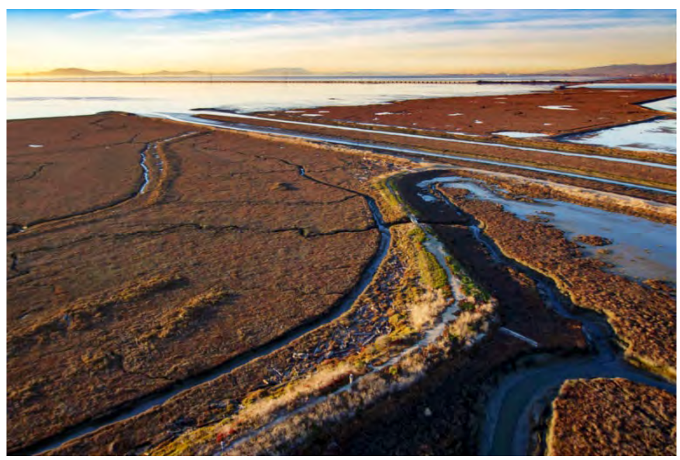
San Francisco Bay Strategic Shallow-Water Placement Pilot Project

Appendices

Emeryville Crescent Marsh: Photo by Michael Layefsky



Whale's Tail Marsh: Photo by Cris Benton, Professor of Architecture, UC Berkeley (retired)

US Army Corps of Engineers San Francisco District

Water Boards

Coastal Conservancy

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Appendix A – ENVIRONMENTAL COMPLIANCE

1. SUMMARY OF COMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS

1 FEDERAL LAWS

CLEAN AIR ACT

Clean Air Act, 42 U.S.C. § 1857h-7, *et seq*. No general conformity analysis is needed because the action alternatives are below de minimus thresholds. The proposed action would not exceed national ambient air quality standards based on modeled estimates of emission rates during project implementation. Modeled estimates of emission rates during project implementation demonstrate that the proposed action would not exceed applicability rates (Appendix A(4)).

CLEAN WATER ACT

Clean Water Act, 33 U.S.C. § 1251, *et seq*. The proposed action would involve discharge of fill material into Waters of the U.S. in the lower South Bay. Although USACE does not issue permits for their own projects, USACE does comply with the guidelines and substantive requirements of Section 404, including Sections 404(b)(1) and 401. A Section 404(b)(1) analysis was conducted on the recommended plan (Appendix A(3)). The analysis concluded that the placement of approximately 100,000 CY would not result in impacts to waters of the U.S. or wetlands. Initial coordination with the RWQCB was conducted and the RWQCB has indicated its support for the project and acknowledges the future requirement to obtain a Section 401 water quality certification prior to initiation of the work. The dredging contractor would be required to implement the measures listed in the BMPs and to avoid and minimize adverse effects on water quality. The project would be in full compliance with the CWA when a Section 401 water quality certification is obtained prior to implementation.

COASTAL ZONE MANAGEMENT ACT

Coastal Zone Management Act, 16 U.S.C. § 1456, *et seq.* Under Section 307 of the CZMA, the San Francisco Bay Conservation and Development Commission (BCDC) (I.e., not the California Coastal Commission (CCC)), has jurisdiction over federal activities in San Francisco Bay to ensure they are “consistent to the maximum extent practicable” with the “enforceable policies” of BCDC’s NOAA-approved San Francisco Bay segment (I.e., the San Francisco Bay Plan) of the California coastal management program (CCMP; 15 CFR § 923, Subpart K; https://bcdc.ca.gov/bcdc-jurisdiction-authority.html). Consistency Determination has been prepared and will be submitted BCDC (Appendix A(5); see *California Coastal Act*, below). The project would be in full compliance with the CZMA after obtaining a Consistency Notification from BCDC prior to implementation.

ENDANGERED SPECIES ACT

Endangered Species Act of 1973, ; 16 U.S.C. § 1531, et seq. Based on the locations of the proposed work, the listed species that could be affected by the proposed action include the California Least Tern, Ridgway's rail, Western snowy plover, and Southern salt marsh harvest mouse under the jurisdiction of USFWS; and the southern DPS of North American green sturgeon Southern DPS, Central California Coast DPS of steelhead, and the critical habitats of these two species ,under the jurisdiction of NMFS. The USACE has determined that the project will not affect FESA-listed species under the jurisdiction of the USFWS, and determined that the project may affect, but is not likely to adversely affect the FESA-listed species and critical habitats under the jurisdiction of NMFS. The USACE will submit a request for concurrence with the not likely to adversely affect determination to NMFS (Appendix A(2)). The project would be in full compliance with FESA once USACE receives written confirmation of concurrence from NMFS prior to implementation.

FISH AND WILDLIFE COORDINATION ACT

Fish and Wildlife Coordination Act of 1958; 16 U.S.C. § 661, *et seq* The USFWS is the Federal agency responsible for administering this act, which requires Federal agencies to coordinate with USFWS and State wildlife agencies during the planning of projects that would result in the control or modification of a natural stream or body of water. The FWCA intends that wildlife conservation be given equal consideration with other features of these projects. USACE initiated coordination with USFWS early in the planning process, and USFWS will provide a Planning Aid Letter (Appendix A(6)) for full compliance in the final report.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

Magnuson-Stevens Fishery Conservation and Management Act of 1996; 16 U.S.C. § 1801, *et seq*. The Magnuson-Stevens Act establishes a management system for national marine and estuarine fishery resources. This legislation requires that all Federal agencies consult with NMFS regarding all actions or proposed actions permitted, funded, or undertaken that may adversely affect Essential Fish Habitat (EFH). Under the Magnuson-Stevens Act, effects on habitat managed under the Pacific Salmon Fishery Management Plan must also be considered. The USACE incorporated an EFH effects analysis into the NMFS FESA concurrence request and requested consultation under the Magnuson-Stevens Act, in parallel with the Section 7 ESA informal consultation (Appendix A(2)). The project would be in full compliance with the Magnuson-Stevens Act once NMFS provides EFH conservation recommendations and USACE responds with a description of proposed measures for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. Full compliance would be achieved prior to implementation.

MIGRATORY BIRD TREATY ACT

Migratory Bird Treaty Act of 1928, 16 U.S.C. § 715, et seq. USFWS is the Federal agency responsible for administering this act, which implements a treaty between the U.S. and Great Britain (for Canada), Mexico, Japan, and the Soviet Union (now Russia) for the protection of migratory birds. Unless permitted by regulations, this law prohibits anyone to "pursue, hunt, take, capture, kill, attempt to take, capture or kill … any migratory bird …or any part, nest, or egg of any such bird" (16 U.S.C. § 703). Areas in the study area have foraging, resting, nesting, and breeding habitat for numerous migratory birds. The project is not expected to affect any migratory bird species or habitats because dredge placement activities will occur 2 miles offshore and abundant alternative foraging habitat in San Francisco Bay is available, and project sedimentation rates in wetland resting, nesting, and breeding habitats will be so low they will be difficult to measure.

MARINE MAMMAL PROTECTION ACT

The Marine Mammal Protection Act (16 U.S.C. §§ 1361-1421h), adopted in 1972. The MMPA makes it unlawful to take or import any marine mammals and/or their products. Under Section 101(a)(5)(D) of this act, an incidental harassment permit may be issued for activities other than commercial fishing that may impact small numbers of marine mammals. An incidental harassment permit covers activities that extend for periods of not more than 1 year, and that will have a negligible impact on the impacted species. Amendments to this act in 1994 statutorily defined two levels of harassment. Level A harassment is defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal in the wild. Level B harassment is defined as harassment having potential to disturb marine mammals by causing disruption of behavioral patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. The project alternatives are not expected to result in impacts to marine mammals that would require an incidental harassment permit.

NATIONAL ENVIRONMENTAL POLICY ACT

National Environmental Policy Act of 1969; 42 U.S.C. § 4321, *et seq*. The Council on Environmental Quality (CEQ) is responsible for ensuring that Federal agencies operate in accordance with NEPA, which requires full disclosure of the environmental effects, alternatives, potential mitigation, and environmental compliance procedures of most Federal management, regulation, or funding activities that affect the environment. NEPA requires the preparation of an environmental document to ensure that Federal agencies accomplish the law's purposes. Although, final public review is not required under NEPA for an EA, the Final EA would undergo a state and agency review in compliance with USACE policy for the review of feasibility studies. The Finding of No Significant Impact (FONSI) would not be signed until after state and agency review. Full compliance with NEPA would be achieved when the FONSI is signed and the Final EA made available to commenting agencies and the public.

NATIONAL HISTORIC PRESERVATION ACT

National Historic Preservation Act of 1966; 54 U.S.C. § 300101, *et seq*. The SHPO in each state is responsible for ensuring that Federal agencies comply with Section 106 of this act, which requires that they consider the effects of a proposed undertaking on properties that have been determined to be eligible for, or included in, the National Register of Historic Places. The Section 106 review process consists of four steps: (1) identification and evaluation of historic properties; (2) assessments of the effects of the undertaking on historic properties; (3) consultation with the SHPO and appropriate agencies to develop a plan to address the treatment of historic properties; and (4) concurrence from the SHPO regarding the agreement or results of consultation. A description of ongoing SHPO (and tribal) consultation activities to date is included in Appendix A(7)). The project would be in full compliance with the NHPA after obtaining concurrence from SHPO on the Section 106 analysis prior to implementation.

SUBMERGED LANDS ACT

The Submerged Lands Act of 1953 (43 U.S.C. § 1301 *et seq*.) grants states title to all submerged navigable lands within their boundaries. This includes navigable waterways, such as rivers, as well as marine waters within the state's boundaries, generally three geographical miles from the coastline. Section 1311(d) of the Submerged Lands Act provides that nothing in the act shall affect the use, development, improvement, or control by or under the constitutional authority of the United States for the purposes of navigation or be construed as the release or relinquishment of any rights of the United States arising under the constitutional authority of Congress to regulate or improve navigation. In compliance with this act, the California State Land Commission will receive a copy of this Environmental Assessment/Environmental Impact Report and will have the opportunity to comment on its potential impacts to submerged lands.

ABANDONED SHIPWRECK ACT

The Abandoned Shipwreck Act, 43 U.S.C. §§ 2101–2106, is a federal legislative act, but does protect shipwrecks found in state waters. The Abandoned Shipwreck Act also states that the laws of salvage and finds do not apply to abandoned shipwrecks protected by the act. Under the Abandoned Shipwreck Act, the United States asserts title to abandoned shipwrecks in state waters that are either:

- Embedded in state-submerged lands;
- Embedded in the coralline formations protected by a state on submerged lands; or
- Resting on state-submerged lands and are either included in or determined eligible for the NRHP.

The Abandoned Shipwreck Act also has a provision for the simultaneous transfer, by the federal government, of title for those abandoned shipwrecks to the state(s) in whose waters the wrecks are located. As detailed further in this section, because there are no known shipwrecks within the federal navigation channels or existing placement sites, no impacts are expected to result from the project alternatives.

2 EXECUTIVE ORDERS

EXECUTIVE ORDER 11990: PROTECTION OF WETLANDS

This order (42 Federal Register [FR] 26961, May 25, 1977) requires federal agencies to minimize destruction of wetlands when managing lands, when administering federal programs, or when undertaking construction. Agencies are also required to consider the effects of federal actions on the health and quality of wetlands. The project alternatives are not expected to result in adverse impacts but rather have beneficial impacts on wetlands.

EXECUTIVE ORDER 13112: INVASIVE SPECIES

The purpose of this order is to prevent the introduction of invasive species, and to provide control for the spread of invasive species that have already been introduced. This order states that the federal government "shall, to the extent practicable and permitted by law, not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions." The project alternatives are not expected to cause the introduction or substantial spread of invasive nonnative plants or wildlife.

3 STATE LAWS

CALIFORNIA ENVIRONMENTAL QUALITY ACT

The California Environmental Quality Act (CEQA) (California Public Resources Code §21000-21178) and the CEQA Guidelines (14 California Code of Regulations 15000-15387) are the primary policies that require projects to analyze potential impacts to land use, as well as to analyze the project's consistency with land use planning policies applicable to the project. This document is intended to fulfill the requirements of CEQA and the CEQA Guidelines.

PUBLIC TRUST DOCTRINE (CALIFORNIA STATE LANDS COMMISSION)

The California State Lands Commission (CSLC) manages lands in California according to the Public Trust Doctrine. Several of the guiding principles of the Public Trust are:

I. Lands under the ocean and under navigable streams are owned by the public and held in trust for the people by government. These are referred to as public trust lands and include filled lands formerly under water. Public trust lands cannot be bought and sold like other state-owned lands. Only in rare cases may the public trust be terminated, and only where consistent with the purposes and needs of the trust.

II. Uses of trust lands, whether granted to a local agency or administered by the state directly, are generally limited to those that are water dependent or related, and include commerce, fisheries, and navigation, environmental preservation and recreation. Public trust uses include, among others, ports, marinas, docks and wharves, buoys, hunting, commercial and sport fishing, bathing, swimming, and boating. Public trust lands may also be kept in their natural state for habitat, wildlife refuges, scientific study, or open space. Ancillary or incidental uses are also permitted—that is, uses that directly promote trust uses; are directly supportive and necessary for trust uses; or that accommodate the public's enjoyment of trust lands. Although trust lands cannot generally be alienated from public ownership, uses of trust lands can be carried out by public or private entities by lease from the CSLC or a local agency grantee.

III. Because public trust lands are held in trust for all citizens of California, they must be used to serve statewide, as opposed to purely local, public purposes (CSLC, 2010).

California Coastal Act

The California Coastal Act includes specific policies (Division 20 of the California Public Resources Code) for planning and regulatory decisions made by the CCC and local governments. The CCC developed the CCMP, pursuant to the requirements of the CZMA, described above. The BCDC, further described below, is the state's coastal zone management agency responsible for reviewing consistency determinations under the CZMA in San Francisco Bay and developed the San Francisco Bay segment of the CCMP, the San Francisco Bay Plan. For activities outside of the Golden Gate, consistency determinations are reviewed by the CCC.

Article 4 of the California Coastal Act requires that marine resources be maintained, enhanced, and where feasible, restored. The act also requires that special protection be given to areas and species of special biological or economic significance. It further requires that uses of marine environments be such that habitat function, biological productivity, healthy species populations, and fishing and recreational interests of coastal waters are maintained for long-term commercial, recreational, scientific, and educational purposes; and that marine resources are protected against the spillage of crude oil, gas, petroleum products, and hazardous substances.

McAteer-Petris Act

The McAteer-Petris Act (California Government Code Section 66000, *et seq*.), first enacted in 1965, created the BCDC to prepare a plan to protect the San Francisco Bay and shoreline, and provide for appropriate development and public access. This act directs BCDC to exercise its authority to issue or deny permit applications for placing fill; dredging; or changing the use of any land, water, or structure in the area of its jurisdiction. The BCDC also reviews determinations of consistency with the CZMA for federally sponsored projects. The San Francisco Bay Plan (Bay Plan) is BCDC's policy document specifying goals, objectives, and policies for BCDC jurisdictional areas. Pursuant to the federal CZMA, USACE is required to be consistent to the maximum extent practicable with the enforceable policies of the Bay Plan.

San Francisco Bay Conservation and Development Commission San Francisco Bay Plan

BCDC has permit authority over development of San Francisco Bay and the shoreline pursuant to the McAteer-Petris Act (California Government Code Section 66000 *et seq*.). The act requires BCDC to prepare a "comprehensive and enforceable plan for the conservation of the water of San Francisco Bay and the development of its shoreline." BCDC's jurisdiction includes all tidal areas of San Francisco Bay up to the line of mean high tide; all areas formerly subject to tidal action that have been filled since September 17, 1965; and the "shoreline band," which extends 100 feet inland from and parallel to the San Francisco Bay shoreline.

The Bay Plan, first adopted in 1969, and last updated in 2011, is BCDC's policy document specifying goals, objectives, and policies for BCDC jurisdictional areas (BCDC, 2007). Policies in the Bay Plan applicable to the proposed project include those in the following categories: Dredging; Fish, Other Aquatic Organisms, and Wildlife; Water Quality; Tidal Marshes and Tidal Flats; Subtidal Areas; and Navigational Safety and Oil Spill Prevention.

Dredging policies in the Bay Plan relevant to the proposed project are summarized below:

Dredging Policy 1. Dredging and dredged material disposal should be conducted in an environmentally and economically sound manner. Dredgers should reduce disposal in San Francisco Bay and certain waterways over time to achieve the Long-Term Management Strategy (LTMS) goal of limiting in-Bay disposal volumes to a maximum of one million CY per year. The LTMS agencies should implement a system of disposal allotments to individual dredgers to achieve this goal only if voluntary efforts are not effective in reaching the LTMS goal. In making its decision regarding disposal allocations, the BCDC should confer with the LTMS agencies and consider the need for the dredging and the dredging projects, environmental impacts, regional economic impacts, efforts by the dredging community to implement and fund alternatives to in-Bay disposal, and other relevant factors.

Dredging Policy 2. Dredging should be authorized when the BCDC can find: (a) the applicant has demonstrated that the dredging is needed to serve a water-oriented use or other important public purpose, such as navigational safety; (b) the materials to be dredged meet the water quality requirements of the Regional Water Board; (c) important fisheries and Bay natural resources would be protected through seasonal restrictions established by the California Department of Fish and Wildlife (CDFW), the United States Fish and Wildlife Service (USFWS), and/or the National Marine Fisheries Service (NMFS), or through other appropriate measures; (d) the siting and design of the project will result in the minimum dredging volume necessary for the project; and (e) the materials would be disposed of in accordance with Policy 3.

Dredging Policy 3. Dredged materials should, if feasible, be reused or disposed outside San Francisco Bay and certain waterways. Except when reused in an approved fill project, dredged material should not be disposed in San Francisco Bay and certain waterways unless disposal outside these areas is infeasible and the BCDC finds: (a) the volume to be disposed is consistent with applicable dredger disposal allocations and disposal site limits adopted by the BCDC by regulation; (b) disposal would be at a site designated by the BCDC; (c) the quality of the material disposed of is consistent with the advice of the Regional Water Board and the Dredged Material Management Office; and (d) the period of disposal is consistent with the advice of the CDFW, the USFWS, and the NMFS.

Dredging Policy 4. If an applicant proposes to dispose dredged material in tidal areas of San Francisco Bay and certain waterways that exceeds either disposal site limits or any disposal allocation that the BCDC has adopted by regulation, the applicant must demonstrate that the potential for adverse environmental impact is insignificant, and that nontidal and ocean disposal is infeasible because there are no alternative sites available or likely to be available in a reasonable period, or because the cost of disposal at alternate sites is prohibitive. In making its decision whether to authorize such in-Bay disposal, the BCDC should confer with the LTMS agencies and consider the factors listed in Policy 1.

Dredging Policy 5. To ensure adequate capacity for necessary Bay dredging projects and to protect Bay natural resources, acceptable nontidal disposal sites should be secured, and the San Francisco Deep Ocean Disposal Site should be maintained. Furthermore, dredging projects should maximize use of dredged material as a resource consistent with protecting and enhancing Bay natural resources, such as creating, enhancing, or restoring tidal and managed wetlands, creating and maintaining levees and dikes, providing cover and sealing material for sanitary landfills, and filling at approved construction sites.

Dredging Policy 6. Dredged materials disposed in San Francisco Bay and certain waterways should be carefully managed to ensure that the specific location, volumes, physical nature of the material, and timing of disposal do not create navigational hazards;

adversely affect Bay sedimentation, currents, or natural resources; or foreclose the use of the site for projects critical to the economy of the San Francisco Bay Area.

POLICIES IN THE BAY PLAN PERTAINING TO FISH, OTHER AQUATIC ORGANISMS, AND WILDLIFE THAT ARE RELEVANT TO THE PROPOSED PROJECT ARE SUMMARIZED BELOW:

Fish, Other Aquatic Organisms, and Wildlife Policy 1. To assure the benefits of fish, other aquatic organisms, and wildlife for future generations, to the greatest extent feasible, San Francisco Bay's tidal marshes, tidal flats, and subtidal habitat should be conserved, restored, and increased.

Fish, Other Aquatic Organisms, and Wildlife Policy 2. Specific habitats that are needed to conserve, increase, or prevent the extinction of any native species, species threatened or endangered, species that the CDFW has determined are candidates for listing as endangered or threatened under the California Endangered Species Act, or any species that provides substantial public benefits, should be protected, whether in San Francisco Bay or behind dikes.

Fish, Other Aquatic Organisms, and Wildlife Policy 4. The BCDC should not authorize projects that would result in the "taking" of any plant, fish, other aquatic organism or wildlife species listed as endangered or threatened pursuant to the state or federal endangered species acts, or the federal Marine Mammal Protection Act, or species that are candidates for listing under the California Endangered Species Act, unless the project applicant has obtained the appropriate "take" authorization from the USFWS, NMFS, or CDFW. The BCDC should give appropriate consideration to the recommendations of the CDFW, NMFS, or USFWS to avoid possible adverse effects of a proposed project on fish, other aquatic organisms, and wildlife habitat.

WATER QUALITY POLICIES IN THE BAY PLAN RELEVANT TO THE PROPOSED PROJECT ARE SUMMARIZED BELOW:

Water Quality Policy 1. Bay water pollution should be prevented to the greatest extent feasible. The Bay's tidal marshes, tidal flats, and water surface area and volume should be conserved, and whenever possible, restored and increased to protect and improve water quality.

Water Quality Policy 2. Water quality in San Francisco Bay should be maintained at a level that will support and promote the beneficial uses of San Francisco Bay as identified in the Regional Water Board's Water Quality Control Plan for the San Francisco Bay Basin and should be protected from all harmful or potentially harmful pollutants. The policies, recommendations, decisions, advice, and authority of the State Water Resources Control Board and the Regional Water Board should be the basis for carrying out the BCDC's water quality responsibilities.

Policies in the Bay Plan pertaining to Tidal Marshes and Tidal Flats relevant to the proposed project are summarized below:

Tidal Marshes and Tidal Flats Policy 1. Tidal marshes and tidal flats should be conserved to the fullest possible extent. Filling, diking, and dredging projects that would substantially harm tidal marshes or tidal flats should be allowed only for purposes that provide substantial public benefits, and only if there is no feasible alternative.

Tidal Marshes and Tidal Flats Policy 2. Any proposed fill, diking, or dredging project should be thoroughly evaluated to determine the effect of the project on tidal marshes and tidal flats and designed to minimize—and if feasible—avoid any harmful effects (Federal Navigation Channels EA/EIR 3.0 Affected Environment and Environmental Consequences).

Policies for Subtidal Areas in the Bay Plan that are relevant to the proposed project are summarized below:

Subtidal Areas Policy 1. Any proposed filling or dredging project in a subtidal area should be thoroughly evaluated to determine the local and Bay-wide effects of the project on: (a) the possible introduction or spread of invasive species; (b) tidal hydrology and sediment movement; (c) fish, other aquatic organisms, and wildlife; (d) aquatic plants; and (e) San Francisco Bay's bathymetry. Projects in subtidal areas should be designed to minimize—and if feasible—avoid any harmful effects.

Subtidal Areas Policy 2. Subtidal areas that are scarce in San Francisco Bay or have an abundance and diversity of fish, other aquatic organisms, and wildlife (e.g., eelgrass beds, sandy deep water, underwater pinnacles) should be conserved. Filling, changes in use; and dredging projects in these areas should therefore be allowed only if: (a) there is no feasible alternative; and (b) the project provides substantial public benefits.

Navigational Safety and Oil Spill Prevention policies in the Bay Plan relevant to the proposed project are summarized below:

Navigational Safety and Oil Spill Prevention Policy 1. Physical obstructions to safe navigation, as identified by the U.S. Coast Guard and the Harbor Safety Committee of the San Francisco Bay Region, should be removed to the maximum extent feasible when their removal would contribute to navigational safety, and would not create significant adverse environmental impacts. Removal of obstructions should ensure that any detriments arising from a significant alteration of Bay habitats are clearly outweighed by the public and environmental benefits of reducing the risk to human safety; or the risk of spills of hazardous materials, such as oil.

Navigational Safety and Oil Spill Prevention Policy 3. To ensure navigational safety and help prevent accidents that could spill hazardous materials, such as oil, the BCDC should encourage major marine facility owners and operators, USACE and the National Oceanic and Atmospheric Administration to conduct frequent, up-to-date surveys of major shipping channels, turning basins, and berths used by deep-draft vessels and oil barges. Additionally, the frequent, up to-date surveys should be quickly provided to the U.S. Coast Guard Vessel Traffic Service San Francisco, masters, and pilots.

2. Endangered Species Act (ESA) and Magnuson-Stevens Fishery Conservation and Management Act

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
450 GOLDEN GATE AVENUE
SAN FRANCISCO, CALIFORNIA 94102-3661

November 9, 2022

Subject: 2023 San Francisco Bay Strategic Shallow-Water Placement Pilot Project – Request for Concurrence with Endangered Species Act Determination and for Essential Fish Habitat Consultation under the Magnuson-Stevens Fishery Conservation and Management Act

Dr. Scott Rumsey,
Acting Regional Administrator
Attn: Gary Stern
San Francisco Bay Branch Chief
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

Dear Dr. Rumsey:

Pursuant to Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 50 C.F.R. Part 402), the U.S. Army Corps of Engineers, San Francisco District (USACE) is requesting concurrence from the National Marine Fisheries Service (NMFS) with our determination that the proposed 2023 Dredge Sediment Strategic Placement Pilot project is not likely to adversely affect the Central California Coast (CCC) distinct population segment (DPS) of steelhead (*Oncorhynchus mykiss*; threatened) and southern DPS of North American green sturgeon (*Acipenser medirostris*; threatened), or the designated critical habitat of the southern DPS of North American green sturgeon.

The USACE also is requesting consultation under the Magnuson-Stevens Fisheries Conservation and Management Act (Magnuson-Stevens Act; 50 C.F.R 600.920(e)). We have determined that the proposed action may affect essential fish habitat (EFH) managed as part of the Pacific Groundfish Fishery Management Plan (FMP), Pacific Salmon FMP, and Pacific Coastal Pelagic Species FMP.

<u>Project Description</u>

The proposed project would involve placing dredged material in shallow water about 2 miles offshore from a sediment-starved tidal wetland and using natural hydrodynamic processes to transport the sediment onto the mudflat and marsh (i.e., strategic placement). The purpose of this pilot project is to examine the ability of tides and currents in San Francisco Bay to move dredged sediment placed in shallow water on the periphery of the bay onto existing mudflats and marshes to increase resilience to rising sea levels. The project will compare the costs of successfully moving a noteworthy and substantial volume of dredged sediment to the target placement area to the costs of traditional placement options (i.e., ocean, in-water, or confined upland disposal).

Dredged material for the proposed project would be obtained from the operations and maintenance (O&M) dredging of Redwood City Harbor (RCH). The O&M dredging activities of RCH Harbor are conducted under separate authorization and that is a separate project. The RCH Project would provide the source material for the 2023 strategic placement of dredged sediment pilot project; however, RCH maintenance dredging occurs every two years independent of the proposed project. The federal Base Plan for maintenance dredging of RCH, as practiced for the past several decades, is completed using clamshell with placement at the designated in-bay site, SF-11. Evaluation of the potential impacts associated with the O&M dredging of RCH are presented in the Final Environmental Assessment/Environmental Impact Report for Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay Fiscal Years 2015-2024. The NMFS has completed ESA consultation on the O&M dredging activities at RCH as part of assessing the effects of the Long-Term Management Strategy for the Placement of Dredge Material in San Francisco Bay (NMFS consultation number WCR-2014-1599).

For the proposed strategic placement pilot project, a small scow will be light loaded with approximately 900 cubic yards (CY) of dredged material at RCH and transported using a tugboat to the project placement site near Eden Landing (Whale's Tail) in south San Francisco Bay (Figure 1). The placement site would be in approximately 9 - 12 feet of absolute water depth. This depth is necessary to accommodate the scow draft and offers the greatest likelihood of sediment transport onto the adjacent mudflat and marsh based on modeling results. The total area of the placement site would be approximately 138 acres. The dredged material from each scow-load would be released all at once through the bottom release doors. Release time is expected to require 9 minutes (Anchor QEA, LLC 2022). Due to drift in the water column, maximum depth of the sediment layer as the dredged material settles on the bottom substrate is expected to be between 10 cm and 30 cm (Anchor QEA, LLC 2022). After placing the dredged material, the tug and scow will return to RCH to repeat the process. The entire placement volume will be approximately 100,000 CY, requiring an estimated 112 scow-loads to complete. At maximum, the placement process could occur 24 hours per day, 7 days per week. However, it is expected to require 19 – 56 days, with an estimated rate of 2 - 6 scow-loads placed per day on average, although placements could occur as often as every 1.5 hours if the tides allow the site to remain deep enough. Work will occur within the in-water work window for dredging, which is June 1 through November 30. The placement area and adjacent mudflat-marsh complex will be monitored before and after placement.

Both pre- and post-project monitoring will occur in the following areas (please see attachment):

Pre-project monitoring

- Bathymetry and topography
- Oceanographic data collection: suspended sediment concentration, wave conditions
- Benthic communities
- Eelgrass surveys
- Sediment flux across the shallows
- Background marsh accretion rates

Post-project monitoring

- Resurveys of placement site
- Benthos, eelgrass recovery
- Oceanographic data collection: suspended sediment concentration, wave conditions

- Sediment flux post placement
- Marsh and mudflat accretion

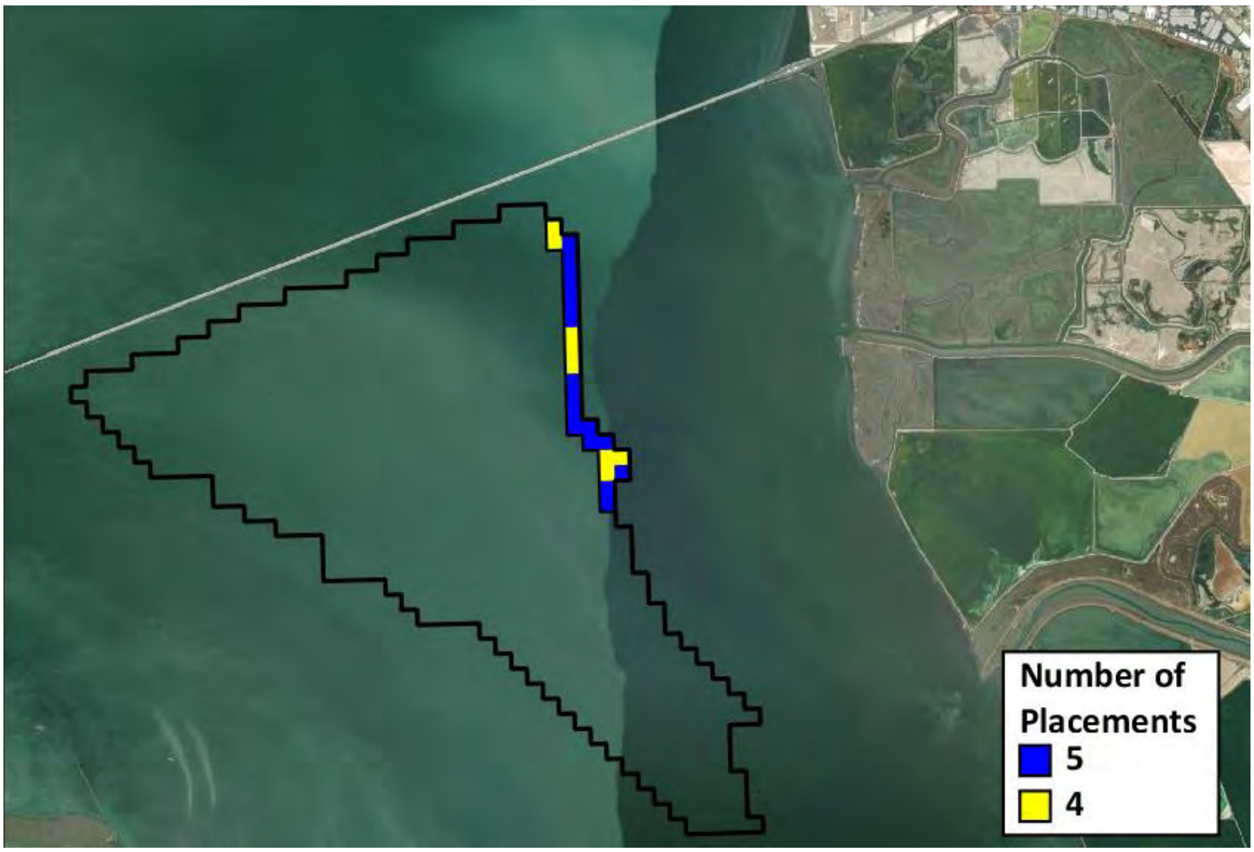

Figure 1. Placement cells in shallow water aproximately two miles off the marsh at Eden Landing (i.e., Whale's Tail) for the Shallow/East placement. The black outline represents the entire placement grid modeled by Anchor QEA, LLC (2022) to identify the best locations for placement, whereas the blue and yellow cells represent the Eden Landing Shallow/East placement footprint cells selected for actual use by the project. Each of the selected cells will receive five or four placements,respectively depending on the water depths and tidal timings. The placement footprint of the blue and yellow cells is approximately 9,700 feet long and 630 feet wide (i.e., 138 acres).

Endangered Species Act Consultation

The proposed project has been reviewed for its potential impacts to threatened or endangered species and designated critical habitats. Primary impacts include the following:

- Benthic invertebrates are expected to be buried by 10 – 30 cm of sediment and potentially injured or killed when the dredge material is placed. Larger or more motile organisms such as fish also could be injured or killed should they remain under or close to the scow when the bottom release doors are opened, and the dredge material is deposited.
- Turbidity and suspended sediment levels in and around the placement site are expected to increase, potentially reducing the ability of fish to feed by sight or increasing energy expenditures due to gill-flaring to clear sediment, etc. Elevated turbidity and suspended sediment levels would be highest during the placement process. However, the project is intended to use natural hydrodynamic processes to move the placed sediment. Therefore, project-related contributions to turbidity and suspended sediment are expected to continue over a period of several months.
- Marsh and mudflat habitats may experience increased rates of sediment deposition, which is the intent of the project. This would occur over a period of several months. Marsh and mudflat accretion rates are expected to be up to approximately 0.1 cm per 2 months per simulation modeling (Anchor QEA, LLC 2022).

Central California Coast Steelhead: As CCC steelhead spawning occurs in nearby south San Francisco Bay watersheds such as Alameda Creek, Coyote Creek, and the Guadalupe River, steelhead could occur at or near the project site. However, adult steelhead migrate into their spawning streams from December through April, and juveniles outmigrate to the ocean from January through May (Fukushima and Lesh 1998). Furthermore, summertime water temperature in south San Francisco Bay can be expected to measure approximately 70 ^{o}F or more (e.g., as measured by the USGS at the Dumbarton Bridge). This temperature is above the preferred temperature ranges for steelhead/rainbow trout (*O. mykiss*) juveniles and smolts generally reported in the literature (e.g., Raleigh et al. 1984; Sauter et al. 2001). Overall, juvenile steelhead are not expected to be in the project area during the period from June 1 through November 30 and hence are not expected to encounter the project. Any early migrating adults would be expected to easily avoid the project due to its small size relative to the large migration corridor in the project area. The effects of the proposed project on juvenile CCC steelhead are expected to be discountable due to their absence, and effects on the few adults that may encounter the project are expected to be minor, temporary, and localized and not impede migration into their south bay spawning streams. The USACE has determined that the proposed project is not likely to adversely affect CCC steelhead.

Southern DPS of North American Green Sturgeon and Critical Habitat: North American green sturgeon may be present year-round in San Francisco Bay. Only juvenile, subadult, and adult rearing or migrating green sturgeon would be present and likely feeding on benthic macroinvertebrates, juvenile crabs, and small benthic fishes. No spawning adults would be present, as green sturgeon spawn in fresh water and the nearest spawning habitat is in the Sacramento River (Moyle 2002).

A summary provided by the San Francisco Estuary Institute of telemetry studies conducted through 2015 primarily on white sturgeon (*Acipenser transmontanus*) suggests that green sturgeon could occasionally occur in south San Francisco Bay (chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.sfei.org/sites/default/files/biblio_files/2015%20Summary%20of%20Sturgeon%20Telemetry%20Studies%20in%20SF%20Estuary.pdf). The most recent summary of sturgeon report card data provided by the California Department of Fish and Wildlife shows zero to low catch of white sturgeon for the months from June through November, 2007-2019 in San Francisco Bay "south of Highway 80" (presumably the Oakland-San Francisco Bay Bridge, approximately 18 miles north of the proposed project; Dubois et al. 2020). Location data are not provided for the green sturgeon that were caught and released by anglers. Interestingly, a blog post from a fishing guide states that one of his favorite, year-round (white) sturgeon fishing areas is south of the Dumbarton Bridge, due to the brackish water and shallow depths; he describes these white sturgeon as "resident" there (https://coastsidefishingclub.com/grey-beard-articles/an-introduction-to-sturgeon-fishing/). The Dumbarton Bridge is located approximately 8 miles south of the proposed project.

More detailed information concerning green sturgeon timing and distribution in San Francisco Bay is provided by the recent acoustic telemetry study of Miller et al. (2020). This study involved surgically implanting small, acoustic transmitters into 41 green sturgeon and 160 white sturgeon in Suisun and San Pablo bays, and then detecting the fish with automated receivers to determine their seasonal distribution in the Sacramento River and Suisun, San Pablo, and San Francisco bays. Large juveniles, subadults, and adults all were tagged as part of the study. Data for 100 green sturgeon and 92 white sturgeon previously tagged for other studies were included in the data analysis. The receiver array is shown in Figure 2; note that area #3 is described as "south San Francisco Bay" and includes approximately six receivers placed along the Bay Bridge as well as a single receiver located at the Dumbarton Bridge. Miller et al. (2020) report that in summer, juvenile and subadult green sturgeon were detected primarily in central San Francisco Bay, San Pablo Bay, and Suisun Bay. Subadults also were detected a few times in the Pacific Ocean. Adult green sturgeon were much more widespread, and also detected in the Pacific Ocean and Sacramento River. Green sturgeon are described as being "highly marine" compared to white sturgeon; juvenile and subadult green sturgeon were detected more often than similarly-aged white sturgeon near the Golden Gate Bridge, and white sturgeon are described as "resident in the estuary throughout adulthood." Miller et al. (2020) report few detections of juvenile, subadult, or adult green sturgeon in south San Francisco Bay in summer or fall. However, all south San Francisco Bay detections were made by the acoustic receivers located at the Bay Bridge, and none occurred at the Dumbarton Bridge. Consequently, there is no evidence from this study that green sturgeon occurred near the area of the proposed project.

Based on the timing and distribution information described above green sturgeon would have a low likelihood of encountering the proposed project. We know that green sturgeon occur north (i.e., in the vicinity of the Bay Bridge) of the proposed project and that white sturgeon occur both to the north and south (i.e., south of the Dumbarton Bridge). Adult white sturgeon may be resident in the brackish waters south of the Dumbarton Bridge. Little is known about green or white sturgeon occurrence specifically in the vicinity of the project area, but in general sturgeon occurrence in south San Francisco Bay during the period from June through November appears to be low.

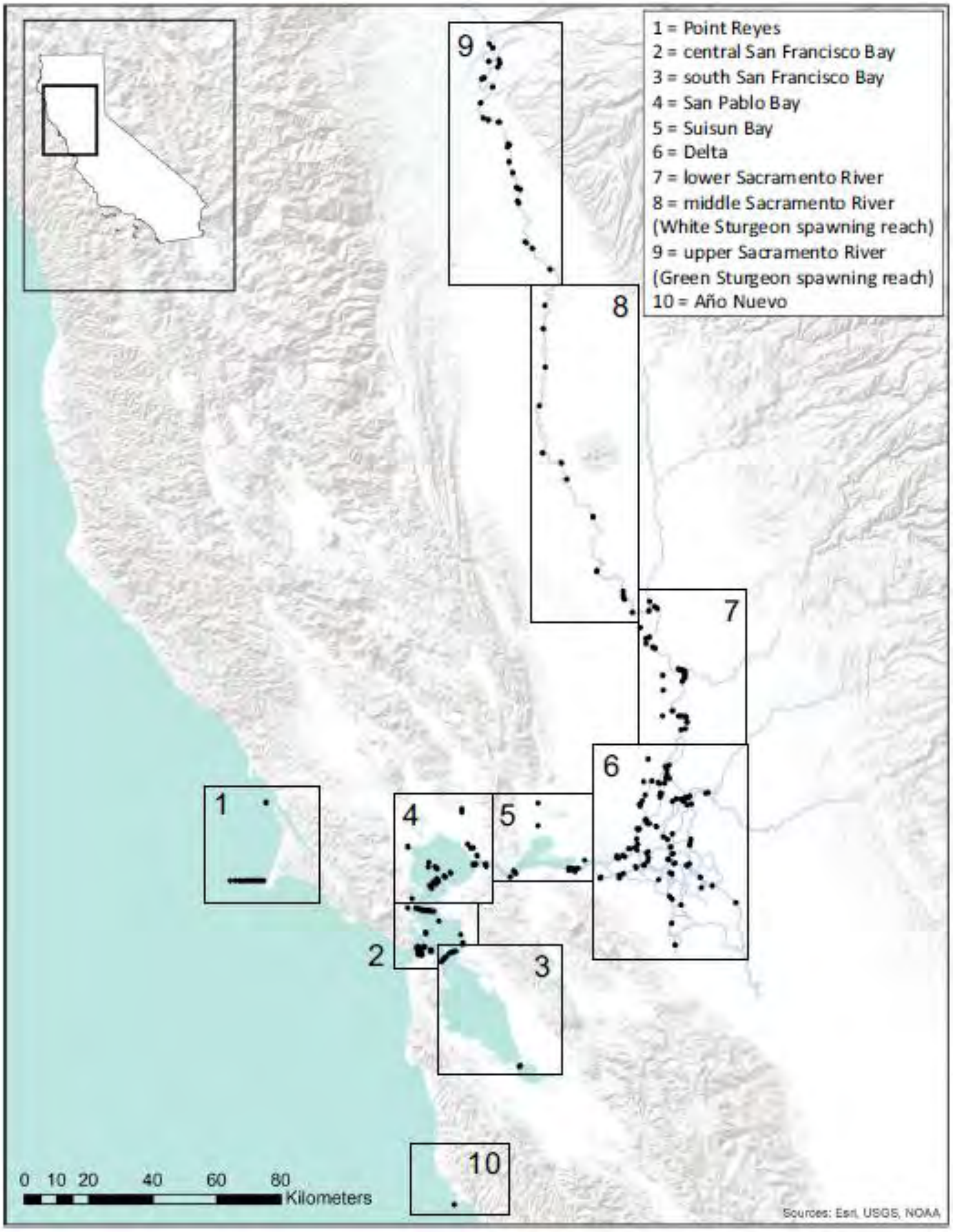

Figure 2. Acoustic receiver array used to assess green and white sturgeon distribution in the Sacramento River and San Francisco Bay. Reproduced from Figure 1 in Miller et al. (2020).

Should a green sturgeon encounter the project, the severity of impacts may depend on the size of the affected individual. Juveniles may have an increased likely of being injured or killed from being buried by sediment, or less capable of avoiding project-related turbidity. Although detections by Miller et al. (2020) of green sturgeon in south San Francisco Bay were low overall, they were greatest for juveniles. Miller et al. (2020) considered the size of juvenile green sturgeon in San Francisco Bay to be up to 90 cm; smaller individuals may be 30 cm (Moyle 2002). Boysen and Hoover (2009) found that juvenile white sturgeon less than 82 mm total length (TL) had "escape speeds" capable of being maintained for 1 minute of less than 40 cm per second, and juveniles measuring 82 - 92 mm TL had escape speeds of 42 - 45 cm per second. In general, larger, motile fish including even juvenile green sturgeon would be expected to move away from the active project area due to the physical disturbance from the draft of the tug and scow as they maneuver in shallow water. It is likely that juvenile sturgeon also could escape burial by project sediment even if they remained directly under the scow when the scow doors opened. Dredge material placement from the proposed project is expected to deposit a sediment layer of 10 - 30 cm thick below or near the transport scow. This deposition would occur over a period of about 9 minutes (Anchor QEA, LLC 2022). Consequently, juvenile green sturgeon should be able to simply swim away from the sediment deposition activities as well as project-related turbidity.

Although dredge placement activities are known to increase turbidity and suspended sediment levels in the water column, this not considered to be a major concern for sturgeon (Stanford et al. 2009). Background turbidity levels in San Francisco Bay are relatively high. Turbidity measured 4 feet from the bottom at the Dumbarton Bridge (USGS gauge 373015122071000) for the years 2014-2021 typically ranged from 200 – 600 formazin nephelometric units (FNU) during the period from June through November but measured as high as 700 – 800 FNU on some occasions. The summary from a symposium concerning dredging effects on green sturgeon and longfin smelt (*Spirinchus thaleichthys*) in the San Francisco Estuary (Stanford et al. 2009) indicates that in one study, white sturgeon "did not disperse during dredging operations, but became more active. This increased activity could have resulted from either stress or increased foraging activity….white sturgeon remained in a disposal site throughout a several hour sediment disposal operation." An overall conclusion of the symposium was that "sturgeon appear to be undisturbed by high concentrations of naturally-produced suspended sediment. Therefore, adverse effects of sediment resuspension are unlikely."

In summary, green sturgeon are unlikely to be in the project area from June through November and hence are not expected to encounter the project. However, any green sturgeon, even a juvenile, that encounters the project during active dredge material placement should be able to swim strongly enough to avoid physical injury or turbidity plumes. Elevated turbidity levels are not expected to adversely affect sturgeon. The USACE has determined that the proposed project is not likely to adversely affect the southern DPS of North American green sturgeon.

Green sturgeon designated critical habitat in San Francisco Bay, San Pablo Bay, and Suisun Bay includes all tidally influence areas up to the elevation of mean higher high water. In the project area, designated critical habitat includes the area upstream to the head of tide endpoint in Alameda Creek.

The proposed project is expected to deposit dredge sediment in a 138-acre area of south San Francisco Bay. The benthic substrate in the south bay is largely mud flat, but also includes oyster shell "hash" (S. De La Cruz, USGS, personal communication, June 28, 2022) and bryozoan reefs (Zabin et al. 2010). Sturgeon likely can be found over all three substrate types in their search for food. Benthic organisms such as macroinvertebrates, juvenile crabs, and small fish (e.g., staghorn sculpin (*Leptocottus armatus*)) may be buried by the proposed dredge material placement and injured or killed. These organisms represent food items regularly consumed by green sturgeon. Elevated turbidity levels also are expected to occur during active placement activities which would occur over 19 – 56 days. However, the dredge material placement site is about 138 acres or 0.22 square miles in size, whereas the area of Suisun, San Pablo, and San Francisco bays combined is estimated to be about 225 square miles (i.e., assuming dimensions of 75 miles long x 3 miles wide on average). Therefore, the dredge material placement area is extremely small relative to the amount of habitat available to green sturgeon, and sturgeon should continue to be able to find foraging habitat and adequate food for the duration of the project. Additionally, benthic organisms are expected to recolonize the dredge material placement site, and the benthos will be monitored for a period of 1 year. Turbidity is expected to subside between scow loads and quickly return to background levels once dredge material placement is complete.

The proposed project is expected to contribute sediment for transport onto nearby wetlands over a period of several months. Consequently, the project may increase turbidity levels in the placement area over the long term. However, due to the elevated background turbidity levels in south San Francisco Bay, project-related turbidity increases are not expected to be measurable following the active period of dredge material placement (Jessie Lacy, USGS, personal communication, June 28, 2022). Transport of sediment through shallow water areas and deposition of small amounts (i.e., up to about 0.1 cm per 2 months) in wetlands near the placement site is considered a beneficial effect of the project but is not expected to meaningfully affect green sturgeon habitat or their benthic food. In any case, sediment transport and deposition will be monitored for a period of 1 year.

Given the analysis provided above, project effects to green sturgeon critical habitat are expected to be minor, temporary, and localized. The USACE has determined that the proposed project is not likely to adversely affect the designated critical habitat of the southern DPS of North American green sturgeon.

<u>Magnuson-Stevens Fisheries Conservation and Management Act (Essential Fish Habitat) Consultation</u>

The proposed project area consists of open water habitat and benthic habitat that may include mudflat, shell hash, or bryozoan reefs. Eelgrass occurs between the dredge material placement site and the wetland targeted for restoration through sediment transport (Figure 3). Marsh habitats also are present. The project area is under tidal influence.

The proposed project is expected to deposit dredge sediment in a 138-acre area of south San Francisco Bay over a period of 19 – 56 days and increase turbidity in the water column. Benthic organisms would be buried and potentially injured or killed. These organisms are expected to recolonize over a period of weeks or months, and the benthos will be monitored for up to one year. The project also would contribute sediment for transport onto nearby wetlands over a period of months or years. Deposition of small amounts (i.e., up to about 0.1 cm per 2 months) is expected to occur in wetlands near the placement site. Sediment transport and deposition will be monitored for a period of 1 year. Sediment deposition onto wetlands is considered a beneficial effect and is the purpose of the project.

Figure 3. Eelgrass mapped near Eden Landing. Includes data from surveys conducted in 2003, 2009, 2013, and 2019. The orange border indicates the 250 m turbidity buffer from NMFS (2011). A comparison with Figure 1 indicates no encroachment of the dredge disposal site into the turbidity buffer. Source: [San Francisco Bay Eelgrass Impact Assessment Tool | CNRA GIS Open Data (ca.gov)]

The eelgrass shown in Figure 3 would be outside of the 250 m buffer zone (i.e., from the dredge placement site) established by NMFS (2011) for protection from indirect effects of dredging activity such as turbidity. Additionally, the substrate and conditions offshore of Eden landing are not especially conducive to eelgrass colonization and growth, and Figure 3 primarily shows individual clones from one spot survey (Kathy Boyer and Keith Merkel, pers. comm., July 2022). However, pre- and post-project eelgrass monitoring would occur to document effects on eelgrass.

The proposed project is expected to have minor, temporary, and localized effects to EFH as described above. The USACE has determined that the project may affect EFH managed as part of the Pacific Groundfish, Pacific Salmon, and Pacific Coastal Pelagic Species fishery management plans.

We are requesting your written concurrence with our determination that the proposed project may affect, but is not likely to adversely affect the CCC DPS of steelhead, southern DPS of North American green sturgeon, or the designated critical habitat of the southern DPS of North American green sturgeon. We also request a response regarding EFH. If you would like to further discuss our determination or require additional information, please contact Dr. Beth Campbell of my staff at elizabeth.a.campbell@usace.army.mil, or at (415) 503-6845 regarding this consultation request.

Sincerely,

BEACH.TESSA.EVE.1385598781 Digitally signed by BEACH.TESSA.EVE.1385598781 Date: 2022.11.09 14:47:02 -08'00'

Dr. Tessa Beach
Environmental Branch Chief

References:

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Enclosure

From: Campbell, Elizabeth A CIV USARMY CESPN (USA) <Elizabeth.A.Campbell@usace.army.mil>
Sent: Thursday, December 8, 2022 12:26 PM
To: Sara Azat - NOAA Federal <sara.azat@noaa.gov>
Cc: Beagle, Julie R CIV USARMY CESPN (USA) <Julie.R.Beagle@usace.army.mil>
Subject: RE: [Non-DoD Source] QUESTIONS - SF Bay Strategic Dredge Placement Pilot

Hi Sara:

Please see our responses below to the questions and comments (in **bold**) from your November 21, 2022 email. A revised monitoring plan including some of the requested information (e.g., regarding eelgrass) is attached, as is a monitoring schedule.

1. **The consultation request letter specifies that the proposed pilot project is not likely to adversely affect the Central California Coast (CCC) distinct population segment (DPS) of steelhead (Oncorhynchus mykiss; threatened) and southern DPS of North American green sturgeon (5; threatened), or the designated critical habitat of the southern DPS of North American green sturgeon. The proposed project also occurs within CCC steelhead critical habitat; please confirm the Corps' determination.**

   We apologize for the oversight. Designated critical habitat for CCC steelhead occurs throughout San Francisco Bay and extends landward to the extreme high tide line (50 CFR Part 226). The proposed project would involve placing approximately 100 kcy of dredged material in a shallow water area located about 2 miles offshore from Eden Landing (Whale's Tail) in south San Francisco Bay, and then allowing natural hydrodynamic processes to transport the sediment onto mudflat and marsh (i.e., strategic placement). The amount of habitat that would be affected is very small compared to the overall amount of bay and estuarine habitat available. Specifically, the placement site will cover about 138 acres or 0.22 square miles compared to the total area of Suisun, San Pablo, and San Francisco bays which is estimated to be about 225 square miles (i.e., assuming dimensions of 75 miles long x 3 miles wide on average). Turbidity is expected to temporarily increase at the placement site, but this would not occur when steelhead are likely to be present due to the June 1 – November 30 placement work window. Benthic fish and invertebrates could be buried and killed by placement activities, but these organisms typically are not consumed by salmonids; effects to steelhead food supply are expected to be insignificant. Marsh and mudflat habitats may experience increased rates of sediment deposition over several months, which is the intent of the project and expected to benefit steelhead through increased food production and maintenance of rearing habitat complexity. Overall, project effects to steelhead habitat are expected to be minor, temporary, and localized. The USACE has determined that the proposed project is not likely to adversely affect the designated critical habitat of CCC steelhead.

2. **One of the stated purposes of the proposed project is to compare the costs of successfully moving dredged sediment to shallow-water placement areas with the costs of traditional placement (i.e., ocean, in-water, or confined upland disposal). Will the comparison be strictly fiscal or will the cost to habitat also be considered? For confined upland disposal, is this assuming the current placement availability only?**

   While a hypothesis is that shallow-water placement may wind up being a lower cost option to supporting marsh and mudflat resilience over time, this study will not be able to actively test that notion in the detail you suggest. Since this is a fully federally funded project, the study funds will be spent to address the incremental cost above the federal standard on the redwood city dredging action in FY23, and monitor the impacts to the benthic habitat and to water quality, and monitor the transport and deposition of sediment post placement. The purpose of the monitoring plan is to understand the impacts to the benthic and pelagic communities (see attached complete/detailed monitoring plan), and to evaluate the impacts and benefits of the project over the period of monitoring.

Strategic shallow water placement may be one of many tools to beneficially use dredged material. This would be in addition to direct (upland) placement at both current sites (Montezuma and Cullinan), and also at other sites as they come online in the future, as well as other methods which have not yet been tested widely in SF Bay such as marsh spraying, thin layer placement, water column seeding and perhaps others. All tools to reuse sediment will be needed given the pace and extent of sea level rise and the projected impacts to the Baylands. Different methods for reusing material will be appropriate in different settings, and that may change over time. For example, in a subsided polder such as Cullinan, direct placement is the most appropriate option. That is true for Bel Marin Keys, as it was for Hamilton, Sears Point and other formerly diked Baylands as they get restored and need a large amount of elevation lift before they are breached.

For existing marshes that are eroding or drowning, direct placement would smother marsh vegetation, and compromise topographic complexity. A more appropriate tool for helping existing marshes and mudflats maintain elevation given lack of sediment supply and rising sea levels may be to augment local sediment supply using strategies such as shallow water placement. This pilot project is intended to start to understand the range of options that exist for existing marshes and mudflats that need sediment augmentation.

3. **Figure 1 in the consultation request letter shows placement cells in shallow water approximately two miles offshore of the Eden Landing marsh. What is the size (acreage) of the individual blue and yellow cells?**

   Total is 138 acres of placement area. Each cell will receive a certain number of placements based on the color of the cells. The cells are 500 ft by 500 ft. Each scow will place 900 CY at a time, and then travel back to the dredging area- this will occur a total of 112 times across a 2-month cycle. One or two placements will occur each high tide, spaced approximately 1.5 hours apart if placed on the same high tide. See figure 1 below attached, which hopefully clarifies placement area.

4. **Thank you for providing the Draft Monitoring Plan. Do you know when the monitoring plan will be finalized?**

   We expect to finalize the monitoring plan concurrent with the EA/IS/MND (approximately February 2023). We will add in the eelgrass reference sites per 4a below and perform both pre- and post-survey eelgrass surveys (see attached complete/detailed monitoring plan). However, we had not expected to make any other significant changes to the monitoring plan.

There are a few questions, and concerns that may be addressed in a Final Plan. Specifically, my initial concerns are:

a. **Please include reference sites for the eelgrass surveys as monitoring (see NMFS California Eelgrass Mitigation Policy and Implementing Guidelines (CEMP), 2014).**

   Per NMFS' policy to recommend no net loss of eelgrass habitat function in California (CEMP 2014), the monitoring plan for the Shallow Water Placement Pilot Project will include pre- and post-surveys of eelgrass in the project area. As described in the EA/IS/MND, the Eden Landing site (see Figure 1 below) was chosen over the Emeryville Crescent Marsh site partially because it avoided a large eelgrass bed under the Bay Bridge. Through conversations with Kathy Boyer (March 30, 2022), and Keith Merkel (April 1, 2022), both felt that the eelgrass that has been mapped in the project area (offshore of Eden Landing) has been ephemeral and they did not consider this to be high quality eelgrass habitat. Both local experts hypothesized that this type of treatment (strategic placement) may be beneficial for eelgrass in the long term. USACE has proposed a research effort in partnership other scientists in the SF Bay and the Pacific northwest to better understand the impacts of beneficial use on eelgrass over time.

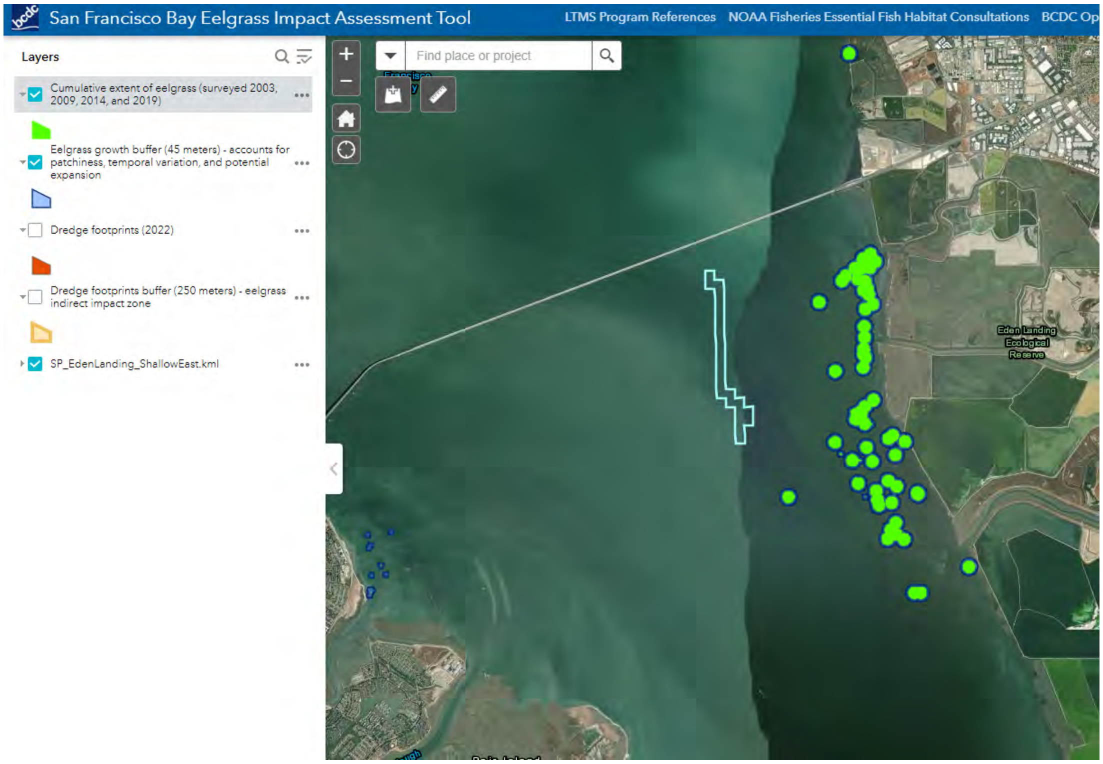

Figure 1. Map of location of mapped eelgrass clones per BCDC Eelgrass Impact Assessment Tool. Placement site (138 acres) is shown in light blue outline.

Below, Figure 2 shows the modeling results of the proposed action after a 2-month modeling window. (Appendix D here: (https://www.spn.usace.army.mil/Missions/Environmental/). Thickness of sediment deposition near the edge of the marsh scarp, and near eelgrass mapped is projected to be less than .1-1 mm in thickness (see blue color ramp on image below).

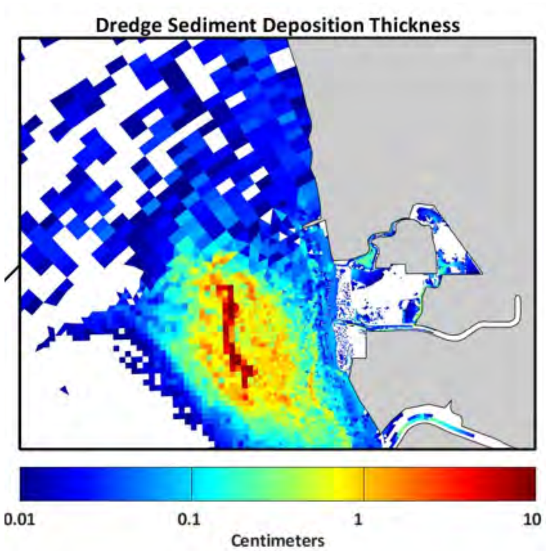

Figure 2. Deposition thickness post modeling runs showing deposition thickness after placement. 10 cm remains in the placement area post 2 months modeling, and will be monitored post placement. Projected thicknesses on mudflats near mapped eelgrass ranges from .1mm (.01 cm) to approximately 1 cm (10mm).

In terms of choosing a reference site, per CEMP guidance, environmental conditions (e.g., sediment, currents, proximity to action area, shoot density, light availability, depth, onshore and watershed influences) at the reference site(s) should be representative of the environmental conditions at the impact area (Fonseca et al.

1998). Where practical, the reference site(s) should be at least the size of the anticipated impact and/or mitigation area to limit the potential for minor changes in a reference site. The nearest site with eelgrass in a similar estuarine environment is near Cogswell Marsh (see northernmost point of eelgrass on Figure 1). This may be the most effective reference site for the Eden Landing Eelgrass surveys but we will confirm with Keith Merkel and Associates in coordination with the USGS and NMFS.

b. **Post-project eelgrass surveys should be conducted, and may need to be conducted for more than one year post-project (see CEMP).**

Per the EA, to verify avoidance of eel grass beds, the PDT or Contractor shall perform preconstruction eelgrass surveys of the Project area during the months of May through September (i.e., the active growth period for eelgrass in San Francisco Bay). All eelgrass surveys shall be performed in accordance with the National Marine Fisheries Service's (NMFS's) California Eelgrass Mitigation Policy (October 2014). The pre-construction survey shall be completed prior to the anticipated start of in- or over-water construction and shall be valid for either 60 days or until the next active growth period if construction occurs after the end of the active growth period.

As stated in the monitoring plan, if the results of the pre-construction survey indicate that eel grass beds are located where the placement will occur, the Applicant shall prepare and submit to the Water Board a mitigation and monitoring plan that will be implemented to compensate for impacts to eel grass beds, and include post-surveys of project area. See attached monitoring plan and schedule. Eelgrass surveys will occur in July 2023 (pre-placement), in December 2023 (6 months post-placement), and in June 2024 (1 year post-placement).

c. **NMFS recommends that fish presence/absence or behavioral monitoring be included in the Draft Monitoring Plan.**

We spoke with Levi Lewis and Ali Weber-Stover through the Wetlands Regional Monitoring Program TAC (which Beth Campbell and Julie Beagle are both members of), and at length on June 10, 2022, about fish monitoring over various substrate types in south San Francisco Bay (I.e., mudflat, shell hash, and bryozoan reefs). They were proponents of doing fish monitoring but given the need for multiple sites including project site and control site, felt that it would be difficult to scale it down to fit a small budget. All parties also recognized that the sampling methodology and questions addressed would be limited. A likely outcome is that zero or a small number of e.g., green sturgeon would be detected but no real information on their behavioral response to dredge material placement. Ultimately, the larger project team (including the Waterboard and BCDC team members) advised us to simplify our biological monitoring to focus on fish habitat through benthic communities (I.e., food supply), water quality, and eelgrass given the limited budget.

The existing monitoring plan has been developed through a partnership with USGS and with input from several parties including members of the WRMP TAC, Keith Merkel, Kathy Boyer, and the USGS PIs and their teams (Karen Thorne, Susan de la Cruz, and Jessie Lacy). The monitoring plan involves a tracer study as well so that the team will be able to track the sediment which otherwise will be too small in deposition thickness to track using traditional survey methods. All told the monitoring plan is over $1 million out of a $3.6 million total project budget, which is more than 27% of the total project budget.

Until we receive this information, we cannot initiate informal ESA and EFH consultations. We are available to help you determine how best to provide this information. If we do not receive a response from you within 30 days, we will discontinue work on your consultation request (and we will close out the request in our tracking system). We will initiate consultation when we receive the needed information (and our tracking system will be updated).

I am particularly interested in discussing the Monitoring Plan for this project. Please let me know if the Corps would like to schedule a time to discuss.

We would be happy to discuss the monitoring plan with you at your convenience. These are times in the next two weeks that work for our schedule, let us know if you have overlapping availability:

Monday December 12: 12-1pm, 4-5m
Tuesday December 13: 10-11am
Thursday December 15: 9-10am, 12-1pm
Wednesday December 21: 11am-12pm

Thanks much Sara for you questions/comments and allowing us to clarify the information.

Beth and Julie

References:

Fonseca, M.S., W.J. Kenworthy, and G.W. Thayer. 1998. Guidelines for the conservation and restoration of seagrasses in the United States and adjacent waters. NOAA Coastal Ocean Program Decision Analysis Series No. 12, NOAA Coastal Ocean Office, Silver Spring, Maryland.

NMFS (NOAA Fisheries). 2014. California eelgrass mitigation policy and implementing guidelines.
West Coast Region, October 2014. 3 pages plus attachments.

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U.S. Army Corps of Engineers
San Francisco District (SPN)
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San Francisco, CA 94102
415-503-6845

From: Sara Azat - NOAA Federal <sara.azat@noaa.gov>
Sent: Monday, November 21, 2022 8:00 AM
To: Campbell, Elizabeth A CIV USARMY CESPN (USA) <Elizabeth.A.Campbell@usace.army.mil>
Cc: Beagle, Julie R CIV USARMY CESPN (USA) <Julie.R.Beagle@usace.army.mil>
Subject: [Non-DoD Source] QUESTIONS - SF Bay Strategic Dredge Placement Pilot

Hello Beth and Julie,
NMFS has received your request, dated November 9, 2022, for concurrence that the 2023 SF Bay Strategic Shallow-Water Placement Pilot Project is not likely to adversely affect species and critical habitat listed under the Endangered Species Act (ESA), specifically, CCC steelhead, North American green sturgeon or their critical habitats. Your request letter also included a request for consultation under the Magnuson-Stevens Fisheries Conservation and Management Act as the proposed action may affect essential fish habitat (EFH) designated under the Pacific Groundfish, Pacific Salmon, and Coastal Pelagic Species Fishery Management Plans.
Thank you for providing the detailed project description and effects of the action in your consultation request letter as well as the Draft Monitoring Plan for the pilot project. I have reviewed the information, and have the following initial comments and questions below:
1. The consultation request letter specifies that the proposed pilot project is not likely to adversely affect the Central California Coast (CCC) distinct population segment (DPS) of steelhead (Oncorhynchus mykiss; threatened) and southern DPS of North American green sturgeon (Acipenser medirostris; threatened), or the designated critical habitat of the

southern DPS of North American green sturgeon. The proposed project also occurs within CCC steelhead critical habitat; please confirm the Corps' determination.
2. One of the stated purposes of the proposed project is to compare the costs of successfully moving dredged sediment to shallow-water placement areas with the costs of traditional placement (i.e., ocean, in-water, or confined upland disposal). Will the comparison be strictly fiscal or will the cost to habitat also be considered? For confined upland disposal, is this assuming the current placement availability only?
3. Figure 1 in the consultation request letter shows placement cells in shallow water approximately two miles offshore of the Eden Landing marsh. What is the size (acreage) of the individual blue and yellow cells?
4. Thank you for providing the Draft Monitoring Plan. Do you know when the monitoring plan will be finalized? There are a few questions, and concerns that may be addressed in a Final Plan. Specifically, my initial concerns are:
a. Please include reference sites for the eelgrass surveys as monitoring (see NMFS California Eelgrass Mitigation Policy and Implementing Guidelines (CEMP), 2014).
b. Post-project eelgrass surveys should be conducted, and may need to be conducted for more than one year post-project (see CEMP).
c. NMFS recommends that fish presence/absence or behavioral monitoring be included in the Draft Monitoring Plan.

Until we receive this information, we cannot initiate informal ESA and EFH consultations. We are available to help you determine how best to provide this information. If we do not receive a response from you within 30 days, we will discontinue work on your consultation request (and we will close out the request in our tracking system). We will initiate consultation when we receive the needed information (and our tracking system will be updated).

I am particularly interested in discussing the Monitoring Plan for this project. Please let me know if the Corps would like to schedule a time to discuss.

Thank you,
Sara
--

Sara Azat (she/her)
Acting CCO Operations & Policy Branch Chief/Division Manager
NOAA Fisheries - West Coast Region
U.S. Department of Commerce
777 Sonoma Ave. Room 325
Santa Rosa, CA 95404
707-575-6067
sara.azat@noaa.gov
https://www.fisheries.noaa.gov/region/west-coast

3. CLEAN WATER ACT

San Francisco Bay Regional Water Quality Control Board

September 23, 2022

Tessa Beach
Chief, Environmental Planning and Sciences
U.S. Army Corps of Engineers
San Francisco District (SPN)
450 Golden Gate Avenue, 4th floor
San Francisco, CA 94102
Email: Tessa.E.Bernhardt@usace.army.mil

Subject: San Francisco Regional Water Quality Control Board Acknowledgement of the San Francisco Bay Shallow-Water Strategic Placement Pilot Project

Dear Ms. Beach:

The purpose of this communication is to respond to a request by the San Francisco District of the U.S. Army Corps of Engineers' (USACE). We have been engaged with USACE staff and management regarding the proposed San Francisco Bay Shallow-Water Strategic Placement Pilot Project (Project), including monthly meetings and a joint effort with Water Board staff to create the Environmental Analysis and Mitigated Negative Declaration.

Due to federal requirements for dredging projects, the USACE is required to submit a request for Water Quality Certification (WQC) pursuant to Section 401 of the federal CWA for review and acceptance by the Water Board prior to commencing any work. To issue a WQC the Water Board will need to receive a valid request in accordance with 40 CFR § 121 and comply with the California Environmental Quality Act. It is the intent of the Water Board to fully review this Project once a valid request for a WQC is submitted to the Water Board, which we understand will occur at the pre-construction engineering and design phase.

If you have any further questions, please contact Christina Toms of my staff at 510-622-2506, or by email at Christina.Toms@waterboards.ca.gov.

Sincerely,

Digitally signed by Xavier Fernandez
Date: 2022.09.23 14:28:26 -07'00'

for

Eileen White
Executive Officer

cc w/ attachments (*all via email*):
Arye Janoff, USACE, arye.m.janoff@usace.army.mil
Julie Beagle, USACE, julie.r.beagle@usace.army.mil

DRAFT Section 404(b)(1) Checklist

Summary Evaluation

PROJECT: National Regional Sediment Management Program Section 1122 Beneficial Use Pilot Project San Francisco Bay Strategic Shallow Water Placement

PROJECT MANAGER: Peter Mull

PROJECT DESCRIPTION: The proposed project would place sediment dredged from a federal San Francisco Bay navigation channel in shallow water on the periphery of the Bay to examine the ability of tides and currents to move the placed material to existing mudflats and marshes. This aquatic placement technique – placing dredged sediment in shallow water in the nearshore adjacent to a tidal wetland and utilizing natural hydrodynamic and morphodynamic processes to move the sediment onto the mudflat and marsh – is referred to as strategic shallow water placement. This strategic shallow-water placement pilot project is expected to move a portion of the placed sediment to the mudflats and the marsh plain, mimicking natural sediment supply to wetland ecosystems to improve habitat and increase mudflat and marsh resilience to sea level rise (SLR).

Based on the modeling results, and other site selection criteria, the proposed project evaluates the potential impacts associated with strategically placing approximately 100,000 cubic yards (yd^3) of dredged sediment from the Redwood City Harbor federal navigation channels over approximately 19 – 56 days using a clamshell dredge and a dump scow at a shallow-depth (9 - 12 feet [ft]), at a 138-acre subtidal site two miles offshore of the Eden Landing Ecological Reserve in southern San Francisco Bay. This proposed pilot project addresses tidal mudflat and salt marsh responses to strategic sediment placement at one South-Bay location.

1. Summary of Technical Evaluation Factors (Subparts C-F).

A detailed evaluation is provided in the main body of this report

	N/A	Not Signif-icant	Signif-icant*
a. Potential Impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C) (Sec. 230.20-230.25)			
1) Substrate -	| |	|x|	| |
2) Suspended particulates/turbidity	| |	|x|	| |
3) Water Quality	| |	|x|	| |
4) Current patterns and water circulation	| |	|x|	| |
5) Normal water fluctuations	| |	|x|	| |
6) Salinity gradients	|x|	| |	| |

b. Potential Impacts on Biological Characteristics of the Aquatic Ecosystem (Subpart D)(Sec. 230.30-230.32)

1) Threatened and endangered species		x	
2) Fish, crustaceans, mollusks and other aquatic organisms in the food web		x	
3) Other wildlife		x	

c. Potential Impacts on Special Aquatic Sites (Subpart E)(Sec. 230.40-230.45)

1) Sanctuaries and refuges		x	
2) Wetlands		x	
3) Mud flats		x	
4) Vegetated shallows		x	
5) Coral reefs	x		
6) Riffle and pool complexes	x		

d. Potential Effects on Human Use Characteristics (Subpart F)(Sec 230.50-230.55)

1) Municipal and private water supplies	x		
2) Recreational and commercial fisheries		x	
3) Water-related recreation		x	
4) Aesthetics		x	
5) Parks, national and historic monuments, national seashores, wilderness areas, research sites, and similar preserves		x	

2. Evaluation and Testing (Subpart G) (Sec. 230.60-230.61)

a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material. (Check only those appropriate.)

1) Physical characteristics	x
2) Hydro-geography in relation to known or anticipated sources of contaminants	
3) Results from previous testing of the material or similar material in the vicinity of the project	x
4) Known, significant sources of persistent pesticides from land runoff or percolation	
5) Spill records for petroleum products or designated hazardous substances (Section 311 of CWA)	

6) Public records of significant introduction of contaminants from industries, municipalities, or other sources | |
7) Known existence of substantial material deposits of substances which could be released in harmful quantities to the aquatic environment by man-induced discharge activities | |
8) Other sources (specify) | |

List appropriate references.
DMMO testing reports & grain size analysis from Fanny

b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredge or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and disposal sites and not likely to require constraints. The material meets the testing exclusion criteria. –

|x| YES |__| NO

3. <u>Disposal Site Delineation (Section 230.11(f))</u>.

a. The following factors, as appropriate, have been considered in evaluating the disposal site.

1) Depth of water at disposal site | x |
2) Current velocity, direction, and variability at the disposal site | x |
3) Degree of turbulence | x |
4) Water column stratification | x |
5) Discharge vessel speed and direction | x |
6) Rate of discharge | x |
7) Dredged material characteristics (Constituents, amount, and type of material, settling velocities) | x |
8) Number of discharges per unit of time | x |
9) Other factors affecting rates and patterns of mixing (specify) | x |

List appropriate references:

LTMS (Long-Term Management Strategy Agencies), 1998. Long-Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region, Final Policy Environmental Impact Statement/Environmental Impact Report. Volume I.

USACE (United States Army Corps of Engineers), 2015. Final Environmental Assessment/Environmental Impact Report Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay Fiscal Years 2015 – 2024 (State Clearinghouse No. 2013022056).

b. An evaluation of the appropriate factors in 4a above indicates that the disposal site and/or size of mixing zone are acceptable

| x | | |
YES NO

4. Actions To Minimize Adverse Effects (Subpart H)(Sec. 230.70-230.77).

All appropriate and practicable steps have been taken, through application of recommendation of Section 230.70-230.77 to ensure minimal adverse effects of the proposed discharge. | x | | |
YES NO

List actions taken:

a. Tidal stage

b. Work windows

c. Amount of fill per scow: 900 CY per scow

5. Factual Determination (Section 230.11).

A review of appropriate information as identified in items 2 - 5 above indicates that there is minimal potential for short or long term environmental effects of the proposed discharge as related to:

a. Physical substrate
(review sections 2a, 3, 4, and 5 above). YES | x | NO | |

b. Water circulation, fluctuation and salinity
(review sections 2a, 3, 4, and 5) YES | x | NO | |

c. Suspended particulates/turbidity (review sections 2a, 3, 4, and 5). YES | x | NO | |

d. Contaminant availability (review sections 2a, 3, and 4) YES | x | NO | |

e. Aquatic ecosystem structure, function and organisms(review sections 2b and c, 3, and 5) YES | x | NO | |

f. Proposed disposal site (review sections 2, 4, and 5) YES | x | NO | |

g. Cumulative effects on the aquatic ecosystem (beneficial!) YES | x | NO | |

h. Secondary effects on the aquatic ecosystem (beneficial) YES | x | NO | |

6. Review of Compliance (Section 230.10(a)-(d)).

a. The discharge represents the least environmentally damaging practicable alternative and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem to fulfill its basic purpose. |_x_| YES |__| NO

b. The activity does not appear to: 1) violate applicable state water quality standards or effluent standards prohibited under Section 307 of the CWA; 2) jeopardize the existence of Federally listed threatened and endangered species or their critical habitat; and 3) violate requirements of any Federally designated marine sanctuary |_x_| YES |__| NO

c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values |x| YES | | NO

d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem |x| YES | | NO

7. Findings of Compliance or non-compliance. (Sec. 230.12)

The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines YES |x | NO | |

_____________________ _____________________________

DATE District Commander

401 Certification
Pre-Filing Meeting Request

Pursuant to the 401 Certification Rule, project proponents must submit a Pre-Filing Meeting Request a minimum of 30 days prior to submitting the 401 water quality certification application or the Consolidated Dredging-Dredged Material Reuse/Disposal application.

If you are applying for a single episode 401 water quality certification for maintenance dredging OR a multi-episode 401 water quality certification for maintenance dredging WITH a first episode approval, please fill out this Form and submit it with your Sampling and Analysis Plan.

If you ae applying for a multi-episode 401 water quality certification for maintenance dredging WITHOUT a first episode approval, please send this completed form by email (rb2-dredgereports@waterboards.ca.gov) AFTER knowing all the information needed in the consolidated application and AFTER receiving an integrated alternatives analysis approval by the LTMS.

If you are applying for one of the following 401 water quality certifications for maintenance dredging:

(1) Single episode with a Tier 1 Analysis, or
(2) Single episode with a Tier 1 Analysis with Confirmatory Chemistry,

please send this completed form by email (rb2-dredgereports@waterboards.ca.gov) AFTER knowing all the information needed in the consolidated application.

If you are applying for a 401 water quality certification for new dredging work, please send this completed form by email (rb2-dredgereports@waterboards.ca.gov) AFTER knowing all the information needed in the consolidated application, AFTER receiving an integrated alternatives analysis approval by the LTMS, and AFTER you have a plan describing avoidance, minimization and compensatory mitigation measures.

To facilitate discussions on timing of permit issuance and application requirements, we appreciate notification (rb2-dredgereports@waterboards.ca.gov) of upcoming permitting requests ahead of receiving the Prefiling Meeting Request.

Project Name: San Francisco Bay Strategic Shallow Water Placement Pilot Project

Project Location, City and County: Approx 37 35 26 N, 122 10 27 W, Hayward, Alameda County

Applicant Name: Julie Beagle, US Army Corps of Engineers, San Francisco District

Applicant Telephone Number: 415-590-0152

Applicant Email Address: Julie.R.Beagle@usace.army.mil

4. Clean Air Act and Climate Change (Green House Gases)

Proposed Alternative A	Redwood City Harbor Sediments Taken to Eden Landing Placement Site						
		ROG	**CO**	**NOx**	**SOx**	**PM_{10}**	**$PM_{2.5}$**
	Peak Daily Emissions Total (lbs/day)	1.24	3.87	28.45	5.09	0.61	0.55
	Yearly Project Emissions Totals (tons/year)	0.04	0.13	0.94	0.17	0.02	0.02
	BAAQMD Average Daily Threshold (lbs/day)	54.00	N/A	54.00	N/A	82.00	54.00
	Project Emissions Exceed BAAQMD Daily Thresholds?	**NO**	N/A	**NO**	N/A	**NO**	**NO**
	BAAQMD Yearly Threshold (tons/year)	10	N/A	10	N/A	15	10
	Project Emissions Exceed BAAQMD Yearly Thresholds?	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
	EPA Yearly Significance Thresholds (tons/year)	100.00	100.00	100.00	100.00	100.00	100.00
	Project Emissions Exceed Federal Yearly Threshold?	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Alternative B	Oakland Dredging Taken to Emeryville Crescent Placement Site						
		ROG	**CO**	**NOx**	**SOx**	**PM_{10}**	**$PM_{2.5}$**
	Peak Daily Emissions Total (lbs/day)	1.27	3.98	29.26	5.24	0.63	0.57
	Yearly Project Emissions Totals (tons/year)	0.04	0.13	0.97	0.17	0.02	0.02
	BAAQMD Average Daily Threshold (lbs/day)	54.00	N/A	54.00	N/A	82.00	54.00
	Project Emissions Exceed BAAQMD Daily Thresholds?	**NO**	N/A	**NO**	N/A	**NO**	**NO**
	BAAQMD Yearly Threshold (tons/year)	10	N/A	10	N/A	15	10
	Project Emissions Exceed BAAQMD Yearly Thresholds?	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
	EPA Yearly Significance Thresholds (tons/year)	100.00	100.00	100.00	100.00	100.00	100.00
	Project Emissions Exceed Federal Yearly Threshold?	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Proposed Alternative A	Redwood Dredging Taken to Eden Landing Placement Site	
	Total CO2eq (lbs/day)	1382.78
	Total Project CO2eq (Tons)	45.63
	Council on Environmental Quality Yearly GHG Threshold (CO2eq) (Tons)	None
	Project Exceeds Council on Environmental Quality Yearly GHG Threshold?	**N/A**
	Project is Significant with Respect to Regional Output?	**No**

Alternative B	Oakland Dredging Taken to Emeryville Crescent Placement Site	
	Total CO2eq (lbs/day)	1422.22
	Total Project CO2eq (Tons)	46.93
	Council on Environmental Quality Yearly GHG Threshold (CO2eq) (Tons)	None
	Project Exceeds Council on Environmental Quality Yearly GHG Threshold?	**N/A**
	Project is Significant with Respect to Regional Output?	**No**

Emissions Inventory and Air Quality Analysis: Redwood Dredging to Eden Landing Placement Site (Alternative A)

Emissions Inventory

Emission Source Data							Pollutant Emission Factors for Specific Construction Equipment (lbs/1,000 Gal)[1]						Daily Equipment Emissions from Construction Activities (lbs/day)					
Construction Activity/Equipment Type	Power Rating (Hp)	Power Rating (kW)	Load Factor	# Active	Hrs per Day	Fuel Use	ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Tug Boat - Redwood to Eden Landing (Towing Barge-Loaded)	800	596.56	0.2	1	2.12	42.40	18.20	57.00	419.00	75.00	9.00	8.10	0.772	2.417	17.766	3.180	0.382	0.343
Tug Boat - Redwood to Eden Landing (Towing Barge-Un-Loaded)	800	596.56	0.2	1	1.59	25.50	18.20	57.00	419.00	75.00	9.00	8.10	0.464	1.454	10.686	1.913	0.230	0.207

Tug speed loaded - 6 knots, 1.06 hours delivery time to Eden Landing Placement Site from Dredge Site, twice per day	
Tug speed unloaded - 8 knots, 0.797 hours return trip to Dredge Site from Eden Landing Placement Site, twice per day	
Tug fuel use - 8 gallons per hour idling, 16 gallons per hour towing unloaded barge, 20 gallons per hour towing loaded barge	
Based on a production rate of 1,800 cy per day and 66 days of dredging (112 trips) for a total of 100,000 CY.	
Clamshell dredge has 2 hours downtime per day for refueling and shift change	
1. Emissions factors for tugboat maintenance dredging taken from the Port of Los Angeles Channel Deepening Project Final Supplemental Environmental Impact Statement/Environmental Impact Report, September 2000.	

Air Quality Analysis

	ROG	CO	NOx	SOx	PM10	PM2.5
Peak Daily Emissions Totals (Redwood to Eden)(lbs/day)	1.24	3.87	28.45	5.09	0.61	0.55
Yearly Project Emissions Totals (Redwood to Eden)(tons/year)	0.04	0.13	0.94	0.17	0.02	0.02
BAAQMD Average Daily Threshold (lbs/day)	54.00	N/A	54.00	N/A	82.00	54.00
Project Emissions Exceed BAAQMD Daily Thresholds?	**NO**	N/A	**NO**	N/A	**NO**	**NO**
BAAQMD Yearly Threshold (tons/year)	10	N/A	10	N/A	15	10
Project Emissions Exceed BAAQMD Yearly Thresholds?	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
EPA Yearly Significance Thresholds (tons/year)	100	100	100	100	100	100
Project Emissions Exceed Federal Yearly Thresholds?	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

$Tug\ Emissions = A * EF * T * F$

Where:
A = # of units Active = the number of machines in use for each type
EF = Emission Factor = lbs per 1000 gallons of fuel combusted contributing emissions for each pollutant
T = Time = daily operating time (hours)
F = Fuel = Fuel used per day in gallons

Note: must divide emission factor by 1000 to convert to lbs/gal

Greenhouse Gas Inventory: Redwood Dredging to Eden Landing Placement Site (Alternative A)

Greenhouse Gas Emissions Inventory

Emission Source Data							GHG Emission Factors for Specific Construction Equipment (lbs/Hp-hr)(lbs/1,000 Gal)[1]				Daily Equipment Emissions from Construction Activities (lbs/day)				
Construction Activity/Equipment Type	Power Rating (Hp)	Power Rating (kW)	Load Factor	# Active	Hrs per Day[1]	Fuel Use	CO	CO_2	CH_4	NOx	CO	CO_2	CH_4	NOx	CO2eq
Tug Boat - Redwood to Eden Landing (Towing Barge-Loaded)	800	596.56	0.2	1	2.12	42.40	57.00	1.12	0.000004	419.00	2.417	380.635	0.002	17.766	827.640
Tug Boat - Redwood to Eden Landing (Towing Barge-Un-Loaded)	800	596.56	0.2	1	1.59	25.50	57.00	1.12	0.000004	419.00	1.454	286.194	0.001	10.686	555.140

Tug speed loaded - 6 knots, 1.06 hours delivery time to Eden Landing Placement Site from Dredge Site, twice per day
Tug speed unloaded - 8 knots, 0.797 hours return trip to Dredge Site from Eden Landing Placement Site, twice per day
Tug fuel use - 8 gallons per hour idling, 16 gallons per hour towing unloaded barge, 20 gallons per hour towing loaded barge
Based on a production rate of 1,800 cy per day and 66 days of dredging (112 trips) for a total of 100,000 CY.
Clamshell dredge has 2 hours downtime per day for refueling and shift change
1. Emissions factors for tugboat maintenance dredging taken from the Port of Los Angeles Channel Deepening Project Final Supplemental Environmental Impact Statement/Environmental Impact Report, September 2000.

Greenhouse Gas Inventory Results

Total CO2eq (lbs/day)	1382.78
Total Project CO2eq (Tons)	45.63
Council on Environmental Quality Yearly GHG Threshold (CO2eq) (Tons)	None
Project Exceeds Council on Environmental Quality Yearly GHG Threshold?	**No**

Tug Emissions = $A * EF * T * F$

Where:
A = # of units Active = the number of machines in use for each type
EF = Emission Factor = lbs per 1000 gallons of fuel combusted contributing emissions for each pollutant
T = Time = daily operating time (hours)

Note: must divide emission factor by 1000 to convert to lbs/gal

CO2eq = CO2 + X*CO + Y*NOx + Z*CH4
Where X = 100 Year Global Warming Potential for Carbon Monoxide = 1
Where Y = 100 Year Global Warming Potential for Oxides of Nitrogen = 298
Where Z = 100 Year Global Warming Potential for Methane = 25
CFR Title 40 Chapter I Subchapter C Part 98: Table A-1 Global Warming Potentials

For Emissions Comparison to Alternatives A and B: No Action - Redwood City Harbor to SF-11

Emissions Inventory

Emission Source Data								Emission Factors (g/hp-hr)				Calculated Emissions (lbs/CY)			
Construction Activity/Equipment Type	**Load Size (CY)**	**Engine Type**	**Engine Size (Hp)**	**Number of Engines**	**Time For 1-way Trip**	**Load Factor**	**Calculated Power Rate (Hp-hr/CY)**	**ROG**	**CO**	**NOx**	**PM10**	**ROG**	**CO**	**NOx**	**PM10**
Tug Boat - Redwood City to SF-11 (Towing Barge-Loaded)	4,500	Tug - Main Engine	1800	1	3.84	0.8	1.2288	0.0300	0.8829	0.9694	0.0224	0.000081	0.002392	0.002626	0.000061
Tug Boat - SF-11 to Redwood City (Towing Barge-UnLoaded)	4,500	Tug - Main Engine	1800	1	2.88	0.8	0.9216	0.0300	0.8829	0.9694	0.0224	0.000061	0.001794	0.001970	0.000045
											Daily Emisions (lbs/day)	0.64	18.84	20.68	0.48

Tug speed loaded - 6 knots, 3.84 hours from Redwood City Dredge Site to SF-11, once per day
Tug speed unloaded - 8 knots, 2.88 hours return trip to Redwood City from SF-11, once per day
Distance from dredge to 3 Mile Limit - 17.5 miles (one-way)
Load Size for Disposal - 4,500 CY
Fill to level (% of capacity) - 90%
Material/round trip - 4500 CY
Transport Rate - 5,000 CY/hr
Emission factors for mechanical dredge engines taken from the USACE Environmental Assessment for Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay Fiscal Years 2015-2024, Appendix B: Air Quality

$Emissions = A * PR * EF$

Where:
A = # of units Active = the number of machines in use for each type
PR = Power Rate = power used per cubic yard of material dredged calculated from the horse power, load factor, and time to dredge each cubic yard.
EF = Emission Factor = fraction of emissions for each pollutant in lbs per hour

Emissions Inventory and Air Quality Analysis: Oakland Dredging to Emeryville Crescent Placement Site Alternative (Alternative B)

Emissions Inventory

Emission Source Data							Pollutant Emission Factors for Specific Construction Equipment (lbs/1,000 Gal)[1]						Daily Equipment Emissions from Construction Activities (lbs/day)					
Construction Activity/Equipment Type	Power Rating (Hp)	Power Rating (kW)	Load Factor	# Active	Hrs per Day	Fuel Use	ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	SOx	PM10	PM2.5
Tug Boat - Oakland to Emeryville Crescent (Towing Barge-Loaded)	800	596.56	0.2	1	2.18	43.6	18.20	57.00	419.00	75.00	9.00	8.10	0.794	2.485	18.268	3.270	0.392	0.353
Tug Boat - Oakland to Emeryville Crescent (Towing Barge-Un-Loaded)	800	596.56	0.2	1	1.64	26.24	18.20	57.00	419.00	75.00	9.00	8.10	0.478	1.496	10.995	1.968	0.236	0.213

Tug speed loaded - 6 knots, 1.09 hours delivery time to Emeryville Placement Site from Dredge Site, twice per day
Tug speed unloaded - 8 knots, 0.82 hours return trip to Dredge Site from Emeryville Placement Site, twice per day
Tug fuel use - 8 gallons per hour idling, 16 gallons per hour towing unloaded barge, 20 gallons per hour towing loaded barge
Based on a production rate of 1,800 cy per day and 66 days of dredging (112 trips) for a total of 100,000 CY.
Clamshell dredge has 2 hours downtime per day for refueling and shift change
1. Emissions factors for tugboat maintenance dredging taken from the Port of Los Angeles Channel Deepening Project Final Supplemental Environmental Impact Statement/Environmental Impact Report, September 2000.

Air Quality Analysis

	ROG	CO	NOx	SOx	PM10	PM2.5
Peak Daily Emissions Totals (lbs/day)	1.27	3.98	29.26	5.24	0.63	0.57
Yearly Project Emissions Totals (tons/year)	0.04	0.13	0.97	0.17	0.02	0.02
BAAQMD Average Daily Threshold (lbs/day)	54.00	N/A	54.00	N/A	82.00	54.00
Project Emissions Exceed BAAQMD Daily Thresholds?	**NO**	N/A	**NO**	N/A	**NO**	**NO**
BAAQMD Yearly Threshold (tons/year)	10	N/A	10	N/A	15	10
Project Emissions Exceed BAAQMD Yearly Thresholds?	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
EPA Yearly Significance Thresholds (tons/year)	100	100	100	100	100	100
Project Emissions Exceed Federal Yearly Thresholds?	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

`

Tug Emissions = $A * EF * T *$ F

Where:
A = # of units Active = the number of machines in use for each type
EF = Emission Factor = lbs per 1000 gallons of fuel combusted contributing emissions for each pollutant
T = Time = daily operating time (hours)
F = Fuel = Fuel used per day in gallons

Note: must divide emission factor by 1000 to convert to lbs/gal

Greenhouse Gas Inventory: Oakland Dredging to Emeryville Crescent Placement Site (Alternative B)

Greenhouse Gas Emissions Inventory

Emission Source Data							GHG Emission Factors for Specific Construction Equipment (lbs/Hp-hr)(lbs/1,000 Gal)[1]				Daily Equipment Emissions from Construction Activities (lbs/day)				
Construction Activity/Equipment Type	Power Rating (Hp)	Power Rating (kW)	Load Factor	# Active	Hrs per Day	Fuel Use	CO	CO_2	CH_4	NOx	CO	CO_2	CH_4	NOx	CO2eq
Tug Boat - Oakland to Emeryville Crescent (Towing Barge-Loaded)	800	596.56	0.2	1	2.18	43.6	57.00	1.12	0.000004	419.00	2.485	391.407	0.002	18.268	851.064
Tug Boat - Oakland to Emeryville Crescent (Towing Barge-Un-Loaded)	800	596.56	0.2	1	1.64	26.24	57.00	1.12	0.000004	419.00	1.496	294.453	0.001	10.995	571.160

Tug speed loaded - 6 knots, 1.09 hours delivery time to Emeryville Placement Site from Dredge Site, twice per day
Tug speed unloaded - 8 knots, 0.82 hours return trip to Dredge Site from Emeryville Placement Site, twice per day
Tug fuel use - 8 gallons per hour idling, 16 gallons per hour towing unloaded barge, 20 gallons per hour towing loaded barge
Based on a production rate of 1,800 cy per day and 66 days of dredging (112 trips) for a total of 100,000 CY.
1. Emissions factors for tugboat maintenance dredging taken from the Port of Los Angeles Channel Deepening Project Final Supplemental Environmental Impact Statement/Environmental Impact Report, September 2000.

Greenhouse Gas Inventory Results

Total CO2eq (lbs/day)	1422.22
Total Project CO2eq (Tons)	46.93
Council on Environmental Quality Yearly GHG Threshold (CO2eq) (Tons)	None
Project Exceeds Council on Environmental Quality Yearly GHG Threshold?	**No**

Tug Emissions = $A * EF * T *$ F

Where:
A = # of units Active = the number of machines in use for each type
EF = Emission Factor = lbs per 1000 gallons of fuel combusted contributing emissions for each pollutant
T = Time = daily operating time (hours)

Note: must divide emission factor by 1000 to convert to lbs/gal

CO2eq = CO2 + X*CO + Y*NOx + Z*CH4
Where X = 100 Year Global Warming Potential for Carbon Monoxide = 1
Where Y = 100 Year Global Warming Potential for Oxides of Nitrogen = 298
Where Z = 100 Year Global Warming Potential for Methane = 25
CFR Title 40 Chapter I Subchapter C Part 98: Table A-1 Global Warming Potentials

For Emissions Comparison to Alternatives A and B: No Action - Oakland Harbor to SF-DODS

Emissions Inventory

Emission Source Data								Emission Factors (g/hp-hr)					Calculated Emissions (lbs/CY)			
Construction Activity/Equipment Type	Load Size (CY)	Engine Type	Engine Size (Hp)	Number of Engines	Time For 1-way Trip	Load Factor	Calculated Power Rate (Hp-hr/CY)	ROG	CO	NOx	PM10	CO_2	ROG	CO	NOx	PM10
Tug Boat - Oakland to 3 Mile Limit (Towing Barge-Loaded)	4,500	Tug - Main Engine	1800	1	8	0.8	2.56	0.0300	0.8829	0.9694	0.0224	568.0000	0.000169	0.004983	0.005471	0.000126
Tug Boat - 3 Mile Limit to Oakland (Towing Barge-UnLoaded)	4,500	Tug - Main Engine	1800	1	10.6	0.8	3.392	0.0300	0.8829	0.9694	0.0224	568.0000	0.000224	0.006602	0.007249	0.000167
												Daily Emisions (lbs/day)	1.77	52.13	57.24	1.32

Tug speed loaded - 6 knots, 10.6 hours from Oakland Dredge Site to 3 Mile Limit, once per day
Tug speed unloaded - 8 knots, 8 hours return trip to Oakland Dredge Site from 3 Mile Limit once per day
Distance from dredge to 3 Mile Limit - 17.5 miles (one-way)
Load Size for Disposal - 4,500 CY
Fill to level (% of capacity) - 90%
Material/round trip - 4500 CY
Transport Rate - 5,000 CY/hr
Emission factors for mechanical dredge engines taken from the USACE Environmental Assessment for Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay Fiscal Years 2015-2024, Appendix B: Air Quality

Emissions = $A * PR * EF$

Where:

A = # of units Active = the number of machines in use for each type

PR = Power Rate = power used per cubic yard of material dredged calculated from the horse power, load factor, and time to dredge each cubic yard.

5. Coastal Zone Management Act: CONSISTENCY DETERMINATION

U.S. Army Corps of Engineers
San Francisco District

450 Golden Gate, 4th Floor
San Francisco, CA 94102

Subject: Consistency Determination for 2023 San Francisco Bay Strategic Shallow-Water Placement Pilot Project

Ms. Brenda Goeden
San Francisco Bay Conservation and Development Commission
455 Golden Gate Avenue, Suite 10600
San Francisco, California 94102

Dear Ms. Goeden,

Pursuant to Section 307c(1) of the Federal Coastal Zone Management Act of 1972 (CZMA), as amended (16 U.S.C.§1451 *et seq.*), the United States Army Corps of Engineers, San Francisco District (USACE) is pleased to submit the enclosed Consistency Determination (CD) for the 2023 San Francisco Bay Strategic Shallow-water Placement Pilot Project, dated January 20, 2023, for your consideration. This following CD incorporates changes and suggestions made by BCDC on Dec 27, 2022.

The proposed placement of dredged material in the shallow, subtidal environment will be located offshore (west) of Eden Landing Ecological Reserve in Alameda County, CA. This pilot project would use dredged material from Operations and Maintenance dredging of the Redwood City Harbor federal navigation channel to examine whether the strategic placement of material can leverage wave/tidal currents to transport sediment onto adjacent tidal mudflats and salt marshes. This approach, if successful, can serve as a valuable tool for augmenting sediment supply to existing mudflats and marshes threatened by drowning due to sea level rise, erosion due to limited sediment supply, and other limiting factors on ecosystem sustainability. This would also provide a complementary approach to beneficial use of dredged material in San Francisco Bay and increase sediment availability in the San Francisco Bay system for natural mudflat and marsh-building processes.

U.S. Army Corps of Engineers
San Francisco District

450 Golden Gate, 4th Floor
San Francisco, CA 94102

If you have any questions or require more information, please contact Julie Beagle at Julie.R.Beagle@usace.army.mil regarding this consultation request.

Sincerely,

BEAGLE.JULIE.RUBEN.1598717792
Digitally signed by BEAGLE.JULIE.RUBEN.1598717792
Date: 2023.01.20 18:04:33 -08'00'

Julie R. Beagle
Environmental Planning Section Chief
U.S. Army Corps of Engineers
San Francisco District

U.S. Army Corps of Engineers
San Francisco District

450 Golden Gate 4th Floor
San Francisco, CA 94102

CONSISTENCY DETERMINATION REQUEST for FISCAL YEAR 2023 through 2033
2023 San Francisco Bay Strategic Shallow-Water Placement Pilot Project

Prepared by U.S. Army Corps of Engineers
San Francisco District

1 INTRODUCTION

The Strategic Shallow-Water Placement Pilot Project in San Francisco Bay, offshore of Eden Landing Ecological Reserve in Union City, Alameda County, California, evaluates both the efficacy of strategic placement as a technique to beneficially use dredged material, and the potential impacts associated with a new method of placing dredged material in San Francisco Bay. This new method uses natural, in-bay hydrodynamic processes to move dredged sediment placed in shallow water to existing mudflats and marshes, enhancing their resilience to rising waters. This project focuses on mudflats and salt marshes at a selected location offshore of the Eden Landing Ecological Reserve. The US Army Corps of Engineers, San Francisco District (USACE) is the project lead, and the California State Coastal Conservancy (SCC) is the non-cost-sharing nonfederal sponsor. The San Francisco Regional Water Quality Control Board (Waterboard) is the California Environmental Quality Act (CEQA) lead. The general project area along the Whale's Tail Marsh shoreline of South San Francisco Bay (Figure 1 and Figure 2).

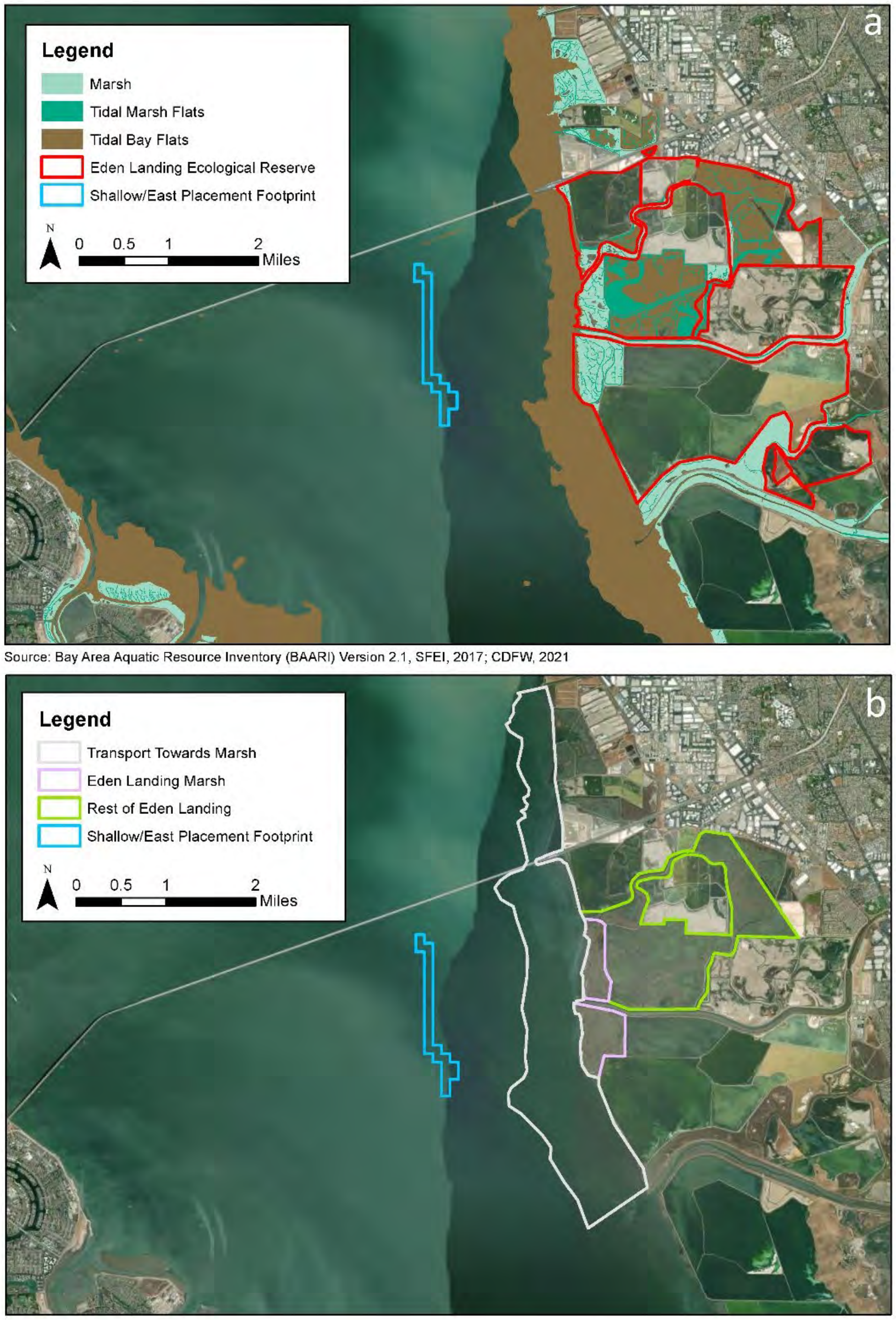

Figure 1. (above) Eden Landing shallow/east placement footprint (blue polygon) in shallow, subtidal environment approximately two miles offshore (west) of Eden Landing Ecological Reserve (red polygon) relative to marsh (light blue), marsh flat (teal), and bay mudflat (brown) habitats. (below) Eden Landing shallow/east placement footprint (blue polygon) relative to target mudflats (gray polygon), Eden Landing Whale's Tail marsh (pink polygon), and the remaining Eden Landing restoration areas subject to tidal influence (green polygon) for

tracking sediment fate of placed material and project success. The placement footprint is approximately 9,700 feet long and 630 feet wide and covers approximately 138 acres.

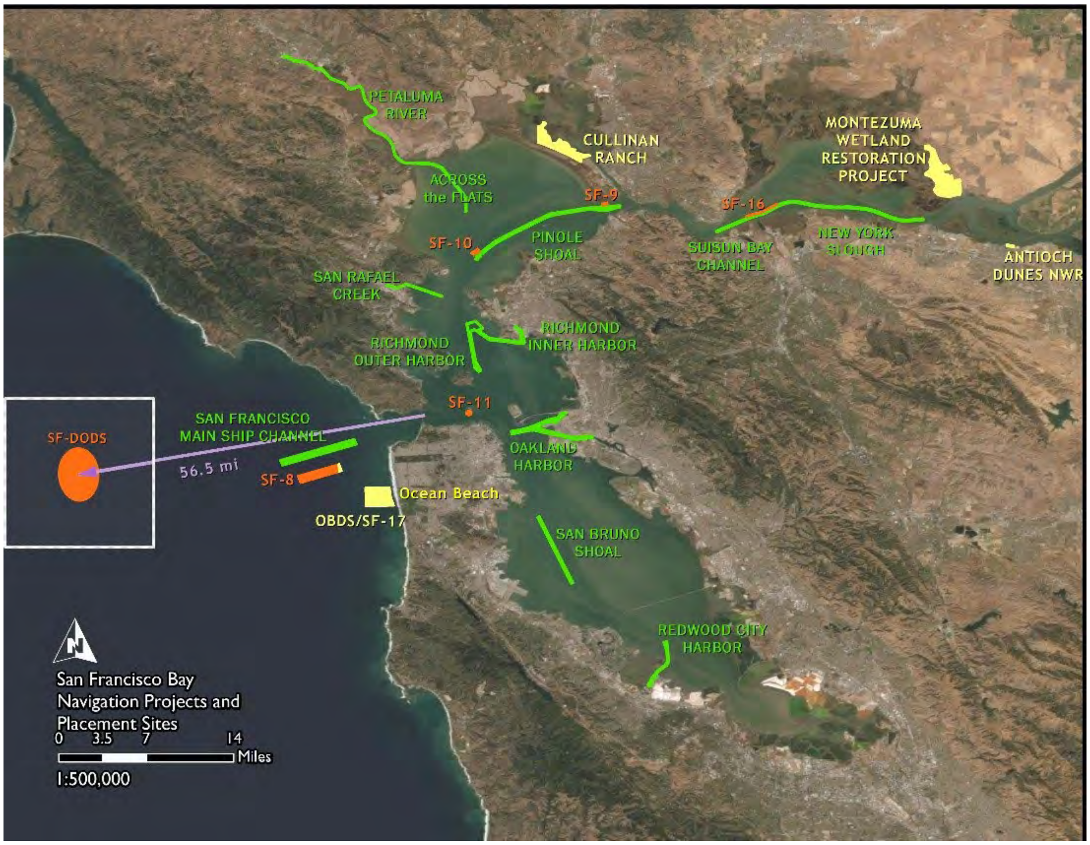

Figure 2. San Francisco District (SPN) Federal Navigation Projects

2 Legal Authority

This Consistency Determination (CD) describes USACE's proposed Strategic Shallow-Water Placement Pilot Project. This CD is being submitted in accordance with the Coastal Zone Management Act of 1972, as amended (CZMA), 16 U.S.C. §1451 and the implementing regulations entitled Federal Consistency with Approved Coastal Management Programs, 15 C.F.R. Part 930. Under these regulations, USACE is responsible for managing its projects within the coastal zone jurisdiction in a manner that is consistent, to the maximum extent practicable, with the applicable coastal zone management program approved by the National Oceanic and Atmospheric Administration (NOAA). The program applicable to USACE projects in San Francisco Bay is the San Francisco Bay Coastal Zone Management Plan (SFB CZMP), which is

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San Francisco, CA 94102

administered by the San Francisco Bay Conservation and Development Commission (BCDC) and was last updated in 2019.

The beneficial use of material dredged from a San Francisco Bay federal navigation channel and placed in shallow water in San Francisco Bay is authorized by Section 1122 of WRDA 2016. Section 1122 requires USACE to establish ten pilot projects nationwide that beneficially use dredged material. The intent is to:

- maximize the beneficial placement of dredged material from federal and non-federal navigation channels;
- incorporate, to the maximum extent practicable, two or more federal navigation, flood control, storm-damage reduction, or environmental restoration projects;
- coordinate the mobilization of dredges and related equipment, including using such efficiencies in contracting and environmental permitting as can be implemented under existing laws and regulations;
- foster federal, state, and local collaboration;
- implement best practices to maximize the beneficial use of dredged sand and other sediments;
- ensure that the use of dredged material is consistent with all applicable environmental laws.

Of the several stated purposes in the pilot program's implementation guidance, this Strategic Placement Pilot Project falls under "Other innovative uses and placement alternatives that produce public, economic, or environmental benefits."

3 Federal Determination

The USACE has evaluated the proposed Project and has determined that it is consistent, to the maximum extent practicable, with the San Francisco Bay Plan Policies. A detailed project description and an assessment of this project's consistency with those policies are provided below.

4 Project Description

The proposed Strategic Placement Pilot Project would place approximately 100,000 CY of sediment from Operations and Maintenance (O&M) dredging using a clamshell dredge and split-hull scows in a subtidal, shallow-water placement area approximately two miles west of Eden Landing Ecological Reserve adjacent to the intertidal mudflat and Whale's Tail marsh (Figure 1). This strategic shallow-water placement pilot project evaluates both the ability of tides and currents to move dredged sediment placed in the nearshore environment to the target and ancillary mudflats and marshes (Figure 3 and Figure 4) the ability of using dredged sediment from an O&M project to supply that sediment.

Over one dredging episode of Redwood City Harbor, scows with dredged material will be diverted from the federal standard placement site SF-11 (Figure 2) and placed at the in-bay, nearshore, strategic-placement site. Based on wave and current modeling, the scows will unload in water depths of approximately 9 - 12 ft in absolute depth (i.e., the placement location will depend on the tidal stage) to maximize landward transport of sediment by waves and currents. Placements will take place during flood tides within a 138-acre placement footprint determined by computer modeling and geospatial analysis to be most suitable for successful transport of sediment toward mudflat and marsh areas. Scows light loaded with 900 CY of dredged material will make approximately 112 round trips between the Redwood City Harbor federal navigation channel and the placement site over 19 – 56 days. All placement activities will occur between June 1 and November 30, which is the work window for O&M dredging activities. There are no anticipated delays in placement once dredging in the designated Redwood City Harbor channel reach and placement at the strategic placement site commences. The specific timing and progression of the placement will be subject to the contractor's execution of the contract.

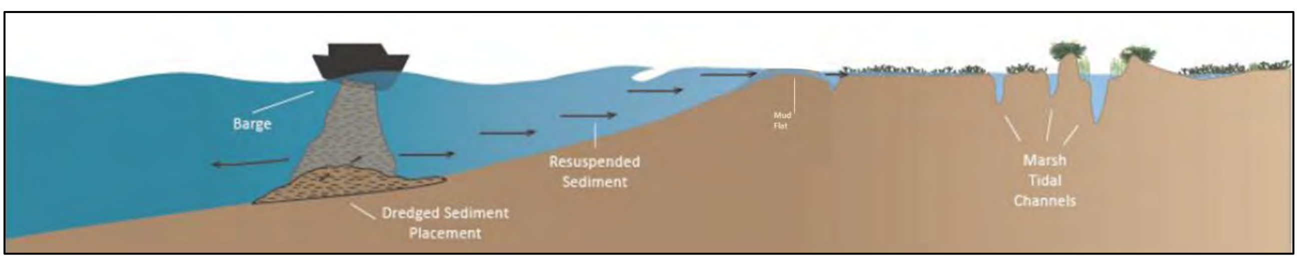

Figure 3. Strategic shallow-water placement cross-sectional conceptual model.

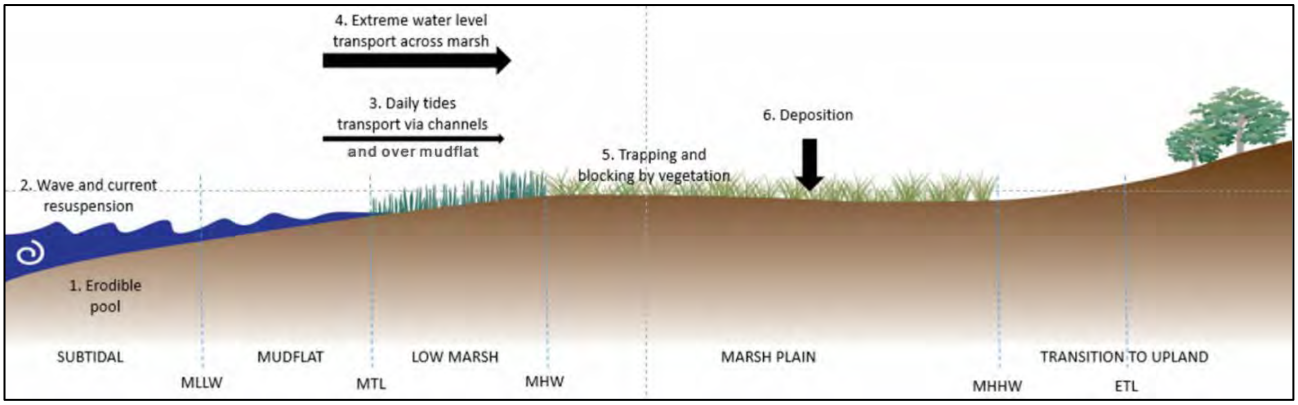

Figure 4.   Sediment supply to mudflats and marshes.

The placement area and adjacent mudflat-marsh complex will be monitored before and after placement. Both pre- and post-project monitoring will occur in the following areas:

Pre-project monitoring (see Appendix D of EA/IS/MND for more detail)

- Bathymetry and topography
- Oceanographic data collection: suspended sediment concentration (SSC), wave conditions
- Benthic communities
- Eelgrass surveys
- Sediment flux across the shallows
- Background marsh accretion rates

Post-project monitoring (Resurveys of placement site)

- Benthos, eelgrass recovery
- Oceanographic data collection: SSC, wave conditions
- Sediment flux post placement
- Marsh and mudflat accretion
- Particle tracking study

5 Consistency with the Applicable Bay Plan Policies

5.1 Existing Conditions

Whale's Tail Marsh is located on the bayward side of the Eden Landing Ecological Reserve, which abuts the eastern shore of South San Francisco Bay. The South Bay can be characterized as a large, shallow basin, with a relatively deep main channel (between 33 – 66 feet deep) surrounded by broad shoals and mudflats. The shallower shoal and mudflat areas (12 feet in depth or less), where the dredged material would be placed, are more prone to wind-generated currents and sediment resuspension than deeper areas such as the Central Bay near the Golden Gate and have the highest suspended sediment concentrations. Within the South Bay (where the strategic placement site is located), sedimentation caused by river inflow is not as important as re-suspension associated with spring-neap tidal cycles in higher total suspended solids (Schoellhamer 1996).

Benthic habitats are dominated by younger Bay Muds with occasional lenses/deposits of silt, sand, shell, and other coarse estuarine materials. The benthic substrate for the Eden Landing strategic placement site is largely mudflat, but also includes oyster shell "hash" (S. De La Cruz, USGS, personal communication, June 28, 2022) and bryozoan reefs (Zabin et al. 2010). The substrate's median particle diameter ranges between 0.006 and 0.0077 mm, and it comprises approximately 4.4% sand, 58.9% silt, and 36.6% clay (Allen et al. 2021).

5.2 Consistency with Fish, Other Aquatic Organisms, and Wildlife Policies

Five of the Bay Plan's fish, other aquatic organisms, and wildlife policies apply to the proposed action: Policies 1, 2, 4, 6, and 7. The proposed placement activities consistency with these policies is discussed below.

Policy 1: To assure the benefits of fish, other aquatic organisms, and wildlife for future generations, to the greatest extent feasible, the Bay's tidal marshes, tidal flats, and subtidal habitat should be conserved, restored, and increased.

The purpose of the proposed action is to determine the effectiveness of strategically placing dredged sediment in the nearshore, shallow-water environment to maximize sediment transport to existing tidal mudflats and tidal marshes while minimizing *ecological impacts to benthic habitats and environmental resources. Specifically, the proposed project aims to assess the ability of this novel sediment-placement technique to transport sediment onto target mudflats and marshes to determine if such dredged material placement may be an effective way to help tidal marsh and intertidal mudflats accrete in elevation as sea levels rise. The project is designed to deposit the minimum amount in the placement area that would still be detectable on the intertidal mudflat and in the tidal marsh. Monitoring of eelgrass, intertidal mudflats, and tidal marsh will be performed to determine the impacts this pilot project may have on benthic communities, and fish habitat.*

The Proposed Action is consistent to the maximum extent practicable with Policy 1.

Policy 2: Native species, including candidate, threatened, and endangered species; species that the California Department of Fish and Wildlife (CDFW), the National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service(USFWS) have listed under the California or Federal Endangered Species Act; and any species that provides substantial public benefits, as well as specific habitats that are needed to conserve, increase, or prevent the extinction of any native species; species threatened or endangered; species that the CDFW has determined are candidates for listing as endangered or threatened under the California Endangered Species Act; or any species that provides substantial public benefits or should be protected, whether in the Bay or behind dikes.

Shallow-water placement would include depositing dredged sediment onto subtidal surfaces, with the potential for direct effects on the subtidal benthic community via burial of organisms living on and within sediments. Deposition will likely be between 10–30 cm in the middle of the placement area, grading to 0.1cm in the surrounding area. Benthic plants and animals directly under a placement mound would generally not survive large amounts of burial, and recolonization from surrounding areas would be the mechanism for recovery. Generally, the effects of burial on benthic biota are mortality or reduction in growth (e.g., Wilber et al. 2007, Kemp et al. 2011). If the properties of sediments placed differ from the placement areas, or the residual particle size differs from the original substrate after waves work the sediments, community shifts in species abundance and composition could be expected (Bishop et al. 2006). Reduction in subtidal benthic primary producers and consumers has the potential to indirectly affect higher trophic levels in the estuarine food web.

Example taxa and species in the subtidal benthic community potentially affected by direct and indirect changes caused by shallow-water placement include: microphytobenthos (e.g., diatoms, cyanobacteria, dinoflagellates), macroalgae (e.g., seaweeds like Ulva angusta), submerged vegetation (e.g., eelgrass Zostera marina), benthic macrofauna (e.g., polychaete worms, amphipods), oysters and bivalves (e.g., Ostrea lurida), Dungeness crab (Metacarcinus magister), deeper-water ground fishes (e.g., green sturgeon (Acipenser medirostris), and shallow subtidal fishes (e.g., leopard shark (Triakis semifaciata) juveniles)

Adult demersal fishes and crabs would be expected to avoid burial by sediment-placement actions, though juveniles may be unable to move away from the impacted area, depending upon species and timing of the action. Example species and taxa indirectly affected by reductions in food availability include demersal fishes that feed on benthic invertebrates, such as green sturgeon and leopard shark; and water-column species that rely on food production by benthic plants and animals, such as zooplankton, fishes, and diving ducks that feed on submerged vegetation, invertebrates, and bivalves. Piscivorous birds may suffer from reduced food resources if their fish prey is less abundant or harder to hunt due to changes in turbidity. The spawning habitat of pelagic fishes, such as Pacific herring (Clupea pallasi), may be altered by the burial or coating of eelgrasses and other surfaces by sediments. Table 8 in the Environmental Assessment summarizes potential direct and indirect impacts and recovery times for aquatic species.

Placing dredged material has the potential to negatively affect native and special-status species through direct burial, alterating habitat, and interrupting the food supply. The project is consulting with NMFS to ensure that any potential effects to special-status species and habitats will be minimized and to ensure protection measures are in place. The project shall comply with the provisions of NMFS in the project's Endangered Species Act (ESA) consultations. The USACE made a no-effect determination for species under USFWS jurisdiction under ESA and coordinated with USFWS through the Fish and Wildlife Coordination Act (FWCA) and includes the Planning Aid Letter submitted by USFWS in this submittal. The CDFW has been present at all Resources Agency Working Group meetings for this project and submitted comments on the draft EA/IS/MND, which have been addressed.

Modeling of the placement predicts that 20–41% of the dredged material may still be present in the placement footprint 2 months after the placement ceases. The model did not look further into the future. Monitoring will be conducted by the USGS for nine *months after placement. The USGS expects the placement area to be indistinguishable from the surrounding area by that time. If there is still a significant amount of material in the placement area, monitoring of the mound could be extended, and potential remediation would be considered.*

Shallow-water placement will result in short-term changes to suspended-sediment concentrations in the water column that will spread out and travel from the source in a sediment plume, locally increasing SSC and turbidity. The larger and heavier particles quickly settle to the bottom near the source, but fine material may remain suspended for some time (usually hours) and travel some distance before settling. Cohen (2010) identifies several potential direct and indirect impacts on organisms from large increases in SSC in the water column. These include clogging the gills of fish and invertebrates, changing the behavior of adult fish, providing cover for prey species and reducing predation, and reducing light penetration, photosynthesis and the productivity and growth of eelgrass, seaweeds and phytoplankton.

Predicted SSC adjacent to the placement footprint could be elevated as much as 500mg/L in the most extreme case. SSC during placement would most frequently range between 50-300mg/L over baseline conditions with the SCC quickly returning to baseline after each placement episode.

Elevated fine-sediment loads can affect fish by causing physical damage to organs, or indirectly by influencing water quality. Primary responses include damage to gills caused by erosion of the mucus coating and abrasion of tissue (Kemp et al. 2011). The extent of response depends on water velocity, concentration, particle size and shape with smaller and more angular clasts having the most negative impact (Kemp et al. 2011). Elevated sediment concentrations can directly influence the fitness of fish by increasing stress and reducing feeding and growth rates. High SSC can cause mortality in fish caused by reduced oxygen uptake because fish must keep their gills clear for oxygen exchange. Fine particles can coat the gill surfaces preventing gas exchange (Rich 2010). On the other hand, intermittent and short-term increases in SSC may benefit some species, such as salmonids, because of the associated increase in density of drifting prey (reviewed in Kemp et al. 2011).

Fishes in mobile life phases would be expected to avoid the placement area and the temporary sediment plume, but those in egg or early larval stages, or fishes that burrow into benthic sediments or hunker down on the bottom, would likely not be able to escape and may suffer morbidity or mortality at the placement site. Increased SSC and turbidity *would be limited in time and space, but could have consequences for water-column species, as discussed above. Reduced food availability could result if burial or high SSC have a large effect on primary or secondary productivity. Driven by natural processes, the placed material will migrate onto the intertidal mudflat and marsh. The monitoring mentioned above will be performed to determine how much sediment migrates to these areas and if there are any noticeable effects to the species that live there. The project is designed to use the minimum amount of placed material possible that would transport a detectable amount of sediment to these habitats.*

The project is consistent with Policy 2 to the maximum extent practicable.

Policy 4: The Commission should:

Consult with the California Department of Fish and Game and the U.S. Fish and Wildlife Service or the National Marine Fisheries Service whenever a proposed project may adversely affect an endangered or threatened plant, fish, other aquatic organism or wildlife species;

Not authorize projects that would result in the "taking" of any plant, fish, other aquatic organism or wildlife species listed as endangered or threatened pursuant to the state or federal endangered species acts, or the federal Marine Mammal Protection Act, or species that are candidates for listing under the California Endangered Species Act, unless the project applicant has obtained the appropriate "take" authorization from the U.S. Fish and Wildlife Service, National Marine Fisheries Service or the California Department of Fish and Game; and

Give appropriate consideration to the recommendations of the California Department of Fish and Game, the National Marine Fisheries Service or the United States Fish and Wildlife Service in order to avoid possible adverse effects of a proposed project on fish, other aquatic organisms and wildlife habitat.

Policy 4 is not an enforceable Policy with respect to a federal agency. BCDC cannot require a federal agency to enter into consultation with another agency. However, please see response to Policy 2 regarding consultations undertaken for this action.

Policy 6: Allowable fill for habitat projects in the Bay should (a) minimize near -term adverse impacts to and loss of existing Bay habitat and native species; (b) provide substantial net benefits for Bay habitats and native species; and (c) be scaled appropriately for the project and necessary sea level rise adaptation measures in accordance with the best available science. The timing, frequency, and volume of fill should be determined in accordance with these criteria.

The project will utilize best management practices and reasonable and prudent measures as coordinated with the Water Board, NMFS, and USFWS to ensure that that near-term impacts from material placement are minimized. Impacts to the placement site are expected to be localized and short term with the benthos community beginning to recover soon after placement. Full recovery of benthos at the placement site could occur within 2 years. Monitoring of the benthic community will take place to discern any changes to the population as it relates food availability. The monitoring will also attempt to discern any impacts to the intertidal mudflat and tidal marsh and species that inhabit them.

This pilot project intends to explore if this strategic placement method can provide direct benefits for bay habitats. It will inform potential future initiatives to beneficially use dredged material for the purpose of helping intertidal and existing tidal marsh habitats stay resilient in the face of sea level rise.

The timing of the project will be concurrent with the operations and maintenance dredging of Redwood City Harbor, which has been coordinated with resource agencies and will occur in the established Long Term Management Strategy (LTMS) work windows for dredging and material placement to ensure that the timing is optimal to avoid impacts to aquatic species. A range of volumes were considered, and the one selected is deemed to be the minimum amount required to achieve a detectable result while also seeking to minimize the potential for adverse effects to species.

The project is consistent with Policy 6 to the maximum extent possible.

Policy 7: Sediment placement for habitat adaptation should be prioritized in (1) subsided diked baylands, tidal marshes, and tidal flats, as these areas are particularly vulnerable to loss and degradation due to sea level rise and lack of necessary sediment supply, and/or in (2) intertidal and shallow subtidal areas to support tidal marsh, tidal flat, and eelgrass bed adaptation. In some cases, sediment placement for a habitat project in deep subtidal areas may be authorized if substantial ecological benefits will be provided and the project aligns with current regional sediment availability and needs.

The proposed pilot project would place dredged material in the nearshore shallow subtidal environment to investigate how it disperses into intertidal mudflat and tidal marsh habitat. The intent is to provide insight and to discern the feasibility of using dredged material as a resource to increase the resiliency of these habitats to sea-level rise.

The proposed action is consistent to the maximum extent practicable with Policy 7.

5.3 Consistency with Water Quality Policies

The primary purpose of the Bay Plan's seven water quality policies is to protect the water quality of the San Francisco Bay. Two of the Bay Plan's water quality policies apply to the proposed placement action: Policy 1 and Policy 2.

Policy 1: is a general policy to prevent water pollution to the greatest extent feasible; conserve, restore, and protect tidal marshes, flats, and water surface area and volume; maintain freshwater flows to protect beneficial uses of the Bay.

The Strategic Placement Pilot Project would not result in adverse effects to tidal marshes or tidal flats, nor would it affect the surface area, flow of water into the Bay, or the volume of the Bay. The project does not involve new terrestrial construction or changes to existing sewage systems, bayside parking lots, or commercial fishing docks. This project will not result in water pollution; it will not alter freshwater inputs into the Bay; and it will not adversely impact public health associated with beneficial uses of Bay resources. Potential impacts to dissolved oxygen levels may occur during the placement of material. Direct, localized, minor, and temporary reductions in dissolved oxygen may occur. The impact to dissolved oxygen would be short-term and less than significant. No impacts to salinity, temperature, and pH are anticipated.

The proposed action plans are consistent to the maximum extent practicable with Policy 1.

Policy 2: Water quality in all parts of the Bay should be maintained at a level that will support and promote the beneficial uses of the Bay as identified in the San Francisco Bay Regional Water Quality Control Board's Water Quality Control Plan, San Francisco Bay Basin and should be protected from all harmful or potentially harmful pollutants. The policies, recommendations, decisions, advice and authority of the State Water Resources Control Board and the Regional Board, should be the basis for carrying out the Commission's water quality responsibilities.

Sediments that will be used for placement are tested prior to dredging, and the results are reviewed by the Dredge Material Management Office (DMMO) prior to dredging, transport, and placement, including evaluation of the potential for impact to aquatic organisms. Sediment testing results for previous USACE maintenance dredging episodes at Redwood City Harbor indicate that, in general, dredged materials from this channel have been suitable for unconfined aquatic disposal. Some isolated areas in Reach 5 of the Redwood City Channel have been identified as containing sediment that is not suitable for unconfined aquatic disposal (NUAD); USACE would avoid importing material from these areas. The USACE is conducting Tier III sediment sampling and analysis prior to the 2023 dredging episode. Based on sediment testing results for each reach in the Redwood City Harbor Channel, USACE would utilize only the reaches with material suitable for in-bay placement. For example, if sediment from Reach 5 is deemed NUAD, but sediment from Reaches 2 and 3 are deemed suitable, the contract would specify that sediment dredged from Reaches 2 and 3 will be used for the strategic placement at the placement site offshore of Eden Landing. Therefore, dredging and placement activities would not be expected to increase contaminant concentrations in the environment above baseline conditions. Significant impacts to water quality are not anticipated. Furthermore, the San Francisco Bay Water Quality Control Board is the lead CEQA agency (per attached ES/IS/MND), and USACE will obtain a 401 water quality certification for the placement action.

This project is consistent to the maximum extent practicable with Policy 2.

5.4 Consistency with Tidal Marsh and Mudflats:

Five of the Bay Plan's tidal marsh and mudflats policies are applicable to the proposed placement action; these included Policies 1, 2, 10, 11, and 12. The proposed action's consistency with these policies is discussed below.

Policy 1: Tidal marshes and tidal flats should be conserved to the fullest possible extent. Filling, diking, and dredging projects that would substantially harm tidal marshes or tidal flats should be allowed only for purposes that provide substantial public benefits and only if there is no feasible alternative.

The proposed pilot project intends to investigate the feasibility of using dredged sediment to enhance the resiliency of tidal marsh and tidal flats. The project would place approximately 100,000 CY of dredged material in the nearshore subtidal zone *at depths of approximately 10 feet MLLW, and the fate of that material will be monitored to determine how much, if any reaches the tidal flats and tidal marsh. The purpose of this project is to investigate the feasibility of using dredged material as a resource to increase the resilience of these habitats with respect to sea-level rise. The amount of material predicted to be transported to nearby tidal flats and marsh would be minimal (less than 1 mm) and is not expected to have any negative impacts to existing tidal-marsh and tidal-flat habitat. Post-placement monitoring will be performed to determine how much material deposits in these habitats and any response that benthic invertebrates, marsh vegetation and wildlife may potentially exhibit.*

This project is consistent to the maximum extent practicable with Policy 1.

Policy 2: Any proposed fill, diking, or dredging project should be thoroughly evaluated to determine the effect of the project on tidal marshes and tidal flats, and designed to minimize, and if feasible, avoid any harmful effects.

The effects of the proposed project on tidal Marsh and tidal flats were thoroughly evaluated in the Environmental Assessment/Initial Study/Mitigated Negative Declaration (EA/IS/MND) and endangered species consultation documents. No significant impacts to resources or special status species and their habitats were identified. Hydrodynamic modeling was performed to determine the appropriate amount of dredged material to be placed to allow detection post placement while minimizing negative impacts to the tidal flats and tidal marsh. As a pilot effort, the project proposes to include a monitoring component to understand the scale of post-placement sediment deposition at the placement site, on the intertidal mudflat, and on the adjacent tidal marsh; and the wind, wave, and sediment flux conditions pre- and post-placement across the interconnected subtidal-mudflat-marsh complex to measure the success and effects of the placement.

This project is consistent to the maximum extent practicable with Policy 2.

Policy 10: Based on scientific ecological analysis, project need, and consultation with the relevant federal and state resource agencies, fill may be authorized for habitat enhancement, restoration, or sea level rise adaptation of habitat.

The proposed pilot project is consistent to the maximum extent practicable with Policy 10 because its goal is to gain insight as to how limited strategic shallow-water placement of dredged material may be utilized to help maintain sediment elevations *on tidal flats and tidal marsh to counter the effects of sea-level rise. Data gathered by this project will be available as a tool to help future restoration practitioners develop strategies to increase the resiliency of these habitats to sea-level rise. Moreover, relevant resource agencies have been consulted, , and applicable approvals have or are being obtained for the action.*

Policy 11: The Commission should encourage and authorize pilot and demonstration projects that address sea level rise adaptation of Bay habitats. These projects should include appropriately detailed experimental design and monitoring to inform initial and future work. Project progress and outcomes should be analyzed and reported expeditiously. The size, design, and management of pilot and demonstration projects should be such that it will minimize the project's potential to negatively impact Bay habitats and species.

The project proposes to include a monitoring component to understand the scale of post-placement sediment deposition at the placement site, on the intertidal mudflat, and on the adjacent tidal marsh; and the wind, wave, and sediment flux conditions pre- and post-placement across the interconnected subtidal-mudflat-marsh complex and measure the success and effects of the placement. Monitoring will include vegetation and benthos response to the placement if any is discerned using a Before-After-Control-Impact (BACI) project design. In addition, pre-project surveys for the presence of eelgrass will be performed. If eelgrass is detected prior to project commencement, post placement surveys will be performed as coordinated with NMFS to determine any loss and appropriate mitigation would be performed per the California Eelgrass Mitigation Policy (CEMP). As stated above in policy 2 hydrodynamic modeling was performed to determine the appropriate amount of dredged material to be placed to allow detection post placement without generating negative impacts to the tidal flats and tidal marsh. A particle tracing study is also included in the monitoring plan.

This project is consistent to the maximum extent practicable with Policy 11.

Policy 12: The Commission should encourage and support research on:

1. Habitat restoration, enhancement, and creation approaches, including strategies for: increasing resilience to sea level rise, placing fill, evaluating habitat type conversion, enhancing habitat connectivity, and improving transition zone design;

2. The estuary's sediment processes;
3. Detection and monitoring of invasive species and regional efforts for eradication of specific invasive species.

The project fits the description of number 1, aiding in habitat enhancement with work to enhance resilience to sea level rise using dredged material placed at a near-shore location. The project also supports number 2, research on the estuary's sediment processes. Through this pilot project, new research will be performed by the USGS that will help understand sediment pathways between the shallows and the intertidal habitats. This project will also include a magnetic particle tracking study, which has been an underexplored research technique in SF Bay.

The project is consistent to the maximum extent practicable with policy 12

5.5 Consistency with Subtidal Policies

The Bay Plan recognizes the importance of subtidal areas to the healthy and sustainable ecology of the San Francisco Bay and Delta. As such, it set forth ten policies to protect, enhance, and restore subtidal habitats in the Bay. Of these, Policies 1, 2, 9, and 10 are applicable to the proposed placement action.

Policy 1: Any proposed filling or dredging project in a subtidal area should be thoroughly evaluated to determine the local and Bay-wide effects of the project on: (a) the possible introduction or spread of invasive species; (b) tidal hydrology and sediment movement; (c) fish, other aquatic organisms, and wildlife; (d) aquatic plants; and (e) the Bay's bathymetry. Projects in subtidal areas should be designed to minimize and, if feasible, avoid any harmful effects.

The effects of the proposed action have been thoroughly evaluated in the project EA/IS/MND.

(a) The project would not introduce or spread invasive species because sediment would be sourced from the nearby Redwood City navigation channel.

(b) Placement would be localized and is not expected to affect tidal hydrology. Increased turbidity and total suspended solids (TSS) would result from the placement of approximately 100,000 CY of sediment in the nearshore environment at Eden Landing. Placing material will create a temporary sediment plume and mound per scow trip. The TSS effects would be short-term, with plumes dissipating on the order

of 15 minutes. Any changes in local currents or circulation patterns from the project would be temporary, and within the range of natural variation observed in local currents and circulation patterns because of the effects of winds, tides, storms, and other physical drivers.

Sediments that remain in subtidal areas have the potential to be of larger grain sizes, and of different properties, than those present before placement, which could result in differing species diversity and composition at the placement site. This effect would be temporary because the placed material would be covered by, and mixed with, sediment falling out of the water column over time. Another possible indirect impact is sediment deposition in nearby flood-control channels and federal navigation channels, however given the volume of sediment placed for this project, this effect would be minimal. Additionally, sediment deposition on adjacent tidal mudflats will provide additional benefits for the Bay's mudflat-marsh systems more broadly.

(c) USACE has determined that the proposed action will not affect FESA-listed species under the purview of the USFWS but may affect but is not likely to adversely affect (NLAA) FESA-listed the Central California Coast DPS of steelhead, southern DPS of North American green sturgeon, or the designated critical habitats of these two species; and may affect essential fish habitat (EFH). The USACE is undergoing section 7 and EFH consultation with NMFS prior to implementing the proposed action.

Direct and indirect impacts from changes to the water column and benthic habitats would be largely localized based on the bathymetry, depth, time of year, and tide stage, of the study site, but implementation of mitigation measure BIO-1 (below) would reduce impacts to habitats, communities, and species to temporary and minor. Though direct impacts would be limited to benthic habitats within the sediment placement footprint, a temporary reduction or shift in subtidal benthic primary producers and consumers could potentially result in indirect impacts to higher trophic levels within the estuarine food web outside the placement footprint, including special-status aquatic species, such as longfin smelt, green sturgeon, and salmonids. These impacts would be temporary and would be unlikely to exceed natural background variation in the region's estuarine food webs.

It is unlikely that turbidities will exceed background levels that are regularly experienced by local biota, especially during high-energy events such as winter *storms. Modeling also indicates that SCC would quickly return to baseline after each placement episode, making these effects on local turbidities and biota temporary.*

(d) As described for policy 2 below, there are no eelgrass beds in the direct footprint of the placement and pre- and post-placement eelgrass monitoring in the vicinity of the placement area will occur as part of the project. Therefore, no significant impacts to eelgrass or other aquatic plants are anticipated from the placement actions.

(e) The proposed project is intended to utilize natural tidal processes to transport placed material to the intertidal mudflat and marsh. Therefore, while short-term mounding after immediate placement would occur, no long-term changes to bathymetry at the site would occur.

This project is consistent to the maximum extent practicable with policy 1.

Policy 2: Subtidal areas that are scarce in the Bay or have an abundance and diversity of fish, other aquatic organisms, and wildlife (e.g., eelgrass beds, sandy deep water, or underwater pinnacles) should be conserved. Filling, changes in use; and dredging projects in these areas should therefore be allowed only if: (a) there is no feasible alternative; and (b) the project provides substantial public benefits.

There are no eelgrass beds in the direct footprint of the placement. The subtidal mudflats shoreward of the placement area is marginal eelgrass habitat that supports intermittent patches of eelgrass which appear and die off depending on annual conditions. Figure 5 represents all of the patches located over four separate annual surveys. None of these patches seem to persist from year to year.

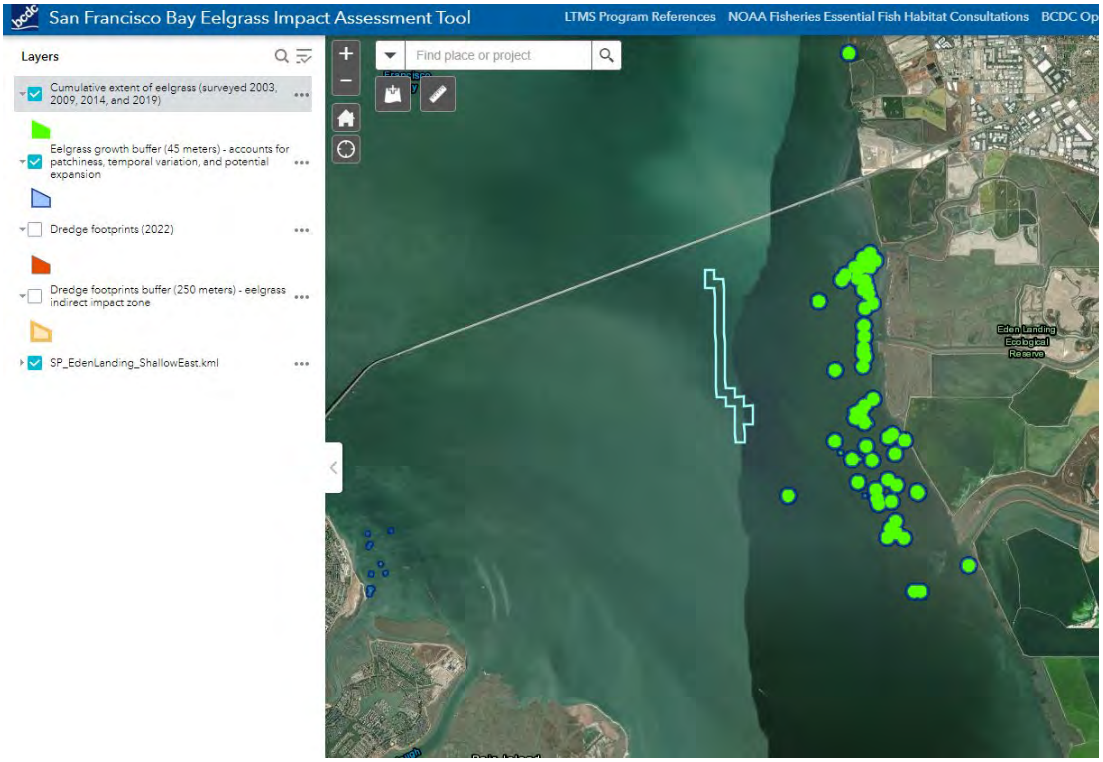

Figure 5. Map showing placement location in light blue, and eelgrass in green. (Source: BCDC SF Bay Eelgrass Impact Assessment Tool)

Eelgrass surveys will be conducted prior to sediment placement to assess conditions at the site. This will allow the project to minimize the potential to directly bury eelgrass by avoiding areas where it is detected. Post placement repeat surveys will be conducted in coordination with other monitoring efforts to sample for size, location, density, and any observed changes to eelgrass conditions post placement. Eelgrass further up on the subtidal flats would receive much less sedimentation and would not be affected (on the order of 1-2mm). Monitoring of turbidity, SSC, and sedimentation will be conducted during placement and for two months after to verify modeling assumptions. In general, project modeling indicates that SCC would quickly return to baseline after each placement episode, making any associated effects temporary.

The overall purpose of the Strategic Shallow-Water Placement Pilot Project is to test a novel approach to increase mudflat and tidal marsh resilience to SLR in SF Bay via strategic placement of sediment dredged from federal navigation channels at a shallow, in-Bay location adjacent to the mudflat and tidal marsh. The goal is to determine if this Engineering with Nature (EWN) approach can be a successful, efficient method to achieve beneficial use of dredged material.

The project is consistent to the maximum extent practicable with policy 2.

Policy 9: The Commission should encourage and authorize pilot and demonstration projects that address sea level rise adaptation of Bay habitats. These projects should include appropriately detailed experimental design and monitoring to inform initial and future work. Project progress and outcomes should be analyzed and reported expeditiously. The size, design, and management of pilot and demonstration projects should be such that it will minimize the project's potential to negatively impact Bay habitats and species.

This pilot project directly meets the intent of Policy 9 because it is a demonstration project to evaluate a method of helping marshes and mudflats keep pace with rising sea levels. The proposed project will not negatively impact the Bay and will potentially decrease risks to public safety by buffering the adjacent shoreline from sea level rise. Extensive monitoring will occur before, during, and after the project's implementation. Monitoring timing will vary by task, but will begin 2 months before placement, and will extend one year after placement. Decisions about specific timing and duration will be made adaptively in consultation with the monitoring team, and project team.

The project is not only consistent to the maximum extent practicable with policy 9 but should be encouraged by the Commission as a pilot to test potential methods to help Bay habitats adapt to sea level rise.

Policy 10: The Commission should continue to support and encourage expansion of scientific information on the Bay's subtidal areas, including: (a) inventory and description of the Bay's subtidal areas; (b) the relationship between the Bay's physical regime and biological populations; (c) sediment dynamics, including sand transport, and wind and wave effects on sediment movement; (d) oyster shell transport; (e) areas of the Bay used for spawning, birthing, nesting, resting, feeding, migration, among others, by fish, other aquatic organisms and wildlife; (f) where and how habitat restoration, enhancement, and creation should occur considering species/habitat needs and suitable project sites; and (g) if, where, and what type of habitat type conversion may be acceptable.

The proposed project location comprises tidal mudflats, salt-water tidal marshes, and subtidal shallow-water environments at the southern end of SF Bay. It aims to understand the scale of sediment deposition post-placement at the placement site, on *the intertidal mudflat, and on the adjacent tidal marsh; and the wind, wave, and sediment flux conditions pre- and post-placement across the interconnected subtidal-mudflat-marsh complex.*

In accordance with the policy, monitoring will be performed to assess potential impacts to eelgrass. Impacts from the project to sensitive aquatic habitats other than eelgrass would be temporary, and within the range of natural physical and biological variability experienced by these ecosystems. The project would not interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors or impede the use of native wildlife nursery sites.

The proposed project in combination with other restoration projects in the bay would have a cumulative beneficial impact on the adjacent mudflat and marsh. This project, being the first of its kind, will also help restoration practitioners assess suitability of shallow-water strategic placement at other potential sites to address mudflat and marsh drowning due to effects of sea level rise in the future.

The project is consistent to the maximum extent practicable with Policy 10.

5.6 Consistency with Dredging Policies

Four of the Bay Plan's dredging policies apply to the proposed placement action: Policies 1, 3, 6, and 11. The proposed placement activities consistency with these policies is discussed below.

Policy 1: Dredging and dredged material disposal should be conducted in an environmentally and economically sound manner. Dredgers should reduce disposal in the Bay and certain waterways over time to achieve the LTMS goal of limiting in-bay disposal volumes to a maximum of 1 million cubic yards (CY) per year. The LTMS agencies should implement a system of disposal allotments to individual dredgers to achieve this goal only if voluntary efforts are not effective in reaching the LTMS goal. In making its decision regarding disposal allocations, the Commission should confer with the LTMS agencies and consider the need for the dredging and the dredging projects, environmental impacts, regional economic impacts, efforts by the dredging community to implement and fund alternatives to in-bay disposal, and other relevant factors. Small dredgers should be exempted from allotments, but all dredgers should comply with policies 2 through 12.

The USACE regulates the discharge of dredged material from its projects to assure that dredged-material placement occurs in an environmentally acceptable manner. The associated EA/IS/MND, in conjunction with the section 404(b)(1) guidelines and public notice coordination process, can be used as a guide in evaluating the project's compliance with environmental standards and regulations. The Redwood City Harbor O&M Project provides for a two-year cycle of maintenance dredging of the federal navigation channel to remove shoaled sediment. Normally, that material is disposed of at SF-11 the approved in-bay federal standard placement site.. The volume of dredged sediment from the federal channels, which is typically less than 80 percent sand, is approximately 400,000 – 600,000 CY biannually. The strategic placement project plan, a beneficial-use pilot project, proposes placing 100,000 CY of that dredged sediment at another in-bay location offshore of Eden Landing. As a result, this pilot project would not increase the amount of sediment that is placed in San Francisco Bay. The USACE does not plan to utilize in-bay disposal in a manner that may trigger allocations.

As such, the strategic placement project is consistent to the maximum extent practicable with BCDC dredging Policy 1.

Policy 3: Dredged materials should, if feasible, be reused or disposed outside the Bay and certain waterways. Except when reused in an approved fill project, dredged material should not be disposed in the Bay and certain waterways unless disposal outside these areas is infeasible and the Commission finds: (a) the volume to be disposed is consistent with applicable dredger disposal allocations and disposal site limits adopted by the Commission by regulation; (b) disposal would be at a site designated by the Commission; (c) the quality of the material disposed of is consistent with the advice of the San Francisco Bay Regional Water Quality Control Board and the inter-agency Dredged Material Management Office (DMMO); and (d) the period of disposal is consistent with the advice of the California Department of Fish and Game, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service.

This project will examine a novel approach to beneficial use within the bay. The volume of the project (100,000 CY) is consistent with applicable dredger disposal allocations since it is a diversion of sediment from one in-bay location to another that could provide benefits to sediment-limited tidal mudflats and marshes. This new placement site and placement method was developed in collaboration with The San Francisco Bay Regional Water Quality Control Board, BCDC, and the Coastal

Conservancy, and the dredged material determined for placement will be based on the DMMO's Tier III testing requirements for the different reaches of the Redwood City Harbor federal navigation channel. The period of disposal will be within the environmental work window (June 1 – November 30), which is consistent with the advice of the California Department of Fish and Game, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service.

The project is consistent to the maximum extent practicable with Policy 3.

Policy 6: Dredged materials disposed in the Bay and certain waterways should be carefully managed to ensure that the specific location, volumes, physical nature of the material, and timing of disposal do not create navigational hazards, adversely affect Bay sedimentation, currents or natural resources, or foreclose the use of the site for projects critical to the economy of the Bay Area.

The location was carefully selected in shallow, subtidal waters of the Bay to avoid any navigational hazards associated with the placement or dispersion of the material. The material to be placed is fine-grained and is thus highly dispersive immediately after placement. The volume of material (approximately 100,000 CY) is small and will be placed in 900 cubic-yard batches.

All these factors ensure the project is consistent to the maximum extent practicable with Dredging Policy 6.

Policy 11:

A project that uses dredged sediment to create, restore, or enhance Bay or certain waterway natural resources may be approved if:

1. The Commission, based on detailed site-specific studies, appropriate to the size and potential impacts of the project, that include, but are not limited to, site morphology and physical conditions, biological considerations, the potential for fostering invasive species, dredged sediment stability, and engineering aspects of the project, determines all of the following:
    a. the project would provide, in relationship to the project size, substantial net improvement in habitat for Bay species;
    b. no feasible alternatives to the fill exist to achieve the project purpose with fewer adverse impacts to Bay resources;
    c. the amount of dredged sediment to be used would be the minimum amount necessary to achieve the purpose of the project;

d. beneficial uses and water quality of the Bay would be protected; and
e. there is a high probability that the project would be successful and not result in unmitigated environmental harm;

The placement of approximately 100,000 CY of dredged material in a shallow, subtidal footprint covering 138 acres is relatively small compared to the overall amount of available open-bay and estuarine habitat throughout San Francisco Bay. Specifically, the placement site will cover about 138 acres, or 0.22 square miles compared to the total area of Suisun, San Pablo, and San Francisco Bays, which is estimated to be about 225 square miles (i.e., assuming dimensions of 75 miles long x 3 miles wide on average).

Modeling predictions suggest that the project would result in approximately 1-2 millimeters of deposition across intertidal mudflats, and approximately 1 millimeter of deposition on parts of Whale's Tail marsh as predicted in the Hydraulic and Sediment Modeling Report in Appendix C of the EA/IS/MND. This deposition is on the order of magnitude of natural depositional processes, and as such, would provide substantial net improvement for mudflat and marsh habitat at Eden Landing Ecological Reserve, given that San Francisco Bay and its surrounding mudflats and marshes, are presently experiencing a deficit in sediment supply.

The planning process narrowed an array of 12 possible locations around San Francisco Bay to two for comparison based on highest probability of success based on eight criteria. These included whether the site 1) experiences marsh erosion or drowning due to a lack of sediment supply; 2) has sufficient wind-wave action to resuspend placed sediment; 3) is proximal to a federal channel; 4) is open to tidal exchange for existing marsh; 5) has water depth sufficient for scows to access for nearshore placement; 6) is proximal to disadvantage communities to enhance their shoreline resilience; 7) has low populations of critical species; and 8) avoids large eelgrass beds and nearshore reef projects. Using the hydrodynamic and sediment transport modeling report to compare the array of project alternatives (i.e., Eden Landing Whale's Tail marsh, Emeryville Crescent marsh, and the no-action alternative for each site [SF-11 and SF-DODS respectively]), it was determined that the placement location offshore of Eden Landing Whale's Tail marsh had the highest chance of success based on the target metrics. Therefore, this strategic placement project, as proposed, was deemed the most feasible for testing this novel placement method.

The modeling framework also examined an array of placement volumes (50,000 – 125,000 CY), and 100,000 CY was the minimum amount necessary to achieve the project purpose, which is to test strategic placement's ability to deliver sediments to the target mudflats and marshes. Lower than 100,000 CY it becomes increasingly more difficult to track sediment deposition in the mudflats and marshes and would be difficult to tell whether this approach to marsh and mudflat resilience would be effective. The project would not adversely impact the beneficial uses and water quality of the Bay (see Consistency with Mitigation Policy 1). Similarly, the project will not result in unmitigated environmental harm given its scale and the implementation of Best Management Practices (BMPs) and avoidance measures (see Section 8 Mitigation Measures of the EA/IS/MND).

2. The project includes an adequate monitoring and management plan and has been carefully planned, and the Commission has established measurable performance objectives and controls that would help ensure the success and permanence of the project, and an agency or organization with fish and wildlife management expertise has expressed to the Commission its intention to manage and operate the site for habitat enhancement or restoration purposes for the life of the project;

The monitoring plan for this project is included in Appendix D of the EA/IS/MND and will monitor 4 general locations: 1) the sediment placement area; 2) the mudflats/shallows; 3) marshes; and 4) South Bay Salt Pond restoration areas at Eden Landing. The approach includes bathymetric surveys to detect changes in morphology and bay floor properties, oceanographic data collection, bed sediment properties, tracer study of bay shallows, marsh restoration sampling, analyzing the effects of the placement on benthic communities, and eelgrass monitoring. Monitoring timing will vary by task, but will begin 2 months before placement, and will extend one year after placement. Decisions about specific timing and duration were made in consultation with the monitoring team and the project team and will continue to use adaptive management principles as the project moves forward. Eelgrass surveys will occur in July 2023 (pre-placement), in December 2023 (6 months post-placement if eelgrass is present during pre-condition surveys), and in June 2024 (1-year post-placement if eelgrass is present during pre-condition surveys).

3. The project would use only clean sediment suitable for aquatic disposal and the Commission has solicited the advice of the San Francisco Bay Regional Water Quality Control Board, the Dredged Material Management Office, and other appropriate agencies on the suitability of the dredged sediment;

The USACE will complete Tier III (chemical and biological) testing of Redwood City Harbor federal navigation channel sediments prior to dredging in 2023 and submit the results to the DMMO to determine the suitability of the material for placement at upland and in-bay sites including the strategic placement site. The channel is expected to produce between 400,000–600,000 CY of suitable material to source the 100,000 CY placement for the Eden Landing strategic placement site. Sediment testing and suitability determination will protect the placement site from contaminants in the dredged material. Based on the Tier III testing results, USACE will avoid importing material from any unsuitable areas.

4. Dredged sediment would not be placed in areas with particularly high or rare existing natural resource values, such as eelgrass beds and tidal marsh and mudflats, unless the material would be needed to protect or enhance the habitat. The habitat project would not, by itself or cumulatively with other projects, significantly decrease the overall amount of any particular habitat within the Suisun, North, South, or Central Bays, excluding areas that have been recently dredged;

Without avoidance and minimization measures, impacts from the proposed project to eelgrass habitats offshore of Eden Landing could potentially occur because of the sensitivity of these communities and their food webs to burial and turbidity, as well as the uncertain rate and extent of recolonization, growth, and recovery post-burial. The proposed project includes pre- and post- placement monitoring for eelgrass, which would reduce the potential for impacts to eelgrass communities in the vicinity of the placement location.

5. The Commission has consulted with the California Department of Fish and Wildlife, the National Marine Fisheries Service, and the U.S. Fish and Wildlife Service to ensure that at least one of these agencies supports the proposed project; and

The USACE has consulted with the California Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service. The consultations and agency comments are provided in the EA/IS/MND Appendix A.

6. The project's design and goals incorporate the best available science on the use of dredged sediment for habitat projects.

The project partnered with USGS to plan monitoring at the placement site and in Eden Landing Ecological Reserve Whale's Tail marsh and adjacent intertidal mudflat to determine the efficacy of the strategic placement of dredged material using the best available monitoring methods and scientific expertise of the target

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mudflat/marsh ecosystem. As part of this partnership, the team has brought in a magnetic particle tracking component which will contribute to the understanding of sediment transport and deposition post placement. The project also leverages best available scientific methods as developed by the USACE Engineering with Nature program to test a novel sediment placement method. These collaborative efforts resulted in a project design and goal that incorporates the best available science.

7. After a reasonable period of monitoring, if either:
    a. the project has not met its goals and measurable objectives, and attempts at remediation have proven unsuccessful, or
    b. the dredged sediment is found to have substantial adverse impacts on the natural resources of the Bay, then the dredged sediment would be removed, unless it is demonstrated by competent environmental studies that removing the material would have a greater adverse effect on the Bay than allowing it to remain, and the site would be returned to the conditions existing immediately preceding placement of the dredged sediment.

This project serves as a pilot effort to assess whether strategic placement is a viable method of dredged material placement for use in other locations. Given that this project involves placing a small volume of sediment in a dispersive environment, and that the Hydraulic and Sediment Modeling Report indicates that the largest impacts will be on the millimeter or centimeter scale of sediment deposition, it is unlikely that this project's placement of sediment would have substantial adverse impacts. In fact, one of the challenges of the project is that it may be difficult to detect an impact at all. Therefore, the project will not require mitigation nor removal of sediment.

To ensure protection of Bay habitats, the Commission should not authorize placement of more than a minor amount of dredged sediment for projects that are similar to the Oakland Middle Harbor Enhancement Area project in characteristics including, but not limited to, scale, bathymetric modification, and type of habitat creation, until The Oakland Middle Harbor Enhancement Area project is completed successfully.

This project is not like the Oakland Middle Harbor Enhancement Area project in size, scale, scope, or goals. It is not analogous in terms of bathymetric modification or habitat creation. Per discussion on Policy 11, this project aims to use the minimum fill necessary to achieve the purpose of the project. It is meant to mimic natural processes and is not constructing new habitat, rather enhancing existing habitat.

Therefore, this policy does not apply to the strategic placement project.

The Commission should encourage research and well-designed pilot projects to evaluate:

1. The appropriate amounts of all habitat types within the Bay, especially for support and recovery of endangered species;
2. The appropriate biological, hydrological, and physical characteristics of locations in the Bay for habitat creation, enhancement, and restoration projects that use dredged sediment;
3. The potential for direct, indirect, and cumulative impacts of such projects;
4. The effectiveness of different dredged sediment placement strategies for habitat restoration, enhancement, and creation; and
5. The feasibility of the beneficial use of dredged sediment in the Bay and certain waterways for habitat creation, enhancement, and restoration.

This strategic placement pilot project serves as a research project to evaluate the effectiveness of a new dredged sediment placement strategy for beneficial use of dredged material for habitat enhancement. Additionally, this project was designed under a coordinated framework with the San Francisco Regional Water Quality Control Board, the California State Coastal Conservancy, and BCDC, with input from the USGS and other scientists both external and internal to USACE. In this way, the project supports BCDC's goal of encouraging such pilot projects to conduct critical research for ecosystem resilience to sea-level rise and other climate change impacts to San Francisco Bay.

Based on the analysis above of the policy subcomponents, *the project is consistent to the maximum extent practicable with Policy 11.*

5.7 CONSISTENCY WITH NAVIGATIONAL SAFETY AND OIL SPILL PREVENTION:

One of the Bay Plan's navigational safety and oil spill prevention policies is applicable to the proposed placement action: Policy 1. The proposed placement action consistency with the policy is discussed below.

Policy 1: Physical obstructions to safe navigation, as identified by the U.S. Coast Guard and the Harbor Safety Committee of the San Francisco Bay Region, should be removed to the maximum extent feasible when their removal would contribute to navigational safety and would not create significant adverse environmental impacts. Removal of obstructions should ensure that any detriments arising from a significant alteration of Bay habitats are clearly outweighed by the public and environmental benefits of reducing the risk to human safety or the risk of spills of hazardous materials, such as oil.

The project may occasionally delay or temporarily impede recreational watercraft during dredging and placement activities. There would be sufficient room for recreational vessels to maneuver around dredging equipment, and therefore, impacts are expected to be negligible. During placement activities, notes to mariners and navigational warning markers would be used as needed to prevent navigational hazards. No permanent changes to underwater bathymetry is anticipated to impact navigation by recreational or commercial vessels.

This project is consistent to the maximum extent practicable with Policy 1.

5.8 Consistency with Environmental Justice and Social Equity

One of the Bay Plan's environmental justice and social equity policies are applicable to the proposed placement action: Policy 3. The proposed placement activities consistency with the policy is discussed below.

Policy 3: Equitable, culturally relevant community outreach and engagement should be conducted by local governments and project applicants to meaningfully involve potentially impacted communities for major projects and appropriate minor projects in underrepresented and/or identified vulnerable and/or disadvantaged communities, and such outreach and engagement should continue throughout the Commission review and permitting processes. Evidence of how community concerns were addressed should be provided. If such previous outreach and engagement did not occur, further outreach and engagement should be conducted prior to Commission action.

Since the project began in earnest in February 2021, there have been two stakeholder meetings (March 10, 2021, and May 16, 2021) which included resource agencies, the dredging community, community and environmental groups, science organizations, and others. These stakeholder charettes helped the team narrow in on key environmental concerns, and criteria for site selection, as well as logistical constraints. Two separate resource agency working group meetings were held with participating and cooperating agencies on March 26, 2021, and April 23, 2022. These discussions included concerns for impacts to environmental resources, and biological communities, and discussions of appropriate levels of monitoring and consultation for this pilot study, as well as tribal and community involvement. Before a site was selected, the project team worked with the West Oakland Environmental Indicators

Project (WOIEP)'s Shoreline Leadership Academy exploring potential partnerships around the Emeryville Site.

Once the Eden Landing Site was selected as the Proposed Action, the project team met with City of Hayward, Alameda County Flood Control and Water Conservation District, Union Sanitary District (USD), and East Bay Dischargers Authority (EBDA) to discuss modeling results and potential impacts and benefits to this part of the shoreline. Given that the results of the modeling show 1-2 mm of deposition, these parties were not concerned with any impacts, and were hopeful in this experiment's viability as a tool as SLR rates increase. Both EBDA and USD are engaged in SLR vulnerability studies and adaptation planning, as saw this project as beneficial to the region. A CEQA notice of scoping was send on July 1, 2022, and a public scoping meeting was held on July 15, 2022, by the Waterboard. During this meeting, members of the public asked thoughtful questions about the potential of this effort to impact waterbirds foraging. On August 18, 2022, the members of the team partnered with the SBSP program to staff a Table at the Downtown Hayward Street Party which is an annual event sponsored by the Chamber of Commerce. The team engaged with members of the public describing the pilot project with visuals and answered questions. On October 5, 2022, the project team hosted a site visit to Eden Landing with the Confederated Villages of Lisjan who were enthusiastic about the study, and would like to stay involved throughout the study and will monitor the data that is collected showing the effectiveness and impacts to the environment that result from this study.

Table 1, Table 2, Table 3, and Table 4 provide past community and community-based organization outreach details, agency engagement, tribal engagement, and other relevant project communications. See also Section 7 of the Environmental Assessment/Mitigated Negative Declaration for details and a complete list of agency, stakeholder, and public outreach.

During the planning process, no comments related to environmental justice or social equity were received, and no communities of concern commented during the public comment period.

This project is consistent to the maximum extent practicable with Environmental Justice and Social Equity Bay policy 3.

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Table 1. Community and community-based organization contact details.

Organization	Contact Person	Date Contacted	Type of Communication	Communication Purpose
West Oakland Environmental Indicators Project/Shoreline Leadership Academy	Phoenix Armenta	3/31/2022	E-mail and Webex	Community Science coordination
East Bay Regional Park District	Matthew Graul (Chief of Stewardship, Stewardship Administration); Doug Bell (Wildlife Program Manager)	11/19/2021, 12/10/2021, 3/29/2022	E-mail and WebEx	Volunteer days/community outreach
City of Hayward	Erik Pearson (Environmental Services Manager); Mary Thomas (Management Analyst); Leigha Schmidt; Jennifer Ott; Chuck Finnie; Alex Ameri; Sara Lamnin; Zach Ebadi; Dustin Claussen; Bryant Duong; Taylor Richard; John Holder (EBRPD, Coordinator for Hayward Area Shoreline Planning Agency)	5/24/2022, 6/14/2022	E-mail and WebEx	Public meeting brainstorm and outreach strategy feedback
Stakeholders	Camen Zind Dredging, Curtin Maritime, Dutra Group, Kiewit, Lind Marine, Manson Construction, Pacific Dredge, Pacific Maritime Group, Restaite Ridredge	5/10/2021, 5/15/2022	E-mail and WebEx	Stakeholder feedback
Downtown Hayward Street Party	City of Hayward	8/18/2022	In-person	Public engagement
Oakland San Leandro Adaptation Working group	Daniele Mieler, City of Alameda	8/14/2022	Virtual presentation	Communication to community based groups from West and East Oakland, and local government representatives

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Table 2. Agency engagement details.

Agency	Contact Person	Date Contacted	Type of Communication	Purpose of Communication
BCDC	Nahal Ghoghaie (EJ Manager), Brenda Goeden (Sediment Program Manager)	8/23/2021	E-mail and webex	Environmental Justice Community Engagement
Alameda County Flood Control & Water Conservation District	Hank Ackerman (Flood Control Program Manager)	5/10/2022, 5/13/2022	E-mail and WebEx	Flood Control channel impacts
Resource Agency Working Group	California State Coastal Conservancy, Bay Conservation and Development Commission, California State Water Control Board, US Environmental Protection Agency, California Department of Fish and Wildlife, California State Lands Commission, National Oceanic and Atmospheric Administration, US Fish and Wildlife Service, California State Parks	3/26/2021, 5/23/2022	E-mail and WebEx	Project Updates
California Department of Fish and Wildlife/South Bay Salt Ponds		1/20/2022, 5/6/2022, 5/31/2022 (incl. State Coastal Conservancy and Invasive Spartina Project)	E-mail and WebEx	Coordination Outreach

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Table 3. Tribal contact details for required consultations under Section 106 of the National Historic Preservation Act.

Tribe	Contact Person	Date Contacted	Type of Communication	Purpose of Communication
Amah Mutsun Tribal Band of Mission San Juan Bautista	Chairperson Irene Zwierlein	4/15/2022	E-mail	Initiate Tribal consultation for NEPA/CEQA and Sec. 106
Costanoan Rumsen Carmel Tribe	Chairperson Tony Cerda	4/15/2022	E-mail	Initiate Tribal consultation for NEPA/CEQA and Sec. 106
Guidiville Indian Rancheria	Chairperson Donald Duncan	4/15/2022	E-mail	Initiate Tribal consultation for NEPA/CEQA and Sec. 106
Indian Canyon Mutsun Band of Coastanoan	Chairperson Ann Marie Sayers and Kanyon Sayers-Roods, MLD Contact	4/15/2022	E-mail	Initiate Tribal consultation for NEPA/CEQA and Sec. 106
Muwekma Ohlone Indian Tribe of the SF Bay Area	Chairperson Charlene Nijmeh and Vice Chairwoman Monica Arellano	4/15/2022	E-mail	Initiate Tribal consultation for NEPA/CEQA and Sec. 106
North Valley Yokuts Tribe	Chairperson Katherine Perez and Timothy Perez	4/15/2022	E-mail	Initiate Tribal consultation for NEPA/CEQA and Sec. 106
The Ohlone Indian Tribe	Andrew Galvan	4/15/2022	E-mail	Initiate Tribal consultation for NEPA/CEQA and Sec. 106
Wuksache Indian Tribe/Eshom	Chairperson Kenneth Woodroy	4/15/2022	E-mail	Initiate Tribal consultation for NEPA/CEQA and Sec. 106
The Confederated Villages of Lisjan	Chairperson Corrina Gould	4/15/2022	E-mail	Initiate Tribal consultation for NEPA/CEQA and Sec. 106
The Confederated Villages of Lisjan	Chairperson Corrina Gould	6/1/2022 10/5/2022	Zoom Meeting In-person site visit to Eden Landing	Meeting to discuss Tribe's involvement in project. Especially interested in all things related to monitoring.

Table 4. Other relevant project communications.

Meeting	Date
Planning Charette	3/10/2021
USGS Monitoring Discussion	3/23/2021
Resource Agency Working Group	3/26/2021
USGS Monitoring Discussion	3/30/2021
USGS Monitoring Discussion	4/29/2021
Presentation to Bay Planning Coalition Dredging and Beneficial Reuse Committee	5/3/2021
Presentation to LTMS Management Committee	5/7/2021
Presentation to Bay RMP Sediment Workgroup	5/20/2021
Presentation to Bay RMP Steering Committee	7/21/2021
Presentation to LTMS Management Committee	9/10/2021
Presentation to Bay Planning Coalition Annual Meeting	10/21/2021
Bay Area One Water Network and San Francisco Estuary Partnership RoundTable on Nature-Based Solutions for climate adaptation	11/3/2021 - 11/4/2021
Presentation to SPN Dredging day	1/27/2022
Presentation to LTMS Project Coordination Meeting	4/19/2022
East Bay Dischargers Authority	7/12/2022
CEQA Notice of Scoping	7/15/2022
Presentations to American Shore and Beach Preservation Association Engineering with Nature short course	9/13/2022

The following agencies were provided the EA/IS/MND for review and comment, along with the interested public, during the public comment period.

A. Federal agencies:

1. U.S. Environmental Protection Agency (EPA Region 9)
2. Advisory Council – Historic Preservation
3. U.S. Fish and Wildlife Service
4. National Marine Fisheries Service

B. B. State and local agencies:

1. Bay Conservation and Development Commission (BCDC)
2. State Lands Commission
3. State Historic Preservation Officer

4. Regional Water Quality Control Board Region (RWQCB)
5. Bay Area Air Quality Management District (BAAQMD)
6. California Department of Fish and Wildlife (CDFW)

5.9 Consistency with Climate Change Policies

Three of the Bay Plan's climate change policies are applicable to the proposed placement action; these included Policies 1, 5, and 6, specifically 6b and 6d. The proposed placement activities consistency with these policies is discussed below.

Policy 1: The Commission intends that the Bay Plan Climate Change findings and policies will be used as follows:

a. The findings and policies apply only to projects and activities located within the following areas: San Francisco Bay, the 100-foot shoreline band, salt ponds, managed wetlands, and certain waterways, as these areas are described in Government Code section 66610, and the Suisun Marsh, as this area is described in Public Resources Code section 29101;

For projects or activities that are located partly within the areas described in subparagraph a and partly outside such area, the findings and policies apply only to those activities or that portion of the project within the areas described in subparagraph a;

For the purposes of implementing the federal Coastal Zone Management Act, the findings and policies do not apply to projects and activities located outside the areas described in subparagraph a, even if those projects or activities may otherwise be subject to consistency review pursuant to the federal Coastal Zone Management Act; and

For purposes of implementing the California Environmental Quality Act, the findings and policies are not applicable portions of the Bay Plan for purposes of CEQA Guideline 15125(d) for projects and activities outside the areas described in subparagraph a and, therefore, a discussion of whether such proposed projects or activities are consistent with the policies is not required in environmental documents.

The proposed project will be located in the San Francisco Bay. In particular, the proposed project location comprises tidal mudflats, salt-water tidal marshes, and subtidal shallow-water environments at the southern end of the Bay. It is located offshore of the City of Hayward in Alameda County and is bounded by the San Mateo

Bridge to the north and the southern shoreline of the Bay to the south. Therefore, the Bay Plan's policies related to climate change are applicable.

Policy 5: Wherever feasible and appropriate, effective, innovative sea level rise adaptation approaches should be encouraged.

The overall purpose of the Strategic Shallow-Water Placement Pilot Project is to test a novel approach to increase mudflat and tidal marsh resilience to sea level rise in SF Bay via strategic placement of sediment dredged from federal navigation channels at a shallow, in-Bay location adjacent to the mudflat and tidal marsh. Strategic placement of sediment is an innovative way to buffer against SLR.

Therefore, this project is consistent to the maximum extent practicable with policy 5.

Policy 6: The Commission, in collaboration with the Joint Policy Committee, other regional, state, and federal agencies, local governments, and the general public, should formulate a regional sea level rise adaptation strategy for protecting critical developed shoreline areas and natural ecosystems, enhancing the resilience of Bay and shoreline systems and increasing their adaptive capacity.

The Commission recommends that: (1) the strategy incorporate an adaptive management approach; (2) the strategy be consistent with the goals of SB 375 and the principles of the California Climate Adaptation Strategy; (3) the strategy be updated regularly to reflect changing conditions and scientific information and include maps of shoreline areas that are vulnerable to flooding based on projections of future sea level rise and shoreline flooding; (4) the maps be prepared under the direction of a qualified engineer and regularly updated in consultation with government agencies with authority over flood protection; and (5) particular attention be given to identifying and encouraging the development of long-term regional flood protection strategies that may be beyond the fiscal resources of individual local agencies.

Ideally, the regional strategy will determine where and how existing development should be protected and infill development encouraged, where new development should be permitted, and where existing development should eventually be removed to allow the Bay to migrate inland.

The entities that formulate the regional strategy are encouraged to consider the following strategies and goals:

(b) Enhance the Bay ecosystem by identifying areas where tidal wetlands and tidal flats can migrate landward; assuring adequate volumes of sediment for marsh accretion; identifying conservation areas that should be considered for acquisition, preservation or enhancement; developing and planning for flood protection; and maintaining sufficient transitional habitat and upland buffer areas around tidal wetlands;

(d)Encourage innovative approaches to sea level rise adaptation;

The purpose of the project is to increase sediment delivery to tidal mudflats and marshes. This project will attempt to augment the local supply of sediment available to support accretion in mudflats and tidal wetland through strategic placement of sediment, which is an innovative way to buffer against sea level rise. The project would place approximately 100,000 CY of dredged material in the nearshore subtidal zone at depths of approximately 10 feet MLLW and the fate of that material will be monitored to determine how much, if any reaches the tidal flats and tidal marsh. Modeling indicates that the project could drive modest amounts of accretion in nearby tidal areas, ranging from about 0.01 cm at the target tidal marsh to about 0.1 cm on adjacent mudflats over a two-month period. Based on initial modeling results, the proposed project action alternatives would see 1–2 mm of sediment deposition on the mudflats between the nearshore strategic placement site and adjacent mudflats (Anchor QEA, 2022). Marsh and restoration sampling will be conducted up to 9 months post-placement to measure accretion rates. A tracer study will also be conducted for up to 6 months post-placement which will help measure the performance of the project. Outcomes of sediment placement projects can be uncertain, so robust monitoring is essential for the project.

The project is expected to have beneficial effects on flood control functions by providing a supplemental source of sediment to accelerate marsh and mudflat accretion to offset future changes in sea level. The accretion rates do not represent a substantial adverse impact to local and regional flood risk management functions. Accretion in local mudflats and marshes would result in a beneficial impact to local and regional flood risk management functions because higher mudflats and marshes are more effective at attenuating wave energy. Impacts to flood risk management functions from the project are therefore less than significant. The project would also likely result in beneficial impacts to local accretion rates. The surface elevations of the marshes are high enough that most of the inundation and sediment transport onto *the marshes will occur when water surface elevations are near MHHW or higher. If this method is effective, it is assumed that it will alter existing habitat conditions and stabilize marshes or mudflats that would be losing elevation as sea-level rises.*

Strategic placement techniques such as the nearshore, shallow-water placement under the Proposed Action, offer one of many possible management approaches to address the future problem of losing mudflats and marshes (Stantec and SFEI, 2017), which provide storm, wave, and erosion buffers along the margins of the Bay. Placement of approximately 100,000 CY of material at either nearshore site would have potential beneficial impacts on storm, wave, and erosion buffers.

Therefore, the project is consistent to the maximum extent practicable with 6b and Policy 6d.

5.10 Consistency with Fills in Accord with the Bay Plan

One of the Bay Plan's fills in accord with the Bay Plan policies is applicable to the proposed placement action: Policy 1a. The proposed placement activities' consistency with the policy is discussed below.

Policy 1: Fills in Accord with Bay Plan. A proposed project should be approved if the filling is the minimum necessary to achieve its purpose, and if it meets one of the following three conditions:

a. The filling is in accord with the Bay Plan policies as to the Bay-related purposes for which filling may be needed (Le., ports, water-related industry, and water-related recreation) and is shown on the Bay Plan maps as likely to be needed; or
b. The filling is in accord with Bay Plan policies as to purposes for which some fill may be needed if there is no other alternative (Le., airports, roads, and utility routes); or
c. The filling is in accord with the Bay Plan policies as to minor fills for improving shoreline appearance or public access.

The fill involved with this project would be minor and the minimum necessary to achieve its purpose. The project would place approximately 100,000 CY of dredged material in the nearshore subtidal zone at depths of approximately 10 feet MLLW. Modeling indicates that the project could drive modest amounts of accretion in tidal areas near the shallow-water placement site, ranging from about 0.01 cm at the target tidal marsh to about 0.1 cm on adjacent mudflats over a two-month period. The proposed project will evaluate the extent to which this method may be an effective *way to increase resilience of mudflats and tidal marshes to sea level rise. The project location is relevant to map 6 of the Bay Plan maps, specifically to Eden Landing Ecological Reserve which is proposed for restoration use. This action would be in accord with this proposed use.*

The project is consistent to the maximum extent practicable with the Bay Plan's fill Policy 1a.

5.11 Consistency with Mitigation Policies

One of the Bay Plan's mitigation policies (Policy 1) is applicable to the proposed placement action. The proposed placement activities' consistency with these policies is discussed below. This project does not include compensatory mitigation, and as such the policies pertaining to compensatory mitigation were deemed non-applicable.

Policy 1: Projects should be designed to avoid adverse environmental impacts to Bay natural resources such as to water surface area, volume, or circulation and to plants, fish, other aquatic organisms and wildlife habitat, subtidal areas, or tidal marshes or tidal flats. Whenever adverse impacts cannot be avoided, they should be minimized to the greatest extent practicable. Finally, measures to compensate for unavoidable adverse impacts to the natural resources of the Bay should be required. Mitigation is not a substitute for meeting the other requirements of the McAteer-Petris Act.

To the maximum extent practicable, the proposed project has been designed to avoid or minimize adverse environmental impacts to San Francisco Bay, in accordance with Bay Plan policies. This has been accomplished by analyzing impacts to environmental resources in the section 404(b)(1) analysis, by analyzing/determining the project's compliance with both NEPA and CEQA thresholds and requirements, and by developing plans for all practicable and appropriate means to avoid or minimize adverse environmental effects.

The strategic placement of 100,000 CY of dredged material in the shallow, subtidal environment will not adversely affect water surface area, volume, or circulation patterns in the Bay. We also do not anticipate the project will have adverse impacts on plants, fish, other aquatic organisms and wildlife habitat, subtidal areas, or tidal marshes or tidal flats. Placement of material in the shallow subtidal environment will result in short-term increases to suspended sediment concentration, but the sediment will settle and disperse on the order minutes (i.e., less than one hour). This will result *in limited and non-adverse impacts to aquatic organisms, wildlife habitat, fish, and subtidal areas. The project, if successful, will provide benefits to tidal marshes, tidal flats, and associated plants in such ecosystems because it will augment sediment supply to a sediment-limited mudflat/marsh system to enhance its resilience to sea level rise.*

As such, adverse impacts to the natural resources listed above will be minimized or avoided. To ensure there are no adverse impacts, USACE and the Waterboard developed the following avoidance and minimization measures for biological resources.

Biological Resources Mitigation Measure (BIO-1)

The project shall comply with the formal consultations issued by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service under the Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act, and Marine Mammal Protection Act. The Permittee shall also implement recommendations made by the California Department of Fish and Wildlife during informal consultation.

Biological Resources Mitigation Measure (BIO-2)

As part of the proposed project, USACE shall conduct pre- and post-placement surveys of eelgrass areal coverage and density within the placement footprint where it overlaps the 45-meter direct impact buffer zone as part of the monitoring plan, and a 250-meter turbidity buffer around eelgrass for determining indirect impacts (indirect impact buffer zone). For more information, see attached monitoring plan (Appendix D) and Section 8 in the EA/IS/MND.

6 Determination

Pursuant to the Federal CZMA of 1972, as amended, and based on the analysis above, USACE has evaluated the 2023 San Francisco Bay Strategic Shallow-Water Placement Pilot Project and finds the proposed project is consistent to the maximum extent practicable with BCDC's applicable Bay Policies. The USACE requests concurrence from BCDC for this consistency determination pursuant to Section 307c(1).

U.S. Army Corps of
Engineers
San Francisco District

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San Francisco, CA 94102

7 REFERENCES

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6. Fish and Wildlife Coordination Act (FWCA) Planning Aid Letter

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:
2023-0003311

Tessa Beach, Ph.D.
Chief, Environmental Branch
U.S. Army Corps of Engineers
San Francisco District
450 Golden Gate Ave 4th Floor
San Francisco, California 94102-3404

Dear Dr. Beach:

Please find enclosed our draft Planning Aid Letter (PAL) for the U.S. Army Corps of Engineers' (Corps) proposed San Francisco Bay Strategic Shallow Water Placement project for your review. This draft PAL will be finalized after receipt of any Corps comments and completion of Endangered Species Act consultation as appropriate.

If you have any questions on this report, please contact Steven Schoenberg of my staff at (916) 930-5672, or at Steven_Schoenberg@fws.gov.

Sincerely,

DANIEL WELSH
Digitally signed by DANIEL WELSH
Date: 2022.10.18 14:57:55 -07'00'

Daniel Welsh
Deputy Field Supervisor

Enclosure

cc:
Eric Jolliffe, Corps of Engineers, San Francisco, California
Julie Beagle, Corps of Engineers, San Francisco, California
Sara Azat, NOAA Fisheries, Santa Rosa, California
Arn Aarreberg, CDFW, Stockton, California

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

DRAFT PLANNING AID LETTER FOR THE SAN FRANCISCO BAY STRATEGIC SHALLOW WATER PLACEMENT PROJECT

PREPARED BY:

Steven Schoenberg, Senior Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Watershed Planning Division
San Francisco Bay-Delta Fish and Wildlife Office
Sacramento, California

PREPARED FOR:

U.S. Army Corps of Engineers
San Francisco District
San Francisco, California

October 2022

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SUMMARY

The proposed action is a pilot project involving placement of 100,000 cubic yards (cy) of dredged material in shallow water, 1-2 miles offshore of Eden Landing, to assess movement towards and deposition in mudflats and marshlands by natural processes (wind, wave, tidal current). The purpose is to evaluate this method as an alternative to either direct placement, which is costly and challenging for many sites, or disposal at approved sites which have no habitat benefit. Relevant physical and biological characteristics will be monitored before and up to a year after placement. Temporary, minor impacts are predicted by model simulations, which will be verified by this monitoring. Pilot project results can be used to refine, modify, and scale up this approach for eventual routine use. Strategic placement has the potential to increase beneficial re-use of dredged material to enhance intertidal habitats and protect them from sea level rise. Such benefits are critical to important regional fish and wildlife resources, including special status species within these habitats. The Fish and Wildlife Service supports the strategic placement pilot project without reservation.

INTRODUCTION

This Planning Aid Letter (PAL) on the Corps of Engineers' (Corps) San Francisco Bay Strategic Shallow-Water Placement Pilot Project (project) has been prepared in accordance with the Fish and Wildlife Coordination Act pursuant to our Scope of Work (SOW) for 2022. Coordination to date has included an initial discussion with Corps staff on April 1, 2022, attendance at a stakeholder meeting on May 16, 2022, and attendance at a larger working group meeting with the Corps and other resource agencies on May 23, 2022. Other communications culminated in completion of the SOW and funding to prepare this PAL in September 2022. Information considered in this PAL includes: the PowerPoint presentation from the working group meeting; Corps-provided internal drafts of the Environmental Assessment, a June 2022 hydraulic and sediment modeling report (Anchor 2022), placement grid images, and a draft monitoring plan (August 17-18, 2022 emails from Eric Jolliffe, South Pacific Division); similar updated materials in the September 23, 2022, Public Release of the Draft Environmental Assessment/Initial Study/Mitigated Negative Declaration, posted on the Corps' website; and other materials in our files on dredging and beneficial re-use studies that overlap the locations in this pilot project (Redwood City Harbor, Eden Landing). Coordination with other agencies involved brief, recent contact with the National Marine Fisheries Service (NMFS) and California Department of Fish and Wildlife (CDFW), however, these agencies are expected to comment independently as well as conduct any necessary consultations for special status species under their authority.

PURPOSE AND NEED

San Francisco baylands (mudflats, marshes) are an extremely important regional fish and wildlife habitat resource, supporting numerous species of birds, fish, and mammals including several endangered species. About 90% of historic tidal marshes have been lost, much at the expense of urban and salt pond development, and the remainder is under continuing threat as a result of subsidence, global sea level rise, and reduced sediment inputs due to dams throughout the region. Although there are major opportunities to restore an estimated 60,000 acres of baylands, a vast quantity of sediment is needed to supplement low levels of natural deposition, and raise surface elevations enough to outpace sea level rise as well as to provide for vegetation establishment that can better trap sediments.

Dredged material from maintenance or new construction of area navigation channels represents the key source of sediment that can potentially be used to conduct tidal habitat restoration, but the primary restoration method to date has involved direct placement of the material after transporting it to the restoration site. Although precise and effective, direct placement is costly and often impractical for many restoration sites inaccessible by barge. An alternative concept which would be tried with the proposed pilot project is "strategic placement", which is to place the material near enough to an intended restoration site, under circumstances of location and seasonal timing, that natural processes over time would move the placed material towards that restoration site. As such, strategic placement can be considered a type of "engineering with nature". The strategy in strategic placement is the use of screening criteria and modeling during project planning to optimize the desired effect while minimizing impacts and costs.

Currently, much of this maintenance dredged material is disposed at approved, designated sites such as SF-DODS (open ocean 55 miles west of the Golden Gate), and SF-11 (in-Bay, near Alcatraz Island). The intent of this type of disposal is to minimize impact, by transporting it far away - as with ocean disposal, or placing it in a site where it will disperse quickly - as with Alcatraz. Material placed at these sites may minimize impacts but it does not enhance habitat. If successful, strategic placement would greatly increase the amount of this material for the purposes of habitat restoration and protection. Moreover, the cost of disposal would be much less than direct placement - which can involve both transportation cost, other substantial placement costs such as offloading facilities to receive and slurry dredged material, piping and pumps to distribute material, and/or tipping costs where these facilities exist (e.g., at permitted sites such as Montezuma Wetlands). Ideally, strategic placement would be done close to the dredge site so it is less costly to transport than ocean or in-Bay disposal.

PROPOSED PROJECT

The proposed project is one of 10 pilot projects funded under Section 1122 of the Water Resources Development Act of 2016 (beneficial use of dredged material). It is a relatively new concept that has not yet been tried in San Francisco Bay and there are few examples world-wide. Many factors can affect the outcome. The Corps applied a screening process to a dozen candidate sites to select one for the pilot project which would be accessible by light-loaded scows, maximize the desired result of having material move from the placement site towards the intended bayland, and minimize effects to eelgrass or listed species. The result of this screening process was the identification of two potential sites that met most of the criteria: Eden Landing (Whale's Tail), located on the east shore of south San Francisco Bay; and Emeryville Crescent, located on the east shore of central San Francisco Bay.

The Corps contracted a consultant to conduct several rounds of three-dimensional modeling of placement scenarios at these two sites that varied in material source, time of year, placement depth, and scow volume (Anchor 2022). Using the simulations from this modeling, the placement option that was predicted to perform best, and is the proposed project, would involve summer placement of about 100,000 cubic yards of dredged material in a 138 acre grid located 1-2 miles west of Whale's Tail marsh in Eden Landing in moderately shallow water during flood tide (9-12 feet absolute depth). Light-loaded scows, about 900 cy per trip (112 round trips), will be used to transport material from the preferred dredge site at Redwood City Harbor to the placement grid. The grid is 9,700 feet long and 630 feet wide. For modeling purposes the grid was assumed to be divided into 24 cells which would each receive 4 or 5 scow loads of dredged material. Redwood City Harbor is not only relatively close to Eden Landing, but the lower sand content of the sediments there will disperse more effectively from the placement site towards shore than higher sand content soils at Oakland Harbor. It will take roughly 19-56 days to conduct the pilot project, depending on the volume of dredged material generated daily. The dredging and placement will take place in June-July 2023.

The placement grid and the mudflat/marsh complex of Eden Landing east of the grid will be monitored for a period 2 months prior to placement to about a year after placement. Monitoring will include oceanographic data, bathymetry, several sediment tracer studies (open water and marsh), sediment cores (physico-chemical and biological), sediment deposition pads, and eelgrass surveys.

BIOLOGICAL RESOURCES

The Redwood City Harbor dredge and Eden Landing (Whale's Tail) locations are fairly well documented in prior planning studies that involved the Service under FWCA in dredging projects (USFWS 2015) and from the South Bay Salt Pond Restoration Program (SBSPRP) (Moffat and Nichol 2015; SBSPRP 2019). Redwood City Harbor begins at the mouth of Redwood Creek in Redwood City, and continues east between undeveloped Bair and Greco Islands, and various sloughs before turning northeast towards the San Bruno Shoals channel. It is regularly dredged for maintenance and tests prior to dredging have always shown the bulk of the material to be Suitable for Unconfined Aquatic Disposal (SUAD). Typical zooplankton, shrimp, polychaetes, and small fish species occupy the channel waters and benthos.

Eden Landing is a 5,000+ acre preserve complex of former industrial salt ponds managed by CDFW since the late 1990s. It is located along the east shore of south San Francisco Bay, generally between State Highway 92 to the north and the Alameda Flood Control Channel to the south. There are also several major interior tidal channels. Much of the area is shallow open water with surface elevations a couple feet below MLLW. A phased habitat restoration under the SBSPRP is under way with the intent of restoring tidal habitat in most of the area, while retaining some as managed pond (SBSPRP 2019). What is referred to as Whale's Tail is the name given to an area of tidal marsh restored in 1930 on the perimeter of Eden Landing in the vicinity of Old Alameda Creek. It is directly east of the proposed strategic placement grid.

The biological resources of Eden Landing are well documented, and include significant and diverse populations of resident and migratory waterbirds, mammals, and fish, among which are several federally listed species. Federally listed species present at Whale's Tail and the fringe of Old Alameda Creek include the endangered salt marsh harvest mouse (*Reithrodontomys raviventris raviventris*) and endangered California Ridgeway's rail (*Rallus obsoletus obsoletus*). Longfin smelt (*Spirinchus thaleichthys*), recently proposed for federal endangered status, and endangered steelhead trout (*Oncorhynchus mykiss*; Central California Coast Distinct Population Segment) may be present in the tidal channels. Endangered California least tern (*Sterna antillarum browni*) and threatened western snowy plover (*Charadrius nivosus nivosus*) have been documented in other specific non-tidal ponds in Eden Landing, areas which are unlikely to be affected by the proposed project.

In its current state, the habitat types within the area potentially affected by the pilot project include shallow tidal marsh in recently restored areas, open waters of recently breached ponds, tidal channels with fringes of marsh, a significant band of mudflat beyond the tidal marsh, and occasional eelgrass in deeper waters beyond the mudflat. Areas with eelgrass provide cover and epiphytic food organisms that attract small fish, invertebrates, and diving birds. The slightly deeper waters beyond the eelgrass would have fish and benthic invertebrate fauna, but a less abundant and diverse assemblage with substantially no terrestrial birds or mammals.

EFFECTS

The modeling included simulations of bathymetric changes and dispersion of the placed material which can be used to estimate impacts. Each barge load release is predicted to result in a mound below the scow of 4-12 inches deep. A short term plume of sediment around 50-300 mg/L (total suspended sediment concentration) over baseline conditions would form and last about 20 minutes. Dissolved oxygen would also be temporarily reduced. In 2 month simulations, a few millimeters or less of the material is predicted to deposit in the mudflat and marsh after the pilot project is complete. This thickness is highly unlikely to elicit detectable adverse effects on these habitats, or on the special status species within them. Nevertheless, the proposed monitoring should be sensitive enough to determine if material is moving into the habitats at the rate predicted by simulations.

Based on these simulations, the effects on biological resources can be roughly described. There is likely to be some smothering and mortality of benthic biota in the actual placement location. Whatever biofilm and prey organisms are there could experience mortality, and would recover in the intermediate term (months to a year). The effect on eelgrass is difficult to estimate, but is likely to be very low for several reasons. First, recent mapping shows there is not much eelgrass between the placement grid and Eden Landing, but enough to evaluate effects on this plant. Second, while eelgrass can be affected by sediment burial, the expected deposition of a few millimeters is much lower than the 2+ centimeters generally considered minimal to have an effect on eelgrass. Nevertheless, the dredged material is siltier than the native sediment and could have some adverse consequence. Eelgrass will be monitored, and any such unintended effect should be detectable and, according to the Environmental Assessment, would be mitigated at a ratio of 1.2:1.

There could also be minor, very localized, effects on fish that are present below the scows at the time of material release, such as by clogging of gills by the fine sediment plume, exposure to any contaminants associated with the sediment, and reduction in individual fitness or even mortality of individuals. However, the more likely response of fish or other mobile organisms would be for them to move away from the plume and be otherwise unaffected.

The dredged material will be tested prior to the project, but based on testing from prior maintenance episodes, Redwood City Harbor materials will likely be again found to be SUAD (Kinnetic and Atkins 2014). This SUAD finding is typically associated with disposal at approved sites such as SF-DODS or SF-11, and SUAD criteria do not include the same bulk chemical criteria used for direct placement in restoration sites as cover or non-cover (foundation) material determinations. However, the Corps has committed to comply with any regulatory requirements by the Regional Water Board and Bay Conservation and Development Commission. If there is some adverse effect on biota, it is likely to show up during monitoring of the pilot project.

Comparatively, the without project effects are fairly well known because they would be an increment of the effects at SF-11 (Alcatraz) where Redwood City Harbor material is normally disposed. The designation process, past use, and associated monitoring of SF-11 to regulate the volume disposed has shown mounding, turbidity, and temporary suppression of benthic biota, along with physico-chemical changes reflecting the constituency of the dredged material. The pilot project may not change effects at SF-11, because the material diverted from Redwood City Harbor may be replaced by disposal of other dredged material sources up to annual limits.

DISCUSSION AND CONCLUSION

The proposed project is an important and necessary first step in evaluating strategic placement as a means of beneficial use of dredged material for habitat restoration and protection in San Francisco Bay. Based on our review, we agree with the site selection of Eden Landing, the selected summer placement, the “shallow/east” option, and the 900 cy scow loads, as described in the Corps’ draft Environmental Assessment. We consider the proposed monitoring plan to be sufficient to assess the basic and most relevant potential biological effects.

The outcome is not certain but, as with any pilot project, its limited scope will also limit any unintended effects. More importantly, the monitoring will facilitate further development of the approach. This pilot project provides necessary initial information to guide refinement of the strategic placement concept.

Scaled up and routinely used, successful strategic placement can potentially yield important habitat benefits to the San Francisco Bay region, in a manner that is both cost and energy efficient. This efficiency may also incrementally reduce greenhouse gas emissions to the global benefit of resources, compared to that used in the current practice of transporting material to designated sites. It is also an alternative where barge access to direct placement is limited by water depth. We have no recommendations at this time, other than for the Corps to proceed with the pilot project as proposed and report the results.

REFERENCES

Anchor [Anchor, QEA, LLC]. 2022. Hydrodynamic and Sediment Transport Modeling of the San Francisco Bay to Evaluate Pilot Sites for Shallow Water Placement of Dredged Material. Prepared for U.S. Army Corps of Engineers San Francisco District. June 2022. 194 pp. including appendices.

Kinnetic and Atkins [Kinnetic Laboratories and Atkins North America]. 2014. Redwood City Harbor 2014 O&M Dredging Sampling and Analysis Results. Prepared for U.S. Army Corps of Engineers, San Francisco District, by Kinnetic Laboratories, Santa Cruz, California, and Atkins North America, Roseville, California. July 2014. 83 pp.

Moffatt and Nichol. 2015. South Bay Salt Pond Restoration Project Beneficial Reuse Feasibility Study. Prepared for the Coastal Conservancy by Moffat and Nichol, Oakland, California. 211 pp. + appendices.

SBSPRP [South Bay Salt Pond Restoration Project]. 2019. Final Environmental Impact Report, Phase 2, Eden Landing Ecological Reserve. April 2019. Available electronically at https://www.southbayrestoration.org/document/phase-2-eden-landing-final-environmental-impact-report

USFWS [U.S. Fish and Wildlife Service]. 2015. Draft Fish and Wildlife Coordination Act report for the Redwood City Harbor Navigation Project. Prepared for U.S. Army Corps of Engineers, San Francisco District. December 24, 2015. 17 pp.

7. NATIONAL HISTORIC PRESERVATION ACT

This appendix details the ongoing consultation required under Section 106 of the National Historic Preservation Act of 1966. The section 106 process seeks to accommodate historic preservation concerns with the needs of Federal undertakings through consultation among the agency official and other parties with an interest in the effects of the undertaking on historic properties, commencing at the early stages of project planning. The goal of consultation is to identify historic properties potentially affected by the undertaking, assess its effects, and seek ways to avoid, minimize or mitigate any adverse effects on historic properties.

Summary of Ongoing Tribal Consultation

The NHPA requires tribal consultation in all steps of the process when a federal agency project or effort may affect historic properties that are either located on tribal lands, or when any Native American tribe or Native Hawaiian organization attaches religious or cultural significance to the historic property, regardless of the property's location. The USACE and the California Water Quality Control Board contacted the Native American Heritage Commission (NAHC) requesting an updated Native American tribal consultation list for the Project. The Sacred Lands File search was negative. USACE obtained a tribal consultation list from the Native American Heritage Commission (NAHC) on 14 April 2020. The following Ohlone Tribes were identified as tribal consulting parties under Section 106 of NHPA and the National Environmental Policy Act (NEPA): The Amah Mutsun Tribal Band, Amah Mutsun Tribal Band of Mission San Juan Bautista, Costanoan Ohlone Rumsen-Mutsun Tribe, Indian Canyon Mutsun Band of Costanoan, and the Muwekma Ohlone Indian Tribe of the SF Bay Area.

On June 1, 2022, a virtual Tribal consultation meeting was held with the Confederated Villages of Lisjan (CVL). The CVL is interested in the Pilot Project and wants the opportunity for monitoring any environment impacts. The Tribe would also like access to the data that is collected showing the effectiveness of this study and are especially interested in learning if it is successful. When cultural resources were discussed, Chairperson Gould referred to the marsh itself as a cultural resource and explained the loss of the marshes and mudflats resulted in the loss of sacred sites. Tribal consultation is ongoing, and a site visit with the CVL Tribe will be scheduled in Fall of 2022.

Summary of Ongoing Consultation with the State Historic Preservation Officer

Consultation with the State Historic Preservation Office (SHPO) was initiated on July 25, 2022, for delineation of the Area of Potential Effect (APE) and the Corps' efforts to identify historic properties located within the APE (36 CFR § 800.4) (see Tribal Consultation and SHPO Consultation letters included). Future consultation will be completed to assess the effects of the undertaking on the resources with SHPO and the Tribes. This consultation will establish if the effects on historic resources are adverse, which is based on criteria established in 36 CFR Part 800 of the ACHP regulations.

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, CORPS OF ENGINEERS
450 GOLDEN GATE AVENUE, 4TH FLOOR, SUITE 0134
SAN FRANCISCO, CA 94102-3406

April 7, 2022

SUBJECT: Strategic Shallow Water Placement Pilot Project

Ms. Irene Zwierlein
3030 Soda Bay Road
Lakeport, CA, 95453

Honorable Chairperson Zwierlein,

The U.S. Army Corps of Engineers San Francisco District (USACE) and San Francisco Bay Water Quality Control Board (Water Board) are reaching out to Tribes that may have interests in the project area. Our purpose is to inform you of the Strategic Shallow Water Placement Pilot Project (Project) during the early phase of environmental planning. Foremost, we invite you to be a part of the planning process out of respect for your unique experience and knowledge, and to collaborate regarding any tribal interests that may be affected by the Project.

USACE is pursuing the Project in accordance with section 1122 of the Water Resources Development Act of 2016 to explore possibilities for beneficially using material dredged from San Francisco Bay Federal navigation channels. The Project goal is to learn how dredged material can be used to enhance wetland recovery to protect communities from storms and rising seas. As a part of the National Environmental Policy Act process, USACE would welcome your engagement on the Project.

Similarly, the Water Board would appreciate your involvement in advance of preparing a document to satisfy the California Environmental Quality Act. The Water Board requested from the Native American Heritage Commission a list of Tribes in or associated with the project area and identified that no Tribes on the list have requested AB52 Consultation. However, in accordance with the Water Boards' Tribal Consultation Policy[1] and Executive Order B-10-11[2], are seeking consultation with California Native American Tribes with interests in project area. The Water Board values tribal input and aspire to educate both staff and Tribes, thus enhancing our activities, policies, and decision-making process and want to understand the unique tribal interests that may be affected by the proposed project.

USACE and the Water Board recognize the regional need to beneficially use sediment from federal dredging projects to support nature-based solutions to adapt to climate change. This Project will place dredged material in shallow water along the Bay's shoreline and utilize natural transport processes to move dredged material to mudflats and marshes (Figure 1). More specifically, we will use a method known as shallow-water placement. This method uses shallow-draft scows to place dredged sediment where it can be readily resuspended by tidal and

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[1]https://www.waterboards.ca.gov/about_us/public_participation/tribal_affairs/docs/california_water_board_tribal_consultation_policy.pdf
[2] https://www.ca.gov/archive/gov39/2011/09/19/news17223/index.html

wind-wave action and then transported by tidal currents. This will increase the resilience of mudflats and marshes using innovative and cost-effective measures.

For this Project, two in-Bay sites are currently being considered: one is adjacent to the Emeryville Crescent Ecological Reserve and the other is adjacent to Whale's Tail Marsh at Eden Landing (Figure 2). We are working with the U.S. Geological Survey to develop protocols for monitoring environmental impacts before, during, and after placement of the dredged material. If possible, we would like to work with Tribes, local community members, and citizen scientists to help monitor the Project's effectiveness.

Currently, we are seeking your input on site selection, developing monitoring plans, and identifying potential impacts to any historic properties that may be in the project area. Your Tribe's involvement will ensure that recommendations and concerns are addressed in our environmental reviews. By expressing your interest in the project, you will be actively informed of the steps we are taking to identify and preserve important places in the San Francisco Bay Region. Your views and comments will ensure that our undertaking incorporates historic preservation when necessary and fulfills the spirit of public stewardship advocated through section 106 review of the National Historic Preservation Act and its implementing regulations at 36 C.F.R. § 800.4(a)(3).

We hope to engage with you prior to public meetings for the Shallow Placement Project, scheduled to begin in May, and a public comment period for the environmental studies which we expect to be available in June. Once the environmental reports are finalized, the project is proposed to begin in the summer of 2023. The USACE and Water Board are available to consult with you on this project, either individually or jointly, at your convenience (e.g., one-on-one meeting or virtual workshops). If you have any comments or questions, please contact USACE's archaeologist Stephanie Bergman at (415) 503-6844 (Stephanie.M.Bergman@USACE.Army.Mil), or the Water Board's Engineering Geologist Lindsay Whalin at (510) 622-2363 (Lindsay.Whalin@waterboards.ca.gov). Thank you for your time and consideration; we look forward to hearing from you.

Sincerely,

Dr. Tessa E. Beach, Environmental Branch Supervisor, San Francisco District

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and

Digitally signed by Thomas Mumley
Date: 2022.04.14 08:47:45 -07'00'

Thomas Mumley, Interim Executive Officer, Water Board

Enclosures
Figure 1: Figure 1: Diagram of Strategic Shallow Water Placement method.
Figure 2: Potential site locations for the beneficial use of dredging materials in marshes and mudflats.

Additional Contacts

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Xavier Fernandez, Water Board Planning/TMDL Division Manager
Xavier.Fernandez@waterboards.ca.gov / 510-332-7318

Samantha Harper, Water Board Tribal Coordinator
Samantha.Harper@waterboards.ca.gov/ 510-622-2415

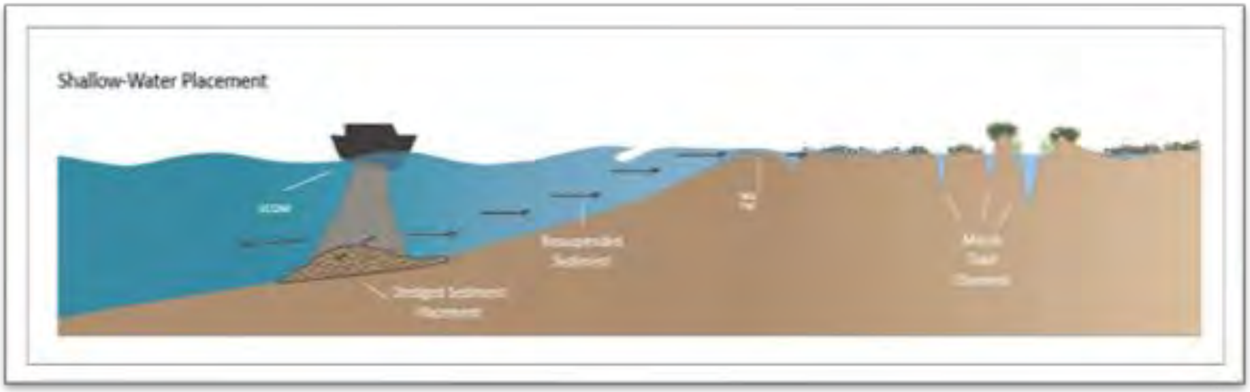

Figure 1. Using natural processes to achieve beneficial use of dredge material, placed in nearshore shallows of SF Bay.

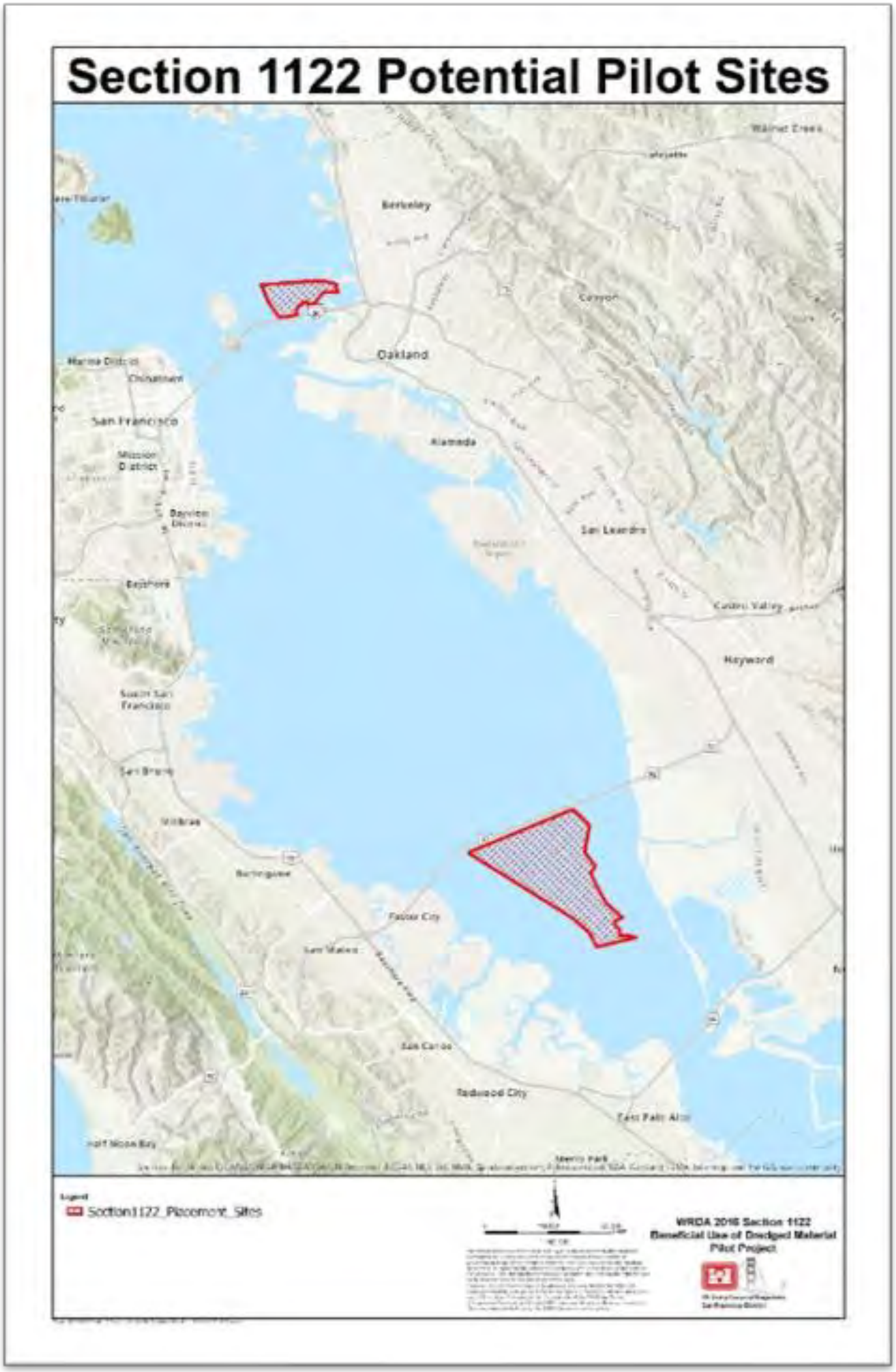

Figure 2: Potential Pilot Site locations in the San Francisco Bay for the study. Note, the proposed pilot project is only for offshore placement, as opposed to direct placement on marshes.

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, CORPS OF ENGINEERS
450 GOLDEN GATE AVENUE, 4TH FLOOR, SUITE 0134
SAN FRANCISCO, CA 94102-3406

July 21, 2022

SUBJECT: Strategic Shallow Water Placement Pilot Project

Julianne Polanco
State Historic Preservation Officer
California Office of Historic Preservation
1725 23rd St., Suite 100
Sacramento, CA 95816

Dear Ms. Polanco,

The U.S. Army Corps of Engineers San Francisco District (USACE) is writing to initiate Section 106 review of the National Historic Preservation Act (54 U.S.C. § 306108) with your office for the Strategic Shallow Water Placement Pilot Project (Pilot Project) during the early phase of environmental planning. USACE is pursuing the Pilot Project with our non-federal sponsor, the State Coastal Conservancy (SCC), in accordance with section 1122 of the Water Resources Development Act of 2016 to explore possibilities for beneficially reusing material dredged from San Francisco Bay federal navigation channels. The in-Bay sediment placement site is two-miles offshore from the Eden Landing Ecological Reserve (ELER), near Hayward in Alameda County. The goal of this project is to place dredge material offshore of an eroding or drowning marsh to nourish the adjacent mudflat, marsh, and restoration habitats. The USACE is writing to consult with the SHPO directly under 36 C.F.R. § 800 for this undertaking.

Description of the Undertaking

The USACE recognizes the regional need to beneficially use sediment from federal dredging projects to support nature-based solutions to adapt to climate change. This Pilot Project will place dredged material offshore in shallow water along the Bay's shoreline and utilize natural transport processes (eg. wind-waves, tides, currents) to move dredged material to mudflats and marshes. More specifically, we will use a method known as shallow-water placement. This method uses shallow-draft scows to place dredged sediment where it can be readily resuspended by tidal and wind-wave action and then transported by tidal currents (Figure 1).

The Section 1122 Pilot Project is planning the sediment placement project near Whale's Tail Marsh, at the Eden Landing Ecological Reserve (ELER) (Figure 2). The project will strategically place 100,000 cubic yards of dredged sediment from Redwood City Harbor federal navigation channel using a dump scow at a shallow (7 – 9 feet depth) subtidal site two miles offshore ELER. Placement will occur over at least 20 days to reduce impacts, and the scow will be lightly loaded in order to get into shallow enough water where sediment can be resuspended for delivery towards the mudflat and marsh. Modeling results show minimal accretion on the adjacent marsh may be ~0.01cm, and ~0.1cm on the mudflats (Figure 3). This is similar to natural accretion rates observed by the U.S. Geological Survey. Modeling results show that 2 months after placement, the change in bathymetry at the placement site will be less than 10cm (Figure 3). This innovative method of placing dredged material will leverage natural, in-bay, hydrodynamic processes to move the sediment placed in shallow water to existing mudflats and marshes, making them more resilient to rising waters.

We are working with the U.S. Geological Survey to develop protocols for monitoring environmental impacts before, during, and after placement of the dredged material. The monitoring program will be implemented for a minimum of 1.5 years. Before the placement of dredged materials, there will be bathymetry and topography surveys of the placement site, in addition to studies of wave conditions, water quality (eg. suspended sediment concentrations), and benthic communities. There will also be eelgrass surveys, and ongoing documentation of marsh accretion rates. After the placement, there will be re-surveys of the placement site; including benthos, eel grass, recovery; and marsh and mudflat accretion. In addition, we will work with Tribes, local community members, and community scientists to help monitor and communicate the Project's effectiveness.

Defining the APE for the Project

The USACE is defining the Undertaking's preliminary area of potential effects (APE) for direct effects to cover the offshore placement site (~138 acres) and the marsh and mudflats within the western extent of the EDER (~2,500 acres), including all monitoring sites (Figure 4). The vertical APE is a minimum depth of 2' and maximum depth of 10' below the surface of the Bay. The APE for indirect effects includes access routes to monitoring sites located within the ELER, and a large buffer around both the placement and depositional site. The APE overlaps the project boundary of the South Bay Salt Ponds Restoration Project, also occurring at the ELER.

Cultural Resources Identified in the APE

The USACE completed a records search on 16 May 2022 at the Northwest Information Center located in Sonoma State University. Records were also reviewed online for results from underwater surveys at NOAA's Automated Wreck and Obstruction Information System (AWOIS), in addition to T-Charts from the U.S. Coast Survey located at https://historicalcharts.noaa.gov/. Four archaeological survey reports, an MA thesis, and an MOA between the US Fish and Wildlife Service (FWS) and SHPO, were reviewed within a one-mile radius of the APE. The entire study area has gone through extensive reconnaissance as well as archival research. Surveys have been funded by government agencies, including the FWS and CalTrans, since the early 1980s. The results of the records search show there is one eligible historic district--HALS-CA-91, the Eden Landing Salt Works landscape--located within the APE, and ten cultural resources are located within or contributing to the ELER Historic District (Table 1). Additionally, the San Mateo Bridge is an eligible historic property adjacent to the APE.

The offshore placement site was surveyed for cultural resources beginning in 1996, when a seismic retrofit for the San Mateo Bridge was first proposed. Numerous other inventories were completed for ecological restoration work at Eden's Landing as part of the South Bay Salt Pond Restoration Project, which resulted in the identification of the ELER Historic District located in the southern end of San Francisco Bay (Figure 5). The Historic District encompasses 6,612 acres divided into 23 ponds and is being mitigated for ecological restoration, which will focus on restoring the salt ponds to naturally functioning, tidally influenced salt marsh which requires breeching levees and opening ponds to the tides, building levees between the newly restored tidal marsh areas and local communities, and restoring habitat features.

Eden Landing was placed on the Nation Register of Historic Places (NRHP) because it is the birthplace of SF Bay's solar salt industry, which grew to be one of the world's largest salt producers. Beginning in the 1850s, Eden Landing's natural conditions of shallow tidal marsh land, relatively dry summers, and navigable creeks that provided shipping points, were critical features for developing the salt industry. The Eden Landing Salt Works landscape encompasses elements that include archaeological features, salt ponds, and water control structures from three of the original salt company operations that provide an essential link to the earliest period of this important industry.

The initial salt production operations at Eden Landing consisted of small, family-owned parcels of less than 50 acres. There were nearly 30 different salt works located within the Eden Landing area between 1850 and 1910. One of the largest salt operations was the Union Pacific Salt Company which was in continuous production from 1872 to 1927. The Oliver Salt Company was among the few nineteenth century salt producers that continued operation into the 1920s. Between 1910 and 1930 the industry began consolidating as the market demand for salt increased beyond the capacity of the small producers. In 1930 the number of operators dropped from 28 to only five; and by the 1940s Leslie became the only major operator. The small ponds have been altered to meet modern large-scale production needs.

Ten cultural resources have been recorded within the Eden Landing Salt Works Historic Landscape, all of which are related to the historic period of salt manufacturing (Table 2). Four sites have been determined eligible, five sites have been determined ineligible, and one site is unevaluated. And, one architectural resource, the Archimedes Screw Windmills has been determined to be a contributing element of the Eden Landing Salt Works historic landscape.

Section 106 Consulting Parties Identified

The USACE and the California Water Board contacted the Native American Heritage Commission (NAHC) requesting an updated Native American tribal consultation list for the Project. The Sacred Lands File search was negative. USACE obtained a tribal consultation list from the Native American Heritage Commission (NAHC) on 14 April 2020. The following Ohlone Tribes were identified as tribal consulting parties under Section 106 of NHPA and the National Environmental Policy Act (NEPA): The Amah Mutsun Tribal Band, Amah Mutsun Tribal Band of Mission San Juan Bautista, Costanoan Ohlone Rumsen-Mutsun Tribe, Indian Canyon Mutsun Band of Costanoan, and the Muwekma Ohlone Indian Tribe of the SF Bay Area.

On June 1, 2022, a virtual Tribal consultation meeting was held with the Confederated Villages of Lisjan (CVL). The CVL is interested in the Pilot Project and wants the opportunity for monitoring plants and the environment. The Tribe would also like access to the data that is collected showing the effectiveness and impacts to the environment that result from this study and are especially interested in learning if it is successful. When cultural resources are discussed, Chairperson Gould referred to the marsh itself as a cultural resource and explained the loss of the marshes and mudflats resulted in the loss of sacred sites. A site visit with the CVL Tribe is scheduled for August.

National Environmental Policy Act and Early Public Scoping

Outreach meetings held for the public were widely attended by members from the City of Hayward and the East Bay Regional Park District. Enthusiasm for the project and interest in citizen science monitoring was expressed by several attendees. Two Resource Agency Working Group (RAWG) meetings were held on March 26, 2021, and June 23, 2022, and a public CEQA scoping meeting was held on June 15. Representatives from the SHPO attended the June 23rd meeting. We invite the SHPO to continue to participate in the environmental review process as a participating agency, per requirements of 40 C.F.R. Part 1501.8. We ask that you respond in writing to confirm or reject your participation. Consistent with 40 C.F.R. Part 1501.8, we will assume your agency to be a participating agency if no response is received.

Future SHPO Consultation

USACE is consulting with your office to comment on our identification efforts and will next consult on the assessment of effects to historic properties within the APE pursuant to 36 C.F.R. § 800.4 and 36 C.F.R. § 800.5. Currently, USACE is seeking your agreement on our delineation of the APE and your office's response to serve as a NEPA participating agency. Thank you for reviewing this project, and we respectfully request your response within 30 days of receipt of this letter. If you have any comments or questions, please contact San Francisco District archaeologist Stephanie Bergman by email at stephanie.m.bergman@usace.army.mil, or phone, (415) 503-6844.Thank you for your time and consideration.

Sincerely,

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Julie R. Beagle, Environmental Section Lead, San Francisco District

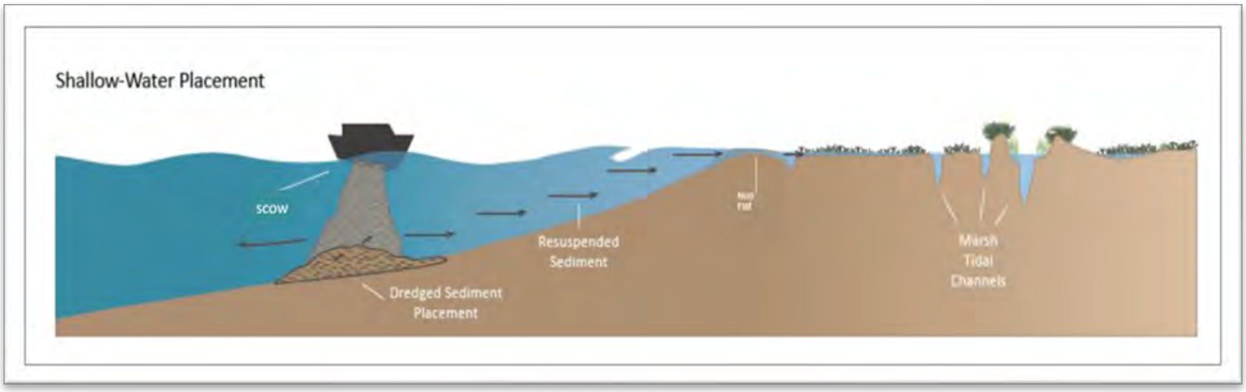

Figure 1: Using natural processes to achieve beneficial use of dredge material, placed in nearshore shallows of SF Bay.

Figure 2: The project location is in the southern portion of the SF Bay, with the proposed placement site in red and the targeted area for deposition in blue/ green hash.

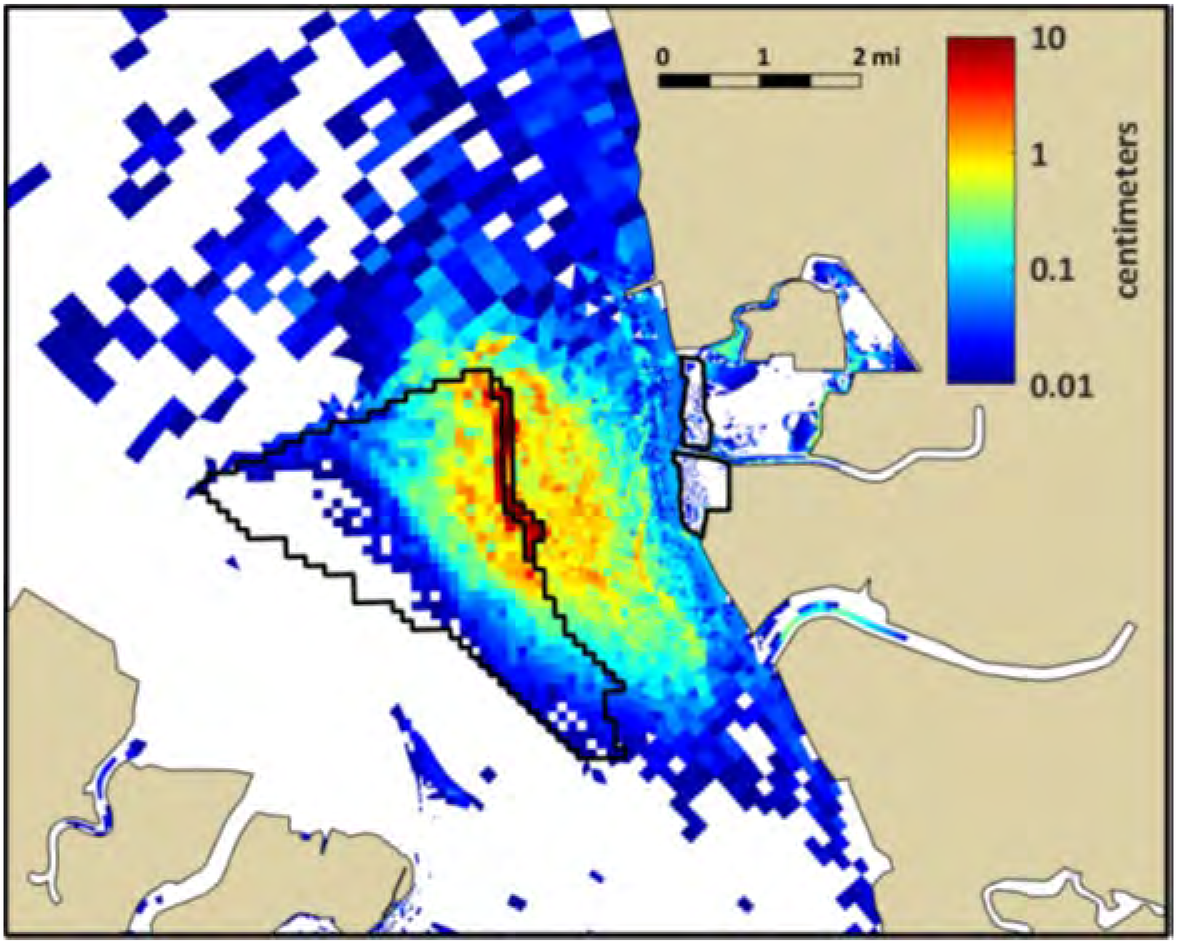

Figure 3: Eden Landing modeling shows shallow/east placement plan view indicating sediment deposition thickness in centimeters after two-month summer model run for 100,000 yd^3.

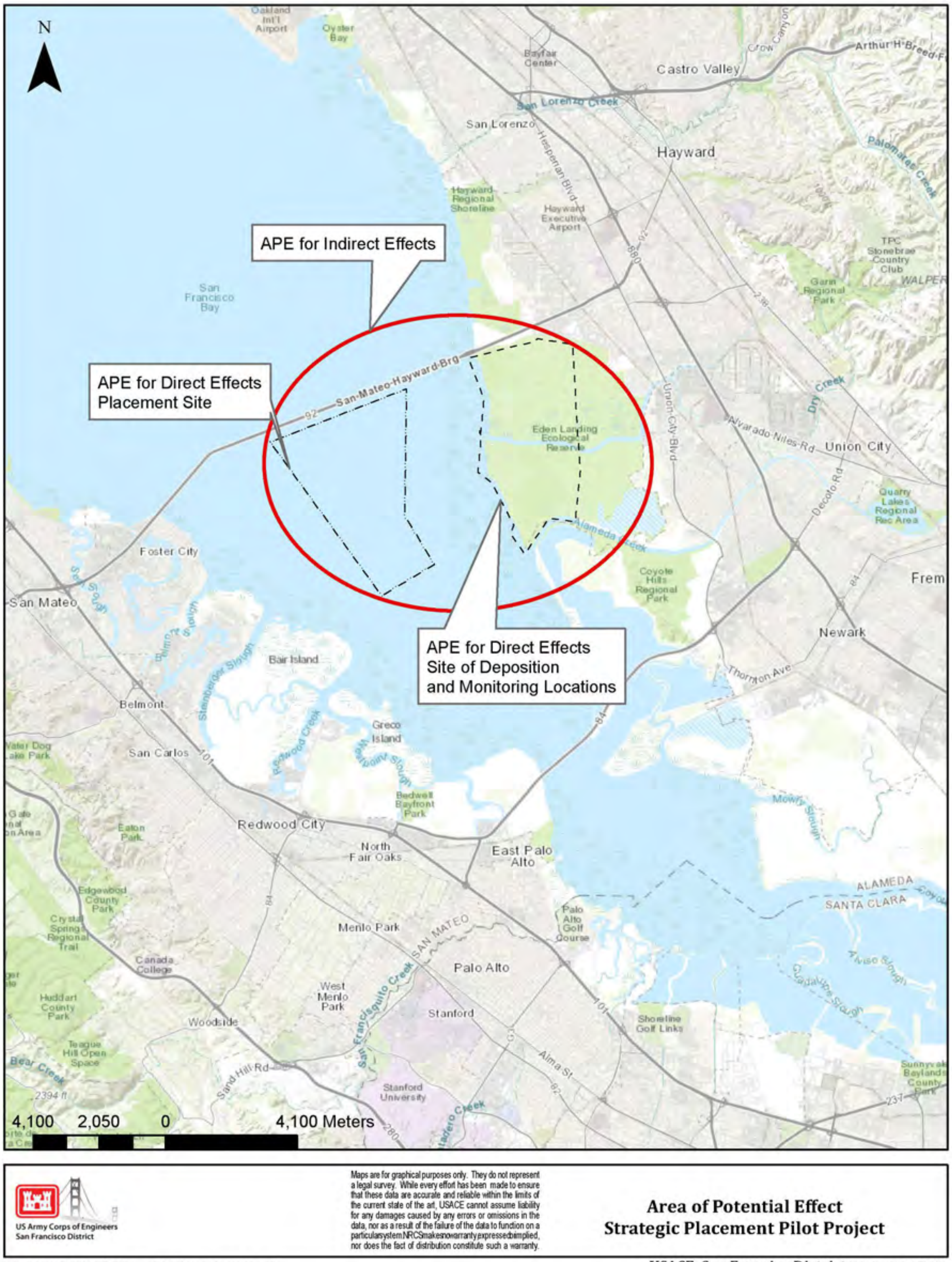

Figure 4: Area of Potential Effects for Direct Effects (placement site, deposition site, and monitoring locations), and buffer to include the APE for Indirect Effects.

Figure 5: One eligible historic district is identified within the APEs, the Eden Landing Salt Work Historic Landscape.

Trinomial Site no.	Primary Site no.	Eligibility	Description
CA-ALA-489H, -501H	P-01-000217	Yes	Eden Landing historic shipping station
CA-ALA-494H	P-01-000210	Yes	Oliver Salt. Co. piling and foundations
	P-01-010740	Yes	Archimedes Screw Windmill
CA-ALA-495H	P-01-00212	No	Former Rocky Point Saltworks—no surface remains
CA-ALA-497H		Yes	Pilings from former Union Pacific Salt
CA-ALA-498H	P-01-214	No	Saltworks, not relocated
CA-ALA-499H	P-01-215	No	Modern refuse scatter
	PF-1	Yes	Whisby Salt Works refuse scatter
	P-01-010834	No	Union City Alvarado Salt Ponds
	FWS-07-12-1	Yes	J. Quigley Alvarado Salt Works, refuse scatter

Table 1: List of identified cultural resources located within the Eden Landing Salt Work Historic Landscape.

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, CORPS OF ENGINEERS
450 GOLDEN GATE AVENUE, 4TH FLOOR, SUITE 0134
SAN FRANCISCO, CA 94102-3406

November 22, 2022

SUBJECT: COE_20220725_001, Section 106 Review for the Strategic Shallow Water Placement Pilot Project

Julianne Polanco
State Historic Preservation Officer
California Office of Historic Preservation
1725 23rd St., Suite 100
Sacramento, CA 95816

Dear Ms. Polanco,

The U.S. Army Corps of Engineers San Francisco District (USACE) is writing in response to a letter received from SHPO dated August 23, 2022, regarding the delineation of the APE and comments on identification efforts for the Strategic Shallow Water Placement Pilot Project. The below response provides clarity to SHPO's comments on how the APE is being defined for the Pilot Project and ensures the USACE is making a "reasonable and good faith effort" to identify historic properties as set forth in the regulations (36 CFR § 800.4(b)(1)).

The USACE is requesting expedited consultation pursuant to 36 CFR § 800.3(g) for review and comment on our identification results and finding of no historic properties affected for the proposed Pilot Project.

Response to SHPO's Comments

1) **SHPO Comment**: The COE describes the purpose of the undertaking as fulfilling a need to beneficially use sediment from federal dredging projects, and that this undertaking proposes to strategically place 100,000 cubic yards of dredged sediment from the Redwood City Harbor federal navigation channel. Please clarify if the referenced dredging is part of this undertaking. If the dredging is not part of the undertaking, please clarify if the COE has concluded the dredging is a separate federal undertaking, and if so, if the Section 106 process has already been conducted.

USACE Response #1): The dredging is a separate federal undertaking, and the Section 106 process has already been completed. The USACE shared the NEPA documentation that summarizes the Section 106 review for maintenance dredging in the

Redwood City Harbor during informal SHPO consultation with SHPO staff, via email correspondence on May 13, 2022. An online copy of this documentation can also be found at: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.spn.usace.army.mil/Portals/68/docs/P%20and%20Programs/Navigation/Fed%20Nav%20Channels_FEAEIR_FONSI%202015.pdf.

2) SHPO Comment: The COE's description of the APE includes areas with the potential for different types of effects as shown on Figure 4, attached to the COE's letter. Please note that the SHPO's understanding of the definition of an APE pursuant to 36 CFR § 800.16(d) comports to the area described by the COE as the "APE for indirect effects" with a vertical extent of up to 10-feet below the surface of the Bay. This APE as shown at Figure 4 as the "APE for indirect effects" appears appropriate for the undertaking as described by the COE. Additional to the clarification on the dredging, if the COE does not consider the area delineated as the "APE for indirect effects" to be the APE, please provide clarification.

USACE Response #2): The preliminary APE for this Pilot Project includes an area for direct effects which consists of the placement site (~138 acres) and the marsh and mudflats within the western extent of the Eden Landing Ecological Reserve (~2,500 acres), comprising all monitoring sites (Figure 1). The vertical APE (also analyzed here for direct effects) is a minimum depth of 2' and maximum depth of 10' below the surface of the Bay. The indirect effects analyzed for this Pilot Project include the temporary noise and visual disturbances by the placement of sediment over a two-month period in the summer of 2023. The APE has been refined to reflect this.

The entirety of the APE for direct effects is 2-10' below surface, as the project is occurring underwater. Material will be placed on the bay floor and sediment will be moved by natural forces. All modeling for the study indicates a maximum sediment deposition thickness of ten centimeters, and a minimum thickness of 1 mm within the APE (Figure 2). The objective of the study is to measure the effectiveness of this one-time placement project through multi-year monitoring. Material will be monitored as it moves through natural waves and tides onto the mudflat and marsh. The magnitude of the project and the extent of potential effects to historic properties is very negligible.

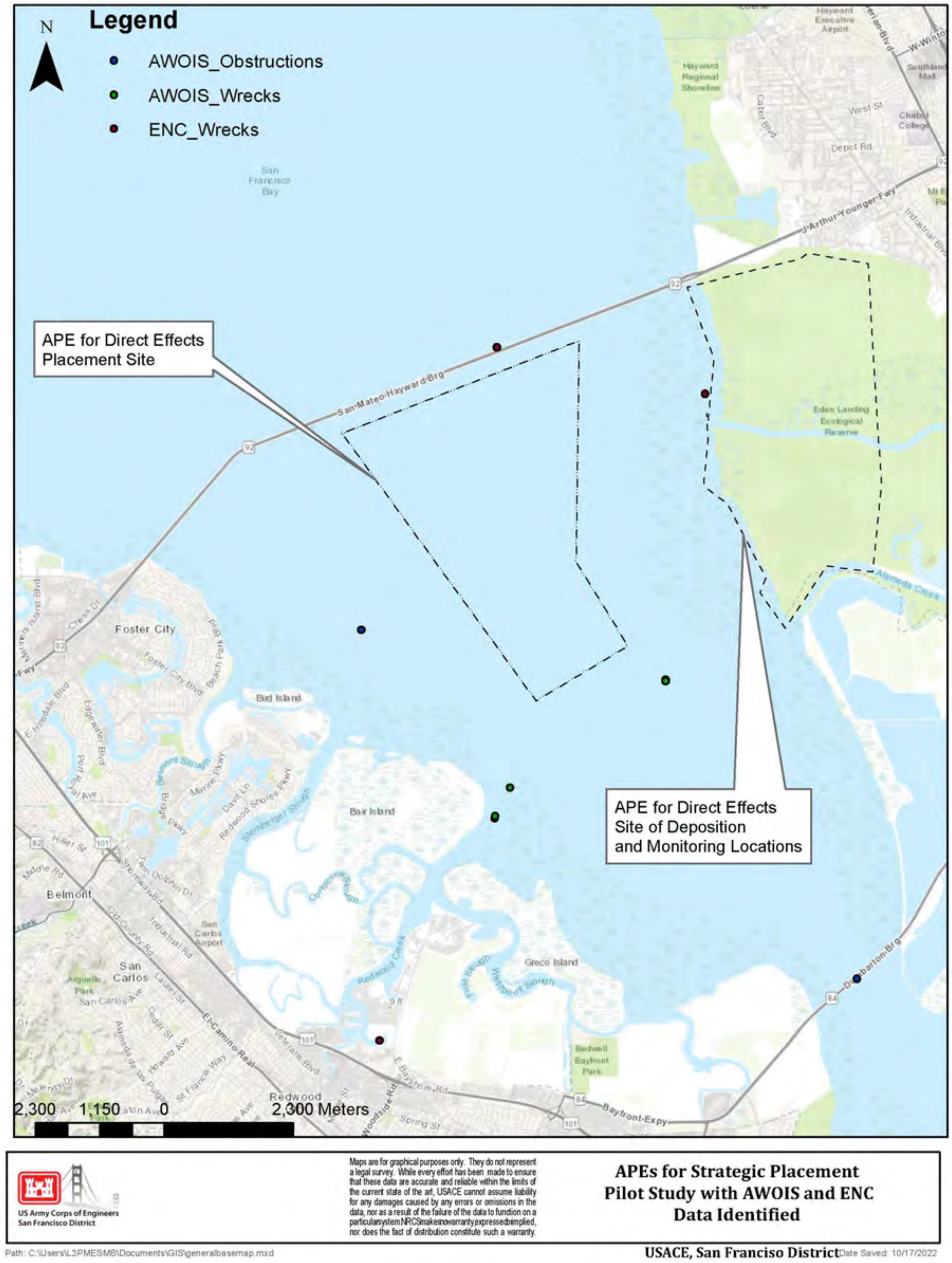

Figure 1: Redefined APE and the results of NOAA's Automated Wreck and Obstruction Information System (AWOIS) database.

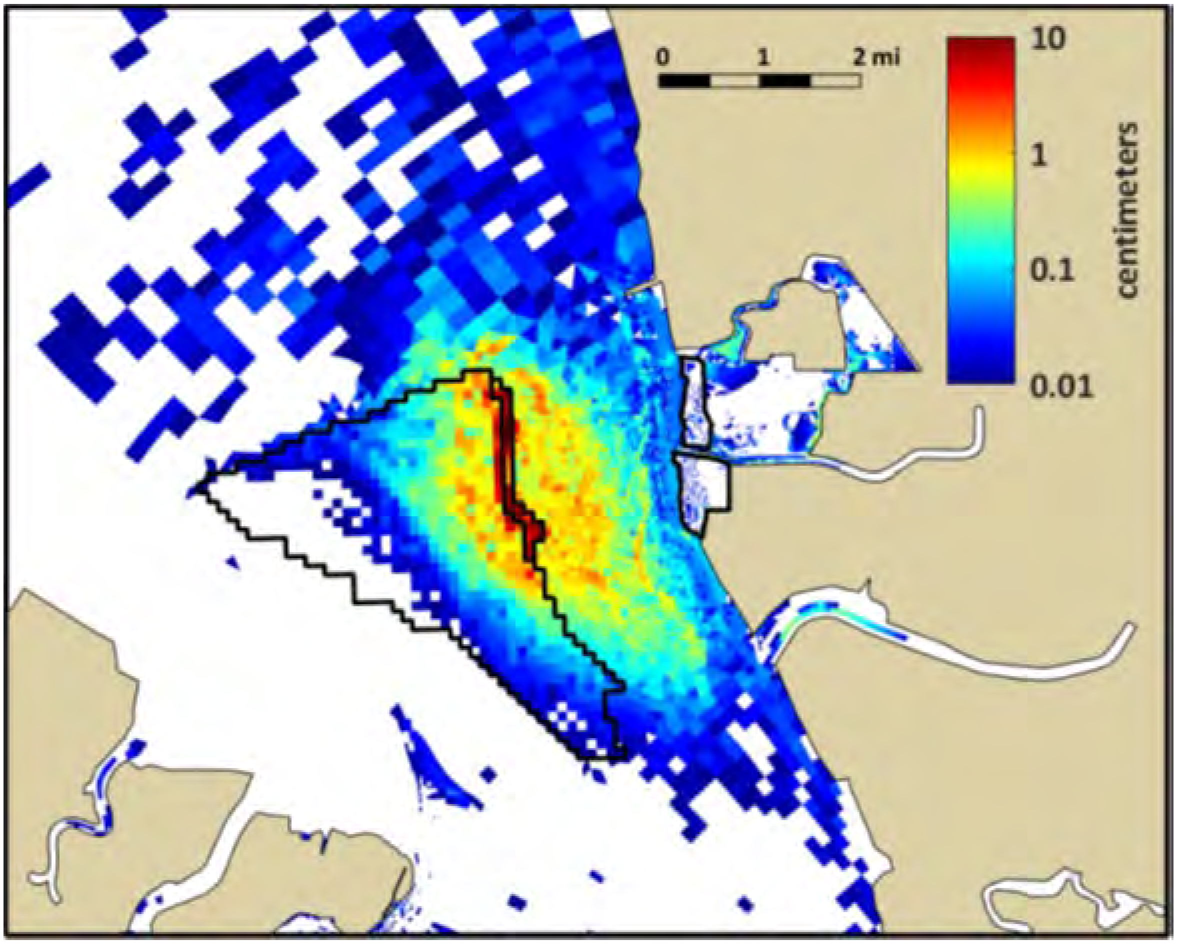

Figure 2: The APE is delineated from the Eden Landing modeling results, which show the shallow placement plan view indicating sediment deposition thickness in centimeters after placing a total of 100,000 yd3 of sediment over the course of two months. Total sediment thickness in the APE measures from 1 mm to 10 cm, which is insufficient to cause affects to historic properties. The direct placement site is the eastern edge of the black polygon where the red is concentrated.

3) **SHPO Comment:** In future consultations, please include a copy of the NAHC response to the Federal agency to document the results of the Sacred Lands File search and the date of the provided contact list. When the Federal agency is using a standardized letter to contact those on the provided NAHC list, only one example of the letter need be submitted with the COE's consultation package to the SHPO.

USACE Response #3: Noted. A copy of the Tribal letter initiating consultation is enclosed. A site visit with Chairperson Corrina Gould and other members of the Confederated Villages of Lisjan occurred on October 5, 2022. The USACE and CVL will schedule regular meetings to share information from monitoring and overall project effectiveness as the Tribe hopes the project will help save the marsh, which is culturally significant. The Tribe will also come back during the summer to watch the project as it is implemented.

4) **SHPO Comment**: The COE states a search of NOAA's Automated Wreck and Obstruction Information System (AWOIS) and T-Charts from the U.S. Coast

Survey was conducted but has not provided the results of that search. Please provide the results of the conducted search.

USACE Response #4) Figure 1 shows the results of the AWOIS data. Several T-Charts were also reviewed, with only one reference to a “Pile” located offshore of Eden Landing. This reference point also appears as an ENC Wreck data point but is located outside the APE. It is possible this reference point indicates a variety of piers and lines of posts that are revealed during low tide and relate to the earlier pond divisions developed for salt production.

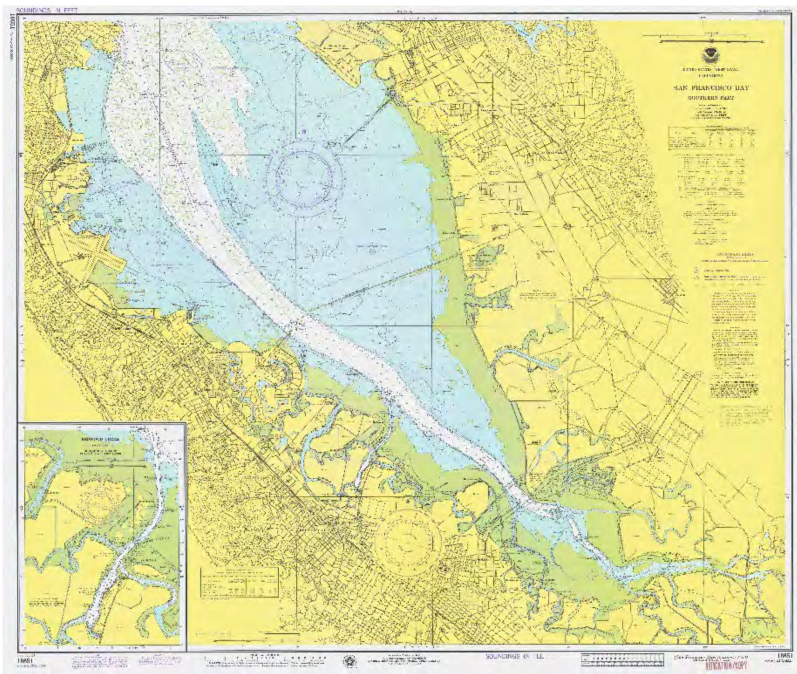

Figure 3: Example of one of the T-Charts Reviewed for the Project Area.

5) **SHPO Comment:** The COE states a search of NOAA’s Automated Wreck and Obstruction Information System (AWOIS) and T-Charts from the U.S. Coast Survey was conducted. It is unclear if this research was sufficient in providing enough data to conclude a reasonable and good faith effort has been made to identify historic properties in the underwater portion of the APE. Generally, a remote sensing survey (I.e., side-scan-sonar, multibeam sonar, magnetometer or subbottom profiler, etc.) is considered a standard method for identifying cultural resources that have the potential to be eligible for inclusion in the National Register. This is the underwater equivalent of a pedestrian survey for terrestrial archaeology. It is recommended a cultural resources underwater survey be conducted or the COE’s convey their reasoning if the Federal agency determines

no identification efforts for the underwater APE are warranted pursuant to 36 CFR § 800.4(b).

USACE Response #6) It is USACE archaeologist Stephanie Bergman's professional recommendation that the federal agency has completed a good faith effort to identify submerged cultural resources for the scope of this pilot study. Please consider the level of effort to identify historic properties in relation to the project's potential to effect historic properties. The pilot study will temporarily place a *maximum of 10 cm of sediment* on the Bay floor. This is very distinct, and novel, compared to disposal sites typically used for dredging projects. This is a nature-based approach to supporting mudflats and marshes which are projected to drown with sea level rise. The project is adding a small amount of sediment to a very turbid bay, where sediment is being moved around all the time to such a high degree that we may not be able to even monitor this type of placement. In this way we are mimicking a natural process, with only minor additions to the depositional environment.

If the project is successful, Eden Landing and other placement sites around the Bay will be selected for repetitive sediment placement and further Section 106 analysis will be completed at that time.

7) The COE states that the offshore placement site was surveyed for cultural resources beginning in 1996, when a seismic retrofit for the San Mateo Bridge was first proposed. If the COE proposes that the survey addresses the above comment, please convey the information the Federal agency used from that survey to make their conclusion and a copy of the survey report.

USACE Response #7) Upon further review I determined the 1996 status report for the seismic retrofit for the San Mateo Bridge does not detail the surveys adequately. However, the information is not warranted as the San Mateo Bridge is not a part of the APE.

8) **SHPO Comment:** The COE identified the Eden Landing Salt Works Historic Landscape (P-01-000217) within the APE and states it has been placed on the National Register of Historic Places. If this property is listed on the National Register, please convey its listing number. If the property has previously been determined eligible for inclusion in the National Register, and not listed on the National Register, please clarify the COE's approach to the Federal agency's obligations pursuant to 36 CFR § 800.4(c).

USACE Response #8:) The Eden Landing Salt Works Historic Landing District is eligible for listing on the NRHP, with SHPO concurrence as shown in the MOA for the South Bay Salt Pond Restoration Project that USACE sent a copy to your office on July 25, 2022. The MOA shows the district has already been evaluated as eligible with concurrence from SHPO. The historic property is not formally listed on the NRHP.

9) **SHPO Comment:** The COE also states the San Mateo Bridge is an eligible historic property adjacent to the APE. Please provide the information the Federal

agency used to come to this conclusion, provide the evaluation and state the Federal agency's determination of eligibility for this property's inclusion in the National Register pursuant to 36 CFR § 800.4(c)

USACE Response #9): Evaluating historic properties *adjacent* to the APE is not required. The large buffer for indirect effects has been removed in the redefined APE, based off modeling results, which further removes the San Mateo Bridge for analysis during this review.

10) **SHPO Comment:** The COE describes the Eden Landing Salt Works Historic Landscape as consisting of ten cultural resources. The COE provided a table attached to their letter listing the ten sites' trinomial numbers, primary numbers, other identifiers (temporary numbers), eligibility, and descriptions. It is unclear from the COE's letter and accompanying table if the ten resources are individually eligible/not eligible for inclusion in the National Register, and also if they are contributors/not contributors to the Historic Landscape, and the information the COE used to make those conclusions.

USACE Response #10: As per Response #8, the historic landscape is already subject to an MOA for the South Bay Salt Pond Restoration project. The list of identifiers and eligibility of resources were identified per the MOA. All cultural resources in the district are behind levees and not subject to tidal influences. The proposed Pilot Project will beneficially protect cultural resources if it is able to stabilize the marsh and keep it intact with sea level rise (SLR).

Figure 4: All cultural resources identified in Phase 2 of the South Bay Salt Pond restoration project at the ELER.

11) **SHPO Comment:** It is recommended that all the **cultural resources** discussed by the COE be shown on an APE map in order to display their spatial relationship to the proposed project activities and better facilitate understanding of the Federal agency's anticipated future assessment of effects.

USACE Response #11) Please refer to Figures 1-3 above.

USACE Finding of Effect

USACE is consulting with your office to demonstrate our identification efforts are adequate and are now requesting your comments on our finding of no historic properties affected. Thank you for reviewing this project, and we respectfully request your response within 30 days of receipt of this letter. If you have any comments or questions, please contact San Francisco District archaeologist Stephanie Bergman by email at stephanie.m.bergman@usace.army.mil, or phone, (415) 503-6844.Thank you for your time and consideration.

Sincerely,

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For
Julie R. Beagle,

Environmental Planning Section Lead, San Francisco District

Appendix B – PLAN FORMULATION

1 INTRODUCTION

This appendix provides details on the plan-formulation process summarized in Sections 1–3 of the main body of the EA/IS/MND. Most USACE Civil Works projects start with a feasibility study where the plan formulation process is applied. If the feasibility report is approved, the project goes to the design phase and then the construction phase. Because Section 1122 legislation requested proposals that specified the project goals, in essence each 1122 project started at the design phase. Still, it was necessary to use elements of the plan formulation process to select the location and placement parameters.

The PDT utilized the following plan-formulation process from the USACE Institute for Water Resources Planning Primer (1997) to determine its proposed action:

Step 1. Identifying problems, opportunities, objectives, and constraints:
Problems are existing, negative conditions.
Opportunities tend to focus on desirable, future conditions.
Objectives are statements that describe the results you want to get by solving the problems and taking advantage of the opportunities you identified.
Constraints are statements about things you want to avoid doing, or things you cannot change, while meeting your objectives.

Step 2. Inventorying and forecasting conditions:
Gathering information about historic and existing conditions produces an **inventory**.
Gathering information about potential future conditions requires **forecasts**.
First, forecast the most likely future **without-project condition** that describes what is expected to happen if no action is taken to solve the problems or realize the opportunities. The without-project condition is the same as the **"no action"** alternative described in the National Environmental Policy Act (NEPA) regulations.
Later (in Step 4), forecast future **with-project conditions** that describe what is expected to happen if each alternative plan is implemented.

Step 3. Formulating alternative plans:
Produce solutions that achieve all or part of one or more of your planning objectives. Solutions are **alternative plans** built from **management measures**.
A **management measure** is a feature or an activity that can be implemented at a specific geographic site to address one or more planning objectives. It may be a "structural" feature that requires construction or assembly on-site, or it could be a "nonstructural" action that requires no construction. Management measures are the building blocks of **alternative plans**.
An **alternative plan** is a set of one or more management measures functioning together to address one or more objectives. Sometimes a plan is one measure. More often it's a set of measures.

Step 4. Evaluating alternative plans:

The essential purpose of the evaluation step is to determine whether a plan you have formulated is worthy of further consideration. Evaluation consists of four general tasks.

First, forecast the most likely with-project condition expected under each alternative plan.

Second, compare each with-project condition to the without-project condition. Do the comparisons reveal any differences between the two futures? Differences between with- and without-project conditions are a plan's **effects** (i.e., **impacts**).

Third, characterize effects – e.g., magnitude, location, timing, and duration.

Fourth, qualify plans for further consideration. This is a pass/fail test that asks, "Are any effects so significant that they would violate some minimum standards?" If not, the plan should be considered further. If so, the plan should be dropped from further consideration, or reformulated to lessen the effect. Some common qualifying criteria are **Completeness**, **Effectiveness**, **Efficiency**, and **Acceptability**.

Step 5. Comparing alternative plans:

The best plan cannot be selected from among a set of good plans unless you have some way to compare them. It is only by comparison that a plan is no longer good enough, or that a good plan becomes the best plan. The purpose of plan comparison is to identify the most important effects, and to compare the plans against one another across those effects. Ideally, the comparison will conclude with a ranking of plans or some identification of advantages and disadvantages of each plan for use by decision makers.

Step 6. Selecting a plan:

Decision makers must purposefully choose the single best alternative future path from among all those that have been considered. The first choice is always to do nothing. Planners have the burden of demonstrating that any plan that is recommended is better than doing nothing. The second choice is to select the plan that is required by law or policy. For example, cost effectiveness is used in many USACE ecosystem restoration project planning investigations. The third choice is to do something else. Regardless of the choice, those who do the choosing must have good reasons for the final selection. Frequently, a non-Federal sponsor of a Civil Works project will find it in their interest to pursue a plan that sacrifices some benefits for additional contributions to other objectives. A plan that is preferred by a sponsor is commonly called the locally preferred plan.

2 BACKGROUND

Section 1122 requires USACE to establish a pilot program to carry out 10 projects for the beneficial use of dredged material. The pilot program can include projects for the purposes of:

(1) reducing storm damage to property and infrastructure;

(2) promoting public safety;

(3) protecting, restoring, and creating aquatic ecosystem habitats;
(4) stabilizing stream systems and enhancing shorelines;
(5) promoting recreation;
(6) supporting risk management adaptation strategies; and
(7) reducing the costs of dredging and dredged material placement or disposal, such as projects that use dredged material for:

(A) construction or fill material;
(B) civic improvement objectives; and,
(C) other innovative uses and placement alternatives that produce public economic or environmental benefits.

Projects identified under Section 1122 must maximize the beneficial placement of dredged material from federal or non-federal navigation channels and ensure that the use of dredged material is consistent with all applicable environmental laws. The USACE is required to carry out the program in consultation with relevant state agencies and to establish regional teams to assist in evaluating the proposals. Each pilot project is to:

- maximize the beneficial placement of dredged material from federal and non-federal navigation channels;
- incorporate, to the maximum extent practicable, two or more federal navigation, flood control, storm-damage reduction, or environmental restoration projects;
- coordinate the mobilization of dredges and related equipment, including using such efficiencies in contracting and environmental permitting as can be implemented under existing laws and regulations;
- foster federal, state, and local collaboration;
- implement best practices to maximize the beneficial use of dredged sand and other sediments;
- ensure that the use of dredged material is consistent with all applicable environmental laws.

This Strategic Placement Project's primary purpose is to evaluate the ability of tides and currents to transport dredged sediment – that is placed in a San Francisco Bay (i.e., SF Bay or the Bay) shallow-water, shoreline environment – to existing mudflats and marshes to make them more resilient to rising sea level. The intent is to increase the temporal adaptability and resilience to increased water levels and reduced suspended sediment in the Bay. The evaluation includes quantification of sediment transported toward target mudflats and marshes, as well as environmental and other impacts of this innovative beneficial use of dredged sediment.

3 SETTING

Maintenance dredging occurs annually in several federal navigation channels, and the dredged material is placed at designated sites in the Bay, in the ocean, or at beneficial-use sites. The Project Delivery Team (PDT) hypothesizes that strategic placement of dredged sediment in the in-Bay nearshore, subtidal environment can take advantage of natural sediment transport processes and pathways within the Bay system to achieve tidal mudflat and marsh deposition via tidal and wave-flux dynamics (i.e., sediment delivery over a given spatial extent through time). At the same time, it could reduce placement costs because in-Bay sites are closer than ocean and upland sites.

The proposed project would place sediment, dredged from a federal in-Bay navigation channel, in shallow water on the periphery of the Bay to examine the ability of tides and currents to move the placed material to existing mudflats and marshes. This aquatic placement technique – placing dredged sediment in shallow water adjacent to a tidal wetland where natural hydrodynamic and morphodynamic processes can move the sediment onto the adjacent mudflat and marsh – is referred to as strategic shallow-water placement. This strategic shallow-water placement pilot project is expected to move a portion of the placed sediment to the mudflats and the marsh plain, mimicking natural sediment supply to wetland ecosystems supporting habitat construction. Monitoring will be integrated to evaluate the environmental impacts and success of this pilot project.

4 LOCATION

The proposed project is in San Francisco Bay in Northern California, which is a large tidal estuary receiving the outflow of large rivers (e.g., Sacramento and San Joaquin Rivers) and other, smaller rivers and creeks in its watershed. Approximately 40% of California's water draining into San Francisco Bay comes from the Sierra Nevada Mountain Range and the State's Central Valley. Specifically, the project site will be in South San Francisco Bay, which is bounded by the San Mateo Bridge to the north and the southern shoreline of the Bay to the south. Tidal mudflats, salt-water tidal marshes, and subtidal shallow-water environments occur in that part of the Bay.

4.1 SAN FRANCISCO BAY

The San Francisco baylands (e.g., mudflats, marshes, and other intertidal habitats) protect critical infrastructure, improve water quality, and provide habitat for thousands of fish and wildlife species, including several endangered and special-status species. Before 1850, San Francisco Bay and its environs included 350,000 acres of freshwater wetlands and 200,000 acres of salt marshes (Figure 1). Subsequently, the region has lost over eighty-five percent of that acreage through diking, dredging, and development. In addition, sea-level rise (SLR) and sediment deficits further threaten long-term bayland sustainability.

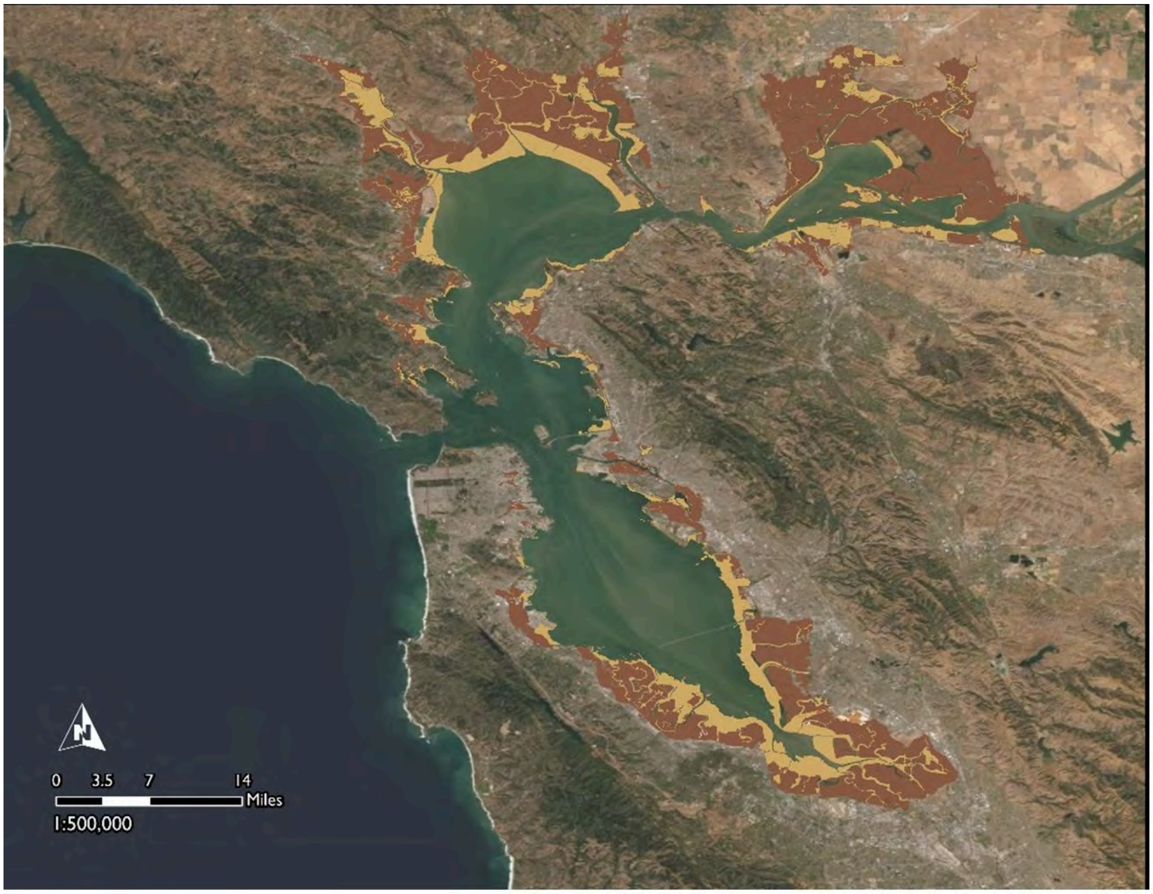

Figure 1. Bay area historical (dark brown) and modern (light brown) baylands.

Efforts are underway to restore these baylands with sediment from other locations. Dusterhoff et al. (2021) of the San Francisco Estuary Institute estimate the Bay's wetlands and mudflats will need approximately 450 million CY of sediment between now and 2100 to maintain existing wetlands and those currently slated for restoration. Sediment dredged from federal navigation channels represents a significant source of supply available for restoration. The practice of beneficially using these sediments to restore marshes already exists and has been successfully implemented (i.e., beneficial use of dredged material, BUDM, or BU). Federal, state, and local agencies and organizations are currently on track to restore 60,000 acres of tidal wetlands to augment 40,000 already-restored acres. The resulting 100,000 acres will help protect the region from tidal flooding and reduce storm damage, especially if sea level rise (SLR) continues as predicted or accelerates.

Through a variety of partnerships, several agencies have acquired land, developed regional plans, conducted environmental reviews, received permits, and are implementing multiple projects to restore critical tidal wetlands for both ecosystem benefits and shoreline protection. Meeting the goal of wetland climate resilience, however, will require optimization on several levels, including finding least-cost methods with streamlined and more-efficient permitting processes to match dredged material volumes with placement site needs and capacities.

In the SF Bay area, the current paradigm of BUDM is to place material directly on subsided baylands to raise site elevations to adjacent marsh plains, thereby supporting rapid development of tidal marsh vegetation and habitat. Subsided restoration sites that are breached without raising site elevations are projected to take 60–75 years to develop into tidal marsh. BUDM can cut development time down to 10–15 years. This is important because restored marshes breached without sediment supply may not accrete fast enough to respond to future rates of SLR. Although direct placement is a critical tool for subsided baylands, it can be a costly restoration strategy. Consequently, given the projected increase in SLR, SF Bay agencies and other organizations are actively evaluating new tools to reduce beneficial-use costs by utilizing natural processes that drive tidal marsh development and resilience under current and future SLR conditions.

The targeted areas for strategic shallow-water placement are locations on the margins of the Bay adjacent to marshes and mudflats in need of sediment (Figure 2, Figure 3). Shallow water ranges from near the bayward edge of the mudflat (around mean lower low water, which is approximately 0 feet North American Vertical Datum [NAVD) to the top of the deep channel (a depth of about 13 feet NAVD).

Figure 2. Napa-Sonoma Marshes State Wildlife Unit (Photo: Aric Crabb).

Figure 3. Low tide on a San Francisco Bay mudflat (Photo: Jitze Couperus [Flickr]).

4.2 Federal Navigation Projects

As part of its operation and maintenance (O&M) program for federal channels in the San Francisco Bay area, USACE annually dredges five federal channels (Suisun, Richmond Inner Harbor, Oakland Harbor, Redwood City Harbor, Main Ship Channel), biannually dredges two federal channels (Pinole Shoal and Richmond Outer Harbor), and periodically dredges several other federal channels (Figure 4). This project proposes sourcing dredged sediment from either the Redwood City Harbor or Oakland Harbor federal navigation channel for strategic placement.

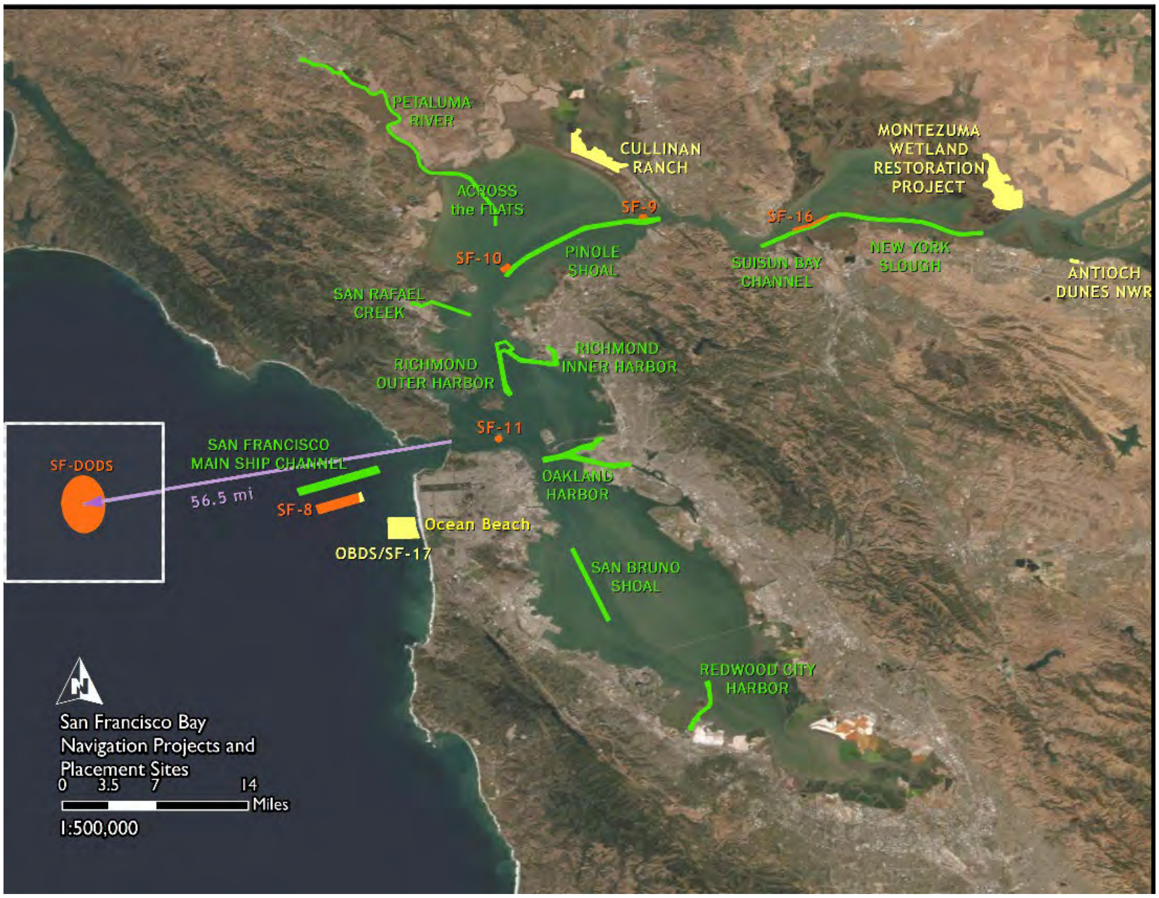

Figure 4. San Francisco District (SPN) federal navigataion projects (green) and traditional placement sites (orange [aqueous] and yellow [beneficial use]).

5 BASIC AND OVERALL Project Purpose

Under Section 404 of the Clean Water Act, USACE is granted permitting authority for any activity that would involve the discharge of dredged or fill materials into waters of the U.S., including wetlands (33 USC 1344). The section 404(b)(1) guidelines prohibit discharge of dredged or fill material if a practicable alternative to the proposed project exists that would have less adverse impacts on the aquatic ecosystem, including wetlands, so long as that alternative does not have other significant adverse environmental consequences. The USACE does not issue itself a permit for its actions involving the discharge of dredged or fill material to waters of the U.S., but instead integrates an equivalent 404(b)(1) analysis in its NEPA documentation. This analysis requires identification of the basic and overall project purposes as defined by the 404(b)(1) guidelines, and an evaluation of alternatives consistent with those purposes to identify the least environmentally damaging practicable alternative.

5.1 Basic Project Purpose

The basic purpose is to ascertain the feasibility of using strategic, in-water sediment placement to maintain mudflats and tidal marshes. This is a water-dependent project under Section 404(b)(1).

5.2 Overall Project Purpose

The overall purpose of the Strategic Shallow Water Placement Pilot Project is to test a novel approach to increase mudflat and salt-marsh resilience to SLR in SF Bay via strategic placement of sediment – dredged from federal navigation channels – at a shallow, in-Bay location adjacent to the mudflat and tidal marsh. This Engineering with Nature (EWN) approach will augment sediment supply in a sediment-starved system to leverage existing morphodynamic processes to transport sediment toward mudflat-marsh systems for habitat reconstruction. The goal is to determine if this EWN approach can be a successful, lower-cost method to achieve beneficial use relative to the cost of traditional placement options (i.e., ocean, in-Bay, or upland sites). This project aims to understand the scale of sediment deposition post-placement at the placement site, on the intertidal mudflat, and on the adjacent tidal marsh; and the wind, wave, and sediment flux conditions pre- and post-placement across the interconnected subtidal-mudflat-marsh complex.

This project also aims to understand the impacts to benthic (i.e., Bay bottom) habitats, and communities; the spatial extent of the effect zone; the temporal scale of disturbance and recovery time; and whether there will be any detrimental impacts to eelgrass beds, oyster beds, or similar environmental resources. This project will include robust monitoring protocols using appropriate methods and techniques to determine sediment deposition and impacts resulting from strategic placement.

6 Alternatives considered but eliminated

The first step in developing alternatives for this project was to reduce the number of suggested sites from several to two sites. Then, various combinations of source channels, placement volumes, and placement areas were used to create several alternatives at each location. Some federal navigation channels are more suited as sources of material for strategic placement than others. For example, Pinole Shoal, Richmond Outer Harbor, and the Main Ship Channel are regularly dredged with a hopper dredge that cannot access shallow water placement sites (i.e., between 13 feet depth NAVD and 0 feet NAVD, or approximately mean lower low water) because these ships have a draft of about 35 feet. Therefore, those channels will not be sources for the material to be placed in shallow water. Because availability of the periodically dredged channels is uncertain, dredged material is expected to be sourced from one or two of the five annually dredged channels. Finally, a sediment-transport model was used to eliminate all but two alternatives (one at each location), which were carried forward for final analysis.

6.1 SITES

Starting with twelve sites (Figure 5), the PDT used eight criteria to reduce the list to two sites (Table 1):

8. Eroding or drowning marsh; lack of natural sediment supply;
9. Sufficient wind-wave action to resuspend placed sediment;
10. Proximity to a federal channel;
11. Open to tidal exchange, existing marsh;
12. Water shallow enough to get scow close to shore;
13. Protection for disadvantaged communities;
14. Lower populations of critical species;
15. Avoiding large eelgrass beds and nearshore reef projects.

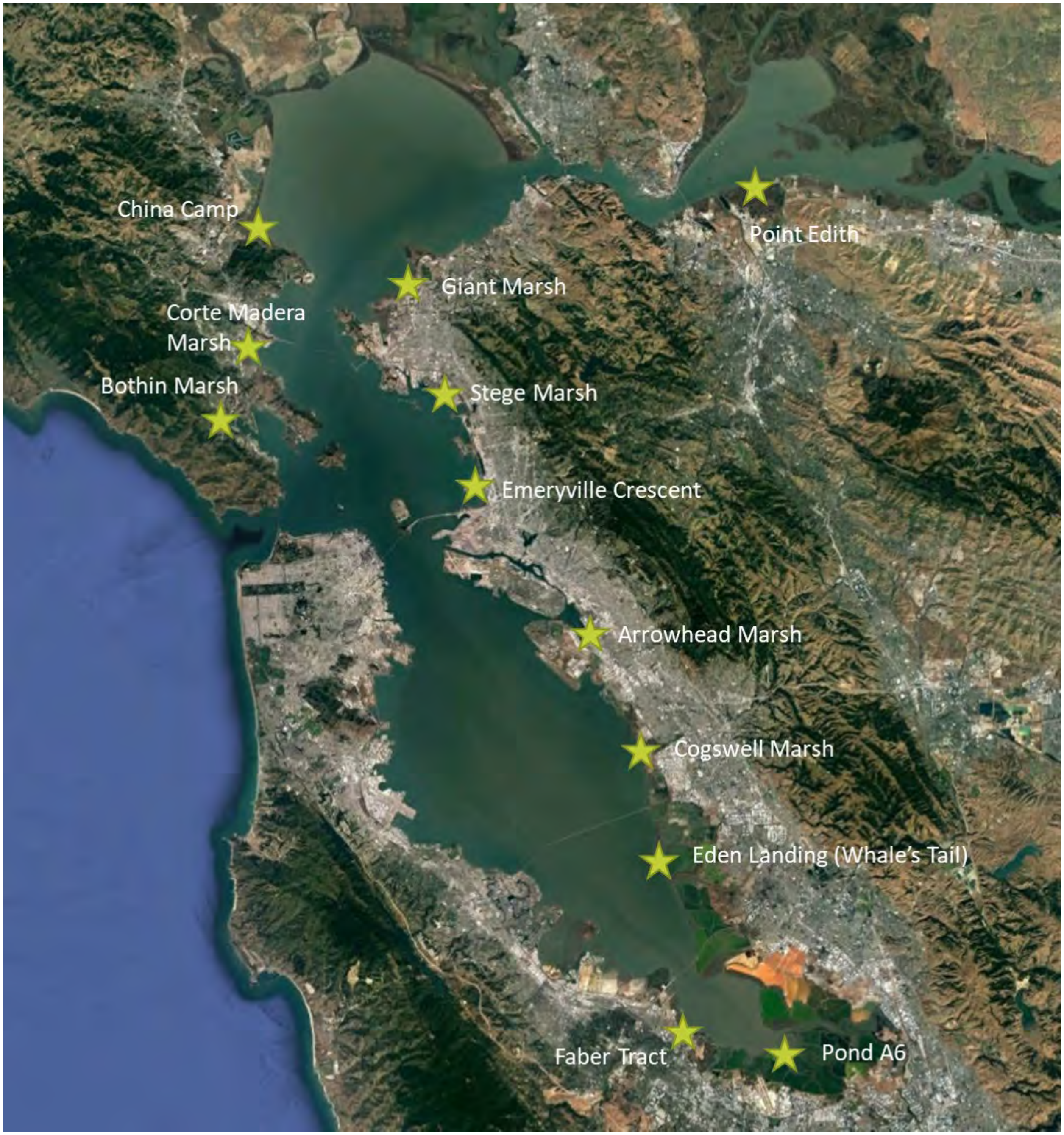

Figure 5. Potential sites for strategic placement across San Francisco Bay.

Table 1. Initial site selection – the checks mark appliable criteria.

Site (south to north)	Criteria								Reject
	1	2	3	4	5	6	7	8	
Pond A6								✔	✔
Faber Tract		✔	✔	✔	✔	✔		✔	✔
Cogswell Marsh	✔	✔	✔	✔	✔	✔			✔
Eden Landing (Whale's Tail)	✔	✔	✔	✔	✔	✔		✔	
Arrowhead Marsh	✔		✔	✔		✔		✔	✔
Emeryville Crescent	✔	✔	✔	✔	✔	✔	✔		
Bothin Marsh	✔			✔				✔	✔
Stege Marsh	✔	✔		✔		✔			✔
Corte Madera Marsh	✔	✔		✔					✔
Giant Marsh		✔	✔	✔	✔	✔		✔	✔
China Camp		✔			✔			✔	✔
Point Edith	✔	✔	✔			✔		✔	✔

6.2 Placement Depths

Three placement depths were selected based on local bathymetry: (1) shallowest and closest with smallest footprint; (2) intermediate depths with tidal timing; and (3) deepest depths with fully loaded scow. These placement depths were chosen to maximize sediment transport to target mudflats and marshes, while balancing the logistical challenges associated with scow accessibility and maneuverability in shallower depths.

6.3 Placement Volumes

Four placement volumes were evaluated: (1) 50,000 CY; (2) 75,000 CY; 100,000 CY, and 125,000 CY. These placement volumes were chosen to maximize sediment transport to target mudflats and marshes and to minimize the benthic impacts of placement.

6.4 Federal Navigation Channels

Navigation projects were assessed for their proximity to selected project locations, their frequency of interannual dredging, the dredged sediment quality and grainsize characteristics, and the logistical feasibility of utilizing said channels as sediment sources to determine channel material suitability for reuse. Redwood City Harbor is the closest navigation channel to Eden Landing (approximately 1.9 – 3.5 miles), and its grain size distribution sufficiently matches the grain sizes on the marsh and mudflat near Eden Landing. As such, Redwood City Harbor navigation channel is the proposed source of material for this project. Oakland Harbor is similarly not far from Emeryville Crescent marsh (approximately 1 – 3 miles).

6.5 Proposed Action Determination – Modeling

Two sites – Eden Landing and Emeryville Crescent Marsh – were analyzed using a quantitative modeling approach (i.e., the UnTRIM Bay-Delta model and the Short-Term Fate [STFATE] of dredged material in open water model) to determine sediment fluxes, shear stresses, transport pathways, and deposition zones for different placement depths and volumes within the placement grid (Figure 6).

Figure 6. Strategic placement sites narrowed down from twelve to two: Emeryville (top) and Eden Landing (bottom). Site map includes both placement footprint (red grid) and target marsh for restoration (aqua hatch).

Placement alternatives incorporated information on flood tides at various stages of the tidal cycle, including Mean Higher High Water (MHHW), Mean Sea Level (MSL), and Mean Lower Low Water (MLLW), during the San Francisco Bay's environmental dredging window (i.e., June 1 – November 30). This determined specific depths for each cell in the placement grid, and ultimately, the design footprints based on depth isolines. The first set of alternatives all utilized the same placement volumes (i.e., 100,000 CY) distributed across the footprint based on scow loading capability as correlated with depths of greater than 9 feet for the shallowest placement; 10 feet for the intermediate placement; and 11 feet for deepest placement. In the first round of modeling, six placement alternatives were analyzed – three for Eden Landing and three for Emeryville Crescent Marsh. The first six scenarios were used to determine whether Emeryville or Eden Landing is most suitable for the pilot project. Different placement strategies at each location were then analyzed to determine the second round of modeling scenarios, and ultimately, to narrow in on the most effective placement strategy (Table 2).

Table 2. First round modeling scenarios testing placement locations, scow volumes, and tidal timings at Emeryville and Eden Landing locations.

Scenario	Placement Grid	Location	Placement Volume (10^3 CY)	Scow Volume (CY)	Minimum Time Between Placements (hrs)	Notes
1	Emeryville	Deep	100	1,400	6	
2	Emeryville	Middle	100	1,150	2	Placements during flood tide
3	Emeryville	Shallow/East	100	900	2	
4	Eden Landing	Deep	100	1,400	5	
5	Eden Landing	Middle	100	1,150	1.5	Placements during flood tide
6	Eden Landing	Shallow/East	100	900	1.5	

The second round of modeling consisted of six scenarios to evaluate the effect of different placement volumes, seasonal differences (summer versus winter), alternate sediment sourcing, and placement footprints (Table 3).

Table 3. Second round of modeling scenarios testing the effect of different placement volumes, seasonality, alternate sediment sourcing and footprint sizes at the Eden Landing location.

Scenario	Placement Grid	Location	Placement Volume (10^3 CY)	Scow Volume (CY)	Minimum Time Between Placements (HRS)	Notes
6	Eden Landing	Shallow/East	100	900	1.5	From First Set
7	Eden Landing	Shallow/East	50	900	1.5	
8	Eden Landing	Shallow/East	75	900	1.5	
9	Eden Landing	Shallow/East	100	900	1.5	Winter Placement
10	Eden Landing	Shallow/East	100	900	1.5	Oakland Sediment
11	Eden Landing	Expanded East	100	900	1.5	
12	Eden Landing	Expanded East	125	900	1.5	

This second round of modeling first examined how efficient different placement volumes (50,000; 75,000; and 100,000 CY) were at Eden Landing assuming the

Shallow/East placement strategy. Another sensitivity analysis examined 100,000 CY placements subject to wind and wave climate conditions during summer and winter months. Modeling also examined placement sensitivity to the original east/shallow placement footprint versus an expanded east footprint that represented a hybrid of the shallow and intermediate depth scenarios with an overall footprint over twice the size of the original shallow-east size (Table 2). Different sediment source channels (i.e., Oakland Harbor versus Redwood City Harbor) were tested to understand the impact of different grain sizes on sediment resuspension and mobility, with coarse sediments from Oakland Harbor channel and fine sediments from Redwood City Harbor channel. Finally, different placement volumes (100,000 CY versus 125,000 CY) were tested within this expanded east footprint.

Modeling results indicated that summer placements were more efficient at delivering sediments to the target mudflat and marsh system. Analysis of wave resuspension potential indicated significantly higher transport due to waves in summer months than in winter months, due to higher wind speeds. Significantly more placed sediment transported to Eden Landing mudflat/marsh complex in the two months following summer placement than in the three months following winter placement. There was also more regional sediment transport north out of South Bay following winter placement. Dredged material placements earlier in the summer when wind speeds are seasonally high are likely to be more effective at transporting sediment into the marsh than late-fall and winter placements.

Larger placement volumes resulted in more sediment reaching the target mudflat and marsh on short time scales (on the order of one to two millimeters) and will therefore be more measurable to determine pilot project success, although millimeter-scale deposition is difficult to measure over a wide area. Placement volume and mudflat and marsh deposition volume were linearly correlated with higher detectability for the 100,000 CY placement at the shallow/east footprint (Figure 7). A larger fraction of Oakland Harbor sediment remains in the placement footprint at end of the two-month analysis period. Dredged material with lower sand content is better for strategic placement, but the differences between dredged material from Oakland Harbor and Redwood City Harbor do not have a large effect on the overall volume of sediment that reaches Eden Landing after two months.

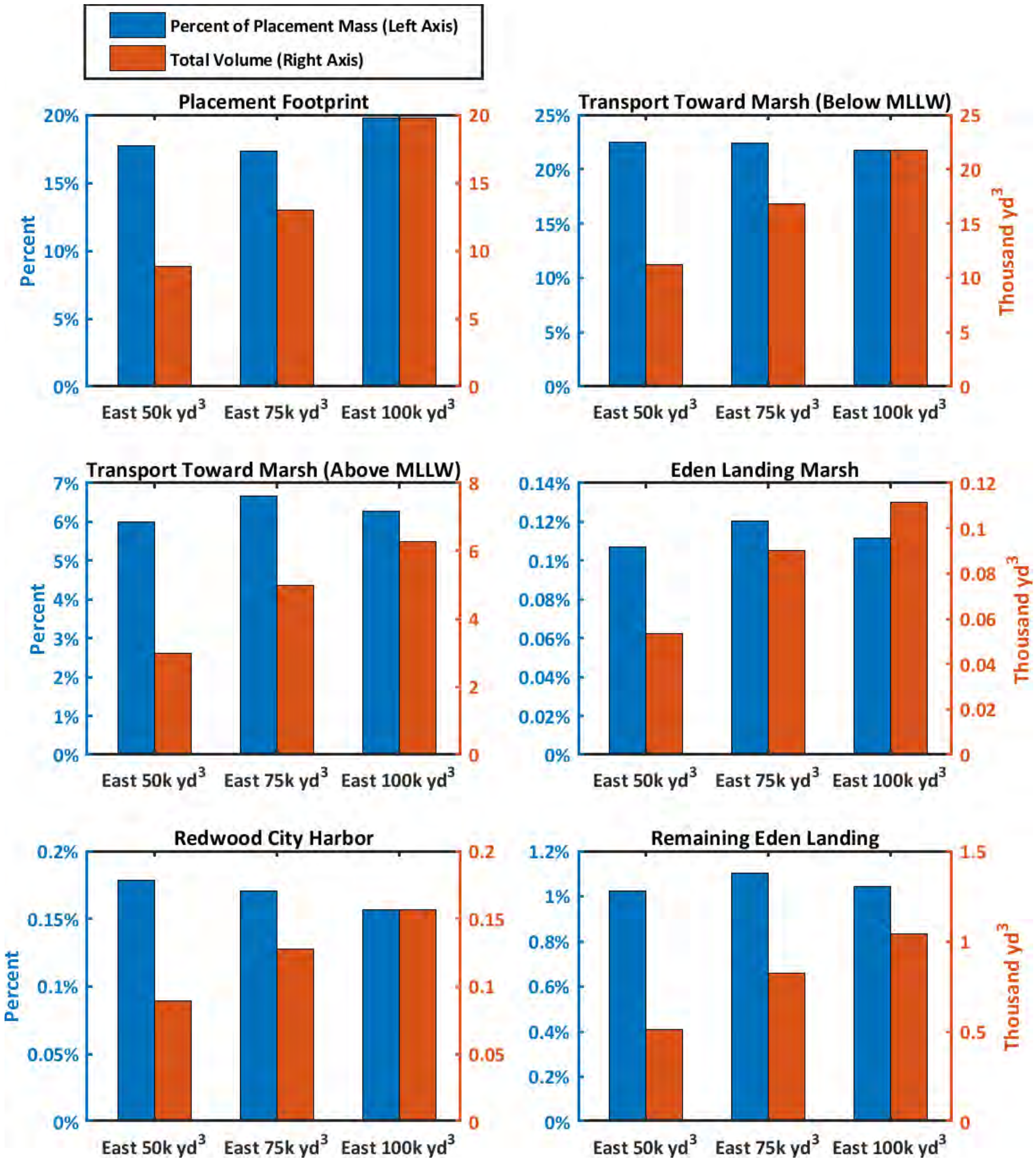

Figure 7. Predicted percentage of dredged sediment mass and dredged material volume in each region at the end of the 2-month simulations for evaluating the placement volume in the shallow/east placement footprint.

The expanded footprint includes areas of greater depth than the original footprint but allowed for thinner placements over the placement footprint. Less sediment was transported out of placement footprint in the two months following placement for the expanded footprint. Overall, results indicate that placements closest to the target marsh at the shallowest depths possible, where wave energy is highest, are most effective at transporting sediment to the marsh.

The final site selection process analyzed the percentage and volume of sediment delivered to the transition tidal flat and upland marsh, as well as the percentage dispersed outside the placement footprint but not to the target locations (i.e., nearshore tidal flat and adjacent marsh) and the percentage re-deposited in federal navigation channels or in nearby flood control channels (Figure 8). These criteria describe the efficiency and impacts of each design alternative, with the goal of maximizing sediment deposition to tidal flats/marshes, and minimizing sediment lost to the Bay, navigation channels and flood control channels. Modeling results indicated that the 100,000 CY shallow/east placement alternative at Eden Landing in the summer months using dredged material from the Redwood City Harbor federal navigation channel was the optimal strategy, which corresponds to scenario 6 (Figure 9, Figure 10, Table 2, Table 3).

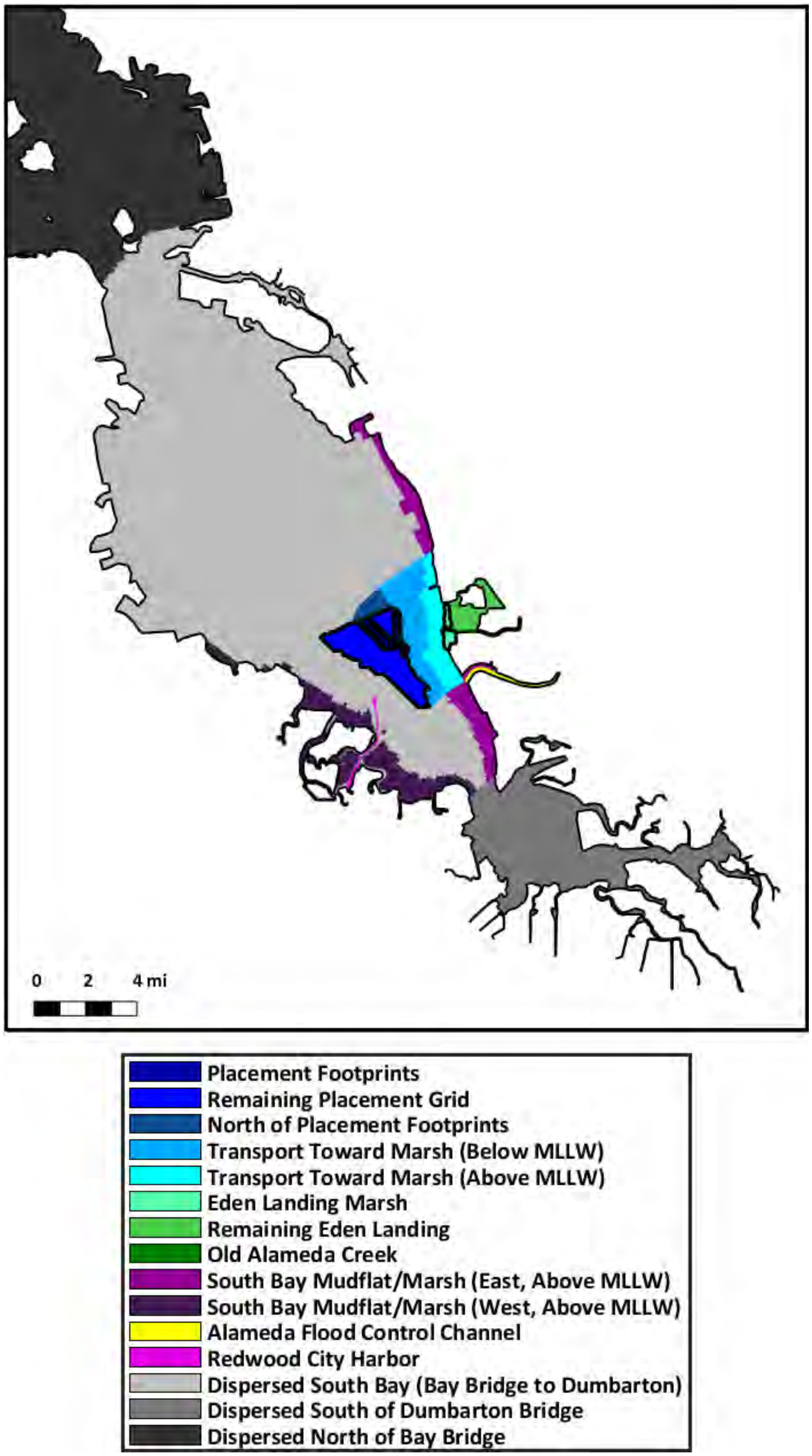

Figure 8. Binned regions to determine sediment transport fate from strategic placements toward target mudflats and marshes, ancillary mudflats and marshes, federal navigation channels, flood control channels, etc.

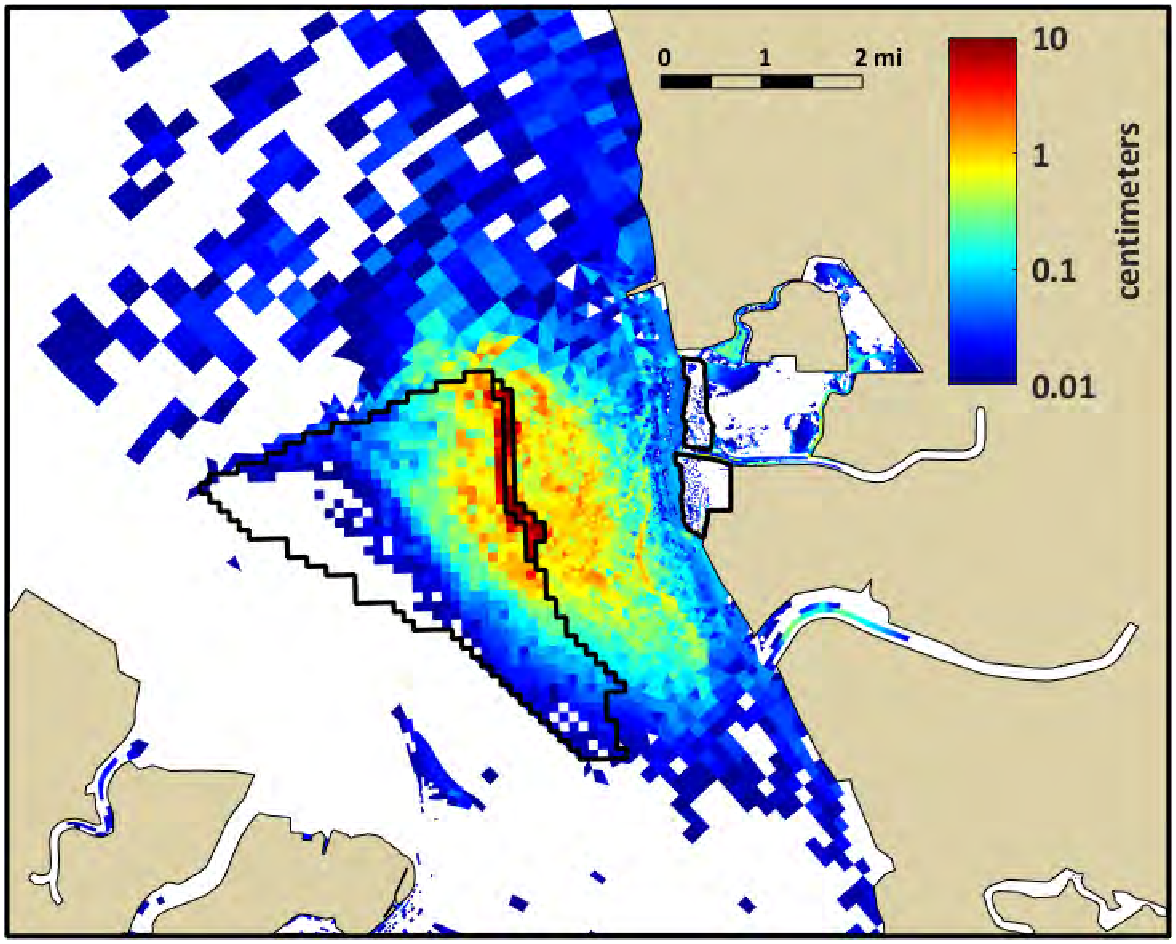

Figure 9. Eden Landing shallow/east placement planview indicating sediment deposition thickness after two-month summer model run for 100,000 CY. Note that deposition thickness is on the order of one to two millimeters in the target mudflat and marsh complex.

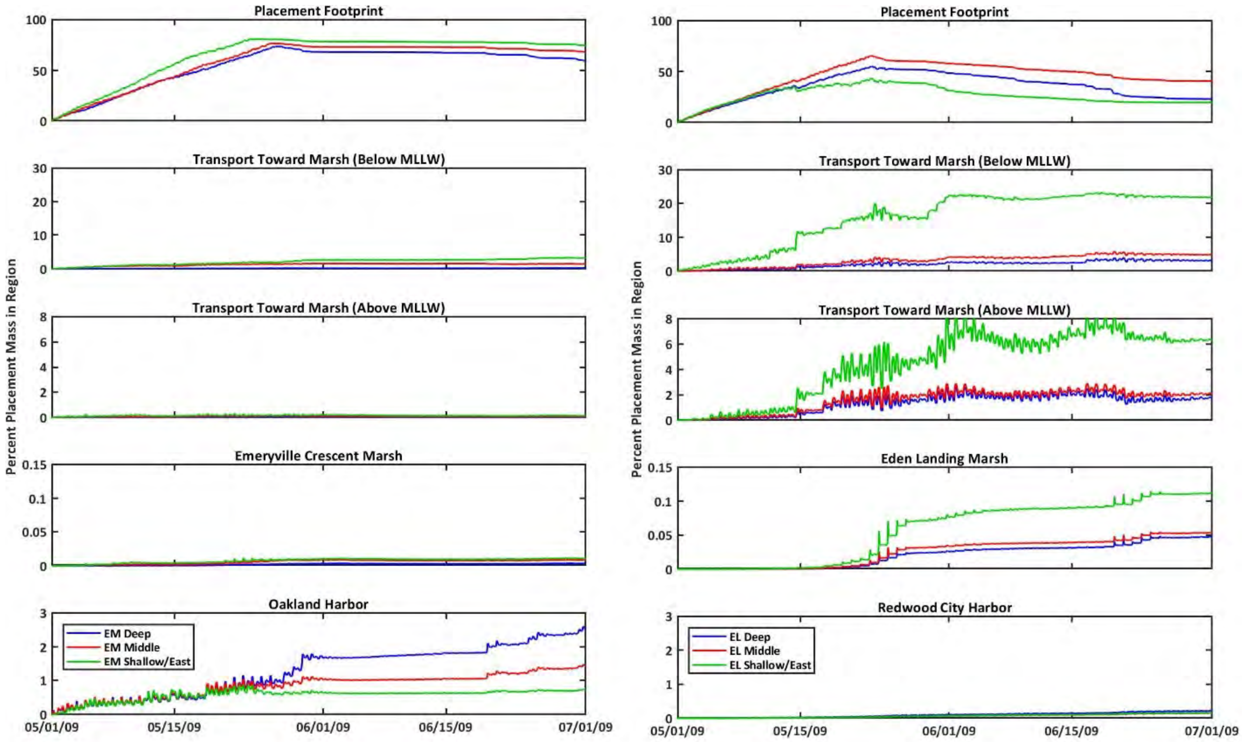

Figure 10. Predicted percentage of dredged sediment mass in each region during the 2-month simulations for the initial three Emeryville scenarios (left) and Eden Landing scenarios (right).

Appendix C– HYDRAULIC AND SEDIMENT MODELING REPORT

August 2022
Section 1122 Pilot Project

Hydrodynamic and Sediment Transport Modeling of the San Francisco Bay to Evaluate Pilot Sites for Shallow Water Placement of Dredge Material

Prepared for U.S. Army Corps of Engineers

August 2022
Section 1122 Pilot Project

Hydrodynamic and Sediment Transport Modeling of the San Francisco Bay to Evaluate Pilot Sites for Shallow Water Placement of Dredge Material

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ABBREVIATIONS

μm	micrometer
BAAQMD	Bay Area Air Quality Management District
BAW	Bundesanstalt für Wasserbau
CCWD	Contra Costa Water District
CIMIS	California Irrigation Management Information System
cm	centimeter
Delta	Sacramento-San Joaquin Delta
DEM	Digital Elevation Model
DICU	Delta Island Consumptive Use
Eden Landing Marsh	Whale's Tail portion of Eden Landing Marsh
FCC	flood control channel
fps	feet per second
ft	foot
kg	kilogram
kg/m^2s	kilogram per square meter per second
m	meter
m^2	square meter
m^3	cubic meter
mm	millimeter
mg/L	milligrams per liter
MHHW	mean higher high water
MHW	mean high water
MLLW	mean lower low water
mph	miles per hour
NA	not applicable
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
Pa	pascals
PDT	Project Delivery Team
RMS	root-mean-square
$RMSD_N$	normalized root-mean-square difference
s	second
SPN	San Francisco District, USACE
SSC	suspended sediment concentration
STFATE	Short-Term Fate

SWAN	Simulating Waves Nearshore
ubRMSD	unbiased root-mean-square difference
$ubRMSD_N$	unbiased normalized root-mean-square difference
UnTRIM	Unstructured Nonlinear Tidal Residual Intertidal Mudflat
US	United States
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WRDA	Water Resources Development Act
yd^3	cubic yards

1 Introduction

Section 1122 of the Water Resources Development Act (WRDA) of 2016 required that the U.S. Army Corps of Engineers (USACE) establish a pilot program to recommend 10 projects for the beneficial use of dredged material. In October 2018, "Restoring San Francisco Bay's Natural Infrastructure with Dredged Sediment: Strategic Placement" was selected as one of the 10 nationwide 1122 Pilot Projects. This pilot project evaluates the effectiveness of strategic open-water placement of dredged material to facilitate the nature-based dispersal of dredged material to beneficial areas.

Between 1800 and 1998, it has been estimated that 79 percent of San Francisco Bay's tidal marshes (150,000 acres) and 42 percent of San Francisco Bay's tidal mudflats (21,000 acres) were lost to diking and filling (Goals Project 2015). There is concern that many of the remaining marshes and mudflats are particularly vulnerable to drowning due to the anticipated increase in sea level rise (Goals Project 2015). In this context, drowning refers to the conversion of baylands to habitats with lower relative tidal elevations (e.g., marsh changing to mudflat or mudflat changing to subtidal habitat).
In particular, recent studies have shown that the accelerating sea level rise rate increases the risk of intertidal areas drowning, especially in systems with low sediment supply (Elmilady et al. 2022).
If mudflat elevation does not keep up with sea level rise, more wave energy will reach the marsh edge, leading to erosion and loss of marsh extent (Goals Project 2015). In this context, providing a supplemental source of sediment to accelerate marsh and mudflat accretion has the potential to reduce the future drowning of mudflats and marshes and help offset future increases in sea level.

The overall goal of this 1122 Pilot Project is to evaluate the potential for strategic placement of dredged material to provide a supplemental source of sediment to accelerate marsh and mudflat accretion to offset future changes in sea level. This study applied a 3D hydrodynamic, wave, and sediment transport model to predict the fate and transport of open-water dredged material placements in San Francisco Bay. Modeling was used to evaluate the suitability of two potential placement sites and to assess the most effective placement strategy for each site.

Previous sediment transport modeling in San Francisco Bay focused on the dispersal of dredged material south of Dumbarton Bridge and demonstrated that dredged material could be naturally transported into breached salt ponds and onto mudflats (Bever and MacWilliams 2014; Bever et al. 2014). The study detailed in this report takes a similar approach and simulates the continual erosion, deposition, and transport of dredged material following open-water placements in San Francisco Bay. A total of 12 sediment transport modeling scenarios were conducted to evaluate how the location of the placements, total volume of placed material, dredged material source, and seasonal timing of the placement affects dispersal away from the placement location.

Dredged material placement scenarios were conducted near two marshes in San Francisco Bay: Emeryville Crescent Marsh and the Whale's Tail portion of Eden Landing Marsh (Eden Landing

Marsh). These two marshes were the target marshes for the natural dispersal of dredged material. Emeryville Crescent Marsh is located north of Oakland Harbor, and the majority of the marsh is at an elevation around mean high water (MHW) and mean higher high water (MHHW; Figure 1-1). The Whale's Tail portion of Eden Landing Marsh is located on the eastern side of South Bay, and the majority of the marsh is also at an elevation around MHW and MHHW (Figure 1-2). The surface elevations of the marshes are high enough that the majority of the inundation and sediment transport onto the marshes will occur when water surface elevations are near MHHW or higher.

This report documents the 3D hydrodynamic and sediment transport model simulations of the dispersal of dredged material and is organized into the following seven primary sections and two appendices:

- **Section 1: Introduction**: This section provides a description of the motivation for the project and a summary of the scope and organization of the report.
- **Section 2: UnTRIM Bay-Delta Model Overview**: This section provides a brief description of the high-resolution UnTRIM Bay-Delta model, the SWAN wave model, and the SediMorph morphological model.
- **Section 3: Model Simulations and Analyses**: This section describes the model simulations and analysis regions used to evaluate the dispersal of dredged material.
- **Section 4: Wave Characteristics, Shear Stress, and Residual Currents Around the Placement Locations**: This section provides the results of analyses evaluating wind waves and bed shear stress in the vicinity of the dredged material placements.
- **Section 5: Evaluation of Dredged Material Placement Scenarios**: This section describes the results of the individual dredged material placement scenarios and provides comparisons of the scenario results.
- **Section 6: Summary and Conclusions**: This section presents a summary of the work conducted and the conclusions of this study.
- **Section 7: References**: This section provides the references cited in this report and the associated appendices.
- **Appendix A: Model Validation**: This appendix documents the validation of predicted suspended sediment concentration during the two time periods simulated for the dredged material placements.
- **Appendix B: Assumptions and Limitations of the Coupled Modeling System**: This appendix details the assumptions and limitations inherent in the UnTRIM Bay-Delta hydrodynamic, wave, and sediment transport modeling system.

Figure 1-1
Map of Emeryville Crescent Marsh (Top) and Distribution of the Elevation of the Marsh Surface (Bottom)

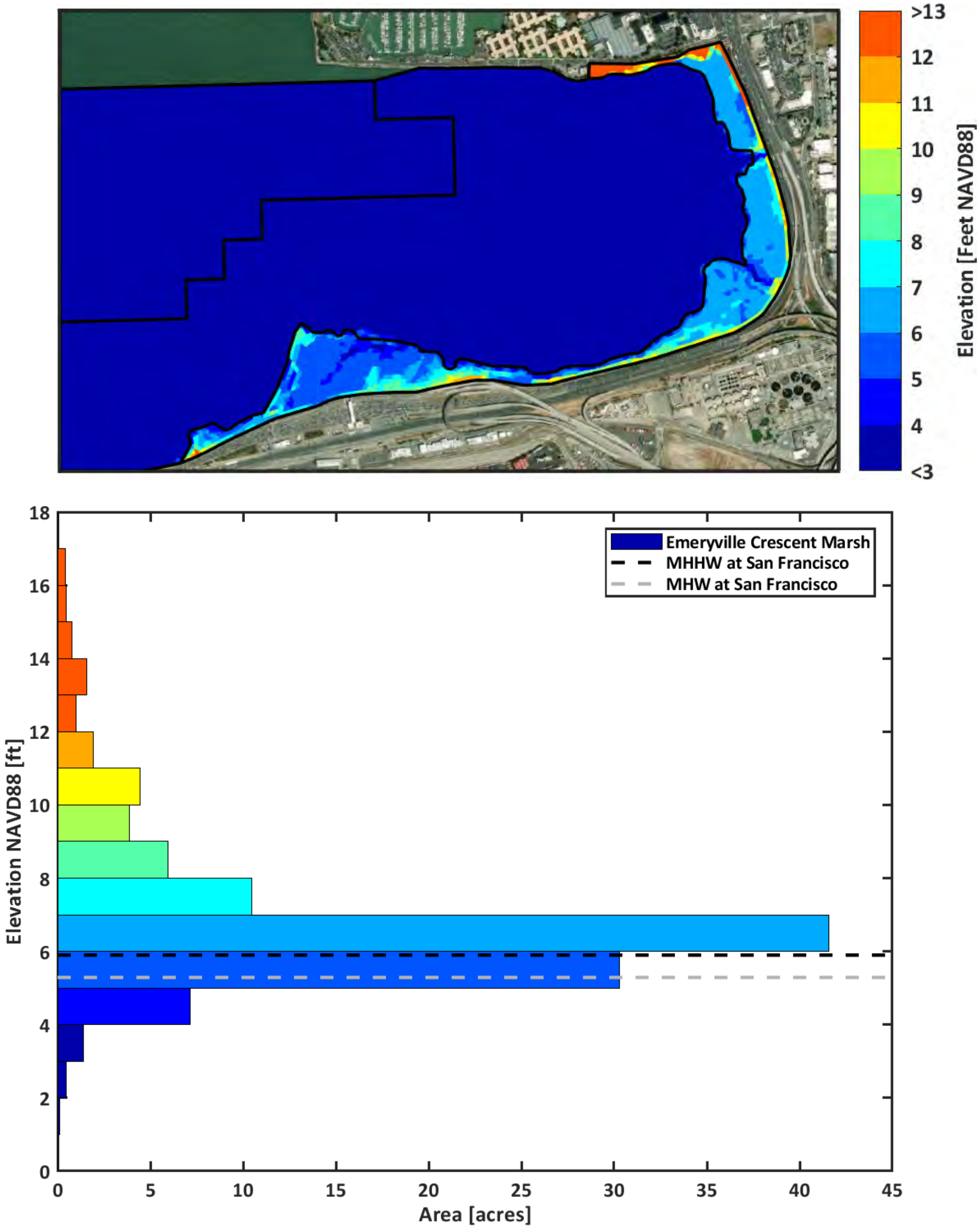
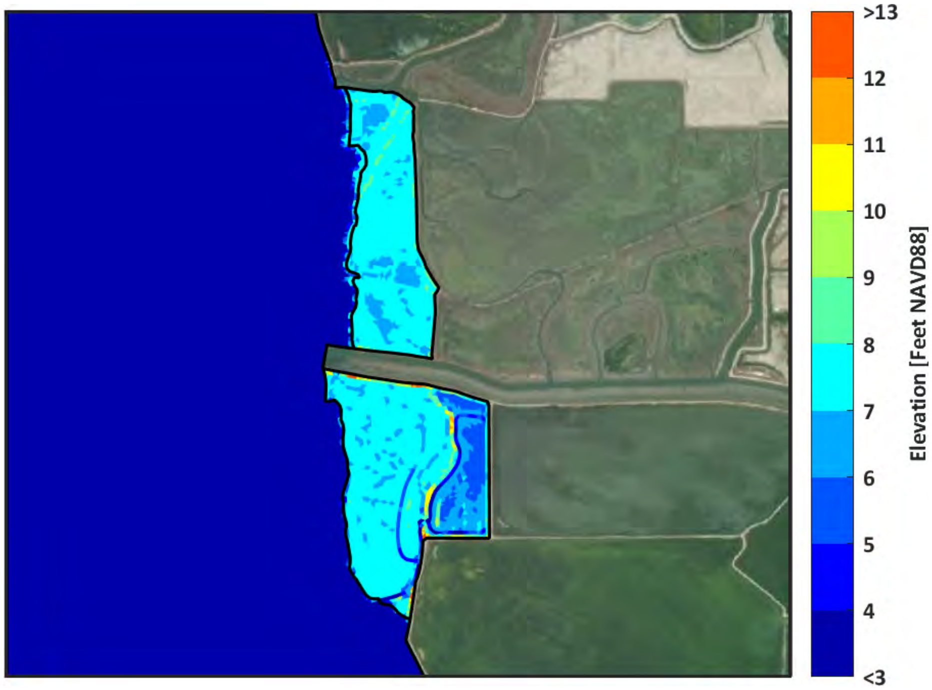
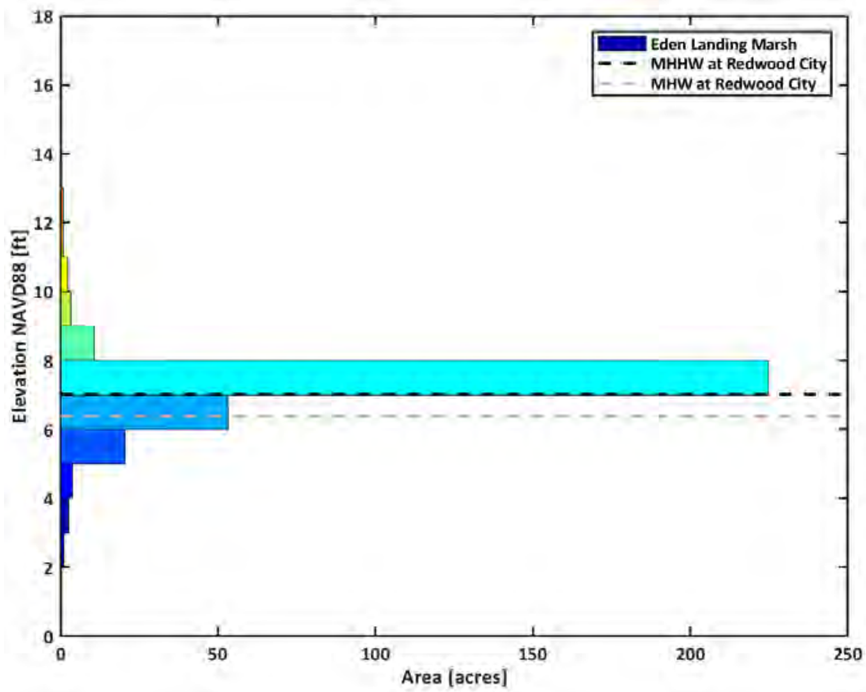


Figure 1-2
Map of Whale's Tail Portion of Eden Landing Marsh (Top) and Distribution of the Elevation of the Marsh Surface (Bottom)





2 UnTRIM Bay-Delta Model Overview

The San Francisco Estuary, comprising San Francisco Bay and the Sacramento-San Joaquin Delta, is a complex environment where freshwater from rivers mixes with saltwater from the ocean (MacWilliams et al. 2022). Important physical processes in the San Francisco Estuary, such as salinity intrusion and sediment transport, result from the complex interactions of tides, wind, and freshwater outflow and require a 3D model operating on a short time-step to accurately represent vertical and horizontal circulation processes (MacWilliams et al. 2016a). In particular, sediment transport in the San Francisco Estuary is driven by the interaction of wind-driven surface currents and wind waves and the combined shear stress of tidal currents and wind waves on sediment on the bed. Thus, the simulation of hydrodynamic and sediment transport processes that affect the deposition, resuspension, and dispersal of placed dredged material requires the application of a well-calibrated 3D hydrodynamic and sediment transport model.

The high-resolution UnTRIM Bay-Delta model is a 3D hydrodynamic model of the Bay and the 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 Delta and 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 Delta. This approach offers significant advantages 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 resulting model contains more than 130,000 horizontal grid cells and more than 1 million 3D grid cells (Figure 2-1). Extensive details of the hydrodynamic model and model inputs are available in MacWilliams et al. (2015).

The turbulence closure model used in this study is a two-equation model consisting of a turbulent kinetic energy equation and a generic length-scale equation. The parameters of the generic length-scale 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. (2005a), except for the minimum eddy diffusivity and eddy viscosity values which were 1×10^{-6} m^2/s. In the horizontal, a constant horizontal eddy diffusivity of 0.5 m^2/s was used. 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 each water column and ensures the turbulent variables remain positive (Deleersnijder et al. 1997).

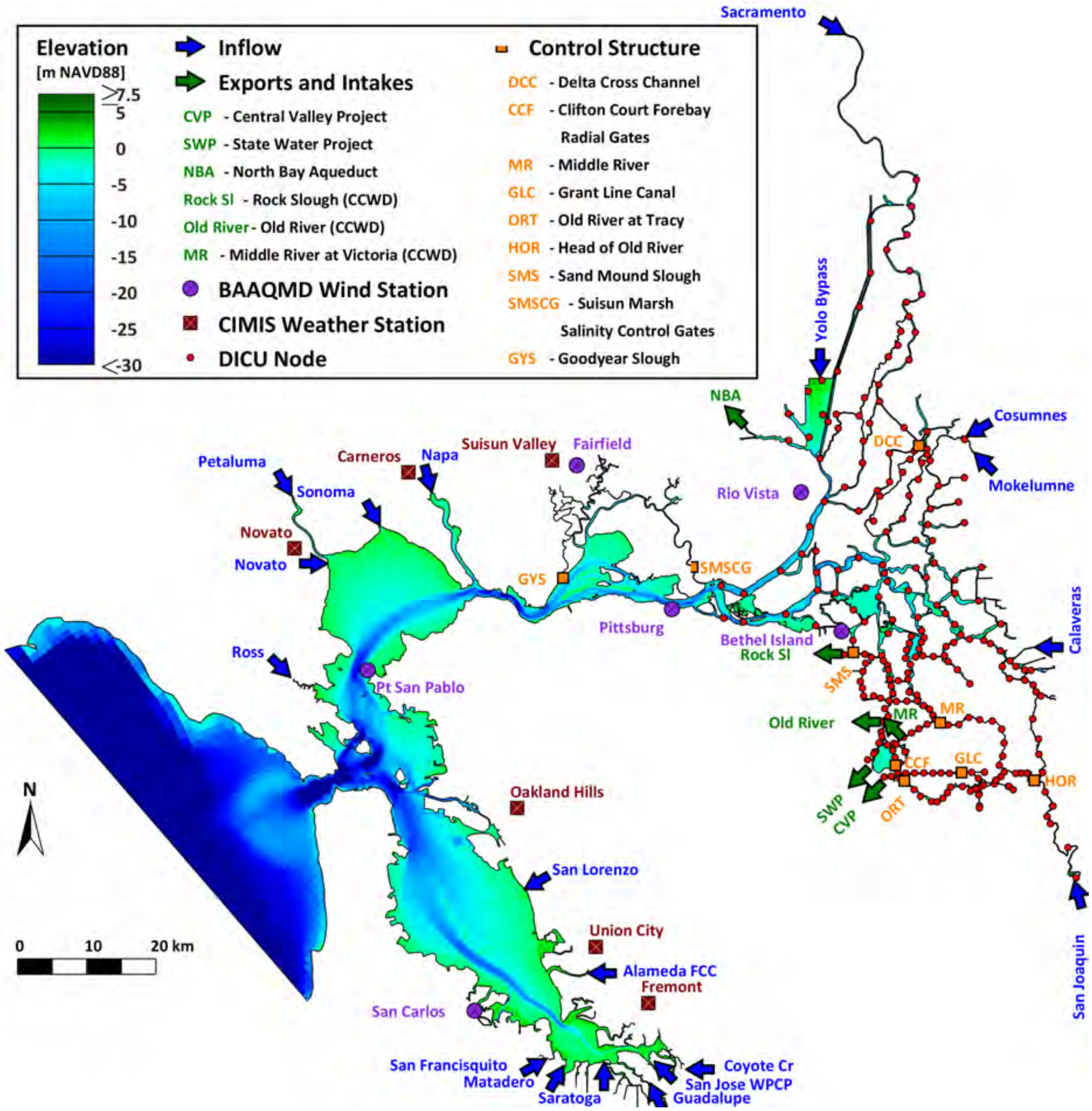
The UnTRIM Bay-Delta model has been applied to the Bay-Delta as part of the Delta Risk Management Strategy (MacWilliams and Gross 2007), several studies to evaluate the mechanisms behind the Pelagic Organism Decline (e.g., MacWilliams et al. 2008), the Bay-Delta Conservation Plan

(MacWilliams and Gross 2010), and for examining X2 and the Low Salinity Zone (MacWilliams et al. 2015). The UnTRIM Bay-Delta model has also been applied for a range of studies by USACE, including the Hamilton Wetlands Restoration Project (MacWilliams and Cheng 2007), the Sacramento River Deep Water Ship Channel Deepening Study (MacWilliams et al. 2009), the San Francisco Bay to Stockton Navigation Project Deepening Study (MacWilliams et al. 2014), and the South San Francisco Bay Shoreline Study (MacWilliams et al. 2012a). The UnTRIM Bay-Delta model has also been applied to several studies of sediment transport in support of the San Francisco Bay Regional Dredged Material Management Program (MacWilliams et al. 2012b; Bever and MacWilliams 2013, 2014; Bever et al. 2014; Delta Modeling Associates 2015) and for turbidity modeling in the Bay-Delta (Anchor QEA 2017; Bever et al. 2018).

The UnTRIM Bay-Delta model has been calibrated using water level, flow, salinity, suspended sediment concentration (SSC), and turbidity data collected in the Bay-Delta in numerous previous studies (e.g., MacWilliams et al. 2008, 2009; MacWilliams and Gross 2010; Bever and MacWilliams 2013; MacWilliams et al. 2015; MacWilliams et al. 2016b; Bever et al. 2018). The model has been shown to accurately predict salinity, tidal flows, water levels, and sediment transport throughout the Bay-Delta under a wide range of conditions (Delta Modeling Associates 2012; Bever and MacWilliams 2013; Bever and MacWilliams 2014; MacWilliams et al. 2015; MacWilliams et al. 2016b; Bever et al. 2018). This report documents the model validation for SSC in the Bay during the study period in Appendix A. Appendix B details the assumptions and limitations of the coupled modeling system that may influence model predictions and the comparison of predicted to observed values.

The hydrodynamic and sediment transport model simulations were conducted using metric units. As a result, the parameter values used in the model are presented in metric units, and the model validation and most of the analysis of the sediment transport modeling results are presented using metric units (e.g., meters, kilograms) in this report. The specifications for the dredged placement scenarios provided by the USACE San Francisco District (SPN) were developed based on United States (US) customary units (e.g., feet, cubic yards). As a result, the description of water depths, dredge material volumes, and some horizontal dimensions are presented using US customary units.

Figure 2-1
High-Resolution UnTRIM San Francisco Bay-Delta Model Domain, Bathymetry, and Locations of Model Boundary Conditions that Include Inflows, Export Facilities, Contra Costa Water District (CCWD) Intakes, Wind Stations from the Bay Area Air Quality Management District (BAAQMD), Evaporation and Precipitation from California Irrigation Management Information System (CIMIS) Weather Stations, Delta Island Consumptive Use (DICU), and Flow Control Structures



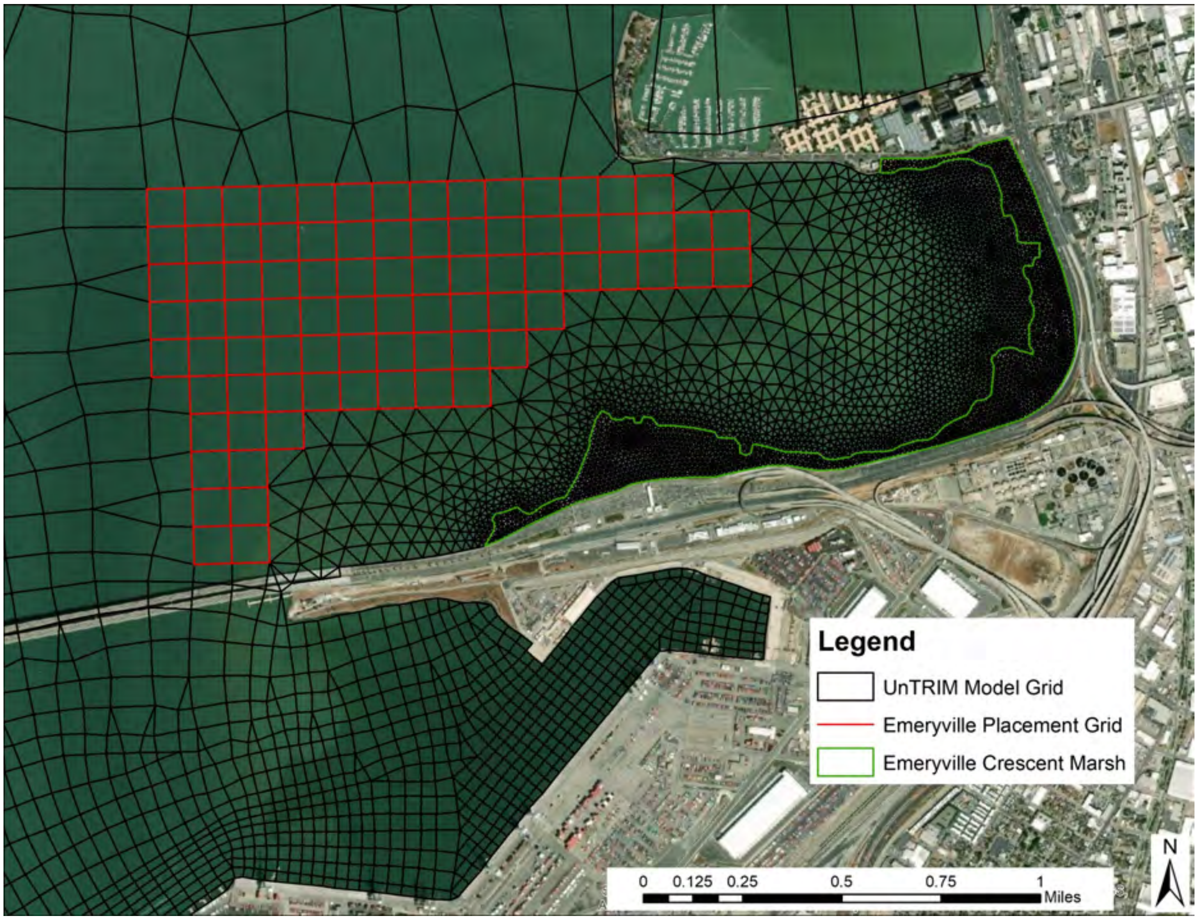
2.1 High-Resolution Grid of Placement Locations

To resolve the transport of sediment following dredged material placements at Emeryville and Eden Landing, the UnTRIM model grid was refined in the vicinity of both potential placement locations. At both locations, a placement grid was established by USACE spanning the region where placements would be evaluated. The placement grid consists of uniform 500-foot (ft) by 500 ft (152.4 m by 152.4 m) square placement cells. The model grid was refined to exactly resolve the placement grid at both potential placement sites.

At the Emeryville placement location (Figure 2-2), the model grid was refined with typical cell sizes in the marsh on the order of 20 m. Between the placement grid and the marsh, the grid cell size transitions from 152.4 m resolution of the placement grid down to approximately 20 m resolution on the edge of the marsh.

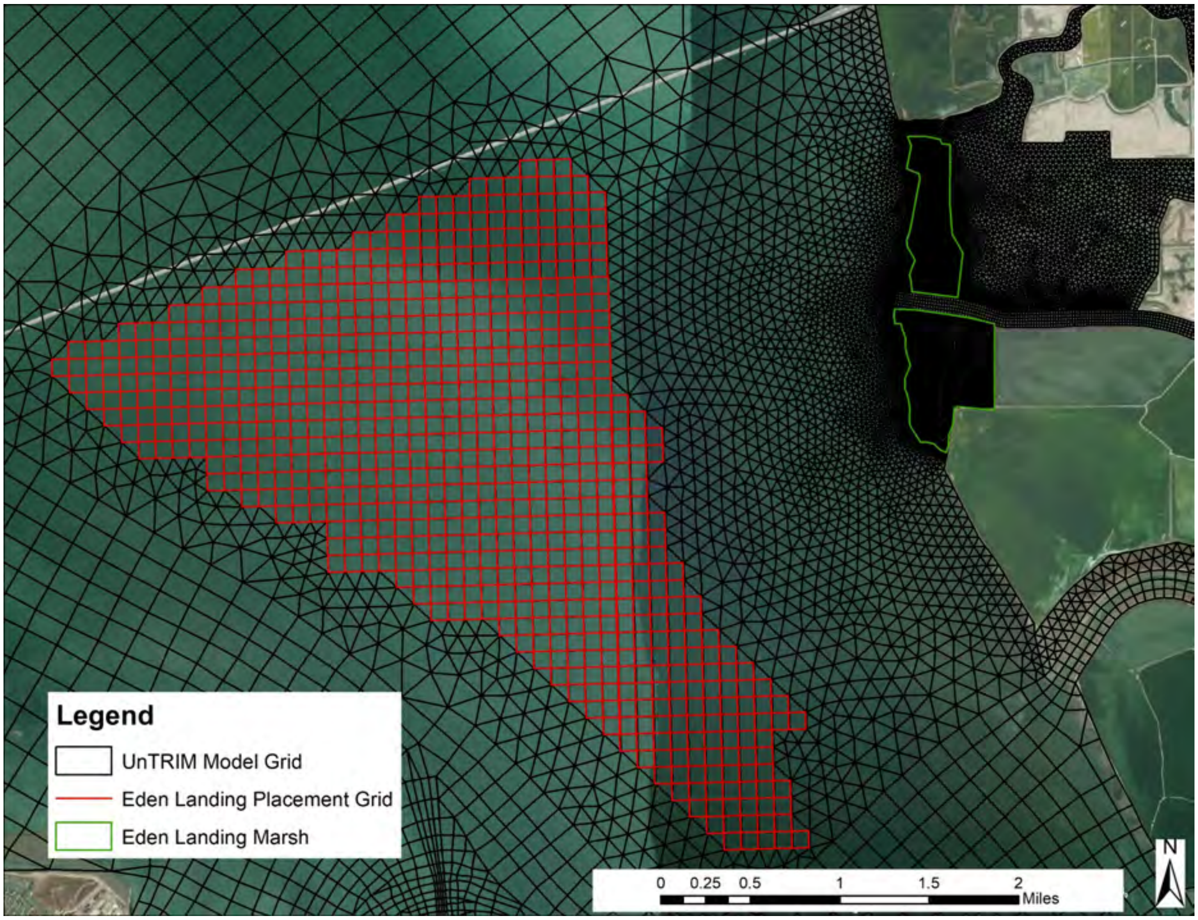
Bathymetry in the two refined portions of the UnTRIM Bay-Delta model grid was updated based on a U.S. Geological Survey (USGS) Coastal National Elevation Database topographic and bathymetric 2-meter Digital Elevation Model (DEM). This DEM spanned the entire San Francisco Bay and was selected for use in this study based on input from SPN. This DEM is referenced to the North American Datum of 1983 (NAD83) horizontal datum and North American Vertical Datum of 1988 (NAVD88) vertical datum. The DEM is available from USGS (2022).

Figure 2-2
High-Resolution Model Grid Around the Emeryville Placement Location



At the Eden Landing placement location (Figure 2-3), the model grid in the Whale's Tail portion of Eden Landing Marsh was refined with typical cell sizes in the marsh on the order of 25 m. The remaining portions of Eden Landing were resolves using a grid resolution between 25 and 50 m. Between the placement grid and the marsh, the grid cell size transitions from the 152.4 m resolution of the placement grid down to approximately 25 m resolution on the edge of the marsh.

Figure 2-3
High-Resolution Model Grid Around the Eden Landing Placement Location



2.2 Sediment Modeling Background

The UnTRIM Bay-Delta model (MacWilliams et al. 2007, 2008, 2009, 2015) has been applied together with the Simulating Waves Nearshore (SWAN) wave model (SWAN Team 2009a) and the SediMorph sediment transport and seabed morphology model (BAW 2005) as a fully coupled hydrodynamic wave-sediment transport model. This coupled modeling system has been used previously to predict sediment transport throughout the Bay-Delta system. Most recently, the model was used to estimate reductions in turbidity throughout Suisun Bay and the confluence region from observed decreases in the wind speed (Bever et al. 2018) and for evaluating sediment flux through the Golden Gate (Anchor QEA 2021). The model has also been applied as part of two projects for USACE to investigate how sea level rise and reduced sediment supply to the Delta impacted sediment routing through the Bay-Delta system and sediment deposition within Suisun and San Pablo Bays (MacWilliams et al. 2012b; Bever and MacWilliams 2014). The coupled models were also used to investigate the effects of breaching Prospect Island on regional turbidity and sediment dynamics in the north Delta and Cache Slough region (Delta Modeling Associates 2014). Other applications of the sediment transport model include simulations of dredged material dispersal in the Northern Bay (MacWilliams et al. 2012b) and the South Bay (Bever and MacWilliams 2014; Bever et al. 2014) to determine the fate of dredged material and investigate whether open-water placements can be used to augment mudflat and marsh sedimentation. Bever and MacWilliams (2013) have also applied the coupled modeling system to investigate wave shoaling and sediment fluxes between the channel and shoals in San Pablo Bay. The UnTRIM Bay-Delta model can be used to predict turbidity as well as sediment transport.

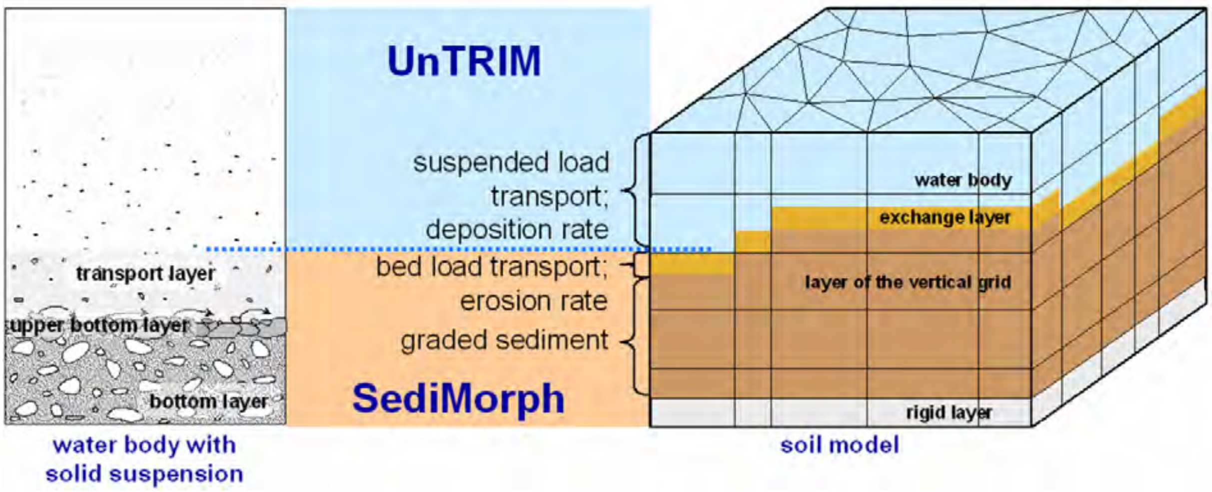
The SWAN model (SWAN Team 2009a) is a widely used model for predicting wind wave properties in coastal areas (e.g., Funakoshi et al. 2008). SWAN "represents the effects of spatial propagation, refraction, shoaling, generation, dissipation and nonlinear wave-wave interactions" (SWAN Team 2009b) on wind 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. In the coupled modeling system, the SWAN model runs on the same unstructured grid as UnTRIM, providing high resolution in areas where it is needed.

The primary purpose of the SediMorph module is to compute the sedimentological processes at the alluvial bed of a free-surface flow, including the following (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 distribution within the bed exchange layer

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 at least one exchange layer, in which sediments are mixed and exchange processes such as erosion and deposition occur. Figure 2-4 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.

Figure 2-4
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: Bundesanstalt für Wasserbau (BAW)

Sediment transport simulations using the UnTRIM Bay-Delta Model include multiple sediment classes, an initial sediment bed based on over 1,300 observed seabed grain size distributions within the Bay and Delta, sediment input from 11 Bay-Delta tributaries, and wave- and current-driven sediment resuspension and transport. In this coupled modeling system, UnTRIM calculates the flow, water level, and salinity, along with suspended sediment advection, settling, and 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 erosion and deposition of sediment and the seabed morphologic change and keeps track of the sedimentological properties within the seabed. The model bathymetry in each grid cell is adjusted each time step to account for erosion and deposition. The configuration of the coupled modeling system, the sediment transport model, and model inputs used in this study is nearly identical to that described in Bever et al. (2018). However, one additional sediment class to represent very fine sediments that settle very slowly was included to improve the predicted SSC and turbidity in the Delta (Table 2-1). Additionally, three separate sediment classes for Silt, Flocculated Silt and Clay, and Sand were included to allow for the tracking of the dredged material separately from other sediment in the system. These three sediment classes used the same sediment parameters as the other Silt, Flocculated Silt and Clay, and Sand classes (Table 2-1).

Table 2-1
Sediment Class Characteristics

Sediment Class	Settling Velocity (mm/s)	Critical Shear Stress (Pa)	Diameter	Density (kg/m^3)	Erosion Rate Parameter (kg/m^{2}s)
Fine silt	0.001	0.0379	11 µm	2,650	2.5×10^{-5} to 10×10^{-5}
Silt	0.038	0.0379	11 µm	2,650	2.5×10^{-5} to 10×10^{-5}
Flocculated silt and clay	2.25	0.15	200 µm	1,300	3×10^{-5} to 12×10^{-5}
Sand	23	0.19	250 µm	2,650	5×10^{-5} to 20×10^{-5}
Gravel	NA	NA	8 mm	2,650	NA
Silt (dredged material)	0.038	0.0379	11 µm	2,650	2.5×10^{-5} to 10×10^{-5}
Flocculated silt and clay (dredged material)	2.25	0.15	200 µm	1,300	3×10^{-5} to 12×10^{-5}
Sand (dredged material)	23	0.19	250 µm	2,650	5×10^{-5} to 20×10^{-5}

Note:
NA: not applicable

The initial sediment bed in the UnTRIM Bay-Delta model was developed by spatially interpolating observed percent mud (silt and clay), sand, and gravel distributions onto the model grid and then separating the interpolated distributions into the sediment classes noted in Table 2-1, as described in Bever and MacWilliams (2013) and Bever et al. (2018). One of the grain size distribution data points was in the Emeryville placement grid (Figure 2-2), and two grain size distribution data points were in the Eden Landing placement grid (Figure 2-3). The grain size distribution for the data point in the Emeryville placement grid included 98.9% mud, 1.1% sand, and no gravel. The average grain size distribution for the two data points in the Eden Landing placement grid included 91.2% mud, 8.8% sand, and no gravel.

2.3 Sediment Model-Data Comparisons

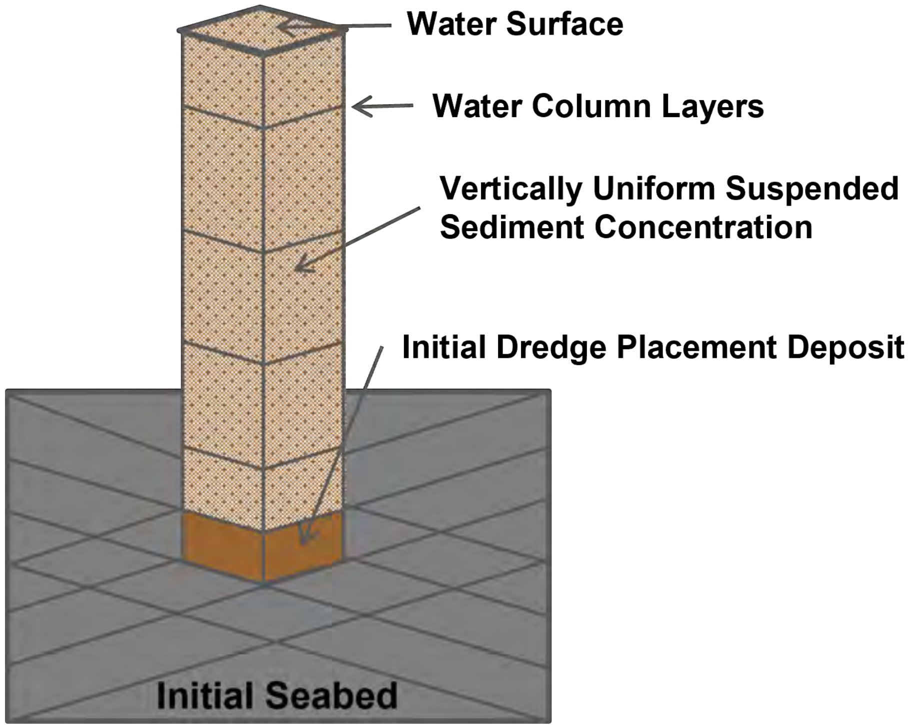
The SWAN wave results have been calibrated and validated to observed wave properties in San Pablo Bay and Suisun Bay (Delta Modeling Associates 2012) and at four locations south of Dumbarton Bridge (Bever and MacWilliams 2014). The sediment transport within the coupled modeling system has been calibrated using a variety of observed data, including SSC time series at multiple locations within the Bay, continuous monitoring stations within Suisun Bay and the Delta, and vertical profiles of SSC along a transect along the axis of the Bay from the far South Bay to Rio Vista. The model has also been validated through comparison of observed and predicted deposition within a breached salt pond during the period following the initial breach (Bever and MacWilliams 2014). Turbidity has been validated using continuous monitoring time series in the Bay and Delta and surface remotely sensed data (Anchor QEA 2017; Bever et al. 2018). The sediment validation demonstrates that the coupled hydrodynamic-wind wave-sediment model is accurately capturing the dominant processes that resuspend, deposit, and transport sediment throughout the

Bay-Delta system and would, therefore, be suitable for predicting sediment transport throughout the Bay-Delta. A detailed validation of predicted SSC using time series at discrete locations during the two time periods considered in this study is presented in Appendix A.

2.4 Sediment Transport Model Dredged Material Placement Framework

The UnTRIM Bay-Delta model can be used to simulate the transport of sediment following dredged material placement events. Dredged material placement events are initialized in the sediment transport model as the 3D sediment transport model simulation progresses. At the time of each dredged material placement event, both suspended sediment and a sediment deposit on the seabed are instantaneously initialized at a single horizontal grid cell. The suspended portion of the placement sediment is set to have a vertically uniform concentration that depends on the amount of each sediment class suspended in the water column during a placement event. The deposited portion is initialized as a sediment deposit having a thickness dependent on the added mass, density of each sediment class, and assumed porosity (Figure 2-5). A porosity of 85% was used in this study, consistent with the porosity used in previous studies (Bever and MacWilliams 2014, Delta Modeling Associates 2015). This 85% porosity value was calibrated through model comparison of predicted and observed sediment depositional volumes in navigation channels (e.g., Delta Modeling Associates 2015) and comparison of predicted and observed deposition thickness following the breach of Salt Pond A6 in the far South Bay (Bever and MacWilliams 2014). Each sediment class can represent different fractions of the total placement sediment mass and different fractions of the suspended and deposited sediment. The dredged material deposited on the seabed acts to fill up multiple seabed layers at the sediment water interface, such that the dredged placement sediment remains at the surface of the seabed where it can be eroded and is not artificially mixed within the initial sediment bed or previous dredged material placements. Sediment eroded from the surrounding initial sediment bed can deposit on top of the placement sediment as the simulations progresses, however.

Figure 2-5
Schematic of a Single Horizontal Grid Cell Immediately Following a Dredged Material Placement Event



A simplification inherent in this model setup is that for each placement the sediment is added to the model at the time of the placement event with a vertically uniform sediment concentration in the water column and a deposit on the seabed. The physics of the actual descent of the sediment from a barge to the seabed are not modeled by the coupled hydrodynamic, wave and sediment transport models. Instead, simulations using the Short-Term Fate (STFATE) model (Johnson and Fong 1995) are used to determine the amounts of dredged material suspended in the water column and deposited on the seabed during the descent from the barge. This is necessary because much of the dredged material is in large clumps that do not behave similarly to the individual sediment particles, and thus this initialization of each placement event provided the most realistic representation possible of the sediment distribution immediately following the placement event.

Following the addition of the sediment to a model grid cell, the sediment in suspension begins to settle toward the seabed and the sediment deposit erodes if the bed shear stress exceeds the critical shear stress of the sediment. The erosion, deposition, and transport of the initially suspended and deposited portions of the placement are then modeled by the coupled hydrodynamic-wave-sediment transport models.

The dredged material placement framework allows for an unrestricted number of placement events within a single simulation. Each placement event has its own date and time, location, scow size, and sediment fractions in suspension and deposition. It also allows for the placement of sediment only in suspension or only on the seabed. Placement events can also be modeled with or without an initial sediment bed and ambient suspended sediments. The sediment used for the dredged material in the model is specified as a separate sediment class to those initially on the sediment bed and discharged from tributaries (Table 2-1) to allow for the tracking of the dredged material separately from other sediment in the system.

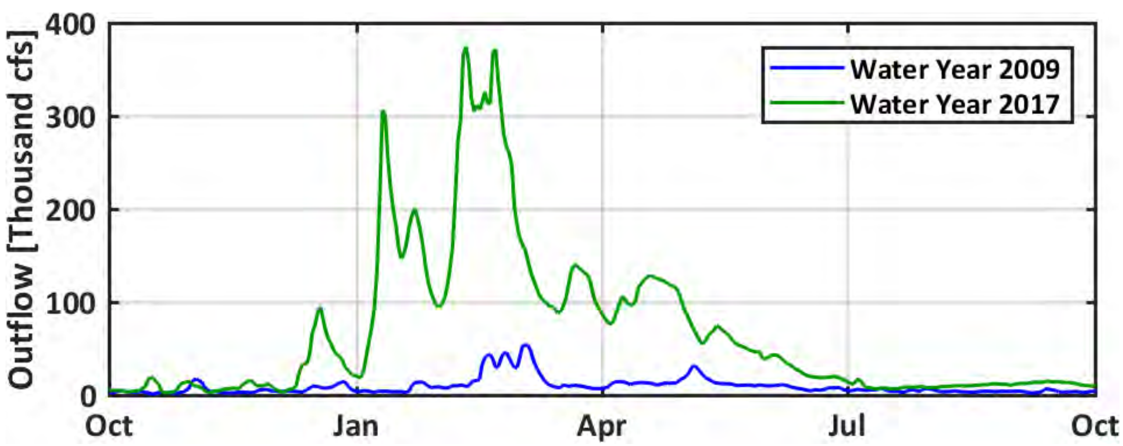
3 Model Simulations and Analyses

This section describes the model simulations and analyses used to evaluate the model predictions. These analyses were used to evaluate the average wave conditions at the two placement locations, determine the timing and model grid cell for each dredged material placement event, and evaluate the fate of the dredged material and the end of the simulation periods.

3.1 Simulation Time Periods

Two time periods were considered for simulating the dispersal of sediment away from dredged material placement locations. One time period was during the winter of a wet year when Delta outflow is relatively high, and one time period was during late spring and early summer of a dry year when wind waves are generally larger and Delta outflow is lower (Section 4). The Dayflow program provides an estimate of the daily net water outflow from the Delta to San Francisco Bay (Delta outflow; CDWR 2022), which was used to compare Delta outflow for the periods simulated. The winter model simulation period spanned 3 months. November 1, 2016, through January 31, 2017, was chosen as the winter period because it has a relatively high, although not extreme, Delta outflow compared to other recent years (Figure 3.1-1).

Figure 3.1-1
Time Series of Dayflow Delta Outflow



The wind speeds around Central Bay and South Bay were evaluated to aid in the selection of the dates for the summer simulation period. Wind direction was then evaluated for the summer and winter periods to determine any differences in wind direction between the two simulation periods. The wind speed during 2 consecutive months was used to determine the root-mean-squared (RMS) wind speed. The RMS is similar to the average, except higher values are weighted more strongly using the RMS than the average. Weighting the higher wind speeds more strongly is beneficial in this analysis because the higher wind events will result in larger wind waves and more sediment resuspension. Due to the short timeline of this study, the Project Delivery Team (PDT) determined it would be beneficial to select a period during which the sediment transport model had previously been calibrated to SSC measurements in the study area so additional model calibration would not be required. Based on a review of 11 periods simulated for previous studies, 3 years were identified for further evaluation in this analysis: 2006, 2008, and 2009. These years were selected for consideration because they had previously been simulated for other projects and the sediment transport model had already been validated to available SSC data in the study area for these periods. The years 2006, 2008, and 2009 also span the full range of water year types from wet to critical water years, to allow for consideration of both the wettest and driest water year classifications. The highest RMS wind speed in Central Bay occurred during May and June 2009 (Figure 3.1-2). The highest RMS wind speed in South Bay occurred during May and June 2008, with the second highest RMS speed in May and June 2009 (Figure 3.1-3). Based on the relatively high RMS wind speeds, May 1 through June 30, 2009, was used for the summer simulation period.

Figure 3.1-2
RMS Wind Speed in Central Bay

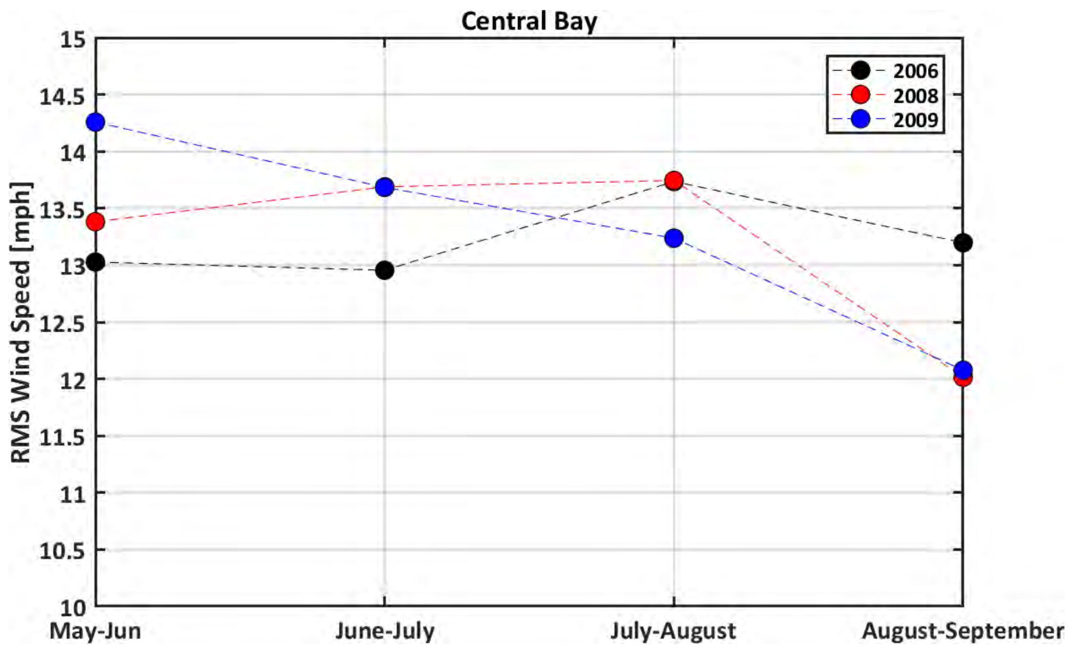
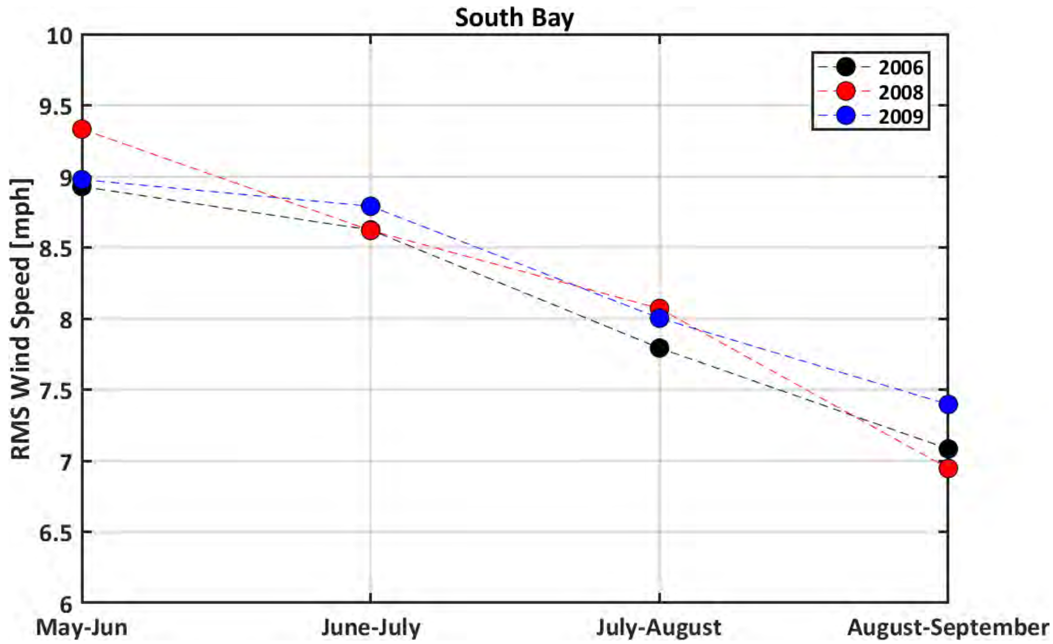


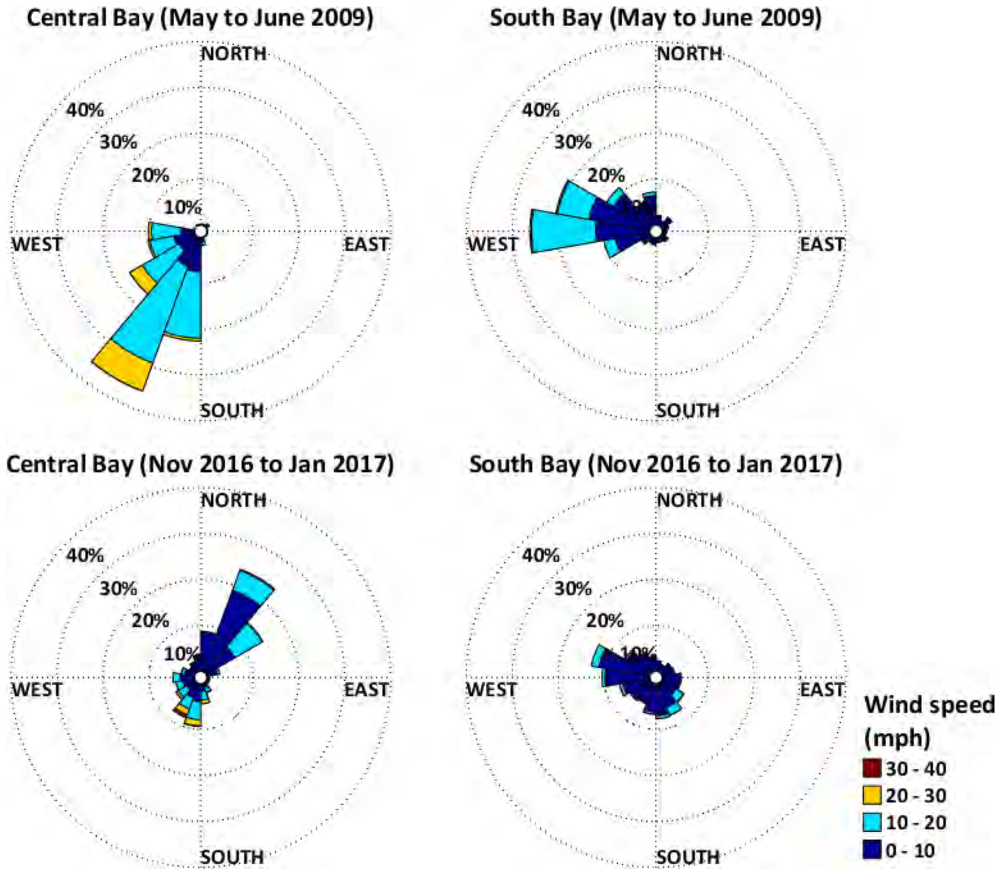
Figure 3.1-3
RMS Wind Speed in South Bay



Directional wind roses were developed from the available wind data in Central Bay and South Bay and used to evaluate differences in wind speed and direction between the summer and winter simulation periods (Figure 3.1-4). The dashed circles on the wind roses represent the percentage of time the wind was blowing from each direction, and the wind speed is represented by the colors. In the Central Bay during the summer simulation period, winds were predominantly from the southwest. A southwest wind direction allows the wind to blow across Central Bay toward the eastern side and results in a relatively long fetch for developing wind waves, compared to winds from the northwest. In the Central Bay during the winter simulation period, winds were predominantly from the northwest, with a small percentage of the winds from the southwest. Northwest winds will result in relatively small wind waves on the eastern side of Central Bay, while the few periods of strong winds from the southwest have the potential to generate relatively large wind waves on the eastern side of Central Bay.

In the South Bay during the summer simulation period, winds were predominantly from the west (Figure 3.1-4). A west wind direction allows the wind to blow across South Bay toward the eastern side and results in a relatively long fetch for developing wind waves, compared to winds from the east. In the South Bay during the winter simulation period, wind direction was more variable than during the summer period. The wind speed was also lower during the winter period than during the summer period, which is shown by most of the wind rose being the dark blue color (0 to 10 miles per hour). Lower wind speeds and some winds from the southeast and east will result in smaller wind waves on the eastern side of South Bay during the winter period than during the summer period.

Figure 3.1-4
Central Bay and South Bay Wind Roses for the Summer and Winter Simulation Periods



Note:
Direction is the direction from which the winds are blowing.

3.1.1 Validation of Predicted Suspended Sediment Concentrations

Because the UnTRIM Bay-Delta model has already been extensively calibrated for water levels, salinity, and flows (MacWilliams et al. 2015), no further model calibration was conducted as part of this study. To validate the prediction of SSC in the study area, the predicted SSC was compared to observed SSC at all locations in San Francisco Bay where SSC measurements were available during the two analysis periods used in this study to evaluate the dredged material placement scenarios. Appendix A provides model validations of SSC throughout the Bay during the period that dredged material dispersal was evaluated. Predicted SSC was compared to observed SSC using time series at discrete locations spanning from Dumbarton Bridge to Mallard Island. Time series data were available from six locations through USGS (USGS 2020) and at another location in San Pablo Bay (Schoellhamer et al. 2008). At the stations where SSC were available from both upper and lower sensors, both the data and the model predicted a large amount of vertical stratification in SSC.

This was particularly evident at the Richmond-San Rafael Bridge, Benicia Bridge, and Dumbarton Bridge stations in the winter period (Table A-1 in Appendix A) and at the Benicia Bridge and Dumbarton Bridge stations during the summer period (Table A-2 in Appendix A).

3.2 Dredged Material Placement Assumptions

This section describes the assumptions of scow size and necessary water depth for placements, the distribution of dredged material between various sediment types, and the estimation of the percentage of material suspended in the water column during a placement event.

3.2.1 Scow Volumes and Necessary Water Depths

Multiple assumptions regarding the amount of dredged material placed during each individual placement event and the placement strategy for each scenario were needed to determine the exact location and timing of each dredged material placement for each scenario. All scenarios assumed the use of 180 ft (length) by 50 ft (breadth) split-hulled bottom dump scow with a capacity of 1,450 cubic yards (yd^3). The dump time is assumed to be 9 minutes. To facilitate the evaluation of placements over a range of placement depths, the scows were assumed to contain either 1,400 yd^3, 1,150 yd^3, or 900 yd^3 of dredged material. The light loading of the scow allowed for a smaller draft depth and facilitated placements in shallower water (Table 3.2-1). Based on information provided by USACE, the water depths necessary for a placement event were 11 ft for the 1,400 yd^3 placements, 10 ft for the 1,150 yd^3 placements, and 9 ft for the 900 yd^3 placements. These were the minimum depth requirements for a placement event used to develop placement scenarios (Table 3.2-1) and included the draft depth plus 1 ft of clearance. Light-loading the barge to less than 900 yd^3 of dredged material was not evaluated in this study. Further reducing the loading of the barge from 900 to 550 yd^3 was considered by the PDT to be impractical due to the increasing number of individual placements and associated costs.

Table 3.2-1
Scow Loading and Draft Assumptions Provided by USACE

Scow Loading (yd^3)	Draft Depth (ft)	Minimum Required Placement Depth (ft)
1,400	10	11
1,150	9	10
900	8	9
550	7	8
0	2.5	NA

3.2.2 Composition of Dredged Material

Data on the sediment dredged from Oakland Harbor and Redwood City Harbor were used to specify the proportion of silt, flocs, and sand model sediment classes in the dredged material. USACE provided the percentage of the dredged material in the barges composed of clumps, sand, silt, clay, and water for material dredged from Oakland Harbor (Table 3.2-2) and Redwood City Harbor (Table 3.2-3). For the specification of the grain sizes of the placed sediment in the sediment transport model, the clumps were assumed to be composed of the same relative fractions of sand, silt, and clay as the values for those constituents provide by USACE. The silt and clay fractions were added together to determine the total percentage of fine sediment in a scow because silt and clay in San Francisco Bay aggregate to form flocs. The total percentage of fine sediment was then separated into the modeled silt and flocs sediment classes by assuming 30% of the fine sediment was disaggregated silt and 70% of the fine sediment was flocs, similar to the assumption made previously when modeling the dispersal of dredged material in far South Bay (Bever and MacWilliams 2014). The resulting percentages of each sediment class for the dredged material used in this study were 20% sand, 24% silt, and 56% flocs for the Oakland Harbor sediment and 10% sand, 27% silt, and 63% flocs for the Redwood City Harbor sediment. The placement scenarios at Emeryville assumed the use of dredged material from Oakland Harbor. The placement scenarios at Eden Landing assumed the use of dredged material from Redwood City Harbor, with the exception of one scenario that evaluated the placement of sediment from Oakland Harbor at Eden Landing.

Table 3.2-2
Dredged Material Characteristics for Oakland Harbor

Material	USACE Provided Percentage of Scow Volume	Percent Sediment	Percent Sand/Silt/Clay	USACE Provided Fall Velocity (fps)
Clumps	20.08%	55.00%	NA	3
Sand	3.31%	9.07%	20.15%	0.025
Silt	5.92%	36.03%	36.03%	0.003
Clay	7.20%	43.82%	43.82%	0.003
Water	63.50%	NA	NA	NA

Note:
NA: not applicable

Table 3.2-3
Dredged Material Characteristics for Redwood City Harbor

Material	USACE Provided Percentage of Scow Volume	Percent Sediment	Percent Sand/Silt/Clay	USACE Provided Fall Velocity (fps)
Clumps	20.07%	54.99%	NA	3
Sand	1.59%	4.36%	9.68%	0.025
Silt	4.66%	12.77%	28.36%	0.003

Material	USACE Provided Percentage of Scow Volume	Percent Sediment	Percent Sand/Silt/Clay	USACE Provided Fall Velocity (fps)
Clay	10.18%	27.89%	61.96%	0.003
Water	63.50%	NA	NA	NA

Note:
NA: not applicable

The percentages of mud, sand, and gravel in the Oakland Harbor and Redwood City Harbor sediment were similar to the available observed grain size distribution data available in the placement grids. Oakland Harbor sediment contained 79.85% mud (silt plus clay), 20.15% sand, and no gravel (Table 3.2-2). The bed grain size distribution data in the Emeryville placement grid included 98.9% mud, 1.1% sand, and no gravel (Section 2.2). The majority of the sediment in both the Oakland Harbor sediment and bed grain size distribution data was mud, although the Oakland Harbor sediment had a higher percentage of sand than the bed grain size distribution data. Some of the difference in the mud and sand percentages may be attributed to only having a single bed grain size distribution sample in the Emeryville placement grid and Oakland Harbor extending west into deeper water where sand is more prevalent.

Redwood City Harbor sediment contained 90.32% mud (silt plus clay), 9.68% sand, and no gravel (Table 3.2-3). The bed grain size distribution data in the Eden Landing placement grid included 91.2% mud, 8.8% sand, and no gravel (Section 2.2). The majority of the sediment in both the Redwood City Harbor sediment and bed grain size distribution data was mud, and the percentages of mud, sand, and gravel were very similar between the Redwood City Harbor sediment and bed grain size distribution data available in the Eden Landing placement grid.

3.2.3 Fraction of Dredged Material Suspended in the Water Column

The dredged material placement framework in the UnTRIM Bay-Delta model assumes the dredged material is added into the simulation after the barge is empty (Section 2.4). Results from the STFATE model (Johnson and Fong 1995) were used to estimate the percentage of the sediment suspended in the water column during descent from the barge. The STFATE simulations used the percentage of clumps, sand, silt, clay, and water in the scow based on the Oakland Harbor and Redwood City Harbor data provided by USACE (Tables 3.2-2 and 3.2-3). The fall velocity of the sediment was also provided by USACE.

Hydrodynamic model simulations were used to determine background current speeds and ranges of water depths over which the placement events could occur for the STFATE simulations. The predicted depth-averaged RMS current speed from May 1 to June 30, 2009, was calculated from the hydrodynamic model output at three locations in the Emeryville and Eden Landing placement grids (Table 3.2-4). The three locations spanned from relatively deep to shallow areas of the placement grids. At each placement depth, the RMS current speeds at Eden Landing were higher than the RMS current speeds at Emeryville.

Table 3.2-4
Current Speed and Range in Water Depth Used for STFATE Simulations

Placement Grid	RMS Current Speed (fps)			Range in Water Depth (feet)		
	Deep	Middle	Shallow/East	Deep	Middle	Shallow/East
Emeryville	0.60	0.41	0.38	11 to 13.5	10 to 12	9 to 11.5
Eden Landing	0.74	0.64	0.59	11 to 14	10 to 13	9 to 12

Completely emptying of the barge during a placement event was assumed to take 9 minutes, and the STFATE results were evaluated 1 minute after the emptying of the barge to estimate the percentage of sediment suspended in the water column during placement. The volume of sediment predicted to remain in suspension and predicted to be deposited on the bed 1 minute after the emptying of the barge was used to determine the percentage of clumps, sand, silt, and clay suspended in the water column during the placement. For each STFATE simulation, 100% of the clumps were predicted to be deposited on the bed at 1 minute after the barge was empty. The total percentages of sand, silt, and clay suspended in the water column were then weighted based on 100% of the clumps being deposited on the bed. The percentages of silt and clay predicted to be suspended in the water column were the same within each STFATE simulation and were used as the stripping percentage for the silt and flocs sediment classes in the sediment transport model. The STFATE simulations resulted in 17.8% to 30.2% of the sand being suspended in the water column and 41.8% to 43.0% of the silt and flocs being suspended in the water column during the placement event (Table 3.2-5). The percentage of sand suspended in the water column used in this study is considerably higher than the percentage used in the previous study evaluating dispersal of dredged material in the far South Bay, in which the sand stripping percentage ranged from 0% to 4.7% (Bever and MacWilliams 2014).
For the far South Bay modeling (Bever and MacWilliams 2014), the STFATE results were evaluated approximately 16 minutes after the barge was emptied, 15 minutes later than was assumed for this study. Based on the fall velocity of 0.025 feet per second for sand (Table 3.2-3), the settling depth of sand over 15 minutes is 24 feet. Because this study evaluated the STFATE results 1 minute after the barge was emptied rather than 16 minutes after the barge was emptied, the percentages of sand suspended in the water column are higher than those used in the previous study focused on the far South Bay, which used the percentages still in suspension 15 minutes later.

Table 3.2-5
STFATE Simulations and Percentages Suspended in the Water Column

Placement Grid	Location (Scow Volume)	Current Speed (fps)	Water Depth (feet)	Percentage Stripped		
				Sand	Silt	Flocs
Emeryville	Deep (1,400 yd^3)	0.60	11	23.6	42.5	42.5
			13.5	27.6	42.9	42.9
	Middle (1,150 yd^3)	0.41	10	21.2	42.2	42.2
			12	25.8	42.7	42.7
	Shallow/East (900 yd^3)	0.38	9	17.8	41.8	41.8
			11.5	24.4	42.5	42.5
Eden Landing	Deep (1,400 yd^3)	0.74	11	30.2	42.5	42.5
			14	29.4	43.0	43.0
	Middle (1,150 yd^3)	0.64	10	26.4	42.2	42.2
			13	26.5	42.8	42.8
	Shallow/East (900 yd^3)	0.59	9	27.5	41.8	41.8
			12	26.4	42.6	42.6

3.2.4 Conversion of Scow Volume to Sediment Mass

The sediment transport model simulates the transport of sediment mass throughout the Bay-Delta. However, the dredged material placement events were developed based on the volume of dredged material in a scow, and some of the volume in a scow is composed of water (Tables 3.2-2 and 3.2-3). This necessitated converting the volume of the scow to the total mass of each sediment class in the scow for simulating the dispersal of dredged material. The volume of sediment in the scow was calculated by assuming 63.5% of the scow volume was water (Tables 3.2-2 and 3.2-3). The resulting sediment volumes for the sand, silt, and flocs sediment classes were then converted to mass using the density of each sediment class (Table 2-1).

Calculations of sediment mass in the scow assumed a porosity of 63.5% (Tables 3.2-2 and 3.2-3), while the sediment bed in the sediment transport model assumed a porosity of 85%. The 85% porosity in the sediment transport model is based on previous calibrations of predicted sediment depositional thickness and volumes. The increase in assumed porosity from the scow to the sediment bed results in a thicker dredged material deposit on the sediment bed than had a 65% porosity been used for the sediment bed. Differences in assumed porosity between in the scow and deposited on the bed are reasonable because some disaggregation of the sediment and increase in porosity will occur during the descent from the scow and subsequent deposition on the bed.

3.2.5 Emeryville and Eden Landing Placement Grids

Grids composed of 500 ft by 500 ft squares were developed by USACE near Emeryville Crescent Marsh and Eden Landing Marsh for potential dredged material placement locations (Figures 2-2 and 2-3). The Emeryville placement grid was composed of 84 individual 500 ft by 500 ft grid cells. The Eden Landing placement grid was composed of 729 individual 500 ft by 500 ft grid cells. Individual dredged material placements in the sediment transport model were specified to occur in one of the placement grid cells. The placement grid cells that included a dredged material placement in a model scenario are termed the "placement footprint." The placement footprint represents the spatial area over which dredged material placements were conducted in any individual scenario.

Figure 3.2-1
Dredged Material Placement Grids

Note:
Red squares are the placement grid cells near Emeryville Crescent Marsh (north) and Eden Landing Marsh (south). The entire extent of the placement cells is termed the "placement grid."

3.3 Dredged Material Placement Sediment Transport Scenarios

A total of 12 dredged material placement scenarios were conducted using the UnTRIM Bay-Delta model. A two-stage approach was used to develop the assumptions for the 12 scenarios. The first six scenarios were used to evaluate whether Emeryville or Eden Landing was most suitable for pilot study and to evaluate different placement strategies at each location to narrow in on most effective placement strategy. At both Emeryville and Eden Landing, three scenarios were developed to simulate placements of fully loaded scows containing 1,400 yd^3 of dredged material at a deep location, partially loaded scows containing 1,150 yd^3 of dredged material near the middle of the placement grid, and partially loaded scows containing 900 yd^3 of dredged material in the shallow/east portion of the placement grid nearest to the target marsh (Table 3.3-1). Based on the results of these first six scenarios, the remaining six scenarios evaluated the effect of different placement volumes, seasonal differences, and other refinements to the placement strategy at Eden Landing (Table 3.3-1). The specific assumptions for all 12 of the placement scenarios were developed through discussion with SPN and the PDT, which included both USACE staff and other stakeholders.

3.3.1 Description of Initial Six Scenarios

The initial six dredged material placement scenarios were designed to evaluate how the locations of the placements affected the amount of material predicted to be transported onto the mudflats and marshes. All six scenarios simulated the May through June 2009 period with faster winds and resulting larger wind waves than the December 2016 through January 2017 period (see Section 4 for a description of the waves and bed shear stress). The larger wind waves result in more sediment resuspension following the dredged material placements.

The initial six dredged material placement scenarios assumed placement of a total of 100,000 yd^3 of dredged material. Using 100,000 yd^3 of material resulted in a total of 72 placement events using a scow loaded with 1,400 yd^3 of dredged material, 87 placement events using a scow loaded with 1,150 yd^3 of dredged material, and 112 placement events using a scow loaded with 900 yd^3 of dredged material. The final placement event in each scenario used a smaller volume of dredged material so that the total volume placed for each scenario was exactly 100,000 yd^3.

Of the first six scenarios, three scenarios were conducted with placements in the Emeryville placement grid, and three were conducted with placements in the Eden Landing placement grid (Table 3.3-1). The scenarios at Emeryville and Eden Landing considered three different locations within each placement grid, representing relatively deep, middle, and shallow locations. Within the Emeryville placement grid, the deep and middle placement locations each consisted of 24 individual placement grid cells, but space constraints limited the shallow location to 12 individual placement grid cells. Within the Eden Landing placement grid, the deep, middle, and shallow placement locations each consisted of 24 individual placement grid cells.

While it was assumed the same size scow was used for all scenarios, different volumes of sediment in the scow were used for the deep, middle, and shallow placement locations to allow for larger placement volumes and fewer placement events in deeper water. The deep locations used a scow loaded with 1,400 yd^3 of dredged material, and each placement event required a minimum water depth of 11 feet. The middle locations used a scow loaded with 1,150 yd^3 of dredged material, and each placement event required a minimum water depth of 10 feet. The shallow locations used a scow loaded with 900 yd^3 of dredged material, and each placement event required a minimum water depth of 9 feet. Sediment characteristics (Section 3.2.2) and stripping percentages (Section 3.2.3) for the Emeryville placement grid scenarios were based on the sediment from Oakland Harbor. Sediment characteristics and stripping percentages for the Eden Landing placement grid scenarios were based on the sediment from Redwood City Harbor.

A hydrodynamic model simulation was used to determine the time-varying water depths in the placement grids for specifying exact locations and times of placement events. Starting at 00:00 on May 1, 2009, every 15 minutes the predicted water depth in each placement grid cell was evaluated to determine whether any water depths were sufficient for a placement event. If no water depths were greater than the minimum depth needed for the scow, the next 15-minute interval was evaluated. If any water depths were sufficient for a placement event, a placement event was specified to occur in the shallowest placement cell with water depths sufficient for a placement. Following each placement event, it was assumed that a minimum amount of time passed before the subsequent placement could occur. The minimum amount of time between placements was determined for each scenario to be as long as possible, while still allowing for all of the placements to occur in less than 28 days. This was necessary because the total duration of most placement simulations was only 2 months. Placements were required to be as evenly spread out in the placement grid as possible, such that if an individual placement cell reached the maximum number of placement events it was removed from consideration for further placements, regardless of the water depth in the placement cell.

The shallow placement locations were more restrictive on when placement events could occur because they required the tidal water surface elevation to be near high water for the water depth to be deep enough to allow for a placement.

For the middle placement locations, the placement events were required to occur during a flooding tide. When placements occur on flood tide the sediment suspended in the water column during placement will initially be transported toward the marsh, potentially resulting in a more effective placement strategy than if placements occur on ebb tide. The change in water surface elevation was used to determine whether the tide was flooding or ebbing. A positive change in water surface elevation indicates the water surface elevation is increasing and the tide is flooding, while a negative change in water surface elevation indicates a decreasing water surface elevation and an ebb tide. To classify as a flooding tide for a dredged material placement, the change in water surface elevation needed to be positive at both the potential time of the placement and 15 minutes after the time of the placement. This ensured that the placements occurred during flood tide and that the tide did not reverse immediately following the placements.

Table 3.3-1
Summary of Dredged Material Placement Scenarios

Scenario Number	Scenario Name	Location	Scow Loading	Dredged Material Placement Volume	Notes
1	Emeryville Deep	Deep	1,400 yd^3	100,000 yd^3	
2	Emeryville Middle	Middle	1,150 yd^3	100,000 yd^3	Placements during flood tide
3	Emeryville Shallow/East	Shallow/East	900 yd^3	100,000 yd^3	
4	Eden Landing Deep	Deep	1,400 yd^3	100,000 yd^3	
5	Eden Landing Middle	Middle	1,150 yd^3	100,000 yd^3	Placements during flood tide
6	Eden Landing Shallow/East	Shallow/East	900 yd^3	100,000 yd^3	
7	Eden Landing 50,000 yd^3	Shallow/East	900 yd^3	50,000 yd^3	Smaller total placement volume
8	Eden Landing 75,000 yd^3	Shallow/East	900 yd^3	75,000 yd^3	Smaller total placement volume
9	Eden Landing Winter	Shallow/East	900 yd^3	100,000 yd^3	Winter period of November 2016 through January 2017—3-month simulation
10	Eden Landing Oakland Harbor Sediment	Shallow/East	900 yd^3	100,000 yd^3	Dredged material based on Oakland Harbor sediment
11	Eden Landing Larger Placement Footprint	Expanded Shallow/East	900 yd^3	100,000 yd^3	Shallow placement location but with a larger placement footprint
12	Eden Landing Larger Placement Footprint 125,000 yd^3	Expanded Shallow/East	900 yd^3	125,000 yd^3	Shallow placement location but with a larger placement footprint and larger placement volume

3.3.1.1 Scenario 1: Emeryville Deep

The Emeryville Deep scenario consisted of 72 placement events in 24 placement grid cells, with three placements in each placement grid cell (Figure 3.3-1). Placements were located in the western deeper portion of the placement grid. Placements were spaced at least 6 hours apart (Figure 3.3-2). The scenario included 100,000 yd^3 of dredged material that was assumed to come from Oakland Harbor and evaluated dispersal from May 1, 2009, through June 30, 2009. Scows were assumed to hold 1,400 yd^3 of dredged material and require a minimum water depth of 11 ft.

Figure 3.3-1
Number of Placement Events in Each Placement Grid Cell: Scenario 1 Emeryville Deep

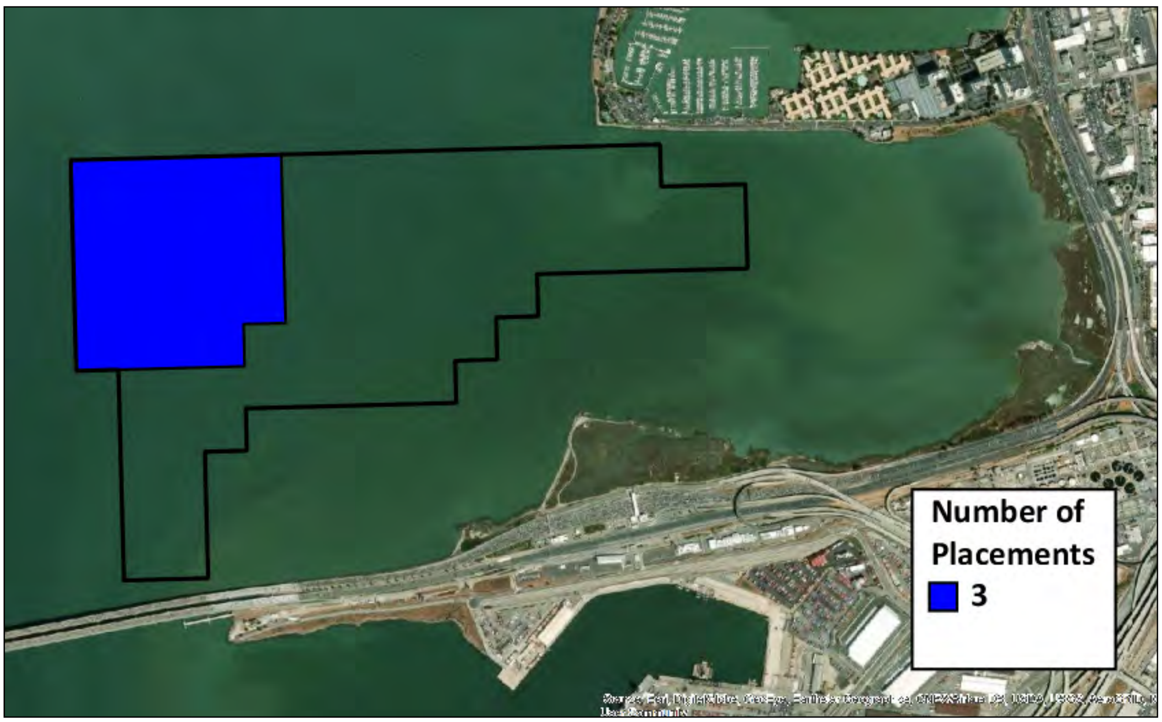
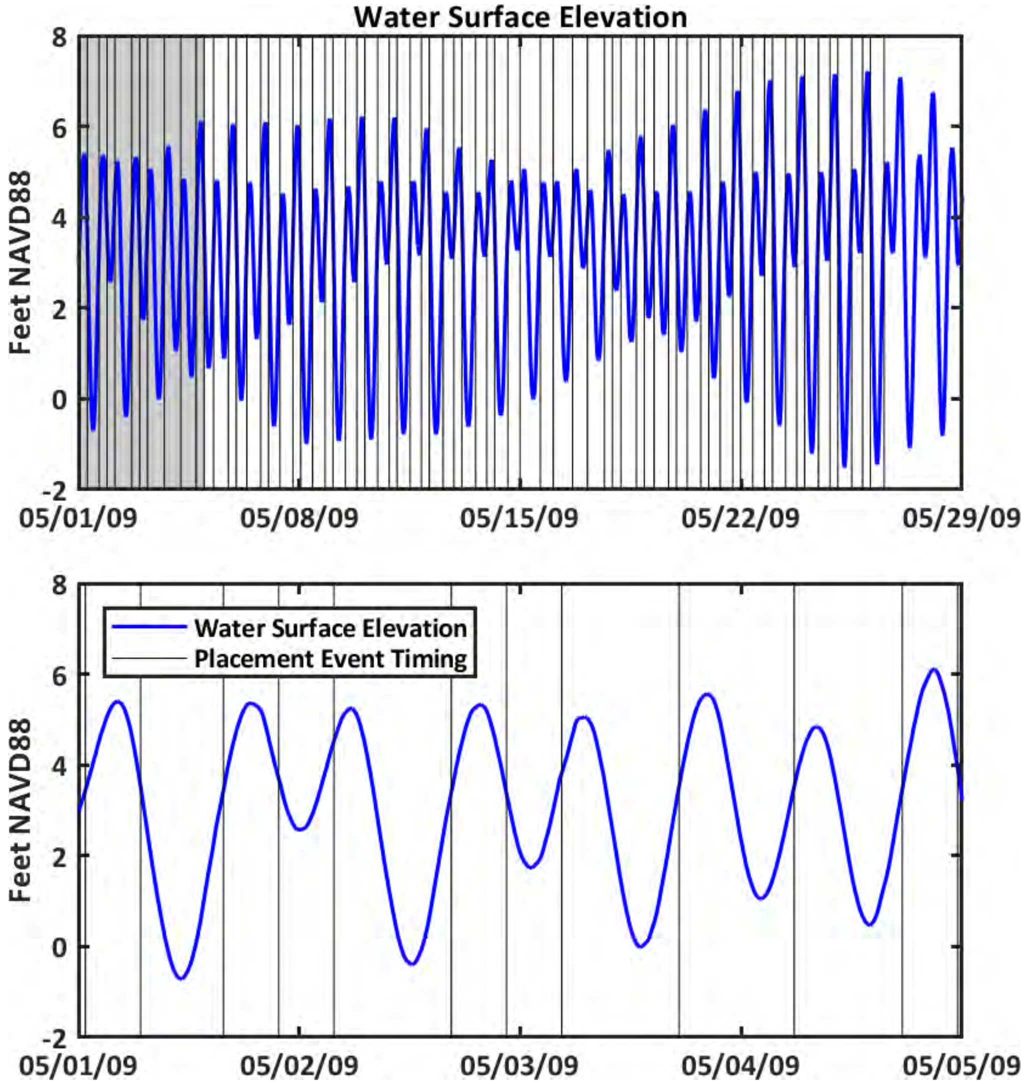


Figure 3.3-2
Water Surface Elevation During Placement Events: Scenario 1 Emeryville Deep



Note:
Shading denotes the time period of the bottom panel.

3.3.1.2 Scenario 2: Emeryville Middle

The Emeryville Middle scenario consisted of 87 placement events in 24 placement grid cells, with three or four placements in each placement grid cell (Figure 3.3-3). Placements were located in the middle portion of the placement grid. Placements were spaced at least 2 hours apart (Figure 3.3-4) and occurred during flooding tide, as described in Section 3.3.1. The scenario included 100,000 yd^3 of dredged material that was assumed to come from Oakland Harbor and evaluated dispersal from May 1, 2009, through June 30, 2009. Scows were assumed to hold 1,150 yd^3 of dredged material and require a minimum water depth of 10 ft.

Figure 3.3-3
Number of Placement Events in Each Placement Grid Cell: Scenario 2 Emeryville Middle

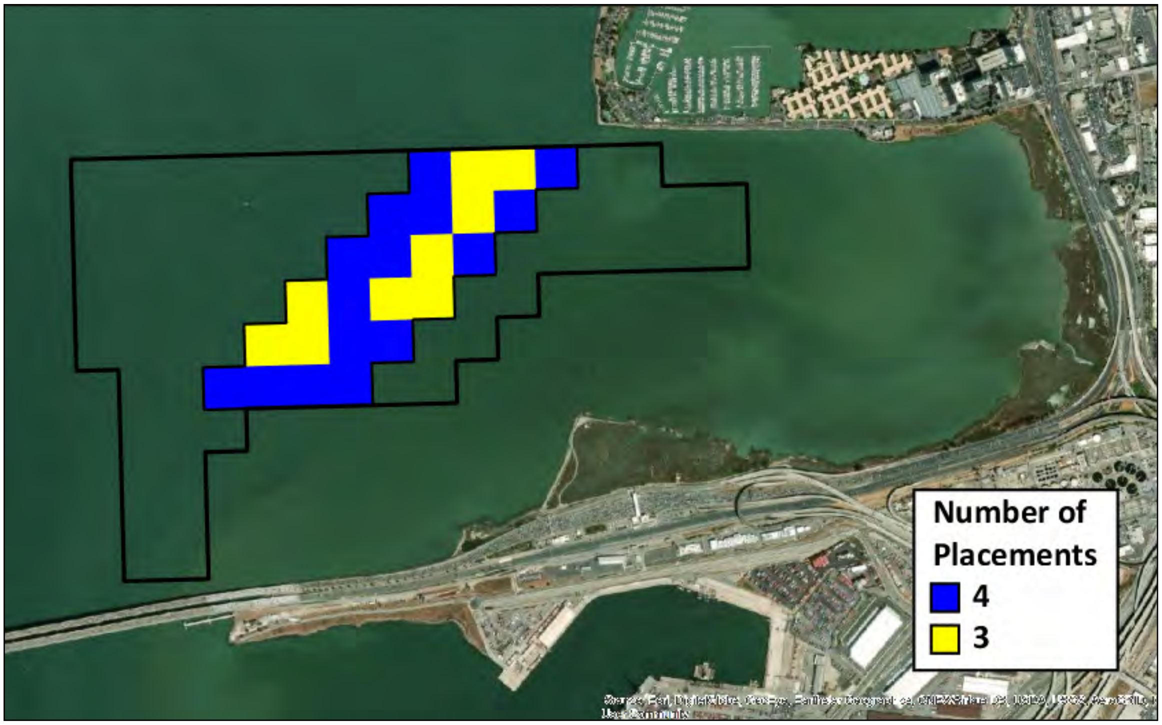
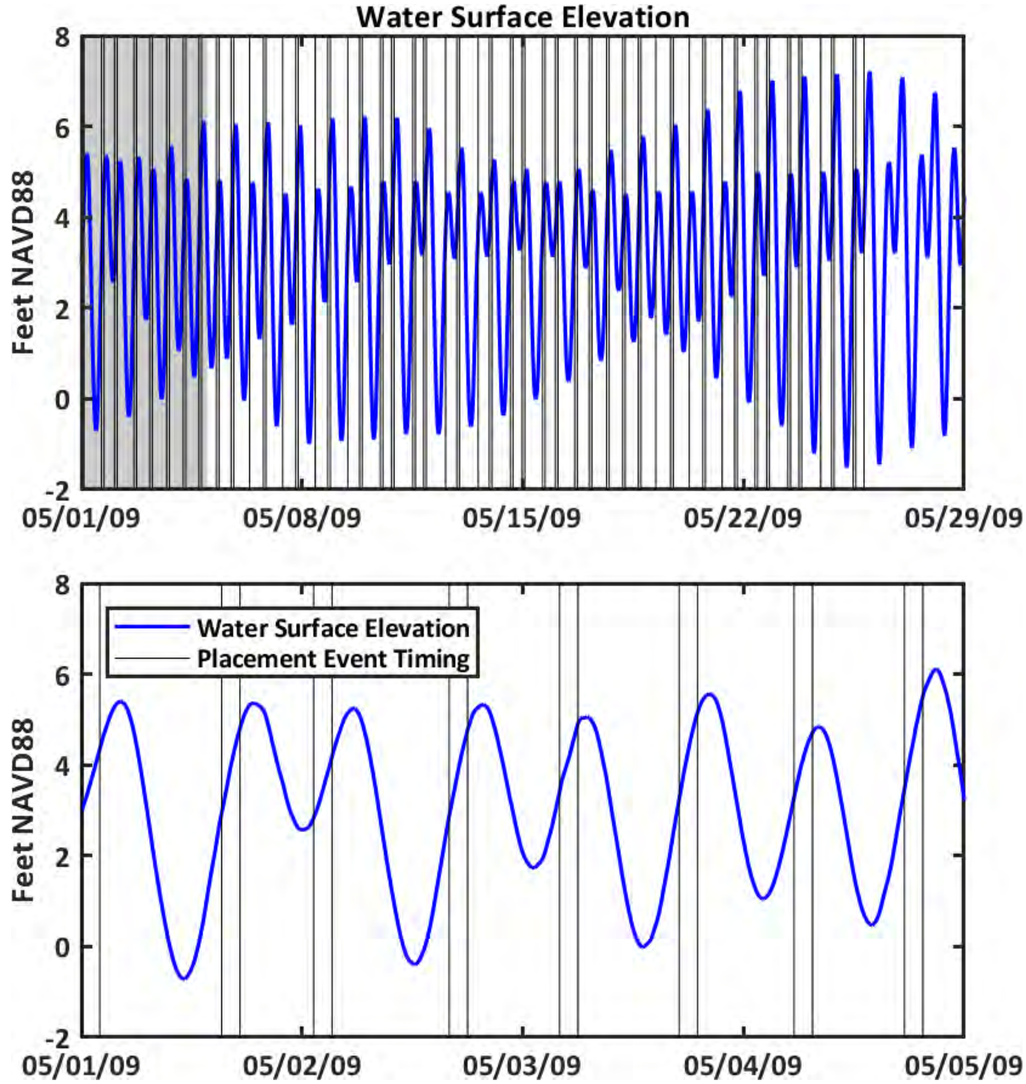


Figure 3.3-4
Water Surface Elevation During Placement Events: Scenario 2 Emeryville Middle



Note:
Shading denotes the time period of the bottom panel.

3.3.1.3 Scenario 3: Emeryville Shallow/East

The Emeryville Shallow/East scenario consisted of 112 placement events in 12 placement grid cells, with nine or ten placements in each placement grid cell (Figure 3.3-5). Placements were located in the eastern shallower portion of the placement grid. Placements were spaced at least 2 hours apart (Figure 3.3-6). The scenario included 100,000 yd^3 of dredged material that was assumed to come from Oakland Harbor and evaluated dispersal from May 1, 2009, through June 30, 2009. Scows were assumed to hold 900 yd^3 of dredged material and require a minimum water depth of 9 ft.

Figure 3.3-5
Number of Placement Events in Each Placement Grid Cell: Scenario 3 Emeryville Shallow/East

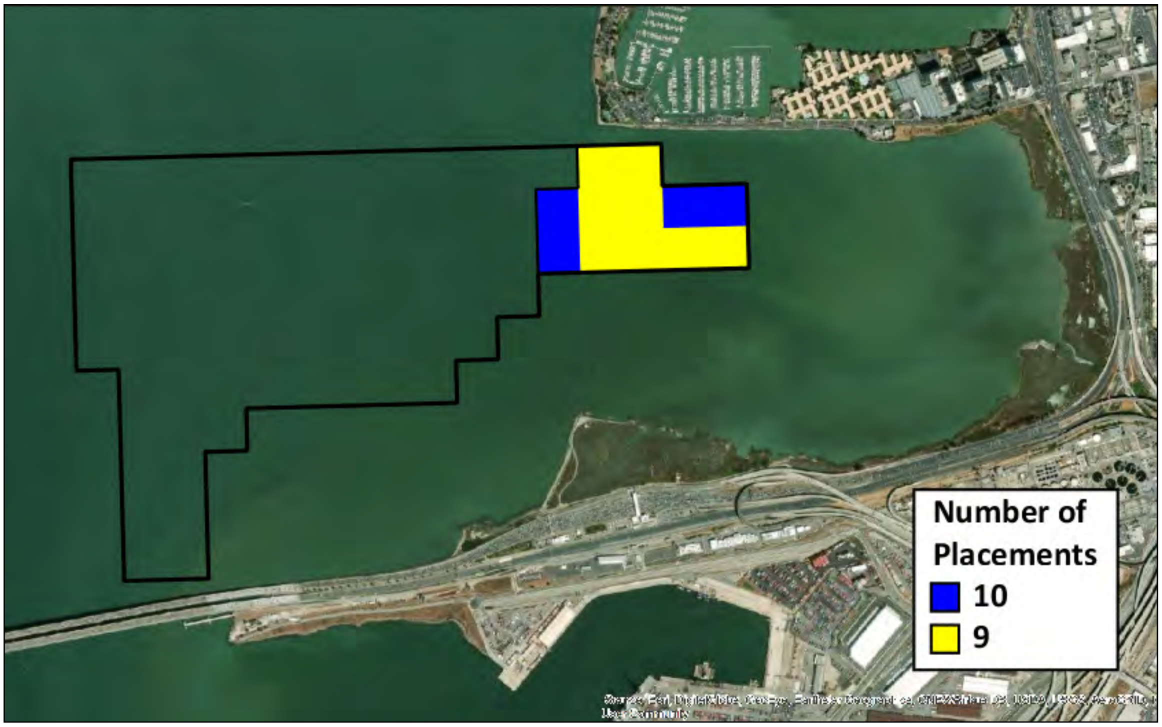
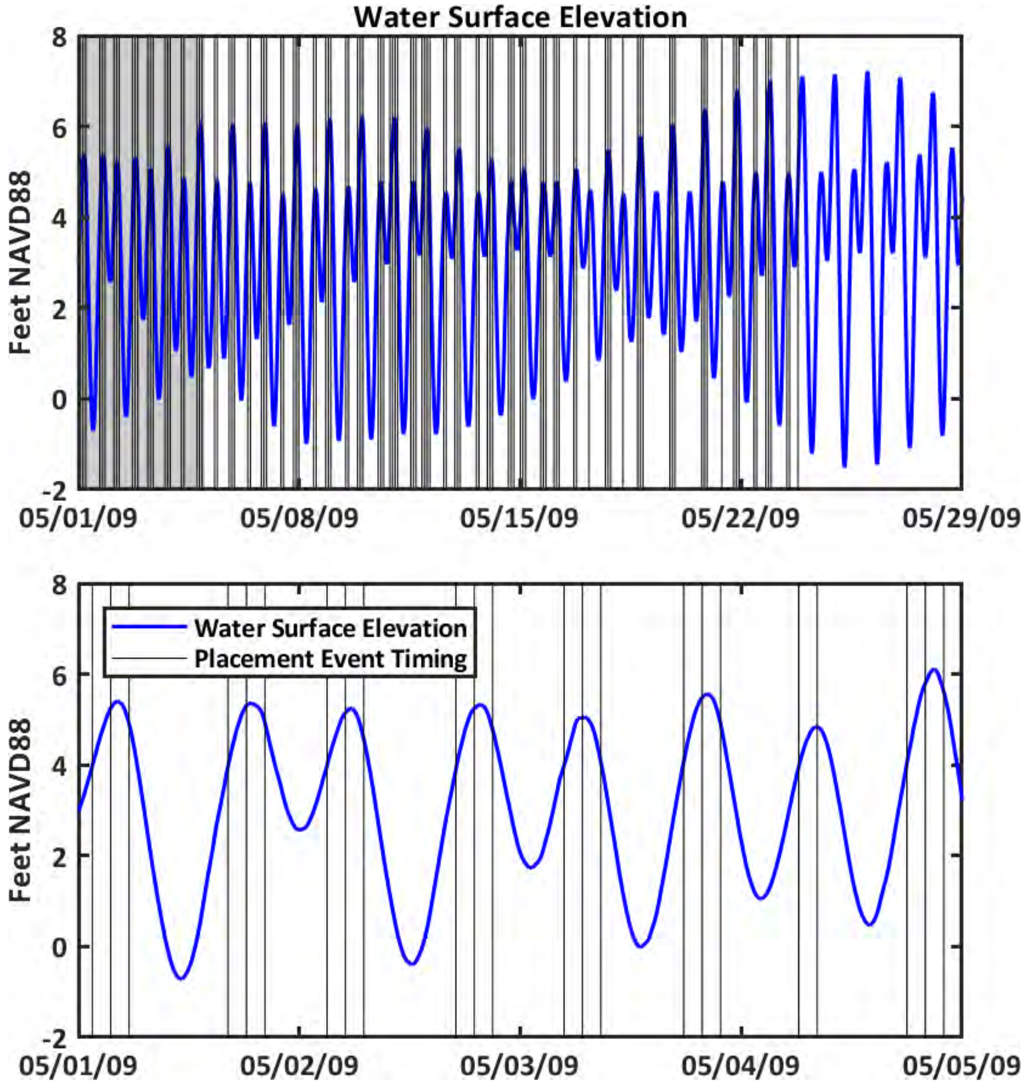


Figure 3.3-6
Water Surface Elevation During Placement Events: Scenario 3 Emeryville Shallow/East



Note:
Shading denotes the time period of the bottom panel.

3.3.1.4 Scenario 4: Eden Landing Deep

The Eden Landing Deep scenario consisted of 72 placement events in 24 placement grid cells, with three placements in each placement grid cell (Figure 3.3-7). Placements were located approximately in the east/west center of the placement grid. Placements were spaced at least 5 hours apart (Figure 3.3-8). The scenario included 100,000 yd^3 of dredged material that was assumed to come from Redwood City Harbor and evaluated dispersal from May 1, 2009, through June 30, 2009. Scows were assumed to hold 1,400 yd^3 of dredged material and require a minimum water depth of 11 ft.

Figure 3.3-7
Number of Placement Events in Each Placement Grid Cell: Scenario 4 Eden Landing Deep

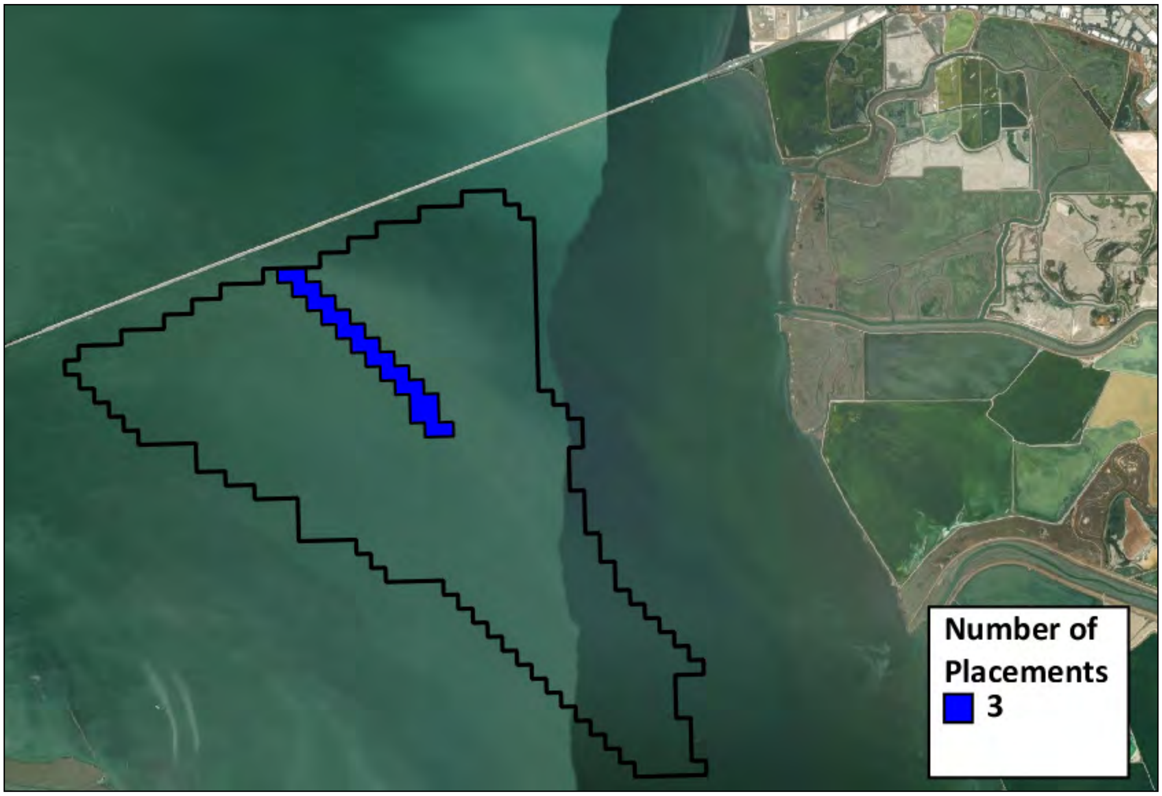
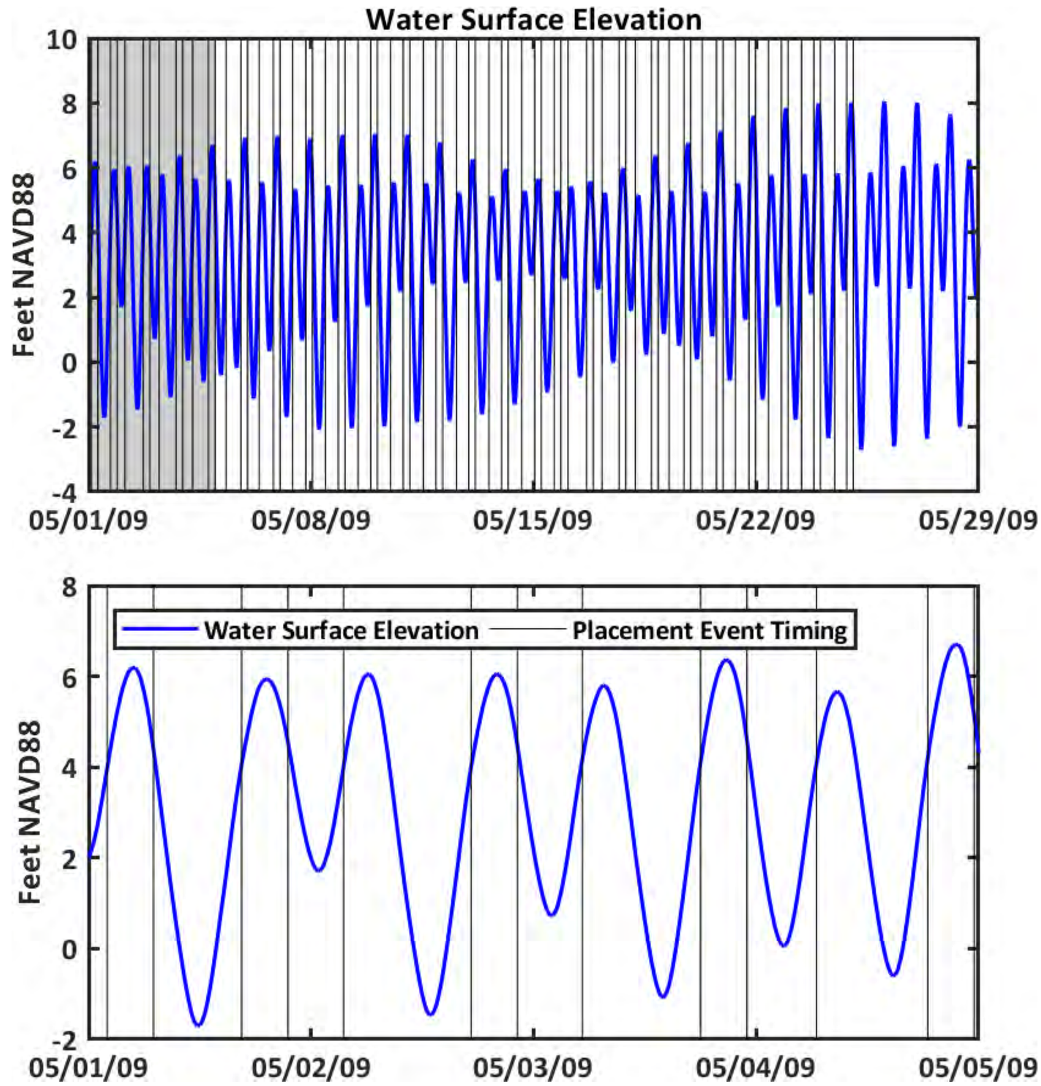


Figure 3.3-8
Water Surface Elevation During Placement Events: Scenario 4 Eden Landing Deep



Note:
Shading denotes the time period of the bottom panel.

3.3.1.5 Scenario 5: Eden Landing Middle

The Eden Landing Middle scenario consisted of 87 placement events in 24 placement grid cells, with three or four placements in each placement grid cell (Figure 3.3-9). Placements were located east of the approximate east/west center of the placement grid. Placements were spaced at least 1.5 hours apart (Figure 3.3-10) and occurred during flooding tide, as described in Section 3.3.1. The scenario included 100,000 yd^3 of dredged material that was assumed to come from Redwood City Harbor and evaluated dispersal from May 1, 2009, through June 30, 2009. Scows were assumed to hold 1,150 yd^3 of dredged material and require a minimum water depth of 10 ft.

Figure 3.3-9
Number of Placement Events in Each Placement Grid Cell: Scenario 5 Eden Landing Middle

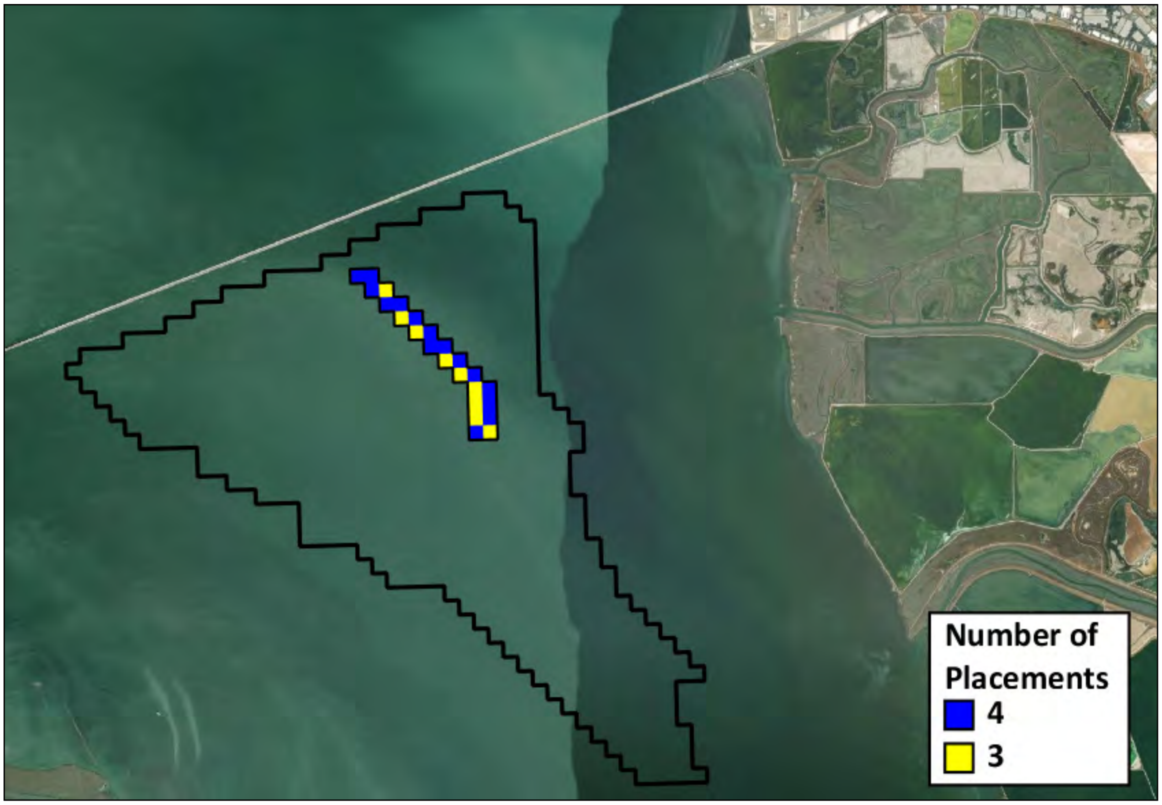
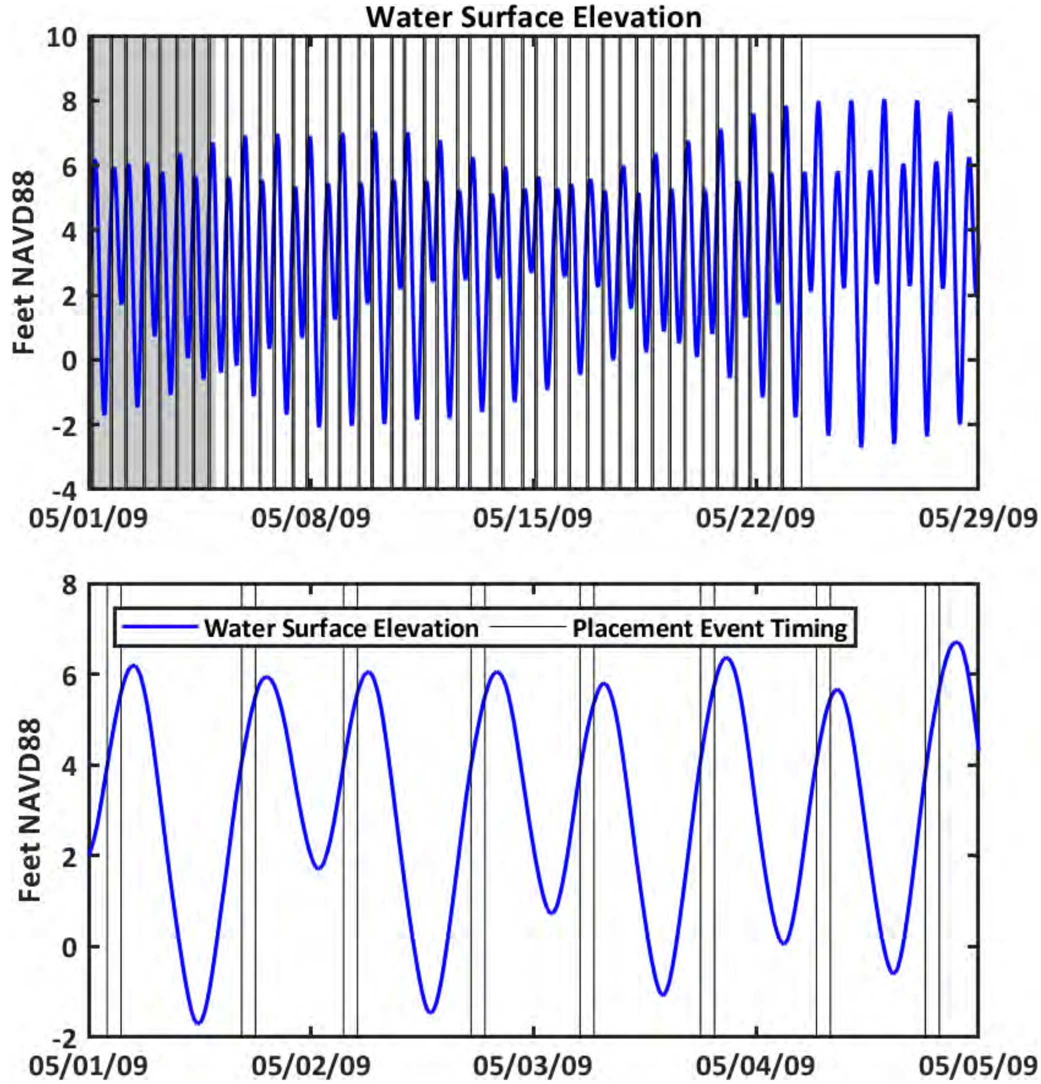


Figure 3.3-10
Water Surface Elevation During Placement Events: Scenario 5 Eden Landing Middle



Note:
Shading denotes the time period of the bottom panel.

3.3.1.6 Scenario 6: Eden Landing Shallow/East

The Eden Landing Shallow/East scenario consisted of 112 placement events in 24 placement grid cells, with four or five placements in each placement grid cell (Figure 3.3-11). Placements were located in the eastern shallower portion of the placement grid. Placements were spaced at least 1.5 hours apart (Figure 3.3-12). The scenario included 100,000 yd^3 of dredged material that was assumed to come from Redwood City Harbor and evaluated dispersal from May 1, 2009, through June 30, 2009. Scows were assumed to hold 900 yd^3 of dredged material and require a minimum water depth of 9 ft.

Figure 3.3-11
Number of Placement Events in Each Placement Grid Cell: Scenario 6 Eden Landing Shallow/East

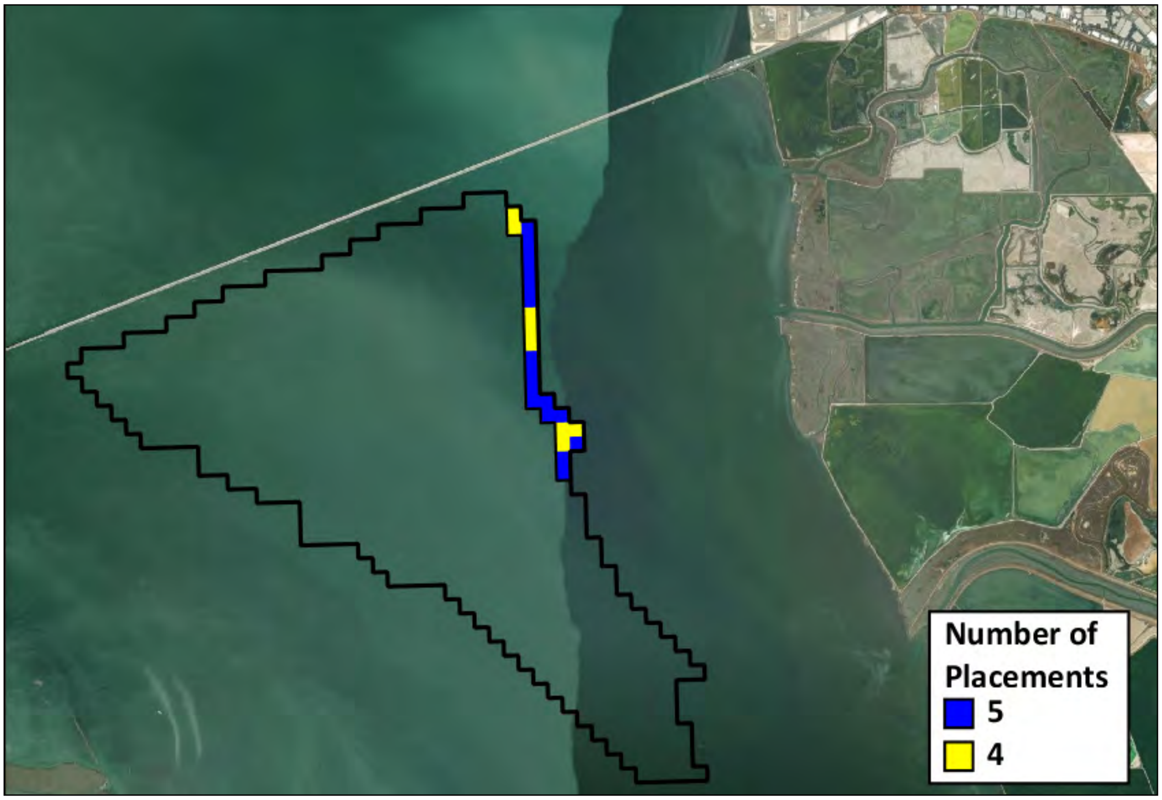
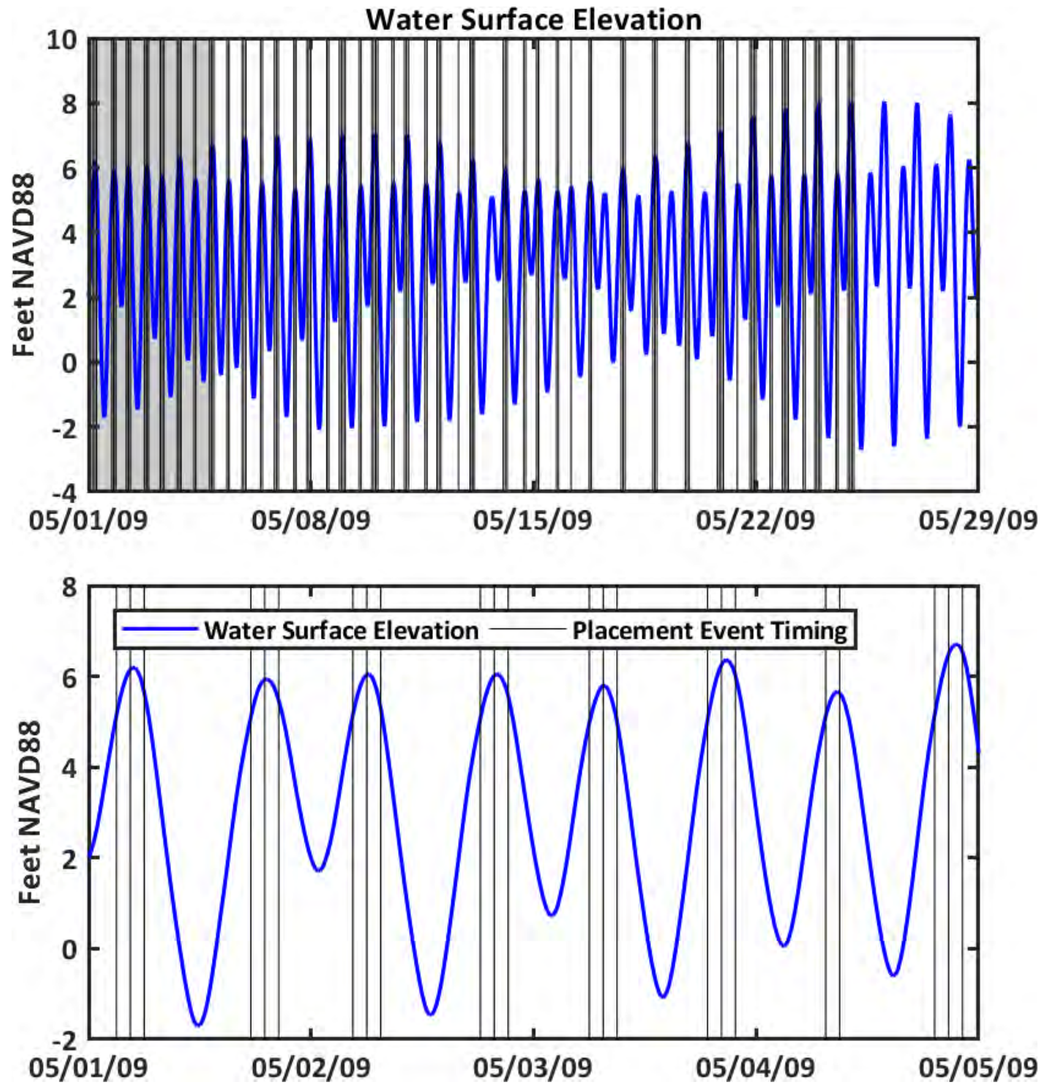


Figure 3.3-12
Water Surface Elevation During Placement Events: Scenario 6 Eden Landing Shallow/East



Note:
Shading denotes the time period of the bottom panel.

3.3.2 Description of Six Additional Eden Landing Scenarios

The initial six scenarios described in Section 3.3.1 indicated more dredged material would be dispersed to mudflats and marshes from the Eden Landing placement location than the Emeryville placement location and that the shallow/east scenario had the most transport of dredged material toward the marsh (Section 5.2). Because of this, the final six scenarios focused on dredged material placements in the shallower eastern portion of the Eden Landing placement grid. These scenarios evaluated using lower volumes of dredged material, conducting placements in the winter, using sediment from Oakland Harbor, and using a larger placement footprint with two volumes of dredged material (Table 3.3-1).

3.3.2.1 Scenario 7: Eden Landing Shallow/East 50,000 yd^3 of Dredged Material

The Eden Landing Shallow/East 50,000 yd^3 of Dredged Material scenario consisted of 56 placement events in the 24 placement grid cells of the Eden Landing shallow/east placement footprint, with two or three placements in each placement grid cell (Figure 3.3-13). Placements were located in the eastern shallower portion of the placement grid. Placements were spaced at least 1.5 hours apart (Figure 3.3-14). The scenario included 50,000 yd^3 of dredged material that was assumed to come from Redwood City Harbor and evaluated dispersal from May 1, 2009, through June 30, 2009. Scows were assumed to hold 900 yd^3 of dredged material and require a minimum water depth of 9 ft.

Figure 3.3-13
Number of Placement Events in Each Placement Grid Cell: Scenario 7 Eden Landing 50,000 yd^3

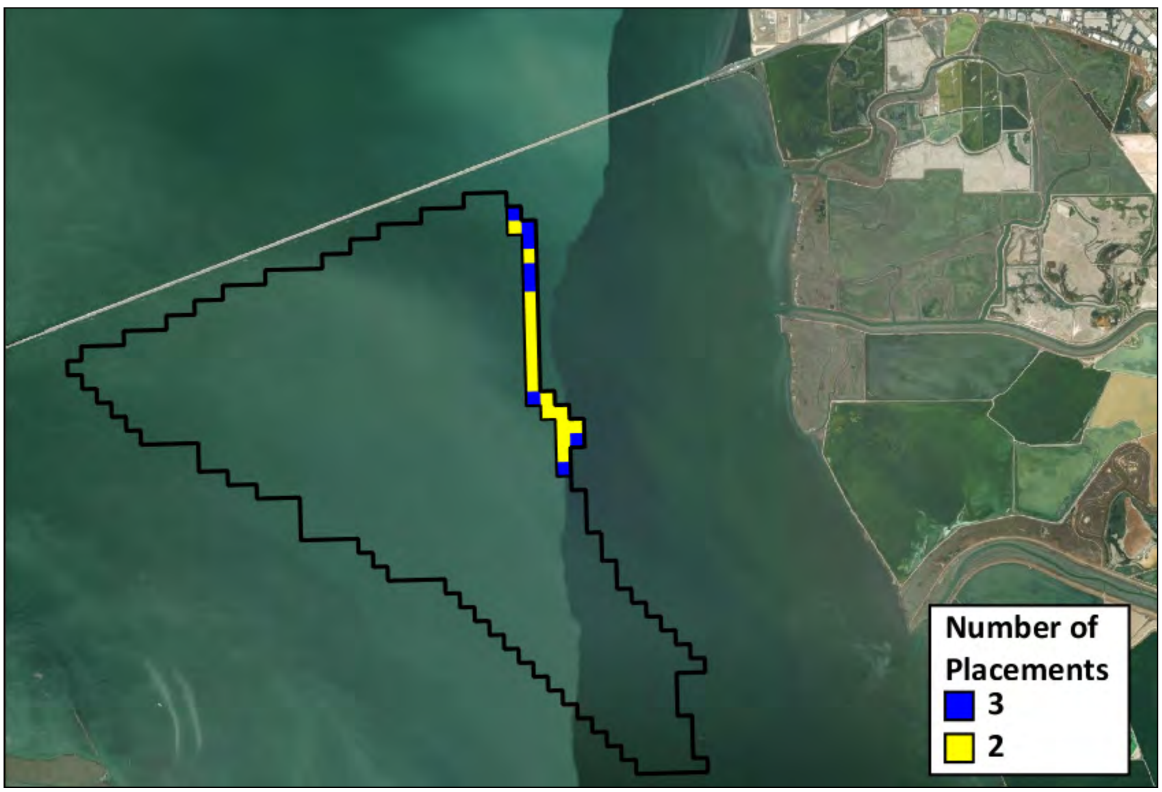
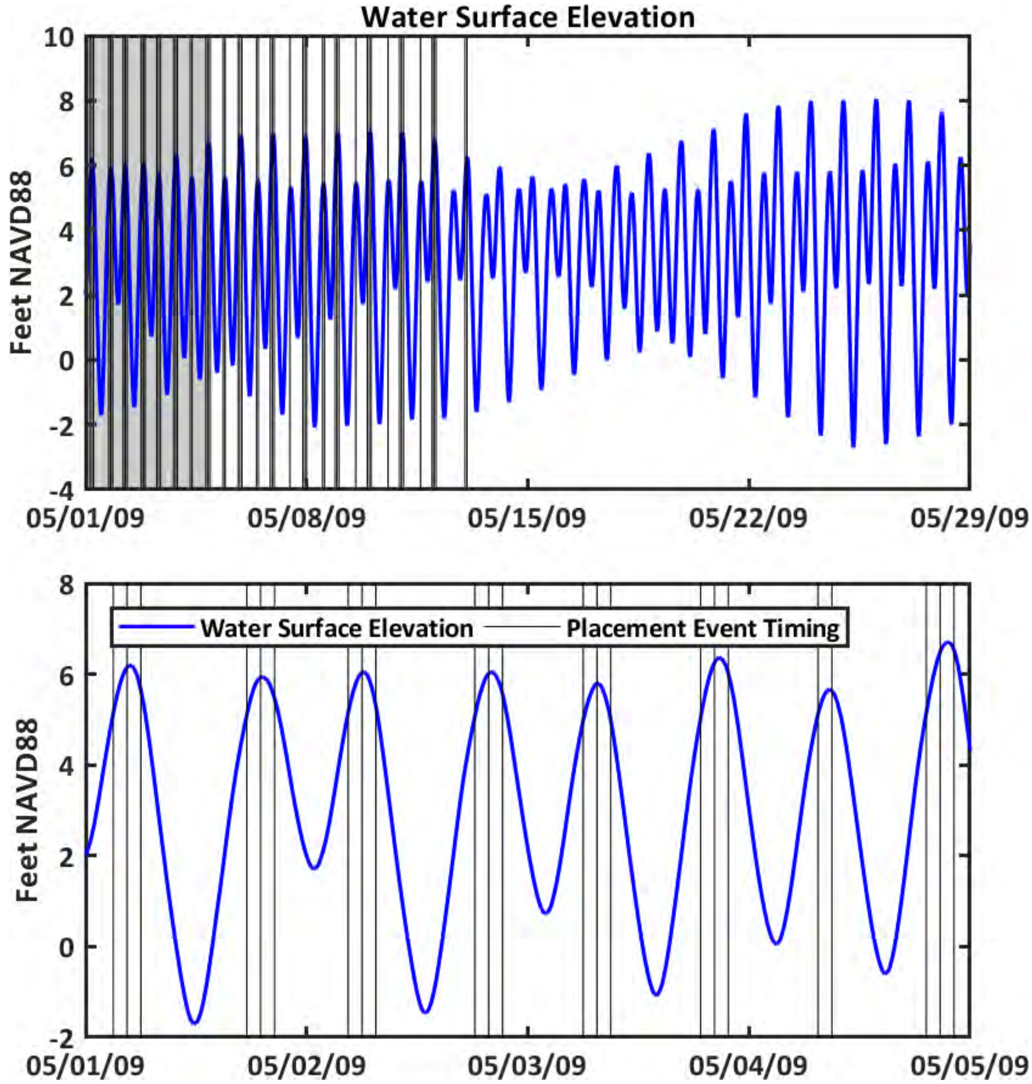


Figure 3.3-14
Water Surface Elevation During Placement Events: Scenario 7 Eden Landing 50,000 yd^3



Note:
Shading denotes the time period of the bottom panel.

3.3.2.2 Scenario 8: Eden Landing Shallow/East 75,000 yd^3 of Dredged Material

The Eden Landing Shallow/East 75,000 yd^3 of Dredged Material scenario consisted of 84 placement events in the 24 placement grid cells of the Eden Landing shallow/east placement footprint, with three or four placements in each placement grid cell (Figure 3.3-15). Placements were located in the eastern shallower portion of the placement grid. Placements were spaced at least 1.5 hours apart (Figure 3.3-16). The scenario included 75,000 yd^3 of dredged material that was assumed to come from Redwood City Harbor and evaluated dispersal from May 1, 2009, through June 30, 2009. Scows were assumed to hold 900 yd^3 of dredged material and require a minimum water depth of 9 ft.

Figure 3.3-15
Number of Placement Events in Each Placement Grid Cell: Scenario 8 Eden Landing 75,000 yd^3

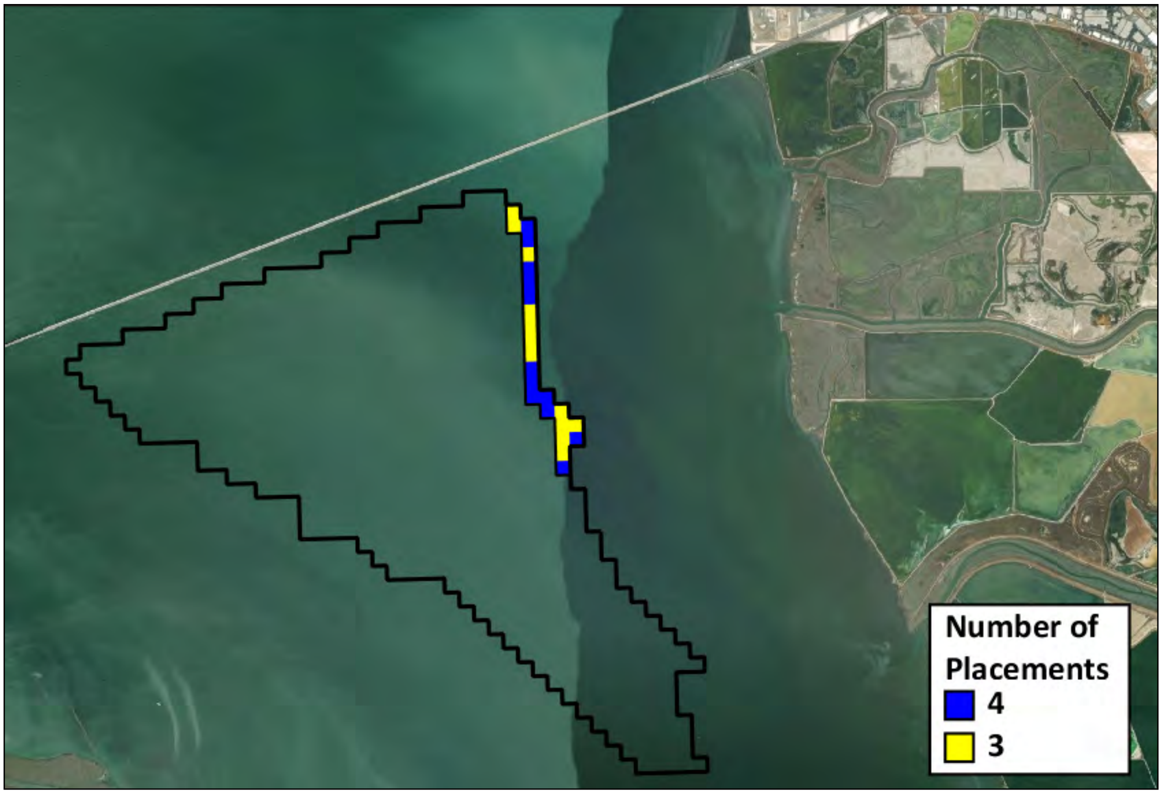
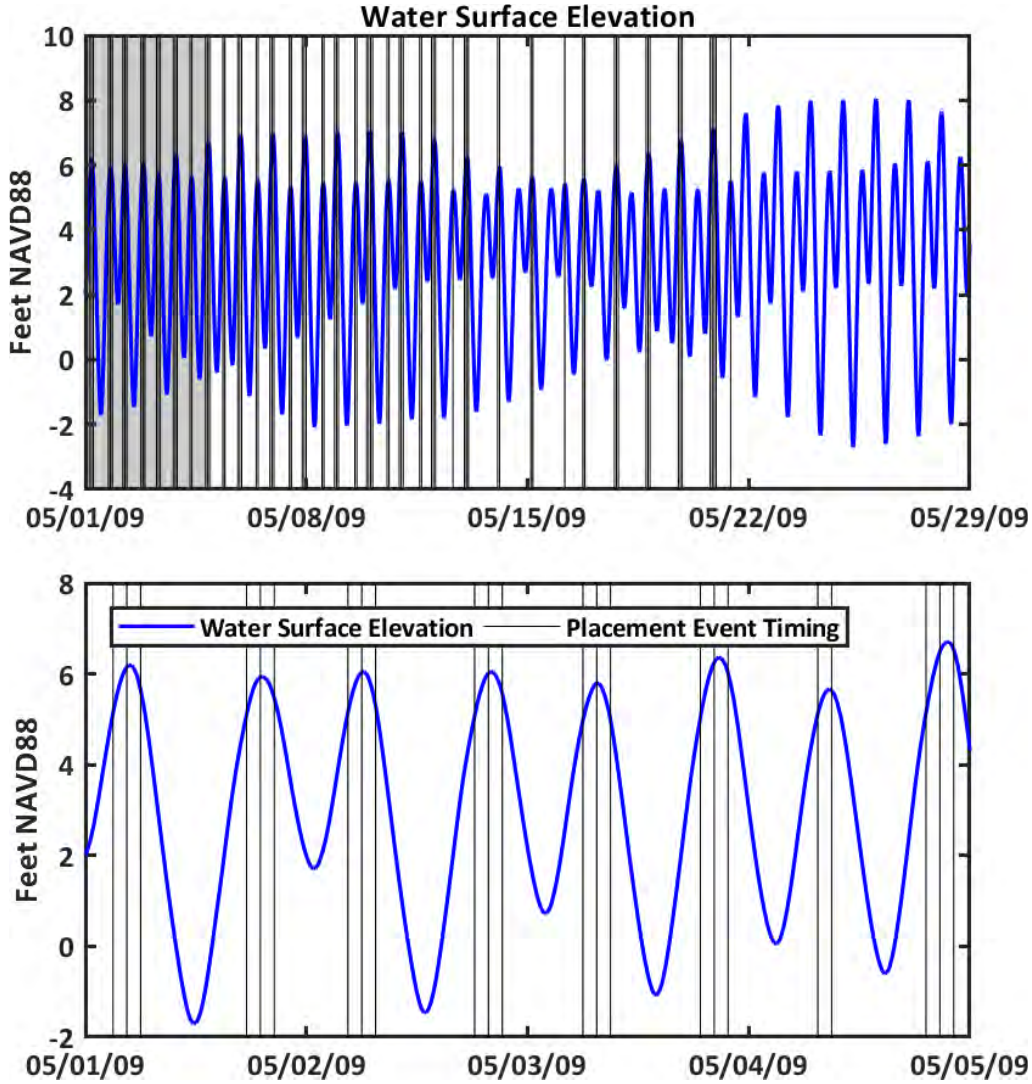


Figure 3.3-16
Water Surface Elevation During Placement Events: Scenario 8 Eden Landing 75,000 yd^3



Note:
Shading denotes the time period of the bottom panel.

3.3.2.3 Scenario 9: Eden Landing Shallow/East Winter

The Eden Landing Shallow/East Winter scenario consisted of 112 placement events in 24 placement grid cells, with four or five placements in each placement grid cell (Figure 3.3-17). Placements were located in the eastern shallower portion of the placement grid. Placements were spaced at least 1.5 hours apart (Figure 3.3-18). For this scenario, placements started at 00:00 on November 1, 2016, and the timing of the placements occurred relative to water depths in November 2016 using the same logic as described in Section 3.3.1. The scenario included 100,000 yd^3 of dredged material that was assumed to come from Redwood City Harbor and evaluated dispersal from November 1, 2016, through January 31, 2017. The winter period for this scenario included the month of November so the placements would occur during the last month of the dredging window. The scenario was 3 months long, 1 month longer than the other scenarios. Scows were assumed to hold 900 yd^3 of dredged material and require a minimum water depth of 9 ft.

Figure 3.3-17
Number of Placement Events in Each Placement Grid Cell: Scenario 9 Eden Landing Winter

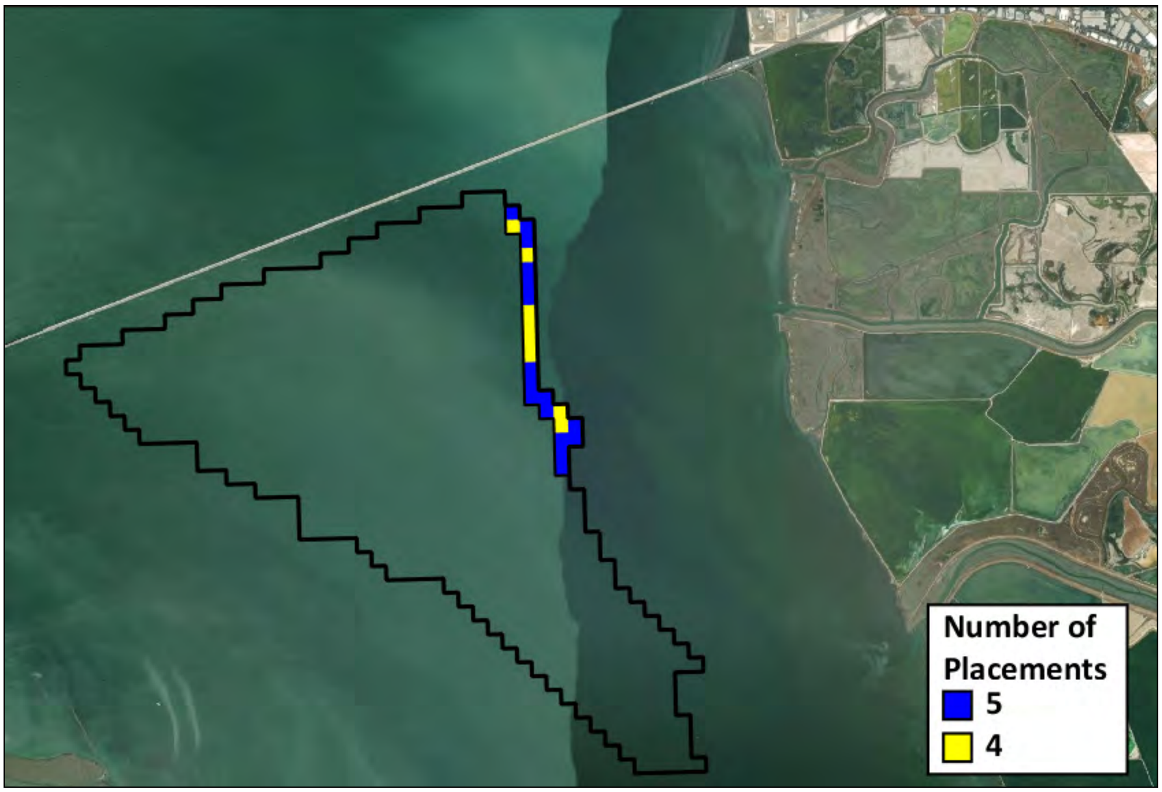
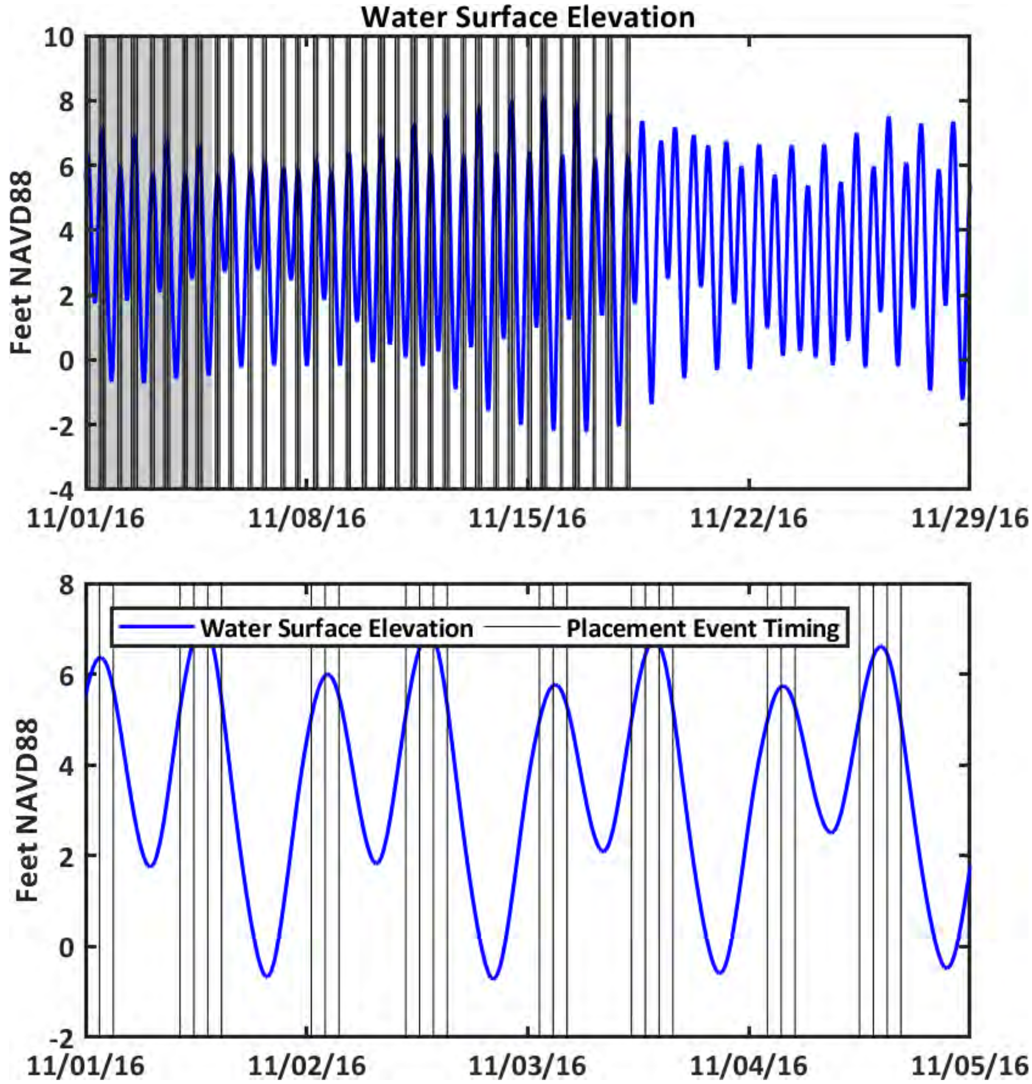


Figure 3.3-18
Water Surface Elevation During Placement Events: Scenario 9 Eden Landing Winter



Note:
Shading denotes the time period of the bottom panel.

3.3.2.4 Scenario 10: Eden Landing Shallow/East Oakland Harbor Sediment

The Eden Landing Shallow/East Oakland Harbor Sediment scenario consisted of 112 placement events in 24 placement grid cells, with four or five placements in each placement grid cell (Figure 3.3-19). Placements were located in the eastern shallower portion of the placement grid. Placements were spaced at least 1.5 hours apart (Figure 3.3-20). The scenario included 100,000 yd^3 of dredged material that was assumed to come from Oakland Harbor and evaluated dispersal from May 1, 2009, through June 30, 2009. Scows were assumed to hold 900 yd^3 of dredged material and require a minimum water depth of 9 ft.

Figure 3.3-19
Number of Placement Events in Each Placement Grid Cell: Scenario 10 Eden Landing Oakland Harbor Sediment

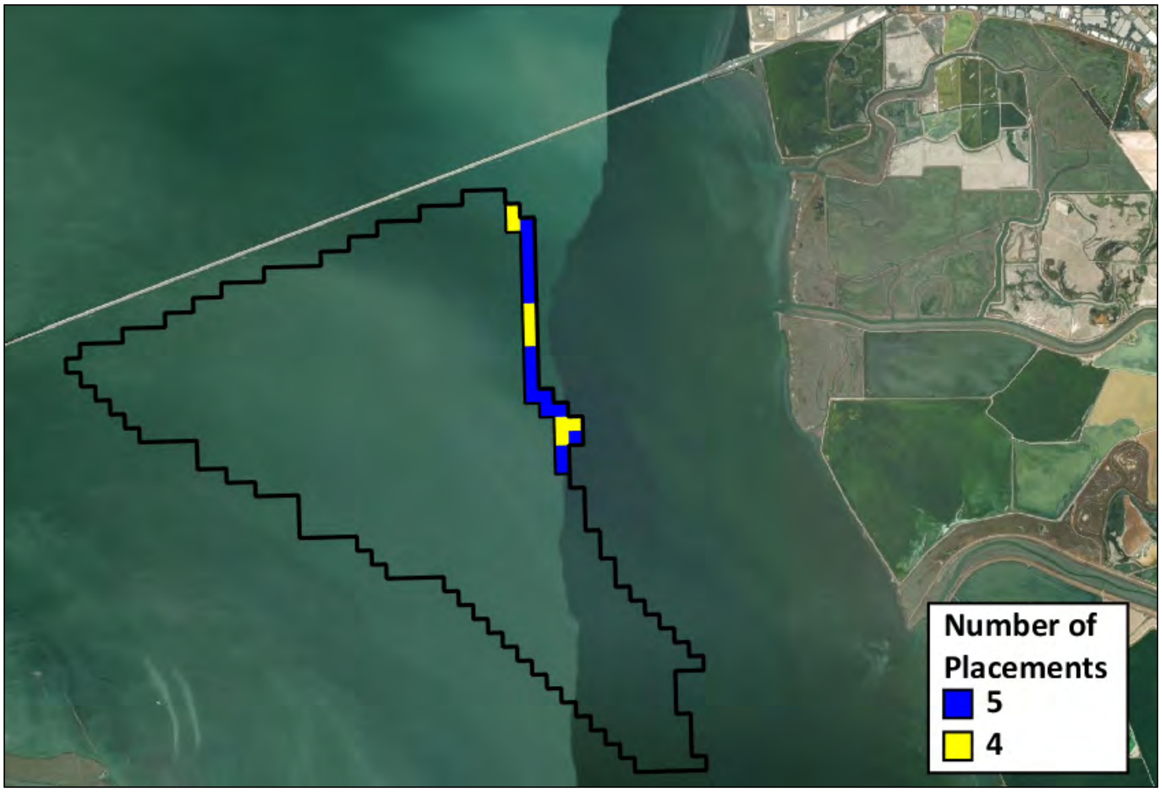
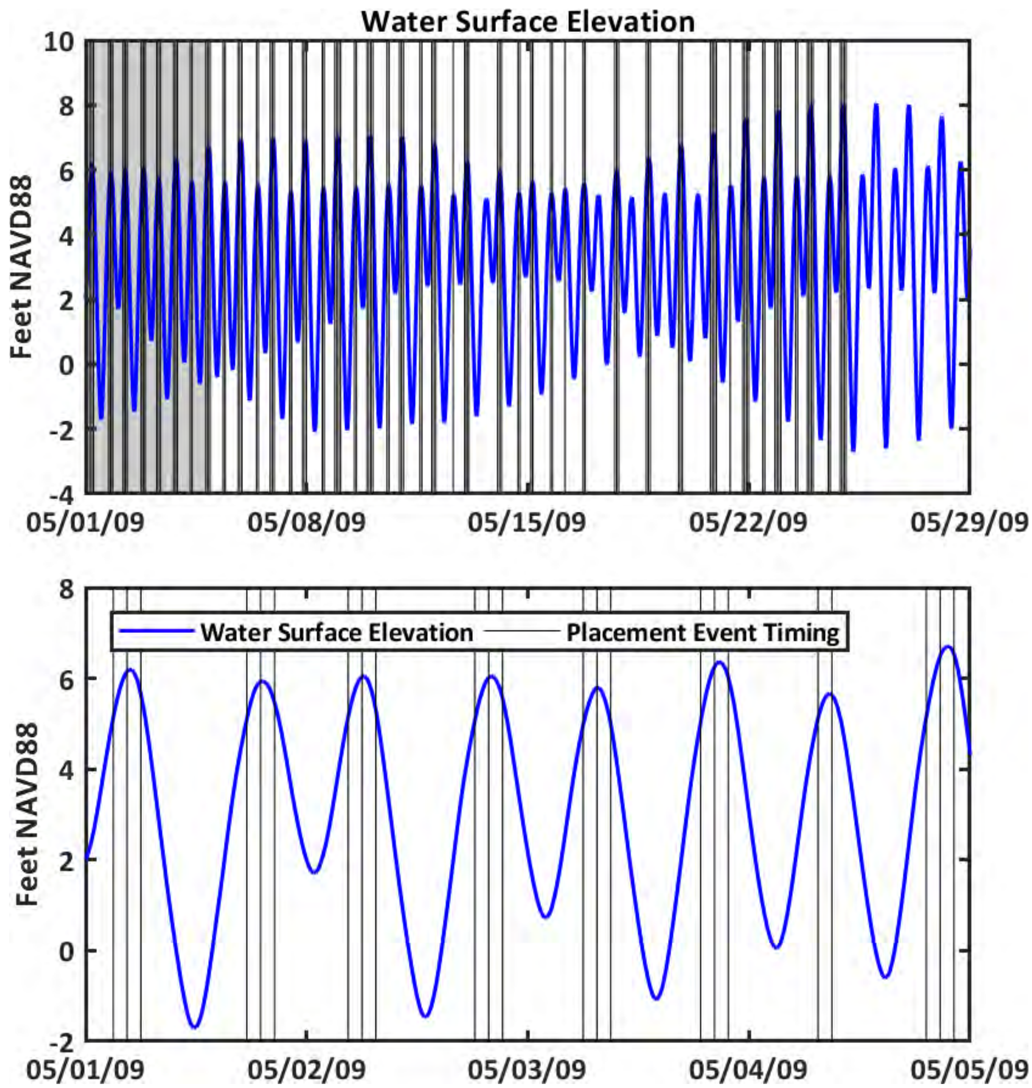


Figure 3.3-20
Water Surface Elevation During Placement Events: Scenario 10 Eden Landing Oakland Harbor Sediment



Note:
Shading denotes the time period of the bottom panel.

3.3.2.5 Scenario 11: Eden Landing Larger Placement Footprint

The Eden Landing Larger Placement Footprint scenario consisted of 112 placement events in 56 placement grid cells, with two placements in each placement grid cell (Figure 3.3-21). Placements were located in the eastern shallower portion of the placement grid. The placement footprint included the 24 placement grid cells in the Eden Landing Shallow/East scenario and an additional 32 placement grid cells directly west. Placements were spaced at least 1.5 hours apart (Figure 3.3-22). The scenario included 100,000 yd^3 of dredged material that was assumed to come from

Redwood City Harbor and evaluated dispersal from May 1, 2009, through June 30, 2009. Scows were assumed to hold 900 yd^3 of dredged material and require a minimum water depth of 9 ft.

Figure 3.3-21
Number of Placement Events in Each Placement Grid Cell: Scenario 11 Eden Landing Larger Placement Footprint

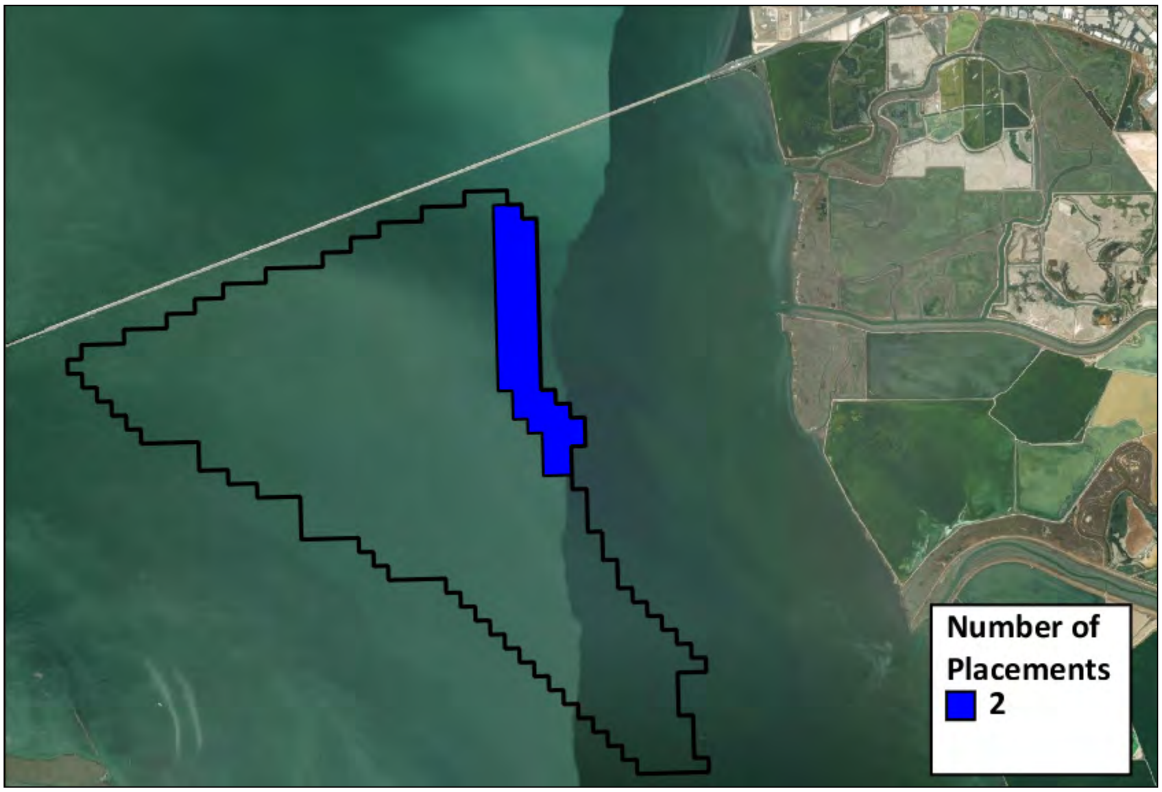
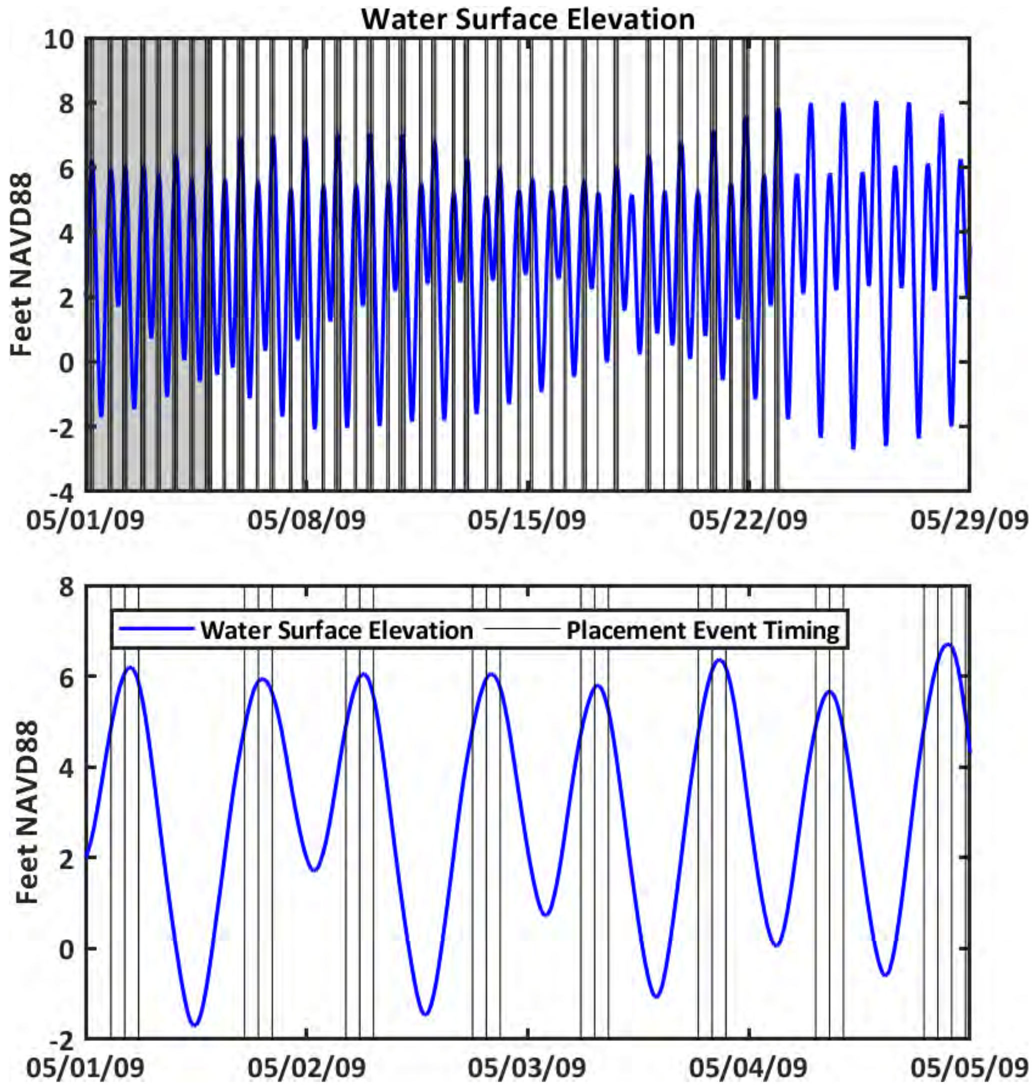


Figure 3.3-22
Water Surface Elevation During Placement Events: Scenario 11 Eden Landing Larger Placement Footprint



Note:
Shading denotes the time period of the bottom panel.

3.3.2.6 Scenario 12: Eden Landing Larger Placement Footprint 125,000 yd^3

The Eden Landing Larger Placement Footprint 125,000 yd^3 scenario consisted of 139 placement events in 56 placement grid cells, with two or three placements in each placement grid cell (Figure 3.3-23). Placements were located in the eastern shallower portion of the placement grid. The placement footprint included the 24 placement grid cells in the Eden Landing Shallow/East scenario and an additional 32 placement grid cells directly west. Placements were spaced at least 1.5 hours apart (Figure 3.3-24). The scenario included 125,000 yd^3 of dredged material that was assumed to come from

Redwood City Harbor and evaluated dispersal from May 1, 2009, through June 30, 2009. Scows were assumed to hold 900 yd^3 of dredged material and require a minimum water depth of 9 ft.

Figure 3.3-23
Number of Placement Events in Each Placement Grid Cell: Scenario 12 Eden Landing Larger Placement Footprint 125,000 yd^3

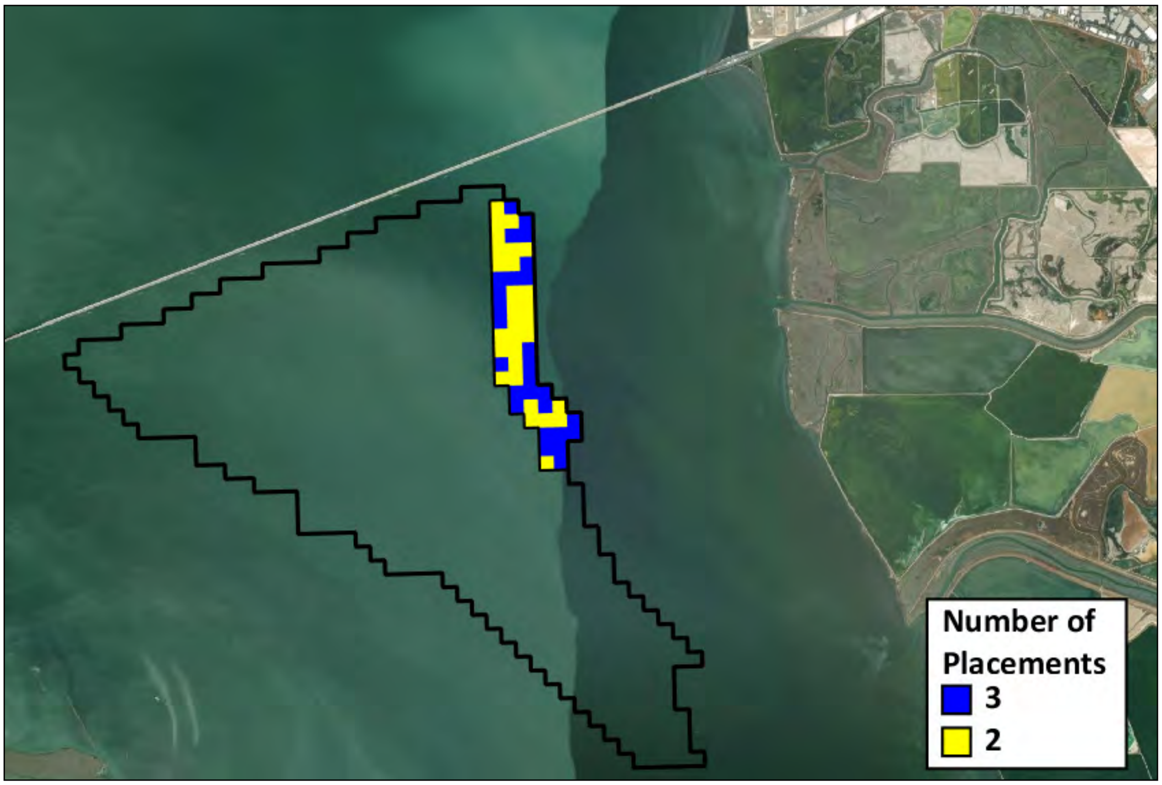
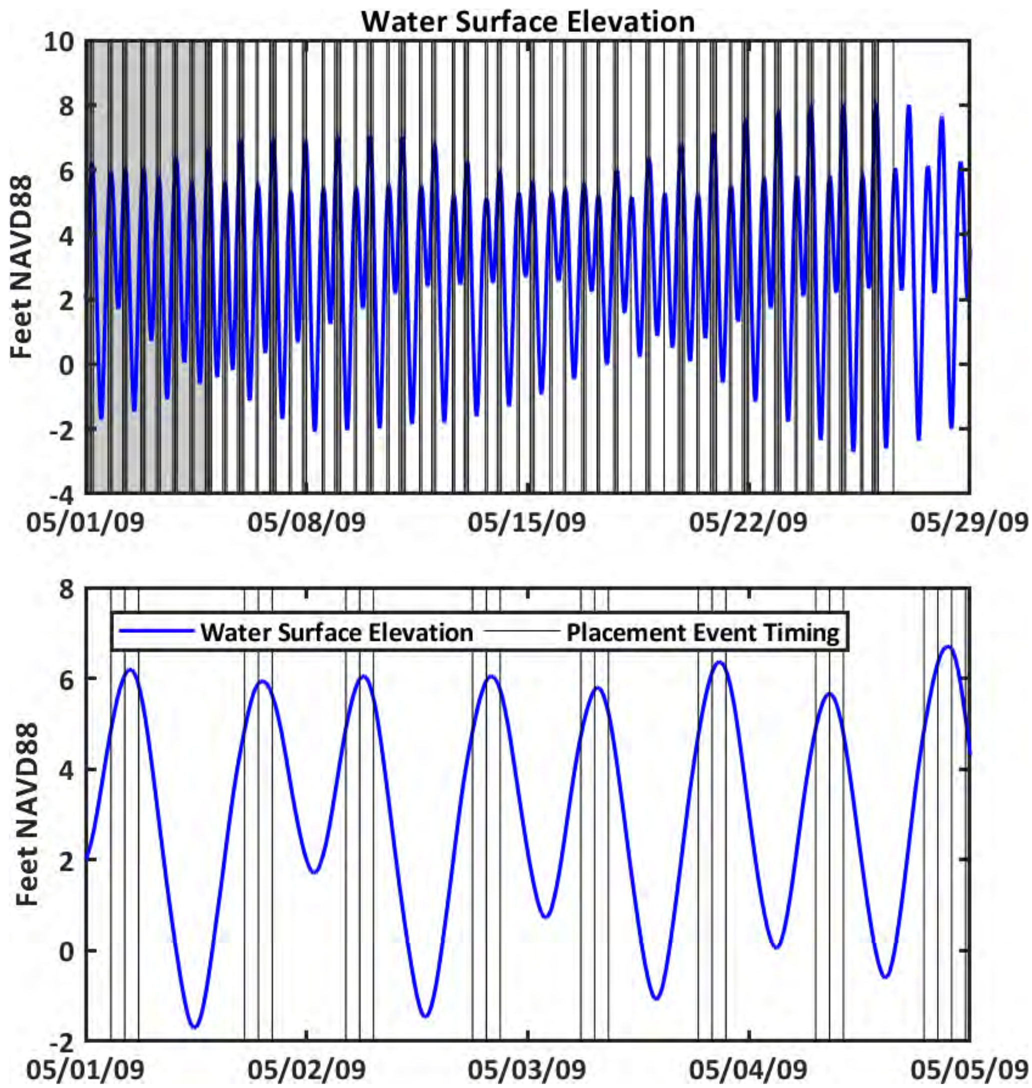


Figure 3.3-24
Water Surface Elevation During Placement Events: Scenario 12 Eden Landing Larger Placement Footprint 125,000 yd^3



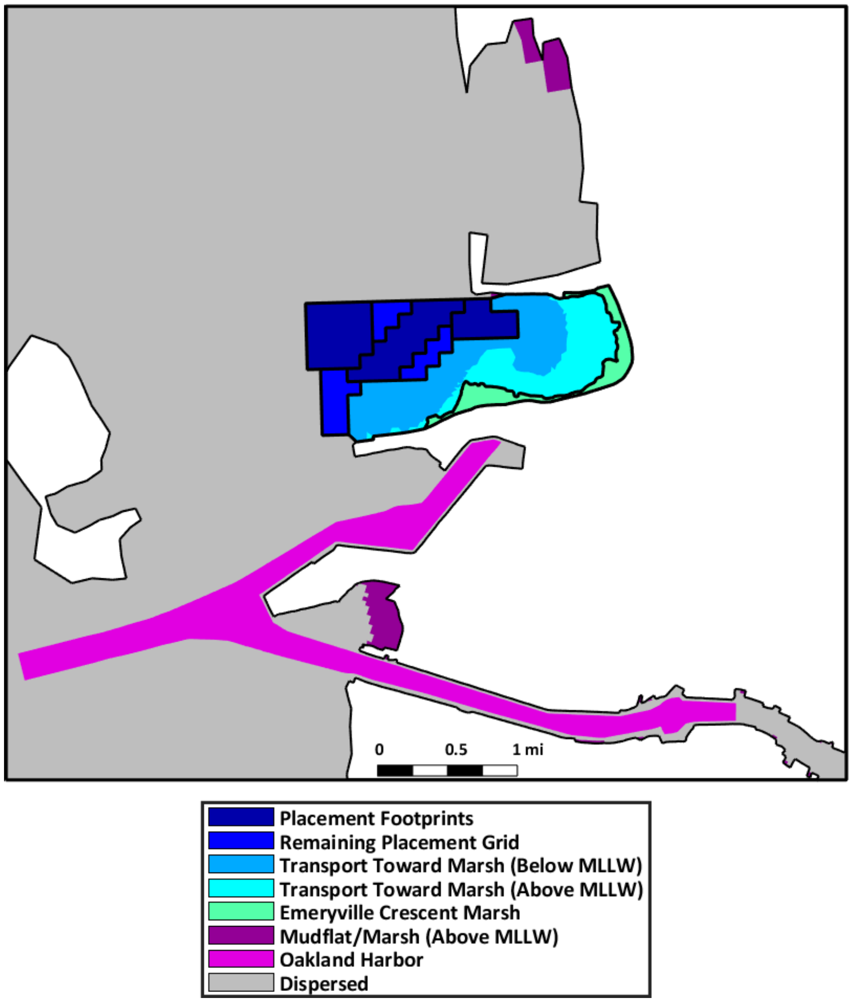
Note:
Shading denotes the time period of the bottom panel.

3.4 Analysis Regions

San Francisco Bay was divided into discrete analysis regions for the analysis of the dredged material placement scenarios. These analysis regions allowed for detailed tracking of where the dredged material was transported throughout the duration of the simulations and for the evaluation of the predicted fate of the dredged material at the end of the simulations. Different analysis regions were used for Emeryville and Eden Landing to tailor the analysis regions to the specifics of each site. The mass of dredged material in each region was tracked throughout each simulation to evaluate the amount of dredged material in each region. Results of the dredged material placement scenarios presented in Section 5 are based on the mass of dredged material in each region. The volume of dredged material in each region is estimated based on the percentage of the total mass of placed dredged material in each region and the total placement sediment mass. The analysis is based on the placement sediment mass because the sediment transport model simulates the continual erosion, deposition, and transport of sediment mass.

Eight analysis regions were identified for evaluating the fate of the dredged material placement near Emeryville (Figure 3.4-1). These analysis regions included the individual placement footprints where the dredged material placements occurred and the remainder of the placement grid. While all the placement footprints are shown on Figure 3.4-1, the subregion for analysis consisted of only the placement footprint associated with a specific dredged material placement scenario. The region representing transport from the placement grid toward Emeryville Crescent Marsh was separated into below and above mean lower low water (MLLW) regions, based on the tidal datum at the San Francisco National Oceanic and Atmospheric Administration (NOAA) station. Emeryville Crescent Marsh was also considered as a separate analysis region. Mudflats and marshes in areas above MLLW close to the placement grid was another analysis region. Oakland Harbor and any other areas below MLLW (dispersed) were also specified as analysis regions. These analysis regions allowed for the thorough tracking of the fate of the dredged material and quantification of where the dredged material was transported during the simulation.

Figure 3.4-1
Analysis Regions Around Emeryville Crescent Marsh



Fifteen analysis regions were identified for evaluating the fate of the dredged material placement near Eden Landing (Figures 3.4-2 and 3.4-3). These analysis regions included the placement footprints where the dredged material placements occurred and the remainder of the placement grid. While all the placement footprints are shown on Figures 3.4-2 and 3.4-3, the subregion for analysis consisted of only the placement footprint associated with a specific dredged material placement scenario. The region representing transport from the placement grid toward Eden Landing Marsh was separated into below and above MLLW regions, based on the tidal datum at the Redwood City NOAA station. The Eden Landing Marsh analysis region consisted of the Whale's Tail portion of the marsh, while then the remaining portions of Eden Landing were considered as a separate analysis region. Old Alameda Creek was also evaluated as a separate region. Other analysis regions included an area north of the placement grid, the Alameda flood control channel (FCC), and the mudflats on the east and west sides of South Bay, and the remaining portions of South Bay below MLLW (dispersed South Bay). For this analysis, South Bay analysis region was defined as the area between the Bay Bridge and Dumbarton Bridge. Mudflats were defined based on the areas with seabed elevation above MLLW. Analysis regions north of the Bay Bridge, south of Dumbarton Bridge, and in Redwood City Harbor were included in the analysis. This large number of analysis regions allowed for thorough tracking of where the dredged material was transported during the simulation.

Figure 3.4-2
Analysis Regions Around Eden Landing Marsh

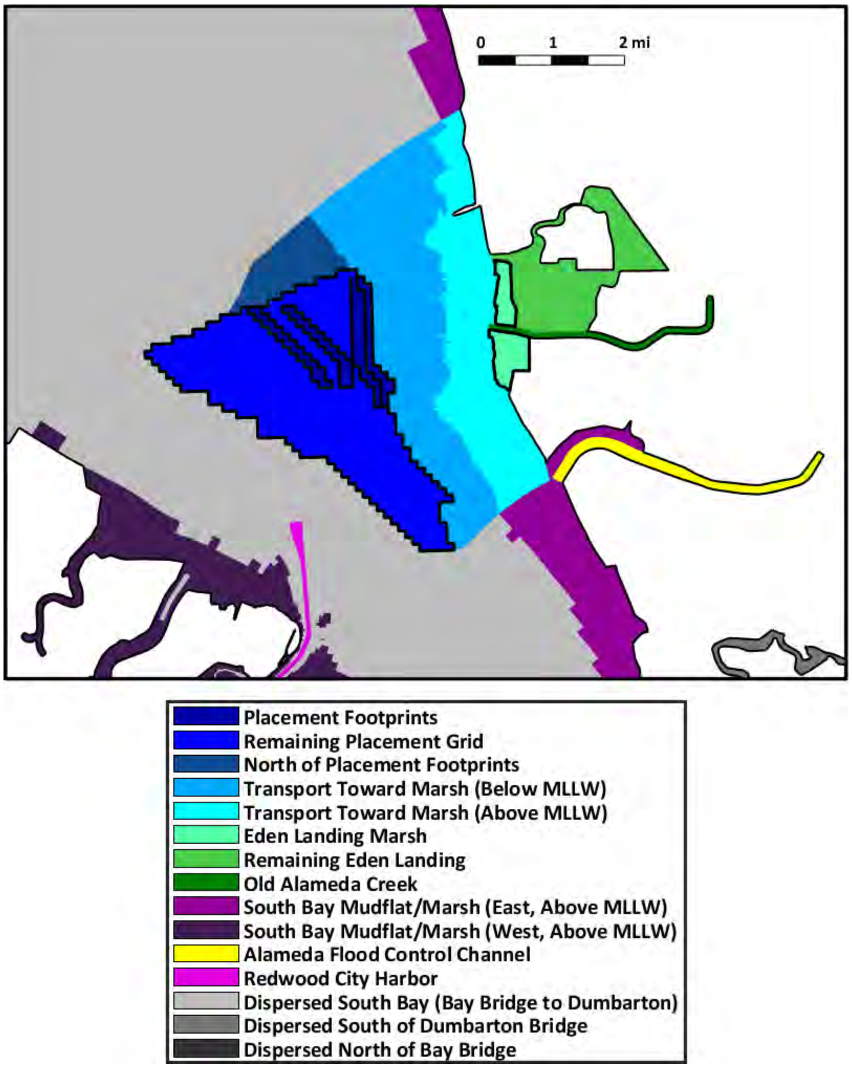
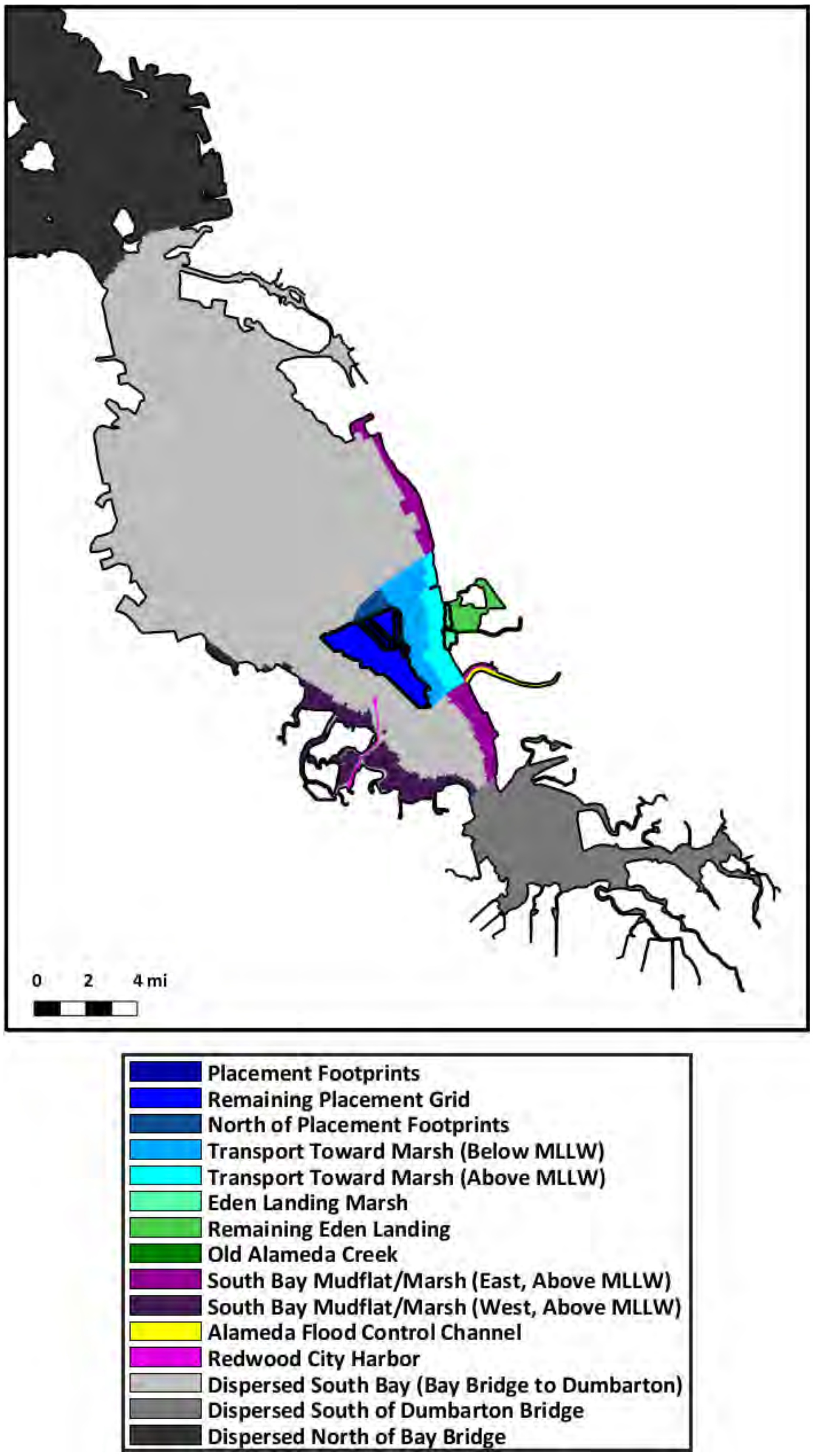


Figure 3.4-3
Wide View of the Analysis Regions Around Eden Landing Marsh



4 Wave Characteristics, Shear Stress, and Residual Currents Around the Placement Locations

This section describes the average wave characteristic and wave-induced bed shear stress in and around the placement grids. This information was used to understand the potential for wind-wave sediment resuspension when developing the specifics of the dredged material placement scenarios. Predicted wave characteristics and wave-induced bed shear stress were evaluated to qualitatively determine differences within a placement area based on varying water depths, between summer versus winter periods, and between the Emeryville and Eden Landing placement areas.

This section also describes the predicted residual (time-averaged) currents around the placement grids, which were used to understand how the average current direction may impact the results of the dredged material placement scenarios—that is, determining whether the residual currents were directed toward the marsh, away from the marsh, or along the shoreline.

4.1 Waves

Predicted wave height and bottom orbital velocity were output hourly from the SWAN wave model, matching the hourly frequency of the available wind data used for model inputs. The bottom orbital velocity is the speed of the back-and-forth water velocity near the bed as a result of the waves, which acts to resuspend sediment. The RMS significant wave height and bottom orbital velocity were calculated from the hourly predictions spanning May 1, 2009, through June 30, 2009 (summer) and December 1, 2016, through January 31, 2017 (winter). The RMS is a type of averaging that weights the larger values stronger than the smaller values. The RMS was used because the larger waves will result in more sediment resuspension than the smaller waves.

The bottom orbital velocity and wave period were used to calculate a wave-induced bed shear stress to better understand the potential for sediment resuspension. Current speed was not included in the bed shear stress calculation, to focus on the potential for wind-wave induced sediment resuspension. The bed shear stress was calculated hourly using the method of Soulsby (1997) shown in Equation 1, and then the RMS bed shear stress was calculated from the hourly predictions.

Equation 1

$$\tau_w = \frac{1}{2}\rho f_w U_w^2$$

where:

τ_w	=	Wave-induced bed shear stress (Pa)
ρ	=	Water density (kg/m^3)
f_w	=	Friction factor (unitless)
U_w	=	Wave bottom orbital velocity (m/s)

The wave friction factor was calculated following Equations 2 and 3.

Equation 2

$$f_w = 1.39(A/Z_o)^{-0.52}$$

where:

f_w	=	Friction factor (unitless)
Z_o	=	Bed roughness (m)

Equation 3

$$\mathrm{A} = \frac{U_w T}{2\pi}$$

where:

U_w	=	Wave bottom orbital velocity (m/s)
T	=	Wave period (s)

The bed roughness (*Zo*) was set to the diameter of the flocculated silt and clay sediment class (200 µm) because that sediment class represents the largest percentage of both the sediment transport model initial sediment bed and the dredged material in the scenarios.

4.1.1 Emeryville Waves and Bed Shear Stress

Around the Emeryville placement area, the RMS significant wave height decreased from the deeper (western) portion of the placement grid into shallower (eastern) water (Figures 4.1-1 and 4.1-2). RMS significant wave height was larger during the summer than the winter period. In the placement grid, RMS significant wave height was 20% to 50% larger during the summer than the winter period, with the percentage increase larger in the shallower eastern portion of the placement grid than the deeper western portion of the placement grid. In the area between the placement grid and Emeryville Crescent Marsh, RMS significant wave height was 10% to 50% higher during the summer period than during the winter, with the percentage increase larger in the shallower western portion of this area.

The RMS bottom orbital velocity during winter was relatively uniform across the placement grid, with the smallest values in the deepest southwest corner of the placement grid (Figure 4.1-3). The RMS bottom orbital velocity increased from the placement grid across the transition mudflat to the marsh as a result of decreasing water depth. During summer, the RMS bottom orbital velocity increased toward the shallowest eastern portion of the placement grid and was relatively high across the majority of the transition mudflat and onto the marsh (Figure 4.1-4). RMS bottom orbital velocities were higher during the summer period than during the winter. In the placement grid, RMS bottom orbital velocities were 10% to 50% higher during the summer period than during the winter, with the percentage increase larger in the shallower eastern portion of the placement grid than the deeper western portion of the placement grid. In the area between the placement grid and Emeryville Crescent Marsh, RMS bottom orbital velocities were 10% to 80% higher during the summer period than during the winter, with the percentage increase larger in the shallower western portion of this area.

RMS bed shear stress showed the same general pattern as the RMS bottom orbital velocity. The RMS bed shear stress during winter was relatively uniform across the placement grid and increased from the placement grid across the transition mudflat to the marsh (Figure 4.1-5). During summer, the RMS bed shear stress increased toward the shallowest eastern portion of the placement grid and was relatively high across the majority of the transition mudflat and onto the marsh (Figure 4.1-6). RMS bed shear stress was higher during the summer period than during the winter. In the placement grid, RMS bed shear stress was little changed to 50% higher during the summer period than during the winter period, with the percentage increase larger in the shallower eastern portion of the placement grid than the deeper western portion of the placement grid. In the area between the placement grid and Emeryville Crescent Marsh, RMS bed shear stress was 10% to 80% higher during the summer period than during the winter, with the percentage increase larger in the shallower western portion of this area. The critical shear stress for the silt, flocculated silt and clay, and sand sediment classes were 0.0379, 0.15, and 0.19 pascals (Pa), respectively (Table 2-1). As such, the RMS wave-induced bed shear stress was high enough to resuspend the dredged material across most of the placement grid.

The maximum bed shear stress was high enough to resuspend the dredged material over the entire placement grid during both the summer and winter periods. This indicates that at some point during each period some of the dredged material would be resuspended by wind waves and there was not a maximum depth in the placement grid beyond which wind-wave induced resuspension would cease to occur. However, because of the differences in the RMS shear stress in the placement grid, the frequency and amount of resuspension will not be consistent throughout the placement grid.

Figure 4.1-1
RMS Significant Wave Height Near the Emeryville Placement Area for Winter

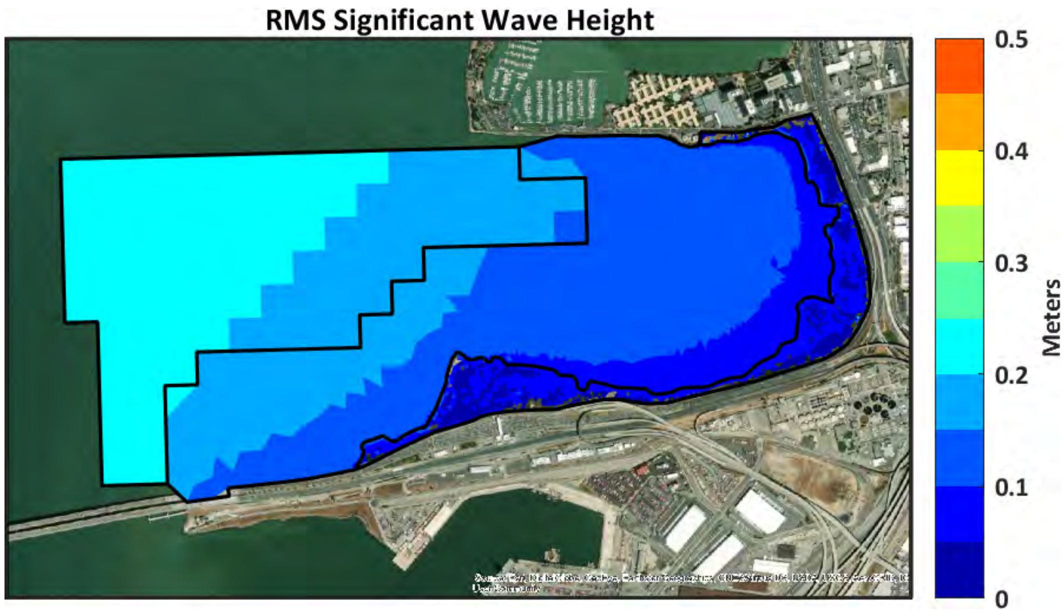


Figure 4.1-2
RMS Significant Wave Height Near the Emeryville Placement Area for Summer

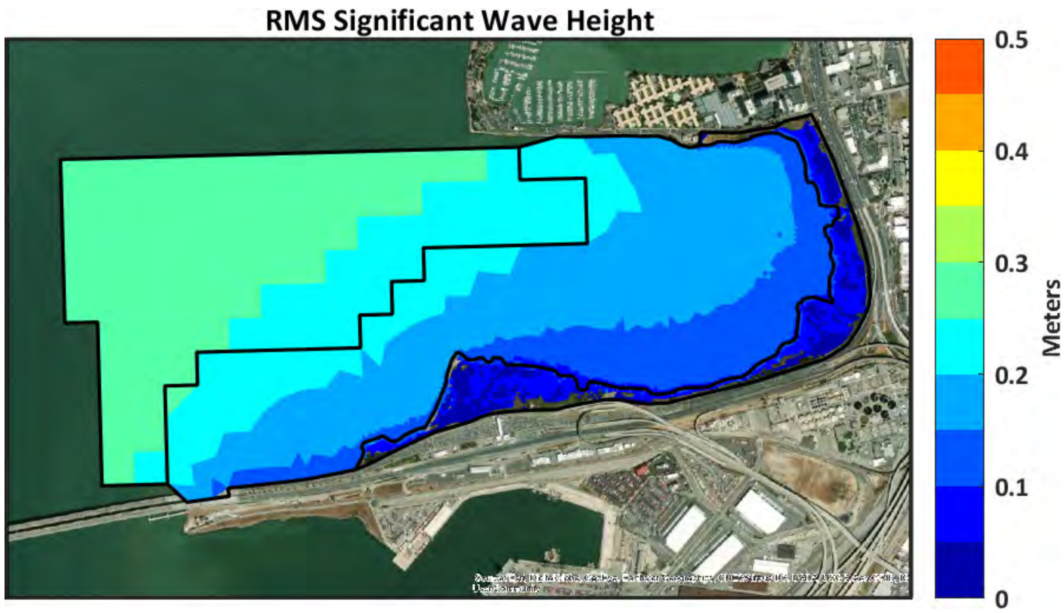


Figure 4.1-3
RMS Bottom Orbital Velocity Near the Emeryville Placement Area for Winter

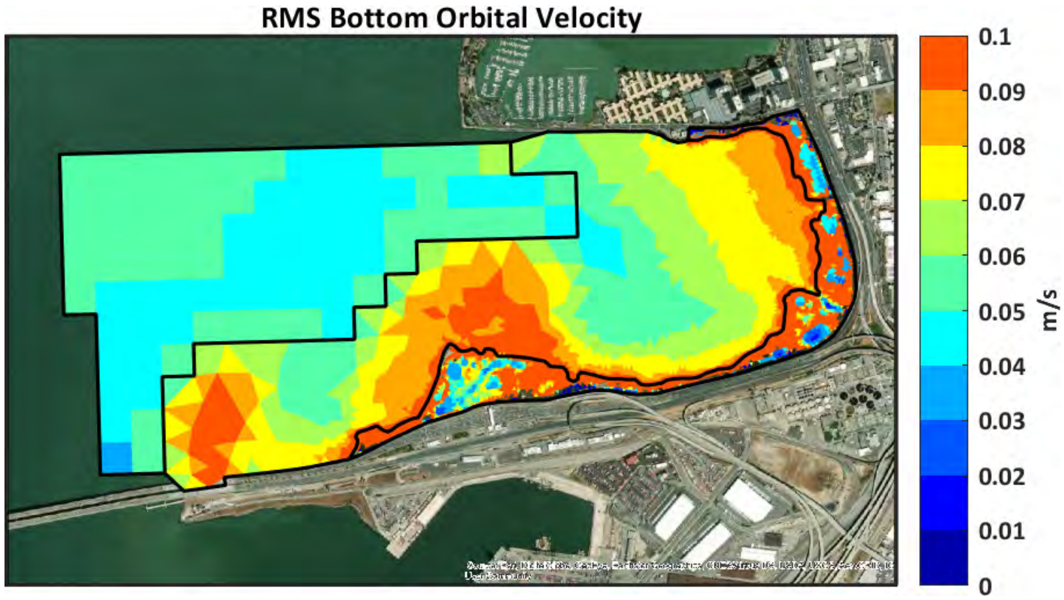


Figure 4.1-4
RMS Bottom Orbital Velocity Near the Emeryville Placement Area for Summer

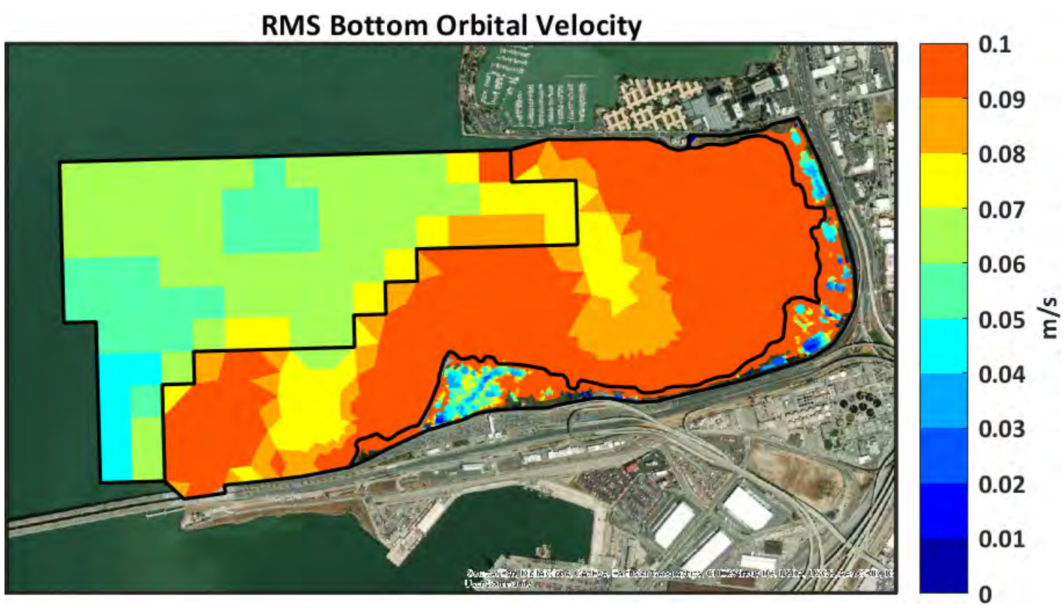


Figure 4.1-5
RMS Bed Shear Stress Near the Emeryville Placement Area for Winter

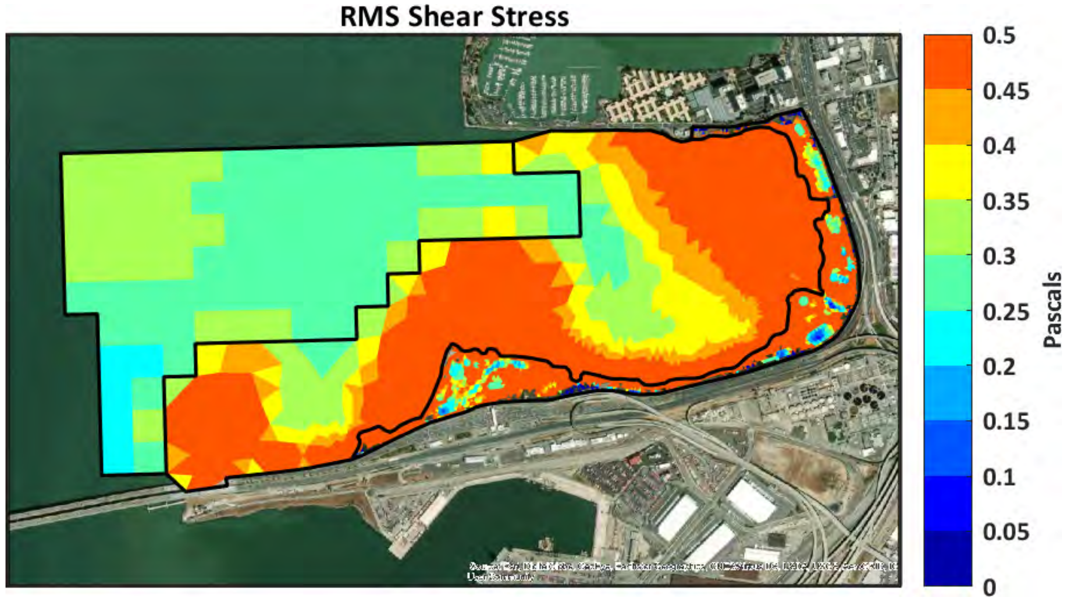
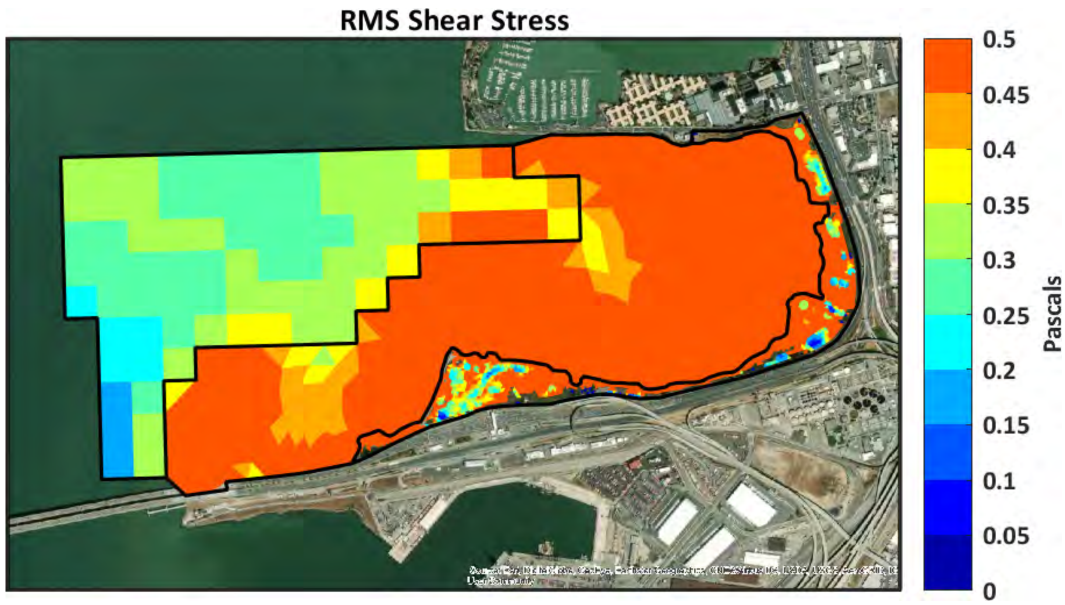


Figure 4.1-6
RMS Bed Shear Stress Near the Emeryville Placement Area for Summer



4.1.2 Eden Landing Waves and Bed Shear Stress

Around the Eden Landing placement area, the RMS significant wave height was relatively uniform throughout the placement grid and across the transition mudflat (Figures 4.1-7 and 4.1-8). RMS significant wave height was larger during the summer than the winter period. In the placement grid, RMS significant wave height was approximately 65% larger during the summer than the winter period. In the area between the placement grid and Eden Landing Marsh, RMS significant wave height was 65% to 90% higher during the summer period than during the winter, with the percentage increase larger in the shallower western portion of this area.

The RMS bottom orbital velocity increased from the deeper western portion of the placement grid across the transition mudflat to the marsh as a result of decreasing water depth (Figures 4.1-9 and 4.1-10). RMS bottom orbital velocities were higher during the summer period than during the winter. In the placement grid in the vicinity of the placement footprints, RMS bottom orbital velocities were 90% to 110% higher during the summer period than during the winter, with the percentage increase larger toward the southern end of the placement footprints. In the area between the placement grid and Eden Landing Marsh, RMS bottom orbital velocities were 110% to 140% higher during the summer period than during the winter, with the percentage increase larger in the shallower western portion of this area.

RMS bed shear stress showed the same general pattern as the RMS bottom orbital velocity. The RMS bed shear stress increased from the deeper western portion of the placement grid across the transition mudflat to the marsh as a result of decreasing water depth (Figures 4.1-11 and 4.1-12). RMS bed shear stresses were higher during the summer period than during the winter. In the placement grid in the vicinity of the placement footprints, RMS bed shear stress was 90% to 120% higher during the summer period than during the winter period, with the percentage increase larger toward the southern end of the placement footprints. In the area between the placement grid and Eden Landing Marsh, RMS bed shear stress was 100% to 150% higher during the summer period than during the winter, with the percentage increase larger in the shallower western portion of this area. The critical shear stress for the silt, flocculated silt and clay, and sand sediment classes were 0.0379, 0.15, and 0.19 Pa, respectively (Table 2-1). As such, during winter, the RMS wave-induced bed shear stress was high enough to resuspend the flocculated silts and clays and sand dredged material only in the eastern shallower portion of the placement grid (Figure 4.1-11). RMS wave-induced bed shear stress was high enough to resuspend the silt sediment class over the entire placement grid. During summer, the RMS wave-induced bed shear stress was high enough to resuspend the silt and flocculated silt and clay dredged material in the majority of the placement grid and the sand dredged material in the eastern half of the placement grid (Figure 4.1-12).

The maximum bed shear stress was high enough to resuspend the dredged material over the entire placement grid during both the summer and winter periods. This indicates that at some point during each period some of the dredged material would be resuspended by wind waves and there was not a maximum depth in the placement grid beyond which wind-wave induced resuspension would cease to occur. However, because of the differences in the RMS shear stress in the placement grid, the frequency and amount of resuspension will not be consistent throughout the placement grid.

Figure 4.1-7
RMS Significant Wave Height Near the Eden Landing Placement Area for Winter

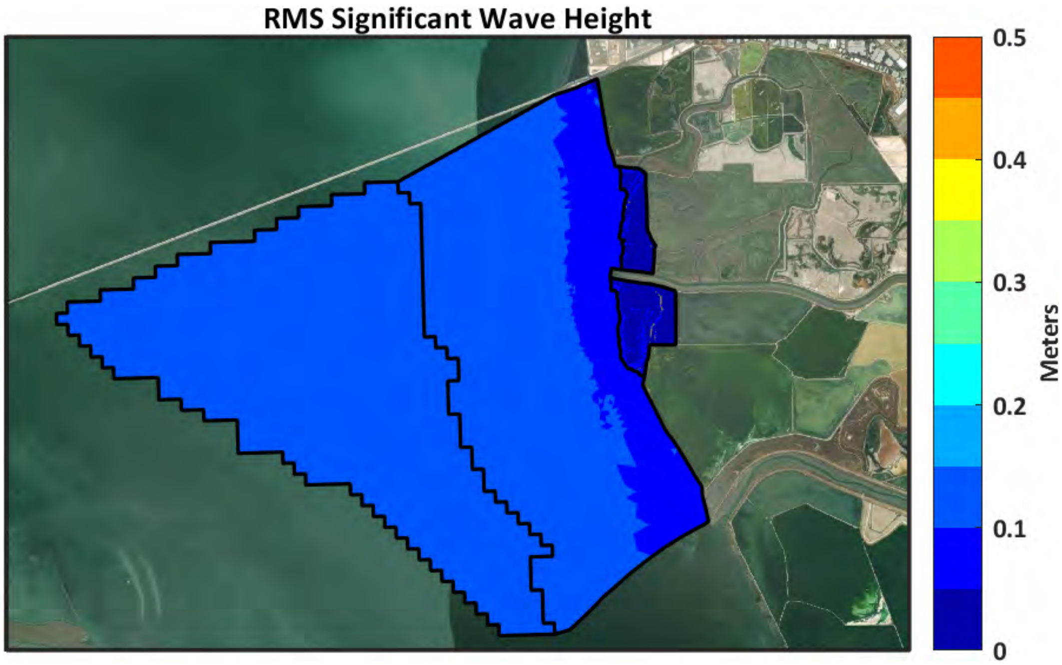


Figure 4.1-8
RMS Significant Wave Height Near the Eden Landing Placement Area for Summer

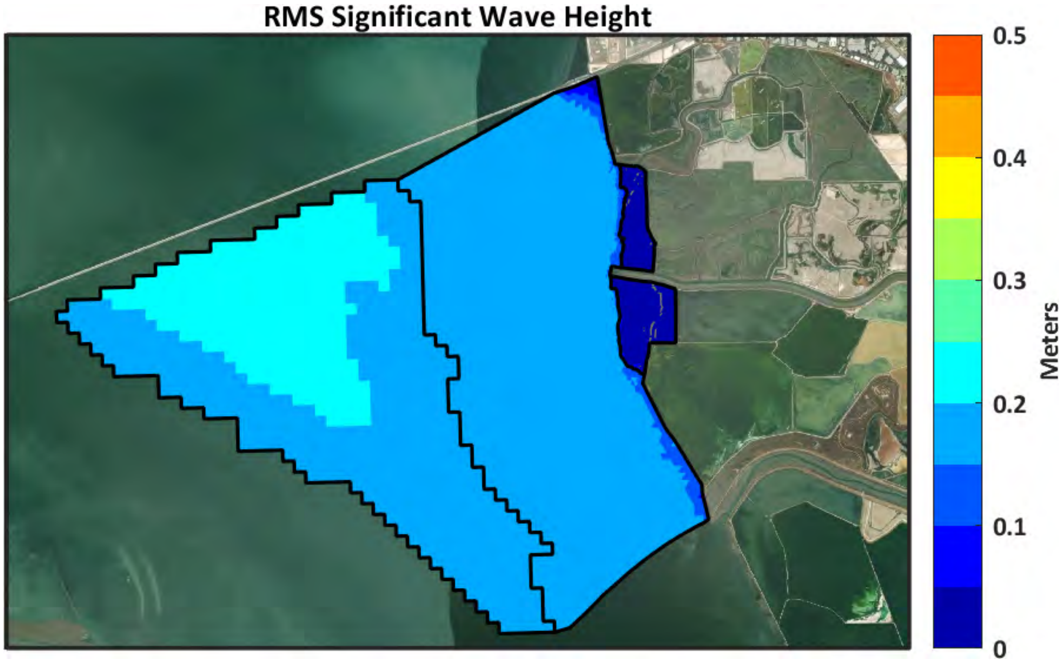


Figure 4.1-9
RMS Bottom Orbital Velocity Near the Eden Landing Placement Area for Winter

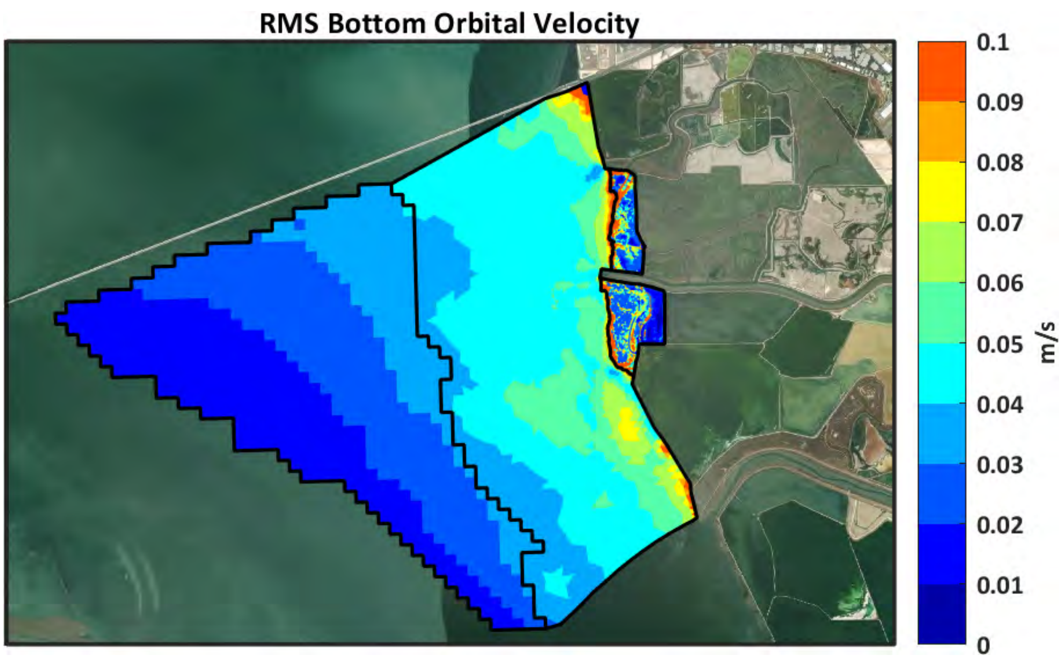


Figure 4.1-10
RMS Bottom Orbital Velocity Near the Eden Landing Placement Area for Summer

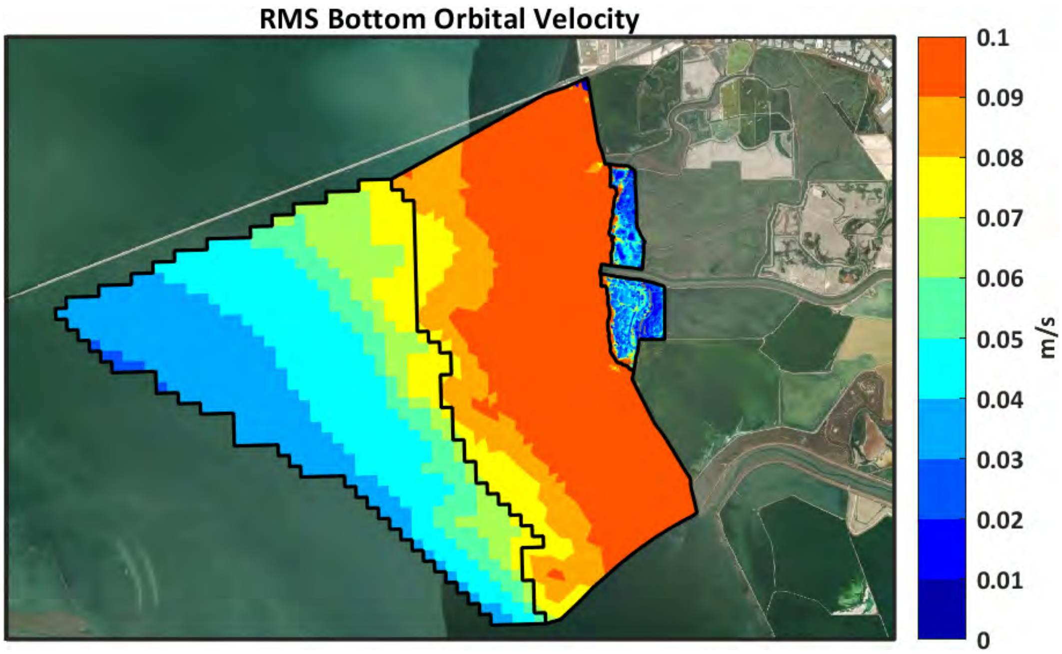


Figure 4.1-11
RMS Bed Shear Stress Near the Eden Landing Placement Area for Winter

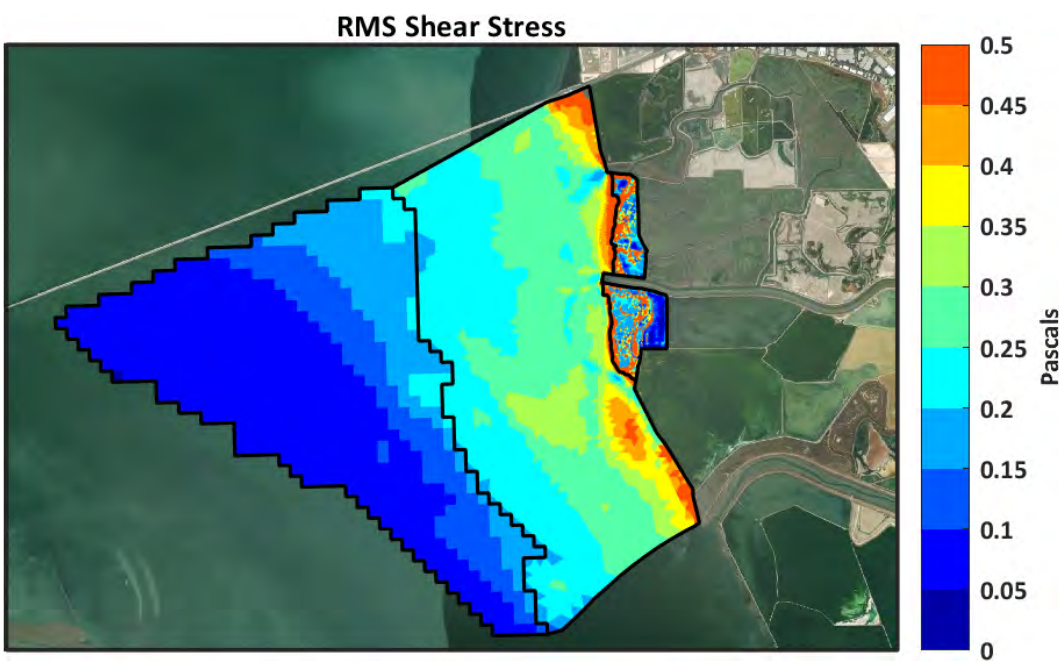
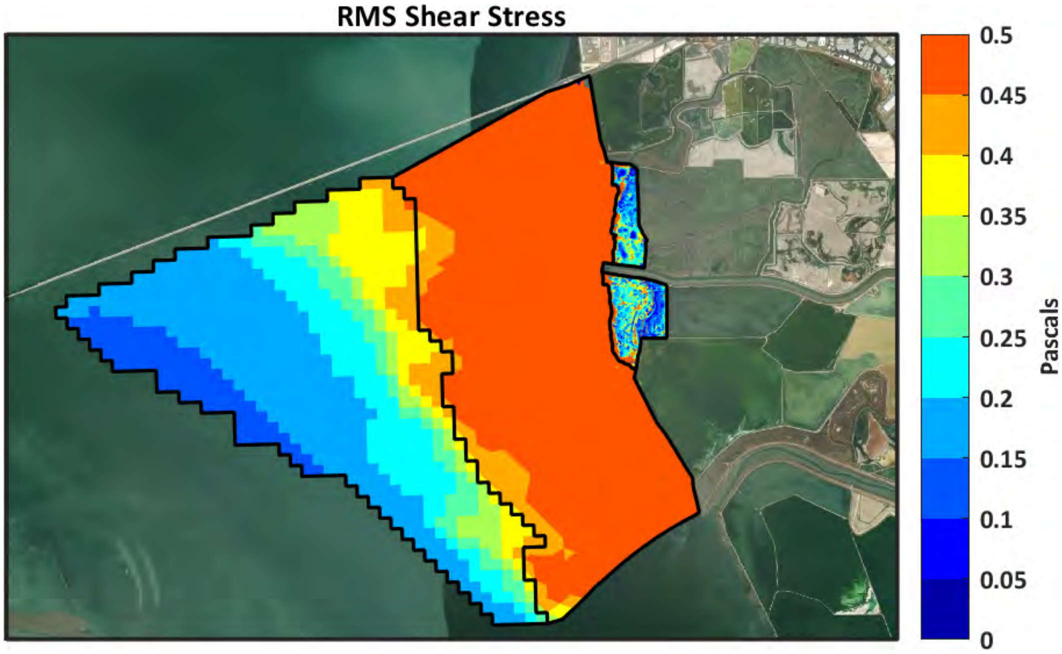


Figure 4.1-12
RMS Bed Shear Stress Near the Eden Landing Placement Area for Summer



4.1.3 Comparison of Summer Versus Winter and Emeryville Versus Eden Landing

Significant wave height, bottom orbital velocity, and bed shear stress were higher during the summer period than during the winter period at both Emeryville and Eden Landing. The larger waves and higher bed shear stress result from the seasonally stronger winds in late-spring and early-summer than during the winter. This does not suggest that winter storms will not act to resuspend sediment, simply that on average the waves and the potential for sediment resuspension were larger during the summer period evaluated.

The bottom orbital velocity and bed shear stress that act to resuspend sediment were the lowest on the western side of the placement grids and highest on the eastern side, at both Emeryville and Eden Landing. This results from the shallowing of the placement grids from the western to the eastern side and the increasing effect of wind waves as the water depth gets lower. The bed shear stress was further evaluated based on a 0.2-Pa cutoff. The threshold of 0.2 Pa was based on the critical shear stress of the flocculated sediment class being 0.15 Pa and the critical shear stress of the sand being 0.19 Pa. At Emeryville, the RMS bed shear stress was greater than the 0.2-Pa threshold over much of the placement grid. However, at Eden Landing the RMS bed shear stress was only greater than this threshold toward the eastern side of the placement grid. Since the RMS is a type of averaging, this does not mean the western side of the Eden Landing placement grid will not have wave-induced resuspension of the dredged material. Rather, it means the eastern side of the placement grid should have much more sediment resuspension and potential for dispersal away from the placement location than the western side of the placement grid.

4.2 Time-Averaged Currents

Residual (time-averaged) currents are the average current speed and direction over a specified time interval. Predicted residual currents were calculated over the summer and winter simulation periods to provide insight into how the average currents may affect dispersal of the dredged material following placement. Although the residual currents provide information on how time-averaged current direction may impact sediment dispersal, sediment dispersal results from a combination of the timing and magnitude of wind-wave resuspension, tidal-current transport, and transport in the residual current direction. As such, residual currents provide additional information but do not necessarily fully predict the net direction of sediment dispersal.

Predicted residual currents were calculated by time-averaging the predicted depth-averaged velocity over the length of the simulation period. The exact start and end times of the averaging periods were selected to coincide with similar phases of the tidal cycle. Depth-averaged residual currents are presented as spatial vector (arrow) maps of the time-averaged circulation near the Emeryville and Eden Landing placement grids. The length of the arrow represents the relative speed of the depth-averaged residual current, and the direction the arrows point is the direction the current is flowing toward. On the maps, depth-averaged residual currents with a speed greater than 0.2 ft/s are plotted as a wider line. This allows for the maps to be easily interpretable without a few longer arrows obscuring other arrows. Time-averaged water depth is shown as the background colors on the maps.

4.2.1 Emeryville

During the summer simulation period, the predicted depth-averaged residual current between the Emeryville placement sites and Emeryville Crescent Marsh was a counterclockwise circulation cell, which was directed toward the south along the western (deeper) side of the Emeryville placement grid and directed toward the north on the eastern (shallower) side along Emeryville Crescent Marsh (Figures 4.2-1 and 4.2-2). The southward depth-averaged residual currents on the western side of the placement grid may act to transport sediment south away from the placement grid and Emeryville Crescent Marsh and toward Oakland Harbor. The northward depth-averaged residual currents on the western side of the placement grid may act to transport sediment away from Emeryville Crescent Marsh.

During the winter simulation period, the predicted depth-averaged residual current was directed toward the south over a large portion of the Emeryville placement grid (Figures 4.2-3 and 4.2-4). Depth-averaged residual current speeds were low on the eastern (shallower) side of the placement grid and shoreward of the placement grid, where the counterclockwise circulation cell was less pronounced than during the summer period. The southward depth-averaged residual currents were larger during the winter simulation period than during the summer. The depth-averaged residual currents east (shoreward) of the Emeryville placement grid were larger during the summer simulation period than during the winter.

Figure 4.2-1
Depth-Averaged Residual Currents near the Emeryville Placement Grid During the Summer Simulation Period

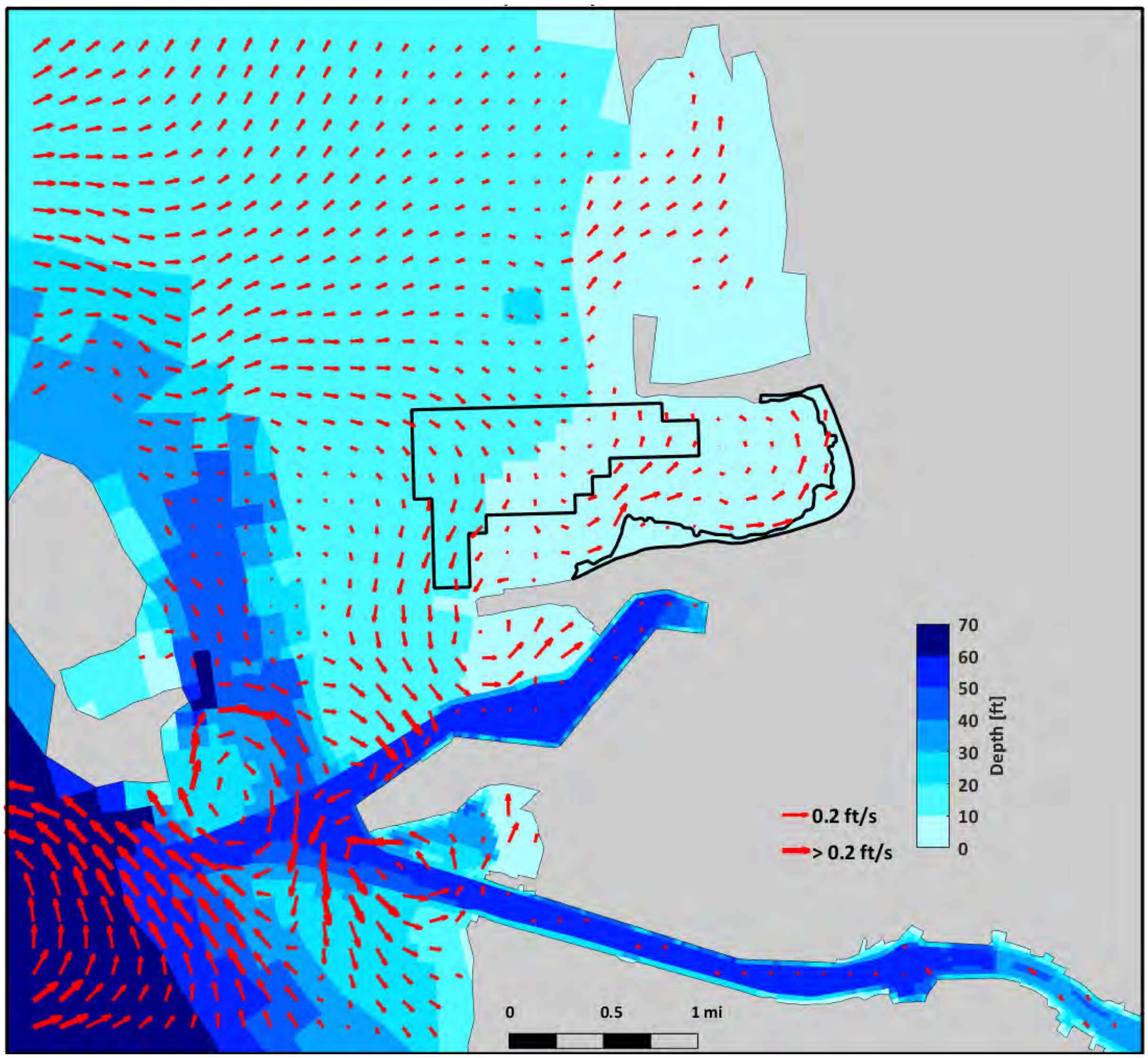


Figure 4.2-2
Depth-Averaged Residual Currents Zoomed in on the Emeryville Placement Grid and Emeryville Crescent Marsh During the Summer Simulation Period

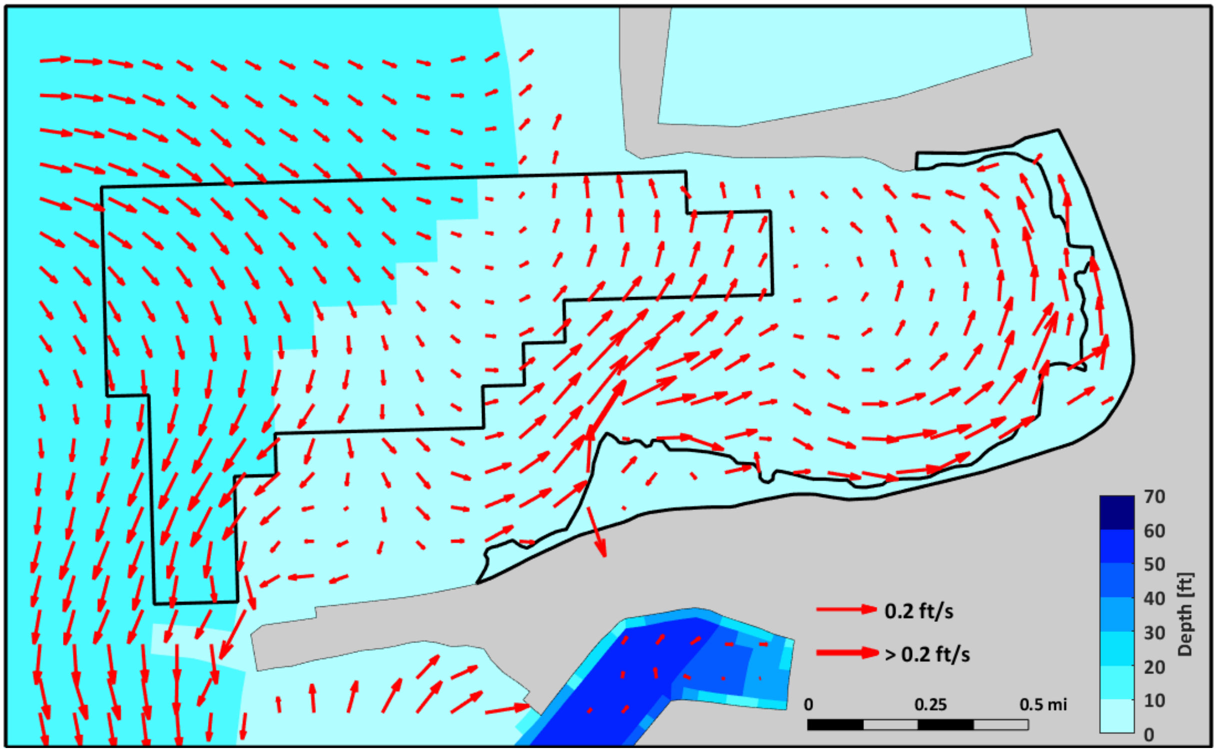


Figure 4.2-3
Depth-Averaged Residual Currents near the Emeryville Placement Grid During the Winter Simulation Period

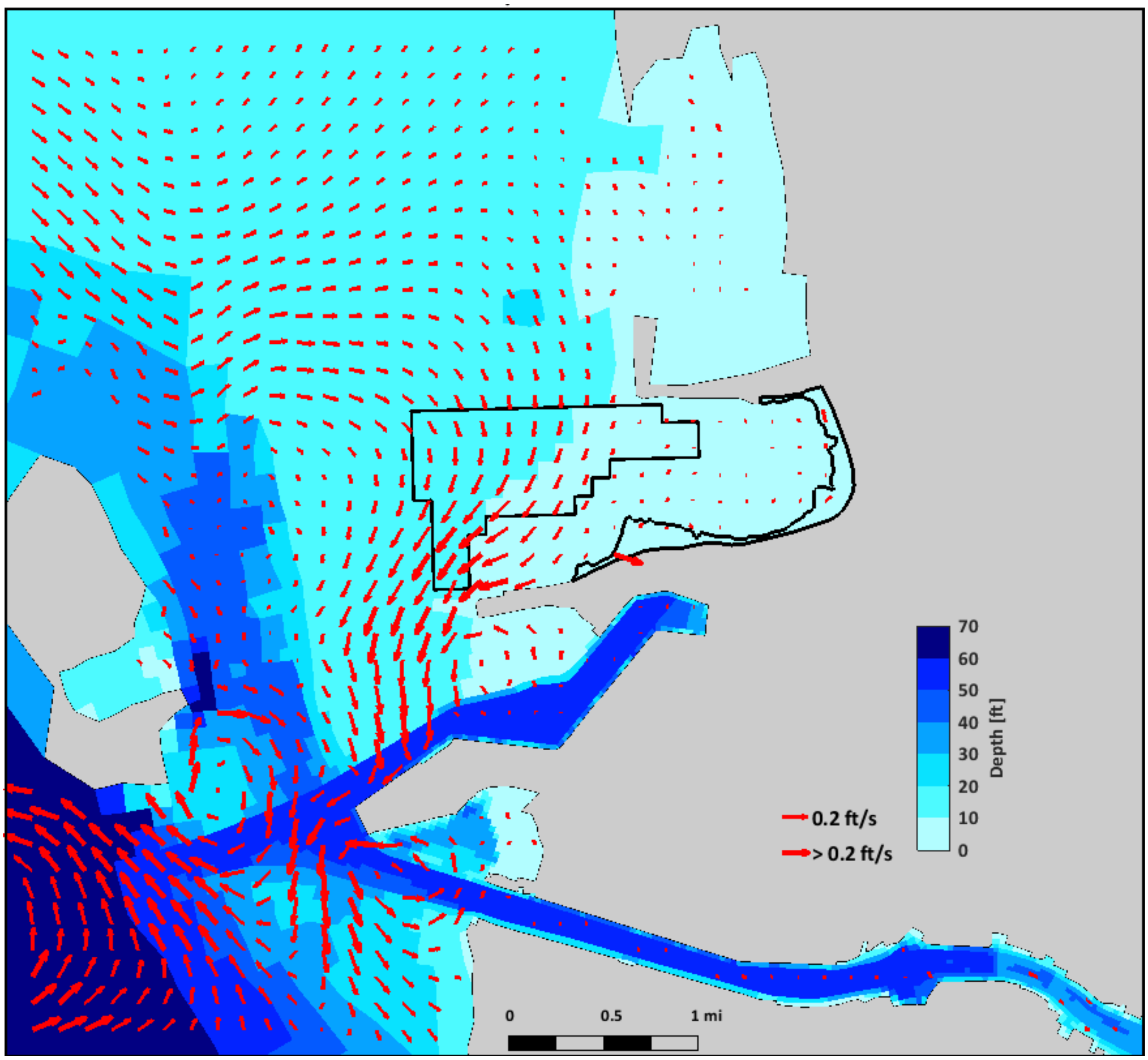
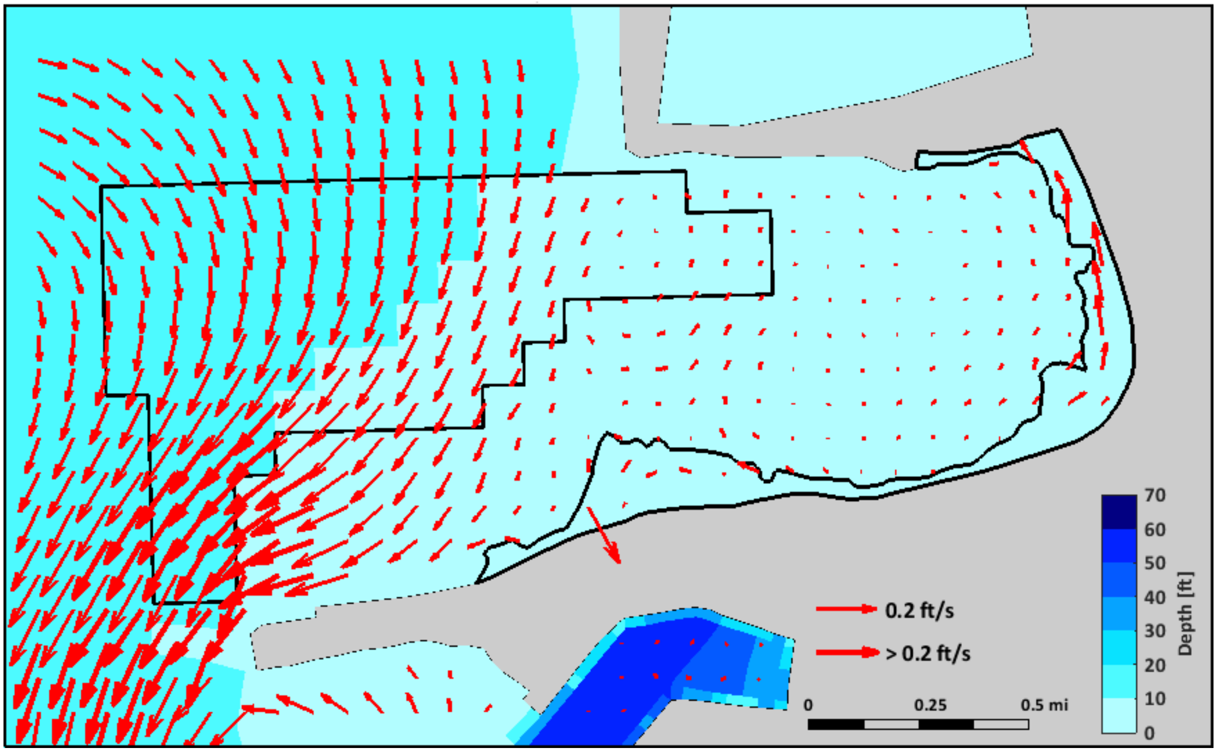


Figure 4.2-4
Depth-Averaged Residual Currents Zoomed in on the Emeryville Placement Grid and Emeryville Crescent Marsh During the Winter Simulation Period



4.2.2 Eden Landing

During the summer simulation period, the predicted depth-averaged residual current was directed toward the north over the northeast portion of the Eden Landing placement grid, where the dredged material placement footprints were located in the sediment transport model scenarios (Figures 4.2-5 and 4.2-6). Depth-averaged residual currents were also directed toward the north between the placement grid and Eden Landing Marsh. West of the dredged material placement grid, a complex pattern of depth-averaged residual circulation was predicted. This pattern includes generally southward directed depth-averaged residual currents in the main channel of South San Francisco Bay and a clockwise rotating depth-averaged residual current south of Redwood City Harbor. Depth-averaged residual currents just north of the placement grid were very low. This area of very low predicted depth-averaged residual currents near San Mateo Bridge is consistent with the findings of Walters et al. (1985) that "horizontal [tidal] residual flows south of San Mateo Bridge appear to be extremely weak and are not measurable." A location of very low residual currents in the middle of South Bay suggests that residual currents in the South Bay may be more complex than interpreted from previous observational data (e.g., Walters et al. 1985; Lacy et al. 1996). The northward predicted depth-averaged residual currents also compare favorably with Gostic (2017), who used sediment transport modeling to predict northward net sediment fluxes on the eastern shoal of South Bay during wet and dry years (see Figure 4.10 in Gostic 2017).

During the winter simulation period, the predicted depth-averaged residual current pattern was very similar to that of the summer simulation period (Figures 4.2-7 and 4.2-8). However, the depth-averaged residual currents were larger during the winter simulation period than during the summer. This increase in the speed of the depth-averaged residual currents is shown by the lengthening of the arrows from the summer simulation period (Figures 4.2-5 and 4.2-6) to the winter simulation period (Figures 4.2-7 and 4.2-8). Similar to the summer period, the depth-averaged residual currents in the main channel of South San Francisco Bay were generally directed southward, with northward directed currents on the eastern side of the South Bay between the placement grid and Eden Landing Marsh and very low depth-averaged residual currents just north of the placement grid.

Figure 4.2-5
Depth-Averaged Residual Currents near the Eden Landing Placement Grid During the Summer Simulation Period

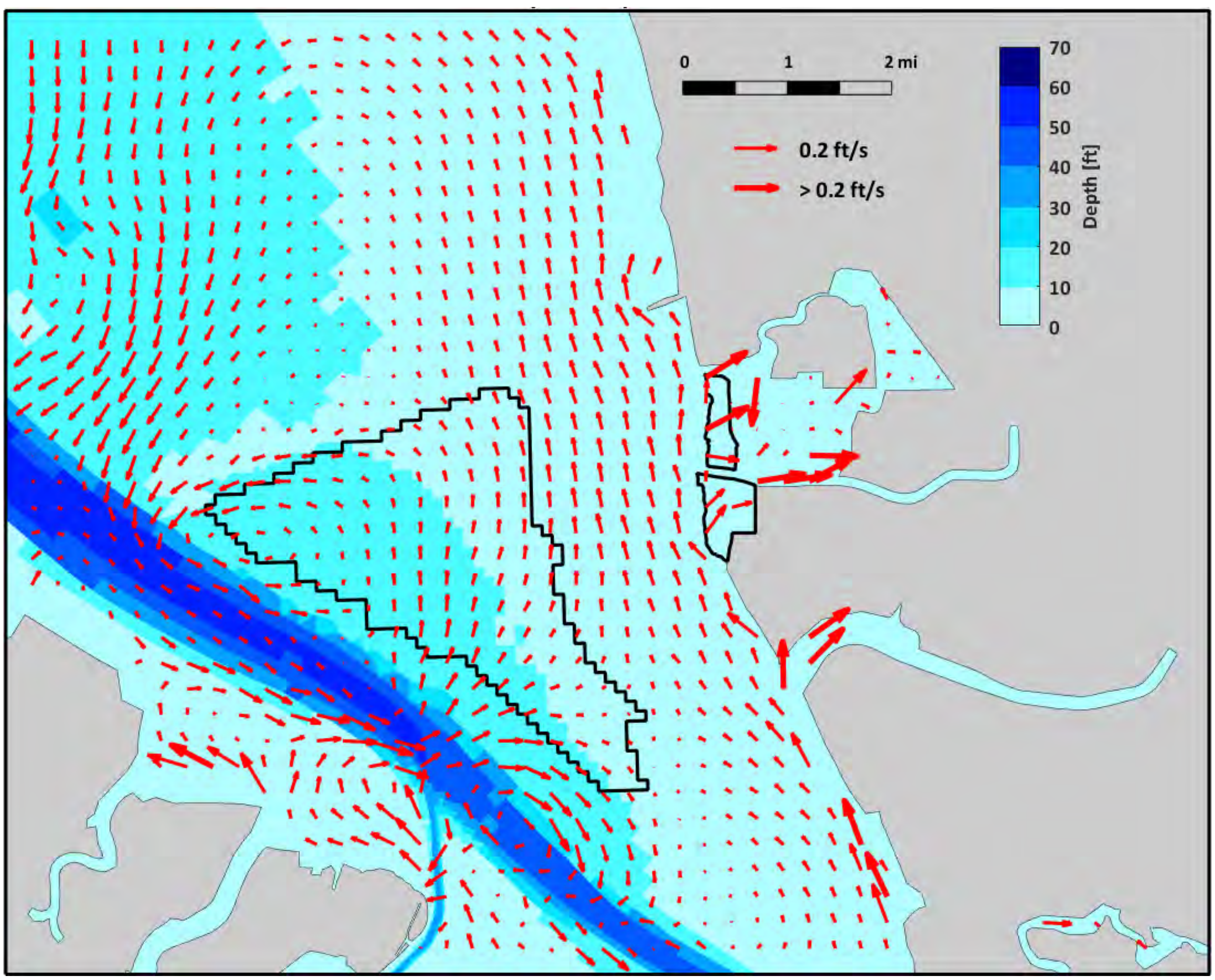


Figure 4.2-6
Depth-Averaged Residual Currents Zoomed in on the Eden Landing Placement Grid and Eden Landing Marsh During the Summer Simulation Period

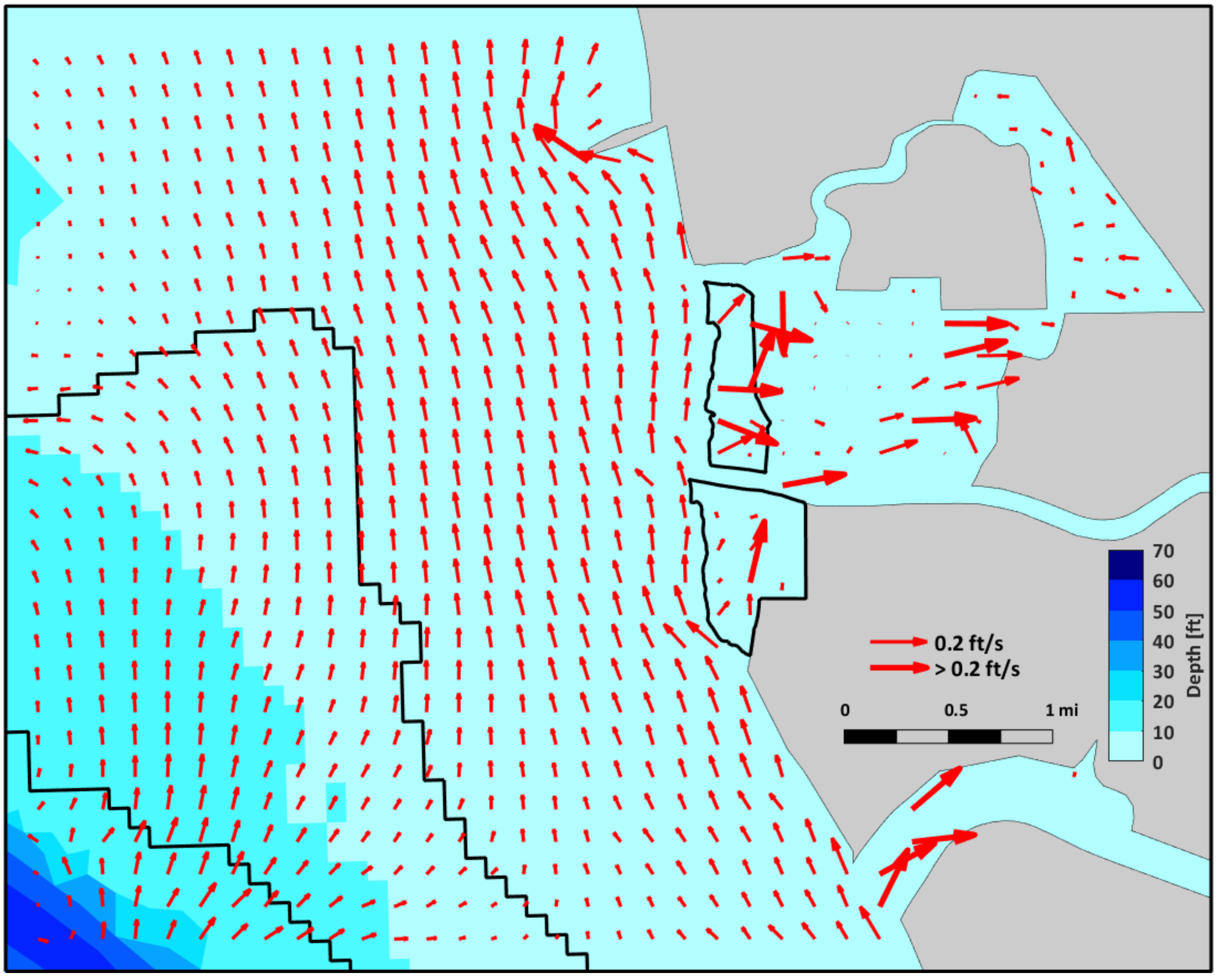


Figure 4.2-7
Depth-Averaged Residual Currents near the Eden Landing Placement Grid During the Winter Simulation Period

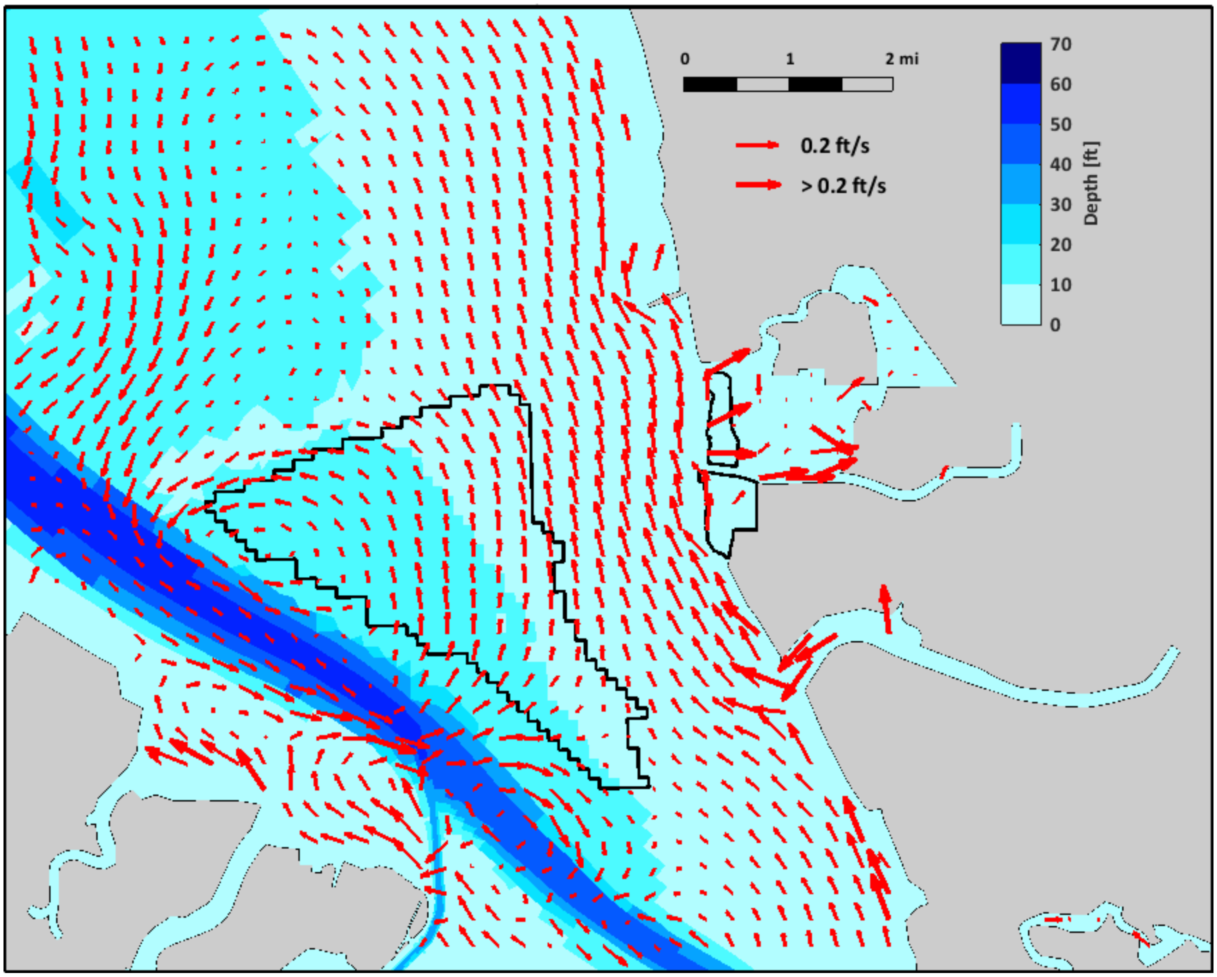
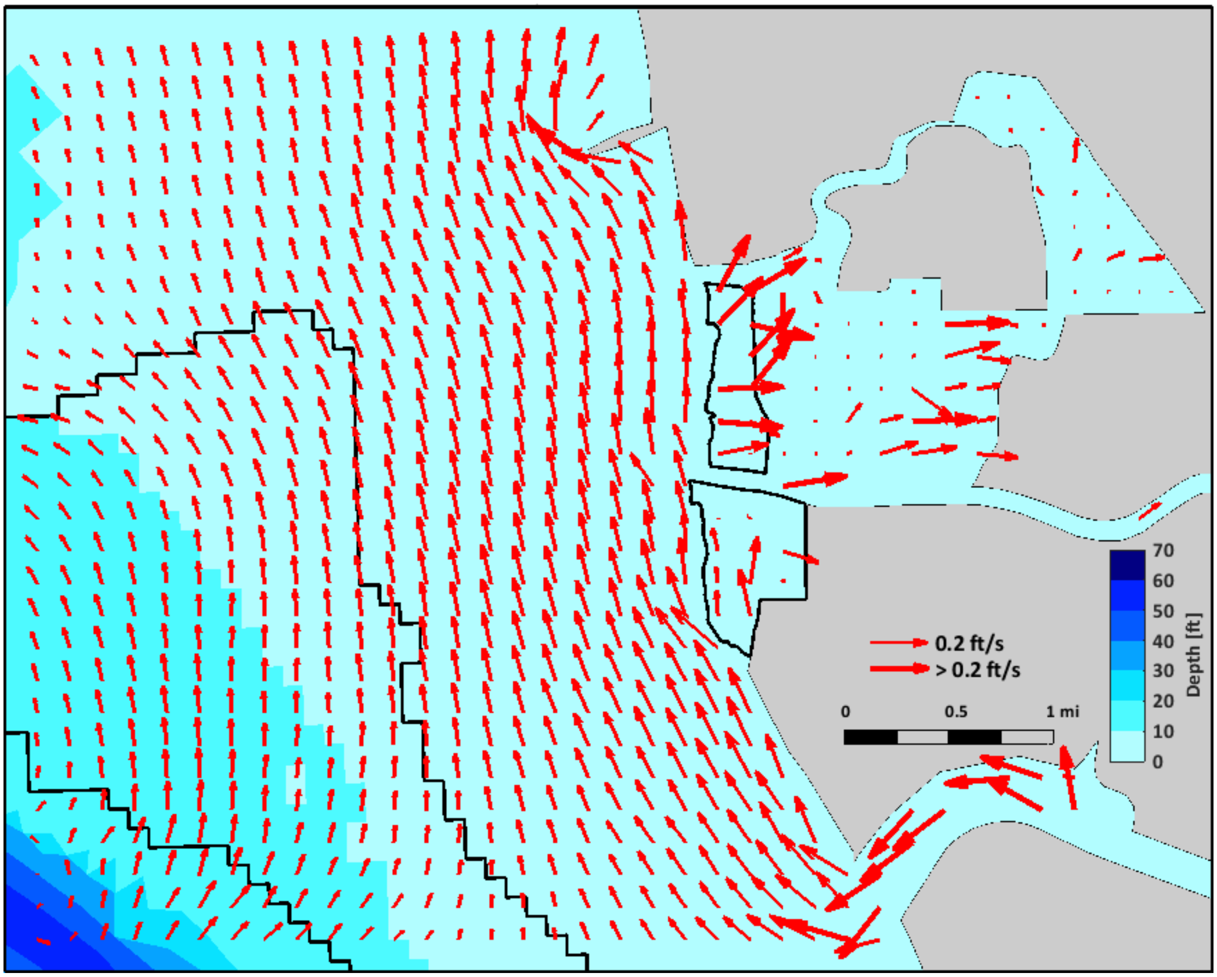


Figure 4.2-8
Depth-Averaged Residual Currents Zoomed in on the Eden Landing Placement Grid and Eden Landing Marsh During the Winter Simulation Period



5 Evaluation of Dredged Material Placement Scenarios

The 12 dredged material placement scenarios were analyzed to determine the predicted amount of dredged material dispersed to specific locations or retained in the placement footprint at the end of the simulations. Sections 5.1 and 5.2 focus on the first six scenarios used to evaluate the Emeryville and Eden Landing placement sites. These six scenarios were developed to evaluate three different placement strategies at each site and provide additional information to inform the selection of the most suitable site for the 1122 pilot study. The results from each of these six scenarios are presented, and then the similarities and differences between the placements at Emeryville and Eden Landing are summarized. Section 5.3 presents the results of the additional six scenarios developed to refine the placement strategy and placement volume at Eden Landing. Section 5.4 compares the set of scenarios focused on the shallow/east placement location at Eden Landing.

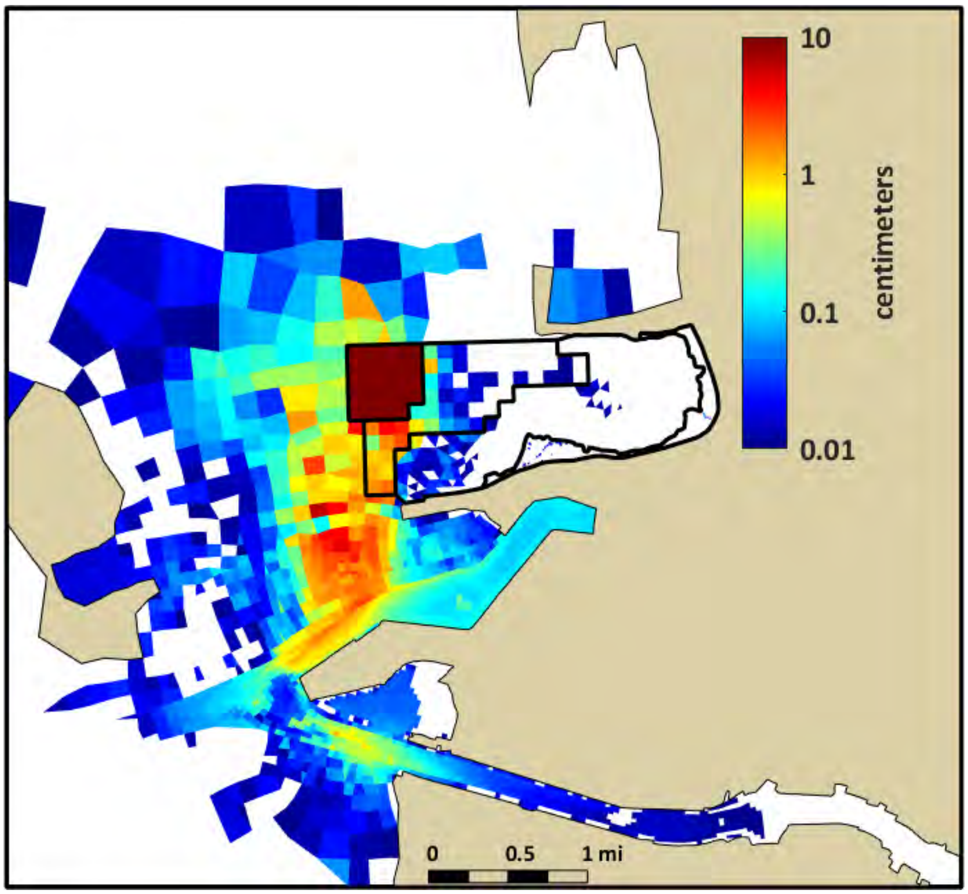
The Emeryville and Eden Landing regions shown on Figures 3.4-1, 3.4-2, and 3.4-3 were used to evaluate the predicted fate of the dredged material at the end of the simulations. The amount of dredged material in the regions are presented as the percentage of the placement sediment mass in each region and as the volume of dredged material in each region. The percentage is presented as the percentage of sediment mass because the sediment transport model simulates the erosion, deposition, and transport of sediment mass. This is the same approach used previously for evaluating the dispersal of dredged material south of Dumbarton Bridge (Bever and MacWilliams 2014). The volume of dredged material in each region was calculated by multiplying the percentage of sediment mass in each region by the total volume of dredged material used in each scenario.

5.1 Initial Emeryville and Eden Landing Scenario Results

5.1.1 Emeryville Deep

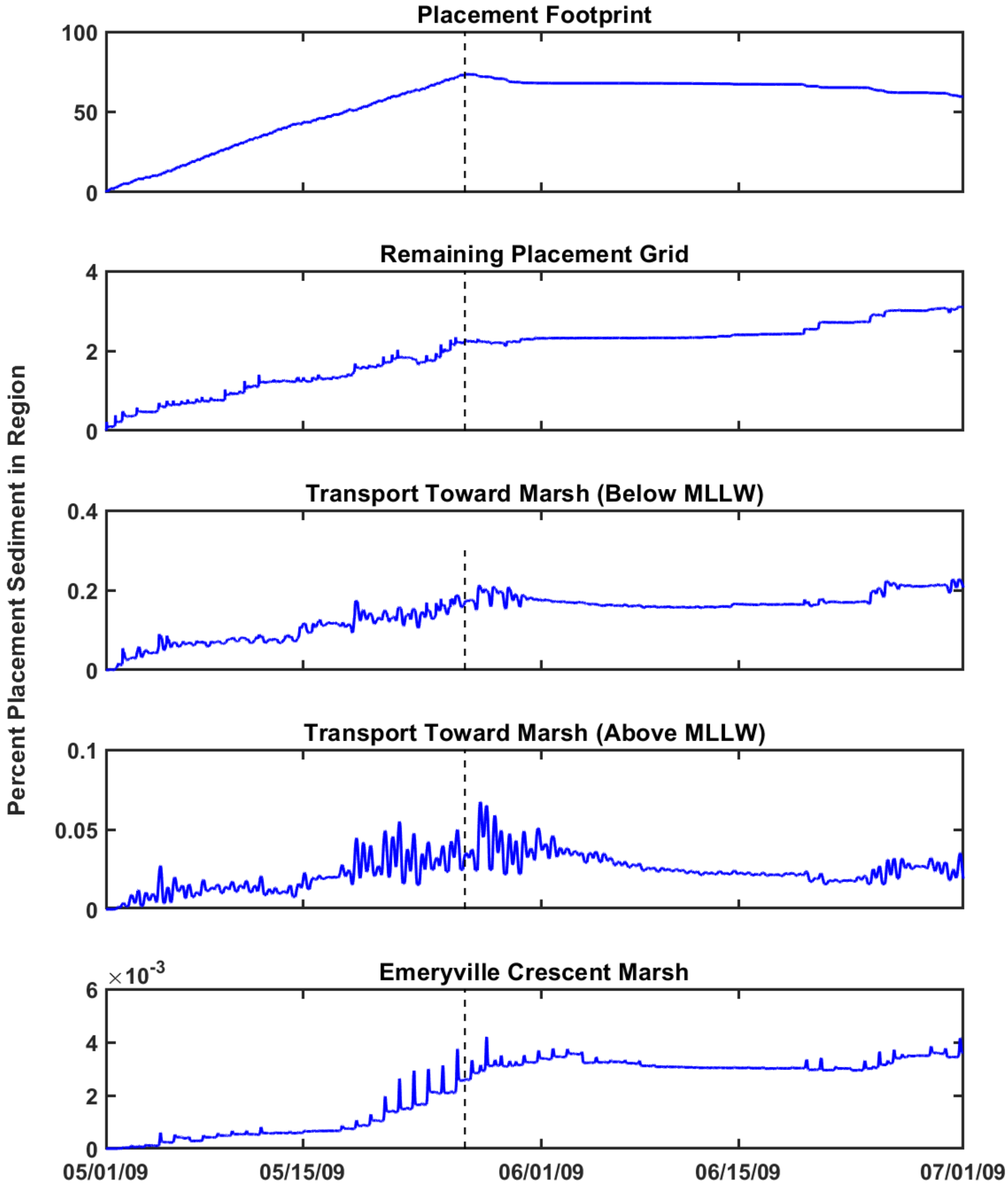
The Emeryville Deep scenario included the placement of 100,000 yd^3 of dredged material on the western side of the placement grid. The scenario assumed a total of 72 placements over a period of 26 days, as described in Section 3.3.1.1. At the end of the 2-month simulation, some of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.1-1), but 60% of the placed dredged material was predicted to remain inside the placement footprint (Figures 5.1-2 and 5.1-3; Tables 5.1-1 and 5.1-2). The model predicted that dredged material that was transported out of the initial placement footprint was predominately deposited toward the west and south of the placement footprint (Figure 5.1-1). Predicted thickness of the dredged material remaining in the placement footprint ranged from 13 to 26 cm, with up to 0.05 cm of dredged material deposition in Emeryville Crescent Marsh (Table 5.1-3). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed and then was predicted to slowly decrease as the dredged material was resuspended (Figure 5.1-2). Much of the dredged material deposited on Emeryville Crescent Marsh was predicted to be transported onto the marsh during the second half of May, when the tidal higher high water level was relatively high and the placements were still occurring. About 3% of the placed dredged material was predicted to be transported into Oakland Harbor, and 34% was predicted to be dispersed to areas deeper than MLLW at the end of the 2-month simulation.

Figure 5.1-1
Predicted Thickness of Dredged Material at the End of the 2-Month Simulation: Scenario 1 Emeryville Deep



Note:
Note the log scale of the color range.

Figure 5.1-2
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulation: Scenario 1 Emeryville Deep



Note:
Vertical dashed line denotes the end of the dredged material placements for this scenario.

Figure 5.1-3
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 2-Month Simulation: Scenario 1 Emeryville Deep

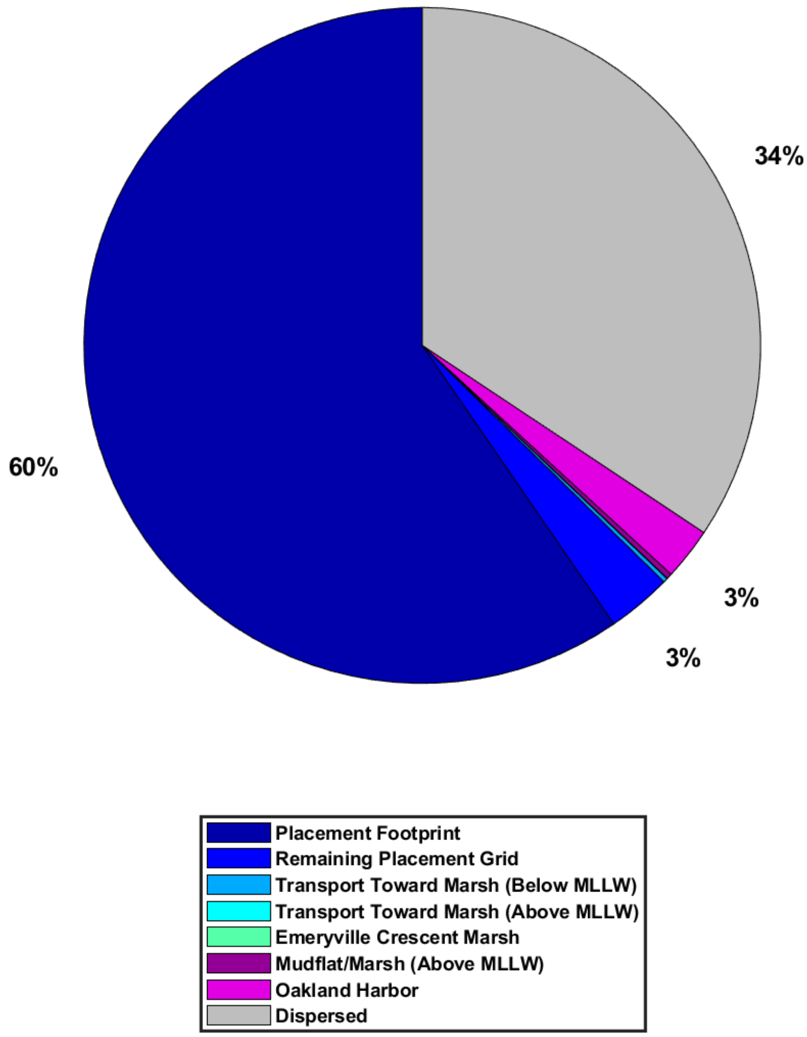


Table 5.1-1
Percentage of Placement Sediment Mass in Each Region at the End of the Three Emeryville Scenarios

Scenario Number	Scenario Name	Placement Footprint	Remaining Placement Grid	Transport Toward Marsh (Below MLLW)	Transport Toward Marsh (Above MLLW)	Emeryville Crescent Marsh	Mudflat/Marsh (Above MLLW)	Oakland Harbor	Dispersed
1	Emeryville Deep	60	3	0.2	<0.1	<0.1	0.3	3	34
2	Emeryville Middle	68	7	1	<0.1	<0.1	0.2	1	22
3	Emeryville Shallow/East	75	6	3	0.1	<0.1	0.2	0.7	15

Note:
Percentages may not round to 100% because of rounding of the values.

Table 5.1-2
Volume of Placement Sediment in Cubic Yards in Each Region at the End of the Three Emeryville Scenarios

Scenario Number	Scenario Name	Placement Footprint	Remaining Placement Grid	Transport Toward Marsh (Below MLLW)	Transport Toward Marsh (Above MLLW)	Emeryville Crescent Marsh	Mudflat/Marsh (Above MLLW)	Oakland Harbor	Dispersed
1	Emeryville Deep	60,000	3,000	200	<100	<100	300	3,000	34,000
2	Emeryville Middle	68,000	7,000	1,000	<100	<100	200	1,000	22,000
3	Emeryville Shallow/East	75,000	6,000	3,000	100	<100	200	700	15,000

Notes:
Sediment volume in each region was calculated by multiplying the percentage in each region shown in Table 5.1-1 by the total placement volume show on Table 3.3-1.
Sediment volume may not sum to the total volume of dredged material because of rounding of the percentages in each region.

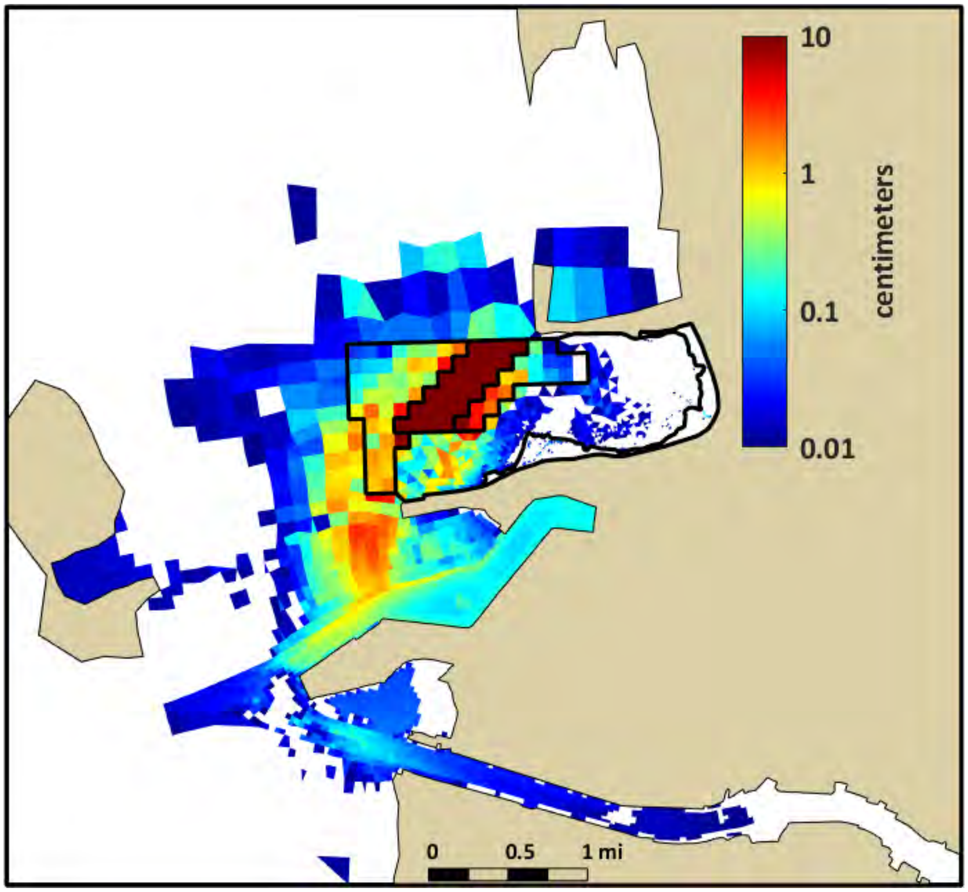
Table 5.1-3
Minimum (Top Number) and Maximum (Bottom Number) Predicted Dredged Material Deposition Thickness in Centimeters in Each Region at the End of the Three Emeryville Scenarios

Scenario Number	Scenario Name	Placement Footprint	Remaining Placement Grid	Transport Toward Marsh (Below MLLW)	Transport Toward Marsh (Above MLLW)	Emeryville Crescent Marsh	Mudflat/Marsh (Above MLLW)	Oakland Harbor	Dispersed
1	Emeryville Deep	13 26	<0.01 4	<0.01 1	<0.01 0.03	<0.01 0.05	<0.01 0.01	<0.01 2	<0.01 6
2	Emeryville Middle	12 30	<0.01 10	<0.01 5	<0.01 0.3	<0.01 0.1	<0.01 0.01	<0.01 0.8	<0.01 4
3	Emeryville Shallow/East	40 56	<0.01 12	<0.01 9	<0.01 0.1	<0.01 0.2	<0.01 0.1	<0.01 0.1	<0.01 11

5.1.2 Emeryville Middle

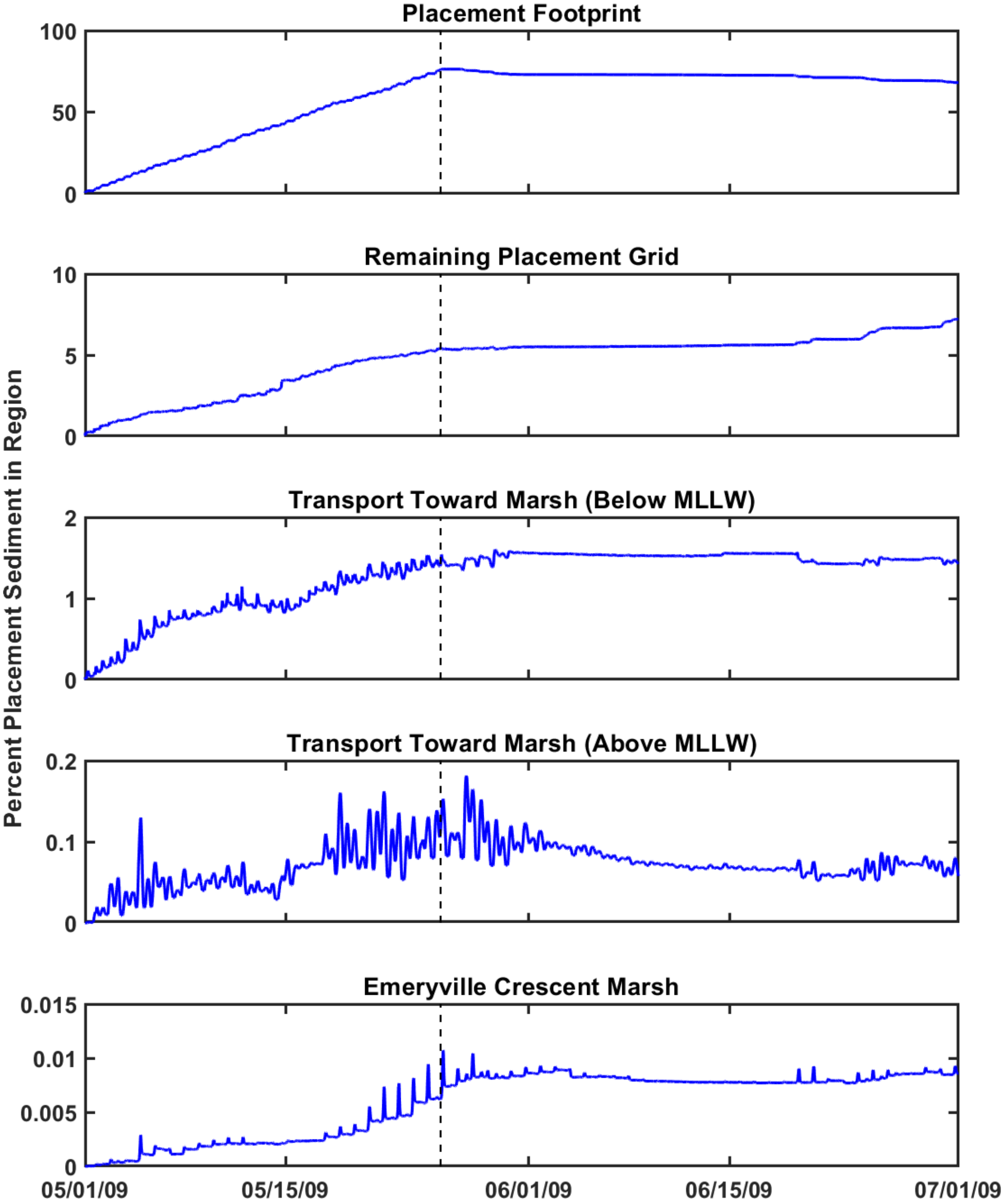
The Emeryville Middle scenario included the placement of 100,000 yd^3 of dredged material near the middle of the placement grid. The scenario assumed a total of 87 placements over a period of 25 days, as described in Section 3.3.1.2. At the end of the 2-month simulation, some of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.1-4), but 68% of the placed dredged material was predicted to remain inside the placement footprint (Figures 5.1-5 and 5.1-6; Tables 5.1-1 and 5.1-2). The model predicted that dredged material that was transported out of the initial placement footprint was predominately deposited toward the west and south of the placement footprint (Figure 5.1-4). Predicted thickness of the dredged material remaining in the placement footprint ranged from 12 to 30 cm, with up to 0.1 cm of dredged material deposition in Emeryville Crescent Marsh (Table 5.1-3). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed and then was predicted to slowly decrease as the dredged material was resuspended (Figure 5.1-5). Much of the dredged material deposited on Emeryville Crescent Marsh was predicted to be transported onto the marsh during the second half of May, when the tidal higher high water level was relatively high and the placements were still occurring. About 1% of the placed dredged material was predicted to be transported into Oakland Harbor, and 22% was predicted to be dispersed to areas deeper than MLLW at the end of the 2-month simulation.

Figure 5.1-4
Predicted Thickness of Dredged Material at the End of the 2-Month Simulation: Scenario 2 Emeryville Middle



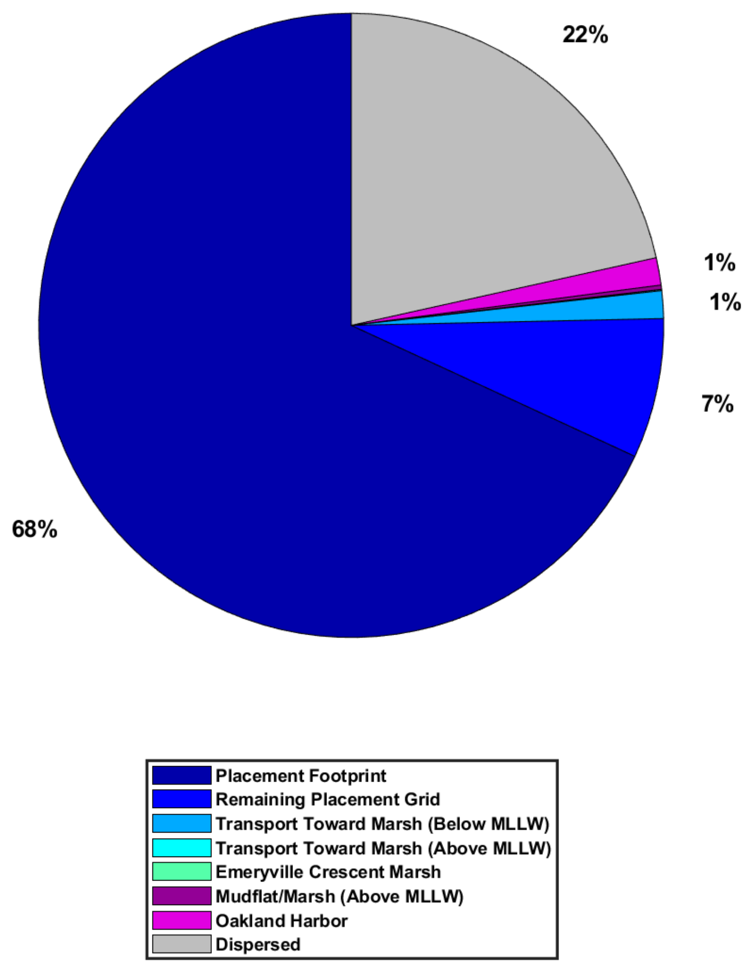
Note:
Note the log scale of the color range.

Figure 5.1-5
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulation: Scenario 2 Emeryville Middle



Note:
Vertical dashed line denotes the end of the dredged material placements for this scenario.

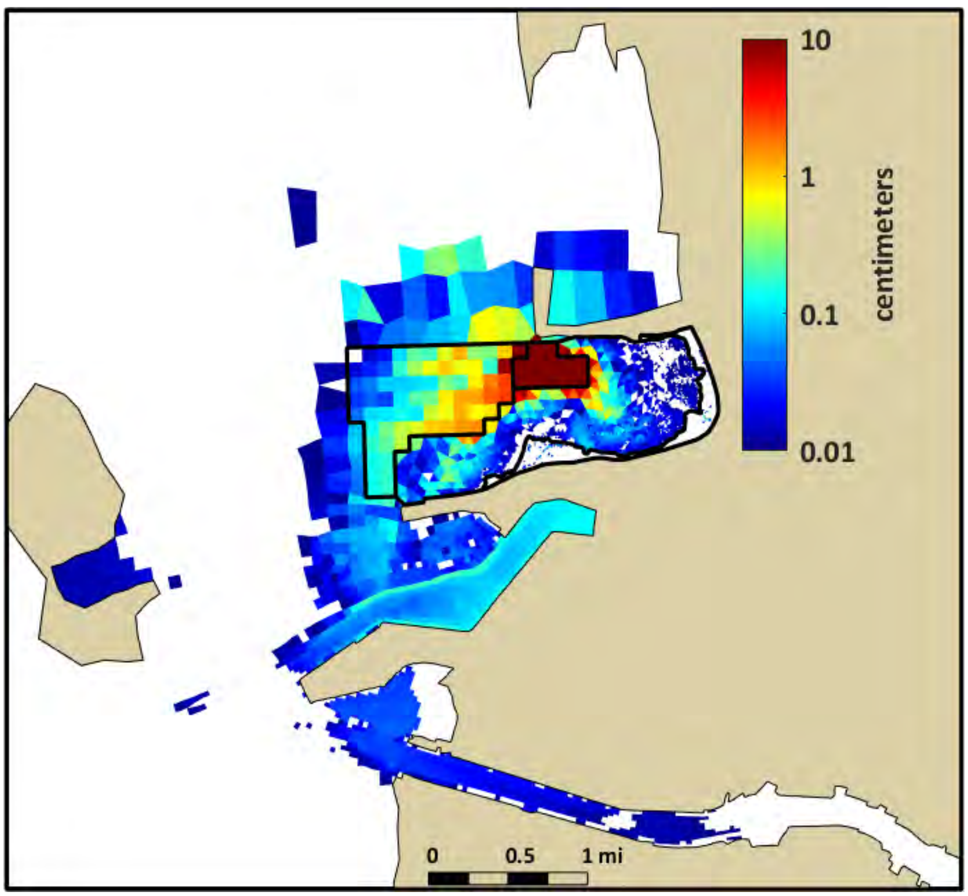
Figure 5.1-6
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 2-Month Simulation: Scenario 2 Emeryville Middle



5.1.3 Emeryville Shallow/East

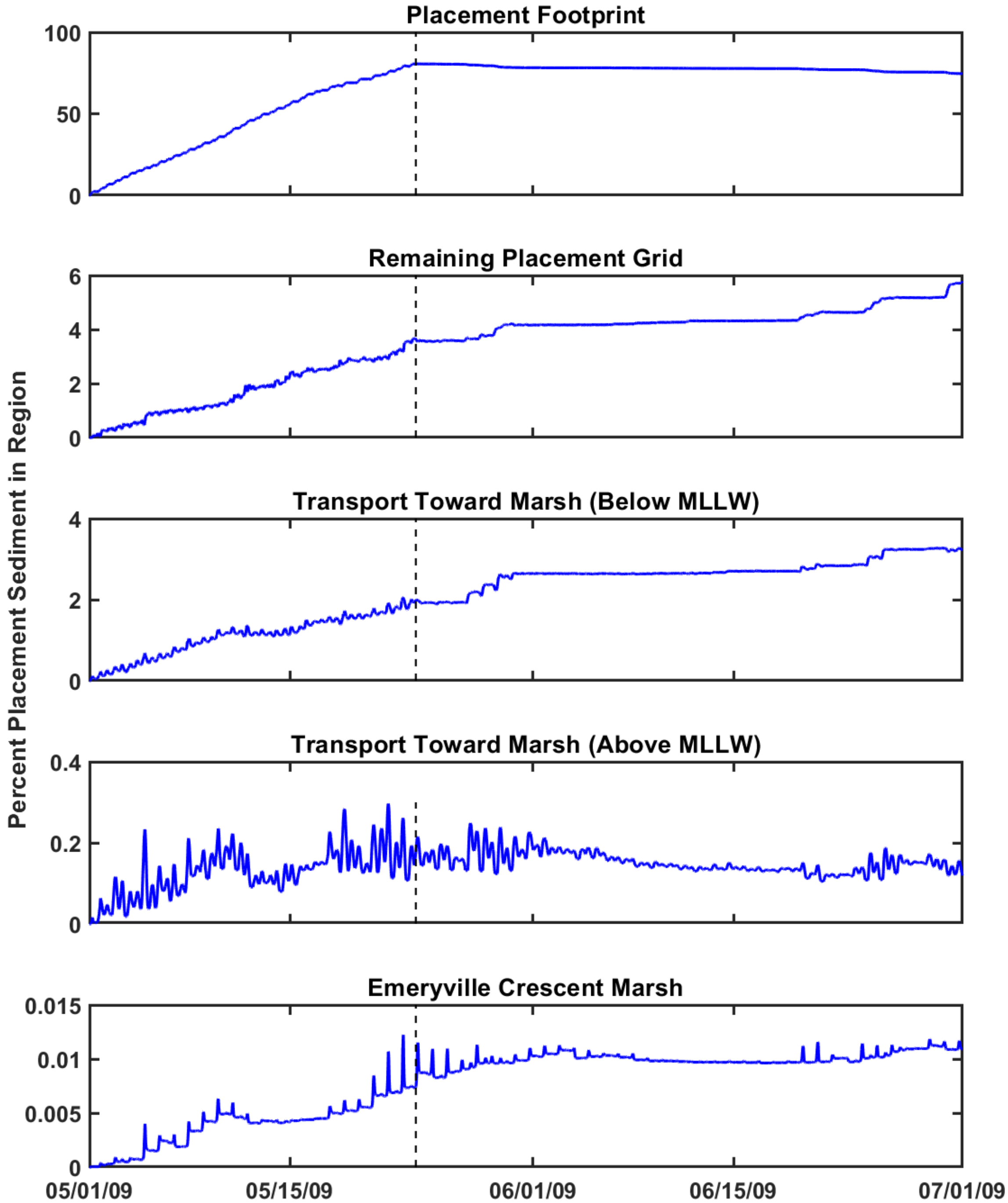
The Emeryville Shallow/East scenario included the placement of 100,000 yd^3 of dredged material on the eastern side of the placement grid. The scenario assumed a total of 112 placements over a period of 23 days, as described in Section 3.3.1.3. At the end of the 2-month simulation, some of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.1-7), but 75% of the placed dredged material was predicted to remain inside the placement footprint (Figures 5.1-8 and 5.1-9; Tables 5.1-1 and 5.1-2). The model predicted that dredged material that was transported out of the initial placement footprint was predominately deposited toward the west and south of the placement footprint, but with more deposition toward Emeryville Crescent Marsh than in the Emeryville Deep and Emeryville Middle scenarios (Figure 5.1-7). Predicted thickness of the dredged material remaining in the placement footprint ranged from 40 to 56 cm, with up to 0.2 cm of dredged material deposition in Emeryville Crescent Marsh (Table 5.1-3). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed and then was predicted to slowly decrease as the dredged material was resuspended (Figure 5.1-8). Much of the dredged material deposited on Emeryville Crescent Marsh was predicted to be transported onto the marsh during two periods in May, when the tidal higher high water level was relatively high and the placements were still occurring. About 0.7% of the placed dredged material was predicted to be transported into Oakland Harbor, and 15% was predicted to be dispersed to areas deeper than MLLW at the end of the 2-month simulation.

Figure 5.1-7
Predicted Thickness of Dredged Material at the End of the 2-Month Simulation: Scenario 3 Emeryville Shallow/East



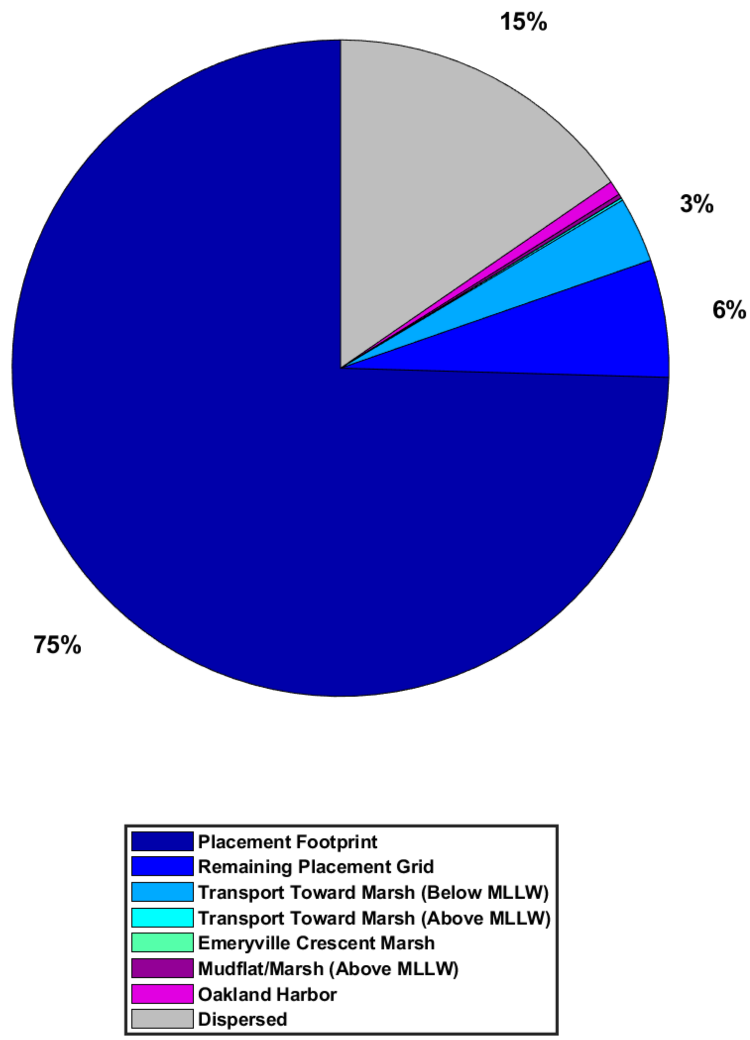
Note:
Note the log scale of the color range.

Figure 5.1-8
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulation: Scenario 3 Emeryville Shallow/East



Note:
Vertical dashed line denotes the end of the dredged material placements for this scenario.

Figure 5.1-9
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 2-Month Simulation: Scenario 3 Emeryville Shallow/East



5.1.4 Eden Landing Deep

The Eden Landing Deep scenario included the placement of 100,000 yd^3 of dredged material along the eastern side of the placement grid. The scenario assumed a total of 72 placements over a period of 25 days, as described in Section 3.3.1.4. At the end of the 2-month simulation, much of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.1-10), but 23% of the placed dredged material was predicted to remain inside the placement footprint (Figures 5.1-11 and 5.1-12; Tables 5.1-4 and 5.1-5). The model predicted that dredged material that was transported out of the initial placement footprint was deposited around the placement footprint, with a skewing of the deposition toward the southeast of the placement footprint (Figure 5.1-12).

Predicted thickness of the dredged material remaining in the placement footprint ranged from 5 to 19 cm, with up to 0.4 cm of dredged material deposition in Eden Landing Marsh (Table 5.1-6). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed and then was predicted to decrease as the dredged material was resuspended (Figure 5.1-11).

At the end of the 2-month simulation period, less than 0.1% of the placed dredged material was predicted to be deposited in Eden Landing Marsh (Figure 3.4-2), and 0.5% was predicted to be deposited in other regions of the Eden Landing complex (Table 5.1-4). Much of the dredged material deposited on Eden Landing Marsh was predicted to be transported onto the marsh during the second half of May and June, during spring tide when the tidal higher high water levels were relatively high. Although only a small portion of the placed dredged material was predicted to reach Eden Landing Marsh within the 2-month simulation period, some of the placed sediment was predicted to be transported toward the marsh. The model predicted that 2% of the placed dredged material was transported towards Eden Landing but was still below MLLW, while an additional 2% of the placed dredged material was predicted to be transported towards the marsh and was already deposited at elevations above MLLW. An additional 1% was predicted to be transported to other areas above MLLW on the eastern side of the South Bay.

About 0.2% of the dredged material was predicted to be transported into Redwood City Harbor, and 0.1% was transported into the Alameda FCC. About 21% of the placed dredged material was predicted to be dispersed within the South Bay below MLLW, 2% dispersed north of Dumbarton Bridge, and 4% dispersed north of the Bay Bridge.

Table 5.1-4
Percentage of Placement Sediment Mass in Each Region at the End of the Simulation for the Scenarios Focused on Eden Landing

	Scenario	Placement Footprint	Remaining Placement Grid	North of Placement Footprint	Toward Marsh (Below MLLW)	Toward Marsh (Above MLLW)	Eden Landing Marsh	Remaining Eden Landing	Old Alameda Creek	South Bay Mudflat/Marsh (East)	South Bay Mudflat/Marsh (West)	Alameda FCC	Redwood City Harbor	Dispersed South Bay	Dispersed South of Dumbarton	Dispersed North of Bay Bridge
4	Eden Landing Deep 100k yd^3	23	39	3	3	2	<0.1	0.5	<0.1	1	1	0.1	0.2	21	2	4
5	Eden Landing Middle 100k yd^3	41	27	2	5	3	<0.1	0.5	0.1	1	0.7	0.1	0.2	16	2	3
6	Eden Landing Shallow/East 100k yd^3	20	22	1	22	6	0.1	1	0.2	2	0.8	0.3	0.2	18	2	4
7	Eden Landing Shallow/East 50k yd^3	18	22	1	23	6	0.1	1	0.2	2	0.9	0.3	0.2	18	2	5
8	Eden Landing Shallow/East 75k yd^3	17	23	1	22	7	0.1	1	0.2	2	0.9	0.3	0.2	18	2	4
9	Eden Landing Shallow/East Winter 100k yd^3	32	22	3	15	2	<0.1	0.3	<0.1	1	0.5	<0.1	<0.1	14	1	9
10	Eden Landing Oakland Sediment 100k yd^3	27	22	1	23	5	0.1	0.8	0.2	1	0.6	0.2	0.1	15	2	3
11	Eden Landing: Expanded East 100k yd^3	34	16	2	18	5	0.1	0.9	0.2	2	0.8	0.3	0.2	17	2	4
12	Eden Landing: Expanded East 125k yd^3	33	14	2	18	6	0.1	0.9	0.2	2	0.8	0.3	0.2	17	2	4

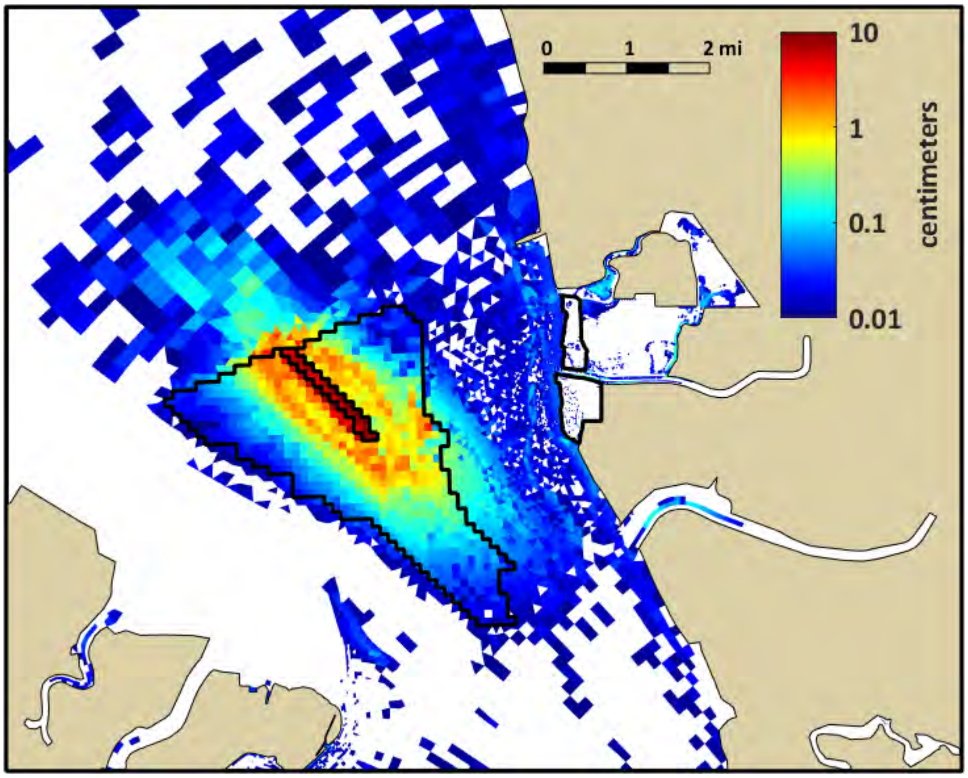
Table 5.1-5
Volume of Placement Sediment in Cubic Yards in Each Region at the End of the Simulation for the Scenarios Focused on Eden Landing

	Scenario	Placement Footprint	Remaining Placement Grid	North of Placement Footprint	Toward Marsh (Below MLLW)	Toward Marsh (Above MLLW)	Eden Landing Marsh	Remaining Eden Landing	Old Alameda Creek	South Bay Mudflat/Marsh (East)	South Bay Mudflat/Marsh (West)	Alameda FCC	Redwood City Harbor	Dispersed South Bay	Dispersed South of Dumbarton	Dispersed North of Bay Bridge
4	Eden Landing Deep 100k yd^3	23,000	39,000	3,000	3,000	2,000	<100	500	<100	1,000	1,000	100	200	21,000	2,000	4,000
5	Eden Landing Middle 100k yd^3	41,000	27,000	2,000	5,000	3,000	<100	500	100	1,000	700	100	200	16,000	2,000	3,000
6	Eden Landing Shallow/East 100k yd^3	20,000	22,000	1,000	22,000	6,000	100	1,000	200	2,000	800	300	200	18,000	2,000	4,000
7	Eden Landing Shallow/East 50k yd^3	9,000	11,000	500	11,500	3,000	50	500	100	1,000	450	150	100	9,000	1,000	2,500
8	Eden Landing Shallow/East 75k yd^3	12,750	17,250	750	16,500	5,250	75	750	150	1,500	675	225	150	13,500	1,500	3,000
9	Eden Landing Shallow/East Winter 100k yd^3	32,000	22,000	3,000	15,000	2,000	<100	300	<100	1,000	500	<100	<100	14,000	1,000	9,000
10	Eden Landing Oakland Sediment 100k yd^3	27,000	22,000	1,000	23,000	5,000	100	800	200	1,000	600	200	100	15,000	2,000	3,000
11	Eden Landing: Expanded East 100k yd^3	34,000	16,000	2,000	18,000	5,000	100	900	200	2,000	800	300	200	17,000	2,000	4,000
12	Eden Landing: Expanded East 125k yd^3	41,250	17,500	2,500	22,500	7,500	125	1,125	250	2,500	1,000	375	250	21,250	2,500	5,000

Table 5.1-6
Minimum (Top Number) and Maximum (Bottom Number) Predicted Dredged Material Deposition Thickness in Centimeters in Each Region at the End of the Simulation for the Scenarios Focused on Eden Landing

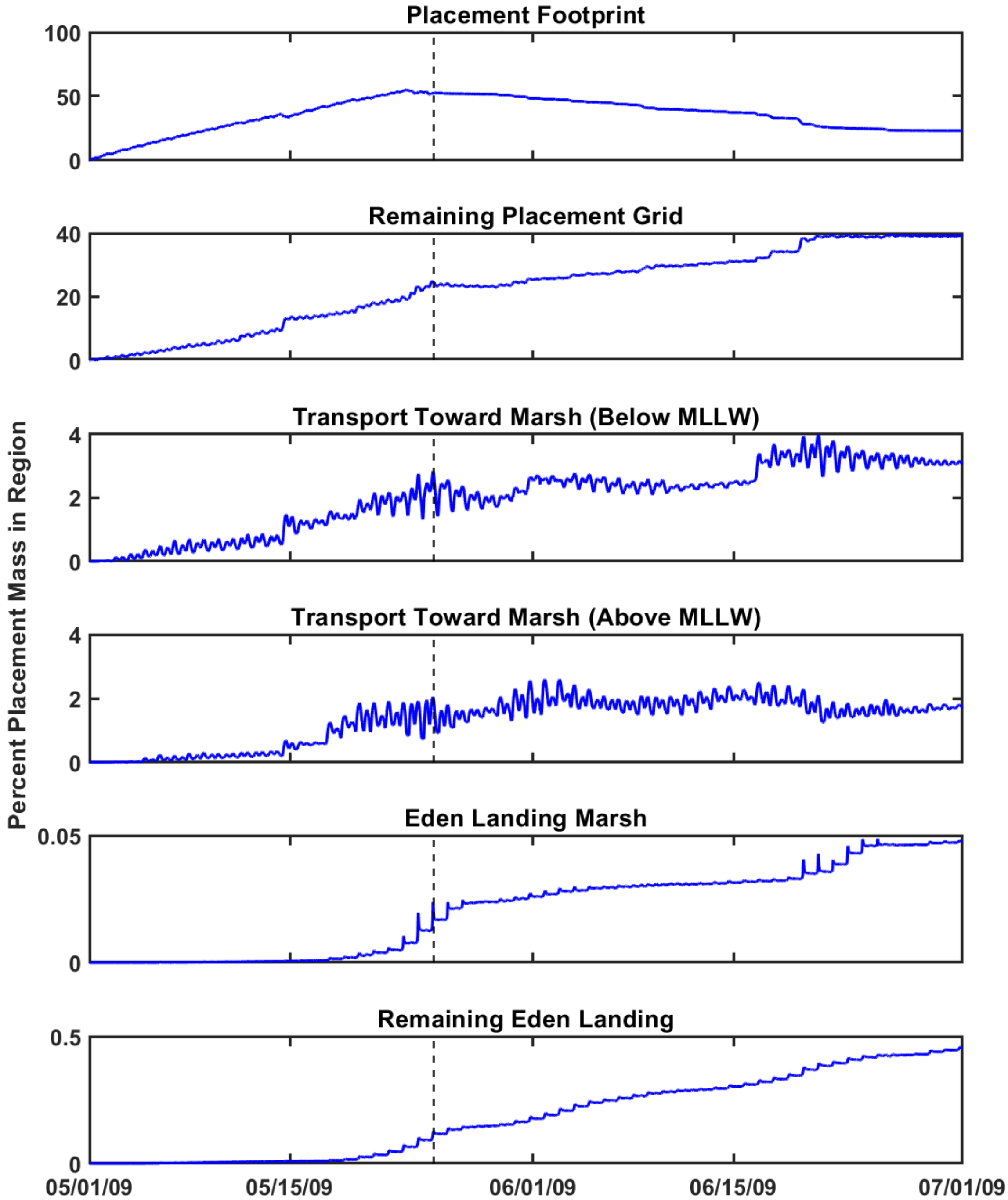
	Scenario	Placement Footprint	Remaining Placement Grid	North of Placement Footprint	Toward Marsh (Below MLLW)	Toward Marsh (Above MLLW)	Eden Landing Marsh	Remaining Eden Landing	Old Alameda Creek	South Bay Mudflat/ Marsh (East)	South Bay Mudflat/ Marsh (West)	Alameda FCC	Redwood City Harbor	Dispersed South Bay	Dispersed South of Dumbarton	Dispersed North of Bay Bridge
4	Eden Landing Deep 100k yd^3	5 19	<0.01 8	<0.01 5	<0.01 0.4	<0.01 0.1	<0.01 0.4	<0.01 0.3	<0.01 0.3	<0.01 0.1	<0.01 0.07	<0.01 0.2	<0.01 0.07	<0.01 2	<0.01 0.1	<0.01 <0.01
5	Eden Landing Middle 100k yd^3	5 21	<0.01 4	<0.01 1	<0.01 0.9	<0.01 0.3	<0.01 0.5	<0.01 0.4	<0.01 0.3	<0.01 0.2	<0.01 0.05	<0.01 0.2	<0.01 0.05	<0.01 0.1	<0.01 0.08	<0.01 <0.01
6	Eden Landing Shallow/East 100k yd^3	0.8 17	<0.01 8	<0.01 0.8	<0.01 7	<0.01 2	<0.01 1	<0.01 0.7	<0.01 0.7	<0.01 0.3	<0.01 0.05	<0.01 0.3	<0.01 0.05	<0.01 0.09	<0.01 0.09	<0.01 <0.01
7	Eden Landing Shallow/East 50k yd^3	0.3 12	<0.01 3	<0.01 0.5	<0.01 6	<0.01 0.7	<0.01 0.6	<0.01 0.4	<0.01 0.3	<0.01 0.1	<0.01 0.03	<0.01 0.2	<0.01 0.03	<0.01 0.05	<0.01 0.06	<0.01 <0.01
8	Eden Landing Shallow/East 75k yd^3	0.6 12	<0.01 5	<0.01 0.6	<0.01 7	<0.01 2	<0.01 0.9	<0.01 0.6	<0.01 0.5	<0.01 0.2	<0.01 0.04	<0.01 0.3	<0.01 0.04	<0.01 0.06	<0.01 0.08	<0.01 <0.01
9	Eden Landing Shallow/East Winter 100k yd^3	5 20	<0.01 7	<0.01 2	<0.01 9	<0.01 0.2	<0.01 0.08	<0.01 0.2	<0.01 0.1	<0.01 0.06	<0.01 0.03	<0.01 <0.01	<0.01 0.03	<0.01 0.08	<0.01 0.03	<0.01 <0.01
10	Eden Landing Oakland Sediment 100k yd^3	1 17	<0.01 8	<0.01 1	<0.01 7	<0.01 1	<0.01 0.9	<0.01 0.6	<0.01 0.6	<0.01 0.3	<0.01 0.04	<0.01 0.2	<0.01 0.04	<0.01 0.07	<0.01 0.07	<0.01 <0.01
11	Eden Landing: Expanded East 100k yd^3	0.2 15	<0.01 4	<0.01 0.8	<0.01 7	<0.01 1	<0.01 0.9	<0.01 0.6	<0.01 0.6	<0.01 0.3	<0.01 0.05	<0.01 0.3	<0.01 0.05	<0.01 0.08	<0.01 0.09	<0.01 <0.01
12	Eden Landing: Expanded East 125k yd^3	0.5 19	<0.01 5	<0.01 1	<0.01 7	<0.01 2	<0.01 1	<0.01 0.8	<0.01 0.7	<0.01 0.3	<0.01 0.06	<0.01 0.4	<0.01 0.06	<0.01 0.1	<0.01 0.1	<0.01 <0.01

Figure 5.1-10
Predicted Thickness of Dredged Material at the End of the 2-Month Simulation: Scenario 4 Eden Landing Deep



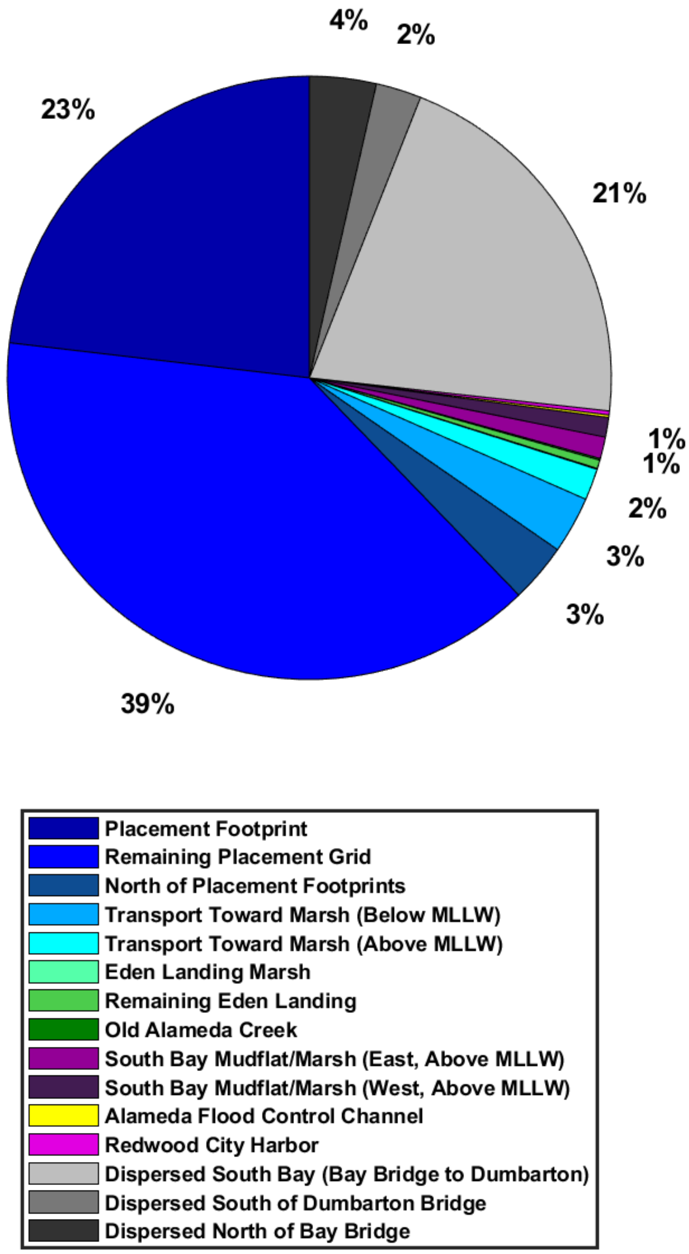
Note:
Note the log scale of the color range.

Figure 5.1-11
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulation: Scenario 4 Eden Landing Deep



Note:
Vertical dashed line denotes the end of the dredged material placements for this scenario.

Figure 5.1-12
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 2-Month Simulation: Scenario 4 Eden Landing Deep



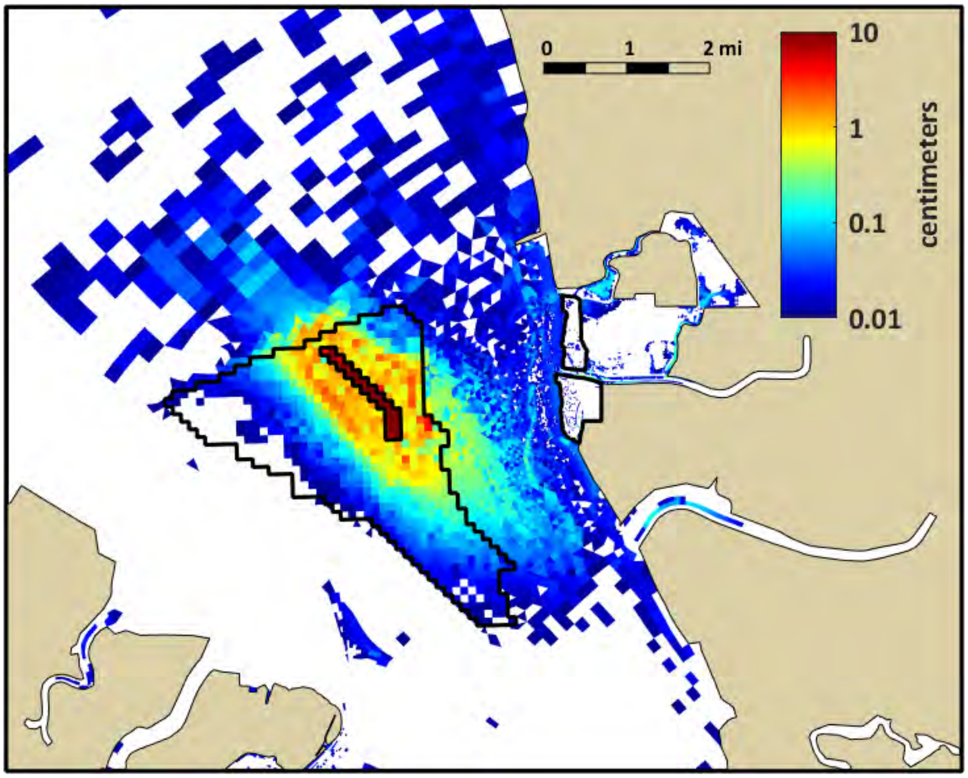
5.1.5 Eden Landing Middle

The Eden Landing Middle scenario included the placement of 100,000 yd^3 of dredged material along the eastern side of the placement grid. The scenario assumed a total of 87 placements over a period of 23 days, as described in Section 3.3.1.5. At the end of the 2-month simulation, more than half of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.1-13), but 41% of the placed dredged material was predicted to remain inside the placement footprint (Figures 5.1-14 and 5.1-15; Tables 5.1-4 and 5.1-5). The model predicted that dredged material that was transported out of the initial placement footprint was deposited around the placement footprint, with a skewing of the deposition toward the southeast of the placement footprint (Figure 5.1-13). Predicted thickness of the dredged material remaining in the placement footprint ranged from 5 to 21 cm, with up to 0.5 cm of dredged material deposition in Eden Landing Marsh (Table 5.1-6). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed and then was predicted to decrease as the dredged material was resuspended (Figure 5.1-14).

At the end of the 2-month simulation period, less than 0.1% of the placed dredged material was predicted to be deposited in Eden Landing Marsh (Figure 3.4-2), and 0.5% was predicted to be deposited in other regions of the Eden Landing complex (Table 5.1-4). Much of the dredged material deposited on Eden Landing Marsh was predicted to be transported onto the marsh during the second half of May and June, during spring tide when the tidal higher high water levels were relatively high. Although only a small portion of the placed dredged material was predicted to reach Eden Landing Marsh within the 2-month simulation period, some of the placed sediment was predicted to be transported toward the marsh. The model predicted that 5% of the placed dredged material was transported towards Eden Landing Marsh but was still below MLLW, while an additional 3% of the placed dredged material was predicted to be transported towards the marsh and was already deposited at elevations above MLLW. An additional 1% was predicted to be transported to other areas above MLLW on the eastern side of the South Bay.

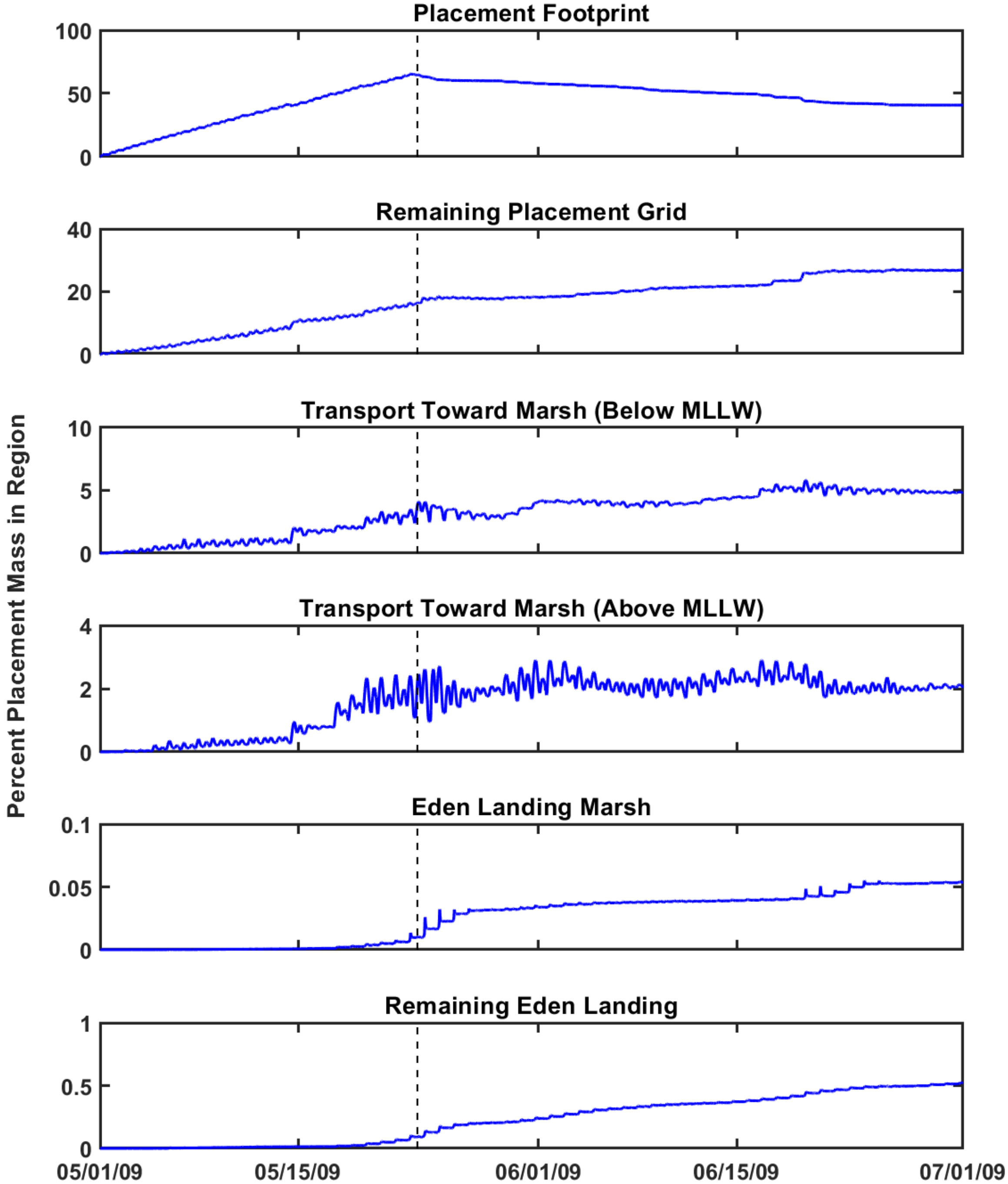
About 0.2% of the dredged material was predicted to be transported into Redwood City Harbor, and 0.1% was transported into the Alameda FCC. About 16% of the placed dredged material was predicted to be dispersed within the South Bay below MLLW, 2% dispersed north of Dumbarton Bridge, and 3% dispersed north of the Bay Bridge.

Figure 5.1-13
Predicted Thickness of Dredged Material at the End of the 2-Month Simulation: Scenario 5 Eden Landing Middle



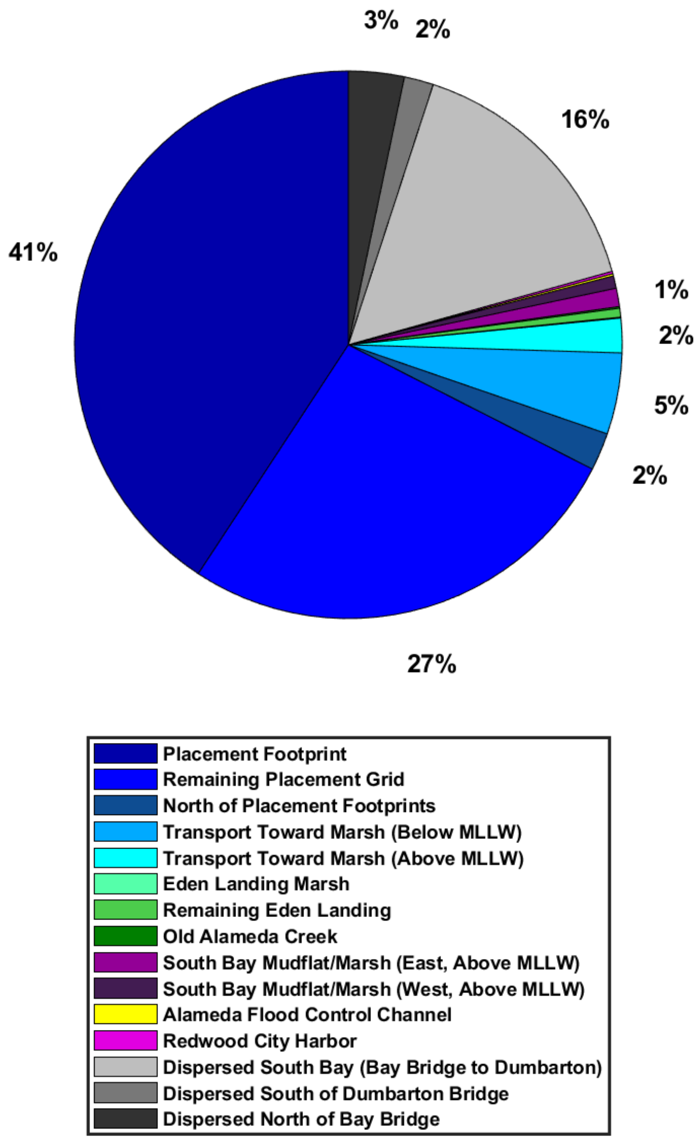
Note:
Note the log scale of the color range.

Figure 5.1-14
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulation: Scenario 5 Eden Landing Middle



Note:
Vertical dashed line denotes the end of the dredged material placements for this scenario.

Figure 5.1-15
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 2-Month Simulation: Scenario 5 Eden Landing Middle



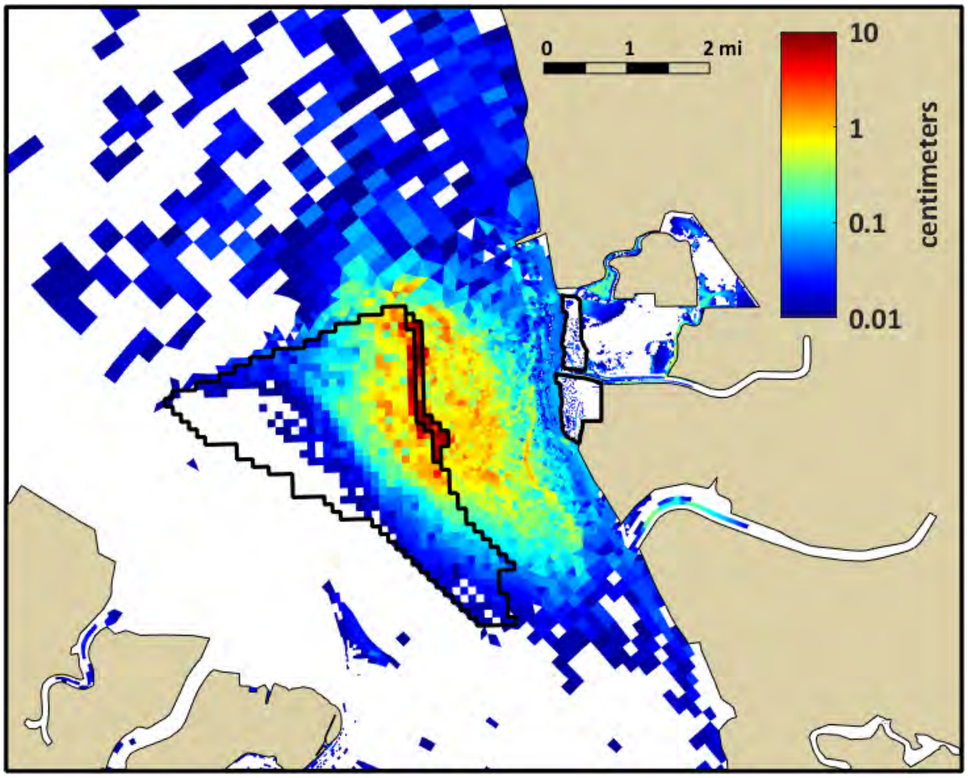
5.1.6 Eden Landing Shallow/East

The Eden Landing Shallow/East scenario included the placement of 100,000 yd^3 of dredged material along the eastern side of the placement grid. The scenario assumed a total of 112 placements over a period of 25 days, as described in Section 3.3.1.6. At the end of the 2-month simulation period, much of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.1-16), but 20% of the placed dredged material was predicted to remain inside the placement footprint (Figures 5.1-17 and 5.1-18; Tables 5.1-4 and 5.1-5). The model predicted that dredged material that was transported out of the initial placement footprint was deposited around the placement footprint, with a skewing of the deposition toward the east and south of the placement footprint (Figure 5.1-16). Predicted thickness of the dredged material remaining in the placement footprint ranged from 0.8 to 17 cm, with up to 1 cm of dredged material deposition in Eden Landing Marsh (Table 5.1-6). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed and then was predicted to decrease as the dredged material was resuspended (Figure 5.1-17).

At the end of the 2-month simulation period, 0.1% of the placed dredged material was predicted to be deposited in Eden Landing Marsh (Figure 3.4-2), and 1% was predicted to be deposited in other regions of the Eden Landing complex (Table 5.1-4). Much of the dredged material deposited on Eden Landing Marsh was predicted to be transported onto the marsh during the second half of May and June, during spring tide when the tidal higher high water levels were relatively high. Although only a small portion of the placed dredged material was predicted to reach Eden Landing Marsh within the 2-month simulation period, a relatively large amount of the placed sediment was predicted to be transported toward the marsh. The model predicted that 22% of the placed dredged material was transported towards Eden Landing Marsh but was still below MLLW, while an additional 6% of the placed dredged material was predicted to be transported towards the marsh and was already deposited at elevations above MLLW. An additional 2% was predicted to be transported to other areas above MLLW on the eastern side of the South Bay.

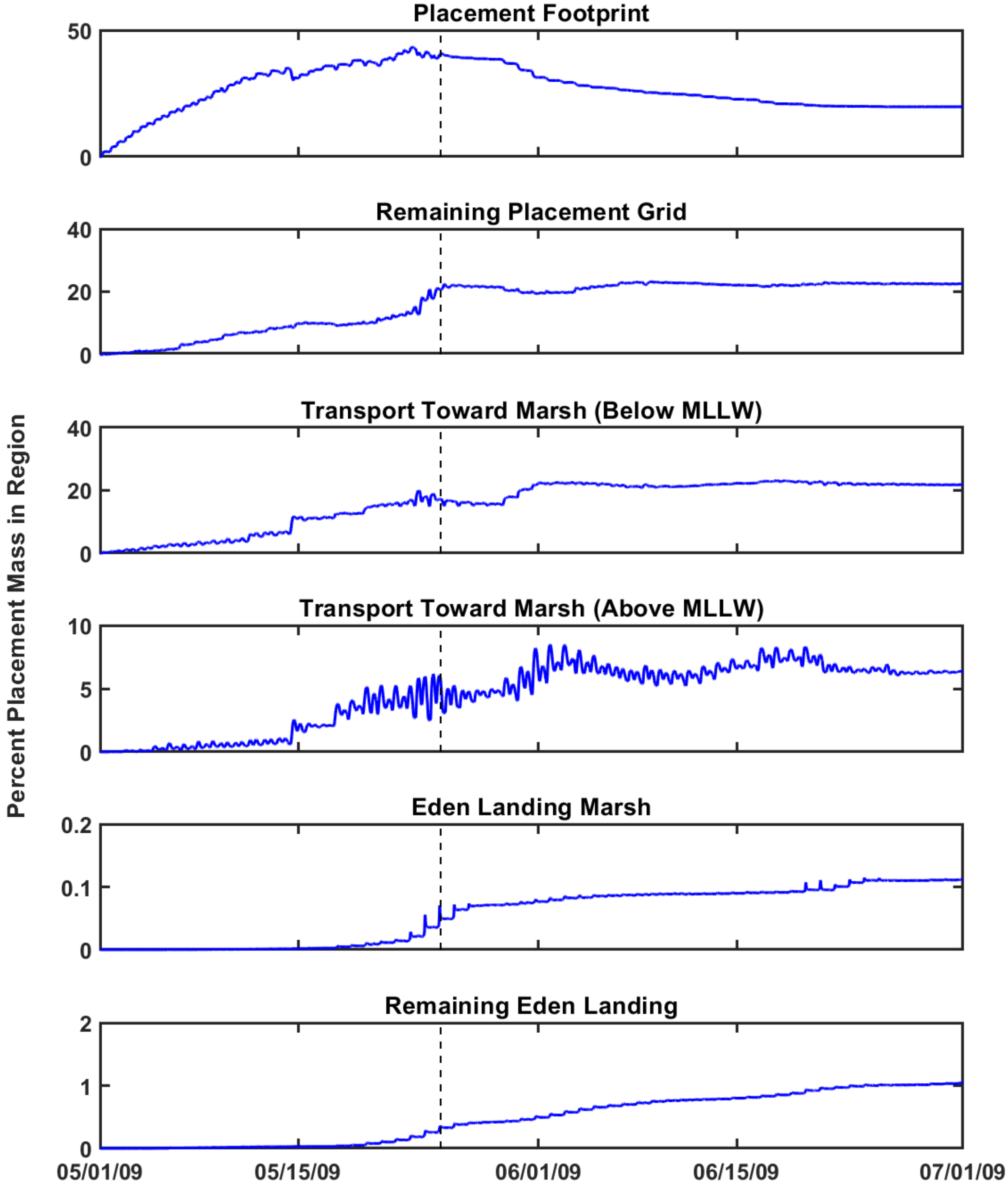
About 0.2% of the dredged material was predicted to be transported into Redwood City Harbor, and 0.3% was transported into the Alameda FCC. About 18% of the placed dredged material was predicted to be dispersed within the South Bay below MLLW, 2% dispersed north of Dumbarton Bridge, and 4% dispersed north of the Bay Bridge.

Figure 5.1-16
Predicted Thickness of Dredged Material at the End of the 2-Month Simulation: Scenario 6 Eden Landing Shallow/East



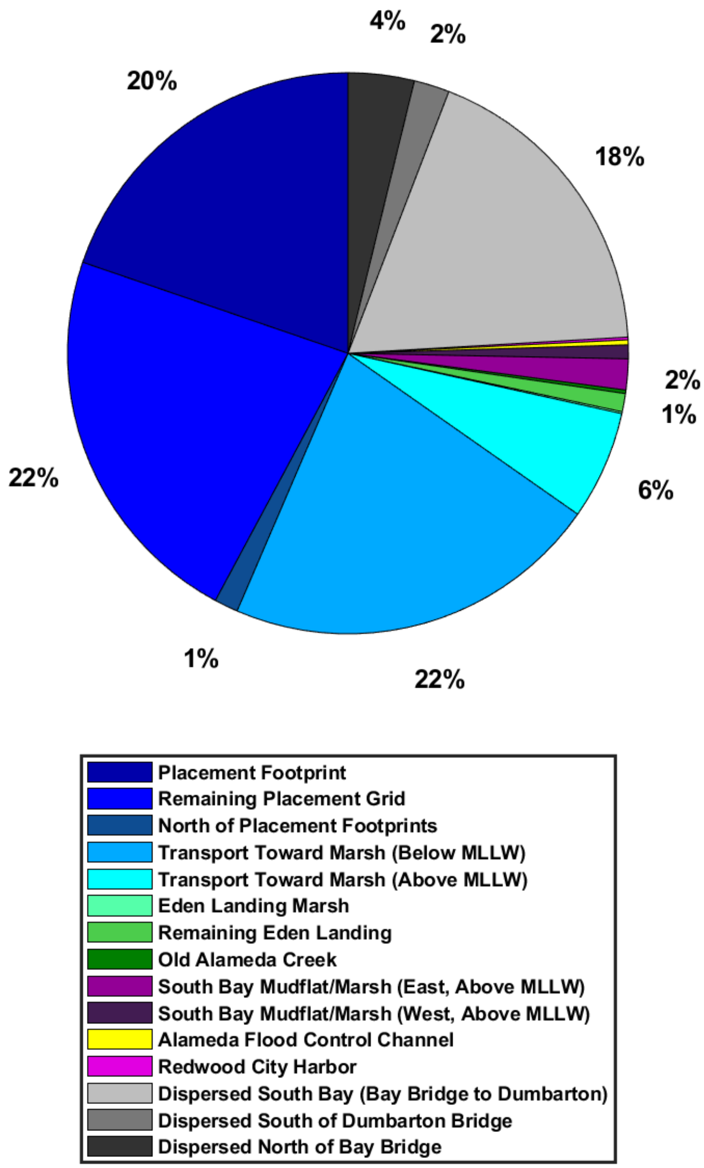
Note:
Note the log scale of the color range.

Figure 5.1-17
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulation: Scenario 6 Eden Landing Shallow/East



Note:
Vertical dashed line denotes the end of the dredged material placements for this scenario.

Figure 5.1-18
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 2-Month Simulation: Scenario 6 Eden Landing Shallow/East



5.2 Comparison of Emeryville and Eden Landing

The depositional pattern of the placed dredged material at the end of the 2-month simulation periods was similar for the Emeryville Deep, Middle, and Shallow/East scenarios (Figure 5.2-1). Deposition was highest in and around the placement footprint and skewed toward the west and south. The Deep and Middle scenarios resulted in little deposition of dredged material east of the placement footprints toward Emeryville Crescent Marsh. The Shallow/East scenario resulted in the most predicted deposition toward Emeryville Crescent Marsh. Residual currents directed south from the deep placement footprint may have resulted in some southward sediment transport away from the target marsh and toward Oakland Harbor from the deep placement footprint (Figure 4.2-2). Residual currents directed north from the shallow/east placement footprint may have resulted in some northward sediment transport away from the target marsh from the shallow/east placement footprint. Generally southward residual currents over the middle placement location may have resulted in some sediment transport directed toward Oakland Harbor or toward the far western side of Emeryville Crescent Marsh from the middle placement footprint.

The depositional pattern of the placed dredged material at the end of the 2-month simulation periods was also similar for the Eden Landing Deep, Middle, and Shallow/East scenarios (Figure 5.2-2). Deposition was highest in and around the placement footprint and skewed toward the southeast. The Deep and Middle scenarios resulted in little deposition of dredged material east of the placement footprints toward Eden Landing Marsh. The Shallow/East scenario had much more predicted eastward deposition toward Eden Landing Marsh than the Deep and Middle scenarios. Northward directed currents over the Eden Landing placement footprints and between the placement grid and Eden Landing Marsh may have resulted in some northward sediment transport from each of the placement footprints (Figure 4.2-6).

At both the Emeryville and Eden Landing placement locations, the highest percentage of the dredged material was transported toward, and supplied to, the respective marshes in the Shallow/East scenarios (Figures 5.2-3 through 5.2-7; Tables 5.1-1 and 5.1-4). The Deep scenarios resulted in the most dredged material being transported back into the federal navigation channels. This was most obvious in the Emeryville Deep scenario, where 3% of the dredged material was predicted to be transported back into Oakland Harbor in the 2-month simulation period (Figure 5.2-7). The Deep scenarios also resulted in the largest percentage of dredged material being dispersed away from any of the other analysis regions (Tables 5.1-1 and 5.1-4).

A lower percentage of the dredged material was predicted to remain in the placement footprints in the Eden Landing scenarios than the scenarios with dredged material placements at Emeryville (Figures 5.2-7 and 5.2-8). This indicates more predicted dispersal from the Eden Landing placement footprints than the Emeryville footprints. For the Emeryville Shallow/East scenario, 75% of the dredged material was predicted to remain in the placement footprint at the end of the simulation, compared to 20% remaining in the placement footprint for the Eden Landing Shallow/East scenario. The Eden Landing scenarios also had more predicted deposition in the target marsh and on other mudflats and marshes—that is, above MLLW outside Eden Landing Marsh or Emeryville Crescent Marsh (Tables 5.1-1 and 5.1-4). The Emeryville scenarios had relatively little predicted deposition on other mudflats and marshes. For the Emeryville Shallow/East scenario, less than 0.1% of the dredged material was predicted to deposit in Emeryville Crescent Marsh and 0.1% was predicted to deposit above MLLW bayward of the marsh at the end of the simulation. For the Eden Landing Shallow/East scenario, 0.1% of the dredged material was predicted to deposit in the Whale's Tail portion of Eden Landing Marsh and 6% was predicted to deposit above MLLW bayward of the marsh at the end of the simulation. The Eden Landing placement location was also predicted to supply dredged material to the other portion of the Eden Landing complex, not simply the Whale's Tail portion of Eden Landing. For the Eden Landing Shallow/East scenario, 1% of the dredged material was predicted to deposit in the remaining portion of Eden Landing.

These findings suggest the Eden Landing placement location may be more suitable than the Emeryville placement location for the natural transport of dredged material away from the initial placement footprint and toward the marsh and to other mudflats/marshes. The findings also demonstrate that placements toward the shallower (eastern) side of the placement grids are more effective at getting transport toward the marshes and mudflats than placements in deeper water further toward the west of the placement grids. Because of these findings, the six additional scenarios described in Sections 5.3 and 5.4 focus on how modifications to the Eden Landing Shallow/East scenario would affect the predicted dispersal of dredged material.

Figure 5.2-1
Predicted Thickness of Dredged Material at the End of the 2-Month Simulations for the Initial Three Emeryville Scenarios

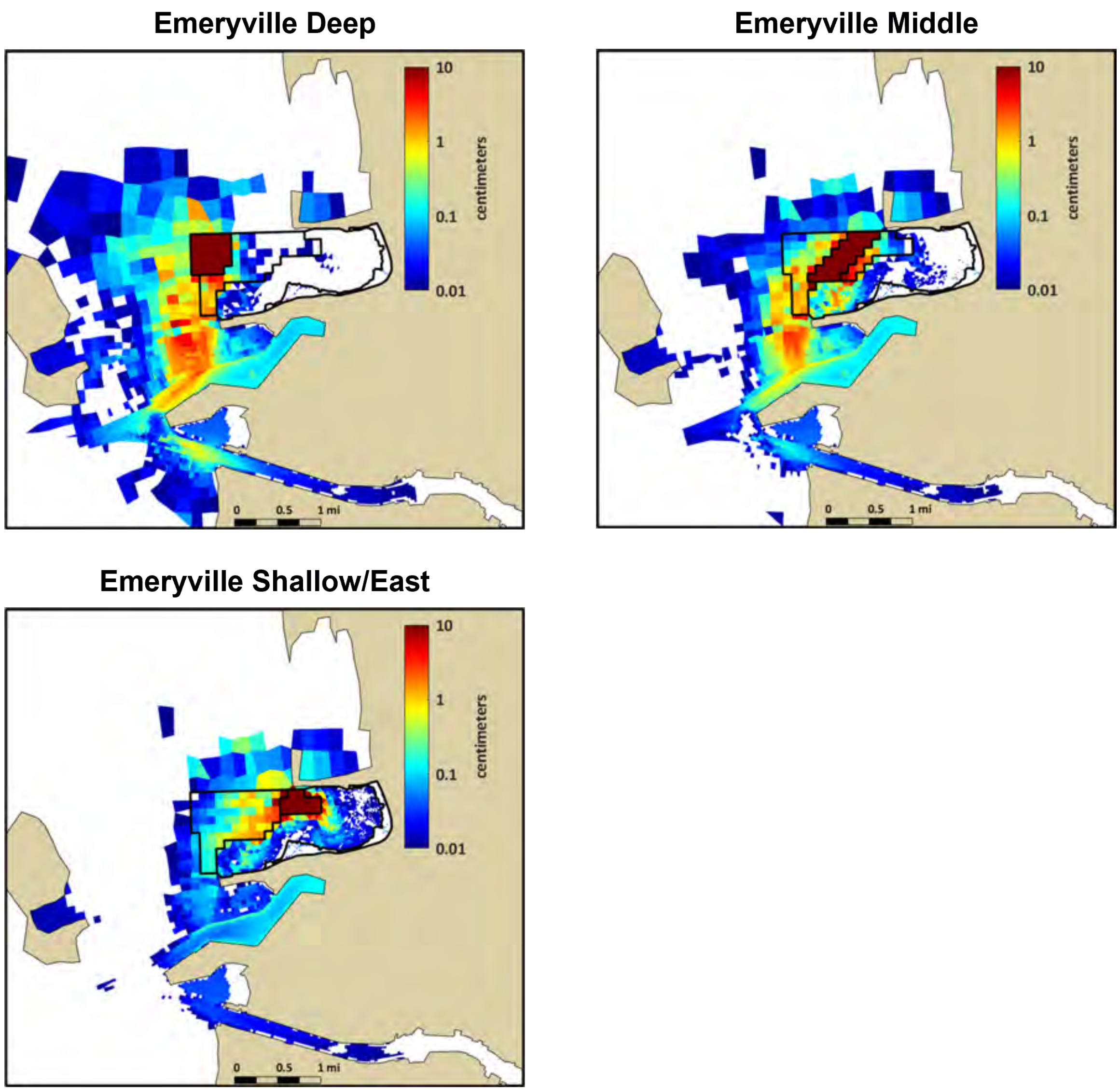


Figure 5.2-2
Predicted Thickness of Dredged Material at the End of the 2-Month Simulations for the Initial Three Eden Landing Scenarios

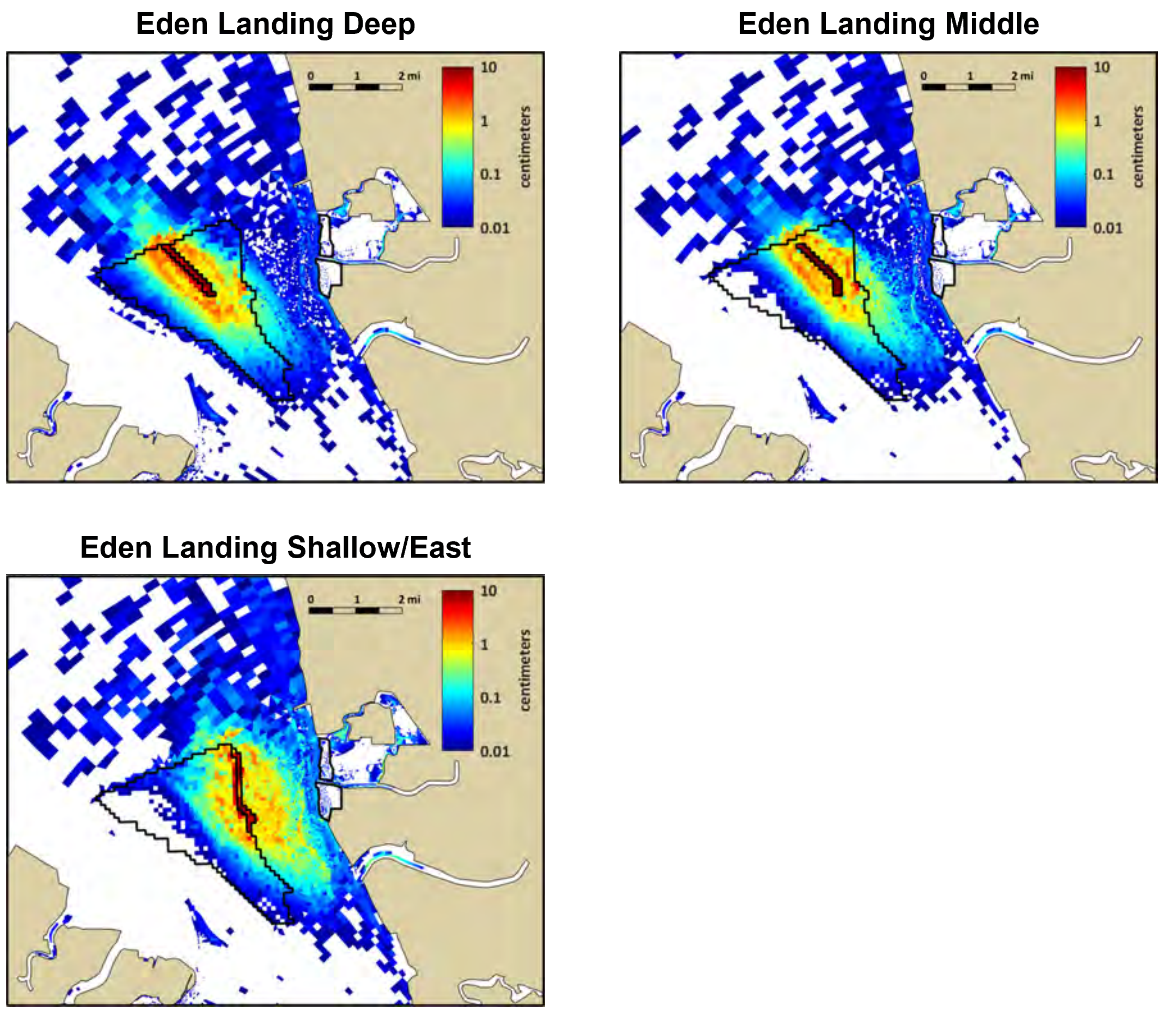
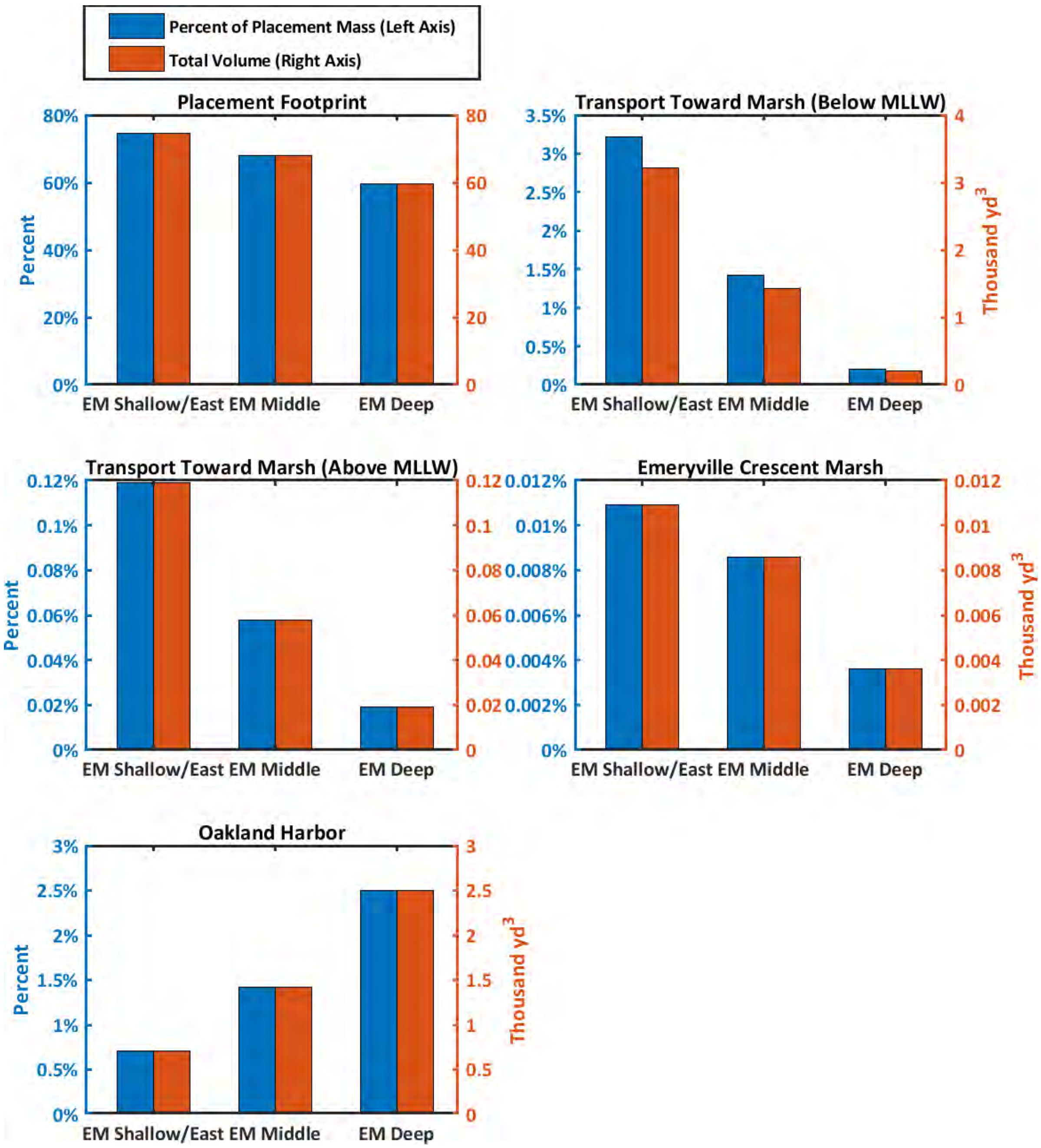
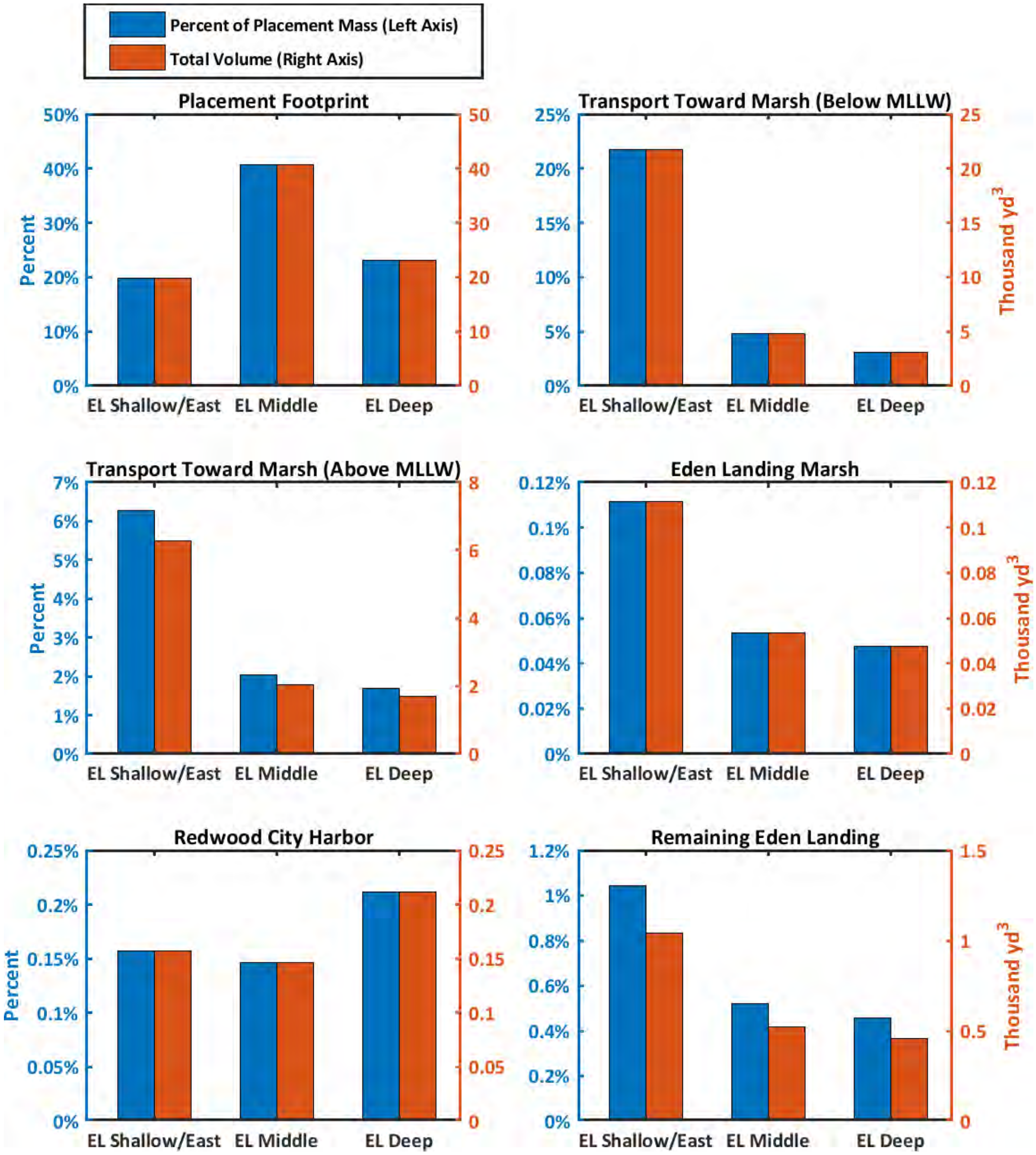


Figure 5.2-3
Predicted Percentage of Dredged Sediment Mass and Dredged Material Volume in Each Region at the End of the 2-Month Simulations for the Initial Three Emeryville Scenarios



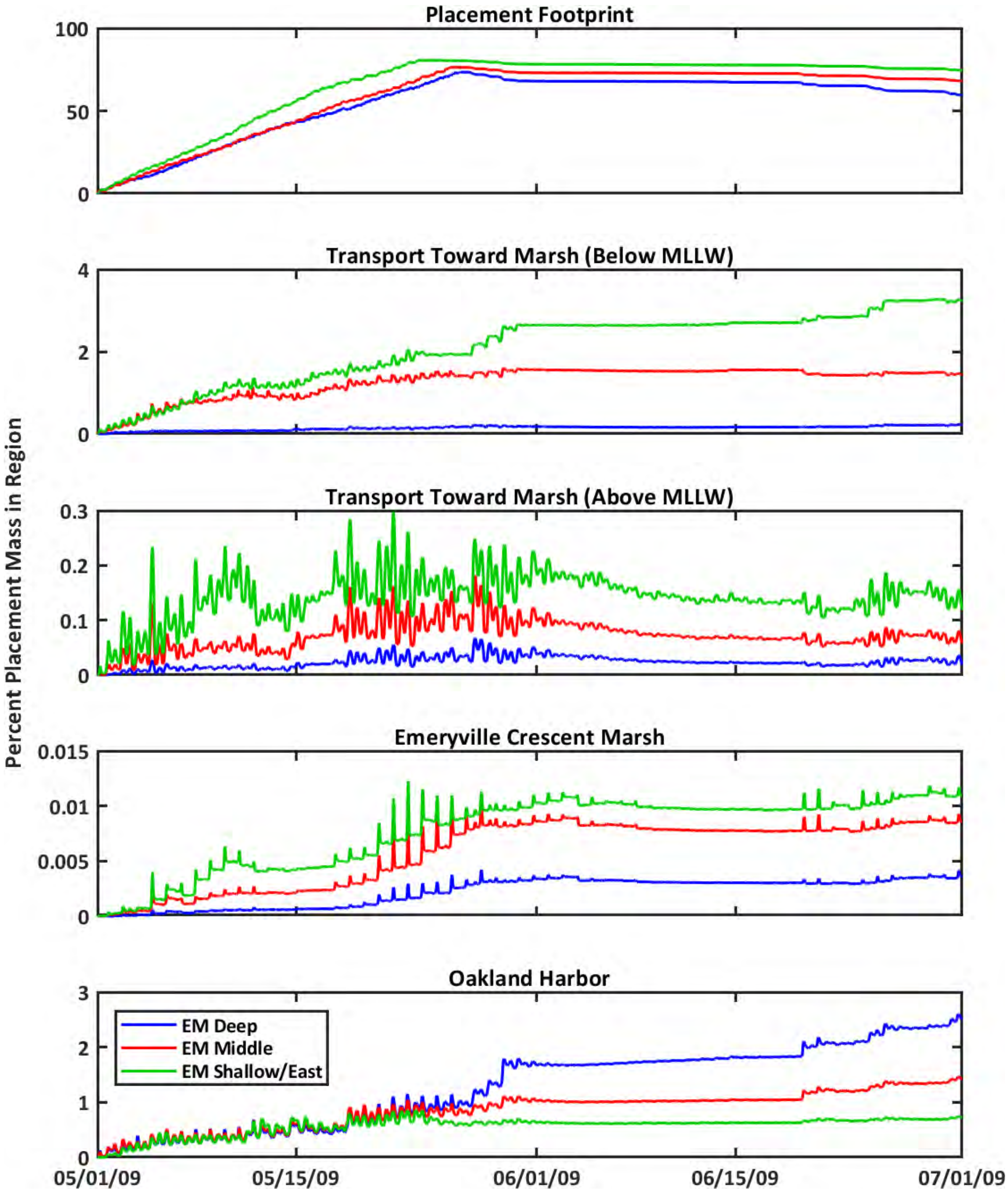
Note:
EM: Emeryville

Figure 5.2-4
Predicted Percentage of Dredged Sediment Mass and Dredged Material Volume in Each Region at the End of the 2-Month Simulations for the Initial Three Eden Landing Scenarios



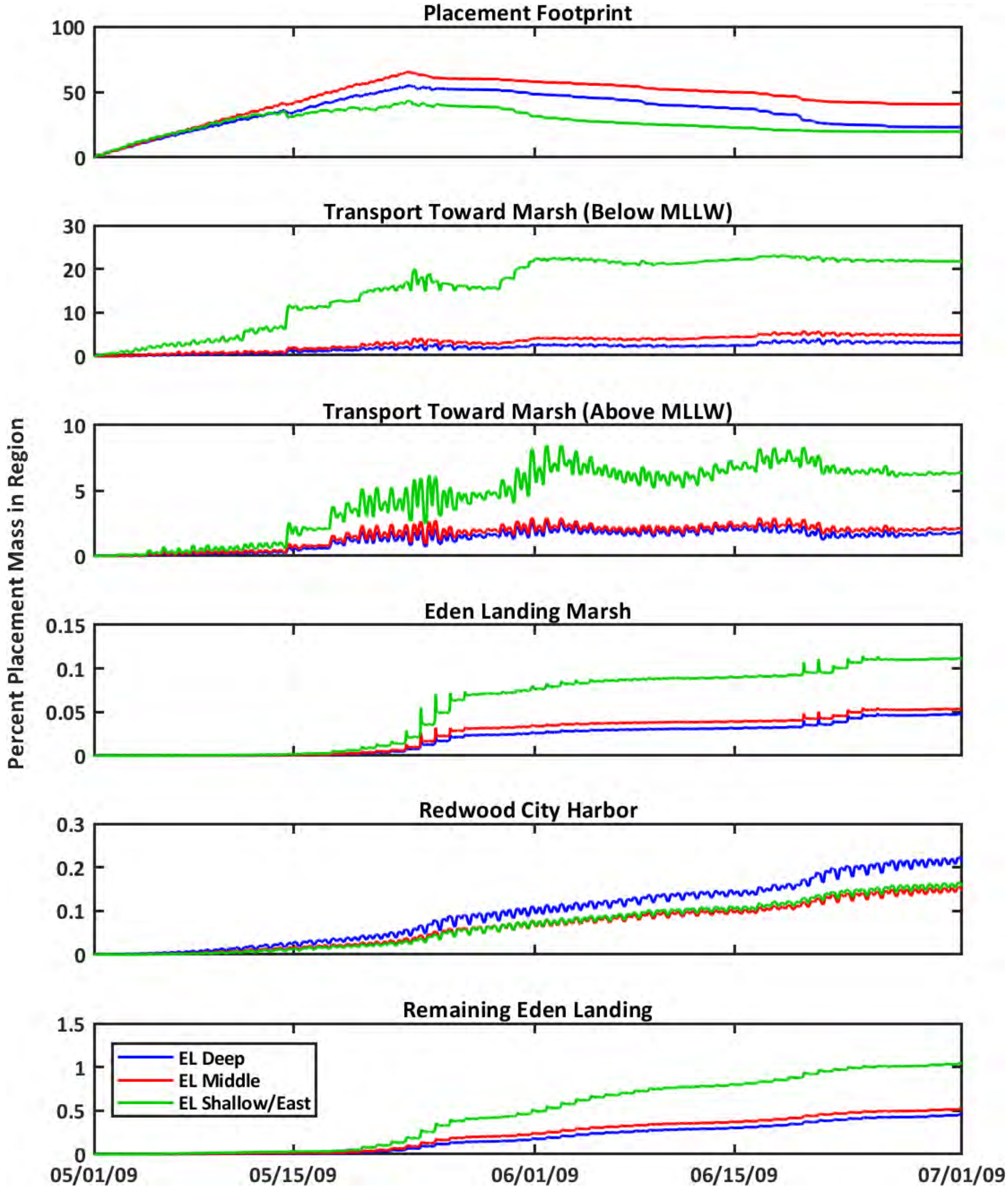
Note:
EL: Eden Landing

Figure 5.2-5
Predicted Percentage of Dredged Sediment Mass in Each Region During of the 2-Month Simulations for the Initial Three Emeryville Scenarios



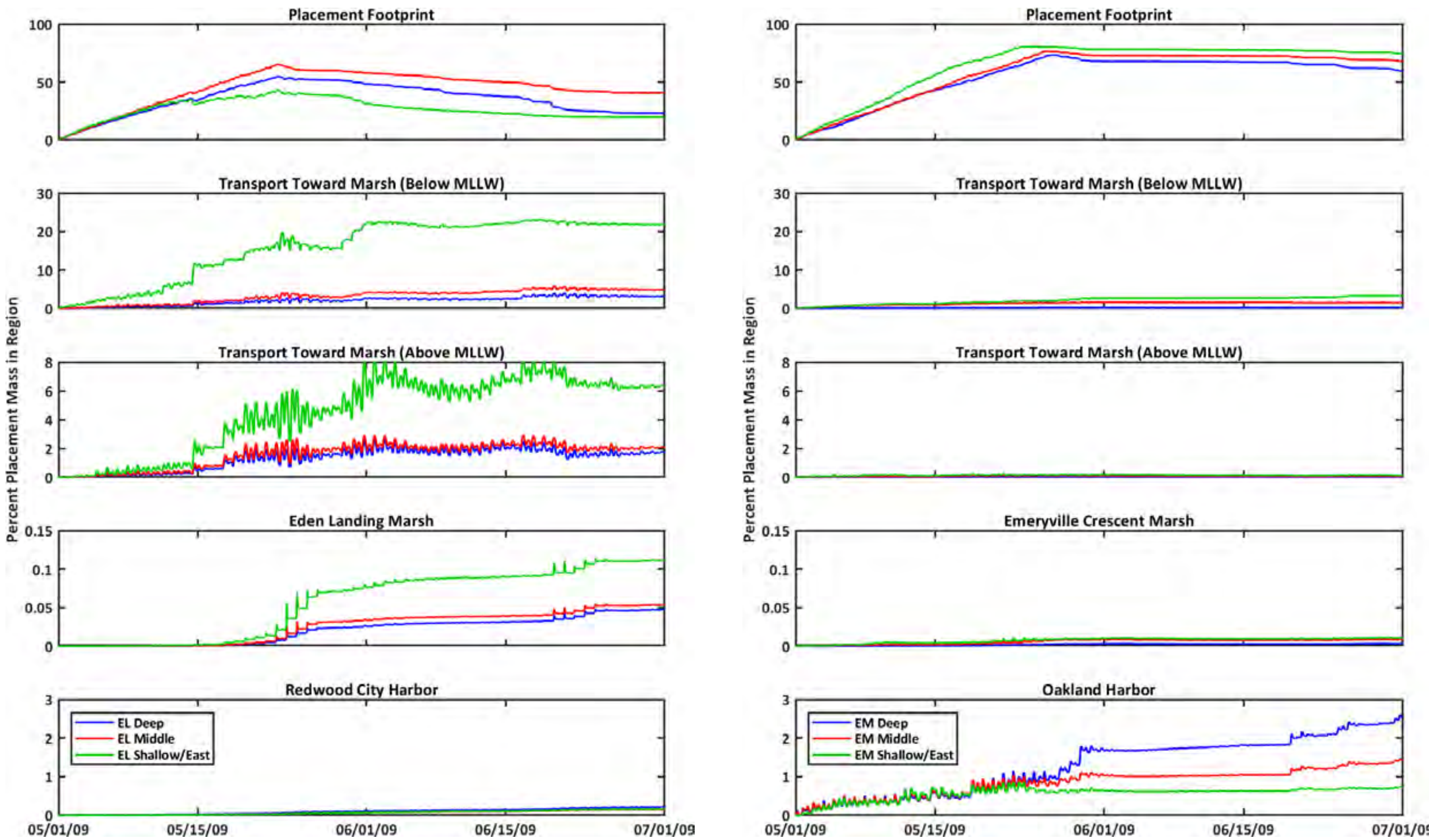
Note:
EM: Emeryville

Figure 5.2-6
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulations for the Initial Three Eden Landing Scenarios



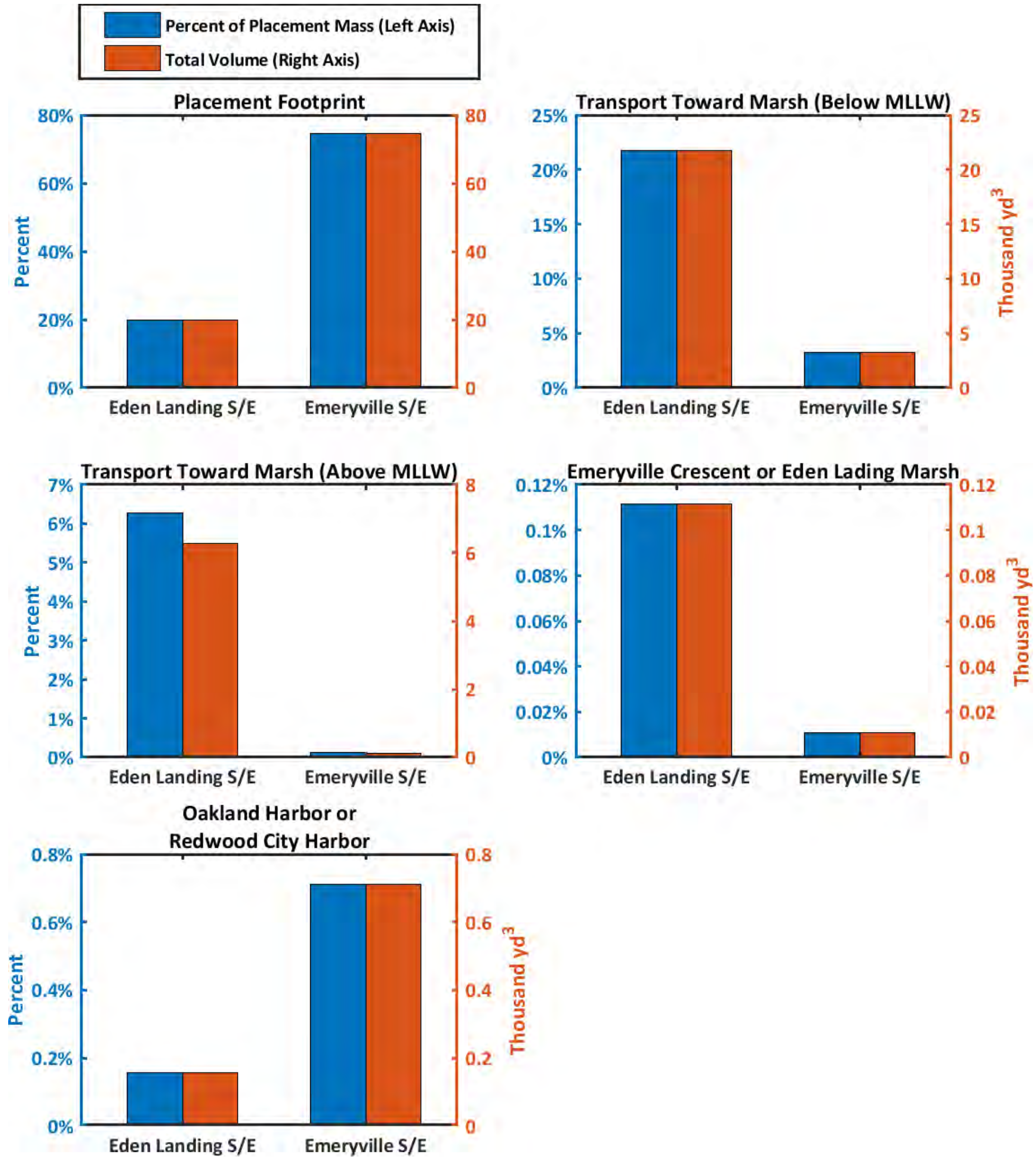
Note:
EL: Eden Landing

Figure 5.2-7
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulations for the Initial Three Emeryville Scenarios (Left) and Eden Landing Scenarios (Right)



Notes:
EM: Emeryville
EL: Eden Landing

Figure 5.2-8
Predicted Percentage of Dredged Sediment Mass and Dredged Material Volume in Each Region at the End of the 2-Month Simulations for the Eden Landing and Emeryville Shallow/East Scenarios



Note:
S/E: Shallow/East scenario

5.3 Results of Six Additional Eden Landing Scenarios

The second set of six scenarios focused on Eden Landing were conducted to refine the placement strategy and placement volume at Eden Landing. These scenarios evaluated the amount of placed dredged material (50,000 yd^3 and 75,000 yd^3), conducting the placements in the winter, using Oakland Harbor sediment at the Eden Landing placement location, using a larger placement footprint, and using a larger placement footprint combined with a larger placement volume (125,000 yd^3).

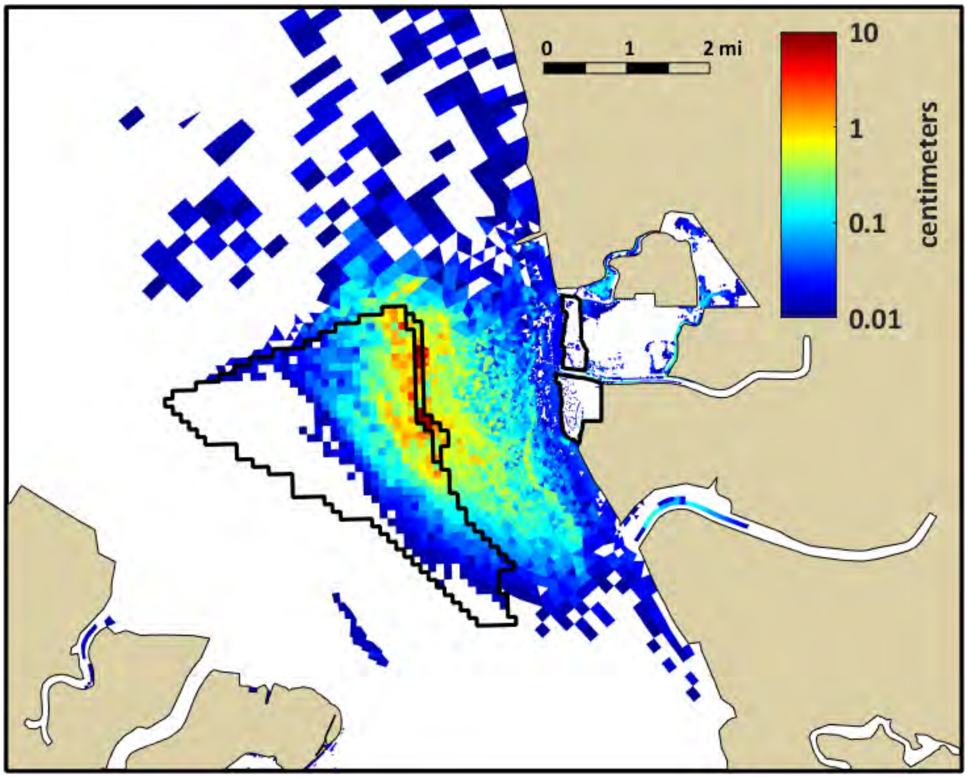
5.3.1 Eden Landing Shallow/East 50,000 yd^3 of Dredged Material

The Eden Landing Shallow/East 50,000 yd^3 of Dredged Material scenario included the placement of 50,000 yd^3 of dredged material along the eastern side of the placement grid. The scenario assumed a total of 56 placements over a period of 13 days, as described in Section 3.3.2.1. At the end of the 2-month simulation period, much of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.3-1), but 18% of the placed dredged material was predicted to remain inside the placement footprint (Figures 5.3-2 and 5.3-3; Tables 5.1-4 and 5.1-5). The model predicted that dredged material that was transported out of the initial placement footprint was deposited around the placement footprint, with a skewing of the deposition toward the east and south of the placement footprint (Figure 5.3-1). Predicted thickness of the dredged material remaining in the placement footprint ranged from 0.3 to 12 cm, with up to 0.6 cm of dredged material deposition in Eden Landing Marsh (Table 5.1-6). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed and then was predicted to decrease as the dredged material was resuspended (Figure 5.3-2).

At the end of the 2-month simulation period, 0.1% of the placed dredged material was predicted to be deposited in Eden Landing Marsh (Figure 3.4-2), and 1% was predicted to be deposited in other regions of the Eden Landing complex (Table 5.1-4). Much of the dredged material deposited on Eden Landing Marsh was predicted to be transported onto the marsh during the second half of May and June, during spring tide when the tidal higher high water levels were relatively high. Although only a small portion of the placed dredged material was predicted to reach Eden Landing Marsh within the 2-month simulation period, a relatively large amount of the placed sediment was predicted to be transported toward the marsh. The model predicted that 23% of the placed dredged material was transported towards Eden Landing Marsh but was still below MLLW, while an additional 6% of the placed dredged material was predicted to be transported towards the marsh and was already deposited at elevations above MLLW. An additional 2% was predicted to be transported to other areas above MLLW on the eastern side of the South Bay.

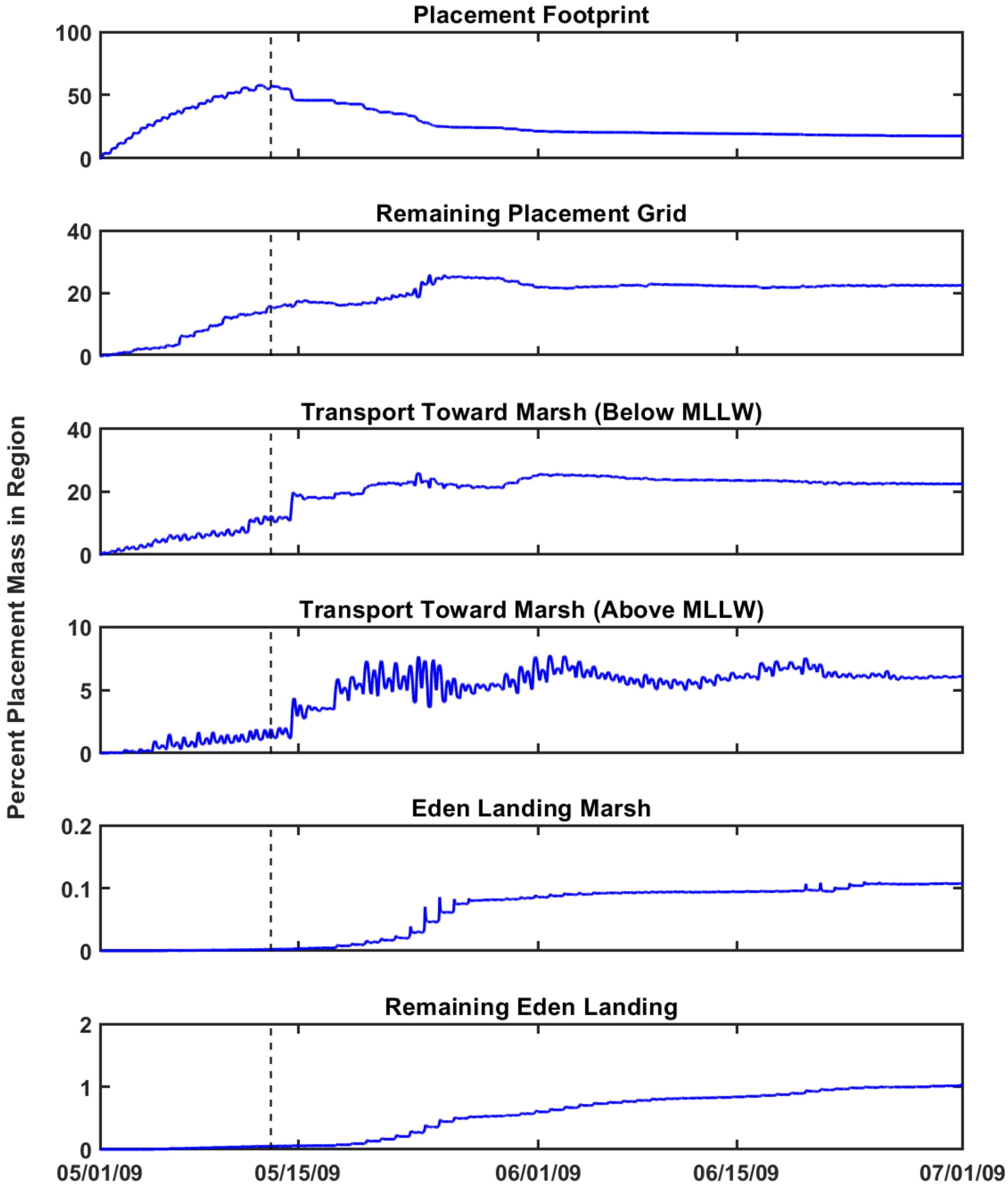
About 0.2% of the dredged material was predicted to be transported into Redwood City Harbor, and 0.3% was transported into the Alameda FCC. About 18% of the placed dredged material was predicted to be dispersed within the South Bay below MLLW, 2% dispersed north of Dumbarton Bridge, and 5% dispersed north of the Bay Bridge.

Figure 5.3-1
Predicted Thickness of Dredged Material at the End of the 2-Month Simulation: Scenario 7 Eden Landing Shallow/East 50,000 yd^3 of Dredged Material



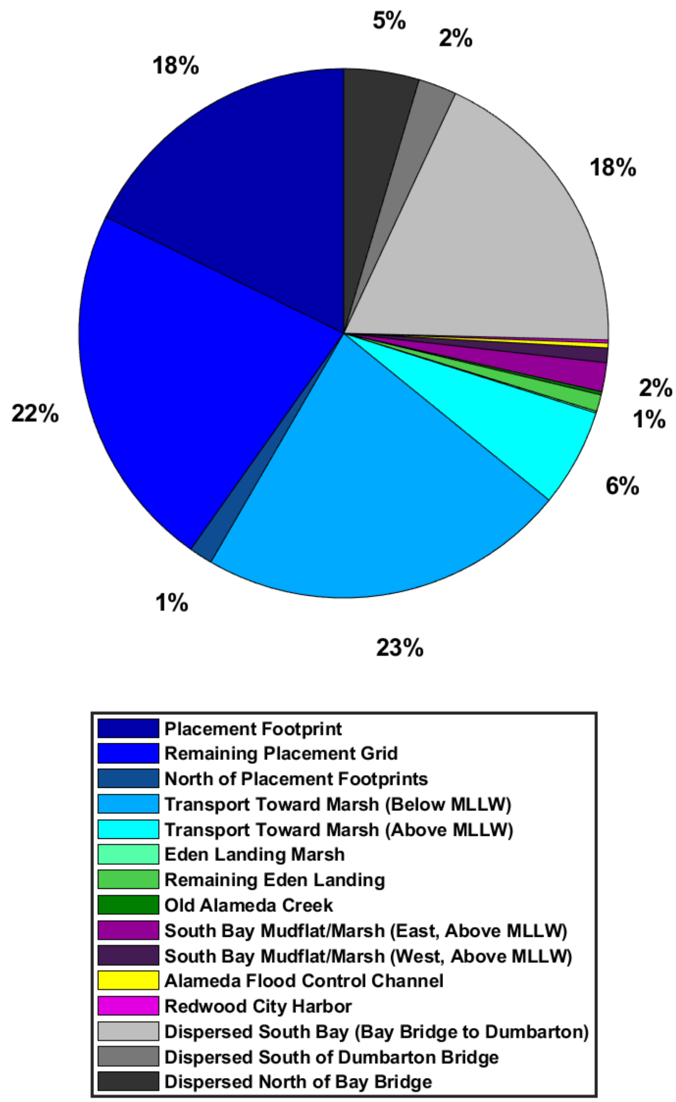
Note:
Note the log scale of the color range.

Figure 5.3-2
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulation: Scenario 7 Eden Landing Shallow/East 50,000 yd^3 of Dredged Material



Note: Vertical dashed line denotes the end of the dredged material placements for this scenario.

Figure 5.3-3
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 2-Month Simulation: Scenario 7 Eden Landing Shallow/East 50,000 yd^3 of Dredged Material



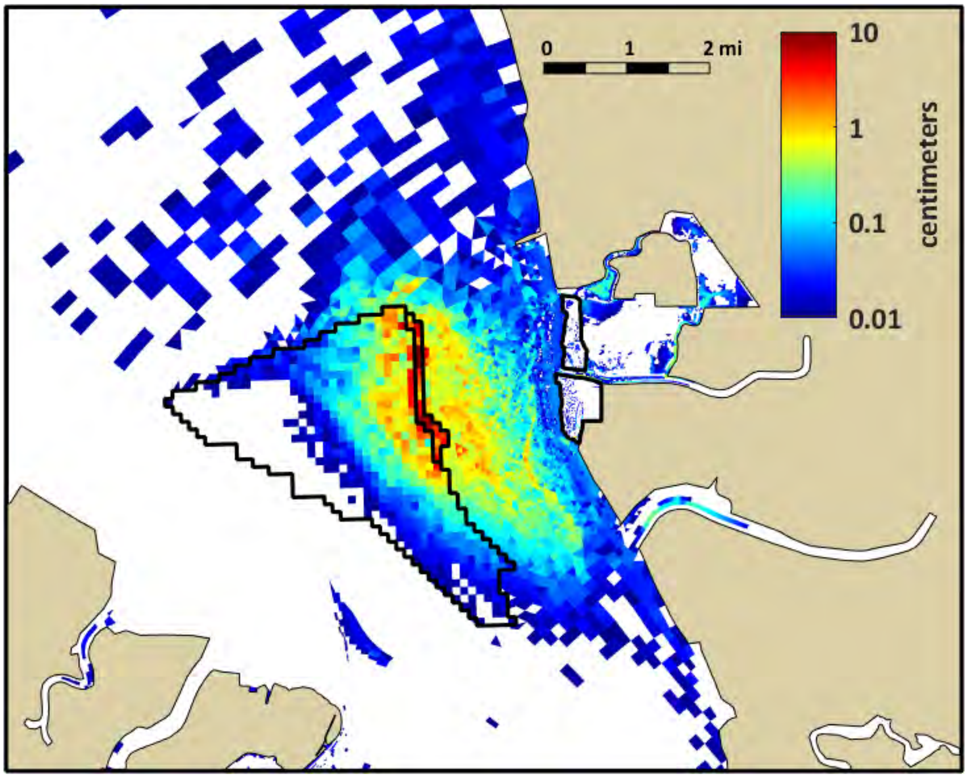
5.3.2 Eden Landing Shallow/East 75,000 yd^3 of Dredged Material

The Eden Landing Shallow/East 75,000 yd^3 of Dredged Material scenario included the placement of 75,000 yd^3 of dredged material along the eastern side of the placement grid. The scenario assumed a total of 84 placements over a period of 21 days, as described in Section 3.3.2.2. At the end of the 2-month simulation period, much of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.3-4), but 17% of the placed dredged material was predicted to remain inside the placement footprint (Figures 5.3-5 and 5.3-6; Tables 5.1-4 and 5.1-5). The model predicted that dredged material that was transported out of the initial placement footprint was deposited around the placement footprint, with a skewing of the deposition toward the east and south of the placement footprint (Figure 5.3-4). Predicted thickness of the dredged material remaining in the placement footprint ranged from 0.6 to 12 cm, with up to 0.9 cm of dredged material deposition in Eden Landing Marsh (Table 5.1-6). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed and then was predicted to decrease as the dredged material was resuspended (Figure 5.3-5).

At the end of the 2-month simulation period, 0.1% of the placed dredged material was predicted to be deposited in Eden Landing Marsh (Figure 3.4-2), and 1% was predicted to be deposited in other regions of the Eden Landing complex (Table 5.1-4). Much of the dredged material deposited on Eden Landing Marsh was predicted to be transported onto the marsh during the second half of May and June, during spring tide when the tidal higher high water levels were relatively high. Although only a small portion of the placed dredged material was predicted to reach Eden Landing Marsh within the 2-month simulation period, a relatively large amount of the placed sediment was predicted to be transported toward the marsh. The model predicted that 22% of the placed dredged material was transported towards Eden Landing Marsh but was still below MLLW, while an additional 7% of the placed dredged material was predicted to be transported towards the marsh and was already deposited at elevations above MLLW. An additional 2% was predicted to be transported to other areas above MLLW on the eastern side of the South Bay.

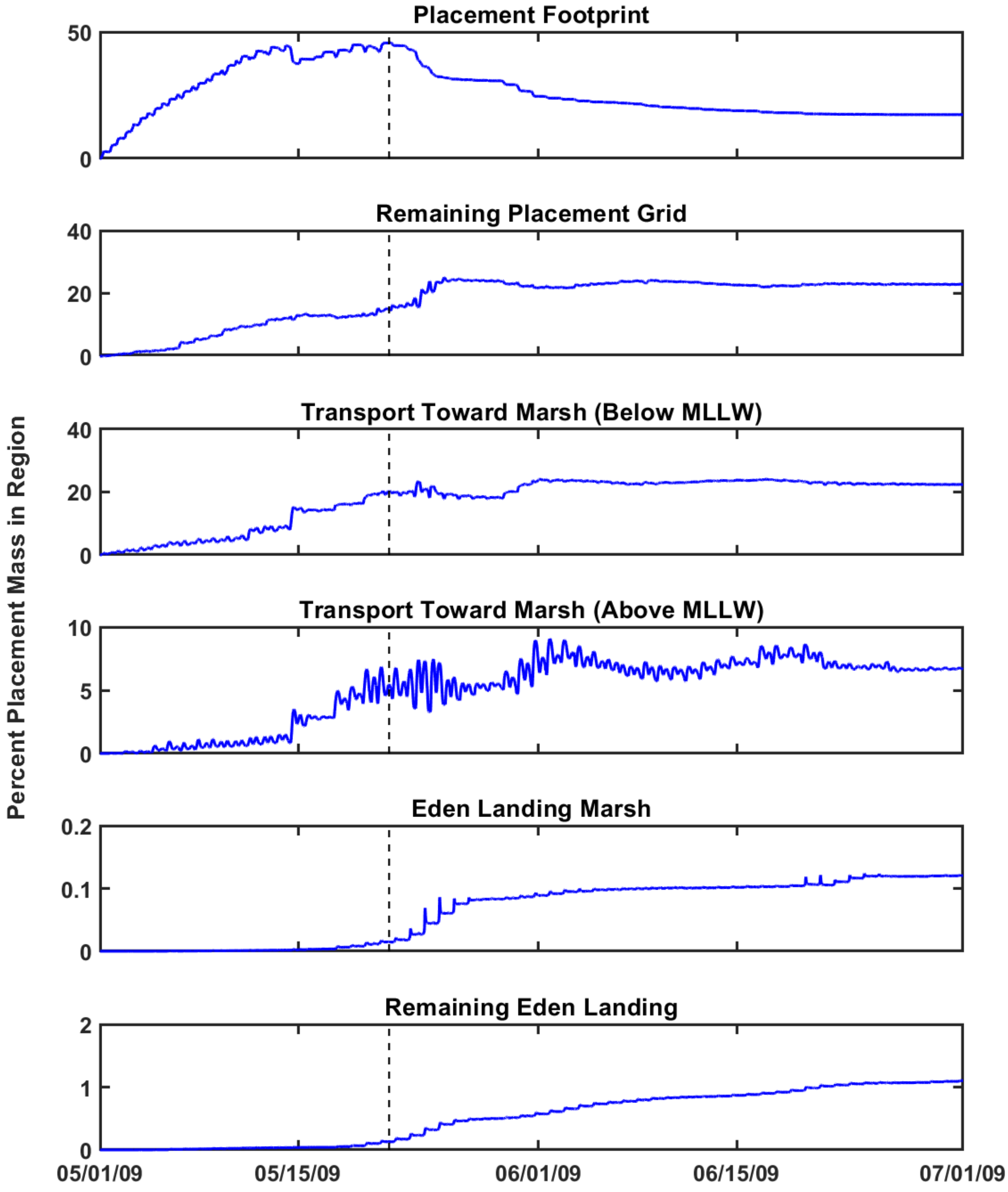
About 0.2% of the dredged material was predicted to be transported into Redwood City Harbor, and 0.3% was transported into the Alameda FCC. About 18% of the placed dredged material was predicted to be dispersed within the South Bay below MLLW, 2% dispersed north of Dumbarton Bridge, and 4% dispersed north of the Bay Bridge.

Figure 5.3-4
Predicted Thickness of Dredged Material at the End of the 2-Month Simulation: Scenario 8 Eden Landing Shallow/East 75,000 yd^3 of Dredged Material



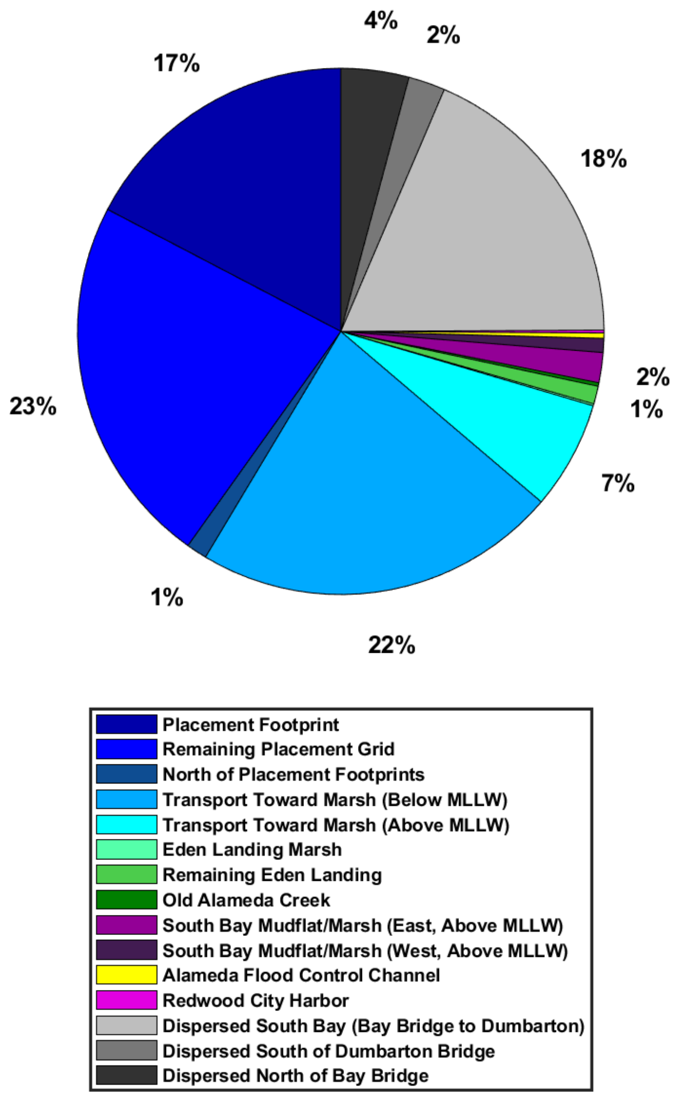
Note:
Note the log scale of the color range.

Figure 5.3-5
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulation: Scenario 8 Eden Landing Shallow/East 75,000 yd^3 of Dredged Material



Note:
Vertical dashed line denotes the end of the dredged material placements for this scenario.

Figure 5.3-6
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 2-Month Simulation: Scenario 8 Eden Landing Shallow/East 75,000 yd^3 of Dredged Material



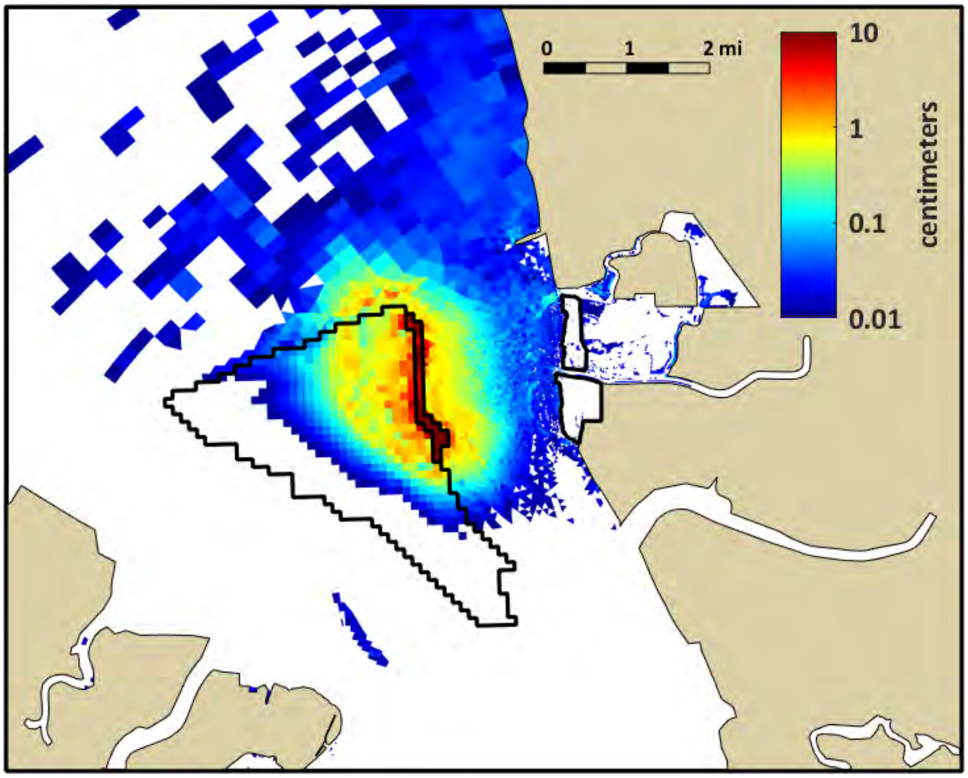
5.3.3 Eden Landing Shallow/East Winter

The Eden Landing Shallow/East Winter scenario included the placement of 100,000 yd^3 of dredged material along the eastern side of the placement grid and spanned 3 months, compared to the 2-month duration of the other 11 scenarios. The scenario assumed a total of 112 placements over a period of 18 days, as described in Section 3.3.2.3. At the end of the 3-month simulation period, much of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.3-7), but 32% of the placed dredged material was predicted to remain inside the placement footprint (Figures 5.3-8 and 5.3-9; Tables 5.1-4 and 5.1-5). The model predicted that dredged material that was transported out of the initial placement footprint was deposited roughly centered around the placement footprint, with the deposition skewed toward the north of the placement grid and north along the shoreline (Figure 5.3-7). Skewing of the deposition toward the north is consistent with the relatively strong northward directed predicted depth-averaged residual currents toward the eastern side of the placement grid during the winter simulation period (Figure 4.2-7). Predicted thickness of the dredged material remaining in the placement footprint ranged from 5 to 20 cm, with up to 0.08 cm of dredged material deposition in Eden Landing Marsh (Table 5.1-6). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed and then was predicted to decrease as the dredged material was resuspended (Figure 5.3-8).

At the end of the 3-month simulation period, less than 0.1% of the placed dredged material was predicted to be deposited in Eden Landing Marsh (Figure 3.4-2), and 0.3% was predicted to be deposited in other regions of the Eden Landing complex (Table 5.1-4). Much of the dredged material deposited on Eden Landing Marsh was predicted to be transported onto the marsh during discrete short-duration events. Although only a very small portion of the placed dredged material was predicted to reach Eden Landing Marsh within the 3-month simulation period, some additional placed sediment was predicted to be transported toward the marsh. The model predicted that 15% of the placed dredged material was transported towards Eden Landing Marsh but was still below MLLW, while an additional 3% of the placed dredged material was predicted to be transported towards the marsh and was already deposited at elevations above MLLW. An additional 1% was predicted to be transported to other areas above MLLW on the eastern side of the South Bay.

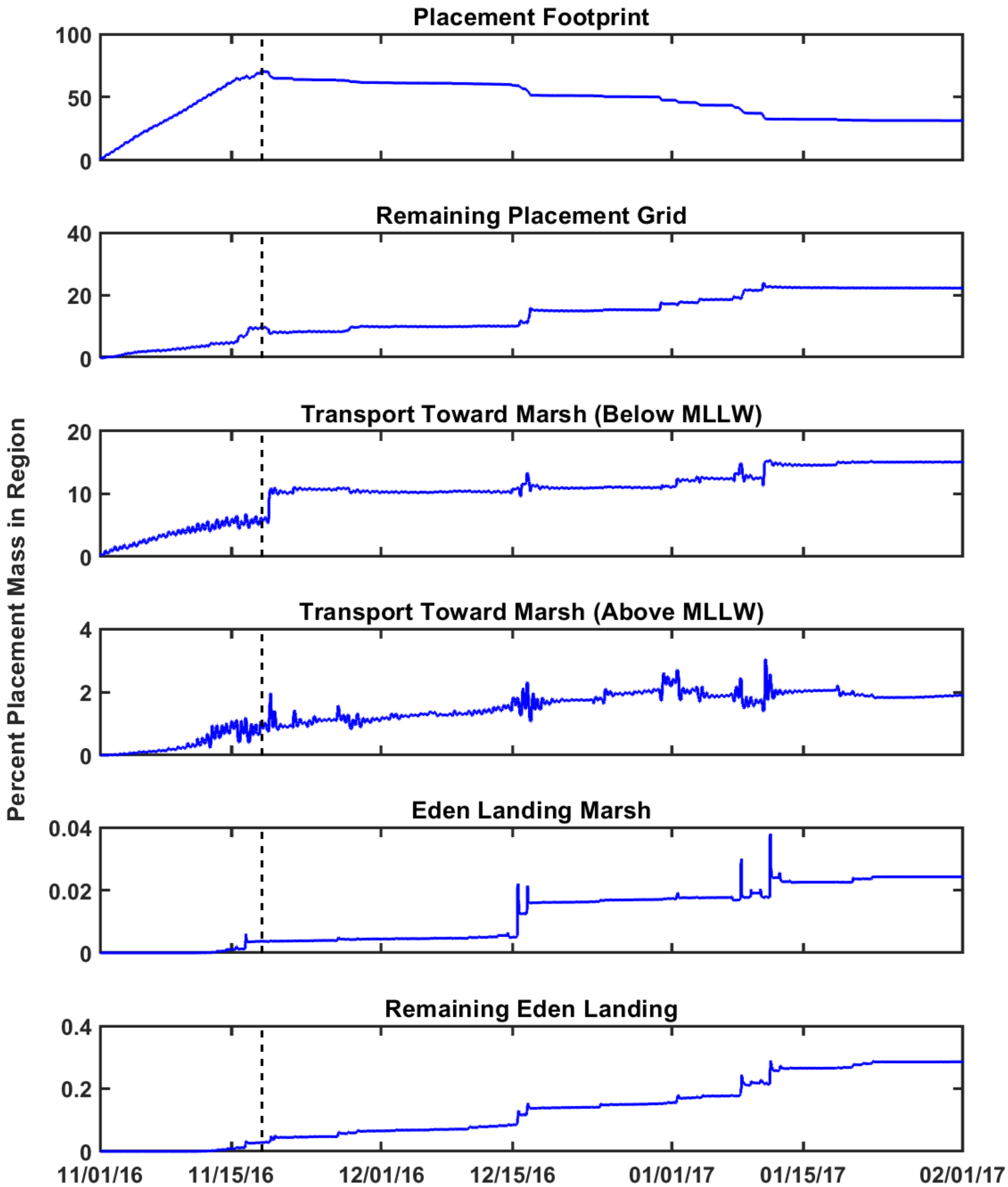
Less than 0.1% of the dredged material was predicted to be transported into Redwood City Harbor or into the Alameda FCC. About 14% of the placed dredged material was predicted to be dispersed within the South Bay below MLLW, 1% dispersed north of Dumbarton Bridge, and 9% dispersed north of the Bay Bridge.

Figure 5.3-7
Predicted Thickness of Dredged Material at the End of the 3-Month Simulation: Scenario 9 Eden Landing Shallow/East Winter



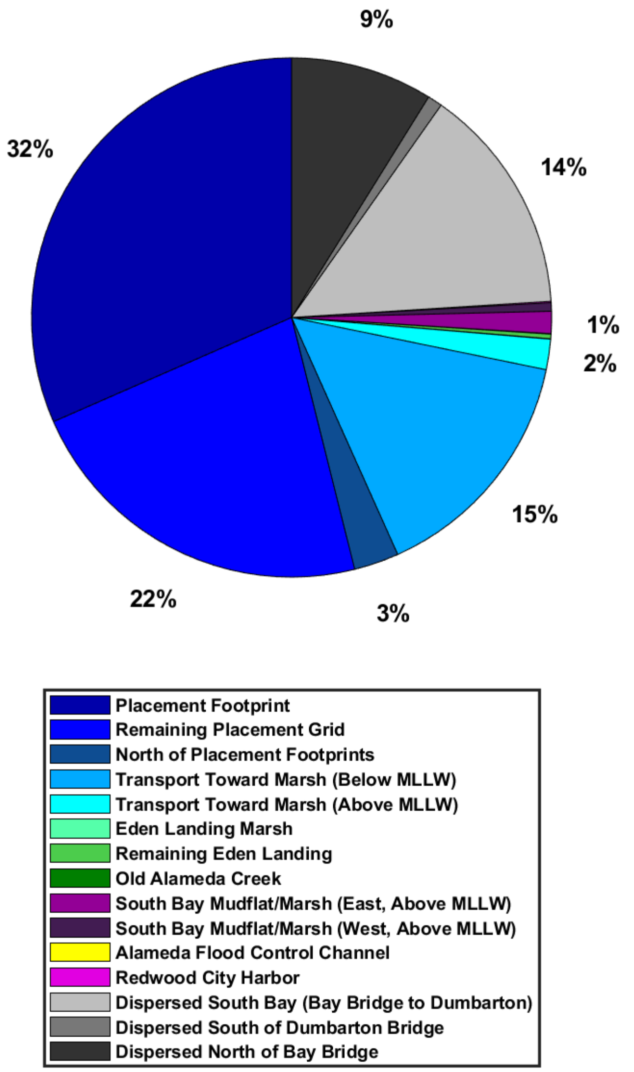
Note:
Note the log scale of the color range.

Figure 5.3-8
Predicted Percentage of Dredged Sediment Mass in Each Region During the 3-Month Simulation: Scenario 9 Eden Landing Shallow/East Winter



Note:
Vertical dashed line denotes the end of the dredged material placements for this scenario.

Figure 5.3-9
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 3-Month Simulation: Scenario 9 Eden Landing Shallow/East Winter



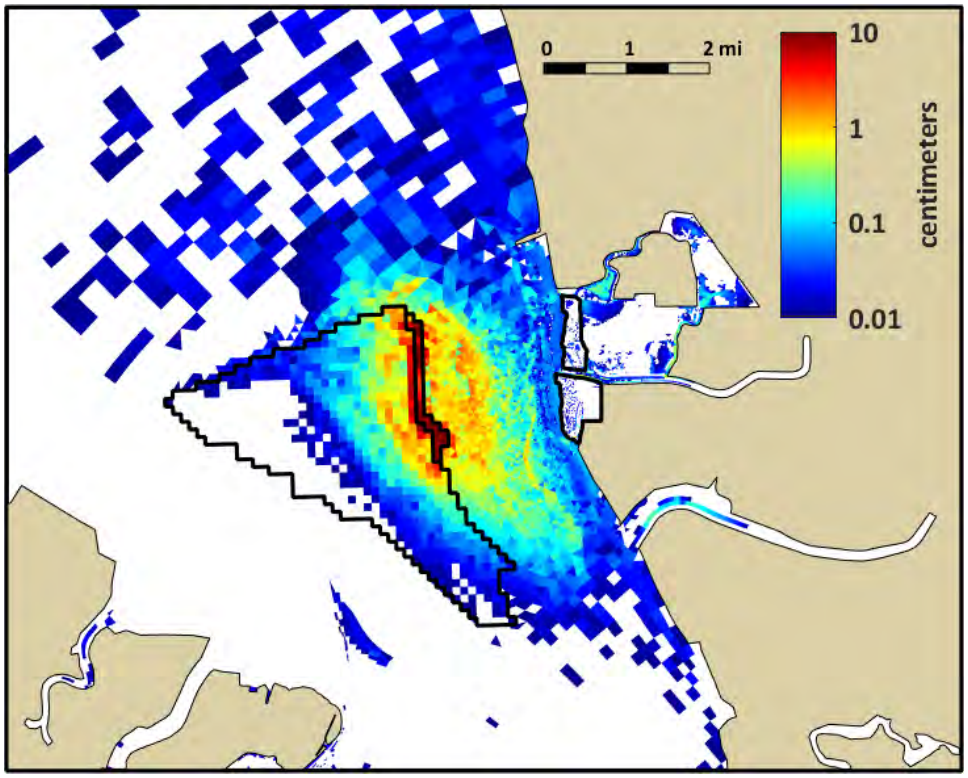
5.3.4 Eden Landing Shallow/East Oakland Harbor Sediment

The Eden Landing Shallow/East Oakland Harbor Sediment scenario included the placement of 100,000 yd^3 of dredged material along the eastern side of the placement grid. The scenario assumed a total of 112 placements over a period of 25 days, as described in Section 3.3.2.4. At the end of the 2-month simulation period, much of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.3-10), but 27% of the placed dredged material was predicted to remain inside the placement footprint (Figures 5.3-11 and 5.3-12; Tables 5.1-4 and 5.1-5). The model predicted that dredged material that was transported out of the initial placement footprint was deposited around the placement footprint, with a skewing of the deposition toward the east and south of the placement footprint (Figure 5.3-10). Predicted thickness of the dredged material remaining in the placement footprint ranged from 1 to 17 cm, with up to 0.9 cm of dredged material deposition in Eden Landing Marsh (Table 5.1-6). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed and then was predicted to decrease as the dredged material was resuspended (Figure 5.3-11).

At the end of the 2-month simulation period, 0.1% of the placed dredged material was predicted to be deposited in Eden Landing Marsh (Figure 3.4-2), and 0.8% was predicted to be deposited in other regions of the Eden Landing complex (Table 5.1-4). Much of the dredged material deposited on Eden Landing Marsh was predicted to be transported onto the marsh during the second half of May and June, during spring tide when the tidal higher high water levels were relatively high. Although only a small portion of the placed dredged material was predicted to reach Eden Landing Marsh within the 2-month simulation period, a relatively large amount of the placed sediment was predicted to be transported toward the marsh. The model predicted that 23% of the placed dredged material was transported towards Eden Landing Marsh but was still below MLLW, while an additional 5% of the placed dredged material was predicted to be transported towards the marsh and was already deposited at elevations above MLLW. An additional 1% was predicted to be transported to other areas above MLLW on the eastern side of the South Bay.

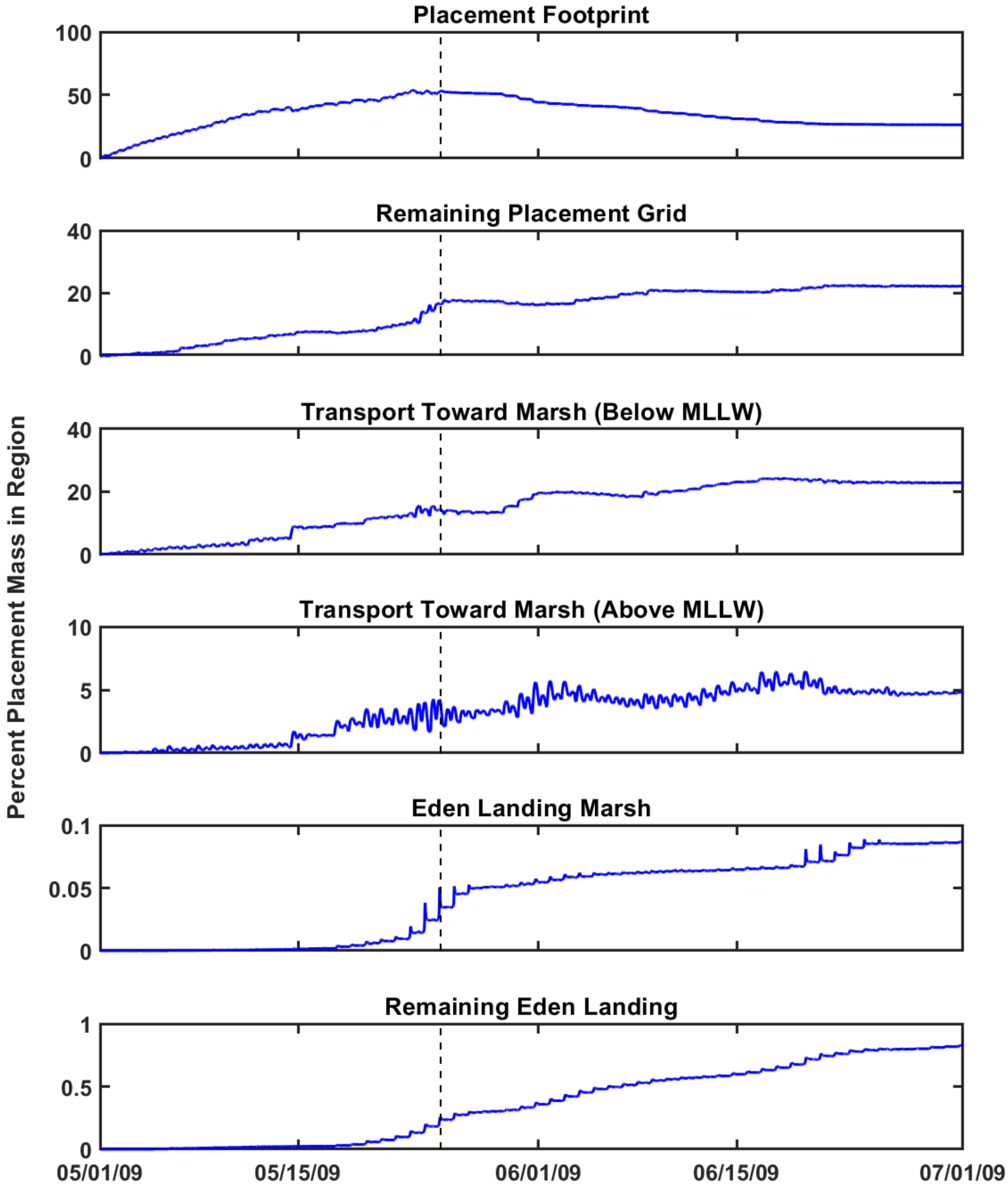
About 0.1% of the dredged material was predicted to be transported into Redwood City Harbor, and 0.2% was transported into the Alameda FCC. About 15% of the placed dredged material was predicted to be dispersed within the South Bay below MLLW, 2% dispersed north of Dumbarton Bridge, and 3% dispersed north of the Bay Bridge.

Figure 5.3-10
Predicted Thickness of Dredged Material at the End of the 2-Month Simulation: Scenario 10 Eden Landing Shallow/East Oakland Harbor Sediment



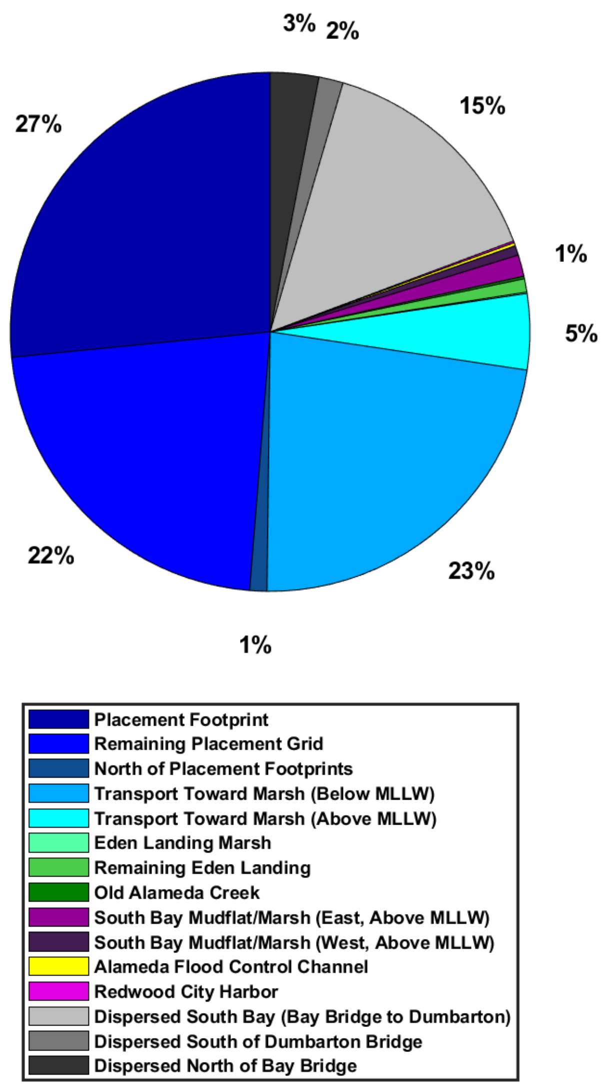
Note:
Note the log scale of the color range.

Figure 5.3-11
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulation: Scenario 10 Eden Landing Shallow/East Oakland Harbor Sediment



Note:
Vertical dashed line denotes the end of the dredged material placements for this scenario.

Figure 5.3-12
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 2-Month Simulation: Scenario 10 Eden Landing Shallow/East Oakland Harbor Sediment



5.3.5 Eden Landing Larger Placement Footprint

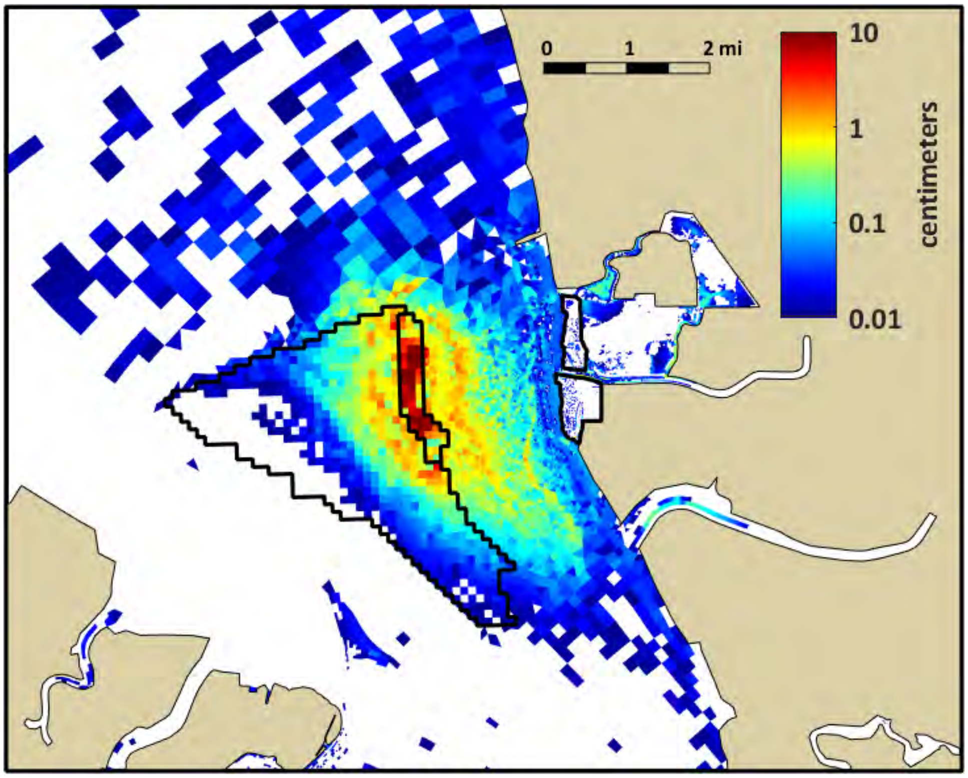
The Eden Landing Larger Placement Footprint scenario included the placement of 100,000 yd^3 of dredged material in a placement footprint near and along the eastern side of the placement grid. The scenario assumed a total of 112 placements over a period of 22 days, as described in Section 3.3.2.5. At the end of the 2-month simulation period, approximately two-thirds of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.3-13), but 34% of the placed dredged material was predicted to remain inside the placement footprint

(Figures 5.3-14 and 5.3-15; Tables 5.1-4 and 5.1-5). The model predicted that dredged material that was transported out of the initial placement footprint was deposited around the placement footprint, with a skewing of the deposition toward the southeast of the placement footprint (Figure 5.3-13). Predicted thickness of the dredged material remaining in the placement footprint ranged from 0.2 to 15 cm, with up to 0.9 cm of dredged material deposition in Eden Landing Marsh (Table 5.1-6). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed, and then was predicted to decrease as the dredged material was resuspended (Figure 5.3-14).

At the end of the 2-month simulation period, 0.1% of the placed dredged material was predicted to be deposited in Eden Landing Marsh (Figure 3.4-2), and 0.9% was predicted to be deposited in other regions of the Eden Landing complex (Table 5.1-4). Much of the dredged material deposited on Eden Landing Marsh was predicted to be transported onto the marsh during the second half of May and June, during spring tide when the tidal higher high water levels were relatively high. Although only a small portion of the placed dredged material was predicted to reach Eden Landing Marsh within the 2-month simulation period, additional placed sediment was predicted to be transported toward the marsh. The model predicted that 18% of the placed dredged material was transported towards Eden Landing Marsh but was still below MLLW, while an additional 5% of the placed dredged material was predicted to be transported towards the marsh and was already deposited at elevations above MLLW. An additional 2% was predicted to be transported to other areas above MLLW on the eastern side of the South Bay.

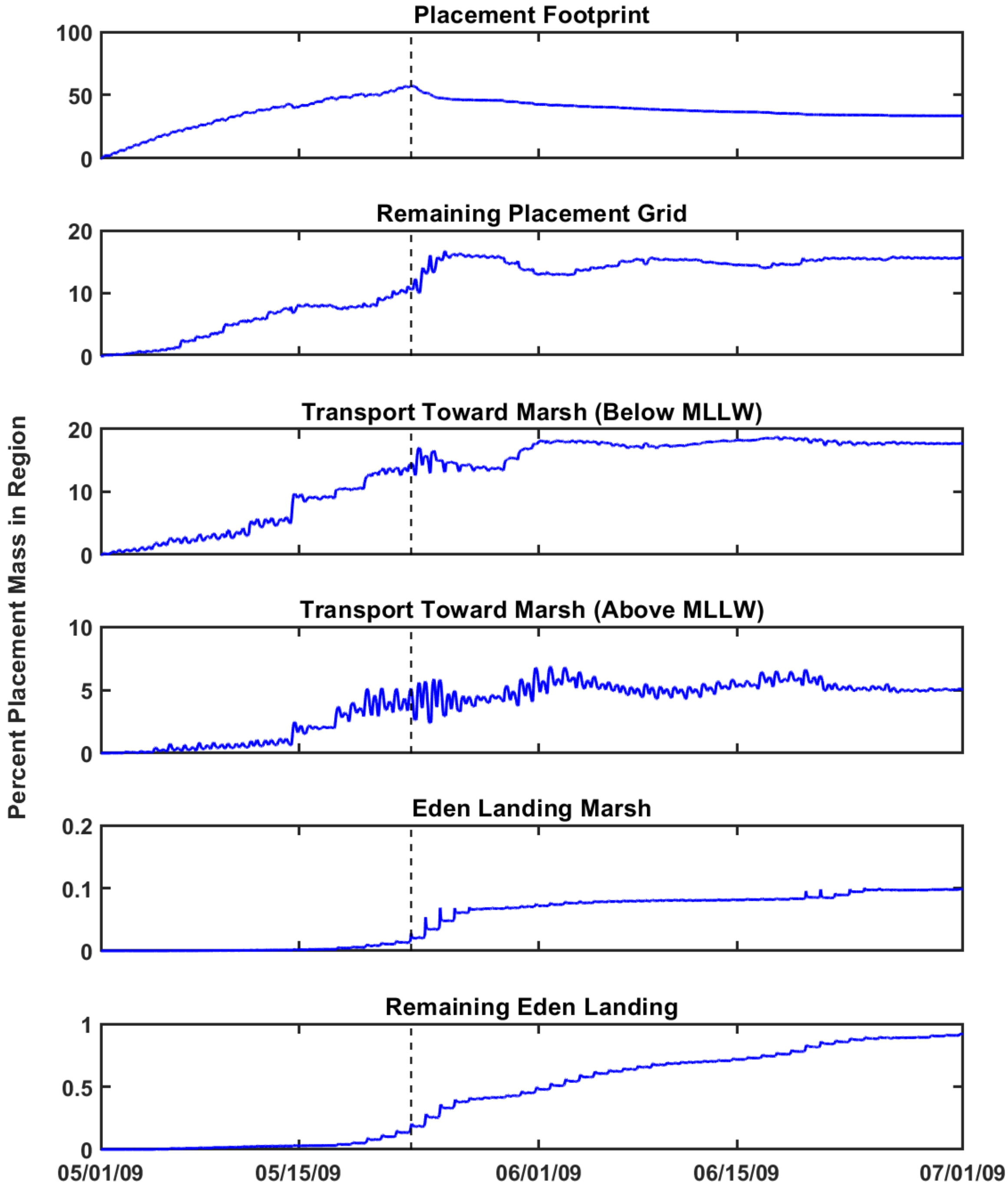
About 0.2% of the dredged material was predicted to be transported into Redwood City Harbor, and 0.3% was transported into the Alameda FCC. About 17% of the placed dredged material was predicted to be dispersed within the South Bay below MLLW, 2% dispersed north of Dumbarton Bridge, and 4% dispersed north of the Bay Bridge.

Figure 5.3-13
Predicted Thickness of Dredged Material at the End of the 2-Month Simulation: Scenario 11 Eden Landing Larger Placement Footprint



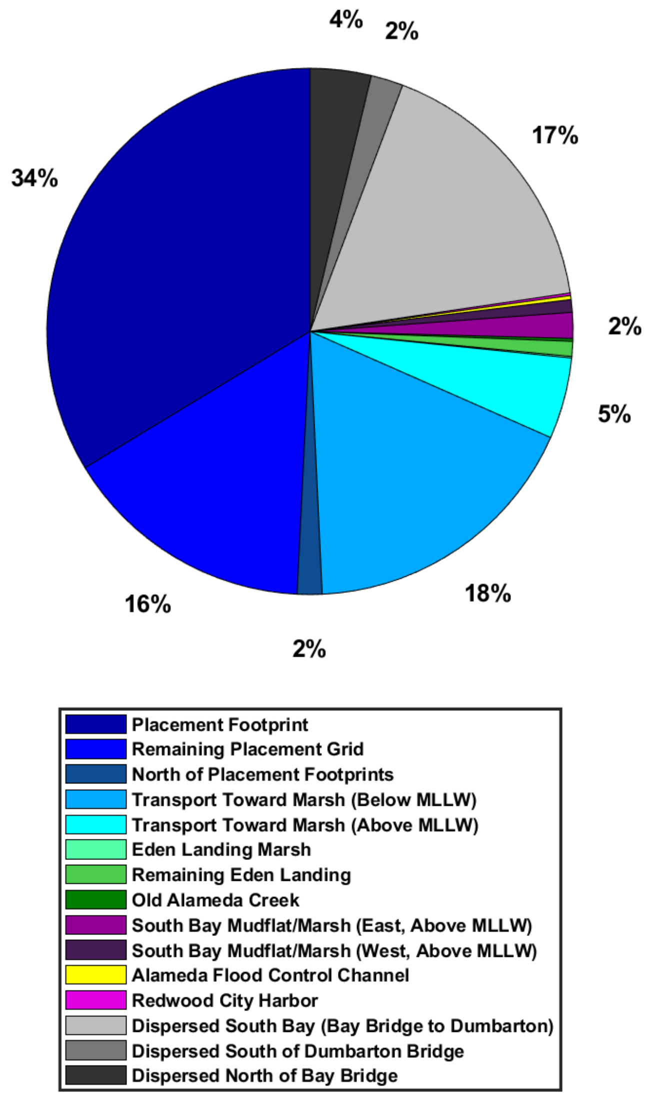
Note:
Note the log scale of the color range.

Figure 5.3-14
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulation: Scenario 11 Eden Landing Larger Placement Footprint



Note:
Vertical dashed line denotes the end of the dredged material placements for this scenario.

Figure 5.3-15
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 2-Month Simulation: Scenario 11 Eden Landing Larger Placement Footprint



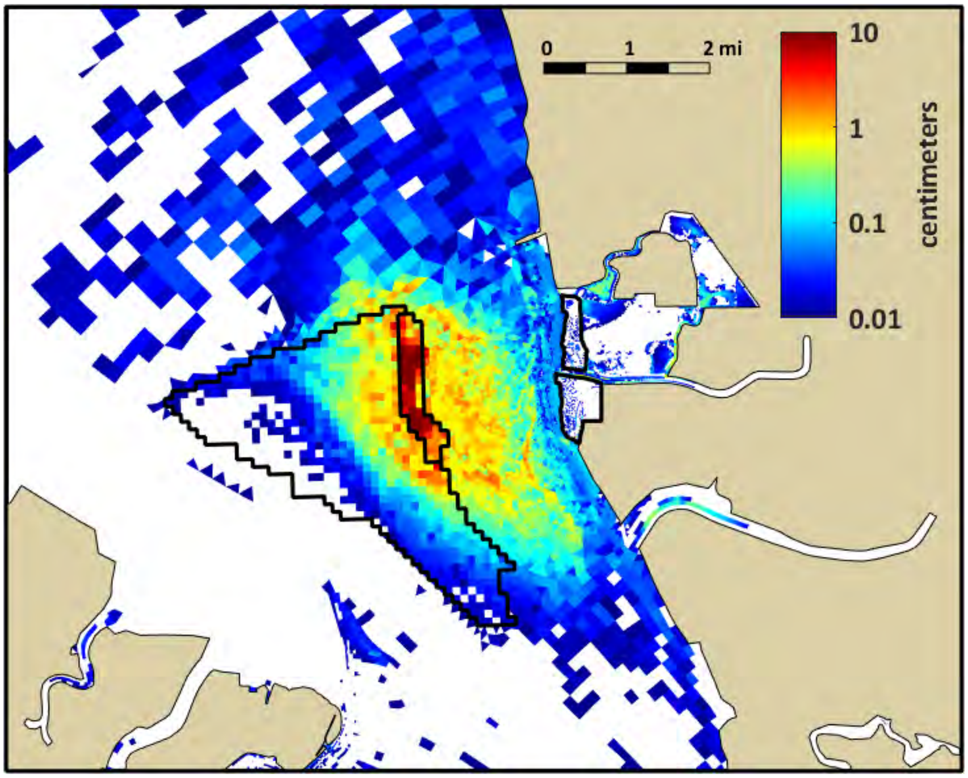
5.3.6 Eden Landing Larger Placement Footprint 125,000 yd^3

The Eden Landing Larger Placement Footprint 125,000 yd^3 scenario included the placement of 125,000 yd^3 of dredged material in a placement footprint near and along the eastern side of the placement grid. The scenario assumed a total of 139 placements over a period of 26 days, as described in Section 3.3.2.6. At the end of the 2-month simulation period, approximately two-thirds of the dredged material was predicted to be dispersed away from the placement footprint (Figure 5.3-16), but 33% of the placed dredged material was predicted to remain inside the placement footprint (Figures 5.3-17 and 5.3-18; Tables 5.1-4 and 5.1-5). The model predicted that dredged material that was transported out of the initial placement footprint was deposited around the placement footprint, with a skewing of the deposition toward the southeast of the placement footprint (Figure 5.3-16). Predicted thickness of the dredged material remaining in the placement footprint ranged from 0.5 to 19 cm, with up to 1 cm of dredged material deposition in Eden Landing Marsh (Table 5.1-6). The percentage of the total amount of dredged material in the placement footprint increased until the placements were completed and then was predicted to decrease as the dredged material was resuspended (Figure 5.3-17).

At the end of the 2-month simulation period, 0.1% of the placed dredged material was predicted to be deposited in Eden Landing Marsh (Figure 3.4-2), and 0.9% was predicted to be deposited in other regions of the Eden Landing complex (Table 5.1-4). Much of the dredged material deposited on Eden Landing Marsh was predicted to be transported onto the marsh during the second half of May and June, during spring tide when the tidal higher high water levels were relatively high. Although only a small portion of the placed dredged material was predicted to reach Eden Landing Marsh within the 2-month simulation period, additional placed sediment was predicted to be transported toward the marsh. The model predicted that 18% of the placed dredged material was transported towards Eden Landing Marsh but was still below MLLW, while an additional 6% of the placed dredged material was predicted to be transported towards the marsh and was already deposited at elevations above MLLW. An additional 2% was predicted to be transported to other areas above MLLW on the eastern side of the South Bay.

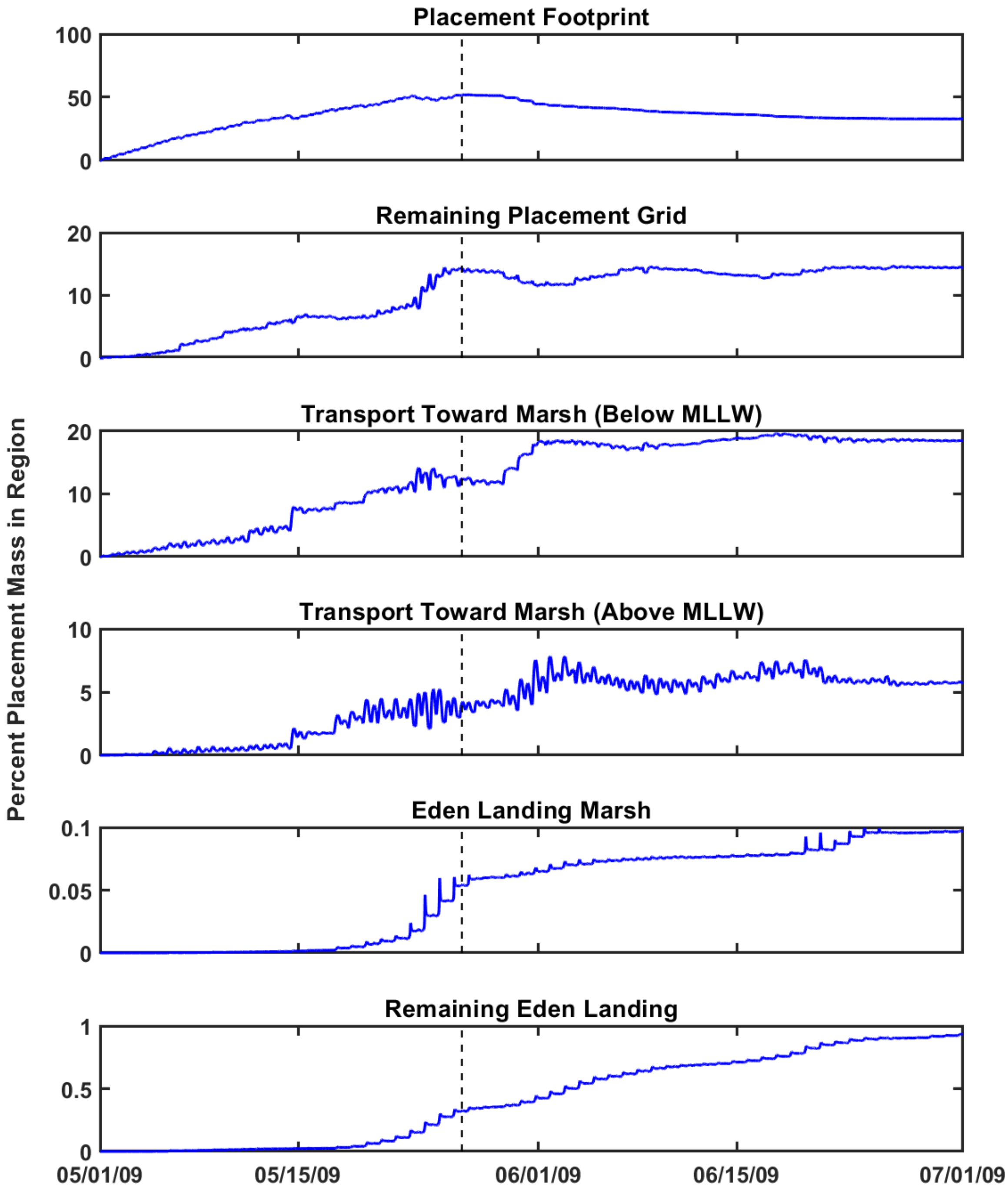
About 0.2% of the dredged material was predicted to be transported into Redwood City Harbor, and 0.3% was transported into the Alameda FCC. About 17% of the placed dredged material was predicted to be dispersed within the South Bay below MLLW, 2% dispersed north of Dumbarton Bridge, and 4% dispersed north of the Bay Bridge.

Figure 5.3-16
Predicted Thickness of Dredged Material at the End of the 2-Month Simulation: Scenario 12 Eden Landing Larger Placement Footprint 125,000 yd^3



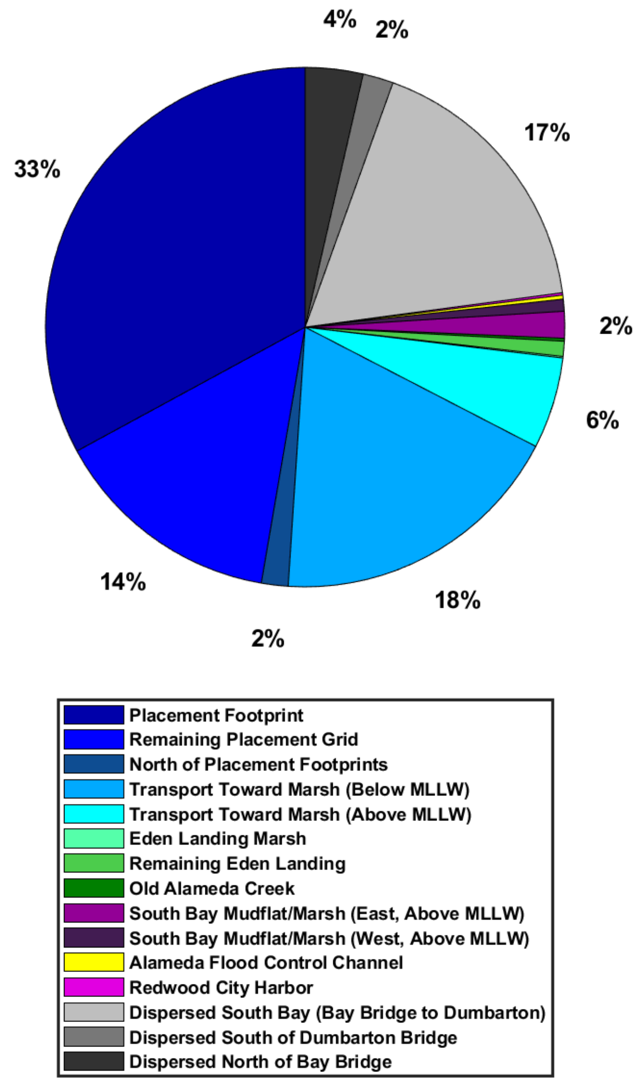
Note:
Note the log scale of the color range.

Figure 5.3-17
Predicted Percentage of Dredged Sediment Mass in Each Region During the 2-Month Simulation: Scenario 12 Eden Landing Larger Placement Footprint 125,000 yd^3



Note:
Vertical dashed line denotes the end of the dredged material placements for this scenario.

Figure 5.3-18
Predicted Percentage of Dredged Sediment Mass in Each Region at the End of the 2-Month Simulation: Scenario 12 Eden Landing Larger Placement Footprint 125,000 yd^3



5.4 Evaluation of Dredged Material Placements at Eden Landing

This section compares the results of the Eden Landing Shallow/East scenario detailed in Section 5.1.6 with the additional Eden Landing scenarios detailed in Section 5.3 and specifically evaluates the following:

- The placement volume in the shallow/east placement footprint
- The sediment source in the shallow/east placement footprint
- Placements during the summer versus winter in the shallow/east placement footprint

- Conducting placements in the shallow/east placement footprint versus an expanded footprint
- The placement volume in the expanded east placement footprint

5.4.1 Evaluation of Placement Volume in the Shallow/East Placement Footprint

Dredged material placements were conducted in the Eden Landing shallow/east placement footprint using 100,000 yd^3, 75,000 yd^3, and 50,000 yd^3 of dredged material. Dispersal away from the placement footprint resulted in similar depositional patterns for each placement volume (Figure 5.4-1); however, the thickness of the dredged material deposition increased with increasing placement volume. That is, the predicted depositional thicknesses were greater with 100,000 yd^3 of dredged material than with 75,000 yd^3 or 50,000 yd^3 of dredged material.

The percentage of dredged material dispersed to the various analysis regions was similar, regardless of the placement volumes considered (Figure 5.4-2 and Table 5.1-4). The placement of different volumes of dredged material (100,000 yd^3, 75,000 yd^3, or 50,000 yd^3) in the shallow/east placement footprint resulted in only small differences in the percentage of the dredged material transported to the analysis regions over the 2 months of the simulations. For the Eden Landing Shallow/East 100,000 yd^3 scenario, 20% of the dredged material was predicted to remain in the placement footprint at the end of the simulation, compared to 17% for the 75,000 yd^3 scenario and 18% for the 50,000 yd^3 scenario. At the end of the simulation, 0.1% of the dredged material was predicted to deposit in the Whale's Tail portion of Eden Landing Marsh for all three of the Eden Landing Shallow/East 100,000 yd^3, 75,000 yd^3, and 50,000 yd^3 scenarios. For the Eden Landing Shallow/East 100,000 yd^3 and 50,000 yd^3 scenarios, 6% of the dredged material was predicted to deposit above MLLW bayward of the marsh at the end of the simulation, compared to 7% for the 75,000 yd^3 scenario. At the end of the simulation, 1% of the dredged material was predicted to deposit in the remaining portion of Eden Landing for all three of the Eden Landing Shallow/East 100,000 yd^3, 75,000 yd^3, and 50,000 yd^3 scenarios.

Because each scenario included a different volume of dredged material, the volume of dredged material dispersed to each analysis region was different for each scenario. The scenario with 100,000 yd^3 of dredged material had the most predicted dispersal to each analysis region, followed by the scenario with 75,000 yd^3 of dredged material, and the scenario with 50,000 yd^3 of dredged material had the lowest predicted volume of dredged material in each region at the end of the simulations (Figure 5.4-3 and Table 5.1-5). The scenario with 100,000 yd^3 of dredged material resulted in the transport of more dredged material toward and into Eden Landing Marsh than the scenarios with a lower total placement volume.

Figure 5.4-1
Predicted Thickness of Dredged Material at the End of the 2-Month Simulations for Evaluating the Placement Volume in the Shallow/East Placement Footprint

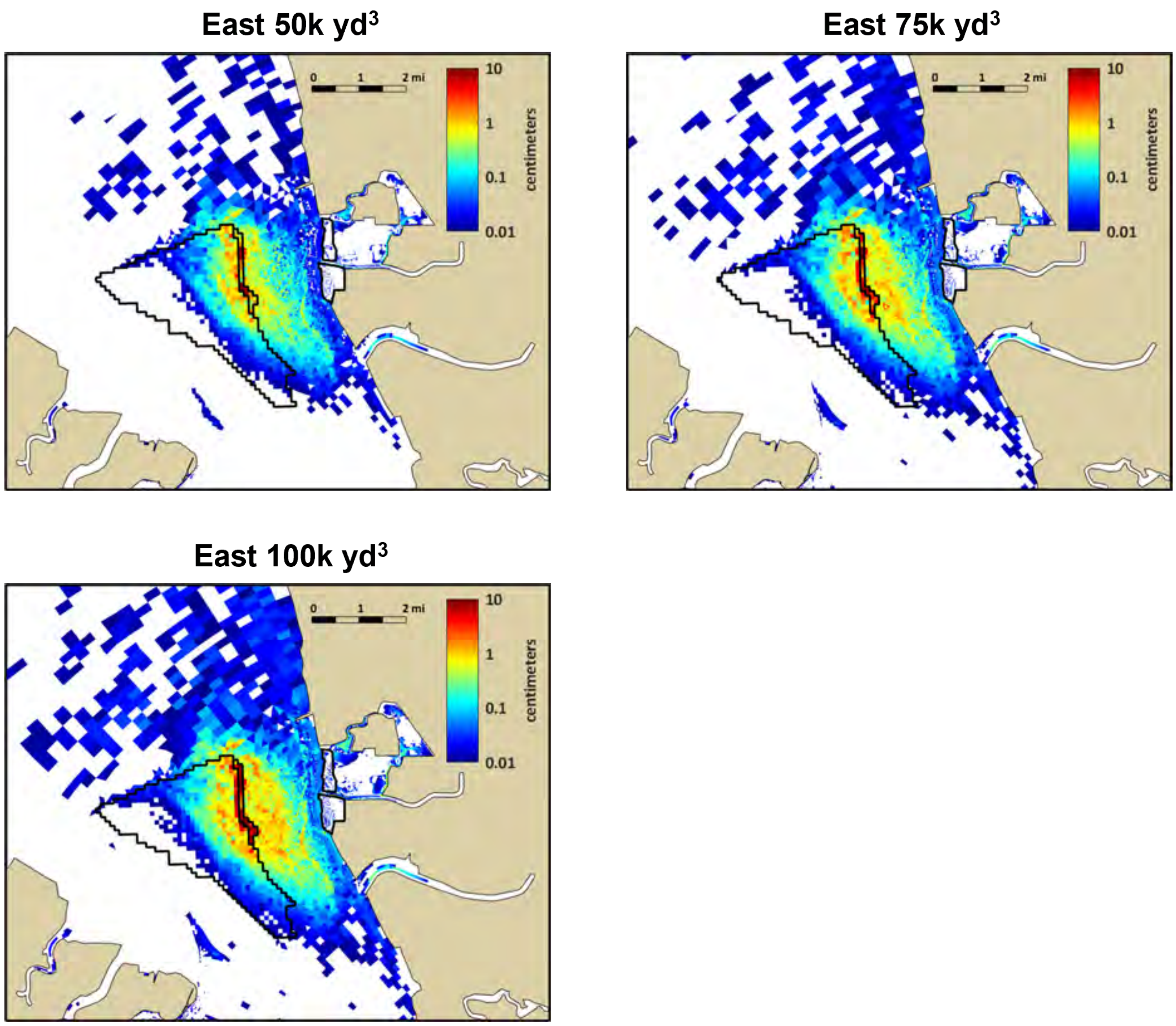
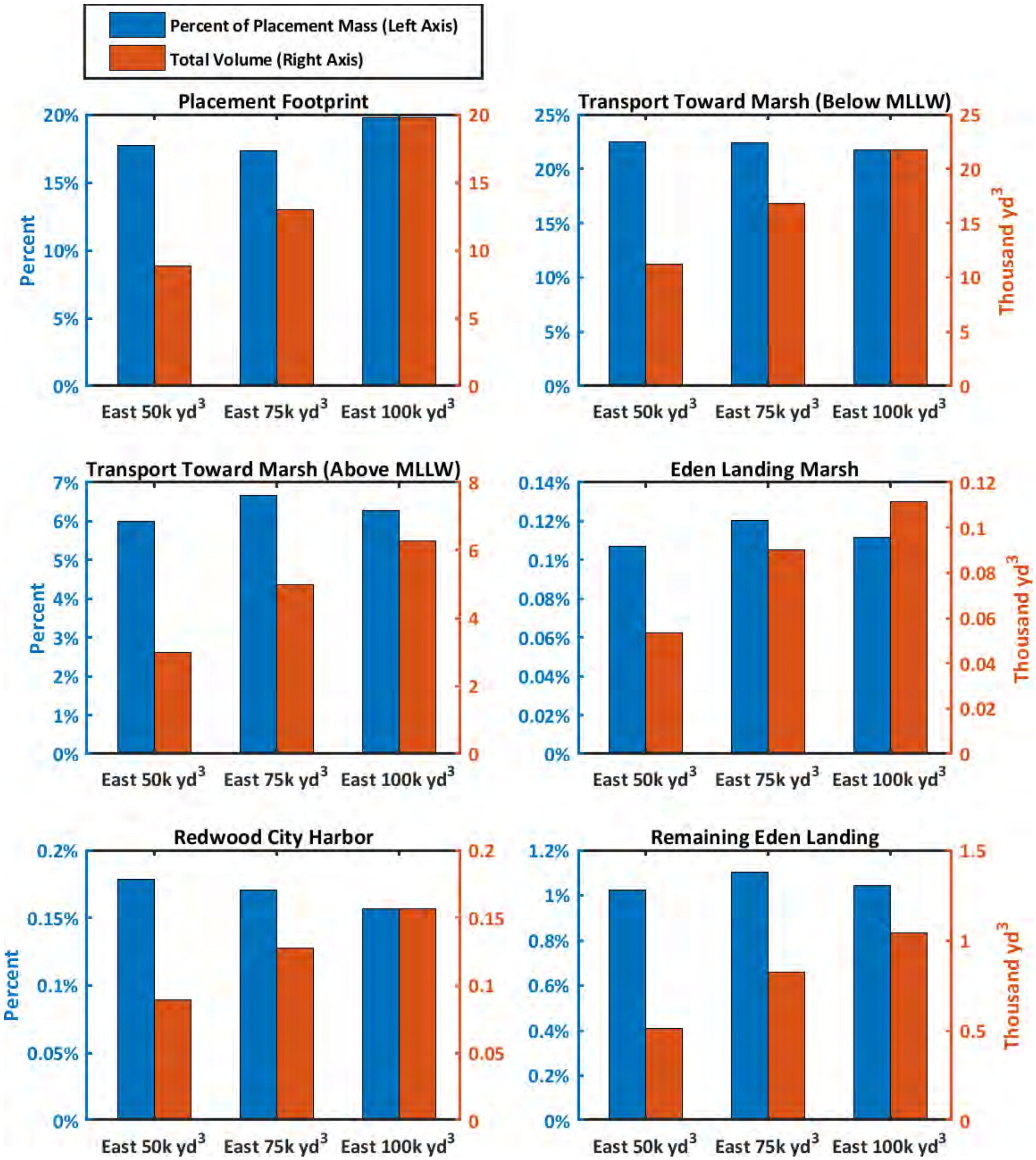


Figure 5.4-2
Predicted Percentage of Dredged Sediment Mass and Dredged Material Volume in Each Region at the End of the 2-Month Simulations for Evaluating the Placement Volume in the Shallow/East Placement Footprint



5.4.2 *Evaluation of Sediment Source in the Shallow/East Placement Footprint*

Dredged material placements were conducted in the Eden Landing shallow/east placement footprint using 100,000 yd^3 of dredged material sourced from Redwood City Harbor and Oakland Harbor. The sediment from Oakland Harbor has roughly twice as much sand as the sediment from Redwood City Harbor (Tables 3.2-2 and 3.2-3). Dispersal away from the placement footprint resulted in similar depositional patterns for each sediment source (Figure 5.4-3); however, the thickness of the dredged material deposition was slightly higher in and near the placement footprint with the Oakland Harbor sediment than with the Redwood City Harbor sediment. The slightly higher depositional thicknesses near the placement footprint when using Oakland Harbor sediment result from the increased sand content of the Oakland Harbor sediment because the sand is not transported as far from the placement footprint as the other sediment classes.

The percentage of dredged material dispersed to the various analysis regions was influenced by the source of the dredged material. Using sediment from Oakland Harbor resulted in a higher percentage of the placed dredged material remaining in the placement footprint at the end of the 2-month simulation than using sediment from Redwood City Harbor (Figure 5.4-4 and Table 5.1-4). For the Eden Landing scenario using Redwood City Harbor sediment, 20% of the dredged material was predicted to remain in the placement footprint at the end of the simulation, compared to 27% remaining in the placement footprint for the Oakland Harbor Sediment scenario. There was a corresponding decrease in the percentage of dredged material dispersed toward the marsh and deposited above MLLW, dispersed into Eden Landing, and dispersed into the remaining portion of the Eden Landing complex. At the end of the simulation, 0.1% of the dredged material was predicted to deposit in the Whale’s Tail portion of Eden Landing Marsh for both the Eden Landing Redwood City Harbor and Oakland Harbor Sediment scenarios. For the Eden Landing scenario using Redwood City Harbor sediment, 6% of the dredged material was predicted to deposit above MLLW bayward of the marsh at the end of the simulation, compared to 5% for the Oakland Harbor Sediment scenario. At the end of the simulation, 1% of the dredged material was predicted to deposit in the remaining portion of Eden Landing for the scenario using Redwood City Harbor sediment, compared to 0.8% deposited in the remaining portion of Eden Landing for the Oakland Harbor Sediment scenario.

The increased sand content of the Oakland Harbor sediment relative to sediment from Redwood City Harbor resulted in a lower percentage of the placed material being transported out of the placement footprint and transported toward the marsh. Although, the percentage of dredged material transported toward Eden Landing Marsh when placing Oakland Harbor sediment was still higher than when placing Redwood City Harbor sediment in either of the middle or deep placement locations (Table 5.1-4).

The volume of dredged material dispersed to the various analysis regions was influenced by the source of the dredged material. Because both scenarios used 100,000 yd^3 of dredged material, the volume of dredged material transported to the analysis regions correlates with the percentages of dredged material detailed in the previous paragraph. Using sediment from Oakland Harbor resulted in a larger volume of the placed dredged material remaining in the placement footprint at the end of the 2-month simulation than what remained using sediment from Redwood City Harbor (Figure 5.4-4 and Table 5.1-5). There was a corresponding decrease in the volume of dredged material dispersed toward the marsh and deposited above MLLW, dispersed into Eden Landing, and dispersed into the remaining portion of the Eden Landing complex. Although, the volume of dredged material transported toward Eden Landing Marsh when placing Oakland Harbor sediment was still higher than when placing Redwood City Harbor sediment in either of the middle or deep placement locations (Table 5.1-5).

Figure 5.4-3
Predicted Thickness of Dredged Material at the End of the 2-Month Simulations for Evaluating the Sediment Source in the Shallow/East Placement Footprint

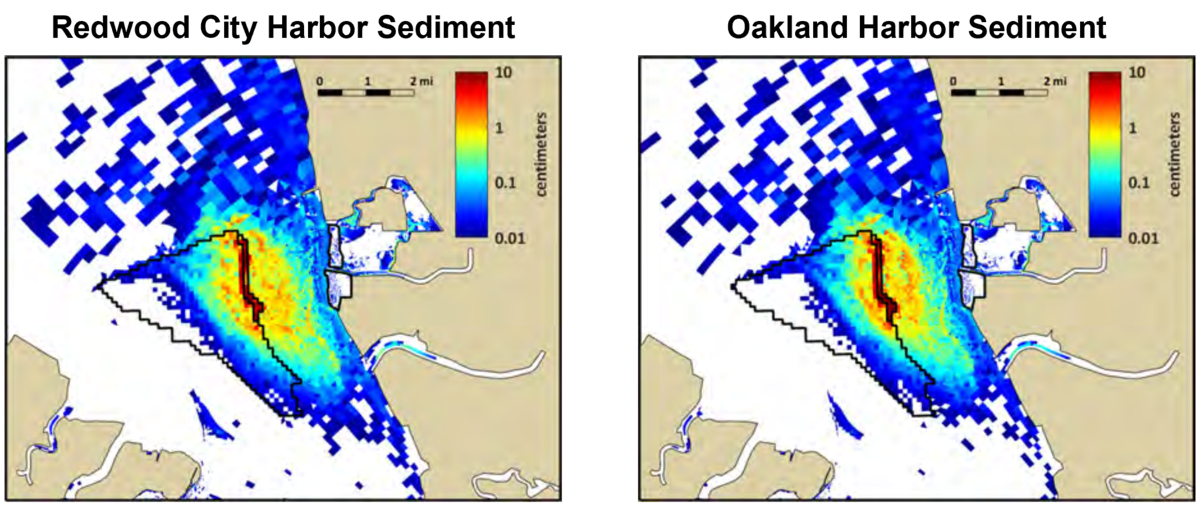
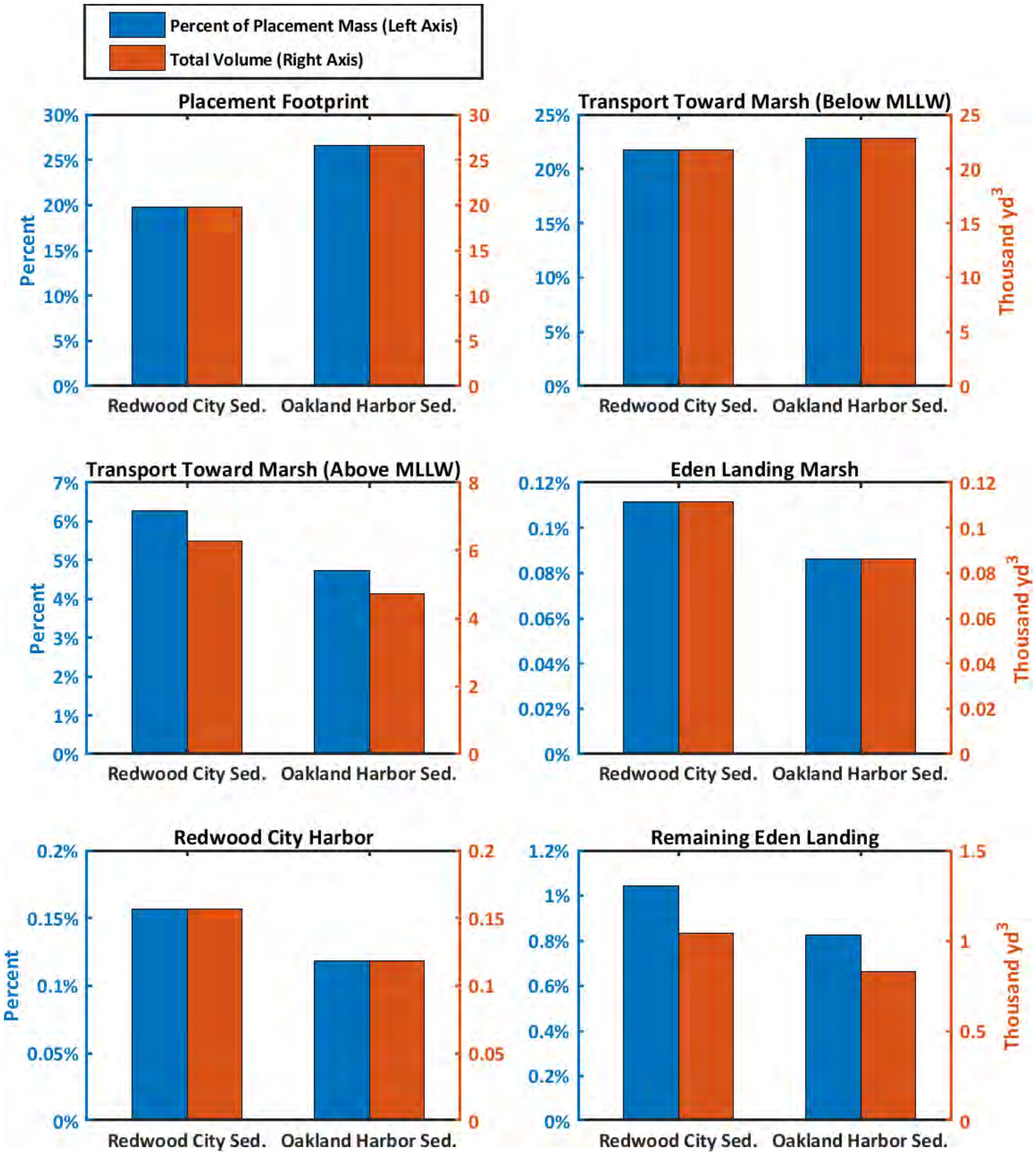


Figure 5.4-4
Predicted Percentage of Dredged Sediment Mass and Dredged Material Volume in Each Region at the End of the 2-Month Simulations for Evaluating the Sediment Source in the Shallow/East Placement Footprint



Note:
Sed.: sediment

5.4.3 *Evaluation of Placements During the Summer Versus Winter in the Shallow/East Placement Footprint*

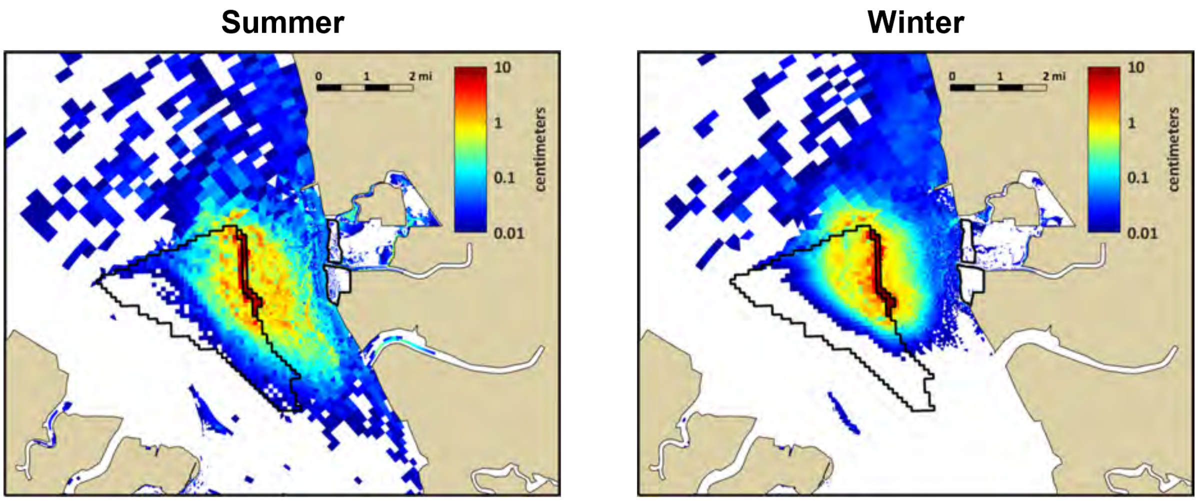
Dredged material placements were conducted in the Eden Landing shallow/east placement footprint using 100,000 yd^3 of dredged material, with placements occurring either in the summer or winter. Wind waves and resulting bed shear stresses are on average higher during the summer simulation period than the winter period (Section 4.1.3), potentially increasing resuspension and dispersal of the dredged material. Freshwater inflows to the Bay are lower in the summer period than during the winter period simulated, which can affect residual circulation and sediment transport in the Bay. Differences in wind speed and direction can also affect residual circulation, particularly in large shallow areas like the eastern side of South Bay. The northward depth-averaged residual circulation was faster during the winter simulation period than during the summer (Figures 4.2-5 and 4.2-7). The winter simulation spanned 3 months, while the summer simulation only spanned 2 months.

Dispersal away from the placement footprint differed between the summer and winter periods and resulted in different depositional patterns for each period simulated (Figure 5.4-5). The deposition resulting from the summer placement was skewed toward the east and south from the placement footprint. However, the deposition resulting from the winter placement was roughly centered around the placement footprint, with additional deposition skewed north of the placement grid and along the shoreline toward the north. The difference in depositional patterns suggests less wave resuspension and dispersal away from the placement footprint and more northward dispersal during the winter period than during the summer period. Lower RMS bed shear stresses during the winter period than during the summer period (Section 4.1.3) supports less wave resuspension during the winter period than during the summer period. Faster northward depth-averaged residual currents during the winter period than during the summer period supports the finding of increased northward sediment dispersal during the winter period than during the summer period.

The percentage of dredged material dispersed to the various analysis regions was influenced by the seasonal period simulated. Conducting the placements during the winter resulted in a higher percentage of the placed dredged material remaining in the placement footprint at the end of the simulations than conducting the placements during the summer (Figure 5.4-6 and Table 5.1-4), even though the winter simulation was 50% longer duration (3 months instead of 2 months). For the Eden Landing Shallow/East scenario, 20% of the dredged material was predicted to remain in the placement footprint at the end of the simulation, compared to 32% remaining in the placement footprint for the Eden Landing Shallow/East Winter scenario. There was a corresponding decrease in the percentage of dredged material dispersed toward the marsh and deposited both below and above MLLW, dispersed into Eden Landing, and dispersed into the remaining portion of the Eden Landing complex. At the end of the simulation, 0.1% of the dredged material was predicted to deposit in the Whale’s Tail portion of Eden Landing Marsh for the Eden Landing Shallow/East scenario, compared to less than 0.1% for the Shallow/East Winter scenario. For the Eden Landing Shallow/East scenario, 6% of the dredged material was predicted to deposit above MLLW bayward of the marsh at the end of the simulation, compared to 2% for the Shallow/East Winter scenario. At the end of the simulation, 1% of the dredged material was predicted to deposit in the remaining portion of Eden Landing for the Eden Landing Shallow/East scenario, compared to 0.3% deposited in the remaining portion of Eden Landing for the Shallow/East Winter scenario. The percentage of dredged material dispersed toward Eden Landing and deposited above MLLW and transported into Eden Landing Marsh when conducting the placements in the winter was similar to when placing sediment in either of the middle or deep placement locations during the summer (Table 5.1-4). Conducting the placements during the winter resulted in a lower percentage of dredged material being transported south of Dumbarton Bridge and a higher percentage of dredged material transported north of the Bay Bridge than when conducting placements during the summer (Table 5.1-4).

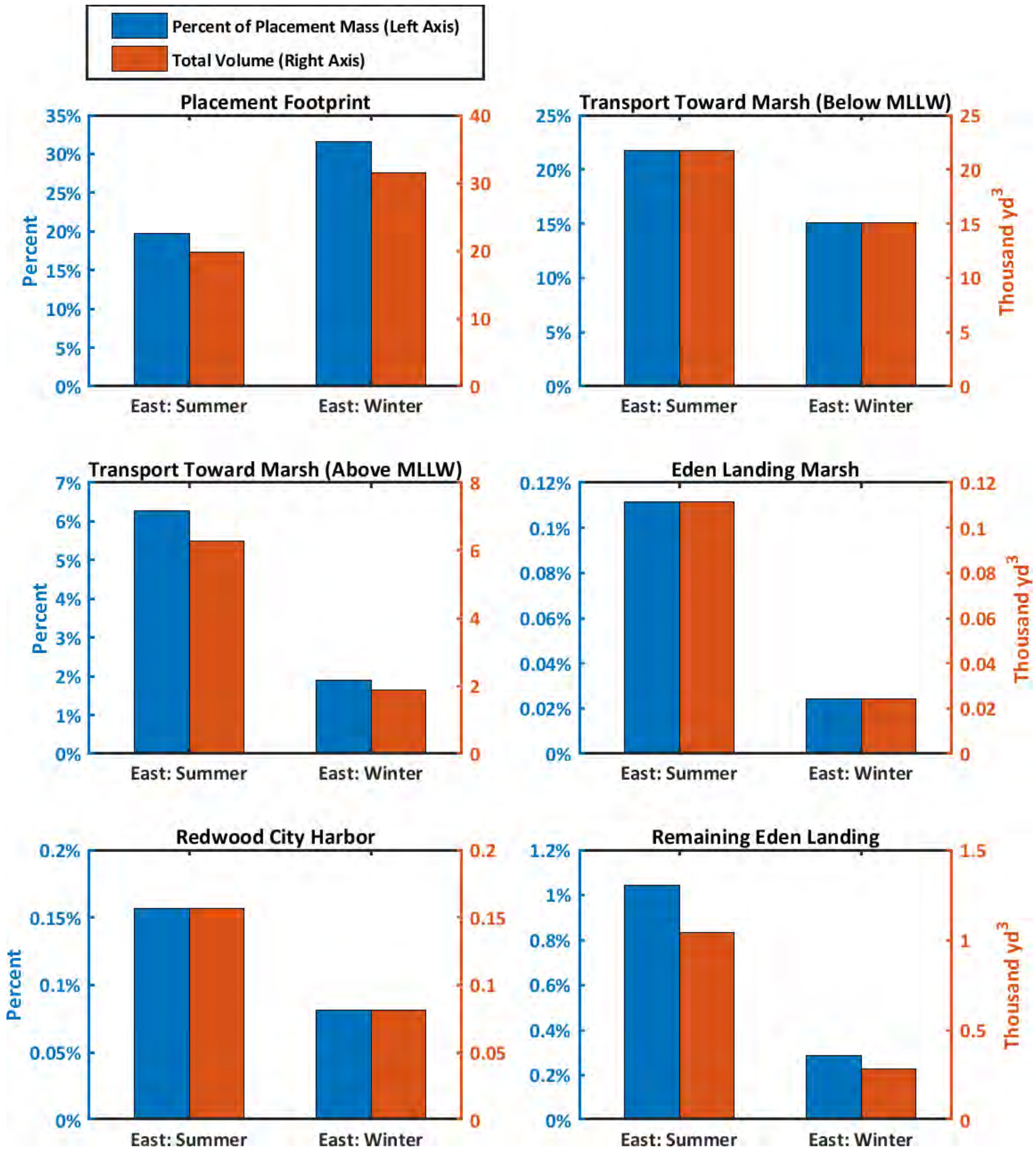
The volume of dredged material dispersed to the various analysis regions was influenced by the seasonal period simulated. Because both scenarios used 100,000 yd^3 of dredged material, the volume of dredged material transported to the analysis regions correlates with the percentages of dredged material detailed in the previous paragraph. Conducting the placements during the winter resulted in a higher volume of the placed dredged material remaining in the placement footprint at the end of the simulations than conducting the placements during the summer (Figure 5.4-6 and Table 5.1-5), even though the duration of the winter simulation was 50% longer (3 months instead of 2 months). There was a corresponding decrease in the volume of dredged material dispersed toward the marsh and deposited both below and above MLLW, dispersed into Eden Landing, and dispersed into the remaining portion of the Eden Landing complex. The volume of dredged material dispersed toward Eden Landing and deposited above MLLW and transported into Eden Landing Marsh when conducting the placements in the winter was similar to when placing sediment in either of the middle or deep placement locations during the summer (Table 5.1-5). Conducting the placements during the winter resulted in a lower volume of dredged material being transported south of Dumbarton Bridge and a higher volume of dredged material transported north of the Bay Bridge than when conducting placements during the summer (Table 5.1-5).

Figure 5.4-5
Predicted Thickness of Dredged Material at the End of the Simulations for Evaluating Summer Versus Winter Placements in the Shallow/East Placement Footprint



Note:
The summer placement was a 2-month simulation; the winter placement was a 3-month simulation.

Figure 5.4-6
Predicted Percentage of Dredged Sediment Mass and Dredged Material Volume in Each Region at the End of the Simulations for Evaluating Summer Versus Winter Placements in the Shallow/East Placement Footprint



Note:
The summer placement was a 2-month simulation; the winter placement was a 3-month simulation.

5.4.4 Evaluation of Conducting Placements in the Shallow/East Placement Footprint Versus an Expanded Footprint

Dredged material placements were conducted in the Eden Landing shallow/east placement footprint and in an expanded shallow/east footprint using 100,000 yd^3 of dredged material. The shallow/east footprint runs along the eastern edge of the placement grid. While the expanded footprint includes all of the placement cells in the original shallow/east footprint, the expanded footprint also includes placement cells to the west of the boundary of the placement grid.

Overall, the depositional pattern resulting from conducting placements in the shallow/east footprint and the expanded footprint were similar (Figure 5.4-7). There was slightly more predicted deposition east of the placement grid when using the shallow/east footprint than when using the expanded footprint.

The percentage of dredged material dispersed to the various analysis regions was influenced by the westward expansion of the placement footprint. Using the expanded placement footprint resulted in a higher percentage of the placed dredged material remaining in the placement footprint at the end of the 2-month simulation versus using the shallow/east placement footprint (Figure 5.4-4 and Table 5.1-4). For the Eden Landing Shallow/East scenario, 20% of the dredged material was predicted to remain in the placement footprint at the end of the simulation, compared to 34% remaining in the placement footprint for the Expanded Shallow/East scenario. There was a corresponding slight decrease in the percentage of dredged material dispersed toward the marsh, dispersed into Eden Landing, and dispersed into the remaining portion of the Eden Landing complex. Although, the percentage of dredged material transported toward Eden Landing Marsh when using the expanded placement footprint was still higher than when placing sediment in either of the middle or deep placement locations (Table 5.1-4). At the end of the simulation, 0.1% of the dredged material was predicted to deposit in the Whale's Tail portion of Eden Landing Marsh for both the Eden Landing Shallow/East and Expanded Shallow/East scenarios. For the Eden Landing Shallow/East scenario, 6% of the dredged material was predicted to deposit above MLLW bayward of the marsh at the end of the simulation, compared to 5% for the Expanded Shallow/East scenario. At the end of the simulation, 1% of the dredged material was predicted to deposit in the remaining portion of Eden Landing for the Eden Landing Shallow/East scenario, compared to 0.9% deposited in the remaining portion of Eden Landing for the Expanded Shallow/East scenario.

The volume of dredged material dispersed to the various analysis regions was influenced by the westward expansion of the placement footprint. Because both scenarios used 100,000 yd^3 of dredged material, the volume of dredged material transported to the analysis regions correlates with the percentages of dredged material detailed in the previous paragraph. Using the expanded placement footprint resulted in a greater volume of the placed dredged material remaining in the placement footprint at the end of the 2-month simulation versus using the shallow/east placement footprint (Figure 5.4-4 and Table 5.1-5). There was a corresponding slight decrease in the volume of dredged material dispersed toward the marsh, dispersed into Eden Landing, and dispersed into the remaining portion of the Eden Landing complex. Although, the volume of dredged material transported toward Eden Landing Marsh when using the expanded placement footprint was still higher than when placing sediment in either of the middle or deep placement locations (Table 5.1-5).

Figure 5.4-7
Predicted Thickness of Dredged Material at the End of the 2-Month Simulations for Evaluating an Expanded Shallow/East Placement Footprint

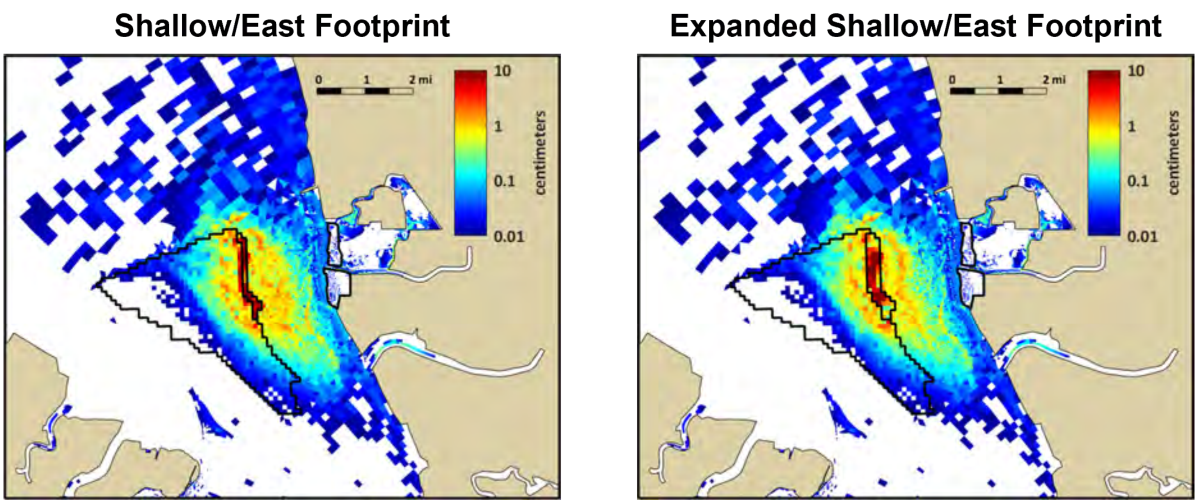
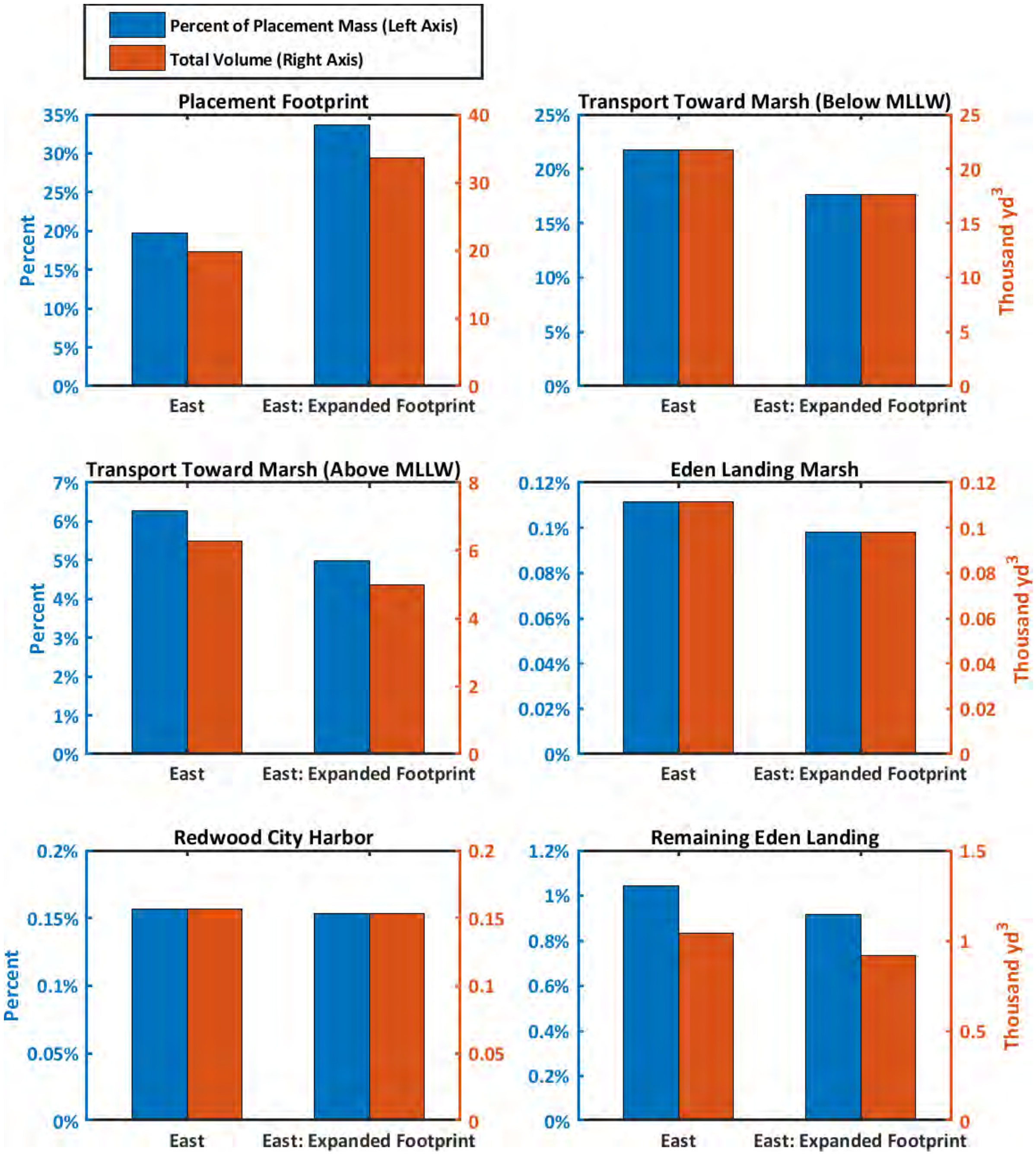


Figure 5.4-8
Predicted Percentage of Dredged Sediment Mass and Dredged Material Volume in Each Region at the End of the 2-Month Simulations for Evaluating an Expanded Shallow/East Placement Footprint



5.4.5 Evaluation of Placement Volume in the Expanded East Placement Footprint

Dredged material placements were conducted in the Eden Landing expanded shallow/east placement footprint using 100,000 yd^3 and 125,000 yd^3 of dredged material. Overall, the depositional pattern resulting from conducting placements in the expanded footprint using 100,000 yd^3 and 125,000 yd^3 of dredged material were similar (Figure 5.4-9). The depositional thicknesses were higher in the 125,000 yd^3 scenario than in the 100,000 yd^3 scenario.

The percentage of dredged material dispersed to the various analysis regions was similar, regardless of the placement volumes considered (Figure 5.4-10 and Table 5.1-4). The placement of different volumes of dredged material, 100,000 yd^3 or 125,000 yd^3, in the expanded shallow/east placement footprint resulted in only small differences in the percentage of the dredged material transported to the analysis regions over the 2 months of the simulations. For the Eden Landing Expanded Shallow/East 100,000 yd^3 scenario, 34% of the dredged material was predicted to remain in the placement footprint at the end of the simulation, compared to 33% remaining in the placement footprint for the Expanded Shallow/East 125,000 yd^3 scenario. At the end of the simulation, 0.1% of the dredged material was predicted to deposit in the Whale's Tail portion of Eden Landing Marsh for both the Eden Landing Expanded Shallow/East 100,000 yd^3 and Expanded Shallow/East 125,000 yd^3 scenarios. For the Eden Landing Expanded Shallow/East 100,000 yd^3 scenario, 5% of the dredged material was predicted to deposit above MLLW bayward of the marsh at the end of the simulation, compared to 6% for the Expanded Shallow/East 125,000 yd^3 scenario. At the end of the simulation, 0.9% of the dredged material was predicted to deposit in the remaining portion of Eden Landing for both the Eden Landing Expanded Shallow/East 100,000 yd^3 and Expanded Shallow/East 125,000 yd^3 scenarios.

Because each scenario included a different volume of dredged material, the volume of dredged material dispersed to each analysis region was different for each scenario. The scenario with 125,000 yd^3 of dredged material had the most predicted dispersal to each analysis region (Figure 5.4-10 and Table 5.1-5). The scenario with 125,000 yd^3 of dredged material resulted in the transport of more dredged material toward and into Eden Landing Marsh than the scenario with a lower total placement volume.

Figure 5.4-9
Predicted Thickness of Dredged Material at the End of the 2-Month Simulations for Evaluating Placement Volume in the Expanded Shallow/East Placement Footprint

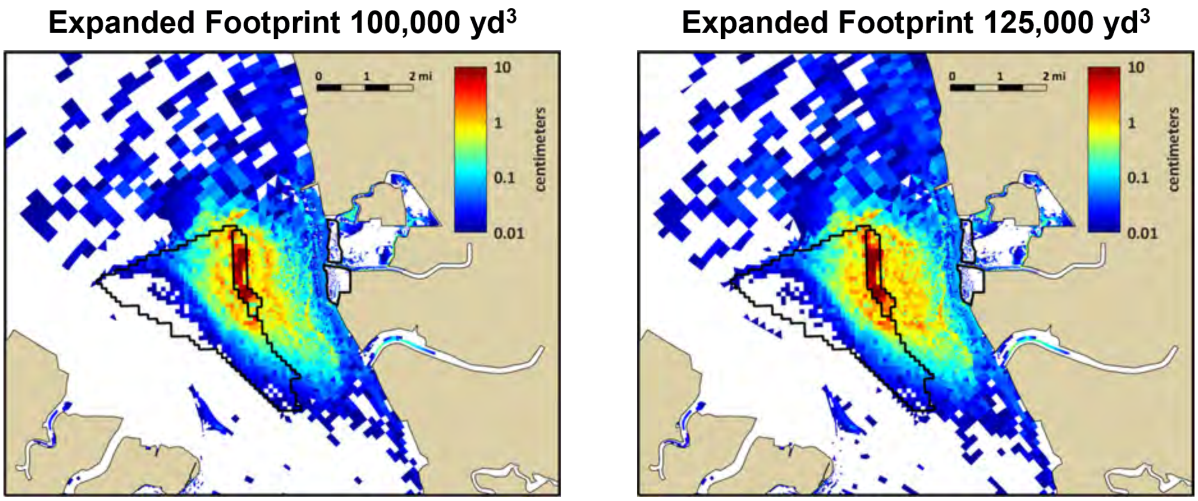
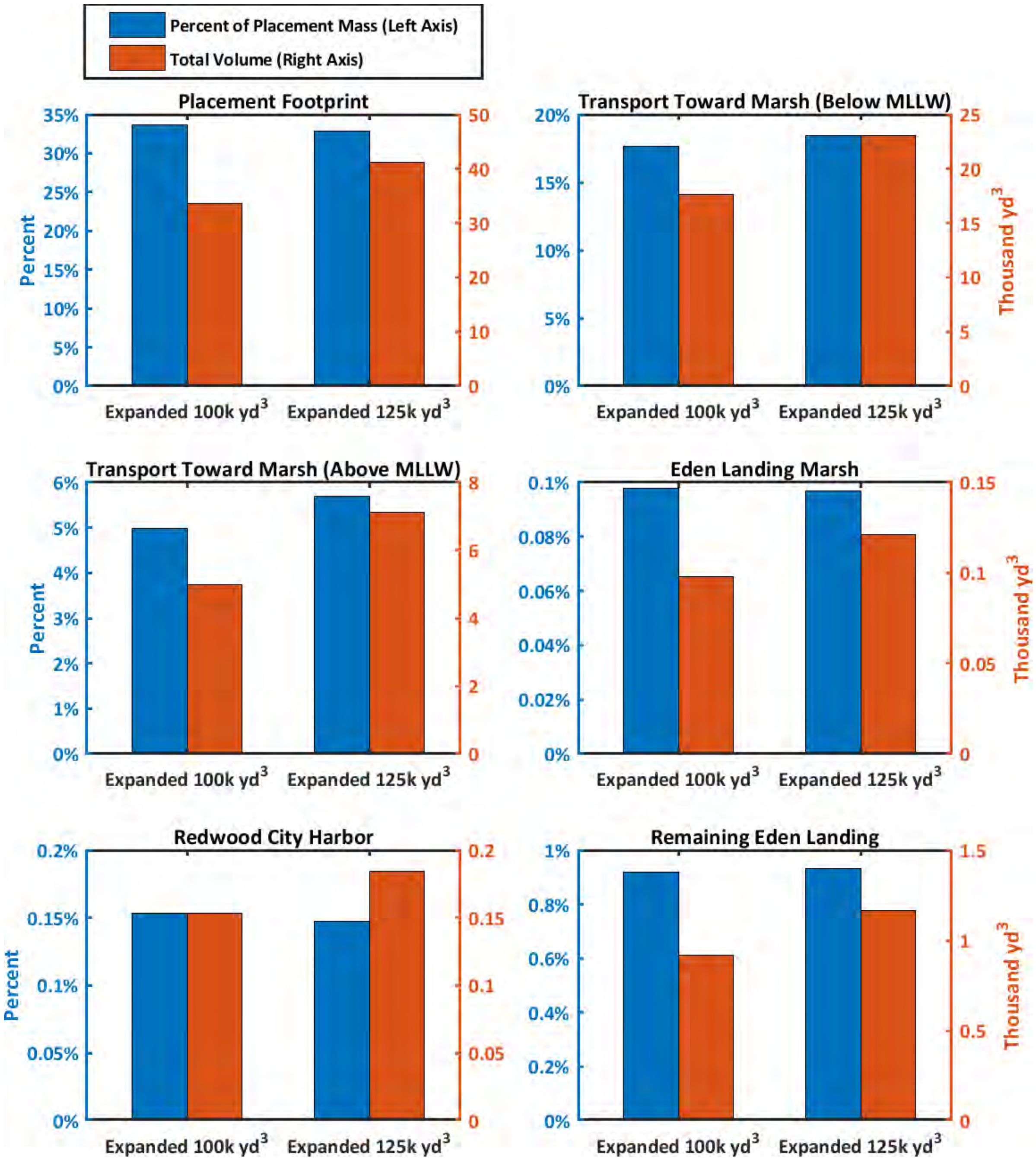


Figure 5.4-10
Predicted Percentage of Dredged Sediment Mass and Dredged Material Volume in Each Region at the End of the 2-Month Simulations for Evaluating Placement Volume in the Expanded Shallow/East Placement Footprint



6 Summary and Conclusions

Previous sediment transport modeling in San Francisco Bay focused on the dispersal of dredged material south of Dumbarton Bridge and demonstrated that dredged material could be naturally transported into breached salt ponds and onto mudflats (Bever and MacWilliams 2014; Bever et al. 2014). The study detailed in this report takes a similar approach and simulates the continual erosion, deposition, and transport of dredged material following open-water placements in San Francisco Bay.

In support of the WRDA Section 1122 Pilot Project in San Francisco Bay, a 3D hydrodynamic, wave, and sediment transport model was applied to predict the fate and transport of open-water dredged material placements in San Francisco Bay. This modeling was used to evaluate the suitability of two potential placement sites for implementation of the pilot study and to assess the most effective placement strategy for each site. A total of 12 sediment transport modeling scenarios were conducted to evaluate how the location of the placements, total volume of placed material, dredged material source, and seasonal timing of the placement affect dispersal away from the placement location.

Dredged material placement scenarios were conducted near two marshes in San Francisco Bay, Emeryville Crescent Marsh (Figure 1-1) and the Whale's Tail portion of Eden Landing Marsh (Figure 1-2). These two marshes were the target marshes for the natural dispersal of dredged material. The surface elevations of both of these marshes are high enough that the majority of the inundation and sediment transport onto the marshes will occur when water surface elevations are near MHHW or higher.

Predicted wave characteristics and wave-induced bed shear stress were evaluated to qualitatively determine differences within a placement area based on varying water depths, between summer versus winter periods, and between the Emeryville and Eden Landing placement areas. Significant wave height, bottom orbital velocity, and bed shear stress were higher during the summer period than during the winter period at both Emeryville and Eden Landing. The larger waves and higher bed shear stress result from the seasonally stronger winds in late-spring and early-summer than during the winter. The bottom orbital velocity and bed shear stress that act to resuspend sediment were the lowest on the western side of the placement grids and highest on the eastern side, at both Emeryville and Eden Landing. This results from the shallowing of the placement grids from the western to the eastern side and the increasing effect of wind waves as the water depth gets lower. The bed shear stress was further evaluated based on a 0.2-Pa cutoff. At Emeryville, the RMS bed shear stress was greater than the 0.2-Pa threshold over much of the placement grid. However, at Eden Landing, the RMS bed shear stress was only greater than this threshold toward the eastern side of the placement grid.

A total of 12 dredged material placement scenarios were conducted using the UnTRIM Bay-Delta model. A two-stage approach was used to develop the assumptions for the 12 scenarios. The first six scenarios were used to evaluate whether Emeryville or Eden Landing was most suitable for pilot study and to evaluate different placement strategies at each location to narrow in on most effective placement strategy. The remaining six scenarios were conducted to evaluate other aspects of the placements at Eden Landing, including the following:

- The placement volume in the shallow/east placement footprint
- The sediment source in the shallow/east placement footprint
- Placements during the summer versus winter in the shallow/east placement footprint
- Conducting placements in the shallow/east placement footprint versus an expanded footprint
- The placement volume in the expanded east placement footprint

Based on the initial six scenarios that evaluated placements at Emeryville and Eden Landing in the deep, middle, and shallow/east portions of the placement grids at each site, the highest percentage of the dredged material was transported toward and supplied to the respective marshes in the shallow/east placement scenarios for the Emeryville and Eden Landing placement locations. The deep placement scenarios resulted in the most dredged material being transported back into the federal navigation channels. The deep scenarios also resulted in the largest percentage of dredged material being dispersed away from any of the other analysis regions.

A lower percentage of the dredged material was predicted to remain in the placement footprints in the Eden Landing scenarios than in the scenarios with dredged material placements at Emeryville. This indicates more predicted dispersal from the Eden Landing placement footprints than from the Emeryville placement footprints. The Eden Landing scenarios also had more predicted deposition in the target marsh and on other mudflats and marshes—that is, above MLLW outside Eden Landing Marsh or Emeryville Crescent Marsh. The Eden Landing placement location was also predicted to supply dredged material to the other portion of the Eden Landing complex, not simply the Whale’s Tail portion of Eden Landing Marsh.

These findings suggest the Eden Landing placement location may be more suitable than the Emeryville placement location for the natural transport of dredged material away from the initial placement footprint and toward the marsh and to other mudflats/marshes. The findings also demonstrate that placements toward the shallower (eastern) side of the placement grids are more effective at getting transport toward the marshes and mudflats than placements in deeper water further toward the west of the placement grids.

Dredged material placements were conducted in the Eden Landing shallow/east placement footprint using 100,000 yd^3, 75,000 yd^3, and 50,000 yd^3 of dredged material. For the range of placement volumes simulated, the model predicted that the percentage of dredged material dispersed to the various analysis regions was similar, regardless of the placement volumes considered. Because each scenario included a different volume of dredged material, the volume of dredged material dispersed to each analysis region was different for each scenario. The scenario with 100,000 yd^3 of dredged material had the most predicted dispersal to each analysis region, followed by the scenario with 75,000 yd^3 of dredged material, and the scenario with 50,000 yd^3 of dredged material had the lowest predicted volume of dredged material in each region at the end of the simulations. The scenario with 100,000 yd^3 of dredged material resulted in the transport of more dredged material toward and into Eden Landing Marsh than the scenarios with a lower total placement volume.

Dredged material placements were conducted in the Eden Landing shallow/east placement footprint using 100,000 yd^3 of dredged material sourced from Redwood City Harbor and Oakland Harbor. The sediment from Oakland Harbor has roughly twice as much sand as the sediment from Redwood City Harbor, and the sand is not transported as far as the other sediment classes used in this sediment transport modeling study. The percentage of dredged material dispersed to the various analysis regions was influenced by the source of the dredged material. The increased sand content of the Oakland Harbor sediment relative to sediment from Redwood City Harbor resulted in a lower percentage of the placed material being transported out of the placement footprint and transported toward the marsh than when placing sediment sourced from Redwood City Harbor. However, the percentage of dredged material transported toward Eden Landing Marsh when placing Oakland Harbor sediment was still higher than when placing Redwood City Harbor sediment in either of the Eden Landing middle or deep placement locations. Because both scenarios used 100,000 yd^3 of dredged material, the volume of dredged material transported to the analysis regions correlates with the percentages of dredged material dispersed to the analysis regions. The comparison of these two scenarios showed that the source of the dredged material influenced the percentages and volumes of material dispersed to the analysis regions, but the effects were smaller than when shifting the placement footprint toward the west. However, the effects of the source of the dredged material could become larger if the sand content of the dredged material was higher than the sand content of the dredged material simulated for these scenarios.

Dredged material placements were conducted in the Eden Landing shallow/east placement footprint using 100,000 yd^3 of dredged material and placements occurring in the summer and winter. The winter simulation spanned 3 months, while the summer simulation only spanned 2 months. The percentage of dredged material dispersed to the various analysis regions was influenced by the seasonal period simulated. Conducting the placements during the winter resulted in a higher percentage of the placed dredged material remaining in the placement footprint at the end of the simulations than conducting the placements during the summer, even though the duration of the winter simulation was 50% longer (3 months instead of 2 months). There was a corresponding decrease in the percentage of dredged material dispersed toward the marsh and deposited both below and above MLLW, dispersed into Eden Landing, and dispersed into the remaining portion of the Eden Landing complex. When conducting the placements in the winter, the percentage of dredged material dispersed toward Eden Landing and deposited above MLLW and transported into Eden Landing Marsh was similar to when placing sediment in either of the middle or deep placement locations during the summer. Because both scenarios used 100,000 yd^3 of dredged material, the volume of dredged material transported to the analysis regions correlates with the percentages of dredged material dispersed to the analysis regions. There was increased predicted northward transport of dredged material in the winter period than the summer period, possibly resulting from the increased northward depth-averaged residual velocity in the winter compared to the summer. The comparison of these two scenarios indicates that differences in waves and hydrodynamics and the seasonal timing of the placements influences the dispersal away from the placement locations, especially when only considering dispersal over a 2- to 3-month period.

Dredged material placements were conducted in the Eden Landing shallow/east placement footprint and in an expanded shallow/east footprint using 100,000 yd^3 of dredged material. While the expanded footprint includes all of the placement cells in the original shallow/east footprint, the expanded footprint also includes placement cells to the west of the boundary of the placement grid. The percentage of dredged material dispersed to the various analysis regions was influenced by the westward expansion of the placement footprint. Using the expanded placement footprint resulted in a higher percentage of the placed dredged material remaining in the placement footprint at the end of the 2-month simulation versus using the shallow/east placement footprint. There was a corresponding slight decrease in the percentage of dredged material dispersed toward the marsh, dispersed into Eden Landing, and dispersed into the remaining portion of the Eden Landing complex. However, the percentage of dredged material transported toward Eden Landing Marsh when using the expanded placement footprint was still higher than when placing sediment in either of the middle or deep placement locations. Because both scenarios used 100,000 yd^3 of dredged material, the volume of dredged material transported to the analysis regions correlates with the percentages of dredged material dispersed to the analysis regions.

Dredged material placements were conducted in the Eden Landing expanded shallow/east placement footprint using 100,000 yd^3 and 125,000 yd^3 of dredged material. The percentage of dredged material dispersed to the various analysis regions was similar, regardless of the placement volumes considered. Because each scenario included a different volume of dredged material, the volume of dredged material dispersed to each analysis region was different for each scenario. The scenario with 125,000 yd^3 of dredged material had the most predicted dispersal to each analysis region. The scenario with 125,000 yd^3 of dredged material resulted in the transport of more dredged material toward and into Eden Landing Marsh than the scenario with a lower total placement volume.

This modeling study evaluated dispersal using discrete placement volumes ranging from 50,000 yd^3 to 125,000 yd^3 and simulations that spanned either 2 or 3 months. The periods simulated for this study were relatively short due to the limited timeline to complete the analysis to support site selection. It is expected that dredged material predicted to remain in the placement footprint or being transported toward the target marsh will continually be transported over time and that a larger fraction of that material will eventually reach the target marshes than was predicted over the first 2 to 3 months. However, because of the short duration of the simulations, there is uncertainty in attempting to extrapolate the results to a longer time period. This uncertainty in extrapolating the results to a longer time period (e.g., 1 year or more) is increased because a large portion of the dispersal away from the placement footprint occurs early in the simulations during the placements and because the results indicate large differences in dispersal between the summer and winter scenarios.

There is inherent uncertainty in the application of hydrodynamic models to predict sediment transport, and a number of assumptions were made to represent the placement of dredged material for this study. Some of these assumptions and limitations are described in Appendix B. Many of these assumptions are likely to affect the scenarios similarly, so the relative comparison between placement sites is less likely to be affected by this uncertainty than the exact magnitude of the deposited sediment. There is greater uncertainty in the exact magnitude of the predicted sediment deposition thicknesses, largely due to the absence of any data to validate the predicted deposition following actual dredged material placements in San Francisco Bay. Additional modeling following the implementation of the 1122 pilot project in San Francisco Bay and validation based on monitoring data collected during the pilot project can be used to further calibrate the model and reduce uncertainty in the long-term predictions of the sediment dispersal and deposition following placement.

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Appendix A
Model Validation

A.1 Summary

Because the UnTRIM Bay-Delta model has already been extensively calibrated for water levels, salinity, and flows (MacWilliams et al. 2015), no further model calibration was conducted as part of this study. To validate the prediction of suspended sediment concentration (SSC) in the study area, the predicted SSC was compared to observed SSC at all locations in San Francisco Bay where SSC measurements were available during the two analysis periods used in this study to evaluate the dredged material placement scenarios. This appendix provides model validations of SSC throughout the Bay during the period that dredged material dispersal was evaluated. Predicted SSC was compared to observed SSC using time series at discrete locations from Dumbarton Bridge to Mallard Island. Time series data were available from six locations through the U.S. Geological Survey (USGS; USGS 2020) and at another location in San Pablo Bay (Schoellhamer et al. 2008).

A.2 Statistics Used for Model Validation

Following the approach used by MacWilliams et al. (2015), model skill and target diagrams were used to provide quantitative metrics for evaluating model accuracy. Willmott (1981) defined the predictive skill of a model based on the quantitative agreement between observations (*O*) and model predictions (*M*), as shown in Equation A-1.

Equation A-1

$$Skill = 1 - \left[\sum_{i=1}^{N} \left| X_{Mi} - X_{Oi} \right|^2 \right] \Bigg/ \left[\sum_{i=1}^{N} \left(\left| X_{Mi} - \overline{X_O} \right| + \left| X_{Oi} - \overline{X_O} \right| \right)^2 \right]$$

where:

X	=	the variable being compared
$\bar{X}$	=	time average of *X*
M_i	=	model value at time *i* of *N* total comparison times
O_i	=	observation at time *i*

Perfect agreement between model results and observations yields a skill of 1. Although the Willmott (1981) model skill metric has some shortcomings (Ralston et al. 2010), it has nevertheless been used for comparing model predictions to observed data in numerous hydrodynamic modeling studies (e.g., Warner et al. 2005b; Haidvogel et al. 2008; MacWilliams and Gross 2013; MacWilliams et al. 2015).

Jolliff et al. (2009) and Hofmann et al. (2011) provide detailed descriptions of target diagrams and their use in assessing model skill. This approach uses the *bias* and the unbiased root-mean-square difference (*ubRMSD*) to assess the accuracy of the model predictions. The *bias* of the model estimates is calculated as shown in Equation A-2.

Equation A-2

$$bias = \frac{1}{N}\sum_{i=1}^{N} X_{Mi} - \frac{1}{N}\sum_{i=1}^{N} X_{Oi}$$

The *ubRMSD* is calculated as shown in Equation A-3.

Equation A-3

$$ubRMSD = \left(\frac{1}{N}\sum_{i=1}^{N} \left[\left(X_{Mi} - \overline{X_M} \right) - \left(X_{Oi} - \overline{X_O} \right) \right]^2 \right)^{0.5}$$

To indicate whether the modeled variability is greater than or less than the observed variability, the *ubRMSD* is multiplied by the sign of the difference in the modeled and observed standard deviations, as shown in Equation A-4.

Equation A-4

$$ubRMSD_2 = ubRMSD(\sigma_M - \sigma_O)/|\sigma_M - \sigma_O|$$

where:

σ_M	=	modeled standard deviation
σ_O	=	observed standard deviation

The *bias* and the $ubRMSD_2$ are normalized (denoted by subscript *N*) by the observed standard deviation to make their absolute values comparable among different variables and different sets of observed data, as shown in Equations A-5 and A-6.

Equation A-5

$$bias_N = bias/\sigma_O$$

Equation A-6

$$ubRMSD_N = ubRMSD_2/\sigma_O$$

On each target diagram, the $bias_N$ between modeled and observed values is plotted on the y-axis, and the $ubRMSD_N$ is plotted on the x-axis. The radial distance from the origin to each data point is the normalized root-mean-square difference ($RMSD_N$), as shown in Equation A-7.

Equation A-7

$$RMSD_N = \sqrt{bias_N^2 + ubRMSD_N^2}$$

MacWilliams et al. (2015) provide a more detailed description of the model validation methods and suggest thresholds for the validation metrics that indicate model accuracy. These target diagram thresholds were adopted in this report to classify the model accuracy. Very accurate predictions are classified as those with an $RMSD_N$ of less than 0.25, and accurate predictions are classified as those with an $RMSD_N$ of less than 0.5. Acceptable predictions are indicated by an $RMSD_N$ of less than 1.0, and an $RMSD_N$ of greater than 1.0 indicates less accurate predictions.

A.3 Validation of Predicted SSC

Predicted SSCs were validated using continuous-monitoring time-series data at fixed locations in the Bay (Figures A-1 and A-2). Time-series SSC was validated at a total of seven locations, with four locations having both upper and lower sensors. This resulted in a total of 11 comparisons. Predicted SSC was validated for the 2009 and 2016 dredged material analysis periods separately, and not all locations were available for both years. The figures for comparing predicted and observed time series include an upper panel that highlights the instantaneous predicted and observed SSC over relatively short time intervals, tidal-averaged predicted and observed SSC on the lower left panel over the complete analysis period, and a scatter plot on the lower right panel incorporating the complete analysis period.

Using the thresholds for model accuracy from MacWilliams et al. (2015), SSC in 2016 to 2017 was acceptably predicted for five comparisons, but the $RMSD_N$ was greater than 1.0 for three comparisons (Table A-1; Figures A-3 through A-11). At the Alcatraz station, predicted SSC accurately captured the increase in SSC as a result of the 2017 high Delta outflow period (Figure A-4). This suggests that the predicted SSC accurately captured the timing of the turbid pulse of water from elevated Delta outflow. The predicted SSC had similar tidal timescale variability to the observed SSC. The model did not capture the very short-duration spikes in observed SSC. At the Pier 17 station, predicted SSC also accurately captured the increase in SSC as a result of the 2017 high Delta outflow period and underestimated the relatively short-duration large-magnitude spikes in the observed SSC at Pier 17. Overall, the predicted SSC accurately reproduced the observed SSC from Benicia Bridge to Dumbarton Bridge.

Using the thresholds for model accuracy from MacWilliams et al. (2015), SSC in 2009 was acceptably predicted for six comparisons, but the $RMSD_N$ was greater than 1.0 for four comparisons (Table A-2; Figures A-12 through A-22). At the Alcatraz station, predicted SSC very accurately captured the tidal and spring-neap variability in the observed SSC (Figure A-13). At the Hamilton Disposal Site (Aquatic Transfer Facility) location on the San Pablo Bay shoals, the predicted SSC captured the tidal and spring-neap variability but did not capture the very short-duration spikes in observed SSC (Figure A-16). Overall, the predicted SSC accurately reproduced the observed SSC from Mallard Island to Dumbarton Bridge.

Table A-1
Predicted and Observed SSC, Cross-Correlation Statistics, Model Skill, and Target Diagram Statistics for SSC Continuous Monitoring Stations for the 2016-2017 Simulation

Station	Mean SSC		Cross Correlation		r^2	Skill	Target Diagram		
	Observed (mg/L)	Predicted (mg/L)	Amp Ratio	Lag (min)			$bias_N$	$ubRMSD_N$	$RMSD_N$
Alcatraz (ALC)	29.5	25.7	0.711	NA	0.445	0.801	-0.212	0.845	0.871
Pier 17 (P17)	50.1	32.1	0.287	NA	0.311	0.607	-0.398	-0.831	0.921
Richmond-San Rafael Bridge (RSR, Upper)	31.8	51.6	0.790	NA	0.366	0.706	0.494	1.061	1.170
Richmond-San Rafael Bridge (RSR, Lower)	63.2	69.7	0.396	NA	0.315	0.699	0.076	-0.840	0.843
Benicia Bridge (BEN, Upper)	63.0	36.0	0.308	8	0.716	0.650	-0.556	-0.719	0.909
Benicia Bridge (BEN, Lower)	100.0	67.5	0.123	24	0.129	0.500	-0.589	-0.933	1.103
Dumbarton Bridge (DUM, Upper)	71.8	56.5	0.241	47	0.366	0.602	-0.250	-0.823	0.860
Dumbarton Bridge (DUM, Lower)	129.4	69.4	0.163	23	0.347	0.498	-0.624	-0.867	1.068

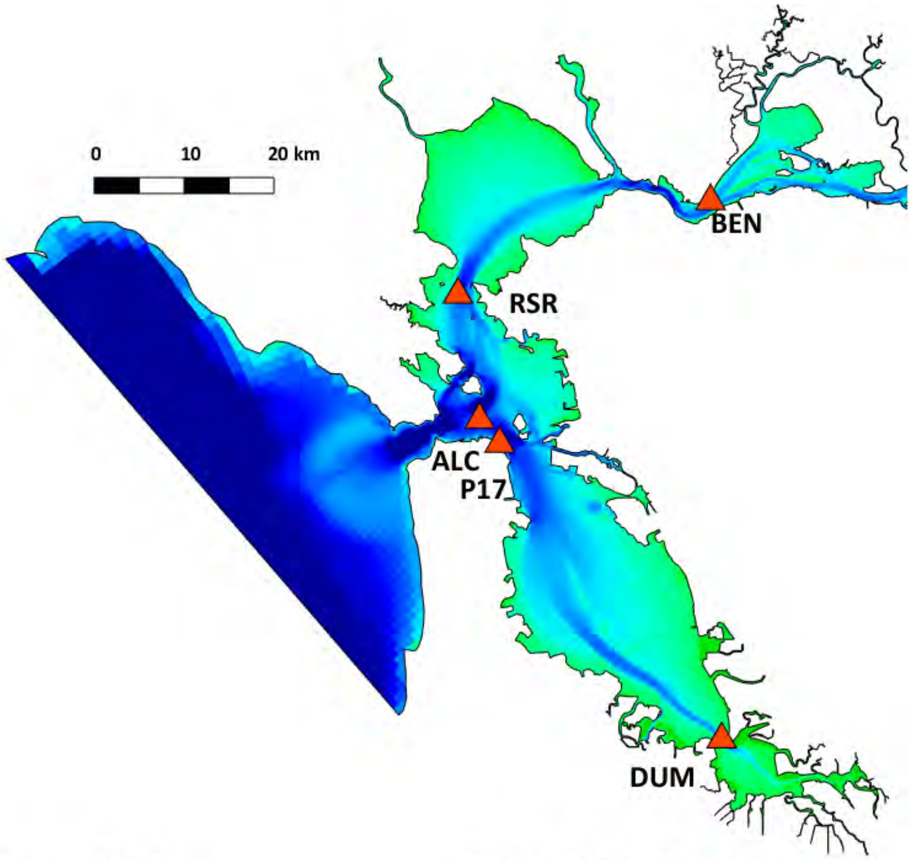
Note:
The cross correlation did not find a maximum r^2 within a lag of ±60 minutes (indicated as "NA" for not applicable).

Table A-2
Predicted and Observed SSC, Cross-Correlation Statistics, Model Skill, and Target Diagram Statistics for SSC Continuous Monitoring Stations for the 2009 Simulation

Station	Mean SSC		Cross Correlation		r^2	Skill	Target Diagram		
	Observed (mg/L)	Predicted (mg/L)	Amp Ratio	Lag (min)			$bias_N$	$ubRMSD_N$	$RMSD_N$
Alcatraz (ALC)	18.5	16.2	0.677	-56	0.636	0.861	-0.302	-0.605	0.676
Richmond-San Rafael Bridge (RSR, Upper)	33.6	33.9	0.322	-7	0.378	0.679	0.012	-0.794	0.794
Richmond-San Rafael Bridge (RSR, Lower)	33.6	45.6	0.322	NA	0.224	0.600	0.405	-0.905	0.991
Hamilton Disposal Site (ATF)	71.8	58.7	0.213	5	0.331	0.561	-0.187	-0.843	0.863
Benicia Bridge (BEN, Upper)	34.6	42.2	0.257	23	0.242	0.611	0.493	-0.871	1.001
Benicia Bridge (BEN, Lower)	83.1	81.2	0.188	38	0.148	0.545	-0.049	-0.929	0.930
Mallard Island (MAL, Upper)	30.7	26.9	0.332	27	0.204	0.600	-0.529	-0.936	1.075
Mallard Island (MAL, Lower)	29.2	28.8	0.168	45	0.030	0.465	-0.048	-1.264	1.265
Dumbarton Bridge (DUM, Upper)	57.5	75.5	0.446	40	0.343	0.666	0.684	-0.829	1.075
Dumbarton Bridge (DUM, Lower)	90.4	88.6	0.280	52	0.311	0.647	-0.042	-0.832	0.833

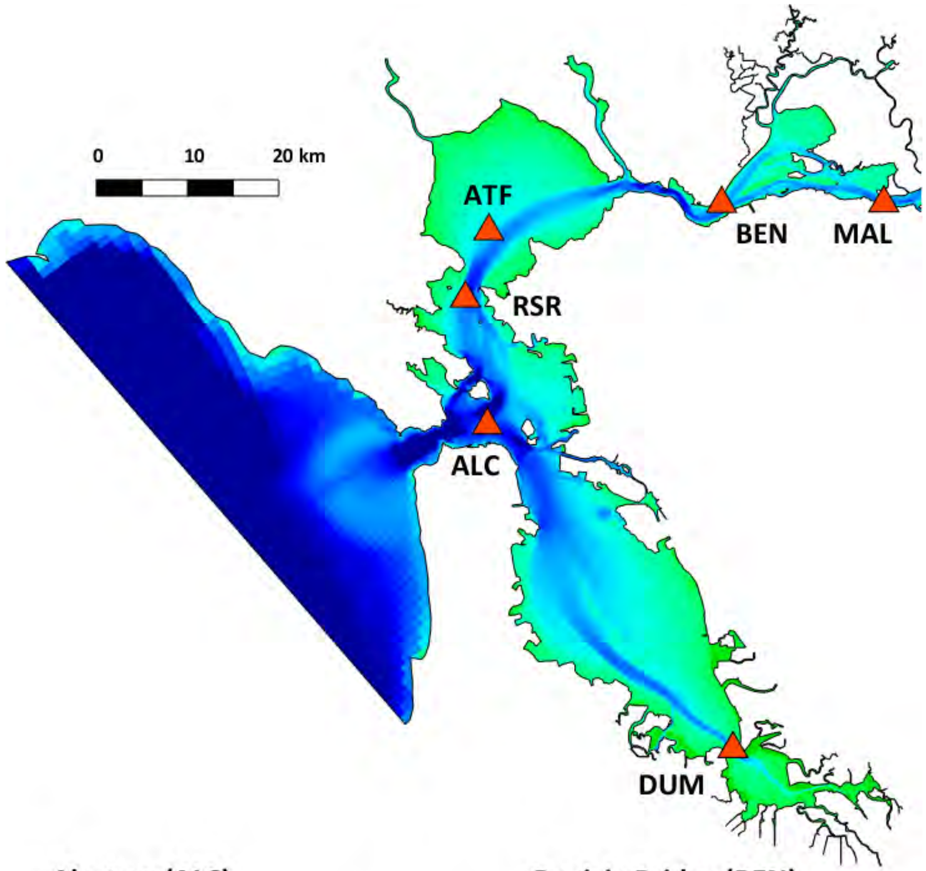
Note:
The cross correlation did not find a maximum r^2 within a lag of ±60 minutes (indicated as “NA” for not applicable).

Figure A-1
SSC Continuous Monitoring Stations Used for Model Validation for the 2016 to 2017 Simulation Period



Alcatraz (ALC)
Pier 17 (P17)
Richmond-San Rafael Bridge (RSR)
Benicia Bridge (BEN, Upper)
Dumbarton Bridge (DUM, Upper)

Figure A-2
SSC Continuous Monitoring Stations Used for Model Validation for the 2009 Simulation Period



Alcatraz (ALC)
Richmond-San Rafael Bridge (RSR)
Hamilton Disposal Site (ATF)
Benicia Bridge (BEN)
Mallard Island (MAL)
Dumbarton Bridge (DUM)

Figure A-3
Target Diagram Showing the Model Validation Using the Time Series SSC for the 2016 to 2017 Simulation Period

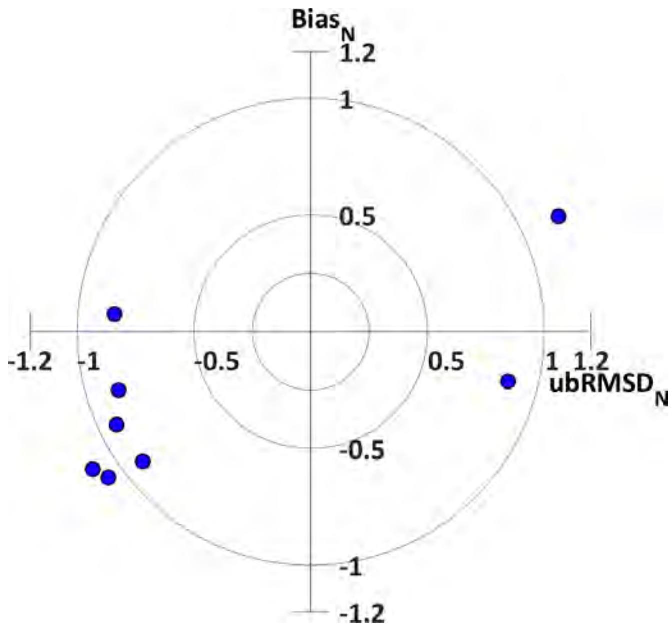


Figure A-4
Observed and Predicted SSC at Alcatraz During the 2016 to 2017 Simulation Period

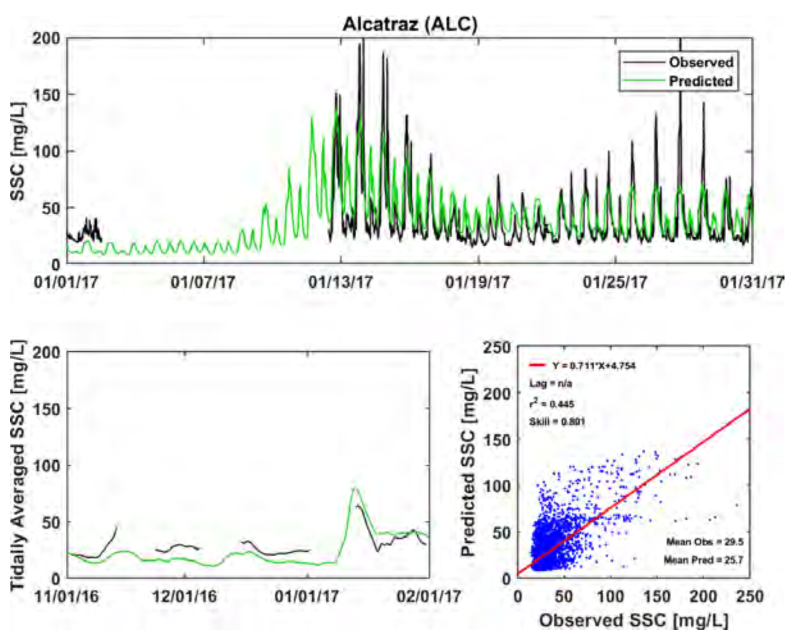


Figure A-5
Observed and Predicted SSC at Pier 17 During the 2016 to 2017 Simulation Period

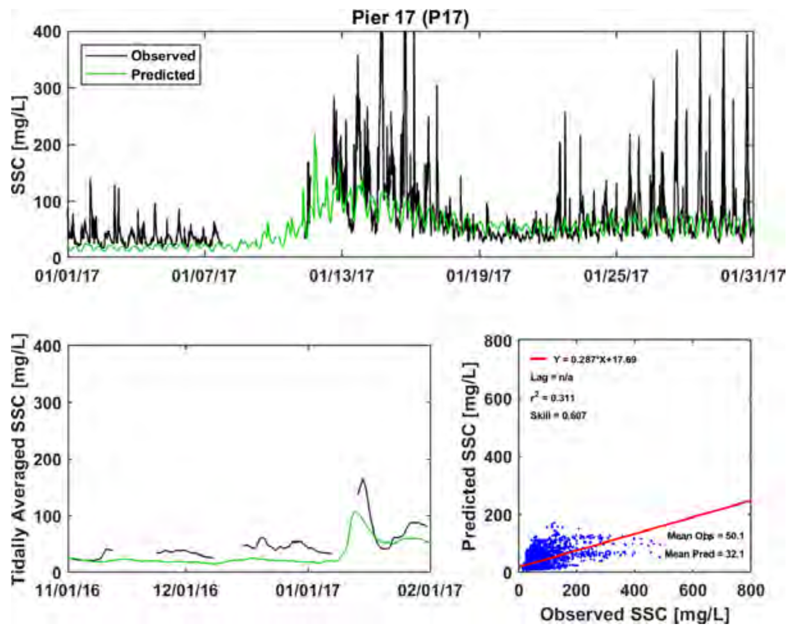


Figure A-6
Observed and Predicted SSC at Richmond-San Rafael Bridge (Upper) During the 2016 to 2017 Simulation Period

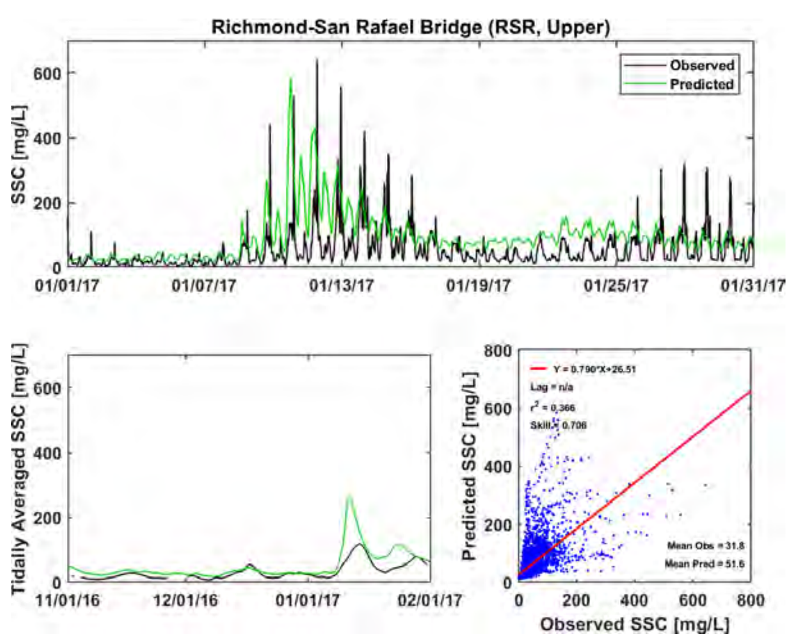


Figure A-7
Observed and Predicted SSC at Richmond-San Rafael Bridge (Lower) During the 2016 to 2017 Simulation Period

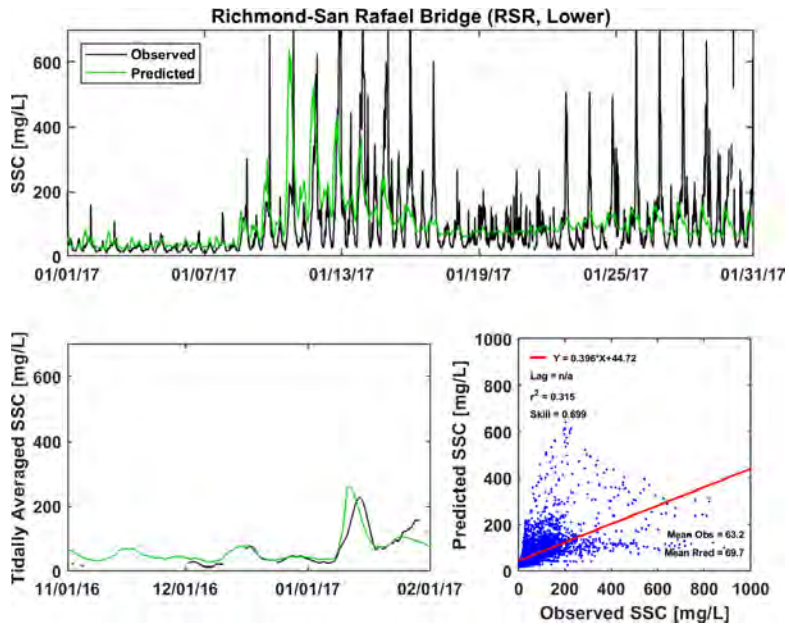


Figure A-8
Observed and Predicted SSC at Benicia Bridge (Upper) During the 2016 to 2017 Simulation Period

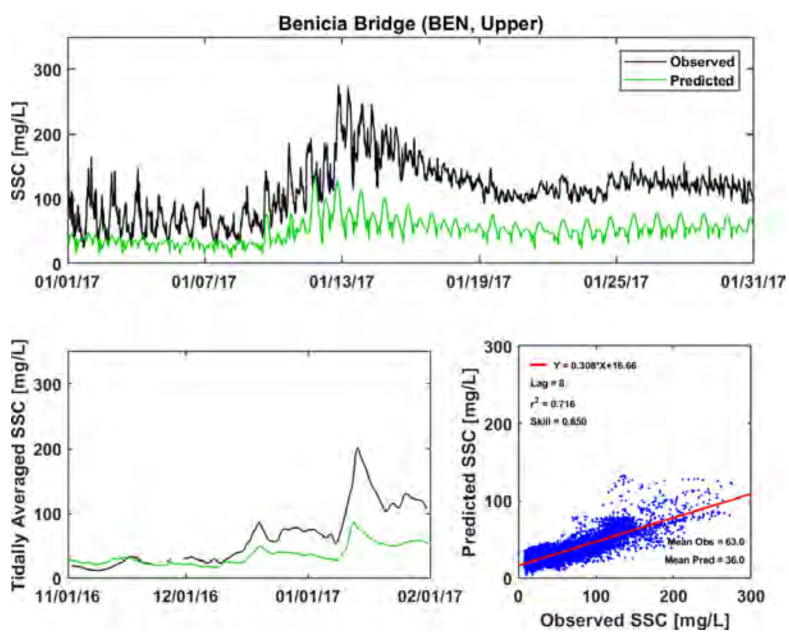


Figure A-9
Observed and Predicted SSC at Benicia Bridge (Lower) During the 2016 to 2017 Simulation Period

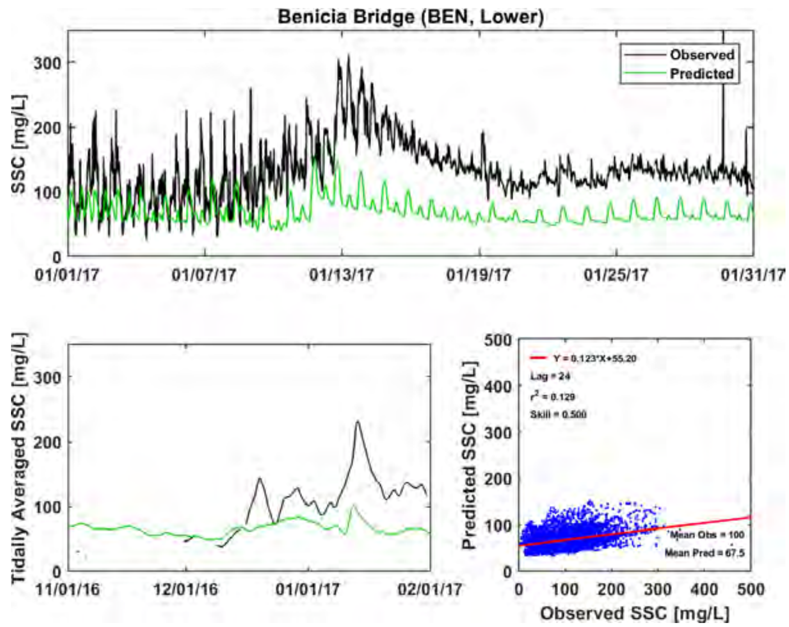


Figure A-10
Observed and Predicted SSC at USGS Dumbarton Bridge (Upper) During the 2016 to 2017 Simulation Period

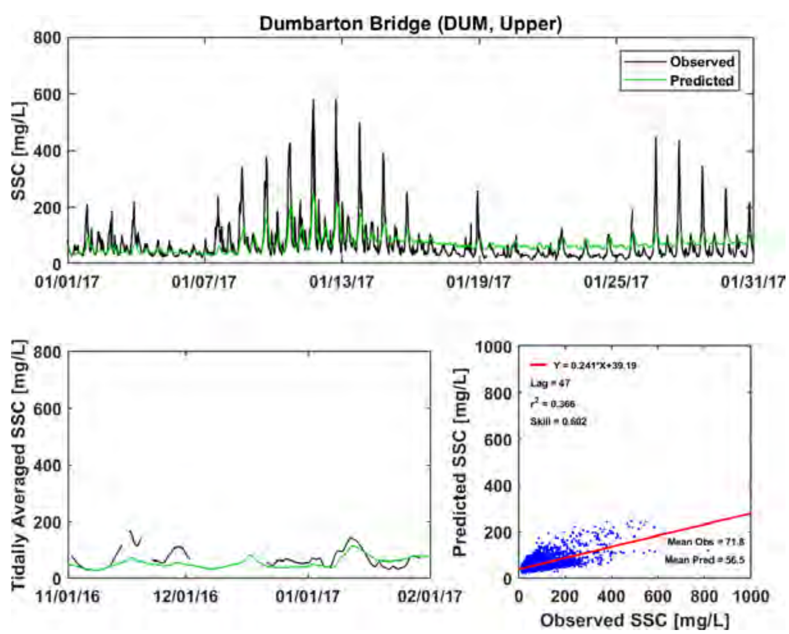


Figure A-11
Observed and Predicted SSC at USGS Dumbarton Bridge (Lower) During the 2016 to 2017 Simulation Period

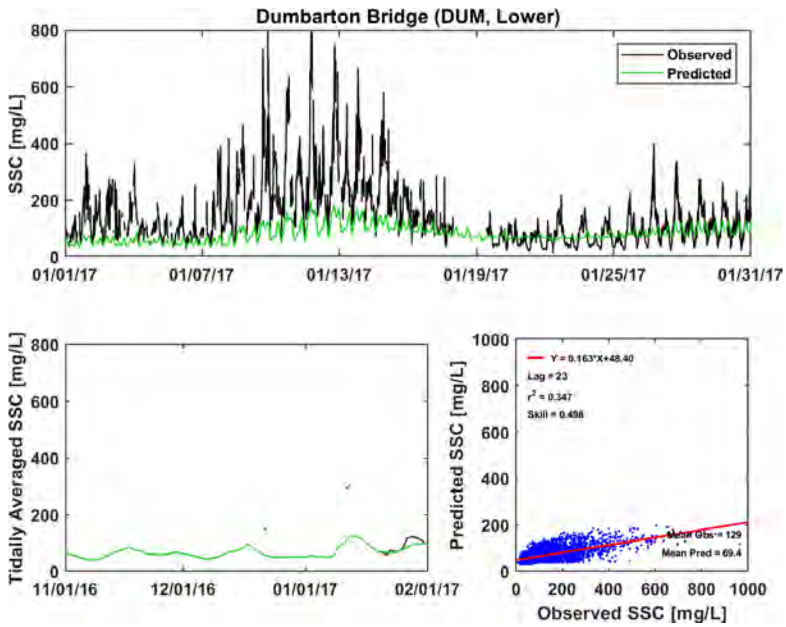


Figure A-12
Target Diagram Showing the Model Validation Using the Time Series SSC for the 2009 Simulation Period

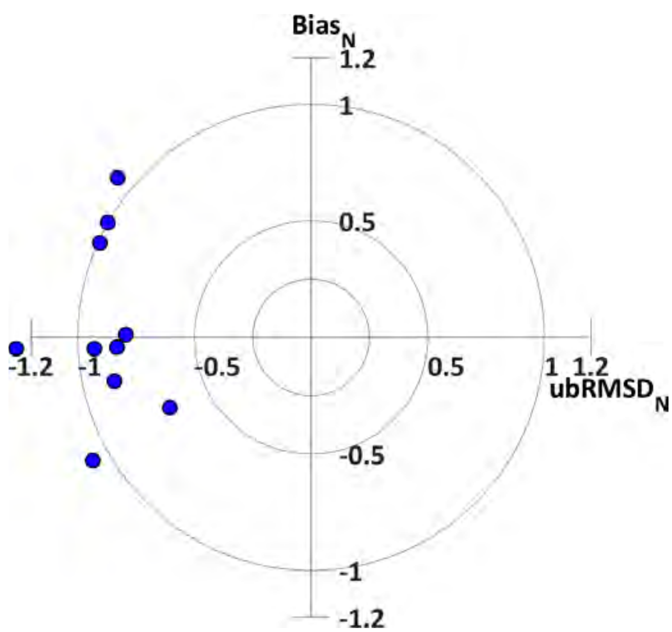


Figure A-13
Observed and Predicted SSC at Alcatraz During the 2009 Simulation Period

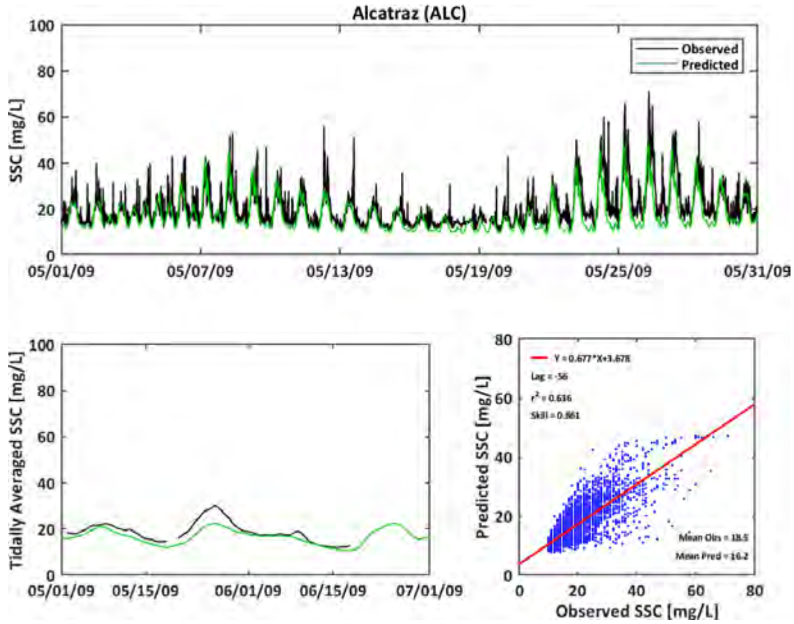


Figure A-14
Observed and Predicted SSC at Richmond-San Rafael Bridge (Upper) During the 2009 Simulation Period

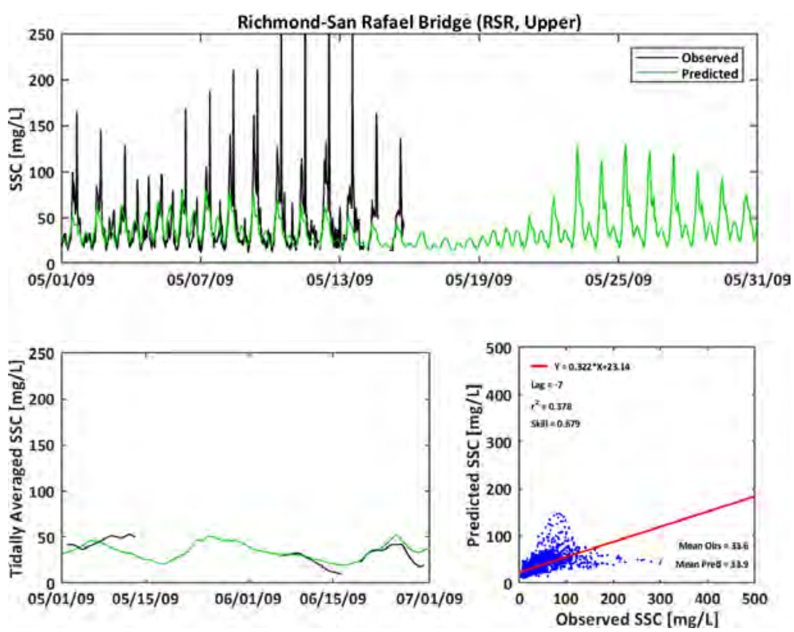


Figure A-15
Observed and Predicted SSC at Richmond-San Rafael Bridge (Lower) During the 2009 Simulation Period

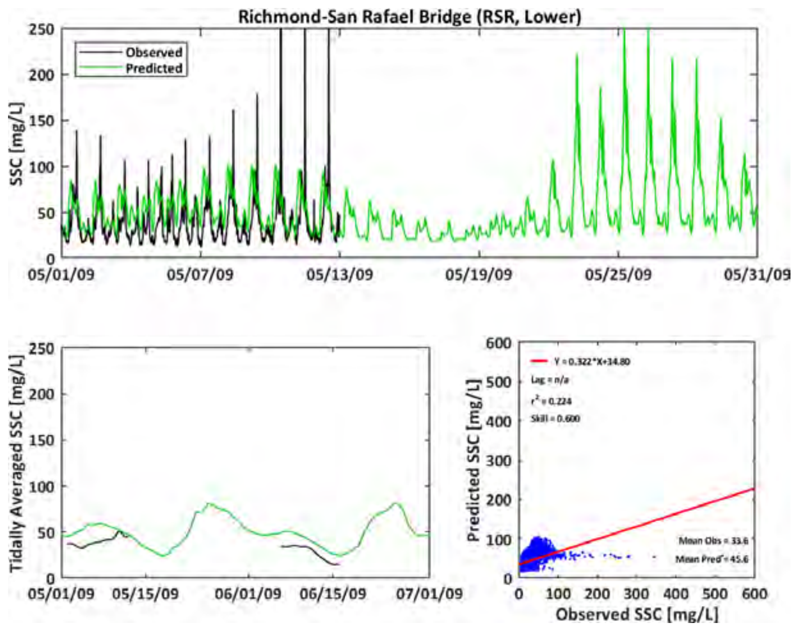


Figure A-16
Observed and Predicted SSC at Hamilton Disposal Site During the 2009 Simulation Period

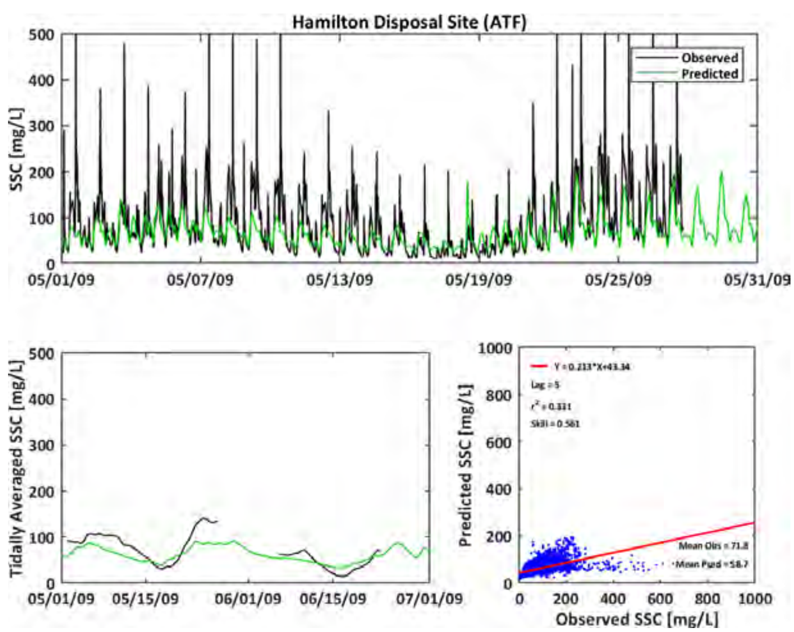


Figure A-17
Observed and Predicted SSC at Benicia Bridge (Upper) During the 2009 Simulation Period

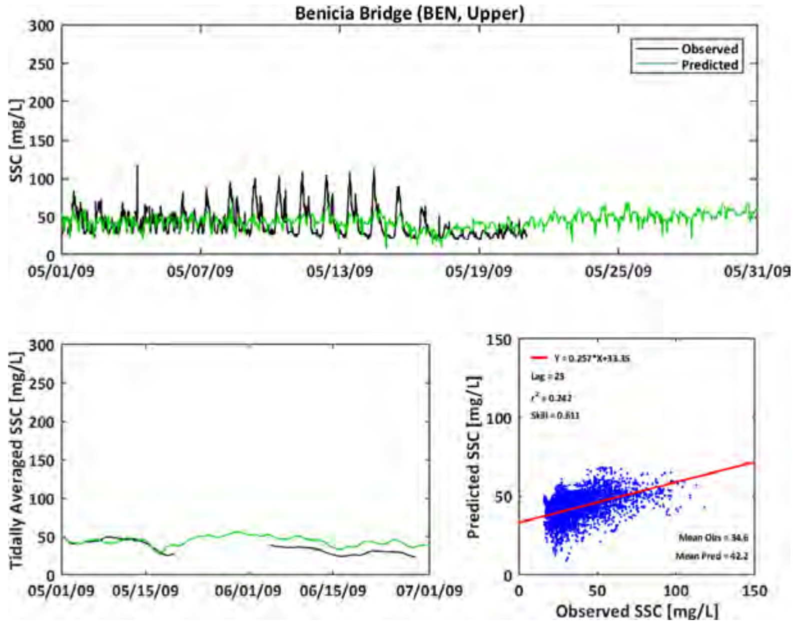


Figure A-18
Observed and Predicted SSC at Benicia Bridge (Lower) During the 2009 Simulation Period

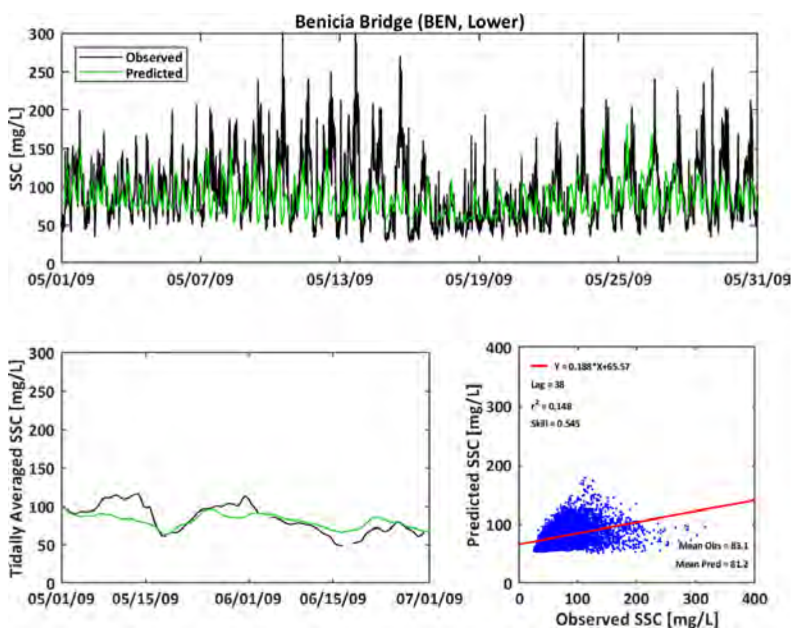


Figure A-19
Observed and Predicted SSC at Mallard Island (Upper) During the 2009 Simulation Period

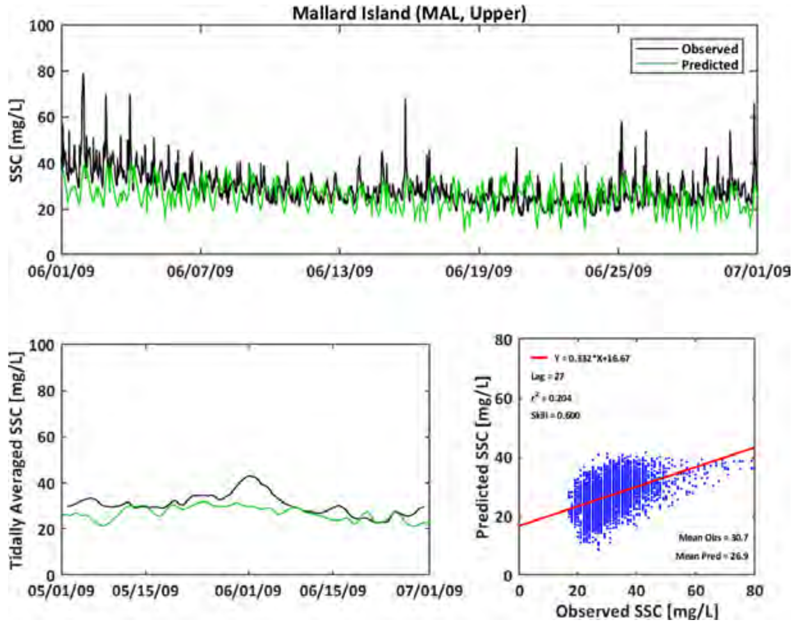


Figure A-20
Observed and Predicted SSC at Mallard Island (Lower) During the 2009 Simulation Period

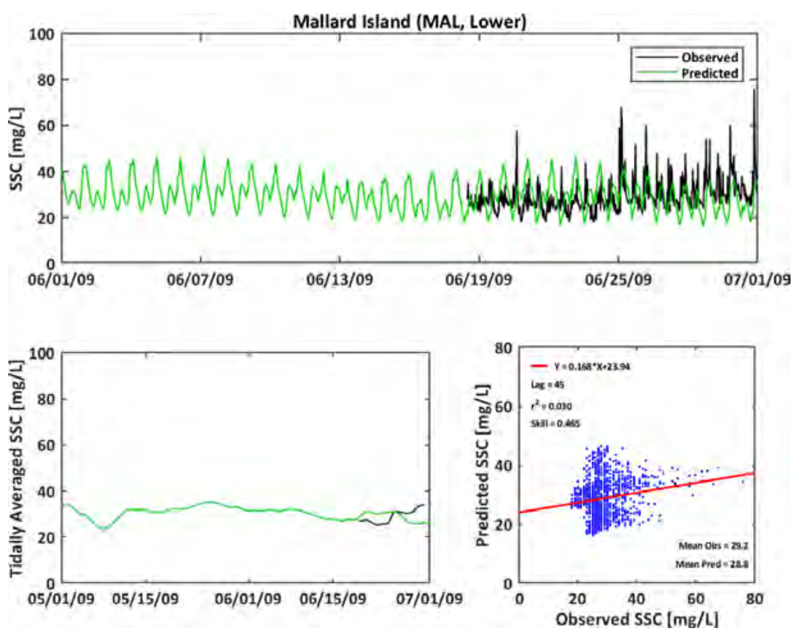


Figure A-21
Observed and Predicted SSC at Dumbarton Bridge (Upper) During the 2009 Simulation Period

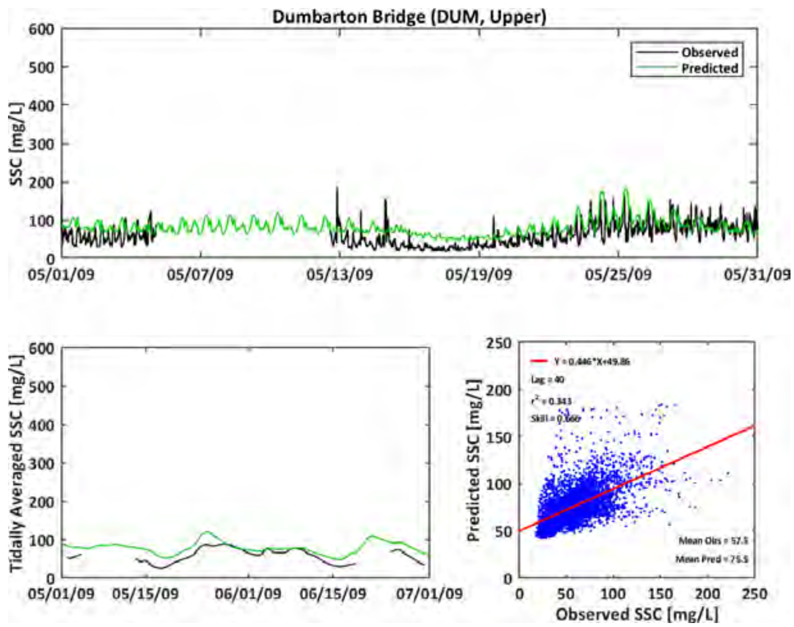
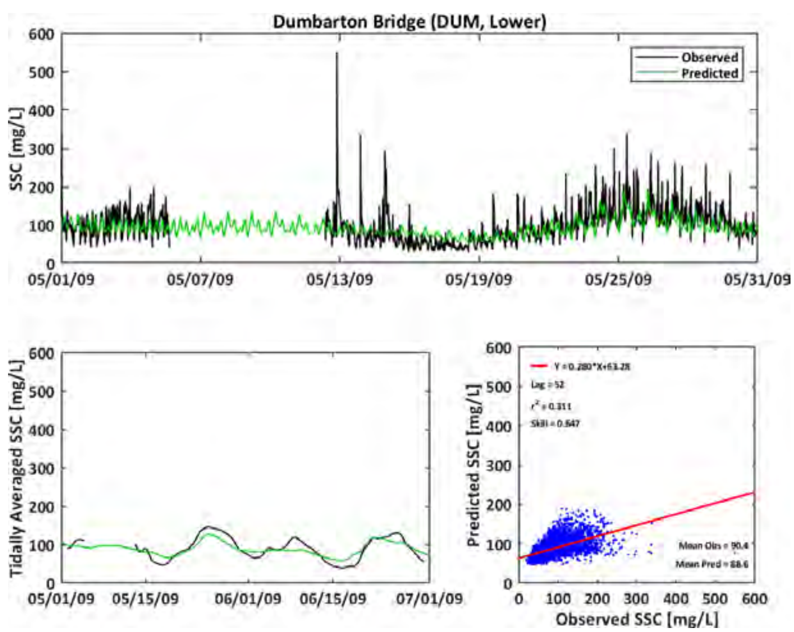


Figure A-22
Observed and Predicted SSC at Dumbarton Bridge (Lower) During the 2009 Simulation Period



Appendix B
Assumptions and Limitations of the Coupled Modeling System

B.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 Simulating WAves Nearshore (SWAN) wave model, and the SediMorph seabed and sediment transport model are presented in MacWilliams et al. (2015), Bever and MacWilliams (2013), and Bever et al. (2018). This appendix summarizes the model boundary conditions and data sources that can be used as a quick reference (Figure B-1; Table B-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 National Oceanic and Atmospheric Administration (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 kilometers west of the open boundary. The initial salinity field in the Bay was specified based on vertical salinity profiles collected by the U.S. Geological Survey (USGS) at 38 stations along the axis of the estuary and in the Delta by interpolating from continuous monitoring stations. 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 B-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 were set based on hourly data from the California Irrigation Management Information System (CIMIS), while evaporation and precipitation in the Delta was 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 B-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).

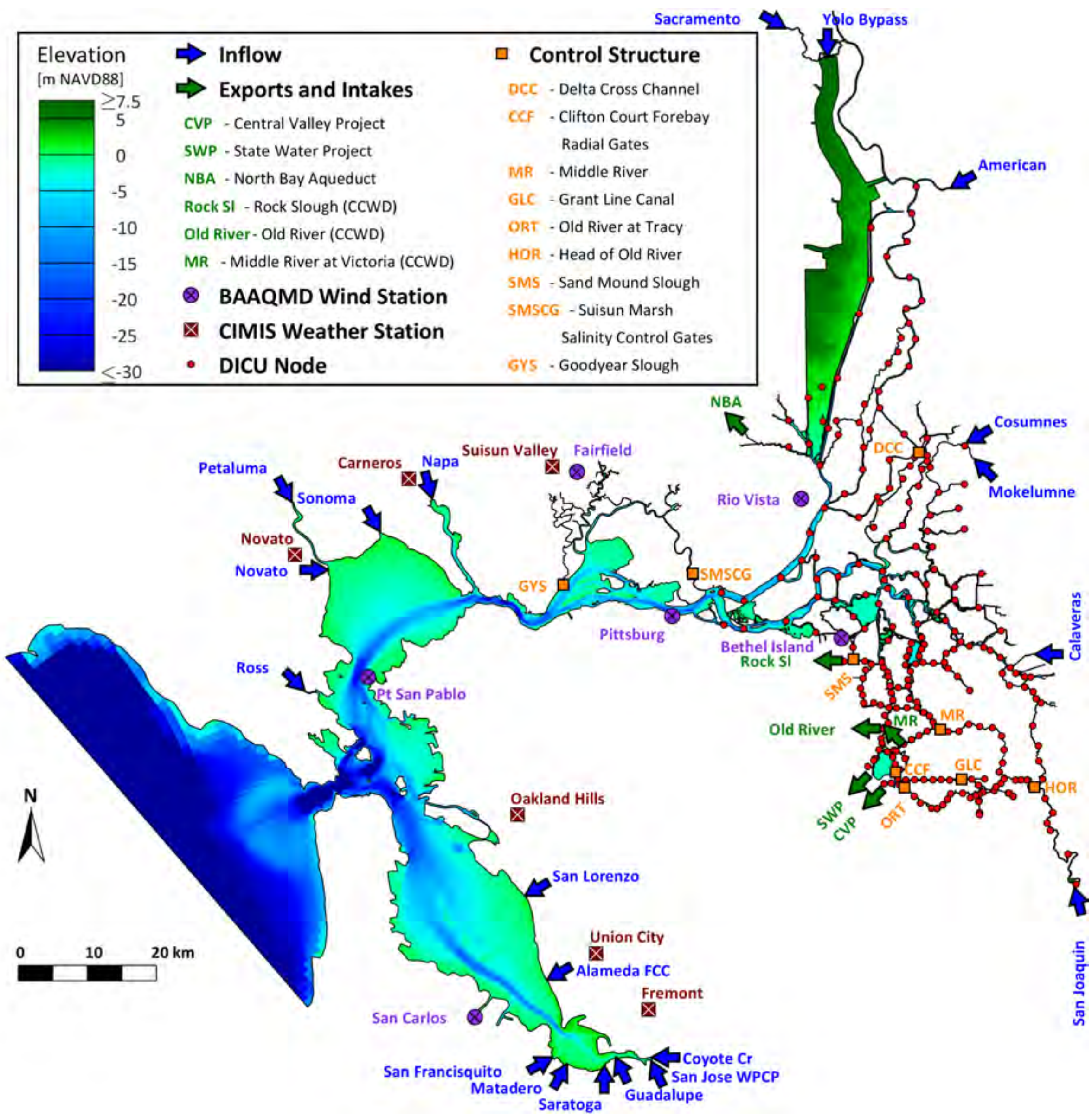
Sediment transport calculations included five sediment classes, each with different particle size, settling velocity, critical shear stress, density, and erosion rate parameter (Table 2-1). The five sediment classes were chosen to represent the dominant constituents in the real Bay grain size distribution and were fine clay/silt, single particle silt, flocculated silts and clays called "flocs," sand, and gravel with characteristics based on data from the 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 Bay-Delta system. Grain size distribution data were compiled from a U.S. Army Corps of Engineers (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 (Wright 2012). Suspended sediment was supplied through river input to the 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). SSCs were set based on time series concentrations from USGS, daily concentrations from USGS, or rating curves, 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 B-1
Summary of Data Sources Used for Model Boundary Conditions

Boundary Condition Type	Boundary Condition/Forcing	Description/Sources
UnTRIM Initial Conditions	Bathymetry	High-resolution bathymetric data from several sources
	Navigation channel alignments in the grid	Provided by USACE
	Salinity	Based on USGS water quality sampling in the Bay and interpolated using continuous monitoring stations in the Delta
Hydrodynamic Forcing	Tidal forcing	6-minute data from NOAA San Francisco tide station (9414290)
	Open boundary salinity	Daily salinity at Farallon Islands
	Inflows	Daily using Dayflow for Delta tributaries and USGS data for Bay tributaries
	Exports	Daily from Dayflow and the California Data Exchange Center
	DICU	Monthly based on the Delta Island Consumptive Use Model
	Flow control structures	Seasonally nine Delta control structures (MacWilliams et al. 2009)
	Evaporation/precipitation	Hourly data from CIMIS
	Wind	Hourly data from 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), and Smith and Friedrichs (2011)
	Seabed grain size distribution	Based on surface grain size distributions from USGS (Barnard et al. 2013; Wright 2012), USACE (Pratt et al. 1994), and dbSEABED database (Jenkins 2010)
	Inflow SSC	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 B-1
Golden Gate High-Resolution UnTRIM Bay-Delta Model Domain, Bathymetry, and Locations of Model Boundary Conditions that Include Inflows, Export Facilities, Contra Costa Water District (CCWD) Intakes, Wind Stations from the Bay Area Air Quality Management District (BAAQMD), Evaporation and Precipitation from California Irrigation Management Information System (CIMIS) Weather Stations, Delta Island Consumptive Use (DICU), and Flow Control Structures



B.2 UnTRIM Numerical Model Uncertainty

As discussed in Section 2, the UnTRIM model has been widely used in the Bay, and numerous detailed model calibrations have been performed. 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 timescale. 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 3D model applied in this project provides a more detailed description of fluid motion in the Bay than depth-averaged or 1D models. The UnTRIM model, like almost all large-scale hydrodynamic models, averages over the turbulent timescale to describe tidal timescale motions. The resulting 3D 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 3D models. 3D 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 3D models, detailed as follows:

- **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 higher 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 3D 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, Light Detection and Ranging (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 timescale motions is parameterized by a turbulence closure, as is done in other 3D hydrodynamic numerical models of similar spatial and temporal scale as the UnTRIM Bay-Delta model (e.g., Warner et al. 2005a; Wang et al. 2011). While many turbulence closures are available (e.g., Warner et al. 2005a), 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 UnTRIM model 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 the 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 ungauged portions of watersheds and uncertainty in estimates of outflows and diversions in the 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 Bay and South Bay, and the highest computationally practical grid resolution throughout the domain. However, some of the available bathymetric data sets in other portions of the Bay are relatively 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 DICU estimates from the California Department of Water Resources. 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.

B.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 and bottom friction.

B.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, as well as bed forms such as ripples and dunes, and can also vary significantly in both space and time.

B.5 Sediment Transport Modeling Assumptions and Limitations

The interaction of tides, winds, waves, and sediments results in complex physical processes that 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 that 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 it 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 as follows.

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 fine silt, silt, and floc sediment classes. The sediment properties for the five modeled sediment classes were selected to represent fine silts, single particles of silt (silt), aggregated clay and silt particles that 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 the 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 SSCs within the Bay. However, in reality, flocs continuously undergo aggregation and disaggregation due to physical and biological changes in the water (Mikkelsen et al. 2006), such as changes to turbulence and the Kolmogrov microscale, varying SSCs, compaction of the seabed and subsequent resuspension, sediment interaction with biofilms, and incorporation into fecal pellets (some examples in Eisma 1986; Fugate and Friedrichs 2003; Hill and McCave 2001). These processes are extremely complex and are not easily incorporated into a numerical model. Previous sediment modeling studies in the Bay (e.g., Bever and MacWilliams 2013, 2014; Bever et al. 2018; van der Wegen et al. 2011; Schoellhamer et al. 2008; Ganju and Schoellhamer 2009) 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 SSCs 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.

Because bed consolidation is not currently represented in the model, the model may overpredict the transport distance of the sediment. 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 SSCs 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 timescales 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 from hydrographic survey data so the modeled thicknesses and volumes agree with the hydrographic survey 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 previously 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 SSCs 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 wide range in environmental conditions 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 SSCs indicate that the model is predicting a similar magnitude of concentration as the observations, capturing the seasonal and spatial trends, and capturing the observed tidal timescale variations and along-estuary spatial structure, this suggests the model is capturing the primary physical processes responsible for sediment transport in the system.

Draft Monitoring Plan

Title: Evaluating the benefits and impacts in shallows and marshes of a pilot strategic sediment placement project in San Francisco Bay

Scope of Work

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ParTrac Sediment Tracing
Keith Merkel and Associates

Background

Tidal salt marshes are an important part of the San Francisco Bay estuary (SFBE) landscape, with extensive plans for restoration over the coming years. The combination of accelerating sea-level rise (SLR) and declining sediment supply to SFBE threatens the persistence of marsh habitats (Schoellhamer 2011, Buffington et al. 2021). A key management questions is how nature-based solutions, including sediment augmentation/placement (also called sediment addition, strategic placement, sediment enhancement, beneficial reuse of dredged material) can nourish tidal mudflats and marshes to build SLR resilience and facilitate marsh restoration projects to prevent submergence. These types of projects have been successful in other parts of the world but are novel in the SFBE. Marshes in SFBE are mineral dominated and rely on sediment delivery from the shallows and creeks to build elevations to support vegetation and wildlife. However, sediment availability varies spatially around the bay and delivery to the mudflat and marshes can vary seasonally. Therefore, the outcomes of sediment placement projects are greatly uncertain and robust monitoring is essential to inform future projects.

Section 1122 of WRDA 2016 requires USACE to establish a pilot program to carry out projects for the beneficial use of dredged material using natural deposition processes to augment marsh elevations. The USACE will lead a pilot program to test an innovative method of strategic shallow water placement of beneficial dredged material to promote mudflat and tidal marsh sedimentation, which would be the first of its kind in the San Francisco Bay region. Using natural transport processes to move the dredged material onshore, this method may be a more cost-effective means than direct sediment placement on tidal marshes and may also promote mudflats and tidal marsh resilience to sea level rise. This also represents a unique opportunity for testing hypotheses and addressing questions regarding maximizing benefits and minimizing unintended consequences to essential fish habitat and associated benthic invertebrate prey resources (De La Cruz et al. 2020).

The Section 1122 Pilot Project is planning a sediment placement project near Eden Landing Ecological Reserve with the goal of nourishing mudflat, marsh, and restoration habitats adjacent to the project site. Placement will occur over at least 20 days (total placement time is TBD) and will deploy around 100,000 cy3 of sediment to reduce impacts; modeling results show minimal accretion on the marsh may be (approximately0.01cm) and mudflats (approximately0.1 cm) in response to the nearby placement (Anchor QEA 2022 report). We propose here to monitor four general locations: sediment placement area, shallows and mudflats, marshes, and restorations.

Study Questions

- How quickly does the sediment disperse from the placement area?
- How do the local wave energy, storms, and the spring-neap tidal cycle influence sediment flux and dispersal of the disposed sediment in the study area?
- Does placement material deposit on the marsh surface or in the restoration area? How long and what abiotic processes determined arrival?
- Are sediment tracers an effective monitoring tool for sediment addition projects?
- How does shallow dredged material placement influence the benthic community and foraging resources for demersal fishes and waterbirds?
- What is the spatial extent of impacts on the benthic community?
- How long does it take for functional recovery of the benthic community to occur?
- How does eelgrass respond to strategic shallow water placement?

Study site

This project will occur at the Section 1122 Pilot Project dredged material placement site and the adjacent mudflats. This project will also take place at Eden Landing Ecological Reserve. Specific sample sites will be chosen during the initial planning process and site visits.

Approach

Task 1 Bathymetric surveys to detect changes in morphology and bayfloor properties

USGS will perform repeated bathymetric surveys to determine the initial impact of placement of dredged sediment on the bayfloor morphology and to assess the rate of sediment dispersal out of the placement area. Surveys will be conducted immediately prior to, and following, completion of the dredged material placement operations to quantify the thickness of sediment deposited. We will survey a portion of the placement area approximately 1.7 km in the alongshore direction and 300 m in the cross-shore direction. The cross-shore extent will span the width of the placement area (approximately 150 m) and an extended circa 75 m buffer in both the offshore and onshore directions. Within this area (more than 50% of the placement area), the survey will achieve full coverage of the bayfloor. Because the placement operations have been designed to minimize sediment accumulation, it may be that it is difficult to detect bathymetric change during the project. If deposition is detected (minimum detectable change in elevation estimated at 10 cm) within the survey area during the initial post-placement survey, additional surveys will be conducted to determine how quickly the deposited sediment is eroded and dispersed from the placement area. In addition, acoustic backscatter data derived from the bathymetric surveys will be inspected and interpreted for indications of change in bayfloor properties (particle size, bulk density) which may show the presence of newly deposited sediment.

Bathymetric data will be acquired utilizing a USGS survey vessel equipped with a 234.5 kHz Systems Engineering and Assessment Ltd. SWATHplus-M interferometric side-scan sonar. Accurate geographical positioning will be achieved using an Applanix Pos M/V that combines positions from global navigation satellite system (GNSS) receivers, with attitude data from an integrated inertial motion unit.

Task 2 Oceanographic data collection

USGS will measure and collect time-series oceanographic data in bay shallows to: 1) monitor for changes in suspended-sediment concentration (SSC) produced by the sediment placement; and 2) document oceanographic forcing before, during, and after the placement of the dredged material, to support the interpretation and modeling of the fate and transport of the sediment. Using specialist oceanographic instruments, deployed on the bayfloor at specific stations around the study site, we will measure currents (speed and direction), wave height, direction and period, tidal height (stage), and suspended-sediment concentrations at 15-minute intervals. Data will be collected over the period from 1 month prior to placement operations commencing; during placement operations (approximately2 months); and up to 3 months after placement is completed (total deployment duration 6 months). The measurement stations will be located both in subtidal waters immediately onshore of the placement area (as close as is practical without impeding operations or risking instrumentation; 1 to 1.5 m below MLLW) and in the intertidal shallows, close to the marsh edge. USGS will measure turbidity via optical backscatter sensors (OBS) and subsequently convert the OBS data to SSC (in mg/l) based upon calibration relationships derived from SSC measured in water samples collected from the study area. Instruments and bayfloor frames will be serviced, data downloaded, and redeployed every 60 days during the deployment period. A data buoy equipped with a wind sensor, to assist in characterizing wind forcing upon the waterbody, will be located offshore of the placement area during the instrument deployment period.

Task 3 Bed sediment properties

Sampling at instrumentation sites

USGS will collect bed shallow sediment core samples (3 replicate push cores) at locations adjacent to three of the intertidal shallows stations. Core samples will be collected every 60 days during site visits for the above-described instrument servicing. The core samples will be subsequently sectioned (vertically) for analyses. All vertical sections of sediment will be analyzed for bulk density, and four sections per push core will undergo grain size analysis. Both these properties influence the erodibility of sediment.

Sampling of the deposited sediment

Following the first and/or second bathymetry surveys after the placement, we will collect push cores in and adjacent to the region of accumulation that is indicated by the bathymetry surveys. The purpose of the sampling will be to verify the thickness of the deposit detected by the bathymetric survey, and, potentially, to measure deposit thickness in regions where it is too thin to detect with the swath bathymetry. Analysis may include visual inspection (documented by photography), grain size analysis, and bulk density, and will be adapted depending upon what is encountered in the field.

Task 4 Tracer study: bay shallows

USGS will provide vessel support and participate in the tracer deployment conducted by Partrac. To track muddy sediments, Partrac will utilise a practical approach commonly termed *floc tagging*, which requires the tracer particles to have similar hydraulic characteristics (i.e. size, density and settling rate) to one or more of those constituent sediment size fractions found within naturally flocculated material, which facilitates floc tracing by directly labelling them (i.e. the floc aggregates will carry tracer particles during ensuing cycles of resuspension and deposition enabling a means of tracking the movement, and crucially, the fate of the mud flocs. The tracer material (1000 kg) will be manufactured to reflect the mean grain size (d_{50}) of dredged sediments. Following manufacture, the tracer properties will be independently tested, and the results considered in the light of potential effects upon transport dynamics. Tracer studies require the tracer material to be introduced into the field with minimal loss and redistribution; ideally tracer material deployment will be conducted under relatively benign meteorological and oceanographic conditions. The tracer should be deployed during slack water or on an ebbing tide. It is envisaged that the tracer will be deployed onto the dredged material placement at a number of strategic locations across the placement area. The tracer will be deployed, as best as is possible, on to the bayfloor through a length of large bore pipe, secured to the side of the vessel. The pipe will be secured in such a manner as to deliver tracer particles to the bayfloor, limiting dispersal in the upper part of the water column during release.

The Tracer introduction field operations will be conducted in three stages, being:

- Preparation and background survey;
- Tracer release (introduction); and,
- Post release sampling.

The Partrac team will be on site to assist with stages 1, 2 and 3. Staff from USGS and USACE will deploy magnets at shallows stations as determined by the design of the tracer study. We will sample bed sediments and the magnets in the shallows for the tracer study prior to tracer deployment and in 4 repeat surveys afterwards, with survey timing and number of sampling locations to be determined in collaboration with Partrac and the wider USGS and USACE project team.

Task 5 Marsh and restoration sampling

Sediment deposition transects will be established across elevation gradients and vegetation type (see Buffington et al. 2020 for details) across Eden Landing marsh and restoration sites. At each sampling location we will deploy glass filter pads along a shore/channel-normal transect that collect mineral and organic matter deposited on the marsh surface. Sediment pad samples will be analyzed in the lab for mineral mass and organic matter. Data collection will occur prior to placement and post placement. Samples will be collected monthly for up to 6 months post-placement.

For all sampling locations, elevation and location will be measured and distance to the nearest marsh creek will be determined. Percent time flooded and depth will be calculated for sampling locations from water level and elevation data. Plant species composition and density can play an important role in rates of sediment deposition. We will conduct vegetation surveys to inventory dominant plant species, density, and elevations pad location. We will determine species, % cover, and average height. To translate deposition into accretion rates we will collect short soil cores adjacent to sediment traps in the marsh to analyze for bulk density and organic matter. Marker Horizons will be deployed using feldspar plots and can provide a comparison between this short-term study and long-term trends. These will be measured throughout the project period.

Task 6 Support for tracer study: marsh and restoration

Sample for dual signature tracer material across the tidal marsh and restoration areas using strong-field magnets. Magnets will be deployed in the water column at strategic locations, for example, at the channel entrances to restorations, for up to 1-year post-placement. A subset of the sediment deposition pads will be analyzed for the tracer. We will conduct six post-placement surveys. The timing of surveys will be adaptive depending on the monitoring of the shallows.

Task 7 Effects of sediment placement on benthic biological community and fish/avian foraging resources

To assess the impacts of the shallow placement of beneficial dredged material on the benthos, we propose to evaluate both the modeled impact zone as well as a “reference” site using a Before After Control Impact (BACI) framework. A BACI framework is more rigorous than a Before and After only study and will allow us to distinguish the impact of environmental or seasonal changes from the impact of dredged material placement (McAtee et al. 2020). Our sampling design will incorporate benthic coring on parallel transects within the placement area to ensure intensive sampling of this zone, as well as perpendicular transects extending in all directions from the placement area. The addition of perpendicular transects will allow us to analyze impacts to the benthos as distance from source increases and modeled sediment depth decreases. The number of cores taken during each sampling event will be based on previous power analyses run on benthic core data from both the Dumbarton shoals and the Central Bay (De La Cruz et al. 2020) to identify the minimum sample size needed to determine a 50% reduction in invertebrate density with 80% power (Steidl et al. 1997; Quinn & Keough, 2002; Di Stefano 2003)

We will use a modified Benthic Resources Assessment Technique (BRAT), a functional approach first developed by the USACE, to quantitatively evaluate and compare dredge-impacted sites in terms of trophic support for bottom feeding fishes (Lunz & Kendall 1982). The BRAT framework integrates information on fish foraging ecology and prey profitability to estimate the energy that is available to particular fish feeding guilds. The modified BRAT (hereafter, MBRAT) is based on SFBE benthic fish foraging ecology and diet information and has been used previously for studies of dredged sites in the estuary (De La Cruz et al. 2017, 2020).

A Sample benthic prey resources at impact and reference sites

Using a BACI framework, we will sample the impact and pre-determined reference site immediately prior to the sediment placement operation, within a month of final sediment placement, and at additional intervals as determined by project team to access duration of placement effects and enable quantification of foraging resources during key points in the annual cycle of benthic consumers such as fish and waterbirds.

Two replicate sediment core samples will be collected at locations set equidistant apart along each transect. Each core will be 10 cm in diameter and a minimum of 20 cm deep to capture the effect of placing up to 10 cm of sediment. Cores will be sliced into shallow (0-4 cm) and mid (4-10 cm) and deep (10-20 cm) increments to measure prey distribution at different depths in the sediment according to MBRAT methodology. Water quality is an important driver of invertebrate communities and continuous measurements will enable us differentiate effects of water quality from those of the sediment placement. To quantify water level (m), temperature (°C), and salinity (PSU) we will install loggers in both the impact and reference areas. Each time we sample an area we will spot check water quality (temperature, salinity, dissolved oxygen (mg/L) using a multi-parameter sonde at the water surface and just above the benthic surface in the demersal zone, at 3 points along each transect. Sediment cores will be collected at multiple points along each transect analyzed at an external laboratory to determine sediment grain size and other characteristics (e.g. organic matter content, sediment texture, sediment pH).

Sample processing

Cores fractions will be immediately transported to the USGS Invertebrate Ecology Laboratory on ice and refrigerated until processed. Within 1-3 days cores will be rinsed through a 500 μm mesh sieve, and fauna retained by the sieve will be preserved in a 70% ethanol with 1% rose bengal dye. All taxa within cores will be sorted, identified and enumerated. Macroinvertebrates will be sorted into four size classes based on fish and waterbird foraging ecology: 0-4 mm, 4-12 mm, 12-24 mm, and 24-50 mm. Taxa from all samples will be identified to a broad taxonomic level (class, order); however, macroinvertebrates in a subset of randomly selected cores from the control and impact sites will be identified to the lowest possible taxonomic level (family, genus, species) to evaluate structural benthic recovery. Ten percent of macroinvertebrate samples will be submitted to an external laboratory for QA/QC procedures (EcoAnalysts, Inc., Moscow, ID). We will calculate dry weight biomass and energy density of available prey using established conversion factors (Brey et al. 1988) or via direct measurement in a micro-calorimeter (Parr 6725 Semi-Micro Calorimeter) as needed.

Data integration and analyses

We will assess the effects of treatment (placement versus control), time since placement, and distance to placement separately for three response variables 1) density (individuals/m^2), 2) dry biomass (g/ m^2), and 3) energetic content (kJ/ m^2) of macroinvertebrates.

Task 8. Eelgrass monitoring:

To verify avoidance of eel grass beds, the PDT or Contractor shall perform pre-construction eelgrass surveys of the Project area during the months of May through September (i.e., the active growth period for eelgrass in San Francisco Bay). All eelgrass surveys shall be performed in accordance with the National Marine Fisheries Service's (NMFS's) California Eelgrass Mitigation Policy (October 2014). The pre-construction survey shall be completed prior to the anticipated start of in- or over-water construction and shall be valid for either 60 days or until the next active growth period if construction occurs after the end of the active growth period. The results of the pre-construction eel grass survey shall be submitted to the Water Board prior to commencement of construction activities. If the results of the pre-construction survey indicate that eel grass beds are located in the placement footprint, the Applicant shall prepare and submit to the Water Board a mitigation and monitoring plan that will be implemented to compensate for impacts to eel grass beds and include post-surveys of project area. Furthermore, construction of the Project shall not commence until the Applicant receives written approval of the mitigation and monitoring plan from the Water Board's Executive Officer.

Monitoring timing will vary by task, but will begin 2 months before placement, and will extend one year after placement. Decisions about specific timing and duration were made in consultation with the monitoring team and the project team. Eelgrass surveys will occur in July 2023 (pre-placement), in December 2023 (6 months post-placement), and in June 2024 (1 year post-placement).

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Timeline for pilot sediment-placement monitoring

Assumes placement starts August 2023 and lasts 45 days

					2023									2024											2025			
TASK	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Marc	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Placement																												
USGS Field activities																												
Plan and prep																												
2.1 Bathy surveys					1		2	1																				
2.2 Oceanographic data																												
2.3.a Sed sampling at platforms					1		1		1			1																
2.3.b sediment sampling/imagery driven by bathy							2																					
2.4 Tracer sampling in shallows					1		2	1	1																			
2.5.a Sediment pads																												
2.5.c Feldspar																												
2.5.d Tracer sampling-marsh and restoration																												
2.7 Benthos																												
5. Eelgrass Surveys																dependent on findings												
Analysis and reporting																												
2.3 Lab analyses																												
2.1 Data processing and analysis: bathy																												
2.2 Data processing and analysis: time series																												
2.5 Lab analyses																												
2.7 Sample analysis																												
Synthesis																												
4. Report preparation (journal papers ready to submit)																												

WERC-Thorne

PCMSC

WERC-De La Cruz

All

Appendix E – REAL ESTATE PLAN

APPENDIX E

REAL ESTATE PLAN

San Francisco Bay
Strategic Placement Pilot Project
Alameda County

PREPARED FOR
SAN FRANCISCO DISTRICT
SOUTH PACIFIC DIVISION
U.S. ARMY CORPS OF ENGINEERS

BY

LOS ANGELES DISTRICT
REAL ESTATE DIVISION
SOUTH PACIFIC DIVISION
U.S. ARMY CORPS OF ENGINEERS

SEPTEMBER 2022

TABLE OF CONTENTS

1. INTRODUCTION

The overall purpose of the Strategic Placement Pilot Project is to test a novel approach to increase mudflat and tidal marsh resilience to sea-level rise (SLR) in the San Francisco Bay in Northern California via strategic placement of sediment dredged from federal navigation channels at a shallow, in-bay location adjacent to the mudflat and tidal marsh. The study area is in the South San Francisco Bay and is bounded by the San Mateo Bridge to the north and the southern shoreline of the Bay to the south. Although the pilot project is entirely federally funded, the California State Coastal Conservancy will serve as the non-cost share non-federal sponsor.

The Real Estate Plan is prepared in support of the *Environmental Assessment (with Draft FONSI) and 404 (b)(1) Analysis & Initial Study (with Draft Mitigated Negative Declaration), San Francisco Bay Strategic Shallow-Water Placement Pilot Project* and is in accordance with ER 405-1-12, Chapter 12, Section 12-16.

The Real Estate Plan is tentative in nature; it is for planning purposes only and both the final real property acquisition lines and the real estate cost estimates provided are subject to change even after approval of the Environmental Assessment.

2. PROJECT AUTHORITY

The study is authorized under Section 1122 of the Water Resources Development Act (WRDA) of 2016. Section 1122 directed the U.S. Army Corps (USACE) to establish a pilot program consisting of ten projects for the beneficial use of dredged material for one of the purposes described below:

1. Reducing storm damage to property and infrastructure;
2. Promoting public safety;
3. Protecting, restoring, and creating aquatic ecosystem habitats;
4. Stabilizing stream systems and enhancing shorelines;
5. Promoting recreation;
6. Supporting risk management adaptation strategies; and
7. Reducing the costs of dredging and dredged material placement such as projects that use dredged material for:
    a. Construction or fill material;
    b. Civic improvement objectives; and
    c. Other innovative uses and placement alternatives that produce public economic or environmental benefits

USACE solicited project proposals through a notice in the *Federal Register* dated 9 February 2018. After review and evaluation of ninety-five proposals, the Assistant Secretary of the Army for Civil Works signed the Programmatic Environmental Assessment and FONSI on 10 October 2018 recommending the ten pilot projects, including the Strategic Placement Project in San Francisco Bay. Of the specific purposes outlined in the pilot program's implementation guidance, the Strategic Placement Project falls under "Other innovative uses and placement alternatives that produce public, economic, or environmental benefits".

The Strategic Placement Project was originally part of a much larger California State Coastal Conservancy proposal for Restoring San Francisco Bay's Natural Infrastructure with Dredged Sediment. For the purposes of a pilot effort, per WRDA 2016 Section 1122, the Strategic Shallow Water Placement Project was considered a separable element that is innovative, has a high potential for benefits, and can be accomplished in one or a few dredging cycles.

3. PROJECT DESCRIPTION

The Recommended Plan would place approximately 100,000 yd^3 of annual maintenance dredged material from the Redwood City Harbor Federal Navigation Channel directly into shallow water adjacent to the mudflat and salt marsh known as Eden Landing. Eden Landing Ecological Reserve, which includes Whale's Tail Marsh, is adjacent to Hayward and Union City in Alameda County and is bounded by Alameda Creek to the south, Old Alameda Creek and a portion of Don Edwards San Francisco Bay National Wildlife Refuge to the north and is west of a mix of restored marsh and post-industrial salt evaporation ponds. The project would evaluate the ability of tides and currents to move dredged sediment placed in the nearshore environment to the adjacent mudflat and marsh.

Placement would be approximately 2 miles offshore of Eden Landing at less than 10 feet below Mean Lower Low Water (MLLW) and at a thickness between 4 inches and 1 foot. Placements will take place during flood tides within a 138-acre placement footprint that was determined by computer modeling and geospatial analysis to be most suitable for successful placement. Scows which will be light loaded to 900 yd^3, will make approximately 112 round trips between Redwood City and the placement site. The placement area and adjacent mudflat-marsh complex will be monitored before and after placement.

4. DESCRIPTION OF LANDS, EASEMENTS, RIGHTS-OF-WAY, RELOCATIONS, AND DISPOSAL AREAS (LERRDs)

There are no lands, easements or rights-of-way necessary for the project. Placement of the dredged material will be below the Ordinary Mean High Water Mark and therefore available under the government's dominant right of navigation servitude as discussed further in Section 9.

5. NON-FEDERAL SPONSOR OWNED LER

There are no lands owned by the Non-Federal Sponsor required for the project.

6. STANDARD AND NON-STANDARD ESTATES

There are no estates required for the project.

7. EXISTING FEDERAL PROJECTS

The Strategic Placement Project would utilize dredged material from the Redwood City Harbor Operations and Maintenance Federal Navigation project. Redwood City Harbor consists of San Bruno Shoal Channel, an entrance channel, outer channel, inner channel, and two turning basins. The project is the only commercial deep-draft harbor in southern San Francisco Bay. Project Operations and Maintenance (O&M) provides for a two-year cycle of maintenance dredging of the main ship channel, which has an authorized project depth of 30 feet MLLW. The dredged material from the Redwood City Harbor is typically placed at SF-11, the in-bay placement site near Alcatraz Island.

There is no overlap with any other existing Federal projects.

8. FEDERALLY OWNED LANDS REQUIRED FOR THE PROJECT

There are no federally owned lands required for the project.

9. AVAILABILITY OF NAVIGATION SERVITUDE

The navigation servitude is the dominant right of the Government under the Commerce Clause of the U.S. Constitution (Art. I, §8, cl.3) to use, control and regulate the navigable waters of the United States and the submerged lands hereunder for various commerce-related purposes. There is a two-step process to determine the availability of the navigation servitude. First, the Government must determine whether the project feature serves a purpose in aid of commerce such as navigation, flood control and hydroelectric power. Second, the subject lands must fall below the mean or ordinary high water mark of a navigable waterway. As the beneficial reuse of dredged material from a federal navigation project has a direct nexus to navigation and the placement of the dredged material will occur below the MLLW it appears the project meets the criteria necessary to exercise navigation servitude.

10. PROJECT MAPS

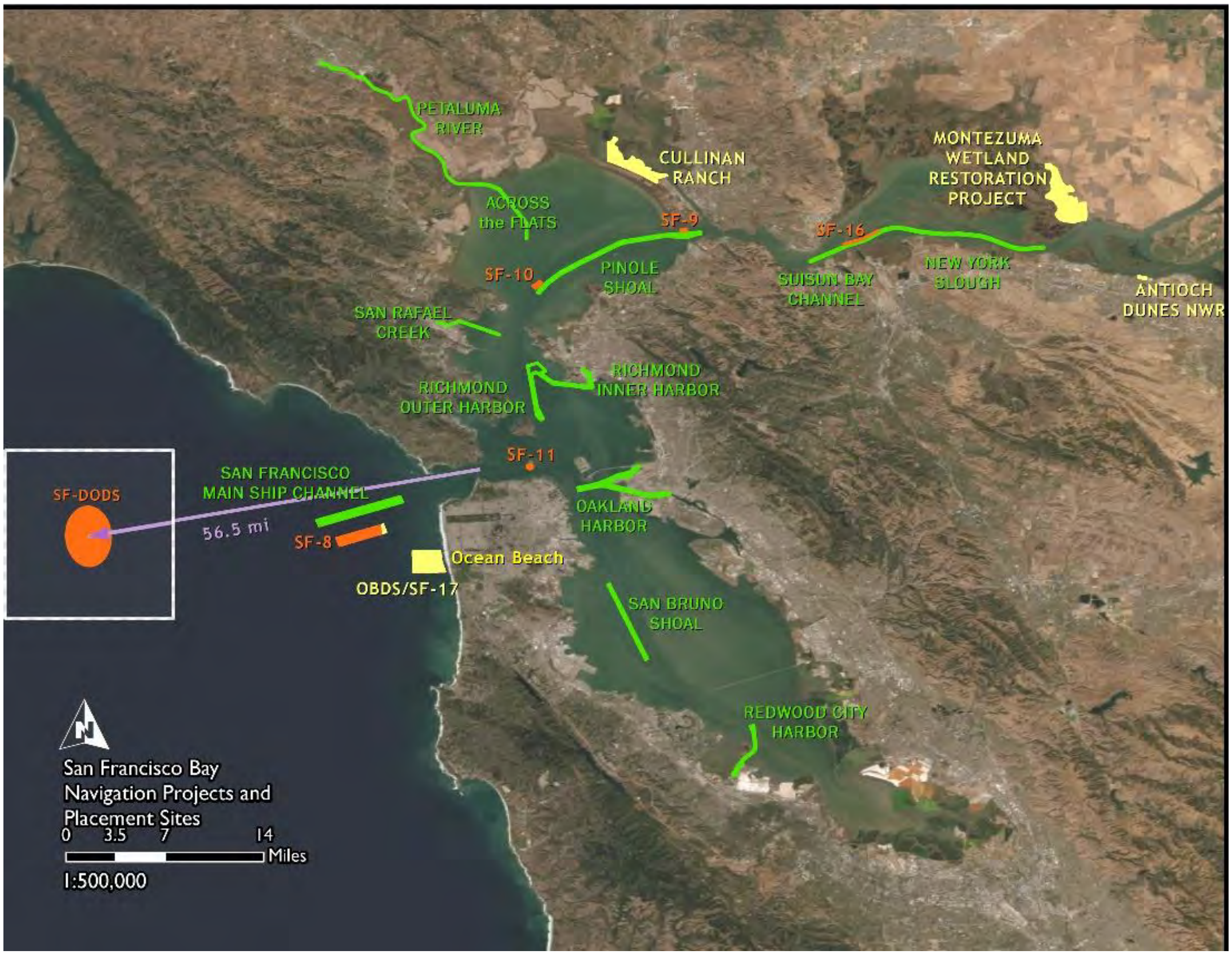

Figure 1. San Francisco District federal navigation projects (green) and traditional placement sites (orange [aqueous] and yellow [beneficial use]).

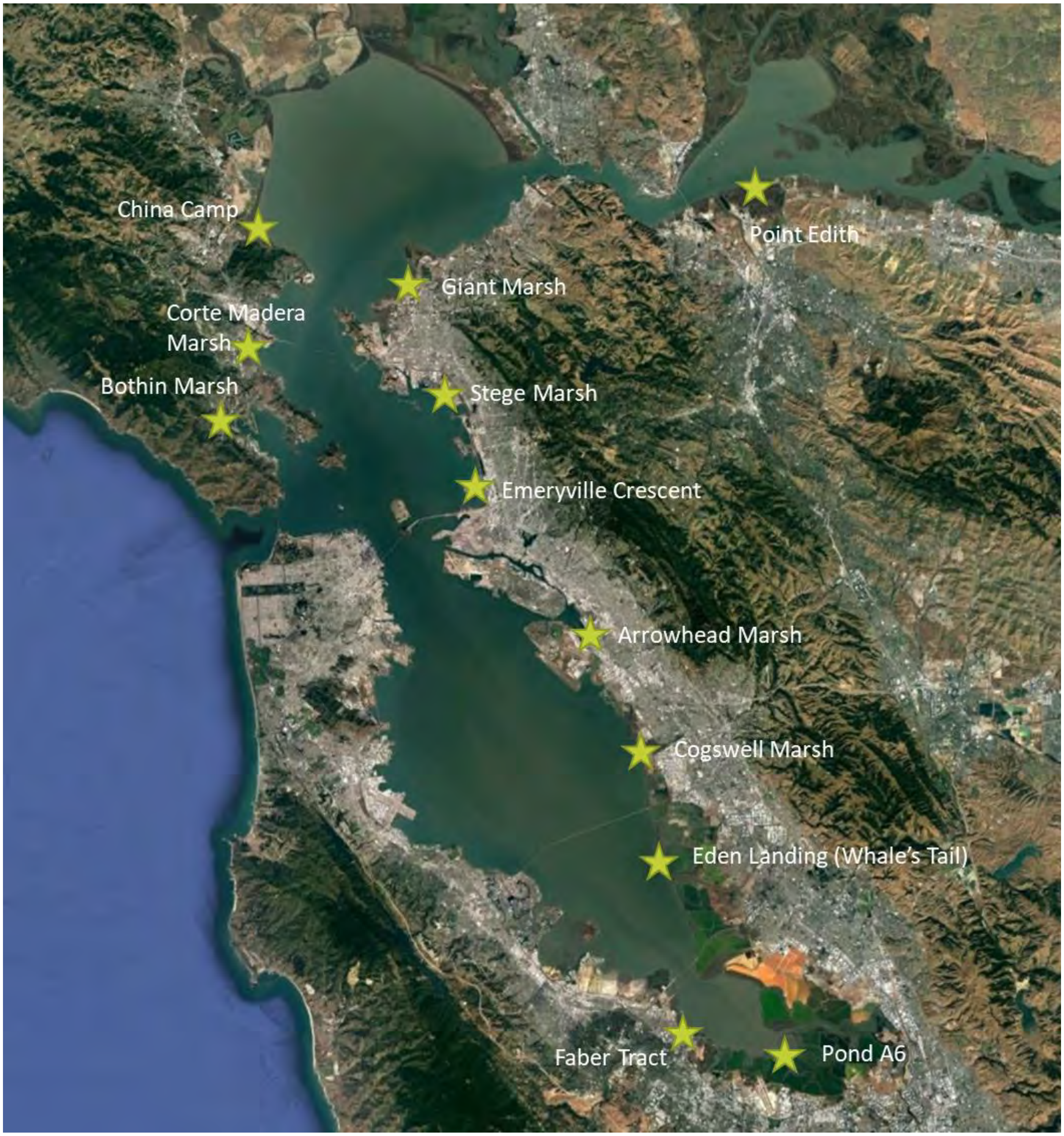

Figure 2. Twelve potential placement sites considered across the San Francisco Bay for strategic placement, including the chosen alternative, Eden Landing.

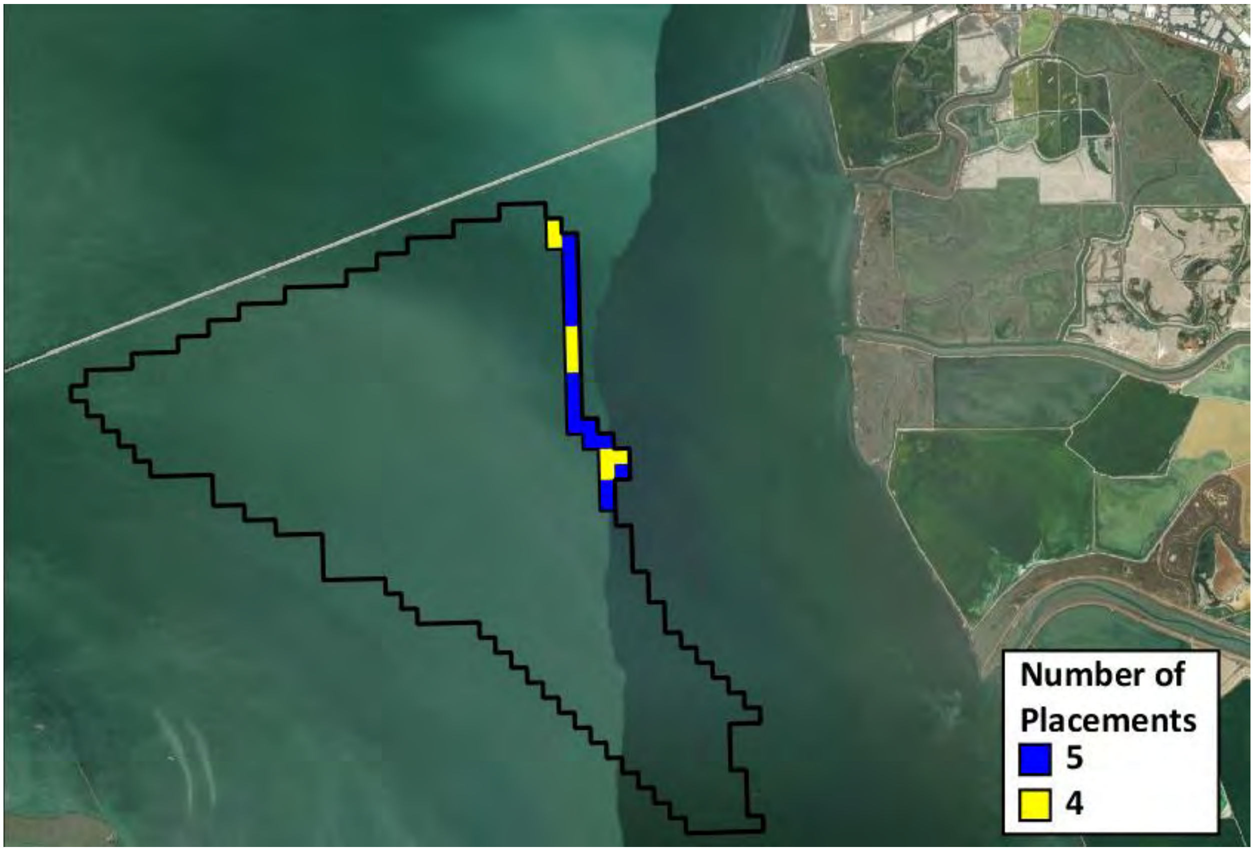

Figure 3. Placement cells in shallow water approximately two miles off the marsh at Eden Landing (i.e., Whale's Tail) for the Shallow/East placement. The black outline represents the entire placement grid, while the blue and yellow cells represent the Eden Landing Shallow/East placement footprint cells with five and four placements respectively depending on the water depths and tidal timings. The placement footprint is approximately 9,700 feet long and 630 feet wide.

11. POTENTIAL FOR INDUCED FLOODING

The project will not induce any flooding. In fact, the shallow water placement of dredged material would have beneficial impacts on flood-control functions of the adjacent marsh.

12. COST ESTIMATE

There are no real estate acquisitions costs associated with the project as all activities will occur within the bay where navigation servitude will be invoked.

13. RELOCATION ASSISTANCE BENEFITS

The project will not displace any residential, commercial, industrial or habitable structures; therefore, the provisions under Title II of Public Law 91-646, as amended, are not applicable.

14. MINERAL/TIMBER ACTIVITIY

All work is anticipated to occur by invoking the navigation servitude. Mineral rights will not be impacted.

15. NON-FEDERAL SPONSOR'S ABILITY TO ACQUIRE

The non-federal sponsor will not be expected to perform any acquisitions.

16. ZONING IN LIEU OF ACQUISITION

There is no zoning in lieu of acquisition planned in connection with the project.

17. ACQUISITION SCHEDULE

All work will be performed under the right of navigation servitude and no acquisitions will be required.

18. FACILITY/UTILITY RELOCATIONS

As all work will occur in shallow water, no facilities or utilities will be impacted by the project.

19. ENVIRONMENTAL CONCERNS

Sediments are tested prior to dredging, and the results are reviewed by the Dredged Material Management Office (DMMO) prior to dredging, transport, and placement, including evaluation of the potential for impact to aquatic organisms. Sediment testing results for previous USACE maintenance dredging episodes at Redwood City Harbor Harbor indicate that, in general, dredged materials from the subject federal navigation channel have been suitable for unconfined aquatic disposal. Some isolated areas in Reach 5 of the Redwood City channel have been identified as containing sediment that is not suitable for unconfined aquatic disposal; USACE would avoid importing material from these areas. Therefore, dredging and placement activities would not be expected to increase contaminant concentrations in the environment above baseline conditions.

Dredging, transport, and placement of dredged material would be conducted in cooperation with the DMMO. This process would identify contaminated sediments and screen out any material that is unsuitable for shallow water placement.

20. LANDOWNER CONCERNS

All work is anticipated to be performed in areas subject to the navigation servitude so no landowners will be affected. The California State Lands Commission has also acknowledged the Government's dominant right of navigation servitude and expressed its support for the pilot project. Additionally, there is strong public support for the restoration of the tidal wetlands in the San Francisco Bay.

21. RECOMMENDATION

This real estate plan has been prepared in accordance with ER405-1-12, Chapter 12 and is recommended for approval.

PREPARED BY:

Kelly Boyd
Kelly Boyd
Realty Specialist
Los Angeles District

REVIEWED AND RECOMMENDED BY:

Cheryl L. Connett

Cheryl L. Connett
Chief, Real Estate Division
Los Angeles District

20 SEP 2022
Date

Appendix F – CEQA CHECKLIST

Appendix F – Environmental Checklist

1. Project Title: San Francisco Bay Strategic Shallow-Water Placement Pilot Project

2. Lead Agency Name and Address:
   San Francisco Bay Regional Water Quality Control Board
   1515 Clay Street, Suite 1400
   Oakland, California 94612

3. Contact Person and Phone: Christina Toms, 510-622-2506

4. Project Location: Offshore of Eden Landing Ecological Reserve within San Francisco Bay, approximate location of 37.596561° N, 122.181325° W

5. Project Sponsor's Name & Address:
   U.S. Army Corps of Engineers
   450 Golden Gate Ave., 4th Floor
   San Francisco, CA 94012

6. General Plan Designation: Not Applicable

7. Zoning: Not Applicable

8. Description of Project: The project is for the U.S. Army Corps of Engineers (USACE or Corps) to test a novel approach to increase mudflat and salt marsh resilience to sea-level rise in San Francisco Bay via strategic placement of dredged sediment at a shallow, in-Bay location adjacent to target mudflats and tidal marshes. The project proposes to use dredge and dump scows to place approximately 100,000 cubic yards of sediment to a shallow-water placement site slightly more than two miles offshore of target wetlands and mudflats in and near the California Department of Fish and Wildlife's Eden Landing Ecological Reserve. The dredged sediment would come from the Corps' approved maintenance dredging of federal navigation channels at the Port of Redwood City that were evaluated for environmental impacts in the *Final Environmental Assessment/Environmental Impact Report for Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay Fiscal Years 2015-2024*. The placement site is 138 acres in size and runs roughly parallel to the tidal marshes at Whale's Tail North and South. Only sediment that meets the criteria for beneficial reuse established by the interagency Dredged Material Management Office would be placed. The average thickness of the sediment deposits would be around half a foot deep. Based on wave and current modeling, the scows would unload in water depths approximately 9 – 12 feet in absolute depth (i.e., the shore-normal placement location will vary depending on the stage of the tide) to maximize marsh-ward transport by waves and currents. Placements will take place over a period of weeks to months during summer 2023 flood tides within the 138-acre placement footprint that was determined by computer modeling and geospatial analysis to be most suitable for successful placement. Scows which will be light loaded to 900 cubic yards and

will make approximately 112 round trips to the placement site. The placement area and adjacent mudflat-marsh complex will be monitored before and after placement.

9. Surrounding Land Uses and Setting: The strategic sediment placement site is in shallow water along the eastern shoreline of southern San Francisco Bay, south of the San Mateo Bridge and west of the 6,400-acre Eden Landing Ecological Reserve (ELER or Eden Landing). The site is roughly two miles offshore of the high tidal marsh complex known as Whale's Tail, which flanks the north and south sides of Old Alameda Creek. Shallow subtidal bay waters, subtidal mudflats, and intertidal mudflats separate the sediment placement site from Whale's Tail. Landward of Whale's Tail is a large complex of former salt production ponds within ELER, some of which are gradually being restored to tidal action through the South Bay Salt Pond Restoration Project (SBSPRP). Public access to ELER is limited to a trail that circumnavigates ponds E12 and E13, and a short spur trail that extends from pond E13 and follows Mt. Eden Creek to a terminus near Whale's Tail North.

10. Other public agencies whose approval is required:

Agency	Approval	Status
San Francisco Bay Conservation and Development Commission	McAter-Petris Act Administrative Permit, Coastal Zone Management Act Consistency Determination	
U.S. Fish and Wildlife Service	Endangered Species Act Section 7 Consultation	
National Marine Fisheries Service	Endangered Species Act Section 7 Consultation, Magnuson-Stevens Fishery Conservation and Management Act Consultation, Marine Mammal Protection Act Consultation	

11. Have California Native American tribes traditionally and culturally affiliated with the project area requested consultation pursuant to Public Resources Code section 21080.3.1? If so, is there a plan for consultation that includes, for example, the determination of significance of impacts to tribal cultural resources, procedures regarding confidentiality, etc.?

Pursuant to Public Resources Code section 21080.3.1, the USACE and the Water Board contacted the Native American Heritage Commission (NAHC) requesting an updated Native American tribal consultation list for the Project. The Sacred Lands File search was negative. USACE obtained a tribal consultation list from the NAHC on 14 April 2020. The following Ohlone Tribes were identified as tribal consulting parties under Section 106 of NHPA and the National Environmental Policy Act (NEPA): The Amah Mutsun Tribal Band, Amah Mutsun

Tribal Band of Mission San Juan Bautista, Costanoan Ohlone Rumsen-Mutsun Tribe, Indian Canyon Mutsun Band of Costanoan, and the Muwekma Ohlone Indian Tribe of the SF Bay Area.

On June 1, 2022, a virtual, informal Tribal consultation meeting was held with the Confederated Villages of Lisjan (CVL). The CVL is interested in the project and wishes to be involved in the monitoring of plants and the effectiveness of the study. The Tribe identified tidal marshes near the sediment placement site as a cultural resource, would like access to the monitoring data that is collected, and are interested in learning if the Pilot Project is successful.

I. Aesthetics

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Have a substantial adverse effect on a scenic vista?			X	
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?				X
c) In nonurbanized areas, substantially degrade the existing visual character or quality of public views of the site and its surroundings? (Public views are those that are experienced from publicly accessible vantage point). If the project is in an urbanized area, would the project conflict with applicable zoning and other regulations governing scenic quality?			X	
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?				X

Discussion

a), c) Public access to the project site is limited to levee-top trails within California Department of Fish and Wildlife (CDFW) lands north of Old Alameda Creek; for resource protection purposes, there is currently no public access to CDFW lands south of Old Alameda Creek. Scenic vistas from these public access points include open water, mudflat, and marsh habitats within the Eden Landing complex and along the San Francisco Bay (SF Bay) shoreline. Nearshore vistas within SF Bay and at the project site typically include barges, tugboats, ferries, and related industrial and commercial shipping operations, as well as recreational vessels, such as sailboats and kayaks. Proposed sediment placement activities will result in the temporary presence of scows and associated sediment management equipment consistent with the existing visual landscapes of nearshore SF Bay, and would occur more than two miles offshore from the nearest public vista point within the CDFW Eden Landing complex. The impacts on scenic vistas would therefore be **less than significant.**

b) There are no trees, rock outcroppings, historic buildings, or scenic highways on the project site and no scenic highways with views of the project site. Therefore, there would be **no impact** to scenic resources.

d) The sediment placement activities proposed as part of the project are temporary, and will occur more than two miles offshore of an ecological reserve with no legal public access between sunset and sunrise. Therefore, there would be **no impact** on nighttime views.

II. Agricultural and Forestry Resources

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?				X
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?				X
c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?				X
d) Result in the loss of forest land or conversion of forest land to non-forest use?				X
e) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use?				X

Discussion

a-e) The project site and vicinity are within San Francisco Bay and does not include agricultural or forested lands. Therefore, the project would have **no impact** on agricultural or forest resources.

III. Air Quality

Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Conflict with or obstruct implementation of the applicable air quality plan?		X		
b) Result in a cumulatively considerable net increase of any criteria for which the Project region is non-attainment under an applicable federal or state ambient air quality standard?		X		
c) Expose sensitive receptors to substantial pollutant concentrations?				X
d) Result in other emissions (such as those leading to odors) adversely affecting a substantial number of people?				X

Background

This section summarizes construction air quality impacts associated with the proposed project and is consistent with the methods described in the Bay Area Air Quality Management District (BAAQMD) *California Environmental Quality Act* (*CEQA) Air Quality Guidelines* (May 2017). Additional detail regarding air quality impacts can be found in Section 4.1.11 and Appendix A-5 of the Environmental Assessment – Mitigated Negative Declaration (EA-MND).

The air quality analysis includes a review of criteria pollutant emissions such as carbon monoxide, nitrogen oxides, volatile organic compounds as reactive organic gases, particulate matter less than 10 micrometers (coarse or PM_{10}), and particulate matter less than 2.5 micrometers (fine or $PM_{2.5}$). Diesel particulate matter is also a concern regarding health risk assessment (HRA).

The United States Environmental Protection Agency (USEPA) has established National Ambient Air Quality Standards (NAAQS) under the Clean Air Act (CAA) for the criteria pollutants and California Air Resources Board (CARB) has established California Ambient Air Quality Standards (CAAQS). Air basins where NAAQS and/or CAAQS are exceeded are designated as a “nonattainment” area. If standards are met, the area is designated as an “attainment” area.

The project site is located within the San Francisco Bay Area Air Basin (Air Basin) under the jurisdiction of the BAAQMD. The BAAQMD is the local agency responsible for the administration and enforcement of air quality regulations for the area. The Bay Area is currently designated “nonattainment” for state and national (1-hour and 8-hour) ozone standards, for the state PM_{10} standards, and for state and national (annual average and 24-hour) $PM_{2.5}$ standards. The Bay Area is designated “attainment” or “unclassifiable” with respect to the other ambient air quality standards. Table AQ-1 below describes the effective NAAQS, USEPA Yearly Significance Thresholds, CAAQS, and BAAQMD thresholds within the project area.

Table AQ-1. NAAQS, USEPA Yearly Significance Thresholds, CAAQS, and BAAQMD thresholds that are effective within the project area.

NAAQS, CAAQS, Federal, and BAAQMD Thresholds for Criteria Air Pollutants Criteria Pollutant	NAAQS	EPA Yearly Significance Thresholds (tons/year)	CAAQS	BAAQMD Daily Threshold (Pounds/Day)	BAAQMD Yearly Threshold (Tons/Year)
Reactive Organic Gases (ROG)	N/A	100	N/A	54	10
Nitrogen Oxides (NOx)	0.05 ppm (Annual) 0.10 ppm (1-Hour)	100	0.03 ppm (Annual) 0.18 ppm (1-Hour)	54	10
Ozone (O3)	0.07 ppm (Annual)	N/A	0.07 ppm (Annual) 0.09 ppm (1-Hour)	N/A	N/A
PM10	150 µg/m3 (24-Hour)	100	20 µg/m3 (Annual) 50 µg/m3 (24-Hour)	82	15
PM2.5	12 µg/m3 (Annual) 35 µg/m3 (24-Hour)	100	12 µg/m3 (Annual)	54	10
Sulfur Dioxide (SO2)	0.03 ppm (Annual) 0.14 ppm (24-Hour)	100	0.04 ppm (24-Hour)	N/A	N/A
Lead	0.15 µg/m3 (90-Day)	N/A	1.5 µg/m3 (30-Day)	N/A	N/A
Sulfate	N/A	N/A	25 µg/m3 (24-Hour)	N/A	N/A
Carbon Monoxide (CO)	9 ppm (Annual) 35 ppm (1-Hour)	100	9 ppm (Annual) 20 ppm (1-Hour)	N/A	N/A
Hydrogen Sulfide (H2S)	N/A	N/A	0.03 ppm (1-Hour)	N/A	N/A
Vinyl Chloride	N/A	N/A	0.01 ppm	N/A	N/A

			(24-Hour)		

Notes: ppm = parts per million; µg/m3 = micrograms per cubic meter

Appendix A-5 of the EA-MND describes the details of the air quality analysis. The results of this analysis are summarized in Table AQ-2:

Table AQ-2. Air quality analysis of the proposed project.

Redwood City Sediments taken to Eden Landing Placement Site						
	ROG	CO	NOx	SOx	PM10	PM2.5
Peak Daily Emissions Totals (lbs/day)	1.24	3.87	28.45	5.09	0.61	0.55
Yearly Project Emissions Totals (tons/year)	0.04	0.13	0.94	0.17	0.02	0.02
BAAQMD Average Daily Threshold (lbs/day)	54.00	N/A	54.00	N/A	82.00	54.00
Project Emissions Exceed BAAQMD Daily Thresholds?	NO	N/A	NO	N/A	NO	N/A
BAAQMD Yearly Threshold (tons/year)	10.00	N/A	10.00	N/A	15.00	10.00
Project Emissions Exceed BAAQMD Yearly Thresholds?	NO	NO	NO	NO	NO	NO
EPA Yearly Significance Thresholds (tons/year)	100.00	100.00	100.00	100.00	100.00	100.00
Project Emissions Exceed Federal Yearly Threshold?	NO	NO	NO	NO	NO	NO

Notes: ROG = reactive organic gases; CO = carbon monoxide; NOx = nitrogen oxides; SOx = sulfur oxides; PM10 = particulate matter smaller than 10 micrometers; PM2.5 = particulate matter smaller than 2.5 micrometers

Discussion

a) The BAAQMD *2017 Clean Air Plan/Regional Climate Protection Strategy (CAP/RCPS)* provides a roadmap for BAAQMD's efforts over the next few years to reduce air pollution and protect public health and the global climate.

When a public agency contemplates approving a project where an air quality plan consistency determination is required, BAAQMD recommends that the agency analyze the project with respect to the following questions: (1) Does the project support the primary goals of the air quality plan; (2) Does the project include applicable control measures from the air quality plan; and (3) Does the project disrupt or hinder implementation of any air quality plan control measures? If the first two questions are concluded in the affirmative and the third question concluded in the negative, the BAAQMD considers the project consistent with air quality plans prepared for the Bay Area.

The recommended measure for determining project support of these goals is consistency with the previously mentioned BAAQMD thresholds of significance. As indicated in Table AQ-2, the proposed project would not exceed the BAAQMD significance thresholds; therefore, the proposed project would support the primary goals of the *2017 CAP/RCPS* and would not hinder implementation of any of the control measures. Impacts to air quality would be limited to the duration of construction, during which Mitigation Measure AQ-1 would be implemented; no long-term changes to emissions would occur as a result of the project.

Construction Impacts

Project construction would generate short-term emissions of air pollutants, including equipment exhaust emissions. The BAAQMD *CEQA Air Quality Guidelines* recommend quantification of construction-related exhaust emissions and comparison of those emissions to significance thresholds.

Table AQ-2 provides the estimated construction emissions for the proposed project. The average daily construction period emissions (i.e., total construction period emissions divided by the number of construction days) were compared to the BAAQMD significance thresholds. Construction-related emissions would be below the BAAQMD significance thresholds. Implementation of mitigation measure AQ-1 would reduce impacts to air quality from project construction to **less than significant with mitigation.**

Mitigation Measure AQ-1

Basic Exhaust Emissions Reduction Measures.

BAAQMD's *CEQA Air Quality Guidelines* require several best management practices to control exhaust emissions regardless of the estimated construction emissions. The BAAQMD requires that the following measures be implemented by the construction contractor:

- Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to five minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations). Clear signage shall be provided for construction workers at all access points.
- All construction equipment shall be maintained and properly tuned in accordance with manufacturer's specifications. All equipment shall be checked by a certified mechanic and determined to be running in proper condition prior to operation.

As indicated, the estimated construction emissions would be below the BAAQMD's significance thresholds and the proposed project construction impacts would be **less than significant with mitigation.**

b) As demonstrated in (a), the project-related construction emissions would be below the BAAQMD significance thresholds. As previously discussed, the Bay Area is currently designated "nonattainment" for state and national (1-hour and 8-hour) ozone standards, for the state PM_{10} standards, and for state and national (annual average and 24-hour) $PM_{2.5}$ standards. The project when considered with additional projects in the region (see list in Chapter 5 of the EA-MND) would not result in a cumulatively considerable net increase of ozone, PM_{10}, or $PM_{2.5}$.Impacts would be **less than significant with mitigation AQ-1**.

c,d) The project site is more than two miles offshore of Eden Landing, and there are no sensitive receptors in the project area that could be exposed to substantial pollutant concentrations or odors. Therefore, there would be **no impact.**

IV. Biological Resources

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies or regulations, or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service?		X		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies or regulations or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service?		X		
c) Have a substantial adverse effect on federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?		X		
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?		X		
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?				X
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?				X

Background

The Project site offshore of Eden Landing supports a suite of subtidal mudflat (benthic) and shallow (less than 18 feet [ft] deep, see Goals Project 1999) open water habitats that are typical of nearshore South San Francisco Bay. Benthic habitats are dominated by younger Bay Muds with occasional lenses/deposits of silt, sand, shell, and other coarse estuarine materials. Open water habitats are dominated by near-marine salinities (about 28 to 33 parts per thousand) except during the winter when periodic pulses of freshwater from local watersheds (e.g., Old Alameda Creek, Mt. Eden Creek) enter the Bay shallows. Local turbidities are typically high due to the wave-driven resuspension of sediment from the region's shallow subtidal and intertidal mudflats and can increase seasonally in response to winter pulses of stormwater from surrounding watersheds. Suspended sediment concentrations (SSC) in SF Bay typically range from 200 milligrams per liter (mg/L) in the winter to 50 mg/L in the summer, with shallow areas and their adjacent channels having the highest SSC (Rich 2010). SSC of up to 600 mg/L have been measured in turbidity maximum zones during winter storms that flush sediment from watersheds into the Bay (O'Connor 1991). Eelgrass (*Zostera marina*) has been consistently observed in the project site and vicinity (BCDC 2022), though the precise locations and distribution of eelgrass appears to shift from year to year.

Phytoplankton, such as diatoms, dinoflagellates, and cryptophytes, form the base of the region's aquatic food web (Cloern and Dufford 2005). Common zooplankton include species of copepods, rotifers, tintinnids, and meroplankton (larval forms of gastropods, bivalves, barnacles, polychaetes [marine bristleworms], and crustaceans [shrimps, crabs, barnacles, etc.]) (Ambler et al. 1985; NOAA 2007). Macrobenthic communities in the Project vicinity are dominated by invertebrates, such as clams (e.g. non-native *Corbula*, native *Mya*), mud snails, mussels, and the native Pacific oyster *Ostrea lurida*. The shells of the latter form regionally unique habitat components as shell deposits within the region's mudflats and shell hash beaches at Whale's Tail North and South. Other common benthic invertebrate communities in the Project vicinity include polychaetes, oligochaetes (earthworms and relatives), amphipods (shrimp-like organisms), isopods (sow bugs and relatives), and crustaceans. The benthic and aquatic food webs support abundant demersal fish, including recreationally important species (e.g., California halibut, striped bass, white sturgeon), key prey species (e.g., anchovies, Pacific herring, and smelt), and federally and state-listed species (longfin smelt (*Spirinchus thaleichthys*), green sturgeon (*Acipenser medirostris*) and salmonids (*Oncorhynchus* spp.). Some demersal fish, such as bat rays, forage on mudflats at high tide. Shallow open water and mudflat habitats in the region (both within the SF Bay and Eden Landing complex) are regionally critical foraging habitat for resident and migratory shorebirds and waterfowl, and serve as a key stop on Pacific Flyway (Warnock et al. 2002). Common bird species include diving ducks (e.g., canvasback, greater and lesser scaup, surf scoter), dabbling ducks (e.g., mallards, pintail, green-winged teal, and Northern shoveler), and shorebirds (e.g., western and least sandpiper, dunlin, long- and short-billed dowitcher, long-billed curlews, whimbrels, and American avocet). Marine mammals, such as seals and sea lions, consume demersal and pelagic fish.

Landward of the Project site, the CDFW Eden Landing complex supports a mosaic of tidal and non-tidal open water, mudflat, and marsh habitats that are shifting and evolving in response to management and restoration actions undertaken as part of the South Bay Salt Pond Restoration Project. General habitat conditions in tidal open water and mudflat areas within Eden Landing tend to echo conditions in similar tidal waters and mudflats offshore, though decreased mixing and extended residence times within former salt ponds likely contribute to locally elevated temperatures and primary productivity, especially during the summer months. Legacy salt ponds that have not been restored to tidal action by the South Bay Salt Pond Restoration Project are managed by CDFW as non-tidal open water and mudflats to support especially high densities of shorebirds and waterfowl, as well as nesting of federally- and state-listed species, such as western snowy plover (*Charadrius alexandrinus nivosus*) and California least tern (*Sternula antillarum browni*). High tidal marsh within the Eden Landing complex (above MHW) is dominated by pickleweed (*Sarcocornia pacifica*) and features commonly associated species, such as salt marsh gumplant (*Grindelia stricta*), fleshy jaumea (*Jaumea carnosa*), saltgrass (*Distichlis spicata*), and salt heath (*Frankenia salina*). Low tidal marsh (between MTL-MHW) is dominated by native Pacific cordgrass (*Spartina foliosa*); non-native smooth cordgrass (*Spartina alterniflora*) is known from the area and monitored/managed by the Invasive Spartina Project (www.spartina.org). Tidal wetlands at Eden Landing are known or assumed to support numerous federally- and/or state-listed fish and wildlife species, including longfin smelt, Ridgeway's rail (*Rallus obsoletus*), black rail (*Laterallus jamaicensis*), salt marsh song sparrow (*Melospiza melodia* spp.), salt marsh yellowthroat (*Geothlypis trichas sinuosa*), and salt marsh harvest mouse (*Reithrodontomys raviventris*).

Discussion

a - d) The project would result in direct impacts to benthic habitats offshore of the CDFW Eden Landing Complex by burying these habitats with a layer of dredged sediment. Sessile organisms, including eelgrass, within the footprint of sediment placement would generally not survive large amounts of burial (e.g., Wilber and Clarke 2007, Kemp et al. 2011), and would primarily recover via recolonization from surrounding areas. If the properties of placed sediment differs substantially from *in situ* sediment in the placement areas, or if the residual particle size in the placement footprint differs from the original substrate after waves and tidal currents re-work the placed sediments, community shifts in species abundance and composition could occur (Bishop et al. 2006). However, any shifts would be within the natural range of variation in the region's benthic characteristics and dependent biological communities driven by tides, waves, and storms, freshwater inputs from local watersheds, seasonal shifts in fields, shoreline erosion, and actions related to salt pond management/restoration.

Though direct impacts would be limited to benthic habitats within the sediment placement footprint, a temporary reduction or shift in subtidal benthic primary producers and consumers could potentially result in indirect impacts to higher trophic levels within the estuarine food web outside the placement footprint, including special-status aquatic species, such as longfin smelt, green sturgeon, and salmonids. These impacts would be temporary, and again, would be unlikely to exceed natural background variation in the region's estuarine food webs. In addition, sediment placement is likely to drive temporary local increases in turbidity within and beyond the placement footprint, which could drive temporary impacts to eelgrass and other light-sensitive species. However, because turbidity is driven by the effects of local tidal currents and waves on the benthos, it is unlikely that turbidities will exceed background levels that are regularly experienced by local biota, especially during high-energy events such as winter storms. Modeling indicates that after dredged sediment placement, SSC adjacent to the placement footprint would most frequently range between 50 and 300 mg/L over baseline conditions, and could be elevated by as much as 500 mg/L in the most extreme case.

However, the modeling also indicates that SCC would quickly return to baseline after each placement episode, making these effects on local turbidities and biota temporary.

The project could result in indirect impacts to non-benthic communities, including nearby mudflat and tidal marsh communities within the Eden Landing complex. The overall project purpose is to test a novel approach to increase mudflat and salt marsh resilience to sea-level rise in SF Bay via strategic placement of dredged sediment at a shallow, in-Bay location adjacent to target mudflats and tidal marshes. Holocene tidal marsh and mudflat ecosystems within the Eden Landing complex and elsewhere in SF Bay have evolved to respond to and benefit from episodic pulses of sediment from both watershed- and estuarine-derived sources; without this sediment, these systems are unlikely to be resilient to rising sea levels driven by climate change (Goals Project 2015). Modeling indicates that the project could drive modest amounts of accretion in nearby tidal areas, ranging from about 0.01 cm at the target tidal marsh to about 0.1 cm on adjacent mudflats over a two-month period. These accretion rates are similar to those observed by the U.S. Geological Survey throughout the estuary's tidal mudflats and marshes. Given this tolerance of variability in natural sediment delivery across space and time, and the relatively modest amount of accretion expected in the region's tidal systems as a result of the project, it is highly unlikely that sensitive tidal marsh communities (and their dependent special-status species) would be adversely impacted by the project.

Example taxa and species in the nearshore community potentially impacted from shallow-water placement at the project site are described in Table BIO-1. Table BIO-2 documents state and federally listed (or proposed) endangered or threatened species under the state and federal Endangered Species Acts (CESA and FESA); designated and proposed critical habitat under FESA; Essential Fish Habitat in accordance with Magnuson Stevens Fishery Conservation and Management Act (MSFCMA); marine mammals protected under the Marine Mammal Protection Act (MMPA); avian species protected under the Migratory Bird Treaty Act (MBTA); and commercially important fish species with the potential to occur in the project action area.

Table BIO-1: Nearshore communities with potential direct and indirect impacts from shallow-water placement at the project site:

Example Species	Physical Effect	Potential Direct Effects	Potential Indirect Effects	Recovery Time
Macroalgae Green algae e.g., *Ulva spp, Gracilaria pacifica*, *Fucus gardneri*	Burial and high SSC	Light reduction: mortality or reduced growth Siltation of vegetative structures: Reduced photosynthesis Smothering of hard surfaces: Reduced habitat area		Unknown in Bay estuary Laminaria shown to rebound from burial after 3 years in other systems (Gubelit 2012)
Microphytobenthos (Subtidal)	Burial	Smothering: mortality, reduced	Reduction in food availability for	1.6 to 2.2 years in Southern California

Example Species	Physical Effect	Potential Direct Effects	Potential Indirect Effects	Recovery Time
e.g., diatoms, cyanobacteria, and dinoflagellates		growth, altered species composition	higher trophic levels Sediment stabilization may be disrupted Reduction in microphytobenthos may increase phytoplankton growth	mudflats (Janousek *et al.* 2007) Burial by more than a few millimeters smothers the biofilm, and recolonization from surrounding areas would be the mechanism for recovery
Phytoplankton e.g., diatoms, microflagellates	High SSC	Light reduction: decreased primary production (Cohen 2008)	Increase in phytoplankton can occur if burial reduces microphytobenthos production (McGlathery *et al.* 2013) Increased phytoplankton blooms possible if release of nutrients from sediments elevates nutrient concentrations (Lohrer and Wetz 2003, Cardoso-Mohedano *et al.* 2016, Zhang *et al.* 2012)	Effect is probably minor and difficult to estimate due to transient nature of sediment plume; light attenuation would last only a few hours
Vegetation (Subtidal) eelgrass (*Zostera marina*)	Burial and high SSC	Light reduction: mortality or reduced growth via burial and high turbidity Reduced photosynthesis and growth via siltation of vegetative structures Habitat modification possible if substrates are changed in properties (grain size, etc.)	Reduced numbers or altered composition of eelgrass-associated species (e.g., epiphytic macroalgae, Pacific herring, halibut, Canada geese) if eelgrass beds were to be significantly altered or reduce	In general, eelgrasses recover from burial in 2 to 5 years (Cabaco *et al.* 2008, Preen et al. 1995, Birch and Birch 1984, Onuf 1991, Blake and Ball 2001, Frederiksen *et al.* 2004, Sheridan 2004) Eelgrasses are sensitive to burial by around 2 to 5 cm, or to about 20 percent of total plant height (Cabaco *et al.* 2008, Munkes *et al.* 2015)

Example Species	Physical Effect	Potential Direct Effects	Potential Indirect Effects	Recovery Time
Invertebrates (Benthic) Macrobenthos: benthic epifauna and infauna, including worms, amphipods, etc.	Burial and high SSC	Smothering: mortality or reduced growth resulting in decreased species number, population density, and biomass of benthic organisms can result from burial and high turbidity	Reduction in food via changes in macrobenthos abundance and composition Habitat modification possible if substrates are changed in properties (grain size, etc.)	3 months to 5 years (Borja *et al.* 2010) Rates of recovery are highly variable depending on the substrate, community type, burial depth, and the extent to which the affected communities adapt to high levels of sediment disturbance
Invertebrates (Pelagic) Zooplankton e.g., copepods and amphipods	Burial and high SSC	Siltation: clogging of physical structures	Decreased primary production via burial or increased turbidity can lead to decreased food availability	Unknown
Invertebrates Native oysters (*Ostrea lurida*) and other bivalves	Burial and high SSC	Smothering: adult mortality or morbidity Siltation and high SSC: disruption of larval dispersal and settling	Reduction in food, via decreased proportion of food items compared to sediments for filter feeding Reduction of habitat by burial of hard surfaces where larva attach	Unknown Zabin *et al.* (2009) found that oysters permanently buried by mud suffered mortality, but survived temporary burial of less than one month
Invertebrates Dungeness crab (*Metacarcinus magister*)	Burial	Smothering: mortality of juveniles if they are unable to excavate from burial by dredge-material placement	Reduction of food via burial of benthic feeding grounds	Areas affected by dredge disposal repopulate with crabs in about 3 weeks (Roegner and Fields 2015) Crabs generally avoid sediment plume and burial, and can dig themselves out of about ~10 cm of material (Roegner and Fields 2015)
Ground Fishes leopard shark (*Triakis semifaciata*) green sturgeon (*Acipenser medirostris*)	Burial	Smothering: mortality of juveniles if they are unable to avoid burial by dredge-material placement	Reduction of food via burial of benthic feeding grounds	Unknown

Example Species	Physical Effect	Potential Direct Effects	Potential Indirect Effects	Recovery Time
Pelagic Fishes (use of near-benthic habitats) Pacific herring (*Clupea pallasi*), longfin smelt (*Spirinchus thaleichthys*) (spawning habitat)	High SSC	Siltation: morbidity and mortality of eggs, delays in hatching via increased SSC, which can adhere to eggs	For Pacific herring, limitation of spawning habitat if eelgrass or other structures, where eggs adhere, are buried or reduced For longfin smelt, Moyle (2002) states that spawning occurs in fresh water over sand, gravel, rocks, and aquatic plants so spawning habitat could be impacted as well if project effects extend into more fresh water areas	Jabusch *et al*. (2008) concluded that effects of elevated SSC from Bay dredging were lower than those experienced by herring during natural tidal cycles, specific effects of actions unknown Longfin smelt expected to be similarly affected
Pelagic Fishes e.g., salmonids, smelt, herring, anchovy	High SSC	Siltation: gill impairment, stress response, morbidity or mortality if SSC is very high Responses vary by species	Decreased food availability for demersal fishes if benthic prey is affected Reduced spawning habitat If eelgrass beds or other breeding surfaces are disrupted	Varies by species, most studies are from lab settings (see details in *Appendix A, Literature Review*)
Birds (Dabbling Ducks) e.g., mallard (*Anas platyrhynchos*), green-winged teal (*Anas carolinensis*), Northern shoveler (*Anas clypeata*)	Burial		Reduced food availability if subtidal vegetation is matted or killed, resulting in reduced seed production, an important dietary element for dabbling ducks (Joint Venture 2006) Reduced cover and nesting habitat if marsh vegetation is matted or buried (Enright n.d.)	Unknown Invertebrate (i.e., food) recovery from burial is 3 months to 7 years Vegetation (i.e., food, cover) recovery from burial is 6 months to 7 years

Example Species	Physical Effect	Potential Direct Effects	Potential Indirect Effects	Recovery Time
Birds (Diving Ducks) e.g., surf scoter (*Melanitta perspicillata*), bufflehead (*Bucephala albeola*)	High SSC	Reduced ability to forage if SSC is too high for visual hunting	Reduced foraging and prey availability if actions affect mollusks, bivalves, crustaceans, aquatic invertebrates, fish roe, and if submerged aquatic vegetation is reduced (Lovvorn et al. 2013)	Unknown Invertebrate (i.e., food) recovery from burial is 3 months to 7 years Eelgrass beds' (i.e., food) recovery is 2 to 5 years
Birds (Piscivorous) e.g., California least tern (*Sternula antillarum browni*)	High SSC	Reduced ability to forage if SSC is too high for visual hunting	Reduced prey availability if fish species are negatively affected by increased SSC, reductions of eelgrass beds or food resources (USACE 1998, USFWS 1998)	Unknown Recovery will depend on fish response and nesting success

Table BIO-2. Special-status species, critical habitats, essential fish habitats, and commercial/recreational fisheries potentially occurring in and near the proposed action area.

Scientific Name	Common Name	Status	Statutory Protection
Sterna antillarum browni	California least tern	Endangered	Federal Endangered Species Act (FESA)
Rallus obsoletus obsoletus	Ridgway's rail	Endangered	FESA
Laterallus jamaicensis coturniculus	California black rail	Threatened, Fully Protected	California Endangered Species Act (CESA)
Charadrius alexandrinus nivosus	western snowy plover	Threatened	FESA
Pelecanus occidentalis californicus	brown pelican	Fully Protected	CESA
Acipenser medirostris	North American green sturgeon, Southern DPS	Threatened with Critical Habitat Present	FESA

Scientific Name	Common Name	Status	Statutory Protection
Acipenser transmontanus	White sturgeon	Species of Special Concern	N/A
Onchorhynchus mykiss	steelhead, Central California Coast and Central Valley ESUs	Threatened	FESA
Oncorhynchus tshawytscha	Chinook salmon, state and federally threatened (Spring-run), state and federally endangered (Winter-run)	Threatened	CESA
Spirinchus thaleichthys	longfin smelt	Threatened	CESA
Reithrodontomys raviventris raviventris	Southern salt marsh harvest mouse	Endangered	FESA
Zalophus californianus	California sea lion	Protected	Marine Mammal Protection Act (MMPA)
Phoca vitulina	Pacific harbor seal	Protected	MMPA
	Pacific Groundfish Fisheries Management Plan (FMP) / Estuaries	Essential Fish Habitat (EFH) / Habitat of Particular Concern (HAPC)	Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)
	Coastal Pelagic FMP	EFH	MSFCMA
	Pacific Salmon FMP	EFH	MSFCMA
	Eelgrass beds	HAPC	MSFCMA
	Olympia oyster beds	HAPC	MSFCMA
Cancer magister	Dungeness crab	Commercial fishery	N/A
Clupea pallasii	Pacific herring	Commercial fishery	N/A
Embiotocidae	Surfperches	Commercial fishery	N/A
Paralichthys californicus	California halibut	Commercial fishery	N/A

Impacts from the project to sensitive estuarine habitats (including tidal wetlands, mudflats, and open waters) other than eelgrass would be temporary, and within the range of natural physical and biological variability experienced by these ecosystems. This includes impacts to habitats presumably used as migratory corridors by anadromous fish, such as salmonids, and catadromous fish, such as green and white sturgeon. The project would not interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites. None of the special-status species in Table BIO-2 are sessile benthic species that will be smothered by placed sediment, therefore, they are not expected to be adversely impacted by the project. USACE, as federal lead for the project, is consulting with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service to ensure compliance with the federal Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act, and Marine Mammal Protection Act, and will informally consult with the California Department of Fish and Wildlife to ensure consideration is given to species of special concern. These consultations are expected to result in conservation measures that will further ensure the protection of the special-status species and communities listed in Table BIO-2, including marine mammals and state-listed longfin smelt. Implementation of these provisions through mitigation measure BIO-1 would ensure that impacts to habitats, communities and species other than eelgrass would be less than significant.

Impacts from the project to eelgrass habitats offshore of Eden Landing are potentially significant, due to multiple factors including the sensitivity of these communities and their dependent food webs to burial and turbidity, and the uncertain rate and extent of recolonization, growth, and recovery post-burial. The San Francisco Bay Conservation and Development Commission's website has a web-based application, San Francisco Bay Eelgrass Impact Assessment Tool (Tool), for assessing the potential impacts of dredging projects on eelgrass. The Tool, which is located at San Francisco Bay Eelgrass Impact Assessment Tool | BCDC Open Data Portal (arcgis.com), shows 1) the maximum extent of eelgrass beds that have been surveyed in San Francisco Bay as of 2021; 2) a 45-meter growth buffer for potential bed expansion (direct impact buffer zone); and 3) a 250-meter turbidity buffer around eelgrass for determining indirect impacts (indirect impact buffer zone). Using the Tool to map the location of the project relative to the location of eelgrass beds and adjacent buffer zones shows that most areas of the project are outside the 45-meter direct impact buffer zone and 250-meter indirect impact buffer zone. Implementation of mitigation measures BIO-1 and BIO-2, below, would reduce impacts to sensitive habitats and species (including eelgrass communities) to **less than significant with mitigation.**

Mitigation Measure BIO-1: The Permittee (USACE) shall comply with formal consultations issued by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service under the Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act, and Marine Mammal Protection Act. The Permittee (USACE) shall also implement recommendations made by the California Department of Fish and Wildlife during informal consultation.

Mitigation Measure BIO-2:

a. Consistent with the June 9, 2011, Programmatic Essential Fish Habitat Consultation Agreement (Agreement) between the U.S. EPA, USACE, and the National Marine Fisheries Service (NMFS), the Permittee (USACE) shall conduct pre- and post-dredge surveys of eelgrass areal coverage and density within the placement footprint where it overlaps the 45-meter direct impact buffer zone.

b. Consistent with the Agreement, the Permittee (USACE) shall implement operational control best management practices (BMPs) to protect eelgrass beds within 250 meters of placement activity from adverse impacts due to excess turbidity in the water column.

c. The Permittee (USACE) shall mitigate for potentially significant impacts in accordance with the California Eelgrass Mitigation Policy and Implementing Guidelines (noaa.gov). In accordance with the policy, monitoring will be performed to assess potential impacts to eelgrass, and if found, eelgrass impacts will be mitigated to less than significant by creating, restoring, and/or enhancing eelgrass habitat at a minimum ratio of 1.2:1 acres. If the Project adversely impacts eelgrass, the Permittee (USACE) shall submit and implement a mitigation plan and schedule, acceptable to Water Board staff. A NMFS-and CDFW-approved mitigation plan and schedule shall be considered acceptable to Water Board staff.

e) No trees would be removed as a result of the project. Therefore, **no impact** would occur.

f) The project site is not covered by any federal, state, or local conservation plan. Therefore, the project would have **no impact** with respect to habitat conservation plan compliance.

V. Cultural Resources

Would the project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Cause a substantial adverse change in the significance of a historical resource pursuant to Section 15064.5?			X	
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to Section 15064.5?				X
c) Disturb any human remains, including those interred outside of dedicated cemeteries?				X

Background

Section 15064.5 of the State CEQA Guidelines establish the definition of historical resource for the purposes of CEQA. Assembly Bill (AB) 52 became effective for all projects, including this one, with CEQA documents prepared after July 1, 2015. The bill added a definition of "tribal cultural resource," which is separate from the definitions for "historical resource" and "archaeological resource" (California Public Resource Code (PRC) Section 21074; 21083.09). Section XVIII of this checklist describes the project's impacts to tribal cultural resources. Under both Section 15064.5 and Section 106 of the National Historic Preservation Act (NHPA), the area of potential effects (APE) for the project includes the offshore placement site (about 138 acres) and the marsh and mudflats within the western extent of the Eden Landing Ecological Reserve (about 2,500 acres). The vertical APE is a minimum depth of 2 inches and maximum depth of 10 inches below the surface of the Bay. The APE for indirect effects includes access routes to monitoring sites located within the Eden Landing Ecological Reserve, and a large buffer around both the placement and replacement site.

To assess compliance with Section 15064.5 of the State CEQA Guideline, a records search was completed at the Northwest Information Center located in Sonoma State University. Records were also reviewed online for results from underwater surveys at NOAA's Automated Wreck and Obstruction Information System, in addition to T-Charts from the U.S. Coast Survey located at https://historicalcharts.noaa.gov/. Four archaeological survey reports, a Master of Arts thesis, and a Memorandum of Agreement between the US Fish and Wildlife Service (USFWS) and SHPO, were reviewed within a one-mile radius of the APE. The entire study area has gone through extensive reconnaissance as well as archival research. Surveys have been funded by government agencies, including the USFWS and CalTrans, since the early 1980s. The results of the records search show there is one eligible historic district within the APE – the Eden Landing Salt Works landscape (HALS-CA-91) – and ten cultural resources are located within or contributing to HALS-CA-91. Additionally, the San Mateo Bridge is an eligible historic property within the APE.

The offshore placement site was surveyed for cultural resources beginning in 1996, when a seismic retrofit for the San Mateo Bridge was first proposed. Numerous other inventories were completed for ecological restoration work at Eden Landing as part of the South Bay Salt Pond Restoration Project, which resulted in the identification of the Eden Landing Ecological Reserve Historic District located in the southern end of San Francisco Bay. The Historic District encompasses 6,612 acres divided into 23 ponds that is gradually being restored by the South Bay Salt Pond Restoration Project into a mosaic of tidal, managed tidal, and non-tidal estuarine habitats.

Eden Landing was placed on the NRHP because it is the birthplace of SF Bay's solar salt industry, which grew to be one of the world's largest salt producers. Beginning in the 1850s, Eden Landing's natural conditions of shallow tidelands, relatively dry summers, and navigable creeks that provided shipping points were critical features for developing the salt industry. The Eden Landing Salt Works landscape encompasses elements that include archaeological features, salt ponds, and water control structures from three of the original salt company operations that provide an essential link to the earliest period of this important industry.

Ten cultural resources have been recorded within HALS-CA-91, all of which are related to the historic period of salt manufacturing. Four sites have been determined eligible, five sites have been determined ineligible, and one site is unevaluated. And, one architectural resource, the Archimedes Screw Windmills, has been determined to be a contributing element of the HALS-CA-91.

Discussion

a) The only historic resources within HALS-CA-91 that would be affected by the project are tidal wetlands and tidally restored salt ponds within the Eden Landing complex. As previously discussed under Section IV, modeling indicates that the project could drive modest amounts of accretion in tidal areas near the shallow water placement site, including within tidal marshes and restored salt ponds at Eden Landing, ranging from about 0.01 cm at the target tidal marsh to about 0.1 cm on adjacent mudflats over a two-month period. These accretion rates are similar to those observed by the U.S. Geological Survey throughout the estuary's tidal mudflats and marshes, and do not represent a substantial adverse impact to these resources. The impacts on cultural resources would therefore be **less than significant.**

b) There are no archeological resources within the project's APE, therefore there would be **no impact** from the project on archeological resources.

c) The shallow water placement site is more than two miles offshore and is not known to contain human remains, therefore there would be **no impact** from the project on human remains.

VI. Energy

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation?				**X**
b) Conflict with or obstruct a state or local plan for renewable energy or energy efficiency?				**X**

Discussion

a), b) The project would not result in wasteful, inefficient, or unnecessary consumption of energy, and would not conflict with or obstruct state or local plans for renewable energy or energy efficiency. The project would not require substantially more energy than USACE's historic and current maintenance dredging operations in San Francisco Bay. The project is designed to maximize transportation of sediment from the placement location to target tidal wetlands and mudflats using natural tidal currents and waves, instead of more energy-intensive transport methods such as direct placement. Therefore, the project would have **no impact** on energy.

VII. Geology and Soils

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.				X
ii) Strong seismic ground shaking?				X
iii) Seismic-related ground failure, including liquefaction?				X
iv) Landslides?				X
b) Result in substantial soil erosion or the loss of topsoil?			X	
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?			X	
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial director indirect risks to life or property?				X
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of wastewater?				X
f) Directly or indirectly destroy a unique paleontological resource or site, or unique geologic feature?			X	

Background

Soil and Geologic Conditions

The project site is located on subtidal (below Mean Lower Low Water [MLLW]) quarternary Bay Muds about 2 miles offshore of Eden Landing. These sediments were deposited during high stands of sea level in the post-Wisconsin (less than 10,000 years ago) period, and have undergone some tectonic and possibly isostatic subsidence since their deposition (Atwater et al. 1977). Local Bay Muds likely also experience ongoing subsidence due to sediment and aquifer-system compaction (Shirzaei and Burgmann 2018). The project's location in the Bay shallows (less than 18 ft deep, see Goals Project 1999) means that local Bay Muds and associated lenses of coarser sediment (e.g., estuarine-derived shell, fluvial-derived silts, sands, and gravels) are regularly exposed to tidal currents and waves that sort, re-work, and transport nearshore sediments. When these sediments are advected into the water column during a flood tide, they can be transported into and deposit within adjacent tidal water bodies, including tidal wetlands and tidally restored former salt ponds within the Eden Landing complex. Depending on conditions, such as wave height, direction, and tidal state, waves can contribute to erosion and retreat of the shoreline, and/or deposit sediment onto shoreline tidal wetlands (such as Whale's Tail North and South).

Seismic Conditions

The site is located in the seismically active Bay Area. It is located about 12.2 miles northeast of the San Andreas fault, 20 miles northeast of the San Gregorio fault, 6.25 miles southwest of the Hayward fault, and 14.3 miles southwest of the Calaveras fault. The probability of a major (6.0 Richter Magnitude or above) earthquake occurring on one or more of these faults by 2043 is 98 percent. During such an earthquake, strong seismic shaking is likely to occur at the site. No faults are mapped as crossing or within a half mile of the site, and the site is not in a fault rupture hazard zone as identified by the California Geological Survey.

Discussion

a) The project site is not located within an area that has been identified as an Alquist-Priolo Earthquake Fault Zone, though it is located in an area that is vulnerable to strong ground shaking, liquefaction, and landslides (California Geological Survey 2018). However, the project does not involve the construction of any structure meant for human use or habitation, and would not influence geological, geotechnical, or seismic conditions near any such structures. Therefore, the project would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death, so there is **no impact** with respect to seismic risk.

b) The purpose of the project is to increase sediment delivery to tidal mudflats and marshes within and offshore of the Eden Landing Complex. Though the placed sediment is likely to erode into the water column and be advected into adjacent tidal waters, sediment placement is unlikely to influence the erosion of *in situ* benthic sediment elsewhere in the vicinity. There is therefore a **less than significant** impact to soil erosion or the loss of topsoil.

c) Saturated Bay Muds are inherently unstable and vulnerable to subsidence, lateral spreading, liquefaction, and related geotechnical risks. The project proposes to place approximately 100,000 cubic yards of dredged sediment (mostly Bay Muds) in a thin layer on top of in situ Bay Muds roughly two miles offshore of Eden Landing. By placing this sediment as evenly as feasible over the 138-acre placement footprint, the average thickness of sediment deposits would be around half a foot deep. It is possible, but unlikely, that thicker deposits would result from operational variability; especially thick deposits could potentially lead to very limited localized compaction, spreading, and displacement of *in situ* Bay Muds. The impact would be **less than significant**.

d) The project would be located on expansive soil, but would not involve the construction of any structure meant for human use or habitation, and would not influence geological, geotechnical, or seismic conditions near any such structures that would result in substantial direct or indirect risks to life or property. There would therefore be **no impact** with respect to expansive soils.

e) The proposed project does not involve installation of a septic system. Therefore, **no impact** would occur with respect to adequacy of site soils for septic systems.

f) The project would not involve deep excavation, therefore potential impacts to paleontological resources are unlikely and would be considered **less than significant**.

VIII. Greenhouse Gas Emissions

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?			X	
b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?			X	

Background

This section describes construction greenhouse gas (GHG) emissions impacts associated with the proposed project and is consistent with the methods described in the BAAQMD *CEQA Air Quality Guidelines* (May 2017).

"Global warming" and "global climate change" are terms typically used to describe the increase in the average temperature of the earth's near-surface air and oceans since the mid-20th century and its projected continuation. Warming of the climate system is now considered to be unequivocal, with global surface temperature increasing approximately 1.33 degrees Fahrenheit (°F) over the last 100 years. Continued warming is projected to increase global average temperature between 2 and 11°F over the next 100 years.

Gases that trap heat in the atmosphere are referred to as GHG because they capture heat radiated from the sun as it is reflected back into the atmosphere, much like a greenhouse does. The accumulation of GHG has been implicated as the driving force for global climate change. The primary GHG are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), ozone, and water vapor.

While the presence of the primary GHG in the atmosphere are naturally occurring, CO_2, CH_4, and N_2O are also emitted from human activities, accelerating the rate at which these compounds occur within earth's atmosphere. Emissions of CO_2 are largely by-products of fossil fuel combustion, whereas methane results from off-gassing associated with agricultural practices, coal mines, and landfills. Other GHG, such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, are generated in certain industrial processes.

CO_2 is the reference gas for climate change because it is the predominant GHG emitted. The effect that each of the aforementioned gases can have on global warming is a combination of the mass of their emissions and their global warming potential (GWP). GWP indicates, on a pound-for-pound basis, how much a gas is predicted to contribute to global warming relative to how much warming would be predicted to be caused by the same mass of CO_2. CH_4 and N_2O are substantially more potent GHG than CO_2, with GWP of a 27 to 30 and 273 times that of CO_2, respectively (USEPA 2022).

In emissions inventories, GHG emissions are typically reported in terms of pounds or metric tons of CO_2 equivalents (CO_2e). CO_2e are calculated as the product of the mass emitted of a given GHG and its specific GWP. While CH_4 and N_2O have much higher GWP than CO_2, CO_2 is emitted in such vastly higher quantities that it accounts for the majority of GHG emissions in CO_2e.

Appendix A-5 of the EA-MND describes the details of the greenhouse gas analysis. The results of this analysis are summarized in Table GHG-1:

Table GHG-1. Greenhouse gas analysis of the proposed project.

Redwood City Sediments taken to Eden Landing Placement Site	
Total CO2eq (lbs/day)	1382.78
Total Project CO2eg (Tons)	45.63
Council on Environmental Quality Yearly GHG Threshold (CO2eq) (Tons)	None
Project Exceeds Council on Environmental Quality Yearly GHG Threshold?	N/A
Project is Significant With Respect to Regional Output?	NO

Discussion

a) See Section 4.1.11 and Appendix A-5 of the EA-MND for information about the model used to quantify GHG emissions associated with project construction activities. The proposed project's estimated construction related GHG emissions would be approximately 108.3 tons of CO_2e. There is no BAAQMD CEQA significance threshold for construction-related GHG emissions. However, this value would be below the 2030 bright line GHG significance threshold of 660 metric tons per year. Therefore, this impact would be **less than significant**.

b) California passed the California Global Warming Solutions Act of 2006 (AB 32; California Health and Safety Code Division 25.5, Sections 38500 - 38599). AB 32 established regulatory, reporting, and market mechanisms to achieve quantifiable reductions in GHG emissions and establishes a cap on statewide GHG emissions. AB 32 required that statewide GHG emissions be reduced to 1990 levels by 2020. The state achieved 1990 levels in 2016 and the levels remained below 1990 levels through 2020 (CARB 2021). In September of 2016, SB 32 extended the goals of AB 32 and set a goal to achieve reductions in GHG of 40 percent below 1990 levels by 2030. In 2017, CARB adopted the 2017 Scoping Plan, which identifies how the state can reach the 2030 climate target to reduce GHG emissions by 40 percent from 1990 levels, and substantially advance toward the state's 2050 climate goal to reduce GHG emissions by 80 percent below 1990 levels.

The project has been reviewed relative to the climate change policies and measures in CARB's *2017 Climate Change Scoping Plan* (CARB 2017) and it has been determined that the Project would not conflict with State GHG reduction goals. Therefore, impacts would be **less than significant**.

IX. Hazards and Hazardous Materials

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?				X
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?				X
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?				X
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?				X
e) For a Project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the Project result in a safety hazard or excessive noise for people residing or working in the Project area?				X
f) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?				X
g) Expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildland fires?				X

Discussion

a-c) Sediment delivered to the project site for subtidal placement would be tested and approved for placement by the Dredged Material Management Office, which bans the in-Bay disposal of any sediment that could be classified as hazardous material. Project construction would not involve the routine transport, use, or disposal of hazardous materials. There is therefore **no impact** with respect to hazards to the public and the environment.

d) The project site is not included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5. There is therefore **no impact** with respect to hazards to the public and the environment.

e) The project site is not within an airport land use plan nor is it within two miles of a public airport or public use airport. The project would not present a hazard to air safety, and **no impact** would occur.

f) Construction of the project is not expected to interfere with the City of Hayward's emergency response because the project site is more than two miles offshore of the City. **No impact** would occur.

g) The project site is within San Francisco Bay, so therefore the project would have **no impact** with respect to wildfire hazards.

X. Hydrology and Water Quality

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or groundwater quality?			X	
b) Substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin?				X
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner which would: i) result in substantial erosion or siltation on- or off-site; ii) substantially increase the rate or amount of surface runoff in a manner which would result in flooding on-or off-site; iii) create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or iv) impede or redirect flood flows?			X	
d) In flood hazard, tsunami, or seiche zones, risk release of pollutants due to project inundation?				X
e) Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?				X

Background

The project site offshore of Eden Landing is located within shallow (less than 18 ft deep, see Goals Project 1999) tidal waters typical of nearshore South San Francisco Bay. Tides at the site are mixed semi-diurnal, with roughly two daily low tides and high tides of unequal height. Tidal datums at the nearby NOAA San Mateo Bridge West station (941-4458) are as follows:

Datum	Elevation (ft NAVD)
MHHW	6.92
MHW	6.29
MSL	3.31
MTL	3.34
MLW	0.39
MLLW	-0.80

Tidal waters are dominated by near-marine salinities (about 28 to 33 parts per thousand) except during the winter when periodic pulses of freshwater from local watersheds (e.g., Old Alameda Creek, Mt. Eden Creek) enter the Bay shallows. These freshwater pulses can temporarily decrease local salinities into brackish ranges, particularly during periods of sustained high flows from the Alameda Creek Flood Control Channel to the south. Water temperatures are typically between 46 and 74°F, with warmer temperatures experienced during the summer months. Local pH in the Bay is relatively constant, and typically ranges from 7.8 to 8.2 (LTMS 1998; SFEI 2013). Tidal waters at the project site are generally well oxygenated (above 5 mg/L); typical concentrations of dissolved oxygen (DO) in most of the Bay range from 9 to 10 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). Local turbidities are typically high (above 50 Nephelometric Turbidity Units, or NTUs) due to the wave-driven resuspension of sediment from the region's shallow subtidal and intertidal mudflats, and can increase seasonally in response to winter pulses of stormwater from surrounding watersheds. Suspended sediment concentrations (SSC) typically range from 200 mg/L in the winter to 50 mg/L in the summer, with shallow areas and their adjacent channels having the highest SSC (Rich 2010). SSC of up to 600 mg/L have been measured in turbidity maximum zones during winter storms that flush sediment from watersheds into the Bay (O'Connor 1991). Wind-waves along the shoreline are consistent but moderate during the summer months; winter storms drive a more variable wave climate that typically features the largest annual wave heights.

Discussion

a) Water quality objectives and beneficial uses (i.e., standards) for the project site are described in the Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) adopted by the San Francisco Bay Regional Water Quality Control Board (Water Board). Beneficial uses of mudflats and tidal marshes in the region include providing estuarine habitat (EST), habitat for special-status and/or rare organisms (RARE), fish migration (MIGR), and recreation (REC-1 and REC-2). Climate change threatens these beneficial uses via rising sea levels, which can drown mudflats and tidal wetlands and convert them to shallow open water habitats (Goals Project 2015). The project is intended to result in beneficial environmental impacts, by augmenting the local supply of sediment available to support accretion in mudflats and tidal wetlands, and help them keep pace with rising sea levels. The water quality objectives at issue for the project are sediment and turbidity. The water quality objective for sediment provides that the sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses. Similarly, the turbidity water quality objective states that waters shall be free of turbidity changes that cause nuisance or adversely affect beneficial uses and increases in turbidity from discharges shall not be greater than 10 percent where background turbidity is greater than 50 NTU. During periods of sediment placement, nearby tidal waters would likely experience temporary increases in sediment and turbidity due to placed material settling on the Bay mudflats and dispersing into the water column. Modeling indicates that after dredged sediment placement, SSC adjacent to the placement footprint would most frequently range between 50 and 300 mg/L over baseline conditions, and could be elevated by as much as 500 mg/L in the most extreme case. However, the modeling also indicates that SCC would quickly return to baseline after each placement episode. Once the material is placed, tidal currents and waves are expected to re-work these sediments, and disperse additional sediment into the water column to support accretion in nearby mudflats and tidal marshes (see [c] below). Given the naturally turbid nearshore environment in the project vicinity, temporary local increases in turbidity would not violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or groundwater quality, so this impact would be **less than significant**. Moreover, in permitting the discharge, the Regional Water Board will have to ensure the discharge meets water quality standards, including antidegradation requirements, further ensuring impacts remain less than significant.

b) The project site is located in San Francisco Bay, two miles offshore of Eden Landing, and will have **no impact** on groundwater resources.

c) The project will not alter any existing drainage patterns in the area, and does not propose any new impervious surfaces or other features that could alter local runoff/flooding patterns. The project proposes to place a thin (average depth of less than half a foot) layer of sediment across roughly 138 acres along the bottom of San Francisco Bay offshore of Eden Landing, to augment local nearshore sediment supplies and support accretion (siltation) on nearby tidal mudflats and marshes to help them keep pace with rising sea levels. Modeling indicates that the project could drive modest amounts of accretion in nearby tidal areas, ranging from about 0.01 cm at the target tidal marsh to about 0.1 cm on adjacent mudflats over the first two months during and after placement. These accretion rates are similar to those observed by the U.S. Geological Survey throughout the estuary's tidal mudflats and marshes. Neither the sediment placement nor the resulting siltation in the project vicinity is expected to substantially influence local wave or tidal dynamics. This impact is therefore **less than significant**.

d) See Section (IX); any sediment delivered to the project site for subtidal placement would be tested and approved for placement by the Dredged Material Management Office, which bans the in-Bay disposal of any sediment that could be classified as hazardous or polluted material. Therefore, even though the project site is within San Francisco Bay, there would be **no impact** with respect to the risk of releasing pollutants due to project inundation.

e) The project is consistent with the Basin Plan and will not influence local groundwater, therefore there is **no impact**.

XI. Land Use and Planning

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Physically divide an established community?				X
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the Project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				X
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?				X

Discussion

a) The project is located within San Francisco Bay and will have **no impact** on established communities.

b) The project site is over two miles offshore of Eden Landing and is not included in any applicable land use plan, general plan, specific plan, local coastal program, or zoning ordinance. The project would not change the existing land use on site and would therefore have **no impact** on plan conformance.

c) The project site is not located within the boundaries of a habitat conservation plan or a natural community conservation plan; therefore, the project would not conflict with any habitat plans and there would be **no impact**.

XII. Mineral Resources

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				**X**
b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				**X**

Discussion

a, b) The project site is within San Francisco Bay and is not identified within any plans as a site containing mineral resources that would be of local, regional, or statewide importance. Therefore, the project would not have any impacts on mineral resources. The project site is also outside of any areas designated by the State Mining and Geology Board as containing regionally significant construction-grade aggregate resources (used in concrete). The project site does not contain any known mineral deposits or active mineral extraction operations. Therefore, the project would have **no impact** on mineral resources.

XIII. Noise

Would the Project result in:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Generation of a substantial temporary or permanent increase in ambient noise levels in vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?			X	
b) Generation of excessive groundborne vibration or groundborne noise levels?				X
c) For a Project within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the Project expose people residing or working in the project area to excessive noise levels?				X

Discussion

a) Noise from dredging equipment such as a dredging ship can generate noise levels from 55 to 87dBA (Joint Guam 2010), or 62 to 80 dBA (Epsilon 2006), which are below the placement noise thresholds in the Federal Transit Administration (FTA) guidelines of 90 dBA during daytime hours. The placement site is over open waters, and there are no sensitive receptors nearby. Short-term noise impacts may occur during placement at the placement site. However, sediment management (including the excavation and placement of dredged materials) has occurred in the past at this location, and ongoing noise from sediment management activities and ambient noise from existing vessel traffic are part of the existing condition. In this context, noise impacts specific to placement of dredged materials from the federal navigation channels would be **less than significant**.

b) The project does not involve use of ground vibratory equipment, so there is **no impact**.

c) The Project site is not within the vicinity of a private airstrip or an airport land use plan, or within 2 miles of a public use airport. Therefore, the Project would have **no impact** on cumulative airport noise**.**

XIV. Population and Housing

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?				**X**
b) Displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere?				**X**

Discussion

a) The project would not build new housing or businesses, nor build any infrastructure that could indirectly support new housing or businesses. Therefore, the project would not induce new development on nearby lands, and **no impact** would occur.

b) The project site is within San Francisco Bay and would not displace existing housing or people, so there would be **no impact**.

XV. Public Services

Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the following public services:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Fire protection?				X
b) Police protection?				X
c) Schools?				X
d) Parks?				X
e) Other public facilities?				X

Discussion

a-e) The project does not propose any public facilities or activities that would require public services; therefore, there would be **no impact** on public services.

XVI. Recreation

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Would the Project increase the use of existing neighborhood and regional parks or other recreational facilities such that physical deterioration of the facility would occur or be accelerated?				**X**
b) Does the Project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?				**X**

Discussion

a-b) The project site is located more than two miles offshore of existing recreational facilities at Eden Landing, and does not propose any new public facilities or activities. Therefore, there would be **no impact** on recreation.

XVII. Transportation/Traffic

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Conflict with a program, plan, ordinance or policy addressing the circulation system, including transit roadways, pedestrian and bicycle facilities?				X
b) Conflict or be inconsistent with CEQA Guidelines Section 15064.3, subdivision (b) (vehicle Miles traveled)?				X
c) Substantially increase hazards due to design features (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				X
d) Result in inadequate emergency access?				X

Discussion

a-d) The project site is more than two miles offshore of Eden Landing within San Francisco Bay, and would be constructed by equipment and personnel that are barged to the project site. No equipment or personnel would be transported to the project site on local surface roads or freeways. Therefore, the project would have **no impact** on traffic and transportation.

XVIII. Tribal Cultural Resources

Would the project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Would the project cause a significant adverse change in the significance of a tribal cultural resource defined in Public Resource Code Section 21074 as either a site, feature, place cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is:				
i) Listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in Public Resources Code section 5020.1(k), or				X
ii) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Public Resources Code section 5024.1. In applying criteria set forth in subdivision (c) of Public Resources Code section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe.				X

Background

Section 21084.1 of CEQA and Section 15064.5 of the State CEQA Guidelines establish the definition of historical resource for the purposes of CEQA. Assembly Bill (AB) 52 became effective for all projects, including this one, with CEQA documents prepared after July 1, 2015. The bill added a definition of “tribal cultural resource,” which is separate from the definitions for “historical resource” and “archaeological resource” (California Public Resource Code (PRC) Section 21074; 21083.09). The bill also added requirements for lead agencies to engage in additional consultation procedures with respect to California Native American tribes (PRC Sections 21080.3.1, 21080.3.2, 21082.3). Specifically, PRC Section 21084.3 states: “a. Public agencies shall, when feasible, avoid damaging effects to any tribal cultural resource. b. If the lead agency determines that a project may cause a substantial adverse change to a tribal cultural resource, and measures are not otherwise identified in the consultation process provided in Section 21080.3.2, the following are examples of mitigation measures that, if feasible, may be considered to avoid or minimize the significant adverse impacts: 1) Avoidance and preservation of the resources in place, including, but not limited to, planning and construction to avoid the resources and protect the cultural and natural context, or planning greenspace, parks, or other open space, to incorporate the resources with culturally appropriate protection and management criteria." California Register of Historical Resources California PRC Section 5024.1 and 14 California Code of Regulations Section 4850 establishes the CRHR, the "authoritative listing and guide to be used by state and local agencies, private groups, and citizens in identifying the existing historical resources of the state and to indicate which resources deserve to be protected, to the extent prudent and feasible, from substantial adverse change."

The USACE and Water Board contacted the Native American Heritage Commission (NAHC) requesting an updated Native American tribal consultation list for the Project. The Sacred Lands File search was negative. USACE obtained a tribal consultation list from the NAHC on 14 April 2020. The following Ohlone Tribes were identified as tribal consulting parties under Section 106 of NHPA and the National Environmental Policy Act (NEPA): The Amah Mutsun Tribal Band, Amah Mutsun Tribal Band of Mission San Juan Bautista, Costanoan Ohlone Rumsen-Mutsun Tribe, Indian Canyon Mutsun Band of Costanoan, and the Muwekma Ohlone Indian Tribe of the SF Bay Area.

On June 1, 2022, a virtual, informal Tribal consultation meeting was held with the Confederated Villages of Lisjan (CVL). The CVL is interested in the project and wishes to be involved in the monitoring of plants and the effectiveness of the study. The Tribe identified tidal marshes near the sediment placement site as a cultural resource, would like access to the monitoring data that is collected, and are interested in learning whether the Pilot Project is successful. As previously discussed under (V) Cultural Resources, the existing tidal marshes in the area are considered a historic resource under the NHPA. No additional historical resources, archaeological resources, or tribal cultural resources were identified in addition to those already analyzed under the NHPA.

Discussion

a) As previously discussed under (IV) Biological Resources, modeling of the proposed project indicates that tidal systems in the area (including existing tidal marshes at Eden Landing) would experience accretion ranging from about 0.01 cm at the target marsh to about 0.1 cm on the mudflats over a three-month period during and after placement. This is similar to natural accretion rates observed by the U.S. Geological Survey in tidal marshes and mudflats throughout the estuary. As such, USACE recommends the Pilot Project will constitute a "No Historic Properties Affected", due to the limited deposition potential of strategic placement. USACE, the federal sponsor, and the Water Board are consulting with SHPO and Tribes on our determination of effect. Therefore, implementation of the proposed project would have **no impacts** on cultural resources.

XIX. Utilities and Service Systems

Would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Require or result in the relocation or construction of new or expanded water, wastewater treatment or storm water drainage, electric power, natural gas, or telecommunications facilities, the construction or relocation of which could cause significant environmental effects?				X
b) Have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry and multiple dry years?				X
c) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?				X
d) Generate solid waste in excess of state or local standards, or in excess of the capacity of local infrastructure, or otherwise impair the attainment of solid waste reduction goals?				X
e) Comply with federal, state, and local management and reduction statutes and regulations related to solid waste?				X

Discussion

a-e) The project does not propose any facilities or structures that require public utilities; therefore, there are **no impacts** with respect to utilities.

XX. Wildfire Hazards

If located in or near state responsibility areas or lands classified as very high fire hazard severity zones, would the Project:

Environmental Issue	Potentially Significant Impact	Less Than Significant with Mitigation	Less Than Significant Impact	No Impact
a) Substantially impair an adopted emergency response plan or emergency evacuation plan?				**X**
b) Due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose project occupants to pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire?				**X**
c) Require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment?				**X**
d) Expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes?				**X**

Discussion

a-d) The project site is within San Francisco Bay, so therefore the project would have **no impact** with respect to wildfire hazards, associated hazards, and equipment /infrastructure needs.

I. MANDATORY FINDINGS OF SIGNIFICANCE

Environmental Issue	Potentially Significant	Less Than Significant with Mitigation	Less Than Significant	No Impact
a) Does the Project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, substantially reduce the number or restrict the range of an endangered, rare or threatened species or eliminate important examples of the major periods of California history or prehistory?		X		
b) Does the Project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a Project are considerable when viewed in connection with the effects of past Projects, the effects of other current Projects, and the effects of probable future Projects)?		X		
a) Does the Project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?				X

a) The purpose of the project is to support native and special-status plants, fish, and wildlife by supporting the health, diversity, and resilience of sensitive estuarine habitats in the vicinity of Eden Landing and within restoring former salt ponds that are part of the South Bay Salt Pond Restoration Project. The project will result in temporary impacts to estuarine habitats and dependent fish and wildlife communities (including special-status species) offshore of Eden Landing, primarily via burial of sessile organisms in the benthos at the sediment placement site and localized temporary increases in turbidity. Buried portions of the Bay bottom are expected to be recolonized by nearby populations of benthic organisms, and turbidity is not expected to increase beyond levels naturally experienced in nearshore habitats. Impacts to eelgrass and water quality from the proposed project are potentially significant, and would be reduced to **less than significant with the incorporation of mitigation** measures AQ-1, BIO-1, and BIO-2.

b) Table 5-2 in Chapter 5 of the EA-MND lists related past, present, and reasonably foreseeable future projects in the vicinity of this proposed project. All of these projects are currently in the planning phases, with the exception of the South Bay Salt Pond Restoration Project and the South San Francisco Bay Shoreline Protection Project. Phase 1 of the South Bay Salt Pond Restoration Project restored roughly 1,700 acres of tidal habitat within the CDFW Eden Landing complex north of Old Alameda Creek; construction of Phase 2, which will restore an additional 2,200 acres to tidal action south of Old Alameda Creek, is expected to begin in 2023. The South San Francisco Bay Shoreline Protection Project will restore roughly 2,900 acres of former salt ponds near the community of Alviso to tidal action; the first phase is currently under construction. All of these projects are designed, permitted, and implemented such that the temporary adverse environmental impacts from construction are anticipated to be offset by longer-term beneficial environmental impacts (improved habitat for native and special-status species, improved flood control, improved recreation, etc.). The only potential cumulatively considerable adverse environmental impacts from the project and those other related projects is from cumulative greenhouse gases resulting from the construction of all these projects. However, with the implementation of mitigation measure AQ-1, and considering the short time span of the project's duration (~25 days), it is unlikely the project, when viewed in connection with other related projects, will result in cumulatively considerable impacts. The proposed project would therefore result in cumulative impacts that are **less than significant with mitigation**.

c) The proposed project would result in no environmental impacts that would drive adverse effects on human beings; therefore, there is **no impact.**

J. Lead Agency Determination

On the basis of the Environmental Assessment and Initial Study, the California Regional Water Quality Control Board, San Francisco Bay Region, declares that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions to the project and mitigation measures identified in the Environmental Assessment and Initial Study have been made by or agreed to by the project proponent and recommends that a mitigated negative declaration be prepared.

This disposition constitutes the official action of the California Regional Water Quality Control Board, San Francisco Bay Region.

Eileen White Digitally signed by Eileen White
Date: 2023.01.29 19:57:07 -08'00'

Eileen White, Executive Officer
California Regional Water Quality Control Board, San Francisco Region

Date

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Appendix G – PREPARERS

USACE San Francisco District

- Peter Mull, Project Manager, USACE San Francisco District
- Julie Beagle, Environmental Planning Section Chief, USACE San Francisco District
- Arye Janoff, Planner, USACE San Francisco District
- John Dingler, Planner, USACE San Francisco District
- Ellie Covington, Environmental Manager, USACE San Francisco District
- Eric Jolliffe, Environmental Manager, USACE San Francisco District
- Tiffany Cheng, Coastal Engineer, USACE San Francisco District
- Jason Emmons, Environmental Manager, USACE San Francisco District
- Elizabeth Campbell, Environmental Manager, USACE San Francisco District
- Stephanie Bergman, Archaeologist, USACE San Francisco District
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- Kelly Boyd, Real Estate Specialist, USACE Los Angeles District

SF Bay Regional Water Quality Control Board Staff

- Xavier Fernandez
- Kevin Lunde
- Jazzy Graham-Davis
- Sami Harper

Non-Federal PDT

- Evyan Sloan, State Coastal Conservancy
- Brenda Goeden, Bay Conservation Development Commission

Appendix H – AGENCY AND PUBLIC PARTICIPATION

Agency and public comments are included below. For public outreach and participation see main body of EA/IS/MND Section 7.

Janoff, Arye M CIV USARMY CESPN (USA)

From: Kristina Hill <kzhill@berkeley.edu>
Sent: Tuesday, September 27, 2022 10:09 AM
To: Janoff, Arye M CIV USARMY CESPN (USA)
Subject: [URL Verdict: Neutral][Non-DoD Source] Re: NOTICE OF RELEASE: Draft Environmental Assessment/Initial Study/Mitigated Negative Declaration for Section 1122 Strategic Shallow Water Placement Pilot Project, San Francisco Bay, California

Dear Arye,

This project near Eden's Landing represents an essential test of our ability to enhance wetlands as sea level rises over the next century and longer. I support the urgent need for this sediment placement, and hope that the project will move forward. Doing nothing will have a much larger environmental impact in a changing climate than any potential negative impact of testing this kind of nature-based strategy for wetland nourishment.

Thanks for seeking comments-
Kristina

____
Kristina Hill, PhD (she/her)
Director, Institute of Urban and Regional Development
Associate Professor of Urban Design, Landscape Architecture and Environmental Planning
College of Environmental Design, University of California, Berkeley, CA 94720
mobile: 434.466.4808

On Fri, Sep 23, 2022 at 5:52 PM Janoff, Arye M CIV USARMY CESPN (USA) <Arye.M.Janoff@usace.army.mil> wrote:

> Dear Interested Parties,
>
> In accordance with the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. § 4321 et seq), as amended, the United States Army Corps of Engineers, San Francisco District (USACE) and the San Francisco Bay Water Quality Control Board (Water Board) has prepared a draft Environmental Assessment/Initial Study/Mitigated Negative Declaration (EA/IS/MND) for the proposed Section 1122 Strategic Shallow Water Placement Pilot Project, located offshore of Eden Landing, near Hayward, California. The EA/IS/MND was prepared in collaboration with the State Coastal Conservancy as the non-federal sponsor for this study, and the Water Board as the California Environmental Quality Act lead. The EA/IS/MND assesses alternatives for the proposed strategic shallow water placement project and analyzes potential environmental effects that could result from those alternatives.
>
> The USACE is providing notice of the availability of this draft EA/IS/MND for public review and comment pursuant to 33 C.F.R. § 230.11 (b) U.S. Army Corps of Engineers – Procedures for Implementing NEPA. The comment period will extend from September 23, 2022 – October 24, 2022. We invite your review and feedback!

The draft EA/IS/MND and associated appendices can be accessed by navigating your web browser to the website below and clicking on the links listed below the heading “Section 1122 San Francisco Bay Strategic Shallow Water Placement Pilot Project” on the left side of the page.

Website: https://www.spn.usace.army.mil/Missions/Environmental/

Due to the current COVID-19 pandemic, USACE prefers to receive comments electronically. Please send electronic comments to me at Arye.M.Janoff@usace.army.mil. If you wish to mail your comments, you may also direct them to me at the address in the letterhead attached. All comments must be received prior to the close of the comment period on October 24, 2022. Thank you for your time and consideration.

Sincerely,

Arye M. Janoff, Ph.D.

Planner and Environmental Manager

Environmental Services Branch – Navigation & Operations Section

U.S. Army Corps of Engineers San Francisco District

(415) 503-6846 (office)

(201) 280-3794 (cell)

Arye.M.Janoff@usace.army.mil

Julie Beagle

Environmental Planning Section Chief

Engineering with Nature Program Manager

U.S Army Corps of Engineers, San Francisco District

(415) 590-0152 (mobile)

Pronouns: she/her/hers

ALAMEDA COUNTY WATER DISTRICT

43885 SOUTH GRIMMER BOULEVARD • FREMONT, CALIFORNIA 94538
(510) 668-4200 • www.acwd.org

October 24, 2022

VIA ELECTRONIC MAIL
Dr. Arye Janoff, Environmental Manager (Arye.M.Janoff@usace.army.mil)
Ms. Julie Beagle, Environmental Planning Section Chief
(Julie.R.Beagle@usace.army.mil)

Mr. John Dingler, General Physical Scientist (John.R.Dingler@usace.army.mil)
U.S. Army Corps of Engineers, San Francisco District, Regulatory Division
450 Golden Gate Avenue, 4th Floor
San Francisco, CA 94102-3404777

Dear Dr. Janoff, Ms. Beagle, and Mr. Dingler:

Subject: Draft Environmental Assessment/Initial Study/Mitigated Negative Declaration for Section 1122 Strategic Shallow Water Placement Pilot Project, San Francisco Bay, California

The Alameda County Water District (ACWD) wishes to thank you for the opportunity to comment on the U.S. Army Corps of Engineers (USACE) Draft Environmental Assessment/Initial Study/Mitigated Negative Declaration (EA/IS/MND) for the Section 1122 Strategic Shallow Water Placement Pilot Project (Project).

The Project is located within the ACWD managed Niles Cone Groundwater Basin (Niles Cone Subbasin 2-09.001 or Niles Cone). The Niles Cone is located within the cities of Fremont, Newark, Union City, and the southern portion of the City of Hayward. ACWD is identified within the Sustainable Groundwater Management Act (SGMA) as an agency created by statute to manage groundwater and deemed to be the exclusive local agency within its statutory boundaries to comply with SGMA. In addition, ACWD is the Groundwater Sustainability Agency for the Niles Cone and has an approved Alternative to a Groundwater Sustainability Plan. ACWD has reviewed the EA/IS/MND and offers the following comments for your consideration:

1. Groundwater Protection: The Niles Cone represents a major source of ACWD's water supply; therefore, it is imperative that ACWD protects the water quality and ensures the continued use of the Niles Cone for water supply for ACWD's customers:

a. Hazards and Hazardous Materials: Page 72 of the EA/IS/MND states, “Sediments are tested prior to dredging in the SF bay and are reviewed by the DMMO [Dredged Material Management Office], which bans the in-Bay disposal of any sediment that could be classified as hazardous or polluted material,” and “Dredged material suitability for placement in-bay would be obtained from the DMMO for source channel sediments prior to the proposed action or alternative B. This process would identify contaminated sediments and screen out any material that is unsuitable for shallow water placement.”

   The EA/IS/MND does not specify the screening levels that would be used to evaluate the suitability of sediment for placement. Please specify what screening levels will be used to evaluate concentrations of potential contaminants in sediment and provide a justification for the suitability of those screening criteria.

b. Groundwater Well Protection/Destruction: Since 2002, ACWD has worked with the South Bay Salt Pond Restoration Project proponents in identification and the proper destruction of abandoned wells in order to protect the Niles Cone. A number of identified wells have not been located and records indicate they are within the Alameda County Flood Control Channel between Alvarado and San Francisco Bay or beneath channel levees.

   ACWD has identified at least ten (10) water wells and one monitoring well located within or in close proximity to the Project Area (see enclosed figure).

   i. The monitoring well within the Project limits is owned and monitored by ACWD. Groundwater sampling and monitoring of the monitoring well is imperative to ACWD’s management of the Niles Cone. Therefore, ACWD requests that the existing monitoring well is protected against being potentially damaged or lost (e.g., buried) during construction activities.

   ii. Historical records indicate the presence of 10 abandoned water wells within the Project area. An extensive effort to locate the wells occurred between 2002 and 2006, and during that time the wells could not be located. Although excavation activities are not expected in the area of the well locations, should the wells be discovered during the improvements, ACWD should be notified within 24 hours of such a discovery. Any abandoned wells must be properly destroyed in accordance with ACWD requirements.

2. <u>ACWD Contacts</u>: The following ACWD contacts are provided so that USACE can coordinate with ACWD as needed during the permitting process:

    - Michelle Myers, Groundwater Resources Manager at (510) 668-4454, or by email at michelle.myers@acwd.com, for coordination regarding ACWD's groundwater resources.

    - Kit Soo, Well Ordinance Supervisor, at (510) 668-4455, or by email at kit.soo@acwd.com, for coordination regarding groundwater wells and drilling permits.

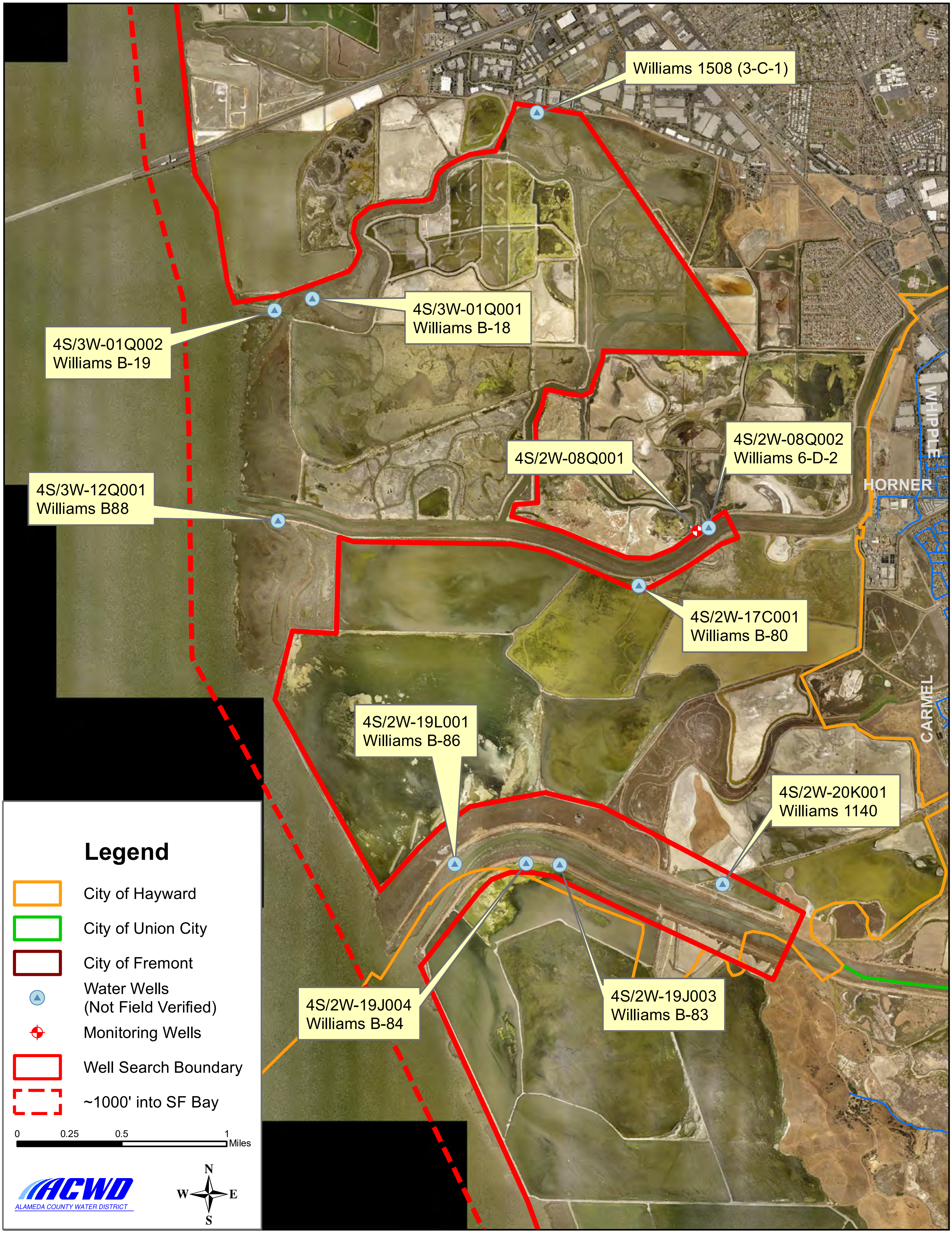
Thank you for the opportunity to comment on the Project at this time.

Sincerely,

Laura J. Hidas

Laura J. Hidas
Director of Water Resources

al/ml
Enclosure
By Email
cc: Michelle Myers, ACWD
Kit Soo, ACWD



Williams 1508 (3-C-1)
4S/3W-01Q001
Williams B-18
4S/3W-01Q002
Williams B-19
4S/2W-08Q001
4S/2W-08Q002
Williams 6-D-2
WHIPPLE
HORNER
4S/3W-12Q001
Williams B88
4S/2W-17C001
Williams B-80
CARMEL
4S/2W-19L001
Williams B-86
4S/2W-20K001
Williams 1140
4S/2W-19J004
Williams B-84
4S/2W-19J003
Williams B-83
Legend
City of Hayward
City of Union City
City of Fremont
Water Wells
(Not Field Verified)
Monitoring Wells
Well Search Boundary
~1000' into SF Bay
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Miles
ACWD
ALAMEDA COUNTY WATER DISTRICT
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E
S

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Marine Region
1933 Cliff Drive, Suite 9
Santa Barbara, CA 93109
wildlife.ca.gov

November 7, 2022

Christina Toms
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612
Christina.Toms@waterboards.ca.gov

Dear Ms. Toms:

San Francisco Bay Strategic Shallow-Water Placement Pilot Project (Project)
Initial Study/Draft Mitigated Negative Declaration (ISMND)
SCH# 2022100155

The California Department of Fish and Wildlife (Department) received a ISMND from the San Francisco Bay Regional Water Quality Control Board (Waterboard) for the Project pursuant the California Environmental Quality Act (CEQA) and CEQA Guidelines.[1]

Thank you for the opportunity to provide comments and recommendations regarding those activities involved in the Project that may affect California fish and wildlife. Likewise, we appreciate the opportunity to provide comments regarding those aspects of the Project that the Department, by law, may be required to carry out or approve through the exercise of its own regulatory authority under the Fish and Game Code.

CDFW ROLE

The Department is California's Trustee Agency for fish and wildlife resources and holds those resources in trust by statute for all the people of the state. (Fish & G. Code, Section711.7, subd. (a) & 1802; Pub. Resources Code, Section 21070; CEQA Guidelines Section 15386, subd. (a).) The Department, in its trustee capacity, has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitat necessary for biologically sustainable populations of those species. (*Id.*, Section 1802.) Similarly for purposes of CEQA, the Department is charged by law to provide, as available, biological expertise during public agency environmental review efforts, focusing specifically on projects and related activities that have the potential to adversely affect fish and wildlife resources. The Department is also responsible for marine biodiversity protection under the Marine Life Protection Act in coastal marine waters of California, and ensuring fisheries are sustainably managed under the Marline Life Management Act.

[1] CEQA is codified in the California Public Resources Code in section 21000 et seq. The "CEQA Guidelines" are found in Title 14 of the California Code of Regulations, commencing with section 15000.

PROJECT DESCRIPTION SUMMARY

Proponent: United States Army Corps of Engineers

Objective: The proposed Project would place sediment dredged from a federal in-bay navigation channel in shallow waters on the periphery of the Bay to examine the ability of tides and currents to move the placed material to existing mudflats and marshes as a way to enhance sea-level-rise resilience.

Location: The placement of dredged material will occur within San Francisco Bay in an area just south of the San Mateo Bridge between the cities of Foster City and Hayward (San Mateo and Alameda Counties).

MARINE BIOLOGICAL SIGNIFICANCE

The San Francisco Bay-Delta is the second largest estuary in the United States and supports numerous aquatic habitats and biological communities. It encompasses 479 square miles, including shallow mudflats. This ecologically significant ecosystem supports both state and federally threatened and endangered species and sustains important commercial and recreational fisheries.

STATE AND FEDERALLY LISTED AND COMMERCIALLY/RECREATIONALLY IMPORTANT SPECIES

Protected species under the State and Federal Endangered Species Acts that could potentially be present near Project activities include:

- Chinook salmon (*Oncorhynchus tshawytscha*), state and federally threatened (Spring-run), state and federally endangered (Winter-run)
- Longfin smelt (*Spirinchus thaleichthys*), state-threatened
- Steelhead (*Oncorhynchus mykiss*), federally-threatened (Central California Coast and Central Valley ESUs)
- Green sturgeon (*Acipenser medirostris*), federally-threatened (southern DPS)
- White sturgeon (A. transmontanus; state species of special concern
- Brown pelican (*Pelecanus occidentalis californicus*), state fully protected

Several species with important commercial and recreational fisheries value that could potentially be impacted by Project activities include:

- Dungeness crab (*Cancer magister*)
- Pacific herring (*Clupea pallasii*)
- Surfperches (*Embiotocidae*)
- California halibut (*Paralichthys californicus*)
- Eelgrass (*Zostera marina*)

COMMENTS AND RECOMMENDATIONS

CDFW offers the comments and recommendations below to assist the Waterboard in adequately identifying and/or mitigating the Project's significant, or potentially significant, direct and indirect impacts on fish and wildlife (biological) resources. Editorial comments or other suggestions may also be included to improve the document.

I. Marine Project Level Impacts and Other Considerations

Longfin Smelt

Comment: As described within the ISMND, Longfin smelt is a state listed species and potential impacts are being evaluated under CEQA only. Within the CEQA determination on page 87, it describes the implementation of mitigation measure BIO-1 would ensure impacts to Longfin smelt would be less than significant. Mitigation measure BIO-1 only describes including provisions of the federal wildlife agencies. Under CEQA, the Department is the trustee agency for the fish and wildlife resources in California and would be responsible for including provisions and measures to be protective of state listed species.

Recommendation: The Department recommends that mitigation measure BIO-1 be amended to include that the Project include provisions of the Department through informal consultations with USACE.

White Sturgeon

Comment: White sturgeon are a state species of special concern (SSC). Although the SSC designation does not have a formal legal status, species are designated to bring additional attention to conservation, research, and recovery of species that have previously been subject to population declines or are generally rare. SSCs should be considered during the environmental review process. CEQA (California Public Resources Code §§ 21000-21177) requires State agencies, local governments, and special districts to evaluate and disclose impacts from "projects" in the State. Section 15380 of the CEQA Guidelines indicates that species of special concern should be included in an analysis of project impacts if they can be shown to meet the criteria of sensitivity outlined therein.

Sections 15063 and 15065 of the CEQA Guidelines, which address how an impact is identified as significant, are particularly relevant to SSCs. Project-level impacts to listed (rare, threatened, or endangered species) species are generally considered significant thus requiring lead agencies to prepare an Environmental Impact Report to fully analyze and evaluate the impacts. In assigning "impact significance" to populations of non-listed species, analysts usually consider factors such as population-level effects, proportion of the taxon's range affected by a project, regional effects, and impacts to habitat features.

Recommendation: The Department recommends that the final MND include analysis of potential impacts to White sturgeon from Project activities.

Recommendation: The Department recommends the final MND add White sturgeon to Table 4-7: Special Status Species, Critical Habitats, and Essential Fish Habitat (EFH) potentially occurring in and adjacent to the proposed action on page 67.

Eelgrass

Comment: As described in the ISMND, there is potential for a significant impact to any eelgrass that may be present. The placement of material would bury existing eelgrass or create conditions that make growth or survival difficult. As the trustee agency for state wildlife resources, including habitats that are important to state managed commercial and recreational fisheries, the Department needs to be involved in reviewing and approving any mitigation and monitoring plan proposed for the Project. Although Mitigation Measure BIO-2 is generally consistent with the Departments recommendations, nowhere in the measure explicitly states that coordination with the Department will occur.

Recommendation: The Department recommends that Mitigation Measure BIO-2, section c be amended to include that the proposed monitoring and mitigation plan will be provided to both state and federal wildlife agencies for review prior to approval and implementation. Additionally, if eelgrass mitigation is determined to be necessary, a Scientific Collection Permit from the Department will be required.

Project Schedule

Comment: The ISMND does not have a specific schedule in which Project activities would occur. To provide more specific recommendations for avoidance and/or minimization of potential impacts, an anticipated schedule of when the activities may occur would be beneficial.

Recommendation: The Department recommends the final ISMND include a schedule of when Project activities may occur including anticipated year and time of the year.

ENVIRONMENTAL DATA

CEQA requires that information developed in environmental impact reports and negative declarations be incorporated into a data base which may be used to make subsequent or supplemental environmental determinations. (Pub. Resources Code, §

21003, subd. (e).) Accordingly, please report any special status species and natural communities detected during Project surveys to the California Natural Diversity Database (CNDDB). The CNNDB field survey form can be found at the following link: https://wildlife.ca.gov/Data/CNDDB/SubmittingData#44524420-pdf-field-survey-form. The completed form can be mailed electronically to CNDDB at the following email address: CNDDB@wildlife.ca.gov. The types of information reported to CNDDB can be found at the following link: https://wildlife.ca.gov/Data/CNDDB/Plants-and-Animals.

FILING FEES

The Project, as proposed, would have an impact on fish and/or wildlife, and assessment of filing fees is necessary. Fees are payable upon filing of the Notice of Determination by the Lead Agency and serve to help defray the cost of environmental review by the Department. Payment of the fee is required in order for the underlying project approval to be operative, vested, and final. (Cal. Code Regs, tit. 14, § 753.5; Fish & G. Code, § 711.4; Pub. Resources Code, § 21089.)

CONCLUSION

The Department appreciates the opportunity to comment on the ISMND to assist the Waterboard in identifying and mitigating Project impacts on biological resources.

Questions regarding this letter or further coordination should be directed to Arn Aarreberg, Environmental Scientist, at (707)791-4195 or Arn.Aarreberg@wildlife.ca.gov.

Sincerely,

Becky Ota

Becky Ota
Habitat Program Manager, Marine Region

ec: Becky Ota, Program Manager
Department of Fish and Wildlife
Becky.Ota@wildlife.ca.gov

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Brenda Goeden, Sediment Program Manager
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Brenda.Goeden@bcdc.ca.gov

Arye M. Janoff, Planner and Environmental Manager
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Arye.M.Janoff@usace.army.mil

Sara Azat, Fish Biologist
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Sara.Azat@noaa.gov

Steve Schoenberg, Senior Biologist
United States Fish and Wildlife Service
Steven_Schoenberg@fws.gov

State Clearinghouse (SCH No. 2022100155)
State.clearinghouse@opr.ca.gov

San Francisco Bay Conservation and Development Commission
375 Beale Street, Suite 510, San Francisco, California 94105 tel 415 352 3600 fax 888 348 5190
State of California | Gavin Newsom – Governor | info@bcdc.ca.gov | www.bcdc.ca.gov

November 7, 2022

Ms. Julie Beagle
Environmental Planning Chief
U.S. Army Corps of Engineers, San Francisco District
450 Golden Gate Ave, 4th Floor
San Francisco, CA 94102

SUBJECT: Draft Environmental Assessment and 404 (b)(1) Analysis Initial Study (with Draft Mitigated Negative Declaration) San Francisco Bay Strategic Shallow Water Placement Pilot Project

Dear Ms. Beagle,

Thank you for the opportunity to comment on the Draft "*Environmental Assessment and 404 (b)(1) Analysis Initial Study (with Draft Mitigated Negative Declaration) San Francisco Bay Strategic Shallow Water Placement Pilot Project*," (Draft EA/MND) prepared by the U.S. Army Corps of Engineers (USACE) in collaboration with the San Francisco Bay Regional Water Quality Control Board. On September 23, 2022, the San Francisco Bay Conservation and Development Commission (BCDC) was notified that the draft document was available for review.

The following are BCDC comments on analysis of the project provided as required by the National Environmental Protection Act (NEPA) and the California Environmental Quality Act (CEQA). BCDC reviews federal projects that have potential to affect the coastal zone, in this instance San Francisco Bay, using its Coastal Zone Management Act (CZMA) authority. The CZMP-SFB includes, among other components, the McAteer-Petris Act and the San Francisco Bay Plan (Bay Plan) which guides our regulatory analysis as well as the Federal and California Code of Regulations.

This project has potential to affect the San Francisco Bay Coastal Zone, and therefore, the project should be reviewed for consistency with the Commission's federally-approved Coastal Management Program for San Francisco Bay CZMP-SFB. We note that a draft consistency determination is included as an appendix to the Draft EA/MND and will provide preliminary comments below. Although the Commission itself has not reviewed the Draft, the staff comments discussed below are based on the CZMP-SFB, which is the same criteria that the Commission would use in its evaluation.

San Francisco Bay Conservation and Development Commission
375 Beale Street, Suite 510, San Francisco, California 94105 tel 415 352 3600 fax 888 348 5190
State of California | Gavin Newsom – Governor | info@bcdc.ca.gov | www.bcdc.ca.gov

I. Summarized Project Description

Project Proponents. U.S. Army Corps of Engineers, San Francisco District (USACE)

Project. The USACE proposes to test the technique of placing sediment offshore and adjacent to tidal marshes and mudflats and use the tides and currents to transport sediment onto target mudflats and tidal marshes for habitat enhancement and to lessen the impacts of sea-level rise. Approximately 100,000 cubic yards (cy) of dredged sediment from either Redwood City Harbor or Oakland federal navigation channels will be transported via light loaded scows and placed in-bay at a shallow location approximately 2 miles from the tidal marsh at Whale Tale's Marsh, and adjacent mudflats near the Eden Landing Ecological Reserve. Over the course of 20-60 days, dredged sediment (900 cy) will be light loaded onto scows and taken to the placement site using a tugboat. Approximately 112 round trips will be made to place the dredged sediment at the placement site. Pre- and post-monitoring will be done at the placement area, mudflats, and tidal marshes.

Project Goals. The goals of the project are to (1) determine if shallow-water placement of sediment will indeed supply sediment to coastal wetlands using tide and currents and the effectiveness of the technique; (2) develop a better understanding of the impacts this shallow-water placement technique has on affected habitats (e.g., eelgrass beds, water column, and oyster beds) and evaluate the scale of disturbance and recovery time; and (3) evaluate sediment deposition on mudflats and tidal marsh habitat post placement and environmental factors (i.e., wind, wave, and sediment flux) pre- and post-placement.

Location. The project will take place in the Bay, at an offshore location adjacent to Eden Landing (Whale's Tail) Ecological Reserve along the eastern shore of South San Francisco Bay Estuary, south of the San Mateo Bridge. The offshore placement location is roughly 2 miles away from mudflats and tidal marshes at Eden Landing.

II. Draft EA/MND General Comments

In reviewing this document and some of the appendices, we found that the primary document was difficult to read and follow the overall structure and analysis. The project description that was being evaluated appeared to vary significantly from section to section. For example, in some areas of the document, the pilot project appears to be the subject of the evaluation and in others it appears that a multi-year placement or program is being evaluated in order to draw desired conclusions that have yet to be tested. Similarly, the analysis in many sections is inconsistent and often times conflicting between the NEPA and CEQA statements. There are several areas where the statements made, or conclusions reached that were unsupported by either facts or analysis. This appears to be in part, due the desire to determine the pilot project a successful technique before the pilot has been completed or monitored. In other areas, the information provided is simply incorrect, such as mudflats become beaches above mean tide level.

Analyses in several areas appear to make incorrect or gross comparisons between potential areas of impact and known conditions, such as the winter storm flows in the North Bay compared to potential impacts of summer placement of sediment in the South Bay, or analysis of benthic impacts that seem to be related to the target locations rather than the placement site, which would have the greater impact to benthic communities. Similarly, there are statement regarding increases of turbidity that appear to find no difference between summer total suspended solids of 50 mg/l and 500 mg/l, which is more characteristic of winter storms when high sediment loads are occurring.

There are several areas of research cited from the 1990's that appear to be outdated or superseded by newer research specific to the area of Alternative A, Eden Landing, that should be referenced, but is not. A noted rationale for selecting the Eden Landing site was because there is relevant and recent data available, but it does not appear to be referenced here.

In addition, there several figures that either lack information or relevance to the analysis of the document or are unclearly presented, such that the reader is left unclear on what the figures and associated text are attempting to communicate and show. This maybe the result of choosing available figures from other documents and not carefully connecting them to the point being made in the text or adjusting the information presented in the figure such that it relates to the text. Similarly, there are numerous typos in the document that create a lack of clarity for the reader.

It is unfortunate, but with the conflicting information, lack of clear analysis, and unsupported conclusions, we find this document without revision does not meet its intended goals. We make these comments respectfully noting the significant time constraints the project team was under to maintain its timeline. We are willing to meet and suggest a detailed discussion of the document's needed revisions if helpful to the project team.

III. MND/CEQA Checklist

An additional area of confusion for staff was that the CEQA analysis included in the Draft EA/MND was not consistent with the CEQA Checklist found in Appendix F. This issue was not identified until very late in the review process, as the Draft EA/MND seemed to indicate that the CEQA analysis was included within. The CEQA analysis contained in the primary document has the same issues discussed above, however, the CEQA Checklist contains very concise and straight forward information regarding the project and its potential impacts per the CEQA guidelines for a Mitigated Negative Declaration. If the document of record is the CEQA Checklist, then that should be identified for the reader early in the Draft EA/MND document or the conflicting CEQA analysis should be removed from the Draft EA/MND and provide clear guidance that they are separate documents.

Overall, the CEQA Checklist appears to cover the project adequately, however it should be noted that the Commission does not rely on CEQA when evaluating a federal project. Under BCDC's federal responsibilities, the Draft EA is the document relied on for the NEPA review.

Two areas of issue with the CEQA Checklist were noted:

In the project description it would be helpful to provide the anticipate maximum and minimum sediment placed rather than only the average on page 1. Similarly, it would be helpful to define what is meant by temporary, such as days or months, etc., particularly in areas where repeated deposits of sediment are being made in shallow water. As with the Draft EA/MND comments, using north bay winter storm maximum turbidity points in comparison to a summer treatment appears to understate the potential impacts to species that may be using the area during placement.

IV. Draft Consistency Determination.

Thank you for including a draft consistency determination as part of this documentation. Unfortunately, similar to the primary document, there appears to be some confusion or misunderstanding of how to conduct a consistency review. In the section of the Draft EA/MND under regulatory programs, there is a list of potential applicable policies from the Bay Plan, but the same policies are not reviewed, or policies that are not applicable were reviewed, creating another inconsistency between the primary document and the appendices. It is also important to note that the author incorrectly include the California Coastal Commission (CCC) in the document. The CCC does not have jurisdiction in San Francisco Bay, and the California Coastal Act also is not applicable to San Francisco Bay, but rather the McAteer Petris Act and the San Francisco Bay Plan are. Please remove references to the California Coastal Commission and the Coast Act.

Policies

In our review of the project in comparison to the applicable Bay Plan policies, we found that the following policies would apply to this project and should be the subject of the consistency determination.

Fish, Other Aquatic Organisms, and Wildlife: Policies 1, 2, 4c, 6, and 7.

Water Quality: Policies 1 and 2.

Tidal Marsh and Mudflats: Policies 1, 2, 10, 11, and 12.

Subtidal Areas: Policies 1, 2, 9, and 10.

Dredging: Policies 1, 3, and 11.

Navigation Safety and Oil Spill Prevention: Policies 1 and 3

EJ and Social Equity: Policy 3.

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Climate Change: Policies 1a & 1c, Policy 5, 6b, and 6d.

Fills in Accord with the Bay Plan: Policy 1(a)

Mitigation (If impacts that cannot be minimized or avoided) Policies 1-6; and 8c.

Generally, the process of making a consistency determination includes providing a project description, providing information and an analysis of how the project would affect the coastal zone, reviewing the applicable laws, policies, and other areas of the specific coastal zone management program, and providing an analysis of how the project is either consistent or consistent to the maximum extent practicable with the Commission's CZMP-SFB. While the draft consistency determination attempts to conduct an analysis, in most areas, information is either lacking or very generalized followed by a statement of consistency that is not supported by the information provided. The consistency determination needs to reference back to the project and describe how each policy is supported. Also note, when information is not provided to support the proposed consistency determination concurrence request, BCDC will request additional information necessary to make that determination. As written, the draft consistency determination is very inadequate and will need significant revisions prior to submittal. As mentioned above, BCDC staff is willing and suggests meeting to discuss this in greater detail.

V. Specific Comments

Staff has more specific comments that can be provided, but they are too numerous to be listed here. Therefore, these represent some improvements that could be made for clarity in specific areas.

1. Referencing modeling figures in the last paragraph in section 3.1 would help the reader understand which is being referenced.
2. Section 2.1 Direct Impacts, the first sentence can be removed as the definition is confusing. Also, there is no need to include a definition as the following section 2.2 does not include a definition of "indirect impacts."
3. Please address the figure legend or information for Table 3-3. The table itself does not mention seasonal differences, alternate sediment sourcing, and footprint sizes. The text following the table mentions the seasonality to be summer and winter months; sediment sourcing is described as coming from Redwood City Harbor (finer sediment) vs Oakland Harbor (coarse sediment). Also, there is no description of the footprint sizes in the table or text.
4. Section 3.1.1., middle of 7th paragraph. The sentence states that "*placement volume and mudflat and marsh deposition volume were linearly correlated with higher detectability for 100k cy*." The correlation between the two volumes is not clearly shown in Figure 3-3. Additionally, the figure legend for Figure 3-3 focuses on the predicted percentage of dredged sediment mass and material volume. There is no clear relationship between

this figure and the text. Please explain this more clearly or if possible, split up the figure into two for better visualization of the correlation.

5. Section 3.1.1., the opening sentence of the 9th paragraph. The sentence states that site selection looks into the percentage and volume of sediment delivered to different locations on the marsh and nearby channels. Figure 3-4 should include some type of percent gradient indicating where sediment is being transported.

6. Figure 4-1 and 4-2, the graph showing the "differences" needs the axis title revised. By having just say differences it is open-ended and unclear what this is referring to.

7. Figures 4-1 and 4-2, figure legends need to be revised for a better understanding of what is being shown. Include A, B, and C labels to help the reader understand what each figure means. For example, 4-1 can be improved by having (A) be the placements cells of the location; (B) Suspended sediment concentrations under baseline and placement conditions over two months; (C) Differences in suspended sediment concentration.

8. Appendix A, Section 4 – Clean Air Act and Climate Change (Green House Gases). The tables are missing information seen in Appendix F – Environmental Checklist. Please include the descriptions as seen in Table AQ-2 (Appendix F, Section III – Air Quality) and Table GHG-2 (Appendix F, Section VIII – Green Houses Emission) for clarification.

Thank you for the opportunity to comment on this Draft for the "*Environmental Assessment and 404 (b)(1) Analysis Initial Study (with Draft Mitigated Negative Declaration) San Francisco Bay Strategic Shallow Water Placement Pilot Project.*" Please note, that while we find the document in need of significant revisions in order to be adequate for its intended purpose, we do support the pilot project and the testing of this technique for sediment delivery. We look forward to meeting with you and your team to support the necessary improvements to the documents and their appendices. We did not review the draft monitoring plan but will review it as part of the consistency determination process. We can be reached at (415) 352-3623 or via email at brenda.goeden@bcdc.ca.gov or Jaime Lopez at (415) 352-3648 or via email at jaime.lopez@bcdc.ca.gov.

Sincerely,

DocuSigned by:

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Sediment Program Manager

Cc: Christina Toms, San Francisco Bay Regional Water Quality Control Board
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