APPENDIX E

PRELIMINARY DESIGN MEMORANDUM OF DREDGED MATERIAL PLACEMENT AT SOUTHERN EDEN LANDING

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MEMORANDUM

TO: Members of the South Bay Salt Pond Restoration Project Management Team

FROM: AECOM

DATE: March 24, 2017

RE: **Preliminary Design Memorandum of Dredged Material Placement at Southern Eden Landing**

1. EXECUTIVE SUMMARY

The former salt production ponds of southern Eden Landing are subsided two to three feet below mean higher high water (MHHW), the approximate target elevation for tidal mid-marsh growth. The State Coastal Conservancy (SCC) and California Department of Fish and Wildlife (CDFW) are proposing to restore the ponds to tidal habitat and/or managed ponds, as described in the Southern Eden Landing Restoration Preliminary Design Memorandum (AECOM 2016a). Prior to breaching the ponds to restore tidal influence, dredged material may be placed in the ponds to raise the pond bottoms to the target elevation of MHW (6.5 feet NAVD88), as well as create habitat transition zones which would otherwise require a significant amount of material import via truck. This memorandum is a conceptual design for dredged material placement at southern Eden Landing (the Project) to inform the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) clearance.

Southern Eden Landing (the Site) is located within the Eden Landing Ecological Reserve (ELER), near the eastern end of the San Mateo Bridge, adjacent to the San Francisco Bay (the Bay). The Site spans 2,210 acres and is comprised of 11 fairly flat pond bottoms separated by former salt production levees. CDFW currently manages water levels within the ponds with pumps and water control structures connected to the Bay and adjoining creeks. The ponds are described in three groups: the Bay Ponds (1,408 acres immediately adjacent to the Bay), the Inland Ponds (440 acres located landward of the Bay Ponds), and the C-Ponds (362 acres located south of the Inland Ponds).

The Site has the capacity to support beneficial reuse of up to 6.0 million cubic yards (MCY) of dredged material to create approximately 1,848 acres of tidal habitat in the Bay and Inland Ponds; the C-Ponds are not being considered for dredged material placement because they have relatively high pond bottom elevations not necessitating large volumes of dredged material, and the ponds are relatively far from the offloading facility. This estimate of 6.0 MCY of dredged material import includes anticipated consolidation of the dredged material and settlement of the pond bottoms, and is based on reaching a target pond bottom elevation of MHW (6.5 feet NAVD88). Minor levee improvements requiring approximately 10,000 CY of fill would provide adequate freeboard for the dredged material placement operation. If the low-lying portions of existing levees are not improved, the volume of beneficial reuse is reduced to 4.0 MCY, and the final pond bottom elevations would be on average 6.0 feet NAVD88, ranging between about 5.5 and 6.5 feet NAVD88. An additional 100,000 CY of dredged material could be utilized to create habitat transition zones (otherwise referred to as gradual-sloped horizontal levees), which vary in size and location by restoration alternative. Given the relatively shallow placement depth in the ponds, only material meeting the Regional Water Quality Control Board (RWQCB) wetland cover suitability criteria would be accepted for placement at the Site.

Dredged material would be sourced from dredging projects around the Bay which typically provide a range of fine and coarse material, although fines would likely be predominant. Dredging projects wishing to dispose of material at the Site would obtain permits to dredge and transport their material to the Project's deep-water transfer point located in the Bay. The Project would seek permits to station an offloader in the Bay, to offload, pump and place the material via pipeline from the offloading facility to the Site. One potential federal dredging project currently on hold, the Redwood City Harbor Navigation Improvement Project, could potentially pump directly to the offloading facility location and not require use of a hydraulic offloader, only supplemental booster pumps (HydroPlan et al. 2015).

The offloading facility would be located in the deep water channel approximately 3 miles offshore from the Site. It would be comprised of a hydraulic offloader, landing barges, temporary mooring piles, delivery vessels, a feed water system, and slurry pipeline. The feed water system would be comprised of an intake pump and fish screen, and would supply water into the delivery vessel (scow or hopper) to create a slurry that the hydraulic offloader (i.e. transfer pump) would pump shoreward via pipeline. The offloading facility would be less than 30,000 square feet in size and approximately 30 temporary mooring piles 18 to 36 inch in diameter would be driven to secure the offloader, landing barges, delivery vessels, and supporting equipment.

The pipeline transporting the slurry from the offloading facility to the Site would be 24 to 36 inches in diameter and manufactured of steel or high density polyethylene (HDPE). It would be submerged from the offloading facility to shore, identified with appropriate signage and lighting according to U.S. Coast Guard requirements. The pipeline would consist of the following approximate lengths: 500 feet floating, 16,000 feet submerged, 14,400 feet primary on shore, and 16,000 feet secondary on shore. Secondary pipeline lengths include diversions from the primary pipeline to prevent material mounding and support habitat transition zone construction. The minimum, maximum, and average pumping distance would be approximately 16,500 feet, 34,000 feet, and 23,700 feet, respectively, depending on pond discharge location. Up to two booster pumps would be located along the pipeline route; potentially one in the Bay, depending on the hydraulic offloader's pumping capacity.

Existing water control structures would be utilized where possible to manage the slurry placed within the ponds; however up to eight water control structures could be modified or added to maximize the residence time in the ponds and promote settling of solids prior to decant discharge into the Bay. M&N (2015) estimated an average annual range of dredged sediment delivery to the Site ranging from 0.9 to 1.8 MCY depending on the market-driven delivery optimization schedule. Assuming an average offloading rate similar to that experienced at the Hamilton Wetlands Restoration Project, the Bay and Inland Ponds have the capacity to receive the 0.9 to 1.8 MCY of dredged sediment in one year, without discharging decant back to the Bay. When discharge does become necessary, water would be returned to the Bay at either the Bay-front levee of Pond E2, or into Old Alameda Creek (OAC) from one of the northern ponds (Ponds E1, E7, or E6). Discharges back to the Bay would meet Waste Discharge Requirements (WDR) as measured at the specified sampling location, typically 100 feet from the discharge location. Turbidity WDRs typically specify a maximum allowable increase (measured in Nephelometric Turbidity Units) of five units or less for background levels less than 50 units, and an increase of 10% or less for background levels greater than 50 units.

Mobilization and site preparation to receive dredged material would span approximately nine months. The Site may receive dredged material between three to seven years, depending on the pace of the dredged material delivery to the Site. Decommissioning and demobilization would occur over approximately 4.5 months after dredged material placement is complete. The offloading facility and booster pumps may be powered by diesel or electric, depending on cost and regulatory emission requirements. Diesel power could prove more economical if the project duration falls under approximately five years, and electric power could prove more economical if the project durations spans longer than approximately five years.

After completion of the placement of dredged material, the other selected restoration, flood control, and recreational features [as described in the Restoration Preliminary Design Memorandum, (AECOM

2016a)] would be constructed to complete Phase 2. The EIR/S is currently being prepared and will be completed in the fall of 2017. Preliminary restoration design was completed in 2016. Preliminary design of dredged material placement, permitting of the selected project, and 100% design would follow in 2018 and the beginning of 2019. Construction could begin as early as the summer of 2019.

2. INTRODUCTION

This memorandum documents the preliminary design of dredged material placement at the southern half of the Eden Landing Ecological Reserve (ELER), owned and operated by the California Department of Fish and Wildlife (CDFW). This design is in support of the South Bay Salt Pond (SBSP) Restoration Project's Phase 2 at the southern Eden Landing Ponds (the Site), and is intended to supplement the Southern Eden Landing Restoration Preliminary Design Memorandum (AECOM 2016a). Refer to the Restoration Preliminary Design Memorandum for additional site-specific information.

2.1 Purpose

The purpose of this memorandum is to inform the CEQA and NEPA approval processes for placing dredged material at the Site. It is also a basis for the next, more detailed design phase in support of the regulatory agency permitting process.

2.2 Project Background

The ELER, and the southern Eden Landing Ponds within it, is near the eastern end of the San Mateo Bridge, south of State Route 92 as it passes through the City of Hayward in Alameda County. The Phase 2 actions at southern Eden Landing are focused on the ponds south of the Old Alameda Creek (OAC) and north of the federally constructed Alameda Creek Flood Control Channel (ACFCC).

The southern Eden Landing Ponds includes 11 ponds, which are described in three groups based on their location within the complex and their proximity and similarity to each other. The groups are as follows and as shown in Figure 2.1:

- The Bay Ponds: Ponds E1, E2, E4, and E7
- The Inland Ponds: Ponds E5, E6, and E6C
- The C-Ponds (also referred to as the Southern Ponds): Ponds E1C, E2C, E4C, and E5C

The goal of the Phase 2 actions is to restore the various pond complexes to a mixture of tidal habitat and managed ponds.

2.3 Limitations

This memorandum provides a preliminary design for dredged material placement which is based on information available at the time and professional judgment pending future detailed engineering analyses. Future design decisions or additional information may change the findings, and corresponding professional judgments presented in this memo. Additional detailed design will be necessary prior to construction. In the event that conclusions or recommendations based on the information in this memorandum are made by others, such conclusions are not the responsibility of AECOM, or its subconsultants.

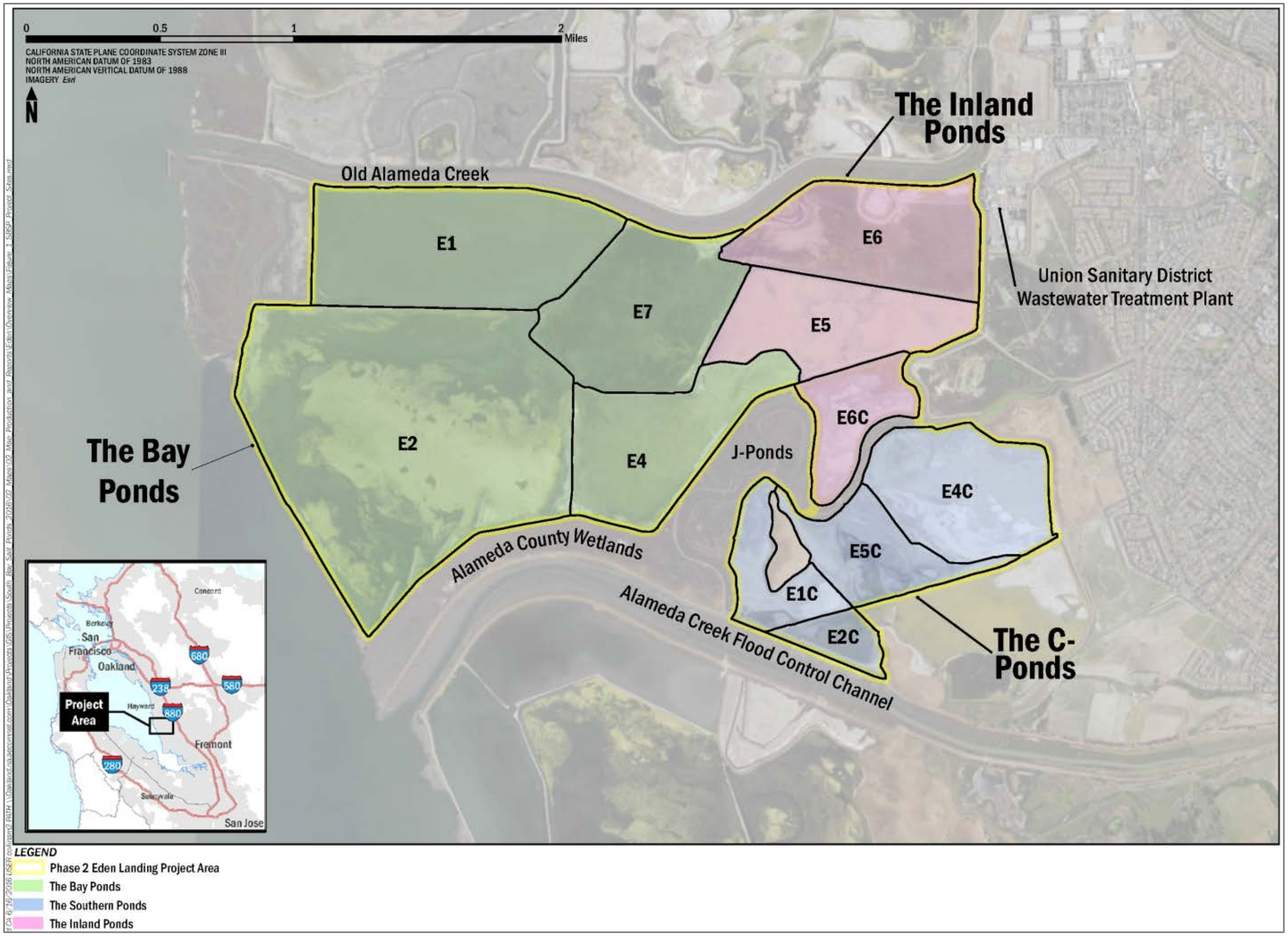


Figure 2.1. Project Area

3. AVAILABLE DATA

3.1 Water Levels

The Redwood City tide gauge (NOAA gauge 9414523), located approximately 7 miles (11 kilometers) west of Eden Landing, was used to represent tidal water elevations at Eden Landing. The 6 minute daily tide data were obtained from National Oceanic Atmospheric Administration's (NOAA) Tides and Currents website (NOAA 2016) and converted to the North American Vertical Datum of 1988 (NAVD88) using NOAA conversions listed in the San Francisco Bay Tidal Datums and Extreme Tides Study Final Report (AECOM 2016b). Table 3.1 summarizes the tidal datums for the three NOAA tide gauges near the project site, showing that the mixed-semidiurnal tides are amplified in the South Bay from a MHHW elevation of 6.9 feet at San Mateo Bridge up to 7.2 feet at Dumbarton Bridge and MLLW from -0.8 to -1.4 feet, respectively. Sources of conversions from tidal to geodetic (NAVD88) datum are listed in Table 3.1.

Table 3.1. Tidal Datums and Extreme Still Water Tide Levels in South Bay

	San Mateo Bridge West, CA Station ID 9414458	**Redwood City, CA Station ID 9414523**	**Dumbarton Bridge, CA Station ID 9414509**
	Feet, NAVD88	Feet, NAVD88	Feet, NAVD88
100-year[1]	10.4	10.7	10.9
10-year[1]	9.3	9.4	9.6
MHHW	6.92	7.10	7.20
MHW	6.29	6.47	6.59
MSL	3.31	3.30	3.27
MTL	3.34	3.28	3.22
NAVD88	0	0.00	0
MLW	0.39	0.10	-0.15
MLLW	-0.80	-1.10	-1.41
NAVD88 Datum Source	Foxgrover et al. 2007	AECOM 2016b	NOAA 2016

[1]Extreme still water tide levels from the *San Francisco Bay Tidal Datums and Extreme Tides Study Final Report* (AECOM 2016b).

3.2 Pond Statistics

In general, the project site is comprised of fairly flat pond bottoms separated by levees. Many of the levees have borrow ditches on the pond side, directly adjacent to the levee. Table 3.2 provides the pond perimeters, acreages, average bottom elevations, and minimum, external levee crest elevations. In general, the internal pond levees are of lower elevation than the surrounding complex perimeter levees. Of note, Pond E2 and E4 are connected with two large breaches and a deteriorating levee, while all other ponds within the Bay and Inland Ponds are separated with existing levees and water control structures.

Table 3.2. Pond Statistics

Pond	Pond Group	Perimeter (ft.)	Area (Acre)	Avg. Pond Bottom Elev. (ft. NAVD88)	Min. External Existing Levee Crest Elev. (ft. NAVD88)	Notes
E1	Bay Ponds	15,801	297	4.8	8.5	Dredged Material Placement Proposed
E2		22,485	692	4.8	9.5	
E7		12,709	217	4.9	9.0	
E4		14,261	202	5.6	9.5	
E6	Inland Ponds	14,046	183	5.1	9.0	
E5		13,682	172	5.3	9.0	
E6C		9,417	85	5.5	9.0	
E1C	C-Ponds	10,254	65	5.8	9.0	No Dredged Material Placement Proposed
E2C		5,682	32	5.2	7.5	
E5C		12,485	97	5.4	9.0	
E4C		10,406	168	5.7	9.0	

3.3 Existing Water Control Structures

Existing water control structures are detailed in Table 3.3 and shown in Figure 3.1. Some existing water control structures may be used during the placement of dredged material, depending on their invert elevations. Further phases of design would confirm and/or determine existing invert elevations and suitability for use during dredged material placement.

Table 3.3. Existing Water Control Structures

Location	Quantity	Size	Invert Elev. (ft. NAVD88)	Type
E2 - Bay	2	48 in.	1.7	Intake/discharge combo gates
OAC - E1	2	48 in.	1.7	Intake/discharge open pipes/combo gates
	2			Intake/discharge slide gates/flap gates
OAC - E1	1	10,000 gpm	-	Pump (#1 Baumberg Intake)
E1 - E2	1	48 in.	1.7	Slide gate
E1 - E7	1	48 in.	2.2	Slide gate
E7 - E4	1	48 in.	-	Slide gate
E7 - E6	1	48 in.	-	Slide gate
E4 - E5	2	48 in.	0.7	Combo gates
E6 - E5	4	30 in.	0.7	Wood gates
E5 - E6C	2	36 in.	2.7	Combo gates
E6C - E4C	2	30 in.	-	Siphons (not operable, but flows depending on water surface elevations)
E2C - E5C	1	36 in.	2.7	Combo gate
ACFCC - E1C	1	7,660 gpm	-	Pump (Cal Hill Intake) (not operable)
ACFCC - E2C	2	48 in.	2.7	Intake/discharge combo gates
E2C - CP3C	1	48 in.	-	Slide gate
E2C - E2C donut	1	36 in.	-	Unknown (open)
E1C - E2C donut	1 1	24 in. 10,000 gpm	- -	Unknown (not operable) Pump (Call Hill Transfer) (not operable)

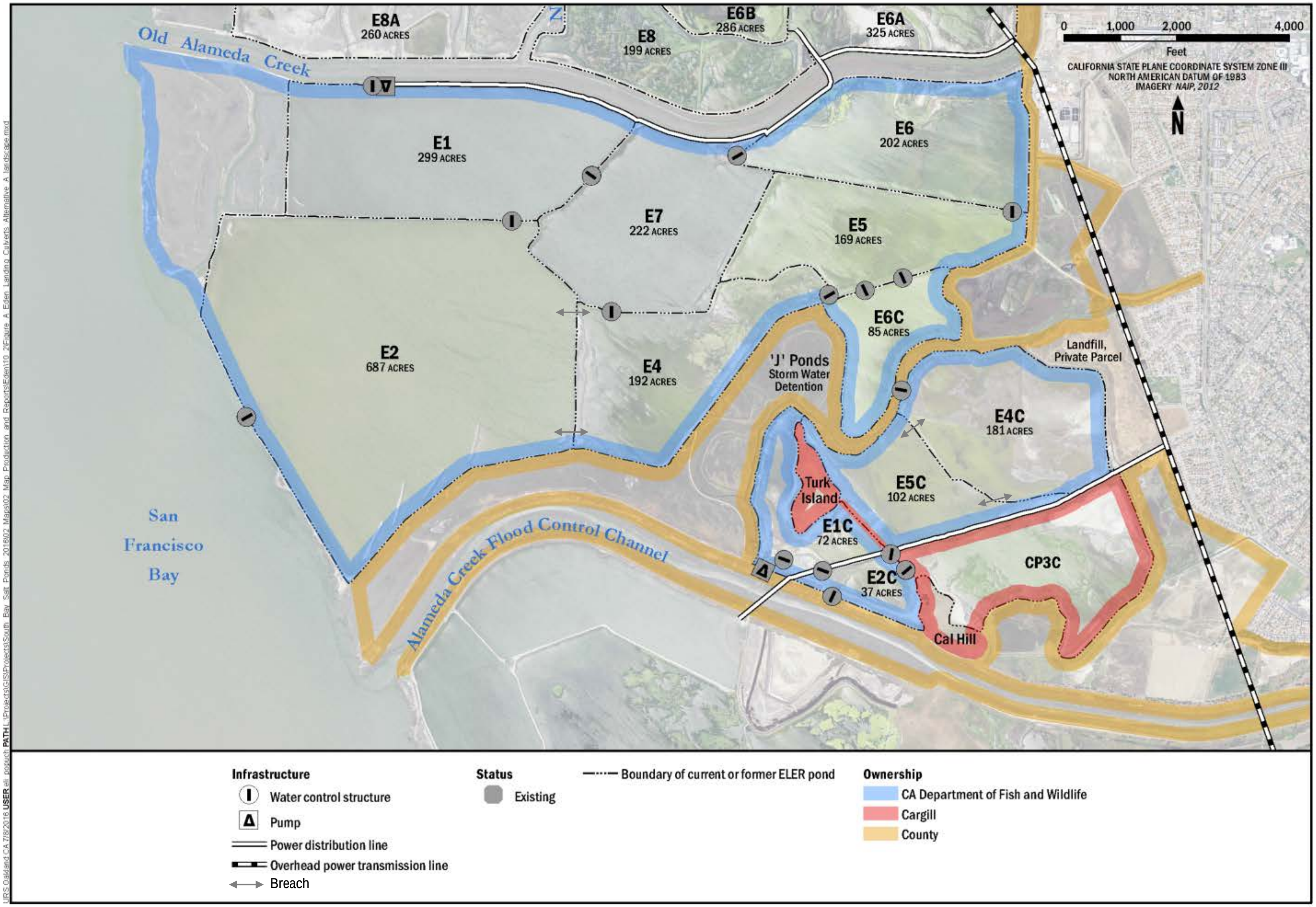


Figure 3.1. Existing Infrastructure

4. PRELIMINARY DESIGN ANALYSIS

The preliminary dredge material design elements of the Eden Landing ponds are discussed in the sections below.

4.1 Material Placement Volumes

If existing levees are utilized as-is, approximately 4.0 MCY of dredged material may be imported and placed in the Bay and Inland Ponds to raise the bottom elevations to an average 6.0 feet NAVD88. This assumes a two-foot freeboard between the maximum slurry elevation and levee crest, a minimum of half a foot of slurry depth during placement (near the end of material placement), and about half a foot to one foot of dredged material consolidation settlement (of the dredged material itself and of the young bay mud beneath the one to two feet of placed material).

If portions of existing levees are improved to a minimum of 10 feet NAVD88, the Bay and Inland Pond bottoms may be raised to the target elevation of MHW (6.5 feet NAVD88) with the placement of 6.0 MCY. Similar assumptions as stated above were assumed. Approximately 10,000 CY would be need from onsite upland areas and to improve levees to 10 feet NAVD88.

Total material volume estimates are summarized in Table 4.1.

Table 4.1. Dredged Material Placement Volumes

Pond Group	Pond	Placement Volume (CY) using existing levees (pond bottoms raised to avg. 6.0 ft. NAVD88)		Placement Volume (CY) with improved levees to 10 ft. (pond bottoms raised to 6.5 ft. NAVD88)		Volume (CY) to improve perimeter levees to 10 ft.	
Bay Ponds	E1	477,000	3,294,000	1,052,000	4,725,000	800	5,600
	E2	2,003,000		2,449,000		0	
	E7	443,000		723,000		2,900	
	E4	371,000		501,000		1,900	
Inland Ponds	E6	334,000	697,000	571,000	1,265,000	0	4,400
	E5	255,000		477,000		0	
	E6C	108,000		217,000		4,400	
C-Ponds	No dredged material placement						
	Total		**3,991,000**		**5,990,000**		**10,000**

*Volumes to raise Pond E7 and E4 levees to 10 feet NAVD88 are for raising the eastern internal levees if the Bay Pond were to receive phased placement of dredged material. If the Bay and Inland Ponds were to receive dredged material in the same phase, the internal Pond E7 and E4 levees would not need to be improved.

These estimated volumes are based on the average pond bottom estimates and minimum existing levee crest elevations as listed in Table 3.2. The two feet of freeboard between the maximum slurry elevation and levee crest is included to provide allowances for wind waves generated within the ponds and to provide time for release of captured precipitation. The young bay mud currently comprising the bottom of the ponds is anticipated to have consolidation settlement on the order of approximately one inch over one year, four inches over seven years, and six inches over 20 years with the placement of approximately two feet of dredged material.

The C-Ponds are not being considered for dredged material placement for the following reasons:

- Flood Protection: Hydrodynamic modeling of large flood events indicated that raising the exterior C-Pond levees to 12 feet NAVD88 could cause an increase in water surface elevation within the C-Ponds and nearby properties (AECOM 2016a). This would decrease existing de-facto flood protection. Raising the levees to 10 feet NAVD88, as opposed to 12 feet, is anticipated to result in similar (but slightly less) flood protection. A reduction in flood protection is not in-line with project goals, and thereby existing levees should not be raised to receive dredged material slurry in the C-Ponds. The lowest existing levees' elevations are approximately 7.5 to 9 feet NAVD88.
- Pond Bottom Elevation/Minimal Placement Volume: The C-Pond bottoms range in elevation between 5 and 6 feet NAVD88, relatively high compared to the other ponds. Because the C-Ponds are currently tidally muted and will remain tidally muted with the proposed restoration design, the target placement elevation is approximately half a foot below the Bay's 6.5 feet MHW elevation. This leaves only approximately a half of foot of placement capacity in the C-Ponds (resulting in the placement of about 443,000 CY total) to reach the target elevation. This could occur through natural sedimentation processes with tidal action over a relatively short time compared to the other ponds.
- Separated Hydraulic System: The C-Ponds are not currently hydraulically connected to the Bay or Inland Ponds, and would require construction of a slurry pipeline across Alameda County Property to connect them. Likely a separate permitted discharge point would be required into the ACFCC, so decant water could be returned to the Bay by gravity. These property ownership and construction challenges could potentially be overcome, but given the limited volume capacity of the C-Ponds, managing these challenges may not be warranted or cost effective.

Dredged material will be placed over approximately 1,848 acres, while levee improvements would occur over up to 23 acres if all levees surrounding the Bay and Inland Ponds were improved to 10 feet NAVD88. Raising the levees to higher elevations (such as 11 feet NAVD88) was investigated, however material needs would exceed available upland material and would require material import or excavation from borrow ditches. Due to the anticipated cost and possibly detrimental higher elevation effects on desired habitat, levee improvements above 10 feet NAVD88 were eliminated from consideration from the project.

Three action alternatives are described in the Restoration Preliminary Design Memorandum (AECOM 2016a). Alternative B (full tidal restoration) and Alternative D (phased tidal restoration) may receive dredged material in the Bay and Inland Ponds. Alternative C (tidal restoration of the Bay Ponds; Inland Ponds to remain as managed ponds), may receive dredged material only in the Bay Ponds, as the Inland Ponds will remain as managed ponds. The anticipated dredged material placement volumes for each action alternative are summarized in Table 4.2. The placed volume depends on if the levees are improved or not to receive material up to the target pond bottom elevation.

Table 4.2. Total Dredged Material Placement Volumes in Bay & Inland Ponds by Alternative

Feature	Alt. B[1]	Alt. C[2]	Alt. D[1]
Raise pond bottoms to 6.0 ft on average using existing levees	3,991,000	3,294,000	3,991,000
Raise pond bottoms to MHW (6.5 ft) with improved levees	5,990,000	4,725,000	5,990,000
Construct Restoration Habitat Transition Zones (net material needed with restoration project assumptions as listed in AECOM 2016a)	83,000	46,000	96,000[3]
Total to avg. 6.0 ft. (CY)	**4,074,000**	**3,340,000**	**4,087,000**
Total to 6.5 ft. MHW (CY)	**6,073,000**	**4,771,000**	**6,086,000**

[1]Dredged material placement in Bay and Inland Ponds
[2]Dredged material placement in Bay Ponds
[3]An additional 49,000 CY of dry material would be imported for levee improvement as part of the restoration project; volume not included here because onsite drying and reuse of dredged material is not proposed for levee improvements.

In addition to placing dredged material on the pond bottoms, dredged material may be utilized to construct habitat transition zones for the three action restoration alternatives, also described in the Restoration Preliminary Design Memorandum (AECOM 2016a). Table 4.2 includes the volume required for construction of habitat transition zones and levee features for each alternative. In general, the restoration features add up to an additional 100,000 CY of dry fill that could be sourced from dredged material, although this number varies by alternative.

Because the restoration design includes channel excavation, the dredged material placed within the ponds will increase the amount of excavation required during the restoration design. This additional excavation volume is listed in Table 4.3 for each alternative assuming the pond bottoms are raised to MHHW. The additional material excavated for the channels would be utilized to create additional island habitats (similar to other excavated channel material). A range of 2 to 4 feet of placed dredged material was assumed (as some of the channels are located in existing borrow ditches), a channel width of 15 to 30 feet, as well as a 30% bulking factor and 20% volume contingency [similar to the Restoration Preliminary Design Memorandum (AECOM 2016a) volume estimates].

Table 4.3. Additional Material Excavation and Placement Required with Dredged Material Placement by Restoration Alternative

Additional Channel Excavation Volume (CY)			
	Alt. B	**Alt. C**	**Alt. D**
Bay Ponds	53,000 CY	53,000 CY	53,000 CY
Inland Ponds	45,000 CY	0 CY	43,000 CY

4.2 Material Sources

Dredged material would be sourced from dredging projects around the Bay; the nearest ongoing project being the Redwood City Federal Maintenance Dredging Project that dredges approximately 430,000 CY on average every 3 years [Moffatt & Nichol (M&N) 2015]. M&N (2015) identified potential federal and non-federal projects that could place material at the Site, the largest sources being Oakland Inner and Outer Harbors, Redwood City Harbor, and numerous ports. In general, material from the Oakland Inner and Outer Harbor is comprised of 30% clay, 30% silt, and 40% sand (M&N 2015). The federal channel at Redwood City Harbor is comprised of predominately silt and clay with less than 2% sands and gravels (HydroPlan et al. 2015). In general, the Site would likely receive both fine and coarse material, thereby requiring secondary pipeline routes (described in the next section) to transport sandy materials throughout the ponds and reduce the amount of mechanical spreading at the slurry outlet.

4.3 Preliminary Design Components

4.3.1 Overview

Preliminary design components are summarized in Table 4.4, the majority of which are shown in Figure 4.1. The following sections describe each design component.

Table 4.4. Dredged Material Placement Design Summary

	Approximate Dimensions/Capacity	Approximate Footprint (SF)	Purpose/Notes
Offloading Facility	-	28,220 SF total	-
Hydraulic Offloader	160 ft long x 50 ft wide	8,000 SF	Transport slurry material from delivery vessels to disposal location via pressure pipeline. May vary in size and pumping capacity.
Piles	10 to 30 piles, 18 to 36 inches in diameter	220 SF	Secure offloading equipment. The number and length of piles depends on the selected equipment, mooring configuration and local geology.
Landing Barges	(2x) 200 ft. long x 50 ft. wide	20,000 SF	Secure delivery vessels while being offloaded. May vary in size.
Support Equipment	Variable	-	Includes Fuel/Water Barge, Crew/Survey Boat, Work Tug, etc.
Pipeline	24 to 36 inch steel and HDPE	140,700 SF total	Transport material from the offloader to the Site.
Floating	500 ft.	1,500 SF	Max. pumping dist. = 34,000 ft.
Submerged	16,000 ft.	48,000 SF	Avg. pumping dist. = 23,700 ft.
Shore (Primary)	14,400 ft.	43,200 SF	Total of 46,900 ft. of pipe.
Shore (Secondary)	16,000 ft.	48,000 SF	
Booster Pumps	-	12,200 SF total	Up to two in-line boosters would increase the pumping capacity of the offloader.
Floating or Jack-up Barge Booster	120 ft. x 60 ft. with (4) piles or spuds	7,200 SF	Requires approximately 8 feet of water depth.
Shore Booster	100 ft. x 50 ft. concrete pad	5,000 SF	-
Site Preparation	-	-	-
Improve Levees to 10 ft. NAVD88	Up to 10,000 CY (with phased Bay & Inland Pond placement)	Up to 23 AC	Allows for greater slurry containment and material placement up to 7.1 ft. NAVD88.
Water Control Structures	Up to eight new construction and two discharge weirs	-	Manage dredged material slurry and decant water.
Power	-	-	Either diesel or electric would provide power to equipment.
Diesel	Large diesel generator barge	2,000 SF	Power offloading facility.
Electric • Substation	120 ft. long x 100 ft. wide	12,000 SF	Transform voltage from high to low and distribute power to equipment.
• Overhead Line	17,700 ft.	-	
• Submarine Cable	16,000 ft.	-	

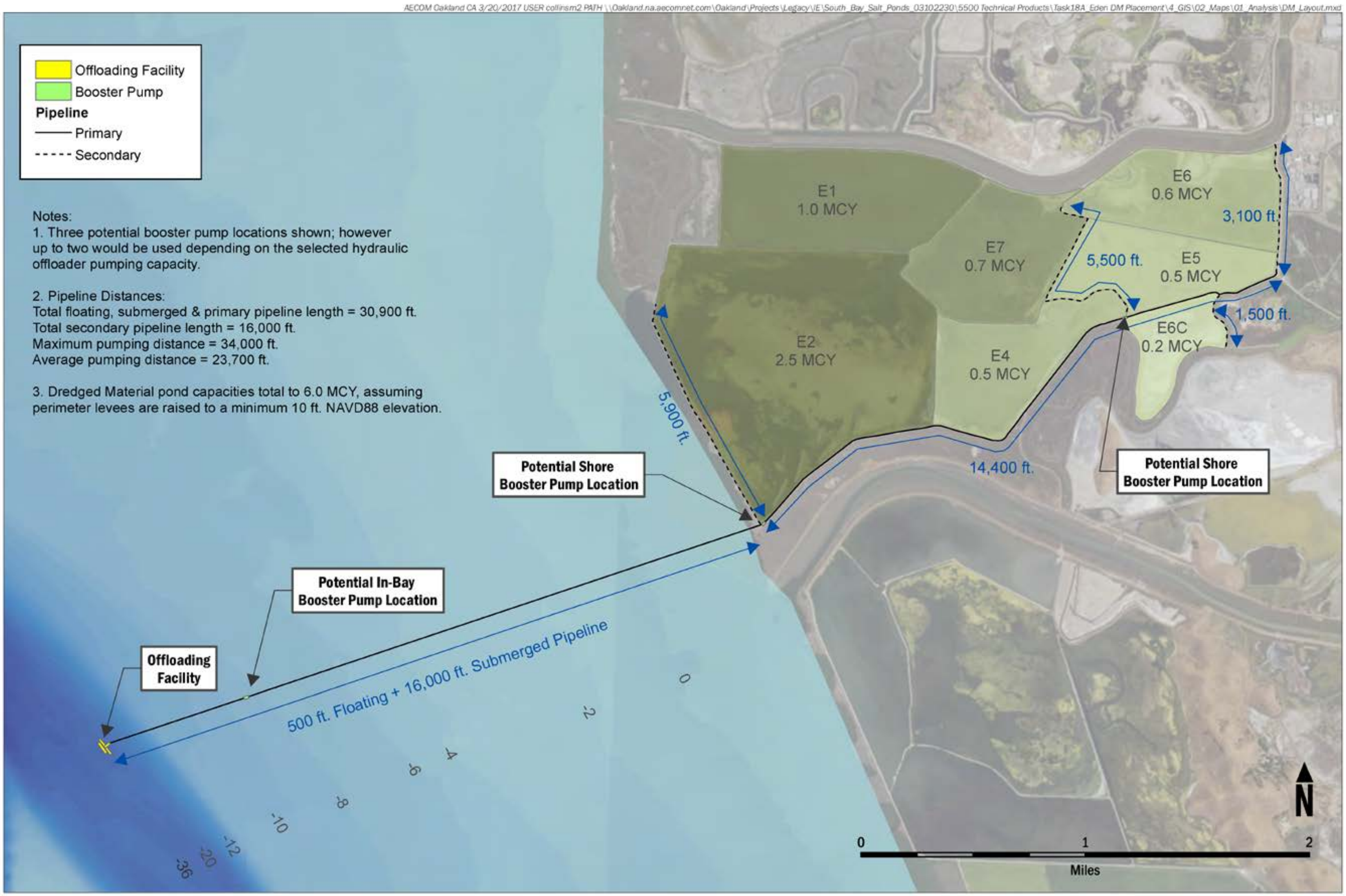


Figure 4.1. Dredged Material Design Components

4.3.2 Offloading Facility

The offloading facility would offload material from barges and scows and transport the material via pipeline to the Site for placement. The offloading facility would be comprised of an hydraulic offloader, temporary mooring dolphins, landing barges, an auxiliary feed water pump, pipelines, delivery vessels, and support equipment. Support equipment would include barges, tug boats, crew boats, and site security. All materials and equipment would contain the appropriate signage and navigation lighting in accordance with U.S. Coast Guard requirements. Material barges or scows (delivery vessels) would range in capacity from 800 to 6,000 CY and would draft up to 18 feet. Given the required water depth for the delivery vessels and offloading equipment, the offloading facility would be positioned approximately 3 miles offshore, past the mudflats and shallow depths bordering the Site. Figure 4.2 shows the deep water channel in where the offloading facility would be located at depths of approximately -35 feet NAVD88.

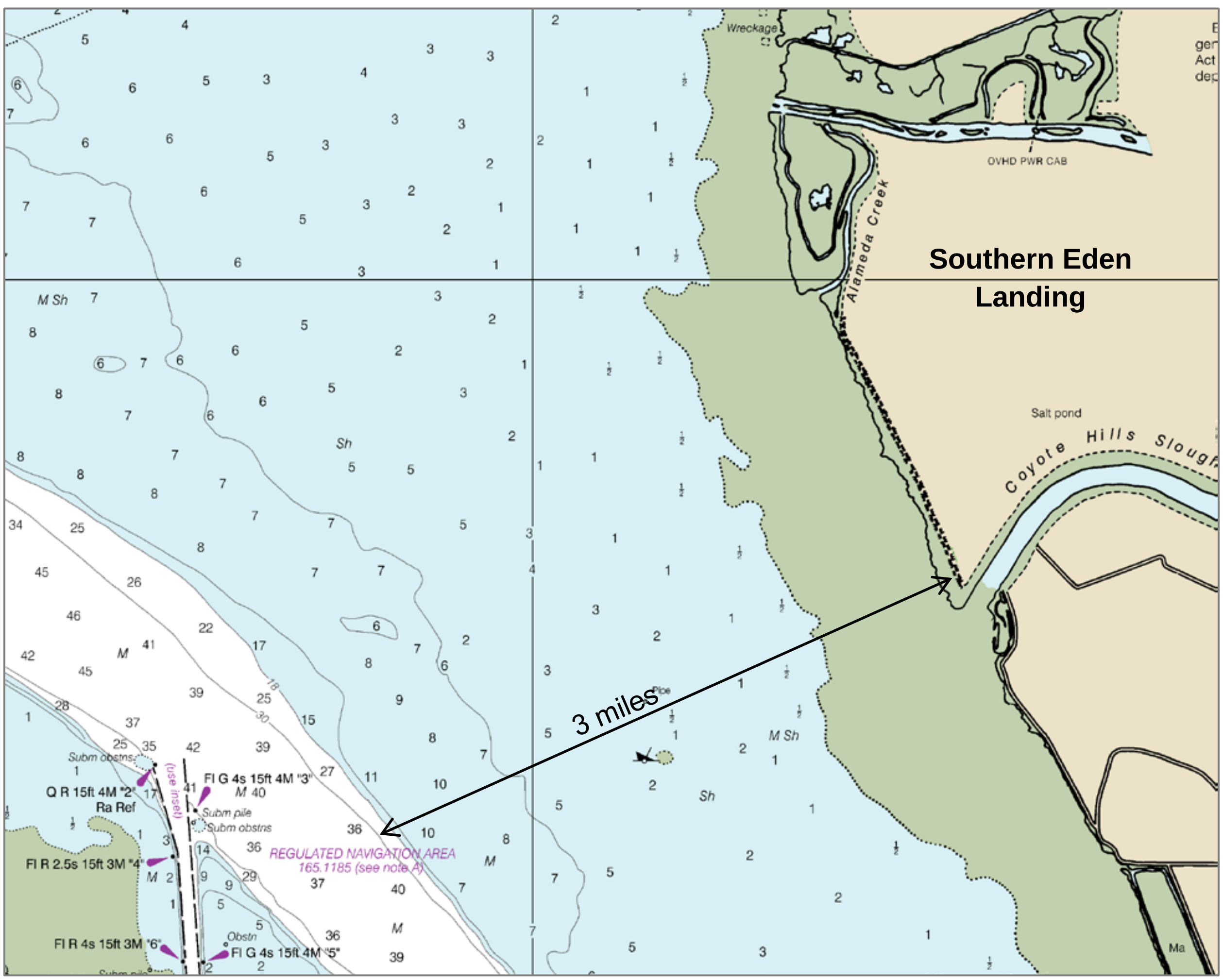


Figure 4.2. NOAA Nautical Chart 18651 San Francisco Bay Southern Part, Soundings in Feet at MLLW

Depending on the material type and selected equipment, an offloading facility and booster pump system (described in the following sections) could be sized to pump material a range of distances, ranging from within the inner pond levee nearest the bay (approximately 3 miles) to the farthest inland extent of the ponds (approximately 6 miles). Most likely a hydraulic offloader with approximately 24 inch suction and discharge, 120 feet long by 50 feet wide (6,000 square feet), would provide the main pumping capacity to place material at the Site. An auxiliary feed water system would slurry the dredged material in scows by agitation with water jets, allowing the hydraulic offloader to suction the slurry through the snorkel and transport the material via pipeline to shore. The hydraulic offloader would be held in position with 10 to 30 steel pipe piles securing the offloading facility. An example of an offloading facility is provided in Figure 4.3.

Figure 4.3. Offloading Facility

Source: HydroPlan et al. 2015

Less likely are the following offloader equipment options:

- Submersible Dredge Pump & Boosters: A submersible dredge pump could be mounted on an excavator secured to a flat-deck barge. This equipment setup would likely have less pumping capacity than a hydraulic offloader, therefore material would be transported at a slower production rate and potentially an additional in-line booster pump may be required. The barge would be held in position with two temporary pile anchors (spuds) 18 to 24 inches in diameter.
- Hopper Dredge Pump-Off: Most Bay Area projects are dredged mechanically or by hopper dredges without pump-out capability (M&N 2015); a hopper dredge pump-off system (with an in-line booster pump within the Bay) is possible but not likely.
- Hydraulic Dredge Pipeline Connection: A continuous pipeline from Redwood City Harbor could transport sediment slurry to the Site, in which case no offloader would be needed. A

pipeline connection would be secured at the transfer point, and booster pumps would be required to support the slurry transport.

Regardless of the material transport system, the slurry would contain approximately 10% to 40% solids by volume. Feed water would be sourced from a screened intake located at the offloader in the deep water channel, similar to the approach taken at the Hamilton Wetlands Restoration Project and the Cullinan Ranch Restoration Project (2016 Richmond Maintenance Dredging Episode). Fish screens would comply with NMFS and CDFW design guidelines to protect species of concern. A recirculation line from the decant water at the Site to the offloading facility, similar to the operation considered for Cullinan Ranch, is not cost effective given the distance from the Site to the offloading facility. For the same reason, a groundwater extraction system to supply slurry water, as utilized at Montezuma Wetlands Restoration Project, is not appropriate for this Site.

4.3.3 Pipeline

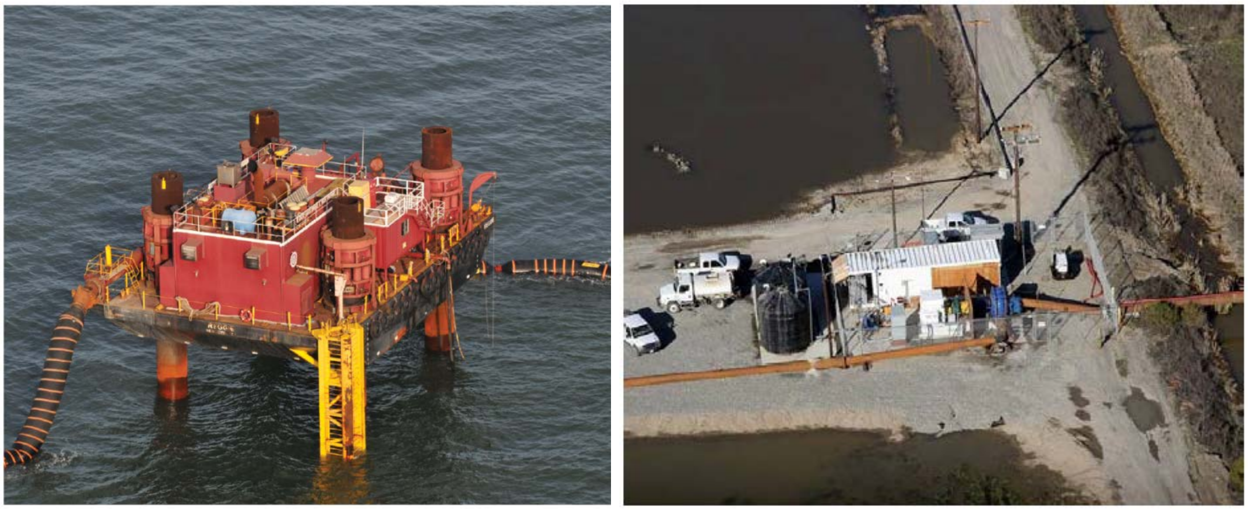
A network of approximately 46,900 feet of pipeline would be installed to transport sediment slurry from the hydraulic offloader to and around the Site. As shown in Figure 4.1, the pipeline would be comprised of approximately 500 feet of floating pipeline (located near the offloader, booster pumps, and shore), 16,000 feet of submerged pipeline, 14,400 feet of primary shore pipeline, and 16,000 feet of secondary shoreline pipeline. Secondary shore pipeline could support the spread of material throughout the ponds and allow for sand mounding along the proposed habitat transition zone locations. The final pipeline routing and pipeline extent would be determined during detailed design.

The floating, submerged and shore pipelines would range in size from 24 to 36 inches in diameter and would be comprised of steel and/or HDPE. Submerged pipeline would be anchored on the Bay bottom with precast concrete pipe weights to reduce navigation hazards and vulnerability to wind and wave action, and would be identified with signs and lights per US Coast Guard guidelines. Portions of the submerged pipeline may be floated above the shallow mudflats if there is a concern of water flow around the pipeline during low tide. The outboard levee would be minimally graded to transition the pipeline from the mudflats to the levee. The onshore pipeline would be secured with stakes on existing levees currently utilized for maintenance access, or on levee shoulders as necessary to sustain equipment access. Existing vegetation on levees would be avoided where possible. Abrupt pipeline turns would be supported with concrete blocks as necessary. The pipeline would undergo repair and replacement due to typical wear and tear over the project length. The type of pumped material (sand and gravel versus silt and clay) would influence the frequency of repair and replacement.

4.3.4 Booster Pump

Given the distance from the offloading facility to the point of discharge at the Site, one or more in-line booster pumps would be required and would be located along the discharge line to increase the pumping production rate and facilitate delivery of the slurry to the Site. Typically boosters are needed every two to five miles and may allow for an additional pumping distance of about two miles. The specific locations of the booster pumps depend on the pumping capacity of the selected offloader and desired discharge location at the Site. For instance, two boosters may be required if slurry is pumped to the northeast corner of the Inland Ponds (approximately 6.1 miles).

Booster pumps may be located along the pipeline in the Bay and/or on pond levees. If located within the Bay, a floating or jack-up booster pump barge may be pile-secured depending on water depth and wind/wave action (see Figure 4.4 for example of a jack-up booster). A jack-up booster pump may be held in place with up to four spuds, while a floating booster pump barge would be secured with approximately 4 piles (each 24 to 36 inches in diameter). Both booster pumps require at least 8 feet of water depth for crew changes with a skiff and provision of fuel, and typically range in size from 3,500 to 7,200 square feet.



Source: Great Lakes Dredge & Dock, 2017 Source: Hammerwold, date unknown

Figure 4.4. Jack-up Booster (left) and Shore Booster Pump (right)

If located on land, a booster pump may be utilized at multiple locations depending on pumping distance and material type. A booster pump station would be approximately 5,000 square feet in size and would likely require temporary placement of material within the ponds for adequate space and access around the equipment (see Figure 4.4 for an example of a shore booster pump).

4.3.5 Site Preparation

4.3.5.1 Improved Levees

As described in Section 4.1, levees could be improved to an elevation of 10 feet NAVD88 to provide sufficient slurry capacity to reach the target pond bottom elevation of MHW. Up to 10,000 CY of material would be sourced from onsite existing levees that are currently above the target elevation of 10 feet NAVD88. The southern levee of Pond E2 and northern levees of Ponds E1 and E7 are proposed for levee lowering. Material would not be sourced from levees proposed for improvement in the preliminary restoration design, so as to avoid lowering and raising the same levees in different phases of the overall project. Table 4.5 shows that the material would be sourced from approximately 5,500 linear feet of relatively high levees, and be used to improve 20,400 linear feet of levees identified for improvement.

Table 4.5. Lengths of Levee Improvement and Material Sources

	Levee Improvement Locations (ft.)	Material Source Locations (ft.)
Bay Ponds	13,400	5,500
Inland Ponds	7,000	0
C-Ponds	0	0
Total	**20,400**	**5,500**

The Restoration Preliminary Design Memorandum (AECOM 2016a) included a geotechnical investigation and analyses. Using information from these analyses, a representative cross section of an existing levee was analyzed for slope stability with slurry up to the levee crest of elevation 10 feet NAVD88. The preliminary resulting factor of safety was 1.3 or greater, which is considered adequate for stability.

4.3.5.2 Site Slurry Capacity and Time to Discharge Decant Water

The Bay and Inland Ponds may receive up to about 6.0 MCY of dredged material to raise the pond bottoms (assuming the perimeter levees are raised to 10 feet NAVD88). With the perimeter levees raised to 10 feet NAVD88, the Bay and Inland Ponds could contain up to 5,565 acre-feet of slurry (at one time if filled to capacity) given the current pond bottom elevations and a freeboard of approximately two feet.

M&N (2015) estimated an average annual range of dredged sediment delivery to the Site ranging from 0.9 to 1.8 MCY depending on the market-driven delivery optimization schedule. Assuming an average offloading rate similar to that experienced at the Hamilton Wetlands Restoration Project, the Bay and Inland Ponds have the capacity to receive the 0.9 to 1.8 MCY annual delivery range (slurried) without discharging decant water back to the Bay.

In later design phases, discharge structures would be designed to allow for decant water release at an appropriate flow rate given anticipated offloading pump rates. Consideration would be given to have adequate capacity for a design rain event as well.

4.3.5.3 Water Control Structures

Existing water control structures are believed to be sufficient to manage the dredged material slurry. However, depending on their invert elevation, location within the ponds, and the selected slurry discharge point within the ponds, additional water control structures may temporarily be built to manage the dredged material slurry. Up to eight new or replaced water control structures would allow for controlled exchange between all Bay and Inland Pond levees, likely no larger than approximately two 48” HDPE pipes per structure. The structures would be temporary, designed to span the approximated time period (less than 10 years) to receive the desired amount of dredged material.

Additionally, up to two decant discharge structures would be constructed at locations described in the next section.

4.3.5.4 Receiving Water Discharge Locations

After solids settlement in the ponds, the resulting decant water will be returned to the Bay or sloughs via one or more permitted discharge locations. Typically discharge locations are selected to maximize the distance from the slurry pipe outlet, or in zones of low velocity such as corners of rectangular-shaped cells. The receiving water body is also a consideration, such as discharging directly into the Bay or into a smaller creek where velocities may suspended creek bed sediments.

Because the location of the slurry pipe outlet may change with material type and volume placed, multiple discharge locations may be considered along the levees between Pond E2 and the Bay, and Ponds E1, E6 and OAC, as shown in Figure 4.5. Likely no more than two locations would be utilized during different phases of dredged material placement. Decant discharge structures typically have stop logs or variable height weirs on the upstream side to allow for the controlled decant of the ponded water on the downstream side; therefore existing water control structures would likely have to be modified to discharge decant water.

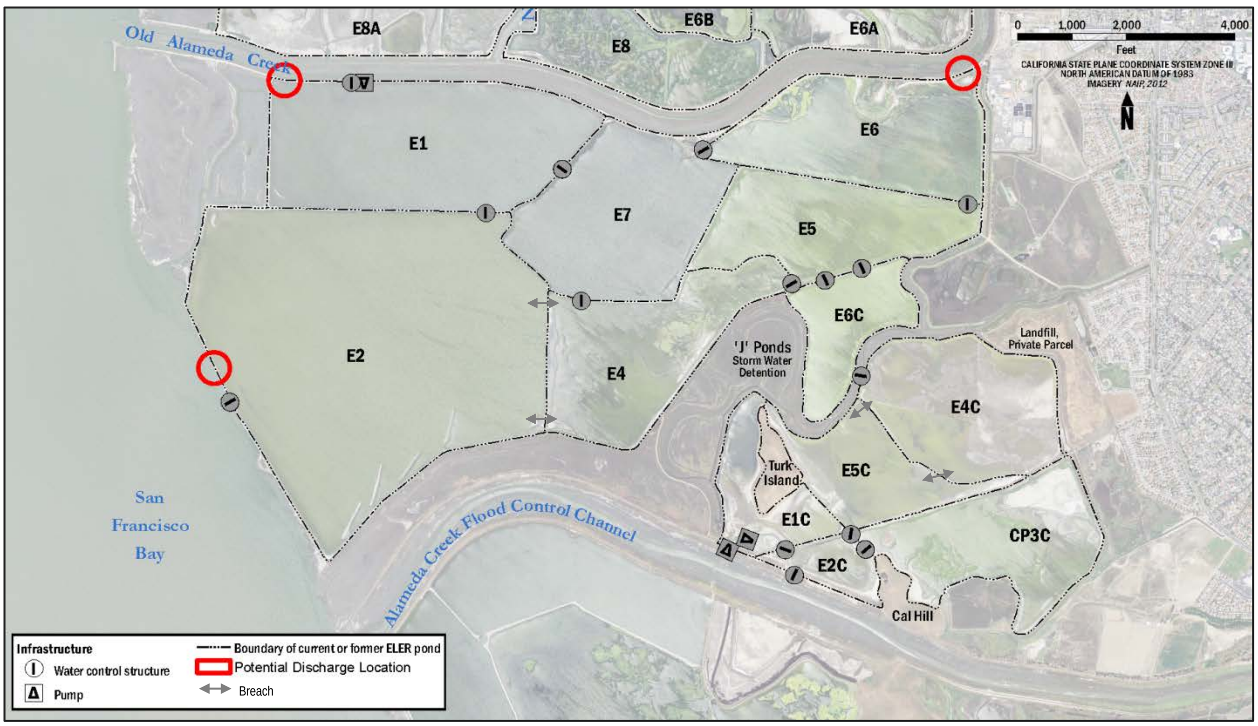


Figure 4.5. Potential Discharge Locations

Similar to other Bay Area beneficial reuse sites, the Project would meet water quality standards in the receiving water as defined in project-specific Waste Discharge Requirements (WDR). Both the Montezuma (RWQCB 2012) and Cullinan (RWQCB 2010) WDRs contain the following receiving water limitation for turbidity (in Nephelometric Turbidity Units):

> If the receiving water background is less than 50 units, an incremental increase of 5 units is allowed, as measured from 100 feet from the discharge location. If the receiving water background is greater than or equal to 50 units, an incremental increase of 10% of background is allowed, as measured from 100 feet from the discharge location.

4.3.6 Power

The offloading facility and booster pumps may be powered by diesel or electric, depending on cost and regulatory emission requirements. Both diesel and electric power options are described below, however only one would be utilized during the Project. Diesel power could prove more economical if the project duration falls under approximately five years, and electric power could prove more economical if the project spans more than approximately five years.

4.3.6.1 Diesel

If diesel were to be selected to power project equipment, a large diesel generator barge would be moored near the offloading facility in the deep-water channel. Booster pumps and onshore equipment would have individual diesel generators that would be maintained by land- and water-based crews. As M&N (2015) suggested, the Project could use low emission (Tier III) engines, install selective catalytic reduction systems, or purchase air quality credits to offset emissions and allow the Project to comply with CEQA annual emission limits. Although not recognized in CEQA emissions analysis, restoration of 1,848 acres of marsh (instead of disposal at SF-DODS 55 nautical miles offshore) results in overall carbon sequestration benefits.

4.3.6.2 Electric

To supply electricity to project equipment, significant electrical infrastructure would be constructed, requiring a large upfront capital investment. M&N (2015) estimated this cost to be between $9 and $12 million. Recent AECOM estimates for an electrical dredge project in southern California estimated a substation alone to be between $4 and $6 millon. Depending on the length and power usage of a project, these upfront costs could be outweighed by the cost savings of electric over diesel power for longer projects (greater than about five years). Placement of dredged material at Eden Landing may fall between three and seven years, as described in more detail in Section 4.5.

Electrical infrastructure necessary to bring power to the offloading facility and booster pumps would include a substation, overhead transmission line, and submarine power cables. The nearest high voltage transmission line for a power drop to a substation is the Grant-Newark overhead double circuit 138kV line located immediately east of the Site, as shown in Figure 4.6. The existing line rating, spare capacity and any necessary upgrades required to interconnect to the PG&E system are unknown at this time. During the early design phase, a detailed electric load study will be required to estimate the total project connected and operating load.

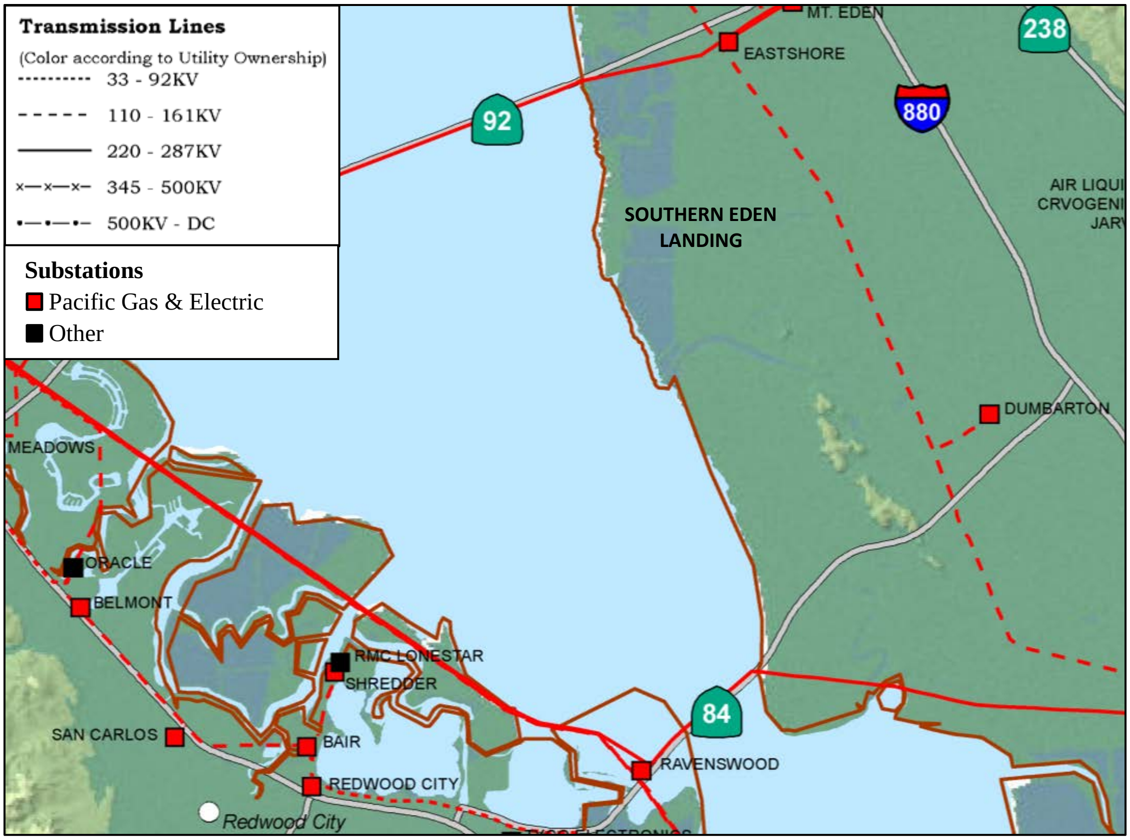


Figure 4.6. Existing Transmission Lines and Substations
Source: California Energy Commission 2015

More details on the electrical infrastructure are listed below:

- **Electric Substation**: Construction of an electric substation would be required to interface with the PG&E power system and transform the voltage from 138kV to 12.47kV, and to provide distribution power to project equipment including booster pumps, the offloading facility, and any other balance of plant loads. Additional transformers and electrical equipment would be required at pump locations to transform the voltage to a useable voltage, likely 2300V or 4140V. The substation site would also include a small unmanned control building/enclosure to house auxiliary controls and protective relay systems. The substation would be supported by a large concrete pad (with foundation piles) and would encompass an area approximately 12,000 square feet in size, similar to that constructed at the Hamilton Wetlands Restoration Project as shown in Figure 4.7. The ideal location of a substation is nearest the equipment on a Bay front levee, which would require temporary placement of material within the ponds for adequate space and access around the equipment. Alternatively, the substation could be located within the Site on a levee (potentially near a shore booster pump), or near the high voltage line on Union Sanitary District property.
- **Overhead transmission line:** The project interconnection will consist of a 138kV line segment extending from the existing PG&E transmission line to the new project 138kV substation. Tubular steel pole structures approximately 70 to 100 feet in height will be required to support

overhead transmission conductors and shield wires. The PG&E line will be looped into the new project substation where the voltage will be transformed to a lower voltage that is suitable for the project distribution system. From the high voltage line near the Union Sanitary District property, approximately 17,700 feet (3.4 miles) of overhead power cables would be installed to reach the shore's edge at the southwest corner of Pond E2.

- **MV Submarine power cables** would carry electric power from the shore's edge to the potential in-bay booster pump and offloading facility. The submerged power cables, as shown in Figure 4.7, would be laid on the Bay bottom and would extend approximately 16,000 feet (3 miles) offshore to the offloading facility.

Figure 4.7. Electrical Substation and Submarine Power Cable used at Hamilton Wetlands Restoration Project
Source: Hammerwold, date unknown

In the next design phase, a Load Interconnection application would need to be filed with PG&E to tie into the existing Grant to Newark 138kV line. PG&E would perform a System Impact Study and Facilities Study that will identify the impact the project will have on the existing power system, system modifications required to interconnect the additional load, and associated costs. This process can take between 6 to 12 months, and would therefore need to be performed early in the design.

Given the interconnection voltage is classified as "transmission" level, the Project would need to be assessed against California Independent System Operator (CAISO) Controlled Grid Reliability Criteria and comply with the CAISO Tariff (accessible at www.caiso.com). The Project would also likely have to file with the Federal Aviation Administration (FAA), in accordance with CFR Title 14 Part 77.9, as the proposed overhead cable structures would be in proximity to navigation facilities and may impact that assurance of navigation signal reception (per Obstruction Evaluation / Airport Airspace Analysis at https://oeaaa.faa.gov/oeaaa).

4.4 Review of Conceptual Cost Analysis

M&N (2015) performed a feasibility study of material sourcing and determined that placement of dredged material at the Site could be cost competitive with existing disposal and placement sites in the Bay Area. The key assumptions listed in M&N (2015) included 7.2 MCY dredged material capacity in the Bay, Inland, and C-Ponds; various material delivery schedules; diesel power, no electric power; and approximately $2-$3/CY for site preparation totaling approximately $19 million. M&N (2015) identified the overall project cost and annual cost to be driven by the dredged material delivery schedule, as opposed to the offloading and placement production rates. This indicates that if the selected restoration project allows for dredged material placement in only the Bay Ponds [i.e. Alternatives C and D (AECOM 2106)], the Project would still potentially be cost competitive to disposal at SF-DODS if it received 1.5 or 1.8 MCY per year [i.e. "optimized" and "super optimized" delivery schedules identified in M&N (2015)]. If the Site were to only receive about 0.9 MCY per year [i.e. the "non-optimized" delivery schedule in M&N (2015)], then placement at the Site would likely not be cost competitive with disposal at SF-DODS.

Two potential projects led by the USACE, the Redwood City Harbor Navigation Improvement Project and the WIIN Pilot Project, have the potential to increase the certainty in dredged material delivery, and keep beneficial reuse costs competitive with other disposal options.

Although currently on hold due to unavailable cost-competitive beneficial reuse sites, the Redwood City Harbor Navigation Improvement Project could provide a substantial volume [1.7, 3.9 or 7.6 MCY (HydroPlan et al. 2015)] for placement at the Site. Because this material would be delivered within a short delivery schedule, the downtime operating costs of the Site would be minimized and the Site could be cost competitive with other Bay Area disposal and placement locations.

Federal navigation projects in the Bay Area produce the majority of the annual dredge volume available for beneficial reuse. If the USACE were to invest in a beneficial reuse site and provide a level of certainty that material would be placed at such a site, downtime equipment costs could be minimized at that site. The "Water Infrastructure Improvements for the Nation Act" (WIIN Act, or WRDA 2016) includes creation of a USACE pilot program to increase beneficial reuse of dredged material. The Bay may be selected as one of the ten regions in which to conduct a pilot study, and in turn southern Eden Landing could be selected as the region's pilot location. The timing however may not align with the restoration progress required of the SBSP Restoration Project.

Since the completion of the M&N (2015) Feasibility Study, two additional events could increase cost competitiveness of beneficial reuse in the Bay Area. Recently, smaller dredge equipment has been utilized to conduct federal navigation maintenance dredging and placement at an in-Bay beneficial reuse site. By utilizing smaller, less-costly scows, projects can improve efficiencies and reduce construction and operation costs (compared to utilizing ocean disposal dump scows). Also, more dredging projects are utilizing NMFS's (2015) Programmatic Biological Opinion; allowing dredgers to operate outside the typical dredging window if all material is placed at a beneficial reuse site. By reducing equipment downtime, operation and maintenance costs are reduced. More projects may also utilize equipment while in the Bay Area, reducing mobilization and demobilization costs.

4.5 Construction Implementation

Construction will be implemented by procuring the services of a general contractor with experience in performing dredged material offloading activities, marine pile driving, levee improvements, and working within and near tidal waters and bay mud. Primary land access to the Site would be as described in the Restoration Preliminary Design Memorandum (AECOM 2016a) and access throughout the pond complex would be via former salt pond levee maintenance roads. The offloading facility, in-bay booster pump, and floating and submerged pipeline would be floated into position at high tides.

The following equipment would likely be used to construct the Project. This equipment list does not include smaller items such as fuel service, maintenance service, personal vehicles, small tools and equipment.

- Hydraulic Offloader
- Booster Pumps
- Floating Barges with Pile Drivers and Cranes
- Equipment Barges / Cable Reel Barges
- Work Tugs
- Crew/Survey Boats
- Amphibious Low Ground Pressure (LGP) Dozers
- Excavators
- Dozers
- HDPE Pipe Fusers
- Impact/Vibratory Hammers
- Dump Trucks
- Flatbed Trucks
- Concrete Trucks
- Water Trucks
- Bucket Trucks
- Compactors
- Pumps
- Generators

Assuming construction is performed in the Bay and on shore concurrently (un-phased throughout the site) the sequence of construction tasks and approximate durations are summarized in Table 4.6.

Table 4.6. Construction Tasks and Durations

Construction Task	Approximate Duration
1. Mobilization	0.5 month
2. Site Preparation 2.1. Pile Installation 2.2. Submerged Pipeline Installation 2.3. In-water Equipment Installation of Offloader, Landing Barges, Floating Pipeline, Support Equipment, and Booster Pump 2.4. Clear & Grub Levees 2.5. Levee Improvements (cut, haul, fill) 2.6. Various Water Control Structures 2.7. Shore Booster Pump Installation 2.8. Shore Pipeline Installation 2.9. Substation 2.10. Overhead Transmission Line 2.11. Submarine Power Cables	7.5 months
3. Dredged Material Placement 3.1. Material Offloading & Placement 3.2. Habitat Transition Zones 3.3. Offseason demobilization, equipment storage, & mobilization	Alternatives B and D: Approx. 10 months of 24-hour days over 3 to 7 years depending on material delivery schedule Alternative C: Approx. 9 months of 24-hour days over 3 to 6 years depending on material delivery schedule
4. Decommissioning 4.1. In-water Equipment Demobilization of Offloader, Barges, Floating Pipeline, Support Equipment, and Booster Pump 4.2. Demolish Piles 4.3. Demolish Submerged Pipeline 4.4. Demolish Shore Booster Pump 4.5. Demolish Shore Pipeline 4.6. Demolish Water Control Structures 4.7. Demolish Substation 4.8. Demolish Overhead Transmission Line 4.9. Demolish Submarine Power Cables	4 months
5. Demobilization	0.5 month

The construction schedule will be driven by construction work windows, weather conditions, and contractor means and methods. As listed in Table 4.6, mobilization and site preparation construction would span approximately 8 months, and would be regulated by work windows described in more detail below. This construction duration assumes an electrical system would be constructed (as opposed to a diesel power system).

In-water construction work (e.g. dredging and pile work) would be restricted by dredging work windows, which span from June 1st through November 30th to protect Steelhead (*Oncorhynchus mykiss*) in South Central and South San Francisco Bay. On-shore construction activities in bird nesting areas could be limited or subject to buffer zones during the following periods listed for each species:

- March 1 to September 15 for Western Snowy Plover (*Charadrius alexandrinus nivosus*)
- February 1 to September 1 for Terns, Avocets, and Stilts
- February 1 to September 1 or earlier (as allowed) for Ridgway's Rail (*Rallus obsoletus*).

After site preparation is concluded, dredged material may be placed at the Site as material becomes available. Most dredging projects occur during the dredging work window, between June 1st and November 30th; however material could potentially be received year-around as the offloading and placement of dredged material is not constrained by this dredging work window. With NMFS's (2015) Programmatic BO that allows dredging outside this work window when the material is beneficially reused, Eden Landing has the opportunity to receive dredged material when other disposal sites are unable to accept material without further consultation with NMFS.

M&N (2015) assumed four to eight years of material acceptance at the Site based on a site capacity to receive 7.2 MCY. Assuming the Site's capacity is reduced by about 1 MCY with the elimination of the C-Ponds, the anticipated period of material acceptance could range from about three to seven years for Restoration Alternatives B and D depending on the amount of material delivered to the Site. For Restoration Alternative C, the anticipated period of material acceptance could range from three to six years. In all alternatives, sediment delivery vessels could come once a day to once every few hours. Decommissioning of equipment and onsite structures would be up to about four months, with a few weeks to demobilize the remaining equipment.

Following demobilization of the dredged material placement equipment, the restoration project as described in the Restoration Preliminary Design Memorandum (AECOM 2016a) would be performed. This work includes channel excavation, levee lowering and raising, habitat island creation, internal and external levee breaching, water control structure removal/modification, habitat transition zone construction, and recreational trail and bridge construction. The final equipment and sequencing will be developed by the selected contractor based on the contractor's detailed work plan.

The Phase 2 Eden Landing Restoration Project is anticipated to have a final EIR/S in the fall of 2017. Preliminary design of the restoration elements was completed in 2016. Preliminary design of dredged material placement, permitting of the selected project, and 100% design would follow in 2018 and the beginning of 2019. Construction could begin as early as the summer of 2019.

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