7	1	1.2	1.7	2.4	1.7	1.4	2	2.8 U
PCB #151	0.5 U	0.4 U	0.4 J	0.5 J	0.6	0.4 J	0.4 J	2.5	2.4 U
PCB #153	1	1.1	1.4	2	3.1	2	1.8	2.5	2.8 U
PCB #156	0.5 U	0.4 U	0.5 U	0.5 U	0.4 J	0.5 U	0.5 U	2.5	2.4 J
PCB #158	0.5 U	0.4 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5	2.4 U

Table 3-4 (cont.): Z Layer Composite Sediment Chemistry Results for Polychlorinated Biphenyls (PCBs)

	CB-DU01A-Z	CB-DU02A-Z	CB-DU03A-Z	CB-DU04A-Z	CB-DU05B-Z	CB-DU06B-Z	CB-DU07B-Z	CB-DU08B-Z	CB-DU09B-Z
PCB #170	0.4 J	0.4 J	0.6	0.7	1.5	0.8	0.7	0.8	1.6 U
PCB #174	0.4 J	0.4 J	0.5	0.6	1.1	0.6	0.6	2.5	2.4 J
PCB #177	0.5 U	0.4 U	0.3 J	0.4 J	0.7	0.4 J	0.4 J	2.5	2.4 U
PCB #180	0.7	0.7	1	1.2	2	1.3	1.3	1.3	1.8 J
PCB #183	0.3 J	0.2 J	0.3 J	0.4 J	0.6	0.4 J	0.4 J	2.5	2.4 U
PCB #187	0.6	0.6	0.7	1	1.9	1.3	1	1.4	1.6 U
PCB #194	0.5 U	0.4 U	0.2 J	0.3 J	0.5	0.3 J	0.3 J	2.5	2.4 J
PCB #195	0.5 U	0.4 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5	2.4 U
PCB #201	0.2 J	0.2 J	0.3 J	0.3 J	0.4 J	0.3 J	0.3 J	0.5	0.6
PCB #203	0.5 U	0.4 U	0.5 U	0.5 U	0.3 J	0.5 U	0.5 U	2.5 U	2.4 U
Total PCB[1]	22	11	20	**25**	**43**	**26**	22	**100**	**28**

Notes: DW: dry weight

Comparative criteria (Table 3-1): Exceeded Bioaccumulation Trigger Exceeded TMDL **Exceeded MWRP surface (cover)** ***Exceeded MWRP foundation (non-cover)***

1. sum of detected 40 PCB compounds

J-detected below the method reporting limit but above the method detection limit Y-non-detect with an elevated reporting limit due to chromatographic interference (equivalent to U with raised MRL)

U-non-detect at the method detection limit

3.2 Elutriate Chemistry Results

Two elutriate procedures were conducted on the sediment composites from each DU. The chemistry results from MET and DI-WET are intended to represent concentrations that may be present in potential discharges from levee breaching and from the make-up water pond if Central Basin sediments were used for fill at MWRP. The tests are respectively representative of marine and freshwater scenarios. The target chemical list for both tests is listed in Table 5-7 of the SAP along with the full methodology for obtaining the elutriate for each test (NewFields 2015).

Briefly, DI-WET involved tumbling a 10 to 1 ratio of deionized (DI) to sediment for 48 hours to extract total and dissolved metals. MET involved mixing and aeration of 150 g/L sediment to site water for about one hour followed by 24 hours of settling. The resulting elutriate was siphoned and sent for chemical analysis.

Chemistry results for both tests are presented in Table 3-5 and are compared to the Regional Water Quality Control Board (RWQCB) daily maximum limits (DML; RWQCB 2013). For the MET, selenium concentrations exceeded the DML for DU01A, DU06B, DU07B, DU08B, and DU09B. Copper concentrations exceeded the DML for all but DU06B. However, the analytical laboratory had interference issues due to the high salinity of the samples. This interference resulted in elevated reporting limits of between 10-12 mg/kg for these two metals, as well as others that did not exceed the DML. Reported concentrations are generally within a factor of two of the elevated MRLs. The biological MET results provided in Section 3.3.4.3.

The interference issues did not occur in the freshwater DI-WET analysis. No exceedances of the DML were noted in the DI-WET samples results. Due to the analytical interference an issue involving the MET elutriates, it is recommended that the DI-WET results be used for evaluating the potential leachate from Central basin sediment composites.

Table 3-5. Summary of Elutriate Chemistry Results for Total and Dissolved Metals

	DML	CB-DU01A	CB-DU02A	CB-DU03A	CB-DU04A	CB-DU05B	CB-DU06B	CB-DU07B	CB-DU08B	CB-DU09B
Modified Elutriate Testing (MET) Results										
Conventionals (mg/L)										
TSS[1]	100	10.2	10.4	8.6	9.5	14	18.2	10.2	15.3	19.6
Total Metals (µg/L)										
Mercury	2.1	0.08 J	0.02 J	0.01 J	0.01 J	0.1 U	0.06 J	0.1 U	0.1 U	0.1 U
Selenium	20	20	12 J	3 J	6 J	6 J	30	40	20	20
Dissolved Metals (µg/L)										
Arsenic	69	37	32	32	32	30	5 U	8	4.5 J	4 J
Cadmium	3.9	2 U	2 U	2 U	2 U	2 U	0.5 J	0.5 J	0.5 J	0.5 J
Chromium	16	10	10	10	10	10	7 J	9 J	9 J	9 J
Copper	9.4	20	20	20	20	20	9 J	20	20	20
Lead	65	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Nickel	74	10	20	20	10	10	10 J	10	10	10
Silver	1.9	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Zinc	90	16 J	17 J	17 J	18 J	18 J	57 J	27 J	26 J	26 J
Deionized Waste Extraction Test (DI-WET) Results										
Conventionals (mg/L)										
TSS[1]	100	50.8	34	44.5	29.3	24.7	49.2	45.4	80	43.3
Total Metals (µg/L)										
Mercury	2.1	0.05 J	0.1	0.3	0.05 J	0.2	0.2	0.1	0.3	0.08 J
Selenium	20	5	4.8	4.5	4.3	5	5.2	5.3	3.5	4.5
Dissolved Metals (µg/L)										
Arsenic	69	51.4	38	44.2	30.6	27.8	28	43.5	39.6	32.2
Cadmium	3.9	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chromium	16	0.9	1	1	1	0.9	0.9	1	0.9	1.2
Copper	9.4	2.2	2	1.9	2	1.9	2.2	1.9	2.5	1.8
Lead	65	0.2	0.2	0.1	0.2	0.3	0.3	0.2	0.4	0.2
Nickel	74	2.7	4.3	2.4	1.8	3	3	4	3.7	1.5
Silver	1.9	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	90	1.5 J	1.4 J	1.1 J	1.4 J	1.5 J	1.2 J	1.2 J	1.6 J	1 J

Notes: DML: Regional Water Quality Control Board Daily Maximum Limit TSS: total suspended solids

Exceeded Daily Maximum Limit

1. The TSS threshold value of 100 mg/L represents an instantaneous maximum rather than a daily maximum limit

J-detected below the method reporting limit but above the method detection U-non-detect at the method detection

3.3 Biological Evaluation Results

Biological testing was conducted to determine suitability for disposal at SF-11, SF-DODS, and for potential beneficial re-use at MWRP. Solid phase (SP), suspended particulate phase (SPP), and bioaccumulation potential (BP) tests were conducted to determine whether anthropogenic contaminants of concern were present at concentrations such that ocean disposal of the dredged material would result in toxicity to aquatic organisms in the water column and/or bioaccumulation of contaminants in unacceptable concentrations in biota. The complete laboratory report, including methods, detailed results, and a QA/QC narrative, is provided in Appendix C. A summary of biological test results, QA/QC, and deviations from the SAP (NewFields 2015) are provided in the subsequent sections.

3.3.1 Solid Phase Amphipod Mortality Bioassay: *Ampelisca abdita*

The SP amphipod mortality bioassay is a 10-day static exposure test with five replicates for each test treatment, reference, and control sediment. At the termination of the test, the number of survivors are counted and compared to controls to determine whether significant mortality has occurred.

The SP amphipod mortality test was initiated on May 7, 2015. Each replicate was stocked with 20 randomly selected test organisms. The SP amphipod test met the QA/QC criteria for control acceptability results with 100% survival (acceptability criterion: > 90%) in the native control sediment. All water quality parameters were within the recommended water quality conditions for the SP amphipod mortality bioassay (Appendix C).

A positive control test (reference toxicant) using KCl was run for the SP amphipod mortality bioassay. The results of the reference toxicity test were an LC_{50} = 1.24 g/L KCl, which was within the laboratory acceptable range of 0.195 to 1.66 g/L KCl for tests using *A. abdita*.

The SP amphipod mortality bioassay mean survival results for *A. abdita* ranged from 90-100% and are summarized in Table 3-6. All of the results met the Limiting Permissible Concentration (LPC) criteria for the test. Therefore, none of the DU sediment composite samples demonstrated an acute toxic response in the amphipod *A. abdita.*

Table 3-6: Test Results for SP Amphipod Mortality Bioassay (*A. abdita*)

Sample ID	Survival					Mean Survival (%)	Significant Biological Effect: R-T ≥ 20%?	Statistically Less than Reference?	Exceeds LPC
	Replicate A	Replicate B	Replicate C	Replicate D	Replicate E				
Control	100	100	100	100	100	100	-	-	-
Reference (R-AM-H)	100	95	95	100	100	98	-	-	-
CB-DU01A	100	100	100	100	100	100	-2; No	No	No
CB-DU02A	100	100	100	100	100	100	-2; No	No	No
CB-DU03A	100	100	90	95	100	97	1; No	No	No
CB-DU04A	100	100	90	100	100	98	0; No	No	No
CB-DU05B	90	100	100	100	85	95	3; No	No	No
CB-DU06B	70	95	95	90	100	90	8; No	No	No
CB-DU07B	100	100	90	95	100	97	1; No	No	No
CB-DU08B	100	100	90	100	100	98	0; No	No	No
CB-DU09B	95	100	90	100	100	97	1; No	No	No

Notes: R: Mean Survival for Reference Sediment T: Mean Survival for Test Sediment LPC: Limiting Permissible Concentration

3.3.2 Solid Phase Polychaete Mortality Bioassay: *Neanthes arenaceodentata*

The SP polychaete mortality bioassay is a 10-day static exposure test with five replicates for each test treatment, reference, and control sediment. At the termination of the test, the number of survivors are counted and compared to controls to determine whether significant mortality has occurred.

The SP polychaete mortality test was initiated on May 4, 2015. Each replicate was stocked with 10 test organisms. The SP polychaete test met the QA/QC criteria for control acceptability results with 96% survival (acceptability criterion: > 90%) in the native control sediment. All water quality parameters were within the recommended water quality conditions for the SP polychaete mortality bioassay (Appendix C).

A positive control test using KCl was run for the SP polychaete mortality bioassay. The results of the reference toxicity test were an LC_{50} = 1.74 g/L KCl, which was within the laboratory acceptable range of 1.08 to 2.17 g/L KCl for tests using *N. arenaceodentata*.

The mean survival results for the SP polychaete (*N. arenaceodentata)* mortality bioassay ranged from 94 to 100% are summarized in Table 3-7. All of the results met the Limiting Permissible Concentration (LPC) criteria for the test. Therefore, none of the DU sediment composite samples demonstrated an acute toxic response in the polychaete *N. arenaceodentata.*

Table 3-7: Test Results for SP Polychaete Mortality Bioassay (*N. arenaceodentata*)

Sample ID	Survival					Mean Survival (%)	Significant Biological Effect: R-T ≥ 10%?	Statistically Less than Reference?	Exceeds LPC
	Replicate A	Replicate B	Replicate C	Replicate D	Replicate E				
Control	90	100	100	100	90	96	-	-	-
Reference (R-AM-H)	90	100	90	100	100	96	-	-	-
CB-DU01A	100	100	90	100	100	98	-2; No	No	No
CB-DU02A	100	100	100	100	90	98	-2; No	No	No
CB-DU03A	100	100	100	100	100	100	-4; No	No	No
CB-DU04A	80	100	100	100	90	94	2; No	No	No
CB-DU05B	100	100	90	100	100	98	-2; No	No	No
CB-DU06B	100	100	100	100	90	98	-2; No	No	No
CB-DU07B	100	100	100	100	100	100	-4; No	No	No
CB-DU08B	100	90	100	100	90	96	0; No	No	No
CB-DU09B	90	100	100	90	100	96	0; No	No	No

Notes: R: Mean Survival for Reference Sediment T: Mean Survival for Test Sediment LPC: Limiting Permissible Concentration

3.3.3 Suspended Particulate Phase Bioassay: *Mytilus galloprovincialis*

The SPP bioassay is a bivalve larval development test that uses sample elutriates of 100%, 50%, 10%, and 1% concentrations and a clean seawater control. Five replicates per elutriate concentration are conducted for approximately 48-96 hours to ensure the proper development of the bivalve larvae. At the termination of the test, the number of survival and normally developed larvae are counted and compared to controls to determine whether significant mortality or abnormal development has occurred.

The SPP tests were initiated on May 6 and 14, 2015. The embryo stocking density was within the method recommended density of 15-30 embryos/ml. The SPP test met the QA/QC criteria for control acceptability results with the Mean Proportion Normal measured at a range of 80.3 to 91.7% (> 70%) and Mean Proportion Survival measure at a range from 97.5 to 99.5% (>70). All water quality parameter were within the recommended water quality conditions for the SPP bioassay (Appendix C).

A positive control test (reference toxicant) using KCl was run for each bath of the SPP larval development bioassay. The results of the reference toxicity test were an EC_{50} = 2.03 g/L and 2.38 g/L KCl, which was within the laboratory acceptable range of 1.93 to 2.58 g/L KCl for tests using *M. galloprovincialis.*

The SPP larval development bioassay results ranged from an EC_{50} of 35.4 (DU04A) to > 100% (DU05B, DU06B, DU07B, DU08B, and DU09B). The test results are summarized in Table 3-8. The evaluation for potential water column toxicity during in-bay disposal at SF-11 is discussed in Section 4.1.

Table 3-8: Summary of Test Results for SPP Larval Development Bioassay (*M. galloprovincialis*)

Sample ID	Concentration (%)	Mean Survival (%)[1]	EC_{50}	Mean Normal Development (%)	EC_{50}
CB-DU01A	Control	90.3	58.5%	98.9	70.2%
	Site Water	84.7		99.5	
	1	88.3		98.8	
	10	83.7		98.9	
	25	79.8		99.5	
	50	85.8		98.1	
	100	0		0	
CB-DU02A	Control	91.4	61.6%	98.6	70.7%
	Site Water	84.7		99.5	
	1	88.0		99.2	
	10	85.2		98.6	
	25	84.5		99.3	
	50	83.4		99.1	
	100	0		0	
CB-DU03A	Control	84.3	63.4%	98.7	67.8%
	Site Water	84.7		99.5	
	1	87.0		97.7	
	10	88.0		98.8	
	25	85.4		98.8	
	50	74.1		92.6	
	100	0		0	
CB-DU04A	Control	80.3	35.0%	97.8	35.4%
	Site Water	84.7		99.5	
	1	88.4		98.1	
	10	88.6		99.0	
	25	84.8		98.7	
	50	0		0	
	100	0		0	
CB-DU05B	Control	87.8	>100%	98.7	>100%
	Site Water	84.7		99.5	
	1	87.0		98.9	
	10	87.5		99.0	
	25	86.6		99.3	
	50	87.4		99.5	
	100	82.8		100.0	
CB-DU06B	Control	91.2	>100%	99.4	>100%
	Site Water	82.9		95.9	
	1	86.9		99.1	
	10	92.5		99.2	
	25	85.1		99.0	
	50	88.3		99.0	
	100	84.5		98.7	

Table 3-8 (cont.): Summary of Test Results for SPP Larval Development Bioassay (*M. galloprovincialis*)

Sample ID	Concentration (%)	Mean Survival (%)[1]	EC_{50}	Mean Normal Development (%)	EC_{50}
CB-DU07B	Control	87.6	>100%	99.5	>100%
	Site Water	82.9		95.9	
	1	87.2		99.6	
	10	88.5		98.8	
	25	90.8		99.5	
	50	76.5		99.3	
	100	88.4		99.3	
CB-DU08B	Control	88.4	>100%	98.7	>100%
	Site Water	82.9		95.9	
	1	83.9		98.7	
	10	89.9		99.4	
	25	84.1		99.5	
	50	90.8		99.3	
	100	88.6		96.7	
CB-DU09B	Control	88.6	>100%	98.8	>100%
	Site Water	82.9		95.9	
	1	88.5		99.8	
	10	88.8		99.4	
	25	91.4		99.3	
	50	87.2		99.1	
	100	89.9		99.8	
R-AM-H	Control	91.7	>100%	97.5	>100%
	Site Water	82.9		95.9	
	1	80.6		96.3	
	10	91.1		96.9	
	50	84.6		95.3	
	100	86.8		96.1	

3.3.4 Additional Toxicity Testing Results

Additional bioassay testing included conducting two water column bioassays using the fish *Menidia beryllina* and the mysid shrimp *Americamysis bahia* to determine suitability for potential disposal at SF-DODS.

3.3.4.1 Water Column Mortality Bioassay: Americamysis bahia

The water column mortality bioassay using *A. bahia* is a 96 hour static exposure test with dilutions of 100%, 50%, and 10% of elutriate, and a clean seawater control. Five replicates per dilution were conducted, with ten test organisms per replicate. At the test termination, the number of survivors are counted and compared to controls to determine whether significant mortality has occurred.

The water column test was initiated in two batches on May 6 and 14, 2015. The test met the QA/QC criteria for control acceptability results with a range from 94 to 100% survival in seawater control (Acceptability criterion ≥ 90%). The water quality parameters for *A. bahia* were within the recommended water quality conditions for the bioassay (Appendix C).

A positive control test using KCl was run for the water column mysid shrimp mortality bioassay. The results of the reference toxicity test were an LC_{50} = 0.56 and 0.63 g/L KCl, which was within the laboratory acceptable range of 0.53 to 0.76 g/L KCl for tests using *A. bahia.*

TheLC_{50} bioassay results for *A. bahia* were all >100% and are summarized in Table 3-9.

Table 3-9: Test Results for Water Column Mortality Bioassay (*A. bahia*)

Sample ID	Concentration (%)	Mean Survival (%)[1]	EC_{50}
CB-DU01A	Control	100	>100%
	Site Water	100	
	1	100	
	10	100	
	25	100	
	50	100	
	100	100	
CB-DU02A	Control	100	>100%
	Site Water	100	
	1	96.0	
	10	98.0	
	25	98.0	
	50	96.0	
	100	98.0	
CB-DU03A	Control	98.0	>100%
	Site Water	100.0	
	1	96.0	
	10	98.0	
	25	96.0	
	50	98.0	
	100	98.0	

Table 3-9 (cont.): Test Results for Water Column Mortality Bioassay (*A. bahia*)

Sample ID	Concentration (%)	Mean Survival (%)[1]	EC_{50}
CB-DU04A	Control	100.0	>100%
	Site Water	100.0	
	1	100.0	
	10	98.0	
	25	96.0	
	50	96.0	
	100	90.0	
CB-DU05B	Control	100.0	>100%
	Site Water	100.0	
	1	98.0	
	10	100.0	
	25	98.0	
	50	100.0	
	100	100.0	
CB-DU06B	Control	98.0	>100%
	Site Water	100.0	
	1	98.0	
	10	98.0	
	25	96.0	
	50	100.0	
	100	94.0	
CB-DU07B	Control	94.0	>100%
	Site Water	100.0	
	1	98.0	
	10	96.0	
	25	98.0	
	50	100.0	
	100	100.0	
CB-DU08B	Control	98.0	>100%
	Site Water	100.0	
	1	98.0	
	10	98.0	
	25	96.0	
	50	100.0	
	100	100.0	
CB-DU09B	Control	96.0	>100%
	Site Water	100.0	
	1	98.0	
	10	100.0	
	25	96.0	
	50	98.0	
	100	98.0	
R-AM-H	Control	100.0	>100%
	Site Water	100.0	
	1	98.0	
	10	100.0	
	50	98.0	
	100	96.0	

3.3.4.2 Water Column Mortality Bioassay: *Menidia beryllina*

The water column mortality bioassay using *M. beryllina* is a 96 hour static exposure test with dilutions of 100%, 50%, and 10% of elutriate as well as clean seawater control. Five replicates per concentration were conducted, with ten test organisms per replicate. At the test termination, the number of survivors are counted and compared to controls to determine whether significant mortality has occurred.

The water column test using M. beryllina was initiated in two batches on May 7 and 13, 2015. The test met the QA/QC criteria for control acceptability results with a range of 94 to 100% survival in seawater control (criterion ≥ 90%). The water quality parameters for *M. beryllina* were within the recommended water quality conditions for the bioassay (Appendix C).

A positive control test (reference toxicant) using KCl was run for the water column fish mortality bioassay. The results of the reference toxicity test were an LC_{50} = 1.32 and 1.41 g/L KCl, which was within the laboratory acceptable range of 0.91 to 1.45 g/L KCl for tests using *M. beryllina.*

The LC_{50} bioassay results for *M. beryllina* were all >100% and are summarized in Table 3-10.

Table 3-10: Test Results for Water Column Mortality Bioassay (*M. beryllina*)

Sample ID	Concentration (%)	Mean Survival (%)[1]	EC_{50}
CB-DU01A	Control	100.0	>100%
	Site Water	100.0	
	1	100.0	
	10	100.0	
	25	100.0	
	50	98.0	
	100	100.0	
CB-DU02A	Control	98.0	>100%
	Site Water	100.0	
	1	100.0	
	10	98.0	
	25	94.0	
	50	94.0	
	100	100.0	
CB-DU03A	Control	100.0	>100%
	Site Water	100.0	
	1	100.0	
	10	100.0	
	25	98.0	
	50	98.0	
	100	96.0	

Table 3-10 (cont.): Test Results for Water Column Mortality Bioassay (*M. beryllina*)

Sample ID	Concentration (%)	Mean Survival (%)[1]	EC_{50}
CB-DU04A	Control	100.0	>100%
	Site Water	100.0	
	1	100.0	
	10	98.0	
	25	96.0	
	50	96.0	
	100	90.0	
CB-DU05B	Control	100.0	>100%
	Site Water	100.0	
	1	98.0	
	10	100.0	
	25	98.0	
	50	100.0	
	100	100.0	
CB-DU06B	Control	100.0	>100%
	Site Water	98.0	
	1	100.0	
	10	100.0	
	25	100.0	
	50	98.0	
	100	100.0	
CB-DU07B	Control	100.0	>100%
	Site Water	98.0	
	1	96.0	
	10	100.0	
	25	100.0	
	50	96.0	
	100	100.0	
CB-DU08B	Control	100.0	>100%
	Site Water	100.0	
	1	98.0	
	10	98.0	
	25	96.0	
	50	100.0	
	100	100.0	
CB-DU09B	Control	96.0	>100%
	Site Water	98.0	
	1	100.0	
	10	98.0	
	25	97.5	
	50	100.0	
	100	100.0	
R-AM-H	Control	100.0	>100%
	Site Water	98.0	
	1	100.0	
	10	98.0	
	50	100.0	
	100	96.0	

3.3.4.3 *Modified Elutriate Test (MET) Bioassay Results*

The MET was conducted for determining whether the material can be placed at MWRP, as per the upland replacement requirements at Montezuma (Order R2-2012-0087) defined in the Title 22 of the California Code of Regulations. The results of the test, using the test species *A. bahia* are presented in Table 3-11.

A positive control test using KCl was run for the water column mysid shrimp mortality bioassay. The results of the reference toxicity test were an LC_{50} = 0.56 and 0.63 g/L KCl, which was within the laboratory acceptable range of 0.53 to 0.76 g/L KCl for tests using *A. bahia.*

None of the elutriates tested exhibited any toxicity.

Table 3-11. Test Results for the Modified Elutriate Test (*A. bahia*)

Test Batch	Elutriate Treatment	Mean Survival (%)
Batch 1 (Initiated 5/6/15)	Control	98.0
	Site Water	100.0
	CB-DU01A	100.0
	CB-DU02A	96.0
	CB-DU03A	100.0
	CB-DU04A	98.0
	CB-DU05B	98.0
Batch 2 (Initiated 5/14/15)	Control	98.0
	Site Water	100.0
	CB-DU06B	100.0
	CB-DU07B	100.0
	CB-DU08B	92.0
	CB-DU09B	96.0

3.3.5 Bioaccumulation Testing Results: *Nereis virens* and *Macoma nasuta*

The 28-day bioaccumulation tests using the polychaete *N. virens* and the bivalve *M. nasuta* were conducted on sediments from all nine DUs. The objective of the bioaccumulation tests was to evaluate the potential uptake of PCBs and PAHs in test organisms. The bioaccumulation tests were run in two batches that terminated on May 27, 2015 (*M. nasuta*) and June 4, 2015 (*N. virens*). Each batch included five replicates from each of the nine sediment composite DUs, a laboratory control sediment, and reference sediment collected from R-AM-H near SF-11.

The bioaccumulation test results are summarized in Table 3-12. The mean percent survival for the control sediment was 98 percent for *M. nasuta* and 96 percent for *N. virens.* All test sediments for *M. nasuta* all exceeded 90 percent mean survival except for DU02A at 89 percent. All test sediments for *N. virens* equaled or exceeded 90 percent mean survival.

Table 3-12: Test Results for the Bioaccumulation Testing (*N. virens* and *M. nasuta*)

	***Macoma nasuta*[1]**		***Nereis virens*[2]**	
	Mean Survival	**Standard Deviation**	**Mean Survival**	**Standard Deviation**
CB-Control	98	2.7	96	5.5
CB-DU01A	98	2.7	92	13.0
CB-DU02A	89	4.2	96	5.5
CB-DU03A	96	4.2	100	0.0
CB-DU04A	94	4.2	92	8.4
CB-DU05B	96	4.2	96	5.5
CB-DU06B	92	7.6	96	5.5
CB-DU07B	98	2.7	94	5.5
CB-DU08B	92	4.5	98	4.5
CB-DU09B	96	4.2	90	17.3
R-AM-H	94	4.2	92	13.0

Notes:
1. all treatments were initiated with 20 clams per replicate
2. all treatments were initiated with 10 polychaetes per replicate

After termination, tissue samples were submitted for chemistry analysis. The five replicates from each sample were homogenized into one composite sample. The DMMO proposed to analyze all composites of both species for PCBs due to exceedances of the BT criteria (Table 3-2). PAH concentrations in sediment composites from DU05B and DU07B both exceeded the BT, however the DMMO only requested tissue analysis for DU05B (Table 3-2). A time-zero (T_0) sample considered representative of tissue concentrations prior to bioaccumulation testing was also submitted to the laboratory for analysis in addition to the samples from Table 3-12. All samples were analyzed for percent lipids and total solids.

The PCB congener results of the tissue analysis are provided in Table 3-13 for *M. nasuta* and Table 3-14 for *N. virens*. PCB congeners were detected in two of the *M. nasuta* tissue composites. Only one congener was detected in DU04A at a concentration qualified at less than the method reporting limit (MRL). Two congeners were detected in DU09B, but again both reported values were less than the MRL (Table 3-13).

PCB detections were more frequent in the *N. Virens* tissues. Total PCB concentrations in the DU composites ranged between 2.7 and 4.0 µg/kg wet weight (WW). These values were consistent with the T_0, control, and reference tissues (Table 3-14). The T_0 tissues had the highest total PCB concentration in Table 3-14 at 5.5 µg/kg WW. The lower PCB concentrations in the remaining samples suggest a net loss of PCBs in tissues during the exposure period to Central Basin sediments.

Several PAHs were detected in the DU05B composite of both species. Total PAHs in the *N. virens* composite from DU05B were 32.0 µg/kg WW. Total PAHs in the T_0 sample was 62.5 µg/kg, but this was mainly due to the detection of perylene at 48.0 µg/kg. Perylene was not detected in any other composites. For comparison, total PAHs concentrations in the control and reference samples were 8.0 and 3.5 µg/kg, respectively (Table 3-15).

Total PAHs in the *M. nasuta* composite were 74.5 µg/kg. Concentrations in the T_0, control, and reference were all below 10.0 µg/kg (Table 3-15).

The difference in concentration between the DU composite and the batch reference and control sediment only demonstrates that uptake may have occurred. The difference does not indicate whether the observed concentration level may be detrimental to resident organisms at the target disposal site. Additional factors need to be considered in determining these potential ecological impacts. Of particular concern is whether or not the target contaminant is available for uptake and has potential to bioaccumulate in the food web to such an extent that concentrations either are causing, or could cause, effects in humans or ecological receptors. These concerns are evaluated three ways in this section:

1. Comparison of test organism tissue concentrations to Federal Department of Agriculture (FDA) or USEPA action levels to evaluate risks to human health. Tissue concentrations less than the Federal thresholds are not expected to pose a risk to human health.

2. Comparison of bioaccumulation testing results from Central Basin to the results of bioaccumulation tests conducted on sediments from the SF-DODS reference site. Comparisons are made first in terms of absolute tissue concentrations. If site tissue concentrations exceed reference concentrations by a significant amount, then the bioavailability and bioaccumulation potential of contaminants is assessed relative to

reference sediment bioaccumulation factors/biota sediment accumulation factors (BAF/BSAF) values.

3. Comparison of bioaccumulation testing tissue concentrations from Central Basin to tissue residue effects data and/or toxicity reference values (TRV). This comparison is only conducted for any contaminant with concentrations significantly exceeding reference tissues from SF-DODS as described in step 2.

The findings of these comparisons are then incorporated with fate and transport considerations to create a general model of bioaccumulation potential and ecological risk at the SF-DODS site.

Table 3-13: Tissue PCB Chemistry Results for Laboratory Bioaccumulation Tests (*Macoma nasuta*)

M. Nasuta	T_0	Control	DU01A	DU02A	DU03A	DU04A	DU05B	DU06B	DU07B	DU08B	DU09B	R-AM-H
Conventionals (%)												
Total Solids	12.6	12.2	11.8	11.8	11.2	12	11.3	11.6	12.3	11.7	11.8	11.3
Percent Lipids	0.488	0.485	0.488	0.473	0.449	0.526	0.414	0.421	0.572	0.366	0.462	0.43
Polychlorinated Biphenyls (µg/kg WW)												
PCB #8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #18	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #28	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #31	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #33	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #44	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #49	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #52	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #56	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #60	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #66	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #70	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #74	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #87	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #95	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #97	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #99	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #101	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #105	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #110	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #118	1 U	1 U	1 U	1 U	1 U	0.6 J	1 U	1 U	1 U	1 U	1 U	1 U
PCB #128	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #132	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #138	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.6 J	1 U
PCB #141	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #149	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 J	1 U
PCB #151	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #153	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #156	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Table 3-13 (cont.): Tissue PCB Chemistry Results for Laboratory Bioaccumulation Tests (*Macoma nasuta*)

M. Nasuta	T_0	Control	DU01A	DU02A	DU03A	DU04A	DU05B	DU06B	DU07B	DU08B	DU09B	R-AM-H
PCB #158	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #170	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #174	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #177	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #180	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #183	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #187	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #194	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #195	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #201	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #203	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total PCB*	1 U	1 U	1 U	1 U	1 U	0.6 J	1 U	1 U	1 U	1 U	1.1 J	1 U

Notes: WW: wet weight T_0: tissue preserved prior to bioaccumulation testing

1. sum of detected 40 PCB compounds

J-detected below the method reporting limit but above the method detection U-non-detect at the method detection

Table 3-14: Tissue PCB Chemistry Results for Laboratory Bioaccumulation Tests (*Nereis virens*)

N. Virens	T_0	Control	DU01A	DU02A	DU03A	DU04A	DU05B	DU06B	DU07B	DU08B	DU09B	R-AM-H
Conventionals (%)												
Total Solids	16.2	14.6	14.8	14.8	13.2	13.5	12.8	14.2	14.6	13.9	14.4	14.5
Percent Lipids	1.35	1.18	1.23	1.21	1.1	1.02	1.01	1.16	1.12	1.12	1.17	1.24
Polychlorinated Biphenyls (µg/kg WW)												
PCB #8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #18	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #28	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #31	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #33	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #44	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #49	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #52	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #56	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #60	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #66	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #70	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #74	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #87	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #95	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #97	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #99	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #101	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #105	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #110	1 U	1 U	1 U	1 U	1 U	0.6 J	1 U	1 U	1 U	1 U	1 U	1 U
PCB #118	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #128	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #132	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #138	1.4	0.6 J	0.6 J	0.6 J	0.6 J	0.6 J	0.5 J	0.5 J	0.7 J	0.6 J	0.6 J	0.5 J
PCB #141	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #149	0.8 J	0.6 J	0.7 J	0.7 J	0.8 J	0.9 J	0.6 J	0.7 J	0.8 J	0.7 J	0.8 J	0.6 J
PCB #151	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #153	1.8	1.7	1.8	1.7	1.6	1.1	0.9 J	1.7	1.8	1.5	1.7	1.5
PCB #156	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Table 3-14 (cont.): Tissue PCB Chemistry Results for Laboratory Bioaccumulation Tests (*Nereis virens*)

N. Virens	T_0	Control	DU01A	DU02A	DU03A	DU04A	DU05B	DU06B	DU07B	DU08B	DU09B	R-AM-H
PCB #158	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #170	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #174	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #177	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #180	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #183	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #187	0.9 J	0.7 J	0.7 J	0.7 J	0.7 J	0.8 J	0.7 J	0.7 J	0.7 J	0.9 J	0.8 J	0.7 J
PCB #194	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #195	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #201	0.6 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PCB #203	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total PCB[1]	5.5	3.6	3.8	3.7	3.7	4	2.7	3.6	4	3.7	3.9	3.3

Notes: WW: wet weight T_0: tissue preserved prior to bioaccumulation testing

1. sum of detected 40 PCB compounds

J-detected below the method reporting limit but above the method detection U-non-detect at the method detection

Table 3-15: Tissue PAH Chemistry Results for Laboratory Bioaccumulation Tests (*Nereis virens*)

	T_0	Control	DU05B	R-AM-H	T_0	Control	DU05B	R-AM-H
	Macoma nasuta				*Nereis virens*			
Conventionals (%)								
Total Solids	12.6	12.2	11.3	11.3	16.2	14.6	12.8	14.5
Percent Lipids	0.488	0.485	0.414	0.43	1.35	1.18	1.01	1.24
Polycyclic Aromatic Hydrocarbons (µg/kg WW)								
Naphthalene	5 U	5 U	5 U	5 U	3 J	4 J	5.5	3.5 J
2-Methylnaphthalene	5 U	5 U	5 U	5 U	5 U	5 U	4 J	5 U
1-Methylnaphthalene	5 U	5 U	5 U	5 U	5 U	5 U	3 J	5 U
Acenaphthylene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acenaphthene	5 U	5 U	5 U	5 U	5 U	5 U	4.5 J	5 U
Fluorene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Phenanthrene	5 U	5 U	11	5 U	5 U	5 U	2.5 J	5 U
Anthracene	5 U	5 U	3 J	5 U	5 U	5 U	5 U	5 U
Fluoranthene	3 J	4 J	11	3 J	3.5 J	5 U	2.5 J	5 U
Pyrene	5 U	4.5 J	22	3.5 J	3.5 J	5 U	4.5 J	5 U
Benzo(a)anthracene	5 U	5 U	3.5 J	5 U	5 U	5 U	5 U	5 U
Chrysene	5 U	5 U	4 J	5 U	5 U	5 U	5 U	5 U
Benzo(b)fluoranthene	5 U	5 U	3.5 J	5 U	5 U	5 U	5 U	5 U
Benzo(k)fluoranthene	5 U	5 U	1.5 J	5 U	5 U	5 U	5 U	5 U
Benzo(a)pyrene	5 U	5 U	4 J	5 U	5 U	5 U	5 U	5 U
Indeno(1,2,3-cd)pyrene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibenz(a,h)anthracene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(g,h,i)perylene	5 U	5 U	4.5 J	5 U	5 U	5 U	5 U	5 U
Perylene	5 U	5 U	3 J	5 U	48	5 U	5 U	5 U
Biphenyl	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,6-Dimethylnaphthalene	5 U	5 U	5 U	5 U	4.5 J	4 J	5.5	5 U
1-Methylphenanthrene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(e)pyrene	5 U	5 U	3.5 J	5 U	5 U	5 U	5 U	5 U
2,3,5-Trimethylnaphthalene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibenzothiophene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Total Benzofluoranthenes	9.9 U	10 U	6.6 J	10 U	10 U	10 U	10 U	10 U
Total PAH[1]	3 J	8.5 J	76.1 J	6.5 J	62.5	8 J	32	3.5 J

Notes: WW: wet weight T_0: tissue preserved prior to bioaccumulation testing

1. sum of detected 25 PAH compounds J-detected below the method reporting limit but above the method detection U-non-detect at the method detection

3.3.5.1 Comparison of Tissue Concentrations to Federal Action Levels

Concentrations in Tables 3-13 through 3-15 were compared to FDA and USEPA human health guidelines. There is no FDA action level for PAH, but a concentration of 6,000 µg/kg for total PAH is the USEPA limit considered to present risk to consumers of fish and shellfish (Oros et al. 2007; USEPA 2000). All PAH concentrations were well below this threshold. There is no FDA action level for PCBs, but there is a tolerance level of 2,000 µg/kg. All Central Basin tissue concentrations were below this level.

The USEPA screening value for recreational fishers is 20 µg/kg. Total PCB concentrations in Tables 3-13 and 3-14 are below these thresholds. The USEPA screening value for subsistence fishers is 2.45 µg/kg. All *M. nasuta* tissues were below this value. *N. virens* tissues exceeded this value due to elevated concentrations in the organisms prior to testing (T_0). However, *N. virens* should not be evaluated for human health risks as it is not a species targeted for consumption.

3.3.5.2 Comparison to SF-DODS Reference Database

The USEPA tracks tissue chemistry results from bioaccumulation testing conducted on sediments from the SF-DODS reference area (http://www.epa.gov/region09/water/dredging/sfdods/index.html). The reference area for SF-DODS is located approximately 20 nautical miles from the disposal site and is considered representative of natural background conditions.

Multiple rounds of bioaccumulation testing have been conducted on *M. nasuta* exposed to SF-DODS reference area sediments. Similarly, multiple rounds of testing have been conducted on polychaetes. However, only one round of testing was conducted using *N. virens* while the remainder of the polychaete tests were conducted using *Nephtys sp*. Bioaccumulation testing results from the SF-DODS reference area included the full suite of contaminants of concern including PCBs and PAH. The PAH list from the SF-DODS reference site only includes the 16 EPA priority compounds instead of the full 25 compounds analyzed as part of the Central Basin testing. Similarly, only PCB Aroclors were analyzed in the SF-DODS reference tissues while PCB congers were analyzed in the Central Basin composites. Total PCBs calculated from congener data are typically higher than that from Aroclor data.

Table 3-16 presents the sums of PCBs, low molecular weight PAH (LPAH), high molecular weight PAH (HPAH), and priority pollutant total PAH from Central Basin alongside the range of concentrations from the SF-DODS reference testing. *M. nasuta* PAH concentrations from DU05B exceeded the maximum from SF-DODS, but were generally within a factor of two. Total PCBs from Central Basin were within the range of concentrations from the SF-DODS reference site.

The LPAH concentration in *N. virens* tissue from Central Basin testing was 12.5 µg/kg, slightly higher than the SF-DODS reference maximum of 11 µg/kg. Both HPAH and total PAH from

Central Basin were within the SF-DODS concentration range (Table 3-16). Total PCB concentrations in the *N. virens* composites from Central Basin ranged from 2.7 to 4.0 µg/kg compared to non-detects in the reference tissues. As mentioned above (Section 3.3.5), the T_0 *N. virens* tissue had higher concentrations PCBs prior to exposure to Central Basin sediments.

Comparison to the SF-DODS reference data indicates that bioaccumulation may have occurred for some of the PAH compounds in the tissues from DU05B. The next step is an evaluation of the bioavailability and bioaccumulation potential using BAF/BSAF values.

Table 3-16. Comparison of Central Basin and SF-DODS Bioaccumulation Tissue Burdens

	DU05B	Central Basin Range	SF-DODS Reference Range
M. nasuta **(µg/kg WW)**			
Total LPAH	14 J	--	ND - 10
Total HPAH	54 J	--	ND - 26
Total PAH[1]	68 J	--	ND - 33
Total PCBs[2]	--	ND - 1.1	ND - 4.2
N. virens **(µg/kg WW)[3]**			
Total LPAH	12.5 J	--	4 - 11
Total HPAH	7 J	--	17 - 25
Total PAH[1]	19.5 J	--	21 - 36
Total PCBs[2]	--	2.7 - 4.0	ND

Notes: ND: non-detect
PAH: polycyclic aromatic hydrocarbon L/H: low/high molecular weight
PCB: polychlorinated biphenyl
1. total PAH is the sum of the 16 USEPA priority pollutants
2. total PCBs is the sum of congeners for Central Basin and sum of Aroclors for SF-DODS
3. *N. virens* tissues were only tested in one batch.

The BAF and BSAF values represent the extent of a contaminant's uptake into tissue relative to the source sediment, and can be representative of both bioavailability and/or bioaccumulation. Bioavailability is the extent that an organism is exposed to a contaminant, while bioaccumulation is the buildup of a contaminant in an organism. Or more simply, bioavailability is the amount available for partitioning from sediment to an organism's tissue, while bioaccumulation results when a significant amount remains in the tissue.

Most PAH compounds have high octanol water partitioning coefficients (K_{ow}), meaning they bind to organic carbon in sediments, or lipids in organisms. Depending on the type and amount of organic carbon, PAH may preferentially bind to sediment and not freely transfer to tissue (Ghosh et al. 2003). Such a scenario would limit the bioavailability of PAH. Similarly, bioaccumulation of PAH is dependent on a variety of factors. Vertebrates are capable of metabolizing PAHs which minimizes the bioaccumulation potential (Varanasi and Usha 1989). By contrast, invertebrates do not metabolize PAH to the same extent (Varanasi and Usha 1989). Therefore, the test species used in this evaluation are good indicators of bioaccumulation potential.

A BAF value is the ratio of tissue concentrations to sediment concentrations. The units for both concentrations are the same, resulting in a unitless value. The BSAF is the ratio of the lipid normalized tissue concentration over the TOC normalized sediment concentration. The magnitude of the BAF/BSAF value provides some indication of the bioavailability and/or bioaccumulation potential. A high BAF/BSAF indicates concentrations are greater in tissue than sediment and suggests that the contaminant is available for uptake from the sediment and may accumulate in higher trophic levels. A low BAF/BSAF indicates that either the contaminant is not available for uptake, or that it does not bioaccumulate.

Table 3-17 lists the BAF and BSAF values from bioaccumulation testing at DU05B and the SF-DODS reference site. Values were calculated for LPAH, HPAH, and total PAH. No TOC or lipids data were available for the SF-DODS reference samples so no BSAF value could be calculated. There were no extreme values in percent TOC or lipids at DU05B. As a result the BAF and BSAF values for DU05B are similar. The BAF values from DU05B are consistently lower than those at SF-DODS for both species. These numbers demonstrate that PAH at DU05B are minimally bioavailable and the bioaccumulation potential from these sediments is low.

Table 3-17. BAF and BSAF Values for Central Basin and SF-DODS Reference Sediment and Tissue Samples

	DU05B		SF-DODS Reference
	BAF	**BSAF**	**BAF**
***M. nasuta*[1]**			
LPAH	0.00070	0.0011	0.098
HPAH	0.0014	0.0021	0.31
Total PAH	0.0012	0.0018	0.20
***N. virens*[2]**			
LPAH	0.00063	0.00039	3.7
HPAH	0.00018	0.00011	1.5
Total PAH	0.00033	0.00021	2.1

Notes: PAH: polycyclic aromatic hydrocarbon L/H: low/high molecular weight PAH
BAF: bioaccumulation factor BSAF: biota sediment accumulation factor
1. SF-DODS reference BAF calculated from the average concentration in tissue divided by the average concentration in sediment. Maximum values were used for sediments.
2. SF-DODS reference BAF calculated from the one reported batch of *N. virens* testing.

3.3.5.3 Comparison of Tissue Concentrations to Tissue Residue Effects Data

While it was demonstrated in Section 3.3.5.2 that the bioavailability and bioaccumulation potential from DU05B was minimal, the magnitude of sediment PAH concentrations in this sample resulted in *M. nasuta* concentrations approximately twice the maximum present in SF-DODS reference site tissues. These concentrations are compared to literature toxicity reference values (TRV) to demonstrate the measured tissue burdens from Central Basin are below levels of ecological concern.

Common sources of tissue effects data include:

- The USACE Environmental Residue Effects Database (ERED) http://el.erdc.usace.army.mil/ered/index.cfm
- Jarvinen and Ankley (1999)

The most common endpoint used to evaluate tissue effects was the lowest observed effects dose (LOED). If the LOED was not presented an approximation was made using an uncertainty factor (USACHPPM 2000; Leidos 2014). The most conservative values were selected for comparison to Central Basin tissues. Effects thresholds presented in Table 3-18 were available for *Nereis sp.* and *Mytilus edulis* as a surrogate for *M. nasuta*. TRVs were only available for select PAH compounds. None of the PAH compounds from the DU05B tissue samples (Table 3-15) exceeded the TRVs, indicating that risks to benthic invertebrates at the concentrations observed in bioaccumulation testing are minimal.

Table 3-18. Summary of Tissue Reference Values used to Evaluate Ecological Impacts

Species Name	Analyte	TRV (µg/kg ww)	Effect Class	Toxicity Measure	Species Lifestage
Mytilus edulis	Acenaphthene	1,470	Behavior	ED50	Adult
Mytilus edulis	Benzo(a)pyrene	300	Reproduction	LOED	N/A
Mytilus edulis	Fluoranthene	220	Reproduction	LOED	N/A
Mytilus edulis	Pyrene	9,450	Behavior	EC50	Adult
Nereis arenaceodentata	Phenanthrene	780	Behavior/ Growth/ Reproduction	LOED	Immature

Notes:
Source: Leidos 2014
ED50: effects dose LOED: lowest observed effects dose
TRV: tissue reference value. All TRVs are LOEDs. ED50 values were converted to LOED using an uncertainty factor of 20.

3.3.5.4 Bioaccumulation Testing Conclusions

All tissue samples were submitted for analysis of PCBs, but only tissues from DU05B were submitted for analysis of PAH.

Concentrations of PAH accumulated by *N. virens* samples were within the range of SF-DODS reference values. PCB concentrations in *N. virens* were detected at low concentrations, compared to non-detects in the reference data. However, the PCB concentrations from the tissue composites were lower than the T_0 sample, indicating that PCBs were already present in the organisms and concentrations were reduced during their exposure period to Central Basin sediments.

Concentrations of PCBs in *M. nasuta* were nearly all non-detects with detected concentrations for three congeners below the MRL. Concentrations of PAH in *M. nasuta* were elevated above the SF-DODS reference concentrations by a factor of two. BAF/BSAF values were calculated to evaluate the possible extent of uptake or bioaccumulation. The BAF values for *M. nasuta* were orders of magnitude lower than those from the reference site indicating little uptake of PAH. Tissue results from DU05B were also compared to literature TRVs to determine if there could be toxic effects at the reported concentrations. DU05B were less than the literature values for each PAH compound evaluated.

Overall, the bioavailability of PAH and PCBs from Central Basin sediments was low, and concentrations that did accumulate in tissues during the testing period were of similar magnitude to reference data and below literature toxicity thresholds.

3.4 Laboratory QA/QC Evaluation

This section provides a summary of the QA/QC results for the analytical data and biological testing conducted for the sediment characterization. The analytical laboratory reports are provided in Appendix B, the biological reports are provide in Appendix C, and the Data Verification and Validation Report, prepared by Northgate Environmental Management is provided in Appendix D.

3.4.1 Analytical Laboratory QA/QC Review

The conclusion of the independent data assessment indicates that the laboratory data for chemical constituents are of good quality. Where available, laboratory and field QC sample results generally met data quality objectives. No data were flagged by the project team during the data verification and validation. Based on the validated data, 100% of the results for the sediment characterization dataset were determined usable and considered valid for decision-making purposes with the exception of the results for grain size analysis reported by CEL (within CEL lab report numbers 4550 and 4559) which have been rejected. Archived samples were subsequently submitted to ARI for grain size analysis and were determined to be of good quality and considered usable for decision-making. The Data Verification and Data Validation report is provided in Appendix D.

3.4.2 Biological Laboratory

The QA/QC measures for the biological testing include the performance of the negative control, positive control, and water quality conditions measured during the test. The negative controls were comprised of native sediments (from test organism collection site), or filtered seawater. The negative controls passed their respective performance criteria for each bioassay test conducted for this characterization. The positive control, or reference toxicant, was within the range of prior laboratory tests for all bioassays conducted, thereby indicating that the test organisms were neither too sensitive nor insensitive relative to prior testing. The water quality measurements were all within the recommended test conditions for all tests. Overall, the QA/QC results for the biological laboratory data indicate the bioassay results are of good quality and are considered usable and valid for decision-making purposes. The biological laboratory report is provided in Appendix C.

4 Evaluation of Potential Water Column Impacts

This section evaluates whether there may be potential chemical impacts on the water column resulting from dredged material disposal at SF-11 and SF-DODS. The results of the larval development bioassay were used in a Disposal Site Dilution Model to determine whether potential toxic effects could occur for sediments disposed in-bay (SF-11) and are discussed in Section X-1. Chemical concentrations in sediment composites that exceeded the TMDL guidelines (mercury, Total PAHs and Total PCBs) were modeled using STFATE to determine whether the contaminants would exceed water quality criteria when disposed at SF-DODS (Section 4-2).

4.1 Potential for water column toxicity during in-bay disposal (SF-11)

As per the ITM guidelines (USEPA et al. 2001), the median effects concentrations (EC50) values for the larval development bioassay were used to predict potential toxicity in the water column. The guidance stipulates that suspended solid concentration in the water column must not exceed 1% of the EC50 (in percent) outside the mixing zone. An EC50 value of 35.4% was reported for the SPP *M. galloprovincialis* larval development test for sample DU04A, which was the lowest among the Central Basin samples. From this result, the limiting permissible concentration (LPC) of 0.354% is the de facto water quality guideline concentration for the suspended solid concentration that must be met after dilution at the disposal site.

A disposal site dilution model for the in-bay SF-11 disposal area was used to simulate the initial mixing concentration of the SPP during disposal. The model assumes that a typical barge is used for disposal (measuring 60 m x 25 m) and a receiving water dilution volume of 627,239 cubic meters based on the dimensions of the SF-11 disposal site. The results of the mixing model are presented in Table 4-1.

The predicted suspended solid concentration is 0.16%, which is less than the LPC of 0.354%. Under the simulated scenario, disposal of Central Basin sediments at SF-11 would not pose a toxicity risk in the water column.

Table 4-1. Mixing Model Results for Determining Potential Toxicity for Placement of Dredged Material at SF-11 In-bay Disposal Site

Site:	**Port of SF, Central Basin**
Species:	***M. galloprovinciallis***
Disposal Site:	**SF-11**
Mixing Zone Volume Calculation	
Depth of disposal site (m)=	15
Pi (constant)=	3.14159
Width of vessel (m)=	10
Length of vessel(m)=	25
Speed of vessel (m/s)=	0.5
Time of discharge (s)=	30
Depth of vessel (m)=	4
Mixing Zone Volume (m^3)=	627,239
Volume of Liquid Phase	
Bulk density (g/cc) =	1.3
Particle density (g/cc) =	2.6
Density of liquid phase (constant) =	1
Vol of disposal vessel (m^3)=	6,000
Liquid phase volume (m^3)=	4,875
Volume of suspended phase	
Silt (%) =	64.0
Clay (%) =	26.2
Volume of Suspended Phase (m^3)=	1,015
Projected Water Column Concentration (SP) =	0.16
Calculation of Water Column Concentration Guideline (percent SP)	
Lowest LC50 or EC50 from bioassay	35.4
LC50 or EC50 X 0.01=	0.354

4.2 Potential for water column impacts at SF-DODS

A conservative evaluation of potential water-column impacts from initial mixing during disposal of Central Basin sediments at SF-DODS was carried out using the Short Term FATE (STFATE) model (Johnson et al., 1994). STFATE simulates the movement of the disposed material as it falls through the water column, spreads over the bottom, and is finally transported and diffused by the ambient current. The model assumes that all contaminants in the dredged material are released into the water column and become available to water-column organisms during disposal. This conservative assumption serves as a screen to reduce the evaluation effort for dredged material that will cause only minimal water-column impact during descent, which is common among large, deep-ocean disposal sites. A single dredged material placement is simulated using a typical split-hull type barge with a capacity of ~5,000 cy. STFATE results are then used to determine if further testing is needed to demonstrate compliance with established water quality criteria (WQC) (USACE/USEPA 1998, Appendix C).

The modeled water column contaminant concentrations are generated using the STFATE model and physical characteristics of the Central Basin sediment (grain size and percent solids), the physical oceanographic conditions of the SF-DODS Disposal Site, and the volume of sediment to be discharged (USEPA/USACE 1998, Appendix C). Disposal was simulated for samples with the highest concentrations of mercury, total PAHs, and total PCBs. The physical characteristics of sample DU05B were used to evaluate water column impacts for total PAH and mercury, and the physical characteristics of sample DU04A were used to evaluate water column impacts for total PCBs. A summary of the input parameters for the STFATE model are included in Table 4-2.

Maximum contaminant concentrations were evaluated for the water column outside the boundary of the disposal site *during* the 4-hr initial-mixing period, and anywhere in the marine environment *after* the 4-h initial mixing period. Under the simulated scenarios, WQC for mercury, total PAHs, and total PCBs were not exceeded for disposal of Central Basin sediments at SF-DODS. Peak concentration within the site during the 4-hr initial mixing period reached 0.000026 mg/L for mercury and 0.033 mg/L total PAHs, while a 4-hr peak concentration of 0.000032 mg/L was predicted for total PCBs. The modeled contaminant concentrations and comparison to WQC are summarized in Table 4-3.

Table 4-2. Summary of Input Parameters for STFATE Model

Input Parameter	Value
SF-DODS disposal site	
Area (ft)[a]	21,130 x 13,200
Depth (ft)	9,500
Density Profile (g/cc)	1.0245 @ 0 ft 1.0250 @ 66 ft 1.0255 @ 131 ft 1.0270 @ 1,968 ft 1.0275 @ 9,500 ft
Current Velocity (fps)	0.83 @ 1,312 ft 0.33 @ 4,592 ft
Disposal Operation	
Vessel Type	Barge or Scow
Vessel Dimensions (ft)	200 x 50
Pre-Disposal Draft (ft)	15
Post-Disposal Draft (ft)	2
Capacity (cyd)	4,800
Disposal Duration (s)	100
Material Properties	
Volumetric Fraction Sand, Silt, Clay, Fluid	DU05B: 0.017, 0.122, 0.100, 0.76 DU04A: 0.017, 0.118, 0.126, 0.75
Fluid Density (g/cc)	1.0245

Notes:

ft= feet

g/cc= grams per cubic centimeter

fps= feet per second

cyd= cubic yards

s= seconds

[a] Site dimensions describe minimum bounding rectangle containing the disposal site

Table 4-3. Modeled Contaminant Concentrations and Comparison to Water Quality Criteria

Sample ID	Contaminant	Sediment Concentration (mg/kg)	Background Concentration in Seawater (mg/L)	Marine WQC (mg/L)	Maximum Disposal Site Concentration after 4-hrs (mg/L)	Maximum Concentration Outside Site (mg/L)
DU05B	Mercury	0.5	0.0001[a]	0.0018[b]	0.000065	0.0001[a]
DU05B	Total PAHs	66	0.0001[a]	0.3[c]	0.00739	0.0001[a]
DU04A	Total PCBs	0.042	0.0001[a]	0.000033[d]	0.000015	0.0001[a]

Notes:

mg/kg= milligrams per kilogram (dry weight)

mg/L= milligrams per liter

Total PAHs= Sum of polycyclic aromatic hydrocarbons

Total PCBs= Sum of polychlorinated biphenyls

[a] Background concentration estimated to be below detection level at Method Detection Limit (MDL)

[b] USEPA Ambient Water Quality Criteria (AWQC)

[c] USEPA Lowest Observable Effects Levels (LOELs)

[d] USEPA Tier II Secondary Acute Value

5 Suitability Recommendations

The following dredged material disposal suitability recommendations are made based on the collective results of the chemical analysis and biological testing completed for this sediment characterization. The recommendations are summarized in Table 4-1.

Based on the DU composite sample chemical analysis and biological testing results, for which no chemistry exceeded threshold values and the biological testing met the Limiting Permissible Concentration interpretive criteria, two DUs (DU02A and DU06B) are recommended as Suitable for Unconfined Aquatic Disposal (SUAD) at SF-11. The dredged material from these two DUs would also be suitable for disposal at SF-DODS (Table 4-1).

Based on the DU composite samples chemical analysis, biological testing, and bioaccumulation tissue residue results, for which: 1) chemistry exceeded threshold values; 2) biological testing met the Limiting Permissible Concentration interpretive criteria; and 3) bioaccumulation testing tissue residues did not indicate significant uptake of contaminants; seven DUs (DU01A, DU03A, DU04A, DU05B, DU07B, DU08B, and DU09B) are recommended as SUAD at SF-DODS (Table 4-1).

The sediment characterization of Central Basin sediments also considered beneficial use of material as wetland surface material or wetland foundation material at MWRP, based on the DU composite samples chemistry, toxicity, bioaccumulation, MET, and DI-WET chemical analysis, and MET toxicity testing. Using the multiple lines of evidence collected and evaluated, four DUs may be suitable as potential surface material and five DUs may be suitable as potential foundation material.

The four DUs (DU01A, DU06B, DU08B and DU09B) that may be considered as potential surface material exceeded the chemical screening criteria for PCBs (4 DUs), PAHs (3 DUs), and Cd (4 DUs). However, the concentrations for PCBs and PAHs did not exceed the surface criteria by a significant amount and the bioaccumulation data did not indicate significant uptake in total tissue residue or as a BAF. Though bioaccumulation tests were not conducted for Cd, the leachability and toxicity tests did not indicate there were significant concerns (Table 4-1). Five DUs (DU02A, DU03A, DU04A, DU05B, and DU07B) may be considered as potential foundation material. Chlordane concentrations exceeded the foundation screening criteria for four of the DUs, however there was no indication of toxicity in any of the sediments. Since no leachability studies were conducted for chlordane, the potential mobility is not known. PAH concentrations exceeded the foundation screening criteria for DU5B, but based on the BAF from the bioaccumulation testing and the fact the sediments would be further isolated, it is unlikely to pose significant risk (Table 4-1).

Table 5-1: Dredged Material Disposal Suitability Recommendations

Proposed Dredging Unit	Sediment Chemistry	Solid Phase Bioassays[1]	Water Column Bioassays[2]	Bioaccumulation Test Results[3]	Water Quality Modeling[4]	Beneficial Reuse (MWRP)[6,7,8,9]	Suitability Recommendations/ Considerations[10]
DU01A	Total PCBs > TMDL	Meets LPC	Meets LPC	No uptake of PCBs Nv: (3.8 µg/kg); Mn: ND (1 µg/kg)	No water column toxicity (SF-11); STFATE modeling of PCBs does not exceed WQC (SF-DODS)[5]	Cd, PAHs, PCBs > surface[6]; Meets elutriate criteria[8]; Meets MET toxicity criteria[9]	SUAD SF-DODS; MWRP surface
DU02A	Total PCBs > BT	Meets LPC	Meets LPC	No uptake of PCBs Nv: (3.7 µg/kg); Mn: ND (1 µg/kg)	No water column toxicity (SF-11);	Cd, Se, PCBs > surface[6]; chlordane > foundation[7]; Meets elutriate criteria[8]; Meets MET toxicity criteria[9]	SUAD SF-11; SUAD SF-DODS; MWRP foundation
DU03A	Total PCBs > TMDL	Meets LPC	Meets LPC	No uptake of PCBs Nv: (3.7 µg/kg); Mn: ND (1 µg/kg)	No water column toxicity (SF-11); STFATE modeling of PCBs does not exceed WQC (SF-DODS) [5]	Cd, PCBs > surface[6]; chlordane > foundation[7]; Meets elutriate criteria[8]; Meets MET toxicity criteria[9]	SUAD SF-DODS; MWRP foundation
DU04A	Total PCBs > TMDL	Meets LPC	Meets LPC	No uptake of PCBs Nv: (4 µg/kg); Mn: (0.6 J µg/kg)	No water column toxicity (SF-11); STFATE modeling of PCBs does not exceed WQC (SF-DODS) [5]	Cd, PCBs > surface[6]; chlordane > foundation[7]; Meets elutriate criteria[8]; Meets MET toxicity criteria[9]	SUAD SF-DODS; MWRP foundation
DU05B	Total PAHs > BT Hg, Total PCBs > TMDL	Meets LPC	Meets LPC	PAHs Nv: (32 µg/kg); Mn: (81.1 J µg/kg) BAF indicates PAHs less bioavailable than at reference[6] No uptake of PCBs Nv: (2.7 µg/kg); Mn: ND (1 µg/kg)	No water column toxicity (SF-11); STFATE modeling of PCBs, PAHS, and Hg does not exceed WQC (SF-DODS) [5]	Cd, Hg, Se, PCBs > surface[6]; PAHs, chlordane > foundation[7]; Meets elutriate criteria[8]; Meets MET toxicity criteria[9]	SUAD SF-DODS; MWRP foundation

Table 5-1 (cont.): Dredged Material Disposal Suitability Recommendations

Proposed Dredging Unit	Sediment Chemistry	Solid Phase Bioassays[1]	Water Column Bioassays[2]	Bioaccumulation Test Results[3]	Water Quality Modeling[4]	Beneficial Reuse (MWRP)[6,7,8,9]	Suitability Recommendation
DU06B	Total PCBs > BT	Meets LPC	Meets LPC	No uptake of PCBs Nv: (3.6 µg/kg); Mn: ND (1 µg/kg)	No water column toxicity (SF-11);	Cd, PAHs, PCBs > surface[6]; Meets elutriate criteria[8]; Meets MET toxicity criteria[9]	SUAD SF-11; SUAD SF-DODS; MWRP surface
DU07B	Total PAHs > BT Total PCBs > TMDL	Meets LPC	Meets LPC	No uptake of PCBs Nv: (4 µg/kg); Mn: ND (1 µg/kg)	No water column toxicity (SF-11); STFATE modeling of PCBs and PAHs does not exceed WQC (SF-DODS) [5]	Cd, Hg, PAHs, PCBs > surface[6]; Meets elutriate criteria[8]; Meets MET toxicity criteria[9]	SUAD SF-DODS; MWRP foundation
DU08B	Total PCBs > TMDL	Meets LPC	Meets LPC	No uptake of PCBs Nv: (3.7 µg/kg); Mn: ND (1 µg/kg)	No water column toxicity (SF-11)[4]; STFATE modeling of PCBs does not exceed WQC (SF-DODS) [5]	Cd, PCBs > surface[6]; Meets elutriate criteria[8]; Meets MET toxicity criteria[9]	SUAD SF-DODS; MWRP surface
DU09B	Total PCBs > TMDL	Meets LPC	Meets LPC	No uptake of PCBs Nv: (3.9µg/kg); Mn: (1.1 J µg/kg)	No water column toxicity (SF-11)[4]; STFATE modeling of PCBs does not exceed WQC (SF-DODS) [5]	Cd, PAHs, PCBs > surface[6]; Meets elutriate criteria[8]; Meets MET toxicity criteria[9]	SUAD SF-DODS; MWRP surface

Notes:
1) Based on two solid phase tests: amphipod mortality (*A. abdita*) and polychaete mortality (*N. arenaceodentata*); (Sections 3.3.1 and 3.3.2).
2) Based on three water column tests: SPP larval development bioassay (*M. galloprovincialis*); water column mysid shrimp mortality bioassay (*A. bahia*); water column fish mortality bioassay (*M. beryllina*); (Sections 3.3.3 and 3.3.4).
3) Laboratory bioaccumulation tests were conducted using two test species: 1) Mn: M. nasuta; 2) Nv: N. virens; No uptake of PCBs (Section 3.3.5); BAF calculated for PAHs was lower than what was observed at reference location indicating limited bioavailability of PAHs (Section 3.3.5.4).
4) No water column toxicity expected if material was disposed of in-bay at SF-11 based on results of SPP larval development test (Section 3.3.3) and the mixing modeling results (Section 4.1).
5) No water quality criteria are expected to be exceeded if material was disposed of at SF-DODS based on STFATE modeling of PCBs, PAHs, or mercury (Section 4.2).
6) Sediment chemistry exceeds wetland surface criteria for beneficial use at MWRP (Section 3.1).
7) Sediment chemistry exceeds wetland foundation criteria for beneficial use at MWRP (Section 3.1).
8) Elutriate criteria is met for DI-WET test (Section 3.2).
9) MET bioassays indicated no elutriate toxicity (Section 3.3.4.3).
10) All 9 DUs are recommended as SUAD (2 at SF-11 and all 9 at SF-DODS); the beneficial reuse as wetland surface or foundation material are listed for potential consideration.
BT: Bioaccumulation Trigger
TMDL: Total maximum Daily Load
LPC: Limited permissible concentration

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Technical Memorandum

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Subject: Central Basin Supplemental Sampling and Analysis Results

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The purpose of this memorandum is to summarize the chemistry results for supplemental samples collected in November 2015. The purpose of the supplemental sampling was to address specific requests by the DMMO in regards to the suitability determinations for sediment within Central Basin for the -32.0 ft to -34.0 ft mean lower low water (MLLW) interval. Z-layer samples were also collected from -34.0 to -34.5 ft MLLW during this supplemental sampling effort.

Previous testing results from samples collected in April 2015 (NewFields 2015) exhibited higher concentrations of total PAHs, total PCBs, and chlordane within DU05B and DU08B. The original sediment characterization evaluated material collected from a depth interval of -32 ft to -37 ft MLLW. The Dredged Material Management Office (DMMO) agencies requested supplemental characterization of these two Central Basin Dredge Units (DU05B and DU08B) within the -32 ft to -34 ft MLLW sediment interval in order to make suitability recommendations.

Table 1 provides the actual coordinates for the sampling locations, along with the observed mudline, core thickness collected, and core depth achieved. Figure 1 displays a plan view of the actual sampling locations for the supplemental sampling effort.

Tables 2 through 5 provide the sediment chemistry results for all DU composites, individual cores, and Z-samples as requested by USEPA. A summary of the results are as follows:

- Total PAHs exceeded the BT in the DU05B composite and 3 out of 5 individual cores. However, in comparison to concentrations in the original samples collected in April 2015 DU05B supplemental concentrations were lower (Table 2);
- Total PAHs were lower in all November 2015 DU05B individual core Z-samples than the composite z-layer sample collected in April 2015 except for CBSS-DU05B-IC9 (Table 3);
- Chlordane was not detected in the November 2015 DU05B composite, individual cores, or Z-samples (Tables 2 and 3);

- PCBs were measured at lower concentrations in both composites (DU05B and DU08B) than samples collected in April 2015 (Table 4). Neither composite sample exceeded the BT or TMDL. Only one core (CBSS-DU05B-IC3) exceeded the BT;
- Total PCBs were generally lower in all November 2015 composites and Z-samples except CBSS-DU05B-Z9 (44.6 µg/kg DW), which was slightly higher than the original composite for DU05B (43.0 µg/kg DW) collected in April 2015 (Table 5).

Based on the chemistry results of the supplemental sediment sampling for the Central Basin and DU05B and DU08B chemical concentrations being similar or lower than the results measured in the samples collected in April 2015, the USACE and Port of San Francisco conclude that additional biological testing is not warranted. Therefore, the -32 to -34 ft MLLW interval for both DUs should be considered suitable for disposal at SF-DODS, as was determined for the -32 to -37 ft MLLW interval sediments tested during the original characterization.

The total PAH concentrations measured in z-layer samples from DU05B range from 3,500 to 34,000 µg/kg dry weight (DW), with two of five samples (DU05B-Z1 and DU05B-Z9) exceeding the bioaccumulation trigger. The area-weighted average total PAH concentration for the DU05B z-layer (i.e. post-dredge surface) is 6,635 µg/kg DW. All of these measured concentrations are significantly lower than the DU05B composite (66,000 µg/kg DW) sample that was submitted for bioaccumulation testing as part of the original characterization in April 2015. As discussed in the Central Basin Sediment Characterization Report, the bioavailability of PAHs from Central Basin sediments was low, and concentrations that did accumulate in tissues during the testing period were of similar magnitude to reference data and below literature toxicity thresholds (NewFields 2015). Therefore, the lower PAH concentrations measured in the -34.0 to -34.5 ft MLLW z-layer investigated as part of the supplemental sampling effort would not cause unacceptable adverse environmental impacts to aquatic receptors.

Table 1. Actual Sample Location Coordinates and Descriptions of Collected Cores

Location	Date Collected	Latitude (NAD83)	Longitude (NAD83)	Mudline Elevation (ft. MLLW)	Core Thickness Collected (ft.)	Depth Achieved (ft. MLLW)	Project and Overdepth (z-layer) Achieved[1]
DU5-01	11/10/2015	37 45.9390	122 22.8672	-30.2	5.5	-35.7	Yes
DU5-03	11/10/2015	37 45.9207	122 22.8354	-30.4	7.0	-37.4	Yes
DU5-09	11/10/2015	37 45.9026	122 22.8257	-30.5	5.5	-36.0	Yes
DU5-02	11/10/2015	37 45.9374	122 22.9280	-25.2	10.0	-35.2	Yes
DU5-04	11/11/2015	37 45.8964	122 22.9299	-24.9	10.0	-34.9	Yes
DU8-01	11/11/2015	37 45.9477	122 23.0282	-15.3	20.0	-35.3	Yes
DU8-02	11/11/2015	37 45.9158	122 23.0476	-15.3	21.0	-36.3	Yes
DU8-02	11/12/2015	37 45.9158	122 23.0485	-16.3	20.0	-36.3	Yes
DU8-03	11/12/2015	37 45.8860	122 23.0227	-18.7	18.0	-36.7	Yes
DU8-04	11/12/2015	37 45.8585	122 23.0441	-20.1	16.0	-36.1	Yes

Notes: NAD =North American Datum MLLW = mean lower low water n/a: not applicable

1: Project depth for the supplemental sampling effort was -34.0 ft MLLW; z-layer depth was -34.0 to -34.5 ft MLLW.

Table 2: Supplemental Sediment Chemistry Results for PAHs and Chlordane in DU05 composite samples and individual cores

	EFH BT	SF Bay Ambient	SF-DODS Reference	Original Sampling Event (-32.0 to -37.0 MLLW)						Supplemental Sampling Event (-32.0 to -34.0 MLLW)					
				CB-DU05B (Comp.)	CB-DU05B-C1	CB-DU05B-C2	CB-DU05B-C3	CB-DU05B-C4	CB-DU05B-C9	CBSS-DU05B-CMP (Comp.)	CBSS-DU05B-IC1	CBSS-DU05B-IC2	CBSS-DU05B-IC3	CBSS-DU05B-IC4	CBSS-DU05B-IC9
				4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	4/21/15	11/10/15	11/10/15	11/10/15	11/10/15	11/10/15	11/10/15
Polycyclic Aromatic Hydrocarbons (µg/kg DW)															
Naphthalene		56.4		870	370	43	320	37	390	130	140	50	87	33	130
2-Methylnaphthalene		20.8		440	240	42	120 J	42	190	44	58	30	50	20	56
1-Methylnaphthalene		37.6		550	670	12	160	11	240	72	59	15	37	12	67
Acenaphthylene		32.6		1,700	1,100	32	730	24	820	250	200	37	190	26	240
Acenaphthene		13.5		1,200	1,600	18	240	14	280	170	230	24	67	14	85
Fluorene		27.1		1,400	2,100	30	540	36	720	250	250	46	140	32	200
Phenanthrene		176		10,000	10,000	180	4,000	140	4,300	1,400	1,100	220	860	140	1,200
Anthracene		80.1		4,700	3,200	100	1,600	110	1,800	760	450	140	330	97	500
Fluoranthene		620		7,900	6,100	330	4,000	350	3,300	1,200	990	440	900	320	1,300
Pyrene		791		10,000	7,900	410	5,100	480	4,600	1,900	1,400	710	1,300	580	1,800
Benzo(a)anthracene		212		4,400	3,400	170	2,200	210	2,100	700	530	260	500	180	740
Chrysene		252		5,000	3,200	200	2,300	270	2,300	970	580	320	540	240	770
Benzo(b)fluoranthene		227		1,900	1,500	180	1,100	260	1,000	520	370	310	350	270	510
Benzo(k)fluoranthene		231		1,200	950	91	640	140	610	300	210	160	200	130	300
Benzo(a)pyrene		428		4,200	3,100	260	2,000	310	2,100	910	640	400	660	340	920
Indeno(1,2,3-cd)pyrene		337		1,600	1,200	160	890	180	840	440	300	240	330	200	450
Dibenz(a,h)anthracene		49.9		490	430	32	260	42	270	120	68	49	70	42	110
Benzo(g,h,i)perylene		416		2,000	1,000	190	790	140	1,000	570	410	310	420	260	580
Perylene		216		750	590	160	420	170	440	290	230	270	190	210	250
Biphenyl		11.7		320	300	14	86 J	14	130	56	56	21	31	17	49
2,6-Dimethylnaphthalene		13		480	560	16	130 J	15	200	69	62	38	54	25	70
1-Methylphenanthrene		37.6		1,400	1,500	29	700	21	720	180	150	31	160	23	220
Benzo(e)pyrene		244		2,000	1,400	150	990	190	1,000	470	350	250	350	220	490
2,3,5-Trimethylnaphthalene		7.43		170	210	5.8	140 U	5.3	79	25	23	15 U	20	14 U	33
Dibenzothiophene		16.3		870	210	12	140 U	18	410	100	74	15	81	10 J	100
Total Benzofluoranthenes				4,600	3,600	370	2,500	540	2,400	1,200	800	620	780	530	1,100
Total PAHs[1]	4,500	4,540	192	66,000	53,000	2,900	29,000	3,200	30,000	12,000	8,900	4,400	7,900	3,500	11,000
Pesticides (µg/kg DW)															
trans-Nonachlor				15						0.98 U	0.96 U	0.99 U	0.99 U	0.97 U	0.98 U
trans-Chlordane				27 Y						0.49 U	0.48 U	0.49 U	0.50 U	0.49 U	1.9 Y
cis-Chlordane				0.97 U						0.49 U	0.48 U	0.49 U	0.50 U	0.49 U	0.49 U
oxy Chlordane				1.9 U						0.98 U	0.96 U	0.99 U	0.99 U	0.97 U	0.98 U
cis-Nonachlor				3.8 Y						0.98 U	0.96 U	0.99 U	0.99 U	0.97 U	0.98 U
Total Chlordane[2]	37	0.34		15						0.98 U	0.96 U	0.99 U	0.99 U	0.97 U	1.9 Y

Table 3: Supplemental Sediment Chemistry Results for PAHs and Chlordane in Z- samples

	EFH BT	SF Bay Ambient	SF-DODS Reference	Original Sampling Event (-37.0 to -37.5 MLLW)	Supplemental Sampling Event (-34.0 to -34.5 MLLW)				
				CB-DU05B-Z	CBSS-DU05B-Z1	CBSS-DU05B-Z2	CBSS-DU05B-Z3	CBSS-DU05B-Z4	CBSS-DU05B-Z9
				4/21/15	11/10/15	11/10/15	11/10/15	11/10/15	11/10/15
Polycyclic Aromatic Hydrocarbons (µg/kg DW)									
Naphthalene		56.4		290	180	40	44	36	380
2-Methylnaphthalene		20.8		79	72	20	57	18	150
1-Methylnaphthalene		37.6		62	77	10 J	14	8.9 J	140
Acenaphthylene		32.6		260	220	28	45	25	810
Acenaphthene		13.5		150	290	20	31	16	250
Fluorene		27.1		240	280	37	50	32	540
Phenanthrene		176		1,500	1,100	170	300	150	5,200
Anthracene		80.1		800	490	110	130	100	2,400
Fluoranthene		620		1,600	1,100	440	430	370	4,400
Pyrene		791		2,000	1,600	620	580	660	5,100
Benzo(a)anthracene		212		930	620	220	200	210	2,300
Chrysene		252		1,000	640	270	220	280	2,600
Benzo(b)fluoranthene		227		620	480	270	190	300	1,100
Benzo(k)fluoranthene		231		350	270	140	95	160	680
Benzo(a)pyrene		428		1,100	800	380	310	370	2,700
Indeno(1,2,3-cd)pyrene		337		500	410	220	150	230	980
Dibenz(a,h)anthracene		49.9		140	93	44	34	44	280
Benzo(g,h,i)perylene		416		630	520	290	230	280	1,300
Perylene		216		330	250	250	110	240	470
Biphenyl		11.7		52	55	15	14	15	120
2,6-Dimethylnaphthalene		13		69	80	19	16	18	180
1-Methylphenanthrene		37.6		300	170	26	51	21	690
Benzo(e)pyrene		244		570	440	230	170	240	1,100
2,3,5-Trimethylnaphthalene		7.43		35	26	15 U	14 U	15 U	80
Dibenzothiophene		16.3		130	86	13 J	20	12 J	420
Total Benzofluoranthenes				1,400	1000	550	390	620	2600
Total PAHs[1]	4,500	4,540	192	14,000	10,000	3,900	3,500	3,900	34,000
Pesticides (µg/kg DW)									
trans-Nonachlor					0.97 U	0.98 U	0.99 U	0.98 U	0.98 U
trans-Chlordane					0.49 U	0.49 U	0.49 U	0.49 U	0.49 U
cis-Chlordane					0.49 U	0.49 U	0.49 U	0.49 U	0.49 U
oxy Chlordane					0.97 U	0.98 U	0.99 U	0.98 U	0.98 U
cis-Nonachlor					0.97 U	0.98 U	0.99 U	0.98 U	4.2 Y
Total Chlordane[2]	37	0.34			0.97 U	0.98 U	0.99 U	0.98 U	4.2 Y

Table 4: Supplemental Sediment Chemistry Results for PCBs in Composite Samples and Individual Cores

	EFH BT	RWQCB TMDL	SF Bay Ambient	Original Sampling Event (-32.0 to -37.0 MLLW)		Supplemental Sampling Event (-32.0 to -34.0 MLLW)						
				CB-DU05B (Comp.)	CB-DU08B (Comp.)	CBSS-DU05B-CMP (Comp.)	CBSS-DU05B-IC1	CBSS-DU05B-IC2	CBSS-DU05B-IC3	CBSS-DU05B-IC4	CBSS-DU05B-IC9	CBSS-DU08B-CMP
				4/21/15	4/16/15	11/10/15	11/10/15	11/10/15	11/10/15	11/10/15	11/10/15	11/11/15
Polychlorinated Biphenyls (µg/kg DW)												
PCB #8			0.14	1.1	0.8	1.4 Y	1.1 Y	1.1 Y	1.1 Y	1.7 Y	1.0 Y	1.6 Y
PCB #18			0.07	1.7	1.9	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #28			0.28	0.3 J	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #31			0.13	1	0.8	0.3 J	0.3 J	0.3 J	0.3 J	0.4 J	0.5 U	0.4 J
PCB #33			0.08	0.6	0.4 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #44			0.33	0.6	0.5	0.3 J	0.5 U	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U
PCB #49			0.25	0.5 J	0.6	0.3 J	0.4 J	0.4 J	0.5 U	0.3 J	0.5 J	0.3 J
PCB #52			0.39	1	1.6	0.7	0.5 U	0.6	0.5 J	0.4 J	0.7	0.5
PCB #56			0.14	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #60			0.07	0.5 U	0.5 U	0.8	1.1	0.5 U	0.5 U	0.5 U	0.5 U	0.8
PCB #66			0.48	0.4 J	0.5 J	0.4 J	0.4 J	0.4 J	0.2 J	0.4 J	0.4 J	0.4 J
PCB #70			0.59	0.7	1	0.4 J	0.4 J	0.5 J	0.5 U	0.4 J	0.4 J	0.4 J
PCB #74				0.6	0.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #87			0.46	0.5 J	0.6	0.5 U	0.5 U	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U
PCB #95			0.60	1	1.6	0.5	0.5	0.6	0.5	0.5	0.6	0.5
PCB #97			0.65	0.3 J	0.5 J	0.4 J	0.3 J	0.3 J	0.5 U	0.3 J	0.3 J	0.3 J
PCB #99			1.15	0.6	1	0.4 J	0.7	0.9	0.5 J	0.7	0.6	0.5 J
PCB #101			0.36	1.6	1.5	0.5 U	0.9	1.0	1.1	0.5 U	1.0 U	0.9
PCB #105			0.36	1.4	2.3	0.3 J	0.5 U	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U
PCB #110			1.04	1.7	1.6	1.0	0.9	1.0	0.9	1.0	1.0	0.8
PCB #118			0.98	1.6	1.2	0.8	0.8	0.9	0.7	0.8	0.9	0.7
PCB #128			0.28	0.6	0.4 J	0.5 U	0.3 J	0.3 J	0.4 J	0.5 U	0.4 J	0.5 U
PCB #132			0.37	1	0.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #138			1.83	3.7	3.4	1.4	1.2	1.6	2.6	1.4	1.7	1.3
PCB #141			0.20	0.6	0.3 J	0.5 U	0.5 U	0.5 U	0.5	0.5 U	0.3 J	0.5 U
PCB #149			1.25	2.5	2	1.2	1.1	1.3	1.6	1.1	1.7	1.1
PCB #151			0.56	0.5	0.4 J	0.3 J	0.5 U	0.5 U	0.5	0.5 U	0.3 J	0.5 U
PCB #153			1.74	1.9	2.3	1.4	1.2	1.6	2.3	1.3	1.5	1.1
PCB #156			0.16	0.5 U	0.5 U	0.5 U	0.2 J	0.5 U	0.3 J	0.5 U	0.5 U	0.5 U
PCB #158			0.15	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.3 J	0.5 U	0.5 U	0.5 U
PCB #170			0.47	0.9	0.9	0.5	0.4 J	0.6	1.2	0.5	0.7	0.5 J
PCB #174			0.49	1.1	0.8	0.6	0.7	0.6	1.1	0.5	1.0	0.5
PCB #177			0.36	0.7	0.4 J	0.3 J	0.3 J	0.4 J	0.6	0.4 J	0.4 J	0.4 J
PCB #180			1.02	1.9	1.4	1.2	1.0	1.2	2.4	1.0	1.5	1.0
PCB #183			0.37	0.7	0.5	0.3 J	0.3 J	0.4 J	0.7	0.4 J	0.4 J	0.3 J
PCB #187			0.87	1.2	1.1	0.9	0.8	1.0	1.2	1.0	1.0	0.8
PCB #194			0.33	0.5	0.2 J	0.3 J	0.3 J	0.4 J	0.6	0.3 J	0.3 J	0.3 J
PCB #195			0.11	0.1 J	0.3 J	0.5 U	0.5 U	0.5 U	0.3 J	0.5 U	0.5 U	0.5 U
PCB #201			0.05	0.5	0.4 J	0.5 U	0.5 U	0.5 U	0.3 J	0.5 U	0.5 U	0.5 U
PCB #203			0.17	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	0.5 U	0.5 U	0.5 U
Total PCBs[3]	18	29.6	18.3	37	34	15.0	14.5	17.1	21.9	13.1	17.6	13.8

Table 5: Supplemental Sediment Chemistry Results for PCBs in Z- samples

	EFH BT	RWQCB TMDL	SF Bay Ambient	Original Sampling Event (-37.0 to -37.5 MLLW)		Supplemental Sampling Event (-34.0 to -34.5 MLLW)					
				CB-DU05B-Z (Comp.)	CB-DU08B-Z (Comp.)	CBSS-DU05B-Z1	CBSS-DU05B-Z2	CBSS-DU05B-Z3	CBSS-DU05B-Z4	CBSS-DU05B-Z9	CBSS-DU08B-Z-CMP (Comp.)
				4/21/15	4/16/15	11/10/15	11/10/15	11/10/15	11/10/15	11/10/15	11/11/15
Polychlorinated Biphenyls (µg/kg DW)											
PCB #8			0.14	1.1 Y	2.5	0.7 Y	1.9 Y	1.1 Y	1.6 Y	1.3 Y	1.5 Y
PCB #18			0.07	6.5	12	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #28			0.28	0.5 U	2.5	0.5 U	0.2 J	0.5 U	0.5 U	0.5	0.2 J
PCB #31			0.13	0.5 U	2.5	0.5 U	0.5	0.5 U	0.4 J	0.6	0.4 J
PCB #33			0.08	0.5 U	2.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #44			0.33	1.2	2.5	0.5 U	0.3 J	0.5 U	0.5 U	1.1	0.3 J
PCB #49			0.25	0.6	2.5	0.4 J	0.4 J	0.5 U	0.3 J	1.3	0.4 J
PCB #52			0.39	2	2.4	0.8	0.7	0.3 J	0.4 J	1.7	0.7
PCB #56			0.14	0.5 U	2.5	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	0.5 U
PCB #60			0.07	0.5 U	2.5	0.8	0.9	0.5 U	0.5 U	0.5 U	1.0
PCB #66			0.48	0.4 J	2.5	0.3 J	0.5 J	0.5 U	0.4 J	1.0	0.5
PCB #70			0.59	1.3	1.2	0.4 J	0.5	0.2 J	0.4 J	1.3	0.6
PCB #74				1	2.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5	0.5 U
PCB #87			0.46	0.8	2.5	0.5 U	0.2 J	0.5 U	0.5 U	0.7	0.5 U
PCB #95			0.60	0.9	1.1	0.6	0.6	0.3 J	0.4 J	1.8	0.7
PCB #97			0.65	1.1	2.5	0.3 J	0.3 J	0.5 U	0.3 J	0.8	0.4 J
PCB #99			1.15	0.9	2.5	0.7	0.8	0.3 J	0.4 J	1.6	0.9
PCB #101			0.36	0.5 U	2.5	0.9	1.0	0.7	0.8	2.7	1.1
PCB #105			0.36	0.9	2.5	0.5 U	0.3 J	0.5 U	0.5 U	0.7	0.2 J
PCB #110			1.04	2.1	2.2	1.0	1.1	0.7	0.8	2.6	1.2
PCB #118			0.98	1.5	1.6	0.8	0.9	0.5	0.7	2.0	0.9
PCB #128			0.28	0.6	2.5	0.4 J	0.4 J	0.5 U	0.5 U	0.8	0.5 U
PCB #132			0.37	0.5 U	2.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
PCB #138			1.83	5.6	4.3	1.3	1.6	0.8	1.2	3.4	1.4
PCB #141			0.20	0.3 J	2.5	0.2 J	0.5 U	0.5 U	0.5 U	0.6	0.5 U
PCB #149			1.25	2.4	2	1.4	1.2	0.7	1.0	3.0	1.3
PCB #151			0.56	0.6	2.5	0.5 U	0.3 J	0.5 U	0.5 U	0.8	0.4 J
PCB #153			1.74	3.1	2.5	2.0	1.4	1.1	1.1	3.1	1.6
PCB #156			0.16	0.4 J	2.5	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	0.5 U
PCB #158			0.15	0.5 U	2.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5	0.5 U
PCB #170			0.47	1.5	0.8	0.5 J	0.5	0.3 J	0.4 J	1.2	0.5
PCB #174			0.49	1.1	2.5	0.5	0.5	0.5 U	0.4 J	1.6	0.5
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PCB #183			0.37	0.6	2.5	0.3 J	0.4 J	0.5 U	0.3 J	0.9	0.3 J
PCB #187			0.87	1.9	1.4	0.9	1.0	0.5 J	0.7	1.8	0.9
PCB #194			0.33	0.5	2.5	0.3 J	0.3 J	0.5 U	0.5 U	0.7	0.3 J
PCB #195			0.11	0.5 U	2.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 J	0.5 U
PCB #201			0.05	0.4 J	0.5	0.3 J	0.5 U	0.5 U	0.5 U	0.5	0.2 J
PCB #203			0.17	0.3 J	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.3 J	0.5 U
Total PCBs[3]	18	29.6	18.3	43	100	16.3	18.3	7.1	11.7	44.6	18.2

Figure 1. Actual Supplemental Sampling Locations in Central Basin

N

0 100 200 400 Feet

Notes on Data Tables:
DW: dry weight
DU: dredged unit
EFH: Essential Fish Habitat
RWQCB: Regional Water Quality Control Board
TMDL: total maximum daily load
BT: bioaccumulation trigger
SF-DODS: San Francisco Deep Ocean Disposal Site
Comparative criteria:
Exceeded SF Bay Ambient   Exceeded Bioaccumulation Trigger   Exceeded TMDL
1. sum of detected 25 PAH compounds
2. sum of detected cis-chlordane, trans-chlordane, oxy-chlordane, cis-nonachlor, and trans-nonachlor, or highest non-detect value.
3. sum of detected 40 PCB compounds
J-detected below the method reporting limit but above the method detection limit
Y-non-detect with an elevated reporting limit due to chromatographic interference (equivalent to 'U' with raised method reporting limit)
U-non-detect at the method detection limit

Reference

NewFields. 2015. Port of San Francisco Central Basin Sediment Characterization Report, Revised. Prepared for the Port of San Francisco, San Francisco, CA, by NewFields, Edmonds, WA. September 29, 2015. (Previously provided to DMMO agencies).

Appendix E:

Real Estate

APPENDIX E

REAL ESTATE PLAN

CENTRAL BASIN CAP 107 NAVIGATION IMPROVEMENT PROJECT
San Francisco, California

PREPARED FOR THE
SAN FRANCISCO DISTRICT
SOUTH PACIFIC DIVISION, U.S. ARMY CORPS OF ENGINEERS

March 2017

PREPARED
BY THE
SACRAMENTO DISTRICT
REAL ESTATE DIVISION
SOUTH PACIFIC DIVISION, U.S. ARMY CORPS OF ENGINEERS

TABLE OF CONTENTS

CENTRAL BASIN CAP 107 NAVIGATION IMPROVEMENT PROJECT
San Francisco, California
REAL ESTATE PLAN

1. Introduction

The purpose of the Central Basin Continuing Authorities Program (CAP)107 Navigation Improvement Project is to study, adopt, construct and maintain navigation improvement projects along Central Basin in the San Francisco Bay in Northern California. The study area, Central Basin Approach Area at the Pier 70 Shipyard (Central Basin and shipyard, respectively), is located at Potrero Point on the eastern waterfront of San Francisco, in the San Francisco Bay. Central Basin is approximately 1.5 miles south of the San Francisco—Oakland Bay Bridge. The Real Estate Plan is prepared in accordance with ER 405-1-12, Section 12-16, Real Estate Plan and in support of the Central Basin Project.

The non-Federal sponsor (NFS) is the City and County of San Francisco acting by and through the Port of San Francisco. On 1 October 2009, the Port submitted a signed Letter of Intent to cost share the Central Basin Pier 70 study. The Port reiterated its interest in partnering with the Corps in a subsequent letter dated 29 April 2013. The Federal Cost Sharing Agreement (FCSA) was signed on 21 June 2013 and the Project Management Plan (PMP) was signed shortly thereafter on 2 July 2013.

This report is tentative in nature, focuses on the Tentatively Selected Plan Plan (TSP), and is to be used for planning purposes only. There may be modifications to the plans that occur during Pre-construction, Engineering and Design (PED) phase, thus changing the final acquisition area(s) and/or administrative and land costs.

2. Project Authority

This study is being conducted under the authority of Section 107 of the River and Harbor Act of 1960 (Pub. L. No. 86-645, 33 U.S.C. 577), as amended, which authorizes the Corps to study, adopt, construct and maintain navigation improvement projects without additional project specific congressional legislation, using the same procedures and policies that apply to congressionally authorized projects. This study is being conducted under the authority of Section 107 of the River and Harbor Act of 1960 (Pub. L. No. 86-645, 33 U.S.C. 577), as amended, which authorizes the Corps to study, adopt, construct and maintain navigation improvement projects without additional project specific congressional legislation, using the same procedures and policies that apply to congressionally authorized projects. The Federal share of initial implementation costs for any one project may not exceed $10 million in accordance with current cost limits authorized by Section 1030 of the Water Resources and Reform Development Act (WRRDA) of 2014 (Pub. L. No. 113-121 [128 Stat. 1193]). WRRDA 2014 was signed into law in June 13, 2014 and implementation guidance was issued 3 December 2014 (USACE 2014).

3. <u>Project Description</u>

The Port of San Francisco (Port) is located on the northern and eastern shores of the City and County of San Francisco, California. The study area, Central Basin Approach Area at the Pier 70 Shipyard (Central Basin and shipyard, respectively), is located at Potrero Point on the eastern waterfront of San Francisco, in the San Francisco Bay. Central Basin is approximately 1.5 miles south of the San Francisco—Oakland Bay Bridge.

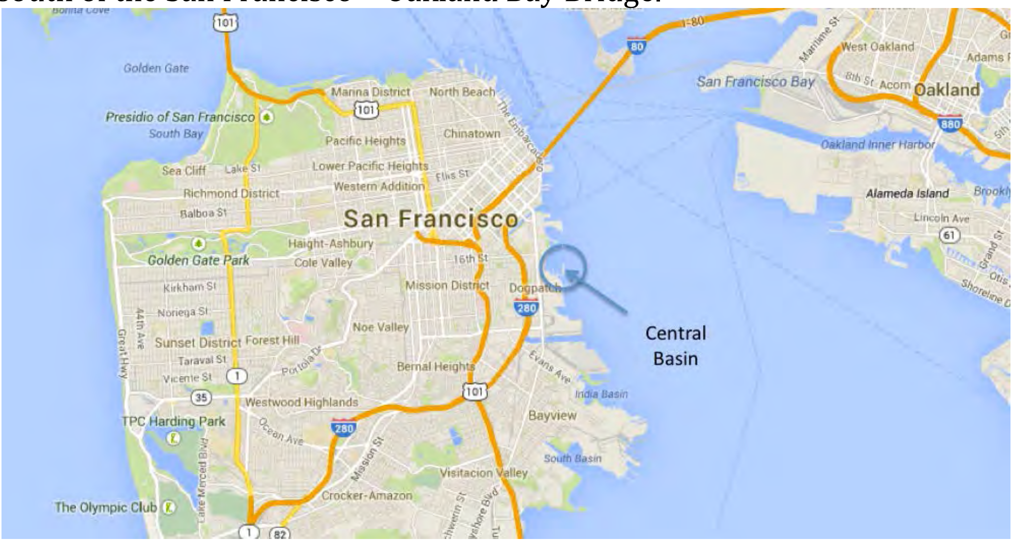


Image 1. Location of Study Area, Central Basin in the Port of San Francisco, California

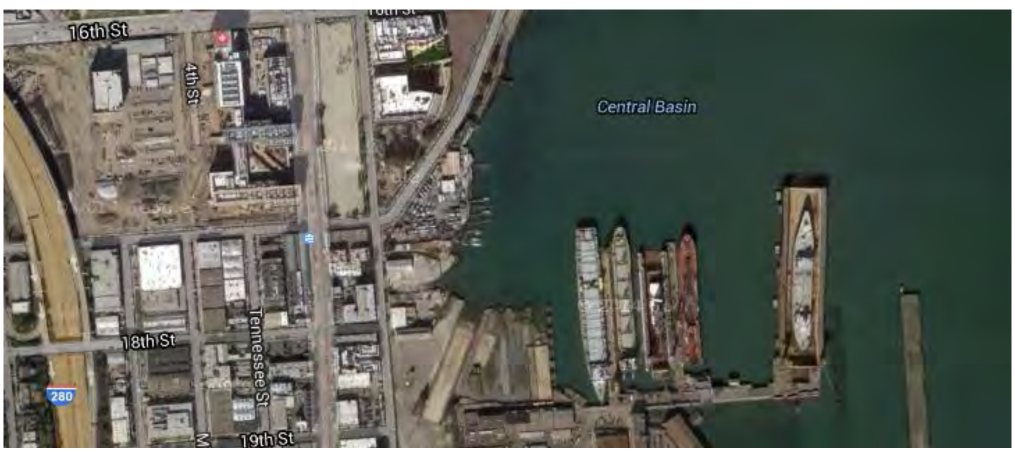


Image 2. Satellite Aerial of Central Basin and Pier 70 Shipyard, San Francisco, California (source: Google)

The project is located in Congresswoman Nancy Pelosi's district, also represented by Senators Boxer and Feinstein of California. Central Basin is the in-bay approach to the shipyard at the Port of San Francisco's Pier 70. The Pier 70 Shipyard features two dry docks, full pier-side facilities, and an available labor force in excess of 1,300, as well as a number of machine and engineering firms.

The Port of San Francisco owns the real property and primary equipment for ship repair, such as the dry docks and cranes, and currently leases such to BAE Systems (BAE). BAE offers full-service ship repair for commercial and government vessels and can accommodate post-Panamax class ships, including cruise ships, tankers, container ships, and more. This active commercial harbor processed 1,088,272 tons of cargo in calendar year 2011. The Port offers a full range of marine terminal services, such as handling of bulk and general cargo, heavy lift services, stevedoring, and storage—both ground and covered.

After evaluating a number of alternatives, Alternative 6 has been identified as the TSP. The TSP proposes to deepen Central Basin to 32 feet mean lower low water (MLLW), plus two feet overdepth and place dredged material, approximately 237,700cy, at SF-DODS.

4. Description of Land, Easements, Rights-Of-Way, Relocation, and Disposal Areas (LERRDs)

The project currently does not require the sponsors to acquire any additional lands for the project where Navigation Servitude applies. In accordance with ER 405-1-12, paragraph 12-29 states, "the non-Federal sponsor should not be instructed to acquire and "provide" such land if it is otherwise available for project purposes through exercise of the navigation servitude rights by the Government."

Placement/disposal sites considered were designated for Beneficial Reuse or permitted sites in the ocean. Furthermore, these sites identified for the project are either through the Long Term Management Strategy (LTMS) program or the site is already identified and permitted through the local agencies.

A temporary work area easement is required. The dredging contractor will need a place to park their trailer, which is their temporary office while they are working on the project for an estimated nine months. The Corps requires space in the trailer so the Construction staff can perform their QA duties. Sponsor will provide an estimated 15,000 square feet of sponsor owned land for the purposes of a trailer and temporary parking spaces.

The USACE Engineer Regulations (ER 1105-2-100) provide that the preferred alternative must be the least costly plan that is consistent with environmental statutes, as set forth in the National Economic Development (NED) Plan for new work projects. Compliance with the ocean dumping criteria of the MPRSA and with the CWA Section 404(b)(1) Guidelines (40 C.F.R. Part 230) is a controlling factor used by the USACE in determining the environmental acceptability of disposal alternatives.

After evaluating a number of alternatives, Alternative 6 has been identified as the TSP. The TSP proposes to deepen Central Basin to 32 feet mean lower low water (MLLW), plus two feet overdepth and place dredged material, approximately 212,120cy, at SF-DODS and supports the goals of LTMS.

After the project partnership agreement (PPA) process is executed, the San Francisco District Engineering Branch will prepare the final design for advertisement and construction. During this process the NFS will be required to provide real estate certification for lands required for the project should there be additional required.

5. LERRDs Owned by the Non-Federal Sponsor and Crediting

Navigation Servitude will apply. Credit will not be afforded for lands that are available to the project through exercise of the navigation servitude. (See Section 9 for further discussion.)

In addition, NFS will not be eligible for credit for placement/disposal sites as it is a permitted site in the ocean. Any costs associated with disposal have been captured under construction costs and not a LERRD.

The dredging contractor will need a place to park their trailer, which is their temporary office while they are working on the project. The Corps requires space in the trailer so the Construction staff can perform their QA duties. Sponsor will provide an estimated 15,000 square feet of sponsor owned land for the purposes of a trailer and temporary parking spaces.

Credit will only be applied to LERRDs owned and/or held by the sponsors that fall within the "project footprint," namely the LERRDs required for the TSP. Lands outside of the project requirements and that may be acquired for the sponsor's own purposes which do not support the minimum interests necessary to construct, operate and maintain the Project would not be creditable LERRDs. Only land deemed necessary to construct, operate and maintain the plan would be creditable.

6. Standard Federal Estates and Non-Standard Estates

The non-Federal sponsor will be required to acquire the minimum interest in real estate that will support the construction and subsequent operation and maintenance of the proposed USACE project.

7. Description of any Existing Federal Projects in or Partially in the Proposed Project

There are no existing Federal projects in the proposed area.

8. Description of any Federally owned Land Needed for the Project

There are no Federally-owned land needed for the Project.

9. Application of Navigational Servitude to the LERRDs Requirement

Navigation Servitude will be applied to this project as it meets the dominant right of the Government under the Commerce Clause of the U.S. Constitution (U.S. CONST. art.I, §, cl.3) to use, control and regulate the navigable waters of the United States and the submerged lands thereunder for various commerce related purposes including navigation and flood control provided in paragraph 12-7 of ER 405-1-12. This project serves a purpose to improve navigation by deepening Central Basin. In addition the project is located below the mean or ordinary high water mark of a navigable watercourse.

10. Project Maps

See Exhibit A.

11. Anticipated Increased Flooding and Impacts

There will be no increased flooding from the proposed project, from either the flood risk management or ecosystem restoration actions.

12. Cost Estimate

There are no real estate acquisition costs associated with the project where Navigational Servitude applies. In addition, placement and disposal actions will occur at SF-DODS where there are no real estate acquisition costs.

However, sponsor will provide an estimated 15,000 square feet of sponsor owned land for the purposes of a trailer and temporary parking spaces (see Section 5 for details). The cost is roughly 44 cents a square foot per month for paved, undeveloped space for a total of $109,400, which includes $59,400 for lands and $50,000 for Fed and non-Fed administrative fees.

13. Relocation Assistance Benefits.

There are no Public Law 91-646 Relocations required in connection with the project.

14. Mineral / Timber Activity.

There are no valuable minerals or timber activity impacted by this project.

15. Non-Federal Sponsor's Ability to Acquire.

The non-Federal sponsors have real estate staff and experience in acquiring real estate for county, State and Federal projects.

16. Zoning Anticipated in Lieu of Acquisition.

There is no zoning in lieu of acquisition planned in connection with the project.

16. Real Estate Acquisition Schedule.

REAL ESTATE ACQUISITION SCHEDULE				
Project Name: South San Francisco Bay Shoreline Study	**USACE Start**	**USACE Finish**	**NFS Start**	**NFS Finish**
Receipt of preliminary drawings from Engineering/PM	Jan 2017	Feb 2017	NA	NA
Receipt of final drawings from Engineering/PM	March 2017	April 2017	NA	NA
Execution of PPA	Jan 2017	**Feb 28, 2017**	NA	NA
Formal transmittal of final drawings & instruction to acquire LERRDS ("Take Letter")	**March 2017**	**April 2017 (May 2017 estimated Solicitation date)**	NA	NA
Conduct landowner meetings (if applicable, NFS responsibility)				
Prepare/review mapping & legal descriptions	NA	NA	NA	NA
Obtain/review title evidence	NA	NA	NA	NA
Obtain/review tract appraisals	NA	NA	NA	NA
Conduct negotiations	NA	NA	NA	NA
Perform closing	NA	NA	NA	NA
Prepare/review condemnations	NA	NA	NA	NA
Perform condemnations	NA	NA	NA	NA
Obtain Possession	NA	NA	NA	NA
Complete/review PL 91-646 benefit assistance	NA	NA	NA	NA
Conduct/review facility and utility relocations.	NA	NA	NA	NA
Certify all necessary LERRDS are available for construction	NA	NA	NA	NA
Prepare and submit credit requests (3 months)	NA	NA	NA	NA
Review/approve or deny credit requests (2months)	NA	NA	NA	NA
Establish value for creditable LERRDS in F&A cost accounting system	NA	NA	NA	NA

COE – Corps of Engineers
NFS – Non-Federal Sponsor

"ANY CONCLUSION OR CATEGORIZATION CONTAINED IN THIS REPORT THAT AN ITEM IS A UTILITY OR FACILITY RELOCATION TO BE PERFORMED BY THE NON-FEDERAL SPONSOR AS PART OF ITS LERRD'S RESPONSIBILITIES IS PRELIMINARY ONLY. THE GOVERNMENT WILL MAKE A FINAL DETERMINATION OF THE RELOCATIONS NECESSARY FOR THE CONSTRUCTION, OPERATION, OR MAINTENANCE OF THE PROJECT AFTER FURTHER ANALYSIS AND COMPLETION AND APPROVAL OF FINAL ATTORNEY'S OPINIONS OF COMPENSABILITY FOR EACH OF THE IMPACTED UTILITIES AND FACILITIES."

18. Description of Facility and Utility Relocations.
There are no identified utilities/facilities that need to be relocated.

19. Hazardous, Toxic, and Radiological Waste (HTRW).

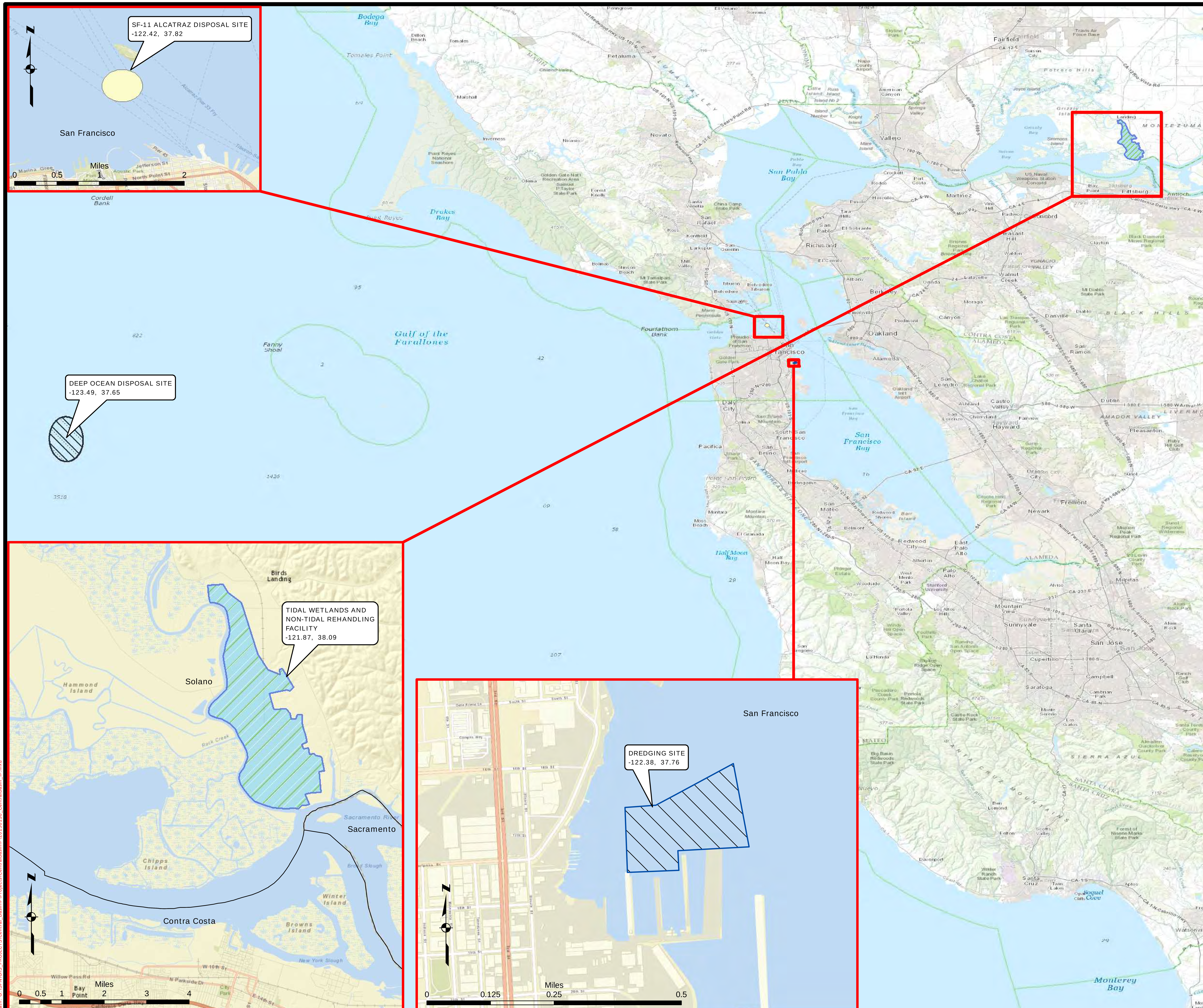
There are no known HTRW issues associated with the proposed project.

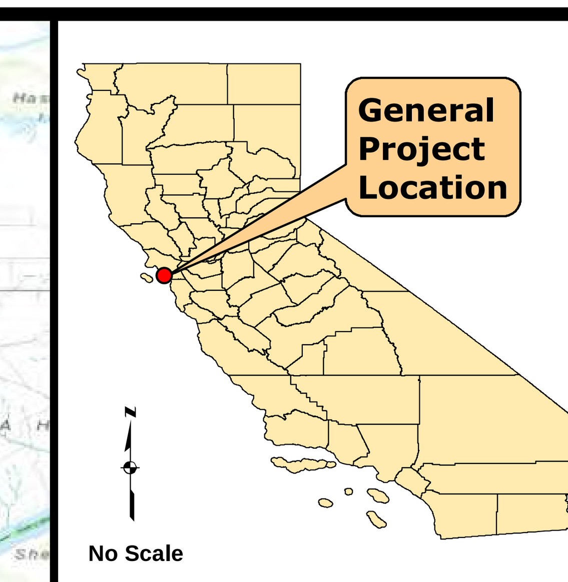
20. Attitude of Landowners.
The sponsors have full support of the project and have received no objections.

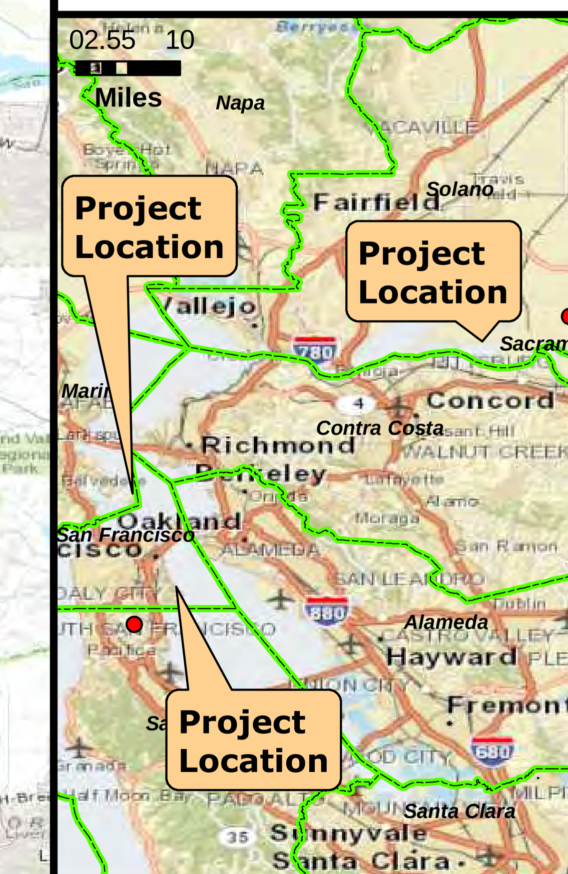
EXHIBIT A PROJECT MAPS

CORPS OF ENGINEERS

U.S. ARMY







MARGINALIA

Miles

0 2.5 5 10

1 inch = 5 miles

Coordinate System:
NAD 1983 StatePlane California III FIPS 0403 Feet
Datum: WGS 1984
Units: Degree

T 8S R 1E (M.D.B. & M.)

GIS files "Placement_Sites, Proposed_Dredge_Footprint & Proposed_Expanded_Dredge_Footprint", were used for reference in this project.

NOTES

Special notes:

1) This information is NOT intended as a substitute for a field survey by a licensed professional, or an application that requires legal or engineering accuracy.
2) Parcel boundary data is only a representation of ground features projected Decimal Degrees on to the Earth's surface by computer programs from raw data obtained from local government agencies and is not necessarily in whole, or in part, based upon any physical survey, study, or recording, professional or otherwise, of the covered properties.

As Applicable

PROJECT MAP

DEPARTMENT OF THE **ARMY**

USING SERVICE ____

LOCATION OF PROJECT

STATE **California**

COUNTY **Solano and San Francisco**

DIVISION **South Pacific (SPD)**

DISTRICT **San Francisco (SPN)**

ARMY AREA **Sixth**

40 miles ENE OF **San Francisco**

2 miles E OF **San Francisco**

55 miles W OF **San Francisco**

TRANSPORTATION FACILITIES

STATE ROADS **State HWY 4**

FEDERAL ROADS **I80, I280 & U.S. HWY 101**

AIRPORTS **San Francisco Int & Buchanan Fld**

ACQUISITION

TOTAL ACRES ACQUIRED ____

FEE ____

PUBLIC DOMAIN: WITHDRAWN ____ / USE PERMIT ____

USE PERMIT (Other than P.D.)

TRANSFER: WITHDRAWN ____ / USE PERMIT ____

LEASE ____

EASEMENT RESERVED IN FEE DISPOSAL ____

LESSER INTERESTS: EASEMENT ____ / PERMIT ____ / LICENSE ____

DISPOSAL

TOTAL ACRES DISPOSED **20.02 Acres**

SOLD ____

PUBLIC DOMAIN: WITHDRAWN ____ / USE PERMIT ____

USE PERMIT (Other than P.D.) ____

TRANSFERRED: FEE ____

LEASES TERMINATED ____

LESSER INTERESTS TERM ____

REASSIGNED ____

ACRES TO ____

LEGEND

EXCEPT FOR SPECIAL SYMBOLS SHOWN BELOW, MAP SYMBOLS ARE STANDARD IN U.S. ARMY FIELD MANUAL, FM 21-31, TOPOGRAPHIC SYMBOLS, DEC. 1968.

- Open ocean, off the continental shelf
- Tidal wetlands.
- Proposed Dredge Footprint
- Proposed Additional Dredge Footprint
- SF-11 Alcatraz

REAL ESTATE OWNERSHIP/ESTATE MAP

DEPARTMENT OF THE ARMY
OFFICE OF THE SACRAMENTO DISTRICT ENGINEER
SOUTH PACIFIC DIVSION

CARTOGRAPHER **J. Henriksen**
CARTO TECH. ____
CHECKED BY ____

SUBMITTED BY
Steve J. Carey
CHIEF, CADASTRAL SECTION

RECOMMENDED BY
Paul Zianno
CHIEF, ACQ. & MGMT. BRANCH

San Francisco **California**

REAL ESTATE DIVISION

Cental Basin Improvement Plan
San Francisco

APPROVED BY **Stan J. Wallin (Acting)** DATE ____
CHIEF, REAL ESTATE DIVISION

OFFICE, CHIEF OF ENGINEERS, WASHINGTON 25, D.C.
REMIS CODE: ____
REMIS UNIQUE ID: ____
INSTALLATION OR PROJECT # ____

Date Saved: 8/4/2015 10:40:39 AM

This sheet originally formatted to ANSI_D, 22"X34".

SHEET 1 OF 1

DRAWING NO. ____

ER 405-1-200 Eng_Form 1456A, Oct 81

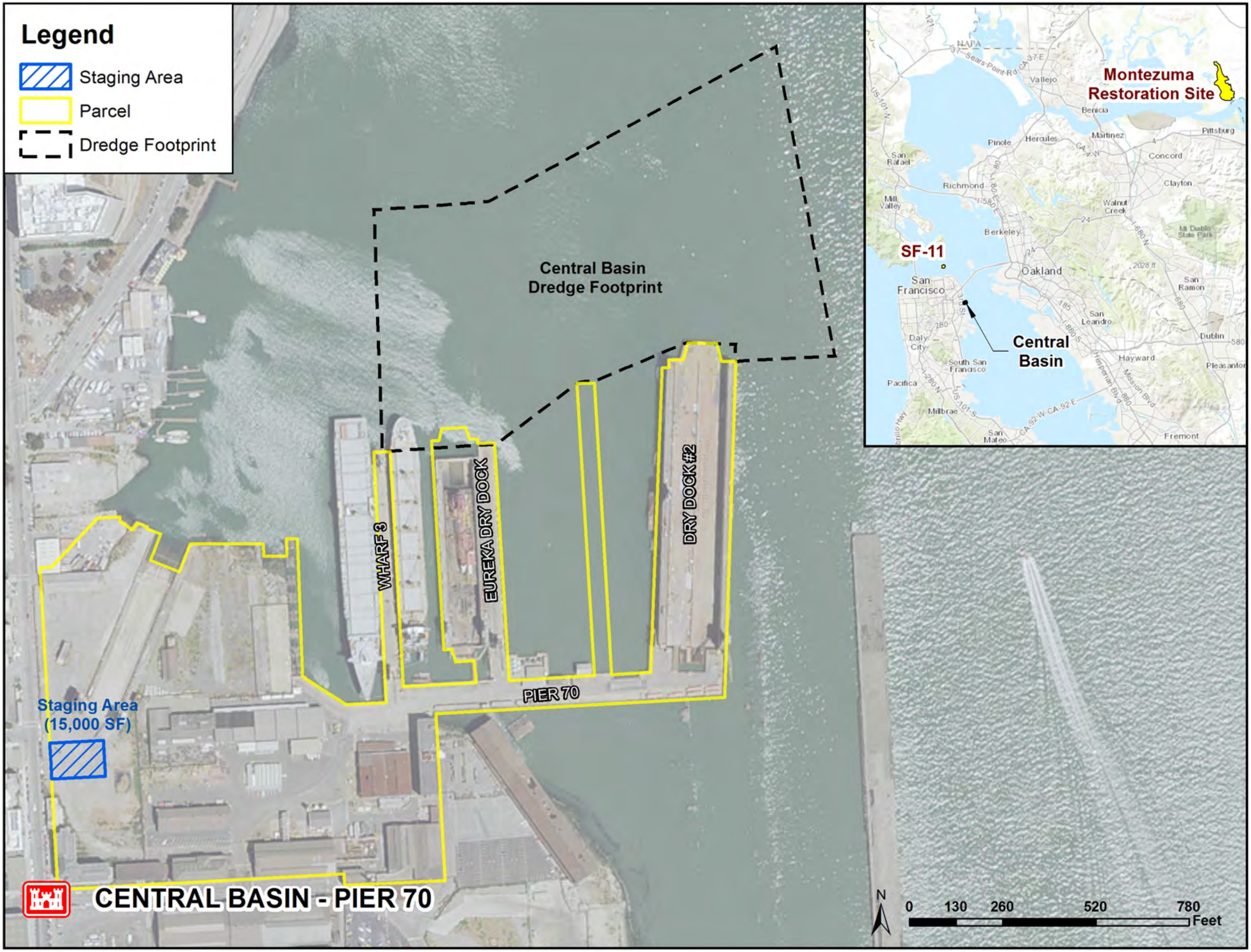

Legend
Staging Area
Parcel
Dredge Footprint
Central Basin
Dredge Footprint
WHARF 3
EUREKA DRY DOCK
DRY DOCK #2
PIER 70
Staging Area
(15,000 SF)
CENTRAL BASIN - PIER 70
Montezuma
Restoration Site
SF-11
Central
Basin
San Francisco
Oakland
Vallejo
Benicia
Martinez
Pittsburg
Concord
Pinole
Hercules
San Rafael
Richmond
Mill Valley
Berkeley
Walnut Creek
Clayton
San Ramon
San Leandro
Dublin
Hayward
Pleasanton
Daly City
South San Francisco
Pacifica
Millbrae
San Mateo
Fremont
N
0 130 260 520 780
Feet

EXHIBIT B-

ASSESSMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY
Central Basin CAP Project

I. Legal Authority:

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes?
YES
b. Does the sponsor have the power of eminent domain for this project?
YES
c. Does the sponsor have "quick-take" authority for this project?
YES
d. Are any of the lands/interests in land required for the project located outside of the sponsor's political boundary?
NO
e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn?
YES (USFWS lands)

II. Human Resource Requirements:

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including PL 91-646, as amended?
NO
b. If the answer to II. A. is "yes", has a reasonable plan been developed to provide such training?
N/A
c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project?
YES
d. Is the sponsor's projected in-house staffing level sufficient considering its other workload, if any, and the project schedule?
YES. The SCC acquires property all the time and the SCVWD has real estate support staff.
e. Can the sponsor obtain contractor support, if required, in a timely fashion
YES
f. Will the sponsor likely request USACE assistance in acquiring real estate?
NO

III. Other Project Variables:

a. Will the sponsor's staff be located within reasonable proximity to the project site?
YES
b. Has the sponsor approved the project/real estate schedule/milestones?
YES

IV. Overall Assessment:

a. Has the sponsor performed satisfactorily on other USACE projects?
YES
b. With regard to this project, the sponsor is anticipated to be: (Capable – Highly Capable – Not capable, etc.)
HIGHLY CAPABLE

V. Coordination:

a. Has this assessment been coordinated with the sponsor?
YES
b. Does the sponsor concur with this assessment?
YES

Prepared by:

Bonievee A. Delapaz

BONIEVEE A. DELAPAZ
Realty Specialist

Reviewed and Approved by:

for [signature] 30 Nov 16

DIANE SIMPSON
Real Estate Contracting Officer

Appendix F:

Cultural Resources

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94103-1398

Ms. Julianne Polanco
Office of Historic Preservation
1725 23rd Street, Suite 100
Sacramento, CA 95816

Dear Ms. Polanco,

The U.S. Army Corps of Engineers, San Francisco District (the Corps) and the non-Federal sponsor, the Port of San Francisco (the Port), have entered into an agreement to conduct a feasibility study under the Corps' Continuing Authorities Program, which will determine whether there is a Federal interest in deepening an area known as the Central Basin Approach Area (Central Basin) that serves the Port's Pier 70 facility.[1] The Central Basin is located on the eastern shore of the City of San Francisco approximately 1.5 miles south of the San Francisco-Oakland Bay Bridge (Figure 1).

On three different occasions over approximately the past 25 years, the Port has dredged Central Basin. In 2011, BAE Systems, which has a 30-year lease of the Pier 70 property and operates the Pier 70 facility, completed its own dredging project. These past dredging projects have removed shoaled sediments to various depths, but the maximum depth reached appears to be -32 feet Mean Lower Low Water (MLLW), with disposal of the dredged material at the approved in-Bay aquatic site. The Corps has issued permits, but has not been directly involved in dredging Central Basin prior to this feasibility study.

Project Description

The USACE Historic Properties Report (2015) included with this consultation presents the Corps' activities and results of its effort to "take into account" the effects of the proposed project on historic properties, and thereby satisfy the underlying requirement of Section 106 of the National Historic Preservation Act of 1966, as amended. The proposed project would dredge approximately 421,000 cubic yards of sediment from Central Basin, resulting in a bottom depth of -35 feet Mean Lower Low Water (MLLW), with an allowance of 2 additional feet (referred to as "overdepth") to ensure adequate clearance for larger ships to access the dry docks. One of these dry docks is the largest publically owned dry dock on the west coast of the United States, and services both commercial and military vessels. Shoaling in Central Basin and its environs has created an increasingly restrictive navigation hazard for vessels that would otherwise use the

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[1]The Port has completed a study of the Pier 70 property to evaluate opportunities to rehabilitate and adaptively reuse historic-era buildings and structures, preserve existing ship-repair operations, provide shoreline public open space, conduct environmental remediation/clean up, and develop an economically viable land use program. There is a Pier 70 facility Master Plan developed by the Port. The Corps is not participating in the Pier 70 project.

dry docks in the Pier 70 facility. The current policy and guidance of the Long Term Management Study for San Francisco Bay prohibits disposal of the dredged materials from this type of project at the aquatic sites traditionally used in the Bay. The two alternative disposal options are reusing the dredged sediment to improve wetland habitats or placing the material in a deep-ocean site.

Area of Potential Effects

Typically an archaeological APE includes any area where project activities could affect the ground surface, either through excavation or deposition. The Central Basin project APE has two Subareas: (A) the existing project channel and maneuvering area and (B) the deep ocean-disposal site. The proposed action is to deepen Subarea A, with disposal of the removed material at Subarea B.

It is generally accepted that the initial construction of shipping lanes and maneuvering areas, and the repeated maintenance dredging of these areas, impact Bay sediments to a point that any submerged cultural resources, if present prior to the work, would have been severely damaged or destroyed. This scenario would likely apply to the Central Basin project, given the historical record of past Basin dredging and adjacent land-based infrastructure. Environmental reviews and prior project documents over the past 20+ years held by the Corps do not indicate submerged cultural resources have been encountered during dredging operations. Records of the current operations that lease the port facilities similarly do not indicate any cultural resources. We therefore have no reason to believe that historic properties are present in the project area, and at this time recommend no additional cultural resource studies be done.

The submerged and previously dredged shipping channel and maneuvering areas (Figure 3) show the approximate horizontal extent of the dredging APE. The thickness of the sediments varies because of the common pattern of uneven shoaling; range is roughly 2-3 meters thick.

The proposed disposal site to use for the material that would be removed in the completion of this project, established under Federal law, is the San Francisco Deep Ocean Disposal Site (SF-DODS) located 50 miles west of the Golden Gate, designated by the Environmental Protection Agency. The U.S. Environmental Protection Agency was the project proponent for the designation of the SF-DODS in 1994, as it provides an environmentally superior alternative to disposal in San Francisco Bay. It lies on the seafloor at approximately 2,500 to 3,000 meters deep.

For a maintenance dredging project, USACE follows Dredging Guidance Letter No. 89-01 (13 March 1989), which states that remote-sensing surveys to identify submerged vessel remains or other sunken maritime artifacts are not required within the boundaries of previously dredged Federal channels. However, if the Corps determines that there is a good reason to believe that archaeological resources exist in a previously dredged channel, and they would be altered or destroyed as a result of project implementation, it may be necessary to perform magnetometer and/or side-scan sonar surveys.

Records and Literature Review

The California State Lands Commission maintains an online database; a search generated a list of records of vessels lost in southern San Francisco Bay.[2] Additionally, The National Oceanic and Atmospheric Administration maintains an online shipwreck database for the Monterey Bay National Marine Sanctuary (MBNMS)[3], populated using the latitude and longitude coordinates provided for a vessel's recorded sinking location. The MBNMS database listed 30 shipwrecks by latitude and longitude coordinates, which represents a partial listing of lost vessels in the ocean waters between San Francisco and Point Sur. The MBNMS funded a submerged cultural resources study in 2001 that generated another database of over 400 shipwrecks; it is available on a compact disk.[4]

The information acquired from the literature and database reviews allows the tentative conclusion that there are no historic properties within the APE. Submerged cultural resources would likely not have survived in the existing shipping channels. None of the plotted locations of known shipwrecks fall within the area of disposal site SF-DODS (Subarea B).

Based upon the above discussion regarding the greatly modified conditions in the existing project channels, it is reasonable to conclude that there is little potential for historic properties to be adversely affected by the deepening. Further, in reference to the negative findings of known shipwreck locations in San Francisco Bay, and the absence of archaeological resources in the proposed disposal area of the APE (Subarea B), it is concluded that no historic properties will be adversely affected by disposal activities.

We have consulted with Indian Tribes and other interested individuals with cultural connections to the area that may be affected by the proposed undertaking (Nov 2015, Nov 2016). Should comments be received, the Corps and the Port will consider recommendations and reopen consultation with you. We have met our commitments in accordance with Section 106 of the NHPA and request conclusion to our consultation regarding this project.

Kathleen Ungvarsky is the District Archaeologist and the point of contact for the historic properties consultation. Please direct questions to her at kathleen.ungvarsky@usace.army.mil or at (415) 503-6842.

Sincerely,

Benjamin Smalley 9 NOV 16
Chief, Environmental Section A

Enclosures: 3 Figures, 1 Appended Report

2 http://shipwrecks.slc.ca.gov

3 http://channelislands.nos.noaa.gov

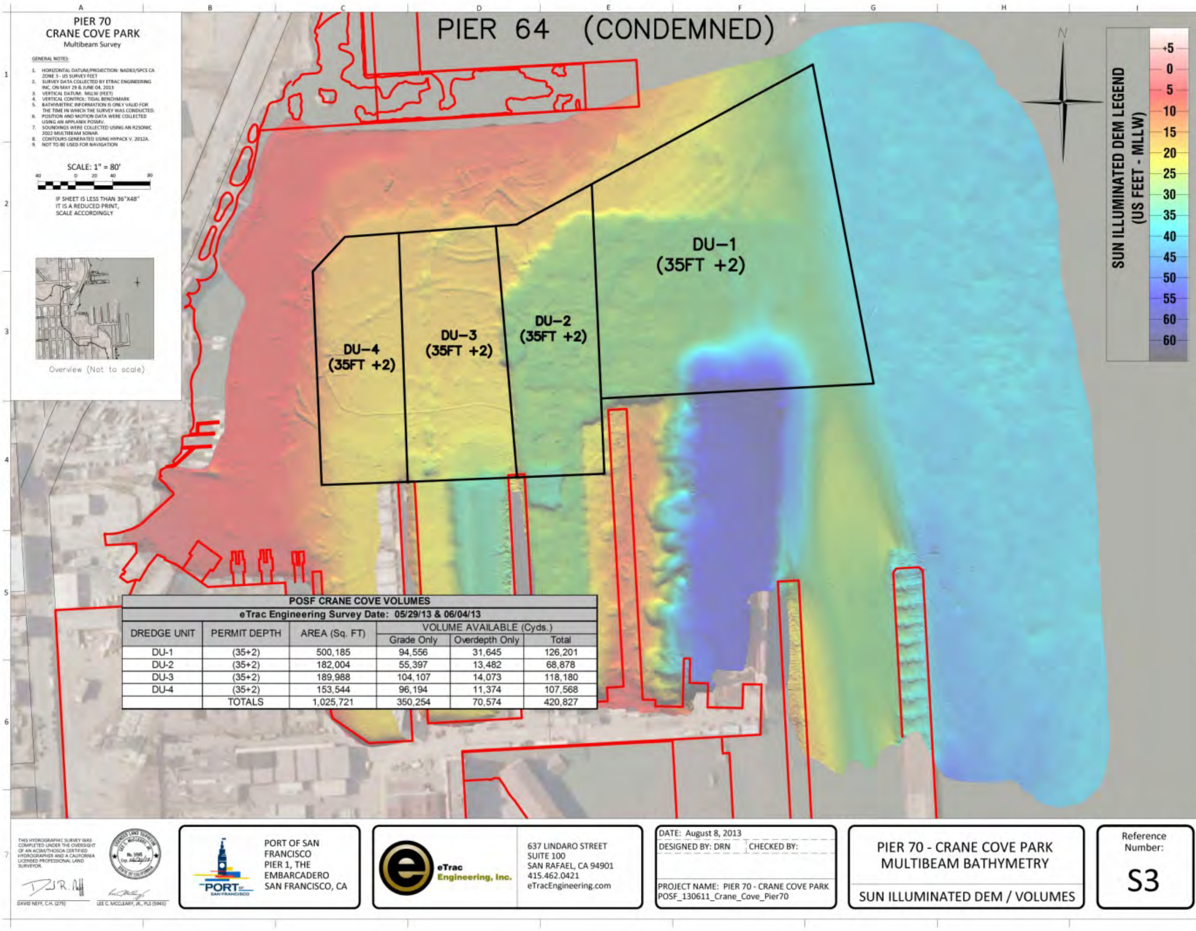
4 "Monterey Bay National Marine Sanctuary Submerged Cultural Resources Study: 2001." Prepared by Underwater Archaeological Consortium (2003).

Figure 1. San Francisco Bay Harbor Central Basin Location Area

San Francisco Bay Harbor Central Basin
Latitude: N 37.76187° *(NAD83 datum)*
Longitude: W 122.37941°

Figure 2. San Francisco Bay Harbor Central Basin; maneuvering area, and approach.

Figure 3. Central Basin Dredging Depths



POSF CRANE COVE VOLUMES
eTrac Engineering Survey Date: 05/29/13 & 06/04/13

DREDGE UNIT	PERMIT DEPTH	AREA (Sq. FT)	VOLUME AVAILABLE (Cyds.)		
			Grade Only	Overdepth Only	Total
DU-1	(35+2)	500,185	94,556	31,645	126,201
DU-2	(35+2)	182,004	55,397	13,482	68,878
DU-3	(35+2)	189,988	104,107	14,073	118,180
DU-4	(35+2)	153,544	96,194	11,374	107,568
	TOTALS	1,025,721	350,254	70,574	420,827

Enclosure 1

HISTORIC PROPERTIES REPORT

U.S. ARMY CORPS OF ENGINEERS
SAN FRANCISCO DISTRICT

PROJECT: Dredging of Central Basin Approach Area

HISTORIC PROPERTIES MANAGER: Kathleen Ungvarsky, Archaeologist, M.A., RPA and Richard Stradford, Archaeologist, M.A.

DATE: 01 April 2015

1.0 Introduction

The U.S. Army Corps of Engineers, San Francisco District (USACE) and the non-Federal sponsor, the Port of San Francisco (Port), have entered into an agreement to conduct a feasibility study under USACE Continuing Authorities Program, which will determine whether there is a Federal interest in deepening an area known as the Central Basin Approach Area (Central Basin) that serves the Port's Pier 70 facility.[1] The Central Basin is located on the eastern shore of the City of San Francisco approximately 1.5 miles south of the San Francisco-Oakland Bay Bridge (Figure 1).

On three different occasions over the past 25 years or so, the Port has dredged the Central Basin. In 2011, BAE systems, which has a 30-year lease of the Pier 70 property and operates the Pier 70 facility, completed its own dredging project. These past dredging projects have removed shoaled sediments to various depths, but the maximum depth reached appears to be -32 feet Mean Lower Low Water (MLLW), with disposal at the approved in-Bay aquatic site. The USACE has issued permits to the parties, but the agency has not been involved in dredging of the Central Basin prior to this feasibility study.

This report presents USACE activities and results of its effort to "take into account" the effects of the proposed project on historic properties, the underlying requirement of Section 106 of the National Historic Preservation Act of 1966, as amended. An historic property is a Federal term that means a cultural resource, for example dating to prehistoric times or historic-era maritime features, determined after analysis to be significant and also retain aspects of integrity. Such a property is said to be eligible for listing in the National Register of Historic Places.

2.0 Project Description

[1]The Port has completed a study of the Pier 70 property to evaluate opportunities to rehabilitate and adaptively reuse historic-era buildings and structures, preserve existing ship-repair operations, provide shoreline public open space, conduct environmental remediation/clean up, and develop an economically viable land use program. There is a Pier 70 facility Master Plan developed by the Port. The USACE is not participating in the Pier 70 project.

The proposed project would dredge approximately 421,000 cubic yards of sediment from the Central Basin, resulting in a bottom depth of -35 feet Mean Lower Low Water (MLLW), with an allowance of 2 additional feet of referred to as “overdepth” to ensure adequate clearance for larger ships to access the dry docks, one of which is the largest publically owned dry dock on the west coast of the United States. This dry dock services both commercial and military vessels. Shoaling in the Central Basin and its environs has created an increasingly restrictive navigation hazard for vessels that would otherwise make use of the dry docks in the Pier 70 facility. The current policy and guidance of the Long Term Management Study for San Francisco Bay prohibits disposal of the dredged materials from this type of project at the historically used aquatic sites in the Bay. The two alternative disposal options are reusing the dredged sediment to improve wetland habitats or placing the material in a deep-ocean site.

Prior to the Port’s purchase of what is now the Pier 70 Shipyard in 1982, Central Basin was privately maintained. The chronology of Pier 70 tenants and owners, primarily for ship building and repair, were Twigg Bros. Boat Works (circa 1880-1920), Union Iron Works (1890-1910), Bethlehem Steel (1910-1980), Port of San Francisco (1982-present), leasing to Todd Shipyard, Southwest Marine, and most recently BAE Systems. The records of the dredging completed during the World War I and II periods when the site was operated by Bethlehem Steel and its predecessors are limited. One Bethlehem Steel plan from 1945 shows planned depths of -26 feet MLLW in the western part of Central Basin and –34 feet MLLW in the center of Central Basin. The currently proposed project is the first time that USACE has participated in determining whether there is a Federal interest in dredging the Central Basin.

3.0 Area of Potential Effects

The area within which an agency is responsible to identify historic properties is known as the Area of Potential Effects (APE). It is defined in 36 C.F.R. § 800.16 as the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking. The APE for the Central Basin dredging project consists of the submerged and previously dredged shipping channel and maneuvering areas. Figure 2 shows the approximate horizontal extent of the dredging APE. The thickness of the sediments varies because of the common pattern of uneven shoaling; range is roughly 2-3 meters thick.

There are two possible disposal sites to use, both established under Federal law, that : (1) the San Francisco Deep Ocean Disposal Site (SF-DODS) located 50 miles west of the Golden Gate, designated by the Environmental Protection Agency and (2) the Montezuma Wetlands Project in the Suisun Marsh, a 2,400-acre commercial facility that accepts clean dredged material to restore wetlands. The U.S. Environmental Protection Agency was the project proponent for the designation of the SF-DODS in 1994 that provided an environmentally superior alternative to disposal in San Francisco Bay. It lies on the seafloor at approximately 2,500 to 3,000 meters deep. EPA was the lead Federal agency who complied with environmental and historic preservation laws, and therefore satisfied the requirements of Section 106. The Montezuma restoration was under the jurisdiction of USACE Section 404 of the Clean Water Act, through which USACE has already satisfied the requirements of Section 106, including an executed Memorandum of Agreement.

4.0 Methods and Results

The USACE has established policy and procedures for conducting remote sensing surveys to identify submerged historic-era cultural resources in previously constructed and maintained navigation channels.[2] Surveys such as magnetometer or side-scan sonar to identify submerged historic-era archaeological sites (e.g., shipwrecks or other sunken maritime features or artifacts) are not required within the boundaries of previously dredged channels or previously used disposal areas, unless USACE determines that there is a good reason to believe that such resources exist, and that they would be altered or destroyed by the project. The USACE is directed to make a reasonable and good faith effort to identify submerged archaeological resources in the APE. For maritime resources, typically this is the review of project documents and research of historical records and other sources. The basis for this approach is the commonly understood
fact that construction of navigation channels, maneuvering areas, and dry docks, etc. destroys or severely damages sunken vessels. It therefore follows that no submerged maritime resources would still exist in the shoaled sediments to be dredged.

In accordance with USACE policy, staff reviewed the cultural resource files in the San Francisco Office, which included published and unpublished archaeological and history manuscripts, and also maps of the historic margins of the Bay marshes and the shoreline areas that have been filled in. For information on wrecked, burned, and abandoned historic vessels in or near the Central Basin, USACE used (1) an internal list of late-18th and early-20th century vessels known to have been lost in the Bay, anonymously prepared from newspaper articles and other media and (2) the online, searchable database maintained by the State Lands Commission.[3] The Port and BAE Systems were a source of information on the history of development of the Pier 70 facility and the scope of previous dredging projects in the Central Basin and its environs. USACE staff archaeologist conducted a site visit of the Pier 70 facility, and observed some of the shoreline industrial features and near-shore areas of shallow Bay waters. The other type of cultural resource is prehistoric archaeological sites derived from Native American occupation of San Francisco Bay, which dotted the shoreline landscape and were first recorded during the early 20th century by archaeologists. None of the more than 400 Native American sites were found in the Central Basin vicinity. The Pier 70 site and adjacent industries have transformed the original Bay shoreline, known as Crane Cove, and it is therefore unlikely to have preserved prehistoric archaeological materials in that location. The APE is well offshore of the historic shoreline, and thus one would expect that this kind of archaeological resource would not be found in this aquatic setting.

The USACE research identified four vessels recorded as lost in the vicinity of the Central Basin. Because the records list only latitude and longitude coordinates, and occasionally notes, the final resting place on the bottom of the Bay is anecdotal. The Canonicus, a brig built in 1853, the Despatch, a steam schooner built in 1905, are recorded as “burned.” The Janette, an 1878 sail schooner, was listed as “capsized,” the steam screw Major Tomkins recorded as

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[2] Dredging Guidance Letter No. 89-01. U.S. Army Corps of Engineers, dated 13 March 1989.
[3] http://shipwrecks.slc.ca.gov

"grounded," and the schooner William L. Mighels listed as "wrecked." The ultimate fate of the vessels is not known; often such ships were salvaged and broken up in San Francisco "ship breaking" yards. Given the available information, USACE has no reason to believe that any remnants of the identified ships exist in the APE or its vicinity.

6.0 Conclusion

Based upon the research results showing a very low possibility that any type of cultural resources would be situated in the Central Basin, USACE has determined that additional research or a remote sensing survey of submerged sediments at the bottom of the Central Basin are not needed. Rather, USACE believes it has sufficiently "taken into account the effects" of the Central Basin project on submerged archaeological resources of prehistoric origin or from the historic era that may qualify for listing in the National Register of Historic Places. In accordance with 36 C.F.R 800.4(a)(1), USACE believes this work presents the results of a "good faith effort" to consider historic properties and that a finding of "no historic properties affected" is appropriate [36 C.F.R 800.4(d)(1)].

Figure 1. Central Basin Approach Area Project Site.

Figure 2. Central Basin Area of Potential Effects. The Pier 70 drydocks are immediately adjacent to the area.

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94103-1398

Ms. Julianne Polanco
Office of Historic Preservation
1725 23rd Street, Suite 100
Sacramento, CA 95816

14 Nov 16

Dear Ms. Polanco,

The U.S. Army Corps of Engineers San Francisco District and the non-Federal sponsor, the Port of San Francisco, consulted with you regarding the Central Basin Approach Area (Central Basin) that serves the Port's Pier 70 facility.[1] We are providing you with our documentation of consultation and letters to Native American Tribes with cultural connections to the area that may be affected by the proposed undertaking. The Corps and the Port will consider all recommendations; although at this time we do not have issues that require additional consultation. We have met our commitments in accordance with Section 106 of the National Historic Preservation Act and request conclusion to our consultation.

If you need additional information or have questions regarding this project please contact the District Archaeologist, Kathleen Ungvarsky, who is our point of contact for the historic properties consultation at kathleen.ungvarsky@usace.army.mil or (415) 503-6842.

Sincerely,

Benjamin Smalley
Chief, Environmental Section A

Enclosures:
Native American Contact Log (letter and telephone)

[1]The Port has completed a study of the Pier 70 property to evaluate opportunities to rehabilitate and adaptively reuse historic-era buildings and structures, preserve existing ship-repair operations, provide shoreline public open space, conduct environmental remediation/clean up, and develop an economically viable land use program. There is a Pier 70 facility Master Plan developed by the Port. The Corps is not participating in the Pier 70 project.

Record of Native American Contacts
Central Basin Approach Deepening, San Francisco, California

DATE TO/FROM

Letter Correspondence
5/02/2015 Native American Heritage Commission (NAHC) Sacred Lands and Tribes
06/04/2015 USACE NAHC negative Sacred Lands file and tribes list
6/04/2015 Letters to NA tribes and representatives:

- Jakki Kehl Ohlone Indian Tribe
- Katherine Erolinda Perez, Ohlone Indian Tribe
- Linda G. Yamane, Ohlone Indian Tribe
- Valentin Lopez, Chairperson Amah Mutsun Tribal Band of Mission San Juan Bautista
- Edward Ketchum Amah Mutsun Tribal Band
- Irene Zwerlin Amah Mutsun Tribal Band of Mission San Juan Bautista
- Michelle Zimmer Amah Mutsun Tribal Band of Mission San Juan Bautista
- Irene Zwierlein Amah Mutsun Tribal Band of Mission San Juan Bautista
- Anne Marie Sayers Chairperson Indian Canyon Mutsun Band of Costanoan
- Rosemary Cambra Chairperson Muwekma Ohlone Indian Tribe of the San Francisco Bay Area
- Andrew Galvan, The Ohlone Indian Tribe of Mission San Jose
- Ramona Garibay Representative c/o Trina Marine Ruano Family
- Trina Marine Ruano Family

Letter Correspondence

11/07/2016 Native American Heritage Commission (NAHC) Sacred Lands and Tribes (attached)
11/08/2016 Native American Tribes and representatives (all letters were the same, the letter to Mr. Ketchum is attached for reference):

- Jakki Kehl Ohlone Indian Tribe
- Katherine Erolinda Perez, Ohlone Indian Tribe
- Linda G. Yamane, Ohlone Indian Tribe
- Valentin Lopez, Chairperson Amah Mutsun Tribal Band of Mission San Juan Bautista
- Edward Ketchum Amah Mutsun Tribal Band
- Irene Zwerlin Amah Mutsun Tribal Band of Mission San Juan Bautista
- Michelle Zimmer Amah Mutsun Tribal Band of Mission San Juan Bautista
- Irene Zwierlein Amah Mutsun Tribal Band of Mission San Juan Bautista
- Anne Marie Sayers Chairperson Indian Canyon Mutsun Band of Costanoan
- Rosemary Cambra Chairperson Muwekma Ohlone Indian Tribe of the San Francisco Bay Area
- Andrew Galvan, The Ohlone Indian Tribe of Mission San Jose
- Ramona Garibay Representative c/o Trina Marine Ruano Family
- Trina Marine Ruano Family

Telephone Correspondence
November 11, 2016. Archaeologist Kathleen Ungvarsky

- Jakki Kehl Jakkikehl@gmail.com
- Anne Marie Sayers 2:54 Detailed message.
- Rosemary Cambra 2:34 PM unable to leave message.
- Ramona Garibay 2:45 PM Left detailed message.
- Linda Yamane 2:48 PM Detailed message
- Edward Ketchum 2:58 PM email document: aerieways@aol.com
- Andrew Galvan 3:25 PM no immediate concerns. Recommends if resources are encountered and Native American remains are exposed follow the State law and contact the County Cororner and Native American Heritage Commission and comply with their recommendations
- Valentin Lopez 3:25 PM Outside Tribal Territory.
- Katherine Perez 3:28 PM Detailed message
- Irene Zwierlein 3:45 PM Unlikely discovery. Spoke on behalf of herself and her daughter Michelle Zimmer (below). Their recommendations for archaeology work is for crews to have cultural sensitivity training. Archaeologists must have knowledge of and be experienced with Northern and Central California archaeology. Native American monitors must be qualified and trained.
- Michelle Zimmer (see Irene Zwierlein above)

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET ST.
SAN FRANCISCO, CALIFORNIA 94103-1398

October 28, 2016

Native American Heritage Commission
915 Capitol Mall, Room 364
Sacramento, California 95814

Dear Native American Heritage Commission,

The U.S. Army Corps of Engineers, San Francisco District and our non-Federal sponsor, the Port of San Francisco, are proposing to deepen the San Francisco Central Basin near Pier 70 along the San Francisco waterfront (Figure 1, attached). In keeping with Section 106 of the National Historic Preservation Act, 36 CFR 800.4, we are requesting information about sacred lands that may be in the project area. These sites may contain unique qualities that may meet the eligibility criteria (36 CFR 60.4) for the National Register of Historic Places and if so, would be eligible for protection under the National Historic Preservation Act (36 CFR 60.4).

This letter is in keeping with our effort to consult with Native American tribes or their representatives that have cultural ties to the project area and knowledge of cultural resources that may be affected by the proposed project. Kathleen Ungvarsky is the District's archeologist and point of contact for the Central Basin historic properties consultation. Please contact her for any correspondence regarding this request. She can be reached by phone at (415) 503-6842, Fax (415) 503-6695, or by email at kathleen.ungvarsky@usace.army.mil.

Sincerely,

Benjamin Smalley
Chief, Environmental Section A

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET ST.
SAN FRANCISCO, CALIFORNIA 94103-1398

May 4, 2015

Native American Heritage Commission
915 Capitol Mall, Room 364
Sacramento, California 95814

Dear Native American Heritage Commission,

The Corps of Engineers, San Francisco District, is proposing a project to deepen the San Francisco Central Basin near Pier 70 along the San Francisco waterfront. In keeping with Section 106 of the National Historic Preservation Act, 36 CFR 800.4, we are requesting information about sacred lands that may be in the project area. These sites may contain unique qualities that qualify for National Register of Historic Places and thus protection under the National Historic Preservation Act (36 CFR 60,4).

We would like to consult with individuals, Native American tribes or their representatives, with cultural affiliation to the area, or specific cultural, ethnographic, or historical knowledge of the area or know of sites, structures, objects, or locations of traditional cultural use that may be affected by the proposed undertaking.

Kathleen Ungvarsky is the District's point of contact for the historic properties consultation. Please contact her with information or any questions or concerns you may have regarding this request. She can be reached by phone 415/503-6842, Fax 415/503-6692 or email Kathleen.ungvarsky@usace.army.mil.

Sincerely,

KUngvarsky

Kathleen Ungvarsky
Archaeologist, Environmental B

Enclosure

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET ST.
SAN FRANCISCO, CALIFORNIA 94103-1398

8 Nov 16

Mr. Edward Ketchum
35867 Yosemite Ave
Davis, CA 95616

Dear Mr. Ketchum,

The U.S. Army Corps of Engineers, San Francisco District (USACE) and the non-Federal sponsor, the Port of San Francisco (the Port), have entered into an agreement to conduct a feasibility study under the USACE Continuing Authorities Program, to determine whether there is a Federal interest in deepening an area known as the Central Basin Approach Area (Central Basin) that serves the Port's Pier 70 facility.[1] Central Basin is located on the eastern shore of the City of San Francisco approximately 1.5 miles south of the San Francisco-Oakland Bay Bridge (see attached maps). The area of potential effects (APE) consists of two subareas: (a) the existing project channel and maneuvering area, and (b) the deep ocean disposal site (SF DODS). The study proposes to deepen subarea A via dredging, and dispose of the material in subarea B.

In keeping with Section 106 of the National Historic Preservation Act, 36 CFR 800.4, we are seeking information from tribes and/or individuals who have specific cultural, ethnographic, or historical knowledge of the area, or of sites, structures, objects, or locations of traditional cultural use that may be affected by the proposed undertaking. These sites may contain unique qualities that are eligible for the National Register of Historic Places and protection under the National Historic Preservation Act (36 CFR 60.4).

For a maintenance dredging project, USACE follows Dredging Guidance Letter No. 89-01 (13 March 1989), which states that remote-sensing surveys to identify submerged vessel remains or other sunken maritime artifacts are not required within the boundaries of previously dredged Federal channels. However, if USACE determines that there is a good reason to believe that archaeological resources exist in a previously dredged channel, and they would be altered or destroyed as a result of project implementation, it may be necessary to perform magnetometer and/or side-scan sonar surveys.

We would appreciate receiving any comments, concerns or information you have regarding this project. We recognize that some information regarding cultural assets may be sensitive; our position is that this information will be used only for project planning purposes in the interests of preserving cultural resources.

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[1]The Port has completed a study of the Pier 70 property to evaluate opportunities to rehabilitate and adaptively reuse historic-era buildings and structures, preserve existing ship-repair operations, provide shoreline public open space, conduct environmental remediation/clean up, and develop an economically viable land use program. There is a Pier 70 facility Master Plan developed by the Port. The Corps is not participating in the Pier 70 project.

Our regulatory procedures allocate 30 days for comments. If no response is received within that timeframe, we assume that you have not identified a need to consult with us on this project. However, your involvement is valuable to us and, should you desire to consult, we will ensure that any concerns or comments you have about the project are carefully considered. Our point of contact is our District Archeologist, Kathleen Ungvarsky, who can be reached at (415) 503-6842; or by email at kathleen.ungvarsky@usace.army.mil.

Sincerely,

Benjamin Smalley
Chief Environmental A

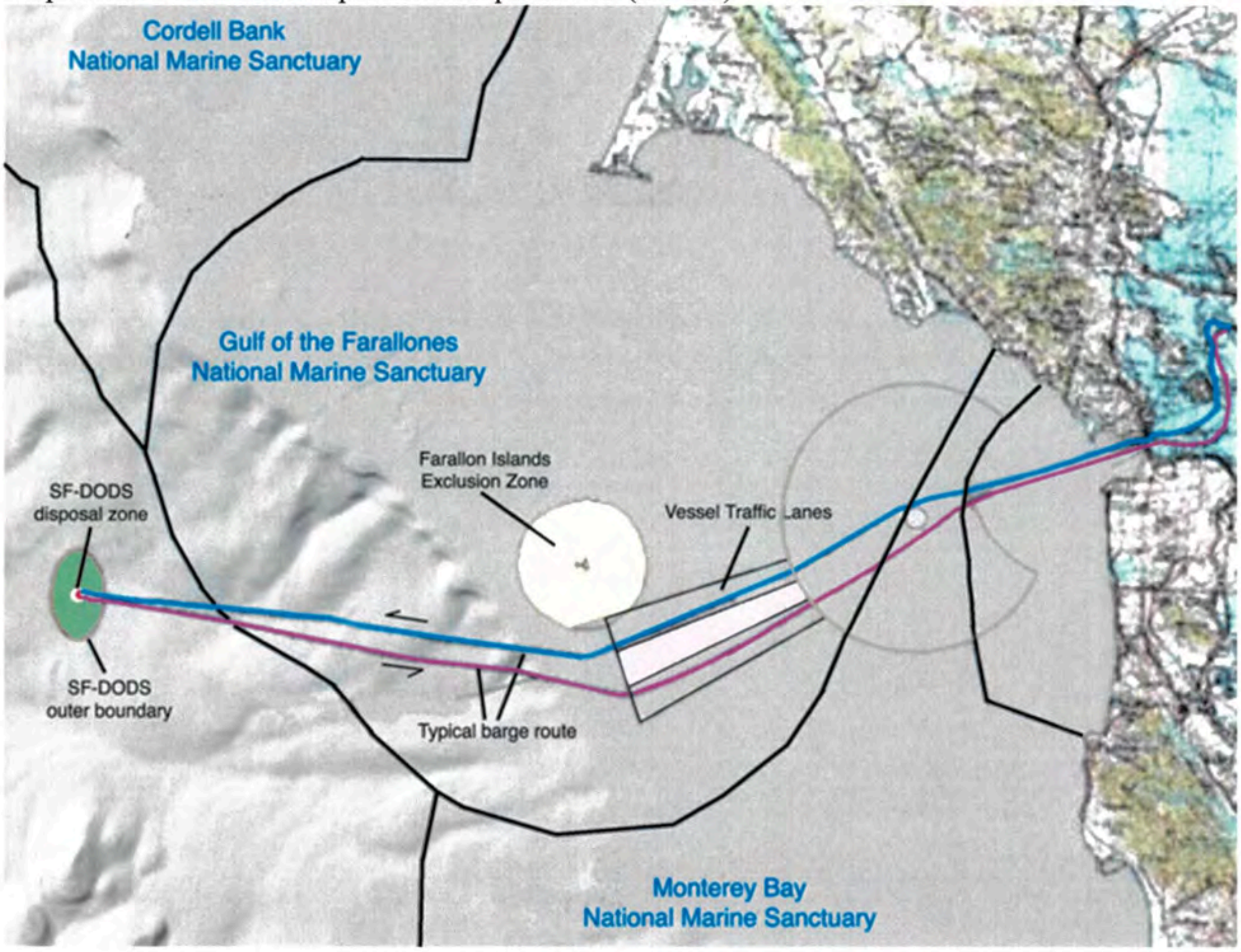
Enclosures:

1. Project Area Map
2. Deep Ocean Disposal Site Map

Map 1. San Francisco Central Basin Project Area Map

San Francisco Central Basin
Latitude: N37.76187° *(NAD83 datum)*
Longitude: W122.37941°

Map 2. San Francisco Deep Ocean Disposal Site (DODS)



San Francisco Deep Ocean Disposal Site
Latitude: 37° 39.0 min N *(NAD83 Datum)*
Longitude: 123° 29.0 min W

Courtesy Copies with enclosures:

Mr. Valentin Lopez
Chairman, Amah Mutsun Tribal Band
PO Box 5272
Galt, CA. 95632

Ms. Rosemary Cambra, Chairperson Muwekma Ohlone Indian Tribe of the SF Bay Area
P.0. Box 360791
Milpitas, CA 95036

Ms. Katherine Erolinda Perez
Ohlone/Costanoan Indian Tribe
P.O. Box 717
Linden, CA 95236

Ms. Jakki Kehl
Ohlone Indian Tribe
720 North 2nd Street
Patterson, CA 94363

Ms. Michelle Zimmer
Amah Mutsun Tribal Band of Mission San Juan Bautista
789 Canada Road
Woodside, CA 94026

Irene Zwierlein
Amah Mutsun Tribal Band of Mission San Juan Bautista
789 Canada Road
Woodside, CA 94062

Representative Ramona Garibay
Ohlone/Costanoan Indian Tribe
C/O Trina Marine Ruano Family
30940 Watkins Street
Union City, CA 94587

Ms. Ann Marie Sayers
Indian Canyon Mutsun Band of Costanoan Indians
P. 0. Box 28
Hollister, CA 95024

Ms. Linda G. Yamane
1585 Mira Mar Avenue
Seaside, CA 93955

Mr. Edward Ketchum
Amah Mutsun Tribal Band
35867 Yosemite Ave
Davis, CA 95616

Appendix G:

Project Documentation

PORT OF SAN FRANCISCO

April 29, 2013

Lt. Col. John K. Baker, P.E.
District Commander
U.S. Army Engineer District, San Francisco
Corps of Engineers
1455 Market Street
San Francisco, CA 94103-1398

Lieutenant Colonel Baker:

I write this letter to request that the U.S. Army Corps of Engineers conduct a study under Section 107 of the River and Harbor Act, as amended, to determine the feasibility of developing a small navigation improvement at San Francisco's Central Basin.

The Port of San Francisco's shipyard, located at Pier 70, is home to the largest publically owned drydock on the west coast of the Americas. This drydock services both private and military vessels. However, siltation in the adjacent Federal Channel (the area that is, essentially, the "driveway" to the drydock) has created an increasingly restrictive navigation hazard for vessels that would otherwise make use of the facility. The area in question is both outside the jurisdiction of the Port and outside the leasehold of the Port's shipyard operator. This request is for the Corps to investigate the possibility of undertaking a project to dredge the area to its nominal depth of -35 feet MLLW.

We understand that, if the study indicates a project with a federal interest is likely, the Port of San Francisco would be required to enter into a contract to pay half the cost of the feasibility study after the first $100,000. Further, if the Corps finds that it is feasible to develop a navigation project at the Central Basin, the Port of San Francisco would agree to provide the local cooperation and cost sharing prescribed by the Secretary of the Army.

Thank you very much for your assistance in this matter. If you require any additional information for this request, please contact Jay Ach at (415) 274-0562.

Sincerely,

Monique Moyer

Monique Moyer
Executive Director

AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY
AND
THE CITY AND COUNTY OF SAN FRANCISCO
ACTING BY AND THROUGH
THE PORT OF SAN FRANCISCO
FOR THE
CENTRAL BASIN PIER 70 DREDGING FEASIBILITY STUDY

THIS AGREEMENT is entered into this 21 day of June, 2013 by and between the Department of the Army (hereinafter the "Government"), represented by the U.S. Army Engineer, San Francisco District and the City and County of San Francisco acting by and through the Port of San Francisco (hereinafter the "Non-Federal Sponsor"), represented by the Executive Director of the Port of San Francisco.

WITNESSETH, THAT:

WHEREAS, the Government received a letter, dated April 29, 2013, from the City and County of San Francisco acting by and through the Port of San Francisco in which it stated its desire to participate in a feasibility study for the development of a small navigation improvement at the Central Basin Pier 70, San Francisco, San Francisco County, California, and in which it acknowledged its financial responsibilities for the study and a project, if one is recommended;

WHEREAS, the Secretary of the Army is authorized by Section 107 of the River and Harbor Act of 1960, Public Law 86-645, as amended (33 U.S.C. 577; hereinafter "Section 107") to allot from certain appropriations an amount not to exceed $35,000,000 per *fiscal year* for the construction of small river and harbor improvements projects and not more than $7,000,000 in Federal funds shall be allotted for a project at any single locality;

WHEREAS, the Government initiated a feasibility study, to be initially Federally funded up to $100,000, and during this Federally funded portion the Government determined that the costs of the feasibility study would exceed $100,000;

WHEREAS, the Government and the City and County of San Francisco acting by and through the Port of San Francisco desire to enter into an agreement (hereinafter the "Agreement") to complete the feasibility study (hereinafter the "*Study*" as defined in Article I.A. of this Agreement) and to share equally the costs of the *Study* that exceed $100,000;

WHEREAS, Section 105(a) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2215(a)), specifies the cost-sharing requirements applicable to the *Study*;

WHEREAS, the Non-Federal Sponsor desires to provide in-kind contributions (hereinafter the "*in-kind contributions*" as defined in Article I.I. of this Agreement) that are necessary to prepare the feasibility report and to receive credit for such contributions toward the amount of its required contribution for the *Study*;

WHEREAS, the Non-Federal Sponsor may provide up to 100 percent of its required contribution for the *Study* as *in-kind contributions*;

WHEREAS, the Government and Non-Federal Sponsor have the full authority and capability to perform as hereinafter set forth and intend to cooperate in cost-sharing and financing of the *Study* in accordance with the terms of this Agreement; and

WHEREAS, the Government and the Non-Federal Sponsor, in connection with this Agreement, desire to foster a partnering strategy and a working relationship between the Government and the Non-Federal Sponsor through a mutually developed formal strategy of commitment and communication embodied herein, which creates an environment where trust and teamwork prevent disputes, foster a cooperative bond between the Government and the Non-Federal Sponsor, and facilitate the successful *Study*.

NOW, THEREFORE, the Government and the Non-Federal Sponsor agree as follows:

ARTICLE I – DEFINITIONS

A. The term "*Study*" shall mean the activities and tasks required to identify and evaluate alternatives and the preparation of a decision document that, when appropriate, recommends a coordinated and implementable solution for dredging the Central Basin to -35 feet Mean Lower Low Water at Central Basin Pier 70, San Francisco, San Francisco County, California. The term includes *in-kind contributions* described in paragraph I. of this Article.

B. The term "*total study costs*" shall mean the sum of all costs incurred by the Non-Federal Sponsor and the Government in accordance with the terms of this Agreement directly related to performance of the *Study* plus the costs of the *Study* incurred by the Government prior to the effective date of this Agreement. Subject to the provisions of this Agreement, the term shall include, but is not necessarily limited to: the Government's costs of plan formulation and evaluation, including applicable economic, engineering, real estate, and environmental analyses; the Government's costs of preparation of the decision document for the *Study*; the costs of *in-kind contributions* determined in accordance with Article II.B.3. of this Agreement; the Government's costs of Agency Technical Review and other review processes required by the Government; the Government's costs of Independent External Peer Review, if required, except for the costs of any contract for an Independent External Peer Review panel; the Government's supervision and administration costs; the Non-Federal Sponsor's and the Government's costs of participation in the Study Coordination Team in accordance with Article III of this Agreement; the Government's costs of contract dispute settlements or awards; and the Non-Federal Sponsor's and the Government's costs of audit in accordance with Article VI.B. and Article VI.C. of this Agreement. The term does not include the first $100,000 incurred by the Government for the *Study*; any costs of dispute resolution under Article V of this Agreement; any costs incurred as part of reconnaissance studies or feasibility studies under any other agreement or program; any costs of a contract for an Independent External Peer Review panel; the Non-Federal Sponsor's costs of negotiating this Agreement; or any costs of negotiating a project partnership agreement for design and construction of a project or separable element thereof.

C. The term "*period of study*" shall mean the time from the effective date of this Agreement to the date that the decision document for the study is duly approved by the Government or the date that this Agreement is terminated in accordance with Article IX of this Agreement.

D. The term "*financial obligations for the study*" shall mean the financial obligations of the Government and the costs for *in-kind contributions*, as determined by the Government, that result or would result in costs that are or would be included in *total study costs*.

E. The term "*non-Federal proportionate share*" shall mean the ratio of the sum of the costs included in *total study costs* for *in-kind contributions*, as determined by the Government, and the Non-Federal Sponsor's contribution of funds required by Article II.B.1.b. of this Agreement to *financial obligations for the study*, as projected by the Government.

F. The term "*Federal program funds*" shall mean funds provided by a Federal agency, other than the Department of the Army, plus any non-Federal contribution required as a matching share therefor.

G. The term "*fiscal year*" shall mean one year beginning on October 1 and ending on September 30.

H. The term "*PMP*" shall mean the project management plan, and any modifications thereto, developed by the Government, and agreed to by the Non-Federal Sponsor, that specifies the scope, cost, and schedule for *Study* activities and guides the performance of the *Study* through the *period of study*.

I. The term "*in-kind contributions*" shall mean planning, supervision and administration, services, materials, supplies, and other in-kind services that are performed or provided by the Non-Federal Sponsor after the effective date of this Agreement in accordance with the *PMP* and that are necessary for performance of the *Study*.

J. The term "*Section 107 Annual Program Limit*" shall mean the statutory limitation on the Government's annual allotment for planning, design, and construction of all projects implemented pursuant to Section 107 of the River and Harbor Act of 1960, Public Law 86-645, as amended (33 U.S.C. 577). As of the effective date of this Agreement, such limitation is $35,000,000.

ARTICLE II - OBLIGATIONS OF THE GOVERNMENT AND THE NON-FEDERAL SPONSOR

A. The Government, subject to receiving funds appropriated by the Congress of the United States (hereinafter the "Congress") and using those funds and funds provided by the Non-Federal Sponsor, expeditiously shall conduct the *Study*, applying those procedures usually applied to Federal projects, in accordance with Federal laws, regulations, and policies. The Non-Federal Sponsor expeditiously shall perform or provide the *in-kind contributions* in accordance with applicable Federal laws, regulations, and policies.

1. To the extent possible, the Government and the Non-Federal Sponsor shall conduct the *Study* in accordance with the *PMP*.

2. The Government shall afford the Non-Federal Sponsor the opportunity to review and comment on all products that are developed by contract or by Government personnel during the *period of study*. The Government shall consider in good faith the comments of the Non-Federal Sponsor, but the final approval of all *Study* products shall be exclusively within the control of the Government.

3. The Government shall afford the Non-Federal Sponsor the opportunity to review and comment on the solicitations for all Government contracts, including relevant scopes of work, prior to the Government's issuance of such solicitations. To the extent possible, the Government shall afford the Non-Federal Sponsor the opportunity to review and comment on all proposed contract modifications, including change orders. In any instance where providing the Non-Federal Sponsor with notification of a contract modification is not possible prior to execution of the contract modification, the Government shall provide such notification in writing at the earliest date possible. To the extent possible, the Government also shall afford the Non-Federal Sponsor the opportunity to review and comment on all contract claims prior to resolution thereof. The Government shall consider in good faith the comments of the Non-Federal Sponsor, but the contents of solicitations, award of contracts or commencement of work on the *Study* using the Government's own forces, execution of contract modifications, resolution of contract claims, and performance of all work on the *Study*, except for *in-kind contributions*, shall be exclusively within the control of the Government.

4. At the time the U.S. Army Engineer, San Francisco District (hereinafter the "District Engineer") furnishes the contractor with the Government's Written Notice of Acceptance of Completed Work for each contract awarded by the Government for the *Study*, the District Engineer shall furnish a copy thereof to the Non-Federal Sponsor.

5. The Non-Federal Sponsor shall afford the Government the opportunity to review and comment on the solicitations for all contracts for the *in-kind contributions*, including relevant scopes of work, prior to the Non-Federal Sponsor's issuance of such solicitations. To the extent possible, the Non-Federal Sponsor shall afford the Government the opportunity to review and comment on all proposed contract modifications, including change orders. In any instance where providing the Government with notification of a contract modification is not possible prior to execution of the contract modification, the Non-Federal Sponsor shall provide such notification in writing at the earliest date possible. To the extent possible, the Non-Federal Sponsor also shall afford the Government the opportunity to review and comment on all contract

claims prior to resolution thereof. The Non-Federal Sponsor shall consider in good faith the comments of the Government but the contents of solicitations, award of contracts or commencement of work on the *Study* using the Non-Federal Sponsor's own forces, execution of contract modifications, resolution of contract claims, and performance of all work on *in-kind contributions* shall be exclusively within the control of the Non-Federal Sponsor.

6. At the time the Non-Federal Sponsor furnishes a contractor with a notice of acceptance of completed work for each contract awarded by the Non-Federal Sponsor for *in-kind contributions*, the Non-Federal Sponsor shall furnish a copy thereof to the Government.

B. The Non-Federal Sponsor shall contribute 50 percent of *total study costs* in accordance with the provisions of this paragraph.

1. The Non-Federal Sponsor shall provide a contribution of funds as determined below:

a. If the Government projects at any time that the collective value of the Non-Federal Sponsor's contributions listed in the next sentence will be less than the Non-Federal Sponsor's required share of 50 percent of *total study costs*, the Government shall determine the amount of funds that would be necessary to meet the Non-Federal Sponsor's required share without considering the credit the Government projects will be afforded for *in-kind contributions* pursuant to paragraph B.4. of this Article. The Government shall determine the amount of funds that would be necessary by subtracting from the Non-Federal Sponsor's required share of 50 percent of *total study costs* the collective value of the Non-Federal Sponsor's contributions under Article III and Article VI of this Agreement.

b. The Non-Federal Sponsor shall provide funds in the amount determined by this paragraph in accordance with Article IV.B. of this Agreement. To determine the contribution of funds the Non-Federal Sponsor shall provide, the Government shall reduce the amount determined in accordance with paragraph B.1.a. of this Article by the amount of credit the Government projects will be afforded for *in-kind contributions* pursuant to paragraph B.4. of this Article.

2. The Government, subject to the availability of funds and as limited by paragraph B.5. of this Article and the *Section 107 Annual Program Limit*, shall refund or reimburse to the Non-Federal Sponsor any contributions in excess of 50 percent of *total study costs* if the Government determines at any time that the collective value of the following has exceeded 50 percent of *total study costs*: (a) the Non-Federal Sponsor's contribution of funds required by paragraph B.1.b. of this Article; (b) the amount of credit to be afforded for *in-kind contributions* pursuant to paragraph B.4. of this Article; and (c) the value of the Non-Federal Sponsor's contributions under Article III and Article VI of this Agreement.

3. The Government shall determine and include in *total study costs* any costs incurred by the Non-Federal Sponsor for *in-kind contributions*, subject to the conditions and limitations of this paragraph. The Non-Federal Sponsor in a timely manner shall provide the

Government with such documents as are sufficient to enable the Government to determine the amount of costs to be included in *total study costs* for *in-kind contributions*.

a. Acceptance by the Government of *in-kind contributions* shall be subject to a review by the Government to verify that all economic, engineering, real estate, and environmental analyses or other items performed or provided as *in-kind contributions* are accomplished in a satisfactory manner and in accordance with applicable Federal laws, regulations, and policies, and to verify that all analyses, services, materials, supplies, and other in-kind services provided as *in-kind contributions* are necessary for the *Study*.

b. The Non-Federal Sponsor's costs for *in-kind contributions* that may be eligible for inclusion in *total study costs* pursuant to this Agreement shall be subject to an audit in accordance with Article VI.C. of this Agreement to determine the reasonableness, allocability, and allowability of such costs.

c. The Non-Federal Sponsor's costs for *in-kind contributions* that may be eligible for inclusion in *total study costs* pursuant to this Agreement are not subject to interest charges, nor are they subject to adjustment to reflect changes in price levels between the time the *in-kind contributions* are provided and the time the costs are included in *total study costs*.

d. The Government shall not include in *total study costs* any costs for *in-kind contributions* paid by the Non-Federal Sponsor using *Federal program funds* unless the Federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the *Study*.

e. The Government shall not include in *total study costs* any costs for *in-kind contributions* in excess of the Government's estimate of the costs of the *in-kind contributions* if the services, materials, supplies, and other in-kind services had been provided by the Government.

4. The Government, in accordance with this paragraph, shall afford credit toward the amount of funds determined in accordance with paragraph B.1.a. of this Article for the costs of *in-kind contributions* determined in accordance with paragraph B.3. of this Article. However, the maximum amount of credit that can be afforded for *in-kind contributions* shall not exceed the least of the following amounts as determined by the Government: the amount of funds determined in accordance with paragraph B.1.a. of this Article; the costs of *in-kind contributions* determined in accordance with paragraph B.3. of this Article; or 50 percent of *total study costs*.

5. Notwithstanding any other provision of this Agreement, the Non-Federal Sponsor shall not be entitled to reimbursement of any costs of *in-kind contributions* determined in accordance with paragraph B.3. of this Article and included in *total study costs* that exceed the amount of credit afforded for *in-kind contributions* determined in accordance with paragraph B.4. of this Article and the Non-Federal Sponsor shall be responsible for 100 percent of all costs of *in-kind contributions* included in *total study costs* that exceed the amount of credit afforded.

C. Notwithstanding any other provision of this Agreement, Federal financial participation in the *Study* is limited by the following provisions of this paragraph.

1. In the event the Government projects that the amount of Federal funds the Government will make available to the *Study* through the then-current *fiscal year*, or the amount of Federal funds the Government will make available for the *Study* through the upcoming *fiscal year*, is not sufficient to meet the Federal share of *total study costs* that the Government projects to be incurred through the then-current or upcoming *fiscal year*, as applicable, the Government shall notify the Non-Federal Sponsor in writing of such insufficiency of funds and of the date the Government projects that the Federal funds that will have been made available to the *Study* will be exhausted. Upon the exhaustion of Federal funds made available by the Government to the *Study*, future performance under this Agreement shall be suspended and the parties shall proceed in accordance with Article IX.C. of this Agreement.

2. If the Government determines that the total amount of Federal funds provided by Congress for all studies and projects implemented pursuant to Section 107 has reached the *Section 107 Annual Program Limit*, and the Government projects that the Federal funds the Government will make available to the *Study* within the *Section 107 Annual Program Limit* will not be sufficient to meet the Federal share of *total study costs*, the Government shall notify the Non-Federal Sponsor in writing of such insufficiency of funds and of the date the Government projects that the Federal funds that will have been made available to the *Study* will be exhausted. Upon the exhaustion of Federal funds made available by the Government to the *Study* within the *Section 107 Annual Program Limit*, future performance under this Agreement shall be suspended and the parties shall proceed in accordance with Article IX.C. of this Agreement.

3. As of the effective date of this Agreement, $2,800 of Federal funds is currently projected to be available for the *Study*. The Government makes no commitment to request Congress to provide additional Federal funds for the *Study*. Further, the Government's financial participation in the *Study* is limited to the Federal funds that the Government makes available to the *Study*.

D. Upon conclusion of the *period of study*, the Government shall conduct an accounting, in accordance with Article IV.C. of this Agreement, and furnish the results to the Non-Federal Sponsor.

E. The Non-Federal Sponsor shall not use *Federal program funds* to meet any of its obligations for the *Study* under this Agreement unless the Federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the *Study*.

F. This Agreement shall not be construed as obligating either party to implement a project. Whether the Government proceeds with implementation of the project depends upon, among other things, the outcome of the *Study* and whether the proposed solution is consistent with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies and with the budget priorities of the Administration.

ARTICLE III - STUDY COORDINATION TEAM

A. To provide for consistent and effective communication, the Non-Federal Sponsor and the Government, not later than 30 calendar days after the effective date of this Agreement, shall appoint named senior representatives to a Study Coordination Team. Thereafter, the Study Coordination Team shall meet regularly until the end of the *period of study*. The Government's Project Manager and a counterpart named by the Non-Federal Sponsor shall co-chair the Study Coordination Team.

B. The Government's Project Manager and the Non-Federal Sponsor's counterpart shall keep the Study Coordination Team informed of the progress of the *Study* and of significant pending issues and actions, and shall seek the views of the Study Coordination Team on matters that the Study Coordination Team generally oversees.

C. Until the end of the *period of study*, the Study Coordination Team shall generally oversee the *Study*, including matters related to: plan formulation and evaluation, including applicable economic, engineering, real estate, and environmental analyses; scheduling of reports and work products; independent technical review and other review processes required by the Government; completion of all necessary environmental coordination and documentation; contract awards and modifications; contract costs; the Government's cost projections; the performance of, scheduling, and determining the value of *in-kind contributions*; determination of anticipated future requirements for real property and relocation requirements and performance of operation, maintenance, repair, rehabilitation, and replacement of the proposed project including anticipated requirements for permits; and other matters related to the *Study*. This oversight of the *Study* shall be consistent with the *PMP*.

D. The Study Coordination Team may make recommendations to the District Engineer on matters related to the *Study* that the Study Coordination Team generally oversees, including suggestions to avoid potential sources of dispute. The Government in good faith shall consider the recommendations of the Study Coordination Team. The Government, having the legal authority and responsibility for performance of the *Study* has the discretion to accept or reject, in whole or in part, the Study Coordination Team's recommendations.

E. The Non-Federal Sponsor's costs of participation in the Study Coordination Team shall be included in *total study costs* and shared in accordance with the provisions of this Agreement, subject to an audit in accordance with Article VI.C. of this Agreement to determine reasonableness, allocability, and allowability of such costs. The Government's costs of participation in the Study Coordination Team shall be included in *total study costs* and shared in accordance with the provisions of this Agreement.

ARTICLE IV - METHOD OF PAYMENT

A. In accordance with the provisions of this paragraph, the Government shall maintain current records and provide to the Non-Federal Sponsor current projections of costs, financial obligations, the contributions provided by the parties, the costs included in *total study costs* for *in-kind contributions* determined in accordance with Article II.B.3. of this Agreement, and the credit to be afforded for *in-kind contributions* pursuant to Article II.B.4. of this Agreement.

1. As of the effective date of this Agreement, *total study costs* are projected to be $1,280,000; the value of the Non-Federal Sponsor's contributions under Article III and Article VI of this Agreement is projected to be $35,000; the amount of funds determined in accordance with Article II.B.1.a. of this Agreement is projected to be $605,000; the costs included in *total study costs* for *in-kind contributions* determined in accordance with Article II.B.3. of this Agreement are projected to be $90,000; the credit to be afforded for *in-kind contributions* pursuant to Article II.B.4. of this Agreement is projected to be $90,000; the Non-Federal Sponsor's contribution of funds required by Article II.B.1.b. of this Agreement is projected to be $515,000; and the *non-Federal proportionate share* is projected to be 49% percent. These amounts and percentage are estimates subject to adjustment by the Government, after consultation with the Non-Federal Sponsor, and are not to be construed as the total financial responsibilities of the Government and the Non-Federal Sponsor.

2. By October 10, 2013 and by each quarterly anniversary thereof until the conclusion of the *period of study* and resolution of all relevant claims and appeals, the Government shall provide the Non-Federal Sponsor with a report setting forth all contributions provided to date and the current projections of the following: *total study costs*; the value of the Non-Federal Sponsor's contributions under Article III and Article VI of this Agreement; the amount of funds determined in accordance with Article II.B.1.a. of this Agreement; the costs included in *total study costs* for *in-kind contributions* determined in accordance with Article II.B.3. of this Agreement; the credit to be afforded for *in-kind contributions* pursuant to Article II.B.4. of this Agreement; the Non-Federal Sponsor's contribution of funds required by Article II.B.1.b. of this Agreement; the total contribution of funds required from the Non-Federal Sponsor for the upcoming contract and upcoming *fiscal year*; and the *non-Federal proportionate share*.

B. The Non-Federal Sponsor shall provide the contribution of funds required by Article II.B.1.b. of this Agreement in accordance with the provisions of this paragraph.

1. Not less than 7 calendar days after the effective date of this Agreement, the Government shall notify the Non-Federal Sponsor in writing of the funds the Government determines to be required from the Non-Federal Sponsor to meet: (a) the *non-Federal proportionate share* of *financial obligations for the study* incurred prior to the commencement of the *period of study*; (b) the projected *non-Federal proportionate share* of *financial obligations for the study* to be incurred for such contract; and (c) the projected *non-Federal proportionate share* of *financial obligations for the study* using the Government's own forces through the first *fiscal year*. Within 30 calendar days of receipt of such notice, the Non-Federal Sponsor shall provide the Government with the full amount of such required funds by delivering a check payable to "FAO, USAED, San Francisco District, L3" to the District Engineer, or verifying to the satisfaction of the Government that the Non-Federal Sponsor has deposited such required funds in an escrow or other account acceptable to the Government, with interest accruing to the

Non-Federal Sponsor, or by presenting the Government with an irrevocable letter of credit acceptable to the Government for such required funds, or by providing an Electronic Funds Transfer of such required funds in accordance with procedures established by the Government.

2. Thereafter, until the work on the *Study* is complete, the Government shall notify the Non-Federal Sponsor in writing of the funds the Government determines to be required from the Non-Federal Sponsor, and the Non-Federal Sponsor shall provide such funds in accordance with the provisions of this paragraph.

a. The Government shall notify the Non-Federal Sponsor in writing, no later than 60 calendar days prior to the scheduled date for issuance of the solicitation for each remaining contract for work on the *Study*, of the funds the Government determines to be required from the Non-Federal Sponsor to meet the projected *non-Federal proportionate share* of *financial obligations for the study* to be incurred for such contract. No later than such scheduled date, the Non-Federal Sponsor shall make the full amount of such required funds available to the Government through any of the payment mechanisms specified in paragraph B.1. of this Article.

b. The Government shall notify the Non-Federal Sponsor in writing, no later than 60 calendar days prior to the beginning of each *fiscal year* in which the Government projects that it will make *financial obligations for the study* using the Government's own forces, of the funds the Government determines to be required from the Non-Federal Sponsor to meet the projected *non-Federal proportionate share* of *financial obligations for the study* using the Government's own forces for that *fiscal year*. No later than 30 calendar days prior to the beginning of that *fiscal year*, the Non-Federal Sponsor shall make the full amount of such required funds for that *fiscal year* available to the Government through any of the payment mechanisms specified in paragraph B.1. of this Article.

3. The Government shall draw from the funds provided by the Non-Federal Sponsor such sums as the Government deems necessary, when considered with any credit the Government projects will be afforded for *in-kind contributions* pursuant to Article II.B.4. of this Agreement, to cover: (a) the *non-Federal proportionate share* of *financial obligations for the study* incurred prior to the commencement of the *period of study*; and (b) the *non-Federal proportionate share* of *financial obligations for the study* as *financial obligations for the study* are incurred. If at any time the Government determines that additional funds will be needed from the Non-Federal Sponsor to cover the Non-Federal Sponsor's share of such financial obligations for the current contract or to cover the Non-Federal Sponsor's share of such financial obligations for work performed using the Government's own forces in the current *fiscal year*, the Government shall notify the Non-Federal Sponsor in writing of the additional funds required and provide an explanation of why additional funds are required. Within 60 calendar days from receipt of such notice, the Non-Federal Sponsor shall provide the Government with the full amount of such additional required funds through any of the payment mechanisms specified in paragraph B.1. of this Article.

C. Upon conclusion of the *period of study* and resolution of all relevant claims and appeals, the Government shall conduct a final accounting and furnish the Non-Federal Sponsor with written notice of the results of such final accounting. If outstanding relevant claims and appeals prevent a final accounting from being conducted in a timely manner, the Government shall conduct an interim accounting and furnish the Non-Federal Sponsor with written notice of the results of such interim accounting. Once all outstanding relevant claims and appeals are resolved, the Government shall amend the interim accounting to complete the final accounting and furnish the Non-Federal Sponsor with written notice of the results of such final accounting. The interim or final accounting, as applicable, shall determine *total study costs*, each party's required share thereof, and each party's total contributions thereto as of the date of such accounting.

1. Should the interim or final accounting, as applicable, show that the Non-Federal Sponsor's total required share of *total study costs* exceeds the Non-Federal Sponsor's total contributions provided thereto, the Non-Federal Sponsor, no later than 90 calendar days after receipt of written notice from the Government, shall make a payment to the Government in an amount equal to the difference by delivering a check payable to "FAO, USAED, San Francisco District, L3" to the District Engineer or by providing an Electronic Funds Transfer in accordance with procedures established by the Government.

2. Should the interim or final accounting, as applicable, show that the total contributions provided by the Non-Federal Sponsor for *total study costs* exceed the Non-Federal Sponsor's total required share thereof, the Government, subject to the availability of funds and as limited by Article II.B.5. of this Agreement and the *Section 107 Annual Program Limit*, shall refund or reimburse the excess amount to the Non-Federal Sponsor within 90 calendar days of the date of completion of such accounting. In the event the Non-Federal Sponsor is due a refund or reimbursement and funds are not available to refund or reimburse the excess amount to the Non-Federal Sponsor, the Government shall seek such appropriations as are necessary to make the refund or reimbursement.

ARTICLE V - DISPUTE RESOLUTION

As a condition precedent to a party bringing any suit for breach of this Agreement, that party must first notify the other party in writing of the nature of the purported breach and seek in good faith to resolve the dispute through negotiation. If the parties cannot resolve the dispute through negotiation, they may agree to a mutually acceptable method of non-binding alternative dispute resolution with a qualified third party acceptable to both parties. Each party shall pay an equal share of any costs for the services provided by such a third party as such costs are incurred. The existence of a dispute shall not excuse the parties from performance pursuant to this Agreement.

ARTICLE VI - MAINTENANCE OF RECORDS AND AUDIT

A. Not later than 60 calendar days after the effective date of this Agreement, the Government and the Non-Federal Sponsor shall develop procedures for keeping books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to this Agreement. These procedures shall incorporate, and apply as appropriate, the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 C.F.R. Section 33.20. The Government and the Non-Federal Sponsor shall maintain such books, records, documents, or other evidence in accordance with these procedures and for a minimum of three years after completion of the accounting for which such books, records, documents, or other evidence were required. To the extent permitted under applicable Federal laws and regulations, the Government and the Non-Federal Sponsor shall each allow the other to inspect such books, records, documents, or other evidence.

B. In accordance with 32 C.F.R. Section 33.26, the Non-Federal Sponsor is responsible for complying with the Single Audit Act Amendments of 1996 (31 U.S.C. 7501-7507), as implemented by OMB Circular No. A-133 and Department of Defense Directive 7600.10. Upon request of the Non-Federal Sponsor and to the extent permitted under applicable Federal laws and regulations, the Government shall provide to the Non-Federal Sponsor and independent auditors any information necessary to enable an audit of the Non-Federal Sponsor's activities under this Agreement. The costs of any non-Federal audits performed in accordance with this paragraph shall be allocated in accordance with the provisions of OMB Circulars A-87 and A-133, and such costs as are allocated to the *Study* shall be included in *total study costs* and shared in accordance with the provisions of this Agreement.

C. In accordance with 31 U.S.C. 7503, the Government may conduct audits in addition to any audit that the Non-Federal Sponsor is required to conduct under the Single Audit Act Amendments of 1996. Any such Government audits shall be conducted in accordance with Government Auditing Standards and the cost principles in OMB Circular A-87 and other applicable cost principles and regulations. The costs of Government audits performed in accordance with this paragraph shall be included in *total study costs* and shared in accordance with the provisions of this Agreement.

ARTICLE VII - FEDERAL AND STATE LAWS

In the exercise of their respective rights and obligations under this Agreement, the Non-Federal Sponsor and the Government shall comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto and Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

ARTICLE VIII - RELATIONSHIP OF PARTIES

A. In the exercise of their respective rights and obligations under this Agreement, the Government and the Non-Federal Sponsor each act in an independent capacity, and neither is to be considered the officer, agent, or employee of the other.

B. In the exercise of its rights and obligations under this Agreement, neither party shall provide, without the consent of the other party, any contractor with a release that waives or purports to waive any rights the other party may have to seek relief or redress against that contractor either pursuant to any cause of action that the other party may have or for violation of any law.

ARTICLE IX - TERMINATION OR SUSPENSION

A. Prior to conclusion of the *period of study*, upon 30 calendar days written notice to the other party, either party may elect without penalty to terminate this Agreement or to suspend future performance under this Agreement. In the event that either party elects to suspend future performance under this Agreement pursuant to this paragraph, such suspension shall remain in effect until either the Government or the Non-Federal Sponsor elects to terminate this Agreement.

B. If at any time the Non-Federal Sponsor fails to fulfill its obligations under this Agreement, the Assistant Secretary of the Army (Civil Works) shall terminate this Agreement or suspend future performance under this Agreement unless the Assistant Secretary of the Army (Civil Works) determines that continuation of performance of the *Study* is in the interest of the United States or is necessary in order to satisfy agreements with any other non-Federal interests in connection with the *Study*.

C. In the event future performance under this Agreement is suspended pursuant to Article II.C. of this Agreement, such suspension shall remain in effect until such time that the Government notifies the Non-Federal Sponsor in writing that sufficient Federal funds are available to meet the Federal share of *total study costs* the Government projects to be incurred through the then-current or upcoming *fiscal year*, or the Government or the Non-Federal Sponsor elects to terminate this Agreement.

D. In the event that this Agreement is terminated pursuant to this Article, the parties shall conclude their activities relating to the *Study* and conduct an accounting in accordance with Article IV.C. of this Agreement. To provide for this eventuality, the Government may reserve a percentage of total Federal funds made available for the *Study* and an equal percentage of the total funds contributed by the Non-Federal Sponsor in accordance with Article II.B.1.b. of this Agreement as a contingency to pay costs of termination, including any costs of resolution of contract claims and contract modifications. Upon termination of this Agreement, all data and information generated as part of the *Study* shall be made available to the parties to the Agreement.

E. Any termination of this Agreement or suspension of future performance under this Agreement in accordance with this Article shall not relieve the parties of liability for any obligation previously incurred. Any delinquent payment owed by the Non-Federal Sponsor shall be charged interest at a rate, to be determined by the Secretary of the Treasury, equal to 150 per centum of the average bond equivalent rate of the 13 week Treasury bills auctioned immediately prior to the date on which such payment became delinquent, or auctioned immediately prior to the beginning of each additional 3 month period if the period of delinquency exceeds 3 months.

ARTICLE X - NOTICES

A. Any notice, request, demand, or other communication required or permitted to be given under this Agreement shall be deemed to have been duly given if in writing and delivered personally or sent by telegram or mailed by first-class, registered, or certified mail, as follows:

If to the Non-Federal Sponsor:

Port of San Francisco
Attention: Executive Director
Pier1, The Embarcadero
San Francisco, CA 94111

If to the Government:

U.S. Army Corps of Engineers
San Francisco District
Central Basin Dredging CAP 107 Project Manager
1455 Market St.
San Francisco, CA 94103-1398

B. A party may change the address to which such communications are to be directed by giving written notice to the other party in the manner provided in this Article.

C. Any notice, request, demand, or other communication made pursuant to this Article shall be deemed to have been received by the addressee at the earlier of such time as it is actually received or seven calendar days after it is mailed.

ARTICLE XI - CONFIDENTIALITY

To the extent permitted by the laws governing each party, the parties agree to maintain the confidentiality of exchanged information when requested to do so by the providing party.

ARTICLE XII - THIRD PARTY RIGHTS, BENEFITS, OR LIABILITIES

Nothing in this Agreement is intended, nor may be construed, to create any rights, confer any benefits, or relieve any liability, of any kind whatsoever in any third person not party to this Agreement.

ARTICLE XIII - OBLIGATIONS OF FUTURE APPROPRIATIONS

A. Nothing herein shall constitute, nor be deemed to constitute, an obligation of future appropriations by the San Francisco Port Commission or the Board of Supervisors of the City and County of San Francisco, where creating such an obligation would be inconsistent with the Charter of the City and County of San Francisco, including, but not limited to, Charter Section 3.105 and the budgetary and fiscal provisions of the Charter.

B. The Non-Federal Sponsor intends to fulfill its obligations under this Agreement. The Non-Federal Sponsor shall include in its budget request or otherwise propose appropriations of funds in amounts sufficient to fulfill these obligations for that year, and shall use all reasonable and lawful means to secure those appropriations. The Non-Federal Sponsor reasonably believes that funds in amounts sufficient to fulfill these obligations lawfully can and will be appropriated and made available for this purpose. In the event funds are not appropriated in amounts sufficient to fulfill these obligations, the Non-Federal Sponsor shall use its best efforts to satisfy any requirements for payments or contributions of funds under this Agreement from any other source of funds legally available for this purpose. Further, if the Non-Federal Sponsor is unable to fulfill these obligations, the Government may exercise any legal rights it has to protect the Government's interests related to this Agreement.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement, which shall become effective upon the date it is signed by the District Engineer.

DEPARTMENT OF THE ARMY	PORT OF SAN FRANCISCO
BY: for [signature]	BY: [signature] for
John K. Baker, P.E. Lieutenant Colonel, US Army District Engineer	Monique Moyer Executive Director Port of San Francisco
DATE: 21 Jun 2013	DATE: 6/21/2013

CERTIFICATE OF AUTHORITY

I, Eileen Malley, do hereby certify that I am the Deputy City Attorney for the City and County of San Francisco, serving as the principal legal officer for the Port of San Francisco, that the City and County of San Francisco acting by and through the Port of San Francisco is a legally constituted public body with full authority and legal capability to perform the terms of the Agreement between the Department of the Army and the City and County of San Francisco acting by and through the Port of San Francisco in connection with the feasibility study for the Central Basin Pier 70 Dredging Feasibility Study, and to pay damages, if necessary, in the event of the failure to perform in accordance with the terms of this Agreement and that the persons who have executed this Agreement on behalf of the City and County of San Francisco acting by and through the Port of San Francisco have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this certification this 21 day of June 2013.

Eileen Malley
General Counsel
Port of San Francisco

CERTIFICATION REGARDING LOBBYING

The undersigned certifies, to the best of his or her knowledge and belief that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

for

Monique Moyer
Executive Director
Port of San Francisco

DATE: 6/21/2013

NON-FEDERAL SPONSOR'S
SELF-CERTIFICATION OF FINANCIAL CAPABILITY
FOR AGREEMENTS

I, Elaine Forbes, do hereby certify that I am the Deputy Director, Finance & Administration of the Port of San Francisco (the "Non-Federal Sponsor"); that I am aware of the financial obligations of the Non-Federal Sponsor for the Central Basin Pier 70 Dredging Feasibility Study; and that the Non-Federal Sponsor has the financial capability to satisfy the Non-Federal Sponsor's obligations under the Agreement between the Department of the Army and the City and County of San Francisco acting by and through the Port of San Francisco for the Central Basin Pier 70 Dredging Feasibility Study.

IN WITNESS WHEREOF, I have made and executed this certification this 21 day of June, 2013.

BY: [signature]

TITLE: Chief Financial Officer

DATE: 6/21/2013

CERTIFICATE OF LEGAL REVIEW

The Agreement between the Department of the Army and the City and County of San Francisco for the Central Basin Pier 70 Dredging Feasibility Study has been fully reviewed and found to be legally sufficient by the San Francisco District, Office of Counsel.

Date: 17 June 13

Jack Kerns
Deputy District Counsel

CERTIFICATE OF CONCURRENCE

The Agreement between the Department of the Army and the City and County of San Francisco for the Central Basin Pier 70 Dredging Feasibility Study has been fully reviewed and I concur that it does not deviate from the Model Agreement for Cost Shared Feasibility Studies of Proposed Projects Under the Continuing Authorities Program and Cost Shared Feasibility Studies of Proposed Projects Under Other Program Authorities that Do Not Require Additional Authorization to Implement Projects, Revised September 26, 2012.

Date: 17 June 13

Jack Kerns
Deputy District Counsel

March 31, 2015

Lieutenant Colonel John Morrow
U.S. Army Corps of Engineers, S.F. District
1455 Market Street
San Francisco, CA 94108-1398

Subject: Plan for Future Dredging of Central Basin at the Port of San Francisco

Dear Lieutenant Colonel Morrow:

The Port of San Francisco (Port) is partnering with the United States Army Corps of Engineers (USACE) on a Continuing Authorities Program Section 107 Navigation study to assess the feasibility of implementing a new Federal deep draft navigation channel to improve commercial transportation efficiencies, safety, and access to the Port's shipyard at Pier 70. The Port, as the non-Federal sponsor, is aware and financially capable to provide project cost share requirements for project implementation.

The Port acquired the Pier 70 Shipyard and its drydocks and piers, as well as Central Basin in 1982 from Bethlehem Steel. The shipyard was founded by Risdon Iron Works in 1884, which launched from the shipyard the first steel-hulled ship built anywhere on the Pacific Rim in 1885. Bethlehem Steel or its preceding subsidiaries acquired the shipyard from Risdon Iron Works in 1905 and operated the shipyard continuously until its sale in 1982. In addition to commercial shipbuilding, Bethlehem built dozens of U.S. Navy warships at Pier 70, especially during both WWI and WWII. Since acquisition of the shipyard, the Port has had seven lessee companies operate there. BAE Systems became the leaseholder in 2005 and operates BAE SF Ship Repair. Neither the Port nor BAE SF Ship Repair nor any previous lessee has a responsibility or obligation to dredge the Central Basin to any depth. There are no aids to navigation marking the Central Basin. While BAE SF Ship Repair has responsibility for dredging its own facilities, which includes the area from the shoreline out to the ends of the piers and drydocks, the lease does not name either BAE SF Ship Repair or the Port as being responsible for dredging the Central Basin outboard of the BAE leasehold. The Port is not legally obligated to perform maintenance dredging at Central Basin.

The only dredging the Port has undertaken in the Central Basin in the last 24 years was via the application of FEMA funds designated for Port use in recovery from the 1989 Loma Prieta earthquake. The FEMA funds were used to dredge the Central Basin in 1999, at which time it had not been dredged for roughly a decade. Since then, the Port has not dredged Central Basin, although it did allow BAE to dredge part of it in 2011, roughly another decade later.

As has been concluded in previous USACE study documents, the Pier 70 Shipyard significantly contributes to both the regional and national economy, as well as functioning as a valued national defense asset. Therefore implementation of a USACE deep draft navigation channel for the Central Basin is of critical importance to the Port of San Francisco and the continuation of robust ship repair operations at the Pier 70 shipyard. The Port appreciates the continuing effort and support by you and your staff in assisting the Port to improve the usefulness of this valued maritime asset.

Please contact John Davey (415-274-0522) or Christine Boudreau (510-220-8152) if you need any additional clarification of these issues.

Sincerely,

Monique Moyer
Executive Director

PORT OF SAN FRANCISCO

Al Paniccia
U.S. Army Corps of Engineers
1455 Market Street
San Francisco, CA 94103-1398

June 10, 2015

Dear Mr. Paniccia

I, the undersigned, as Chief Wharfinger for the Port of San Francisco have reviewed the historical and current data and diagrams that are relevant to utility infrastructure that is contiguous and or intersects the area of the proposed Project - USACE Future Dredging of Central Basin. Upon this review I have found no utility infrastructure present within or adjacent to the project area.

John Davey, Chief Wharfinger
Port of San Francisco
Pier 1, The Embarcadero
San Francisco, CA 94111
Phone 415-274-0522
Fax 415-274-0528
E-mail mailto:john.davey@sfport.com
Website http://www.sfport.com/

cc: Christine Boudreau Associates LLC.